

DIAGNOSTICS

Guide for the Analysis of Polygraphic and Polysomnographic Measurements with MSV

REV 02, Mai 2023

DIAGNOSTICS

Dear Customers,

You have chosen a polygraphy or polysomnography device from Löwenstein Medical. Thank you for your trust in our product!

As a supplement to our briefing at your site or via the Internet, this guide should help you to analyze the poly(somno)graphic measurements with the software delivered with your device.

If you would like to have further consultation, please speak to your local Löwenstein employee or get in touch with us at info@loewensteinmedical.com.

Kind regards,

Your Löwenstein Team



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This guide contains step-by-step instructions on how to analyze the poly(somno)graphic measurements and generate related reports. In addition, the most important functions in the poly(somno)graphic analysis of the MSV software are explained.

1. Open the Software

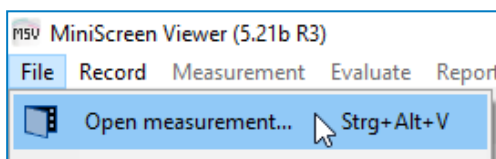
Open the **MSV software** with a double click on the MSV icon.



2. Working Directory

All previously conducted and stored measurements can be found in the **Working Directory**. From there the measurements can be opened.

Open the working directory from the menu under **File – Open measurement** or click the symbol for the working directory in the software.

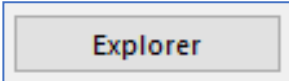


The stored measurements can be viewed in the **Working Directory**. Information, which can be user-defined, is displayed for each measurement. In the example below, each recording includes the patient surname, first name, archive, date of birth, patient number, begin, validated, comment, measurement time and channel set. The information is sorted in the basic settings after the start (most recent measurement shown above).

To open a measurement, click on it and **Select** it in the footer or double click on the measurement.

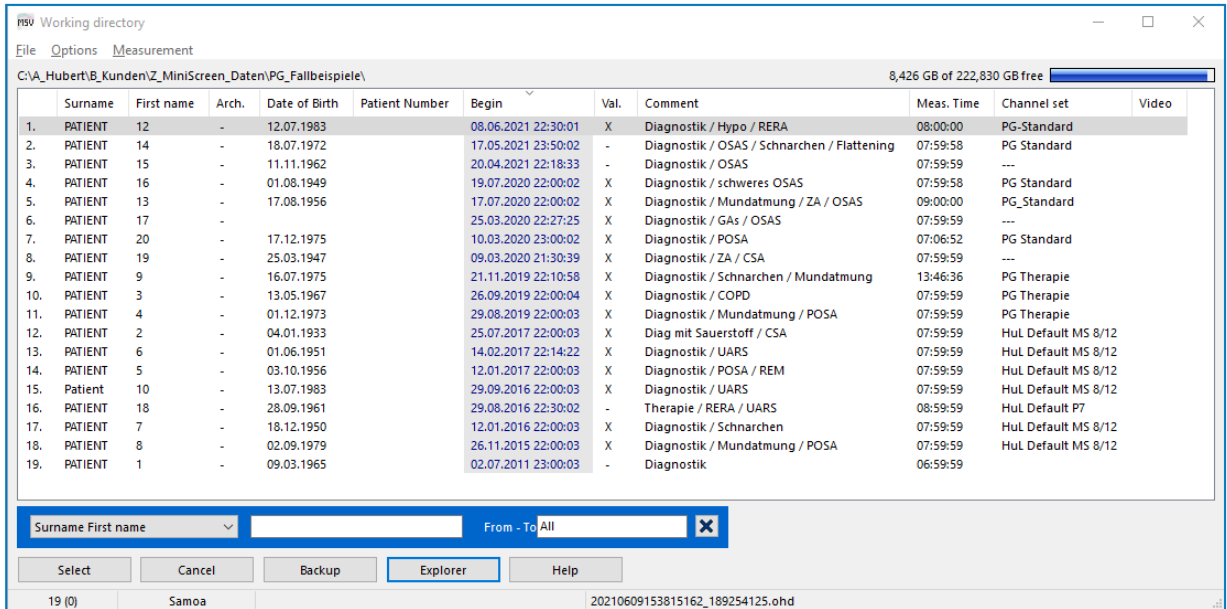
There are two different ways to **select several measurements at once.**

- Activate Explorer in the footer.

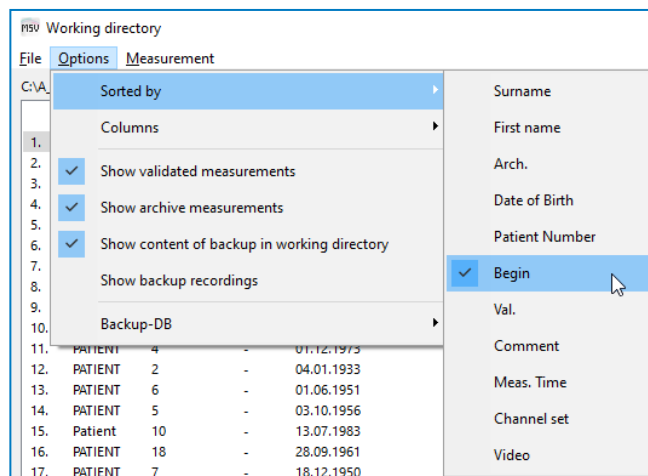


- With the Control key held down, mark individual measurements.

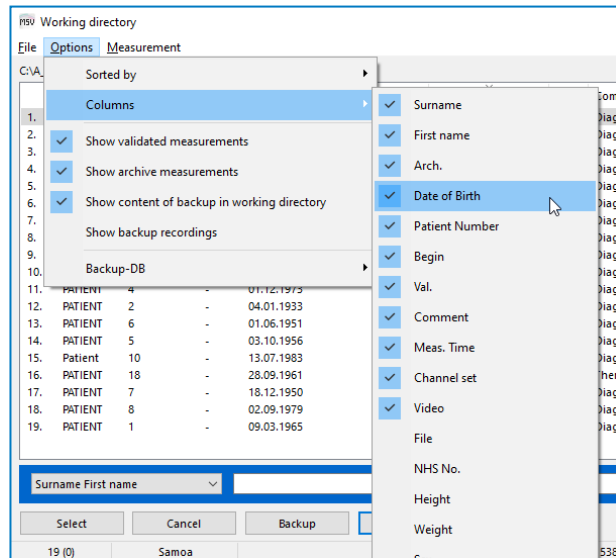
- With the Shift key held down, you can mark an entire range of measurements.



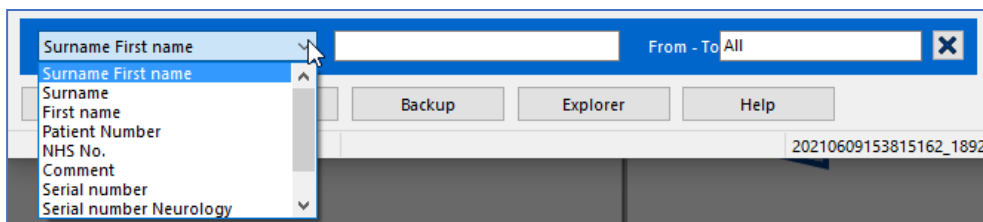
You can change the sorting settings under **Options – Sorted by.**



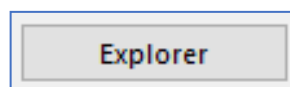
You can change the columns to be displayed under **Options – Columns.** With the Drag-and-Drop function, you can change the position of the column headings as you like.



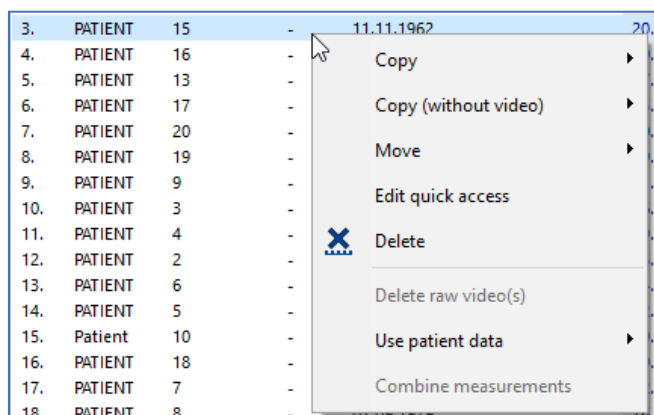
Specific measurements can be retrieved via the Search function in the footer.



The Explorer function has to be activated in order to copy, move or delete measurements. Click the **Explorer** button in the footer.

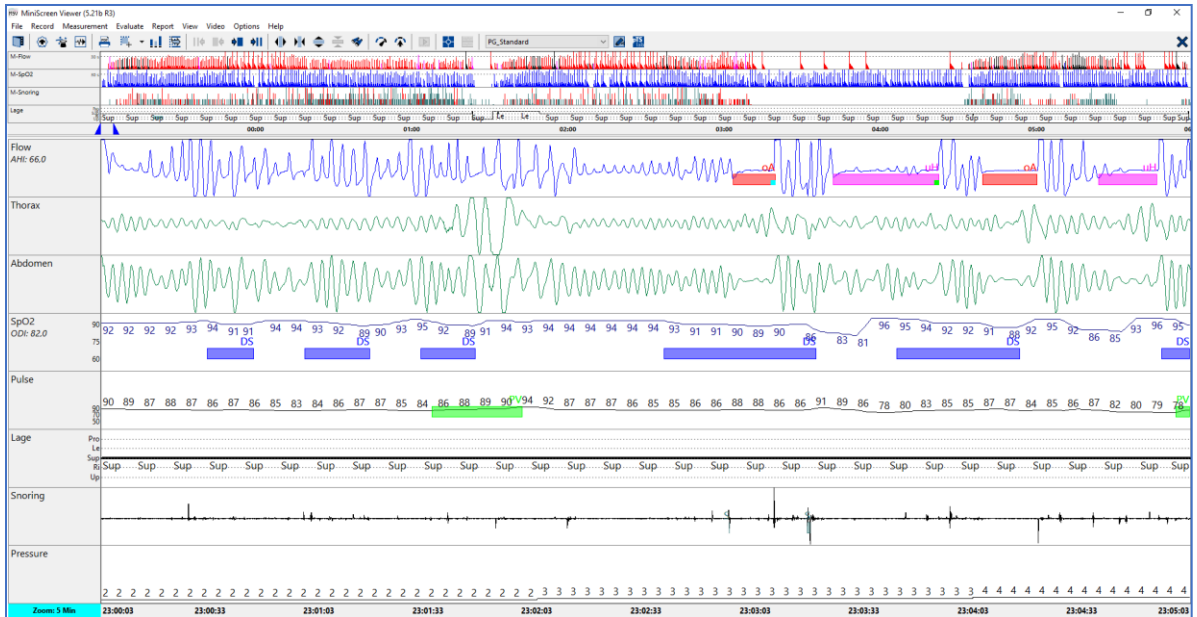


With a click of the right mouse key on the selected measurement, you can copy, move or delete the measurement.



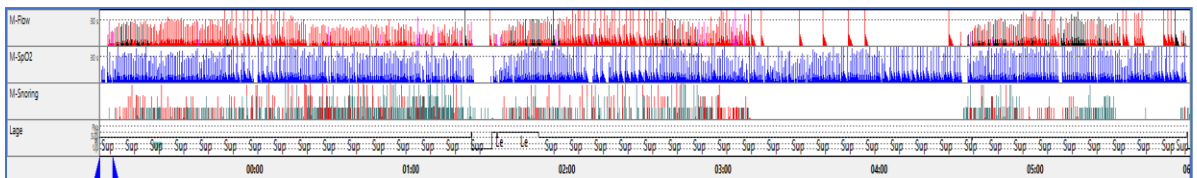
3. Displaying Measurements

The desired measurement opens in a **preset view** at the start of the measurement.



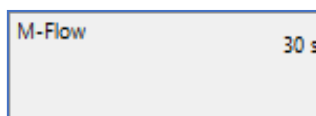
The view consists of **two separate windows**. The upper window is an overview based on the entire measurement time.

In this example the results are displayed for channels Flow, SpO₂, snoring and position in relation to each other.

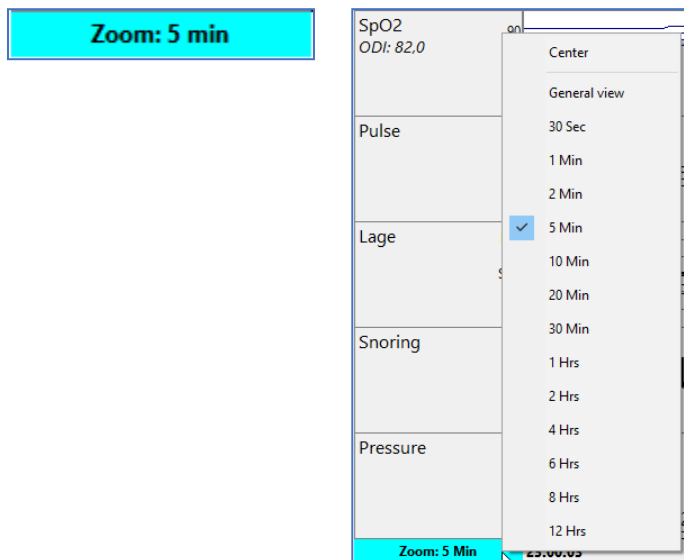


The **channel names** Flow, SpO₂ and Snoring are shown on the left side, starting with the initial **M**.

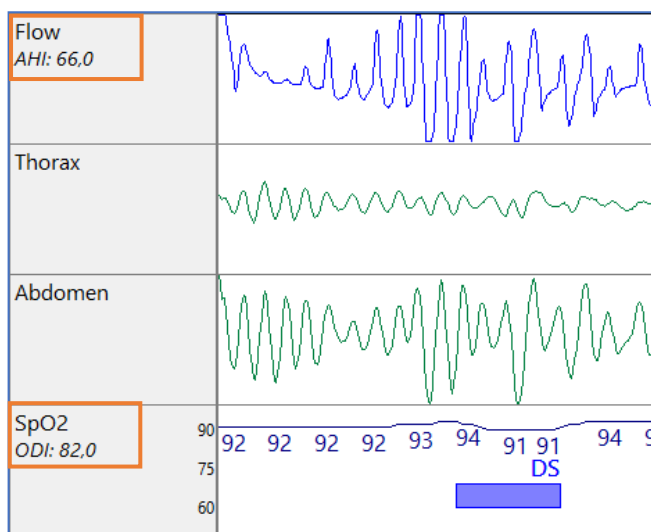
In this case, **M** stands for **Marking** or **Event**. In this example, **M-Flow** means that all the analyzed respiratory events in the flow channel are entered vertically according to their event color.



The lower **main window** is displayed with 5-minute intervals. The time basis can be changed with a mouse click on the turquoise **Zoom field**.



The **channel names** are shown on the left-hand side of the screen. In the channels Flow and SpO₂ we can see a live calculation of the AHI and EI indices.

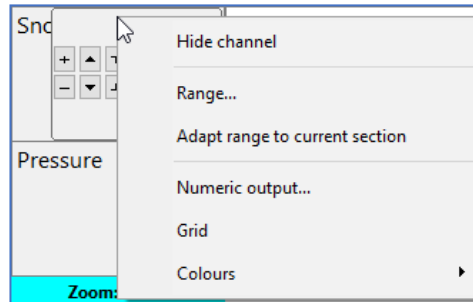


The **footer** contains the information Patient name, measurement Date, Channel set and File.

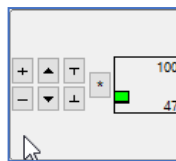
Patient: PG_Schulung_obstr., **Date:** 01.07.2009 **Channel set:**

File: demo004.ohd





When you click on the **channel name** with the right mouse key, the following menu opens up. Here the channels can be hidden, the range automatically adapted to the channel borders (best-fit function) and grids, numerics and colors changed. These changes apply for as long as the measurement is open. The changes are not stored.



When you position the **mouse cursor** on the **channel name**, an interactive menu appears.



The following settings can be made in this menu:

-  : Optical zoom function of the curves.
-  : Channel can be spread out to its full height.
-  : Shift the base line upwards and downwards.
-  : Reset function

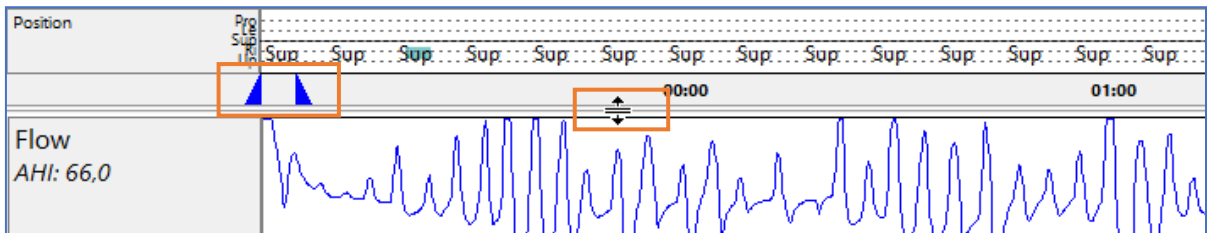
Each **channel** can be moved in its position with the **drag-and-drop** function. To do so, click the channel name with the left mouse key and, holding down the mouse key, move to the desired position and let go of the mouse key.



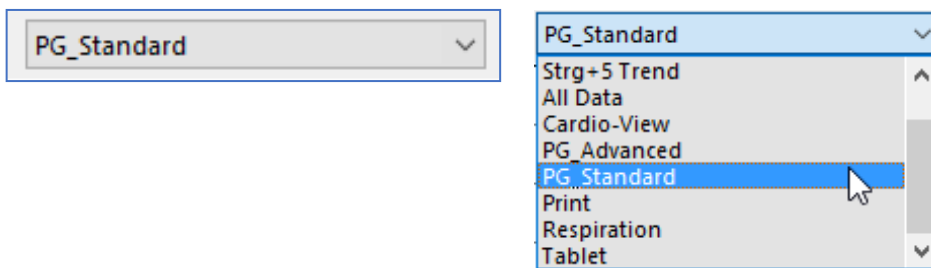
The **two windows** are separated from each other by a **variable bar**. The size of the windows can be varied as described below.

The cursor is positioned on the bar until it changes to a black block with two files pointing upwards and downwards. Press down and hold the left mouse key. Move the cursor vertically to resize the window.

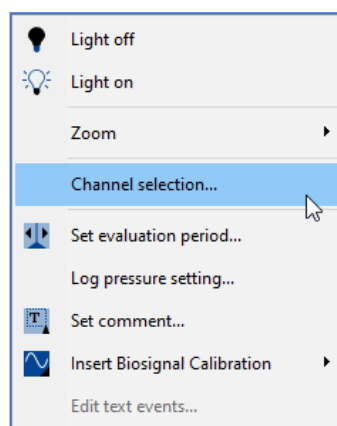
The **two blue arrows** show the displayed area in the main window.



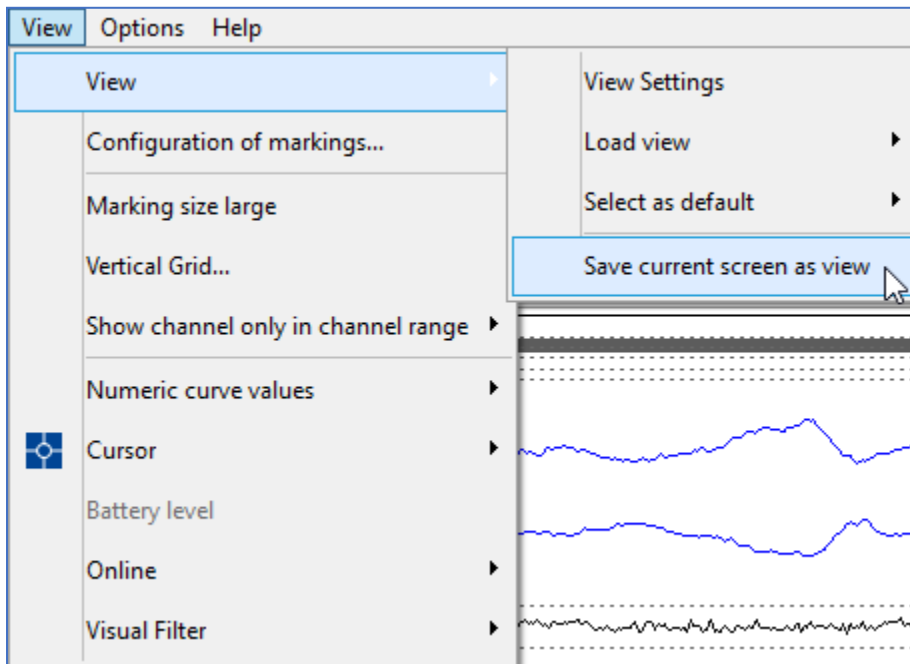
The **preset view** is shown in the menu. Other stored views can be retrieved via the dropdown menu function.



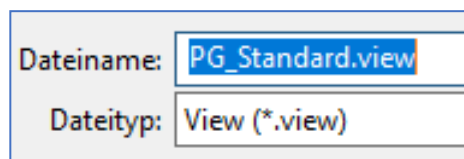
With a click of the right mouse key you can open the following menu in the large main window. There you can select and de-select channels in a list under **Channel selection**.



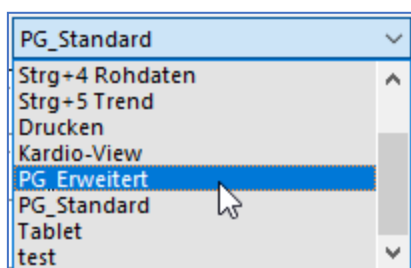
If views have been changed individually, (hiding, adding or moving channels, changing colors), these changes can be saved in the menu under **View – View – Save current screen as view**.



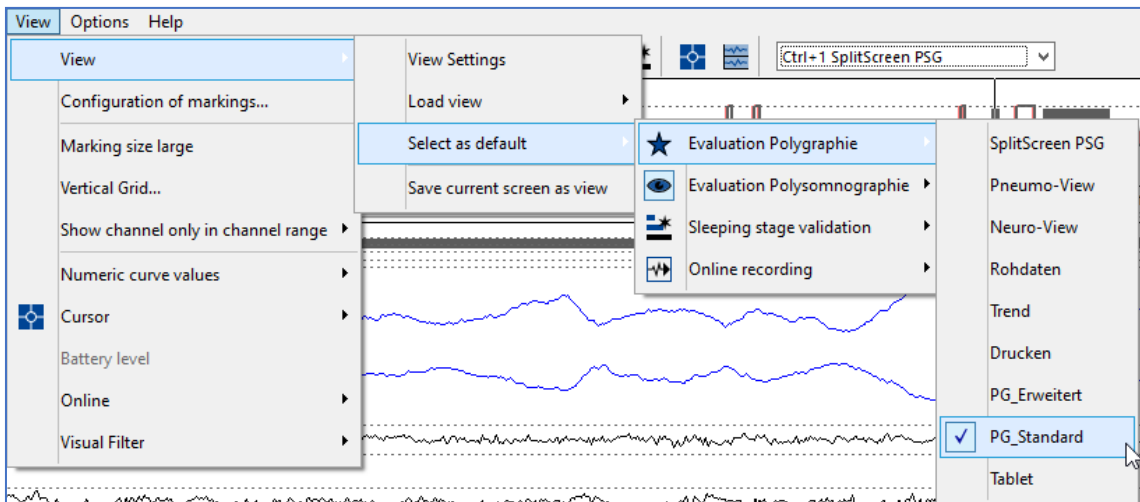
The existing flow can be overwritten or a new view can be created by changing the **file name**.



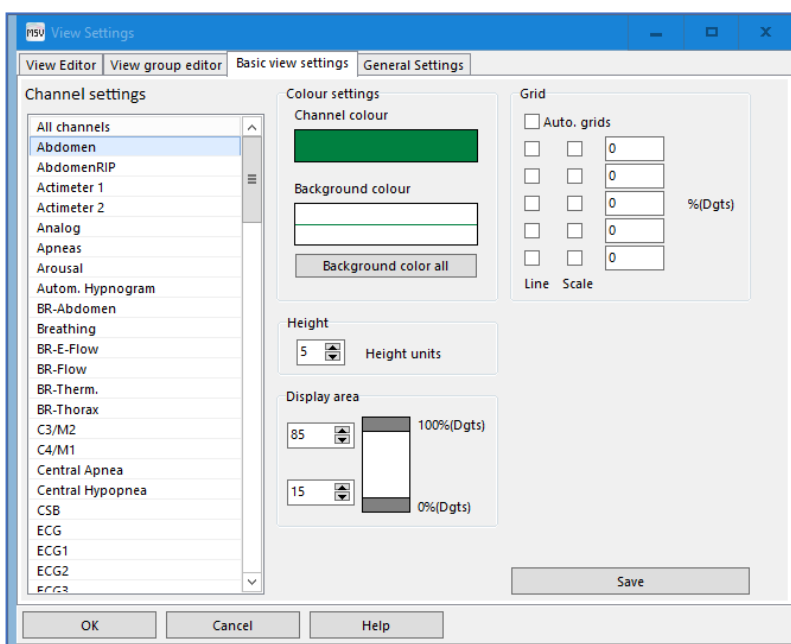
After restarting the software, a newly created view is listed in the drop-down menu and is therefore available for selection



If a certain view shall always be loaded directly when opening a recording, this can be set as a default. To do this select in the menu bar the point **View – View – Select as default** and choose the desired function (Evaluation PG, Evaluation PSG, Sleep stage validation, Online recording) and then activate the corresponding view.



To set view settings for specific channels such as colors, area to be displayed, curve values etc. globally for all views, select in the menu bar **View – View – View settings** and then **Basic view settings**. These settings can be made for each channel in this menu. Changes must be confirmed with **Save** and are applied to all views directly

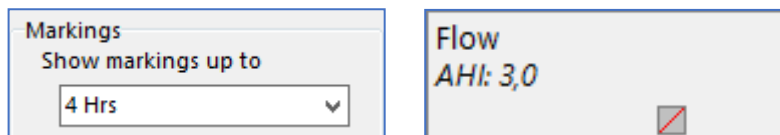


In all channels in which events can be assigned, these can be automatically hidden from a self-selected zoom level in order to have a better overview at larger zoom levels.

This can be set in the menu under **View – View – View settings – Basic View settings** under *Show markings up to*.

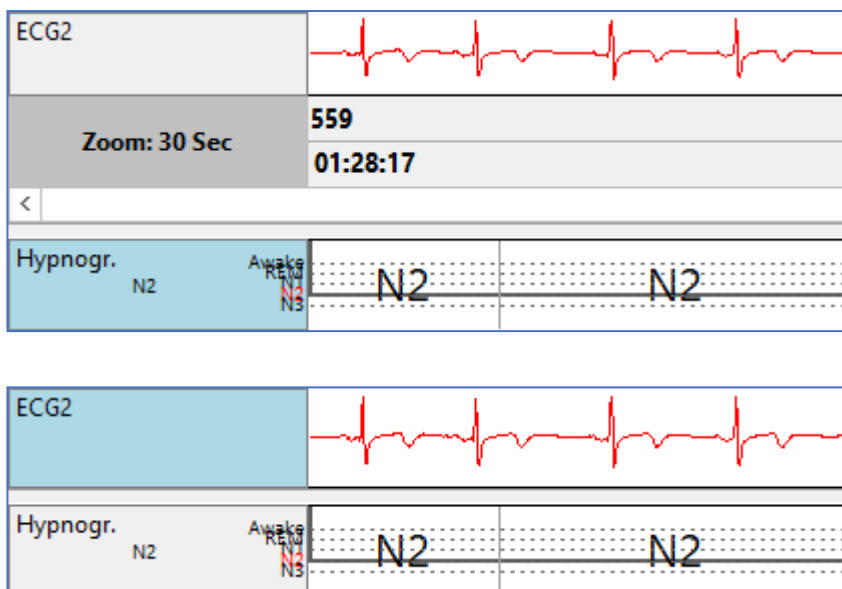
In the example shown below, markers (events) are no longer displayed in the channel at a zoom level greater than 4 hours.

This is displayed in the channel designation with a gray square crossed out in red.



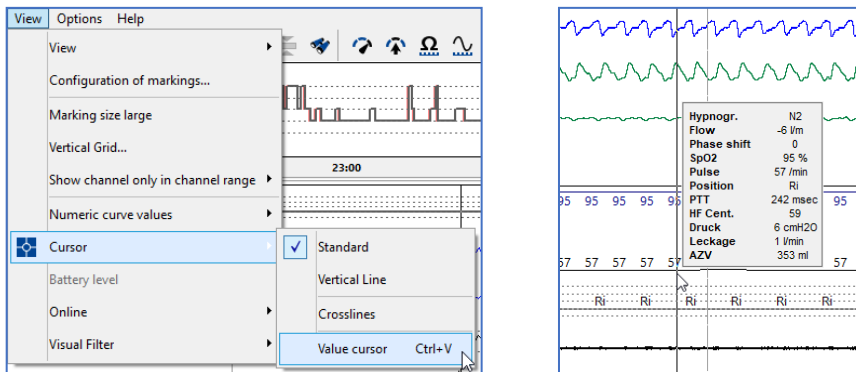
The **time and epoch bar** displayed at the bottom of the data window can be **hidden or shown** using the keyboard shortcut **Ctrl + Y**.

This can be an advantage for better clarity, especially when using the SplitScreen View.



The so-called **value cursor** can be called up using the key combination **Ctrl + V**, or alternatively via the menu item **View – Cursor – Value cursor**.

This displays all numerical values at the cursor position in a vertical reference and changes them automatically when the cursor position changes horizontally.



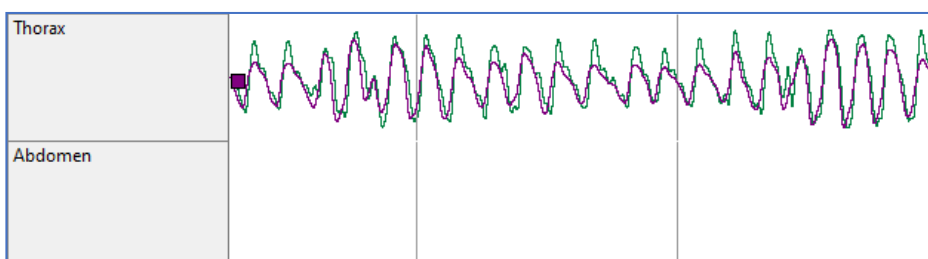
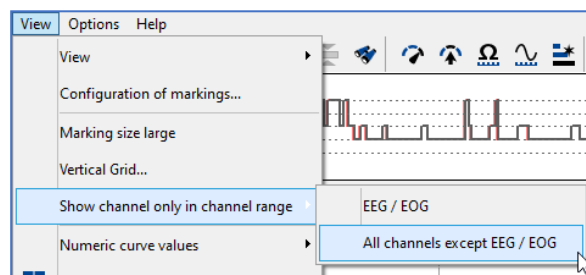
It is possible to move curves beyond their channel boundaries, e.g. to place the Thorax and Abdomen curve on top of each other to better detect paradoxical or opposing breathing efforts.

The basic requirement for this is that under **View – Show channel only in channel range – All channels except EEG/EOG** is deactivated. By means of the

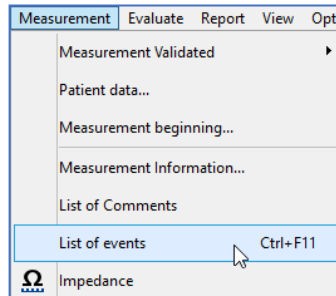


function to move channels vertically (function via channel name, See

page 9) or to move the channel vertically using the key function **Ctrl + Shift + pressed left mouse button**.



There is the possibility to open a **List of events**. Select therefore Measurement – List of events in the menu bar. In this, all the events that have occurred are listed chronologically by type. By double-clicking on an event, the software automatically jumps to the corresponding event in the measurement.

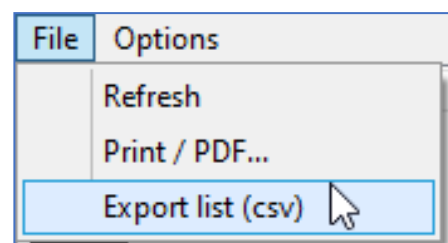
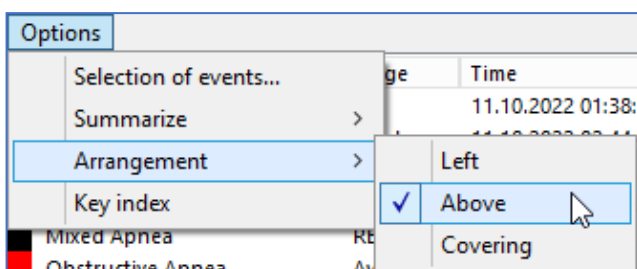


A screenshot of the 'List of events' window. The window has a title bar 'PMSV List of events' and a menu bar 'File Options'. Below the menu bar is a table with the following columns: Type, Event, Stage, Time, Duration, Position, and Visibility. The table contains 16 rows of event data. At the bottom of the window are buttons for 'OK', 'Refresh', and 'Print / PDF...', along with a note: 'Double-click on list entry: Launch "Confirm Events"'. The table data is as follows:

Type	Event	Stage	Time	Duration	Position	Visibility
Mixed Apnea	Mixed Apnea	N2	11.10.2022 01:38:36	26,6	Position Supine	no
Mixed Apnea	Mixed Apnea	Awake	11.10.2022 02:44:41	17,6	Position Supine	no
Mixed Apnea	Mixed Apnea	Awake	11.10.2022 03:08:31	13,0	Position Supine	no
Mixed Apnea	Mixed Apnea	Awake	11.10.2022 04:44:29	10,7	Position Supine	no
Mixed Apnea	Mixed Apnea	REM	11.10.2022 04:45:54	28,7	Position Supine	no
Obstructive Apnea	Obstructive Apnea	Awake	11.10.2022 04:22:43	19,5	Position Right	no
RERA	RERA	Awake	10.10.2022 23:04:06	13,4	Position Supine	no
Irregular Snoring	Irregular Snoring	N1	11.10.2022 02:43:33	0,8	Position Supine	no
Irregular Snoring	Irregular Snoring	N1	11.10.2022 03:26:16	0,4	Position Supine	no
Irregular Snoring	Irregular Snoring	N1	11.10.2022 03:26:27	0,4	Position Supine	no
Irregular Snoring	Irregular Snoring	N1	11.10.2022 03:26:41	0,2	Position Supine	no
Irregular Snoring	Irregular Snoring	N1	11.10.2022 03:26:43	0,5	Position Supine	no
Irregular Snoring	Irregular Snoring	N1	11.10.2022 03:26:51	6,2	Position Supine	no
Irregular Snoring	Irregular Snoring	REM	11.10.2022 04:46:50	0,3	Position Supine	no
Snoring	Snoring	Awake	10.10.2022 21:50:38	0,3	Position Supine	no
Snoring	Snoring	Awake	10.10.2022 21:50:44	0,6	Position Supine	no
Snoring	Snoring	Awake	10.10.2022 21:51:46	1,1	Position Supine	no

The positioning of the event list window can be selected under **Options – Arrangements**.

The list can be exported to an Excel-format under **File – Export list (csv)**.



4. Analysis of a Measurement (PG)

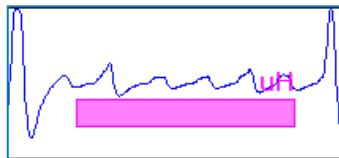
Right after a measurement has been read from the poly(somno)graph device, it will be pre-analyzed by the software. Then the software makes suggestions for events in the channels Flow, SpO₂, Snoring, Pulse and, if applicable, pulse wave.

The following respiratory events in the Flow channel are pre-analyzed.

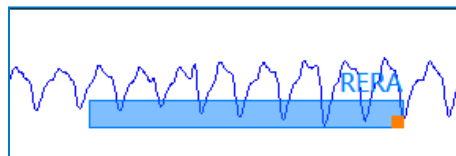
- Central, Obstructive and Mixed Apnea



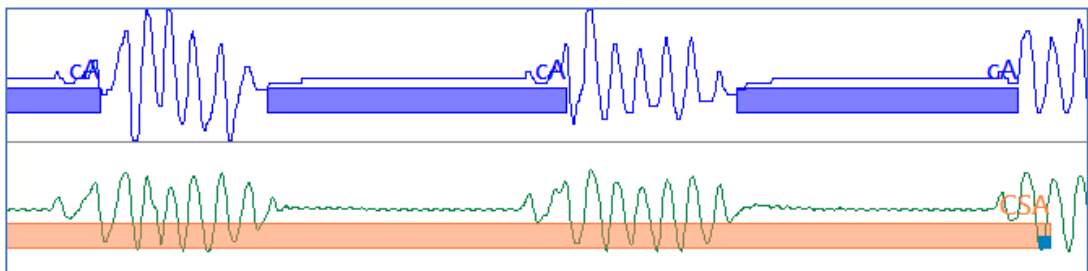
- Hypopnea (settable: distinction between Central and Obstructive)



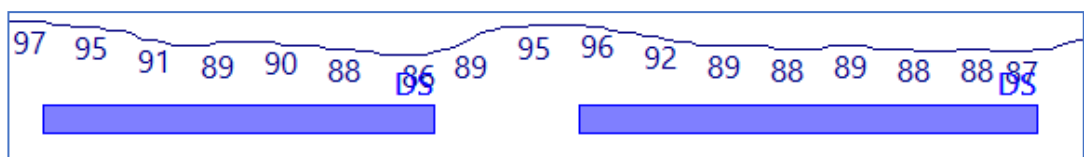
- (settable) RERA



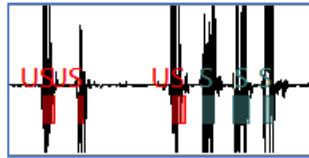
- Cheyne-Stokes Respiration



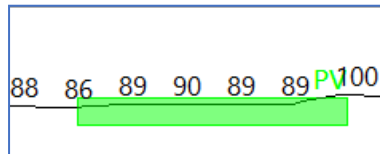
The analysis of desaturation is made in the SpO₂ channel.



Snoring events are detected in the Snoring channel.



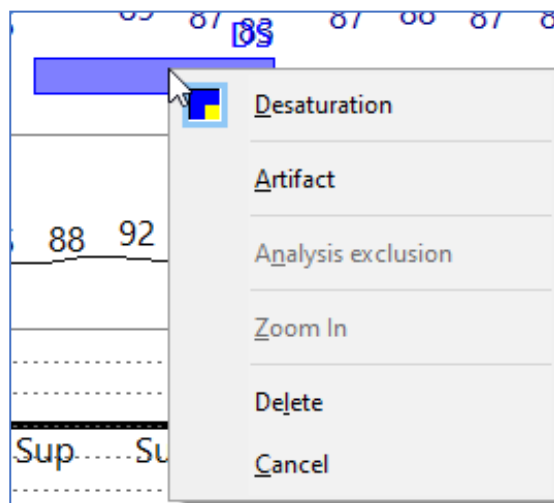
An analysis of **Pulse variances** is made in the **Pulse** channel.



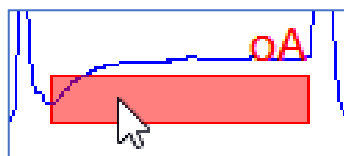
Pre-analyzed events can be processed as follows:

Events can be deleted.

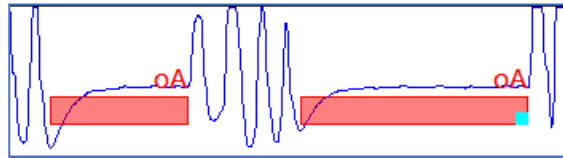
- Click the event with the right mouse key and select **Delete**.



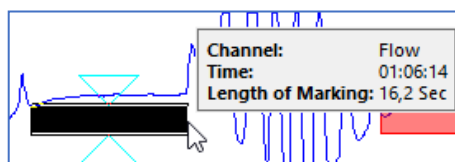
- Position the mouse cursor on the event and press the **DEL** key on the keyboard.



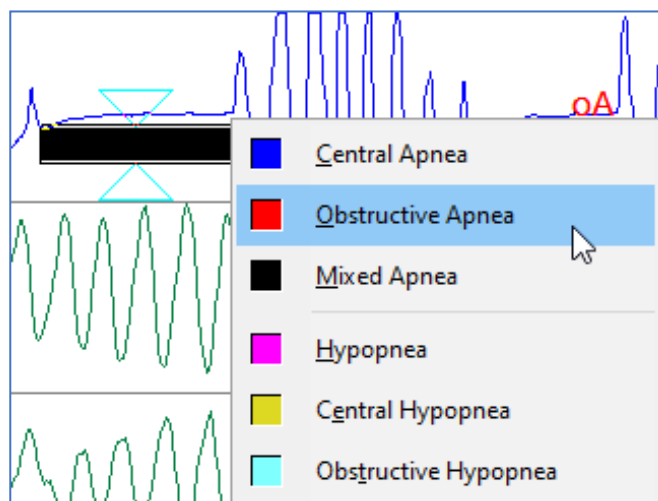
Events which have been assigned by the **automatic analysis** can be distinguished from those that are assigned **manually**. In the example below, the left event was marked by the automatic analysis and the one on the right by a manual process. In the manual event, you can see a small square in its complementary color at the end.



To **mark an event**, place the cursor at the beginning of the event and hold down the left mouse key. Now the cursor can be drawn over the event to the end.



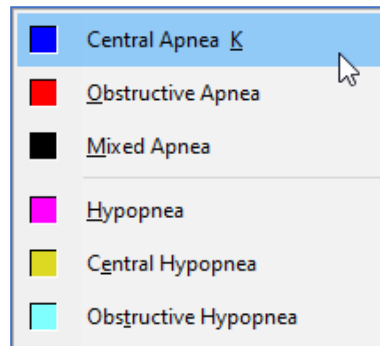
When you **let go of the mouse key**, a context menu opens up. The content of the menu depends on the channel in which the event was marked. In the example below, the flow channel is selected. The **context menu** contains a list of **events** that can be marked in the channel.



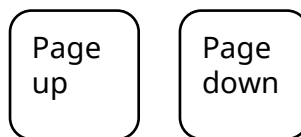
Here the desired event can be clicked and it will be marked in the corresponding channel. In the context menu the shortcut key associated with the event is marked on the keyboard.

When the corresponding letter is part of the event name, that letter is underlined. Example: O in Obstructive Apnea.

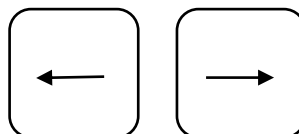
When the corresponding letter is not part of the event name, that letter is displayed and underlined after the event name. Example: K after Central Apnea.



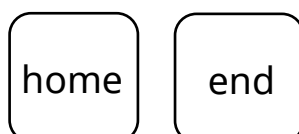
Use the Page up and Page down keys on the keyboard to **leaf through** the **measurement**. Each press of the key moves one zoom step forwards or backwards. Example: when the zoom is set to 5 (five) minutes, the measurement moves in five-minute increments.



You can use the left and right **cursor keys** to move the measurement one-half the width of the screen.



To go to the start of the measurement, press the **home** key. With the **end** key, you can jump to the end of the measurement.



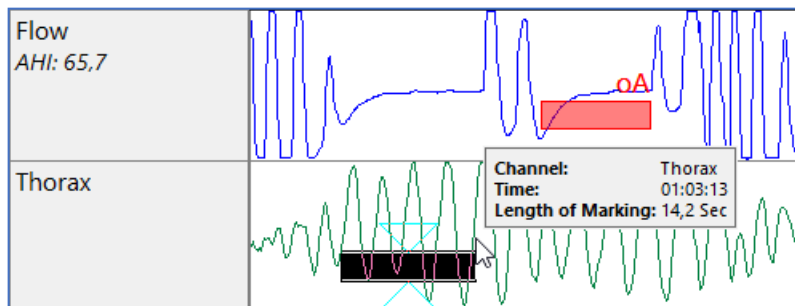
The **Quick Mode** can be used to make the analysis faster and easier. Select the following symbol from the menu to activate it.



With **Quick Mode** activated, the **following** can be done more quickly.

- **Delete events** simply with the right mouse key.
- When you are **marking events**, no context menu appears when only one event can be entered in the selected channel.
- **Quick Scoring function** for **respiratory events** over the Thorax and Abdomen channels. Respiratory events occurring in the Flow channel can be marked in parallel in the Thorax and Abdomen channel for the marked period. In the default setting, events are marked directly in Thorax (hypopnea) and Abdomen (obstructive apnea) for occurrences in the Flow channel.

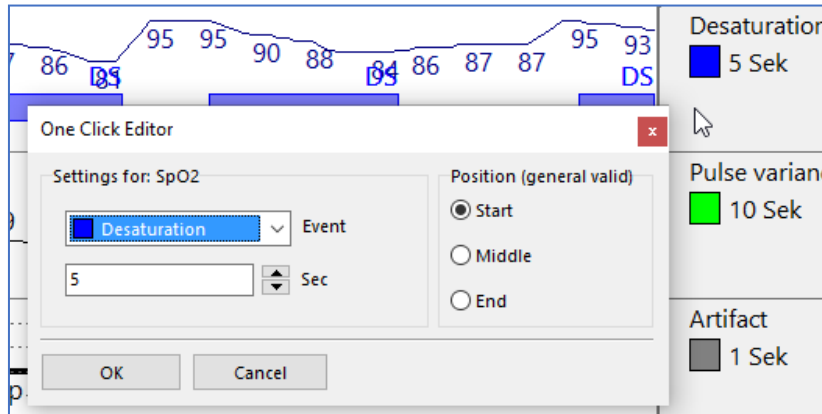
The default setting can be changed in the One-Click-Mode.



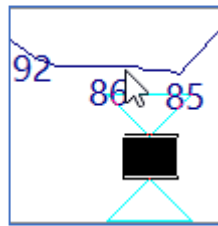
In **One-Click-Mode** you can set the length and type for pre-defined events in the corresponding channel with a mouse click.



The **length** and **type** of an event, which depend on the channel in question, can be defined in the **interaction panel** on the **right edge** of the screen. With the right mouse key, click on the field at the end of the channel and then define length and type.

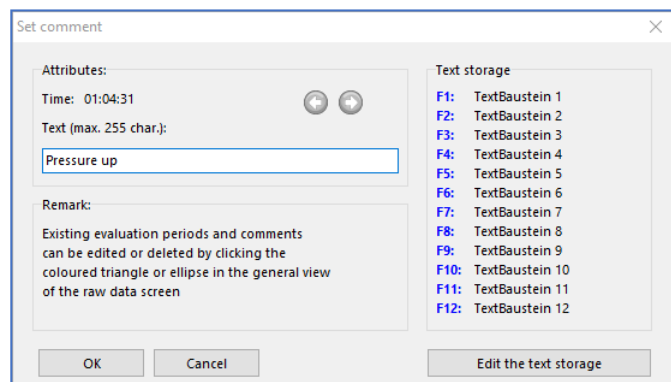
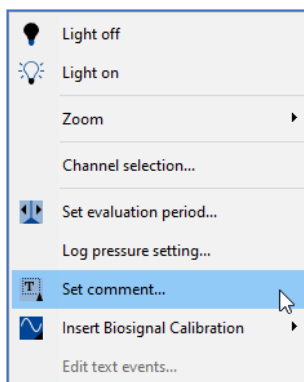


A **black marking** appears on the cursor that depicts the length of the event. With a click of the left mouse key, you can set the event directly in the relevant channel.



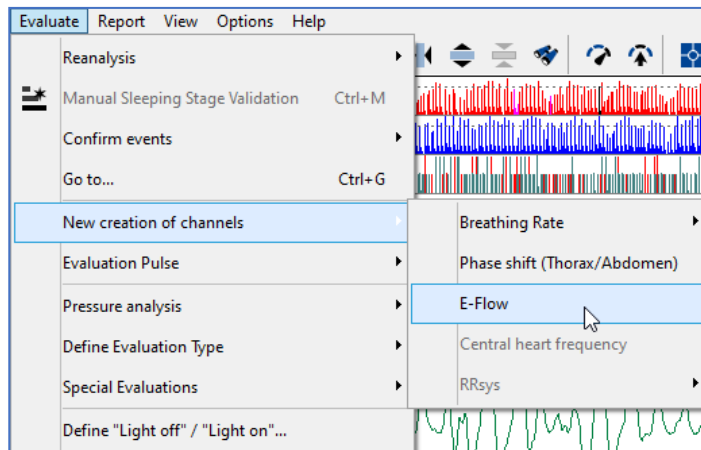
The Quick mode and the One-Click mode can be used together.

You can set a **comment** with the right mouse key in the main window. Select **Set comment** in the context menu or by pressing the **Ctrl key + Space bar** at the same time. In the Set comment window you can define text blocks to be stored.

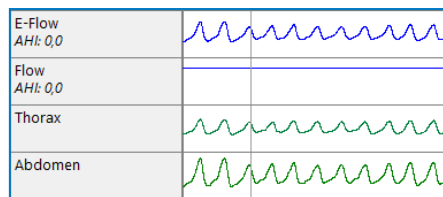


It can happen that the flow signal gets lost (e.g., patient movement) during a recording even in the case of unattended studies. MSV offers a feature to **recalculate the flow signal** for those cases. The **E-Flow** can be recalculated in the following way.

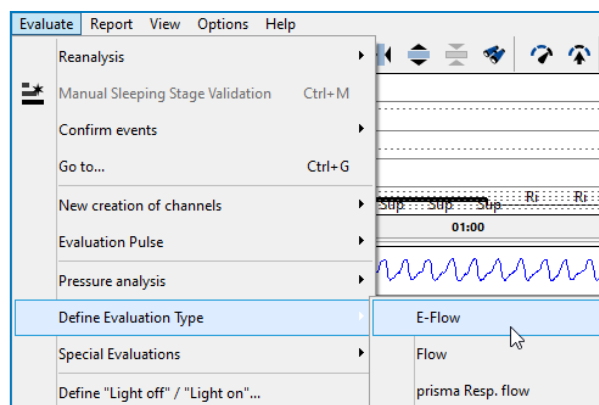
1. Open the dedicated measurement in MSV.
2. Choose **Evaluate – New creation of channels** in the menu bar.



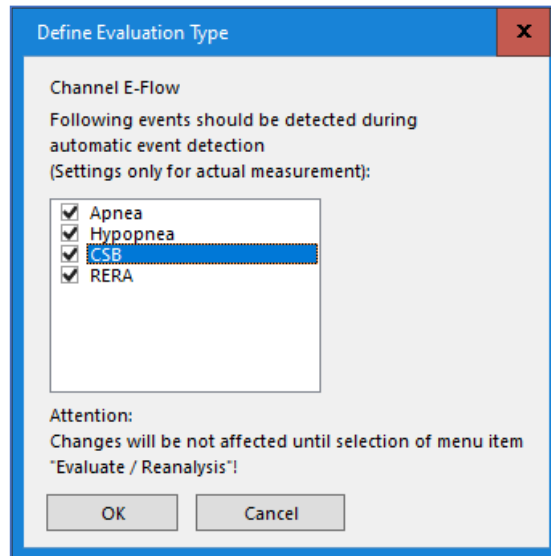
The software creates the channels **E-Flow** and shows it in the recording automatically. This channel can be used for manual scoring directly. If there shall be a Reanalysis (automatic analysis) done, the following steps are mandatory.



3. Choose **Evaluate – Define Evaluation Type – E-Flow** from menu bar.

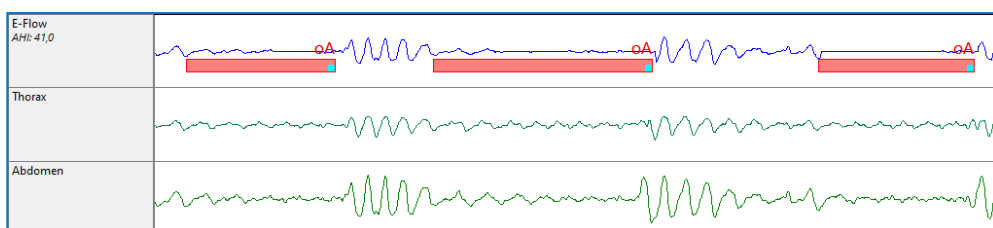
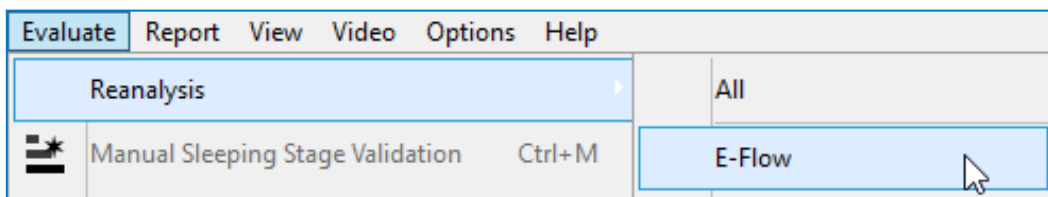


Select all events in the appearing window, which shall be analyzed in the channel E-Flow and confirm with OK.



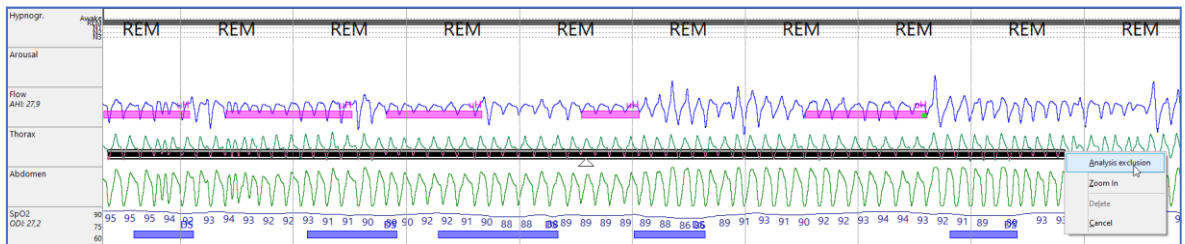
4. Choose **Evaluate – Reanalysis – E-Flow** form menu bar.

An automatic reanalysis is done in E-Flow. All detected events are scored in the channel and are used for reporting.

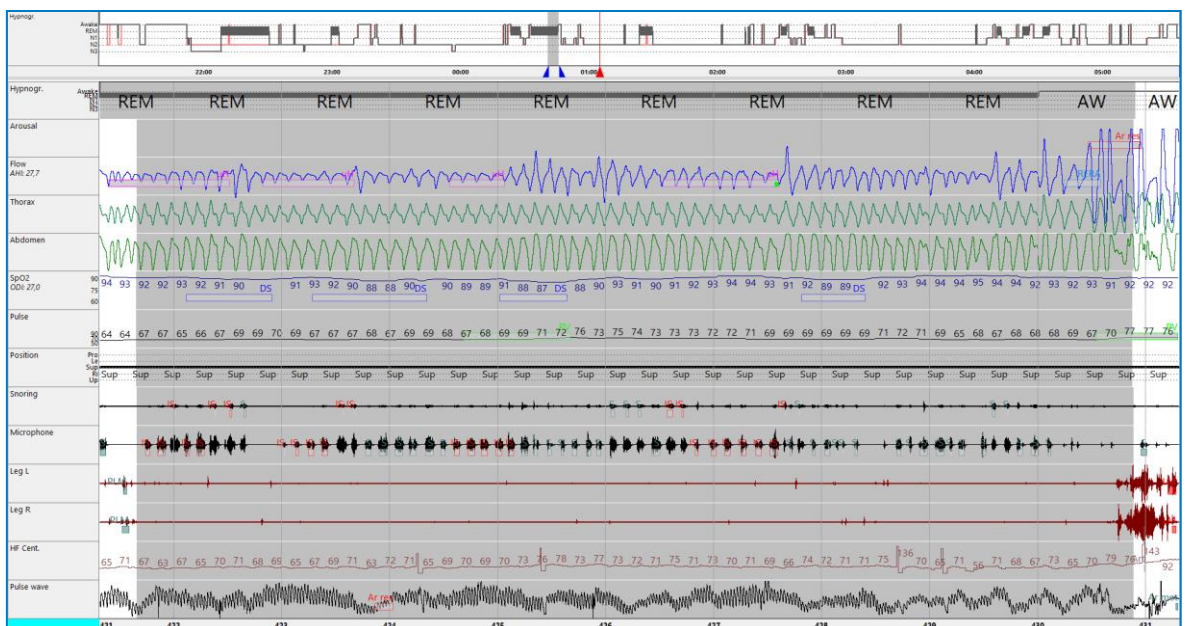


If a **certain area** in a measurement is to be **completely excluded** from the **analysis** (consideration in the report as well), this can be done using **Analysis exclusion**.

To do this, **mark the desired area** in any channel with the **left mouse button** pressed completely and when you release the mouse button select **Analysis exclusion** in the appearing context menu.

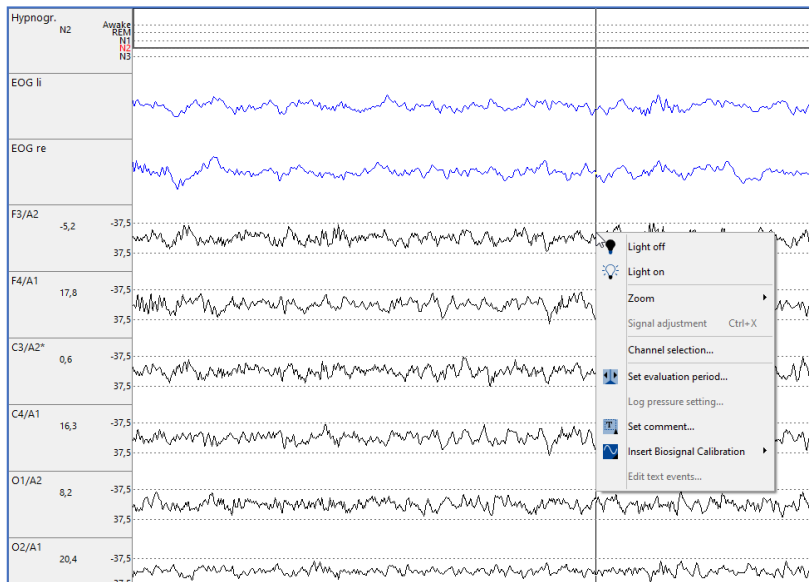


The marked, selected area is shaded in gray. **All events** within the gray marking area and the marked period are **ignored for the analysis** (not considered in the report).

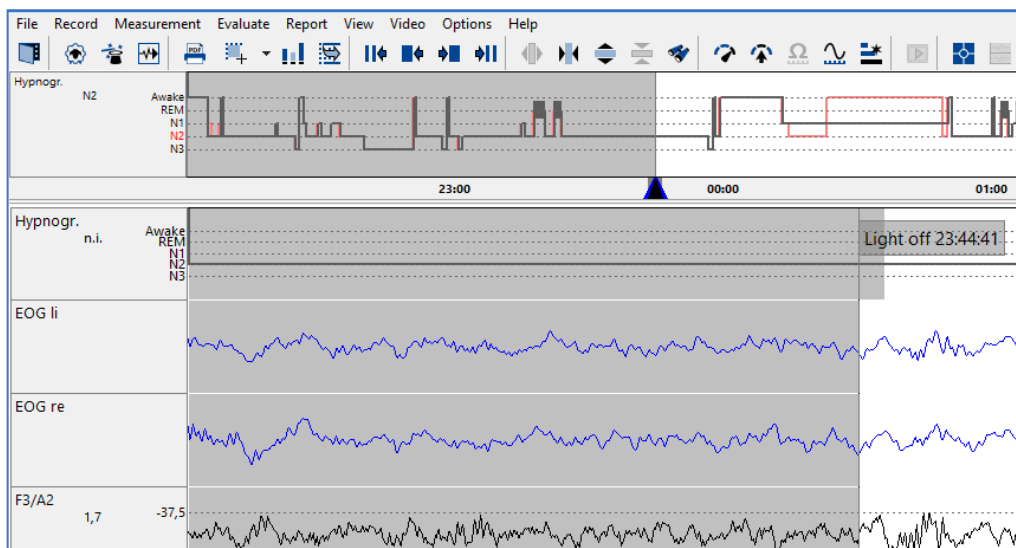


In order to **exclude a certain period of time from the analysis at the beginning and/or at the end of the measurement**, the markers **Light off** and **Light on** can be set. This can be done in PG as in PSG measurements. The analysis time period will be specified as real patient recording time.

To select Light off or Light on, click with the **right mouse button** in one of the raw data windows and **choose Light off or Light on** from the context menu.

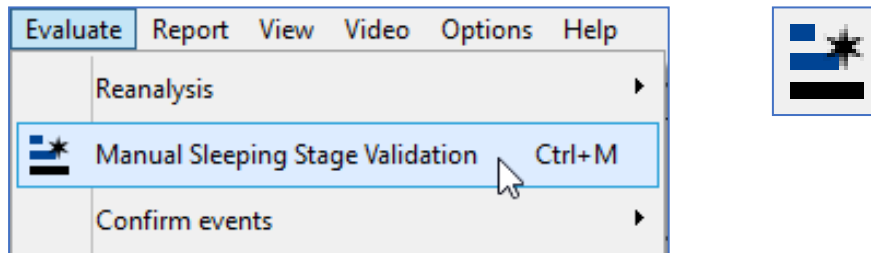


The defined „Light on“ periods are shaded in gray. All events within the gray marking area and the marked period are ignored for the analysis (not considered in the report). The period between Light off and Light on is defined as “Time in Bed” in MSV.



5. Analysis of Sleep Stages and Arousal (PSG)

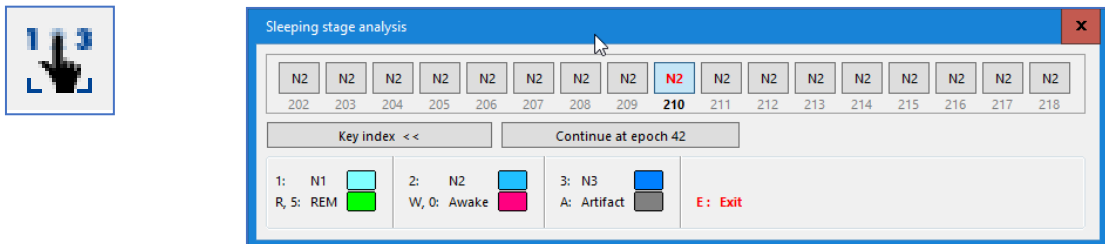
It is necessary to activate the Manual Sleeping Stage Validation to score sleep stages manually. Choose this from menu bar **Evaluate - Manual Sleeping Stage Validation** or directly in the icon bar.



The menu bar changes the look-and-feel to the needs of sleep stage scoring automatically. Recognizable by the red STOP sign in the left upper corner. The visualization changes to the Neuro-View automatically too.



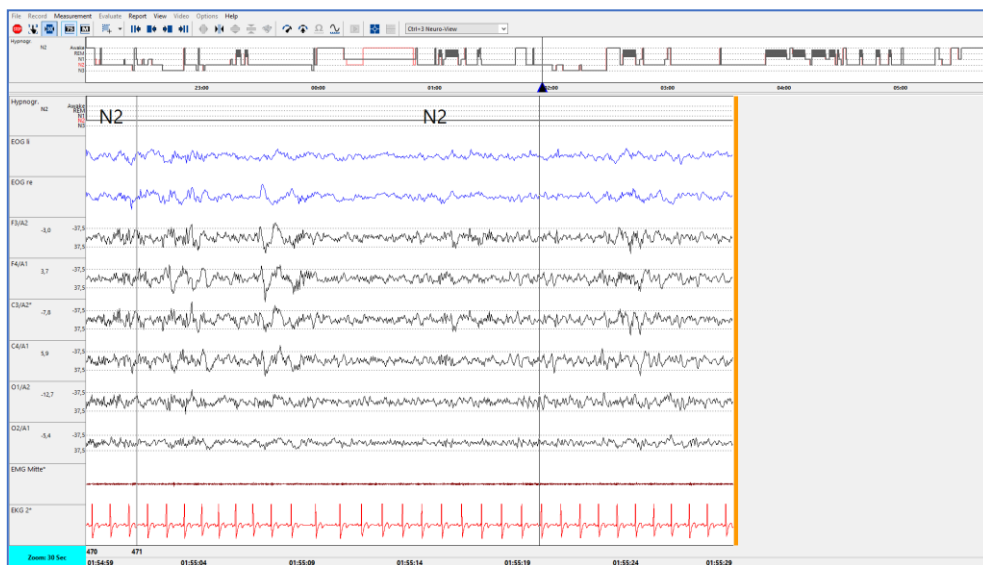
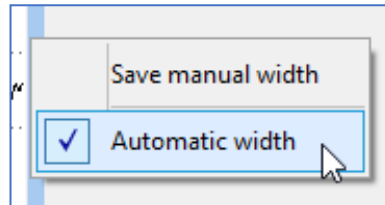
Clicking on the icon keyboard layout (2nd icon from left) opens a window in which an overview of the assigned sleep stages for the current period is displayed. In addition, the assignment of the shortcut keys for the sleep stage evaluation can be viewed.



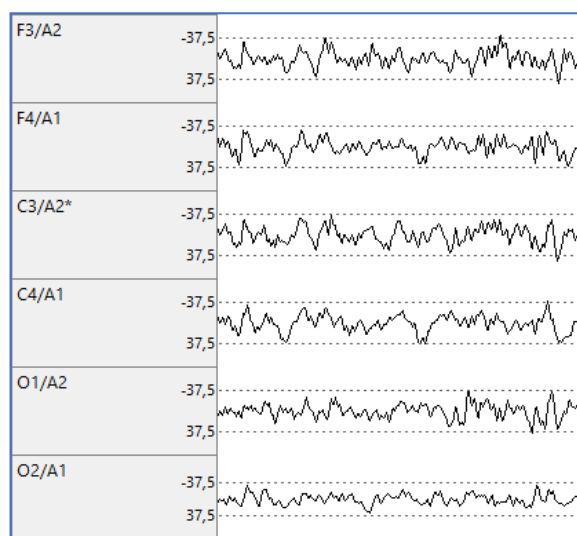
In the window shown above, epoch 66 in the middle is the one that currently can be edited in the software. The epoch bar shows eight epochs each in the previous and subsequent time history.

By selecting a shortcut on the keyboard for assigning sleep stages, the software automatically jumps on epoch forward and classifies the current one depending on selection. The software remembers the epoch in which the last manual selection was made. With the button **Continue at epoch**, it is possible to jump to this epoch later in a targeted manner.

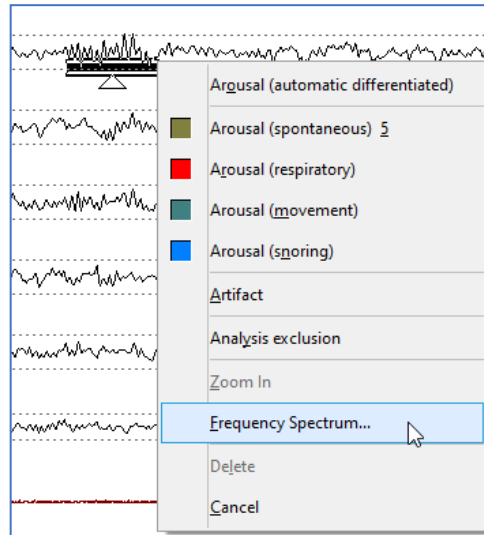
The neurological window can be compressed individually using the third symbol from the left, 30 seconds = 30 cm. This is an advantage when using very wide monitors, so that an epoch isn't displayed too stretched out. With a click of the right mouse button, the set width can be saved permanently.



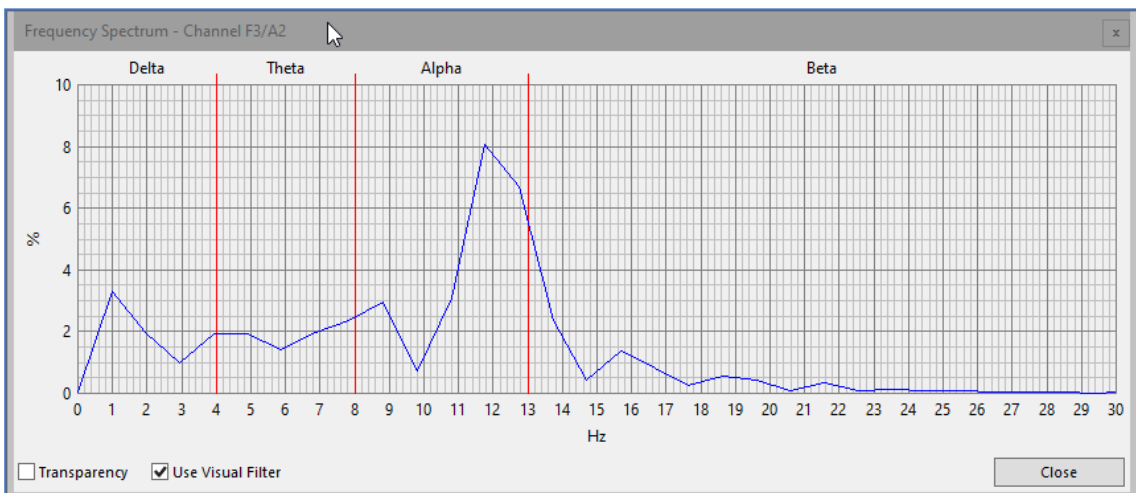
The 75µV reference lines can be shown and hidden using the fourth symbol from the left. These can be seen as dashed lines in the EEG channels.



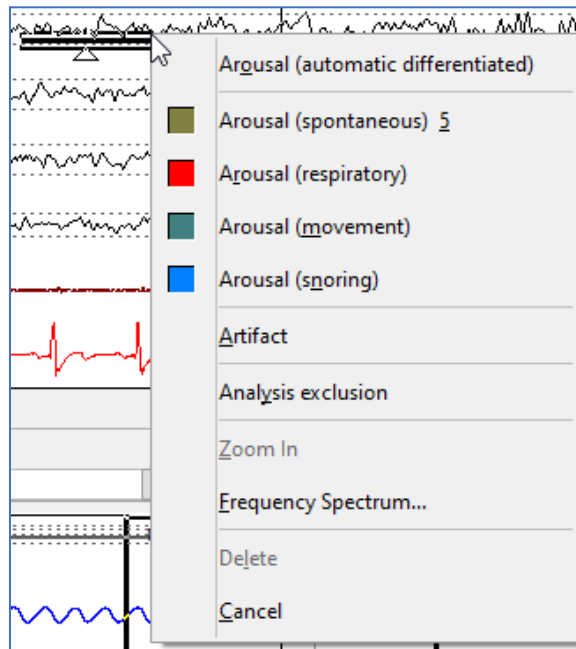
EEG frequencies can be shown as a Frequency Spectrum. To do this, mark the desired EEG area with the left mouse button pressed and then select Frequency Spectrum from the popping up menu.



In the window that appears, a distribution of the frequency of frequencies in the selected area is shown.



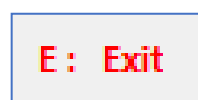
When drawing in arousal, you have the following options to choose from.



Arousal (automatic differentiated). The software analysis whether a **respiratory, movement or snoring** event occurs in temporal relation to the **arousal**. If this is the case, the software automatically classifies the arousal as a respiratory, movement or snoring arousal. The temporal relation can be influenced via analysis criteria. If no associated event is apparent, the **arousal** is considered **spontaneous**.

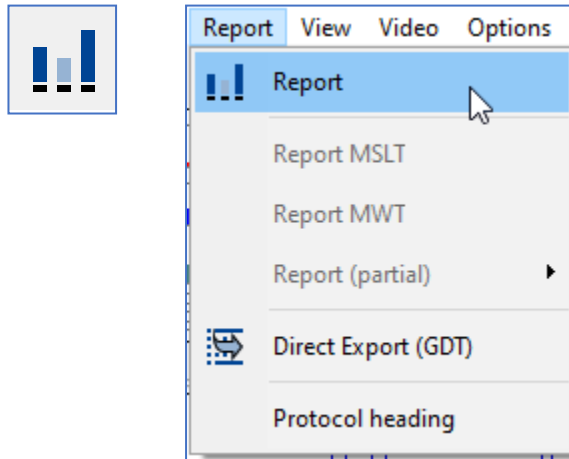
Alternatively, the four arousal types can be selected manually in the menu.

To **exit** the **manual sleep stage mode**, either press the **Stop icon** in the top left corner or press the key **E** on the keyboard. The menu bar switches back to the normal display mode automatically and the previously selected view is loaded.

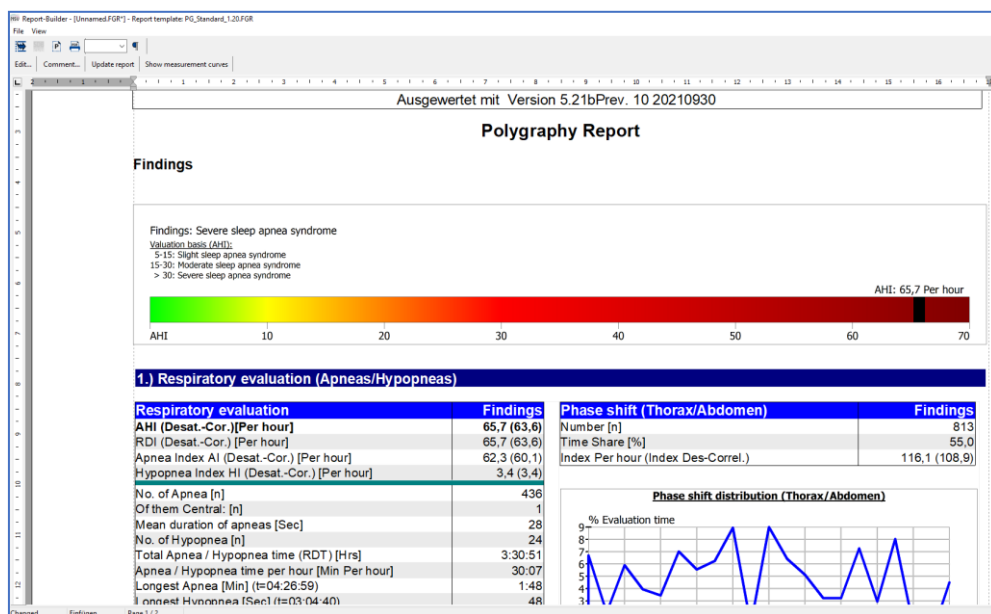
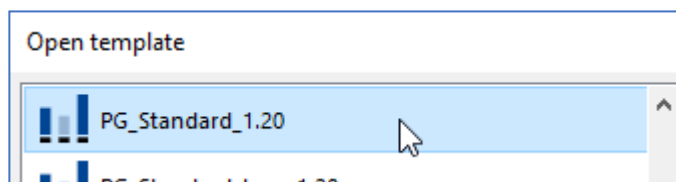


6. Report Generation

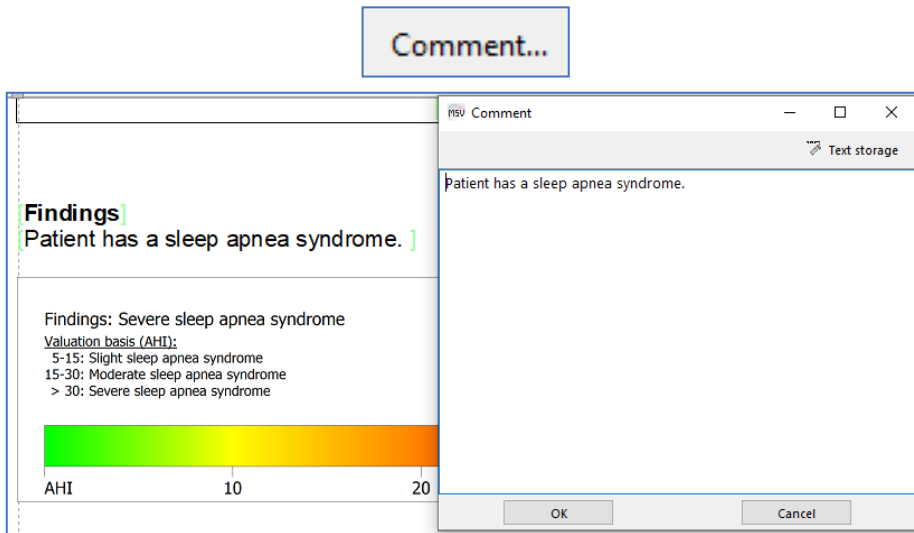
To generate a report for analyzed measurements, select **Report – Report** in the menu or click on the following symbol in the menu.



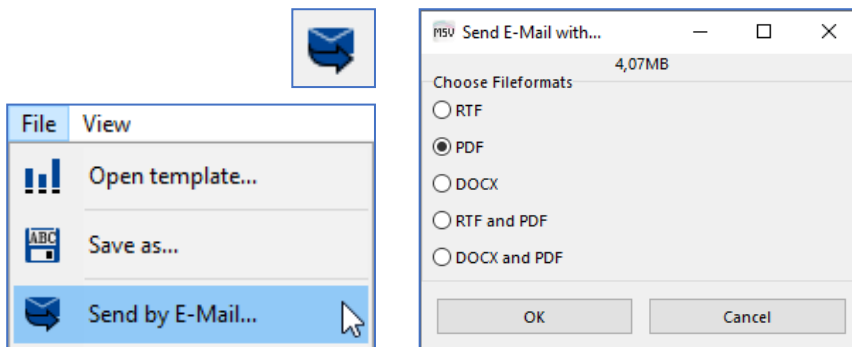
The list that opens contains a variety of **report templates**. Open the template you want to use with a double click.



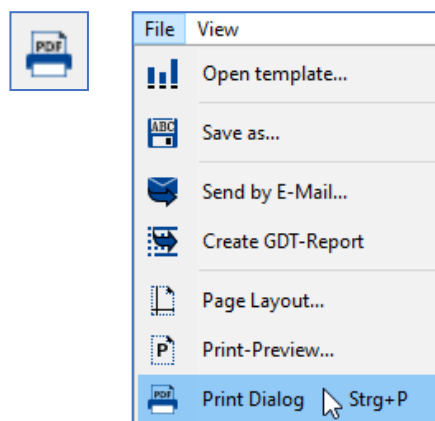
A user-defined text can be added to the menu with use of the **Comment** field. Text blocks can be stored in the comment window.



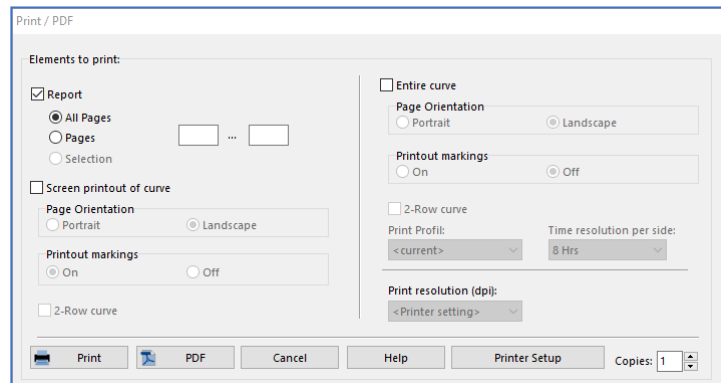
A generated report can be sent by e-mail. From the menu select **File – Send by E-Mail** and then choose the document file format.



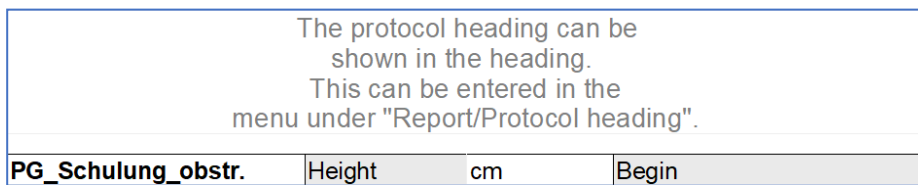
Select **File – Print Dialog** to print the report or to save it as a PDF.



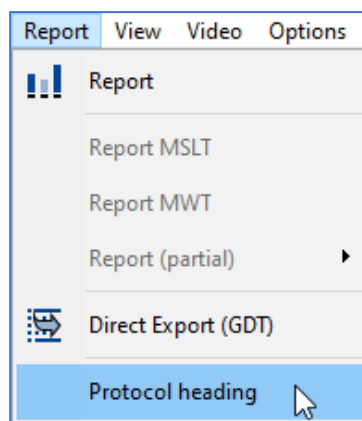
In the Print Dialog that opens choose **Print** or **PDF** from the footer.



A customized protocol heading can be entered in the **header** of the **Report template**. It also is possible to add a **logo (JPG)** to the header.

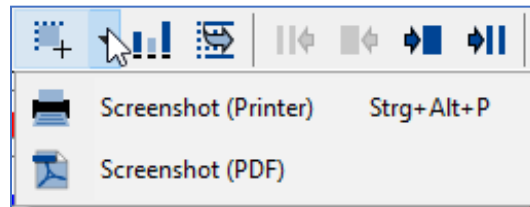


To edit the protocol heading, select **Report – Protocol heading** from the software menu.

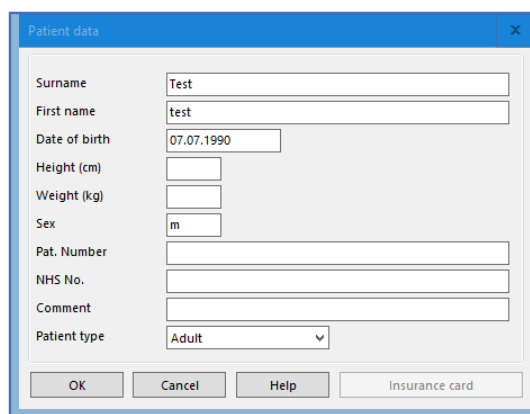
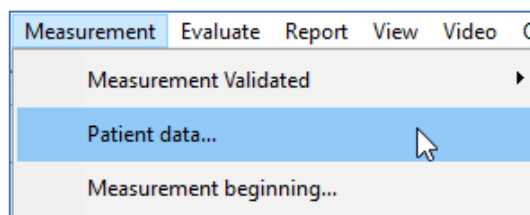


7. Other Functions

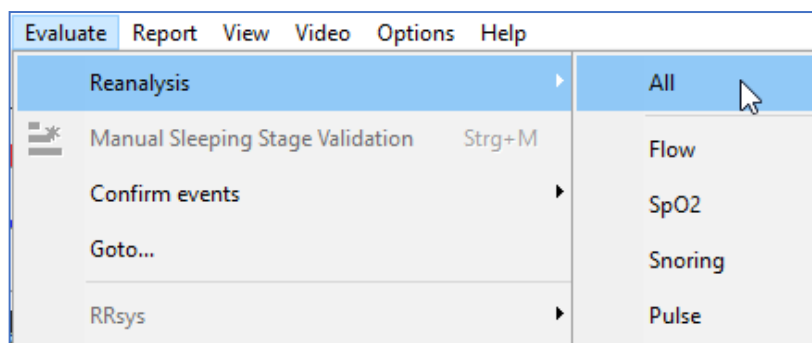
To make a **screenshot** of the current screen, select the fifth symbol from the left in the menu. The screenshot can be printed right away or saved as a PDF file.



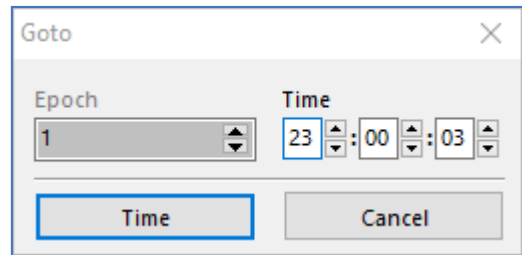
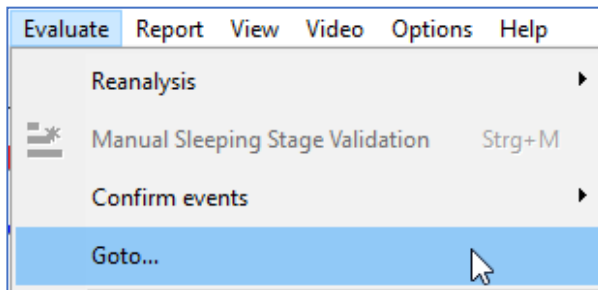
Changes can be made to **patient data** in the menu under **Measurement – Patient data**. This data can also be changed after the recording has terminated.



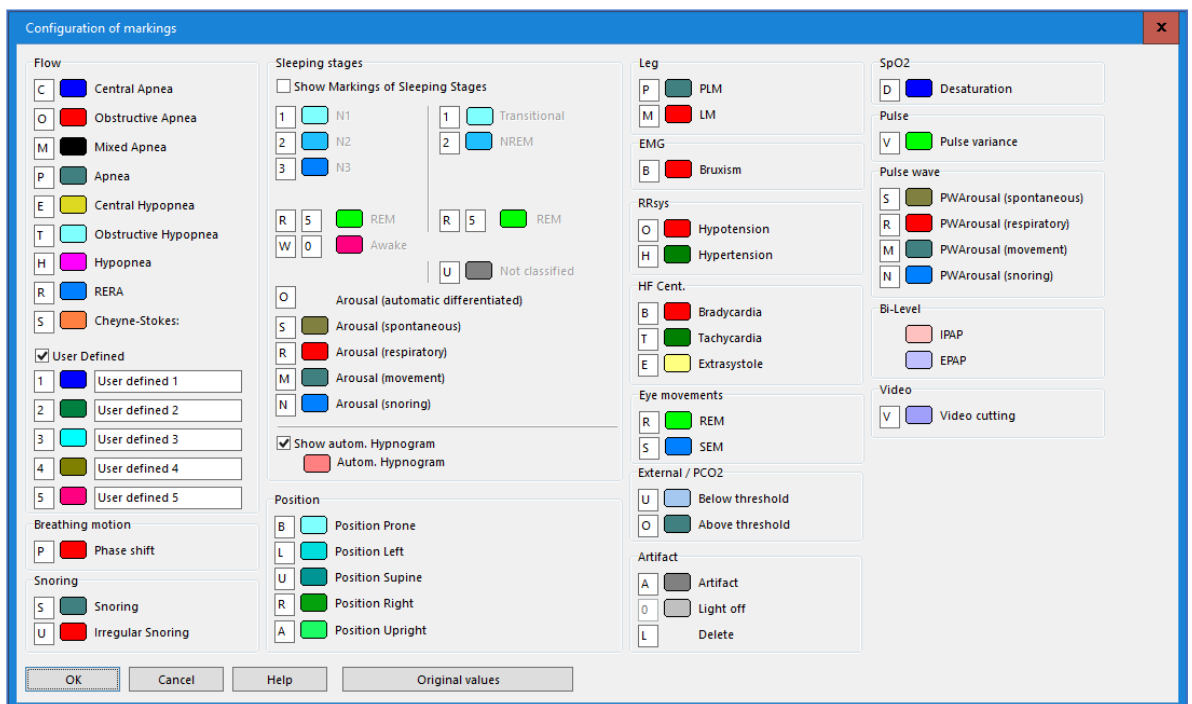
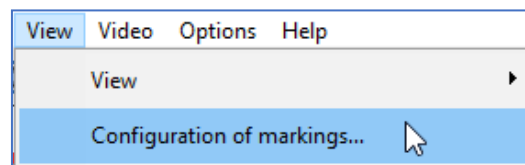
An automatic **Reanalysis** of the entire measurement or individual parameters can be selected from the menu **Evaluate – Reanalysis**.



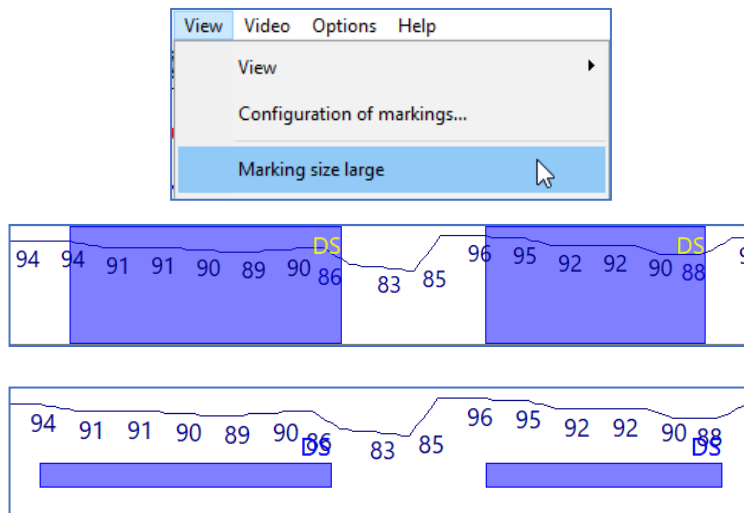
To jump to a certain point in the measurement, use the function **Go to**, which can be called up from the menu under **Evaluate – Go to**. It also can be called up with the key combination **Ctrl + G**.



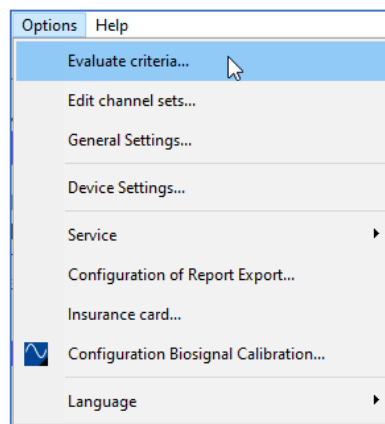
Changes can be made to the event colors and shortcut keys under **View – Configuration of markings** in the menu.



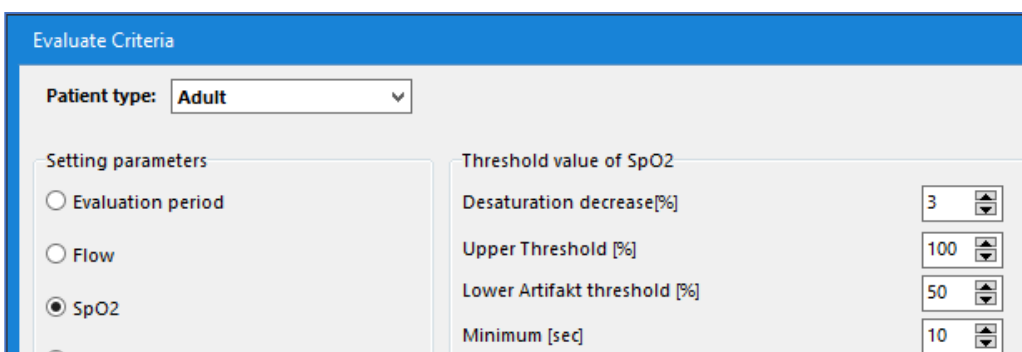
Under **View – Marking size large** you can select a large or small display of the event.



Changes to the analysis parameters can be made under **Options – Evaluate criteria**.

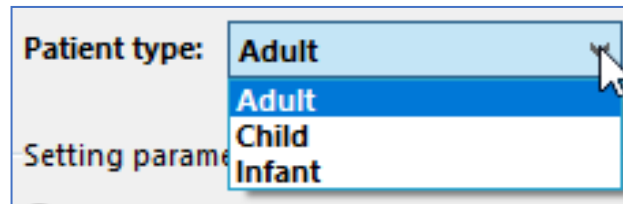


In the window that opens up, items are divided up by topic on the left-hand side. Below the corresponding section, **thresholds** and **individual functions** can affect the **automatic analysis**. Changes made first go into effect at the next automatic analysis or reanalysis.

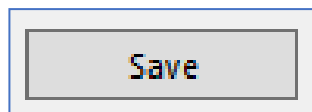


Evaluate criteria can be set for three different patient types.

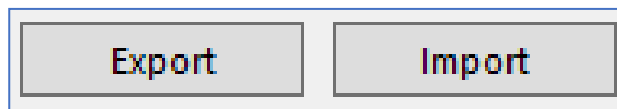
Adult, Child, Infant.



If changes were made to the evaluate criteria and these are to be applied permanently, it is necessary to **apply** the **changes** with **Save**. Any changes made will only take effect during the next automatic analysis or Reanalysis.

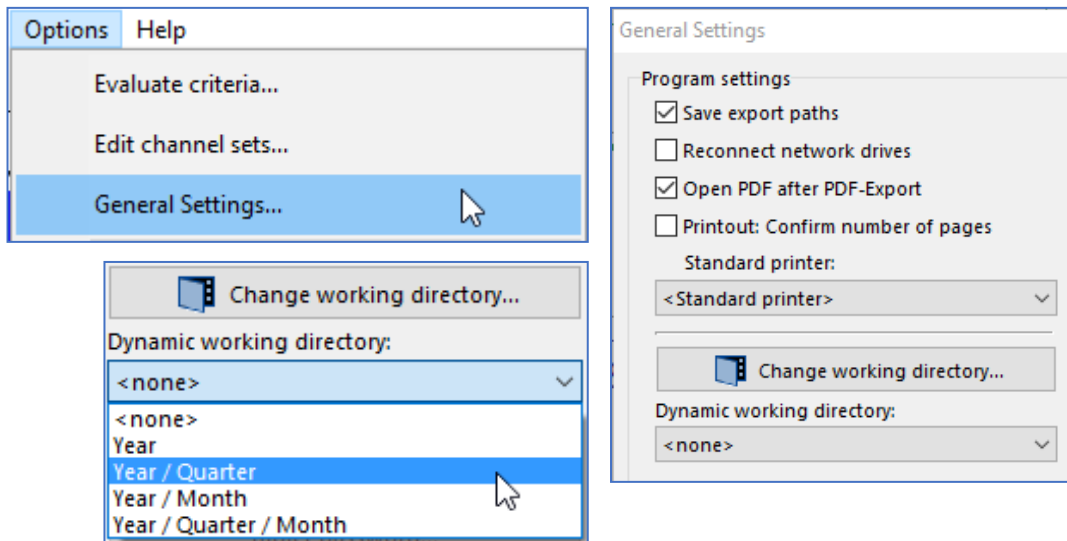


Individual analysis settings can be **exported** as an analysis profile and **imported** again at a given point in time. Analysis profiles are saved in Profile folder as .acp files.

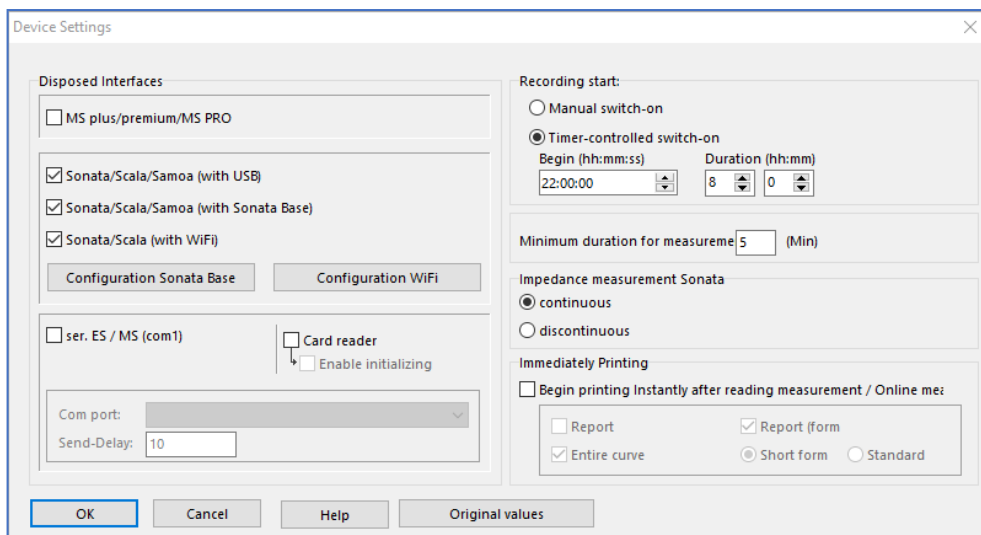


The most important point under **Options – General Settings** is the setting for the **Working Directory**. All measurements are stored and retrieved from there. The directory can be maintained on a local computer or on a network drive (Server/NAS).

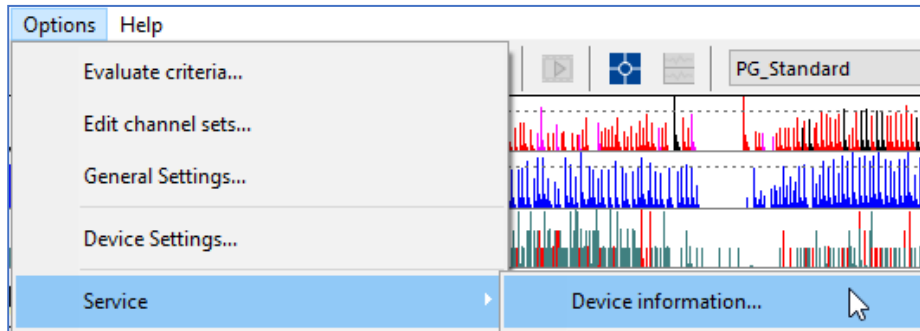
It is possible to set up a **Dynamic working directory**, which will be modified per year/quarter/month. The software will add a new subdirectory automatically at the interval selected.



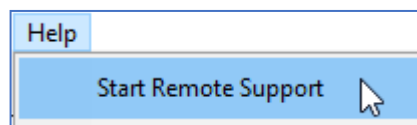
Settings can be made under **Options – Device Settings** for the devices used and the time and duration for the time-controlled start of a measurement.



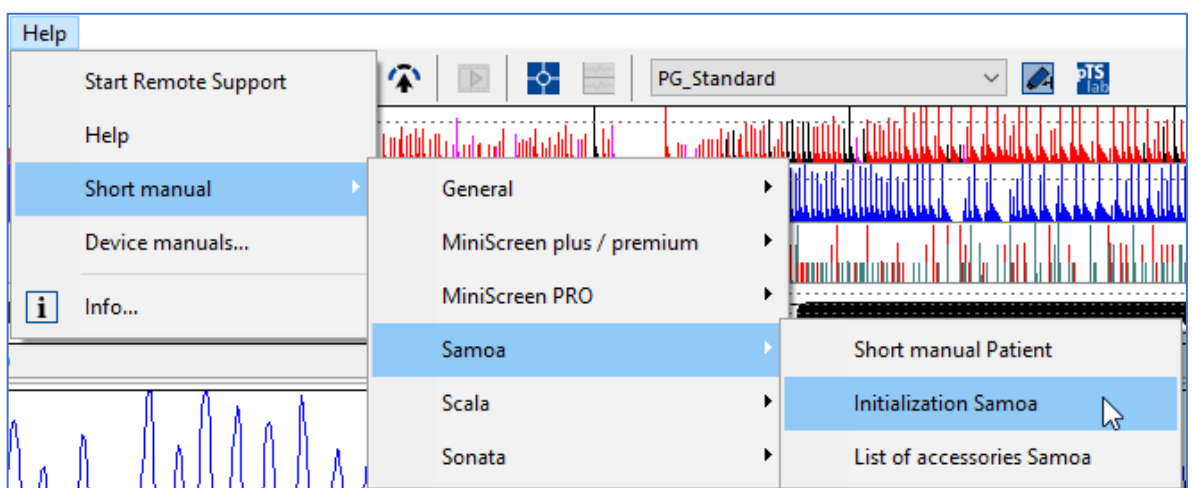
Information about programmed measurements and device-internal firmware status and serial numbers, etc., can be called up via Options – Service - Device information.



If you need help from Remote Support with questions of any kind, gain access to TeamViewer under Help – Start Remote Support. The computer in use needs an Internet connection for Remote Support.



Device-specific instructions are stored under Help – Short manual and can be called up as PDF files.



8. Key Combinations

Ctrl + G	Go to ...
Ctrl + P	Print
Ctrl + M	Manual Sleep Stage Validation
Ctrl + I	List of Impedance
Ctrl + Y	Hide Time/Epoch bar
Ctrl + V	Value cursor
Ctrl + Alt + V	Working Directory
Ctrl + Alt + P	Print Screenshot
Ctrl + Space bar	Set a Comment
Ctrl + F11	List of events
Ctrl + Shift + A	Show used Evaluate criteria
Ctrl + Shift + Space bar	Set Evaluation period
F2 + Left mouse button	Individual screenshot to insert it in the report
Ctrl + Shift + pressed left mouse button	Moving channels outside of channel boundaries

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With people in mind