

# User Manual

UNEEG™ EpiSight

Version number 1.11

UNEEG™ EpiSight is released as part of the medical device encevis™



Manufacturer:  
AIT - Austrian Institute of Technology GmbH;  
Giefinggasse 4; 1210 Vienna; Austria  
Date of manufacture: 2021



Use-by date:  
Windows 10: 10/2025



Notified Body:  
DQS Medizinprodukte GmbH; August-Schanz-Straße 2;  
60433 Frankfurt am Main; Germany



Caution: Please read paragraphs marked with this symbol carefully as they contain important safety information.









Issuing date of this document:  
2021-03-30

# Table of Content

Warnings and precautions .....	5
Contraindications .....	6
Possible adverse effects .....	6
Quick Start Guide.....	7
Installation and license activation .....	8
UNEEG™ EpiSight Patient Database .....	9
UNEEG™ EpiSight Trending.....	10
UNEEG™ EpiSight Spectrogram.....	11
UNEEG™ EpiSight Report.....	12
Keyboard shortcuts.....	13
UNEEG™ EpiSight.....	14
Overview.....	15
UNEEG™ EpiSight Patient Database.....	16
Patient list .....	16
Add a new patient to the database .....	17
Patient and data information.....	17
UNEEG™ EpiSight Viewer .....	19
Overview.....	19
Global timeline.....	20
Trending traces .....	21
Spectrogram traces .....	23
EEG traces.....	24
Using markers in EpiSight.....	25
UNEEG™ EpiSight Report .....	30
UNEEG™ EpiSight settings menu.....	33
General settings .....	33
Display calibration .....	36
Show marker list.....	37
Appendix A .....	38
Description of the algorithms.....	39
UNEEG™ EpiSight seizure detection .....	39
UNEEG™ EpiSight rhythmic pattern detection .....	39
UNEEG™ EpiSight aEEG.....	40
UNEEG™ EpiSight background frequency .....	41

UNEEG™ EpiSight spectrogram .....	41
-----------------------------------	----

## Warnings and precautions

	This version of UNEEG™ EpiSight is CE-certified as a medical device. If your country requires any other approval for medical devices you must not use this version of UNEEG™ EpiSight. Please contact your local distributor to receive a version of UNEEG™ EpiSight that is not certified as a medical device and can be used outside countries that accept the CE mark.
	The modules from UNEEG™ EpiSight for the automatic analysis of EEG cannot replace the examination by the physician. As for any other automatic procedure there can be inaccuracies during the analysis with UNEEG™ EpiSight. The original EEG still needs to be used for the evaluation and the results of UNEEG™ EpiSight need to be confirmed based on the unaltered raw EEG trace.
	UNEEG™ EpiSight does not provide any diagnosis or diagnostic recommendations or predictions of the patient's state. It remains the responsibility of the physician to decide over the diagnosis or to induce treatment.
	The use of the software cannot replace the real-time surveillance by medical staff particularly of the vital functions. The patient's safety remains the responsibility of the medical professional.
	The maximum length for one continuous EEG recording that can be analyzed with UNEEG™ EpiSight is one year. If a recording is longer than one year, UNEEG™ EpiSight will stop processing.
	UNEEG™ EpiSight seizure detection cannot be used as an alarm system, since there may be a delay of several minutes between the clinical onset of a seizure and the display of the detected pattern. Some EEG-events with epileptic seizures that have an electrographic correlate might be missed. For this reason, UNEEG™ EpiSight seizure detection can only support but cannot replace the qualified expert in the real-time monitoring.
	UNEEG™ EpiSight detection of rhythmic pattern, aEEG or background frequency must not be used as an alarm system, since the visualization of patterns could be delayed by up to several minutes.
	Some events, where patterns defined in the Standardized Critical Care EEG Terminology of the American Clinical Neurophysiology Society are visible in the EEG, might be missed. All measures of the module UNEEG™ EpiSight pattern detection must be evaluated in combination with the original raw EEG and must not be the only basis for a diagnosis, treatment or change of treatment.

## Contraindications

There are no known contraindications for the use of UNEEG™ EpiSight.

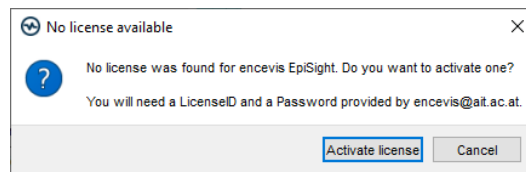
## Possible adverse effects

There are no known possible adverse effects when using UNEEG™ EpiSight.

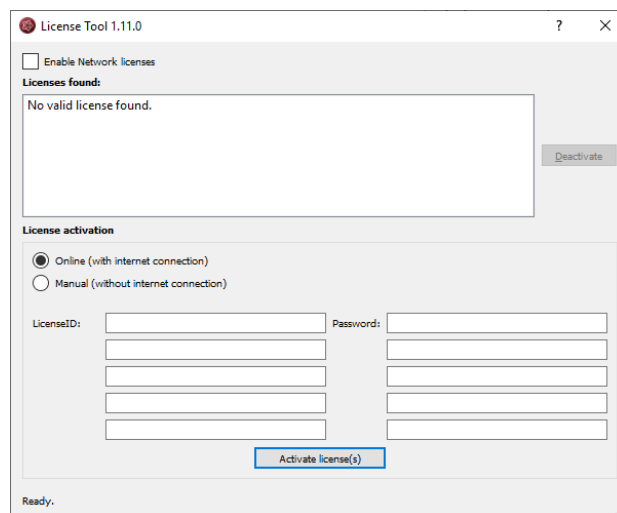
# Quick Start Guide

## Installation and license activation

1. Download UNEEG™ EpiSight.
2. Start the **UNEEG™ EpiSight Installer** by double-clicking the downloaded executable.
3. The installer will guide you through the installation process.
4. Once the installation has finished, start UNEEG™ EpiSight by clicking on the icon on your desktop.
5. You can add new patients to the database and import data.
6. In order to open the patient's EEG, you will need an active license.
7. Click on “*Open patient*”, the following window will pop up:



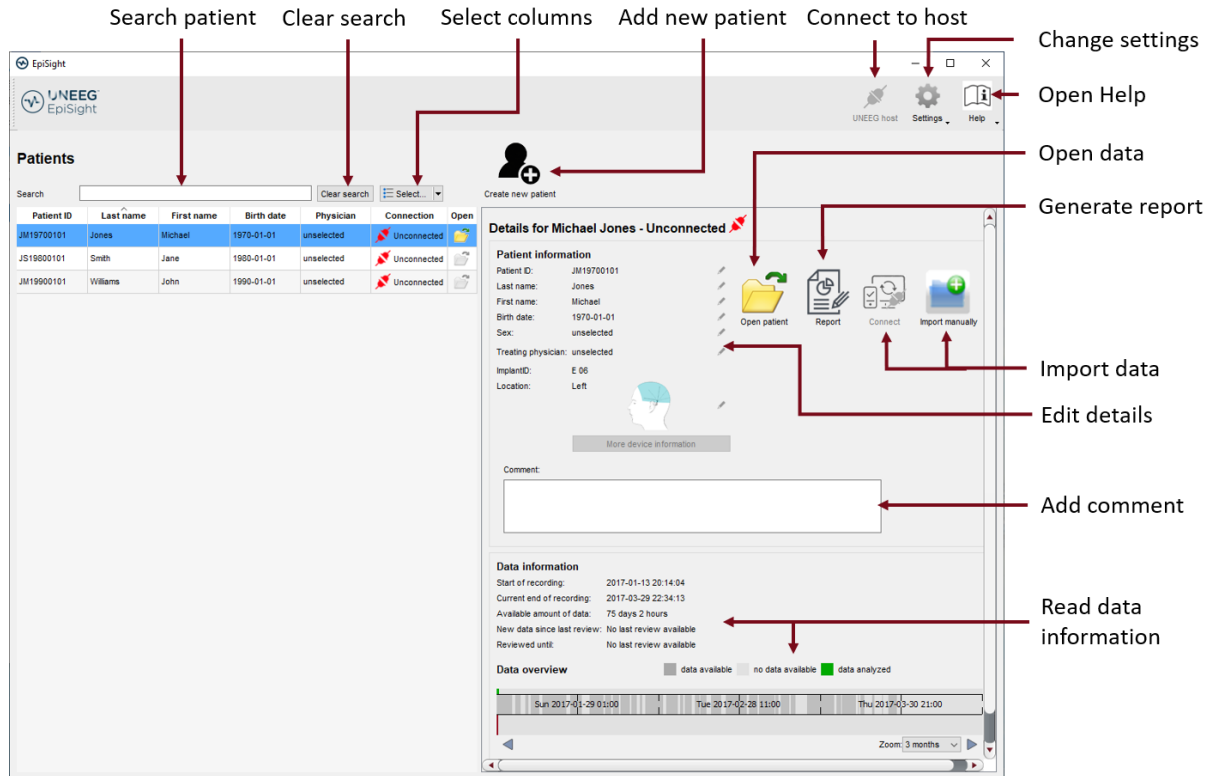
8. Press “*Activate license*”, the License Tool will pop up.



9. If you are connected to the internet, select „*Online*“ as activation mode. Otherwise, select “*Manual*” and contact your distributor in order to get the keys for the manual activation.
10. Enter your LicenseID and Password.
11. Press “*Activate license(s)*”.

## UNEEG™ EpiSight Patient Database

Starting UNEEG™ EpiSight will open the patient database window.

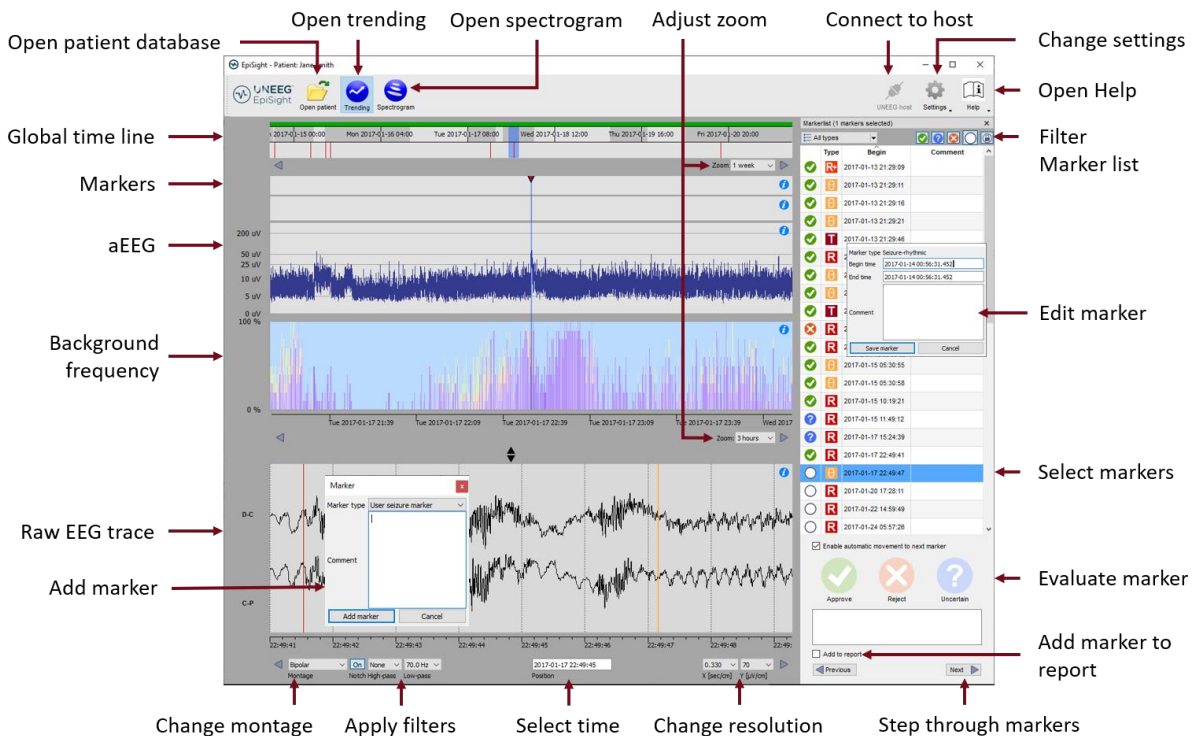


The patient database offers the following functionalities:

- Search for a patient by ID, name or date of birth
- Select the columns shown in the patient list
- Add a new patient
- Edit the patient's information
- Get the information about the EEG data available for each patient
- Open the patient's EEG
- Generate a report
- Import data by connecting to the UNEEG ProConnect
- Import data manually by selecting a folder
- Connect to the UNEEG ProConnect
- Change settings
- Open help

## UNEEG™ EpiSight Trending

Clicking on “Open patient” will open the UNEEG™ EpiSight Trending window.

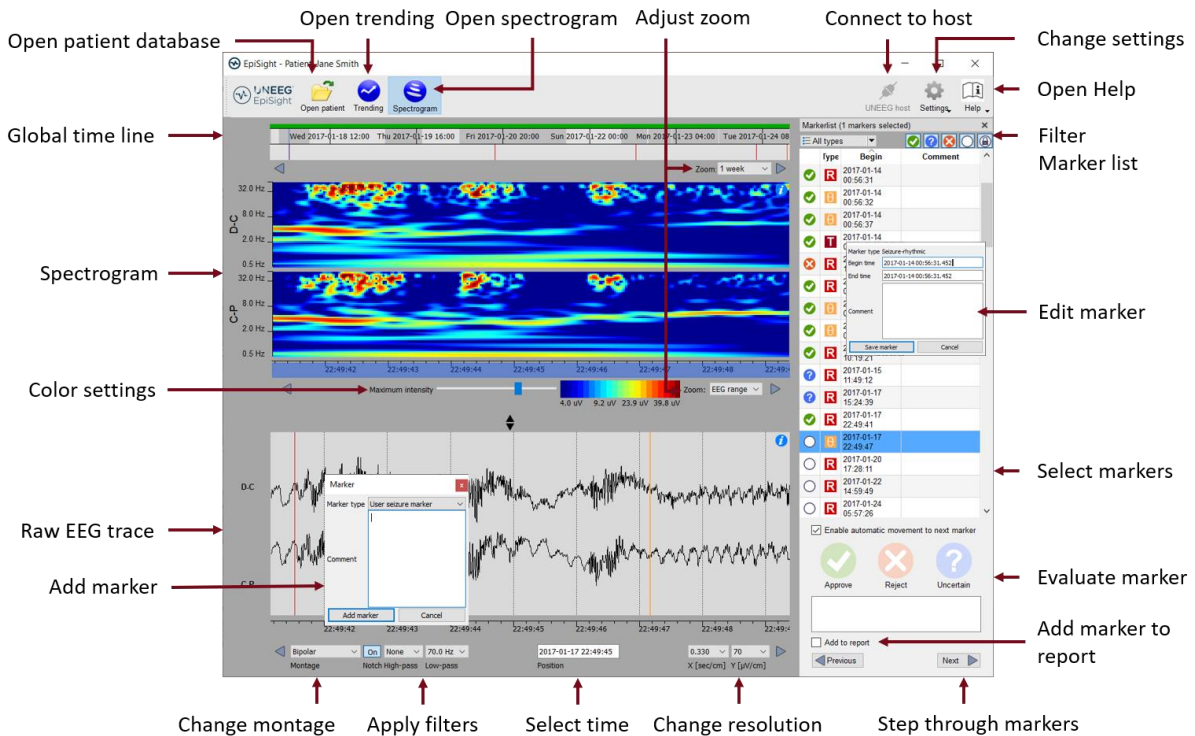


EpiSight EEG-trending includes the following functions and traces:

- Global timeline with an overview over all available data
- Zoom in the global timeline and in the analysis windows over a drop-down menu or the mouse wheel
- Seizure and other markers in a trace and in a list on the right side of the window
- Rhythmic pattern markers
- Amplitude-integrated EEG (aEEG)
- Background frequency
- EEG plot synchronized to the traces above
- Change montage
- Apply notch, high-pass and low-pass filters
- Change resolution in time and voltage
- Add markers
- Review and edit markers
- Filter marker list by marker type and by status

## UNEEG™ EpiSight Spectrogram

Clicking on the icon “Spectrogram” will show the spectrogram traces.

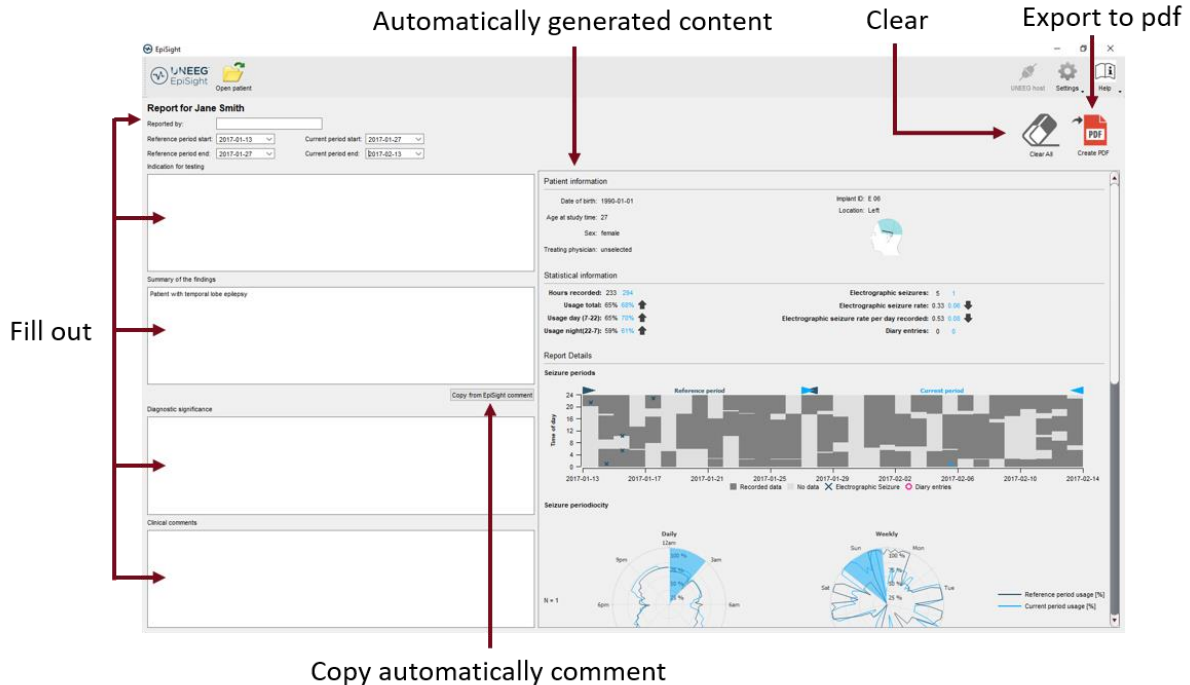


The spectrogram adds the following functionalities:

- Display of the spectrogram of the channels D-C and C-P.
- Get the estimated frequency in the spectrogram trace
- Adjust the color settings by changing the maximum intensity shown.

## UNEEG™ EpiSight Report

Clicking on “**Report**” will open the report window.



The screenshot shows the EpiSight report interface for a patient named Jane Smith. The interface is divided into several sections:

- Header:** Includes the UNEEG EpiSight logo and a title bar with 'Automatically generated content', 'Clear', and 'Export to pdf' buttons.
- Form Fields (Left):**
  - Report for Jane Smith:** Includes fields for 'Reported by', 'Reference period start/end', 'Current period start/end', and 'Indication for testing'.
  - Summary of the findings:** A text area for the patient's findings.
  - Diagnostic significance:** A text area for diagnostic significance.
  - Clinical comments:** A text area for clinical comments.
- Report Details (Right):**
  - Patient information:** Includes date of birth, age at study time, sex, and location.
  - Statistical information:** Includes hours recorded, seizure rates, and diary entries.
  - Seizure periods:** A heatmap showing seizure activity over time.
  - Seizure periodicity:** Two circular plots showing seizure activity by day of the week.

Annotations with red arrows point to various features:

- Fill out:** Points to the form fields on the left.
- Copy automatically comment:** Points to the 'Copy from EpiSight comment' button.
- Automatically generated content:** Points to the top header area.
- Clear:** Points to the 'Clear All' button.
- Export to pdf:** Points to the 'Create PDF' button.

The report offers the following functionalities:

- Enter additional clinical information including:
  - Indication for testing
  - Summary of the findings
  - Diagnostic significance
  - Clinical comments
- Generate content automatically including:
  - Patient information
  - Statistical information
  - Overview of seizure periods over time
  - Seizure periodicity plots
  - Seizure rate over time
  - Examples of seizures
- Copy the EpiSight comment
- Export to a pdf file

## Keyboard shortcuts

The following table shows a summary of keyboard shortcuts available in UNEEG™ EpiSight

Modifier	Key	Function
		<b>EEG Plot area</b>
	Arrow left	Scroll EEG-Plot one page to the left
	Arrow right	Scroll EEG-Plot one page to the right
Shift	Arrow left	Scroll EEG-Plot one second to the left
Shift	Arrow right	Scroll EEG-Plot one second to the right
	Home	Scroll EEG-Plot to the beginning of the recording
	End	Scroll EEG-Plot to the end of the recording
		<b>Marker List</b>
	Arrow up	Scroll one row up in the marker list
	Arrow down	Scroll one row down in the marker list
Shift	Arrow up	Expand selection with next marker up
Shift	Arrow down	Expand selection with next marker down
Ctrl	A	Select all marker currently visible in the marker list
Ctrl	C	Copy selected marker to the clipboard
	A	Rate selected markers as "approved"
	R	Rate selected markers as "rejected"
	U	Rate selected markers as "uncertain"
		<b>Trending and Spectrogram</b>
Ctrl	S	Show spectrogram
Ctrl	T	Show trending
		<b>Edit Comment</b>
Ctrl	E	Open the comment dialog
Ctrl	Enter	Save changes and close comment dialog
	Esc	Discard changes and close comment dialog

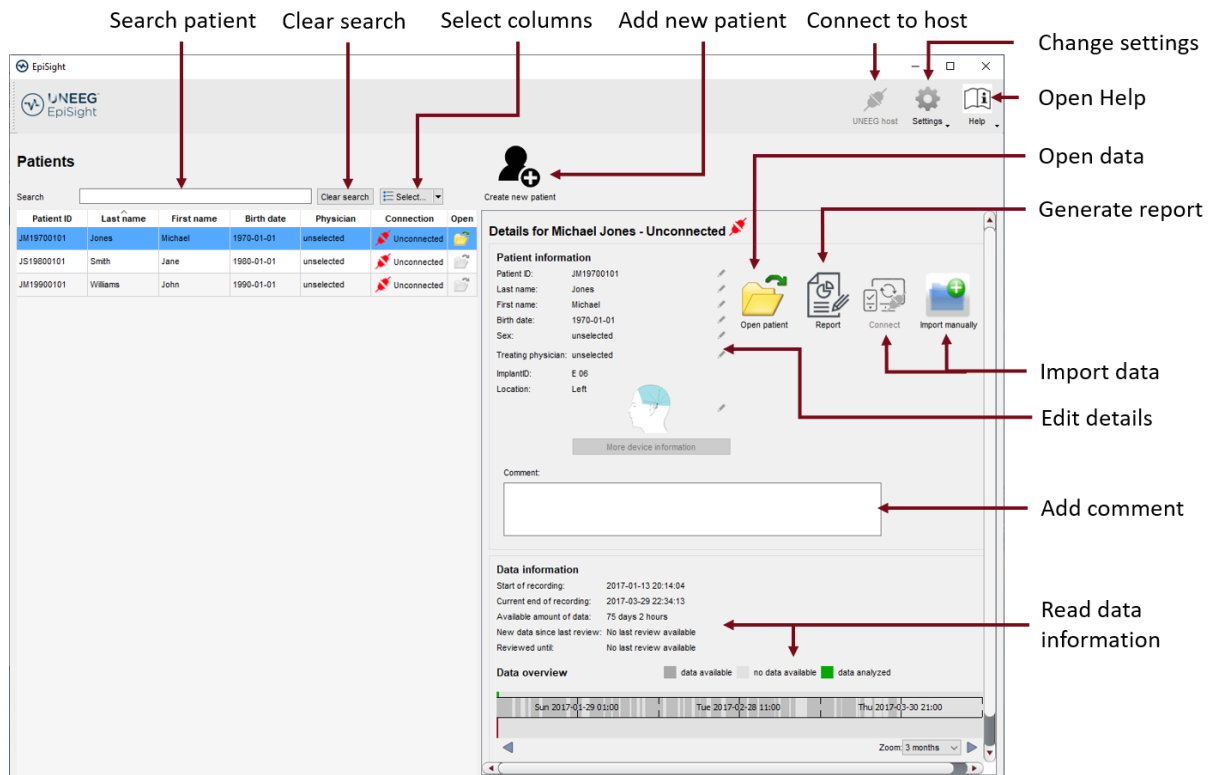
# UNEEG™ EpiSight

# Overview

UNEEG™ EpiSight is a software that enables you to review your patients' EEG recorded with a UNEEG SubQ™ 24/7 device. It includes a patient database, an EEG viewer, a series of EEG analysis and reporting tools. The software has several windows that will be described in the following sections.

# UNEEG™ EpiSight Patient Database

When you start UNEEG™ EpiSight, the patient database window opens.



In the following, the functions of the patient database will be described.

## Patient list

In the left panel the list of patients registered in the database is shown.

### Search patient

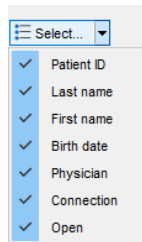
Fill in the search field and the list will be automatically filtered. The filtered results are shown in the patient list.

### Clear search

Click on the button "Clear search" and the search results will be cleared. All patients contained in the database will be shown again.

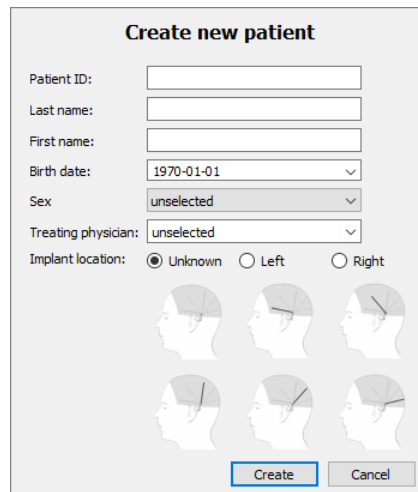
### Select columns

You can choose which columns are shown in the patient list by clicking on the drop-down menu “*Select*” as seen below and clicking on the check box on the left of the column name.



## Add a new patient to the database

In order to add a new patient to the database, click on the field “*Create new patient*”. The following window will pop-up:



Fill out the patient information. You must specify at least a patient ID or first and last name. This information can also be edited later.

## Patient and data information

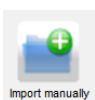
In the right panel of the window the detailed information of the patient selected in the patient list are shown. You will also find buttons to open a patient, connect to UNEEG ProConnect, write a report and import data manually.



**Open patient:** If data is available, the folder icon will be shown in color. Clicking on “*Open patient*” will open the UNEEG™ EpiSight Viewer with the EEG traces and the analysis of the patient's data. This can also be done by clicking on the icon in column “*Open*” or with a double click on the row in the patient list. If no data is available, the folder icon “*Open data*” will be shown in grey. You can then connect to the UNEEG ProConnect or import data manually.



**Generate report:** Clicking on “Report” will lead you to the report window. For more details go to the section [UNEEG™ EpiSight report](#).



**Import manually:** Use this option to manually import EEG data that have been stored on your file system. By clicking on “*Import manually*” you can select a folder where the recorded EEG files are stored. Clicking on “*Select folder*” will start the import of the data. EpiSight will recognize which recordings are new and related to your patient and the respective implant ID. The results of the import will be shown in the area “*Data information*”.



Note that the folder containing your EEG files will appear empty when you select it in the dialog.



**Connect:** You can connect a patient to a UNEEG™ ProConnect system if it is configured for your setup. Please consult the UNEEG™ documentation on how to establish the connection between EpiSight and ProConnect.

### Update patient information

The patient information can be edited anytime. Every field can be edited individually. Click on the little pencil symbol on the right side of the information. After changing the information press return or click outside the editing field.

### Add comment

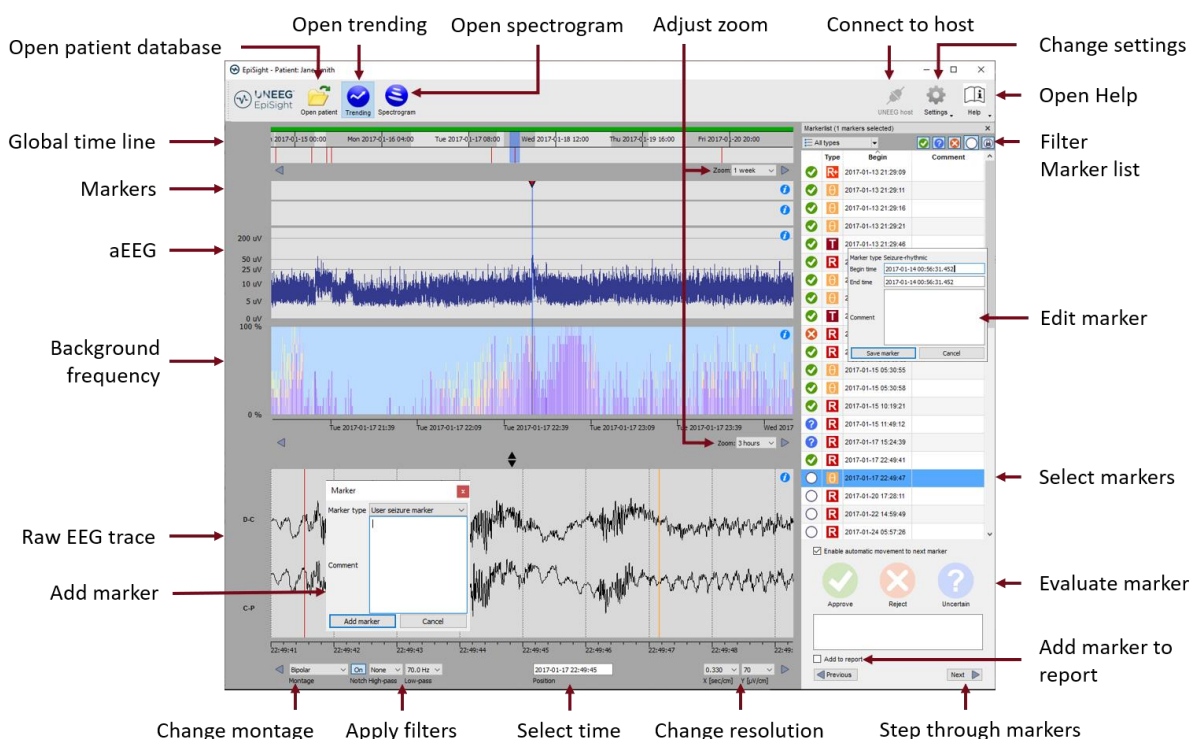
The field comment leaves space to enter additional information. This field can be pasted to the report. See the report section for details.

In the bottom part of the panel, the information about available data of the selected patient is shown. This includes:

- **Start of recording:** The date of the first recorded EEG data
- **Current end of recording:** The date of the last recorded EEG data
- **Available amount of data:** This shows the number of days and hours of recorded EEG data. This number can be much smaller than the total length of the recording as the patient might not have recorded 24hours per day.
- **New data since last review:** Information about the status of the review of the data. This field shows the time span between the date of the last approved marker and the current end of the recording.
- **Reviewed until:** This field shows the date of the last approved marker for this patient
- **Data overview:** The data overview indicates when EEG data is available for the patient. Dark grey areas show time periods with available data. Light grey areas indicates those periods where no EEG data were recorded. A colored bar shows how much of the data has already been analyzed. The latter is green when the analysis is in process and blue when the analysis is done.

# UNEEG™ EpiSight Viewer

Clicking on "Open patient" in the patient database will open UNEEG™ EpiSight Viewer with the trending traces.



In the following, the functions and the traces of EpiSight Viewer will be described.

## Overview

UNEEG™ EpiSight performs automated analysis on the EEG data and shows the EEG in parallel. This includes a seizure detection and classification of epochs related to patterns defined in the ACNS's Standardized Critical Care EEG Terminology. In addition, it shows aEEG, the background frequency and a spectrogram. It provides a condensed graphical representation that helps to assess important information about the state of your patient's brain. UNEEG™ EpiSight Viewer consists of a global timeline, several trending traces, spectrogram traces, the raw EEG traces and a marker list.

## User- and data input

The input to UNEEG™ EpiSight is the raw EEG signal only. No video or other data are used by the algorithm. Any settings selected in the Viewer (e.g. filter settings or montage) are for

visualization purposes only. The algorithm does not consider the visualization settings to perform calculations and thus no user input is possible nor needed.

## User-defined parameters

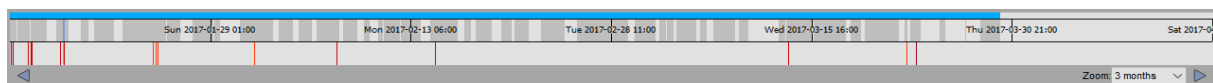
There are no parameters in the algorithm that can be changed by the user.

## Outputs to the user

UNEEG™ EpiSight makes the results available to the user in form of different types of markers as a function of time. The markers are to be interpreted as epochs in the EEG with a high probability of having certain signal characteristics. The results are presented in a graphical user interface.

## Global timeline

The global timeline at the top of the display gives an overview of the complete length of the available EEG and the point in time that is currently shown in the traces below. The global timeline is shown both in the trending and in the spectrogram window.



The top line shows the **progress of the analysis**. It is green during calculation and blue when the calculations are done.

Below the progress line, dark grey areas show **when EEG is available**. Light grey areas indicate periods where no EEG data was recorded.

In the bottom line, vertical bars indicate several types of **marker found in the EEG**. These bars match the time of the entries in the marker list. All marker except pattern markers are shown. You can click on any of these bars to show the corresponding EEG in the EEG plot below (lower panel). For more information on the possible markers, go to the section [Markers](#).

### Effect of status filter in the marker list

When you filter the marker list by the rating status “Approved”, “Rejected”, “Uncertain”, or “Locked” only markers with the selected status will appear in the marker line. Filtering can be done by clicking on the icons on the top right corner of the marker list. Note that filtering the marker list by marker type will not have any effect on the markers shown in this trace.

The blue vertical bar shows the **time interval** that is currently shown in the analysis traces. The width of this blue bar is set by the zoom of the analysis traces.

### Zooming in the global timeline

The global timeline has several zoom levels from 1 week to 12 months. At startup, the zoom level will be set such that the global timeline always shows the complete EEG. You can change this zoom level by using the drop-down menu “Zoom” on the right corner underneath the global timeline or by using the mouse wheel when the mouse pointer is inside the global timeline.

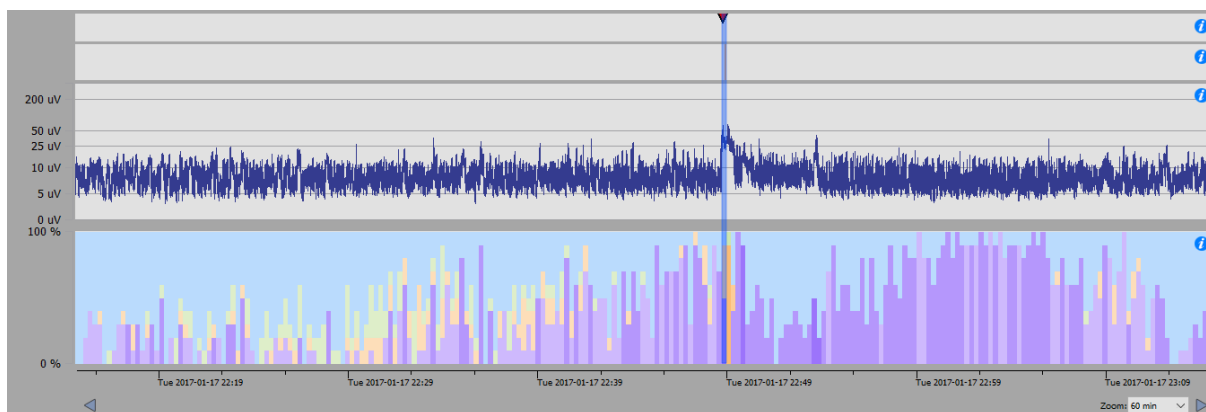
## Navigation in time

To navigate in time click on the global timeline. This will set the trending traces below to this selected time. A blue bar indicates the new selected time window. You can hold and drag the blue bar with the mouse to change its position in time.

Hold and drag your mouse at any place of the global timeline to move the global time. Alternatively, use the arrow buttons underneath the traces to move back and forward in time. The step size is defined in the settings, see section [Page movement](#).

## Trending traces

The traces underneath the global timeline are trending traces that are calculated automatically. Each of the traces is described in the following sections.



## Seizures and other markers

In the first trace underneath the global timeline, all seizure marker, user-defined markers and file markers are shown as little triangles. These markers can also be found in the [marker list](#). The color of the triangle gives information about the [marker type](#). In principle, the markers that are shown are those that are automatically detected by UNEEG™ EpiSight seizure detection. There are three different types of seizure markers:

<b>T</b>	Detection of seizure with high-amplitude tonic activity
<b>R</b>	Detection of seizure with large increase in rhythmic amplitude
<b>R+</b>	Detection of seizure with small increase in rhythmic amplitude and frequency change

By clicking on a triangle, the corresponding marker in the marker list will be selected and the raw EEG at this time will be shown in the EEG traces below.

### Effect of status filter in marker list

When you filter the marker list by the rating status “Approved”, “Rejected”, “Uncertain”, or “Locked” only the markers with the selected status will appear in this marker trace. This can

be done by clicking on the icons on the top right corner of the marker list. Note that filtering the marker list by marker type will not have any effect on the markers shown in this trace.

For more information on the seizure detection algorithm go to section [Seizure detection](#) in Annex 1. For more information on the markers and the possible marker types go to section [Markers](#).

## Pattern markers

In the second trace underneath the global timeline, vertical bars show all markers that were generated by the rhythmic pattern detection. These markers can also be found in the [marker list](#). The color of the bars gives information about the [marker type](#). There are three different types of pattern markers:

$\delta$	Rhythmic delta activity including sharp waves or spikes
$\theta$	Rhythmic theta activity
$\alpha$	Rhythmic alpha activity

By clicking on the marker, the marker in the marker list will be selected and the raw EEG at this time will be shown in the EEG traces below.

### Effect of status filter in marker list

When you filter the marker list by the rating status “Approved”, “Rejected”, “Uncertain”, or “Locked” only the markers with the selected status will appear in this marker trace. This can be done by clicking on the icons on the top right corner of the marker list. Note that filtering the marker list by marker type will not have any effect on the markers shown in this trace.

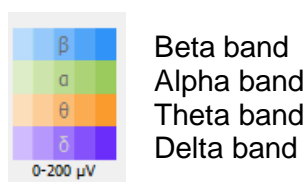
For more information on the pattern detection algorithm go to section [Rhythmic pattern detection](#). For more information on the markers and the possible marker types, go to section [Markers](#).

## Amplitude-integrated EEG (aEEG)

In the third trace underneath the global timeline, the amplitude-integrated EEG (aEEG) is shown. The aEEG trend displays the amplitude characteristics of a filtered, rectified representation of the EEG signal as a function of time. Time is displayed on the x-axis and the aEEG amplitude measure on the y-axis. The amplitude integrated EEG is shown on a combined linear and logarithmic scale in the range 0 $\mu$ V - 400  $\mu$ V as defined in [Zhang et al. 2013](#). When you click in the trace, the raw EEG at this point in time is shown in the EEG traces below. The aEEG trend provides a simplified depiction of amplitude characteristics of the EEG signal and is intended to be used in conjunction with other EEG trends and with the original EEG waveforms for a complete and thorough analysis of the EEG.

## Background frequency

In the fourth trace underneath the global timeline, the background frequency is shown. The UNEEG™ EpiSight background frequency feature consists of a continuous measure that describes the frequency distribution of the EEG. The relative proportions of the four Berger frequency bands delta (< 4Hz), theta (4-7.5 Hz), alpha (7.5-12.5Hz), and beta (>12.5 Hz) are shown in the range between 0-100% as a function of time. The intensity of the colors corresponds to the amplitudes in these four frequency bands. The amplitudes for each Berger band, which directly correspond to the power levels in a conventional spectrogram, are indicated by color intensities in the UNEEG™ EpiSight frequency band graph: high amplitudes are indicated by high intensities and vice versa. The color code is the following:



When you click in the trace, the raw EEG at this point in time is shown in the EEG traces below.

### Navigation in time

To navigate in time, you can click in any of the traces. This will set the EEG traces underneath to show this selected time. The blue bar indicates the new selected time window. Hold and drag your mouse to move the traces or use the arrow buttons underneath the traces to move back and forward in time. The step size is defined in the settings, see section [Page movement](#).

### Zoom

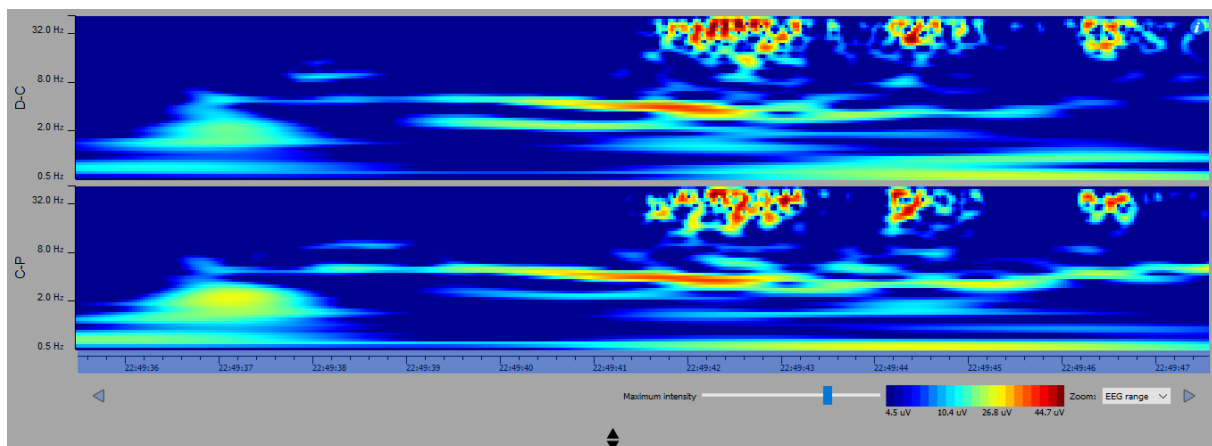
The trending traces have several zoom levels from 15 min to 7 days. At startup the zoom level is 3 hours. You can change this zoom level by using the drop-down menu “Zoom” on the right side underneath the trending traces or by using the mouse wheel when the mouse pointer is inside any of the trending traces.

### Adjust height

You can adjust the height of the traces by clicking, holding and dragging the mouse on the two opposite black triangles in the area between the trending traces and the EEG traces.

## Spectrogram traces

The spectrogram is shown when you click on the icon “*Spectrogram*” in the tool bar on the top left. The trending traces are then replaced by the spectrogram traces.



The spectrogram describes the distribution of power over the frequency components of the EEG data. The power spectral density is calculated for each channel using Gabor wavelets. The x-axis represents time and the logarithmic y-axis represents the frequency. The value of the power spectral density is shown as a heat map. At a particular frequency and time, cooler colors, as blue and green, show lower power and warmer colors, as yellow, orange and red, show higher power. For each channel of the montage a trace is shown.

By moving the mouse cursor in the traces, you can read the exact time and frequency the mouse is pointing at.

### Set maximum intensity

The legend below the spectrogram shows the detailed color map in  $\mu\text{V}$  for amplitudes of sinusoidal signals. This mapping can be interactively shifted to achieve optimal contrast for given data. Click, hold and drag the slider “*Maximum intensity*” to the left or to the right.

### Navigation in time

To navigate, you click on any of the traces. This will set the EEG traces underneath to show this selected time. The blue bar overlaying the x-axis indicates the new selected time window. Hold and drag your mouse to move the traces or use the arrow buttons underneath the traces to move back and forward in time. The step size is defined in the settings, see section [Page movement](#).

### Zoom

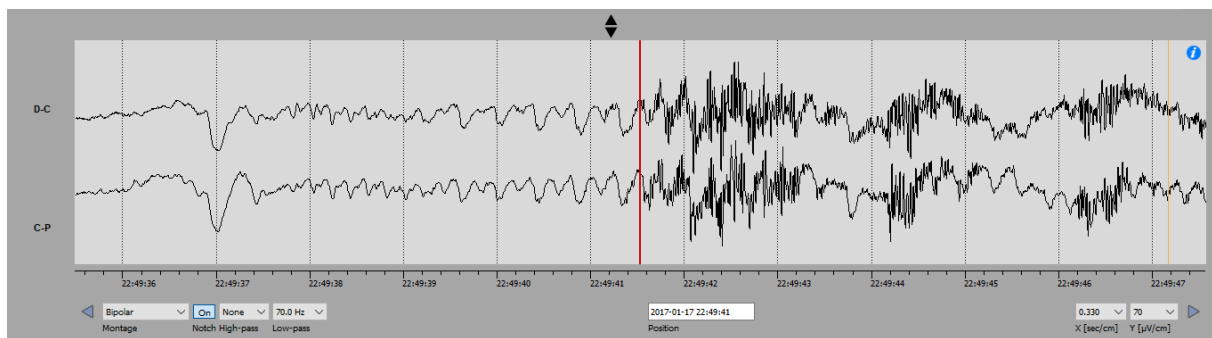
The spectrogram traces have several zoom levels from 15 sec to 10min. At startup the zoom level is 3 minutes. You can change this zoom level by using the drop-down menu “*Zoom*” on the right side underneath the spectrogram traces or by using the mouse wheel when the mouse pointer is inside any of the spectrogram traces.

### Adjust the height of the spectrogram

You can adjust the height of the traces by clicking, holding and dragging the mouse on the two opposite triangles in the area between the spectrogram traces and the EEG traces.

## EEG traces

In the lower part of the window, the EEG traces are shown. Several controls can be found on the top and underneath that change the visualization of the acquired EEG traces.



### Adjust height

You can adjust the height of the traces by clicking, holding and dragging the mouse on the two opposite triangles in the area between the trending traces and the EEG traces.

### Navigation in time

Hold and drag your **mouse** to move the traces or use the **arrow buttons** underneath the traces to move back and forward in time. The step size is defined in the settings, see section [Page movement](#). You can also use the left and right **arrows keys** of your keyboard to move back and forward in time. This will move the EEG-trace one screen size to the left or right. When using **SHIFT + arrow key** the EEG trace will move in steps of one second.

To move to a specific point in time you can click in the field "*Position*" under the EEG plot and enter the date and time you want to see the EEG.

### Montage

You can choose between two possible montages: bipolar (D-C, C-P) or three channels (D-C, C-P, D-P). Because only three electrodes are available, we did not add a possibility to define new montages.

### Notch filter

Click on the button "On" / "Off" above the "*Notch*" label to switch on/off the notch filter at 50Hz or 60Hz, depending on your country.

### High-pass filter

Click on the drop-down list "*High-pass*" and select the frequency you want for the high-pass filter.

### Low-pass filter

Click on the drop-down list "*Low-pass*" and select the frequency you want for the low-pass filter.

### Time resolution

Click on the drop-down list "X [sec/cm]" at the right bottom of the viewer and select the new time resolution.

### Voltage resolution

Click on the drop-down list "Y [µV/cm]" at the bottom of the viewer and select the new voltage resolution.

## Using markers in EpiSight

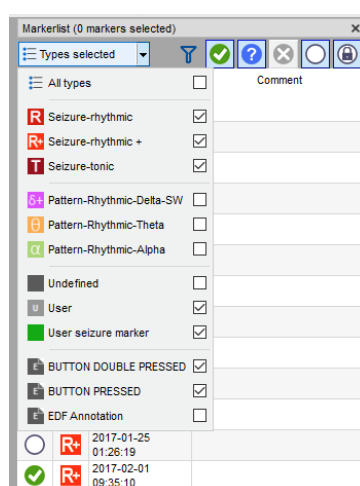
Special EEG events can be marked in the EEG using markers. A marker includes the following information:

- Type (see the different marker types)
- Begin time
- Comment

Markers are saved with the data and can be viewed in the marker list anytime. To distinguish different types of markers, each marker type has its own color and letter that appears as an icon in the marker list. In the EEG traces, markers appear as colored vertical lines. The color of the traces can be defined by the user.

## Marker types

All available marker types can be seen by opening the drop-down list “All types”.



### Pattern markers

Pattern markers are generated automatically by the UNEEG™ EpiSight analysis. They can be reviewed and their status can be changed as described in section [Marker status](#). They cannot be deleted. Their color can be changed in the settings. For more details go to section [Marker types](#).

### Seizure markers

Seizure markers are generated automatically by the EpiSight analysis. They can be reviewed, and their status can be changed as described in section [Marker status](#). They cannot be deleted. Their color can be changed in the settings. For more details go to section [Marker types](#). There are three types of markers: **Seizure-rhythmic** **R** indicates seizures with large increase in rhythmic amplitude. **Seizure-rhythmic+** **R+** indicates seizures with small increase in rhythmic amplitude and frequency changes. **Seizure-tonic** **T** indicates seizures with high amplitude tonic activity.

### User seizure marker

User seizure markers are markers that can be defined by the user. You can add these markers directly in the EEG traces. It is recommended to use this marker if you find additional seizures in the EEG that were not detected by the automatic analysis. The status of a user seizure marker is always locked since they cannot be rated. They can be deleted anytime. Their color can be changed in the settings. For more details go to section [Marker types](#).



*User seizure marker* is the only user-defined marker type that will be included in the statistical information and the plots in the report section. The number of markers of

type “User seizure marker” and approved markers of type “Seizure markers” will be shown as number of electrographic seizures in the report.

### User markers

User markers are markers that can be defined by the user. You can define as many different types of user marker as you need. Section [Marker types](#) describes how to define your own seizure marker type. The status of these user markers is locked as they cannot be rated. They can be deleted anytime.

### External marker types

External marker types are markers that are imported from the EEG files. Their type name cannot be changed. The color and the letter can be customized. Their status is locked and they cannot be deleted.

## Marker status

The marker status can be used to rate the relevance of a system generated marker. The status can be defined for all automatically generated markers of the type Seizure and Pattern. The default status is empty and can be changed by the user during review.

Markers can have five different types of status:



**Empty:** This is the default status for Seizure and Pattern markers.



**Approve:** This status should be selected when the user agrees with the marker.



**Reject:** This status should be selected when the user disagrees with the marker.



**Uncertain:** This status should be selected when the user is not sure about the correctness of the marker.



**Locked:** This status is set by default for all markers other than Seizure and Pattern and cannot be changed.



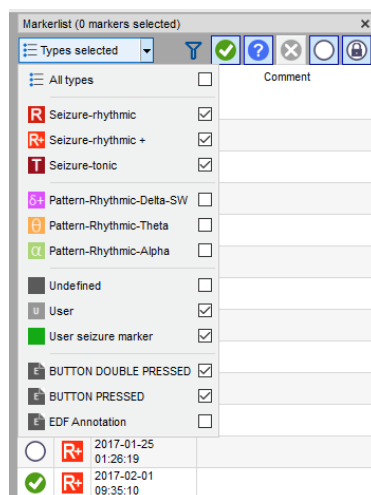
Only marker rated “Approved” will be considered in the report of EpiSight. Only these markers will be included in the statistics and the different plots.

## Marker list

The marker list is visible at the right side of the screen. It shows all available markers: This can be markers that are already contained in the EEG file, added by the automated analysis or added manually by the user. If you do not see a marker list, go to “*Settings > Show Markerlist*” to show the marker list.

### Filter by marker type

All markers have a defined type. These marker types are described in the section [Marker types](#). You can filter the maker list by the type of marker. Select all marker types you want to see in the drop-down list "All types".



### Filter by marker status

You can filter the marker list by the status of the markers. Click on the icon of the status you want to show or hide in the marker list.



This filter will also apply on the markers shown in the marker traces of the trending view on the left.

### Navigate through the list

Select the marker with the mouse or use the keyboard arrows for going up and down the list.

### Sort the list

Click on the title of the column you want to sort by.

### Change the fields of a marker

You can edit a marker by double-clicking in the row or right-clicking and selecting "Edit" in the context menu of the marker list. Alternatively, you can also edit a marker with a right-click directly on the marker line in the EEG traces and selecting "Edit marker" in the context menu.

### Delete user markers

You can delete a marker or a selection of markers by right-clicking on a marker and selecting "Delete selected" in the context menu. You can select several markers at once by selecting the markers while holding the Ctrl-key. They will then appear selected (colored in blue). Seizure and pattern markers cannot be deleted. They can only be set to state "Rejected".



Markers will be permanently deleted. There is no possibility to undo this action.

## Review markers

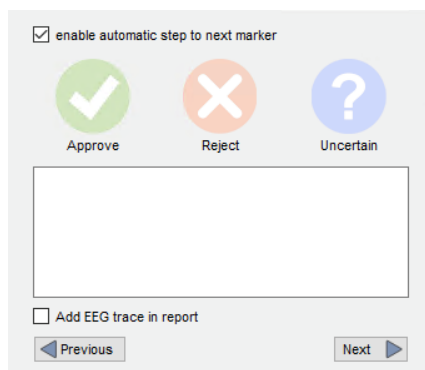
During review, the user has the possibility to rate all automatically generated markers of the type Seizure and Pattern by assigning a status to each item. The different types of status are described in the section [Marker status](#).



Only marker rated “Approved” will be considered in the report of EpiSight. Only these markers will be included in the statistics and the different plots.

## Rate markers

Markers can be rated by clicking on the icons *Approve*, *Reject* or *Uncertain* that appear on the right bottom corner of the marker list as seen in the picture below. The status can be changed anytime.



The interface shows a checkbox labeled "enable automatic step to next marker" which is checked. Below it are three circular icons: a green checkmark labeled "Approve", a red X labeled "Reject", and a blue question mark labeled "Uncertain". Below these icons is a large empty rectangular box. At the bottom, there is a checkbox labeled "Add EEG trace in report" which is unchecked, and two buttons labeled "Previous" and "Next".

## Step to the next marker

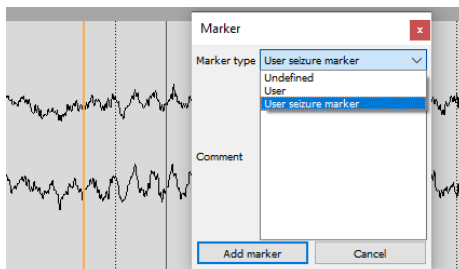
If you check the box “*Enable automatic movement to next marker*”, the next marker in the list will be automatically selected once you clicked on any of the status icons *Approve*, *Reject* or *Uncertain*. If the box is unchecked, you can get to the next marker by selecting it in the marker list or by pressing the buttons “*Next*” or “*Previous*”.

## Add seizure example to report

By checking the box “*Add EEG trace in report*”, an image of the EEG around the selected marker is generated and added to the report. The EEG will be shown 10 seconds before and 50 seconds after the marker. For more details, go to the section [Report](#).

## Adding a new marker to the EEG

A double-click in the EEG traces will open a marker window as seen below.

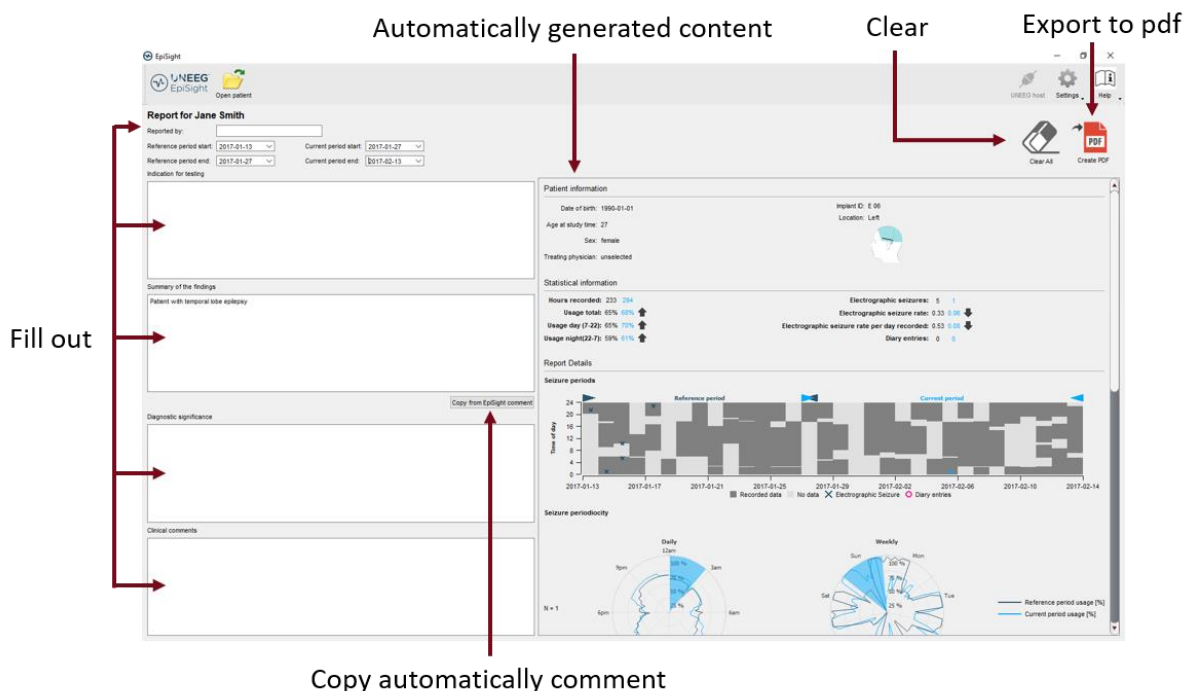


The window shows EEG traces on the left. On the right, there is a "Marker" window with a dropdown menu for "Marker type" showing options: "User seizure marker", "Undefined", "User", and "User seizure marker". Below the dropdown is a text area for "Comment". At the bottom are two buttons: "Add marker" and "Cancel".

Select the marker type you want to insert and optionally write a comment. “*Add marker*” will insert the marker into the system. You can also add a marker by right-clicking on the EEG traces and selecting “*Add marker*”.

# UNEEG™ EpiSight Report

Clicking on “**Report**” in the data information window will open the report window of UNEEG™ EpiSight. All data entered in the report will be saved automatically when you go back to the patient database.



The screenshot shows the UNEEG EpiSight Report window. On the left, there are input fields for patient information and a section for clinical notes. On the right, there is a summary of findings and a detailed report section. Annotations include:

- Automatically generated content**: Points to the summary of findings and the detailed report section.
- Clear**: Points to the 'Clear All' button in the top right corner.
- Export to pdf**: Points to the 'Create PDF' button in the top right corner.
- Fill out**: Points to the input fields on the left side of the window.
- Copy automatically comment**: Points to the 'Copy from EpiSight comment' button in the detailed report section.

## User input to the report

On the left side of the window you can enter clinical information that you would like to include in the report.

### Report by

Enter the author(s) of the report

### Reference period and current period

The reference period and the current period are used to generate the information shown on the right side of the window. The current period is the period you are reporting. All seizures in this period will be shown in the plots on the right side of the window. The current period is always shown in **blue**.

The reference period is a previous time period that you want to compare the current values against. It is used to calculate the statistical information. All seizures in this time period are included in the seizure periods plot but are not shown in the seizure periodicity figures. The reference period is shown in grey.

### **Indication for testing**

The indication for testing can be entered in the corresponding field.

### **Summary of the findings**

The summary of the findings can be entered in the corresponding field. By clicking on the button “*Copy from EpiSight comment*”, all comments previously entered in the patient information screen will be automatically pasted to the summary of findings field.

### **Diagnostic significance**

The diagnostic significance can be entered in the corresponding field.

### **Clinical comments**

The clinical comments can be entered in the corresponding field.

## **Automatically generated content**

The right side of the window shows the content that is generated automatically based on the reference period and current period entered on the left side.

### **Patient information**

The patient information added to the report is the following:

- Date of birth
- Age at study time
- Sex
- Treating physician
- Implant ID and Location

### **Statistical information**

The statistical information shows the calculated values for the **current** period in **blue** and in **grey** for the **reference** period. An arrow shows if the values have increased or decreased compared to the reference period. The values include:

- Hours recorded
- Usage total
- Usage day from 7:00 until 22:00
- Usage night from 22:00 until 7:00
- Number of electrographic seizures
- Electrographic seizure rate
- Electrographic seizure rate per day recorded
- Diary entries

### **Seizure periods**

This diagram shows the recorded EEG data and the seizures that occurred in this time period. The x-axis represents days, the y-axis time of day. The left side of the diagram shows the reference period indicated by the two grey triangles facing each other. The right side shows the current period indicated by two blue triangles. The time intervals, where EEG was

recorded are plotted in dark grey. Light grey indicates time periods when no data is available. Dark crosses show electrographic seizures detected during the reference period. Blue crosses indicate seizures during the current period. Pink circles depict diary entries, i.e. double pressed and button double pressed events.

### Seizure periodicity

The seizure periodicity plot gives an overview of the use of the device and the distribution of seizures over the day and week. The number of seizures detected is shown next to “N=”.

The left seizure periodicity plot “*Daily*” shows the average distribution over the day. The grey and blue lines represent the average usage of the device over the day for the reference and the current period, respectively. Time periods when electrographic seizures occurred during the current period are shown as blue areas. The radius of the area shows the percentage of the seizures that occurrence in each time period.

The right seizure periodicity plot “*Weekly*” shows the average distribution over a week. The grey and blue lines represent the average usage of the device per day of the week for the reference and the current period, respectively. Time periods when electrographic seizures occurred during the current period are shown as blue areas. The radius of the area shows the percentage of the seizures that occurrence in each time period.



Only markers rated as approved are counted.



Only markers of type “seizure” and “user defined seizure” are included in this plot.



Only seizures occurring during the current period are shown.

### Seizure rate over time

This diagram shows a histogram giving the number of seizures per day for the reference period in comparison the current period. Reference period and current period are indicated by the two grey and blue triangles facing each other, respectively.

### Exemplar electrographic seizures

This section contains images of the EEG surrounding a marker for which the “*Add EEG trace in report*” checkbox has been checked as described in the [Add to report](#) section. An image of the EEG around the marker is generated and added to the report. The EEG will be shown 10 seconds before and 50 seconds after the marker.



Only markers rated as approved and added to the report will be shown.

## Clear all

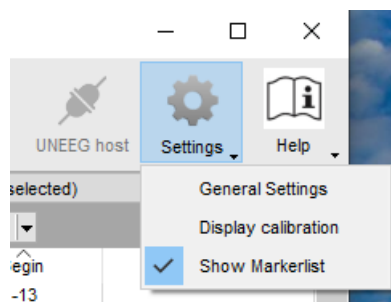
Clicking on the button “*Clear all*” will delete all fields and return the values of the reference and current periods to the default values. For the default settings, the entire time range for which EEG data are available is selected. For the reference period the first half of this period is selected. The current period will cover the second half of the available EEG data.

## Create pdf

Clicking on the button “*Create pdf*” will start the export of the report to a pdf file. In a dialog the filename and the path to the file can be chosen.

# UNEEG™ EpiSight Settings Menu

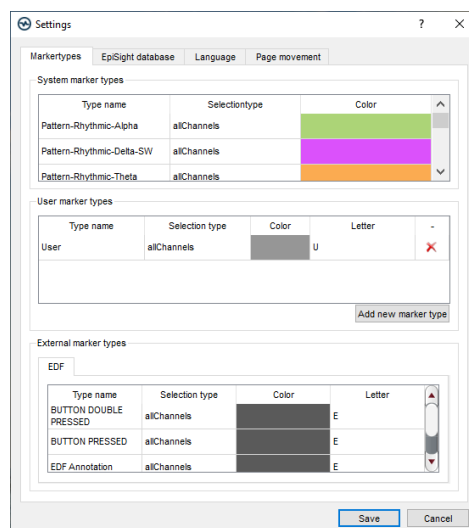
Several settings can be selected for UNEEG™ EpiSight. You open the settings menu by clicking on the settings button in the upper right corner.



## General settings

Selecting “**General settings**” leads you to a window with the four tabs. The settings apply to all patients and data equally. Please note that changes in the settings will only be applied after restarting EpiSight.

## Marker types



In this tab, you can see which marker types are available and how to manage them.

### System marker types

*System marker types* are the default marker types of UNEEG™ EpiSight. They include:

- [Pattern marker](#)
- [Seizure marker](#)
- [User seizure marker](#)

You can define the color of each marker type by double clicking on the field "Color". The color will be used for the icon in the marker list, in the timelines of the trending area and in the EEG trace. You cannot rename these marker types or change the letter that appear in the marker list icon.

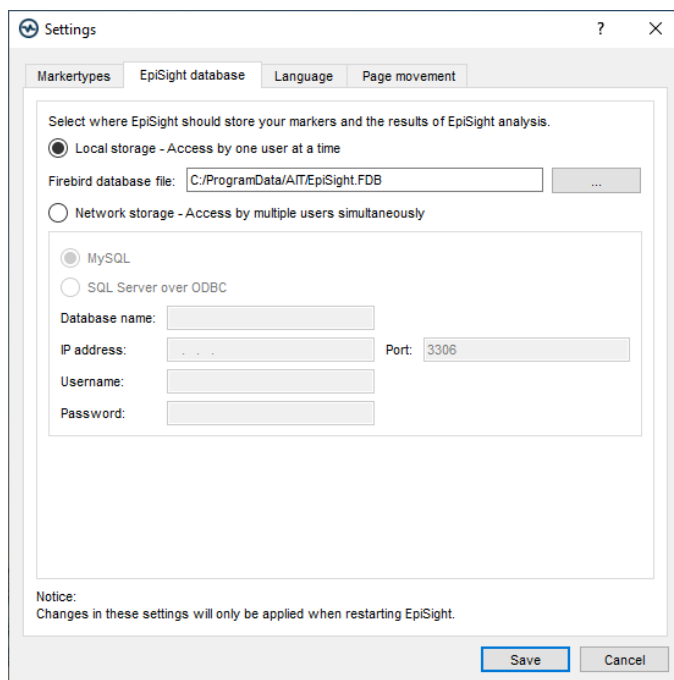
### User marker types

*User marker types* are all marker types defined by the user. You can add new marker types by pressing the button "Add new marker type" and define the name, the color and the letter that will appear in the marker list icon. The color will be used for the icon in the marker list, in the timelines of the trending area and in the EEG trace.

### External marker types

*External marker types* are marker types defined by the different EEG recording systems. For UNEEG™ EpiSight only the EDF file format is supported. You cannot add new markers here, but you can change the color and the letter that will appear in the marker list icon. The color will be used for the icon in the marker list, in the timelines of the trending area and in the EEG trace.

## EpiSight database



The screenshot shows the 'Settings' dialog box with the 'EpiSight database' tab selected. The dialog has four tabs: 'Markertypes', 'EpiSight database', 'Language', and 'Page movement'. The 'EpiSight database' tab contains the following options:

- Select where EpiSight should store your markers and the results of EpiSight analysis.**
  - ☒ Local storage - Access by one user at a time
    - Firebird database file: C:/ProgramData/AIT/EpiSight.FDB
  - ☐ Network storage - Access by multiple users simultaneously
- Database type:**
  - ☒ MySQL
  - ☐ SQL Server over ODBC
- Database name:** [Text field]
- IP address:** [Text field] **Port:** 3306
- Username:** [Text field]
- Password:** [Text field]

At the bottom, there is a 'Notice' section stating: 'Changes in these settings will only be applied when restarting EpiSight.' and two buttons: 'Save' and 'Cancel'.

UNEEG™ EpiSight stores markers and results of the UNEEG™ EpiSight calculation in a database. You can store this database at several locations:

#### Local storage - Accessible by one user at a time

This is the best mode, when the results of your review with UNEEG™ EpiSight should only be accessed from your local PC. Only one user at a time can then access the results. You can leave the file name at the default value or select a personalized name.

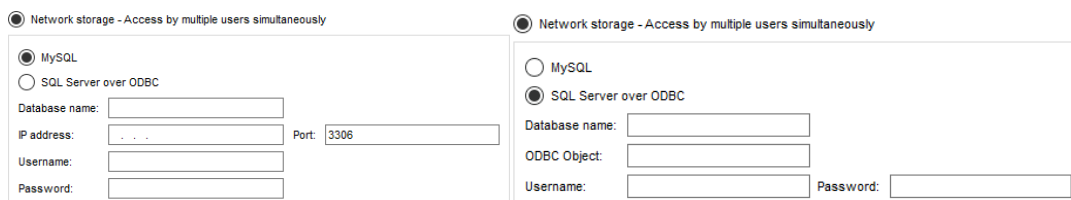
### Network storage - Accessible by multiple users simultaneously

This is the best mode, when you want to access the results of your review with UNEEG™ EpiSight from several PCs in your network. With this option several users can access the results at the same time. If you want to use this option, you will need a dedicated database server. UNEEG™ EpiSight supports the database systems MySQL and MS SQL server over ODBC. Please contact your IT administrator to set up such a database system.



Please make sure that your IT administrator properly secures the database system and always uses SSL certification for all database connections.

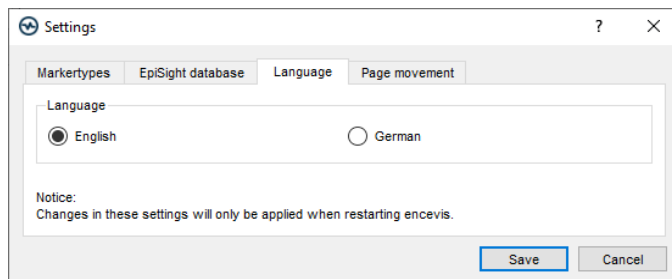
To use this network option, you need to specify a database that everybody using the UNEEG™ EpiSight can access. Your IT administrator will provide you with the necessary information shown in the screenshot below.



Please note that changes in these settings will only be applied after restarting UNEEG™ EpiSight.

## Language

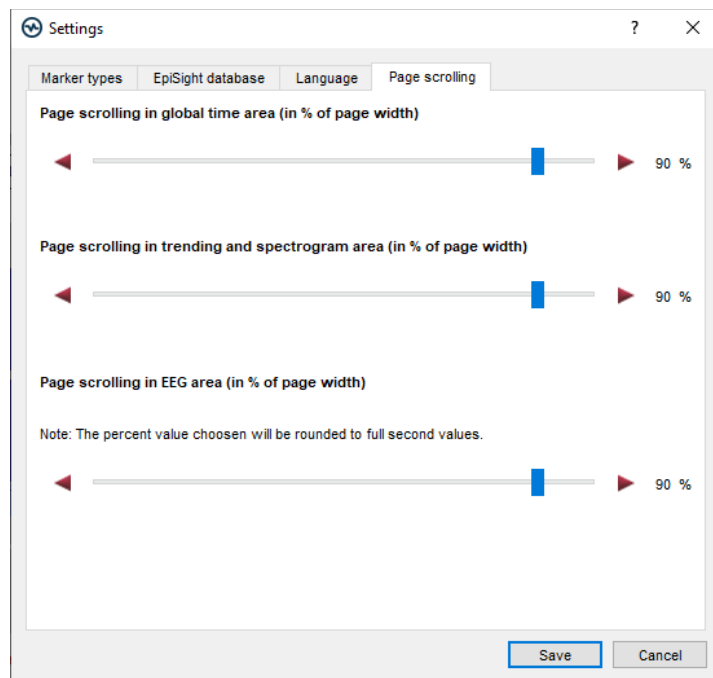
You can select the languages English or German.



Please note that changes in these settings will only be applied after restarting UNEEG™ EpiSight.

## Page scrolling

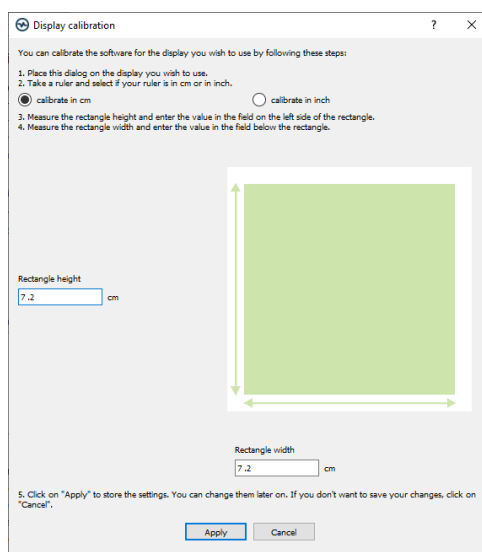
In this tab, you can adjust the scroll steps of the different traces in the UNEEG™ EpiSight viewer.



Use the sliders to select values between 1% and 100%. The selected percentage of the current window length will then be used as the page feed when moving from one page to the next.

## Display calibration

This setting adjusts the UNEEG™ EpiSight visualization to the display that you are using. Selecting “**Display calibration**” opens the following window:



Follow the instructions in the window. Measure the rectangle height and width and enter the values in the corresponding text boxes. Then click on “**Apply**”.

## Show marker list

Check the box on the left on of “**Show marker list**” in order to switch on and off the marker list in the UNEEG™ EpiSight trending.

# Appendix A

# Description of the algorithms

## UNEEG™ EpiSight seizure detection

The UNEEG™ EpiSight seizure detection is based on a computational method which automatically detects epileptic seizures in digitized EEG. EEG segments with artifacts like i.e. excessive amplitudes or artifacts from loose electrodes are removed automatically and are not used for detection. This will avoid false alarms based on measurement problems. Frequencies below 0.7Hz and above 70Hz are removed by finite impulse response filters. Line noise is removed with notch filters at 50 and 60 Hz. The EEG is then scanned for rhythmic patterns in the time and frequency domain. An energy detector scans for tonic or tonic-clonic seizures with strong muscle artifacts. All extracted features are normalized by a spatio-spectral model of the brain activity that is continuously updated by past information from the EEG. A set of classifiers is used to remove events with physiological origin. The use of these adaption and classification algorithms avoids repeated detections of physiological or pathological patterns that are no seizures and is therefore another important mechanism to avoid excessive false alarms. Further details can be found in [Fürbass et al., “Automatic multimodal detection for long-term seizure documentation in epilepsy”; Clinical Neurophysiology 128 (2017) 1466–1472, May 2017].

## UNEEG™ EpiSight rhythmic pattern detection

UNEEG™ EpiSight rhythmic pattern detection is based on a computational method, which automatically detects rhythmic EEG patterns in digitized EEG. Three different types of patterns are detected. Rhythmic delta activity including sharp waves and spikes (Rhythmic-Delta-SW) is defined as repeating discharges with uniform morphology without an inter-discharge interval with a frequency up to 4Hz that come with frequent intermixed sharp waves/spikes or a sharply contoured pattern. Polyspike, spike or sharp wave consistently followed by a slow wave in a regularly repeating and alternating pattern are also detected. Rhythmic theta activity (Rhythmic-Theta) is defined as repeating discharges with uniform morphology without an inter-discharge interval with frequencies between 4-7.5Hz. Rhythmic alpha activity (Rhythmic-Alpha) is defined as repeating discharges with uniform morphology without an inter-discharge interval with frequencies between 7.5-12Hz.

At the beginning, EEG segments with artifacts like i.e. excessive amplitudes or artifacts from loose electrodes are removed automatically and are not used for detection. This will avoid false alarms based on measurement problems. Frequencies below 0.4 Hertz and above 70 Hertz are then removed by a finite impulse response filter. The signal in each bipolar channel is divided into segments that represent spikes, waves, or any other discharge item with durations between 40ms and 1.5s and amplitudes above 20µV. The wave segmentation procedure scans the EEG signal in the time domain for arbitrary peaks with more than 20µV. Each peak is then extended on both sides as long as the waveform lies above two projection lines that start at the borders of the starting peak and have 20% reduced slope value. All resulting wave segments below 40ms and above 1.5s are dropped. These single-channel

segments are then combined over all channels. The resulting segments are then marked as spike, sharp wave, or non-spike segment by a spike-detection algorithm. The resulting segments are also used to build groups representing Rhythmic-Delta-SW, Rhythmic-Theta and Rhythmic-Alpha segments as described above. The next step checks if a pattern meets minimal requirements for duration and the number of discharges. Patterns that do not meet these criteria are discarded. Finally, segments of equal pattern type are concatenated to groups with a maximal duration of 30 seconds. More details of the algorithm can be found in [Füßbass et al., “Automatic multimodal detection for long-term seizure documentation in epilepsy”; Clinical Neurophysiology 128 (2017) 1466–1472, May 2017].

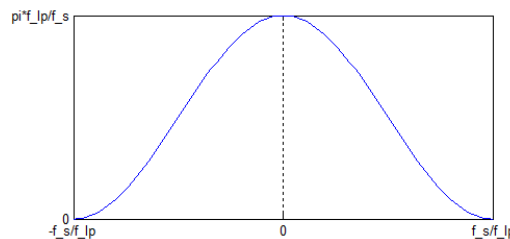
## UNEEG™ EpiSight aEEG

UNEEG™ EpiSight aEEG calculate and visualize a continuous measure that describes the EEG by showing the aEEG as defined in [Zhang, D., Ding, H., 2013. “Calculation of compact amplitude-integrated EEG tracing and upper and lower margins using raw EEG data.” Health (N. Y.) 05, 885–891”, <http://dx.doi.org/10.4236/health.2013.55116>]. The method describes an algorithm to calculate aEEG for single EEG channels.

Channel-wise calculation of aEEG starts by applying the asymmetrical filter to the EEG channel. The frequency response is approximated using a finite impulse response filter that implements the specified 12dB per decade increasing filter response in the range of 2 to 20Hz. The filtered signal is called  $x_{bp}$ . Then, the envelope detection of the filtered time series data is implemented by applying a low pass filter  $h_{lp}$  to the signal.

$$x_{lp}(t) = (|x_{bp}(t)|) * h_{lp}$$

The filter impulse  $h_{lp}$  is a raised cosine window of length  $2 f_s / f_{lp}$ , where  $f_s$  is the sampling frequency,  $f_{lp}$  is the cutoff frequency of the lowpass. In our implementation  $f_{lp} = 2$ . The impulse response is shown in the following figure:



Impulse response of the aEEG

This implementation will result in a smoothened line which will be subsequently used as amplitude feature  $y_{aEEG}$ . After smoothening, non-overlapping segments of 0.5 seconds are defined, and the maximum and minimum value of each segment is calculated. Then the average value of the maximum and minimum segment values over all channels are calculated respectively resulting in values aEEG\_max and aEEG\_min. The amplitude-integrated EEG plot of UNEEG™ EpiSight visualizes these average values by drawing a line between aEEG\_max and aEEG\_min as well as connection line between them.

## UNEEG™ EpiSight background frequency

The UNEEG™ EpiSight background frequency feature calculates and visualizes a continuous measure that describes the EEG by showing the frequency distribution of the EEG. The relative proportions of the four Berger frequency bands delta (< 4Hz), theta (4-7.5 Hz), alpha (7.5-12.5Hz), and beta (>12.5 Hz) are shown. The intensity of the colors corresponds to the amplitudes in these four frequency bands.

For the calculation of the frequency band measures, the input signals are divided into segments of three seconds duration. Then the dominant frequency band for each segment is determined, i.e., delta, theta, alpha or beta. The relative frequency of the dominant Berger-bands is calculated within windows of 15 seconds. The amplitude for each Berger frequency band is determined as an average over all segments that have been assigned to that frequency band respectively. The amplitudes for each Berger band, which directly correspond to the power levels in a conventional spectrogram, are indicated by color intensities in the UNEEG™ EpiSight frequency band graph: high amplitudes are indicated by high intensities and vice versa.

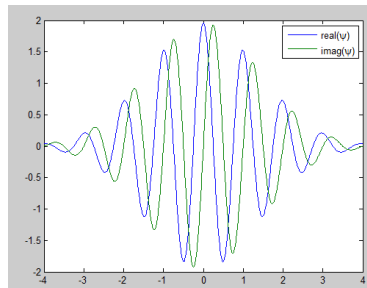
## UNEEG™ EpiSight spectrogram

The spectrogram calculates a continuous wavelet transform of the input data. This transform is implemented as a bank of FIR filters using different, scaled versions of an analytic Morlet wavelet (or Gabor wavelet)

$$y_k(t, f) = \sum_{\tau = -2 \frac{\alpha_{BW}}{f_{\max}}}^{2 \frac{\alpha_{BW}}{f_{\max}}} x_k(t) \psi_f^*(t - \tau).$$

Each of these filters corresponds to a specific frequency  $f$  in the resulting time-frequency (TF) representation. The impulse response of the filter for frequency  $f$  is defined as

$$\psi_f(t) = \frac{4f}{\alpha_{BW}} \sqrt{\frac{3}{\pi}} e^{2\pi i f t} e^{-\left(\frac{t f}{\alpha_{BW}}\right)^2}.$$



Note that the energy of this wavelet is centred around frequency  $f$  and that the scaling is such, that the convolution with a sinusoidal signal of amplitude 1 at frequency  $f$  leads to an output signal of constant amplitude 1.

The frequency points  $f_j$  used for the analysis are determined with

$$f_j = f_{\min} e^{\frac{j}{N_f - 1} \log\left(\frac{f_{\max}}{f_{\min}}\right)}, \quad j = 0, \dots, N_f - 1.$$

The convolution is executed at a sampling rate of  $2f_{\max}$ , therefore the input signal is initially down-sampled to this rate. After convolution a second down-sampling step with a factor of  $d$  is executed. The last step is the calculation of intensities in dB using the equation  $y = 20 * \log_{10} x \text{ dB}$ ."