USER MANUAL

SennsLite Software

Version 1.3.2

February 2026

Bitbrain

CONTENT

1. Introduction

SennsLite is a research application for data collection with several sensor modalities seamlessly synchronized.

This software allows the user to record data from a single or multiple Bitbrain devices and sensor modalities simultaneously, synchronize the sensors and export the output to an interoperable format so that the researchers can perform their own analysis.

This document includes installation guidelines, an overview of the different operation modules (Recording module, Data Manager module, and Settings module) and a description of the exported data. For Ikon and Ikon Sleep EEG devices, the guide also covers IkonApp, a software module intended for home-based signal recording by participants. Finally, annexes are included for device-specific information and guidelines for contacting Bitbrain technical support.

1.1 CONNECTIVITY

Most of the Bitbrain EEG devices (Air, Diadem, Hero, Versatile) and other biosignal systems (Versatile Bio and Ring) transfer data to the recording station using a Bluetooth connection. The Ikon and Ikon Sleep EEG devices use Bluetooth Low Energy (BLE).

Important note: Devices with Bluetooth Low energy (BLE) modules (Ikon and Ikon Sleep) require Windows 11 for proper operation and connectivity stability. Please note that Windows 10 is no longer supported by Microsoft, and no further improvements to BLE performance are expected. For this reason, we strongly recommend using these devices only with Windows 11.

Note that Bluetooth connectivity does not guarantee that all data packages are received. For this reason, Ikon and Ikon Sleep devices include an internal SD card to store the data. In the case of the other Bitbrain devices, they feature a slot for an external 8 GB SD card.

1.2 SOFTWARE VERSIONS

SennsLite is available for Windows OS (10 or later) and Linux (Ubuntu 22.04).

2. Windows Installation

Use the Windows installer provided by Bitbrain in the Download Center to set up the software on the selected computer. These are the steps to follow for a successful installation.

1. Select the language to use during the installation.

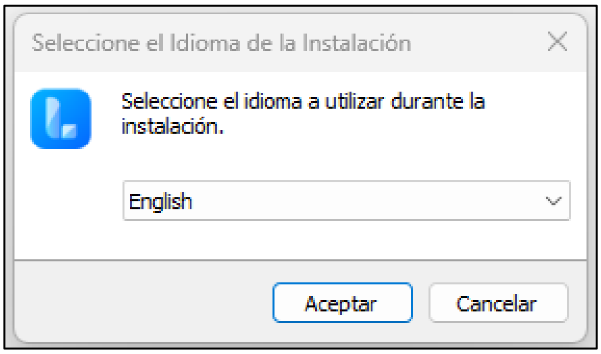

Figure 1. Language selection window for installation

2. Accept the license agreement.

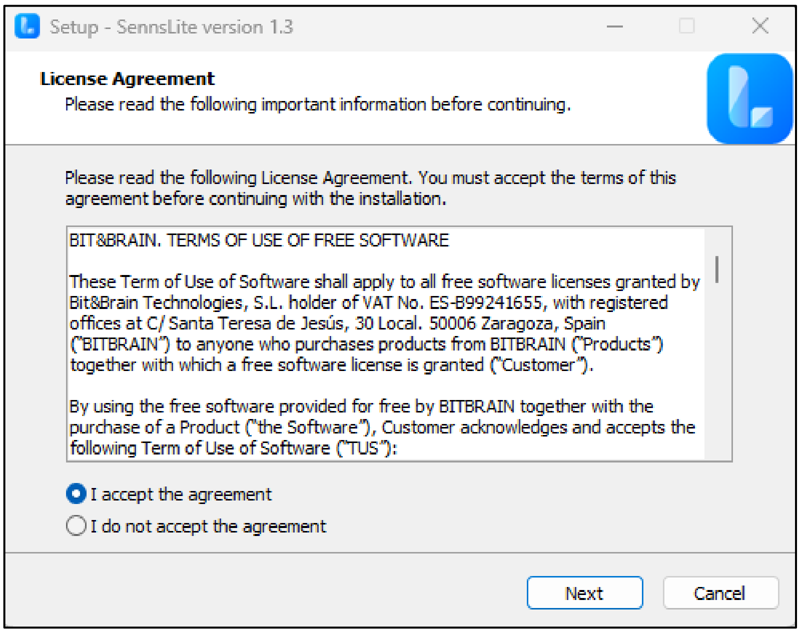

Figure 2. License agreement acceptance dialog box

3. Select where to install SennsLite.

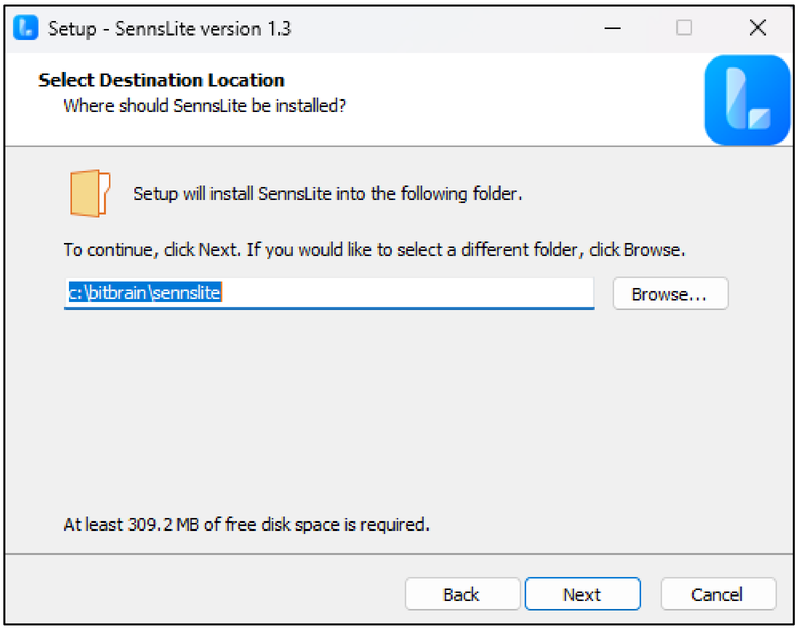

Figure 3. Window to select SennsLite Destination Location

4. Select where to place the program's shortcuts.

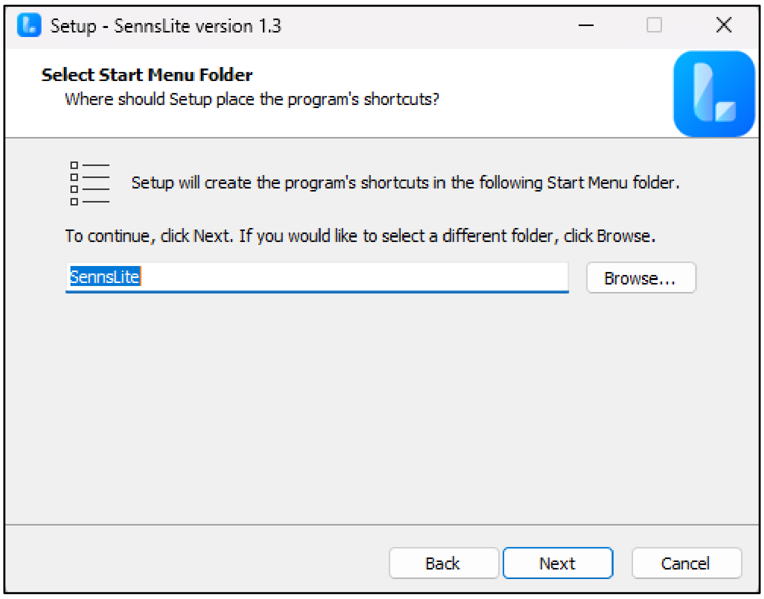

Figure 4. SennsLite shortcut placement screen

5. Confirm the previous settings to proceed with the installation of the software.

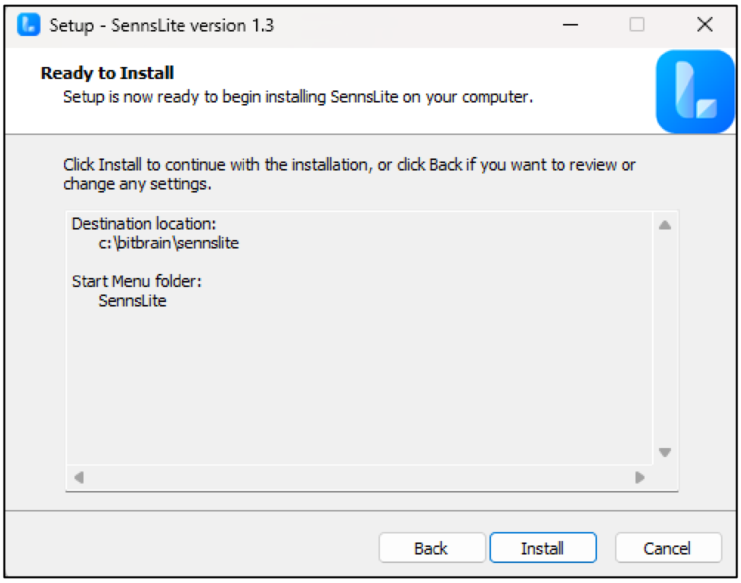

Figure 5. SennsLite installation window

6. After clicking install, the installation process takes place.

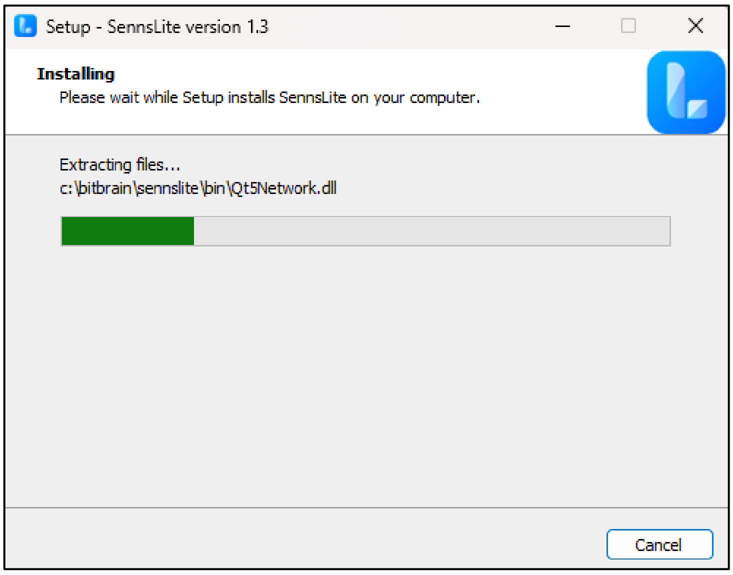

Figure 6. SennsLite installation in progress

7. The installation is finished, and the software can be used.

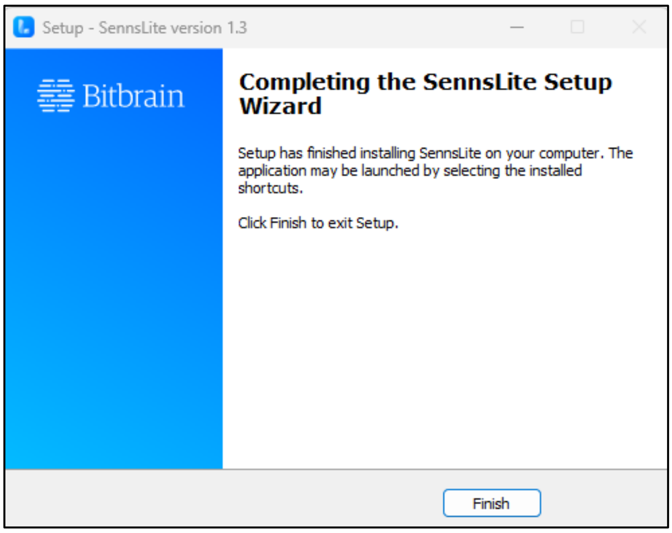

Figure 7. SennsLite installation complete

3. Linux Installation

This section explains how to install and run SennsLite on Linux. The process is straightforward and only needs to be completed once on each computer.

First, download the required files for Linux (Ubuntu 22.04) provided by Bitbrain in the Download Center. Then, extract the package into a local folder on your computer. Once extracted, you will find the SennsLite directory structure, including the release/base folder used in the steps below.

If this is the first time you are running SennsLite on a Linux machine, follow these steps:

1. Navigate to the installation directory

   Open the folder where SennsLite was extracted and go to: release/base/main

2. Locate the installer script

   Inside this folder, you should find a file called: installer.sh

3. Open a terminal in the folder

   Right-click anywhere inside the release/base folder and select "Open in Terminal".

4. Run the installer

   In the terminal, execute the following command: 'sudo ./installer.sh'.

   You will be prompted to enter a password. This is your Linux login password. This step installs the required components to run SennsLite on your system —primarily Qt and LSL dependencies—using the Ubuntu package manager.

Once the installation step has been completed (either just now or previously), SennsLite can be launched as follows:

1. Open a terminal in the same directory, following the steps explained previously.

   If the terminal is no longer open, right-click inside the release/base/main folder again and select "Open in Terminal".

2. Start SennsLite

   Run the following command: './lite_exec.sh'

SennsLite will now start and is ready to be used on Linux.

Note: The installer.sh script only needs to be executed once per machine. For subsequent uses, you can directly run ./lite_exec.sh to launch SennsLite.

4. Software Modules

The software has **three main** modules of operation:

- *Recording*: Allows the definition of the participant ID, destination folder, and the devices and signals to be recorded.
- *Data Manager*: Allows the export and visualization of recorded and synchronized data for further analysis. If SD card recording was previously enabled in the Recording Module, data from the SD card can also be imported through this window.
- *Settings*: Allows the configuration of specific application options, like export settings, user markers, LSL streaming and the IkonApp configuration.

Three main buttons in the top-left corner of the initial screen of the software allow the navigation between these windows, as seen in Figure 8.

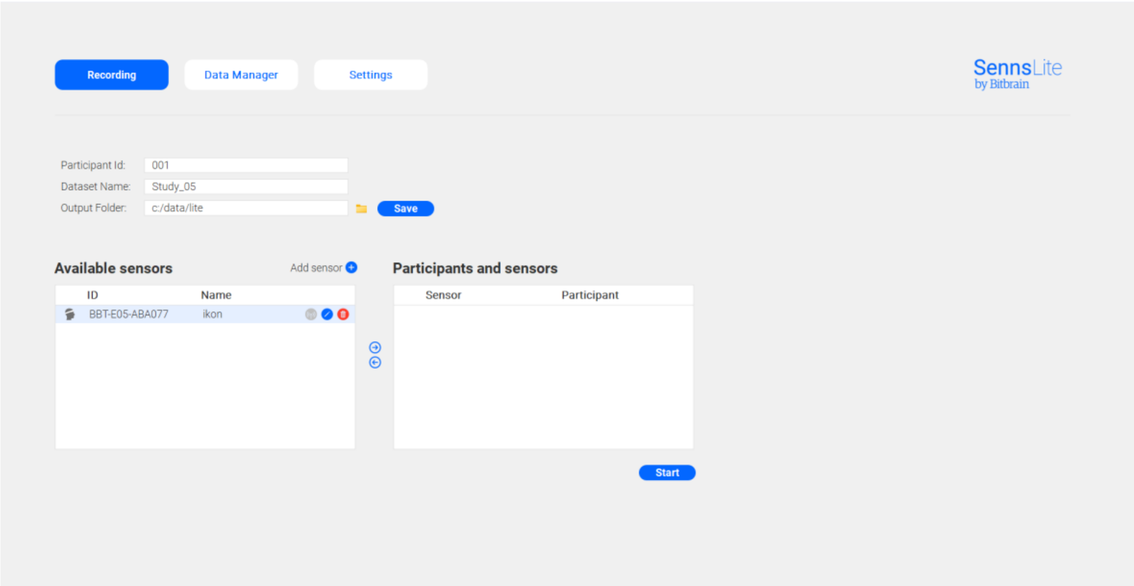

Figure 8. Initial screen of SennsLite software.

5. Recording Module

To perform a recording, 3 steps must be completed:

1. Configuration: Set up the participant and dataset IDs, as well as the output folder, and the devices from which to record. Also configure the settings of each device: serial number, signal types, ability to record in the SD card and to stream data through LSL.

2. Data quality checking: Review the data quality indexes before starting the actual recording. This helps ensure proper device placement, especially for EEG electrodes. Currently, quality indexes are available for signals captured across all EEG devices and for additional biosignals recorded with the Ring device.

3. Actual recording: perform the actual recording to save the data to disk.

5.1 CONFIGURATION

In the upper left part of the screen seen in Figure 9, there are three text boxes that need to be completed before starting any recording:

- Participant ID: Alpha-numerical ID.

- Dataset ID: Name of the folder where the dataset will be recorded.

- Output folder: Path to the folder where the dataset will be stored.

The "Save" button allows to store the defined "Participant ID", "Dataset ID" and "Output folder" settings.

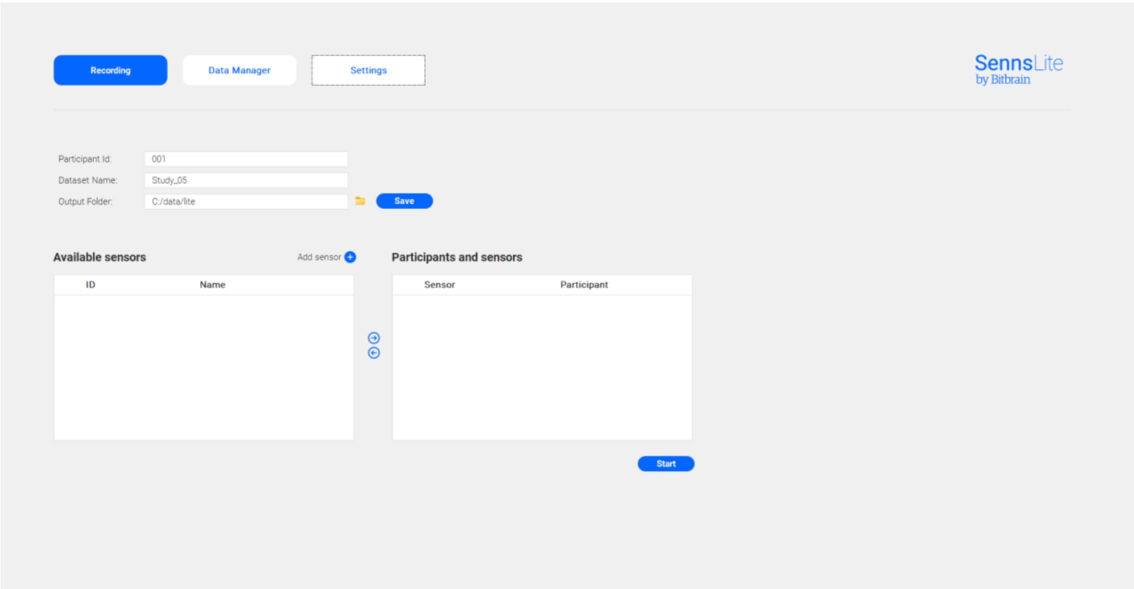

Figure 9. Recording Module

These three configuration parameters are mandatory and determine the output folder where the data is stored (see Section 6).

5.1.1 Adding a New Device

By clicking on the "Add sensor" button (see Figure 9), a screen will open (see Figure 10) to guide the user in the process of adding and configuring a new device. The following parameters must be configured:

- Type: Select the type of sensor from a dropdown menu.
- Name: Set a name to identify the device.
- Id: Type the serial number of the device.
- Signals: Select the signals to be recorded with the device.
  Only the selected signals will be recorded by the device, and it will not be possible to recover non-selected signals during recording or when exporting data.
- SD Card: Enable the recording to the device's SD card.
- LSL streaming: Enable the streaming of data through LSL.
- Settings wheel: Provides amplifier information, including firmware version and internal SD card capacity. Only available for BLE devices (Ikon and Ikon Sleep). For the rest of the devices, this button will appear disabled.

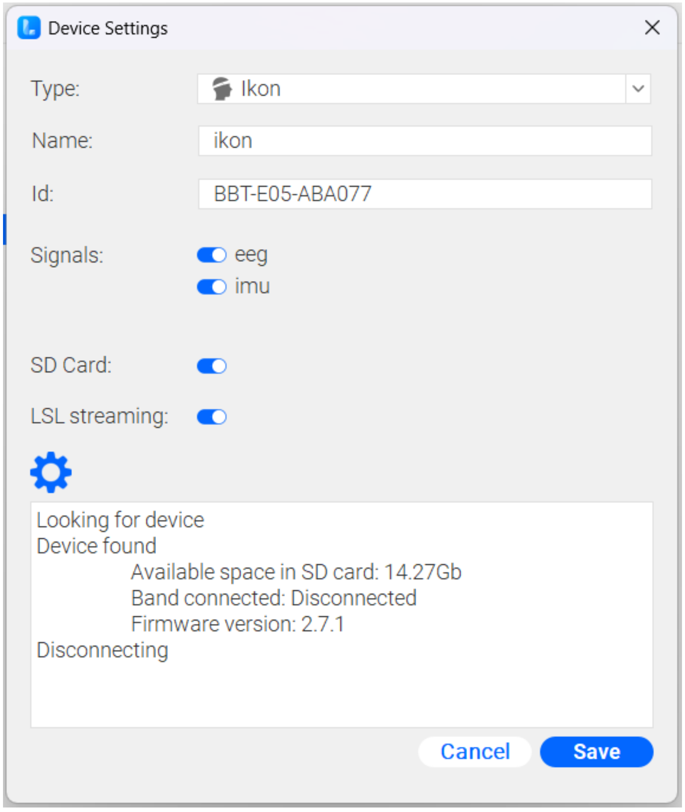

Figure 10. Device Settings window

Once the sensor has been configured, click on the "Save" button to continue.

The newly added device will then appear in the "Available sensors" list with its corresponding serial number that identifies it, as seen in Figure 11.

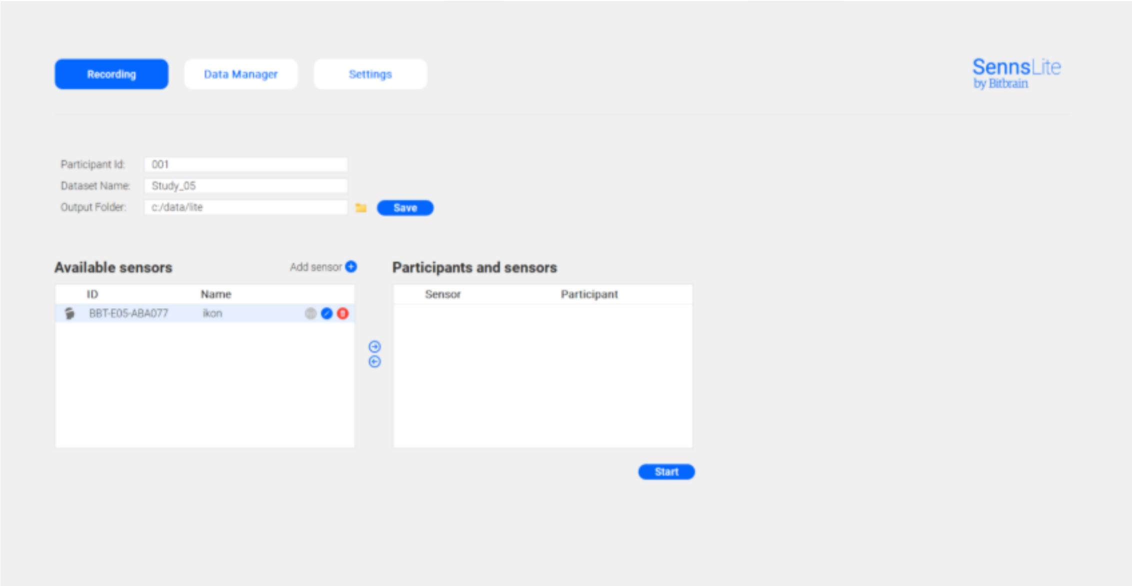

Figure 11. Sensor added to the "Available sensors" list

The buttons next to each sensor in the "Available sensors" list, allow the following actions:

- Pairing of the Bluetooth device: this step is mandatory (only once in a computer) for the standard Bluetooth devices. It is not needed in Ikon or Ikon Sleep as it uses a BLE connection and therefore this button appears disabled.
- Edit the device settings.
- Remove the device from the list.

Once the configuration is set and the sensor is added, select the device from the "Available sensors" list and transfer it to the "Participants and sensors" list using the horizontal arrows, allowing it to be included in the upcoming recording session, as seen in Figure 12. Additional sensors and participants can be defined and saved, enabling recordings with multiple devices and/or participants within a single session. For more detailed information on how to do this, see Section 9. Once configured, click on the "Start" button to proceed to the "Sensors checking" window.

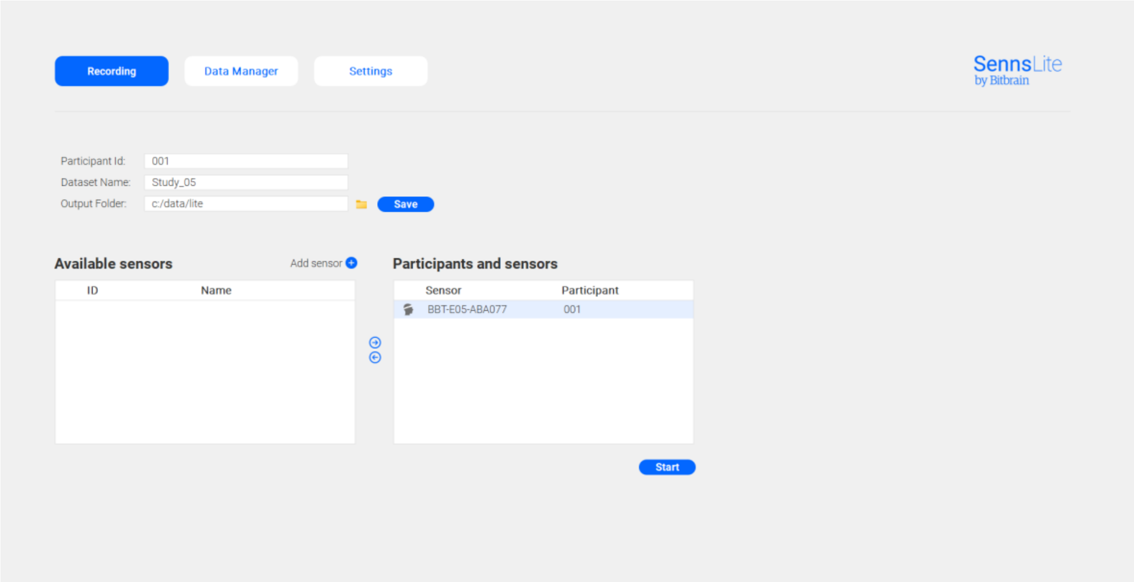

Figure 12. Selected device in the "Participants and sensors" list

5.1.2 Define Custom Layout (Only Applies to Versatile EEG Devices)

In the water-based EEG devices (Versatile 8, 16, 32, 64ch and Versatile Kids 16, 32ch) an icon with the figure of a head will appear next to the "EEG" signal button, as indicated in Figure 13.

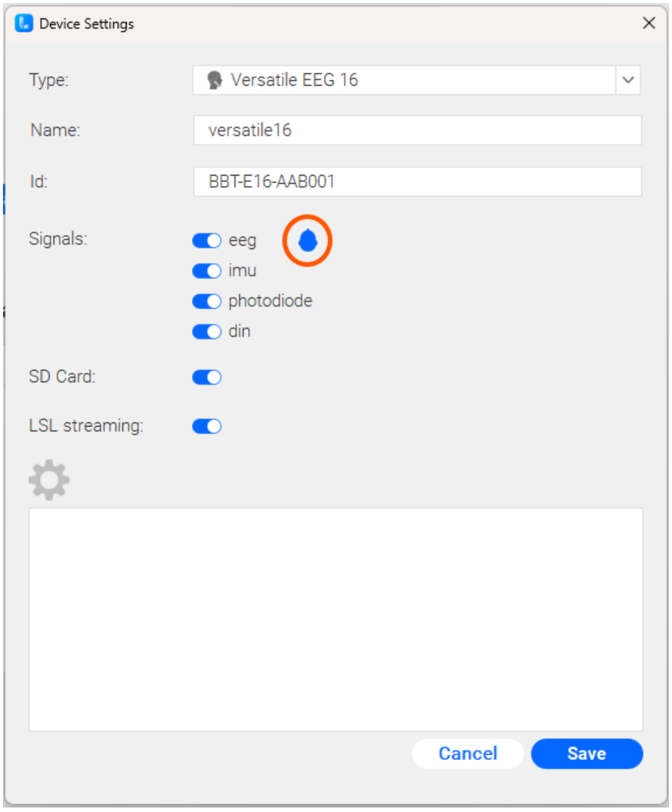

Figure 13. Device Settings window for Versatile EEG devices

This functionality allows the user to define the EEG sensor placement and visualization. Specifically, it enables the definition of the sensor positions on the head according to the international 10/10 electrode positioning system for EEG recording, as well as the selection of the order in which EEG channels are displayed in subsequent windows ("Sensor checking" and "Study in process"). Channels can be visualized either ordered by anatomical brain regions or ordered sequentially by sensor number.

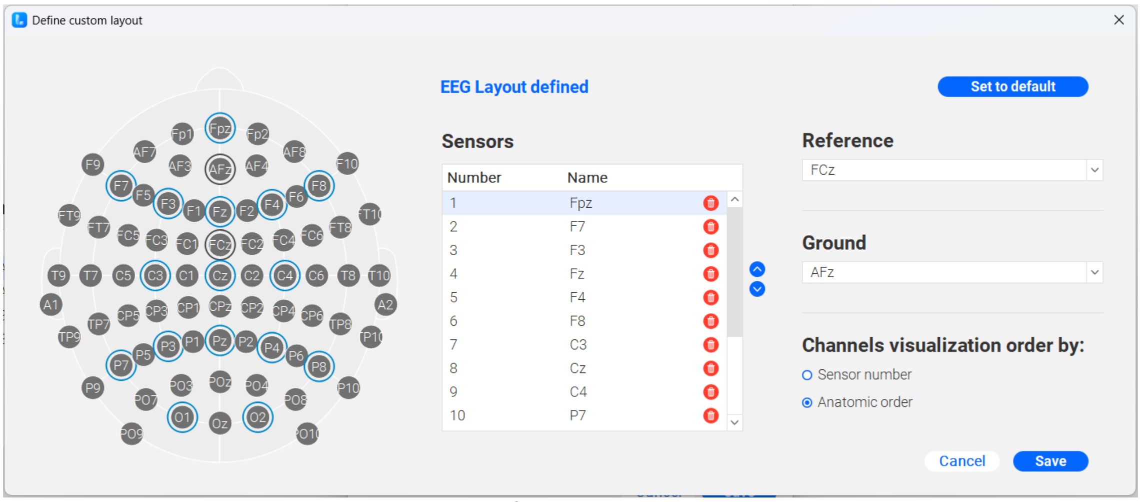

Figure 14. Custom layout definition window in Versatile EEG devices

Clicking the blue head icon (circled in Figure 13) opens up a window titled "Define custom layout" (Figure 14) that contains several interactive components:

- The head illustration in the left shows all the available positions in the cap, according to the EEG international positioning system. The ones that are circled in blue represent those that are selected as recording sensors, and the ones that are circled in grey represent the reference and the ground.
- The "Sensors" list displays the selected recording EEG sensors. The "Number" corresponds to the one found in each cable of the sensors' bundle, and the "Name" represents the position that each one occupies in the cap.
- The reference and ground sensors that appear in the right side of the window cannot be changed, except in the Versatile Kids, where the reference sensor can be reassigned using the dropdown menu.
- The "Channel visualization order" allows the user to choose how to visualize the selected EEG signals in the display of the following window ("Sensors checking").

A default layout is established according to the 10/10 and 10/20 international system for EEG recording; however, it can be changed based on the desired configuration of the sensors in the cap. This allows for a fully customizable arrangement of sensors in Versatile EEG devices.

The default EEG layout and visualization parameters are set once the device is added, but they can be adjusted through the following actions:

- The blue up and down arrows next to the sensors' list (see Figure 14) can be used to move the names to occupy the corresponding position set in the cap.

- The blue “Set to default” button seen in the top right corner of Figure 14, allows the user to directly set the default parameters for the sensors’ layout and the channels visualization order.

- The reference and ground sensors that appear in the right side of the window seen in Figure 14, cannot be changed, except in the Versatile Kids, where the reference sensor can be reassigned using the dropdown menu.

- To remove a sensor from the list, click on the red trash-can button associated with that sensor.

- Then, to add a new sensor, the desired location can be directly selected on the head illustration by clicking on the available position. The sensor can then be adjusted using the up and down arrows, as mentioned above, to match the corresponding cable number.

- The effect of the selection in “Channel visualization order by:” will only be visible in the next windows “Sensors checking” and “Study in process” as its function is to reorganize the displayed EEG signals independently of the physical sensor positions on the cap.

    - When "Anatomic order” is selected, the software arranges the signals by anatomical region only for visualization: from left to right, frontal sensors are at the top, followed by fronto-parietal and parietal sensors, then temporal and temporo-parietal sensors, and finally the occipital sensors at the bottom of the signal display. This only affects the order of visualization of the signals in the display. The correspondence between the sensor number (on the cable) and the electrode position on the cap according to the international system will not be affected.
      This grouping only places signals from nearby brain regions together, making visual inspection and signal quality checking easier and more intuitive.

    - When “Sensor number” is selected, signals are displayed in ascending order according to their assigned sensor numbers, starting from 1 up to the last sensor available on the Versatile device.

The EEG layout properties established when clicking on the “Set to default” button, will set the “Channel visualization order” to “Anatomic order”, ensuring that, no matter how the sensors are positioned in the cap, the signals will be visualized from the front to the back, from left to right. It will also set the sensors’ position to the recommended EEG layout for each device, which can be checked in Bitbrain’s Help Center.

Once the layout is set, click on the “Save” button to continue.

5.2 DATA QUALITY CHECKING

After pressing the "Start" button in the Recording module (Figure 12), the quality of the registered signal must be verified through the indicators for each type of sensor.

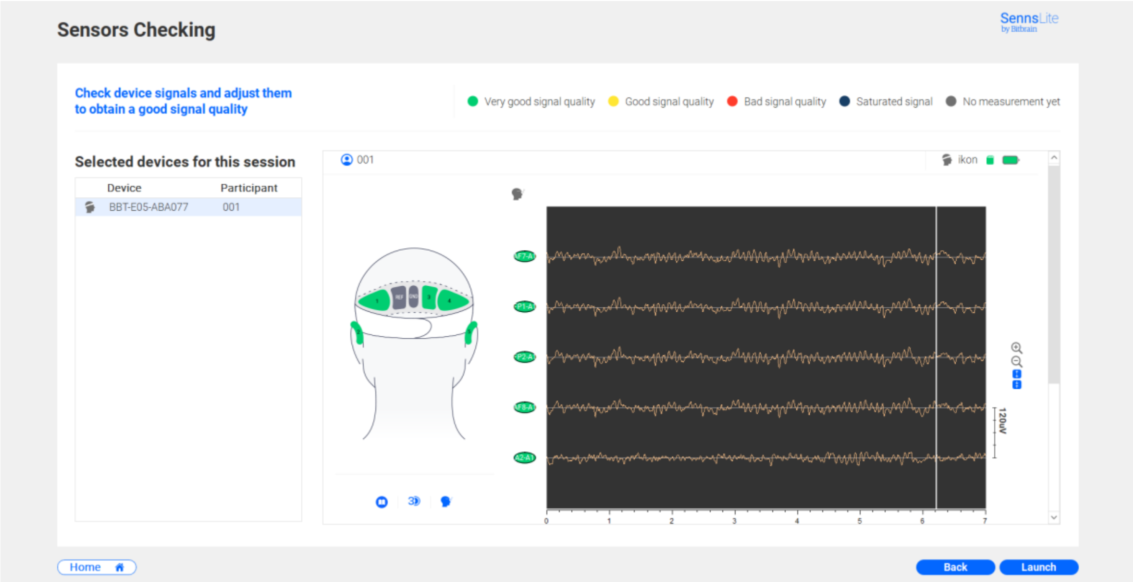

Figure 15. Sensors checking window

As shown in Figure 15, the icons in the upper right corner of the signal viewer indicate the status of the SD card, connection and battery:

- SD card & connection feedback
  - Green circle (Device connected): The recording in the SD card was not enabled in the Device Settings window and the device is correctly connected.
  - Red circle (Device disconnected): The recording in the SD card was not enabled in the Device Settings window and the device is disconnected.
  - Green SD card icon (Device connected and recording on microSD): The recording in the SD card was enabled in the Device Settings window, and the signal is being received and recorded to the SD card correctly.
  - Crossed SD card icon (Not streaming but a record on microSD card was started): The recording in the SD card was enabled in the Device Settings window, the recording started on the SD card, but no signal is currently being received. This is typically because the device is out of Bluetooth range or the connection has been lost.
  - Gray SD card icon with a blinking red cross: The recording in the SD card was enabled in the Device Settings window, but data is not being written to the SD card. This can occur if the SD card is missing, incorrectly inserted or not properly detected by the device. This status only applies to devices with an external SD card and does not affect Ikon or Ikon Sleep devices.

- Battery status: The icon shows 5 battery ranges depending on the charge level sent by the device:
    - 0-20%
    - 20-40%
    - 40-60%
    - 60-80%
    - 80-100%

The icons on the right side of the signal viewer allow the user to adjust how the signals are displayed:

- The magnifying glass buttons allow the user to zoom in or out, making the signals appear wider or narrower.
- The blue buttons with inward and outward arrows control the vertical spacing between channels allowing a tighter or looser visualization of signals.

The left part of the window shows a list of devices. Selecting a device shows the corresponding streaming data in the signal viewer. Right-clicking on the signal viewer allows the configuration of filter settings (see Section 5.2.1 for more details).

In the screen shown in Figure 15, the signal quality indicators are displayed using a colour legend (displayed in the upper part of the screen) for each sensor. These quality indicators are displayed over each position in the head illustration and in the left side of the signal viewer as well. Here, the name of each derivation is shown parallel to the number of the sensor. In Versatile EEG devices, they are shown as configured in the "Define custom layout" pop-up.

For EEG and Ring devices signals, the quality indicators can take the following levels:

- Light grey indicates that no measurement is available yet.
- Dark grey indicates that the signal is saturated.
- Red indicates poor signal quality.
- Yellow indicates good signal quality.
- Green indicates very good signal quality.

These quality indicators have a circle around it, which denotes how close the current level is from an adjacent one (i.e., transitions between green-yellow, and yellow-red states). This way the progress in the signal quality can be tracked.

Once the signal is checked and an optimal status is achieved, click on the "Launch" button to start the data acquisition.

5.2.1 Filter Settings

Besides the zoom and the spacing buttons on the right side of the viewer, there are more visualization options available by right clicking on the plot, including channel selection, x-y rescale and signal filtering.

These parameters **do not change the recording process, only the visualization. All the signals are registered unfiltered.**

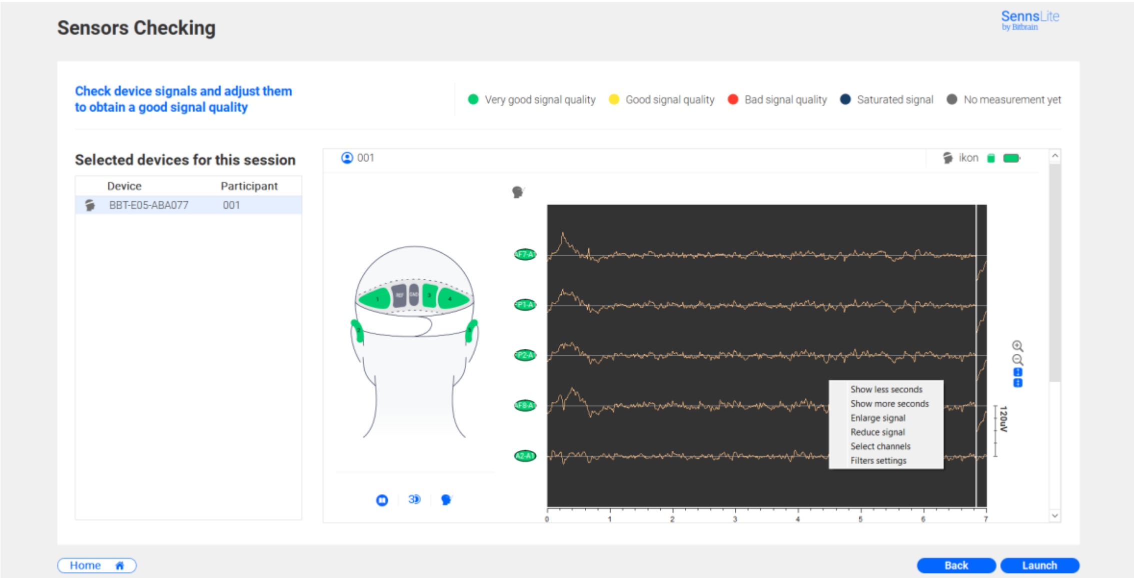

Figure 16. Visualization settings

The filter settings allow the user to apply visualization filters to the signal:

- Notch filter
- Pass filter: Highpass, lowpass, or bandpass filter
- Re-referencing **(just for the Ikon EEG device)**: The Ikon has the reference in the forefront (FP1 position, see Section 10 for further information). With this option, the re-referencing can be disabled, or set to A1 or A2 sensors.

By default, the re-referencing for the EEG signal in the Ikon device is set to A1 (note again this does not change the recording process, only the visualization).

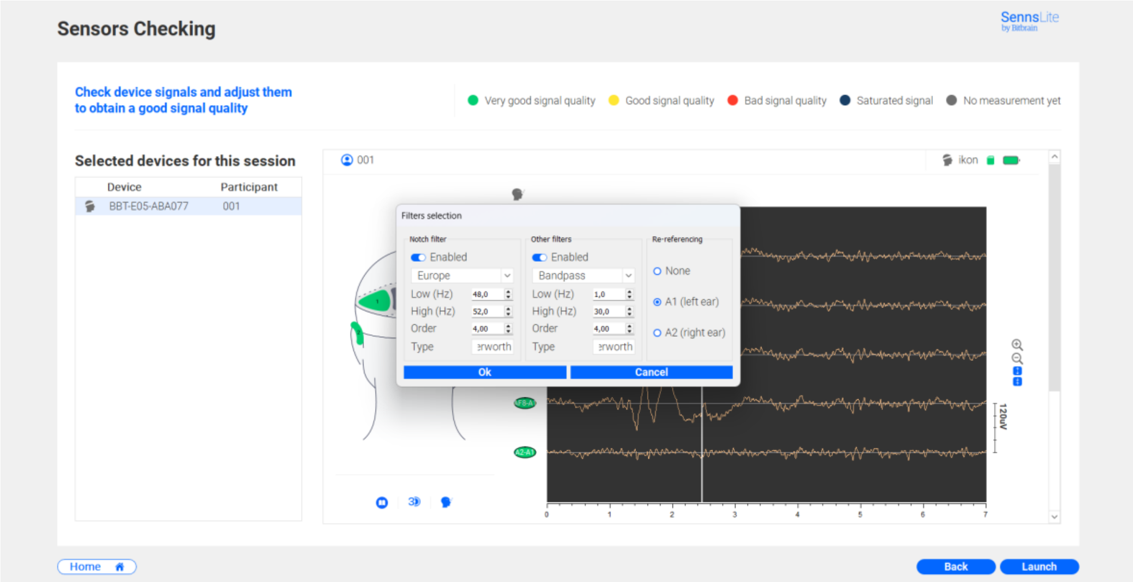

Figure 17. Recommended filter settings tab

The default visualization settings for each signal type are defined in Section 8.5

5.3 RECORDING

Once the user clicks on the "Launch" button, the "Study in process" window will come up (as shown in Figure 18), where the data acquisition will take place. The recordings will be saved in the path previously established in the "Recording" module (Section 5.1).

Important: Before starting a recording, ensure that the computer used for data acquisition is configured to prevent sleep mode and that system updates are paused during the session. This is recommended to help avoid interruptions to the Bluetooth connection and prevent data loss. These settings can be adjusted in the operating system's power management settings.

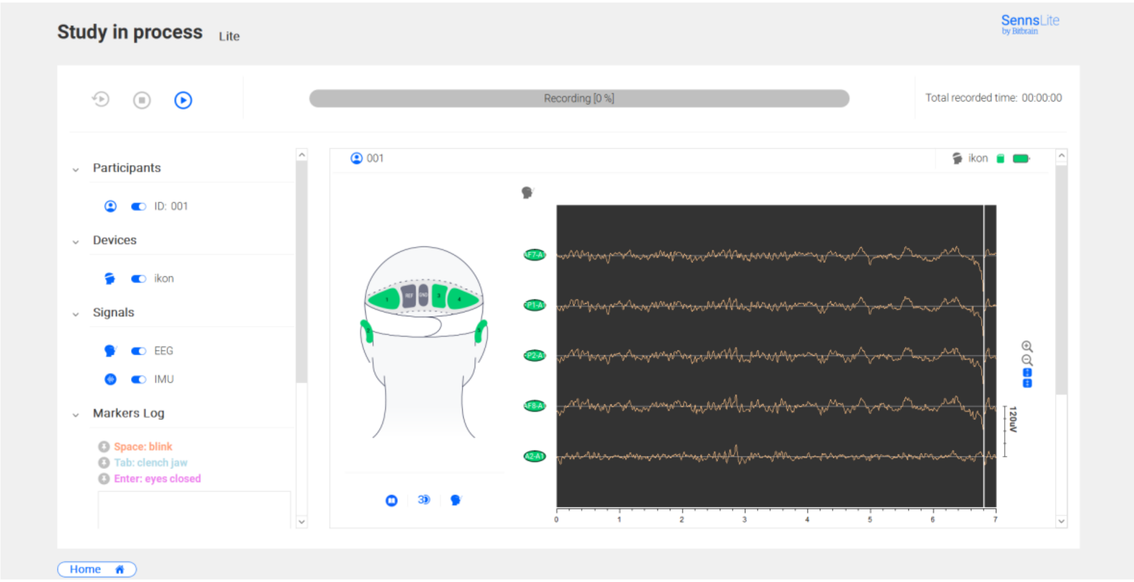

Figure 18. Recording window for Ikon device

In the upper left corner of the window shown in Figure 18, "Start", "Stop" and "Re-start" buttons are displayed and can be used to control the recording:

- To start the data acquisition process, click on "Start" button and carry out all the tasks defined on the experimental design.
- Click on "Stop" button to stop the recording process.
- To continue recording, click on the "Re-start" button. This will create a new recording within the same session. Once every task has been finished, click on "Home" button to get back to the main screen.
- After this, remove the devices from the participant and switch them off.

Below there is a description of the remaining options in the interface.

5.3.1 Registering Events

The user can register events during the recording by pressing different predefined keys. These keys must be configured in the Settings module before starting the session (see Section 7). When an event is triggered, it is marked in the online signal viewer as a vertical line and is also registered in the “Markers log”. These events are recorded across all the devices and signal types included in the session.

5.3.2 Graphical Elements Description

In the upper part of the “Study in process” window (see Figure 18) there are the following elements:

- In the upper central part of the window there is a bar that indicates when a task is being recorded.
- In the upper right corner, there is a timer that shows the total time recorded.

The left side of the window in Figure 18 shows a list of selectors that allow the user to customize how participants, devices and signals are visualized in this window. These options only affect what is shown on this screen and do not impact the recording process.
If any item is deselected, it will simply stop being displayed, but the data will continue to be recorded as usual. The following options can be selected:

- Participant´s ID
- Devices being recorded
- Signals being recorded
- Markers log: User makers will be logged in the "markers log" window and will be a relative and absolute counter for the markers (for more information, see Section 7).

The right side displays the signal viewer together with the following information (see Section 5.2 for more details on the possible icon statuses):

- Device name
- SD card & connection feedback
- Battery status
- Buttons that control the vertical spacing between channels allowing a tighter or looser visualization of signals.

In Figure 27, below each of the illustration representing the sensors’ layout and the real-time contact-quality feedback, there are four blue buttons that can perform the following actions, from left to right:

- Access to the Bitbrain Download Center, where the Hardware’s User Guides and Software's documentation can be found and downloaded.
- Display of the 3D brain layout (just for EEG devices).
- Display of the sensor numbers or locations. Note that for Ikon devices, which support re-referencing, the EEG sensor locations also represent the reference (e.g., FP1-A1).
- Open a full screen graph to check all the EEG channels from a single device at once.

The bar in the signal viewer moves from left to right and represents the current time instant in every signal from every device.

6. Data Manager Module

This module allows you to manage recorded data:

- Import the content of the SD card (if enabled in the recording).
- Visualize the data.
- Export the data to EDF (only available for EEG recording devices) or CSV.

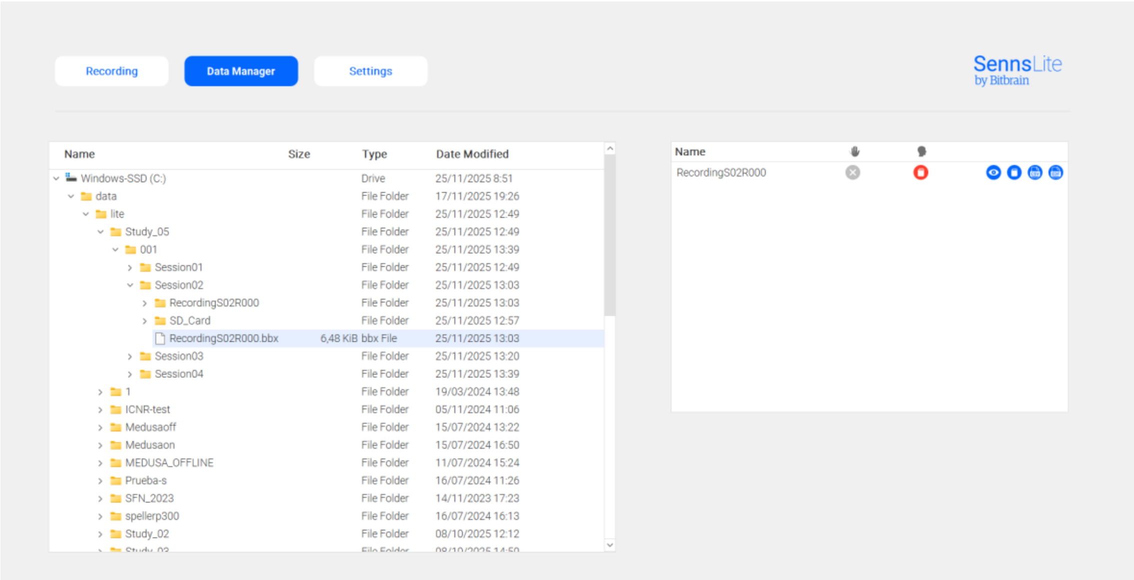

Figure 19. Data Manager Module

On the left side of the window shown in Figure 19 a file explorer tab is displayed.

Data recorded with SennsLite follows a logical folder structure:

- The output folder defined by the user (e.g., C:/data/lite) is the path in which the dataset folder is saved.
- Folder with the dataset ID (e.g., Study_05)
- Folder with the participant ID (e.g., 001)
- Folder with the session number (e.g., Session02) contains the bbx file with the recording or recordings.

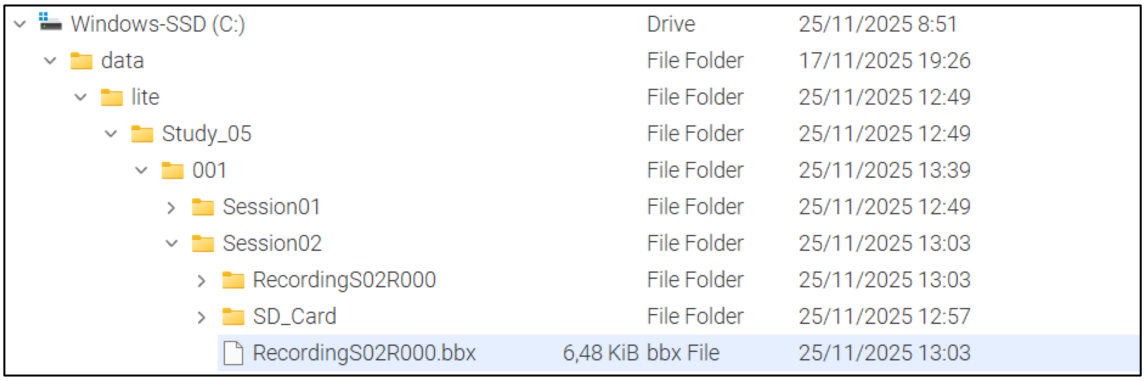

Figure 20. Logical folder structure for a recording

Note that the session number is not defined by the user but is an internal number that is automatically increased every time a study is launched using the same configuration of the three parameters (output folder, participant, dataset). The session count starts at 01 and will increment by 1 as additional recordings are made within the same study configuration. Each recording will be identified with the name “RecordingS[number of session]R[number of recording]” and saved in a bbx file, as shown in Figure 20, from which the visualization, import, and export of the data will take place.

After selecting the bbx file of a recording session, the right side of the Data Manager module, will display information regarding the kind of sensor used in the recording (EEG, biosignals), and options to visualize the signal, import the SD card, and export the data in .csv and .edf files. This can be seen in Figure 21. Please note that only data recorded with EEG devices can be exported to EDF format. Signals acquired with devices that capture other types of biosignals, such as the Ring or the Versatile Bio, cannot be exported to this format.

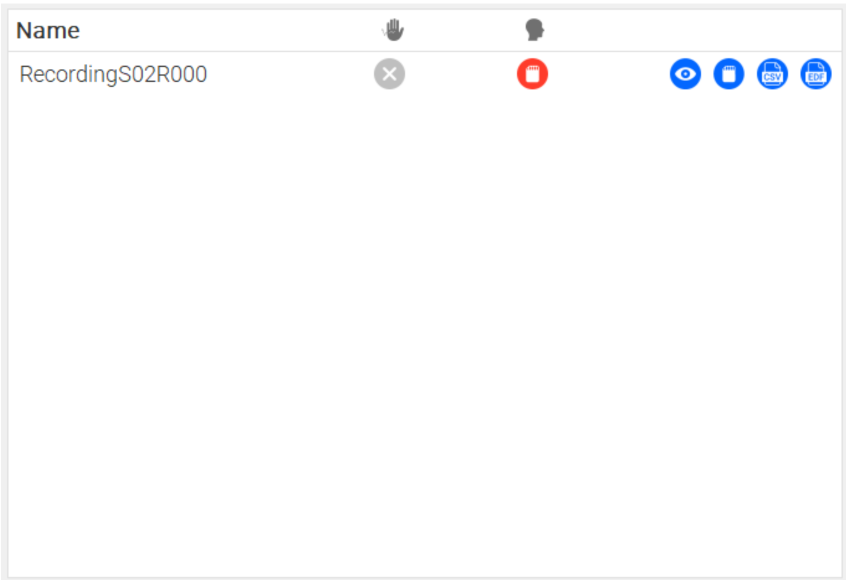

Figure 21. Recording status icons and buttons

Figure 21 shows different icons and buttons that accompany the selected recording (bbx file):

- The “Name” column indicates the name of the selected recording file (e.g., RecordingS02R000)

- The hand icon (Biosensing) indicates whether biosignals (such as those recorded with the Ring or Versatile Bio devices) are present in the recording and their condition; and the head icon (EEG) indicates the presence and state of the EEG devices. These two columns can take up the following statuses:
    - A **grey cross** means that no signals were recorded with the corresponding type of device during the session. Figure 21 shows that no biosignals were recorded.
    - A **red SD card icon** indicates that data was recorded correctly from the device, but the SD card content has not yet been imported. Figure 21 illustrates this state, specifically for the EEG signal recorded in that session.
    - After the SD card data is imported, by clicking on the "Import sdcard file" button, the icon will change to a **green SD card icon**, confirming that the signals from the corresponding device have been recorded correctly and the SD card has also been imported successfully.
    - If the SD card recording was not enabled during the session, these icons will show a **green checkmark**, indicating that the device was recorded correctly but without the SD card backup.
- The four blue buttons will be explained individually in the following subsections. From left to right, they allow the user to visualize the recorded signals within the software, import the SD card content, export the recording in CSV format (for all Bitbrain devices), and export the recordings in EDF format (only available for EEG signals).

6.1 VISUALIZATION WINDOW

The visualization window allows users to see the recorded signal within the software. Filter settings configuration is the same as the one described in Section 5.2.1. The window shown in Figure 22 can be accessed by clicking on the eye button that appears next to the device status icons of each recording shown in Figure 21.

- On the upper left side of the screen, the timer shows the current time and the total duration of the recording.
- In the central part of the window, a time bar represents the total duration of the recording and can be used to navigate through different segments of the recording. The icons located to the left of this bar also facilitate navigation.
- On the upper right side, the "Scale" buttons allow the user to see the whole recording.
- On the left part of the screen, a list shows the sensors used in the recording, the signals recorded from each sensor, and the events logged during the session.

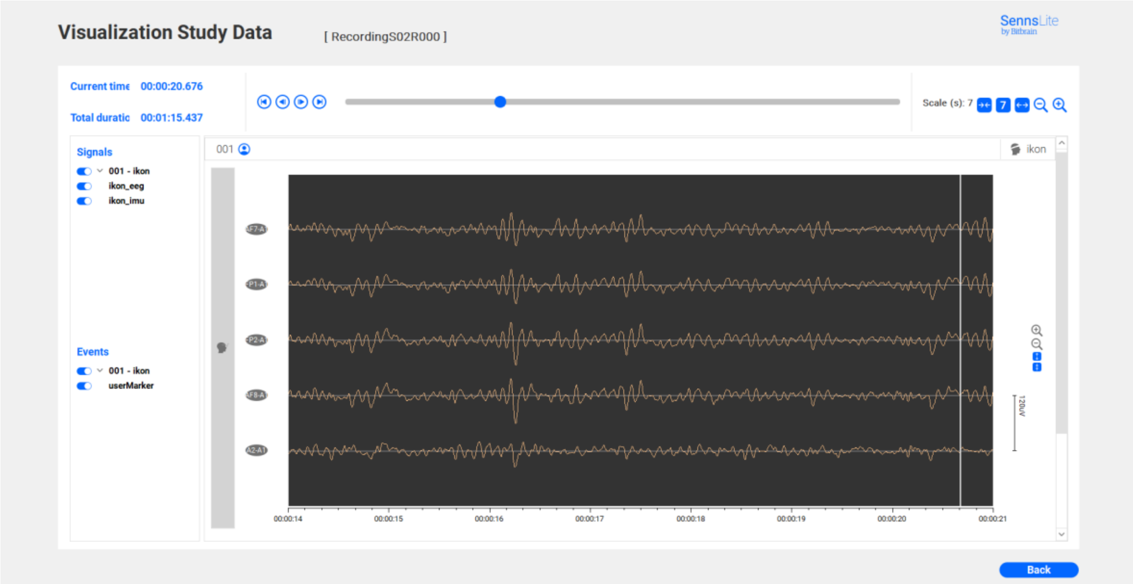

Figure 22. Window for offline visualization of recordings

Please note the following shortcuts for easier navigation:

- CTRL+Left/Right: Move forward or backward in the displayed data window.

6.2 IMPORTING SD CARD FILES

Files from recordings saved to the devices' SD card can be imported to the computer through the blue SD card button that appears next to the device status icons of each recording in the Data Manager module, as show in Figure 21.

To do so, remove the SD card from the device and plug it into the computer on which SennsLite is installed. Once it is recognized by the computer, click on the bbx file and then on the button to import the SD card content. This process will directly extract the data from the SD card and fill in any possible gap in the signal, from samples that may have been lost due to Bluetooth connection interruptions.

If the data needs to be imported on a different computer from the one used during the recording, the destination computer must also have SennsLite installed. In this case, first copy the folder generated during the recording (which contains the bbx file) to the new computer. Then, open SennsLite, navigate to the copied folder path from the Data Manager module, locate the bbx file, and follow the same SD card import procedure described above.

It is important to note that the "Import SD card" functionality uses the bbx file to uniquely identify each recording and automatically associate it with the corresponding data stored in the SD card. While folders related to the study, dataset, or participant can be moved if needed, the SD card data files, must not be modified or relocated.

Once the import process is completed successfully, a confirmation message like the following will pop up and the recording status icons will update accordingly, changing to a green SD card icon, as described in Section 6.

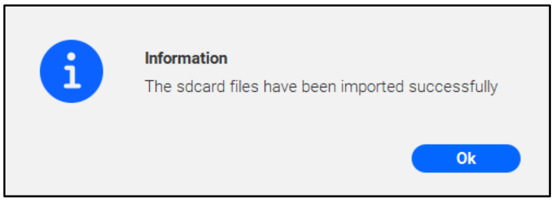

Figure 23. Message for correct SD card import

6.2.1 Importing SD Card Files in Ikon Devices

The process of importing SD card content from Ikon and Ikon Sleep devices is slightly different as they have an internal SD card integrated that can be accessed by connecting the device to the computer using a USB-C cable. To import files from the SD card, follow the steps below:

- Connect the turned off amplifier through cable to the computer.
- Click the amplifier "On" button so that the computer will detect the internal SD card.
- Once it is detected, click on the import SD card button from SennsLite to import files.

Once the data has been imported, the content from the internal SD card will be deleted automatically.

6.3 DATA EXPORT

To export the data, select the bbx file from the desired recording and click on the corresponding button to export in EDF or CSV format. These buttons can be found next to the device status icons of each recording, as shown in Figure 21:

- EDF is a standardized file format designed for storing biological signals. One file is generated for every recording device. Currently, this format is supported for Bitbrain devices that record EEG signals. Biosignals acquired with the Ring device or the Versatile Bio cannot be exported to EDF.
- CSV is an interoperable file format for storing tabular data in plain text. One file is generated for every device signal. Signals recorded from all Bitbrain devices can be exported to this format. We provide two output formats with varying levels of detail. Depending on the selected mode in the "Settings" window (Lite or Full), the corresponding folder will be created with the name of the recording followed by "_CSV_full" or "_CSV_lite". If the user wishes to export both, they won't overwrite.

Section 8 provides a detailed information of the exported data.

Once the export process is completed successfully, a message will appear indicating the output folder where the exported files have been saved.

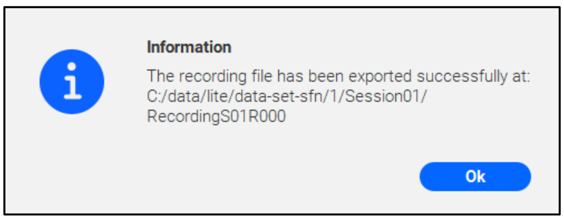

Figure 24. Message for the correct exportation of the recording files

Before proceeding with the data export, SD card recordings (if enabled) should be imported. **If not, the exported data will only contain the data received during online operation with possible missing values due to the Bluetooth connectivity.** This can be checked in the *info.json* file, which stores metadata for each recording. If the fields *sd_sync_read* and *sd_data_read are set to "true",* it confirms that the SD card content was included in the exported data (see Section 8).

Export Data per Dataset

To export multiple recordings at once, select the desired dataset and click the corresponding button to export the data in CSV or EDF format. For more information about the exported data, see Section 8.

7. Settings Module

This module allows the user to configure various settings, as shown in Figure 25:

- Exporting data method: The CVS export format (CSV-Lite, CSV-Full) can be selected in this module. Check Section 8 for detailed information of the exported data.
- User Marker keys: Up to five markers can be set.
  - Select the number of markers from the dropdown menu from 0 to 5.
  - Key: Keys from the keyboard are set by default but can be changed from F1 - F12, Space, Tab and Enter. Please note that each key can only be assigned once. Using the same key for multiple events will cause an error when saving the configuration.
  - Label: be defined to identify the marker.
  - After setting the markers, save the configuration by clicking on the "Save config" button.
- LSL streaming for events:
  - Task start and stop: Event sent at the beginning and the end of the recording.
  - User markers: markers included by user.
  - Signal quality.
  - Synchronization: An event sent periodically to maintain synchronization.
- IkonApp Configurator: Participant self-recording module configurator only for Ikon and Ikon Sleep devices. Please refer to Section 12 for more details regarding the configurator and recorder.

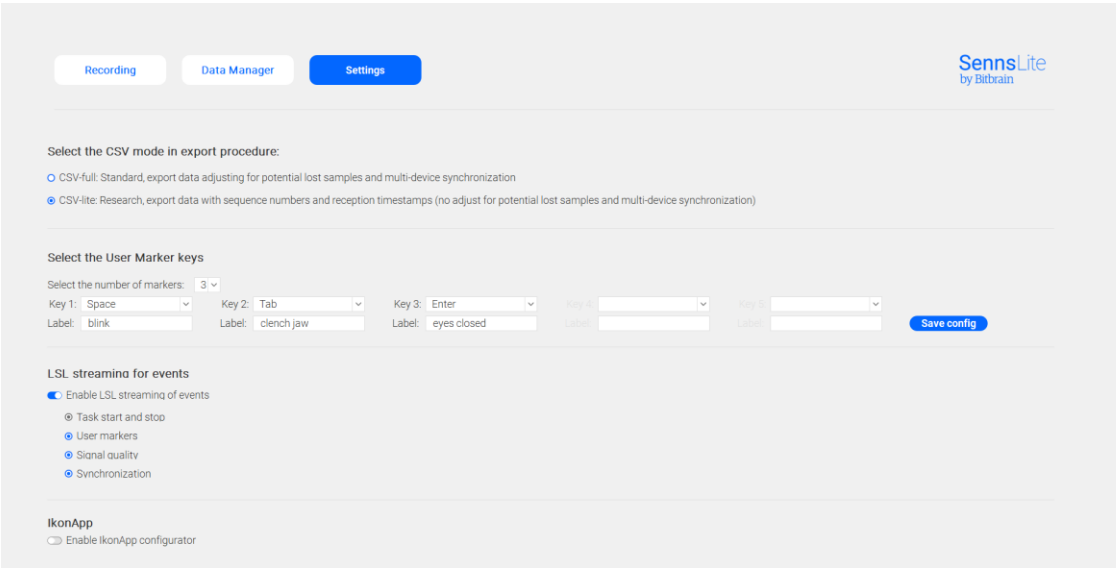

Figure 25. SennsLite Settings Module

8. Description of Exported Data Format

SennsLite allows exporting the data in two formats:

- EDF is a standardized file format designed for storing biological signals. One file is generated for every device. Supported for Bitbrain devices that record EEG signals. For simplicity, this software and document refer to it as "EDF"; however, the files are specifically provided in the EDF+ format.
- CSV is an interoperable file format for storing tabular data in plain text. One file is generated for every device signal. Signals recorded from all Bitbrain devices can be exported to this format. We provide two output formats with varying levels of detail (Lite and Full).

These three output data formats (EDF, CSV-Lite, CSV-Full) differ in the following properties:

- Resolution and filtering: EDF represents the signal values in 2 bytes (16 bits), which does not allow to store the EEG and PPG signals as the full range of the amplifier ADC is 24 bits. Thus, EEG and PPG signals are high pass filtered (0.1 Hz, 2nd order Butterworth filter) when exported to EDF format. CSV formats (CSV-Lite, CSV-Full) export the full-band signals.
- Lost samples adjust: Some signal samples might be lost due to the wireless nature of the communication. In EDF and CSV-Full, the exported signals are expanded with *NaN* values in case of lost samples. In CSV-Lite, additional information such as a sequence number (counter) is provided to detect these missing samples.
- Multi-device adjustment: In simultaneous multi-device recordings, the devices might start the recording with a slight difference (even when they are commanded at the same time). In EDF and CSV-Full, all signals share a common initial time (*t0*), and they are padded with initial *NaN* values, so that the first sample corresponds to the same time point across devices. In CSV-Lite, each device's signal includes its own initial timestamp (*t0*), which may differ between devices.

The following table summarizes this information:

	EDF	CSV-Full	CSV-Lite
Supported devices	EEG devices (Ring and Versatile Bio not supported)	All	All
Full-band	No, EEG and PPG are high prefiltered (0.1 Hz)	Yes	Yes
Lost samples adjust	Yes	Yes	No
Multi-device adjust	Yes	Yes	No

In the next subsections we describe:

- EDF format
- CSV format
- Events
- Metadata (JSON files)
- Signal properties for every sensor modality, and the events properties.
- Information on how Bitbrain devices handle data transfer and timestamps.

8.1 EDF FORMAT

We provide an EDF file for every recorded device, thus containing all its signals that operate at different sampling rates.

The EDF file is composed of a set of channels:

Example:

eeg_AF7, eeg_A1, eeg_Fp2, eeg_AF8, eeg_A2, mask_eeg, imu_1, imu_2, imu_3, imu_4, imu_5, imu_6, imu_7, imu_8, imu_9, mask_imu, spo_1, spo_2, spo_3, mask_spo

Channel	Description
<signal_id><i> * In case of EEG signals, we provide the position: <signal_id>_<loc>	Values of signal <signal_id> and channel i (from 1 to N). EEG and PPG signals are high pass filtered (0.1 Hz, 2nd order Butterworth filter) and clipped to (-3000, 3000) uV.
mask_<signal_id>	Mask of boolean values (0 or 1) for each signal that indicates whether samples were lost and should be interpreted as missing values (*NaN*). A sample *j* was lost in signal *eeg* when *mask_eeg[j]* is 1. Note we include a mask channel because *NaN* values cannot be represented in EDF format.

Header of the EDF file

The header of the EDF file fills the following fields:

- Start date and start time (note these fields provide a resolution of seconds; for a higher time resolution access the UTC timestamps provided in the JSON file – metadata).
- Patient code

- Equipment (device type)

8.2 CSV FORMAT

We provide a CSV file for every recorded signal.

The first line contains a header with the name of the columns.

Examples:

CSV-Full: ch1-AF7, ch2-A1, ch3-Fp2, ch4-AF8, ch5-A2

CSV-Lite: ch1-AF7, ch2-A1, ch3-Fp2, ch4-AF8, ch5-A2, sequenceNumber, timestampReception, timestamp

The CSV file contains the following columns:

Column	Full/Lite	Description
ch<i> * In case of EEG signals, the position is added: ch<i>-<loc>	Full/Lite	Values of channel i (from 1 to N).
sequenceNumber	Lite	Sequence number (counter) is incremented by 1 every block.
timestampReception	Lite	Reception timestamp (high res., us) per block, might be *null* if lost online.
timestamp	Lite	Corrected timestamp (high res., us), using the t0 computation

8.3 EVENTS

The events registered with SennsLite during the recording are exported to CSV files.

We provide a CSV file for every event type.

The first line contains a header with the name of the columns.

Examples:

timestamp, value1

The CSV file contains the following columns:

Column	Description
timestamp	Timestamp (high res., us) when the event occurred.
value<i>	Value(s) of the event.

	Note that one event might have several values. For instance, one event type "quality" is provided for every device that provides the signal quality of every channel.

8.4 METADATA (JSON FILES)

The metadata is provided in a file with a JSON data format with the following fields.

system
- version: version of the data exporter
- adjust: full, lite

status:
- ok: bool, indicates whether the data export was successful
- t0: float, initial ts (high res., us) of the recording (full export only)
- tn: float, final ts (high res., us) of the recording (full export only)
- utc: object with fields:
  - enabled: bool, indicates whether UTC timestamp could be measured
  - stable: bool, indicates whether the UTC timestamps were stable
  - t0: float, initial ts (us) in UTC units (when stable = true)
  - tn: float, final ts (us) in UTC units (when stable = true)

signals: array object of:
- id: string, id
- num_channels: int, number of channels
- num_elements: int, samples per block
- sampling rate: int, nominal sampling rate
- other information:
  - signal loc: string list, list of EEG positions (only available for EEG)
  - subject name: id of the participant
  - device name: id of the device
  - device type: (Ikon, Ikon Sleep, Diadem, Hero, Air, Versatile EEG, Versatile Kids EEG, Versatile Bio, Ring)
  - signal type: signal type, see Section 8.5
- status: status of the export procedure on this signal, object with fields:
  - enabled: bool, indicates whether the signal could be exported
  - error_flag: int, indicates the error (when enabled = false)
  - error_message: string, indicates the error (when enabled = false)
  - sd_sync_read: bool, indicates whether the SD card (sync file) was read
  - sd_data_read: bool, indicates whether the SD card (data file) was read
- internal: advanced metadata information, object with fields:
  - pad_ini: int, number of padding samples added to the beginning (full export only)
  - pad_end: int, number of padding samples added to the end (full export only)
  - t0: float, initial ts (us)
  - tn: float, initial ts (us)
  - utc: object (idem as utc object in status)

event: array object of:
- id: string, id
- num_channels: int, number of channels

- other information: device name, config

8.5 SIGNAL AND EVENTS PROPERTIES

This section contains the description of the signal and event properties. The signal properties are grouped into devices sharing sensor modalities:

- EEG systems and Versatile Bio
- Ring device

8.5.1 Signals of EEG Systems and Versatile Bio

The signals are recorded without any filtering. All the signals are sampled at 256 Hz (8 samples per block) except for the IMU (32 Hz, 1 sample per block). In the case of EEG signals, [1-30] Hz bandpass filter is applied for visualization purposes only.

SIGNAL TYPE	DESCRIPTION	DEVICE TYPE
eeg	EEG signal Number of channels * Samples per block: 8 Sampling rate: 256 Hz Unit: uV Visualization filter: [1-30 Hz] *The number of channels [value n] depends on the device type.	Ikon (n=5) Ikon Sleep (n=2) Air (n=8) Diadem (n=12) Hero (n=10) Versatile EEG 8 (n=8) Versatile EEG 16 (n=16) Versatile EEG 32 (n=32) Versatile EEG 64 (n=64)
imu	Inertial measurement unit (IMU) Number of channels: 9 - ch 1: accelerometer, x-axis (g) - ch 2: accelerometer, y-axis (g) - ch 3: accelerometer, z-axis (g) - ch 4: gyroscope, x-axis (deg/s) - ch 5: gyroscope, y-axis (deg/s) - ch 6: gyroscope, z-axis (deg/s) - ch 7: magnetometer, x-axis (uTeslas) - ch 8: magnetometer, y-axis (uTeslas) - ch 9: magnetometer, z-axis (uTeslas) Samples per block: 1 Sampling rate: 32 Hz	Ikon Ikon Sleep Air Diadem Hero Versatile EEG Versatile Bio
photodiode	Photodiode input Number of channels: 1 Samples per block: 8 Sampling rate: 256 Hz Unit: uV	Air Diadem Versatile EEG
din	Digital input Number of channels: 1* Samples per block: 8 Sampling rate: 256 Hz Unit: bit	Diadem Versatile EEG Versatile Bio

	*The number of channels is 1, except for the Versatile 32 (n=3)	
dout	Digital output Number of channels: 1 Samples per block: 8 Sampling rate: 256 Hz Unit: bit This signal type generates TTL pulses that, when received in the DIN of another device, can be used to synchronize them at sample level.	Versatile Bio
analog	Input to record analogic signals such as GSR, respiration, temperature, photodiode, etc. The Versatile Bio has 7 analogic inputs. Samples per block: 8 Sampling rate: 256 Hz Unit: uV	Versatile Bio
exg	Input to record bipolar signals such as ECG, EMG, etc. The number of inputs depends on the device type [value n]. Samples per block: 8 Sampling rate: 256 Hz Unit: uV	Versatile EEG 32 (n=2) Versatile Bio (n=9)
ppg	PPG signal Number of channels: 3 - ch 1: red light intensity - ch 2: infrared light intensity - ch 3: green light intensity Samples per block: 1 Sampling rate: 32Hz Unit: nA	Ikon Sleep

8.5.2 Signals of the Ring Device

The signals are recorded without any filtering. The signals are sampled at 32 Hz (2 samples per block). [0.5-2] Hz and [0.5-4] Hz bandpass filters are applied to the GSR and BVP signals, respectively, for visualization purposes only.

SIGNAL TYPE	DESCRIPTION	DEVICE TYPE
gsr_bvp_acc	The Ring device provides the following signals: Number of channels: 5 - ch 1: galvanic skin response (GSR) (S) - ch 2: blood volume pulse (BVP) (uV) - ch 3: accelerometer (ACC), x-axis (g) - ch 4: accelerometer (ACC), y-axis (g) - ch 5: accelerometer (ACC), z-axis (g) Samples per block: 2 Sampling rate: 32 Hz	Ring

8.5.3 Events

The table shows all possible events logged by SennsLite along with a description.

EVENT	DESCRIPTION
userMarker	Denotes the time instants in which the user pressed a key. Each marker presents three values: - ch1: marker index as defined in Settings: - value = 0 (Key 1) - value = 1 (Key 2) - value = 2 (Key 3) - value = 3 (Key 4) - value = 4 (Key 5) - ch2: number of occurrences of this marker type - ch3: number of occurrences of any marker type
{deviceID}_quality	Signal quality values for a given device (specified by its ID), available for EEG systems and for the Ring device. A signal quality value is provided for every channel; thus, the number of channels matches the number of channels in the original data. - ch1: signal quality of channel 1 - ... - chN: signal quality of channel N The signal quality values are: - value = 1, optimal quality - value = 2, fair quality - value = 3, bad quality - value = 4, saturated signal

8.6 UNDERSTANDING DATA TRANSFER AND SYNCHRONIZATION

Bitbrain EEG devices iteratively register a "block of data" and transfer it to the recording software. This data transfer happens block by block at a fixed rate of 32 Hz (i.e., every 31.25 ms a "block of data" is recorded and transferred to the recording computer).

The data blocks contain multiple signals (for instance EEG, SPO, IMU) and a sequence number. This sequence number is a counter to detect missing blocks due to the wireless nature of the communication (either using standard Bluetooth or Bluetooth Low Energy in Ikon). At reception, the software captures a "reception timestamp".

Based on all this information (sequence number, reception timestamps, and the fact that we impose a data transfer at a fixed rate), we can apply a series of algorithms to correct the jitter from the timestamps, estimate the initial time point of each signal (referred as to "t0" in this section), and synchronize the signals from multiple devices. The synchronized data is exported in CSV format along with metadata.

Finally, it is important to understand that data blocks contain, for each signal, a pre-defined number of samples. For instance, since the sampling rate of the EEG is 256 Hz, we capture 8 samples of EEG per block (and channel). In case of SPO and IMU signals they have a sampling rate of 32 Hz, thus 1 sample of data is transferred per block.

8.6.1 Timestamps

We capture two types of timestamps:

- High resolution timestamps (using QueryPerformanceCounter in Windows OS). These timestamps have a high resolution (<1us) and can be used for time-interval measurements.
- UTC timestamps (using GetSystemTimePreciseAsFileTime in Windows OS). These timestamps measure absolute time units and can be used to synchronize to external events.

Both types of timestamps are captured in microsecond units.

All the timestamps contained in the exported files (either signals or events) are high resolution timestamps. The metadata contains the initial time point estimates in both timestamps formats, so that a correspondence between them can be computed.

9. Annex 1: Multi-device and Multi-participant Recording Configuration

SennsLite allows the simultaneous and synchronized recording of multiple Bitbrain devices across different participants within the same session. To enable this functionality, each participant must be configured with a unique participant ID and associated with a specific device.

Participants and devices must be added sequentially, ensuring that each participant-device pair is saved and assigned before configuring the next one.

To configure the first participant, these steps must be followed:

1. In the Recording module, define the participant ID in the study parameters and click "Save", as described in Section 5.1.
2. Add and configure the device that will be used by this participant in the Device Settings window, following the instructions in Section 5.1.1.
3. Assign the device to the participant by moving the configured device from the "Available sensors" list to the "Participants and sensors" list. At this point the association between the Participant ID and the device serial number can be verified in the "Participants and sensors" list.

It is very important that before configuring the second participant, the previous participant-device pair has already been added to the "Participants and sensors" list. Otherwise, previously defined parameters will be overwritten.

Repeat the steps above for each additional participant making sure that each participant ID is associated with a different device; and each device is assigned to a single participant, as seen in

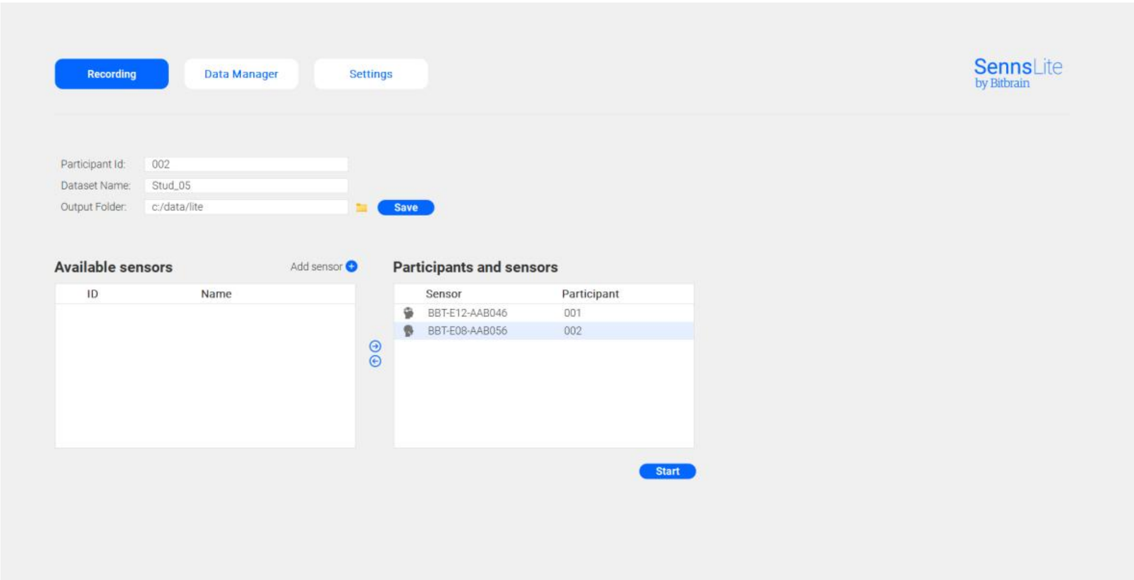

Figure 26. Multi-participant and multi-device Recording module

Once all participant-device pairs have been correctly configured, the “Participants and sensors” list will display them as the final confirmation before moving onto the next windows. Click on “Start” to begin the Sensors checking process and the actual recording. Signals from all the participants and devices will be displayed simultaneously in the subsequent screens.

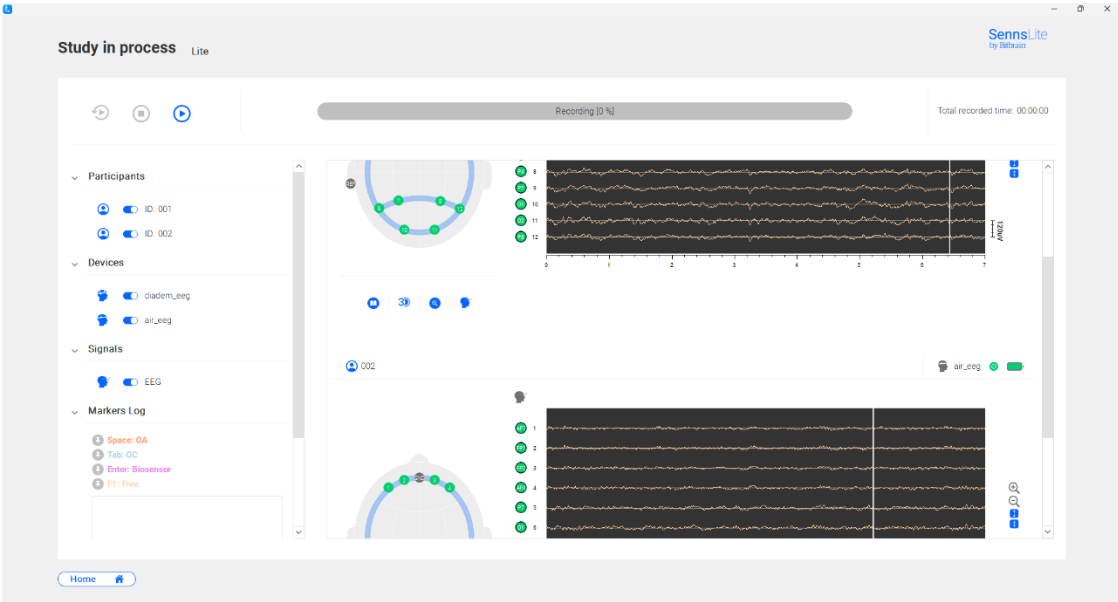

Figure 27. Recording module with two EEG devices

10. Annex 2: Device-specific Information

10.1 IKON EEG REFERENCE

The Ikon device has sensors in the forehead (Af7, Fp1, Fp2, Af8) and in the upper part of the ears (A1, A2). The ground electrode is in Fpz, and the amplifier reference is in Fp1.

The design decision to have the amplifier reference in Fp1 allows to:

- Provide signal quality indexes in the ear sensors. This is interesting as the ear sensors are likely to be more difficult to place correctly than forefront sensors, thus helping in the correct placement of the device by non-experts.
- Set the reference to A1 or A2 in offline analysis depending on the researcher's needs, or switch between them if the contact is lost in any of them. In summary, this potentially makes the technology more robust for real-word recordings. This point also applies to online processing scenarios, in which the reference can be dynamically switched.
- Have a linked-ears reference.

Important: while the EEG signal is re-referenced in the signal viewer in SennsLite for usability, it is stored unfiltered and with the amplifier reference (Fp1). Thus, researchers that load the exported data will commonly need to re-reference the signal to either A1 or A2 for its interpretation.

10.1.1 Re-referencing

Recorded data can be expressed in the form:

(Af7-Fp1, A1-Fp1, Fp2-Fp1, Af8-Fp1, A2-Fp1)

Re-referencing implies to perform a mathematical operation to transform this to:

(Af7-A1, Fp1-A1, Fp2-A1, Af8-A1, A2-A1)

This Python code performs such an operation:

```
def _rereference_array(data: np.ndarray) -> np.ndarray:
    """
      Perform re-referencing of EEG data to A1 (ch index = 1).

      Parameters:
      - eeg_data: numpy array of shape (num_channels, num_samples)
        - locations: (Af7-Fp1, A1-Fp1, Fp2-Fp1, Af8-Fp1, A2-Fp1)

      Returns:
      - eeg_data_referenced: numpy array of shape (num_channels, num_samples)
        - locations: (Af7-A1, Fp1-A1, Fp2-A1, Af8-A1, A2-A1)
      """
    reference_ch = 1
    ch_ref = np.copy(data[reference_ch, :])
    for ch in range(data.shape[0]):
        if ch != reference_ch:
            data[ch, :] = data[ch, :] - ch_ref
        else:
            data[ch, :] = -data[ch, :]
```

```
    return data
```

10.2 VERSATILE 64CH EEG CONFIGURATION

The Versatile EEG 64 consists of two 32-channel EEG amplifiers connected to each other through a synchronizer. For this system, **both amplifiers** must be manually paired via Bluetooth with the computer before configuring the device in SennsLite. In the SennsLite interface, when configuring the device, you will be asked to enter the Main and Secondary amplifier IDs.

The Main ID corresponds to Amplifier 1 serial number, and the Secondary ID corresponds to Amplifier 2 serial number, as described in the Versatile 64ch EEG user guide. When viewing the participant from behind, the Main amplifier is positioned on the left side of the base and the Secondary amplifier on the right side.

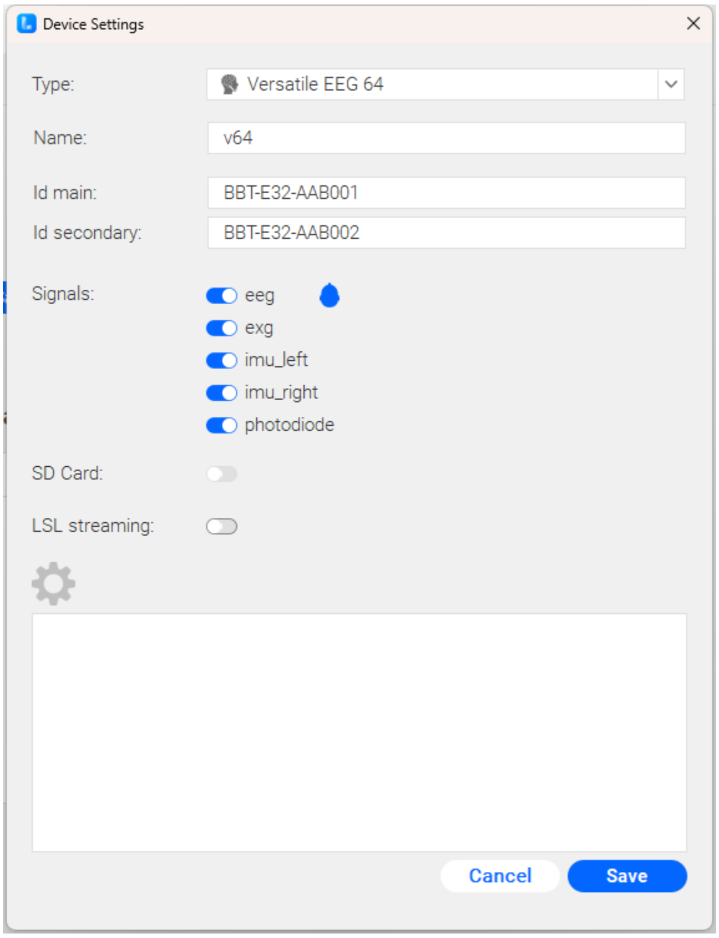

Figure 28. Device Settings dialog box for Versatile EEG 64

10.2.1 Versatile 64ch EEG Layout

In the “Device Settings” dialog box shown in Figure 28, when clicking on the head illustration next to the “EEG” signal selector, another window will appear to define the custom layout, as mentioned in Section 5.1.2. In this device, the section to choose the channel visualization order is particularly interesting due to the quantity of available channels. The "Anatomical order" option is recommended as the signals will be organized by brain region making the analysis easier. This allows channels affected by eye movements and blinks to be displayed in a logical order in the frontal region, while alpha waves are more prominent in the occipital channels and gradually decreases towards the prefrontal ones. This facilitates the interpretation of spatial patterns across the scalp.

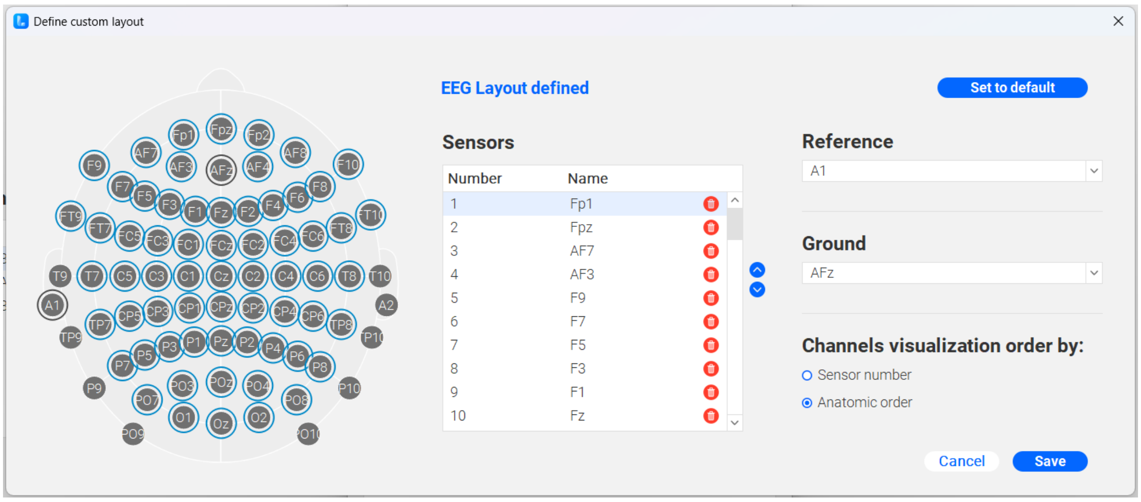

Figure 29. Define custom layout for Versatile 64ch EEG

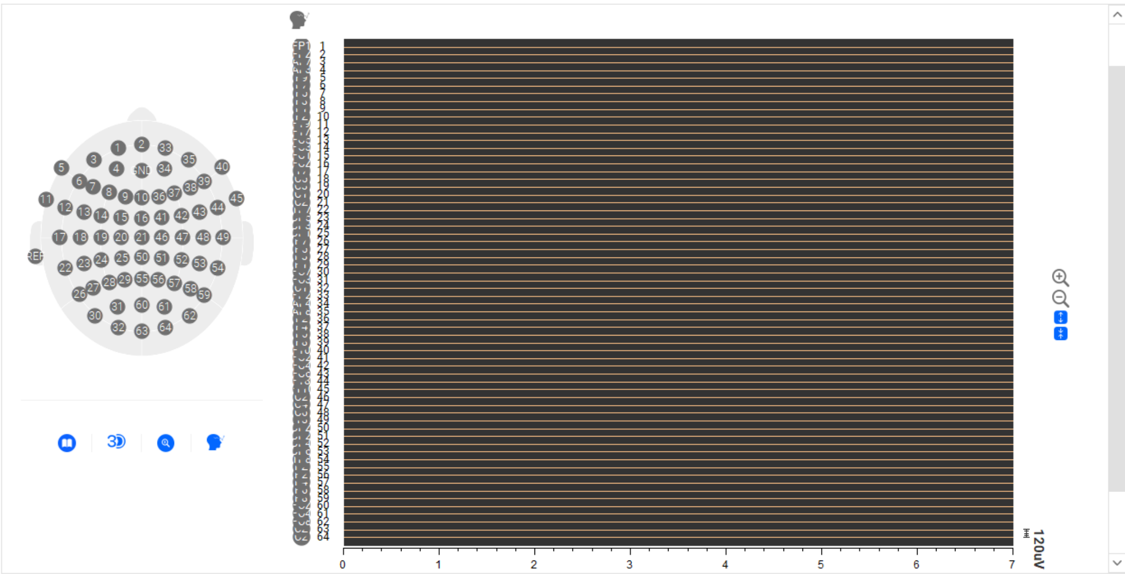

Figure 30. Visualization of channels ordered by sensors number

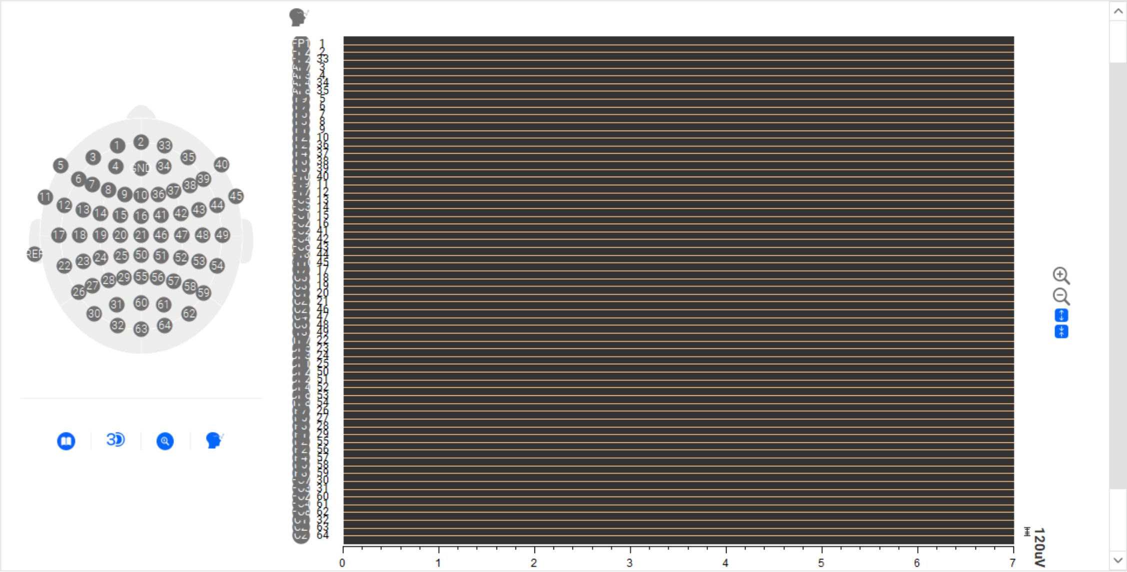

Figure 31. Visualization of channels ordered by anatomic order

11. Annex 3: LSL Connectivity

This software allows no further interaction with the data while acquiring but visualization (filtering only affects visualization). For those users that want to access the data while being acquired, we provide the LSL server option.

If this feature is enabled (Section 5.1.1), an LSL server will be created when the acquisition starts. This server will publish one data stream per signal being acquired. Other applications in the same computer or over the network can connect to the server to subscribe to any of the stream and receive the data online to do any kind of external processing using this standard protocol.

To record properly with LSL protocol, some third-party applications should be needed to perform this recording. The LabRecorder is the default recording program that comes with LSL. It allows the recording of all streams on the lab network (or a subset) into a single file. The LabRecorder application is shown in the following example.

LabRecoder can be downloaded here: [GitHub - labstreaminglayer/App-LabRecorder: An application for streaming one or more LSL streams to disk in XDF file format.]

To perform the recording properly the following steps should be performed:

1. Configure the device in SennsLite, activating the LSL streaming switch.

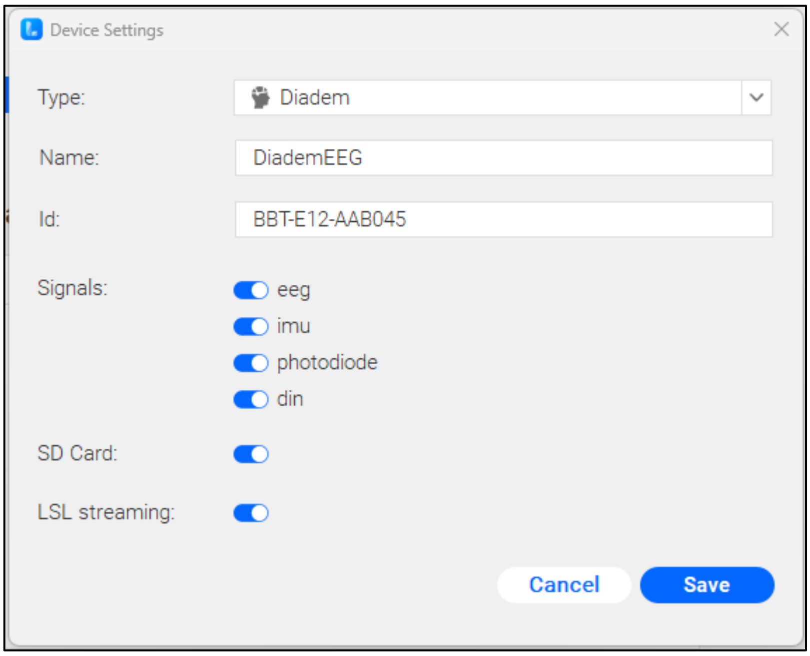

Figure 32. Device Settings window with LSL Streaming enabled

2. Go through the configuration steps and throughout the quality check process. And get to the recording screen.

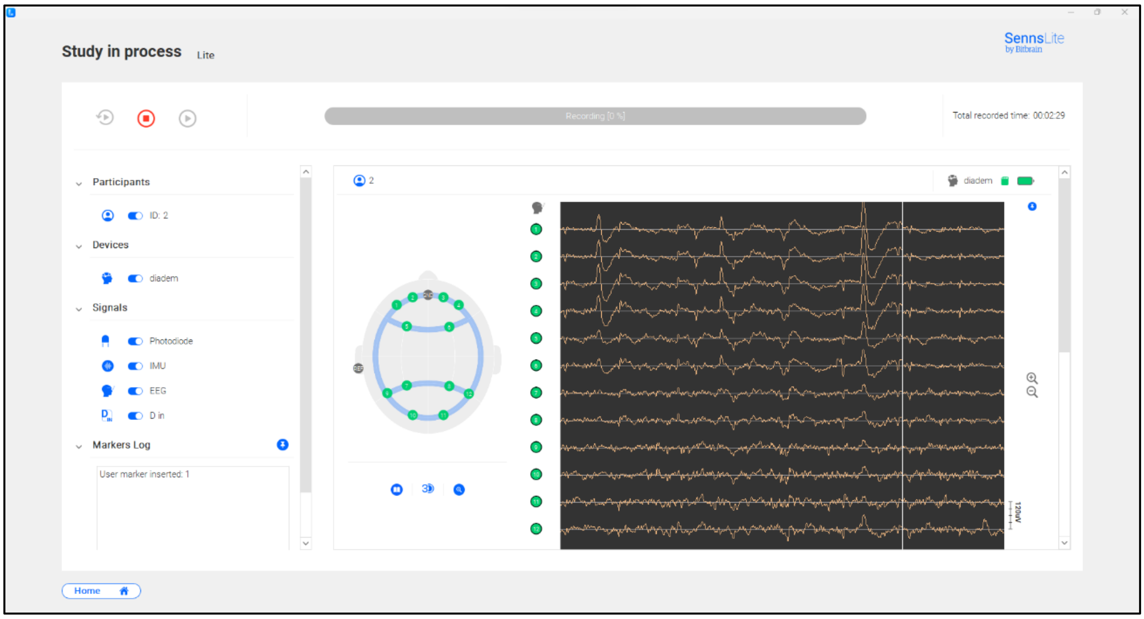

Figure 33. Study in process window

3. Start SennsLite recording.

4. Launch LabRecorder.

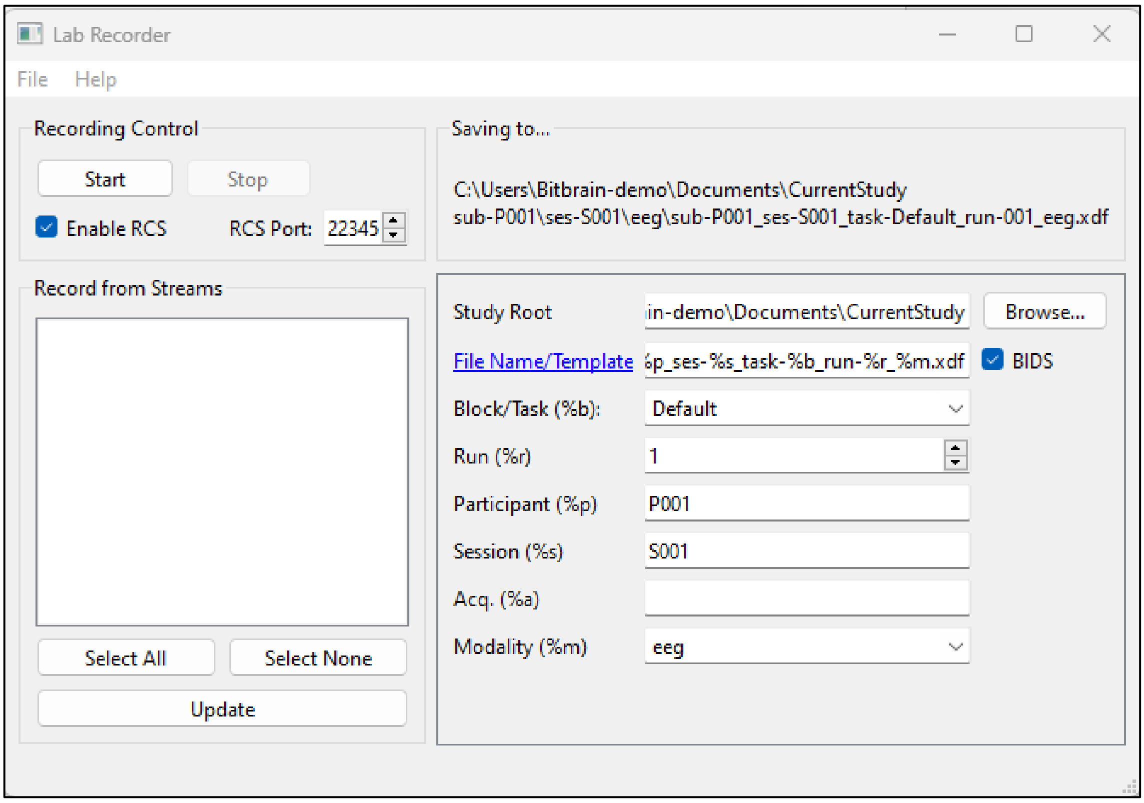

Figure 34. Lab Recorder Window

5. Update available signals and select the relevant ones for the data set.

6. Select the folder to record the data set.

7. Start LabRecorder recording.

8. Carry out the experimental design.

9. Stop LabRecorder recording.

10. Stop SennsLite recording.

After this recording process, a .xdf file should have been created in the previously selected directory.

11.1 OUTPUT STREAMS

We below provide a table with the signal streams provided. Note that in addition to signal values we also provide a sequence number for detecting potential lost packages: Channels ch 1 to ch n in each signal correspond to the number of channels for the specific device and/or signal type; and the next channel, ch n +1, contains the sequence number.

A timestamp is assigned to every sample of every signal. These timestamps values are in seconds with a precision up to milliseconds. A smooth algorithm is performed over the transmitted timestamps (LSL) to reduce the inherent jitter in the Bluetooth transmission.

SIGNAL TYPE/OUTLET ID	LSL METADATA	DEVICE TYPE
eeg <device_name>_eeg	EEG signal Number of channels * Samples per block: 8 Sampling rate: 256Hz Unit: uV *The number of channels [value n] depends on the device type.	Ikon (n=5) Ikon Sleep(n=2) Air (n=8) Diadem (n=12) Hero (n=10) Versatile EEG 8 (n=8) Versatile EEG 16 (n=16) Versatile EEG 32 (n=32) Versatile EEG 64 (n=64)
imu <device_name>_imu	IMU signal Number of channels: 9 - ch 1: accelerometer, x-axis (g) - ch 2: accelerometer, y-axis (g) - ch 3: accelerometer, z-axis (g) - ch 4: gyroscope, x-axis (deg/s) - ch 5: gyroscope, y-axis (deg/s) - ch 6: gyroscope, z-axis (deg/s) - ch 7: magnetometer, x-axis (uTeslas) - ch 8: magnetometer, y-axis (uTeslas) - ch 9: magnetometer, z-axis (uTeslas) Samples per block: 1 Sampling rate: 32 Hz	Ikon Ikon Sleep Air Diadem Hero Versatile EEG Versatile Bio

photodiode <device_name>_photodiode	Photodiode input Number of channels: 1 Samples per block: 8 Sampling rate: 256 Hz Unit: uV	Air Diadem Versatile EEG
din <device_name>_din	Digital input Number of channels: 1* Samples per block: 8 Sampling rate: 256 Hz Unit: bit *The number of channels is 1, except for the Versatile 32 (n=3)	Diadem Versatile EEG Versatile Bio
dout <device_name>_dout	Digital output Number of channels: 1 Samples per block: 8 Sampling rate: 256 Hz Unit: bit	Versatile Bio
analog <device_name>_analog	Input to record analogic signals such as GSR, respiration, temperature, photodiode, etc. The Versatile Bio has 7 analogic inputs. Samples per block: 8 Sampling rate: 256 Hz Unit: uV	Versatile Bio
exg <device_name>_exg	Input to record bipolar signals such as ECG, EMG, etc. The number of inputs depends on the device type [value n]. Samples per block: 8 Sampling rate: 256 Hz Unit: uV	Versatile EEG 32 (n=2) Versatile Bio (n=9)
ppg <device_name>_ppg	ppg signal Number of channels: 3 - ch 1: red light intensity - ch 2: infrared light intensity - ch 3: green light intensity Samples per block: 1 Sampling rate: 32Hz Unit: nA	Ikon Sleep
gsr_bvp_acc <device_name>_signal	ring signal The Ring device provides the following signals: Number of channels: 5 - ch 1: galvanic skin response (GSR) (S) - ch 2: blood volume pulse (BVP) (uV) - ch 3: accelerometer (ACC), x-axis (g) - ch 4: accelerometer (ACC), y-axis (g) - ch 5: accelerometer (ACC), z-axis (g) Samples per block: 1 Sampling rate: 32 Hz	Ring

start/stop	Denotes the instant when the recording in SennsLite has started or stopped.	All
userMarker	Denotes the time instants in which the user pressed a key. The marker is a string containing its label (as defined in Settings)	All
{deviceID}_quality	Signal quality values for a given device (specified by its ID), available for EEG devices and for the Ring device. A signal quality value is provided for every channel; thus, the number of channels matches the number of channels in the original data. - ch1: signal quality of channel 1 - ... - chN: signal quality of channel N The signal quality values are: - value = 1, optimal quality - value = 2, fair quality - value = 3, bad quality - value = 4, saturated signal	Ikon Ikon Sleep Air Diadem Hero Versatile EEG Ring
lslSync	Pulse sent every 10 seconds. Each pulse is marked by a number starting in 0 that grows one by one	All

12. Annex 4: Ikon App for Windows

Ikon App in Windows is a software module that allows the recording of EEG signals in a home-based environment from a Windows device. ***Ikon App is only compatible with Ikon and Ikon Sleep devices.***

Ikon App in Windows comprises a configurator, called Ikon App Configurator; and a recorder, which is the Ikon App itself. The Ikon App Configurator is integrated into SennsLite, while the recorder (Ikon App) can be accessed from the same computer but, outside of SennsLite. It is included by default when downloading and installing SennsLite.

The idea is to download the Ikon App into a Windows laptop that the participant can take home. For that, the researcher will have to first complete the participant parameters through the Ikon App Configurator and leave the Ikon App shortcut in a visible spot on the desktop of the computer. This way it can be easily accessed by the participants at their home.

12.1 IKON APP CONSISTS OF A SIMPLE RECORDER THAT ENABLES PARTICIPANTS TO START AND STOP SESSIONS BY THEMSELVES.HOW TO SET IKON APP CONFIGURATOR

Ikon App must be configured through the specific SennsLite module, as well as the Ikon EEG devices that will be used for the recording. The workflow is defined by the following steps:

1. At the bottom of SennsLite Settings module (Figure 35), enable Ikon App Configurator.

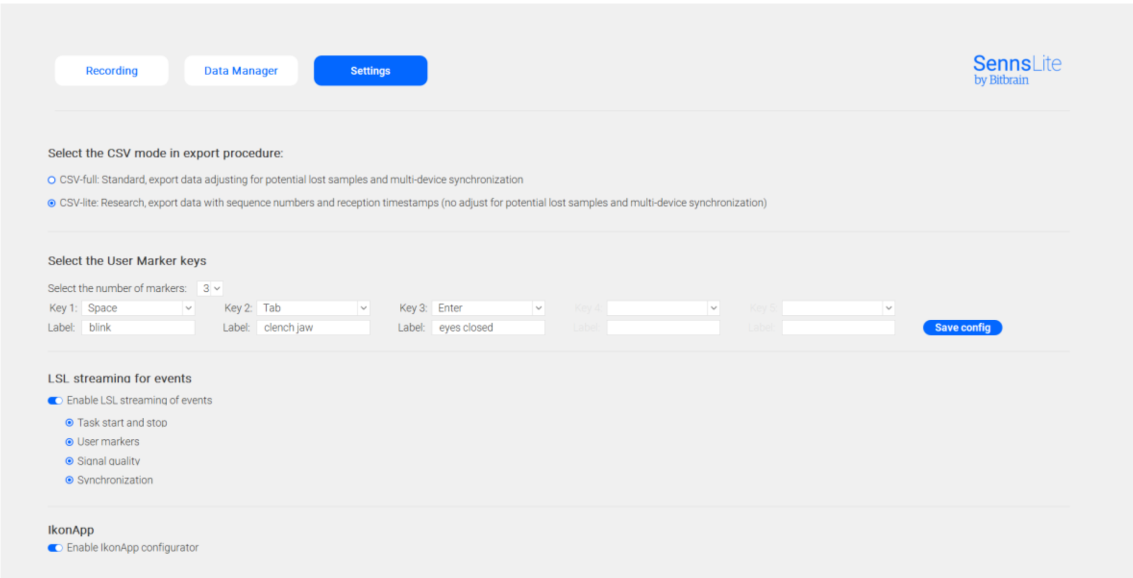

Figure 35. Settings Module to enable Ikon App Configurator

2. In the SennsLite Recording module, add the device that will be used for the recordings to the "Available sensors" list. Refer to Section 5.1.1. to add a new device.

3. Click on the red "Ikon App Configurator" button to set the desired parameters for the study (Figure 36).

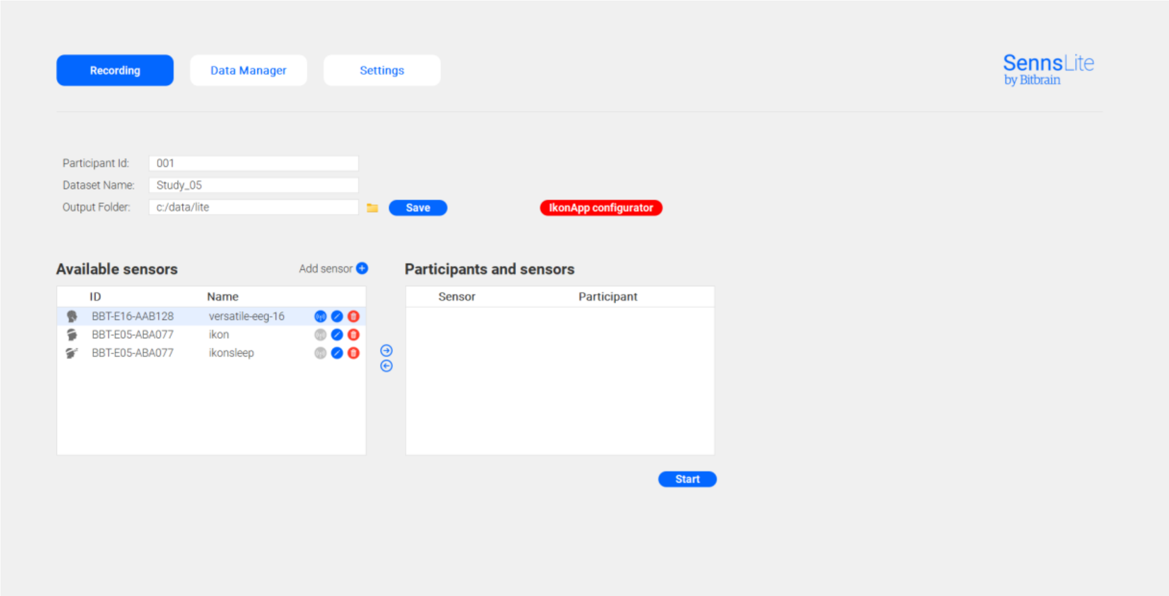

Figure 36. Ikon App Configurator button appears red until the parameters are set

4. Complete the required information regarding participant ID, dataset name, and output folder, as shown in Figure 37. Then, select the device that was previously configured for use in the recording and click on "Save" to keep the defined parameters.

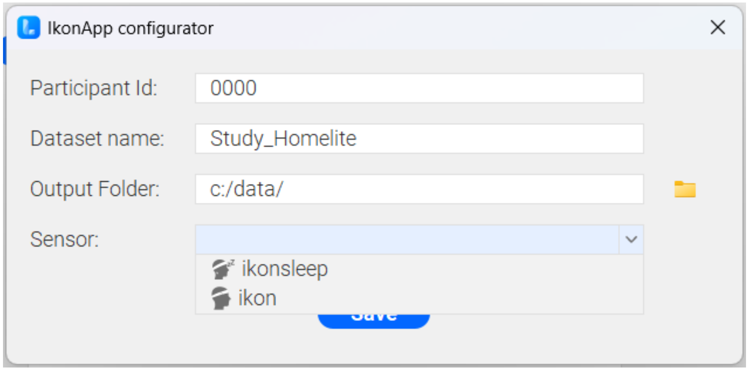

Figure 37. Ikon App Configurator dialog box

5. Once everything has been set correctly, the Ikon App button in the Recording module will be shown in blue, as seen in Figure 38.

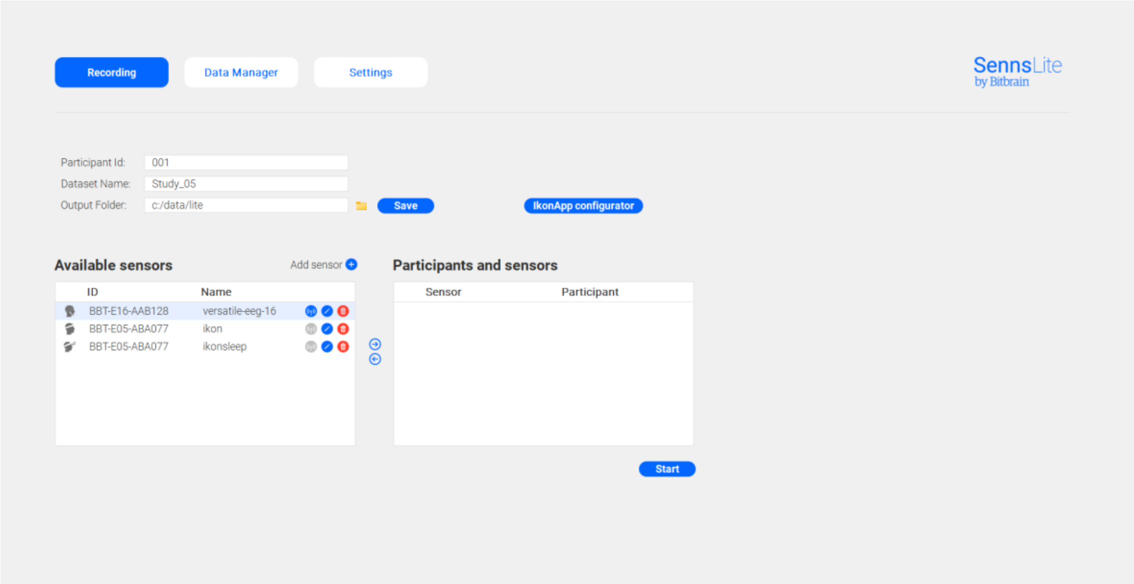

Figure 38. Ikon App Configurator button appears blue after the parameters are set

6. At this point, SennsLite can be closed as it only serves to configure the Ikon App recorder.

12.2 HOW TO RUN IKON APP

Ikon App can be used by participants with no technical expertise to record EEG data by themselves, following these steps:

1. If SennsLite was installed using the default settings, the Ikon App can be launched by running "*C:\bitbrain\sennslite\bin\ikonapp.exe*". Alternatively, the Ikon App may be opened by searching for it in the Windows taskbar.

2. Ikon App will open displaying the main window shown in Figure 39. Here, the online impedances read from the sensors of the device can be checked. This window also allows the user to identify the participant and device being used for the current session. They should correspond with what was established in the Ikon App Configurator. The correct connection status is represented through the green SD card icon in the top right corner, next to the battery status icon. This means the recording in the SD card was enabled in the Device Settings window, and the signal is being received and recorded to the SD card correctly. The following information is displayed on that screen:

    a. Participant ID

    b. Type of sensor being used in the recording (Ikon / Ikon Sleep)

    c. Device connectivity and battery status. Please refer to Section 5.2 (SD card & connection feedback) for a complete overview of all connectivity icon indicators, including their possible statuses and corresponding meanings.

    d. Sensors' layout diagram in the corresponding type of band

    e. Start/ Stop buttons for recording

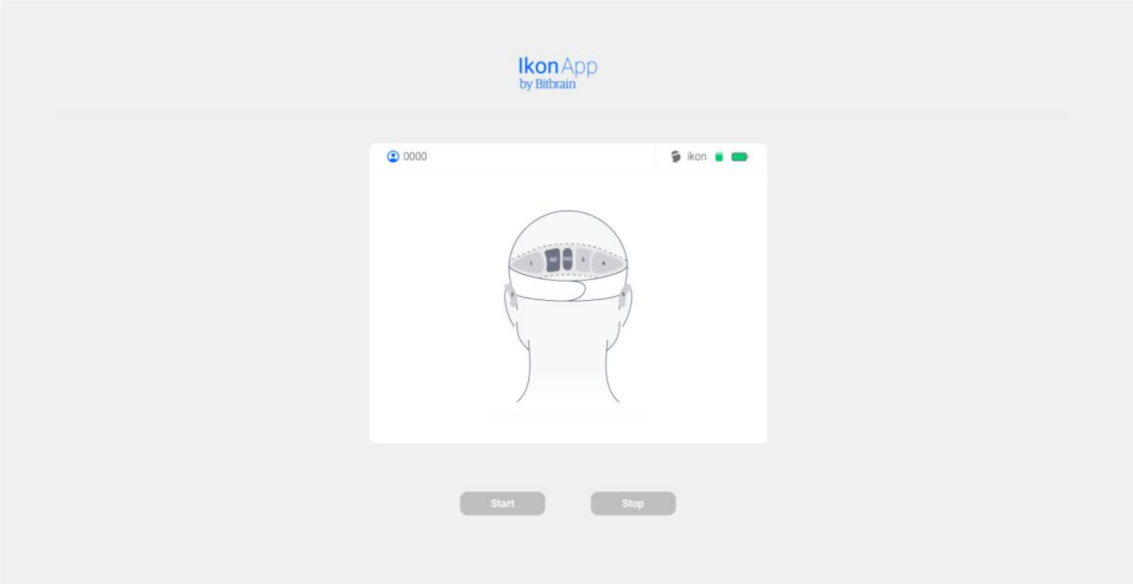

Figure 39. Ikon App Main Window

3. Before starting the recording, it is recommended to adjust the device to the participant's head until all the impedances appear in green, to ensure optimal sensor placement and obtain the highest possible EEG data quality. However, the recording can still be initiated even if not all impedances reach optimal levels.

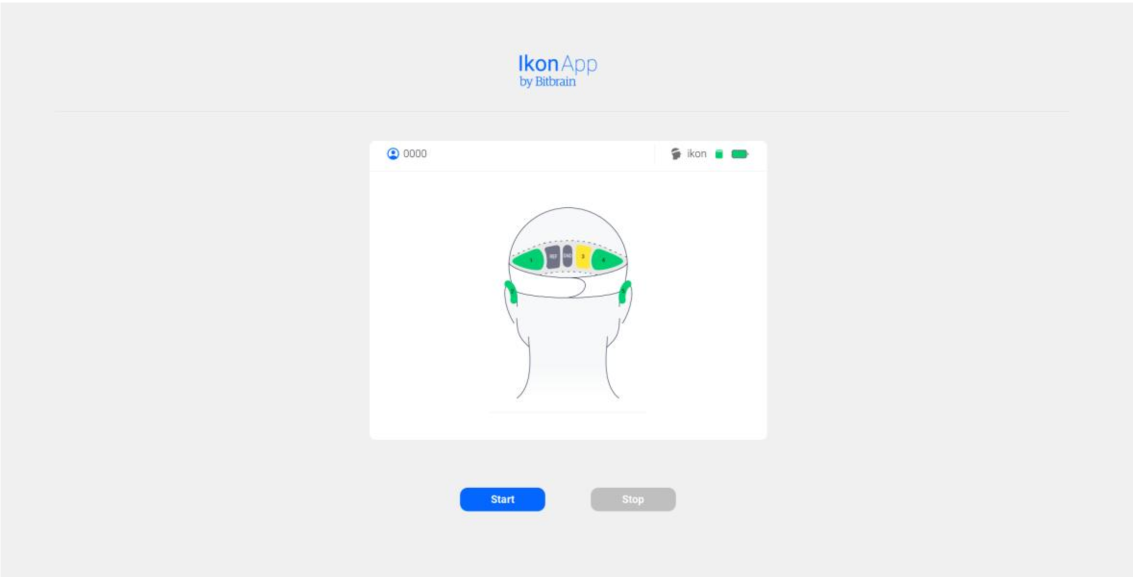

Figure 40. Signal quality check in Ikon App

4. It is important that the amplifier is powered on and properly connected to the corresponding band. If these conditions are not met, a message with a "Retry" button will appear (see Figure 41), allowing the user to re-check the connectivity of the device with the band.

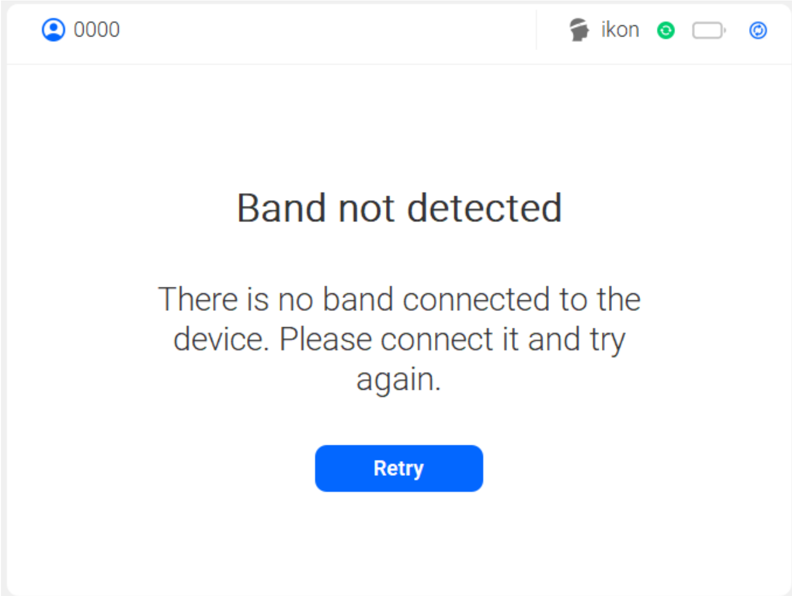

Figure 41. Dialog box to retry the connection of the device in Ikon App

5. Click on "Start" to start the recording.
6. Once the recording has begun the participant will have access to the same information as above (the participant ID, the type of device, the device connectivity and battery status), as well as the following:
    a. Session and recording identification numbers
    b. Timer showing the total recording duration.

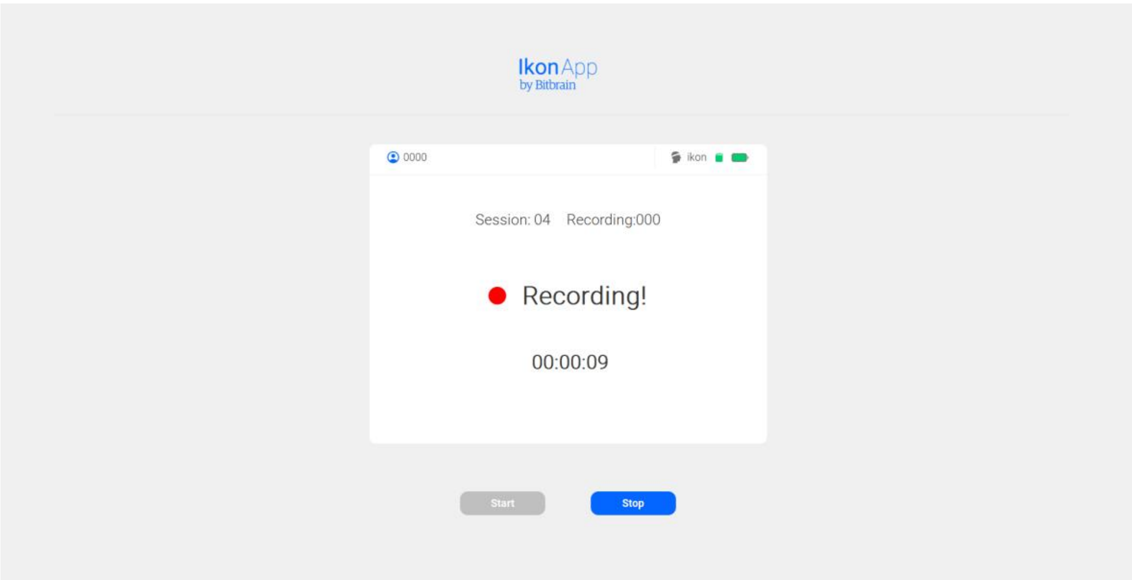

Figure 42. Recording Window in Ikon App

7. Click on "Stop" to stop the recording
8. Close Ikon App.

12.3 HOW TO EXPORT DATA RECORDED WITH IKON APP

Export data recorded with Ikon App through SennsLite Data Manager. Check Section 6 for detailed information regarding data export.

13. Annex 5: Ikon App for Android

Ikon App in Android is a mobile recording solution that allows the recording of EEG signals in a home-based environment from an Android smartphone. ***Ikon App is only compatible with Ikon and Ikon Sleep devices.***

Ikon App for Android comprises a configurator called Ikon App Configurator; and a recorder, which is the Ikon App itself. Both the Ikon App Configurator and the Ikon App can be downloaded through an APK and can be used directly from the smartphone. However, SennsLite will be needed later for the import of the SD card content and export of the recordings in CSV and/or EDF formats.

Before starting data collection, researchers must first configure the study parameters through the Ikon App Configurator. The Ikon App provides a simple interface that allows participants to start and stop recording sessions. Once recordings are completed, SennsLite on a Windows or Linux computer is required to import the SD card content and export the data in CSV and/or EDF formats.

13.1 DOWNLOAD AND INSTALLATION

Ikon App for Android can be downloaded from the appropriate link in our Download Center, where you will find an Android Package Kit (APK) file to install the two mobile apps (Configurator and Recorder). Since the application is distributed as an APK file, the smartphone must allow the installation of third-party applications. During the installation process, the Android operating system will prompt the user to grant the required permission, if it is not already enabled.

You can directly download the APK into your mobile phone or download it to a computer and transfer it to the smartphone using a cable. Using the phone's file browser, navigate through the internal storage to locate the .apk file and tap on it to run the installer. This process is shown in Figure 43. Once installed, the applications will be available in the application menu, as shown in Figure 44.

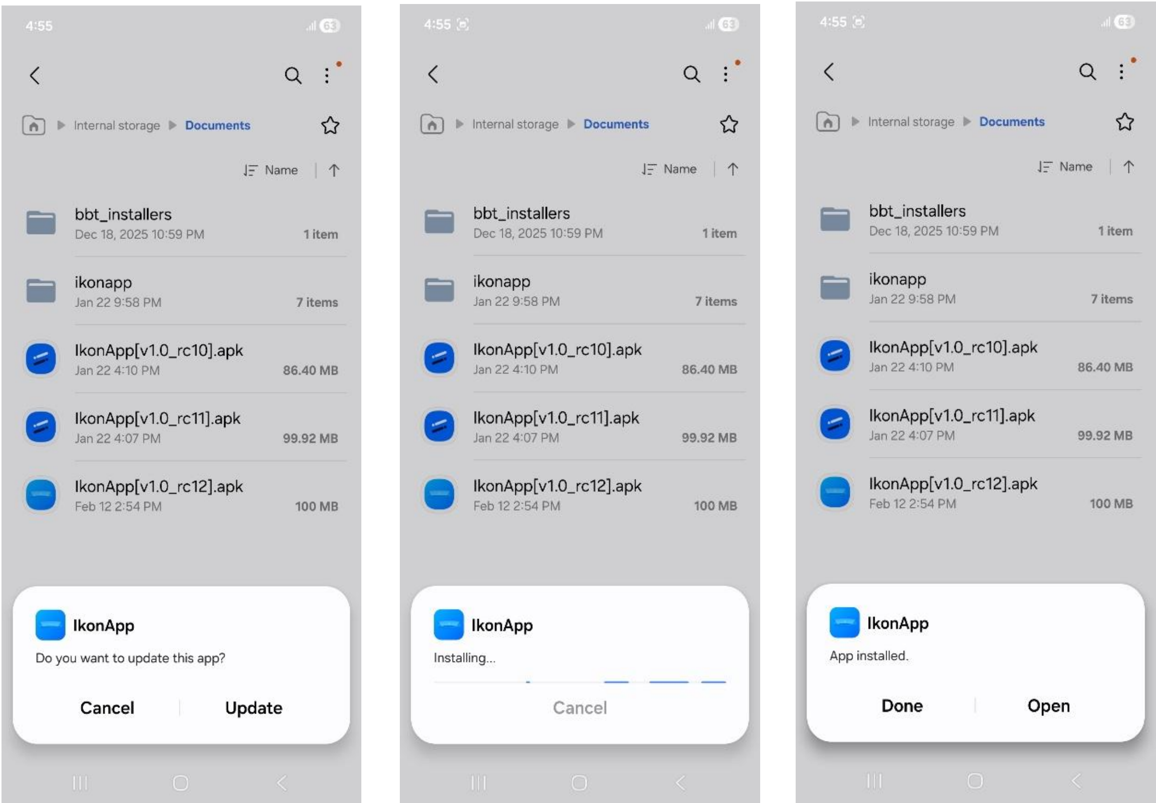

Figure 43. Ikon App installation process

Figure 44. Ikon App and Ikon App Configurator installed in the application menu

13.2 HOW TO SET IKON APP CONFIGURATOR

Before starting the session, the first step will be to open the Ikon App Configurator and complete the recording parameters shown in Figure 45:

- Participant ID: Alpha-numerical identification for the participant.
- Dataset Name: Name of the folder where the dataset of recordings will be saved.
- Sensor ID: Amplifier Serial Number.
- Sensor Type: Selector for the type of device that will be used in the recording (Ikon or Ikon Sleep)

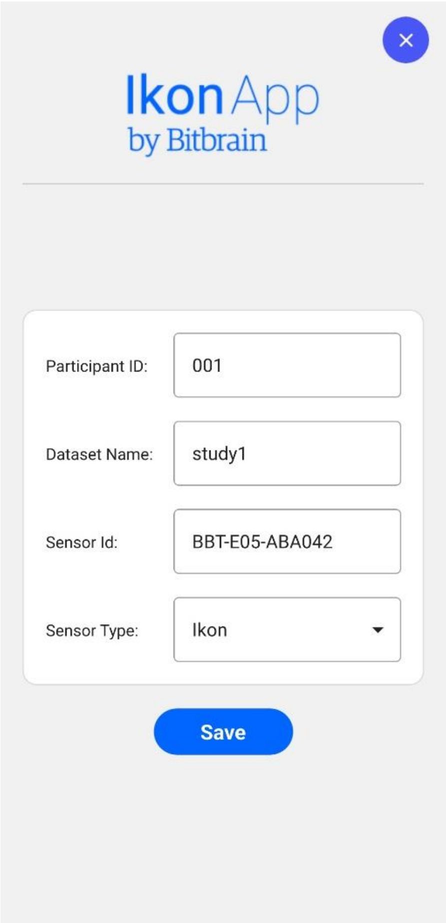

Figure 45. Ikon App Configurator main window

Once the parameters are set, click on the “Save” button and a confirmation message will appear stating that the configuration was updated successfully.

These parameters will define the recording that will be performed in the Ikon App.

At this point the amplifier can be turned on and connected to the type of band selected in “Sensor type”.

13.3 HOW TO RUN IKON APP

Ikon App is the application from which the sessions will be recorded.

After setting the parameters in the Ikon App Configurator, turning on the amplifier and connecting it to the corresponding band, the Ikon App can be directly opened to begin with the recording.

Figure 46 shows the window that opens when the Ikon App is first launched, given a certain set of parameters established in the Ikon App Configurator. At this point, the Ikon App is trying to find the device in the Bluetooth network and connect to it. The serial number will be the unique identifier of the amplifier, and no manual Bluetooth connection is needed as the Ikon and Ikon Sleep devices feature BLE connectivity that allows the automatic connection between the device and the Ikon App.

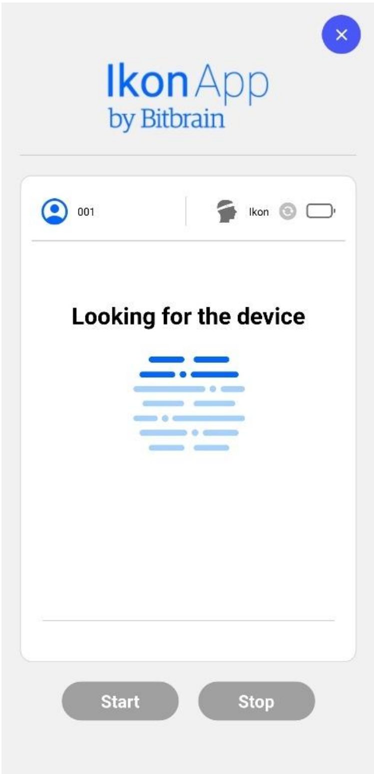

Figure 46. Ikon App process of finding the device in the Bluetooth network

Please refer to Section 13.6 for more details regarding connectivity checks and troubleshooting after device setup.

Once the amplifier-band pair is correctly detected, the participant can proceed with the placement of the device. The correct connection status is represented through the green circle with arrows in the top right corner, next to the battery status icon, as seen in Figure 47. Additional information is displayed on that same screen (from top to bottom and from left to right):

- Participant ID
- Type of sensor being used in the recording (Ikon/ Ikon Sleep)
- Device connectivity and battery level status. Please refer to Section 5.2 (SD card & connection feedback) for a complete overview of all connectivity icon indicators, including their possible statuses and corresponding meanings.

- Sensor's layout diagram in the corresponding type of band
- Start/Stop buttons for recording

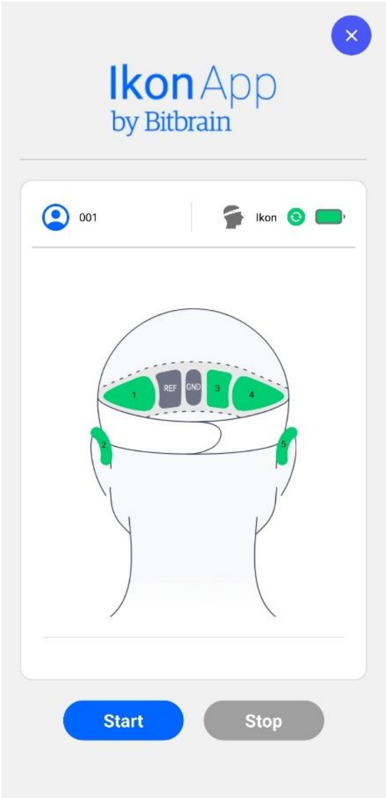

Figure 47. Signal quality check in Ikon App

This window allows the user to check the online impedances read from the device's sensors. This window also enables the user to identify the participant and device being used for this session, in alignment with the parameters established in the Ikon App Configurator.

Before starting the recording, it is recommended to adjust the device to the participant's head until all the impedances appear in green, in order to ensure optimal sensor placement and obtain the highest possible EEG data quality. However, the recording can still be initiated even if not all the impedances reach optimal levels.

To start the recording, click on "Start" and the screen shown in Figure 48 will appear.

The user will have access to the same information (the participant ID, the device connectivity and battery status), as well as:

- Session and recording identification numbers
- Timer showing the total recording duration

Once a recording has been started, data acquisition will continue uninterrupted even if the user temporarily leaves the Ikon App (for example, by switching to another application or returning to the home screen). The recording runs safely in the background and remains active until the user explicitly stops it from within the Ikon App or exits the application using the on-screen close button.

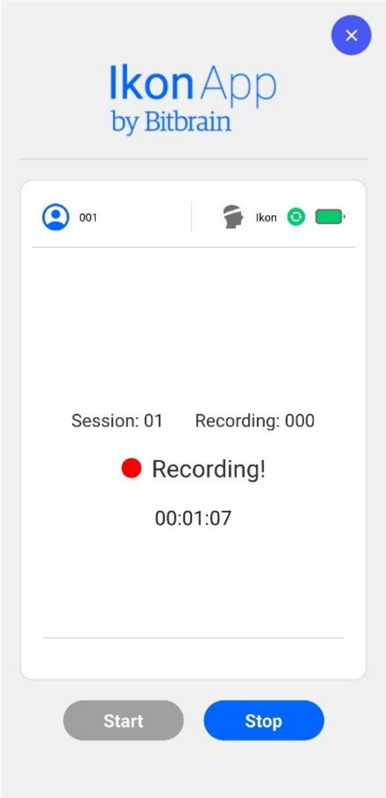

Figure 48. Recording window in Ikon App

To stop the recording click on the "Stop" button and the session will finish. If you wish to perform another task, you can click on "Start" again and a new recording will be created inside that session. The dataset will be stored in the internal storage of the device > Documents > ikonapp. The rest of the folders in this path are created according to the configuration of the Ikon App Configurator (Dataset name > Participant ID > Session > Recording).

To exit the application, click the cross button in the top-right corner of the screen and a confirmation message will appear, as shown in Figure 49. This is the recommended and safest way to close the application, as it ensures that any ongoing recordings are properly terminated and that the connection with the amplifier is correctly stopped.

Alternatively, but less safe for successfully disconnecting, you can exit the application by closing it and removing it from the device's background tasks, ensuring that it disconnects from the amplifier. This can be verified by checking the white LED lights on the amplifier: if they are blinking, it indicates that the device is correctly disconnected.

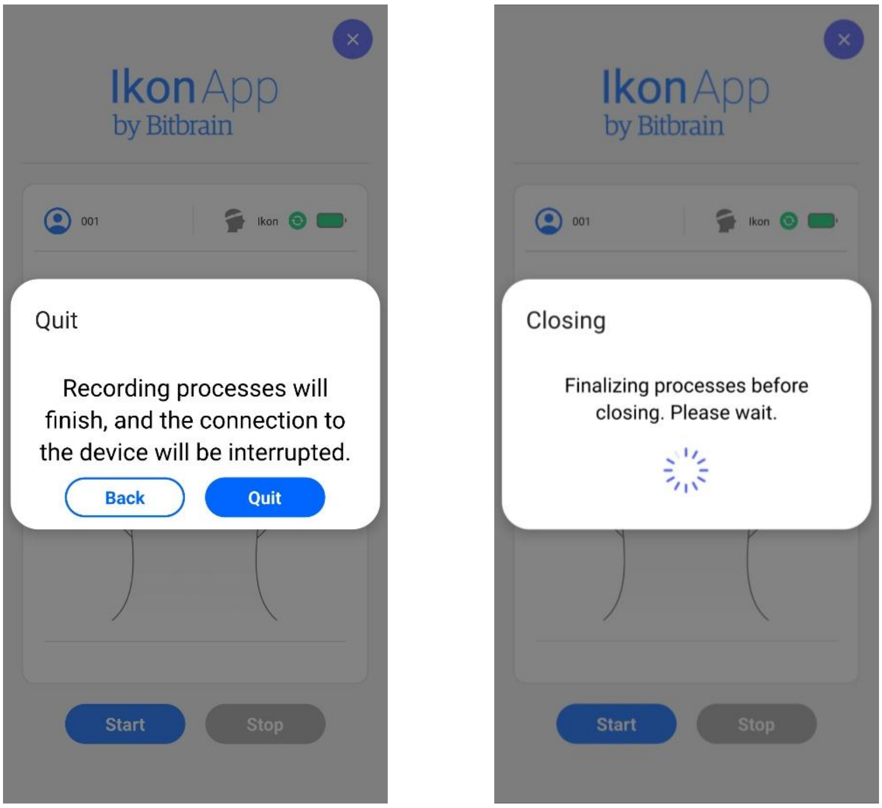

Figure 49. Confirmation message to exit Ikon App

13.4 DATA IMPORT FROM IKON APP RECORDINGS IN ANDROID

The import of recordings stored in the internal SD card of Ikon and Ikon Sleep devices must be carried out through SennsLite. To do so, please follow the steps below:

1. Connect the smartphone on which the Ikon App recordings were performed to a computer on which Sennslite is installed using a cable.
   Note: Make sure to select the "Transferring files" option in the smartphone's USB settings. This is necessary for the computer to correctly access the internal storage and retrieve the recorded files.

2. Copy the recorded files from the mobile device storage to a directory on the computer.

3. Disconnect the smartphone from the computer, then connect the device amplifier.

4. Follow the instructions in Section 6.2.1 to import files from the internal SD card of Ikon / Ikon Sleep devices.

13.5 HOW TO EXPORT DATA RECORDED WITH IKON APP IN ANDROID

Export data recorded with Ikon App through SennsLite Data Manager. Check Section 6 for detailed information regarding data export.

13.6 CONNECTIVITY SUPPORT

When Ikon App is launched, the connectivity and status of the device are automatically checked to ensure it is ready for recording. This step verifies that the system is properly set up and that the amplifier and band are correctly connected. If any of these conditions are not met, a message with a "Retry" button will appear, allowing the user to re-check the device and band connectivity before starting the recording. The most common cases and their solutions are described below:

- "Couldn't find the device" message appears when the amplifier is turned off at the time of the check. To resolve this, turn on the amplifier and click Retry.
- "Band not detected" message appears when the amplifier is on but not connected to a band. To solve this, connect the amplifier to the correct band and click Retry.
- "Wrong band" message appears when the amplifier is connected to a band type that does not match the one configured in the Ikon App Configurator. To solve this, connect the amplifier to the correct band type and click Retry.
- "Reconnecting" message appears when the amplifier goes out of Bluetooth range. To solve this, bring the amplifier back within range of the smartphone and the connection will be re-established automatically.

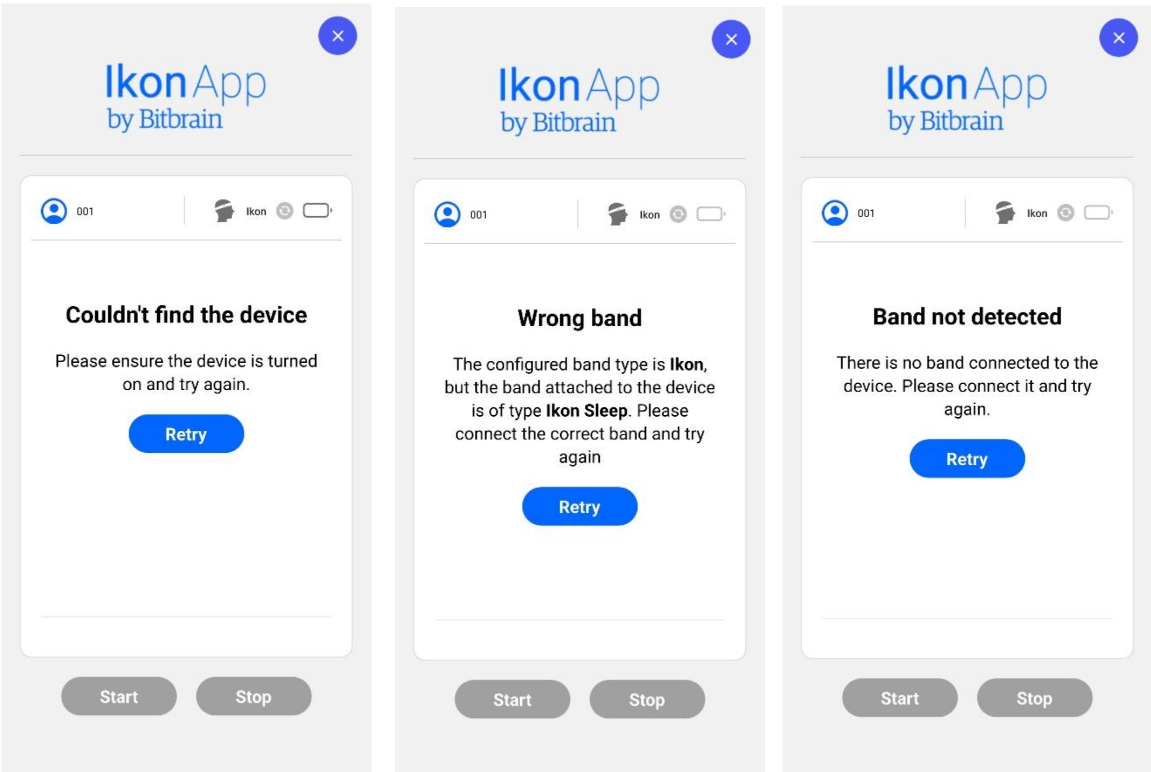

Figure 50. Connectivity feedback messages shown when device or band conditions are not correctly met.

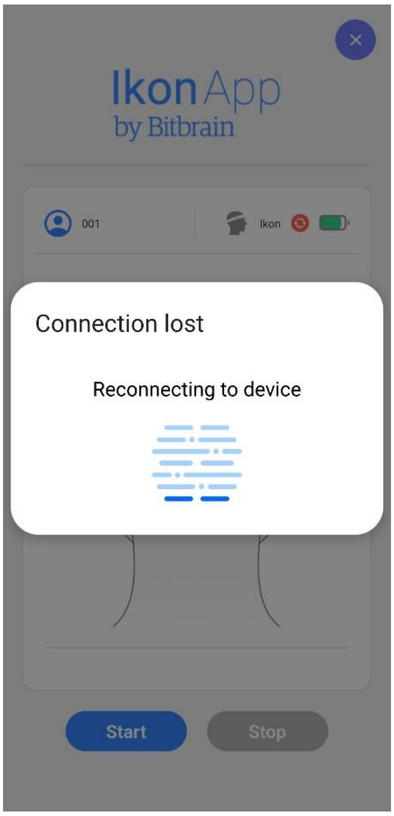

Figure 51. “Reconnecting” notification during temporary disconnection.

14. Contact

For any problem, question or comment please contact us at support@bitbrain.com

www.bitbrain.com
info@bitbrain.com