User Manual

Neuron-Spectrum.NET
(Version 3)

Software

UM015.04.002.001
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The digital systems Neuron-Spectrum-1, Neuron-Spectrum-2, Neuron-Spectrum-3, Neuron-Spectrum-4, Neuron-Spectrum- 4/P and CloudEEG with Neuron-Spectrum.NET software are intended for use as digital neurophysiological systems intended for recording, processing and display biopotential signals such as Electroencephalography (EEG) and long-latency Evoked Potential (EP). Polysomnography (PSG) derives from Electroencephalography (EEG) by the means of a dedicated software module and dedicated electrodes.
The devices are portable and can register up to 8 (Neuron-Spectrum-1), 16 (Neuron-Spectrum-2), 19 (Neuron-Spectrum-3), 21 (Neuron-Spectrum-4, Neuron-Spectrum-4/P) EEG channels, 1 (Neuron-Spectrum-1, Neuron-Spectrum-2, Neuron-Spectrum-3 and Neuron-Spectrum-4) or up to 4 polygraphic channels (Neuron-Spectrum-4/P: ECG, EOG),-1 breath channel and 2 direct current channels (Neuron-Spectrum-4/P).
Neuron-Spectrum.NET includes the Evoked potentials averaging function and Quantitative electroencepalogaphy (qEEG) , including specific parameters such as Rhythmicity, FFT power ratio and amplitude metrics.
The devices do not provide alarms and do not provide to the user any diagnostic conclusion about the patient's condition. They are intended for use in the patient care institutions, diagnostics centers, neurosurgical hospitals experimental laboratories and sleep laboratories.
The patient group includes all ages and sexes.*

*Safety of use for this age group is confirmed by the results of clinical data

Caution: Federal law restricts this device to sale by or on the order of a licensed healthcare practitioner

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Introduction

Neuron-Spectrum.NET software is intended to perform EEG exams with the use of digital EEG and EP systems of **Neuron-Spectrum** series manufactured by **Neurosoft** Ltd. and also to analyze the recorded EEG and generate report.

Neuron-Spectrum.NET software is equally convenient for routine EEG exams, long-term EEG monitoring with video recording, evoked potentials (EP) acquisition, polysomnography (PSG) studies, cerebral function monitoring and scientific researches. The software automatically detects all the connected digital EEG and EP systems of **Neuron-Spectrum** series and allows selecting the required device before exam start. The program can restore automatically the connection with the device after the accidental disconnection and continue the recording. Also, the program provides the function of automatic saving of exam during the recording with the specified time interval which is useful for the recording of long-term EEG exams to prevent data loss in case of emergency power down of the computer and other failures. The convenient montages manager gives the possibility to create any variant of electrodes placement with 10-20 or 10-10 system using up to 256 derivations.

The program supports several users, at that the settings of one user do not impact the settings of other users. The program provides the customizable graphical interface which can be changed from the simple one (several main big buttons on the toolbar) up to the complicated one which gives the full access to all the program functions. Besides, graphic user interface option is integrated to contol the program using touchscreen display. The program settings are very simple and convenient, they are divided into acquisition settings and analysis settings. The use of acquisition styles and analysis styles allows switching quickly between different program settings. It is possible to use the acquisition wizard and the analysis wizard which allow to perform EEG acquisition, analysis and generation of reports in the automatic mode. The exams can be stored both in database (local or network) and the separate files (archive). The possibility of the exam export to optical media in different formats is implemented.

The program allows performing the quick navigation over the recorded EEG, exporting the exams to EDF+ format, printing of the selected EEG fragments and all the record.

The program is supplied with the different analysis techniques. Three levels of analysis are available in the program: analysis during EEG recording in the real-time mode, express-analysis of the displayed EEG fragment (without selection of analysis epochs) and epochs analysis.

The program provides the flexible system of the reports generation. Each user can generate any exam reports using his/her own report templates. The report template defines the exam information to be added and its sequence. Together with text interpretation it may include any analysis results (tables, 2D or 3D maps, graps and hystograms). The exam reports can be stored in RTF, PDF or Microsoft Word format.

Neuron-Spectrum.NET can be supplemented with **Neuron-Spectrum-EP.NET** software for long-latency evoked potentials acquisition, **Neuron-Spectrum-Video.NET** software intended for the synchronous video and audio monitoring of a patient and **Neuron-Spectrum-PSG.NET** software for the polysomnography studies. The listed programs are optional and protected by a special software protection key.

1. General Information about Program Operation

Neuron-Spectrum.NET runs on the Windows operating system that is why the principle of operation with it does not differ from any other applications functioning in the mentioned operating system. Before the digital EEG and EP system connection to computer and starting to use the program, it is necessary to install it to the computer. To start the operation with the program, one should run it.

1.1. System Requirements

Neuron-Spectrum.NET software is developed for the use under control of Windows XP Service Pack 2, Windows XP Service Pack 3, Windows Vista Service Pack 1, Windows 7, Windows 8 operating systems. Consequently, the base requirements to the computer hardware correspond to the requirements of the above-mentioned systems. Besides, the computer should have at least one USB connector for the device attachment. For the comfortable operation with **Neuron-Spectrum.NET** it is required to have additional computer resources. For example, to analyze EEG in the real-time mode during the acquisition, the additional computational resources can be required and for the more detailed EEG review it is better to use the monitor with not less than 19 inches size.

The recommended system requirements:

- Processor: Intel Core i5 with 2 GHz clock rate and higher.
- Main memory: 4 GB and higher.
- Monitor: 24 inches and higher, resolution 1280×1024 pixels and higher.
- Free space on a disk: 1.5 GB to install the program and 20 GB and higher to store the exams.
- USB port to attach the device.

Neurosoft Ltd. provides the possibility to purchase any digital EEG and EP system of **Neuron-Spectrum** series together with the computer. In this case, the computer is completely ready to operate with the device, and all the required software is installed. If you plan to use the digital EEG and EP system of **Neuron-Spectrum** series with other computer, you should first install **Neuron-Spectrum.NET** software on it. The disk with the distributive of the program is included in the digital EEG and EP system delivery set. Besides, during all the device operation life you can download the last versions of the required software free of charge via internet.

1.2. Program Setup

To start the process of **Neuron-Spectrum.NET** software setup, insert the disk or flash drive with the program distributive to the disk drive of your computer. If after several seconds the setup program does not run automatically, start *Autorun.exe* file from the CD or flash drive. In the appeared dialog box (Fig. 1.1) choose "**Neuron-Spectrum.NETomega** EEG acquisition and analysis" item. After that, the dialog box offering to choose the program interface language will appear on the screen (Fig. 1.2).

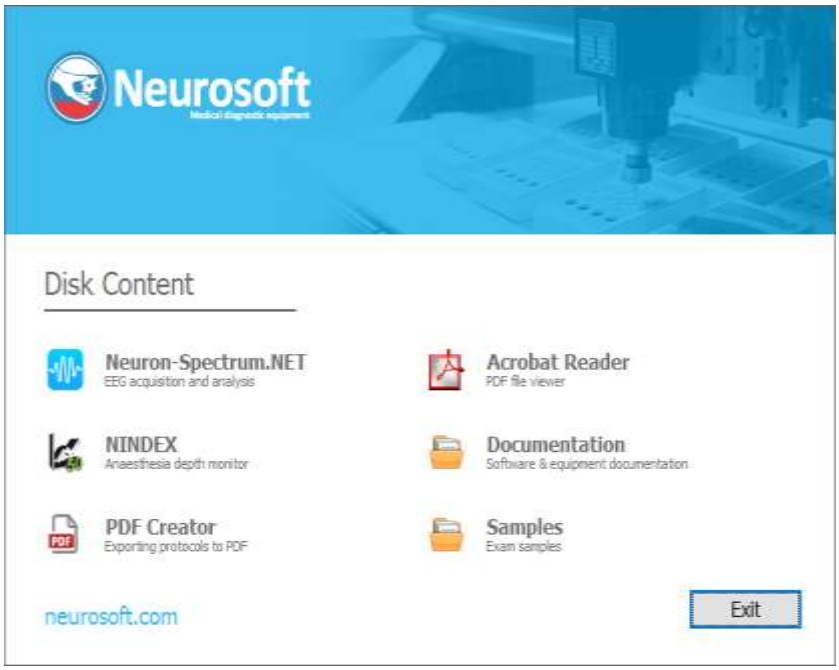


Fig. 1.1. Program setup.

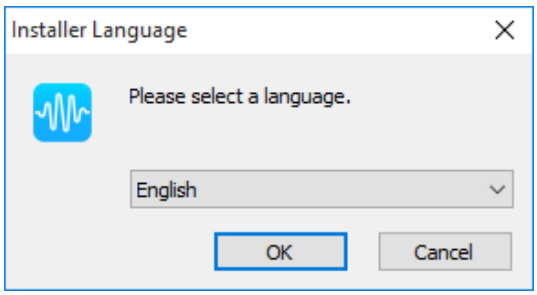


Fig. 1.2. Selection of program language.

After program interface language is selected, press “OK” button to continue the setup or “Cancel” button to deny it. If you continue the setup, the following dialog box will appear on the screen (Fig. 1.3).

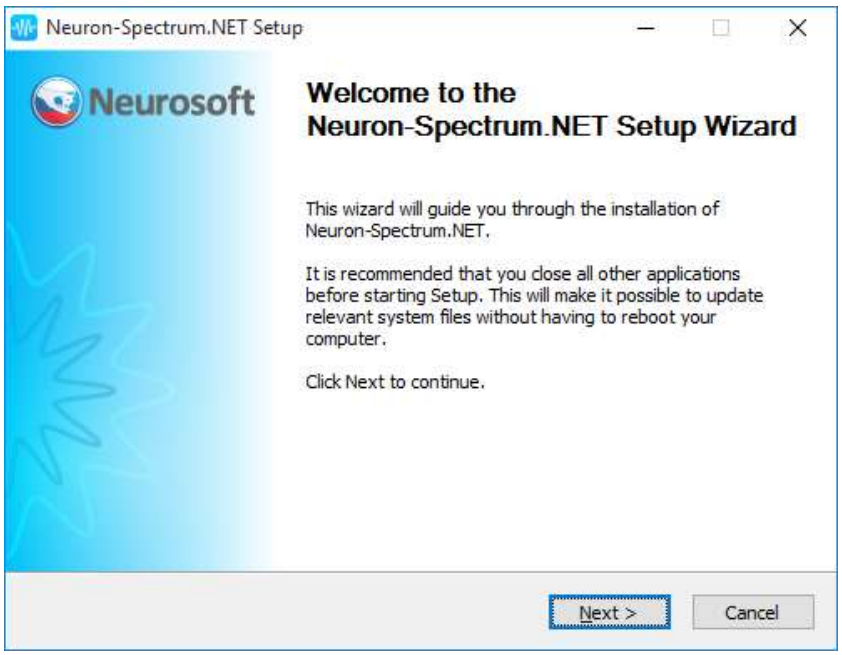


Fig. 1.3. Welcome of setup program.

To continue the program setup, press “Next >” button. The “License Agreement” dialog box will appear at the screen (Fig. 1.4).

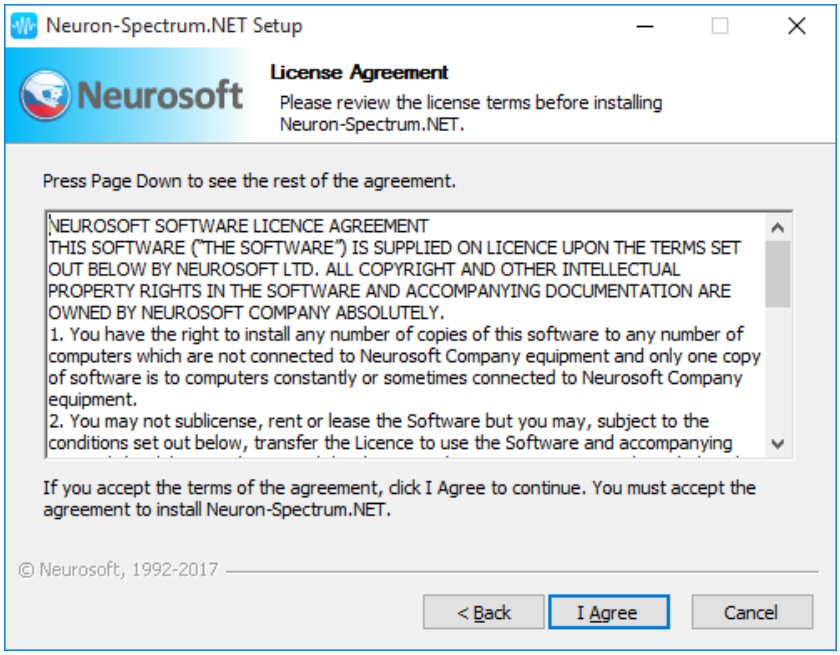


Fig. 1.4. “License Agreement” dialog box.

To continue the program installation, press “Next>” button. If 64-bit operating system is integrated, the dialog box offering to select the program version will appear at the screen (Fig. 1.5). By default it is offered to install 64-bit program version.

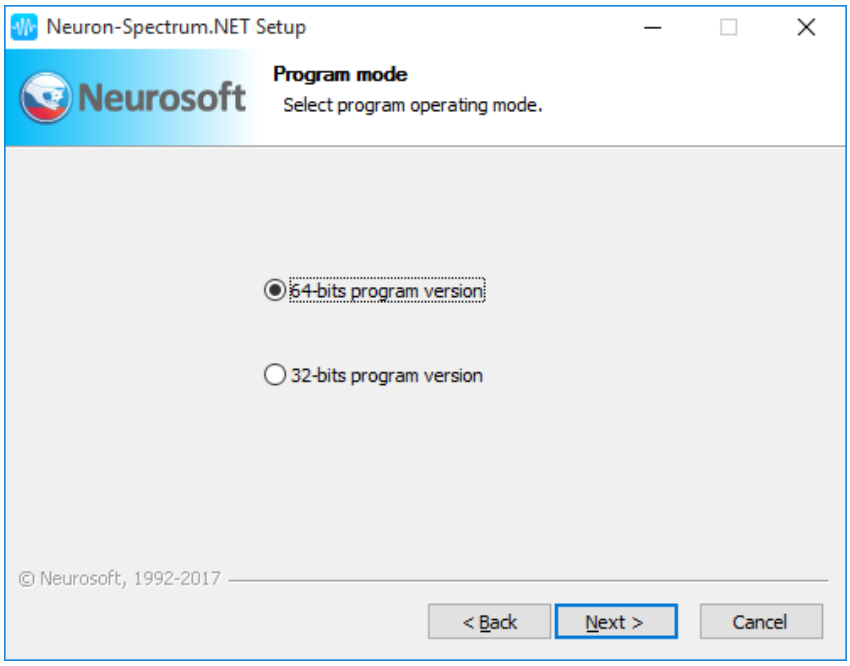


Fig. 1.5. Request to select processor capacity.

To continue the program setup, press “Next >” button. The dialog box offering to choose the place of the program installation will appear on the screen (Fig. 1.6). By default the program will be installed to *C:\Program Files\Neurosoft\Neuron-Spectrum.NETomega*. To change the directory of the program setup, press “Browse…” button and select the folder for the program setup.

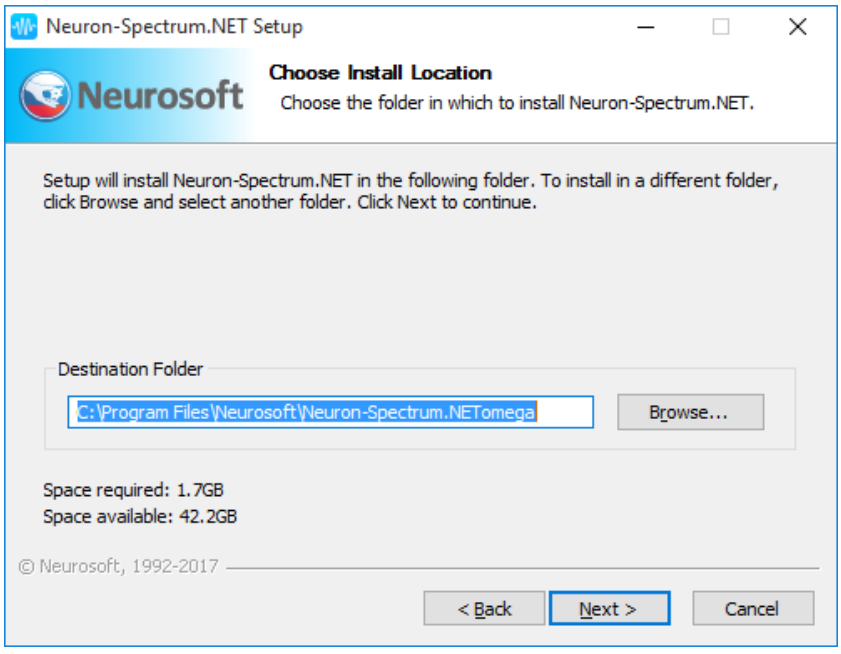


Fig. 1.6. Request to choose the place of the program setup.

To continue the program setup, press “Next >” button. To return to the previous setup step, press “< Back” button. In the appeared dialog box (Fig. 1.7) press “Install” button to finish the program setup.

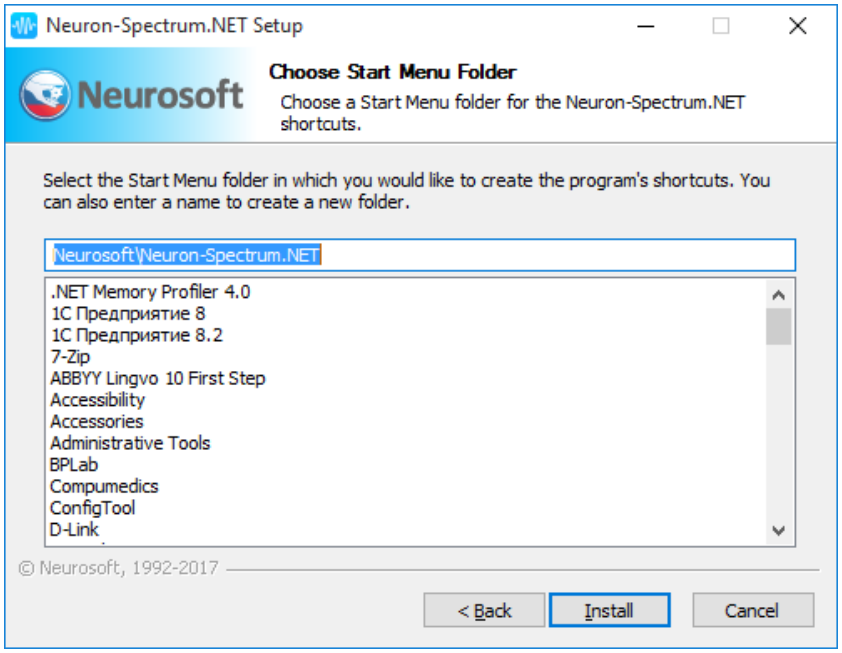


Fig. 1.7. Program installation.

In the next dialog box (Fig. 1.8) wait for the setup ending and press “Next >” button to finish the program setup (Fig. 1.9).

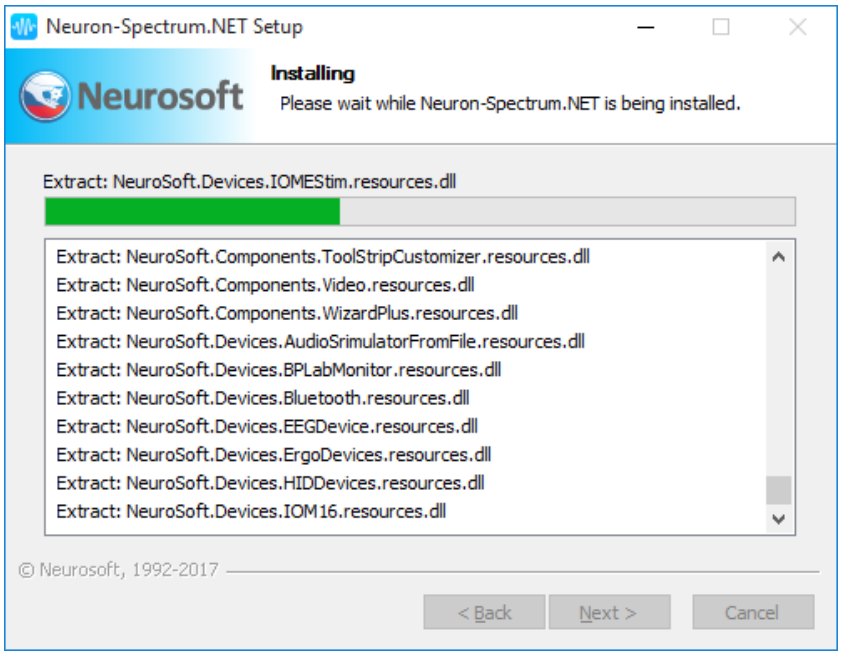


Fig. 1.8. Process of program setup.

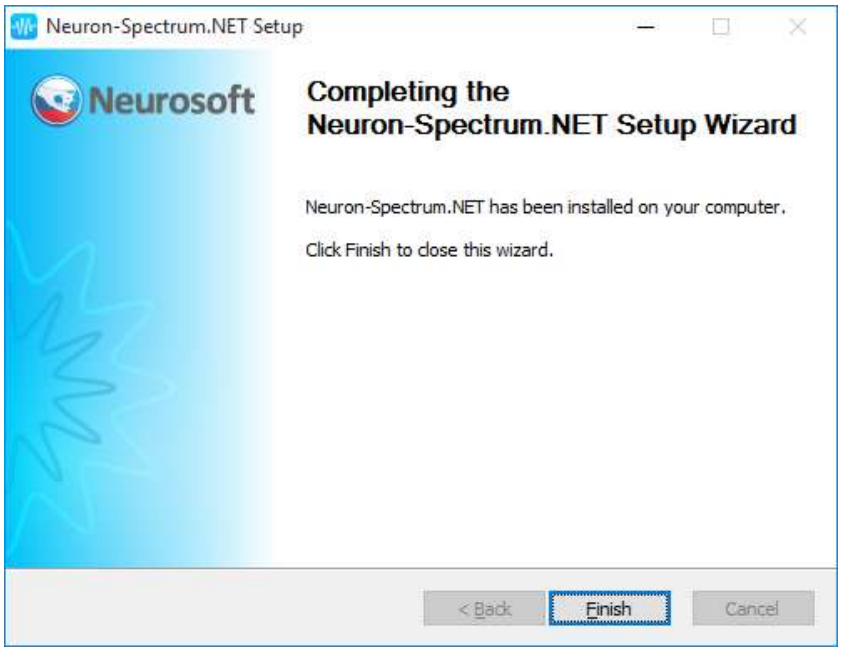


Fig. 1.9. Finishing of program setup.

If you install **Neuron-Spectrum.NET** software on your computer for the first time, the program wizard will install automatically Microsoft DirectX of 9.0c version to your computer. At that, the Microsoft DirectX setup window (Fig. 1.10) will appear on the screen. To install Microsoft DirectX, follow the instructions of the program wizard.

Fig. 1.10. Setup of Microsoft DirectX of 9.0c version.

At the setup of **Neuron-Spectrum-Video.NET** (see chapter 10 "**Neuron-Spectrum-Video.NET**") or **Neuron-Spectrum-PSG.NET** software (see chapter 11 "**Neuron-Spectrum-PSG.NET**") all the required video and audio codecs will be installed on your computer (Fig. 1.11).

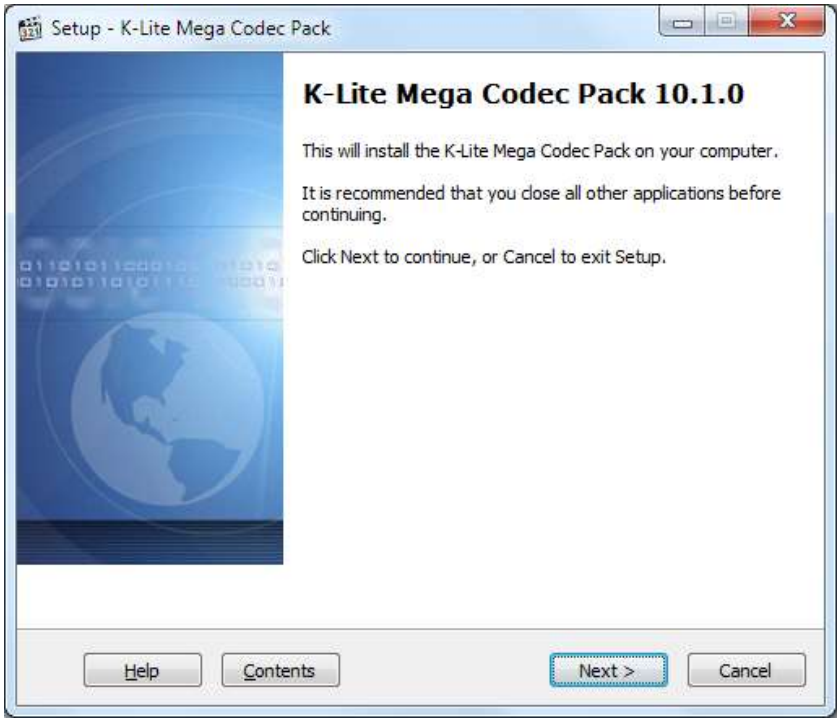


Fig. 1.11. Installation of video and audio codecs.

At the purchase of digital EEG and EP system of **Neuron-Spectrum** series manufactured by **Neurosoft** Ltd., you get the right to update periodically the software allowing to operate with the above-mentioned digital EEG and EP system free of charge. To install the new version of **Neuron-Spectrum.NET** software, perform all the steps listed in this section (see section 1.2 "Program Setup"). At the first run of the updated version, the program will ask the way of user settings updating (Fig. 1.12).

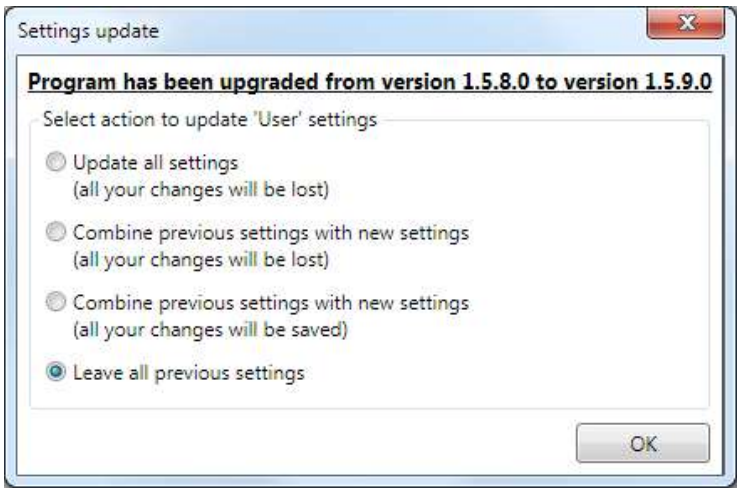


Fig. 1.12. Updating of program settings.

You can choose one of the following ways to update program settings:

- **Update all settings (all your changes will be lost).** All the program settings will be updated. At such type of renew all the montages, markers, functional tests, acquisition and analysis templates, desktops created by a user will be lost. The program will look like the one just installed with the default set of montages, markers, tests, etc. All additional settings made by a user (new montages, markers, tests, etc.) will be lost. Such type of updating is required only at a pinch.

- **Combine previous settings with new settings (all your changes will be lost).** At such type of updating the user settings will be replaced by the default settings of the new program version.

- **Combine previous settings with new settings (all your changes will be saved).** At such type of update all the settings will remain the same but the new settings with default values available in the new program version will be added to them. This way of settings updating is the most preferable.

- **Leave all previous settings**. All user settings will remain the same. However, in this case the new settings available in the new program version will be inaccessible what is why this way of updating is not advisable.

1.3. Program Run

To run **Neuron-Spectrum.NET**, it is necessary to install it first on the computer (see section 1.2 “Program Setup”). If the program is installed, it is required to fulfill one of the following operations to run it:

- Double-click the program shortcut  on the desktop with the left mouse button.

- Select the program in the **Start** menu of the operating system: *Start\All programs\Neurosoft\Neuron-Spectrum.NETomega\Neuron-Spectrum.NETomega*.

- Run *C:\Program Files\Neurosoft\Neuron-Spectrum.NETomega\NeuroSoft.EEG.WPF.exe* file.

1.4. Main Program Window

After the program run a user identification window will appear on the screen (Fig. 1.13). **Neuron-Spectrum.NET** software supports the operation of several users. If you started the program for the first time, enter your name. In case it is done not for the first time, choose your name from the combo-box. If you do not want others to work with the program under your name, enter the password. In this case, the program will require the password each time at each next run. If you do not plan to organize the multi-user mode of operation with the program, you can check “Do not show this window” checkbox in the bottom part of the window. In this case, the identification window will not appear at the next program runs. To finish the identification, press “OK” button. If you press “Cancel” button, the program run will be cancelled.

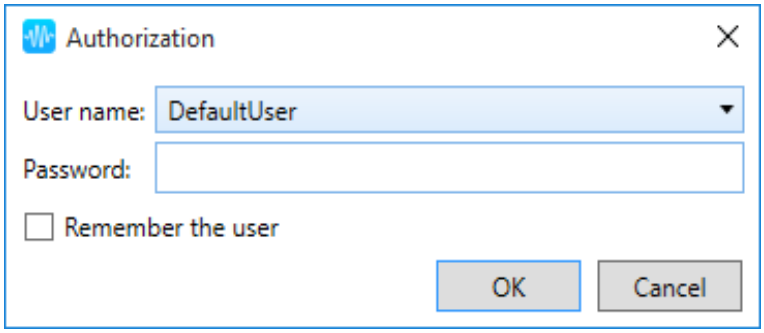


Fig. 1.13. User identification of the program.

On identification process completion, the main program window will appear on the screen (Fig. 1.14).

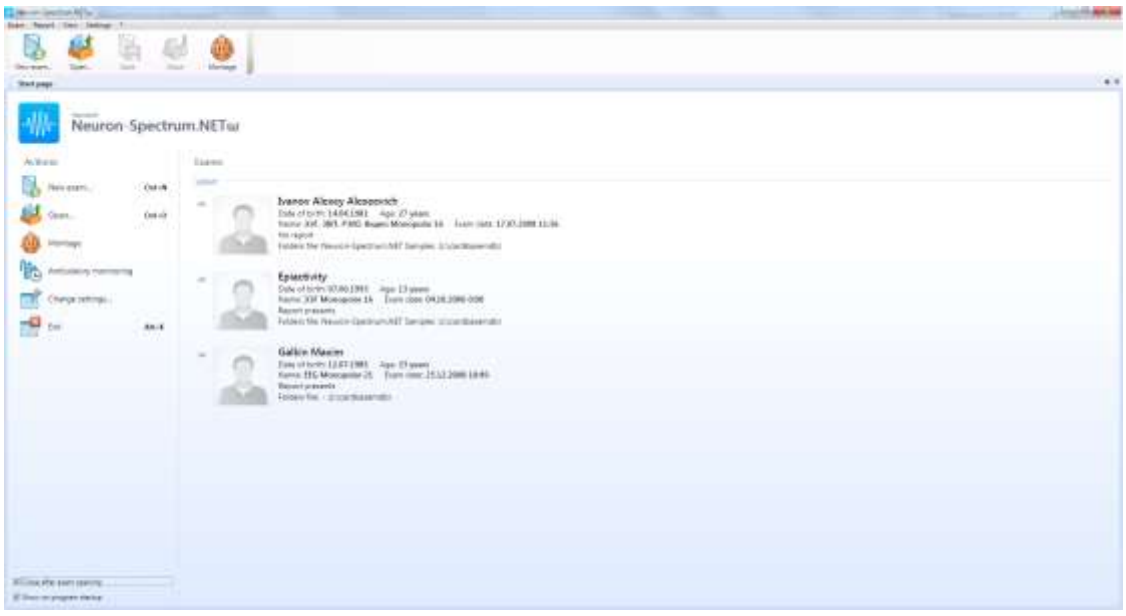


Fig. 1.14. The main window of **Neuron-Spectrum.NET** software.

The main program window has a traditional structure for Windows applications. The top part of the window contains its title and window control buttons. Just after the title, the panel of the program main menu can be seen. Using the menu commands, you can create new exams, open the existing ones, control EEG acquisition, perform the analysis, generate exam reports, change the settings. Using the menu, a user can

get the access to all the program functions. The most frequently used program functions can be placed on the toolbar buttons. The main toolbar is located under the menu bar of the program. **Neuron-Spectrum.NET** has several toolbars for the acquisition, analysis, exam generation, etc. Each toolbar can be located in any part of the program window according to user's preferences. A user can also adjust both the visibility of toolbars and the visibility, the size and the view of toolbar buttons. See more details concerning the toolbar setup in section 8.13 "Toolbar Setup". The remained part of the window is occupied by the program work space. EEG review and analysis windows, exam report managers can be located here. By default the start page is opened when the program is run (**View|Start page** menu items). The most often used commands are located in the left part of start page and the list of latest exams opened with the program is shown in the right part.

Besides "Program application selection" dialog box appears at the screen at the first program run (Fig. 1.15).

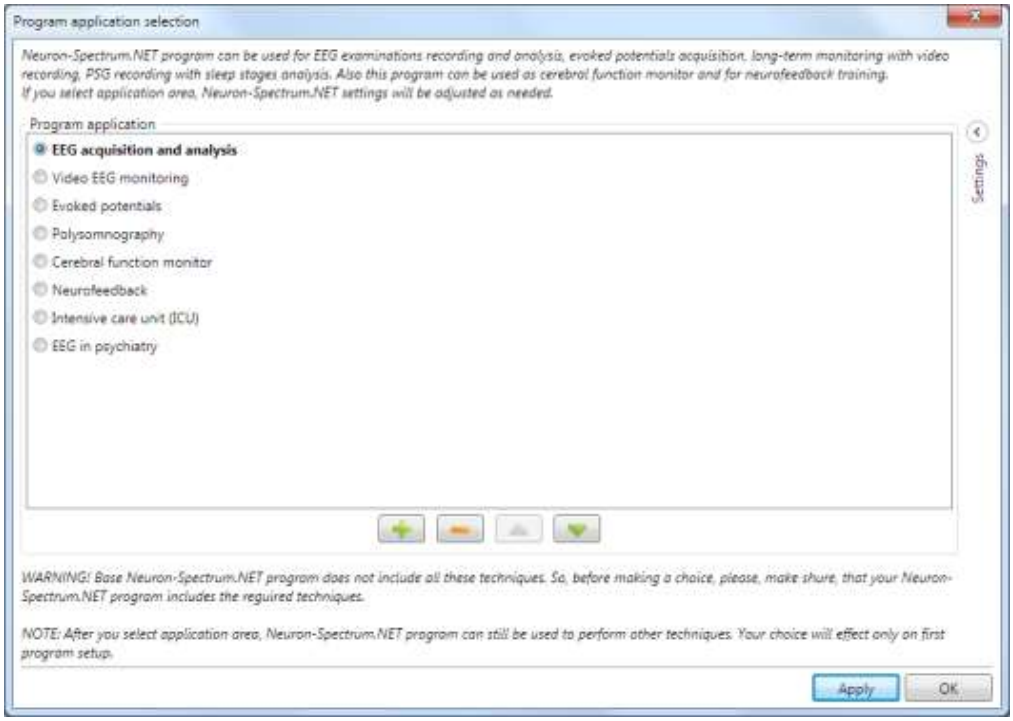


Fig. 1.15. Neuro-Spectrum.NET applications.

The selection of application area allows to customize the program with one click. Just select the required area in the list and press "Apply" button. At that the program will automatically detect the settings and parameters required for the selected application area. If you are not sure in application area or plan to use the program in several application areas, you can skip this step by closing this dialog box. Next time you open **Neuron-Spectrum.NET** you can use **Settings|Program application selection** menu item to customize quickly the program for the required exams. Besides with this window you can create or save your own application areas with your own settings (Fig. 1.16).

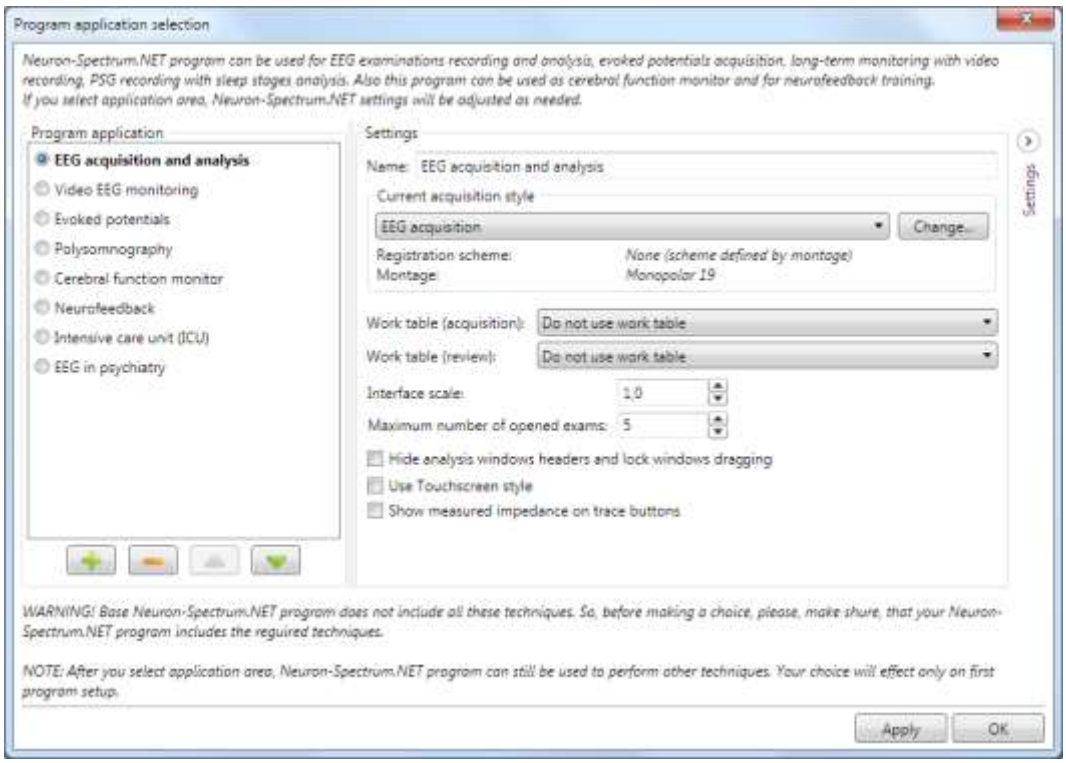


Fig. 1.16. Selection of application area and setup of exam parameters.

1.5. Program Exit

On program operation completion, it should be closed. To do this, it is necessary to execute one of the following operations:

- Press  button in the top right corner of the main program window.
- Use **Exam|Exit** menu command.
- Use **[Alt+X]** hotkey combination.
- Use  button on the start page.

2. Quick Start

The example of the typical EEG exam recording using **Neuron-Spectrum.NET** program is descibed in this chapter. This program should be installed on your computer beforehand (see section 1.2 “Program Setup”) and digital EEG and EP system should be connected to computer USB port.

1. Run **Neuron-Spectrum.NET** software on your computer (see section 1.3 “Program Run”).

2. After the program start, the user identification window (Fig. 2.1) will appear on the screen. Enter user name and press “OK” button.

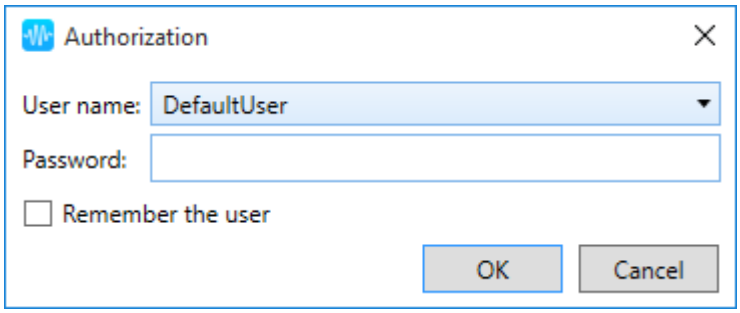


Fig. 2.1. Identification of program user.

3. At first program start you will be prompted to select its main application area (Fig. 2.2). **Neuron-Spectrum.NET** software can be used for performing of various techniques. So, as soon as you specify the application area, the software will be set up automatically for the proper performing of chosen technique. Later you can change your choice using **Setup|Program application selection** menu item.

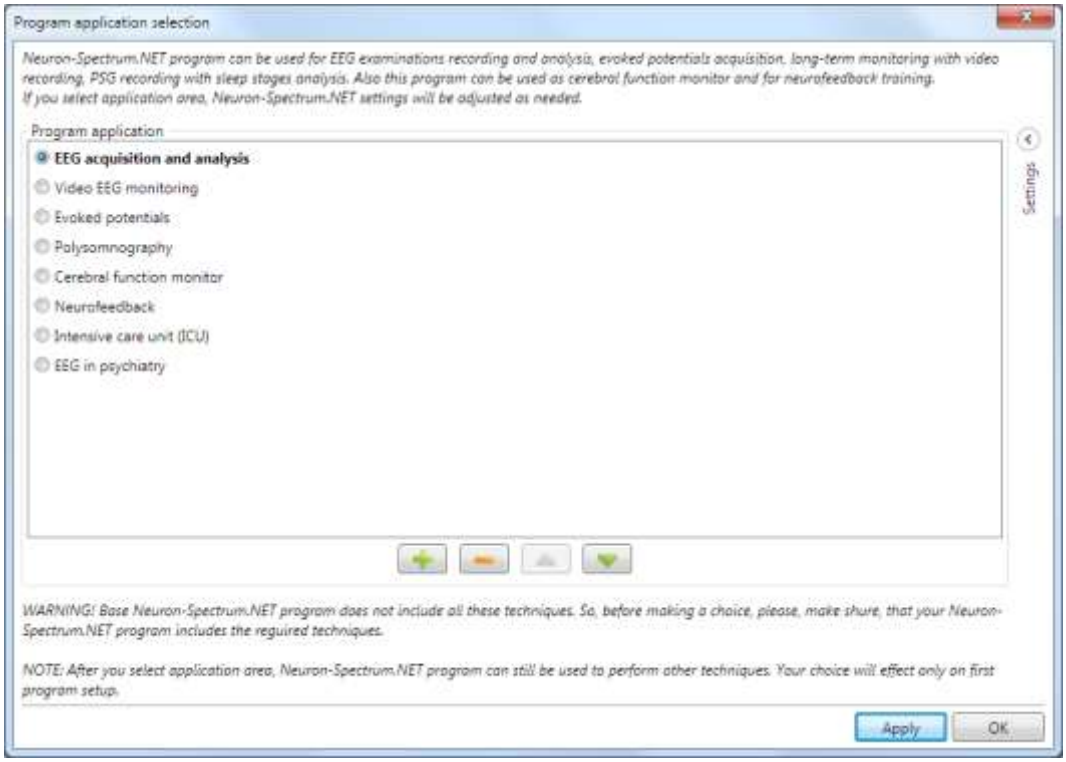


Fig. 2.2. Selection of Neuron-Spectrum.NET application area.

4. In the main program window (Fig. 2.3) press “New exam” button on the toolbar or use **Exam|New…** menu command. Also to create the new exam, you can use **[Ctrl+N]** key combination or the corresponding button at start page.

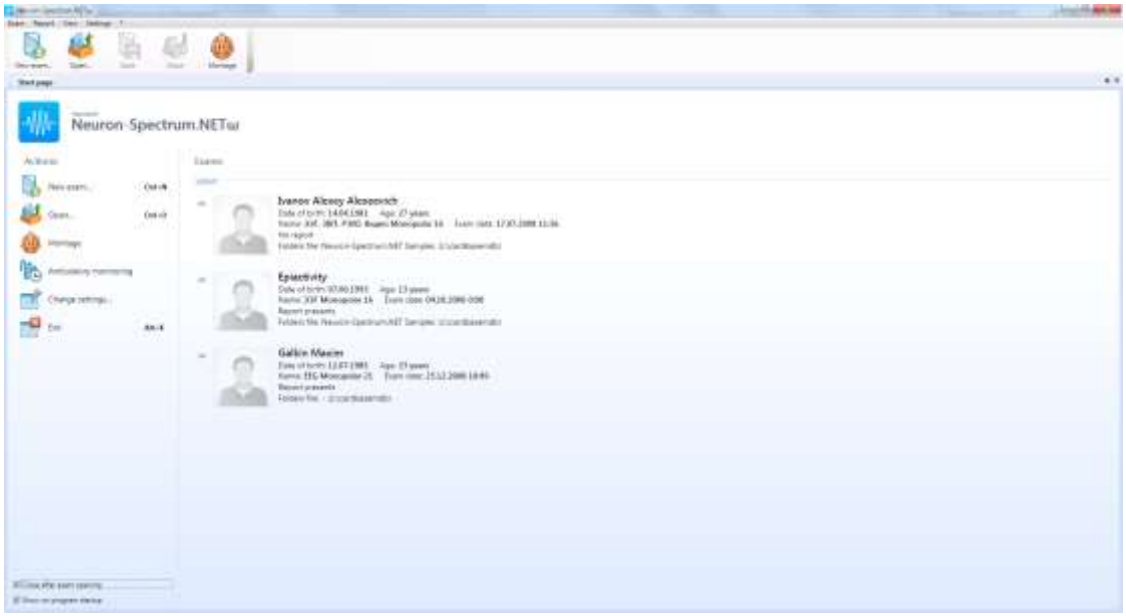


Fig. 2.3. Main window of **Neuron-Spectrum.NET** software.

5. In the appeared dialog box enter a patient’s data (Fig. 2.4) and press “OK” button. On the **Acquisition** tab you can choose the required “Current acquisition style” from the corresponding combo-box (see section 8.2.2 “Acquisition Styles”).

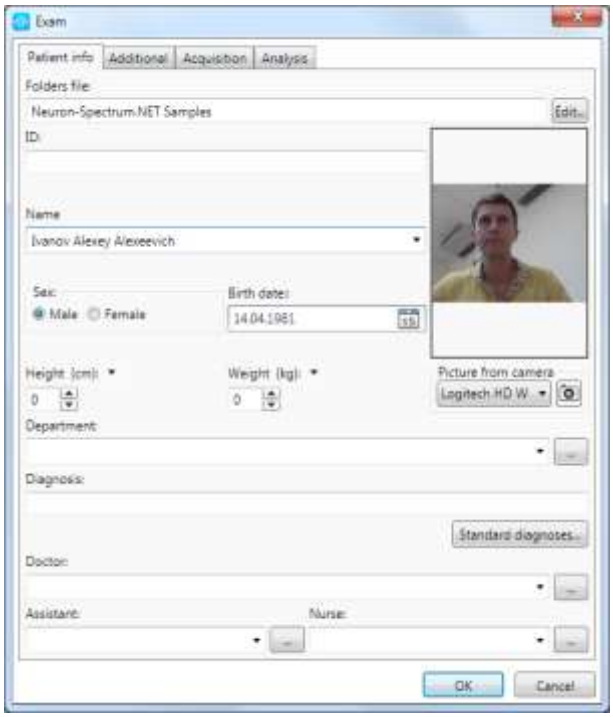


Fig. 2.4. Entering of patient’s data.

6. After the acquisition parameters are downloaded (Fig. 2.5), press “Impedance” button on the toolbar.

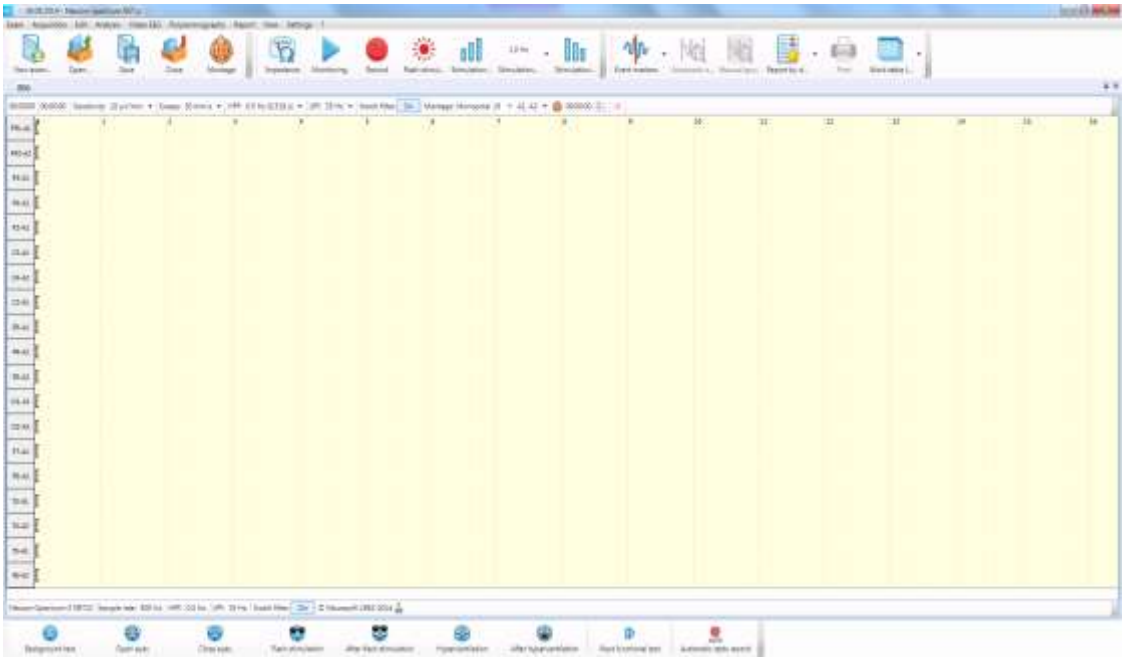


Fig. 2.5. The acquisition window after new exam creation.

After that, the dialog box with the results of electrode impedance measurement (Fig. 2.6) will appear on the screen. You can place the electrodes on a patient with simultaneous control of setting quality.

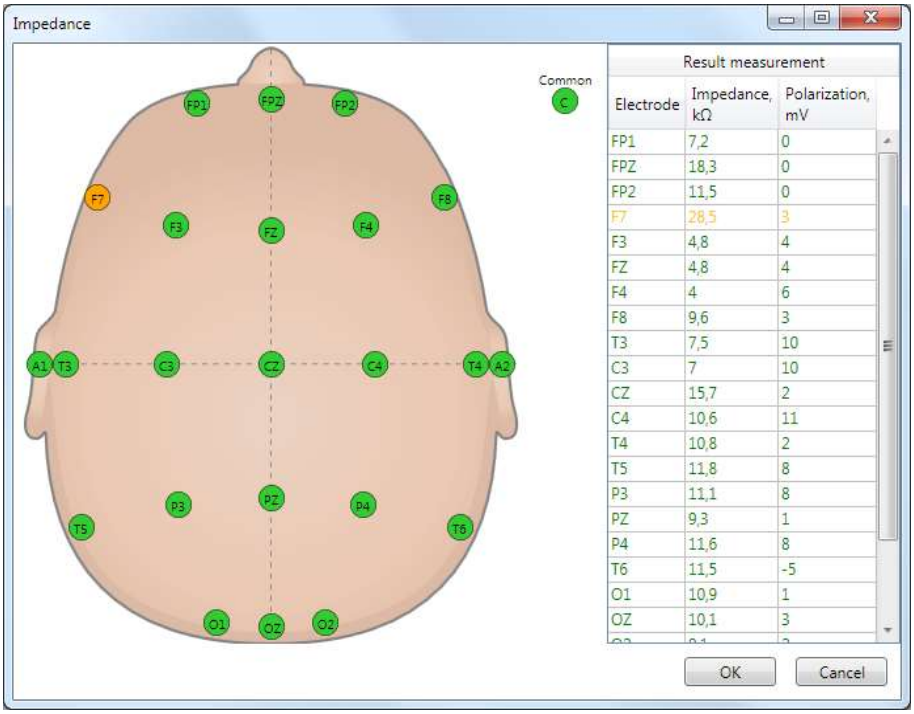


Fig. 2.6. The impedance measurement.

7. On electrode placement completion, press “Monitoring” button on the toolbar to check EEG signal. Calm down a patient, make sure in the stability of monitoring signal and press “Record” button on the toolbar. From this moment EEG acquisition is started, the functional test “Background test” is run automatically.

8. To record the following functional tests, you can use the buttons on a special panel located under EEG traces (Fig. 2.7).

Fig. 2.7. Panel to record functional tests.

9. To arrange the event markers during EEG acquisition, you can use “Event markers” button with drop-down list located on the toolbar.

10. To finish EEG acquisition, press “Stop” button on the toolbar. The navigation over the recording can be done with the use of the arrow buttons, mouse scroll or navigator located under EEG traces (see section 5.4 “Navigation over EEG”). To review the analysis results during the recording or after it you can open the required analysis windows using **Analysis** menu item (see section 6.4 “Analysis Windows”).

11. To prepare the automatic report, press “Report by default template” button on the toolbar or choose the required report template using the combo-box of this button. After that the automatic report will be generated.

12. If the printer is connected to your computer, you can print the exam report using “Print” button on the toolbar. Also you can print EEG traces using main menu commands (see section 5.13 “EEG Printing”).

13. To save the exam, press “Save” button on the toolbar.

14. To close the exam, press “Close” button on the toolbar.

To get a more profound insight into the functions and possibilities of **Neuron-Spectrum.NET**, please, read carefully the following chapters of this manual.

3. Operation with Exam Manager

EEG exams performed with the use of **Neuron-Spectrum.NET** program can be saved both in separate files (archives) and exam databases (local or network). To store and get an access to the performed exams, use “Exams manager” program. Using this program you can create exam databases and patient cards, store and open the performed exams, save the selected exams to archive. “Exams Manager” allows burning CD or DVD with the exams to move to other computers. Besides, it contains the tools for exams search, selection and generation of statistical reports. More detailed description of “Exams manager” program is given in the “Exams Manager” user manual.

Besides the standard operations “Exams Manager” includes some operations being specific for EEG exams. Using the corresponding button on the toolbar you can work with EEG exams without opening them (Fig. 3.1).

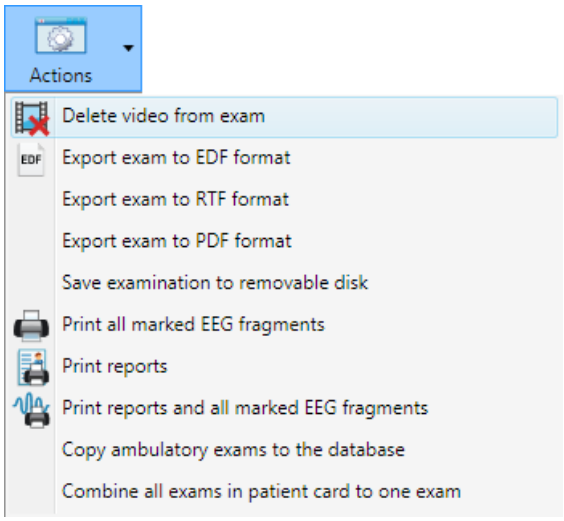


Fig. 3.1. Operations with EEG exams being performed in “Exams manager”.

4. EEG Acquisition

To start the new EEG exam, execute one of the following operations:

- Use **Exam|New…** menu command.
- Use **[Ctrl+N]** hotkeys on the keyboard.
- Press the corresponding button on the toolbar or start page (see annex 1).

Attention! According to American Clinical Neurophysiology Society Guideline hyperventilation should be used routinely unless medical or other justifiable reasons (e.g., a recent intracranial hemorrhage, significant cardiopulmonary disease, sickle cell disease or trait, or patient inability or unwillingness to co-operate) contraindicate it.

Allergic reactions and inflammatory changes of the skin are possible in the places where electrodes, sensors, stimulators are applied. When performing functional tests (such as photic stimulation, auditory stimulation and hyper-ventilation) the side effects are also possible. EEG examinations must be per-formed only by qualified medical personnel in a specially equipped room.

4.1. Creation of Patient Card

While creating a new exam you should first enter a patient's data (Fig. 4.1). The "Exam " window contains four tabs.

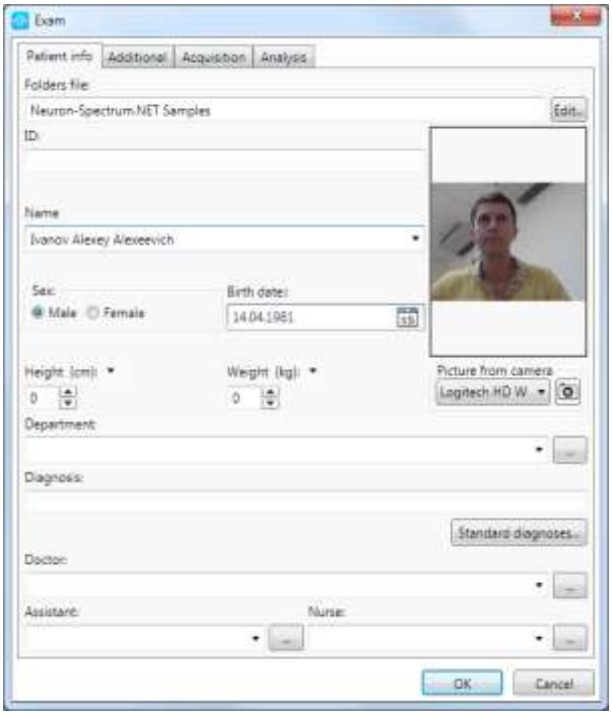


Fig. 4.1. Entering patient's data.

On “Patient info” tab it is required to enter patient’s name, sex, date of birth, department and provisional diagnosis. You can also enter patient’s ID number and attach a photo using a file or make a snapshot with the video camera connected to computer. Set of fields to enter patient’s data can be changed with the use of context menu available by right-clicking. To change a patient’s photo, left-click the rectangular area in the right part of the window. It is not obligatory to complete all the indicated fields. To start a new exam, it is enough to press “OK” button or **[Enter]** key. When you enter the first letters of patient’s name the program offers you the list of patients from the current database whose names start from the entered combination of letters. If the card of an examined patient already exists in the database, it will be enough to select the patient from the offered list. In this case all the rest fields will be automatically completed with the values from the database, and the new exam will be saved in the existing patient card. If there is no patient with the entered name in the database, new patient card will be created.

On “Additional” tab (Fig. 4.2) you can also enter policy number, address, telephones, e-mail of a patient and text comments. It is not obligatory to complete these fields. Except the indicated fields you can specify the additional entry fields. To change the basic and additional patient data during the exam you can use **Exam|Information…** menu command.

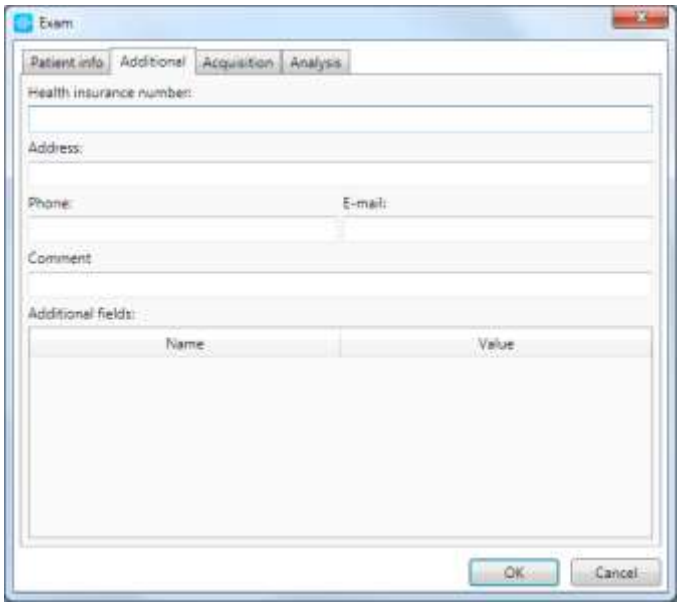


Fig. 4.2. The additional patient’s data.

Using two next tabs of “Exam” dialog box you can control the acquisition and analysis parameters of the new exam. On “Acquisition” (Fig. 4.3) tab you can choose the acquisition style for the new exam. The “Current acquisition style” combo-box contains all the acquisition settings. If you press “Change…” button, you can edit the acquisition styles (see section 8.2.2 “Acquisition Styles”). During EEG acquisition you can change the acquisition parameters, for example, select any other montages (see section 8.2.1 “Montage Editing”) from the list, set other filters and trace displaying scales. Besides, you can set up acquisition wizard at this tab (see section 8.2.3 “Acquisition Wizard”). This acquisition wizard allows to record EEG in automatic mode.

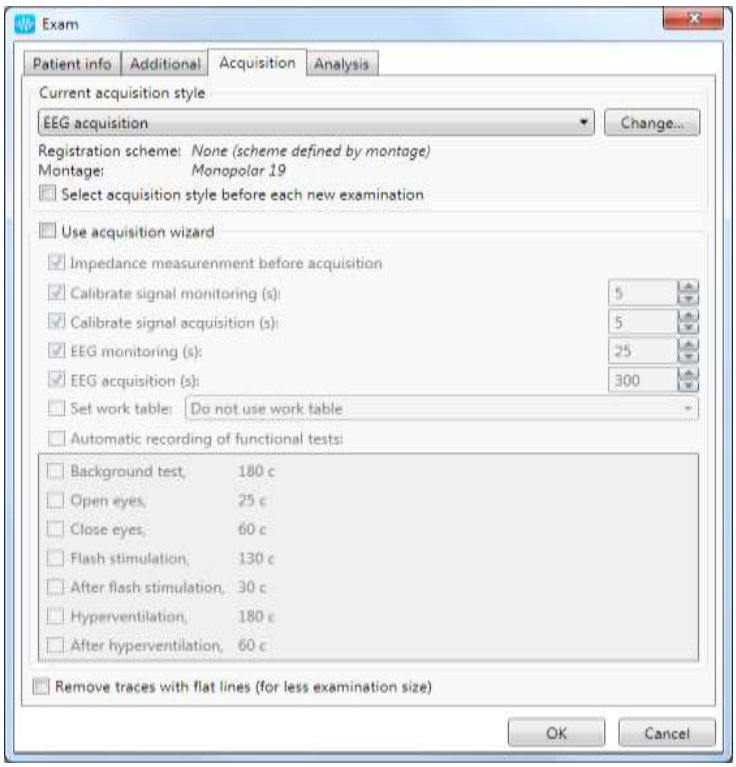


Fig. 4.3. Setup of new exam acquisition parameters.

On the “Analysis” tab (Fig. 4.4) you can select the analysis style for a new exam. The analysis style contains all analysis settings. If you press “Change…” button, you can edit the analysis styles (see chapter 8.7.1 “Analysis Styles”). Also on the “Analysis” tab, you can select the work table for a new exam (see chapter 5.15 “Work Tables”). The work table contains the toolbar settings and layout of the recording and analysis windows.

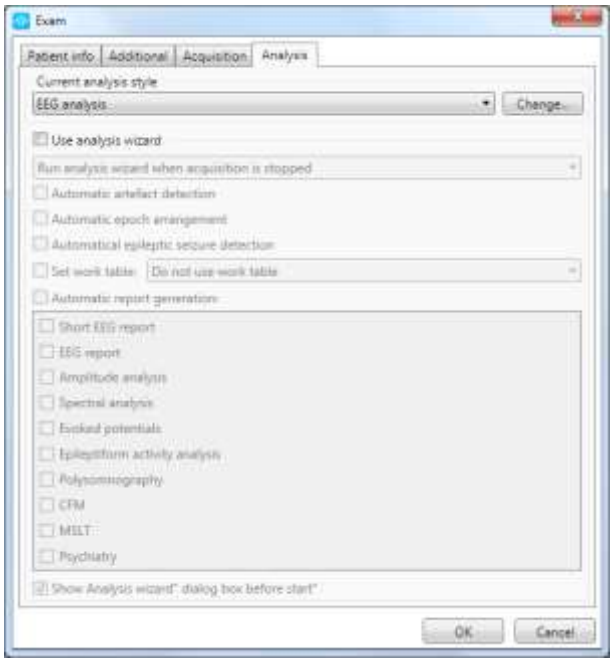


Fig. 4.4. Setup of new exam analysis parameters.

As soon as you filled all the required fields in the new exam window and pressed “OK” button, the new EEG exam will be created. In the beginning of an exam, the program

will identify the presence of the devices connected to the computer and select the one which should be used by default in the current acquisition style. If the program detects several devices none of which is indicated in the current acquisition style, you will be offered to select the device for a new exam performing (Fig. 4.5). The serial number of device is given in the brackets. If only one device is connected to the computer, the program will activate it.

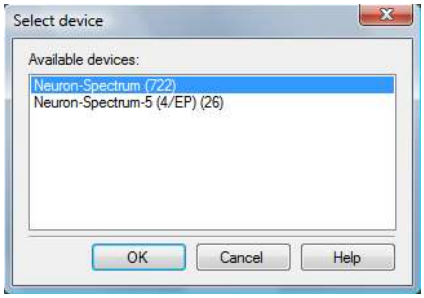


Fig. 4.5. Selection of a device for a new exam acquisition.

On exam creation completion the windows of EEG acquisition, review and analysis will be displayed in the working area of the main program window according to the current work table (see chapter 5.15 “Work Tables”). The possible view of the main program window after the creation of a new exam is shown in Fig. 4.6.

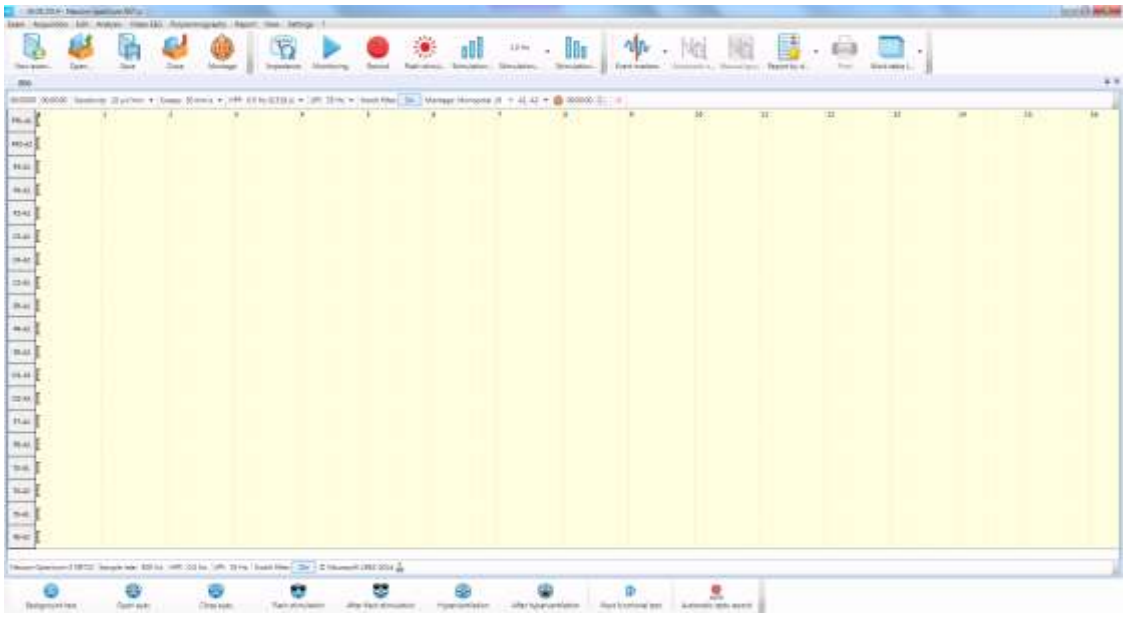


Fig. 4.6. The main program window after the new exam creation.

After the creation of a new exam, the new items **Acquisition, Edit** and **Analysis** will be added to the main program menu. Also, the corresponding toolbars will be supplemented. Using the indicated menu items and toolbar buttons, you can start an exam acquisition. It is necessary to pay attention that the acquisition parameters (the montage, the sampling rate, the traces scale and sweep speed, the filters, etc.) are downloaded from the current acquisition style. However, all of them can be changed during the recording, using the corresponding menu items and toolbar buttons. If you prefer the use of wizard for an exam acquisition, an exam acquisition is

started automatically. The steps that are preselected in the acquisition wizard settings will be fulfilled.

4.2. Sampling Rate Setup

All EEG and EP systems of **Neuron-Spectrum** series are digital ones. It ensures the high quality of the signal transfer and the noise immunity. The brain signals are analogue ones, hencefore it is required to specify the sampling rate to digitize them with digital amplifiers. The higher is the sampling rate, the higher is the quality of the recorded signal and the bigger volume of the memory is required for its storage. For EEG acquisition it is not recommended to set the sampling rate lesser than 200 Hz, because it can result in the loss of the high-frequency components of a signal. Too high value of a sampling rate will increase the exam size considerably, but it will not impact greatly the signal quality. To record the signal with up to 70 Hz frequency, it is enough to set 200 Hz sampling rate, however, for routine EEG exams it is recommended to use 500 Hz sampling rate to ensure the analysis of high-frequency phenomena. For long-term EEG exams and polysomnography studies it is recommended to use 200 Hz or 100 Hz sampling rate (to decrease the exam size). The sampling rate for the recording of a new exam is specified in the current acquisition style (see chapter 8.2.2 “Acquisition Styles”). You can change it using **Acquisition|Sampling rate** menu item. Also, the sampling rate value can be changed using the status line located under EEG traces in the bottom part of the main program window (see section 5.14.8 “Status Line”). It should be noted that the sampling rate can be changed only before the beginning of EEG acquisition. After the acquisition start, it is impossible to change the sampling rate.

4.3. Filter Setup

Usually EEG signal incoming from the brain via the amplifier of the digital EEG and EP system is filted before the saving (or displaying on the screen). The digital filters are applied to filter the signal from noises and admixtures that can hinder the visual analysis of the recorded traces. To filter EEG the following filters can be used:

- High pass filter (HPF) from 0.05 up to 10 Hz is intended to remove the low-frequency component from the signal. For EEG acquisition, 0.5 Hz filter is used usually.

- Low pass filter (LPF) from 5 up to 500 Hz is intended to remove the high-frequency component from the signal. For EEG acquisition, 35 or 75 Hz filter is used usually. The lower cutoff frequency, as any other filter, can not exceed half of sampling rate of the signal being recorded (see section 4.2 “Sampling Rate Setup”).

- Notch filter 50 or 60 Hz is intended to remove the mains noise from the signal.

Each filter can be adjusted to the specified frequency or switched off. The filter settings for a new exam are downloaded from the acquisition style. You can change the filters using **Acquisition|Filters** menu command or directly on the acquisition toolbar (see section 4.11 “Acquisition Parameters”). The filters can also be changed in the status line located under EEG traces (see section 5.14.8 “Status Line”) or using “Acquisition parameters” dialog box (Fig. 4.15).

Please take into consideration that the filtration of EEG signal results makes its irreversible changes. Thus, for example, the signal filtered by LPF with 35 Hz frequency will not contain actually the fluctuations higher the above-mentioned frequency. If it is required to analyze higher frequencies, **Neuron-Spectrum.NET** provides the possibility to store the non-filtered data (raw EEG) in the exam. In this case, the filtration will be performed only at the displaying or printing of EEG traces. It allows to review the recorded EEG with the arbitrary set of filters without signal distortion.

The storage of the non-filtered EEG in the exam is possible only at 200 Hz sampling rate and higher, because the on-line filtration of the signal with lower frequency adds noises to EEG trace.

The EEG filtration mode can be specified in the acquisition style manager (see section 8.2.2 “Acquisition Styles”). However, it should be noted that the filtarion on the fly at the review requires the additional computational resources and can slow down the speed of EEG review, analysis and generation of exam reports.

If you store the nonfiltered data, the signal with the frequency bandpass in the range from 0.5 up to 200 Hz for devices of **Neuron-Spectrum** series is saved in the exam. It provides an opportunity to record so called wideband EEG. Subsequently, you can set the arbitrary set of filters for each derivation at the traces displaying on the screen. The use of low frequency compensation filters allows to set HPF from 0.01 Hz. To record the ultra-high frequency signal in more than 200 Hz bandwidth, it is required to use a special amplifier with enhanced bandwidth.

4.4. Selection of Montage, Setup of EEG Scale and Sweep Speed

The acquisition montage for a new exam is set from the current acquisition style. It can be changed before a new exam (Fig. 4.3) or directly during the exam recording with the use of **View|EEG|Montages** menu command or with the use of “Acquisition Panel” (see section 5.14.9 “Acquisition Panel”). Besides, you can change the montage using the hotkeys specified for this montage. To open quickly the required montage, you can add the corresponding button to “Montage” toolbar (see section 8.13 “Toolbar Setup”). To edit the existing montages, create the new ones and remove created earlier ones, it is necessary to use the montage manager (see section 8.2.1 “Montage Editing”) by pressing the corresponding button on the toolbar (see Annex 1). The montage defines the number and the order of the derivations, their visibility and the color of traces. Besides, in the montage manager you can specify the individual parameters of the derivations. For each derivation you can specify the following:

- Derivation name – the derivation name which is visible on the trace button in the left part of EEG window.
- Derivation type – the derivation type (EEG, EOG, EMG, ECG, etc.). The dervation type is used for some types of analysis.
- Derivation color – the color of trace derivation on the screen.
- Scale – the scale of derivation displaying (for the derivations of the different types; as a rule, different scales of the displaying are used as they have different amplitude).
- Calibration cut – the size of the calibration cut.
- High pass filter – high pass filter for this derivation.
- Low pass filter – low pass filter for this derivation.
- Notch filter – the filter of mains disturbances rejection for this derivation.
- Input range – the range of the input signal for the polygraphic channel.

You can edit the derivation parameters during EEG recording both for all the derivations at once and for each separate derivation. For example, to change the filters for all the derivations, use **Acquisition|Filters** menu command or acquisition toolbar (see section 5.14.9 “Acquisition Panel”). At that, the filters for all the derivations except the ones with the individual parameters will be changed.

To change the filters for a separate derivation, double-click the derivation trace button with the left mouse button or use the context menu of the trace button. Using the items of the context menu you can control the visibility of the traces, invert the traces, change the parameters of the derivation. The manager of the derivaton parameters looks is shown in Fig. 4.7.

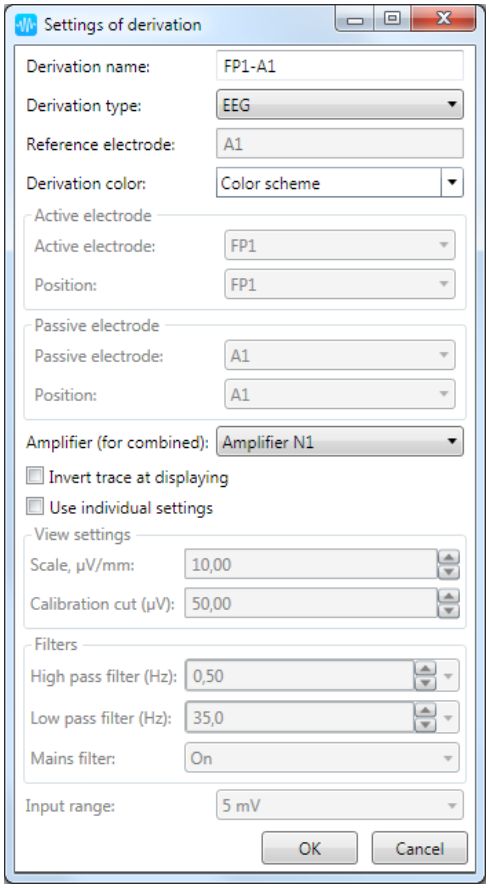


Fig. 4.7. Editing of the derivation parameters.

To use the individual parameters for this derivation, it is required to select the corresponding checkbox. The change of the common parameters for all the channels (scale, filters) does not impact the derivations with the individual parameters.

To change the scale of all the derivations with the common parameters, use **View|EEG|Scale** menu command or the toolbar. Besides, you can change the scale using **[+]** (increase) and **[–]** (decrease) keys. At that, the scale for all the derivations will be changed except the ones with the individual parameters.

To change EEG sweep speed, use **View|EEG|Sweep** menu command or the toolbar. Besides, you can change the sweep speed using **[*]** (increase) and **[/]** (decrease) keys.

To make the EEG sweep speed and traces scale precisely equal to the specified values in millimeters, it is necessary to perform beforehand the screen calibration (see chapter 8.5 “Screen Calibration”).

4.5. Electrode Placement

The detailed description of EEG electrode placement procedure is given in Annex 3 of this manual. Besides, the “Electrode Placement Tip” window is added to Neuron-Spectrum.NET program to facilitate the workflow of untrained EEG technicians (Fig. 4.8).

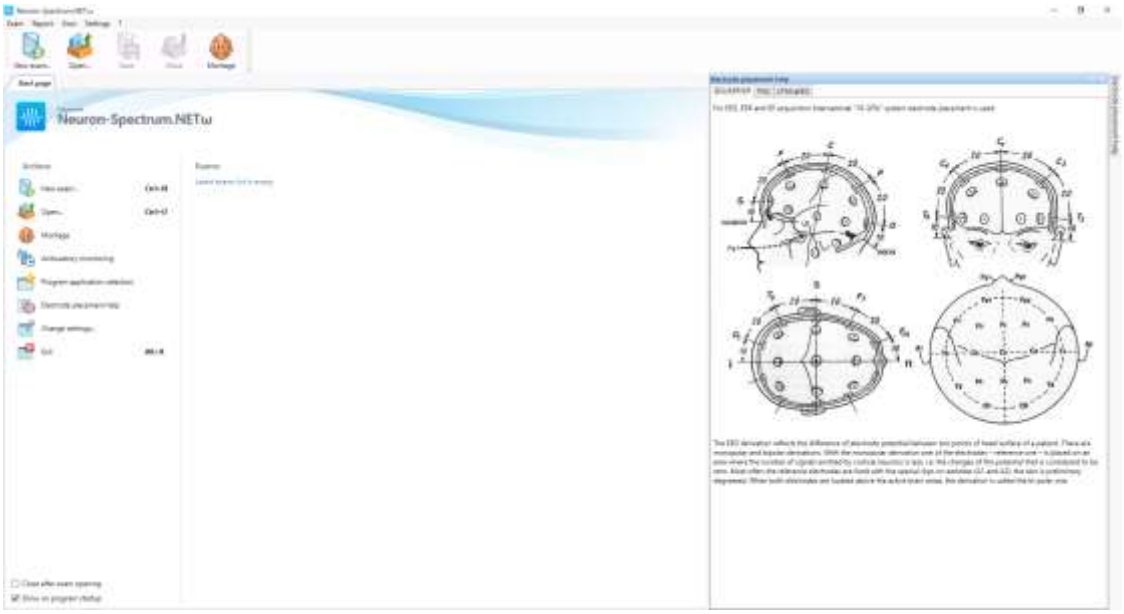


Fig. 4.8. EEG electrode placement tips.

By default this window title is located in the right part of the main program window. To open the window, left-click the title with the mouse. The brief description of International “10–20” system is given in this window.

4.6. Electrode Impedance Measurement

Before EEG recording start, it is required to check the quality of the electrode setting. To do this, measure the impedance. By default the process of the impedance measurement is started automatically at EEG recording or monitoring run. For the compulsory run of impedance measurement process before EEG recording or during EEG recording, it is required to use **Acquisition|Impedance** menu command or press the corresponding button on the toolbar (see Annex 1). On the front panel of some digital EEG and EP systems the special button to start impedance measurement is provided. Besides, to run the impedance measurement, you can use **[Ctrl+I]** hot key combination or **[F5]** key on the keyboard. After that, the dialog box with the impedance measurement results will appear on the screen (Fig. 4.9).

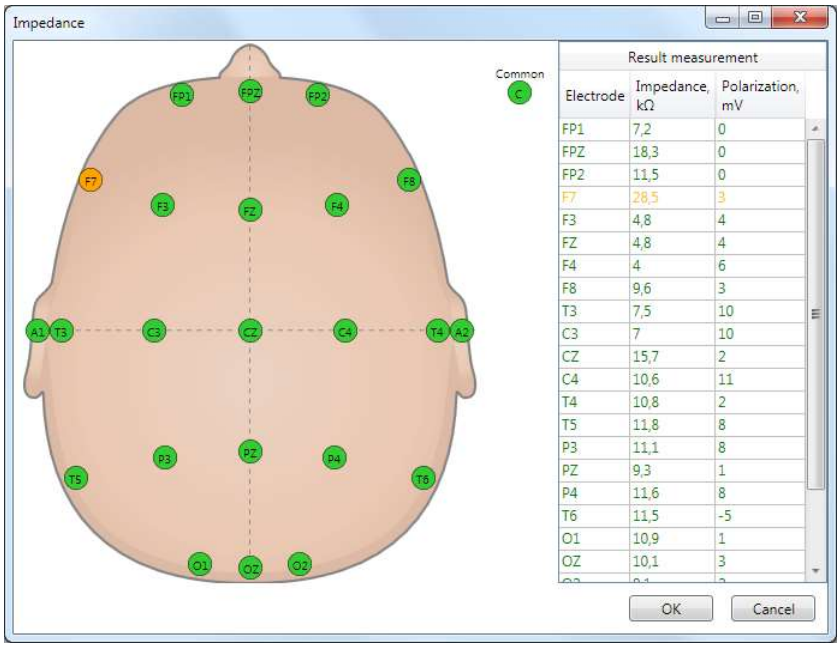


Fig. 4.9. Impedance measurement.

In this window you can see the quality of the electrode setting in the real-time mode. The results of the measurement are updated at about once per second (depending on device type and number of used derivations). The values of the impedance and electrodes polarization are displayed in the table located in the right part of the window. As soon as you receive the acceptable quality of the electrodes setting, press “OK” button or **[Enter]** key. If the button for the impedance measurement run is available on the front panel, you can close this window by pressing it. The measured impedance will be saved in the exam. To review the results of the impedance measurement in the exam, use “Exam Inspector” (see section 5.14.1 “Exam Inspector”), in “Current impedance” window (see section 5.14.4 “Current Impedance”) or in “Trends” window shown as a trend (see section 6.4.11 “Trends”). Also the trace buttons can be color-coded depending on the obtained impedance values (the corresponding checkbox should be selected on “Hardware” page of “Settings” dialog box opened by **Settings|Edit** menu command)

If you do not want the impedance measurement results to be saved in the exam, close the impedance measurement window using button or “Cancel” button or press **[Esc]** key. If before the impedance measurement start the EEG recording was in process, it will be continued automatically. The acceptable values for EEG recording are the following: impedance values, which do not exceed 30 kΩ and polarization values which are lesser 300 mV.

4.7. Monitoring and Recording of Calibration Signal

Sometimes before EEG recording it is required to record the calibration signal to conform the digital EEG and EP system operability (Fig. 4.10). To do this, use **Acquisition|Calibration|Calibration signal recording** menu command. Also for the recording of the calibration signal you can use the corresponding button on the toolbar (see Annex 1), **[Ctrl+Alt+C]** key combination or **[F4]** key. For the monitoring of the calibration signal without its saving in an exam, use

Acquisition|Calibration|Calibration signal monitoring menu command and the corresponding button of the toolbar. Besides, you can use **[Ctrl+C]** key combination or **[F3]** key for the monitoring of the calibration signal.

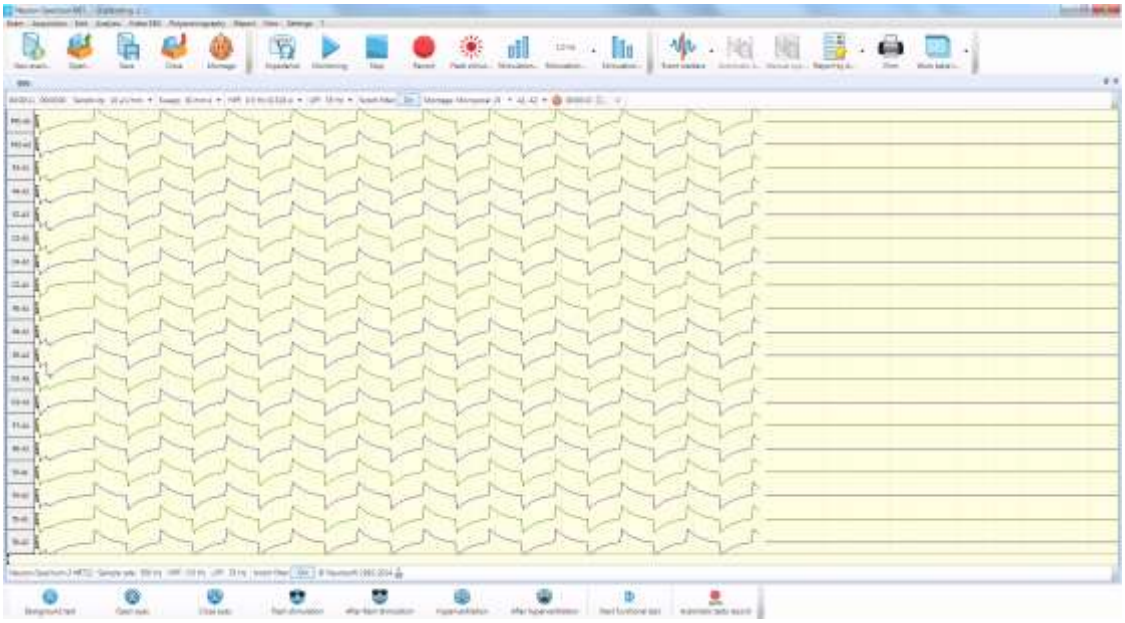


Fig. 4.10. Recording of calibration signal.

When you record and monitor the calibration signal, it is required to remember the following:

- to obtain more correct stepwise signal, disable the filters (especially the high pass filter) as fas the filtration causes the distortions.

- the calibration is always performed for monopolar derivations that is why if the bipolar derivation is present in the current montage, only the active channel will be calibrated. After the calibration finishing the image of the obtained calibration signal by the bipolar derivations is not reliable (the amplitude of the calibration signal can be close to the zero) as far as the bipolar channels are calculated ones. To review the recorded calibration signal by bipolar derivations, use the “As Recorded” review mode (see section 5.6 ““As Recorded” Mode).

- the calibration is always performed for the hardware reference electrode. After the calibration finishing the image of the obtained calibration signal with ear reference electrodes is not reliable (the amplitude of the calibration signal can be close to the zero) as far as these channels are calculated ones. To review the recorded calibration signal, use the “As Recorded” review mode (see section 5.6 ““As Recorded” Mode”).

4.8. EEG Monitoring

When electrode placement quality is checked (see section 4.5), one can start EEG recording. Before EEG recording start it is recommended to check the quality of EEG traces without recording them to the exam. It can be done with the use of EEG monitoring. To start EEG monitoring, it is necessary to use **Acquisition|Monitoring** menu

command or  button on the toolbar. Besides, the EEG monitoring can be started with **[Ctrl+M]** key combination or **[F6]** key. During EEG monitoring the EEG traces are displayed on the screen but are not saved to the computer hard disk.

4.9. EEG Acquisition

To start EEG recording, use **Acquisition|Record** menu command or  button on the toolbar. Also, to start EEG recording, you can use **[Ctrl+R]** key combination or **[F7]** key. During EEG recording you can change the montage, the traces scales, the filters (both for all the derivations and for each separate derivation), the sweep speed. You can analyze EEG data using the analysis in the real-time mode (see section 6.1 “Analysis during EEG Acquision”) or review and analyze already recorded EEG fragment using the extra EEG window (see section 5.14.2 “Extra EEG Window”).

At any moment of EEG recording you can measure the impedance (see section 4.5) to check the electrode setting quality. You can start EEG recording and control some recording parameters using the context menu of the traces (Fig. 4.11).

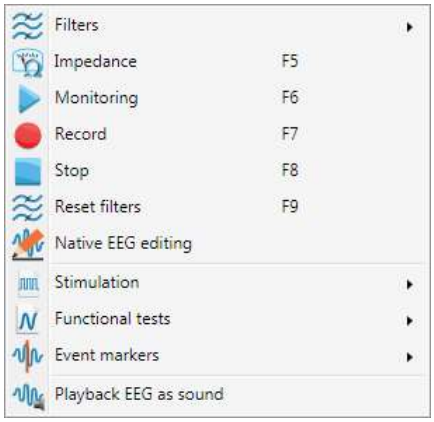


Fig. 4.11. Context menu of the traces.

If “Start functional test record on EEG acquisition begin” checkbox (Fig. 8.18) is selected in the settings of the functional tests of the current acquisition style (see section 8.2.2 “Acquisition Styles”), the recording of the first functional test from the available tests list is run at the beginning of EEG recording. If the indicated checkbox is not selected, the recording of the functional test is not started at EEG recording. More detailed information concerning the recording of the functional tests is given in section 4.12 “Functional Test Acquisition”.

Option of delayed acquisition start and stop can be useful for PSG recording. Using it you can set the time of acquisition start and stop. It is convenient in case you are going to perform recording at night when patient sleeps. In this case you can fix the electrodes and sensors on a patient beforehand, check electrode impedance, and set the time of acquisition start, for example, to start acquisition at 11 p.m. when patient will sleep in order not to record data when patient is awake. You can also set the time of record stop, for example, at 7 a.m. (Fig. 4.12).

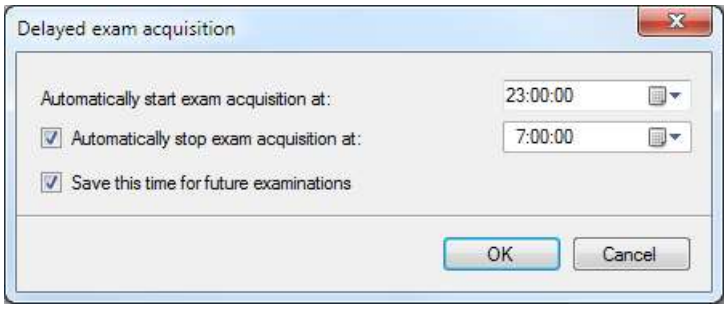


Fig. 4.12. Delayed acquisition start.

To use the option of delayed acquisition start, choose **Acquisition|Delayed acquisition start** main menu item or corresponding toolbar button (see Annex 1).

4.10. Monitoring/Recording Stop

To stop EEG recording or monitoring or the calibration signal, use **Acquisition|Stop** menu command or  button on the toolbar. Besides, the acquisition can be stopped with the use of **[Ctrl+T]** key combination or **[F8]** key.

4.11. Acquisition Parameters

To perfrom different types of EEG exams it is required to set the different acquisition parameters (sampling rate, registration montage, filters, trace displaying scale, etc). To save all the acquisition parameters, use the acquisition styles (see section 8.2.2 “Acquisition Styles”). Before starting an exam you can choose one of the acquisition styles to perform new EEG exam (Fig. 4.3). However, during the exam performing it is often required to change some acquisition parameters. The acquisition panel (Fig. 4.13) located above EEG traces is intended to display total recording time and current functional test recording time (see section 4.12 “Functional Test Acquisition”), navigation over the functional tests. Using the acquisition panel, you can change the scale of the traces for the derivations with the common settings, sweep speed of traces, current montage of the acquisition or review. You can also choose the trace shift mode where you can move EEG traces vertically relatively to each other using the mouse. You can show or hide the acquisition panel using **View|Acquisition panel** menu item.

Fig. 4.13. Acquisition panel.

Some acquisition parameters can be changed with the use of status line (Fig. 4.14) located under EEG traces.

Fig. 4.14. Status line.

The name of device used for the acquisition and its serial number are displayed in the status line. Before the beginning of the acquisition you can change the sampling rate (see section 4.2 “Sampling Rate Setup”). During the acquisition you can change

the filter parameters for the derivations with the common settings using the status line. Show or hide the status line with **View|Status line** menu item.

Also to control the acquisition parameters during the exam performing, use “Acquisition parameters” window (Fig. 4.15). Choose **Acquisition|Acquisition manage windows|Acquisition parameters** menu item to show or hide this window.

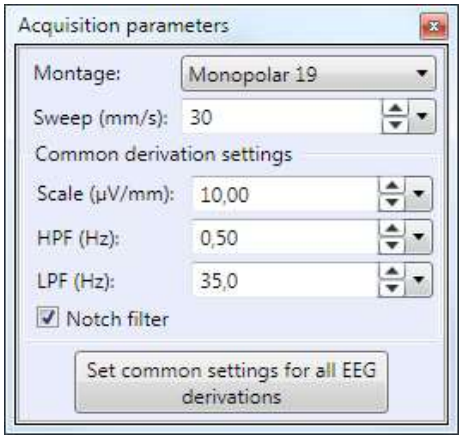


Fig. 4.15. Acquisition parameters.

Using “Acquisition parameters” window you can set not only the montage and sweep speed but also the scale of the trace displaying and filter settings for the channels with the common settings.

Each derivation of the current montage can have both common and individual settings of the parameters. To control the derivation settings, you can use its context menu. To do this, right-click the derivation name (Fig. 4.7). Besides, to control the individual parameters of a derivation, you can use “Acquisition parameters” (Fig. 4.16) window. To do this, it is required to select the derivation with the left mouse button. In this case, the parameters of the specified derivation will be available in “Acquisition parameters” window.

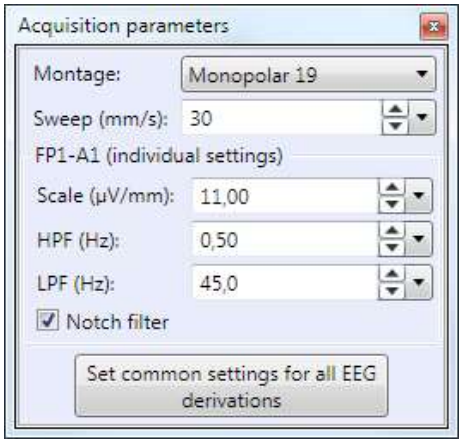


Fig. 4.16. Acquisition parameters for a derivations with individual settings.

4.12. Functional Test Acquisition

The functional tests are often performed during EEG exam recording. During the recording of the functional tests a patient is exposed to different impacts (eyes opening,

eyes closing, hyperventilation, stimulation, etc.). The list of the available functional tests is downloaded from the current acquisition style. You can create the new functional tests and edit the lists of the tests in the acquisition style manager (see section 8.2.2 “Acquisition Styles”). To record the functional tests, use the acquisition window for functional tests (Fig. 4.17). The control window of the functional tests can be shown and hidden using **Acquisition|Acquisition manage windows|Functional tests** menu command or with the corresponding button of “Acquisition” toolbar (see the Annex 1).

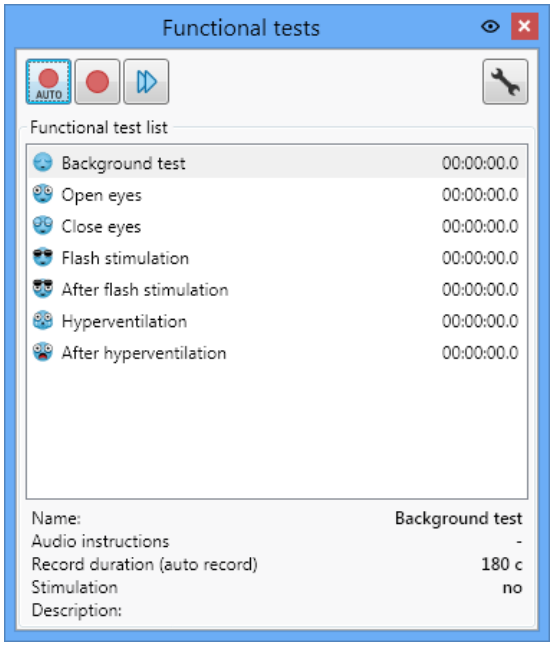


Fig. 4.17. “Functional tests” window.

The toolbar with automatic acquisition buttons to record functional tests, selected test, next test from the list and button to customize the current settings is located in the top part of the window. The list of available functional tests from the current acquisition style is displayed in the central part of the window (see section 8.2.2 “Acquisition Styles”). The description of the selected functional test is shown in the bottom part of the window. Using “Functional test list setup” button you can add other functional tests to the list.

During the recording of the functional tests in the automatic mode each test from the list will be recorded for the time interval specified in its settings (Fig. 8.19). If the functional test is selected, it will be recorded until the recording is stopped or the acquisition of the next test is started. You can also start the acquisition of the next functional test from the list using the corresponding button on the “Acquisition” toolbar or using **[Alt+N]** key combination. During the acquisition of the functional test, the time of the current test is displayed in the corresponding line. The checkboxes of the recorded tests are selected in the list and colored green.

To record the functional test, you can use **Acquisition|Functional tests** menu item and corresponding button on the “Acquisition” toolbar. Besides, the key combination can be specified for each functional test. Also, the stimulation type can be defined for each functional test, this stimulation should performed during the acquisition of this

test. The stimulation can be carried out in the manual and software modes. Before the recording of each functional test the beep for a patient can sound. To do this, it is required to specify the audio file with the warning in the settings of the functional test. The audio files with the verbal warning for the typical functional tests are located in the *Sound* folder of the program working directory. See more information concerning the setup of the functional tests and the stimulation settings in section 8.2.2 “Acquisition Styles”.

Also the functional test panel located under EEG traces is intended for the recording of the functional tests. You can show/hide it with **View|Functional tests panel** menu command (Fig. 4.18).

Fig. 4.18. Panel for functional tests recording.

The panel for the functional tests recording contains all the functional tests from the current list of tests downloaded from the acquisition style (see section 8.2.2 “Acquisition Styles”). Also, there are the buttons for the recording of the next test from the list and automatic recording of all the functional tests. The current test being recorded is highlighted, already recorded tests are colored green.

In case you record an exam with the use of the acquisition wizard (see section 8.2.3 “Acquisition Wizard”), all the functional tests specified in its settings will be recorded automatically. Also to perform the automatic recording of all the functional tests from the current list, use the corresponding button of “Acquisition” toolbar or **[Alt+Shift+F]** key combination. During automatic recording of functional test the progress bar showing recording process can be seen in “Functional tests” window.

Attention! Photic stimulation and hyperventilation are provocative maneuvers intended to elicit epileptiform discharges, and potentially seizures, in susceptible patients. Patients and caregivers should be informed of this possibility in advance.

Such functional tests must be performed only by qualified medical personnel in a specially equipped room.

4.13. Stimulation during EEG Acquisition

Sometimes during the acquisition a patient is exposed to the different types of the stimulation to detect a pathology which can not be identified at EEG background recording or during the acquisition of evoked potentials (EP). The digital EEG and EP systems of **Neuron-Spectrum** series and **Neuron-Spectrum.NET software** support the following stimulators:

- Built-in flash – the photic stimulator connected to the digital EEG and EP system unit.

- Built-in auditory stimulator – the auditory stimulator connected to the digital EEG and EP system unit.

- Built-in pattern-stimulator – the pattern-stimulator connected to the digital EEG and EP system unit.

- **Neuro-MEP** visual stimulator (Neuro-MEP auditory-visual stimulator unit) – the visual stimulator for the evoked potentials acquisition manufactured by **Neurosoft** Ltd. It is connected to the computer separately via USB port and has wider possibilities in comparison with the built-in visual stimulator.

- **Neuro-MEP** auditory stimulator (Neuro-MEP auditory-visual stimulator unit) – the auditory stimulator for the evoked potentials recording manufactured by **Neurosoft** Ltd. It is connected to the computer separately via USB port and has wider possibilities in comparison with the built-in auditory stimulator.

- **Neuro-MEP** electrical stimulator (Neuro-MEP electrical stimulator unit) – the electrical stimulator for the evoked potentials recording manufactured by **Neurosoft** Ltd. It is connected to the computer separately via USB port and has wider possibilities in comparison with the built-in electrical stimulator.

- **Neuro-MEP** pattern-stimulator (Neuro-MEP auditory-visual stimulator unit) – the pattern-stimulator for the evoked potentials recording manufactured by **Neurosoft** Ltd. It is connected to the computer separately via USB port and has wider possibilities in comparison with the built-in pattern-stimulator.

- **Neuro-MS/D** magnetic stimulator – the magnetic stimulator manufactured by **Neurosoft** Ltd. It is connected to the computer separately via USB port.

- High resolution pattern-stimulator – the pattern-stimulator with 800x600 pixels screen resolution. It allows to stimulate using colored penlights or video clips.

- Auditory stimulation from files – the stimulation of a patient carried out by the playback of the specified set of auditory files with the use of the audio board of the computer via the loudspeakers or headphones. In *Sounds/Audio files for cognitive EP* folder of the working directory of the program you can find the ready-made files for the stimulation. Also you can record the auditory files by yourself using the built-in means of the operating system or third-party programs for the processing of the auditory files. For the stimulation you can use the auditory files with **.wav*, **.wma*, **.mp3* resolution.

- LED photic stimulator – stimulator manufactured by Neurosoft Ltd. It allows adjusting amplitude, duration and color of photic stimulus.

- Presentation software – stimulation program operating on a separate computer. It allows creating your own stimulation programs. It is commonly used for scientific researches.

The settings of each above-mentioned stimulator (stimulation frequency, amplitude, etc.) are downloaded from current acquisition style (see section 8.2.2 “Acquisition Styles”). To control the stimulation process during the acquisition and also adjust all the above-mentioned stimulators, use the stimulation control window (Fig. 4.19).

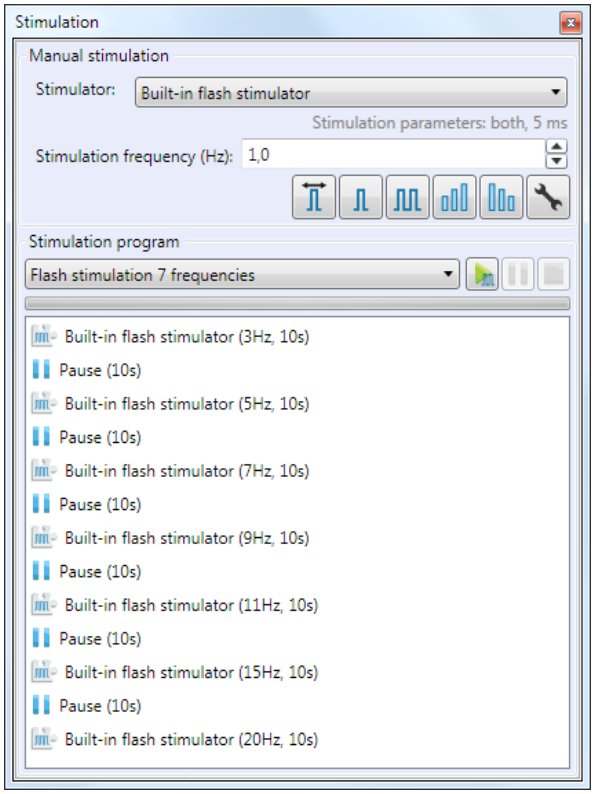


Fig. 4.19. Stimulation control window.

To show or hide the stimulation control window, use **Acquisition|Acquisition manage windows|Stimulation manager** menu command or the corresponding button on “Acquisition” toolbar (see the Annex 1). The stimulation control window is divided into two parts. The top part is intended for the control of the manual stimulation and stimulator settings. Here you can select the stimulator from the combo-box, specify the stimulation frequency for it with the use of the corresponding input box. Using the buttons you can deliver a single stimulus, start/stop the repetitive stimulation, increase/decrease the stimulation frequency, activate the dialog box with the settings for the selected stimulator. Besides, stimulation period change function by normal distribution law is available for photic stimulation.

The bottom part of the window is intended for program stimulation mode control. Here you can choose the stimulation program using the combo-box and run it. To edit the stimulation programs, use the acquisition style manager (see section 8.2.2 “Acquisition Styles”).

Also, you can control the stimulation without using this window. Use **Acquisition|Stimulation** menu item or the buttons on the “Stimulation” and “Stimulation frequency” toolbars. Besides, the stimulation can be controlled with the following key combinations:

[Alt+F] – flash stimulation on/off.

[Alt+A] – auditory stimulation on/off.

[Alt+Shift+A] – on/off of auditory stimulation from files.

[Alt+P] – pattern-stimulation on/off.

[Alt+M] – magnetic stimulation on/off.

[Alt+U] – stimulation frequency increase by a step.

[Alt+D] – stimulation frequency decrease by a step.

[Alt+H] – hyperventilation on/off.

[Alt+Space] – termination of any stimulation.

4.14. Event Markers

Sometimes it is necessary to fix some events happened during EEG acquisition. The event markers are intended for that. Each user can create her/his own event markers and arrange them on EEG both during acquisition, review and analysis. When an exam is created, the list of available markers is downloaded from the current acquisition style (see section 8.2.2 “Acquisition Styles”). To control the event markers during acquisition, use a special window (Fig. 4.20).

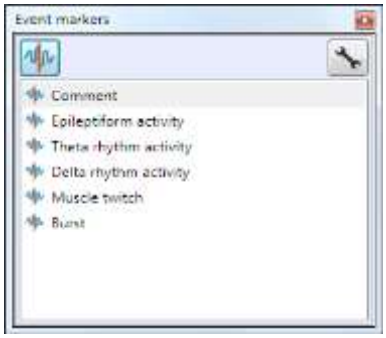


Fig. 4.20. Event markers.

This window can be displayed on the screen using **Acquisition|Acquisition manage windows|Event markers** menu command or the corresponding button on “Acquisition” toolbar (see the Annex 1). Using this window you can see the list of the available event markers, add new event markers and arrange a selected marker on EEG. Also, you can edit the existing event markers (Fig. 8.27) and remove them.

Besides, to arrange the markers on EEG, one can use **Acquisition|Event markers** menu item or the corresponding button on the toolbar. Each event marker may have separate button on “Markers” toolbar. Also, the key combination can be specified for each marker. See more information about the setup and creation of event markers in section 8.2.2 “Acquisition Styles”.

Usually the event markers on EEG are displayed as vertical signed lines but sometimes it is required to hide them. To control the visibility of the different types of the markers, use “Navigator” (see section 5.14.6 “Navigator” and the “Events list” (see section 5.14.5 “Events list”). Besides, the marker line can be displayed as a short segment at the bottom or the top of the EEG review window. To control the appearance of event markers, use **View|Event Markers** menu item.

Using the context menu of event markers you can remove and rename them both after the acquisition finishing and also during it. Any event marker can be moved and renamed. To display the context menu of the marker on the screen, place the mouse cursor on the event marker and click the right mouse button.

You can specify the hot keys for the event marker arrangement on EEG traces during the acquisition. To do this, enter the hotkey combination for the marker in the marker settings window (Fig. 8.27). Besides, you can set the audio notification for a patient. The prepared audio file of **.wma*, **.wav*, **.mp3* format can be used as a beep. The audio notification can sound both before the beginning of the marker setup on the traces and also after it.

4.15. Exam Saving and Closing

On exam acquisition completion, you can pass to its analysis and report generation. If you plan to perform the analysis of the recorded exam later, it should be saved and closed. To save the exam, use **Exam|Save** menu command or  button on the toolbar (see the Annex 1). Also you can save the exam using **[Ctrl+S]** key combination. To close the exam, use **Exam|Close** menu command,  button on the toolbar or **[Alt+X]** key combination. Before closing of non-saved exam, the program will offer you to save it (Fig. 4.21).

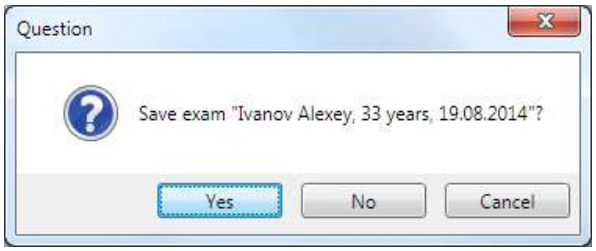


Fig. 4.21. Request to save an exam.

After an exam closing, the program is ready to start a new one or open the existing one.

4.16. Exam Export and Import

Besides an exam saving in the database, you can export it to different formats to move it and review on other computers. To do this, use **Exam|Save as…** menu command. You can save EEG as a video clip (**.avi*), text file (**.txt or *.rtf*), XML file (**.xml*), set of graphical files (**.bmp* or **.emf*) or in EDF+ format (**.edf*), PDF format (*Adobe Portable Document *.pdf*) or EDF+ (**.edf*) format (Fig. 4.22).

Using “Exams Manager” window (see chapter 3 “Operation with Exam Manager”) you can copy the selected exams to *.nsarc archive.

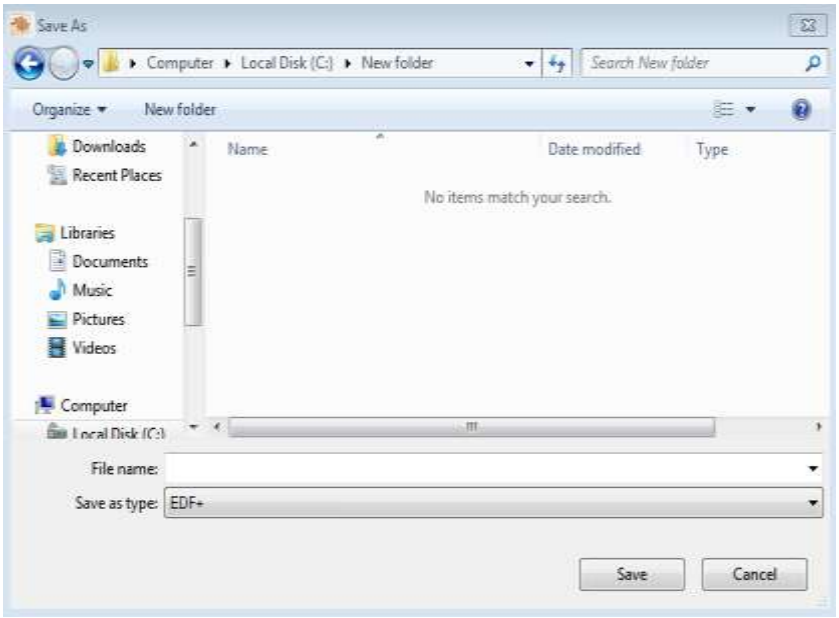


Fig. 4.22. Exam export.

1. **EEG saving as a video clip.** The result of this operation is a video file with **.avi* extension in which the current exam is recorded. If, besides EEG, you can see the express-analysis windows on the screen, they are also recorded in a file. Thus, at the next review of this file using the arbitrary program for video playback, you can see not only EEG but also the analysis results. To save an exam as a video clip, choose “Video” in “File type” combo-box of **Save as**… (Fig. 4.22) window, and press “Save” button. The received file can be played in the arbitrary program for video playing or with the use of *EEGViewer.NET* program. This format can be used to export exams with video (“EEG video” window shoud be opened during the export). To reduce the size of video file it is recommended to use one of video codecs installed on your PC. The program will offer you the preferable codec. Using one of most modern codecs H.264 you can make a quality video of small size. So, you can save video record even for long-term exams. To shorten the time of video clip creation, it is recommended to use the option of automatic exam export (see section 8.2.4 “Exam Export”).

2. **EEG saving as a set of graphical files** (set of images). It allows to save EEG page by page as a consequently named graphical files (pictures) with **.bmp, *.png* or **.emf* extension. Afterwards such files can be reviewed with the use of the arbitrary program of image review or with the use of “EEGViewer.NET” pro-

gram. To save an exam as a set of graphical files, choose “Bitmap”, “PNG” or “Metafile” in “File type” combo-box of **Save as**… window and press “Save” button.

3. **EEG saving in EDF+ format**. It allows to export an exam in a file with **.edf* extension for the reviewing in EEG analysis programs supporting EDF+ format. The most widely used format of saving and exchanging EEG exams is EDF+ format that is why practically all the programs for EEG review and analysis support it. To save an exam in this format, choose “EDF+” in “File type” combo-box of **Save as**… window (Fig. 4.22) and press “Save” button. The received **.edf* file can be reviewed with the use of **EEGViewer.NET** program or imported to **Neuron-Spectrum.NET** software. The advanced digital EEG and EP systems with 24-bit ADC allow using new BDF+ format instead of EDF+. The only difference between them is the BDF+ keeps the trace counts as 24-bit data. The import and the export of exams from BDF+ are supported by Neuron-Spectrum.NET program.

4. **EEG saving as ASCII-text file**. It allows to save an exam traces as a text file in ASCII format. The received text file can be reviewed with the use of **EEGViewer.NET** program or imported to **Neuron-Spectrum.NET** software.

5. **EEG saving as XML file**. It allows to save an exam traces as XML file. The received file can be reviewed with the use of **EEGViewer.NET** program or imported to **Neuron-Spectrum.NET** software.

6. **EEG saving in RTF format (Rich Text Format)**. It allows to save the exam reports and EEG traces as text file with **.rtf* extension. EEG traces are copied to file as images. The received file can be reviewed on any computer using WordPad, MS Word and other text editors supporting RTF format. Using text editor, you can print the file.

7. **EEG saving in PDF format (Adobe Portable Document).** It allows to save exam reports and EEG traces as file with **.pdf* extension. EEG traces are copied to file as images. The received file can be reviewed on any computer in Adobe Reader program or other viewer supporting PDF format. You can also print this file on printer.

Neuron-Spectrum.NET software ensures automatic export of exam to one of specified formats. Saved exams can be used as backup copies or, for example, you can store this exam in cloud storage in Internet (see section 8.2.4 “Exam Export”).

To review EEG traces saved in above-mentioned formats, use EEGViewer.NET program (Fig. 4.23) included in **Neuron-Spectrum.NET** software delivery set.

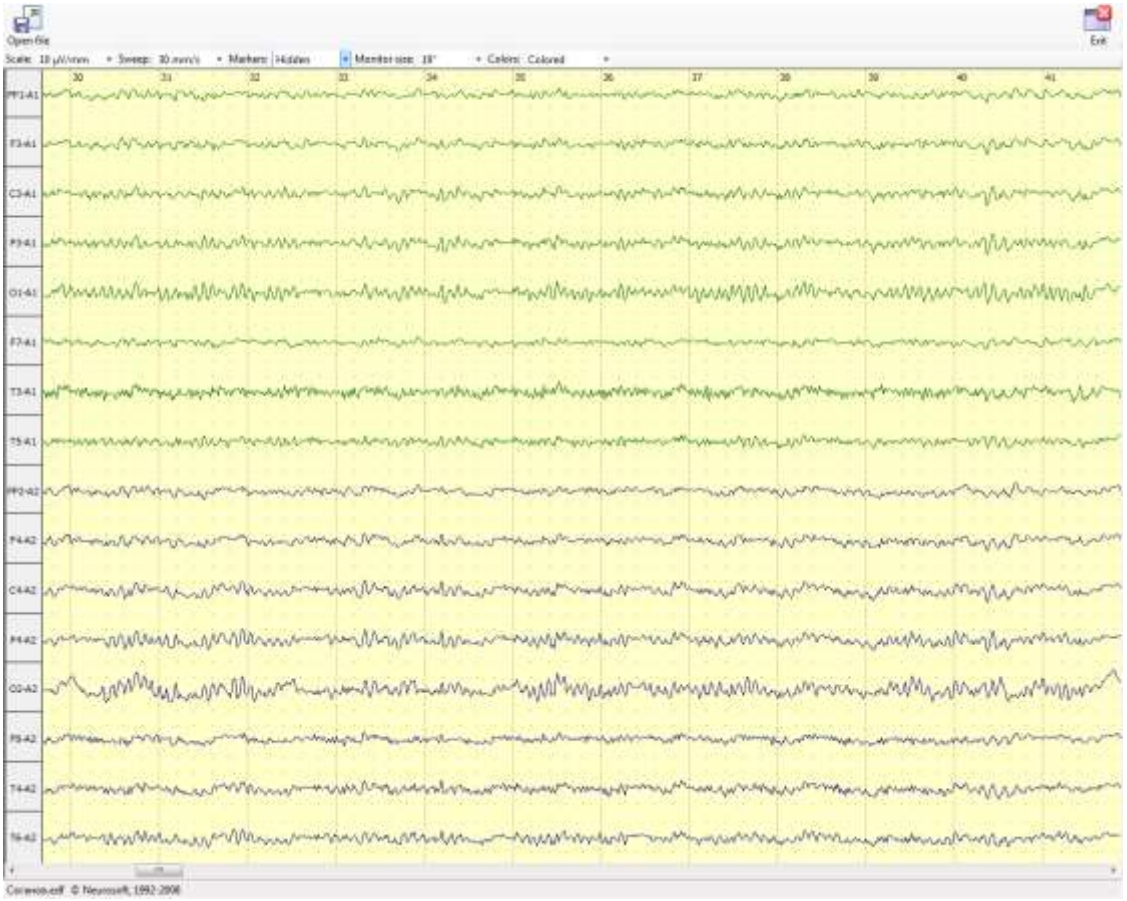


Fig. 4.23. EEGViewer.NET window.

To import EEG exams saved in text, XML or EDF files to **Neuron-Spectrum.NET software**, use **Exam|Import…** menu command.

4.17. Exam Saving to Removable Disk

Sometimes it is required to save a copy of current exam to the portable media (rewritable CD or DVD, flash card, etc.) to transfer it and review on other computer. To do this, use **Exam|Save to removable disk** menu command. If you select this command, the program will ask you the way to save an exam and the parameters of the saving (Fig. 4.24).

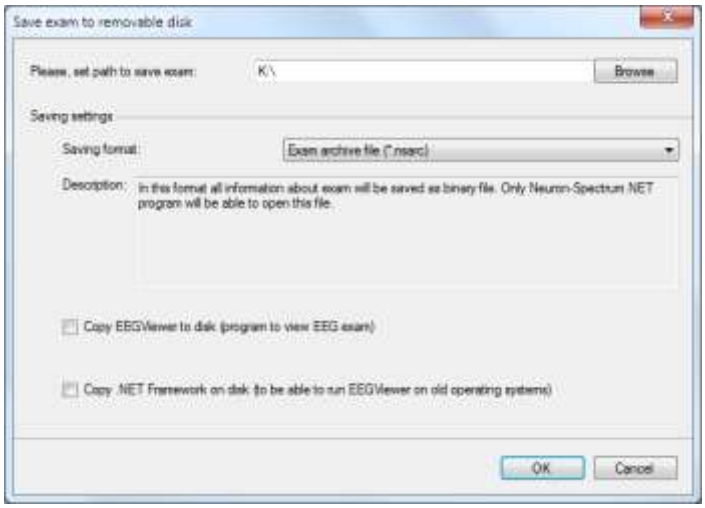


Fig. 4.24. Parameters of exam saving to portable media.

You can indicate where and in what format it is required to save an exam. In addition to an exam, you can burn **EEGViewer.NET** program for EEG exam review to the removable disk. To do this, it is necessary to check the corresponding checkbox. **EEGViewer.NET** review program will allow you to review the saved exam in any of the available formats.

5. EEG Review and Editing

Neuron-Spectrum. NET provides wide possibilities for the convenient and quick navigation over EEG. In this chapter the ways of navigation over EEG and its editing will be described.

5.1. Exam Opening

To open the created earlier exam, use **Exam|Open…** menu command,  button on the toolbar or **[Ctrl+O]** key combination on the keyboard. Using the Exams Manager software (see section 3 “Operation with Exam Manager”) you can open an exam from the database or from *nsarc archive.

5.2. Exam Import/Export to EDF+ Format

To store EEG exams in separate files and also transfer exams to other computer and export to other programs for EEG review and editing, you can use several formats. The most popular format is EDF+ one. The import and the export of exams to EDF+ format is supported by **Neuron-Spectrum.NET** software. To export an exam to EDF+ format, open the required exam (see section 5.1 “Exam Opening”) or create a new one (see chapter 4 “EEG Acquisition”) and use **Exam|Save as…** menu command. In **Save as…** dialog box enter the file name and press “Save” button. You can transfer the saved file to other computers and review in other programs for EEG review and analysis supporting the import from EDF+ format (practically all the modern programs for EEG acquisition and analysis support this format). To import an exam from the file with **.edf* extension to **Neuron-Spectrum.NET** software, use **Exam|Import…** menu command. Select the required **.edf* file in the “Open” dialog box and press “Open” button.

5.3. EEG Review

You can review the recorded EEG in the arbitrary montage. To select the montage, use **View|EEG|Montages** menu command or the combo-box on “Acquisition panel” (see section 5.14.9 “Acquisition Panel”). Besides, each montage can have the hot key combination (see section 8.2.1 “Montage Editing”). Also, at EEG review you can change traces scale, sweep speed, used filters, etc. If the exam contains non-filtered data (fig. 8.14), you can change parameters of filters. If an exam contains the filtered data, the change of filters is possible only at EEG recording.

You can change the scales and the filters for all the channels with common settings using the indicated menu commands or “Acquisition panel”. However the montage can contain the derivations with the individual settings of the displaying and filtration (for example, ECG or EMG channel). The scales and filters parameters for such channels are specified individually using the context menu of the derivation.

The derivation buttons with the individual settings are highlighted dark-grey and marked by Italic font (Fig. 5.1).

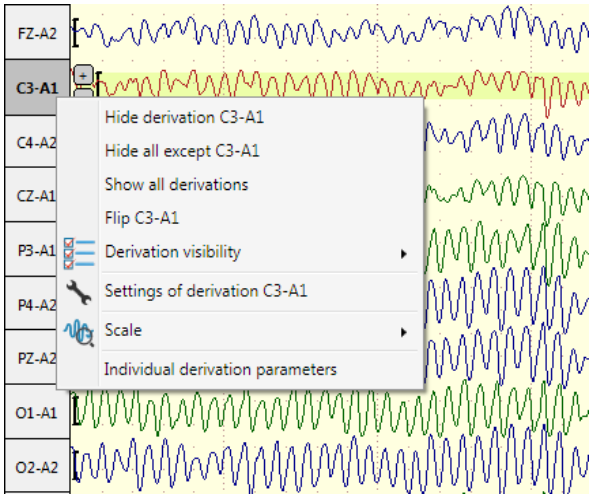


Fig. 5.1. The context menu of the derivation.

Using the context menu of the derivation you can hide the derivation, hide all the derivations except the selected one, show all the derivations of the montage, invert the derivation trace, review and change the derivation parameters (Fig. 4.7). Also you can specify the individual scale and filters parameters for the selected derivation.

Sometimes at small sweep speeds and high frequency of the recorded signal, the peaks of EEG traces can merge together owing to the limited screen resolution (Fig. 5.2). To display EEG traces evenly on the screen, and also for the speeding up of the traces drawing, use **View|EEG|EEG traces optimization** menu command (Fig. 5.3).

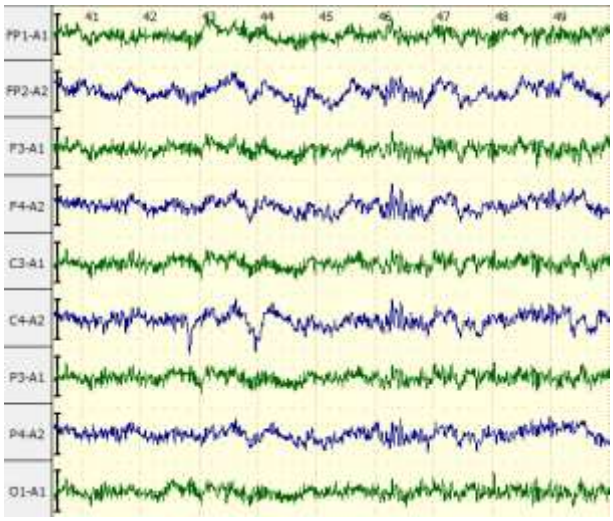


Fig. 5.2. The review of EEG traces without optimization.

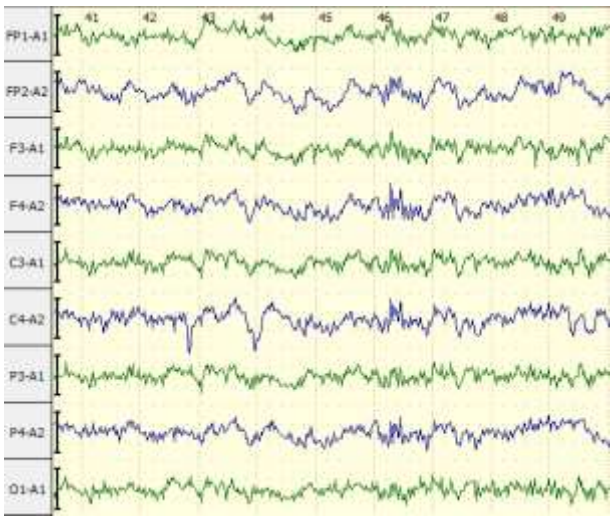


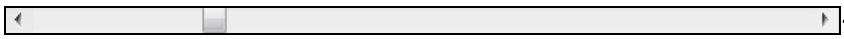
Fig. 5.3. The review of EEG traces with optimization.

Time scale is displayed in the top part of window with traces. Its visibility is adjusted using **View|EEG|Time scale** menu item.

At EEG review you can measure the amplitude and duration of trace fragment using the left mouse button and simultaneously holding down **[Shift]** key. To perform the measurement of EEG parameters you can use different modes of review described in the next sections of this chapter.

5.4. Navigation over EEG

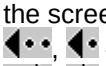
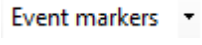
To scroll EEG, you can use the scroll bar which is located over EEG traces:

 . This scrool bar is visible only if the navigation bar is hidden (see section 5.14.6 “Navigator”).

Navigation over EEG can be performed using the “Navigation” toolbar:

, with the special navigation bar (see section 5.14.6 “Navigator”) and with the keyboard and mouse. Besides, you can use some analysis windows to navigate over EEG (see section 5.14 “Review and Navigation over EEG”). The description of the toolbar buttons used for navigation is given in Table 5.1.

Table 5.1. The toolbar buttons for navigation over EEG

Button	Key combination	Description
	Home	Instantaneous move to the record beginning.
	Ctrl+PgUp	Automatic shift to the record beginning with EEG scrolling. The scrolling speed can be changed with scroll wheel or left-click in the bottom part of the screen:  – increase the scrolling speed.  – decrease the scrolling speed. Space – moving stop.
	Shift+PgUp	Automatic move to the record beginning with page-by-page EEG scrolling. The speed of page scrolling can be changed with mouse wheel or left-click in the bottom part of the screen:  – increase the scrolling speed.  – decrease the scrolling speed. Space – moving stop.
	PgUp	Move one page left.
	Left	Move one second left.
	Right	Move one second right.
	PgDn	Move one page right.
	Shift+ PgDn	Automatic move to the record end with page-by-page EEG scrolling. The scrolling speed can be changed with mouse wheel or left-click in the bottom part of the screen:  – increase the scrolling speed.  – decrease the scrolling speed. Space – moving stop.
	Ctrl+PgDn	Automatic move to the record end with EEG scrolling. The scrolling speed can be changed with mouse wheel or left-click in the bottom part of the screen:  – increase the scrolling speed.  – decrease the scrolling speed. Space – moving stop.
	End	Instantaneous move to the record end.
		Selection of an element for the navigation. The navigation can be performed over the functional tests, the event markers, the stimulation events, the epochs, the artifacts.
		Move to the previous element.
		Move to the next element.

You can also move over EEG using the mouse scroll. Besides, you can move to one page or half a page up and down by clicking the left mouse button in the bottom part of the screen. The mouse cursor looks the following:

– move one page forward.

– move one page back.

– move half a page forward.

– move half a page back.

If your computer has touchscreen interface, use touscreen controls instead of mouse cursor or buttons. Long touch of screen emulates right-click and a tap does the left-click. To scroll the traces, touch your screen with two fingers and swipe to scroll bar. If it is required to select the trace fragment, touch the screen with two fingers and swipe along the traces. To facilitate the program operation with touchscreen controls, use the special mode. Activate it with **Settings|Use Touscreen style** main menu item.

5.5. Wave Measurement Mode

Neuron-Spectrum.NET provides the wave measurement mode to measure the amplitude, the duration and the frequency of the separate wave on EEG trace or group of waves. To activate the wave measurement mode, use **Edit|Wave measurement mode** menu command or the corresponding button on “Edit” toolbar (see the Annex 1). Also, you can use the corresponding item of the context menu of EEG traces. To measure the wave, point the mouse cursor on EEG wave and click the left mouse button, after that the wave will be selected and its amplitude, duration and frequency will be calculated and displayed (Fig. 5.4).

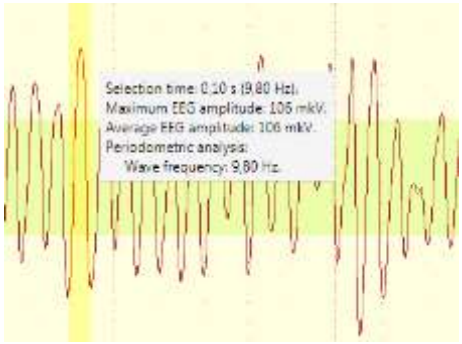


Fig. 5.4. Wave measurement mode.

To measure the average frequency and the amplitude of some trace fragment, point the mouse cursor to the fragment beginning, left-click and without releasing it, move the cursor to the fragment end (Fig. 5.5).

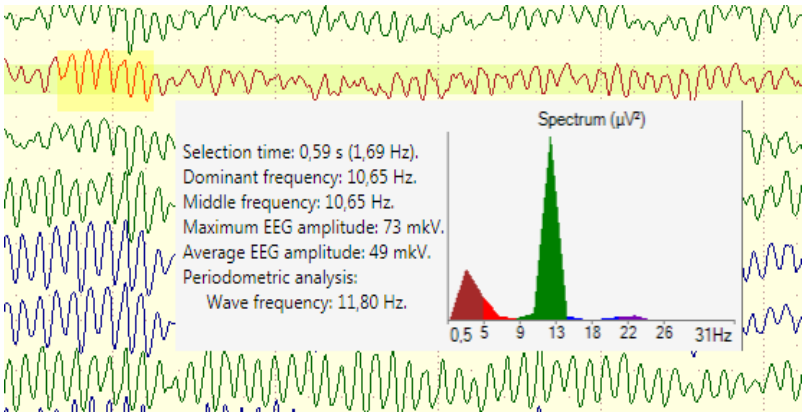


Fig. 5.5. Measurement of the amplitude and the duration of the trace fragment.

Using the context menu, you can copy the measurement results to current exam report.

To exit the wave measurement mode, use **Edit|Wave measurement mode** or the corresponding toolbar button. Also you can use the corresponding item of context menu of EEG trace (Fig. 5.8).

It is not obligatory to enable wave measurement mode to measure duration and amplitude of arbitrary trace fragment. You may press and hold **[Shift]** key and select trace fragment with the mouse as shown in Fig. 5.6.

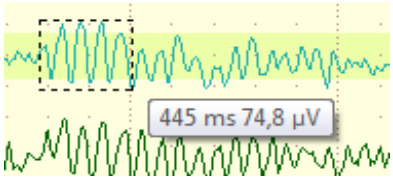


Fig. 5.6. Measurement of the amplitude and the duration of the trace fragment.

5.6. “As Recorded” Mode

Sometimes during EEG analysis it is required to review the record in the way it was recorded (with the same scales, in the same montages and with the same sweed speed). To implement it, **Neuron-Spectrum.NET** provides “As recorded” mode. To activate this mode, it is necessary to use **Edit|As recorded mode** menu command or the corresponding button on “Edit” toolbar (see the Annex 1). Also, you can use the corresponding item of the context menu of EEG traces (Fig. 5.8). In “As recorded” mode during the move over EEG the review parameters will change automatically according to those specified during EEG acquisition (the analogue of “paper” EEG). To exit “As recorded” mode, use **Edit|As recorded mode** menu command or the corresponding button on the toolbar. Also, you can use the corresponding item of the context menu of EEG traces (Fig. 5.8).

5.7. Measuring Marker Tool

The measuring marker mode is provided to mark EEG fragment of a specified duration. It gives the possibility to analyze it in the analysis windows which are visible on the screen. In this mode two markers appear on the EEG traces, the fragment be-

tween these markers is analyzed in all the analysis windows which are visible on the screen. Using the mouse, you can shift the markers. During the move over EEG traces, the positions of markers remain the same. It allows to continue the analysis of new record fragment. To switch on/off this mode, use **Edit|Measuring markers mode** menu command or the corresponding button on “Edit” toolbar (see the Annex 1). Also, you can use the corresponding item of the context menu of EEG traces (Fig. 5.8).

5.8. “Magnifier” Mode

Sometimes the monitor resolution is not enough for the detailed review of some fragment of a trace. The “Magnifier” mode is intended to zoom in the trace image at displaying. To activate this mode, press **[Ctrl+Alt]** key combination and holding it down, shift the mouse cursor to the required trace fragment (Fig. 5.7).

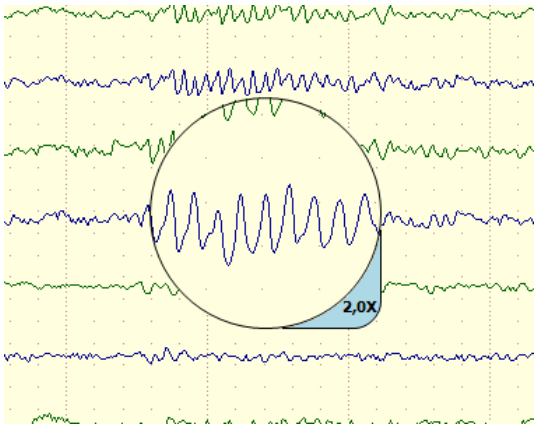


Fig. 5.7. “Magnifier” mode.

To control the multiplicity of the zoom in, you can use the scroll wheel. If you release **[Ctrl+Alt]** key combination, the “Magnifier” mode is switched off automatically.

5.9. EEG Playing back as a Sound

Neuron-Spectrum.NET provides the possibility to play EEG back as a sound. Both the selected fragment of the record and the whole record can played back, at that you can determine the derivations for the playing back beforehand. Also you can set the speed of EEG playing back as a sound which may be actual for the review of long-term EEG exams. To start EEG playing back as a sound, you can use the same named command of the context menu (Fig. 5.8).

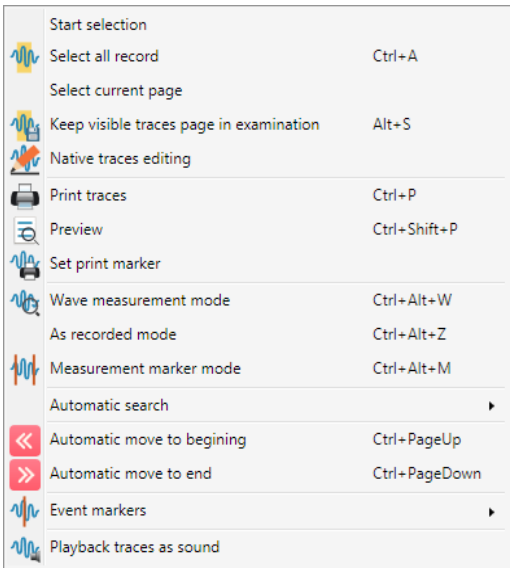


Fig. 5.8. Context menu of EEG review.

Also, using the context menu of EEG traces, you can control the fragment marking, edit EEG traces, print EEG traces, switch on/off different modes of exam review, start the search of visual phenomena, control the navigation over EEG, arrange the event markers.

During EEG acquisition you can also run the playback of recorded signal as a sound from the specified derivations. EEG signal can be modulated by the frequency selected arbitrary while playing back as a sound (Fig. 5.9).

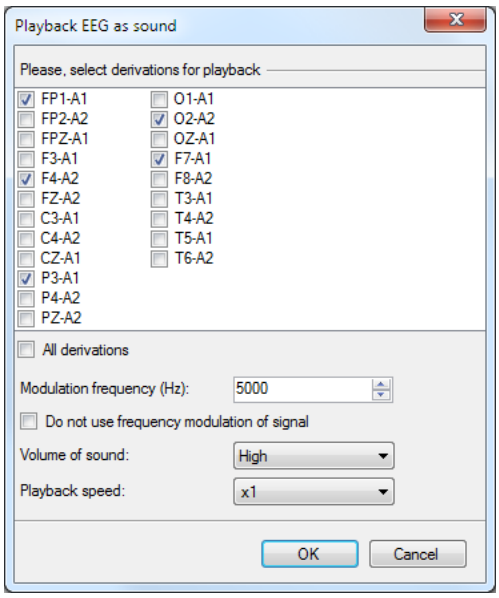


Fig. 5.9. “Playback EEG as a sound” dialog box.

5.10. Selection of EEG Fragments

During EEG review and analysis it is often required to perform the certain actions with some fragments of the record (print, analyze, etc.). To select the record fragment, left-click EEG trace and holding it down, move the mouse cursor to the right. When mouse cursor approaches to the visible border of EEG area, the traces will automati-

cally scroll to the required side. Thus, you can select the fragment longer that the screen width. To do this, right-click EEG traces where you would like to start the selection. In the appeared context menu (Fig. 5.8) choose “Start selection” item, move to the fragment end over EEG (see section 5.4 “Navigation over EEG”), right-click and choose “End selection” item of the context menu. To select current EEG page, you can use **Edit|Select current page** item of the main menu or the corresponding item of the context menu. To select the whole EEG record, it is required to use **Edit|Select all record** menu command, the context menu of trace (Fig. 5.8) and **[Ctrl+A]** key combination. The record fragments can be selected also using the “Navigator” window (see section 5.14.8 “Status Line”). You can see the duration of the selected fragment in the status line under EEG traces. If you use touchscreen monitor, touch trace fragment with two fingers at trace fragment beginning and swipe up to the fragment end.

As soon as you finished the selection, the results of the analysis of the selected EEG fragment will appear in all visible express-analysis windows (see section 6.2 “Express-analysis”). To perform the operations with the selected fragment, use **Edit|Selected fragment** menu command or the context menu. To do this, point the mouse cursor to the selected fragment and right-click. The context menu of the selected fragment will appear on the screen (Fig. 5.10).

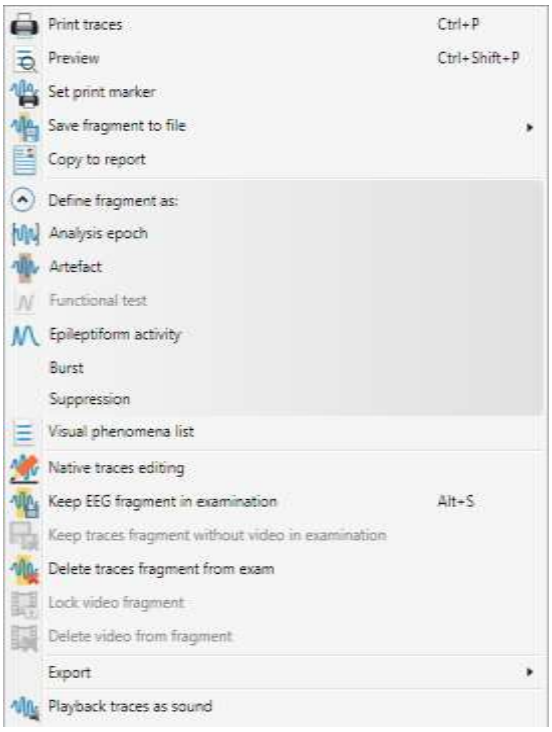


Fig. 5.10. Context menu of selected EEG fragment.

Using the menu commands, you can print the selected fragment, preview it before printing, postpone the printing of the fragment, save it as **.bmp, *.png,*.emf* or **.avi* file to review it on any computer without using any special programs, copy to the current exam report or save as a separate exam.

Also, you can define the selected EEG fragment as the analysis epoch (analysis epochs can be of different length), the record artifact (fragments marked as artifacts

are not analyzed), the functional test (functional tests can be added to the exam, renamed and removed) or some visual phenomenon. The list of the available visual phenomena is downloaded from the analysis style (see section 8.7.1 “Analysis Styles”), however you can change it using **Visual phenomena list** menu command (Fig. 5.11). Using the visual phenomena manager, you can add new phenomena, change or remove the existing ones. For each visual phenomenon you can set the color of selection on EEG.

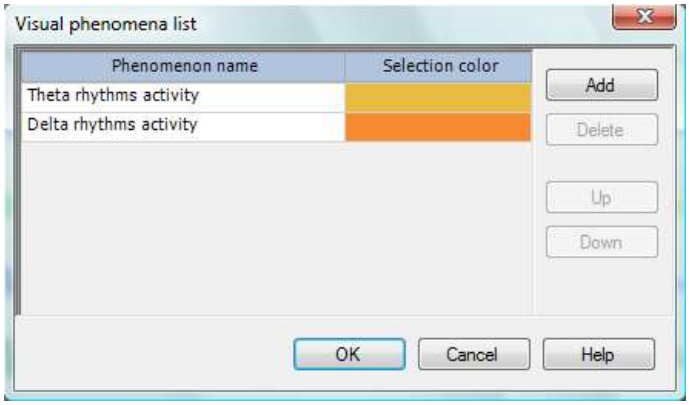


Fig. 5.11. Editor of visual phenomena list.

Also using menu commands of selected EEG fragment (**Export|Export to EDF+)**, you can export it to EDF+ format (**.edf* file).

5.11. Arrangement of Event Markers

Usually to fix some events occurred during the EEG recording, the event markers are used (see section 4.14 “Event Markers”). However, sometimes it is required to apply the event markers during EEG review, for example, to simplify the following analysis or to mark the record fragment. To arrange the event markers during EEG review, use **Edit|Event markers** menu command or the corresponding button with drop-down menu on the toolbar. Also, you can use the context menu. To do this, right-click EEG traces and choose “Event markers” command (Fig. 5.8). The list of available event markers is downloaded from the analysis style (see section 8.7.1 “Analysis Styles”). The event markers specified by a user are displayed in “Navigator” (see section 5.14.6 “Navigator”, “Exam Inspector” (see section 5.14.1 “Exam Inspector” and “Event list” see section 5.14.5 “Events list”). You can move the markers arranged on EEG using the mouse cursor, rename and remove them using the context menu of marker. You can specify the key combination for each marker. Besides you can add any event marker buttons to “Markers” toolbar.

Besides event markers Neuron-Spectrum.NET provides process markers that can be used to select long-term record fragments.

If it is required, some event markers may contain input fields, for example, to show a patient’s temperature or blood pressure.

5.12. Arrangement of Analysis Epochs

During EEG analysis the stationary fragments of the record are usually selected for the further mathematical analysis. Such fragments are called the analysis epochs. **Neuron-Spectrum.NET** provides several ways of epoch arrangement on EEG:

- Selection of record fragments and identification of them as analysis epochs (see section 5.10 “Selection of EEG Fragments”). To define the selected EEG fragment as analysis epoch, use the context menu of the selected fragment which is available by the right mouse button click.

- Arrangement of each epoch separately **(Analysis|Analysis Epochs|New analysis epoch** menu command, the corresponding button on the toolbar or **[Ctrl+Shift+E]** key combination).

- Manual mode of analysis epoch arrangement (**Analysis|Analysis Epochs|Manual mode of epochs arrangement** menu command, the corresponding button on the toolbar or **[Ctrl+Alt+Shift+E]** key combination). In this mode you can quickly and easily review all EEG record with analysis epoch arrangement (Fig. 5.12).

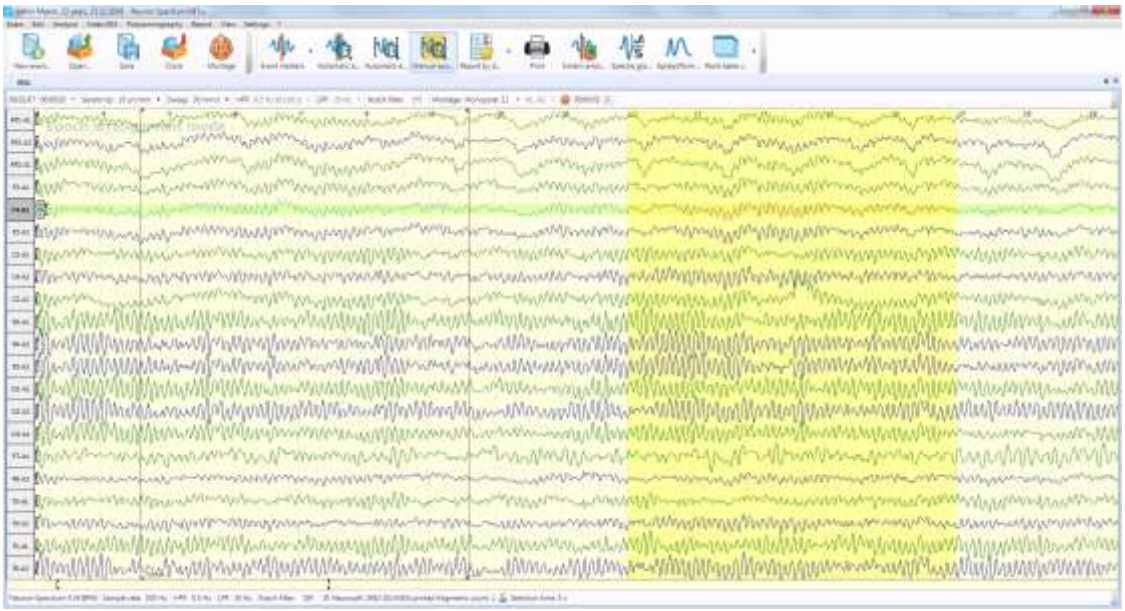


Fig. 5.12. The special mode for analysis epochs arrangement.

While moving over EEG with the use of mouse wheel or keyboard keys, you can arrange the analysis epochs with one left-click or **[Space]** key. The combination of **[Ctrl+Z]** keys denies the previous selection of an epoch. To exit from the special mode, press **[Esc]** key or use **Analysis|Analysis Epochs|Manual mode of epochs arrangement** menu command, correponding button on the toolbar or **[Ctrl+Alt+Shift+E]** key combination.

The parameters of epochs arrangement are downloaded from the current analysis style (see section 8.7.1 “Analysis Styles”). You can specify the epoch length, the arrangement area (all the recording, except artifacts or the selected functional tests), the percentage of the epochs overlapping (for the arrangement near the artifacts). Af-

ter the epochs arrangement you can move them using the mouse and change their duration. To move the analysis epoch, point the mouse cursor to the left border of an epoch, to change its duration – to the right one. All the analysis epochs are displayed in the “Exam Inspector” (see section 5.14.1 “Exam Inspector”). To change the view of the analysis epoch, use **View|Analysis epochs** menu command. The analysis epochs can be hidden, displayed in the bottom part of the screen under EEG traces, can be displayed with the vertical bars. The epoch length can not be lesser than one second. Using the context menu, you can select the analysis epoch for its analysis in all the express-analysis windows, which are visible on the screen, remove the current epoch or all the analysis epochs.

All visible analysis windows (see section 6.4 “Analysis Windows”) are automatically switched to epochs analysis mode (see section 6.3 “Epoch Analysis”) at the arrangement of first analysis epoch. And vice versa if none analysis epoch is arranged in the exam, all analysis windows are switched to express-analysis mode (see section 6.2 “Express-analysis”).

5.13. EEG Printing

Often the electronic form of EEG is not enough. It is required to have a copy of fragments or all EEG record on the paper. To do this, the program provides the possibility to print EEG (the printer should be connected to computer beforehand or available by the network and setup). For the printing of current EEG page, use the button on “Analysis” toolbar or **[Ctrl+P]** key combination (see the Annex 1). To print the selected EEG fragment (see section 5.10 “Selection of EEG Fragments”), you can use the context menu for the selected fragment, **Edit|Selected fragment|Print traces** menu command or **[Ctrl+P]** key combination. To print all EEG record, it is necessary to select the whole record using **Edit|Select all record** menu command or **[Ctrl+A]** key combination and then print the selected fragment.

You can print EEG traces not only during exam review but also during EEG recording directly. To print just recorded EEG fragment during EEG acquisition, use the corresponding button on “Analysis” toolbar or **[Ctrl+P]** key combination. If your computer is rather slow, the delay of recorded data displaying during the printing is possible (see section 8.7.1 “Analysis Styles”). That is why the checkbox for the delayed EEG printing during the acquisition is provided in print settings. If this checkbox is selected, than during EEG acquisition you can use the print button on the toolbar (see the Annex 1), the corresponding menu command or **[Ctrl+P]** key combination, however the EEG printing will not occur. After the acquisition end, all EEG fragment selected by you will be printed. Before the printing, the dialog box with the list of the fragments selected for the printing will appear on the screen. In this dialog box you can change the record fragments for printing (Fig. 5.13). You can cancel the printing of some fragments, increase or decrease the number of pages for printing for each fragment, preview each fragment before printing.

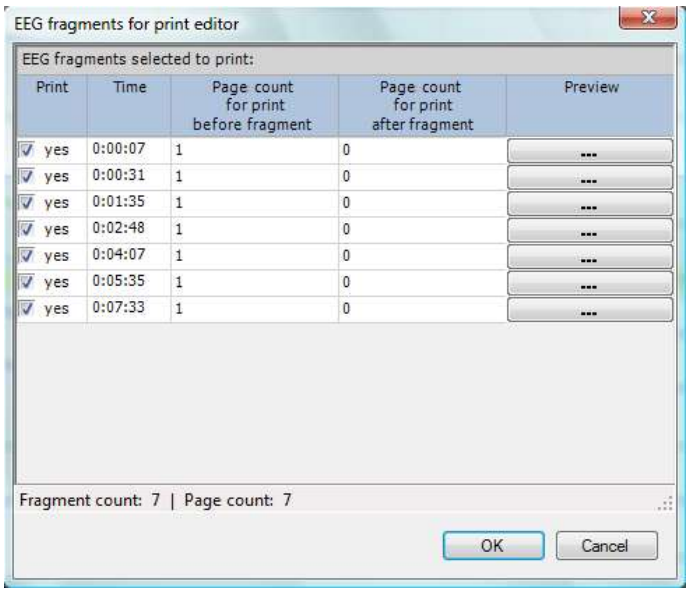


Fig. 5.13. Preview of EEG fragments before printing

If the checkbox of the delayed printing is not selected in the analysis style, EEG printing can be performed directly during EEG acquisition. One print page fragment of EEG record at the horizontal list position from the current moment is sent to print.

If the printer is not connected to your computer at present moment, you can use delayed printing mark option to mark the record fragments to be printed in the future (**Edit|Set print marker** menu item or **[P]** key).

During EEG printing some information about a patient (name, date of birth), acquisition parameters (sampling rate, filters) and EEG displaying (scale, sweep speed) is shown on each page under the traces. The data set to be displayed at EEG printing is defined in the printer settings of the current analysis style (see section 8.7.1 “Analysis Styles”).

Before EEG printing you can assess its view and arrangement. To do this, use **Edit|Selected fragment|Preview** menu command, the corresponding button on the “Analysis” toolbar, the context menu or **[Ctrl+Shift+P]** key combination (see the Annex 1).

All printed EEG pages are marked with “Start/End printing” service marker. The list of EEG fragments sent to printer can also be seen in “Exam Inspector” window. Using the context menu, you can print these fragments once again.

By default, the colors are converted to black-and-white ones at EEG traces printing. But if you wish, you can print the colored EEG traces. To do this, change the corresponding setting on “Print” (Fig. 8.46) page of the current analysis style.

5.14. Review and Navigation over EEG

EEG review and navigation windows are described in this section.

Besides the main window with EEG, **Neuron-Spectrum.NET** provides other windows intended for the control of the acquisition, for the displaying of the analysis results, for navigation over EEG. The additional windows can be in several positions:

Floating position – the window can be moved to any point of the screen. To move the window, press the window title with the left mouse button and without releasing it, drag the window in the required position. If you wish to change the parameters of the floating window, point the mouse cursor to the right bottom corner of the window, press the left mouse button and without releasing it, change the size of the window. The window in the floating position can overlap some parts of EEG traces that is why such position is not always convenient (Fig. 5.14).

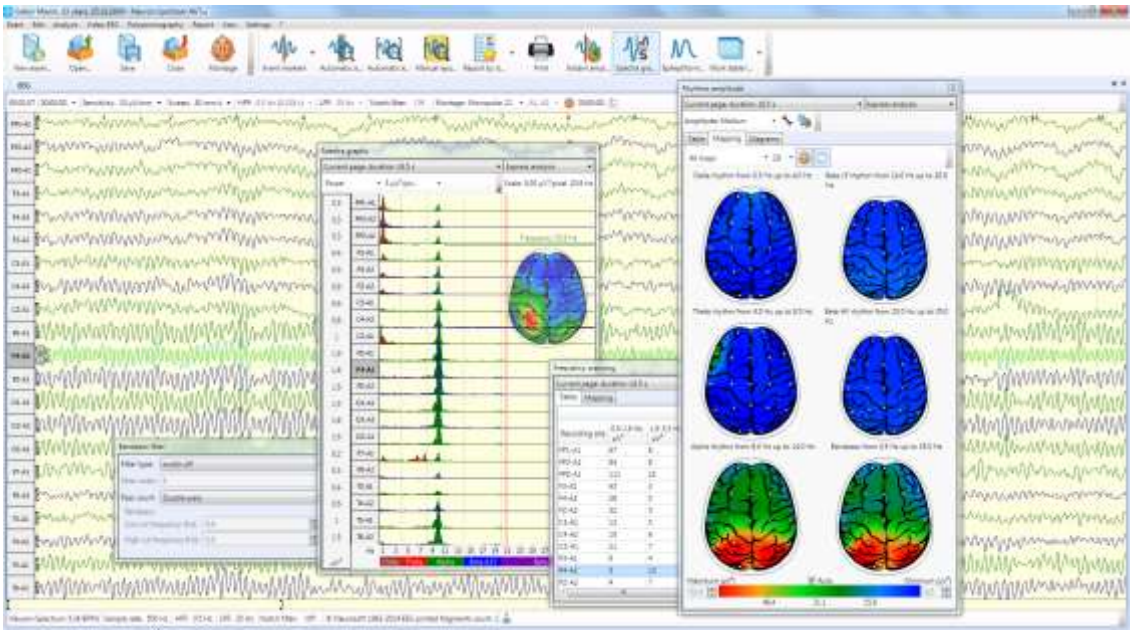


Fig. 5.14. Floating position of the windows.

To avoid the trace overlapping with floating windows you can make them transparent. To do this, use  button rightward the window title. Customize the parameters of transparency using the context menu (Fig. 5.15).

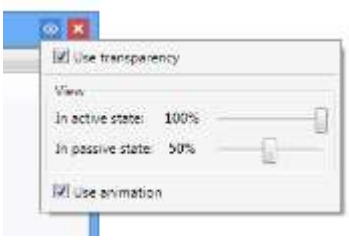


Fig. 5.15. Setting the floating window transparency.

The semitransparent floating windows are sometimes used to show the windows with video or topographic maps to see simultaneously the analysis results and recorded traces.

- **Attached position** – each window can be attached to left, right, top or bottom part of the working area of main program window. For example, “Exam Inspector” (see section 5.14.1 “Exam Inspector”) is better to attach to the left or right part and “EEG Trend” (see section 6.4.11 “Trends”) to the bottom one. In the attached position the window does not overlap EEG traces. Several windows as the tabs can be attached to one border of main program window. To attach the window to any border of the window, press the window title with the mouse and drag it to the required part of the screen (Fig. 5.16, Fig. 5.17).

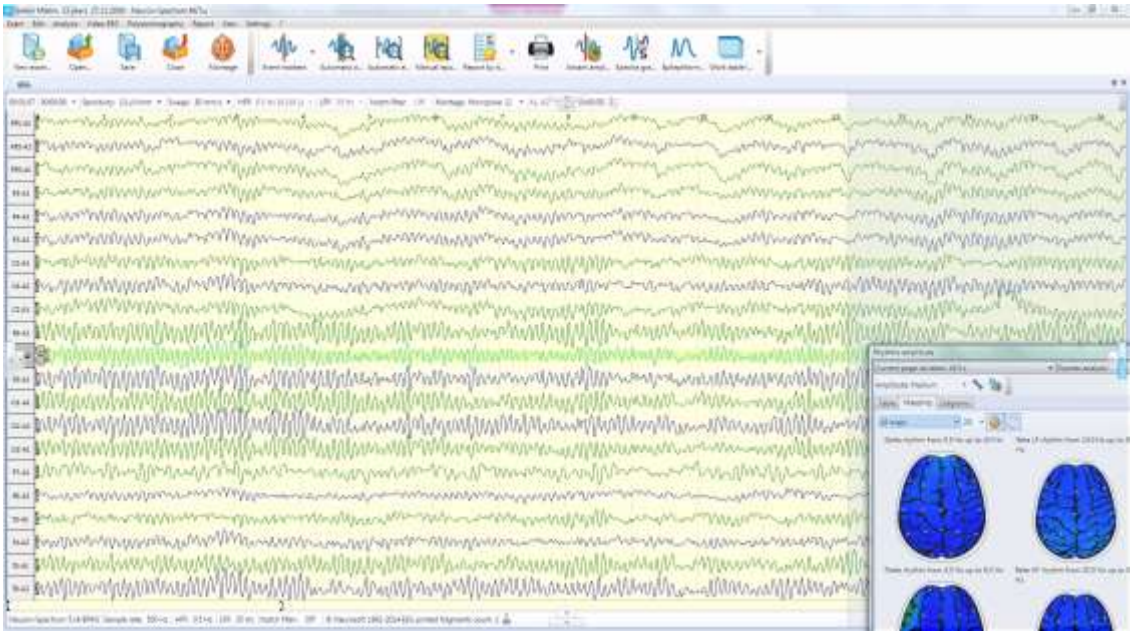


Fig. 5.16. Attachment (dragging) of windows.

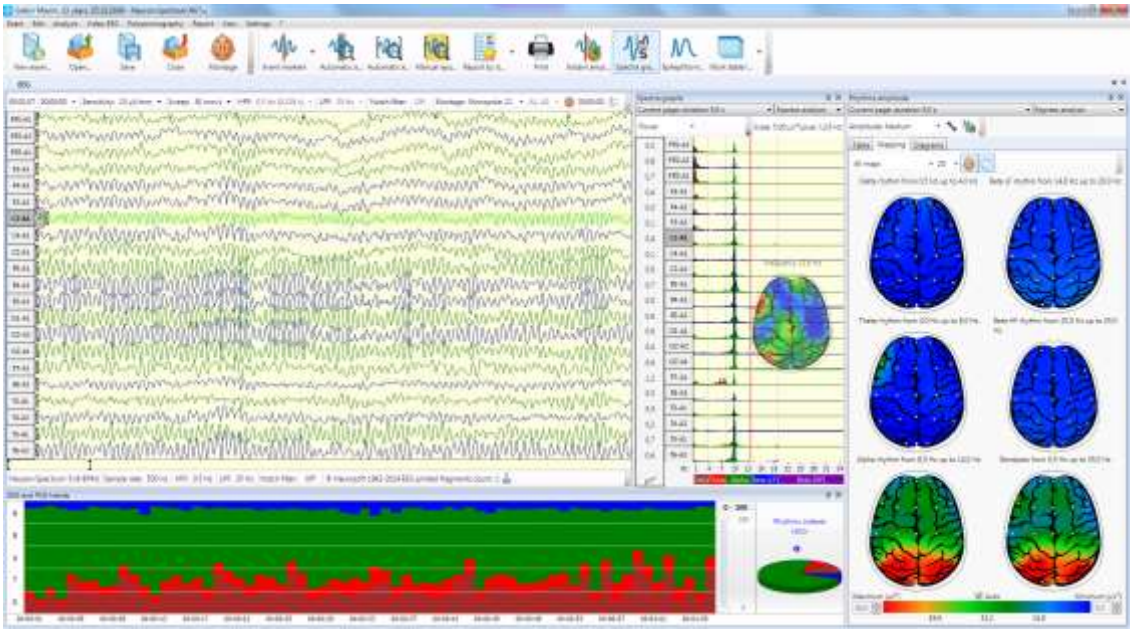


Fig. 5.17. Attached position of windows.

- **Pop-up position** – the window is hidden, only the title is visible. To display the window, point the mouse cursor on the visible title and left-click it. When you close the window, it will automatically switch to the hidden position. To switch the window to the pop-up position, press □ button in the right top corner of the window (Fig. 5.18).

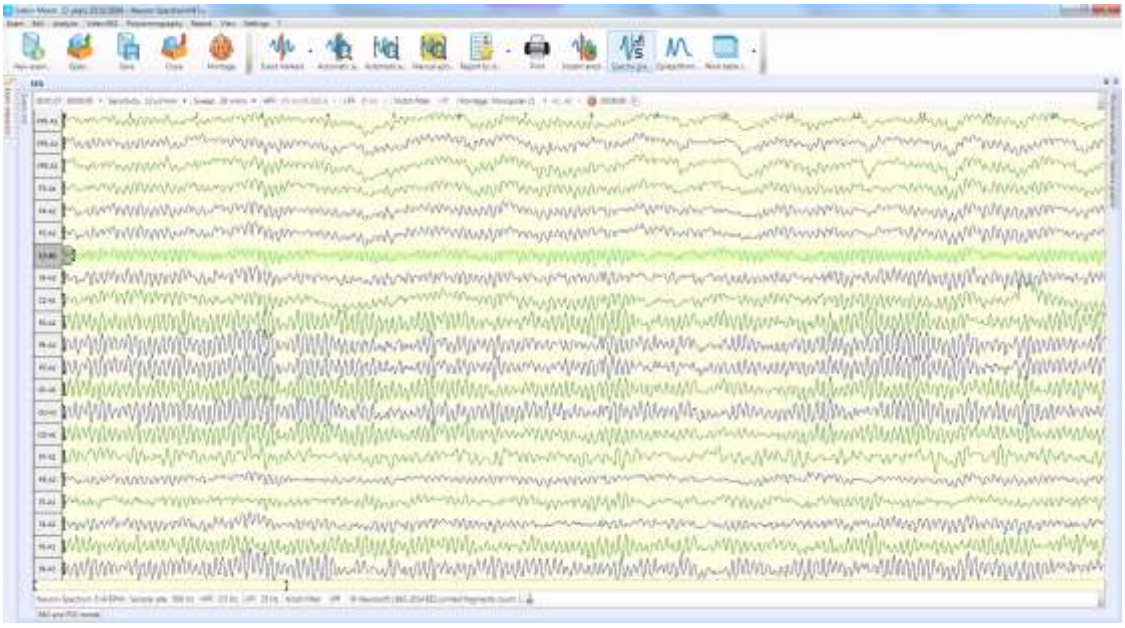


Fig. 5.18. Pop-up position of windows.

5.14.1. Exam Inspector

One of the main additional windows intended to show the exam structure is “Exam Inspector” window (Fig. 5.19).

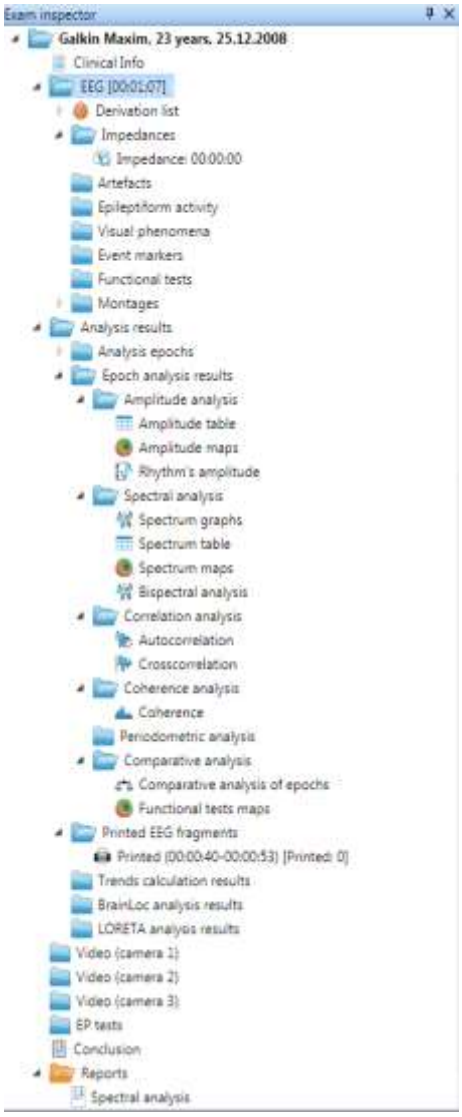


Fig. 5.19. “Exam inspector” window.

To show or to hide the “Exam Inspector” window, use **View|Exam inspector** menu command or **[F11]** key of your keyboard.

The “Exam Inspector” contains all the information concerning the exam. The exam structure in “Exam Inspector” is shown as a tree. Using the tree elements you can move over EEG, control the derivations visibility, open the analysis windows and exam reports. The list and the description of the “Exam Inspector” tree elements is given in the Table 5.2.

Table 5.2. Description of “Exam Inspector” tree elements

Element Name	Element Description
Patient name	Root element of a tree.
Clinical info	Using this element you can open “Clinical info” window (see section 7.4 “Clinical State”).
EEG	Contains the elements describing the exam structure.
List of derivations	Contains the list of derivations of the current montage. Using the elements of this list you can control the visibility of the separate derivations.
Impedance measurement	The list of all the measured impedances which were saved during the exam (see section 4.5 “Electrode Impedance Measurement”). To review the results of the impedance measurement, it is quite enough to double-click the element with the left mouse button. At that, the window with the measurement results will appear on the screen, and the current position on EEG traces will move to the impedance measurement moment.
Record artifacts	The list of all the exam artifacts selected on EEG. To move to any artifact, it is enough to double-click the corresponding element with the left mouse button.
Epileptiform activity	The list of all the selected fragments of epileptiform activity. To move to any fragment, it is enough to double-click the corresponding element with the left mouse button.
Visual phenomena	The list of all the selected visual phenomena. To move to any phenomenon, it is enough to double-click the corresponding element with the left mouse button.
Event markers	The list of all the event markers on EEG traces. To move to any marker, it is enough to double-click the corresponding element with the left mouse button.
Functional tests	The list of all functional tests registered during EEG exam. To move to the beginning of any test, it is enough to double-click the corresponding element with the left mouse button.
Montages	The list of montages used during exam acquisition.
Analysis results	Contains the elements describing EEG analysis results.
Analysis epochs	The list of selected analysis epochs. To move to any epoch, it is enough to double-click the corresponding element with the left mouse button.
Epoch analysis results	Contains the elements for the access to epoch analysis results.
Amplitude analysis	Contains the elements for the access to the amplitude analysis results of the epochs.
Table of amplitudes	Using this element you can open “Table of amplitudes” window (see section 6.4.3 “Table of Amplitudes”).
Amplitude mapping	Using this element you can open “Amplitude mapping” window (see section 6.4.4 “Amplitude Mapping”).
Amplitude of rhythms	Using this element you can open “Amplitude of rhythms” window (see section 6.4.6 “Amplitude of Standard EEG Rhythms”).
Spectral analysis	Contains the elements for the access to the spectral analysis results of the epochs.
Spectrum graphs	Using this element you can open “Spectrum graphs” window (see section 6.4.7 “Spectrum Graphs”).
Frequency characteristics	Using this element you can open “Frequency table” window (see section 6.4.8 “Frequency ”).
Mapping of spectrum amplitude	Using this element you can open “Spectrum mapping” window (see section 6.4.9 “Spectrum Mapping”).

Table 5.2. Continued

Element Name	Element Description
Printed EEG fragments	All EEG pages sent to printing are listed in this element. When you select the nested element with the left mouse button, you can review EEG fragments printed before. Besides, using the context menu you can print all the fragments in the list.
List of video fragments	Contains all the video fragments recorded during an exam (only for **Neuron-Spectrum-Video.NET**).
EP tests	Contains the list of tests with stimulation performed during an exam (see chapter 9 “Neuron-Spectrum-LEP.NET).
Conclusion	Using this element you can open “Conclusion” window (see section 7.5 “Conclusion”).
Reports	Contains the list of all exam reports. To open any report, double-click the corresponding element with the left mouse button.

5.14.2. Extra EEG Window

Besides the main EEG window, **Neuron-Spectrum.NET** provides an extra window for EEG review and analysis (Fig. 5.20). To show or hide this extra EEG window, use **View|Extra EEG window** menu command or the corresponding button on the “View” toolbar (see the Annex 1).

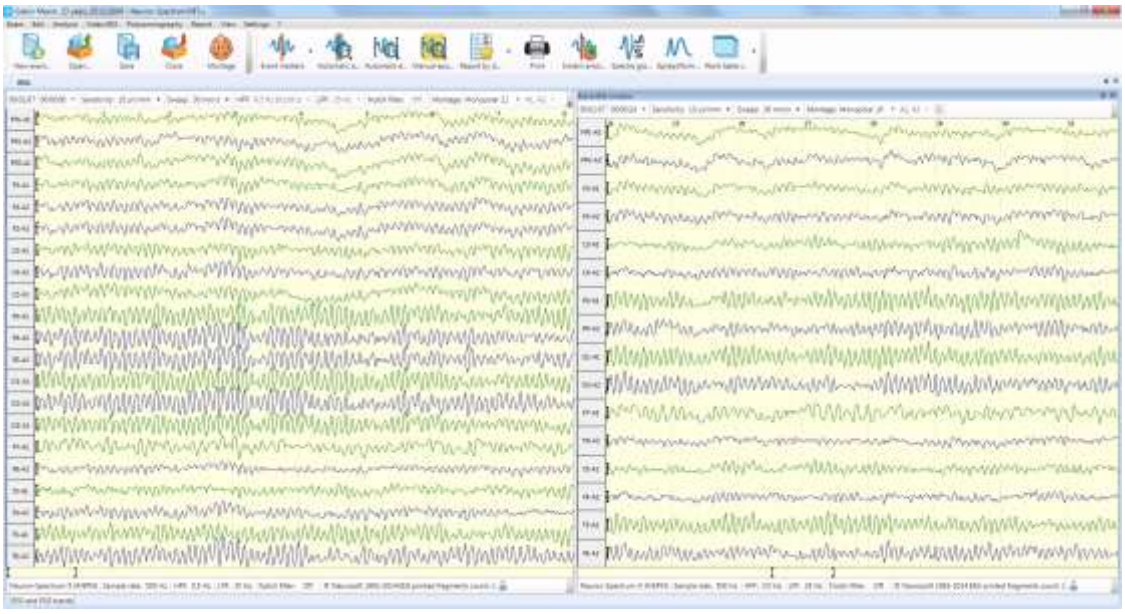


Fig. 5.20. Main EEG window is to the left, the extra one is to the right.

In the extra EEG window you can review EEG traces with its own scales, sweep speed and montages. To move over EEG, the extra window is provided with own scroll bar and own “Navigator” (see section 5.14.6 “

Navigator”). In the extra EEG window (as in main EEG window) you can select the record fragments for the analysis, the detection, the printing, etc., arrange and edit the event markers, the analysis epochs. Using the extra window you can see two fragments of the trace simultaneously. Using the extra EEG window, you can review and analyze EEG even during the recording. Thus, you can observe the acquisition process in the main window, and review and analyze the recorded part of EEG in the extra EEG window. It is convenient to perform the long-term exams.

5.14.3. Current Montage Window

The current montage window (Fig. 5.21) is intended for displaying of the current montage. To show or hide “Current montage” window, you can use **View|Current montage** menu command or the corresponding button on “View” toolbar (see the Annex 1).

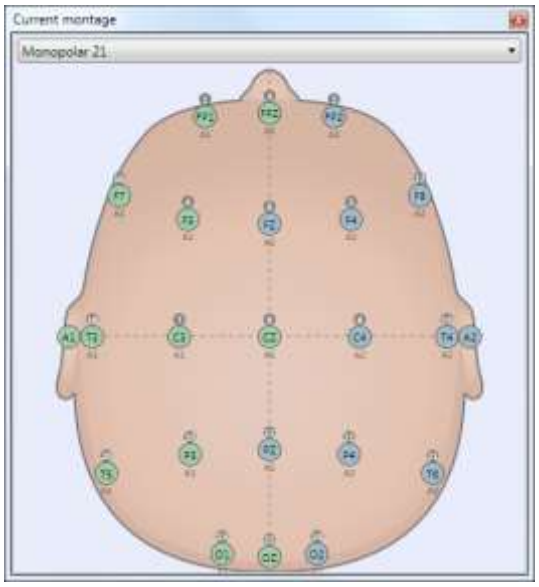


Fig. 5.21. The current montage window.

Using this window you can select the current derivation by clicking it with the left mouse button. Besides, using the combo-box at the top of the window, you can change the current montage. The list of the available montages includes all the montages of the current acquisition style (see section 8.2.2 “Acquisition Styles”). The displaying properties of each montage depend on its settings (see section 8.2.1 “Montage Editing”). If the electrode system is used in the current acquisition style, the list of available montages will contain only those ones that meet the selected system.

5.14.4. Current Impedance

To display the current impedance vales during acquisition or review, use “Impedance: before record beginning” window (Fig. 5.22). To show or hide this window, use **View|Current impedance** main menu command or the corresponding button on “View” toolbar (see Annex 1).

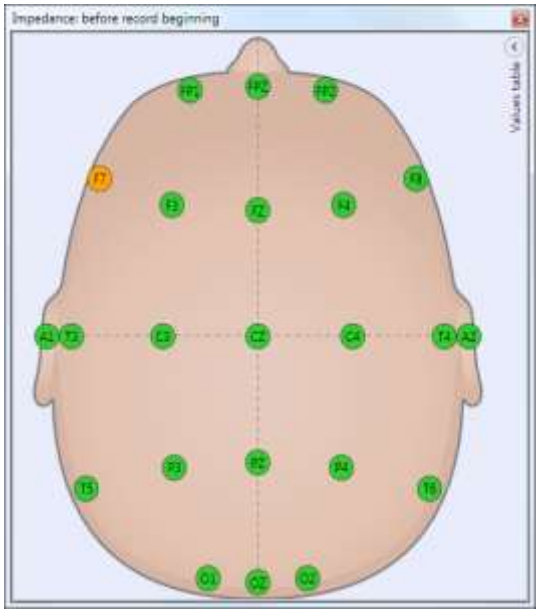


Fig. 5.22. Current impedance.

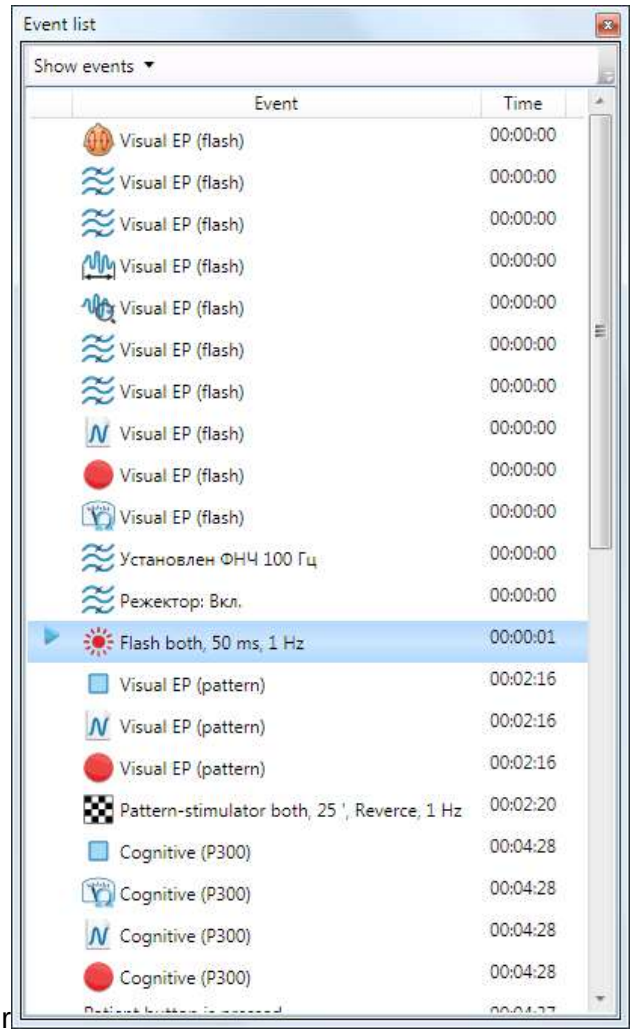
In this window you can see the color-coded impedance values obtained during the acquisition or current impedance values measured during exam review. If it is required, you can view the numerical values of measured impedances by each derivation on “Value table” tab. The borders of green, yellow and red colors of impedance indication values can be specified in acquisition style editor on “Impedance measuring” page (see section 8.2.2 “Acquisition Styles”). In this window you can see even those impedance values that were obtained at EEG acquisition termination (this mode is available for a limited number of EEG systems). Besides, the color-coded current impedance values can be displayed on trace buttons (see section 8.3 “Adjusting EEG Review”).

5.14.5. Event List

During EEG recording, a lot of events are recorded. To display these events and navigate over them, you can use “Event list” (Fig. 5.23). The events are divided into several groups:

- **Service events** – the events connected with the change of acquisition parameters (change of sweep speed, scale, montage, filters, etc.). The service events, as a rule, are not of interest to a user and are hidden by default.
- **User events** – the event markers specified by a user.
- **Print markers** – the print markers arranged during exam acquisition or review.
- **Functional tests** – the events of the beginning of the functional tests recording.
- **Stimulation events** – the events connected with the stimulation during an exam (the beginning of the stimulation, the end of the stimulation, the change of stimulation frequency, etc.).
- **Impedance measurement events** – impedance measurement events occurred during exam acquisition.

To filter the list of events in the window, you can use **Show events** menu command. Please remember, that the events, which are visible in “Events list”, are visible both on EEG traces and in “Navigator” (see section 5.14.6 “Navigator”).



Navigator

Fig. 5.23. The event list.

The events list shows the event name and the time of its beginning. As for the service events, you can see the astronomical time. To navigate to any event in the list, it is enough to click it with the left mouse button.

5.14.6. Navigator

The “Navigator” is intended for the instantaneous move to any point of EEG trace and schematic representation of all exam and events occurred during this exam recording. The “Navigator” is located under EEG traces (Fig. 5.24). To show or hide the “Navigator”, use **View|Navigator** menu command or the corresponding button on “View” toolbar (see the Annex 1).

Fig. 5.24. Navigator.

The advantage of “Navigator” is that it shows the whole record independently of its size in one window schematically. The “Navigator” represents all the events, the functional tests and the selected fragments as the vertical bars. The current fragment of the record, which is visible on the screen, is displayed in “Navigator” as a frame. If you point the mouse cursor on any event, you will see the pop-up help with the event name. To move to an event, click the left mouse button. To filter the events visible in “Navigator”, you can use the context menu. To do this, point the mouse cursor on “Navigator” and click the right mouse button. In the appeared context menu (Fig. 5.25) the event types displayed in “Navigator” are checked.

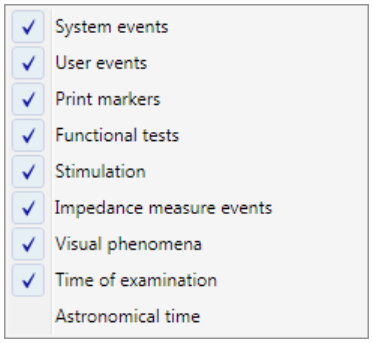


Fig. 5.25. The “Navigator” context menu.

The event types being visible in “Navigator” correspond to the ones which are visible in “Event list” (see section 5.14.5 “Events List”) and on EEG traces.

To move over EEG using the “Navigator”, you can move the frame indicating the current visible fragment of the traces or left-click any point of “Navigator”. Also using the “Navigator” you can select the fragments. To select the fragment (see section 5.10 “Selection of EEG Fragments”), left-click the fragment beginning and, without releasing the mouse button, move the pointer to the fragment end.

During the exam recording the “Navigator” is updated every 10 seconds but you can use it to move over EEG only when the recording is complete. To review the recorded part of an exam, use “Extra EEG window” (see section 5.14.2 “Extra EEG Window”).

5.14.7. Calibration Cuts

During EEG acquisition and analysis it is convenient to have the calibration cuts on the screen with the known height to assess EEG amplitude (Fig. 5.26). To show or hide the calibration cuts, you can use **View|Calibration cuts** menu command or the corresponding button on “View” toolbar (see the Annex 1).

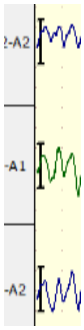


Fig. 5.26. Calibration cuts.

The visibility of the calibration cuts by default and its height for the derivations with the common settings are downloaded from the acquisition style (see section 8.2.2 “Acquisition Styles”). You can specify the individual height of the calibration cut for each derivation (Fig. 4.7). Besides calibration EEG trace is color-coded by default to assess the trace amplitude. The color can be customized by a user (see section 8.4 “Color Scheme”).

5.14.8. Status Line

The status line is located under EEG traces in the bottom part of the main window (Fig. 5.27). It is intended to show the parameters of the exam acquisition. To show or hide the status line, you can use **View|Status line** menu command or the corresponding button on “View” toolbar (see the Annex 1).

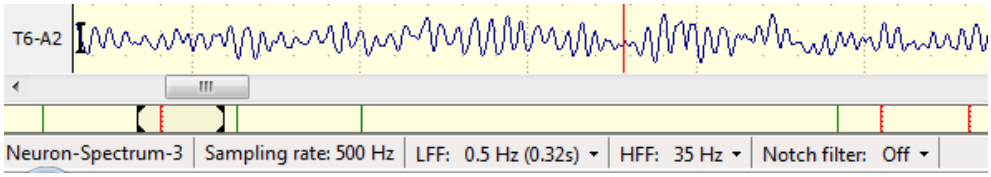


Fig. 5.27. The status line.

The status line displays the name of the digital EEG and EP system used for the exam recording, the sampling rate and the filters parameters. Before the recording start, you can change the sampling rate using the status line. During the acquisition and the review of an exam, you can change the filters. After the repetitive opening of an exam it is possible to change the filters but only in case the exam contains non-filtered data, otherwise, it is impossible to change the filters (see section 4.3 “Filter Setup”). Also the battery charge level, position of patient’s body and luminance level can be shown at the status line of some devices. If the free disk space is not enough, the program will display the warning message in the status line. When the free disk space is lesser than it is required to store 24-hour record, the program will display

the corresponding yellow-text warning message. If the free disk space is lesser than required to store 8-hour record, the program will display red-text warning message.

5.14.9. Acquisition Panel

The “Acquisition panel” is located in the top part of the working area of the main window (Fig. 5.28). It is intended to show the parameters of EEG displaying and acquisition. To show or hide the “Acquisition panel”, you can use **View|Acquisition panel** menu command or the corresponding button on “View” toolbar (see the Annex 1).

Fig. 5.28. Acquisition panel.

The “Acquisition panel” contains the total time of the recording, the time of the functional test recording, the name of the current functional test. Using this panel, you can perform the navigation over the recorded functional tests. Besides using the acquisition panel you can change the traces scale (only for the derivations with the common settings), the sweep speed and the acquisition montage. With “Ref” drop-down list (Fig. 5.29) you change the reference electrode of the current montage.

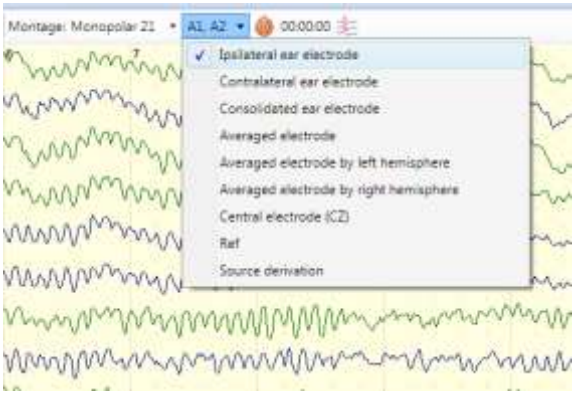


Fig. 5.29. The reference reconstruction of a montage.

Using “Acquisition montage” button  you can review EEG traces in a way they were recorded physically by the digital EEG and EP system. If you press  button, you can switch to trace displaying mode where you can scroll EEG traces vertically. It can be useful to compare visually several traces. Besides this mode allows to display the montage with a large number of derivations (128 and 256 traces) as each trace is positioned at a definite height and those ones that do not fit the screen size, can be seen with vertical scroll.

5.14.10. Record Time

The record time is constantly displayed on the acquisition panel (see section 5.14.9 “Acquisition Panel”). It can be also displayed at EEG traces. To show or hide the record time at traces, you can use **View|Record time** menu command or the corresponding button on “View” toolbar (see Annex 1).

5.14.11. Current Function Test Time

The current functional test time is constantly displayed at acquisition panel (see section 5.14.9 “Acquisition Panel”). It can be also displayed at EEG traces. To show or hide the record time at traces, you can use **View|Current functional test time** menu command or the corresponding button on “View” toolbar (see Annex 1).

5.14.12. Astronomical Time

At EEG review and analysis it is sometimes required to know the time of the day and exact astronomical time when an exam was recorded. To show or hide the astronomical time, you can use **View|Astronomical time** menu command or the corresponding button on “View” toolbar (see the Annex 1). The example of astronomical time displaying is shown in the Fig. 5.30.

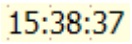


Fig. 5.30. The astronomical time.

The astronomical time by default is located in the left top corner of EEG traces window. However, you can drag it to any part of the window using the mouse. Besides the astronomical time, the date can also be displayed. To do this, choose the corresponding item of the context menu. Right-click the astronomical time and choose “Show date” drop-down menu item. Also using the context menu you can change the font size for the time displaying.

5.14.13. Current Functional Test

The name of the functional test is displayed in acquisition panel (see section 5.14.9 “Acquisition Panel”). However, if you wish, you can display it also on EEG traces (Fig. 5.31).

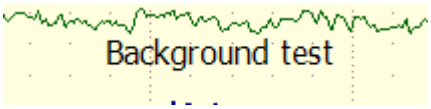


Fig. 5.31. Current functional test.

To show or hide the current functional test on EEG trace, you can use **View|Current functional test** menu command or the corresponding button on “View” toolbar (see the Annex 1). The current functional test by default is located in the left top corner of EEG traces window. However, you can drag it to any part of the window using the mouse. Using the context menu, you can change the font size of functional test name displaying.

5.14.14. Pop-up Windows Related to User Actions

Many options in Neuron-Spectrum.NET software can be activated with hot key combinations. For example, you can press the corresponding key combinations to change montage, sweep speed, trace scale, stimulation frequency. To pay user's attention to changes occurred, the corresponidng pop-up windows appear at the screen (Fig. 5.32).

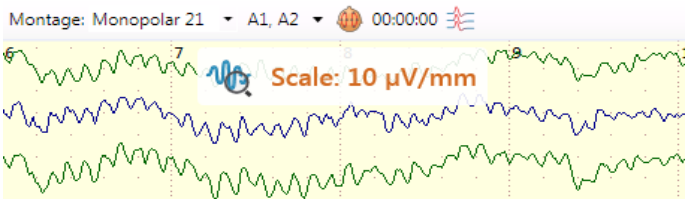


Fig. 5.32. Pop-up windows related to user's actions.

The pop-up windows can be disabled with **View|Show user actions pop-up messages** main menu command.

5.15. Work Tables

During EEG recording it is convenient to have several big buttons allowing to control the acquisition process and EEG trace window on the screen. During the analysis, however, it is better to have small buttons to control the analysis process and some visible analysis windows. The work tables are intended to store and switch quickly between different window layouts and toolbars. To control the work tables, you can use **View|Work table** menu item and  toolbar button with drop-down list (Fig. 5.33).

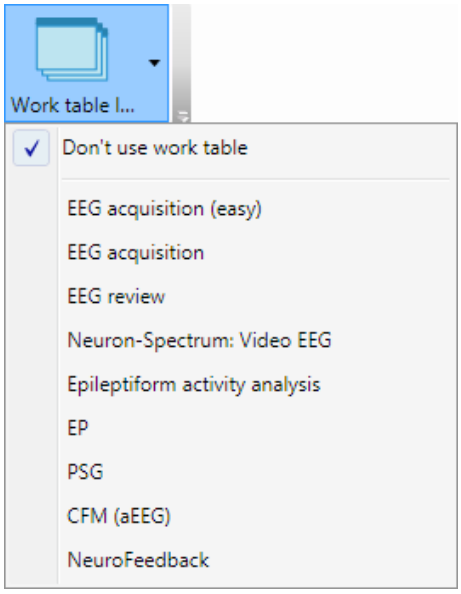


Fig. 5.33. The selection of the work table from the drop-down list.

Using this menu item you can download the work tables from the list, save the current layout of the windows on the desktop, remove the work tables. Also, to download the work tables, you can use the corresponding button on "View" toolbar. The work tables can be saved in a file and restored from a file.

By default, the program provides several work tables but you can create new work tables and remove the existing ones.

The work tables store the following data:

- The location of the acquisition, the navigation and the analysis windows on the screen.
- The visibility, the position, the size and the view of the toolbars and their buttons.
- The “Navigator” visibility.
- The visibility of the calibration cuts.
- The visibility of the status line.
- The visibility of the “Acquisition panel”.
- The visibility of the astronomic time.
- The visibility of the current functional test.
- The visibility of the panel for functional test recording.
- The visibility and settings of trends in “Trend” window.

You can select separately the work table for EEG acquisition and analysis (Fig. 4.4). During the acquisition or analysis you can select any work table using **View|Work table** menu item or the toolbar button.

Even if you do not use the work tables, user settings contain separately the analysis window layout, acquisition toolbar (is downloaded at the creation of a new exam) and analysis toolbar (is downloaded at the exam opening).

5.16. Native EEG Editing

Sometimes it is useless to store the whole EEG record in the database. It is required to save only the most characteristic and interesting fragments of the traces. It is especially important when the long-term EEG exams are recorded. The removal of the fragments from an exam, which do not represent any interest, allows to decrease considerably its size and speed up the navigation over it. To remove the fragment of the record from an exam, select the required fragment of the traces (see section 5.10 “Selection of EEG Fragments”), right-click it and choose “Delete EEG fragment from exam” item in the context menu. Also, you can use the reverse mechanism, i.e. you can select the fragments which should be saved in an exam. To do this, select the required fragment of the traces, right-click it and choose “Save fragment to file” item of the context menu or press **[Alt+S]** key combination. The status bar under deteled fragment is marked with grey color (Fig. 5.34).

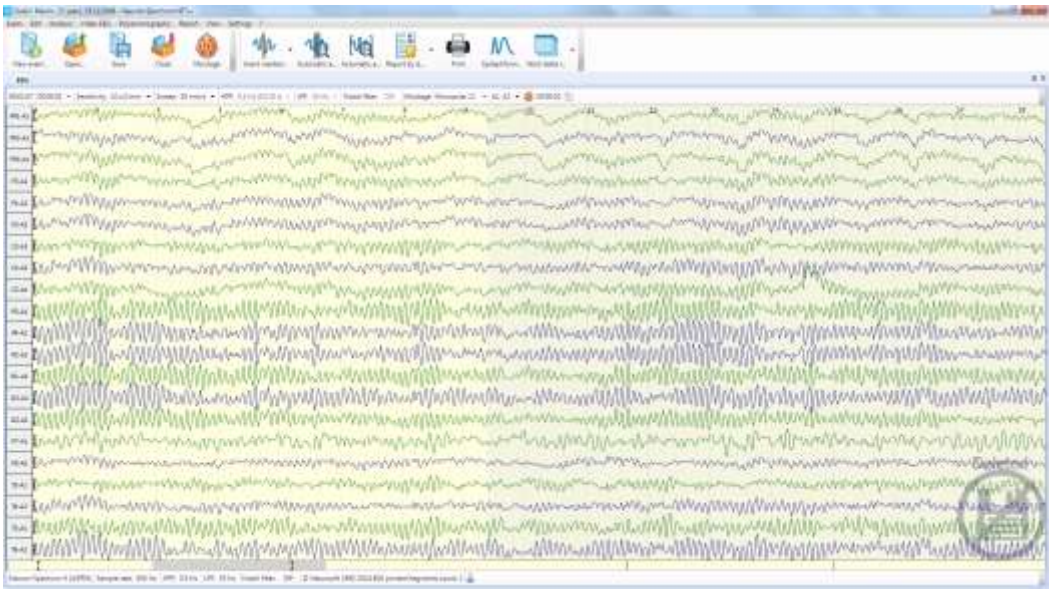
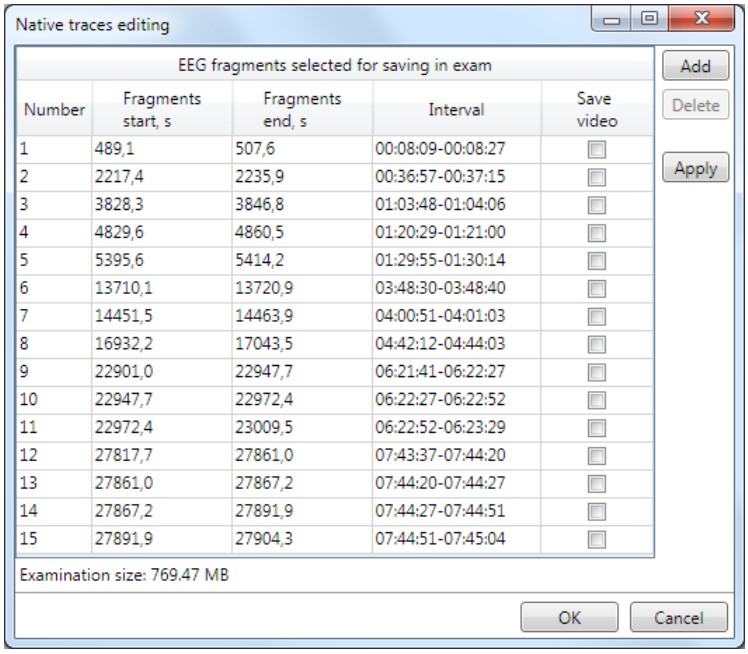


Fig. 5.34. EEG fragment selected for the removal (to the right).

To control EEG fragments selected for the removal or saving, use “Native EEG editing” window (Fig. 5.35). You can open this window using **Edit|Native EEG editing** menu command.



Number	Fragments start, s	Fragments end, s	Interval	Save video
1	489,1	507,6	00:08:09-00:08:27	
2	2217,4	2235,9	00:36:57-00:37:15	
3	3828,3	3846,8	01:03:48-01:04:06	
4	4829,6	4860,5	01:20:29-01:21:00	
5	5395,6	5414,2	01:29:55-01:30:14	
6	13710,1	13720,9	03:48:30-03:48:40	
7	14451,5	14463,9	04:00:51-04:01:03	
8	16932,2	17043,5	04:42:12-04:44:03	
9	22901,0	22947,7	06:21:41-06:22:27	
10	22947,7	22972,4	06:22:27-06:22:52	
11	22972,4	23009,5	06:22:52-06:23:29	
12	27817,7	27861,0	07:43:37-07:44:20	
13	27861,0	27867,2	07:44:20-07:44:27	
14	27867,2	27891,9	07:44:27-07:44:51	
15	27891,9	27904,3	07:44:51-07:45:04	

Fig. 5.35. “Native EEG editing” window.

In this window you can see the list of EEG fragments selected for removal or saving. Using “Add” button, you can add new fragments of an exam to this list. You can delete the fragments from the list using “Delete” button. Also, you can change the borders of each fragment in the list. If you press “Apply” button in this window or save an exam, the results of the editing will be saved. The message window requiring to specify the saving parameters will be displayed on the screen at the saving of the editing results (Fig. 5.36).

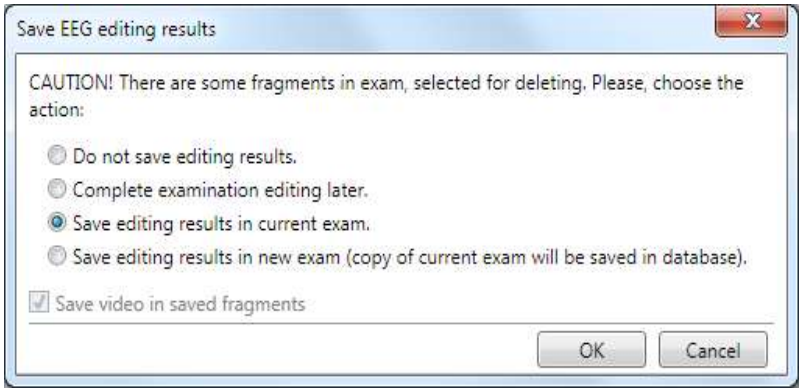


Fig. 5.36. Saving of EEG editing results.

You can refuse to save the exam editing results, save the editing results in the current exam or save the editing results as a new exam, at that the native exam will remain in the database without any changes. If the saved EEG fragments have the synchronous video signal, you can save video or refuse it; in this case only EEG traces will remain in the exam.

5.17. Saving of Changes

After introducing the changes in an exam (addition of the analysis epochs, visual phenomena, artifacts, reports, etc) you can save them or refuse to save. To save the changes, use **Exam|Save** menu command, the corresponding button on the toolbar (see the Annex 1) or **[Ctrl+S]** key combination. To close the exam, use **Exam|Close** menu command, the corresponding button on the toolbar (see the Annex 1) or **[Ctrl+X]** key combination. If you do not want to save the changes introduced in an exam, press “No” button in the appeared dialog box (Fig. 4.21).

6. EEG Analysis

The stationary fragments of the record selected as analysis epochs are usually taken into consideration at EEG analysis (see section 5.12 “Arrangement of Analysis Epochs”). Using **Neuron-Spectrum.NET** you can also analyze any selected fragment of the record, the current EEG page which is visible on the screen.

Besides, you can perform the analysis during EEG acquisition directly. In this case, the last part of the record is analyzed, its size is defined by the analysis epoch. Each second the analysis results are updated. It provides the possibility to follow EEG

changes during the recording in the real-time mode. To display the analysis results, use the analysis windows (see section 6.4 “Analysis Windows”).

6.1. Analysis during EEG Acquision

As it was mentioned before, **Neuron-Spectrum.NET** software provides the possibility to analyze the recorded signal in the real-time mode. To display the analysis results during EEG recording, open one or several analysis windows at your option (see section 6.4 “Analysis Windows”). Each second of the recording the analysis results in the windows opened by you will be updated. The last recorded fragment of EEG is analyzed. The size of the analyzed fragment is defined by the size of the analysis epoch by default (see section 5.12 “Arrangement of Analysis Epochs”). The analysis in the real-time mode allows you to assess the parameters of the recorded EEG signal during the acquisition and follow its changes. It should be noted, that the analysis in the real-time mode requires higher computer performance and can not operate on the computers with insufficient computational resources (see section 1.1 “System Requirements”).

Using “Extra EEG window” window during EEG acquisition directly, you can review and analyze the recorded part of an exam.

6.2. Express-analysis

Express-analysis is EEG analysis which does not require the selection of the analysis epochs. Express-analysis is used when it is necessary to assess the parameters of some fragment of EEG record. The analysis in the real-time mode can be related to the express-analysis. To display the results of the express-analysis, open one or several analysis windows at your option (see section 6.4 “Analysis Windows”). In the windows opened by you the analysis results of the selected fragment of EEG record are displayed (see section 5.10 “Selection of EEG Fragments”). If none of the record fragment is selected, the current EEG page visible on the screen is analyzed. In this case, the results of the express-analysis will update automatically at moving over EEG (see section 5.4 “Navigation over EEG”). During EEG monitoring or recording, the analysis results are displayed in the analysis windows in the real-time mode.

You can use the express-analysis both for the main and extra EEG window (see section 5.14.2 “Extra EEG Window”). Using the “Extra EEG window”, you can analyze the recorded part of EEG directly during EEG acquisition in the main window.

6.3. Epoch Analysis

To analyze all EEG record, it is recommended to arrange first the analysis epochs in it (see section 5.12 “Arrangement of Analysis Epochs”). The analysis epoch is the stationary fragment of EEG record. The size of the analysis epoch in seconds is defined by the current analysis style (see section 8.7.1 “Analysis Styles”), however you can change it using **Analysis|Analysis epoch|Epoch length by default** menu command.

To display the results of the epoch analysis, open one or several required analysis windows (see section 6.4 “Analysis Windows”). In the opened analysis windows the averaged results of epoch analysis in all the record or the selected functional test are displayed. If you add new analysis epochs or remove the existing ones, the analysis results will update automatically. In case of epochs missing, the analysis windows may contain no results or express-analysis results (see section 6.2 “Express-analysis”).

6.4. Analysis Windows

The analysis windows are intended to display the analysis results. Each window can show the results of express-analysis (see section 6.2 “Express-analysis”) and epoch analysis (see section 6.3 “Epoch Analysis”). To switch between the express-analysis and the epoch analysis, use the combo-box in the right top corner of the window (Fig. 6.1).

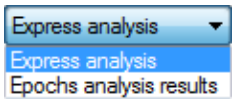


Fig. 6.1. Switching between express-analysis and epoch analysis.

In the left top corner of the window the analyzed fragment of the record is displayed:

- **Express-analysis:**
  - “Selected fragment” – the selected fragment of the record is analyzed (see section 5.10 “Selection of EEG Fragments”). The analysis results are updated automatically at the selected EEG fragment change.
  - “Current page” – the current EEG page which is visible on the screen, none of the fragment is selected. The analysis results are updated automatically at the navigation over EEG (see section 5.4 “Navigation over EEG”).
  - “Last epoch of record” – the last recorded part of EEG with the duration up to 5 seconds is analyzed (depending on the used duration of the analysis epochs) directly during the acquisition. The analysis results are updated automatically each second of the record.
- **Epoch Analysis:**
  - “All record” – the analysis epochs of all record are analyzed. The analysis results are updated automatically at the addition, the removal and the moving of epochs. If the analysis epochs are missed, nothing is displayed in the window. The analysis results of each epoch are averaged.
  - “Functional test” – only epochs included in this functional test are analyzed. The analysis results are updated automatically at the addition, the removal and the moving of epochs. If the analysis epochs are not included in this test, nothing is displayed in the window. The analysis results of each epoch are averaged.

To select the functional test for the analysis at the epoch analysis, you can use the combo-box in the left top corner of the window (Fig. 6.2). The list contains only those functional tests that were recorded during an exam.

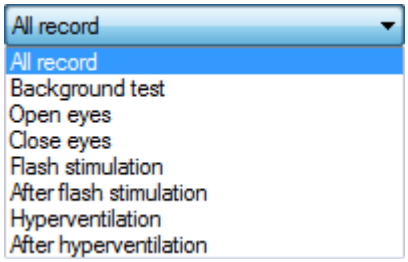


Fig. 6.2. The selection of the functional test for the analysis.

When the functional test is selected from the list, the automatic navigation to the beginning of the selected functional test occurs. On the contrary, while moving over EEG to the functional test, the analysis results of the current functional test are displayed automatically in the analysis window. Thereby the synchronous review of EEG traces and analysis results is provided.

Simultaneously you can use several analysis windows for EEG analysis. You can arrange them arbitrary on the screen. The analysis windows can be in several positions:

- **Floating position** – the window can be moved to any point of the screen. To move the window, press the window title with the left mouse button and without releasing it, drag the window in the required position. If you wish to change the size of the floating window, point the mouse cursor to the right bottom corner of the window, press the left mouse button and without releasing it, change the size of the window. The window in the floating position can overlap some parts of EEG traces that is why such position is not always convenient (Fig. 5.14).

Docked position – each window can be attached to left, right, top or bottom part of the working area of main program window. For example, “Exam Inspector” (see section 5.14.1 “Exam Inspector”) is better to attach to the left or right part and “EEG Trend” (see section 6.4.11 “Trends”) to the bottom one. In the attached position the window does not overlap EEG traces. Several windows as the tabs can be attached to one border of main program window. To attach the window to any border of the main window, press the window title with the mouse and drag it to the required part of the screen (Fig. 5.16, Fig. 5.17).

- **Pop-up position** – the window is hidden, only the title is visible. To display the window, point the mouse cursor on the visible title. After the end of operation with the window, it will automatically switch to the hidden position. To switch the window to the pop-up position, press button in the right top corner of the window (Fig. 5.18).

To save the current layout of the analysis windows, you can use the working tables option described in section 5.15 “Work Tables”.

6.4.1. Bandpass Filter

Besides the filtration at EEG acquisition (see section 4.3 “Filter Setup”) it is sometimes useful to apply the bandpass filter to EEG traces (at the further review and analysis) to select the standard EEG rhythms distinctly or remove noises and artifacts. Using “Bandpass filter” window (Fig. 6.3) you can apply different filters corresponding to the standard rhythms to EEG record. Besides, you can use the arbitrary bandpass filter with the specified bandpass. To show or hide “Bandpass filter” window, use **View|Analysis windows|Bandpass filter** menu command or the corresponding button on “Analysis” toolbar (see the Annex 1).

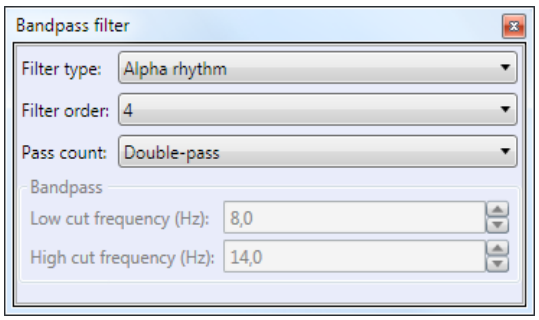


Fig. 6.3. The bandpass filter.

Using “Filter type:” combo-box, you can select the bandpass filter corresponding to the standard rhythm or the arbitrary bandpass filter. Also, you can set the filter order. The higher is the filter order, the better is the filtration quality and the slower it works. To perform the filtration, you can specify the number of passes. Usually the single-pass filters make a definite phase shift to the signal. To avoid the phase shift, the double-pass filtration can be used.

You can specify the bandpass for the arbitrary filter using the input boxes for the low cutoff frequency and high cutoff frequency. The cutoff frequencies for the bandpass filters corresponding to the standard rhythms are specified in the settings of the particular rhythm. The settings of the standard rhythms are downloaded from the current analysis style (see section 8.7.1 “Analysis Styles”).

6.4.2. Instant Amplitude

To assess the EEG amplitude, you can use the calibration cuts (see section 5.14.7 “Calibration Cuts”). Also, to define the amplitude of one EEG wave or group of waves you can use the wave measurement mode (see section 5.5 “Wave Measurement Mode”).

To define accurately EEG amplitude at a certain moment of the recording, use **Analysis|Amplitude analysis|Instant amplitude** menu command or the corresponding button on “Analysis” toolbar (see the Annex 1).

In instant amplitude measurement mode, the instant position marker is displayed on EEG traces, and the amplitude measured relative to the baseline for each derivation at a certain moment is shown to the left of EEG trace buttons (Fig. 6.4).

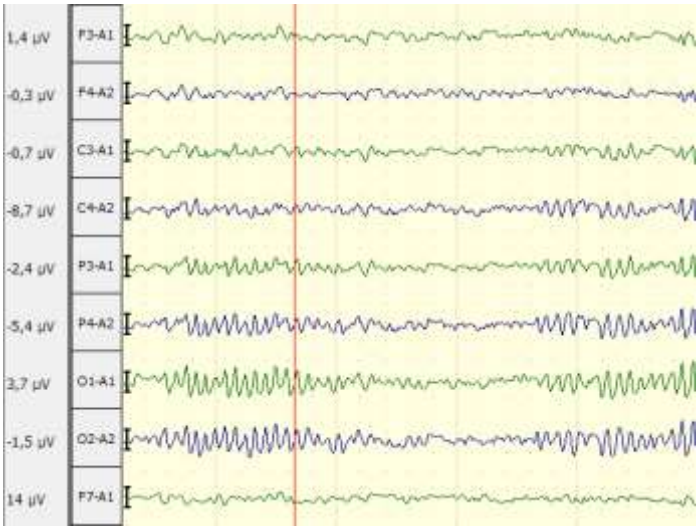


Fig. 6.4. Instant EEG amplitude.

When the marker is dragged with the mouse or during the navigation over EEG traces, the values of the measured amplitudes are recalculated automatically. To hide the instant position marker and the amplitude panel, use **Analysis|Amplitude analysis|Instant amplitude** menu command or the corresponding button on the toolbar. Also, you can use the context menu. To do this, point the mouse cursor on the instant position marker or the amplitude panel and right-click it.

The topographic map of the instant amplitudes can be displayed on the screen besides the values of the instant amplitudes (Fig. 6.5). The topographic map of the instant values of the amplitudes is semitransparent and allows to review the results of the amplitude mapping at a certain moment simultaneously with EEG review. If you move the measuring marker, the map will also move. It gives an opportunity to follow the dynamics of EEG amplitude distribution in time. Using the context menu you can copy the topographic map of instant amplitudes to the report.

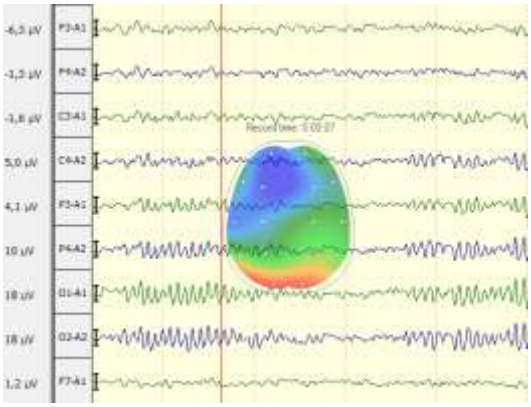
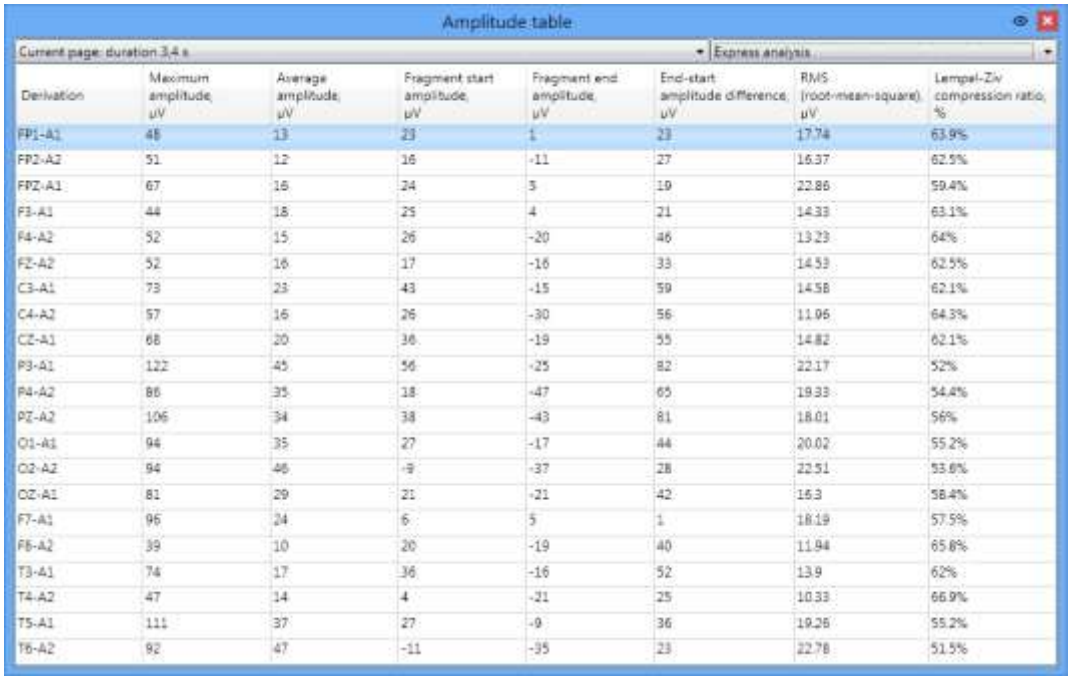


Fig. 6.5. The mapping of the instant values of EEG amplitude.

To refuse the displaying of the topographic map of the instant values of EEG amplitude on the screen, use the context menu while dragging the measuring marker. To do this, point the mouse cursor on the marker of the instant position or the amplitude panel and right-click it.

6.4.3. Table of Amplitudes

The “Amplitude table” window is intended to show the instant, average and maximum EEG amplitudes in the derivations (Fig. 6.6). To show or hide this window, use **Analysis|Amplitude analysis|Amplitude table** menu command or the corresponding button on “Analysis” toolbar (see the Annex 1). The table shows the results of the amplitude measurement in the derivations. The settings of the amplitude analysis are downloaded from the current analysis style (see section 8.7.1 “Analysis Styles”).



Derivation	Maximum amplitude, µV	Average amplitude, µV	Fragment start amplitude, µV	Fragment end amplitude, µV	End-start amplitude difference, µV	RMS (root-mean-square), µV	Lempel-Ziv compression ratio, %
FP1-A1	48	13	23	1	23	17.74	63.9%
FP2-A2	51	12	16	-11	27	16.37	62.5%
FPZ-A1	67	16	24	5	19	22.86	59.4%
F3-A1	44	18	25	4	21	14.33	63.1%
F4-A2	52	15	26	-20	46	13.23	64%
FZ-A2	52	16	17	-16	33	14.53	62.5%
C3-A1	73	23	43	-15	59	14.58	62.1%
C4-A2	57	16	26	-30	56	11.96	64.3%
CZ-A1	68	20	36	-19	55	14.82	62.1%
P3-A1	122	45	56	-25	82	22.17	52%
P4-A2	86	35	18	-47	65	19.33	54.4%
PZ-A2	106	34	38	-43	81	18.01	56%
O1-A1	94	35	27	-17	44	20.02	55.2%
O2-A2	94	46	-9	-37	28	22.51	53.6%
OZ-A1	81	29	21	-21	42	16.3	58.4%
F7-A1	96	24	6	5	1	18.19	57.5%
F8-A2	39	10	20	-19	40	11.94	65.8%
T3-A1	74	17	36	-16	52	13.9	62%
T4-A2	47	14	4	-21	25	10.33	66.9%
T5-A1	111	37	27	-9	36	19.26	55.2%
T6-A2	92	47	-11	-35	23	22.78	51.5%

Fig. 6.6. Table of amplitudes.

Using the context menu, you can change the visibility of the table columns and copy it to the current report. If you select the table row, the corresponding derivation is activated in EEG traces window. And vice versa if you change the active derivation in EEG traces window, the selected table row will change.

The table contains data on minimum, maximum and average amplitude on the selected fragment, amplitudes at the start and at the end of the selected fragment, end-start difference, root mean square amplitude value and Lempel-Ziv compression ratio. Lempel-Ziv compression ratio characterize signal repeatability. The better signal repeatability, the higher compression ratio. For healthy person this value may vary from 60% up to 90%, and for patients with Alzheimer disease and other cerebral disorders it may decrease to 40%. You can monitor the treatment or the disease progress observing the time variation of the Lempel-Ziv compression ratio.

To display the table data as topographic maps, use “Amplitude maps” window (see section 6.4.4 “Amplitude Mapping”). To show the results of the amplitude analysis by standard EEG rhythms, use “Standard EEG rhythm amplitude” window (see section 6.4.6 “Amplitude of Standard EEG Rhythms”).

6.4.4. Amplitude Mapping

To display the results of the amplitude analysis as topographic maps, use “Amplitude mapping” window (Fig. 6.7). To show or hide this window, use **Analysis|Amplitude analysis|Amplitude maps** menu command or the corresponding button on the “Analysis” toolbar (see the Annex 1). In this window you can see six topographic maps simultaneously or each map separately. To select the topographic map, use the combo-box located on the toolbar in the top part of the window. Also, using the toolbar you can select the view of the topographic maps (2D or 3D), specify the visibility of the electrodes on the maps and the synchronous rotation for 3D maps (Fig. 6.8).

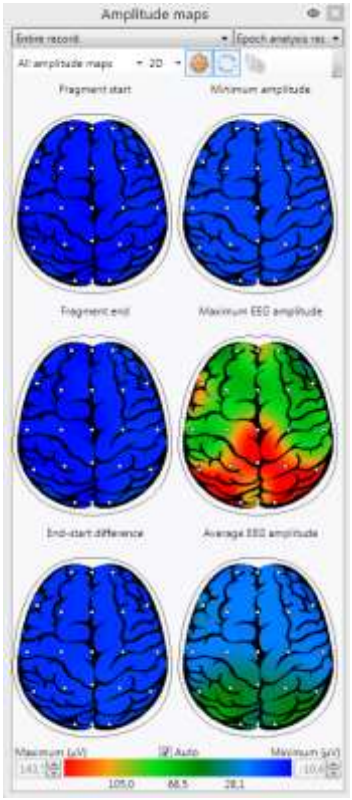


Fig. 6.7. Amplitude mapping.

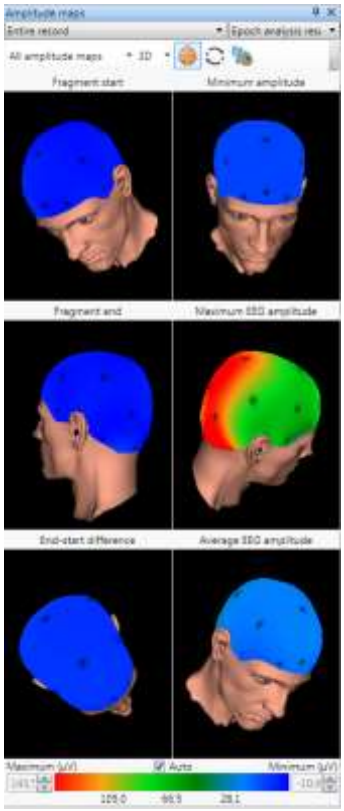


Fig. 6.8. 3-D amplitude mapping.

Note: The use of 3D mapping is possible only if Microsoft DirectX of 9.0c version is installed on the computer (see section 1.2 “Program Setup”).

The settings of the topographic maps (the palette, the resolution, etc.) are downloaded from the analysis style (see section 8.7.1 “Analysis Styles”) but you can change them using **Setup** context menu command (Fig. 6.9). Also using the context menu, you can copy the separate topographic map or all maps to the current exam report.

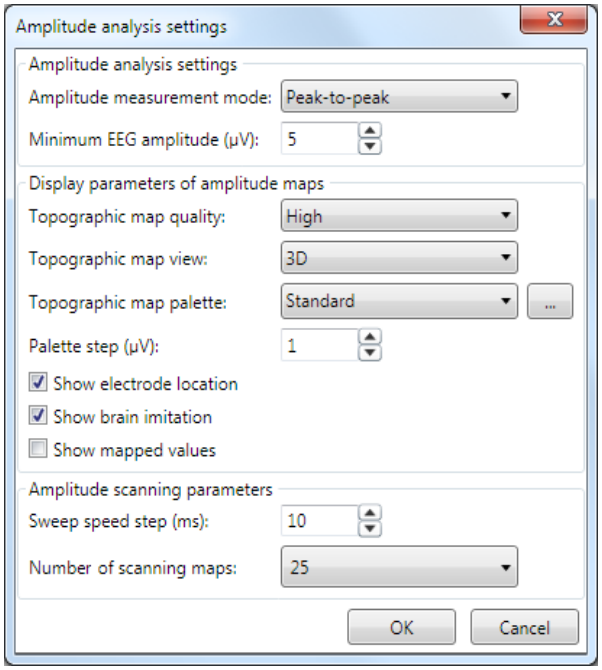


Fig. 6.9. The settings of the parameters of the amplitude analysis and the topographic mapping.

Using the settings of this window you can control the parameters of the amplitude analysis. Also, you can setup the parameters of the topographic mapping. You can change the quality of the topographic maps from the low one (to speed up the repainting) up to ideal one (for more detailed displaying), the map view (flat 2D or 3D), specify the color palette, the electrode visibility, the sweep step (see section 6.4.5 “Amplitude Scanning”) and the step of the palette change.

The color palette can consist of two or more colors. You can select one of the offered color palettes using the combo-box (Fig. 6.9) or you can create your own ones using the palette manager (Fig. 6.10).

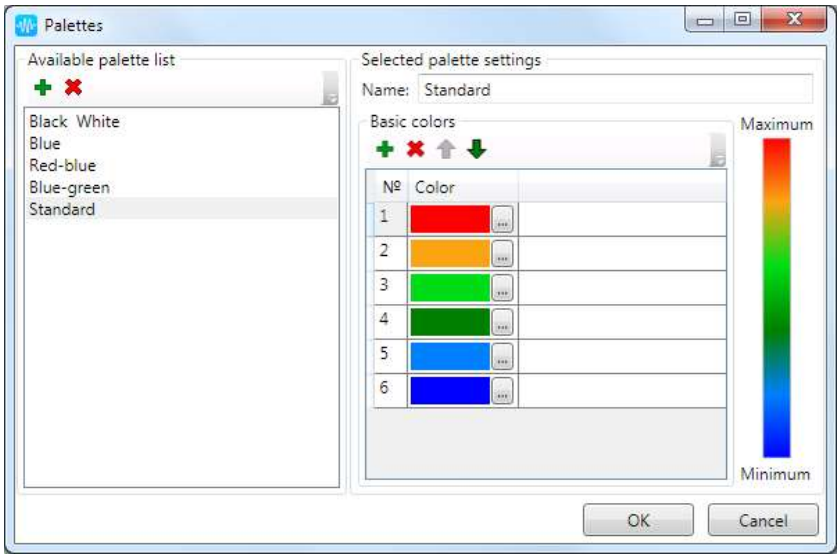


Fig. 6.10. The manager of the palette for the topographic maps.

Using this manager, you can change any palette in the list of the available ones, create the new ones and remove the existing ones.

In the bottom part of the topographic map window (Fig. 6.7), (Fig. 6.8) the current palette bar and the boundary values of the amplitude for the mapping are located. The “Auto” checkbox means that the boundary values of the mapping amplitude are calculated automatically based on the minimum and maximum values of EEG amplitude. If you wish, you can uncheck the “Auto” checkbox, and change the boundary values of the mapping amplitude. It will allow you to generate the topographic map in a definite amplitude range.

You can also open “Amplitude mapping” extra window as for other analysis windows using the corresponding button on the toolbar. The extra analysis window allows to compare the parameters of the different record fragments.

6.4.5. Amplitude Scanning

The “Amplitude scanning” analysis window (Fig. 6.11) is intended to display an instant amplitude with a definite step specified in the analysis style (see section 8.7.1 “Analysis Styles”), to show the dynamics of EEG amplitude change. You can change the scanning step in the amplitude analysis settings manager (Fig. 6.9) using the context menu. To show or hide the amplitude scanning window, use **Analysis|Amplitude analysis|Amplitude scanning** menu command or the corresponding button on the “Analysis” toolbar (see the Annex 1).

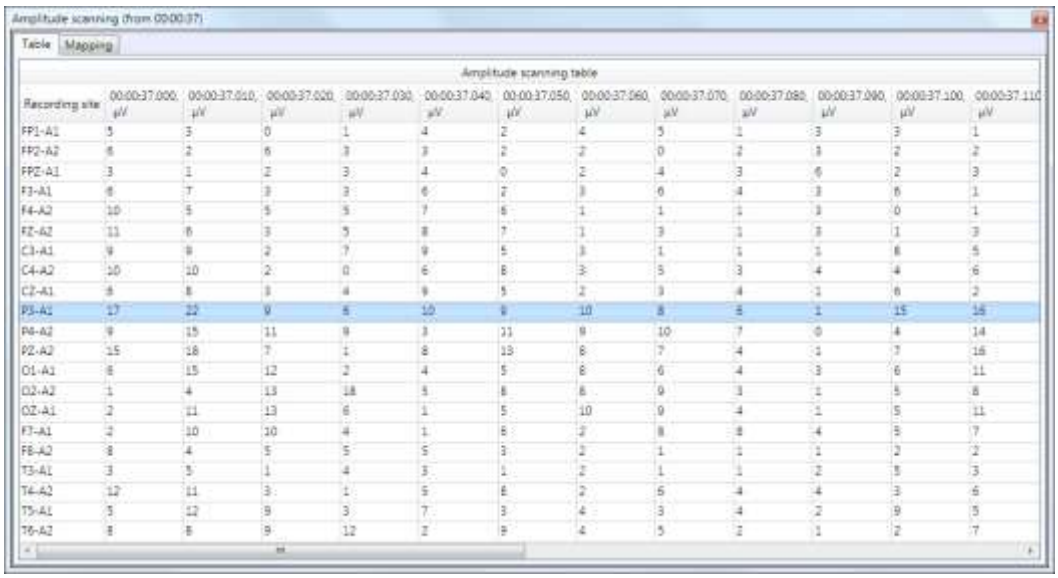


Fig. 6.11. Amplitude scanning.

The amplitude scanning window contains two tabs: “Table” and “Mapping”. The “Table” tab shows from 9 up to 36 values of the amplitudes by the derivations measured with the scanning step. The first column contains the amplitudes measured at the beginning of the current EEG page or the selected EEG fragment (see section 5.10 “Selection of EEG Fragments”). The “Mapping” tab (Fig. 6.12) represents from 9 up to 36 topographic maps corresponding to the table columns.

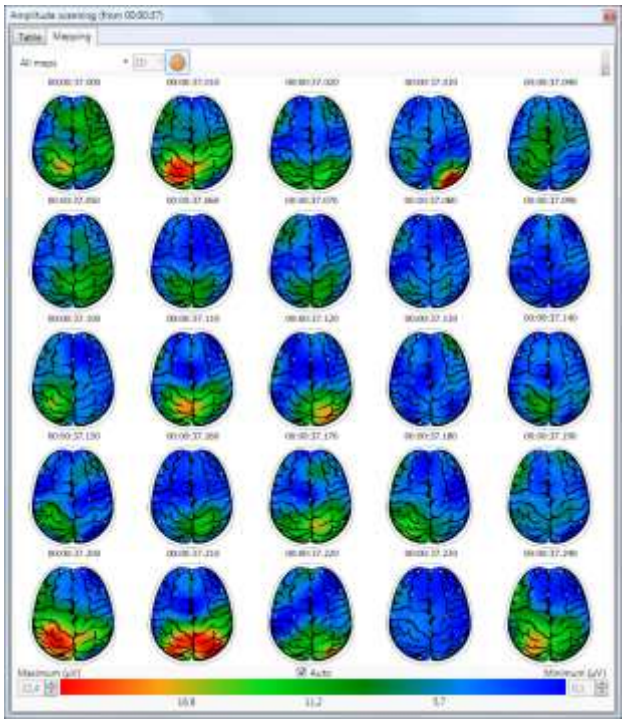


Fig. 6.12. The amplitude scanning mapping.

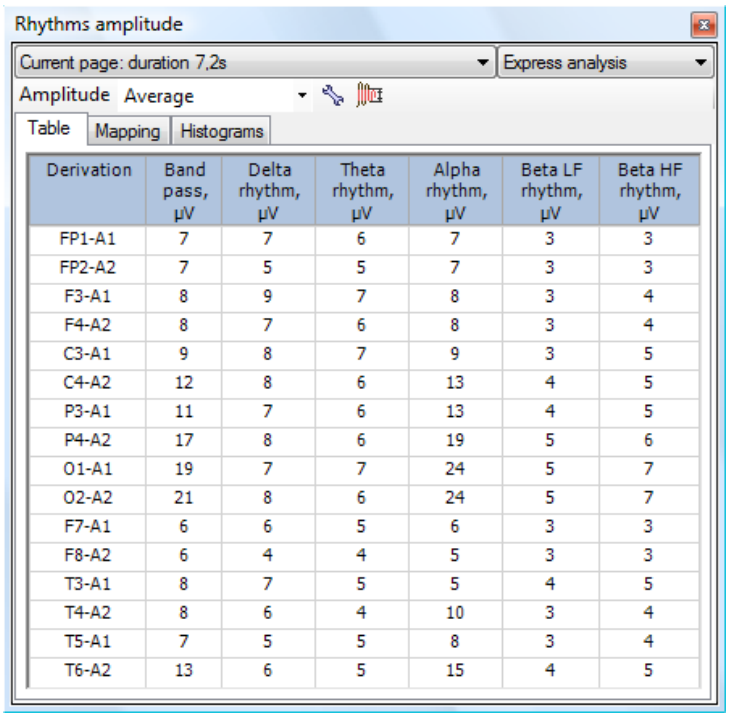
Using the context menu you can adjust the parameters of the amplitude analysis and the topographic mapping (Fig. 6.9). Also in the window with settings you can specify the scanning step and map quantity (9, 16, 25 or 36).

Using the toolbar you can choose any map for the detailed study. Also using the toolbar buttons, you can choose the topographic mapping view (2D or 3D) and specify the visibility of electrodes on the maps.

In the bottom part of the “Topographic mapping” tab the current palette bar and the boundary values of the amplitude for the mapping are located. The “Auto” checkbox means that the boundary values of the mapping amplitude are calculated automatically based on the minimum and maximum values of EEG amplitude. If you wish, you can uncheck the “Auto” checkbox, and change the boundary values of the mapping amplitude. It will allow you to display the topographic maps in a definite amplitude range.

6.4.6. Amplitude of Standard EEG Rhythms

To display EEG amplitude separately by rhythms, use “Rhythms amplitude” window (Fig. 6.13). To show or hide the “Rhythms amplitude” window, use **Analysis|Amplitude analysis|Rhythms amplitude** menu command or the corresponding button on the “Analysis” toolbar (see the Annex 1).



Derivation	Band pass, μV	Delta rhythm, μV	Theta rhythm, μV	Alpha rhythm, μV	Beta LF rhythm, μV	Beta HF rhythm, μV
FP1-A1	7	7	6	7	3	3
FP2-A2	7	5	5	7	3	3
F3-A1	8	9	7	8	3	4
F4-A2	8	7	6	8	3	4
C3-A1	9	8	7	9	3	5
C4-A2	12	8	6	13	4	5
P3-A1	11	7	6	13	4	5
P4-A2	17	8	6	19	5	6
O1-A1	19	7	7	24	5	7
O2-A2	21	8	6	24	5	7
F7-A1	6	6	5	6	3	3
F8-A2	6	4	4	5	3	3
T3-A1	8	7	5	5	4	5
T4-A2	8	6	4	10	3	4
T5-A1	7	5	5	8	3	4
T6-A2	13	6	5	15	4	5

Fig. 6.13. Table with EEG rhythm amplitudes.

The “Rhythms amplitude” window contains three tabs: “Table”, “Mapping” and “Histograms”. The columns of “Table” tab show the standard EEG rhythm amplitudes of the analyzed record fragment by the derivations. Using the toolbar, you can display the average, maximum and minimum amplitudes of the standard EEG rhythms or assymetry of standard EEG rhythms amplitude in percents in the table. If you use **Setup** context menu item and the corresponding toolbar button, you can change the parameters of the amplitude analysis (Fig. 6.9). Using the context menu, you can copy the analysis results to the current exam report. Also, you can display the analysis results as the topographic maps (Fig. 6.14) and the histograms (Fig. 6.15).

Using the toolbar of “Mapping” tab (Fig. 6.14), you can display simultaneously the amplitude maps of all standard EEG rhythms or the selected map separately for its detailed study. Also, you can choose the mapping view (2D or 3D), specify the visibility of the electrodes on the maps and the synchronous rotation for 3D maps using the toolbar buttons.

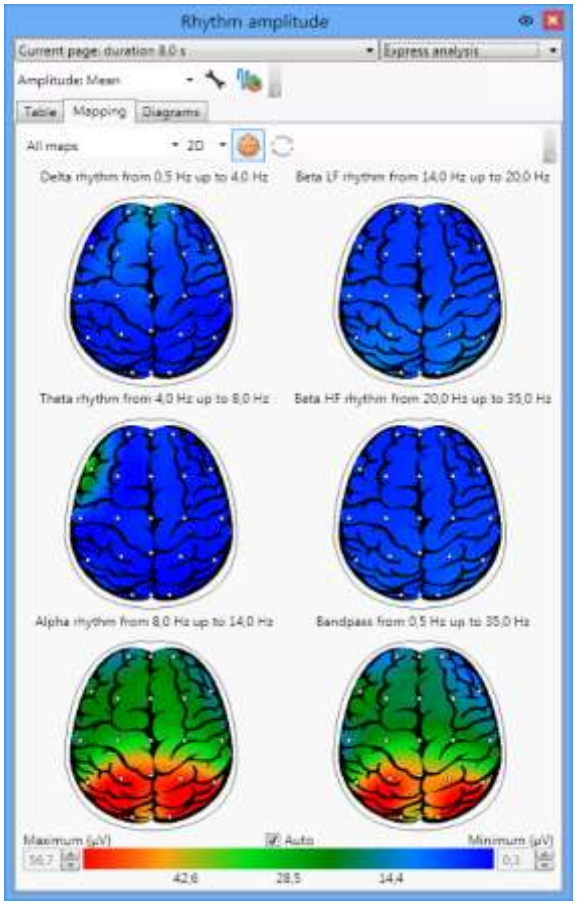


Fig. 6.14. The amplitude mapping of EEG rhythms.

In the bottom part of the “Mapping” tab, the current palette bar and the boundary values of the amplitude for the mapping are located. The “Auto” checkbox means that the boundary values of the mapping amplitude are calculated automatically based on the minimum and maximum values of EEG amplitude. If you wish, you can uncheck the “Auto” checkbox, and change the boundary values of the mapping amplitude. It will allow you to display the topographic map in a definite amplitude range.

On the “Histograms” tab (Fig. 6.15) you can see the histograms for EEG derivations consisting of five columns of standard EEG rhythms. The column height corresponds to the amplitude of the rhythm. All the histograms are made in one scale. The name of the derivation for which the histogram was generated is displayed in the left top corner. The color of histogram columns is defined by the corresponding rhythm color in the current color scheme (see section 8.4 “Color Scheme”).

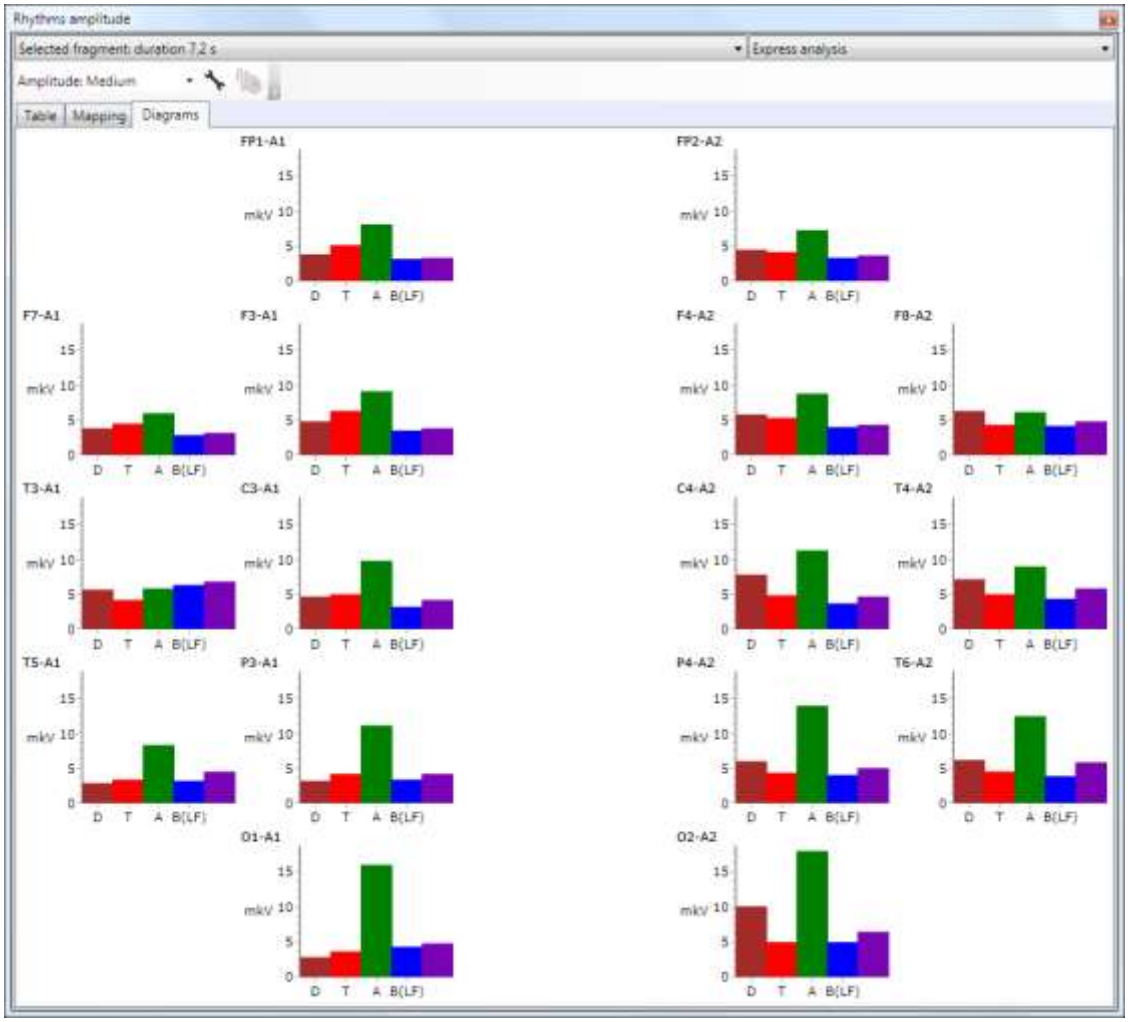


Fig. 6.15. The amplitude of standard EEG rhythms. The histograms.

You can also open “Amplitude mapping” extra window as for other analysis windows using the corresponding button on the toolbar. The extra analysis window allows to compare the parameters of the different record fragments. For example, to compare the average EEG amplitudes during “Background record” and “Open eyes”, it is required to display two windows “Rhythms amplitude” on the screen, specify the analysis type “Epochs analysis” for them and select “Background record” in the first window and “Open eyes” in the second one (Fig. 6.16) for the analysis.

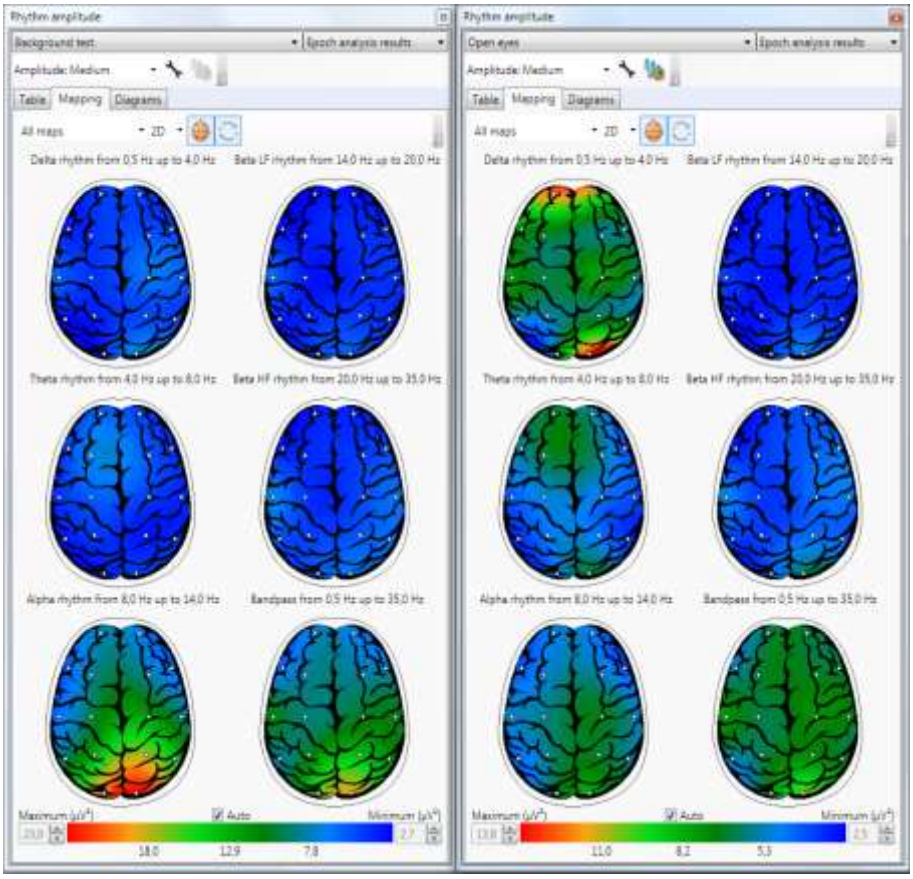


Fig. 6.16. The comparison of the amplitudes of standard EEG rhythms in two functional tests.

6.4.7. Spectrum Graphs

The spectral EEG analysis performed with the use of the fast Fourier transform (FFT) allows to transfer the recorded signal from the time domain to the frequency one. The use of the frequency notation of the signal is the integral part of the modern mathematical EEG analysis. To perform the fast Fourier transform in the continuous recorded signal, the stationary fragments of the record called “analysis epochs” should be selected. In **Neuron-Spectrum.NET** the analysis epoch can be of the arbitrary length. In the acquisition style you can set the analysis epoch length calculated in seconds by default. For the fast Fourier transform it is required to have the analysis epoch with length equal to 2 in N power of counts. To rid a user of the necessity to calculate the number of counts at the specified sampling rate, **Neuron-Spectrum.NET** provides the algorithm of automatic calculation of epoch length for the fast Fourier transform depending on the specified length of analysis epoch in the acquisition style. For example, the analysis epoch length will be 2500 counts at 500 Hz sampling rate and for this length of analysis epoch equal to 5 sec-

onds. At that, the epoch length for the fast Fourier transform will be 2048 counts (two in eleventh power). Thus, 2 epochs by 2048 counts with the overlapping will be analyzed for the spectral analysis of all epoch with 2500 counts duration (Fig. 6.17). The analysis results of two epochs will be averaged.

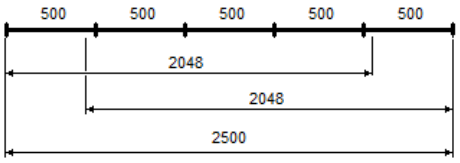


Fig. 6.17. The scheme to calculate epoch length for fast Fourier transform.

The “Spectrum graphs” analysis window (Fig. 6.18) is intended to display the graphs of spectrum amplitude and spectrum power by the derivations. To show or hide the “Spectrum graphs” window, use **Analysis|Spectral analysis|Spectrum graphs** menu command or the corresponding button on the “Analysis” toolbar (see the Annex 1).

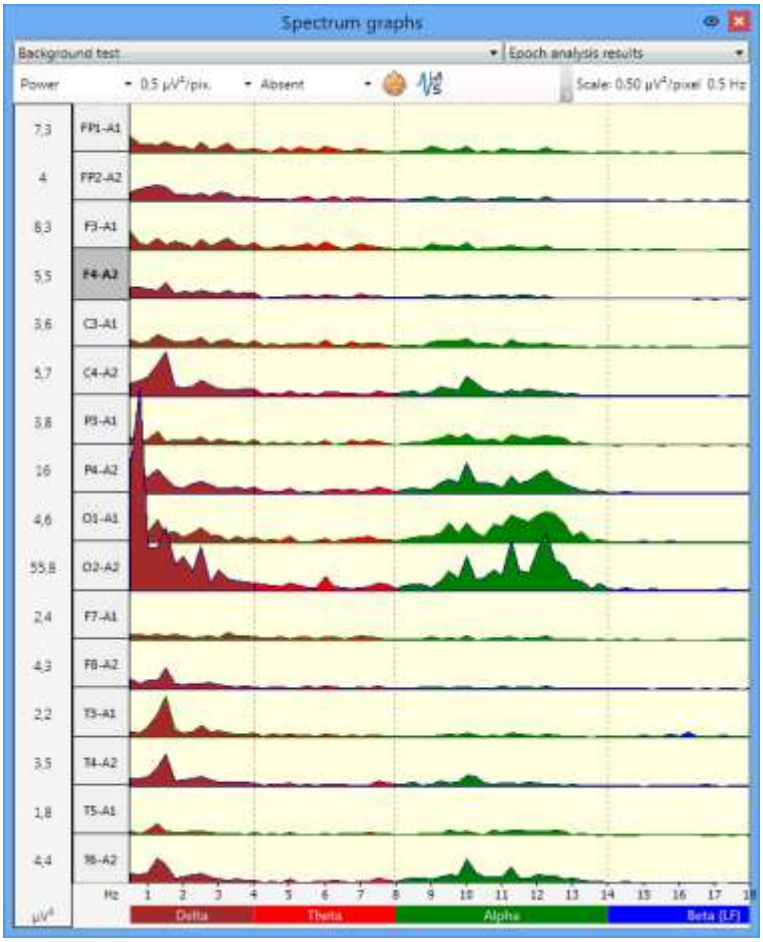


Fig. 6.18. The “Spectrum graphs” window.

The spectrum graphs in all visible EEG derivations are shown in this window. The signal frequency is on the abscissa axis, the amplitude or the spectrum power (depending on the settings) is on ordinate axis. You can change the analysis parameter, the graph scale and window function using the toolbar. Also, using the toolbar buttons you can arrange the spectrum graphs by 10-20 system (Fig. 6.19) and open “Spectrum graphs” extra window. The use of “Spectrum graphs” extra window allows to compare the frequency spectrum of the different record fragments.

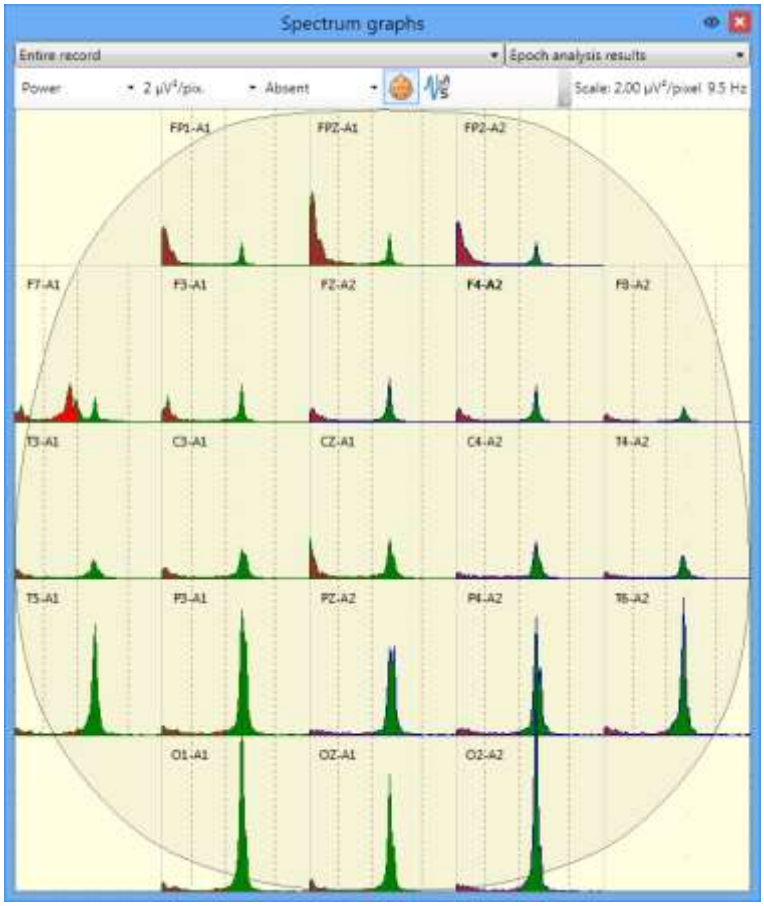


Fig. 6.19. Spectrum graphs arranged by 10-20 system.

For example, to compare the frequency of EEG spectrum during “Background record” and “Open eyes”, it is required to display two “Spectrum graphs” windows on the screen, specify the analysis type “Epochs analysis” for each of them and select “Background record” in the first window and “Open eyes” in the second one (Fig. 6.20).

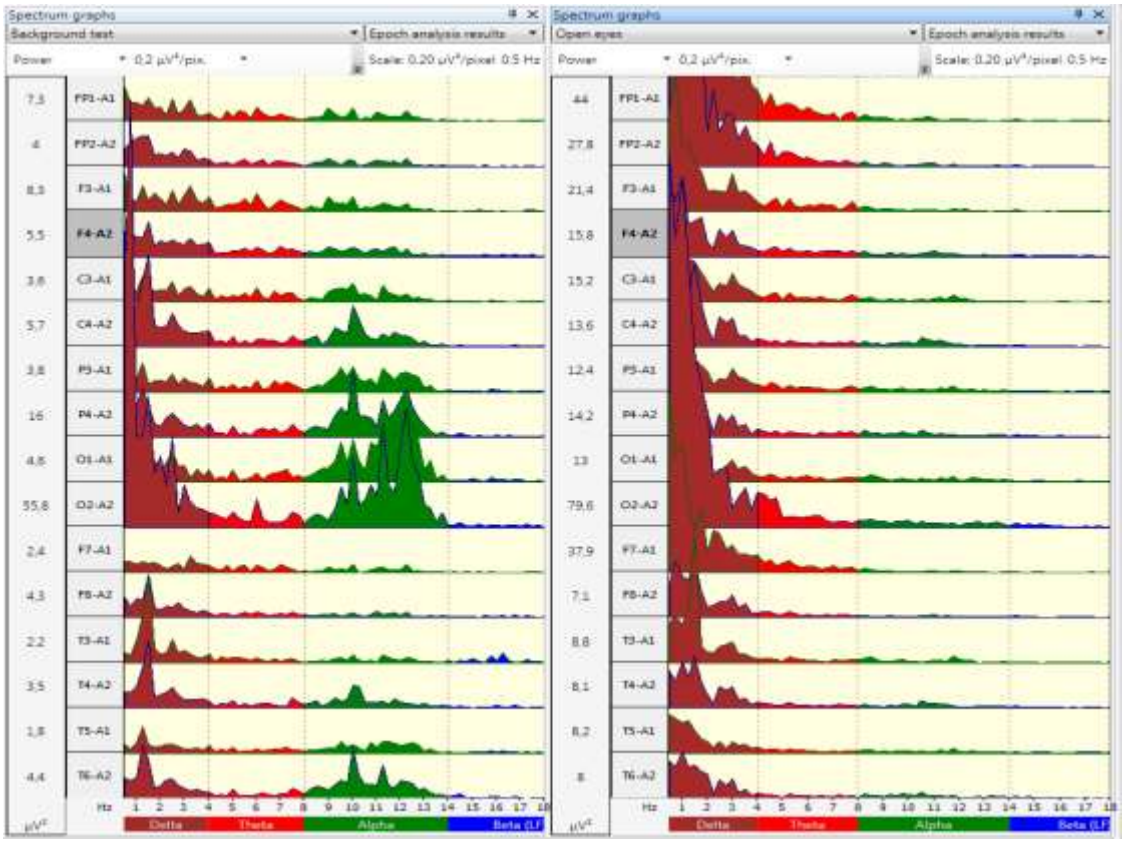


Fig. 6.20. The comparison of spectrum graphs of two functional tests.

Using **[+]** and **[-]** keys of your computer keyboard you can change the scale of spectrum graphs.

To activate the settings of the spectral analysis parameters you can use “Frequency spectrum settings” item of the context menu (Fig. 6.21). Also using the context menu, you can copy the spectrum graphs to the current position of the active report of an exam.

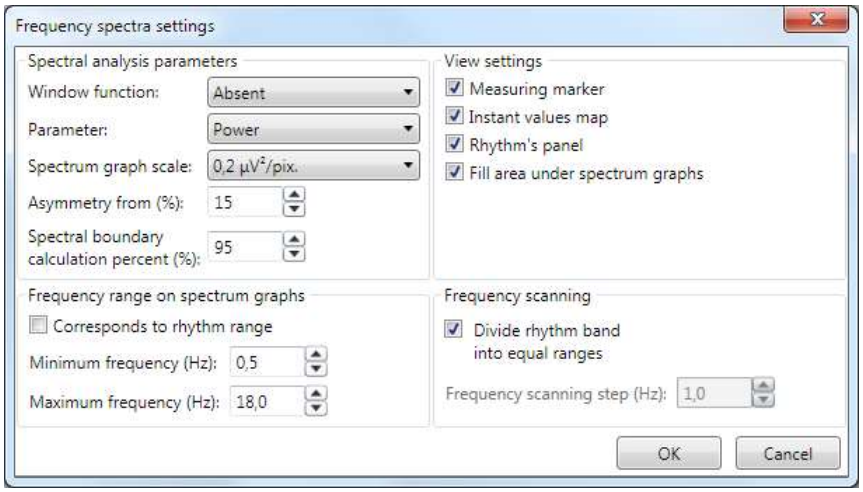


Fig. 6.21. The frequency spectrum settings.

In the settings window you can set the window function (it is required to smooth the edge effects at the spectral analysis), analysis parameter (the amplitude or the power), the scale of the spectrum graphs, the threshold percent of the asymmetry by hemispheres and the percent to calculate the spectral boundary. In the parameters of the spectrum graph displaying you can set the visibility of the measuring marker (to define the amplitudes of the graphs at the selected frequency), the visibility of the instant value map, the visibility of the rhythm panel of the waves (under abscissa axis), indicate to fill the area under the spectrum graphs or not. The color of filling corresponds to the rhythm color from the current color scheme (see section 8.4 “Color Scheme”). Also, you can set the frequency range to display the spectrum graphs. If you use the frequency range which differs from standard EEG rhythm ranges, you can change it using **[*]** and **[/]** keys of the computer keyboard.

The values of the graphs amplitudes on the specified frequency for each derivation are displayed in the “Spectrum graphs” window at the visible measuring marker. Besides, the visualization of the topographic map of the graphs values on the specified frequency is possible at the measuring marker shift (Fig. 6.22).

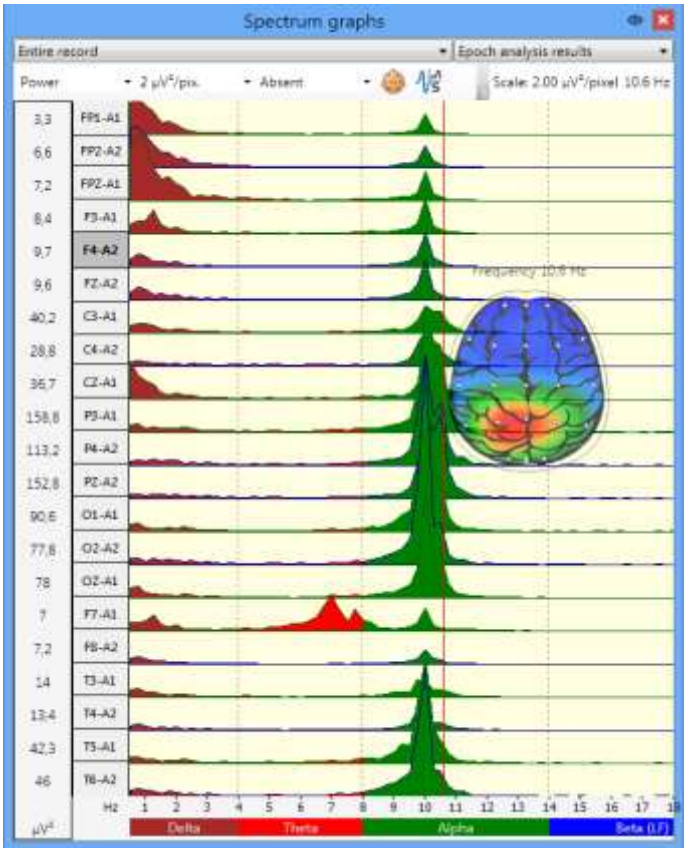


Fig. 6.22. The visualization of the values of the spectrum graphs on the specified frequency.

The topographic map of the graph values on this frequency is semitransparent. It appears automatically at the left mouse button pressing, moves together with the measuring marker. This window with spectrum graphs and topographic map can also be used to determine the individual alpha frequency that is important, for example, when making decision to treat depression using transcranial magnetic stimulation (TMS). Not only treatment TMS protocol for depression, but the possibility of such treatment depends on the individual alpha frequency.Using the context menu, which is available at the right mouse button clicking, you can copy the map of the instant values to the current position of the active report.

The “Spectrum graphs” window provides the function of the detailed representation of separate spectrum graphs and their comparison. For the detailed representation of one graph, choose it by clicking the derivation name with the left mouse button and use the “Detailed view of spectrum graphs” command of the context menu. To display two or more spectrum graphs and compare them, choose several graphs. To do this, press **[Ctrl]** key on the keyboard and without releasing it, click the derivation names of the required graphs with the left mouse button. Then, use the “Detailed view of spectrum graphs” command of the context menu (Fig. 6.23).

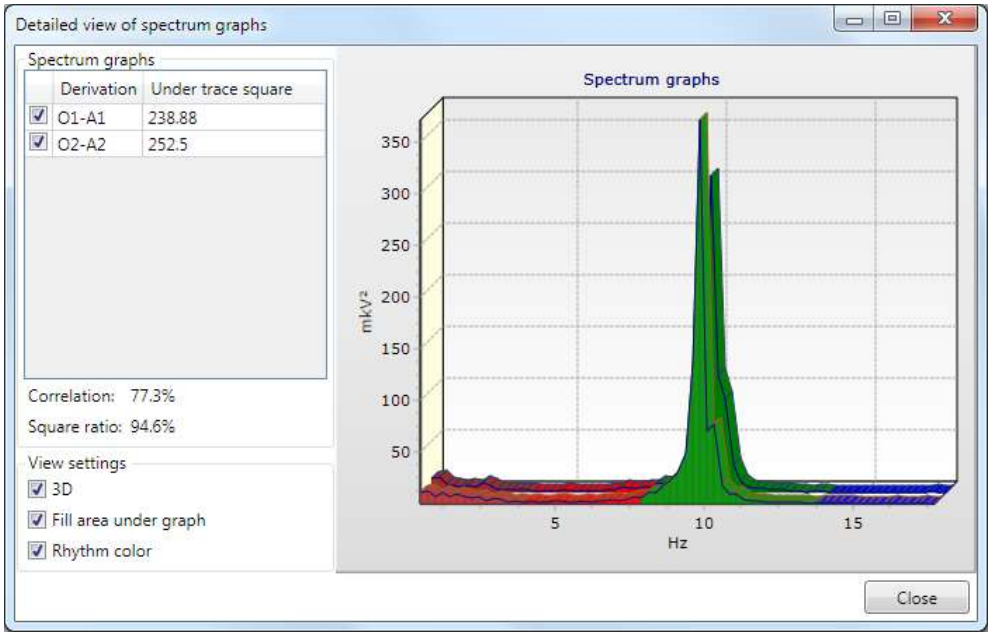
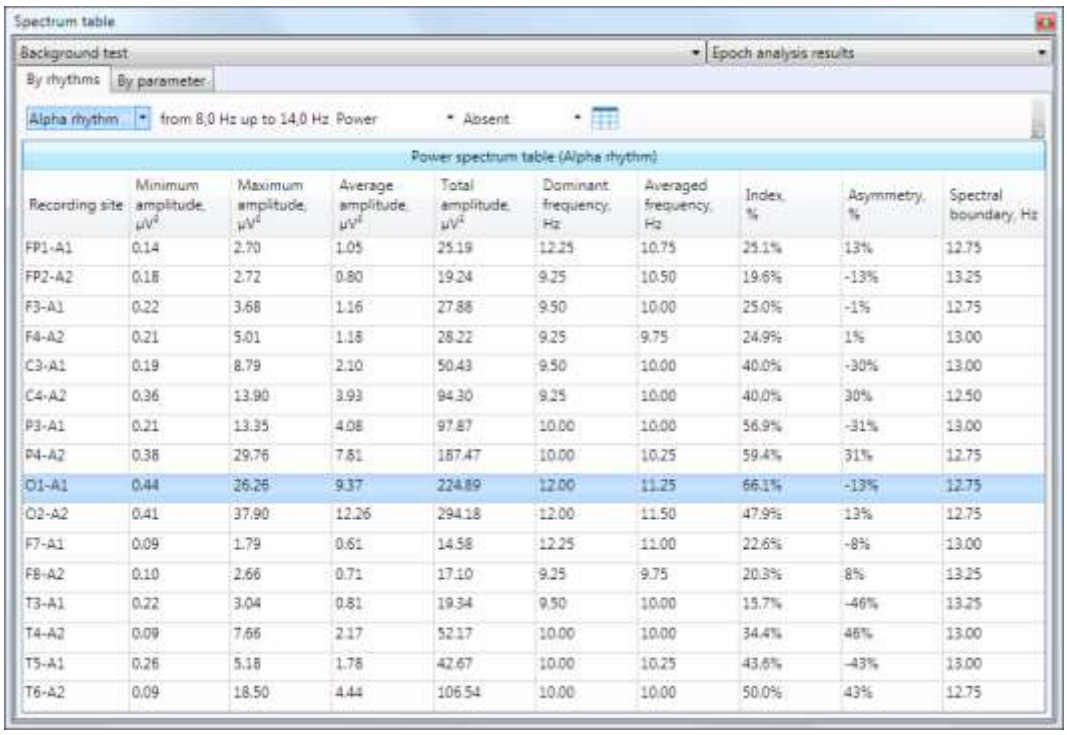


Fig. 6.23. The detailed view and comparison of spectrum graphs.

For each graph in the detailed view window you can set the visibility and the parameters of the representation (2D, 3D, colors, filling). The area under the graph is calculated for the graphs. When two graphs are compared, the percent of their mutual correlation and area ratio are calculated.

6.4.8. Frequency Characteristics

For the table representation of the frequency characteristics of a signal use “Spectrum table” analysis window (Fig. 6.24).To show or hide the “Spectrum table” window, use **Analysis|Spectral analysis|Spectrum table** menu command or the corresponding button on the “Analysis” toolbar (see the Annex 1).



Power spectrum table (Alpha rhythm)

Recording site	Minimum amplitude, μV²	Maximum amplitude, μV²	Average amplitude, μV²	Total amplitude, μV²	Dominant frequency, Hz	Averaged frequency, Hz	Index, %	Asymmetry, %	Spectral boundary, Hz
FP1-A1	0.14	2.70	1.05	25.19	12.25	10.75	25.1%	13%	12.75
FP2-A2	0.18	2.72	0.80	19.24	9.25	10.50	19.6%	-13%	13.25
F3-A1	0.22	3.68	1.16	27.88	9.50	10.00	25.0%	-1%	12.75
F4-A2	0.21	5.01	1.18	28.22	9.25	9.75	24.9%	1%	13.00
C3-A1	0.19	8.79	2.10	50.43	9.50	10.00	40.0%	-30%	13.00
C4-A2	0.36	13.90	3.93	94.30	9.25	10.00	40.0%	30%	12.50
P3-A1	0.21	13.35	4.08	97.87	10.00	10.00	56.9%	-31%	13.00
P4-A2	0.38	29.76	7.81	187.47	10.00	10.25	59.4%	31%	12.75
O1-A1	0.44	26.26	9.37	224.89	12.00	11.25	66.1%	-13%	12.75
O2-A2	0.41	37.90	12.26	294.18	12.00	11.50	47.9%	13%	12.75
F7-A1	0.09	1.79	0.61	14.58	12.25	11.00	22.6%	-8%	13.00
F8-A2	0.10	2.66	0.71	17.10	9.25	9.75	20.3%	8%	13.25
T3-A1	0.22	3.04	0.81	19.34	9.50	10.00	15.7%	-46%	13.25
T4-A2	0.09	7.66	2.17	52.17	10.00	10.00	34.4%	46%	13.00
T5-A1	0.26	5.18	1.78	42.67	10.00	10.25	43.6%	-43%	13.00
T6-A2	0.09	18.50	4.44	106.54	10.00	10.00	50.0%	43%	12.75

Fig. 6.24. Frequency characteristics.

This window contains two tabs. On “By rhythms” tab you can review the parameters of each rhythm separately or the total range of the frequencies. Using the toolbar you can specify the frequency range for the analysis (separately by rhythms or the total frequency range), analysis parameter (amplitude or power) and the window function (to smooth the edge effects). Using the context menu you can setup the visibility of the separate columns of the table and copy the table in the current report or export it to MS Excel. All values of this table are calculated using the related spectrum graph. Thus, the table shows the minimum, maximum and average amplitudes of spectrum within the specified range. The total amplitude is shown as an area under the spectrum graph. The dominant frequency shows the frequency where the maximum spectrum amplitude is obtained. The average frequency is the one dividing the spectrum graph to two equal area halves displayed under the spectrum graph. The rhythm index shows the percent ratio of area displayed under the spectrum graph within the specified range to the total spectrum power within the whole bandwidth. The asymmetry indicates the difference between the derivations of left and right hemispheres in percents. The spectral boundary shows the spectrum frequency. Leftward this value 95% of spectrum power by the area under the graph is observed. The percent to calculate the spectral boundary is spectified in the spectral analysis settings (Fig. 8.45). Dispersion shows the ratio of maximum rhythm power to the total rhythm power in percent and characterizes the intensity of dominant rhythm frequency. For alpha rhythm, there are the works showing the dependence of functional state of the brain on the level of its dispersion. It is known, for example, the norms of alpha rhythm dispersion are given for healthy people and for people with organic brain lesions of various severity.

On “By parameter” tab (Fig. 6.25) you can compare the values of this parameter by all standard EEG rhythms. Using the toolbar you can select the analysis parameter. Using the context menu you can setup the visibility of the separate columns of the table and copy the table in the current report of an exam or export it to MS Excel.

Derivatione	Band pass	Delta rhythm	Theta rhythm	Alpha rhythm	Alpha rhythm normal 45% - 100%	Beta LF rhythm	Beta HF rhythm	Alpha/ Theta
EEG FP1-A1 [FP1]	100	64.6	5.8	26.5	26	1.8	1.3	4.57
EEG FPZ-A1 [FPZ]	100	70.4	5.1	22.3	22	1.2	0.9	4.37
EEG FP2-A2 [FP2]	100	67.1	5.6	24.8	25	1.2	1.2	4.43
EEG F7-A1 [F7]	100	18.1	50.3	28.8	29	1.6	1.2	0.57
EEG F3-A1 [F3]	100	41.6	6.7	47.4	47	2.5	1.6	7.07
EEG FZ-A2 [FZ]	100	33.4	6.2	55.6	56	2.7	2.1	8.97
EEG F4-A2 [F4]	100	35.6	5.9	53.7	54	2.5	2.2	9.1
EEG F8-A2 [F8]	100	33.2	7.1	52.6	53	3.5	3.6	7.41
EEG T3-A1 [T3]	100	25.9	7.1	57.4	57	5.7	3.7	8.08
EEG C3-A1 [C3]	100	34.2	6.2	53.8	54	3.6	2.1	8.68
EEG CZ-A1 [CZ]	100	51.8	5.5	39.1	39	2.2	1.4	7.11
EEG C4-A2 [C4]	100	16.2	7.3	70.6	71	3.5	2.3	9.67
EEG T4-A2 [T4]	100	19	6.1	67.9	68	4.1	2.8	11.13
EEG T5-A1 [T5]	100	9.4	6.1	78.4	78	3.8	2.2	12.85
EEG P3-A1 [P3]	100	8.2	4.9	81.7	82	3.4	1.8	16.67
EEG PZ-A2 [PZ]	100	6.3	4.4	84.4	84	3.2	1.7	19.18
EEG P4-A2 [P4]	100	7	4.1	84.5	84	2.9	1.5	20.61
EEG T6-A2 [T6]	100	8.9	4.6	81.2	81	3.7	1.5	17.65

Fig. 6.25. The frequency characteristics by parameter.

You can open “Spectrum table” extra window, as for other analysis windows, using the corresponding button on the toolbar. The extra analysis window allows to compare the parameters of the different record fragments.

6.4.9. Spectrum Mapping

To display the frequency characteristics of the signal as maps, use “Spectrum mapping” window (Fig. 6.26). To show or hide this window, use **Analysis|Spectral analysis|Power spectrum maps** menu command or the corresponding button on the “Analysis” toolbar (see the Annex 1).

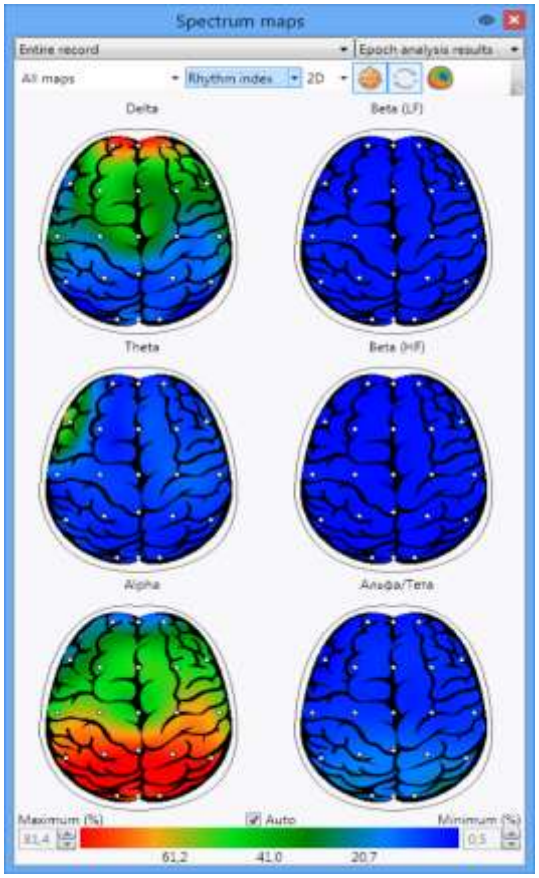


Fig. 6.26. The spectrum power mapping.

Using the toolbar, you can select the maps, which are visible on the screen (all together or separately), the mapping value (total, average or maximum amplitude or spectrum power, index of standard EEG rhythms or hemispheric assymetry), the maps view (2D or 3D), the visibility of the electrodes on maps and synchronous rotation for 3D maps. Using the context menu, you can copy any map to the current report of an exam and adjust the mapping parameters (Fig. 6.27).

In the bottom part of the window the current palette bar and the boundary values of the mapping amplitude are located. The “Auto” checkbox means that the boundary values of the mapping amplitude are calculated automatically based on the minimum and maximum values of EEG amplitude. If you wish, you can uncheck the “Auto” checkbox, and change the boundary values of the mapping amplitude. It will allow you to display the topographic maps in a definite amplitude range.

You can open “Spectrum mapping” extra window, as for other analysis windows, using the corresponding button on the toolbar. The extra analysis window allows to compare the parameters of the different record fragments.

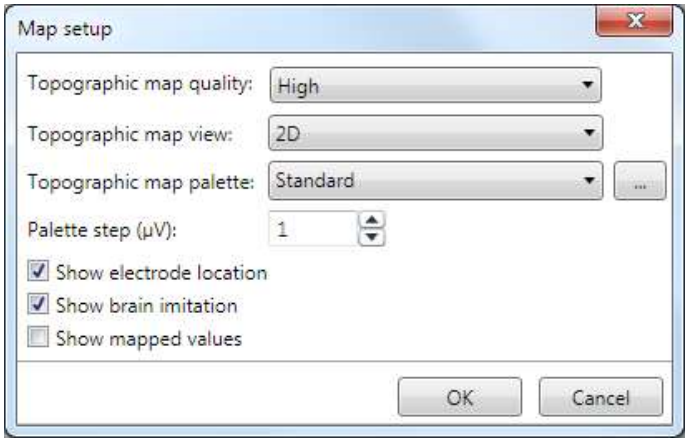


Fig. 6.27. The setup of the mapping parameters.

In the settings window you can set the quality of the topographic maps (from the low one to speed up the repainting up to ideal one for more detailed displaying), their view (2D or 3D), select the color palette or create a new one for the mapping (Fig. 6.10), the electrodes and its positions visibility on maps and step of the palette change.

6.4.10. Mapping of Functional Tests

The “Functional tests mapping” window (Fig. 6.28) is intended to display simultaneously the topographic maps for all functional tests performed during an exam. To show or hide this window, use **Analysis|Comparative analysis|Functional tests mapping** menu command or the corresponding button on the “Analysis” toolbar (see the Annex 1). The analysis epochs should be selected first in the performed exam. The epochs of each functional test are analyzed.

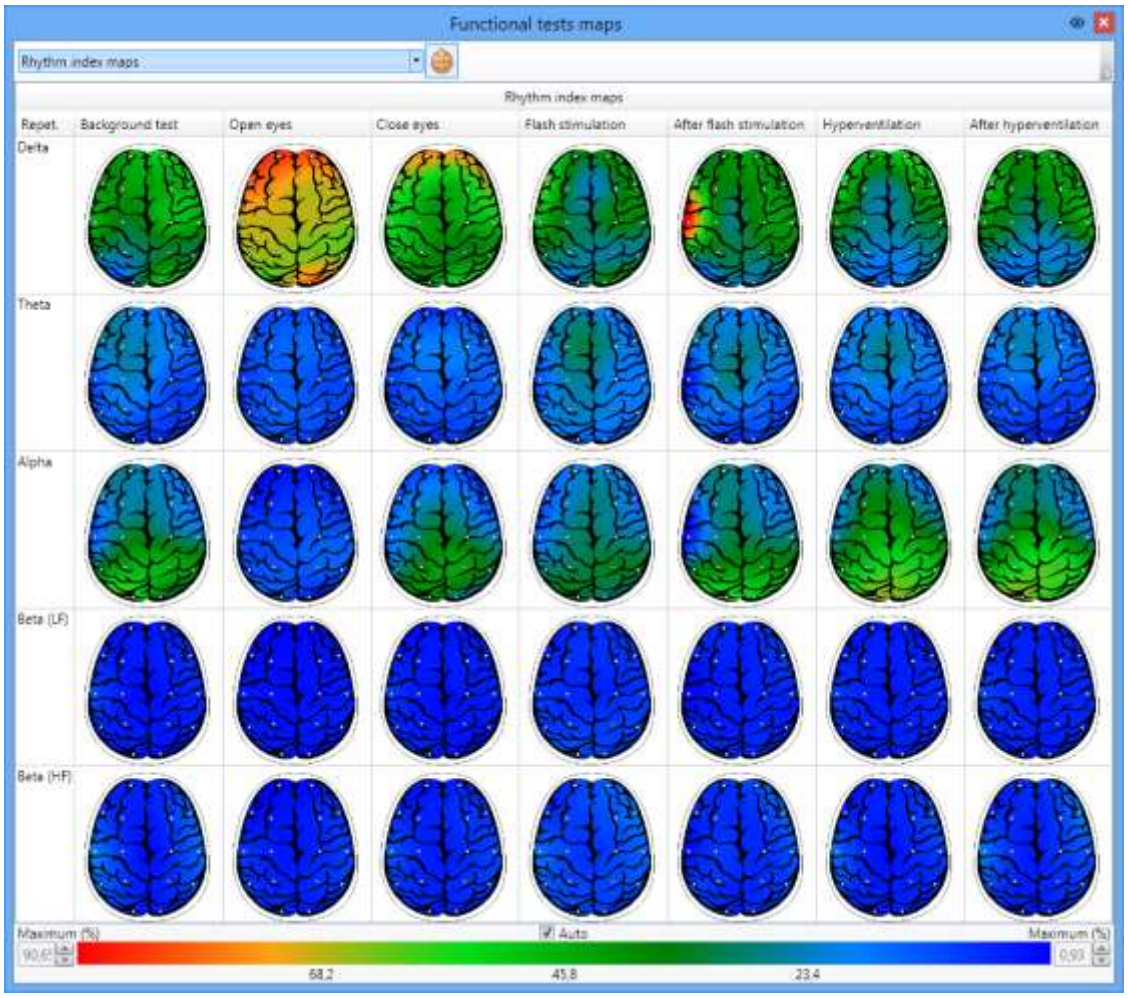


Fig. 6.28. The maps of functional tests.

Using the toolbar in the top part of the window you can select the view of the displayed topographic maps and the visibility of the electrode arrangement on the map. The following types of the mapping can be visualized in this window for the comparison:

- the average EEG amplitude mapping;
- the maximum EEG amplitude mapping;
- the mapping of average spectrum power (or spectrum amplitude);
- the mapping of maximum spectrum power (or spectrum amplitude);
- the mapping of indices of standard EEG rhythms;
- the mapping of the average coherence spectra;
- the mapping of the maximum coherence spectra.

In the bottom part of the window the current palette bar and the boundary values for the mapping scale are located. The “Auto” checkbox means that the boundary values of the mapping scale are calculated automatically based on the minimum and maximum values of the mapping function. If you wish, you can uncheck the “Auto” checkbox, and change the boundary values of the mapping scale. It will allow you to display the topographic map in a definite amplitude range.

Using the context menu (Fig. 6.29) you can set up the mapping parameters, copy the visible maps to the current exam report and also control the visibility of the separate rows and columns of the table. For example, you can exclude some functional tests from the analysis and select only the required standard EEG rhythms.

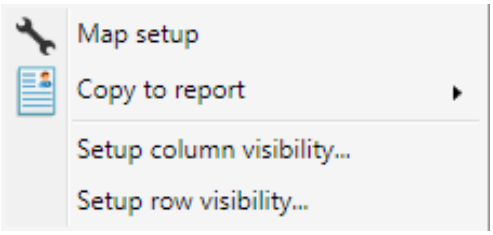


Fig. 6.29. The context menu of “Functional tests mapping” window.

6.4.11. Trends

The “EEG and PSG trends” window (Fig. 6.30) is intended to display the different trends of the record. To show or hide this window, use **Analysis|Trends** menu command or the corresponding button on the “Analysis” toolbar (see the Annex 1).

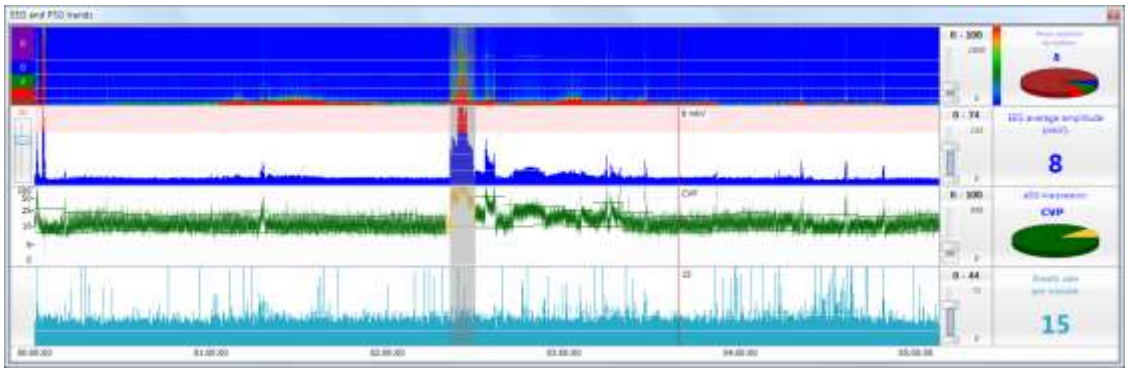


Fig. 6.30. The frequency spectrum trend.

By default the toolbar of this window can be hidden to save the space for trend visualization. To show the toolbar, choose the corresponding context menu item with right mouse button. With the toolbar you can calculate the trends, shift over them, adjust the sweep speed, set the time scale, control the event marker visibility and information panel, select the visible trends: the trend of the frequency spectrum (Fig. 6.30), the trend of standard EEG rhythm indices (Fig. 6.33), the trend of the average or maximum EEG amplitude (Fig. 6.34), etc.

The record artifacts are marked with grey color on trends, the current position on EEG is indicated by red vertical line. The time scale is located in the bottom part of the window. The sweep speed control allows you to fit the trend to the current width of “EEG and PSG trend” window or specify the required sweep speed. For each visible trend you can set the derivations to calculate it. It can be done in “EEG and PSG trend” window (Fig. 6.31). If all visible derivations are selected to calculate the trend, then all visible derivations will be analyzed. To exclude one or several EEG derivations from the calculation, hide them (see section 5.3 “EEG Review”). In “EEG and PSG trend” window you can add EEG and PSG trends, change their visibility and order, indicate

the derivations to calculate the trend and the necessity to fill the area under the trends.

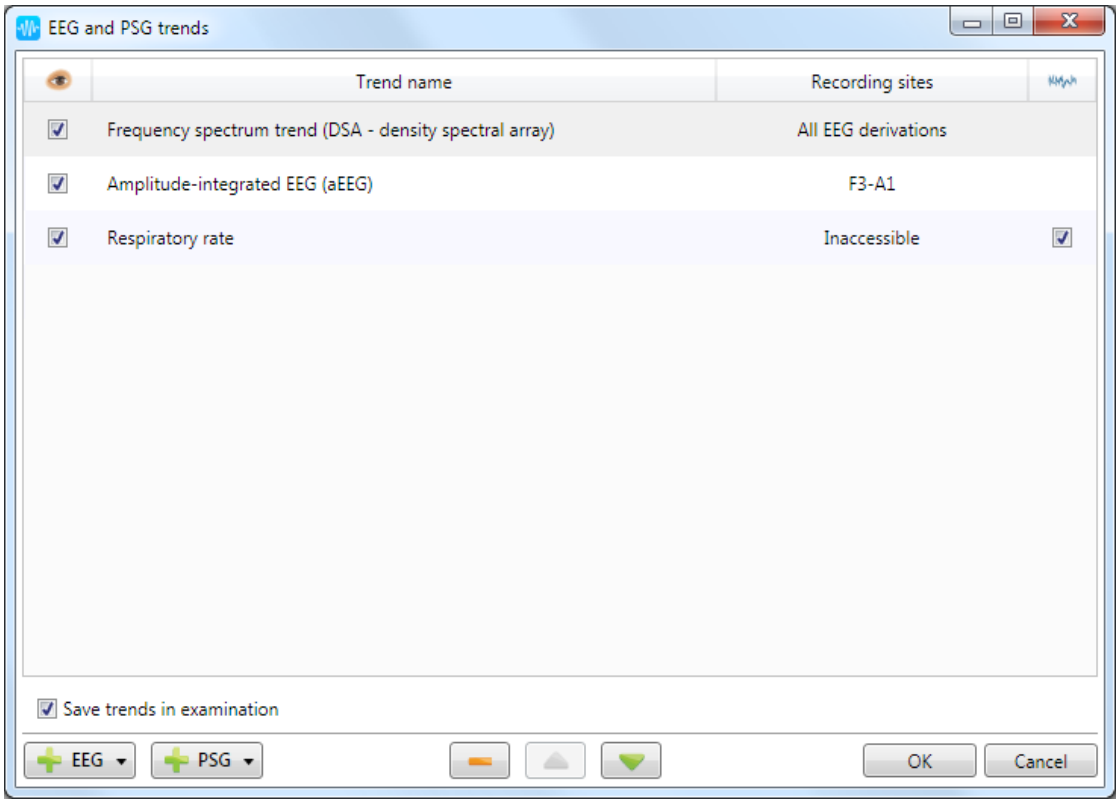


Fig. 6.31. The selection of derivations to calculate the trend.

As soon as you customized the visibility of trends and derivations for calculation, press “OK” button. In “EEG and PSG trends” window you can see the selected trends. If the long-term record is analyzed, the trend calculation may take a lot of time. As far as trend calculation is displayed separately, you can continue the operation with the program even during the calculation (Fig. 6.32).

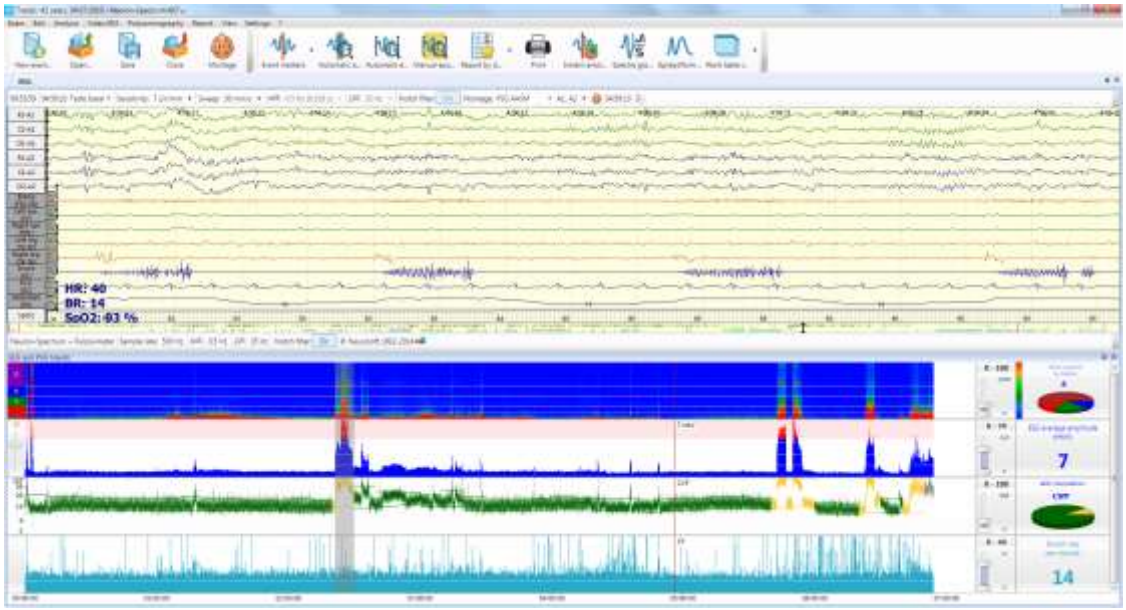


Fig. 6.32. Review of several trends.

The different controls can be integrated for different trends. For example, the panel of standard EEG rhythms is located in the left part of the screen to show the frequency spectrum trend, the right panel contains the palette of the trend colors with boundary values. The boundary values of the spectrum amplitude for the palette are calculated automatically but you can change them. At that, the view of the trend will also change. If you point the mouse cursor over the trend, you can see the pop-up semitransparent window with current trend parameters.

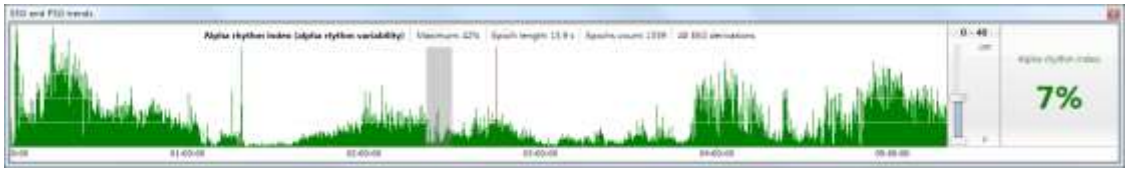


Fig. 6.33. The trend of alpha rhythm index.

When rhythm index trend is calculated (Fig. 6.33), the current calculated rhythm index is displayed in the top part of the current position bar. The boundary values of the trend are shown in the right part of the window (from 0 to 100%). When you change them, the trend height also changes. The maximal value of the rhythm index, length of analysis epoch to calculate the trend, number of epochs and derivations to calculate the trend are shown in pop-up window in the top part of the window.

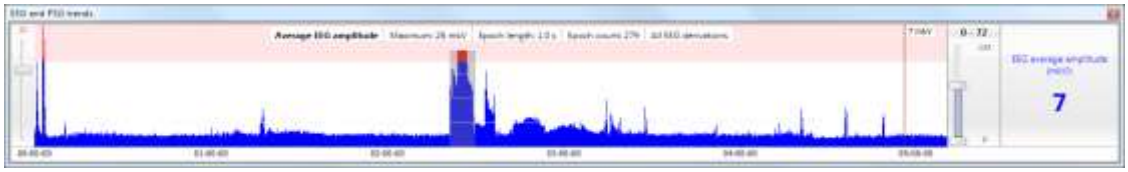


Fig. 6.34. The trend of average EEG amplitude.

At the calculation of EEG amplitude trends (Fig. 6.34), the current EEG amplitude is shown in the top part of the current position bar. The boundary values for the trend are given in the right part of the window. The boundary values are calculated automatically but you can change them. In the top part of the window (in the pop-up window) the maximum amplitude, the length of the analysis epoch at the trend calculation, the number of epochs and derivations to calculate the trend and the epoch number are displayed.

Using the context menu, you can copy any trend or all visible trends to the current exam report. The parameters of calculation and displaying of some trends can be changed using the context menu.

The number and the arrangement of the trend windows and also the derivations selected for the calculation are saved in the work table (see section 5.15 “Work Tables”) and restored at the next exam opening.

If the trend windows are opened during the exam recording, the analysis results are updated in them automatically in the time intervals which are proportional to the record duration. At that the last obtained values will be displayed at information panels of trends (Fig. 6.35).

The information panel with the current trend value (Fig. 6.35) is displayed in the right part of the trends. For example, the diagram of the wave rhythm power ratio is plotted for the frequency trend. The information panel can be used either during the acquisition and both during the exam review.

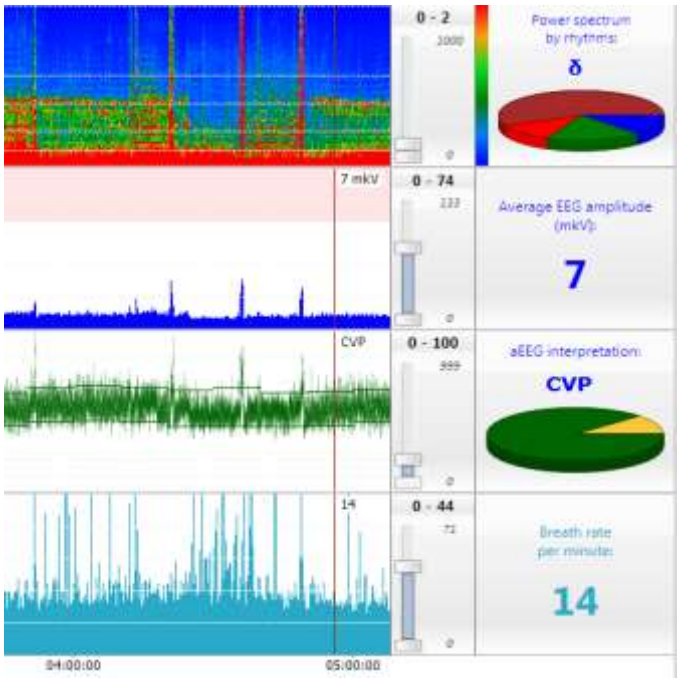


Fig. 6.35. The example of information panel of EEG trend.

The following types of trends are available for review and analysis:

- EEG trends:
  - DSA – density spectral array is meant for the visual representation of EEG frequency structure in time.
  - Delta rhythm index shows the variation of delta rhythm index in time.
  - Theta rhythm index shows the variation of theta rhythm index in time.
  - Alpha rhythm index (α-rhythm variability) shows the variation of alpha rhythm index in time.
  - Beta rhythm index shows the variation of beta rhythm index in time.
  - Avarage amplitude shows the variation of EEG average amplitude in time.
  - Maximal amplitude shows the variation of EEG average amplitude in time.
  - Ratio of alpha rhythm index to delta rhythm index shows the variation of this ratio in time.
  - Ratio of alpha rhythm index to theta rhythm index shows the variation of this ratio in time.

- Ratio of (alpha+beta) index to (theta+delta) rhythm index shows the variation of this ratio in time.
- Full power spectrum trend shows the variation of full power spectrum with time.
- Ratio of alpha- and beta-rhythms indices shows the ratio of alpha- and beta-rhythm indices in time.
- Spectral entropy trend shows the variation of spectral entropy (first order derivative from power spectrum) in time.
- Impedance – shows the changes of impedance values obtained during an exam.
- Resting state index — anesthesia depth monitoring. The average coherence for the P3-PZ and P4-PZ derivations in the gamma range of 30-45 Hz at 8 second analysis epochs is displayed.
- Ratio of theta rhythm index to beta rhythm index shows the variation of this ratio in time.

- PSG trends (see chapter 11 “Neuron-Spectrum-PSG.NET):
  - SpO2 trend – trend of oxygen saturation level changes occurred during exam (Fig. 11.7).
  - Respiratory trend shows the respiratory rate changes of a patient occurred during an exam.
  - Abdominal effort trend shows the “Abdom” trace amplitude changes.
  - Thorax effort trend shows the “Thorax” trace amplitude changes.
  - Heart rate trend shows the heart rate changes during an exam (Fig. 11.8)
  - Limb movement trend shows the amplitude changes of limb movement trace (Fig. 11.9)
  - Snoring trend shows snoring trace amplitude changes.
  - Body position trend shows patient's body position changes occurred during an exam.
  - Eye movement trend shows the changes of eye movement trace amplitude occurred during an exam.
  - EMG amplitude trend shows EMG trace amplitude changes occurred during an exam.
  - CPAP pressure trend shows CPAP pressure changes occurred during an exam. If BiPAP devices are used, the IPAP (inhalation) and EPAP (exhala-

tion) pressures may be shown on this trend. Besides the leackages may also be shown here. The visibility of these parameters is set with the context menu of the trend.

- PTT (pulse transition time) trend shows PTT changes occurred during an exam.
- Luminance trend shows the luminance changes occurred during an exam.
- Temperature trend shows patient's body temperature changes occurred during an exam.
- PSG events – shows PSG events selected during an exam (apnea, desaturation, snoring, tachycardia, etc.).

Besides the above-mentioned trends the hypnogram can be shown in hypnogram marking mode in trend window (see section 11.3 "Hypnogram").

7. Creation of Exam Reports

The documented result of the performed exam is the exam report. Each exam can contain several exam reports. You can create the new (empty) reports and generate them manually and also can use the automatic generation of the reports according to prior generated templates. As a rule, the program includes one or several report templates by default but you can create you own templates of the reports.

By default, the exam reports are stored in RTF format but if Microsoft Word 2007 or higher is installed on your computer, the reports can be created and stored in Microsoft Word format. To do it, use **Report| Use Microsoft Word** command of main menu.

7.1. New Exam Report

To create new (empty) exam report, it is necessary to choose **Report|New…** menu command or use the corresponding button of the toolbar (see the Annex 1). At that, the window with the input box for entering of the report name and the comments to it will appear on the screen (Fig. 7.1).

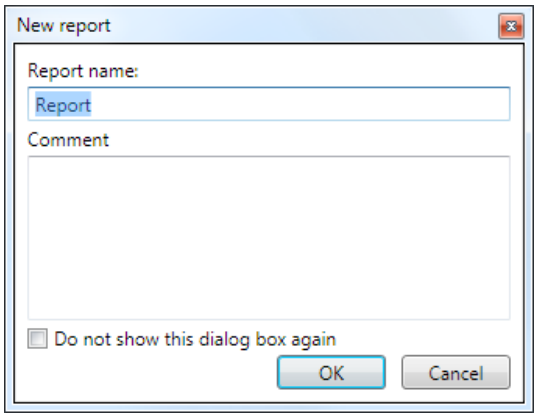


Fig. 7.1. The creation of new exam report.

To create the new report, press “OK” button (or **[Enter]** key on the keyboard), to cancel the creation of a new report, press “Cancel” button (or **[Enter]** key on the keyboard). If you do not want this window to appear again at the creation of the next new report, select the checkbox in the bottom part of this window (Fig. 7.2). As soon as you fill all the required input boxes and press “OK” button, the text editor of new exam report will appear on the screen (Fig. 7.2).

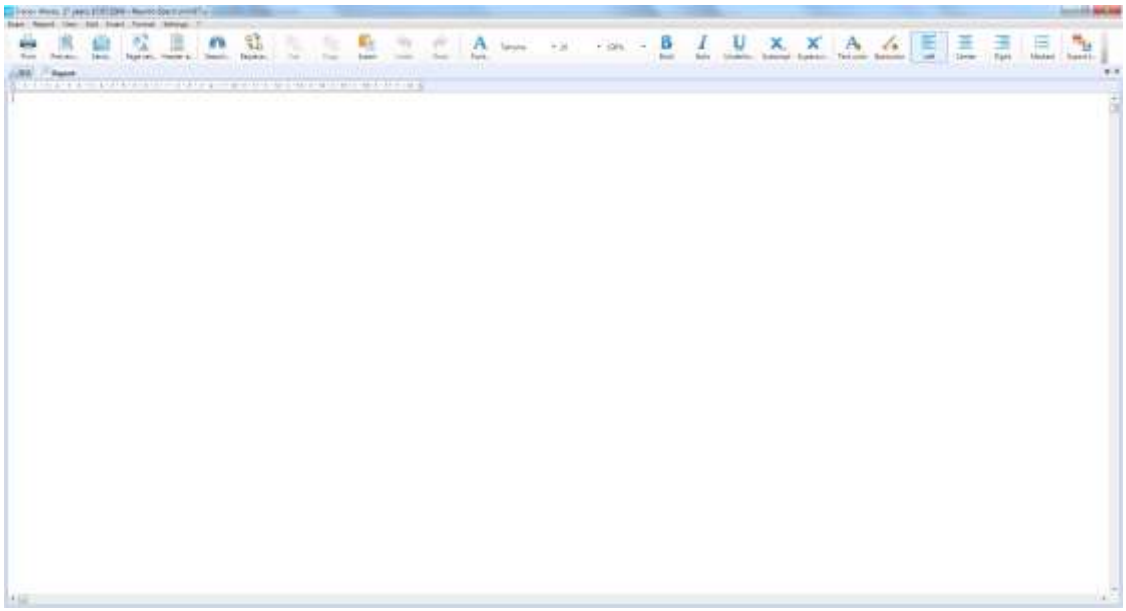


Fig. 7.2. The editor of exam report.

Besides the field to enter the report text, you can see the name of the exam report and the toolbar to work with it on the screen. The description of the toolbar buttons is given in Table 7.1.

Table 7.1. The description of buttons for the report editing

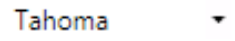
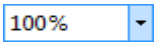
Button	Description
	Print the exam report.
	Preview the exam report.
	Send the exam report by e-mail.
	Customize the page settings.
	Customize page header.
	Search the specified text.
	Replace the one text by another one.
	Cut the selected text to clipboard.
	Copy the selected text to clipboard.
	Insert the content of clipboard to exam report.
	Cancel the last operation.
	Cancel previous changes.
	Change the current font.
	Select the current font name.
	Select the current font size.
	Report scale.
	Bold type.
	Italyc style.
	Underline style.
	Interlinear.
	Superlinear.
	Select font color.
	Select background color.
	Left-justified alignment.
	Center alignment.

Table 7.1. Continued

Button	Description
	Right-justified alignment.
	Marked list.
	Export report to Adobe PDF.

After the generation of the report text and completion of all the required operations with it (printing, sending by e-mail, etc.), you can close the window of the report editor.

To save the generated report in an exam, save the exam by pressing  button. All the reports saved in an exam can be copied in the specified catalogue. You can choose the catalogue to copy exam reports on the “Report” tab of “Settings” window (Fig. 7.3) which is available using **Setup|Change…** menu command.

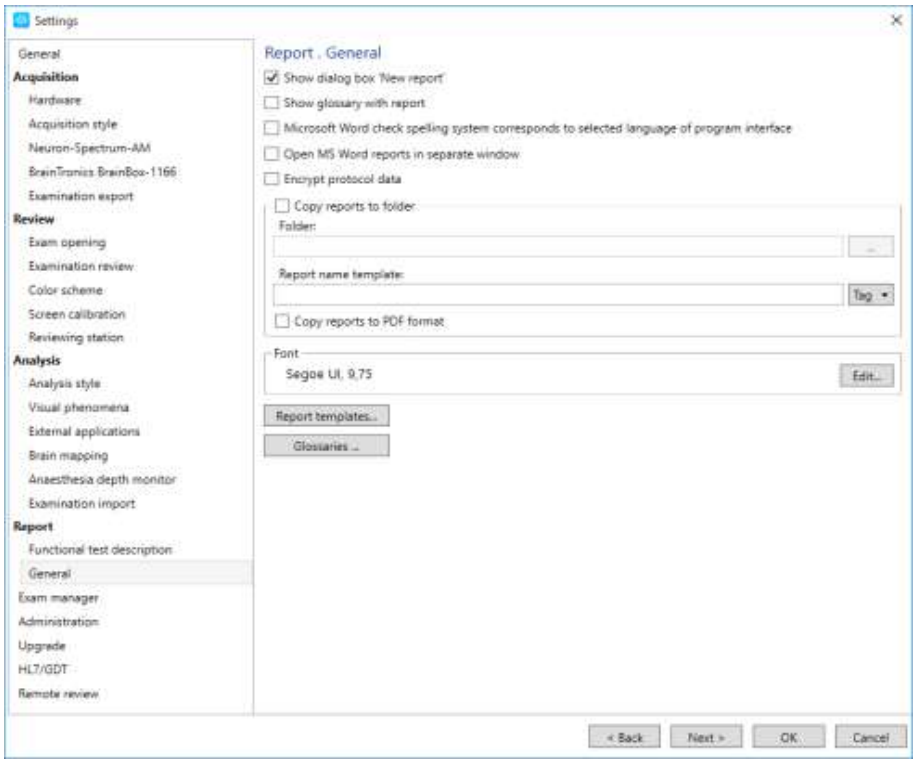


Fig. 7.3. The general settings of exam reports.

To open the created earlier report to review and edit, use **Report|Open…** menu command, choose the report you would like to open from the list of all reports (Fig. 7.4) and press “OK” button. After that the editor of exam report with the text of the selected report (Fig. 7.2) will be opened. Also to opne the report, you can use “Exam inspector”.

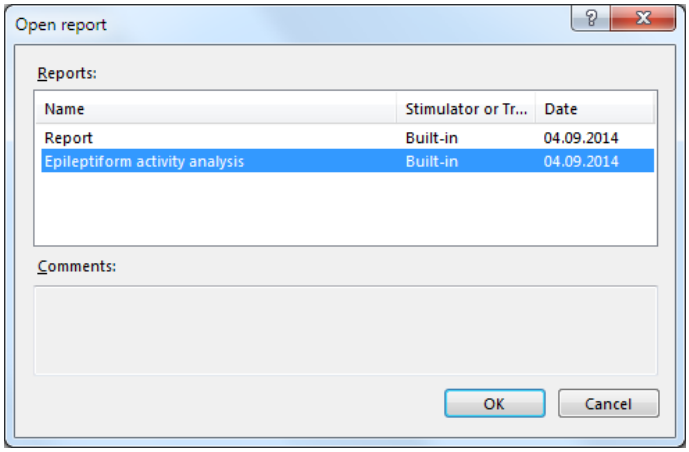


Fig. 7.4. Opening exam report.

7.2. Exam Report on Basis of Template

The default report templates are created to avoid manual entering of report text. The report template is the basis for exam report generation. The order, the composition and type of the information included in the report are defined in the template. To create the exam report on the template basis, use **Report|Templates** menu command and select the template from the list. After that, the window for the creation of a new exam report (Fig. 7.1) will appear on the screen. In this window you can enter the report name and comments for it. To generate the report, press “OK” button. After the report generation the text editor window will appear on the screen. It contains the exam report with data inserted. The order is described in the report template (text conclusions, table data, topographic maps, graphs, etc.). To change the order or type of the information included in the report, edit the report template.

To generate quickly the report, use  button on the toolbar. If you press this button, the exam report will be generated on the basis of template specified in the current acquisition style as a default template (see section 8.2.2 “Acquisition Styles”). Besides you can create a report on the basis of any default template or open the created one using the drop-down menu of the button.

7.2.1. Editing of Report Templates

As it was described above, the report templates define which information and in what order should be included in the exam report. Each template can be changed with the regards to user requirements. It ensures the flexible system of exam report generation.

To edit the report templates, use **Report|Template editor…** menu command. The editor of exam report templates is shown in Fig. 7.5.

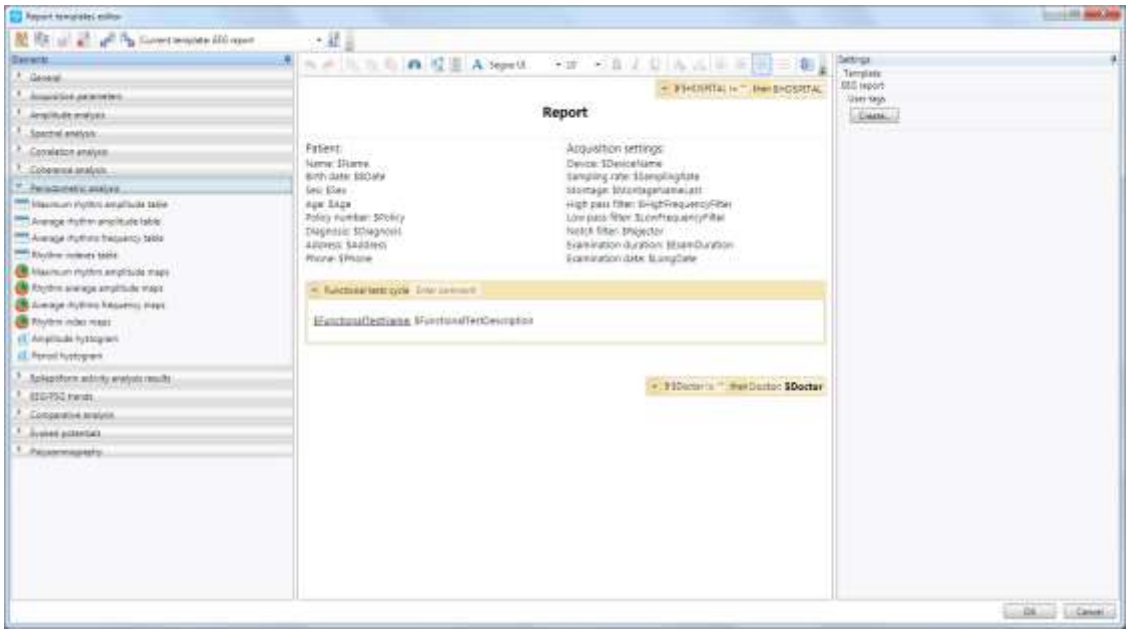


Fig. 7.5. The editor of exam report templates.

The toolbar to customize the report templates is located in the top part of the window. Using the buttons of this toolbar, you can create new report templates, remove the existing ones, import the templates from files, export the templates to files (for example, to transfer to other computer) and rename. You can specify hotkey combination for the quick report generation on the basis of this template (see section 8.13 “Toolbar Setup”). The combo-box of the available report templates is located in the middle part of the toolbar. After the selection of the required report template from this list, you can pass to its editing. The window of the template editor is divided into three parts. The left part contains the list of the information that can be added to the report. The information unit to add to the report is called block. All blocks are divided into groups. The group names can be seen on the tabs. To select the active tab, left-click it. To include the required block to the report template, drag it with the mouse to the middle part of the window.

The interactive representation of the template is located in the middle part of the window. Here you can see the data elements included to the report. Using the toolbar over this representation, you can change the order of the blocks going, remove the unnecessary ones, copy, cut and insert them from the clipboard, edit the text, insert tags into the text. Thus you can assess the correctness of information adding to your future report.

The right part of the editor contains the “Settings” panel of the current block. Each block has its own settings. Using the “Settings” bar located in the right part of the window, you can set up any block from the list of the blocks included in the report.

To add some information on exam to the report, you can use tags (see section 7.6 “Use of Tags in Report Templates”). With the toolbar you can add different tags to the report text. During report generation these tags will be replaced with actual data from the current exam. For example, **$Name** tag will be replaced with patient’s name and **$FunctionalTestDescription** tag will insert the text conclusion for functional test. It is better to use this tag in cycle body of functional test. In this case the text conclusion on all performed functional tests will be added in turn to the exam report. For each functional test you can select the information to include to the report. To do this, use “Report. Functional tests description” page of “Settings” window (Fig. 7.6).

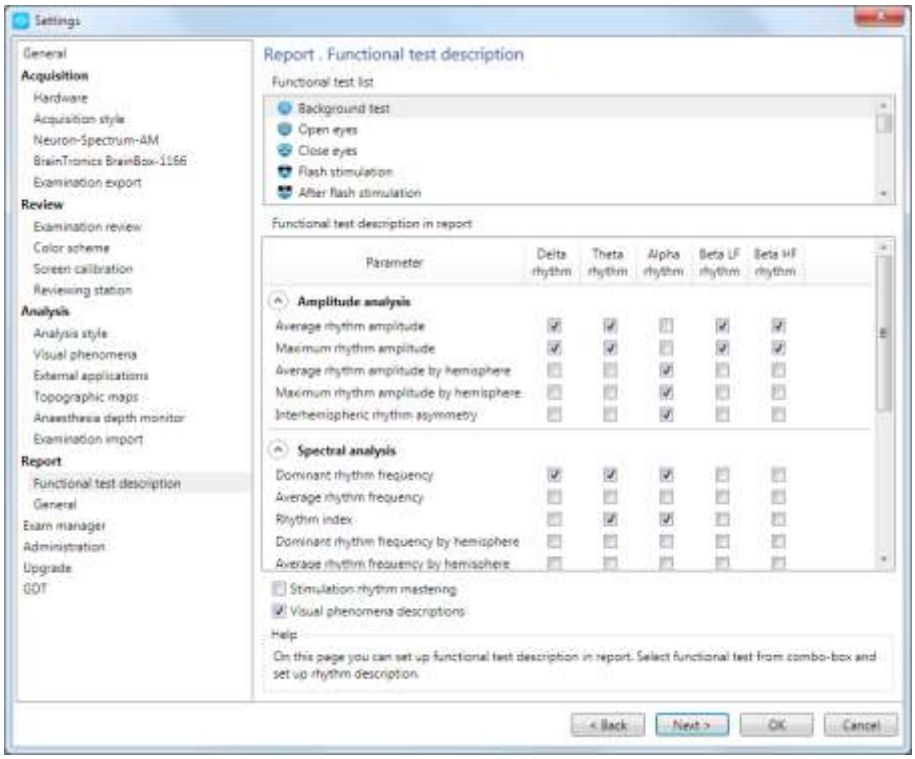


Fig. 7.6. The settings of functional test description in exam report.

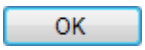
Besides the preset tags you can create your own user tages. The values of these tags will be requested each time before exam report generation in a separate dialog box. Using these tags you can add to the report those data that are not included by default.

The description of some blocks and tags that can be useful for you to create your own report templates is given in the Table 7.2.

Table 7.2. Description of Tags to Edit the Text

Tag/Block Name	Tag/Block Description
$Name	Inserts patient's name to report.
$BDate	Inserts patient's date of birth to report.
$Age	Inserts patient's age at exam date.
$MontageNameLast	Inserts name of montage used for acquisition to report.
$MaximumAmplitudeAlphaRhythmLeft	Inserts maximal amplitude of alpha rhythm over left hemisphere (μV) to report. If this tag is in cycle body of functional test, the amplitude of alpha rhythm is calculated for current test, otherwise it is done for all analysis epochs detected during an exam. The value of this tag can be either added to the report test or it can be used in conditional statements. For example, you can indicate that if the value of this tag exceeds the specified value, a certain phrase should be added to the report, if it does not, than other phrase is added. Using the conditional statements you can create multilogic report templates.
Patient's photo	Inserts patient's photo to report.
If…then	Inserts conditional statement to report template. Using conditional statements you can add different information to report depending on different conditions. The conditional statements can be nested. It allows making rather complex logical schematics if it is required.
Functional test cycle	This tag is intended to sort out the cycle by all functional tests performed during exam. The blocks and tags included into this cycle body can add information calculated for a certain functional test to report.
First measured impedance	Inserts data on first impedance measurement.
Assymetry of alpha rhythm amplitude	Inserts topographic map of alpha rhythm amplitude assymetry.
EEG/PSG trends	Inserts calculated values of EEG and PSG trends.
Amplitude analysis conclusion	Inserts amplitude analys conclusion to report.

If you wish, you can edit the existing report templates by adding, removing or setting up the elements. Also, you can create the new templates of the reports. It should be noted that the creation and set up of the report templates is rather long and tedious work but if you apply some efforts you will get completely satisfying exam reports.

Let us consider the example of creation of a new exam report template. To create new report template, use  button on the toolbar. In the new template creation window (Fig. 7.7) enter the name of the report template and press 

button or **[Enter]** key on the keyboard.

Fig. 7.7. Creation of new report template.

Now new report template is empty (Fig. 7.8).

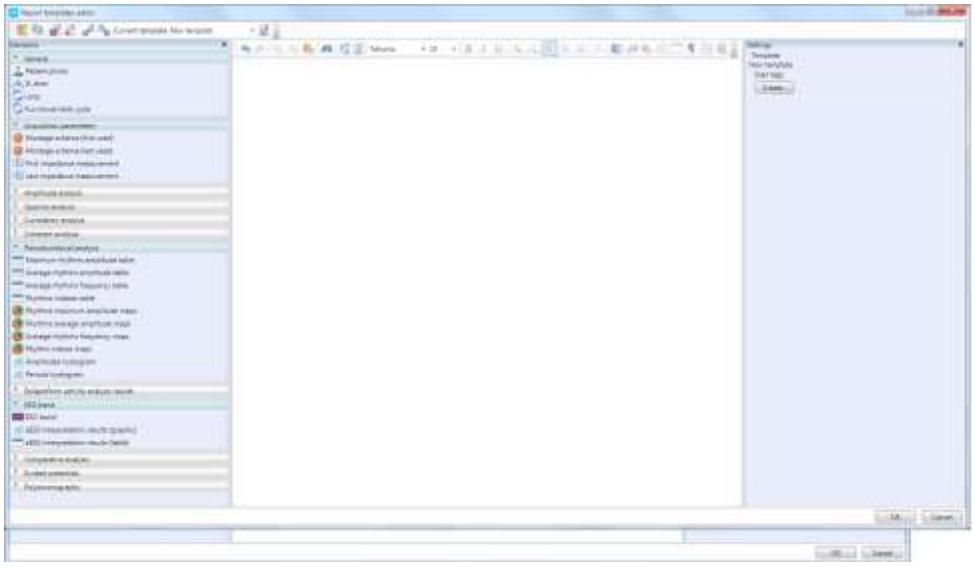


Fig. 7.8. Empty report template.

If you want to add a report name, enter the text to the central area of editor window and specify the font for it. Often it is required to write the name of medical establishment (with small font) where an exam is done before a report name. To do this, use conditional statement to add the name of medical establishment if it is known (Fig. 7.9). You can enter your medical establishment name on “General” page of “Settings” window (Fig. 8.1).

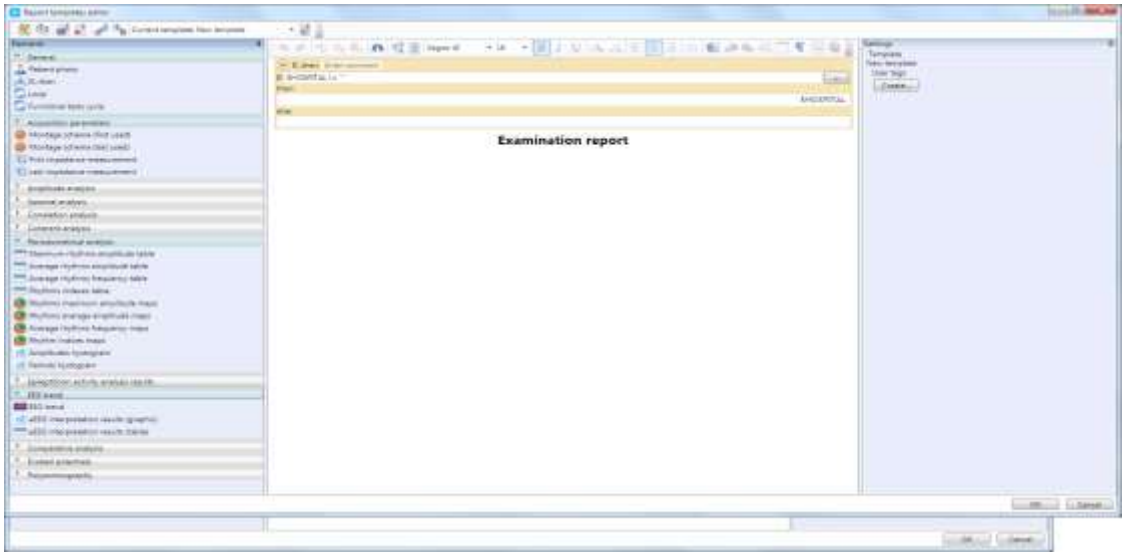


Fig. 7.9. Adding report name.

Then add information on patient and acquisition parameters to report. To do this, add **Table-container** element to report using the corresponding button on toolbar. In the right part of window you can find the settings of current element. Set the number of rows per unit and choose two in “Column count”. Such table-container allows to arrange different report elements in one row. For example, several topographic maps can be arranged in one line. Fill in patient’s data in the left part of the table and acquisition parameters in the right one. Use tags to add this information to the report. To add the tag to the report template, use the corresponding button on toolbar (Fig. 7.10).

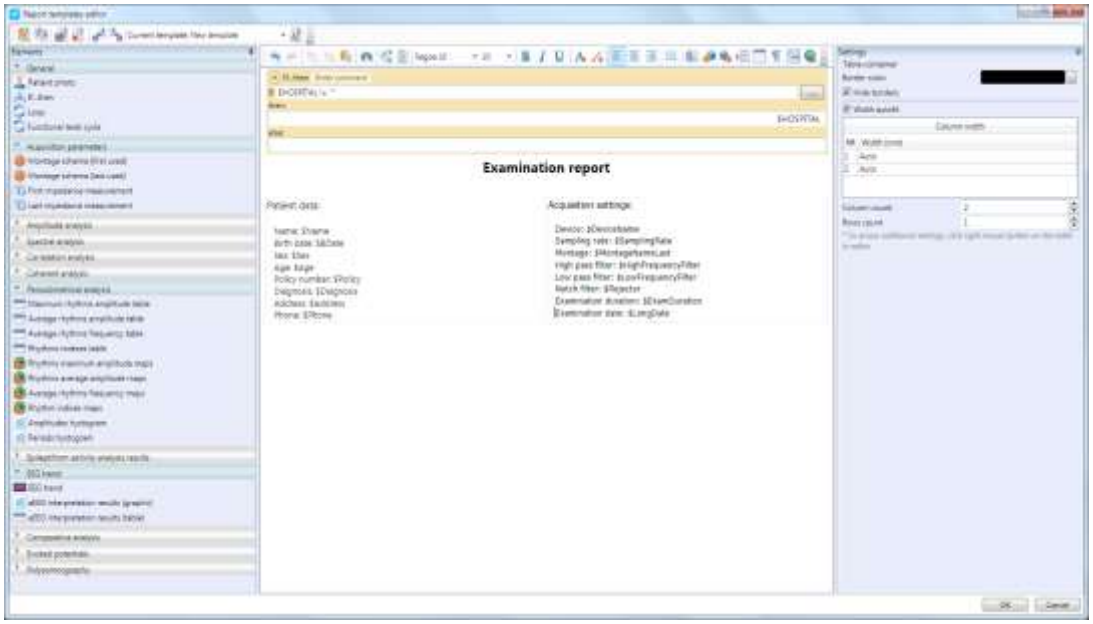


Fig. 7.10. Adding patient’s information.

Other analysis elements (tables, topographic maps, graphs) can be added to the report template. The data calculation for these elements is done by all selected analysis epochs (see section 5.12 “Arrangement of Analysis Epochs”). The current element of report template is customized in the right part of editor window (Fig. 7.11).

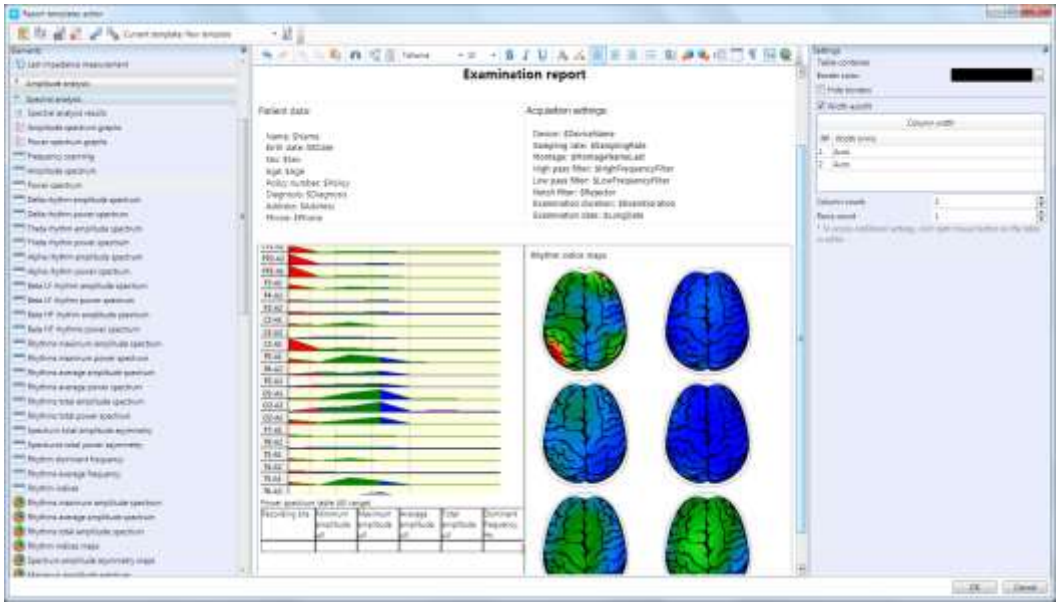


Fig. 7.11. Adding results of exam analysis.

Now let's consider the way to include the analysis results on all performed functional tests (see section 4.12 "Functional Test Acquisition") to the report. Use "Functional test cycle" block of "General" page. This block does not insert any information to exam report but the elements nested in it will be used in turn for each functional test performed during an exam. Using **$Functional TestName** and **$Functional-TestDescription** tags add the name and the description of functional tests to the report. Then add any other analysis results calculated for each test respectively to report using other blocks (Fig. 7.12). On completion add a signature of physician who performed an exam to report template. To do this, use the conditional statement. If user name is specified (see section "Program Run" (Fig. 1.13)), it is added to report (Fig. 7.13).

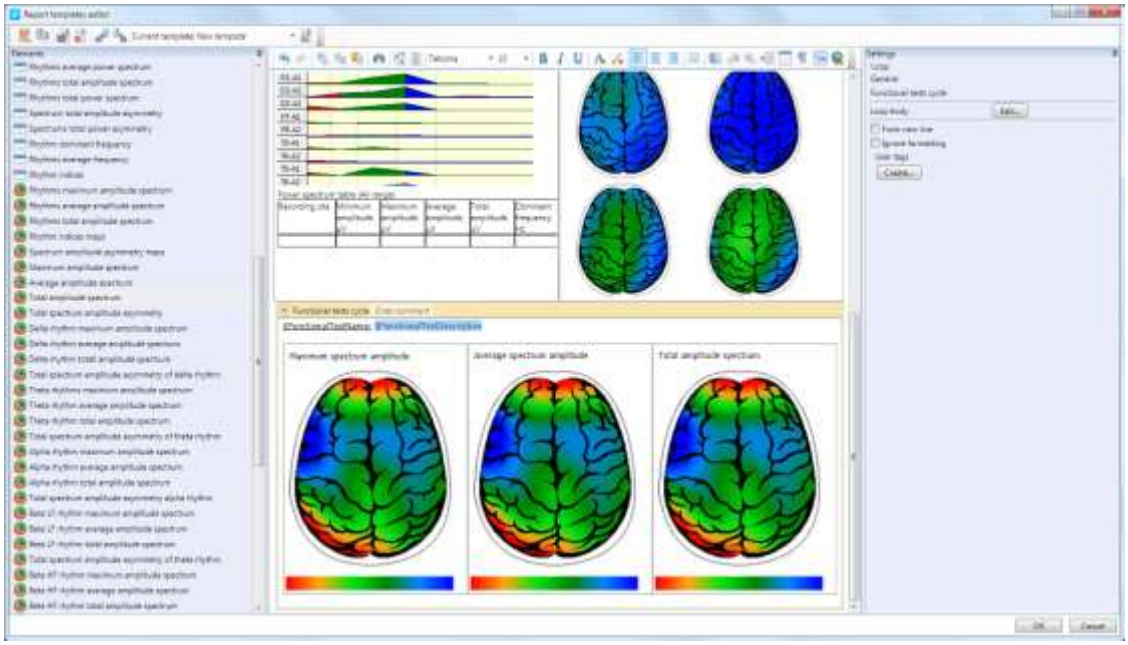


Fig. 7.12. Adding analysis results of performed functional tests.

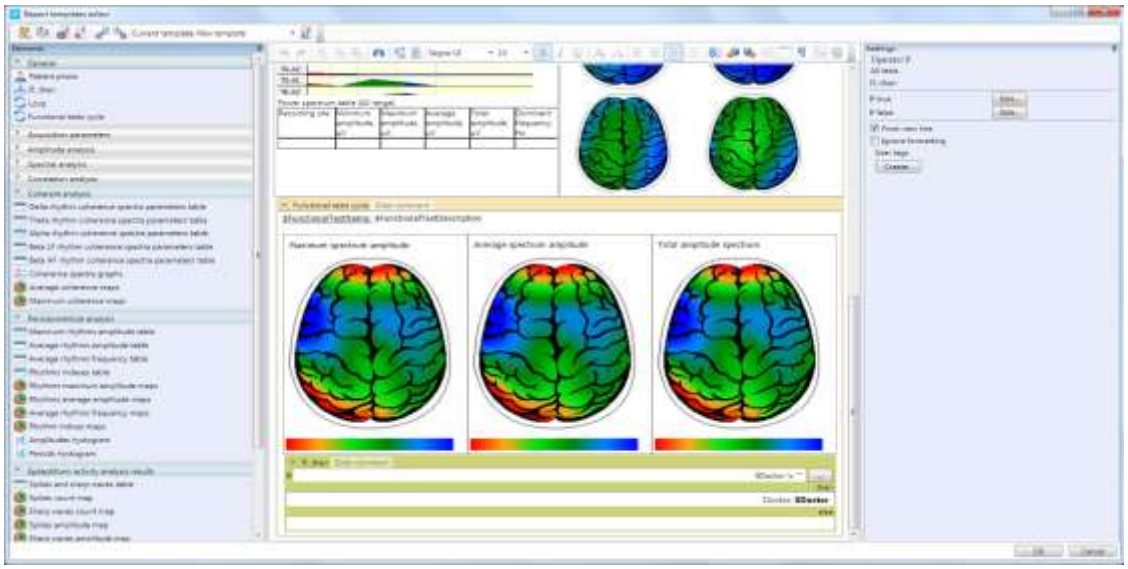


Fig. 7.13. Adding information on user who performed an exam.

Using toolbar buttons of report template you can set page orientation for this report and also field width and header text.

7.3. Glossary

The useful tool for the report generation is the dictionary of standard expressions or the glossary. The dictionary is intended for the structured storage of the typical phrases and expressions, which are usually used at an exam report generation. A user can insert the phrases from the dictionary to the current exam report. Also, you can enlarge the dictionary with your own phrases, combine them into groups. To open the glossary, use **View|Glossary** menu command or **[Alt+G]** key combination (Fig. 7.14).

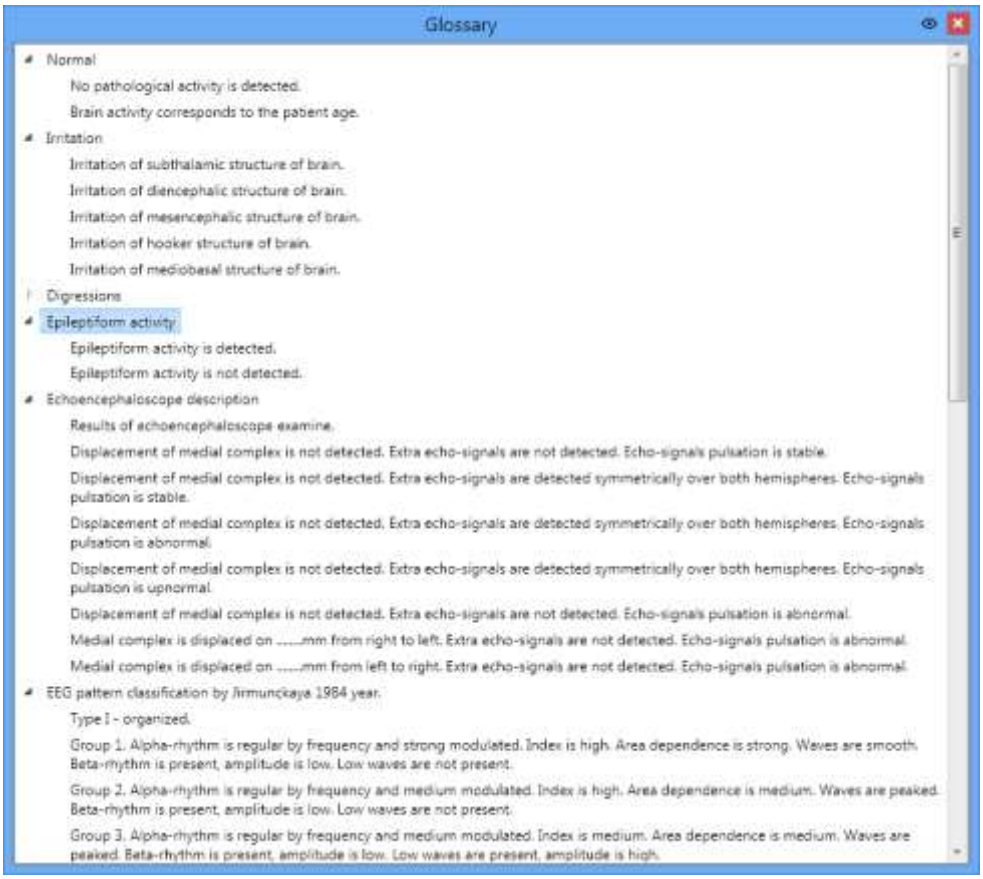


Fig. 7.14. Glossary.

If you want to add the phrase from the glossary to the current position of the exam report, double-click it with the left mouse button. Using the context menu, which is available at the right mouse button clicking, you can add new phrases, new sections to the glossary, edit and remove the existing phrases and sections of this glossary.

On the “Report” tab of the program settings window (Fig. 7.3) which is available by **Setup|Change**… menu command, you can set automatic opening of the “Glossary” window at the report generation.

7.4. Clinical State

The “Clinical state” is one more text document which is kept in an exam besides the reports. As a rule, “Clinical state” document is intended for the description of

a patient state before an exam. To review and edit “Clinical state” document, use **Exam|Clinical state** menu command.

7.5. Conclusion

The “Conclusion” is one more document which is kept together with the exam reports and “Clinical state” document. It is intended for the interpretation writing by exam results. To review and edit “Conclusion” document, use **Exam|Conclusion** menu command.

7.6. Use of Tags in Report Templates

If you want to add some data to a report which will be known only at a report generation stage (for example, name and age of a patient), you can use the so called “tags” in the text of the report templates. All the tags will be replaced by their values at the report generation stage. The general tags of an exam are listed in Table 7.3.

Table 7.3. The general tags of an exam

Tag Name	Tag Description
$ID	patient’s code
$NAME	patient’s name and surname
$FIRSTNAME	patient’s first name
$LASTNAME	patient’s last name
$MIDDLENAME	patient’s middle name
$AGE	patient’s age
$SEX	patient’s gender
$BDATE	date of birth
$REGDATE	date of registration in database
$CARDCOMMENT	comments to patient’s card
$ADDRESS	address
$PHONE	phone number
$LONGDATE	exam date (long format)
$TIME	time of exam beginning
$COMMENT	comments to exam
$DIAGNOSIS	provisional diagnosis
$CARDNAME	card-file name
$CURDATE	current date
$CURLONGDATE	current date (long format)
$CURTIME	current time
$WEIGHT	patient’s weight (kg)
$HEIGHT	patient’s height (cm)
$POLICY	insurance number
$EMAIL	e-mail address
$EDITUSER	physician’s name
$CREATEUSER	physician’s/technician’s name who created an exam

Table 7.3. Continued

Tag Name	Tag Description
$EDITDATE	date of last change
$DEPARTMENT	department
$BMI	body mass index
$USERFIELD1	user parameter 1
$USERFIELDN	user parameter N
$EXAMGUID	Unique examination number

The tags listed in this table can be used in any part of report template. Besides the general tags of an exam, some text elements of a template can contain the specific tags which can be used only in the text of these elements, for example, “Amplitude analysis resume” can contain the tags with the results of EEG amplitude measurements. Using drop-down menu of  button on report template toolbar, you can add the tags to the element text. The tags can participate in conditional and cyclic statements.

The complete list of available tags is given in Table 7.4.

Table 7.4. Tags with Results of Different Analysis Types

Tag Name	Tag Description
Tags to describe the acquisition parameters	
$MontageNameFirst	Name of first specified montage
$MontageNameLast	Name of last specified montage
$SamplingRate	Sampling rate
$DeviceName	Device name
$HighFrequencyFilter	High pass filter
$LowFrequencyFilter	Low pass filter
$Rejector	Notch filter
$CreateUserName	User name
$ExamDuration	Exam duration
$AmplitudeComputeMode	EEG amplitude calculation mode
Tags to describe the functional tests (can be used in the functional test cycle)	
$FunctionalTestName	Functional test name
$FunctionalTestDescription	Functional test description
$EPFunctionalTestName	Functional EP test

Table 7.4. Continued

Tag Name	Tag Description
Tags to describe the functional tests with EP acquisition	
$EPReactionTime	Patient reaction time during cognitive EP acquisition (ms)
$EPPatientErrorsText	Number or patient errors during cognitive EP acquisition
Tags to describe the amplitude analysis results	
$AverageAmplitudeEEG	Average EEG amplitude (µV)
$AverageAmplitudeAlphaRhythm	Average amplitude of alpha rhythm (µV)
$AverageAmplitudeBetaLFRhythm	Average amplitude of beta LF rhythm (µV)
$AverageAmplitudeBetaHFRhythm	Average amplitude of beta HF rhythm (µV)
$AverageAmplitudeDeltaRhythm	Average amplitude of delta rhythm (µV)
$AverageAmplitudeThetaRhythm	Average amplitude of theta rhythm (µV)
$MaximumAmplitudeEEG	Maximum EEG amplitude (µV)
$MaximumAmplitudeAlphaRhythm	Maximum amplitude of alpha rhythm (µV)
$MaximumAmplitudeBetaLFRhythm	Maximum amplitude of beta LF rhythm (µV)
$MaximumAmplitudeBetaHFRhythm	Maximum amplitude of beta HF rhythm (µV)
$MaximumAmplitudeDeltaRhythm	Maximum amplitude of delta rhythm (µV)
$MaximumAmplitudeThetaRhythm	Maximum amplitude of theta rhythm (µV)
$AverageAmplitudeEEGLeft	Average EEG amplitude over the left hemisphere (µV)
$AverageAmplitudeAlphaRhythmLeft	Average amplitude of alpha rhythm over the left hemisphere (µV)
$AverageAmplitudeBetaLFRhythmLeft	Average amplitude of beta LF rhythm over the left hemisphere (µV)
$AverageAmplitudeBetaHFRhythmLeft	Average amplitude of beta HF rhythm over the left hemisphere (µV)
$AverageAmplitudeDeltaRhythmLeft	Average amplitude of delta rhythm over the left hemisphere (µV)
$AverageAmplitudeThetaRhythmLeft	Average amplitude of theta rhythm over the left hemisphere (µV)
$MaximumAmplitudeEEGLeft	Maximum EEG amplitude over the left hemisphere (µV)
$MaximumAmplitudeAlphaRhythmLeft	Maximum amplitude of alpha rhythm over the left hemisphere (µV)
$MaximumAmplitudeBetaLFRhythmLeft	Maximum amplitude of beta LF rhythm over the left hemisphere (µV)
$MaximumAmplitudeBetaHFRhythmLeft	Maximum amplitude of beta HF rhythm over the left hemisphere (µV)
$MaximumAmplitudeDeltaRhythmLeft	Maximum amplitude of delta rhythm over the left hemisphere (µV)
$MaximumAmplitudeThetaRhythmLeft	Maximum amplitude of theta rhythm over the left hemisphere (µV)
$AverageAmplitudeEEGRight	Average EEG amplitude over the right hemisphere (µV)
$AverageAmplitudeAlphaRhythmRight	Average amplitude of alpha rhythm over the right hemisphere (µV)

Table 7.4. Continued

Tag Name	Tag Description
$AverageAmplitudeBetaLFRhythmRight	Average amplitude of delta LF rhythm over the right hemisphere (μV)
$AverageAmplitudeBetaHFRhythmRight	Average amplitude of beta HF rhythm over the right hemisphere (μV)
$AverageAmplitudeDeltaRhythmRight	Average amplitude of delta rhythm over the right hemisphere (μV)
$AverageAmplitudeThetaRhythmRight	Average amplitude of theta rhythm over the right hemisphere (μV)
$MaximumAmplitudeEEGRight	Maximum EEG amplitude over the right hemisphere (μV)
$MaximumAmplitudeAlphaRhythmRight	Maximum amplitude of alpha rhythm over the right hemisphere (μV)
$MaximumAmplitudeBetaLFRhythmRight	Maximum amplitude of beta LF rhythm over the right hemisphere (μV)
$MaximumAmplitudeBetaHFRhythmRight	Maximum amplitude of beta HF rhythm over the right hemisphere (μV)
$MaximumAmplitudeDeltaRhythmRight	Maximum amplitude of delta rhythm over the right hemisphere (μV)
$MaximumAmplitudeThetaRhythmRight	Maximum amplitude of theta rhythm over the right hemisphere (μV)
$MinimumAmplitudeEEG	Minimum permissible EEG amplitude (μV)
$MinimumAmplitudeAlphaRhythm	Minimum permissible amplitude of alpha rhythm (μV)
$MinimumAmplitudeBetaLFRhythm	Minimum permissible amplitude of beta LF rhythm (μV)
$MinimumAmplitudeBetaHFRhythm	Minimum permissible amplitude of beta HF rhythm (μV)
$MinimumAmplitudeDeltaRhythm	Minimum permissible amplitude of delta rhythm (μV)
$MinimumAmplitudeThetaRhythm	Minimum permissible amplitude of theta rhythm (μV)
Tags to describe the spectral analysis results	
$DominantFrequencyAlphaRhythm	Dominant frequency of alpha rhythm (Hz)
$DominantFrequencyAlphaRhythmLeft	Dominant frequency of alpha rhythm over the left hemisphere (Hz)
$DominantFrequencyAlphaRhythmRight	Dominant frequency of alpha rhythm over the right hemisphere (Hz)
$DominantFrequencyAlphaRhythmAsymmetry	Interhemispheric assymetry of dominant frequency of alpha rhythm
$DominantFrequencyBetaLFRhythm	Dominant frequency of beta LF rhythm (Hz)
$DominantFrequencyBetaLFRhythmLeft	Dominant frequency of beta LF rhythm over the left hemisphere (Hz)
$DominantFrequencyBetaLFRhythmRight	Dominant frequency of beta LF rhythm over the right hemisphere (Hz)
$DominantFrequencyBetaLFRhythmAsymmetry	Interhemispheric assymetry of dominant frequency of beta LF rhythm
$DominantFrequencyBetaHFRhythm	Dominant frequency of beta HF rhythm (Hz)

Table 7.4. Continued

Tag Name	Tag Description
$DominantFrequencyBetaHFRhythmLeft	Dominant frequency of beta HF rhythm over the left hemisphere (Hz)
$DominantFrequencyBetaHFRhythmRight	Dominant frequency of beta HF rhythm over the right hemisphere (Hz)
$DominantFrequencyBetaHFRhythmAsymmetry	Interhemispheric assymetry of dominant frequency of beta HF rhythm
$DominantFrequencyDeltaRhythm	Dominant frequency of delta rhythm (Hz)
$DominantFrequencyDeltaRhythmLeft	Dominant frequency of delta rhythm over the left hemisphere (Hz)
$DominantFrequencyDeltaRhythmRight	Dominant frequency of delta rhythm over the right hemisphere (Hz)
$DominantFrequencyDeltaRhythmAsymmetry	Interhemispheric assymetry of dominant frequency of delta rhythm
$DominantFrequencyThetaRhythm	Dominant frequency of theta rhythm (Hz)
$DominantFrequencyThetaRhythmLeft	Dominant frequency of theta rhythm over the left hemisphere (Hz)
$DominantFrequencyThetaRhythmRight	Dominant frequency of theta rhythm over the right hemisphere (Hz)
$DominantFrequencyThetaRhythmAsymmetry	Interhemispheric assymetry of dominant frequency of theta rhythm
$AverageFrequencyAlphaRhythm	Average frequency of alpha rhythm (Hz)
$AverageFrequencyAlphaRhythmLeft	Average frequency of alpha rhythm over the left hemisphere (Hz)
$AverageFrequencyAlphaRhythmRight	Average frequency of alpha rhythm over the right hemisphere (Hz)
$AverageFrequencyAlphaRhythmAsymmetry	Interhemispheric assymetry of average frequency of alpha rhythm
$AverageFrequencyBetaLFRhythm	Average frequency of beta LF rhythm (Hz)
$AverageFrequencyBetaLFRhythmLeft	Average frequency of beta LF rhythm over the left hemisphere (Hz)
$AverageFrequencyBetaLFRhythmRight	Average frequency of beta LF rhythm over the right hemisphere (Hz)
$AverageFrequencyBetaLFRhythmAsymmetry	Interhemispheric assymetry of average frequency of beta LF rhythm
$AverageFrequencyBetaHFRhythm	Average frequency of beta HF rhythm (Hz)
$AverageFrequencyBetaHFRhythmLeft	Average frequency of beta HF rhythm over the left hemisphere (Hz)
$AverageFrequencyBetaHFRhythmRight	Average frequency of beta HF rhythm over the right hemisphere (Hz)
$AverageFrequencyBetaHFRhythmAsymmetry	Interhemispheric assymetry of average frequency of beta HF rhythm
$AverageFrequencyDeltaRhythm	Average frequency of delta rhythm (Hz)
$AverageFrequencyDeltaRhythmLeft	Average frequency of delta rhythm over the left hemisphere (Hz)
$AverageFrequencyDeltaRhythmRight	Average frequency of delta rhythm over the right hemisphere (Hz)
$AverageFrequencyDeltaRhythmAsymmetry	Interhemispheric assymetry of average frequency of delta rhythm

Table 7.4. Continued

Tag Name	Tag Description
$AverageFrequencyThetaRhythm	Average frequency of theta rhythm (Hz)
$AverageFrequencyThetaRhythmLeft	Average frequency of theta rhythm over the left hemisphere (Hz)
$AverageFrequencyThetaRhythmRight	Average frequency of theta rhythm over the right hemisphere (Hz)
$AverageFrequencyThetaRhythmAsymmetry	Interhemispheric assymetry of average frequency of theta rhythm
$IndexAlphaRhythm	Alpha rhythm index (%)
$IndexAlphaRhythmLeft	Alpha rhythm index over the left hemisphere (%)
$IndexAlphaRhythmRight	Alpha rhythm index over the right hemisphere (%)
$IndexAlphaRhythmAsymmetry	Interhemispheric assymetry of alpha rhythm index
$IndexBetaLFRhythm	Beta LF rhythm index (%)
$IndexBetaLFRhythmLeft	Beta LF rhythm index over the left hemisphere (%)
$IndexBetaLFRhythmRight	Beta LF rhythm index over the right hemisphere (%)
$IndexBetaLFRhythmAsymmetry	Interhemispheric assymetry of beta LF rhythm index
$IndexBetaHFRhythm	Beta HF rhythm index (%)
$IndexBetaHFRhythmLeft	Beta HF rhythm index over the left hemisphere (%)
$IndexBetaHFRhythmRight	Beta HF rhythm index over the right hemisphere (%)
$IndexBetaHFRhythmAsymmetry	Interhemispheric assymetry of beta HF rhythm index
$IndexDeltaRhythm	Delta rhythm index (%)
$IndexDeltaRhythmLeft	Delta rhythm index over the left hemisphere (%)
$IndexDeltaRhythmRight	Delta rhythm index over the right hemisphere (%)
$IndexDeltaRhythmAsymmetry	Interhemispheric assymetry of delta rhythm index
$IndexThetaRhythm	Theta rhythm index (%)
$IndexThetaRhythmLeft	Theta rhythm index over the left hemisphere (%)
$IndexThetaRhythmRight	Theta rhythm index over the right hemisphere (%)
$IndexThetaRhythmAsymmetry	Interhemispheric assymetry of theta rhythm index
$ChannelNameDominantAlphaRhythm	Derivation with domininat alpha rhythm
$ChannelNameDominantAlphaRhythmLeft	Derivation with domininat alpha rhythm over the left hemisphere
$ChannelNameDominantAlphaRhythmRight	Derivation with domininat alpha rhythm over the right hemisphere
$ChannelNameDominantBetaLFRhythm	Derivation with domininat beta LF rhythm
$ChannelNameDominantBetaLFRhythmLeft	Derivation with domininat beta LF rhythm over the left hemisphere
$ChannelNameDominantBetaLFRhythmRight	Derivation with domininat beta LF rhythm over the right hemisphere
$ChannelNameDominantBetaHFRhythm	Derivation with domininat beta HF rhythm
$ChannelNameDominantBetaHFRhythmLeft	Derivation with domininat beta HF rhythm over the left hemisphere

Table 7.4. Continued

Tag Name	Tag Description
$ChannelNameDominantBetaHFRhythmRight	Derivation with domininat beta HF rhythm over the right hemisphere
$ChannelNameDominantDeltaRhythm	Derivation with dominant delta rhythm
$ChannelNameDominantDeltaRhythmLeft	Derivation with dominant delta rhythm over the left hemisphere
$ChannelNameDominantDeltaRhythmRight	Derivation with dominant delta rhythm over the right hemisphere
$ChannelNameDominantThetaRhythm	Derivation with dominant theta rhythm
$ChannelNameDominantThetaRhythmLeft	Derivation with dominant theta rhythm over the left hemisphere
$ChannelNameDominantThetaRhythmRight	Derivation with dominant theta rhythm over the right hemisphere
Tags to describe the sleep stage scoring	
$ExamStartDate	Exam start date
$ExamStartTime	Exam start time
$ExamEndTime	Exam end time
$LightsOffTime	Light switch off time
$LightsOnTime	Light switch on time
$TimeInBed	Time in bed
$EpochTime	Analysis epoch duration
$EpochCount	Number of epochs
$TotalSleepPeriodTime	Sleep period time
$StartOfSleepPeriod	Start of sleep period
$EndOfSleepPeriod	End of sleep period
$TotalSleepTime	Total sleep time
$SleepOnset	Sleep onset
$LatencyToPersistentSleep	Persistent sleep onset
$TotalTimeSleepStage1DuringSleepPeriod	Total time of first sleep stage
$TotalTimeSleepStage2DuringSleepPeriod	Total time of second sleep stage
$TotalTimeSleepStage3DuringSleepPeriod	Total time of third sleep stage
$TotalTimeSleepStage4DuringSleepPeriod	Total time of fourth sleep stage
$TotalTimeSleepStageNREMDuringSleepPeriod	Total time of NREM sleep
$TotalTimeSleepStageREMDuringSleepPeriod	Total time of REM sleep
$TotalTimeSleepStageDeltaDuringSleepPeriod	Total time of delta sleep (S4+S4)
$WakeAfterSleepOnset	Wake after sleep onset
$TotalTimeAwakeDuringSleepPeriod	Wake during sleep period
$WakeAfterFinalArousal	Wake after final arousal
$SegmentsCountDuringSleepPeriodTime	Number of segments during sleep period
$TotalSegmentsCountDuringSleep	Number of segments during sleep
$FirstAwakeLatency	First awake latency
$LastDeltaEpizodeLatency	Latency of last delta sleep period
$NumberOfAwakenings	Number of awakenings

Table 7.4. Continued

Tag Name	Tag Description
$NumberOfAwakeningsMoreThen3Minute	Number of awakening with more than 3 minute duration
$SleepEfficiencyIndex1	Sleep effificency index 1 (total sleep time /total time in bed)
$SleepEfficiencyIndex2	Sleep effificency index 2 (sleep period time/total time in bed)
$MovementsActivationIndex	Movement activation index
$TheNumberOfArousals	Number of arousals
$TheArousalIndex	Arousal index
$REMObstructiveApneaCount	Number of obstructive apnea events during REM sleep
$REMObstructiveApneaIndex	Obstructive apnea index during REM sleep
$REMMixedApneaCount	Number of mixed apnea events during REM sleep
$REMMixedApneaIndex	Mixed apnea index during REM sleep
$REMCentralApneaCount	Number of central apnea events during REM sleep
$REMCentralApneaIndex	Central apnea index during REM sleep
$NREMNumberOfLMArousals	Number of arousals associated with limb movements during NREM sleep
$TheLMArousalIndexNREM	Index of arousals associated with limb movements during NREM sleep
$NREMNumberOfPLMArousals	Number of arousals associated with periodic limb movements during NREM sleep
$ThePLMArousalIndexNREM	Index of arousals associated with periodic limb movements during NREM sleep
$NREMNumberOfSpontaneousArousals	Number of spontaneous arousals during NREM sleep
$TheSpontaneousArousalIndexNREM	Index of spontaneous arousals during NREM sleep
$TheNumberOfPLMArousals	Number of arousals associated with periodic limb movements during sleep
$ThePLMArousalIndex	Index of arousals associated with periodic limb movements during sleep
$TheNumberOfCAPs	Number of cyclic alternating pattern events during the sleep
$TheCAPIndex	Cyclic alternating pattern event index during the sleep
$TheCAPDurationPercent	The percent of the total cyclic alternating pattern event duration to the sleep time
$SleepQualityIndex	Sleep quality index
$RelativeSleepQualityIndex	Relative sleep quality index
$SleepCyclesCount	Number of sleep cycles
$REMSleepLatencyOnset	REM sleep latency onset
$FirstStageSleepLatencyOnset	First sleep stage latency
$SecondStageSleepLatencyOnset	Second sleep stage latency
$ThirdStageSleepLatencyOnset	Third sleep stage latency

Table 7.4. Continued

Tag Name	Tag Description
$FourthStageSleepLatencyOnset	Fourth sleep stage latency
$REMPercentInTTS	REM sleep percent in total sleep time
$FirstStagePercentInTTS	First stage percent in total sleep time
$SecondStagePercentInTTS	Second stage percent in total sleep time
$ThirdStagePercentInTTS	Third stage percent in total sleep time
$FourthStagePercentInTTS	Fourth stage percent in total sleep time
$REMPercentInRecord	REM sleep percent in total record time
$FirstStagePercentInRecord	First stage percent in total record time
$SecondStagePercentInRecord	Second stage percent in total record time
$ThirdStagePercentInRecord	Third stage percent in total record time
$FourthStagePercentInRecord	Fourth stage percent in total record time
$WakeStagePercentInRecord	Wake percent in total record time
Tags for Multiple Sleep Latency Test	
$MSLTSleepEfficiency	Mean sleep efficiency (%)
$MSLTMeanSleepLatency	Mean sleep latency (min)
$MSLTNumberOfNapsWithREM	Number of naps with REM sleep
$MSLTREMAveragedLatensyFromLightsOff	Mean REM sleep latency from light off Средняя латентность REM-сна от выключения света
$MSLTREMAveragedLatensyFromSleepOnset	Middle REM sleep latency from sleep onset
Tags to describe the Respiration Analysis Results During the Sleep	
$ApneaCount	Total number of apnea during the sleep
$ObstructiveApneaCount	Total number of obstructive apnea during the sleep
$CentralApneaCount	Total number of central apnea during the sleep
$MixedApneaCount	Total number of mixed apnea during the sleep
$HypopneaTotalCount	Total number of obstructive hypopnea during the sleep
$CentralHypopneaTotalCount	Total number of central hypopnea during the sleep
$RespiratoryEffortTotalCount	Total number of respiratory efforts during the sleep
$ApneaPlusHypopneaCount	Total number of apnea and hypopnea during the sleep
$ApneaPlusHypopneaPlusRespiratoryEffortCount	Total number of apnea, hypopnea and respiratory efforts during the sleep
$CheyneStokesRespirationTotalCount	Total number of Cheyne Stokes respiratory events during the sleep
$ApneaIndex	Number of apnea per one sleep hour
$ObstructiveApneaIndex	Number of obstructive apnea per one sleep hour
$CentralApneaIndex	Number of central apnea per one sleep hour
$MixedApneaIndex	К Number of mixed apnea per one sleep hour
$HypopneaIndex	Number of obstructive hypopnea per one sleep hour
$CentralHypopneaIndex	Number of central hypopnea per one sleep hour

Table 7.4. Continued

Tag Name	Tag Description
$RespiratoryEffortIndex	Number of respiratory efforts per one sleep hour
$ApneaPlusHypopneaIndex	Number of apnea and hypopnea per one sleep hour
$ApneaPlusHypopneaSpineIndex	Number of apnea and hypopnea in supine position per one sleep hour
$ApneaPlusHypopneaNonSpineIndex	Number of apnea and hypopnea in nonsupine position per one sleep hour
$ApneaPlusHypopneaPlusRespiratoryEffortIndex	Number of apnea, hypopnea and respiratory efforts per one sleep hour
$CheyneStokesRespirationIndex	Number of Cheyne Stokes respiratory events per one sleep hour
$UARSIndex	Number of UARS (UpperAairway Resistance Syndrome) events per one sleep hour
$BruxismIndex	Number of bruxism events per one sleep hour
$ApneaMaxDuration	Maximum duration of apnea
$HypopneaMaxDuration	Maximum duration of obstructive hypopnea
$CentralHypopneaMaxDuration	Maximum duration of central hypopnea
$ObstructiveApneaMaxDuration	Maximum duration of obstructive apnea
$CentralApneaMaxDuration	Maximum duration of central apnea
$MixedApneaMaxDuration	Maximum duration of mixed apnea
$ApneaAverageDuration	Mean duration of apnea
$HypopneaAverageDuration	Mean duration of obstructive hypopnea
$CentralHypopneaAverageDuration	Mean duration of central hypopnea
$ObstructiveApneaAverageDuration	Mean duration of obstructive apnea
$CentralApneaAverageDuration	Mean duration of central apnea
$MixedApneaAverageDuration	Mean duration of mixed apnea
$ApneaTotalDuration	Total duration of apnea
$HypopneaTotalDuration	Total duration of obstructive hypopnea
$CentralHypopneaTotalDuration	Total duration of central hypopnea
$ObstructiveApneaTotalDuration	Total duration of obstructive apnea
$CentralApneaTotalDuration	Total duration of central apnea
$MixedApneaTotalDuration	Total duration of mixed apnea
$ApneaTotalDurationToTotalSleepTimePercent	Total duration of apnea to sleep time
$HypopneaTotalDurationToTotalSleepTimePercent	Total duration of obstructive hypopnea to sleep time
$CentralHypopneaTotalDurationToTotalSleepTimePercent	Total duration of central hypopnea to sleep time
$ObstructiveApneaTotalDurationToTotalSleepTimePercent	Total duration of obstructive apnea to sleep time
$CentralApneaTotalDurationToTotalSleepTimePercent	Total duration of central apnea to sleep time
$MixedApneaTotalDurationToTotalSleepTimePercent	Total duration of mixed apnea to sleep time

Table 7.4. Continued

Tag Name	Tag Description
$REMApneaIndex	Apnea index during REM sleep
$REMHypopneaIndex	Obstructive hypopnea index during REM sleep
$REMCentralHypopneaIndex	Central hypopnea index during REM sleep
$REMApneaAndHypopneaIndex	Index of apnea and hypopnea during REM sleep
$REMApneaCount	Number of apnea events during REM sleep
$REMHypopneaCount	Number of obstructive hypopnea events during REM sleep
$REMCentralHypopneaCount	Number of central hypopnea events during REM sleep
$REMApneaAndHypopneaCount	Number of apnea and hypopnea events during REM sleep
$NREMApneaIndex	Apnea index during NREM sleep
$NREMHypopneaIndex	Index of obstructive hypopnea during NREM sleep
$NREMCentralHypopneaIndex	Central hypopnea index during NREM sleep
$NREMApneaAndHypopneaIndex	Index of apnea or hypopnea duiring NREM sleep
$NREMApneaCount	Number of apnea events during NREM sleep
$NREMHypopneaCount	Number of obstructive hypopnea events during NREM sleep
$NREMCentralHypopneaCount	Number of central hypopnea events during NREM sleep
$NREMApneaAndHypopneaCount	Number of apnea and hypopnea events during NREM sleep
Tags to describe the oxygen saturation analysis results during sleep time	
$BackgraundSaturationLevel	Background saturation level
$MaxDesaturationDuration	Maximum duration of desaturation
$AverageDesaturationDuration	Mean duration of desaturation
$DesaturationsCount	Number of desaturations
$DesaturationsTotalDuration	Total duration of desaturations
$DesaturationTotalDurationToTotalSleepTime	Total duration of desaturations to total sleep time
$DesaturationIndex	Number of desaturations per one sleep hour (index)
$AverageSaturationLevel	Average saturation level (%)
$MinimumSaturationLevel	Minimum saturation level (%)
$SaturationLevel1	Specified saturation level 1
$SaturationLevel2	Specified saturation level 2
$SaturationLevel3	Specified saturation level 3
$SaturationTotalTimeLessThenLevel1	Total time when saturation is below level 1
$SaturationTotalTimeLessThenLevel2	Total time when saturation is below level 2
$SaturationTotalTimeLessThenLevel3	Total time when saturation is below level 3

Table 7.4. Continued

Tag Name	Tag Description
Tags to describe the heart rate analysis results during the sleep	
$AverageHeartRate	Average heart rate (bits/min)
$MinHeartRate	Mimimum heart rate (bits/min)
$MaxHeartRate	Maximum heart rate (bits/min)
$HeartRateVariability	Heart rate veriability (bits/min)
$BrachycardiaCount	Number of brachycardia events
$TachicardiaCount	Number of tachycardia events
$AsystoliaCount	Number of asystolia events
$MaxAsystoliaDuration	Maximum duration of asystolia event (s)
Tags to describe the snoring analysis results during the sleep	
$SnoreCount	Total number of snoring events
$SnoreTotalDuration	Total duration of snoring events
$SnoreIndex	Number of snoring events per hour
$SnoreAverageDuration	Average duration of snoring event
$SnoreMaxDuration	Maximum duration of snoring event
Tags to describe the body position analysis results during the sleep	
$SpineTotalSleepTime	Total sleep time in supine position
$SpineSleepTimePercent	Sleep time percent in supine position
$NonSpineTotalSleepTime	Total sleep time in nonsupine position
$NonSpineSleepTimePercent	Sleep time percent in nonsupine position
$LeftTotalSleepTime	Total sleep time in left lateral position
$LeftSleepTimePercent	Sleep time percent in left lateral position
$RightTotalSleepTime	Total sleep time in right lateral position
$RightSleepTimePercent	Sleep time percent in right lateral position
$ProneTotalSleepTime	Total sleep time in prone position
$ProneSleepTimePercent	Sleep time percent in prone position
Tags to describe the limb movement analysis results during the sleep	
$PLMTotalCount	Total number of periodic limb movement events
$PLMIndex	Index of periodic limb movement events
$LMTotalCount	Total number of limb movements
$LMIndex	Index of limb movements

You can define your own tags which values will be requested at the stage of the report generation. The user tags can have line, numerical or list format. The line tags can be used for the entering of arbitrary text information to the report. The numerical tags are intended to add quantitative data to the report, for example, a patient's body temperature at the moment of an exam performing, blood pressure, dominating frequency of alpha rhythm, etc. The list tags are intended to add one of the prior defined values to the report text, for example, the modulation level of alpha rhythm: "low", "moderate" or "high" (Fig. 7.15).

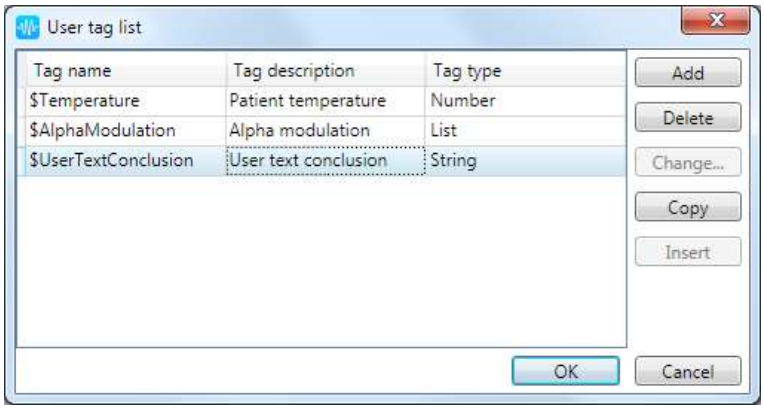


Fig. 7.15. Creating user tags.

7.7. Recording of Audio Comments

Besides text recording of an exam, **Neuron-Spectrum.NET** software provides the possibility to record and then play back the audio comments and interpretations. To record the audio comments, your computer should be equipped with the microphone. The recording and playing back of the audio comments is carried out with the use of “Dictaphone” window (Fig. 7.16). Show or hide “Dictaphone” window using **Report|Dictaphone** menu item.

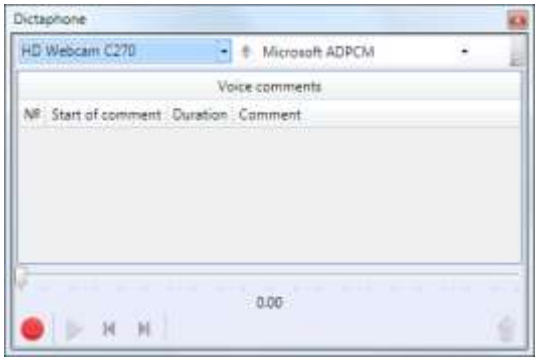


Fig. 7.16. The dictaphone.

Using the combo-boxes located on the toolbar of “Dictaphone” window, you can select and set up audio recorder (several audio recorders should be connected) and audio compression program (by default the recommended codec Microsoft ADPCM is set). You can start the recording of new audio comment or playing back of the selected comment using the buttons in the bottom part of the window. Besides, you can move between the comments, remove them, change the playing back volume. You can enter text comment for each audio comment from the list (Fig. 7.17). When the comment is selected from the list, the automatic move of EEG to the start point of audio comment recording occurs. The “Sound comment” marker is arranged on EEG automatically.

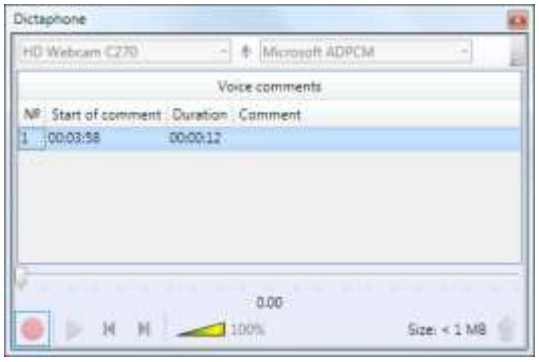


Fig. 7.17. The example of dictaphone use.

If you double-click the audio comment with the left mouse button, it will be played back. The current position of the comment playing is shown on the time line located in the bottom part of the window.

8. Program Settings

To start working with **Neuron-Spectrum.NET** software, there is no need in changing any its settings. The program is already set up to perform typical EEG exams. At the first program run you can choose the application area (Fig. 1.15). After that the program will be automatically adjusted to perform the corresponding exam types. However, if you wish, you can change the program settings. The settings of different program users are stored in separate files and downloaded at the program run at the moment of user identification (see section 1.3 “Program Run”). The settings of one user can not impact the settings of other program users. The current settings of the program can be saved in a file and restored from a file (for example when it is required to upload the program settings to other computer). To save the program settings to file, use **Setup|Save…** main program menu command, and to restore them from a file, execute **Setup|Load…** menu command. If it is required to change the program settings, use **Setup|Change…** menu command.

The “Settings” window (Fig. 8.1) contains the following sections:

- “General” – user settings. It contains information about current user of a program and some personal settings. On this page you can enter the name of medical establishment where the equipment is installed.
- “Acquisition”:
    - “Hardware” – general settings of used device.
    - “Acquisition style” – EEG acquisition mode settings. It contains the current acquisition style (see section 8.2.2 “Acquisition Styles”) and the acquisition wizard settings (see section 8.2.3 “Acquisition Wizard”).
    - “Automatic exam export” – settings of automatic export of exams.
- “Review”:
    - “Examination review” – settings of exam displaying parameters.
    - “Color scheme” – settings of colors for all visual program elements.
    - “Screen calibration” – settings of current monitor scale to display accurately and correctly EEG on monitors of different sizes.
    - “Reviewing station” – settings of access parameters to remote computer in LAN to review the exam results.
- “Analysis”:
    - “Analysis style” – EEG analysis mode settings. It contains the current analysis style (see section 8.7.1 “Analysis Styles”).

    - “Visual phenomena” – list of visual phenomena. It allows adding visual user phenomena.
    - Topographic maps – parameters to display topographic maps.
    - Anaesthesia depth monitor – settings to work with NINDEX program allowing to monitor anaesthesia depth.
- “Report”:
    - Functional test description – the settings of description of functional tests in exam report.
    - General – general setting of exam reports.
- “Exams Manager” – “Exams Manager” settings.
- “Administration” – the program settings that can be changed only by administrator.
- “Upgrade” – the automatic update of program settings.
- “GDT” – GDT settings.

8.1. General Settings

The general program settings (Fig. 8.1) contain the name and the password of a current user, the checkbox for the identification performing at the program run (see sections 1.3 “Program Run” and 1.4. “Main Program Window”) and the settings at the program start. By default, no additional actions are performed at the program run, but if you set the corresponding settings, the run of new exam or the opening of the existing one after the program start can be executed automatically. The login and the password of a user are required for multi-user program use. The login is used for the identification of a user and downloading of the corresponding settings, and the password is done for the protection of program login under other name. If the program is used only by one user, there is no need in performing the identification of this user at the program run.

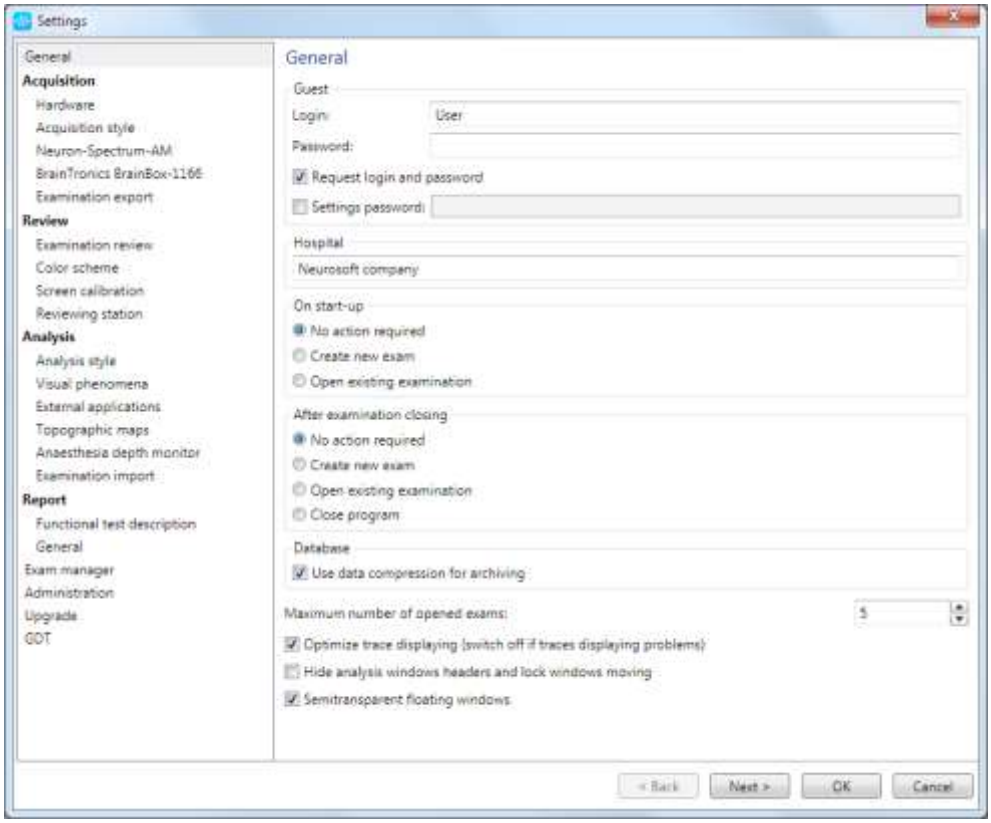


Fig. 8.1. The general program settings.

8.2. Acquisition Mode Settings

On the “Hardware” page of “Acquisition” section (Fig. 8.2) you can specify the power supply frequency, choose the notch filter type to reject the mains interference, set the type of used headphones, pattern-stimulator diagonal, etc. On this page you can also adjust the parameters of impedance measurement. Other acquisition and impedance measurement settings can be adjusted in acquisition style wizard (see section 8.2.2 “Acquisition Styles”).

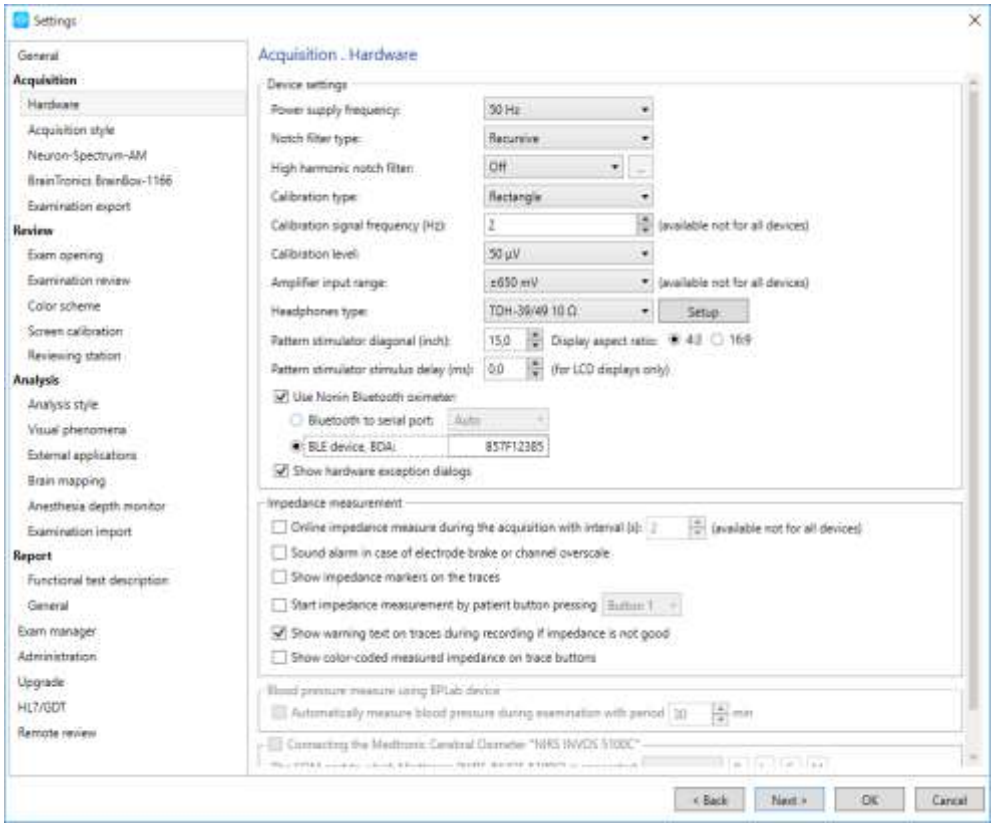


Fig. 8.2. Hardware settings.

On the “Acquisition style” page (Fig. 8.3) you can choose and edit the current acquisition style (see section 8.2.2 “Acquisition Styles”) and the settings of acquisition wizard (see section 8.2.3 “Acquisition Wizard”). All the settings of acquisition mode (hardware settings, filter parameters, stimulation settings, parameters of trace displaying, etc.) are stored in the acquisition style. You can select the current acquisition style in the combo-box. At the selection of the acquisition style, all the settings of the acquisition mode will be downloaded from it. Thus, you can easily switch between different acquisition settings, for example, to perform the exams using different templates. You can select the current acquisition style before the beginning of each new exam (Fig. 4.3). If you want to edit the current acquisition style (see section 8.2.2 “Acquisition Styles”), you can use “**Setup**…” button located to the right of the combo-box.

Besides the acquisition style, you can set up the parameters of the acquisition wizard in this section (see section 8.2.3 “Acquisition Wizard”). By default, the acquisition wizard is not used. You can set up the acquisition wizard at the creation of each new exam (Fig. 4.3).

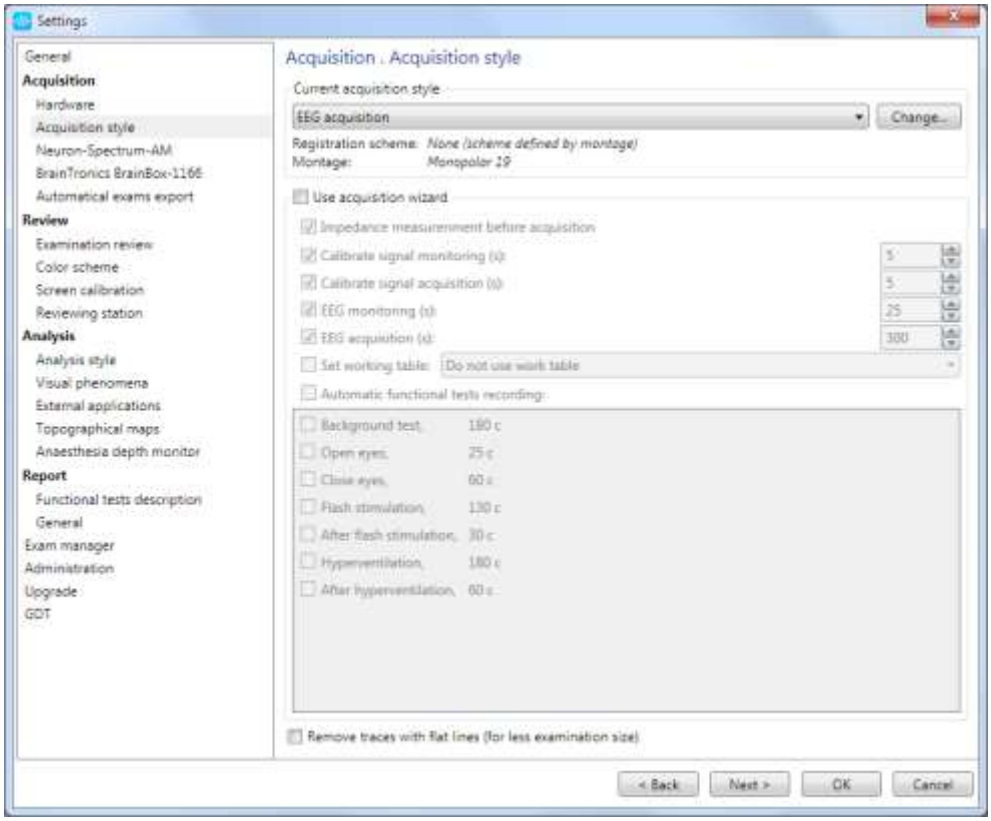


Fig. 8.3. Setup of current acquisition style.

8.2.1. Montage Editing

The different montages are used for EEG acquisition depending on the number of the placed electrodes, use of the additional channels and exam purpose. You can specify the active acquisition montage in the acquisition style (see section 8.2.2 “Acquisition Styles”) or at the creation of the new exam (Fig. 4.3). During exam performing you can change the active montage at any moment (see section 4.4 “Selection of Montage, Setup of EEG Scale and Sweep Speed”). The set of the typical montages is already provided by default in the program settings but each user can create own montages, change or remove the existing ones. To do it, use the montages manager window (Fig. 8.4).

You can open the montages manager by pressing  button on the toolbar of main program window or using **Settings|Montage** menu command. This window can be opened from acquisition style settings (Fig. 8.16) and using “Exam” window (Fig. 4.3).

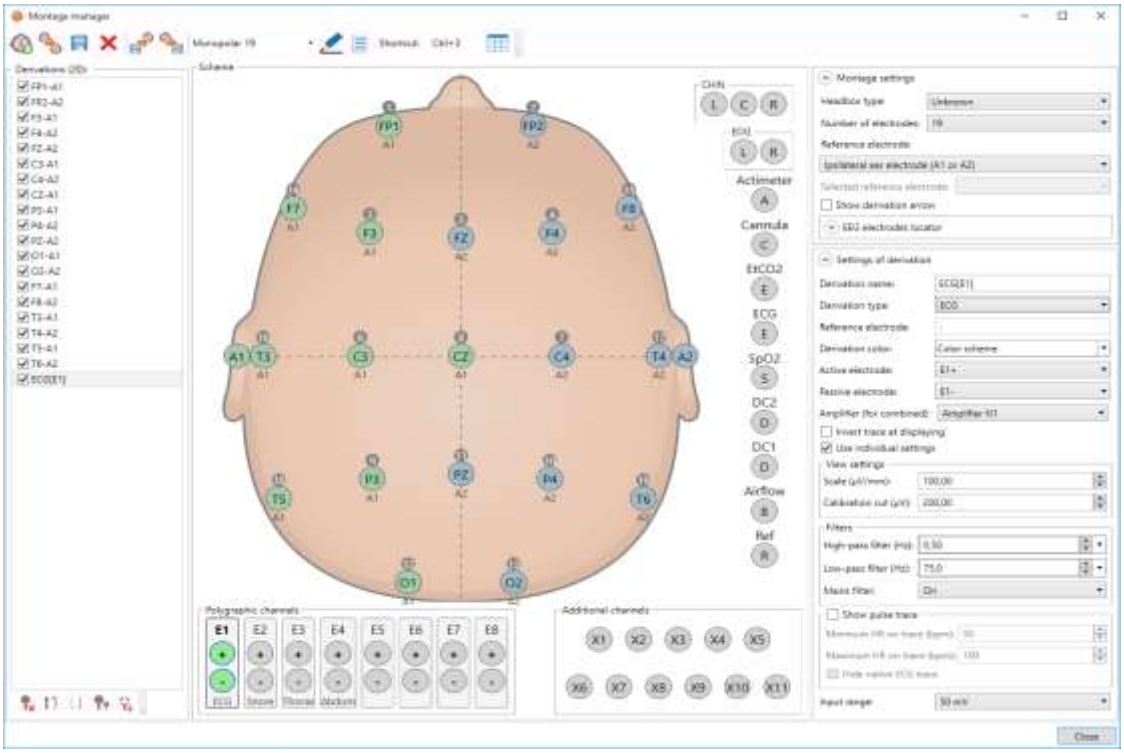


Fig. 8.4. Editing montages.

You can see the name of the current montage in the middle part of toolbar of montage manager window. Using the combo-box you can select other montage for editing. Also you can create new montages (including creation on the basis of the current one), save the introduced changes, remove the montages, export them to file and import them from file (for example, to move to other computer) using the toolbar buttons. Besides, you can rename the montage and specify hotkey combination for it (for the quick switch on of this montage during EEG acquisition or review). You can also choose the table representation of montage.

The working area of the montage manager window is divided into three parts:

- “Derivations” – it contains the derivations included in the current montage. It allows to set up the visibility and individual parameters of each derivation.
- “Scheme” – it contains the graphic presentation of scheme of electrode placement with the possibility to create new derivations using the mouse.
- “Montage settings” – it contains the settings of the current montage. The “Derivation settings” section contains the settings of the selected derivation (Fig. 8.5).

All the derivations included to the montage are listed in the derivation list. Using the checkbox opposite the name of each derivation, you can change its visibility. Afterwards, you can control the visibility of the derivations at EEG acquisition using “Ex-

am inspector" (see section 5.14.1 "Exam Inspector") or the context menu of the derivation. Using the toolbar buttons located over the list of the derivations, you can change the order of derivations, remove them from the montage and duplicate them. The number of the derivations included in the montage is displayed near "Derivations:" name in brackets.

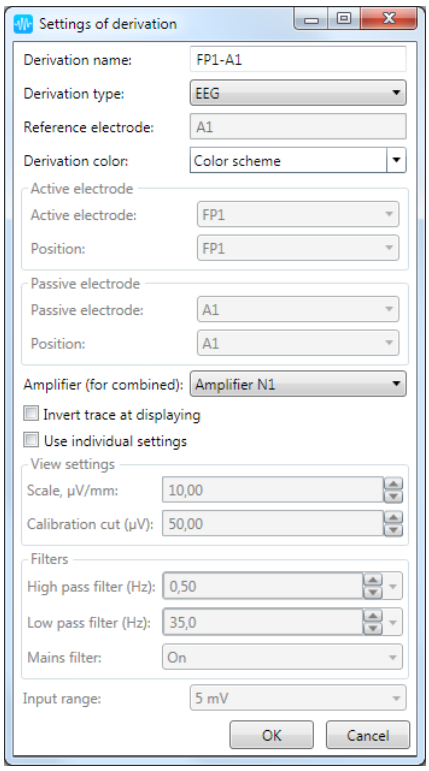


Fig. 8.5. Editing derivation settings.

Using the montage scheme in the middle part of the window, you can add new derivations to the montage by mouse click or touchscreen controls. To add the monopolar derivation to montage, left-click on the corresponding electrode on the graphic scheme. At that, the new derivation corresponding to the settings of the derivation in the right part of the window will be added to montage. To create the bipolar derivation, press the active electrode with the left mouse button and holding it down, move the mouse cursor to the passive electrode and after that release the mouse button. Left-click the polygraphic channel under the montage scheme to include the polygraphic channels to the montage. To include the additional "non EEG channels" to montage, it is necessary to left-click the corresponding channel located to the right of the montage scheme.

Some devices of Neuron-Spectrum series can be equipped with direct current channels (DC1, DC2, etc.). The sensors with stepwise (body position sensor) or continuous (for example, cannula) level of direct current can be connected to them. If you apply such sensors, it is required to adjust the direct current channels according to the connected sensors. The sensor signal level at output is specified in the technical manual for this sensor. If this manual is missing, the signal level can be defined experimentally, for example, you can connect the sensor to device and perform a test. Neuron-Spectrum.NET software provides automatic calibration of direct current sensors in

cases their parameters are indeterminate (see section 11.14 “Direct Current Channels”).

Some EEG devices supported by the program do not have direct current channels. In this case the attachment of such sensors is impossible.

In the right part of the window, you can set the parameters of the montage and the derivations. You can choose the type of used device, set the number of used electrodes and select the reference electrode for this montage. Both ear electrodes and any EEG electrode placed on a patient’s head can be used as a reference electrode. Also, the use of the joint and averaged electrodes (in case you use the averaged electrode as a reference one, you can indicate the derivations participating in the averaging) is possible as a reference electrode. Also, you can select “Source derivation” as a reference electrode. In this case the signal from each electrode will be averaged with the signals from near electrodes. The use of such type of reference electrode results in the amplification of the valuable EEG activity and the rejection of arbitrary EEG activity at the traces displaying.

We offer you to consider the example of the new montage creation. Let us assume that it is required to create the montage with **CZ** central reference electrode to perform for PSG studies. To create a new montage, use  button on the toolbar. In the appeared window enter the name of the new montage (Fig. 8.6).

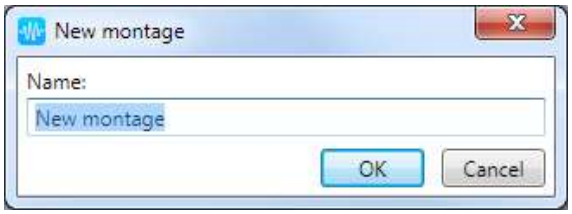


Fig. 8.6. Creating new montage.

The new montage does not contain any derivations. Define what number of the derivations should be in the montage. For example, it is required to create the montage with nineteen derivations. In the right part of the manager in “Number of electrodes:” drop-down box choose “19”. Select “Central electrode (Cz)” in the “Reference electrode:” drop-down box (Fig. 8.7).

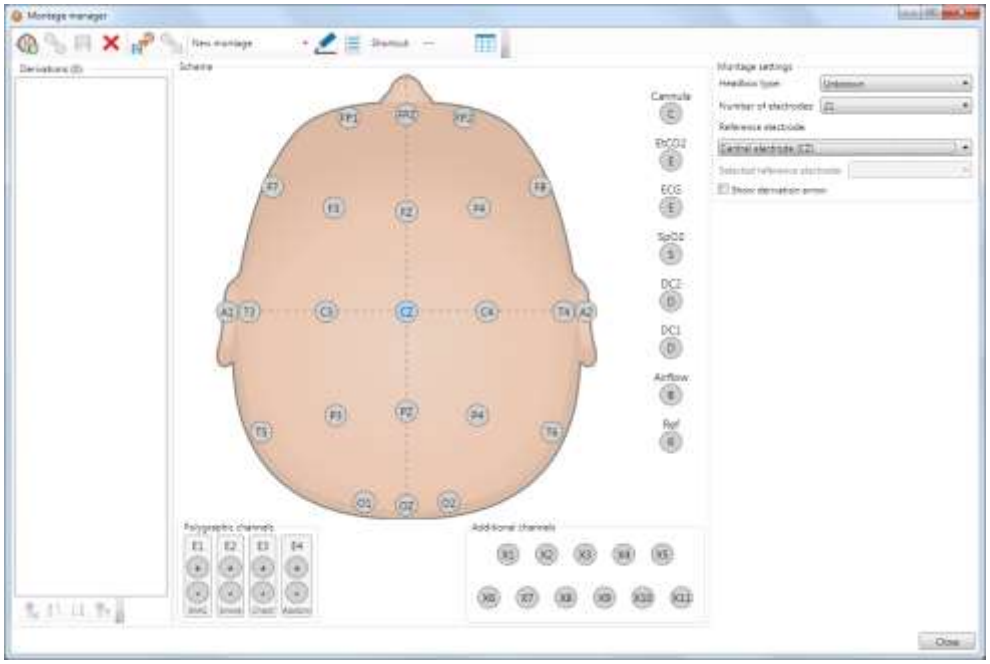


Fig. 8.7. Parameters of new montage.

Add several monopolar EEG derivations to the montage: F3-Cz, F4-Cz, C3-Cz, C4-Cz, O1-Cz, O2-Cz. To do it, left-click on the corresponding electrodes (Fig. 8.8).

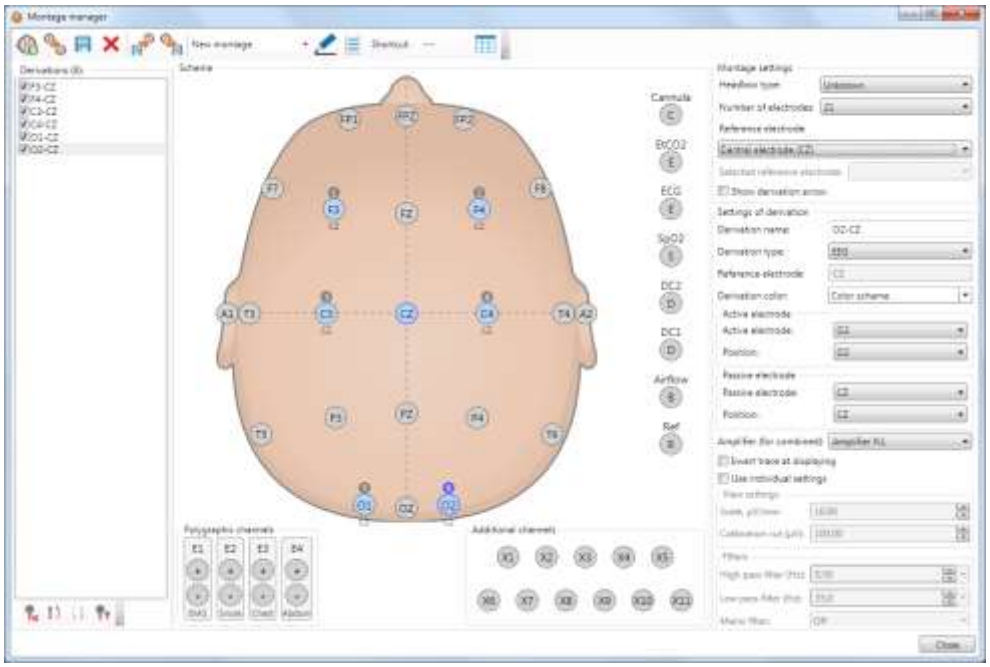


Fig. 8.8. Adding monopolar EEG derivations.

After that, add two EOG derivations to the montage: FP1-Cz, FP2-Cz. The parameters of these derivations should be changed using “Derivation settings” section in

the right part of the window. In this part (Fig. 8.5) select the type of derivations “EOG (left)” (left eyer) and “EOG (right)” (right eyer) respectively (Fig. 8.9).

Add EMG derivation from the first polygraphic channel to montage. To do it, point the mouse cursor to the first polygraphic channel “E1” and left-click on it.

After that, add ECG derivation to the montage. If your digital EEG and EP system has a separate connector for ECG, than you should only add the additional ECG channel to the montage. To do this, move the mouse cursor to “ECG” channel in the list of the additional channels located to the right of the electrode scheme on a head and left-click on it. Also, you can use any connector for EEG derivation as an ECG. For example, create the derivation “F8-Cz” and set “ECG” derivation type for it (Fig. 8.9).

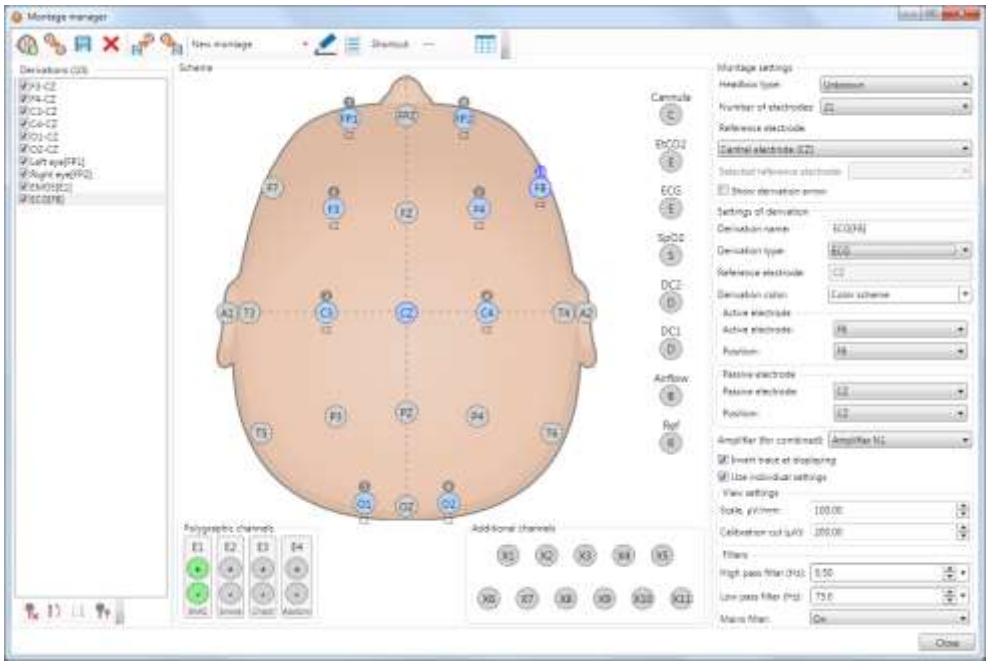


Fig. 8.9. Adding EOG, EMG and ECG derivations.

Add “Respiration”, “SpO_2” channels to the montage and “DC1” channel for body position sensor from the list of additional channels located to the right of electrode scheme on a head (Fig. 8.10).

To connect the snoring sensor, use “E2” polygraphic channel. Use polygraphic channels “E3” and “E4” to attach thoracic and abdominal movement efforts sensors respectively (Fig. 8.10).

To connect the limb movement sensors, create two bipolar derivations: “P3-T5” and “P4-T6”.

To do this, point the mouse cursor to “P3” electrode on the electrode scheme, left-click on it and holding it down, move the mouse cursor to “T5” electrode and release the mouse button. In the same way create “P4-T6” derivation. Set “Left leg” and “Right leg” in the “Site type:” drop-down box respectively (Fig. 8.10).

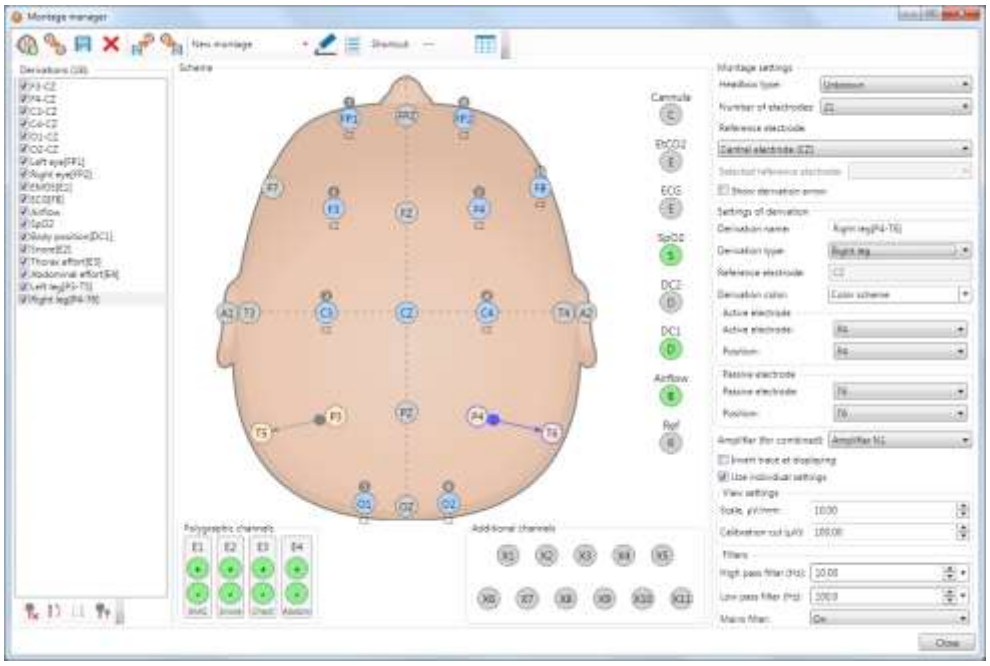


Fig. 8.10. Adding the following channels: respiration, SpO_2, body position, snoring, limb movement, thorax and abdomen.

The creation of the montage for polysomnography studies performing is completed.

8.2.2. Acquisition Styles

All program settings connected with EEG acquisition are combined into the acquisition styles. Use of several acquisition styles allows to switch quickly between the different sets of acquisition mode settings (for example, to perform exams using the different templates). You can set the current acquisition style using **Setup|Change…** main menu command (Fig. 8.3) or before new exam start directly (Fig. 4.3). During exam performing you can not change the current acquisition style but you can change any settings of the program and device separately using main menu and toolbar.

In “EEG acquisition styles” window (Fig. 8.11) you can change the existing styles of acquisition mode and create your own ones. To get an access to “EEG acquisition styles”, use “**Setup…**” button on “Acquisition. Acquisition style” page (Fig. 8.3) Before the beginning of each new exam (Fig. 4.3) you can select the current acquisition style and edit it.

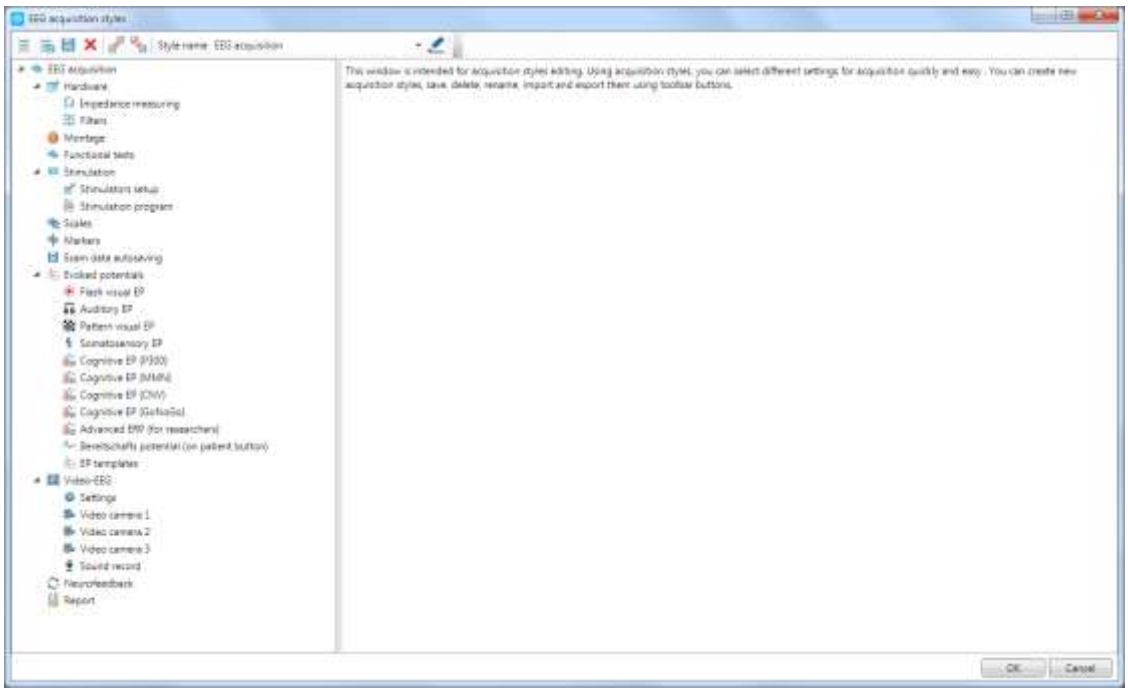


Fig. 8.11. Editing acquisition styles.

In the middle part of the toolbar of acquisition style manager you can see the name of the current style. Using the combo-box you can select other style for editing. Also you can create new styles (including on the basis of the current one), save the introduced changes, remove the styles, export them to file and import them from file (for example, to move to other computer) using the toolbar buttons. Besides, you can rename the style.

The working area of the window is divided into two parts:

- “Acquisition style settings” – it contains the settings elements.
- “Item properties” – it contains the description of the current element of the settings tree with the possibility to change its parameters.

Further all elements of acquisition style settings will be described.

On the “Hardware” page (Fig. 8.12) you can select the device from the list of the connected ones to be used for this acquisition style by default. Also you can run the testing program for the selected device and control its limitations in rent mode.

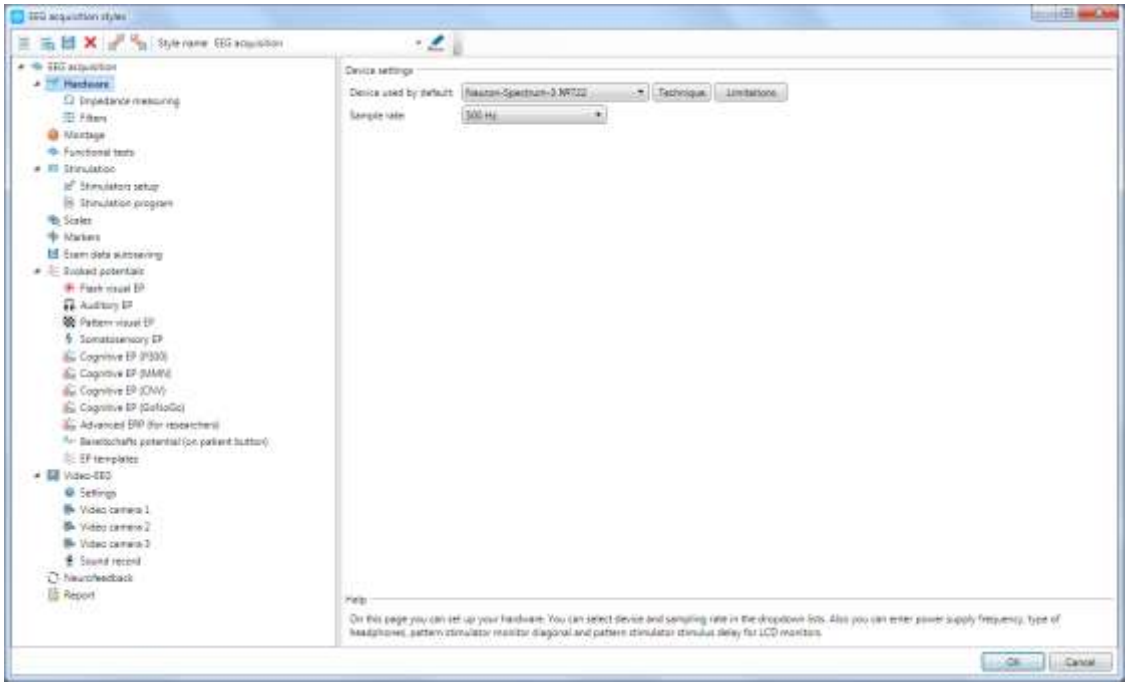


Fig. 8.12. Hardware settings.

Besides, on this page you can set the sampling rate of device (see section 4.2 “Sampling Rate Setup”). On “Hardware” page of “Settings” window (Fig. 8.2) you can also choose the power supply frequency for notch filter, level of the calibration signal, type of the used headphones, diagonal of the used pattern monitor and delay of pattern stimulus (for LCD monitors as they have some delay at the image displaying).

On the “Impedance measurement” page (Fig. 8.13) you can set the borders of impedance values to mark them red, yellow or green color. Also you can activate/deactivate the impedance indication on the front device panel, stepwise impedance measurement at device button pressing, enable automatic impedance measurement before the acquisition start or with the specified time interval.

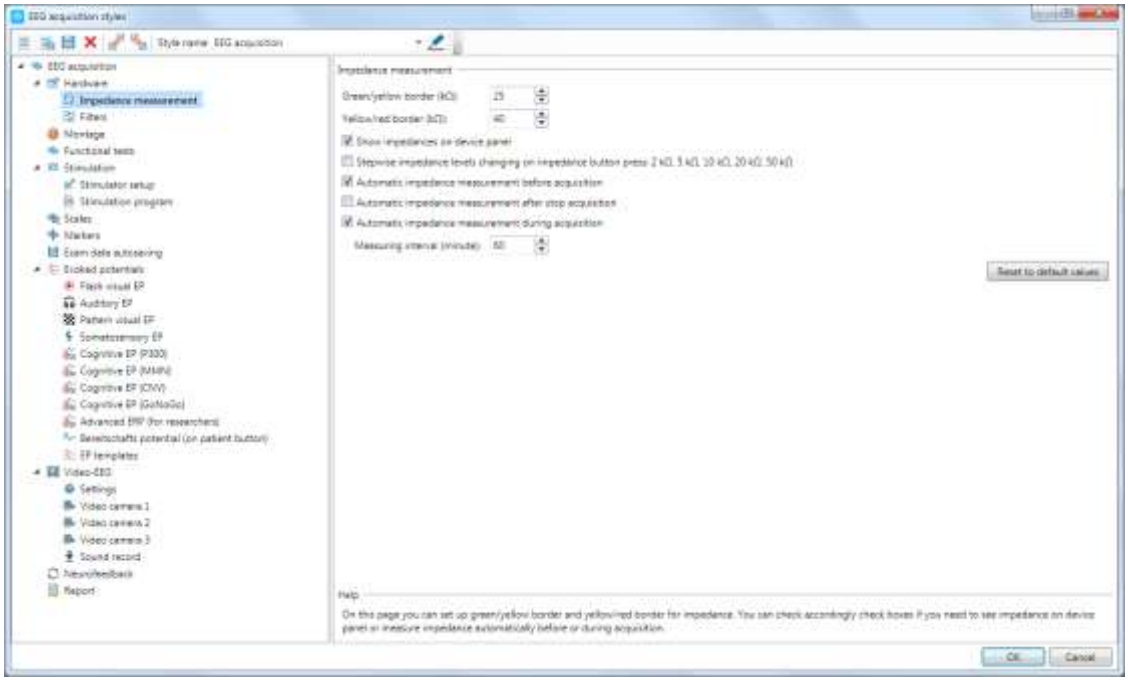


Fig. 8.13. Impedance measurement settings.

By default before the beginning of EEG recording the impedance measurement is run automatically if it has not been measured yet. You can disable this function by unchecking the corresponding checkbox.

On the “Filters” page (Fig. 8.14) you can adjust the parameters of filters used at EEG acquisition by default (see section 4.3 “Filter Setup”). You can set the high cutoff frequency and low cutoff frequency and also enable the use of the notch filter. At specified sampling rate equal to 200 Hz and higher, the non-filtered data can be stored in an exam, the filter will be applied only at traces displaying on the screen. The storage of non-filtered data in an exam will allow to review EEG traces with an arbitrary set of filters, changing high pass and low pass filters at EEG review on-the-fly. However, please, remember that “on-the-fly” filtration requires the additional computer resources and can slow down the speed of EEG review, analysis and generation of exam reports.

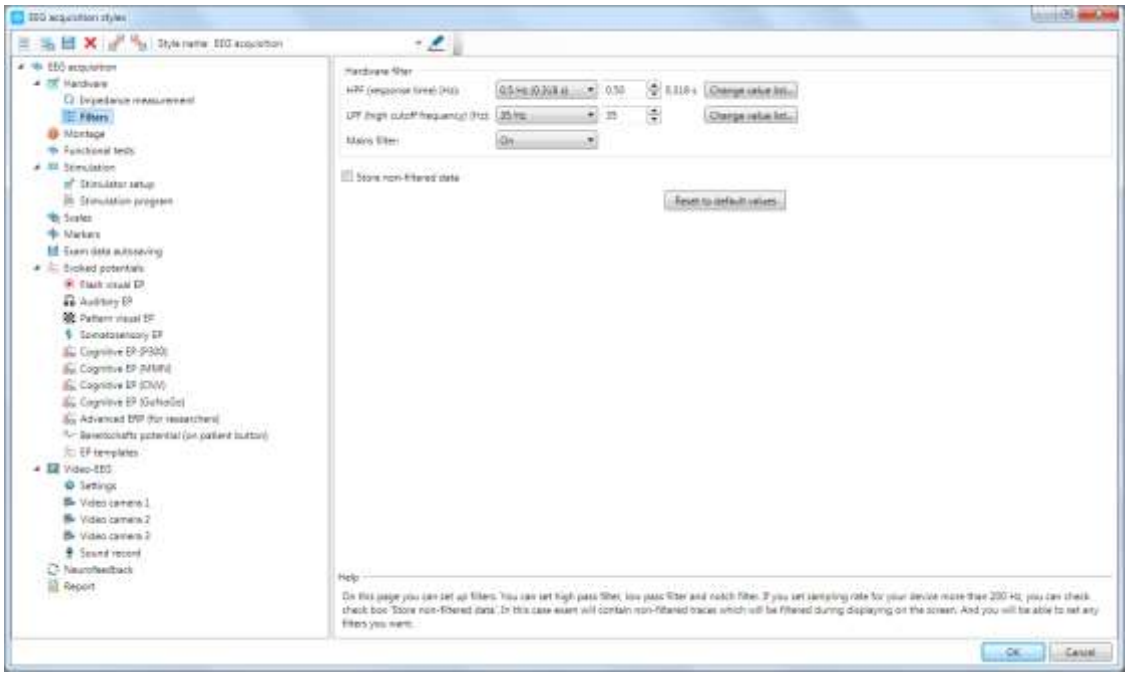


Fig. 8.14. Filter settings.

You can set the frequencies of filters by either selecting them from drop-down box or entering them manually in the corresponding input boxes if the required values are missing. Besides you can add your values of cutoff frequencies to drop-down lists or remove the unnecessary frequencies (Fig. 8.15). To do this, press “Change value list” button (Fig. 8.14). During the acquisition you can change the selected frequencies of filtration. Also you can adjust the specific filtration parameters.

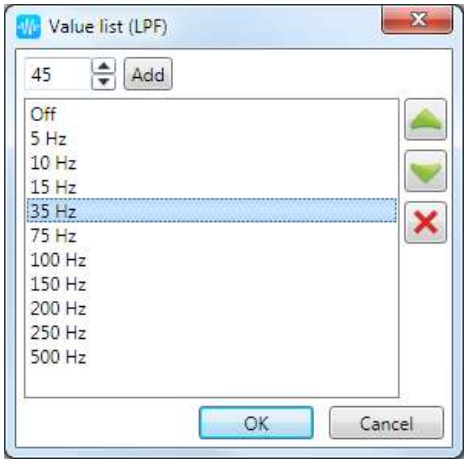


Fig. 8.15. Editing LPF list.

On the “Montage” page (Fig. 8.16) you can see the current active montage used by default in this acquisition style. Using the combo-box, you can set other montage. During EEG acquisition or review you can change the acquisition montage or review. Also you have an access to the montage manager from this page (see section 8.2.1 “Montage Editing”).

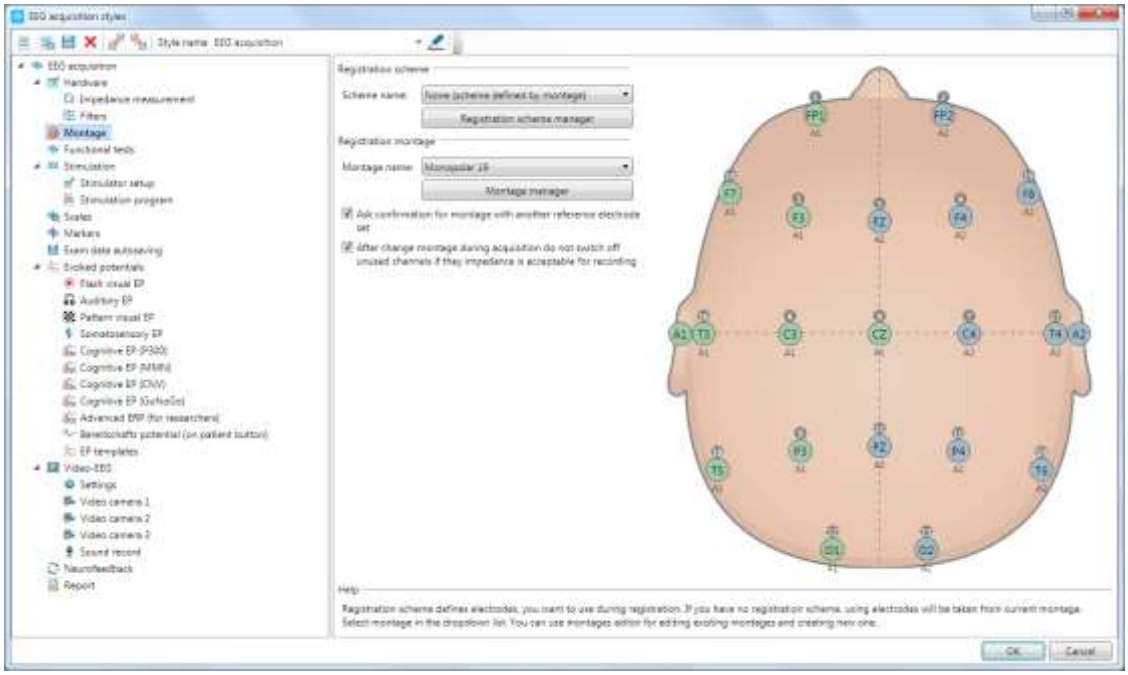


Fig. 8.16. Selecting current montage.

Besides the montage you can create the registration scheme. The registration scheme defines the list of electrodes used at the acquisition and the reference electrode. If you have the registration scheme, than during an exam recording you will have an access only to those montages which correspond to the selected registration scheme. The digital EEG and EP system is programmed according to the selected registration scheme (i.e. only channels indicated in the registration scheme regardless of the current specified montage will be recorded). If the registration scheme is not selected, all montages from the list will be available for you and the device will be programmed according to the selected montage (i.e. the channels indicated in the current montage will be recorded, if you switch the montage the used channels will be reprogrammed). In this case the signal is not recorded by non-used channels.

Using the combo-box you can select the registration scheme, and with “Montage manager” button you can create new registration schemes, edit them and remove the existing ones. The principle of the registration scheme creation is similar to the creation of the montages (Fig. 8.17).

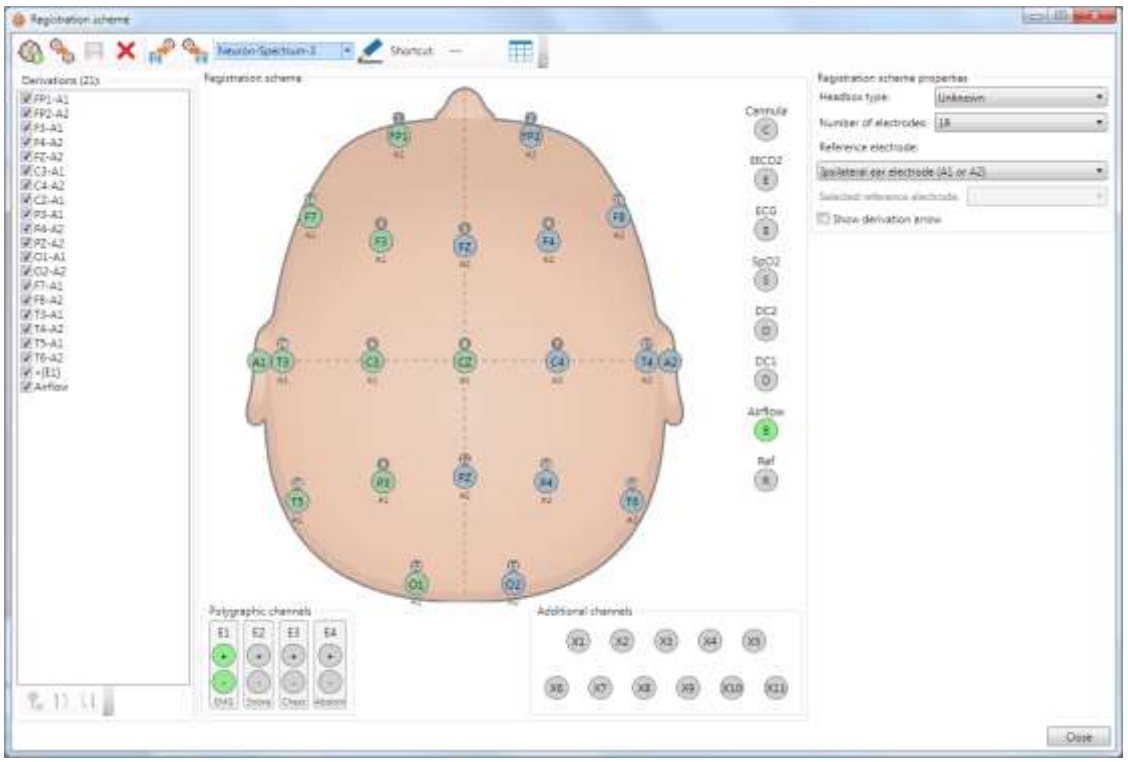


Fig. 8.17. Editing registration schemes.

On the “Functional tests” page (Fig. 8.18) you can specify the current list of the functional tests for this acquisition style. In the right part of the page all available functional tests are listed. Using the checkboxes near them you can select the tests to perform. With the buttons under the test list you can add, change or remove the existing functional tests. The sequence order of functional tests included to the acquisition style (the list leftward) can be changed using the buttons under the list.

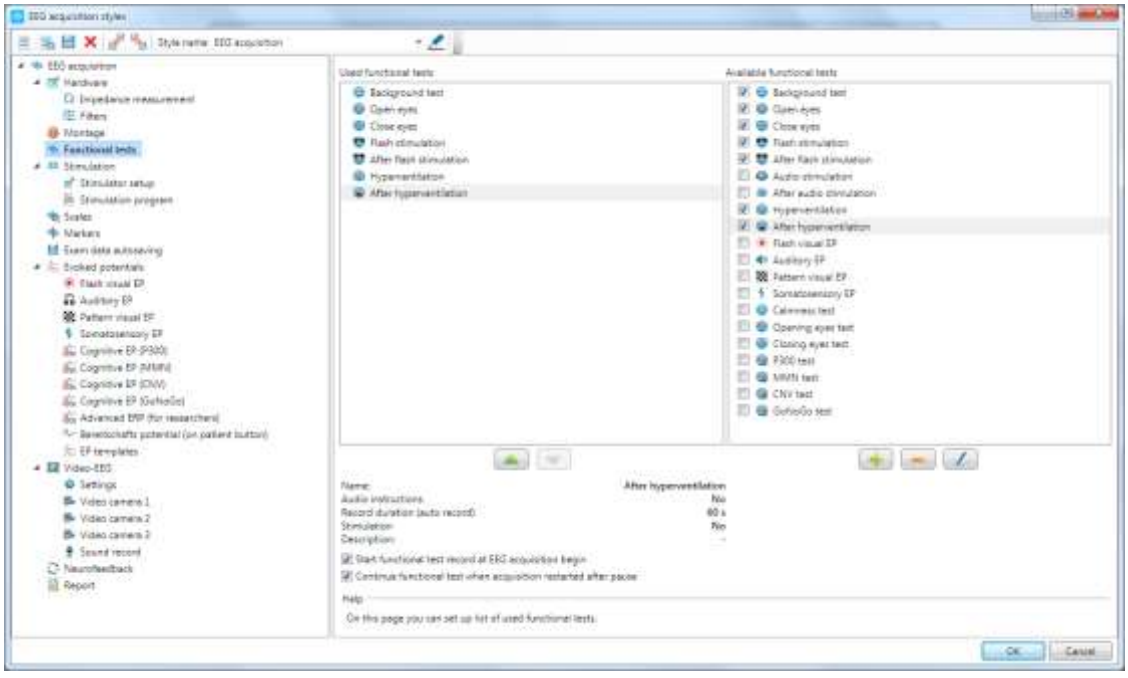


Fig. 8.18. The setup of the functional tests.

In the functional test manager (Fig. 8.19) you can indicate the name of the test (full and short), specify the hotkey combination, the icon for displaying. To select an icon,

press the square area to the left of “Browse” button with the left mouse button and select the icon from the combo-box (Fig. 8.20). Using “Browse” button you can set an icon for a functional test from an arbitrary graphic file.

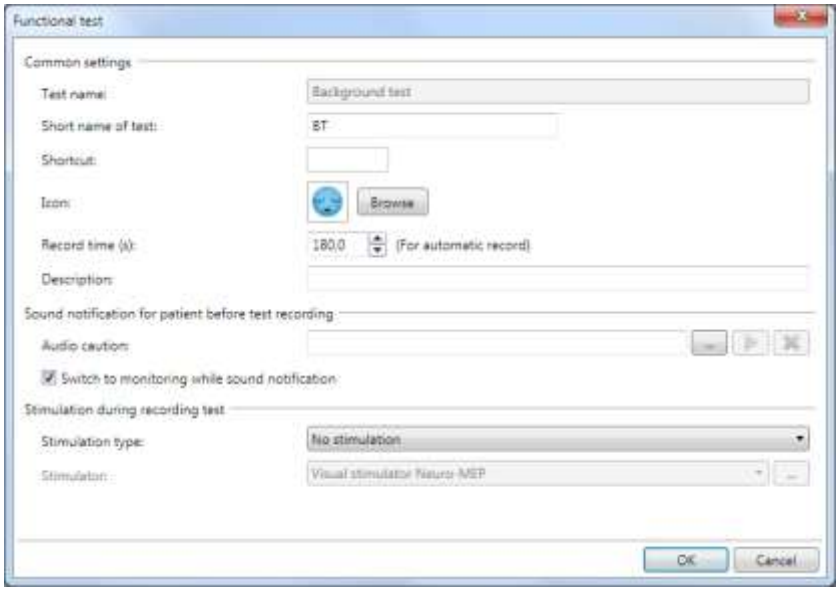


Fig. 8.19. Editing functional test.

Fig. 8.20. Selecting an icon for functional test.

Also in the functional test manager you can specify the time of the test record at the automatic acquisition of functional tests (see section 4.12 “Functional Test Acquisition”), for example, with the use of acquisition wizard (see section 8.2.3 “Acquisition Wizard”). For each functional test the description line is provided, here you can enter the arbitrary text information.

Before the beginning of each functional test recording, a doctor performing an exam, usually offers a patient to execute these or those actions (for example, to breath deeply or relax and close the eyes). As a rule, a doctor has to repeat one and the same phrases for each patient at the performing the single-type exams. To get rid a doctor of these repetitions, the program provides a possibility to play back the indicated audio files before the recording of any functional test. In the functional test manager you can indicate the file with audio notification related to this test. In the “Sounds” file of Neuron-Spectrum.NET working directory there are some files with audio notification for the typical functional tests but you can record your own audio notifications in **.wav* format. During the audio notification playing back the program can switch to the monitoring mode and continue EEG recording.

During the recording of some functional tests it is sometimes required to perform a patient's stimulation (see section 4.13 "Stimulation during EEG Acquisition"). For each test you can indicate the stimulation type (without stimulation, manual or software). If you choose the manual stimulation, you can also select the stimulator and set it up for this test. In this case in the beginning of the test record, the selected stimulator will be programmed according to the specified settings (at that the stimulation start does not occur). If you choose the software stimulation, you can indicate the stimulation program for this test. In this case the selected stimulation program starts automatically at the beginning of the test recording. During the acquisition of the functional tests for which the stimulation is not specified (without stimulation), the automatic programming of the stimulators and the stimulation start do not occur but you can adjust the parameters of stimulation and perform the stimulation during the whole EEG record (see section 4.13 "Stimulation during EEG Acquisition").

To adjust the stimulators and create the stimulation programs for the current acquisition style, use "Stimulation" page. On the "Stimulators setup" page (Fig. 8.21) you can set up all the supported stimulators. The stimulator settings specified in the acquisition style, will be downloaded to the hardware before the exam recording. At that you can change the stimulation settings during an exam recording (see section 4.13 "Stimulation during EEG Acquisition").

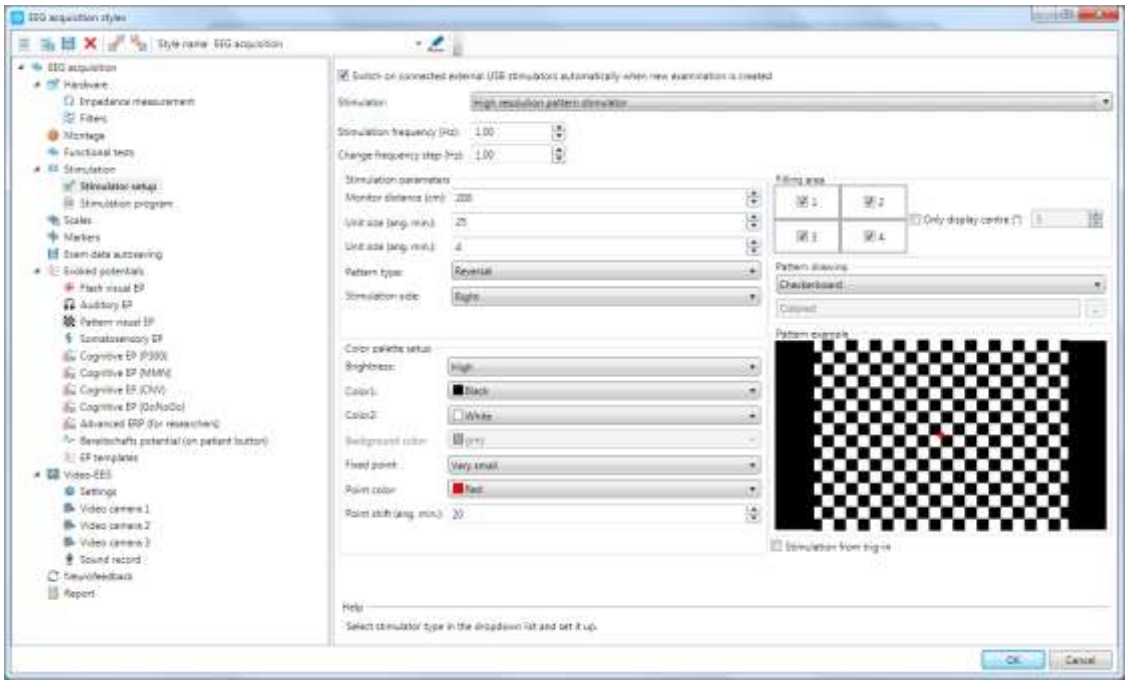


Fig. 8.21. Adjusting stimulators.

On the “Stimulation program” page (Fig. 8.22) you can select the stimulation program for the current acquisition style from the list of all available stimulation programs. Also, you can create new stimulation programs, edit the existing ones and remove them. The stimulation program consists of one or several stimulation commands executed consequently. For each stimulation command you can select the stimulator and adjust its settings. Besides, the pauses between stimulation commands can be included in the stimulation program.

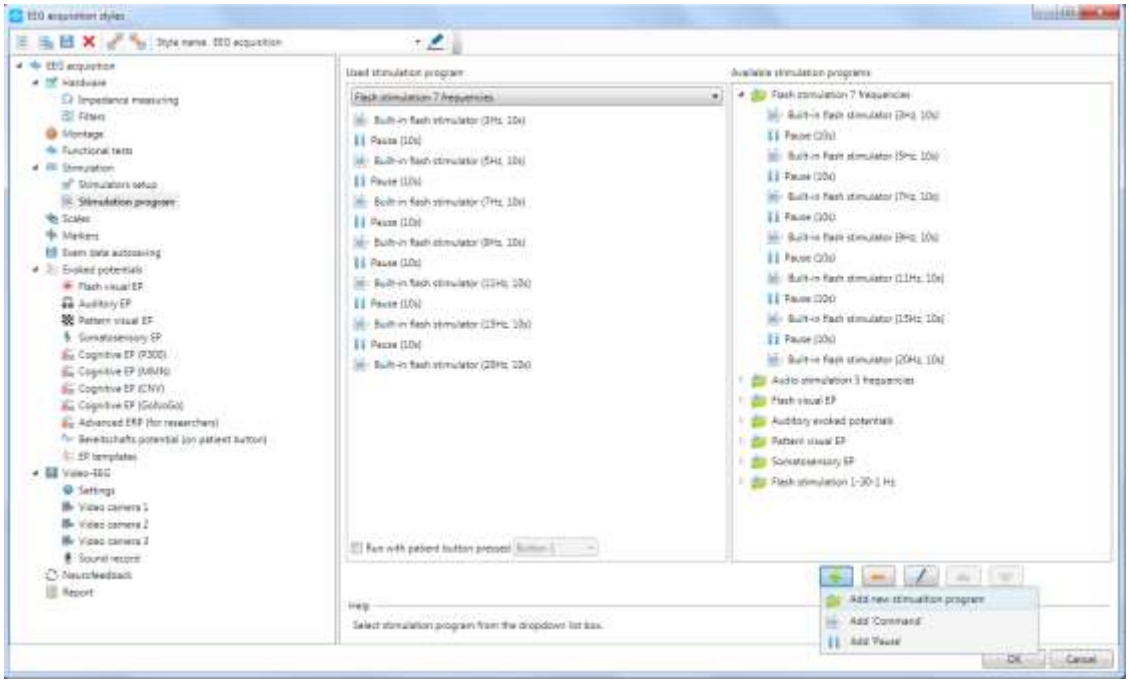


Fig. 8.22. The stimulation program setup.

We offer you to consider the example of stimulation program creation. Let us assume that it is required to create the photic stimulation program (using photic stimulator of the digital EEG and EP system) starting from 5 Hz stimulation frequency with its further increase up to 20 Hz. The stimulation interval for each frequency – 20 seconds, the frequency increase step is 5 Hz. To create a new stimulation program, use drop-down menu of  button located under the list of available stimulation programs and enter the name of new stimulation program (Fig. 8.23).

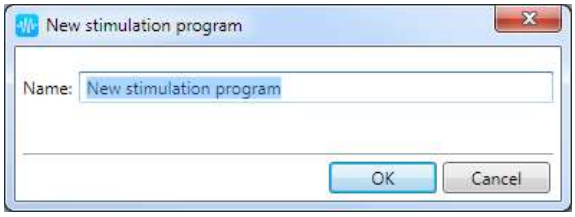


Fig. 8.23. Creating new stimulation program.

The new stimulation program will be added to the list of available ones. To add first stimulation command, use  button again. In the appeared dialog box enter the stimulation command parameters (Fig. 8.24).

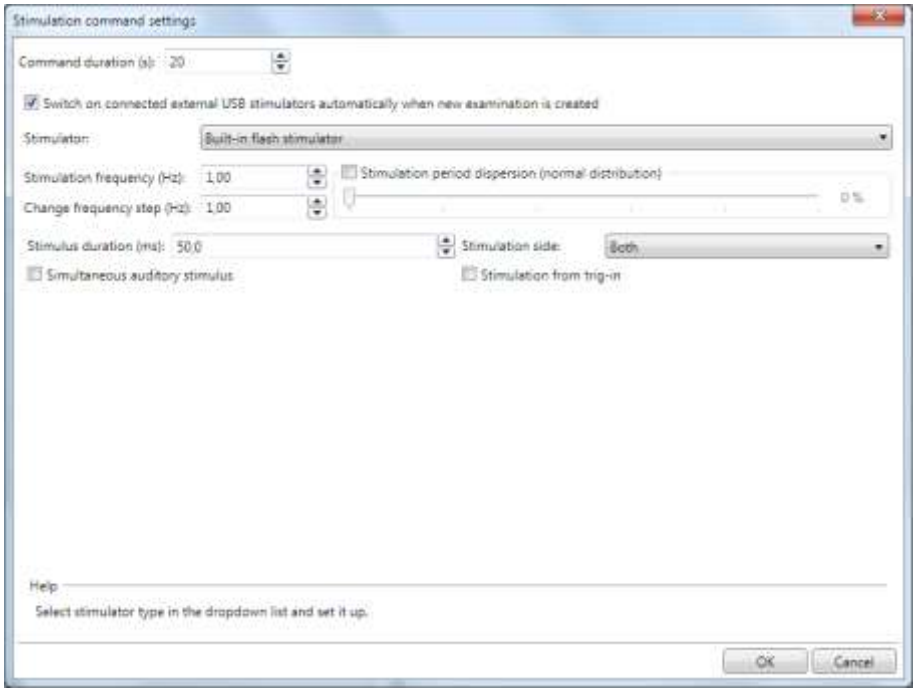


Fig. 8.24. The setup of stimulation command parameters.

In the “Stimulation command settings” window, you can set the duration of stimulation command, the stimulator type and all its parameters. Set 20 seconds duration and 5 Hz stimulation frequency of the first stimulation command. In the same way, add 10, 15 and 20 Hz stimulation commands to the new stimulation program. For stimulation command with 20 Hz frequency, it is necessary to change the stimulus duration as at 50 ms stimulus duration and 20 Hz stimulation frequency, the stimulator will operate continuously. That is why set 40 ms stimulus duration for the stimulation command with 20 Hz frequency. If you wish, you can add the intervals without stimulation to the stimulation program. To do it, use drop-down menu of  button to add the pause. The stimulation commands with different stimulators can be used within one program.

On “Scales” page (Fig. 8.25) you can adjust the scale and sweep speed of EEG traces by default and also the visibility and the size of calibration cuts. During the acquisition or review of an exam you can change the scale of displaying and sweep speed of traces. Besides, each derivation can have specific settings of displaying. Also you can change the list of scale values and sweep speeds to select them quickly during an exam.

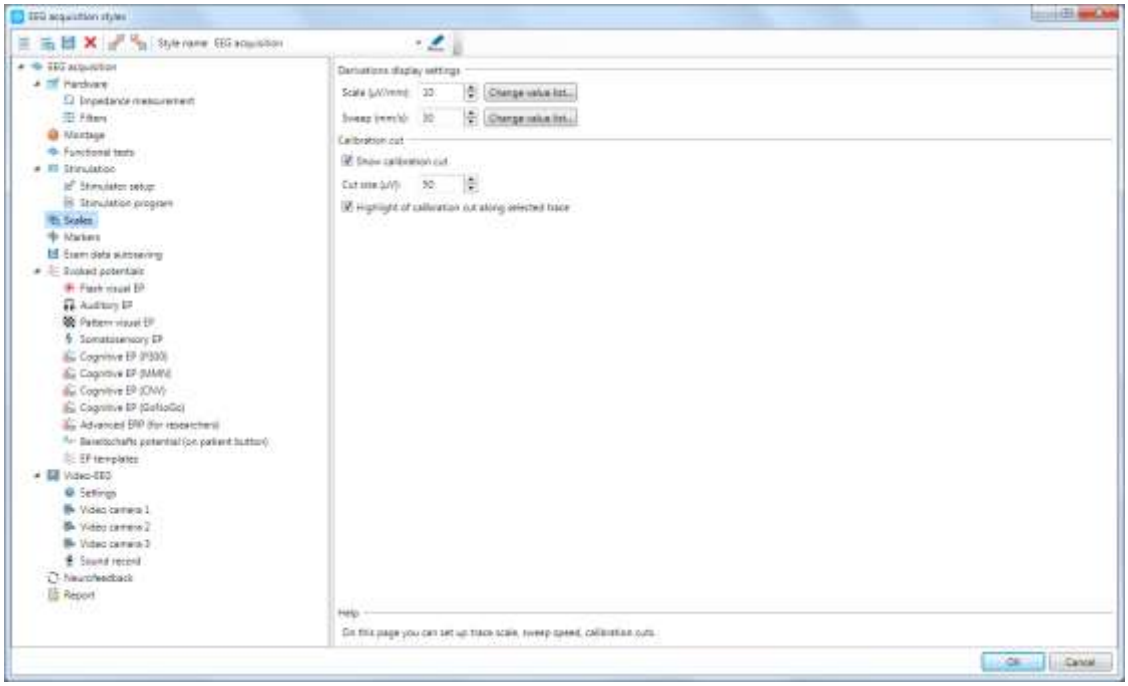


Fig. 8.25. Adjusting scales.

On “Markers” page (Fig. 8.26) you can see the list of available event markers in the right part of the window (see section 4.14 “Event Markers”). In the left part of the window you can see the list of event markers selected for use in the current acquisition style. You can add new markers, change and remove the existing ones. For each marker you can specify the hotkey combination for quick marker arrangement on EEG. Also, you can specify the view of event markers on EEG traces.

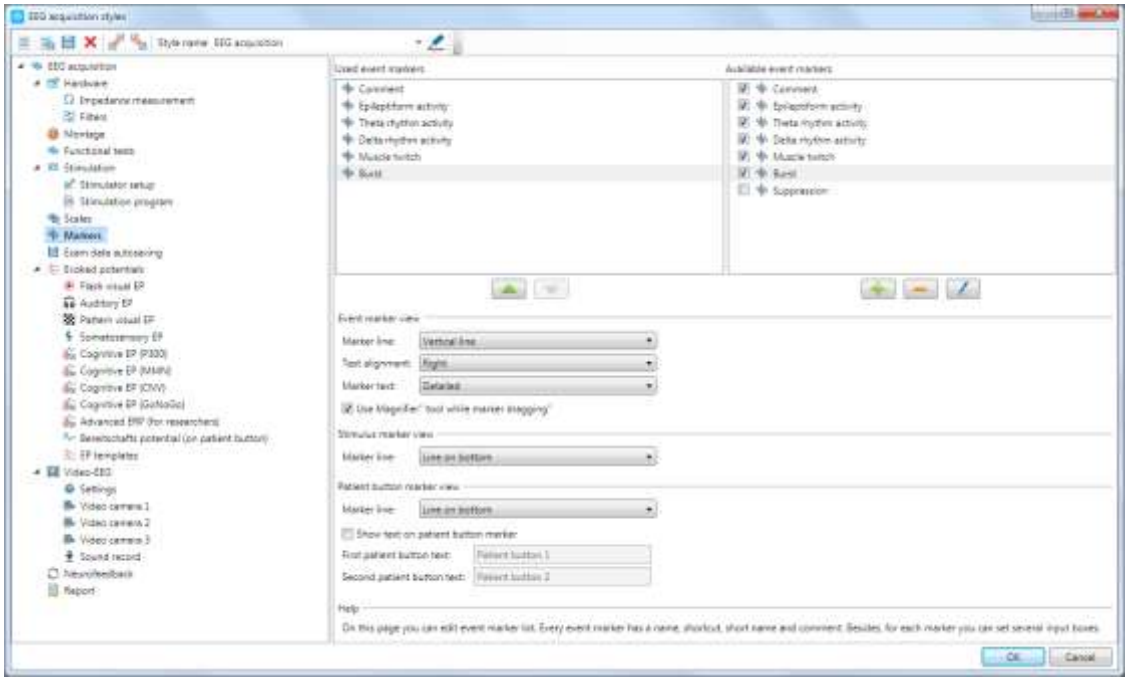


Fig. 8.26. The setup of event markers.

When creating new event marker (Fig. 8.27) you can specify its name (full and short), hotkey combination for quick marker arrangement on EEG, icon, color and type of marker. The marker line color is defined by the current color scheme of the program by default (8.4 “Color Scheme”), but if you wish, you can set the individual color for a marker.

The markers are divided into two groups: the event markers and the markers with data input. The event markers indicate the definite event occurence at a certain moment of EEG record. The markers with data input both indicate the definite event occuring and store the additional information about it (for example, to enter the blood pressure or heart rate of a patient during EEG record). For markers with data input it is required to define the set of input boxes, which will be filled by a user during marker arrangement on EEG.

Also process-markers are created to show some processes during exam. As opposed to event markers, the process-markers have onset and offset. Using process-markers you can indicate some impacts with certain duration (for example injection and effect of a drug).

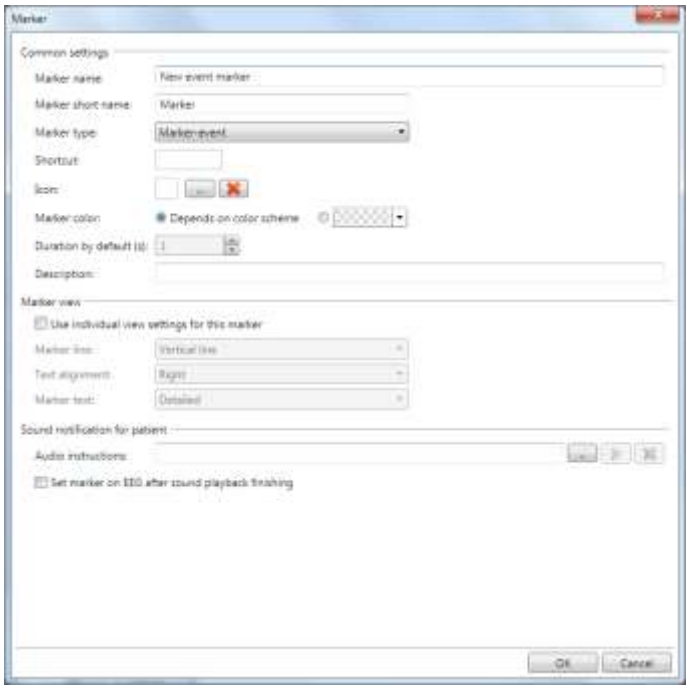


Fig. 8.27. Creating new event marker.

On “Exam data autosaving” page (Fig. 8.28) you can set the time interval for automatic exam saving during EEG acquisition. It is very important for the recording of long-term EEG exams to prevent the data loss in the result of power failure or other emergencies. The exam recording terminated because of emergency can be continued by opening the required exam and selecting **Exam|Restart acquisition** menu item.

Besides, you can set various parameters of auto saving, set the automatic segmentation of long examination into shorter ones, for example, to make 3 8-hour exams instead of 24-hour one. It can be required if you want to analyse and edit the exam periodicaly while it is acquired. The option of automatic data saving at the record beginning and after its completion can be also useful.

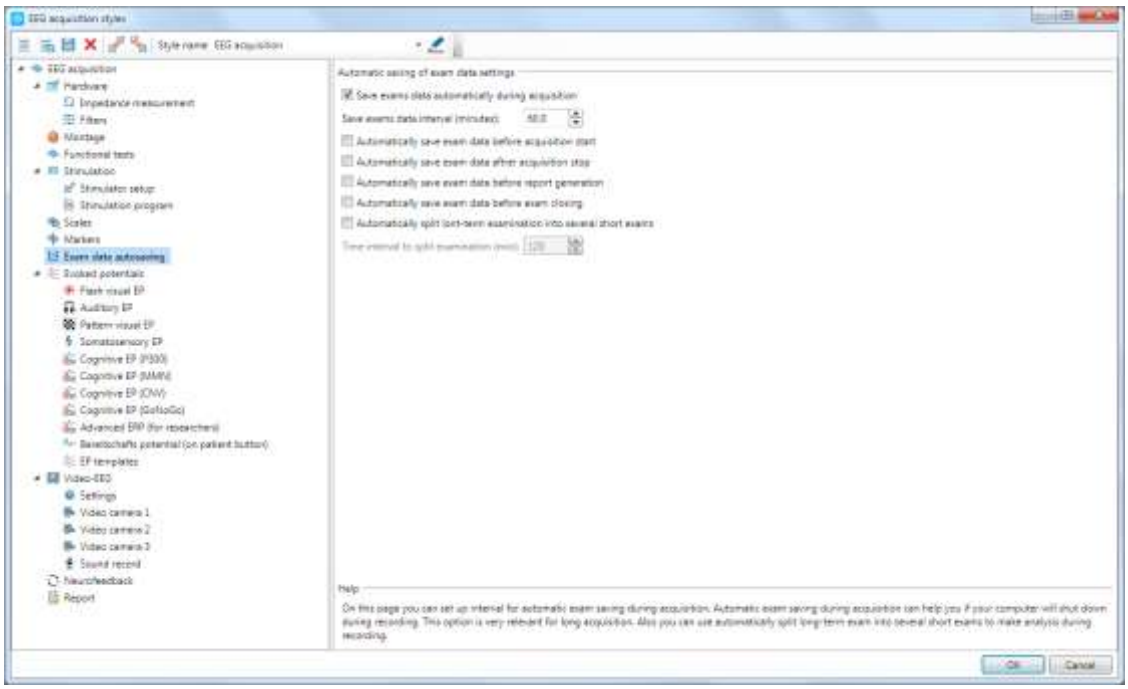


Fig. 8.28. The setup of automatic exam saving.

Using “Evoked potentials” page (Fig. 8.29), you can adjust the acquisition parameters of the evoked potentials (filters, epoch length, number of averagings) and stimulation parameters.

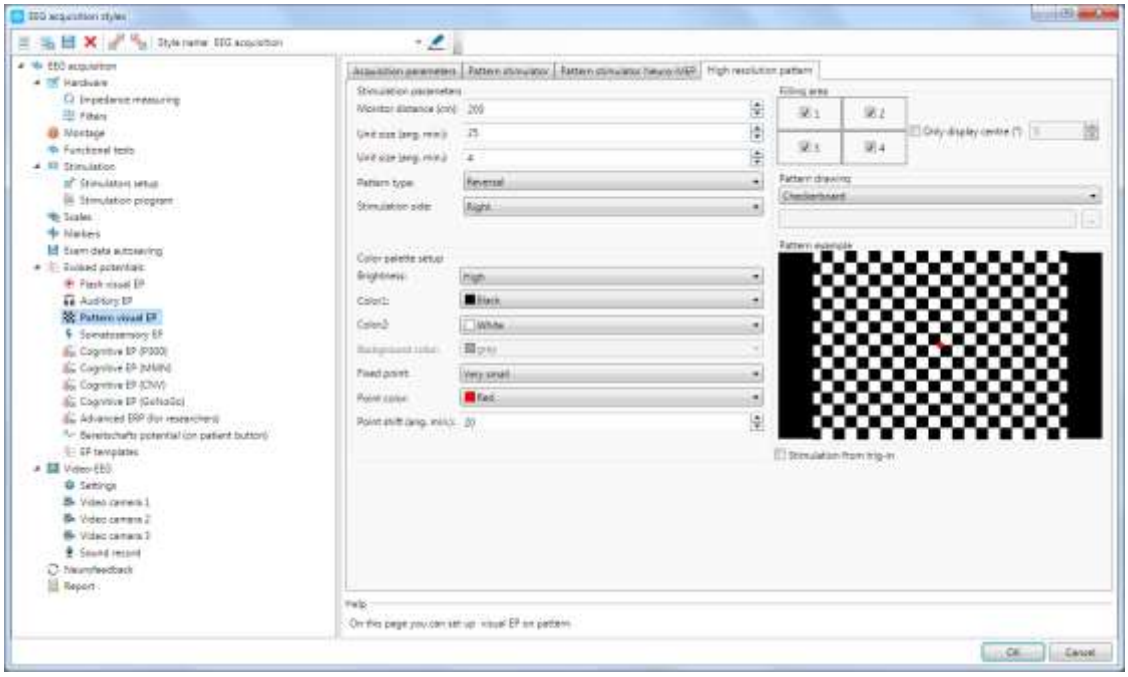


Fig. 8.29. The setup of stimulators for evoked potentials.

On “EP templates” page you can create the templates of stimulators settings. When you record EP, you can switch quickly between different settings using preset templates.

Using “Video EEG” page (Fig. 8.30), you can set the parameters of the synchronous video recording during the exam acquisition. The recording can be performed from three video cameras simultaneously, and you can set up the parameters of each of

them. Besides, the automatic cut of video to the fragments is performed during video recording. It is done to provide the possibility of the further removal/saving of video by parts. You can set the duration of video fragments. You can set the duration of video fragments. Also, if your video camera supports the option of control from the computer, you can set the video camera control protocol and port of control cable connection to the computer.

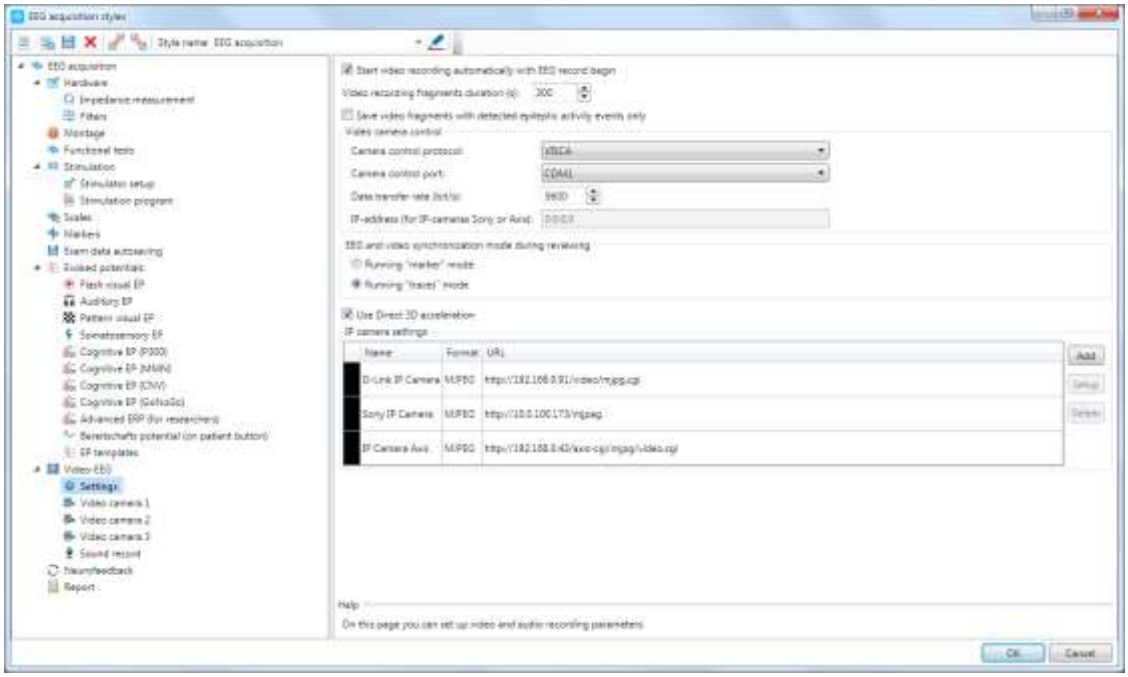


Fig. 8.30. The setup of video EEG.

You can set up available IP cameras on this page. To do this, press “Add” button. You can connect the IP camera using the HTTP, RTSP или ONVIF protocol. In the appeared dialog box (the dialog box view depends on the selected protocol) (Fig. 8.31) set the name of your network camera, network address (URL), login and password to get an access and video resolution used.

Fig. 8.31. Adjusting IP camera.

On “Report” page (Fig. 8.32) you can preset the report template to be used by default for exams recording for the selected acquisition style (see section 7.2 “Exam Report on Basis of Template”).

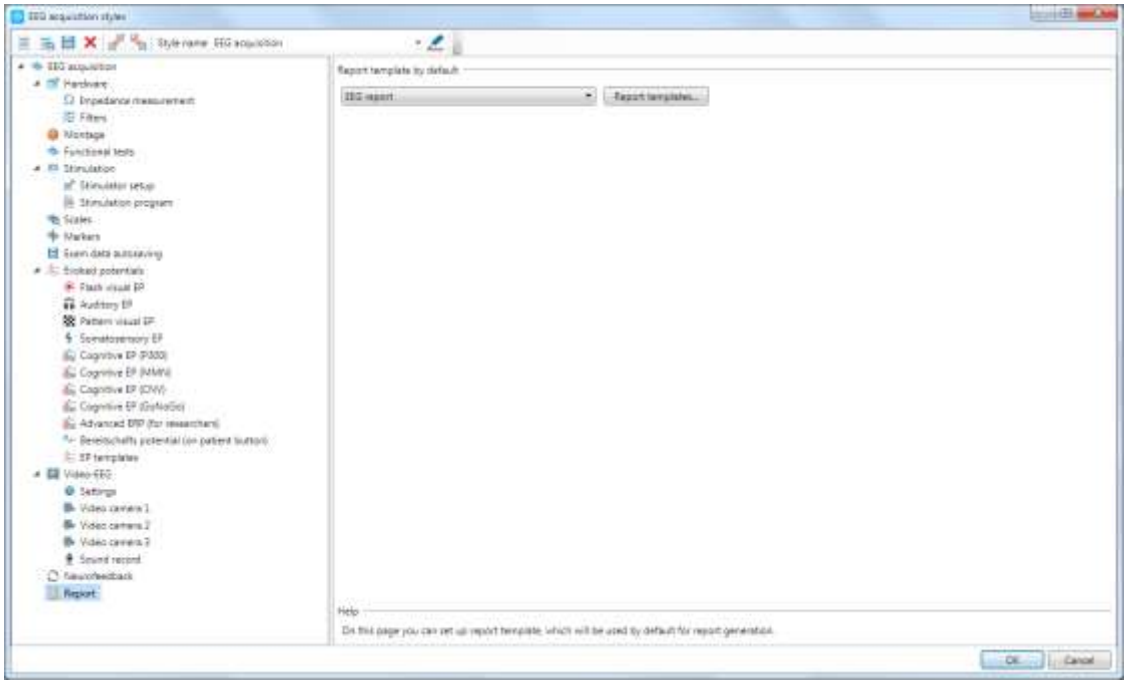


Fig. 8.32. Customizing report template.

8.2.3. Acquisition Wizard

Neuron-Spectrum.NET software allows to perform EEG acquisition in automatic mode using the acquisition wizard. In the acquisition wizard settings (Fig. 4.3, Fig. 8.3) you can set the operations which should be carried out during an exam. For example, in the acquisition wizard settings you can activate/deactivate the function of the impedance measurement before the beginning of EEG recording (see section 4.6 “Electrode Impedance Measurement”), perform the monitoring and recording of calibration signal and EEG, indicate which functional tests are to be recorded during an exam. You can set the duration of monitoring, EEG recording and calibration. During recording of functional tests in the automatic mode, pay attention to its duration specified in its settings (Fig. 8.19).

On the “Acquisition style” page of “Settings” window, you can adjust the acquisition wizard settings used for an exam acquisition (Fig. 7.3). Before the beginning of each new exam, you can set up the acquisition wizard or deny its use (Fig. 4.3).

We offer you to consider the example of typical EEG exam recording using the wizard. Let us assume that it is required to measure the impedance during an exam and perform the recording of selected functional tests after several seconds of monitoring. To do it, adjust the functional test beforehand, set its duration at the automatic recording and, if you wish, indicate the audio files with notifications for these tests (Fig. 8.18, Fig. 8.19). The example of the acquisition wizard settings is shown in Fig. 8.33.

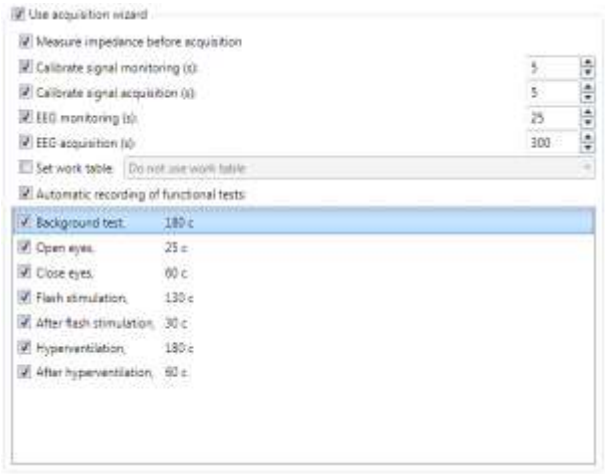


Fig. 8.33. The example how to adjust acquisition wizard.

After a patient's card filling (see section 4.1 "Creation of Patient Card") the acquisition wizard will run automatically the impedance measurement. On impedance measurement completion, EEG monitoring shall continue for 25 seconds and signal recording shall do for 300 seconds. After that, the selected functional tests will be recorded consequently, and the exam recording will be finished.

On exam recording completion (both using the wizard and without it), you can pass to the analysis of the recorded exam.

8.2.4. Exam Export

On “Examination export” page you can set up the automatic export of all recorded exams to one of available data formats (Fig. 8.34). You can specify the path to save. If you use special program to synchronize data with cloud storage, you can upload performed exams to your cloud storage using automatic export function. Also you can select the format to export upon your choice. For example, if you plan to review the exam at smartphone or tablet computer, you can export an exam in graphic file format (**.png*) or document format (**.rtf* or **.pdf*). Also an exam can be exported as a video file (**.avi*). If it is required to review and analyze EEG exam, it is preferable to use EDF or NSARC format. An exam can be exported in several different montages.

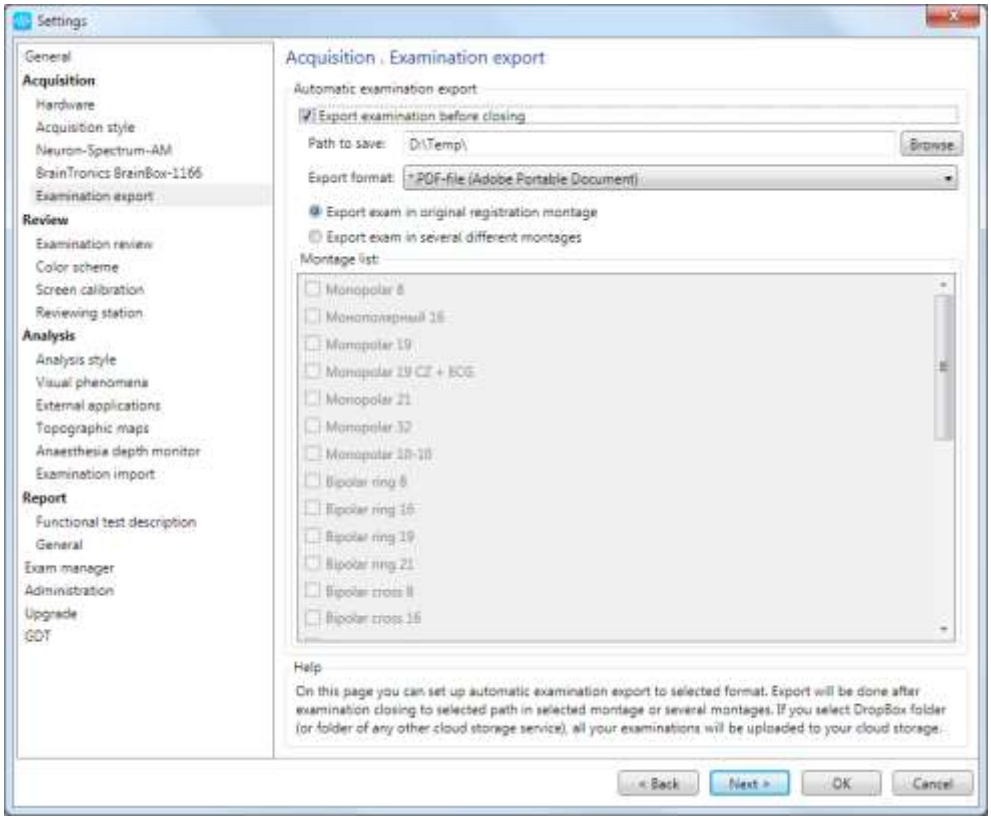


Fig. 8.34. Adjusting automatic exam export.

Neuron-Spectrum.NET software provides an opportunity to save automatically recorded exam into the following formats:

- PNG. The exam is saved as a set of graphic files with EEG traces. If you save exam in this format, it will be saved as several graphic files with EEG traces. The advantage of this method is the possibility to view saved exam on any computer with any operating system.

- PDF (Adobe Portable Document). The exam with acquired traces and created reports is saved as PDF file. It is possible to view saved exam on any computer with any operating system.

- RTF (file of Rich Text format). The exam with acquired traces and created reports is saved as RTF file. It is possible to view saved exam on any computer with any operating system.

- EDF (European Data Format). Exam saved in this format can be opened only in specialized programs, but in this case you have an opportunity to change montages, displaying scale, sweep speed, filters etc.

- NSARC-archive. It is a special format used only in **Neuron-Specrum.NET** software. In case you save exam in this format you will be able to view it only in **Neuron-Specrum.NET** software. Exam saved in this format contains all exam data, including video.

- AVI video. The exam is saved as video and you will be able to view it on any PC. If you choose this format for exam export before acquisition start, the software prompts you for video codec used for video stream compression. It is recommended to use H.264 codec. It ensures the high quality of the video at small size of video file. Using this format you can export even many-hour-long exams to video files.

Exam export is done after acquisition completion and closing. The exam copy is saved in the specified format in the selected folder. The original exam is saved in the database. As it was stated before, this option can be used for automatic copying of all performed exams both to selected computer folder and cloud storage in Internet (if computer is connected to Internet). To do this, install cloud storage gateway (special program) of one of cloud storage providers (Dropbox, SkyDrive, Google Disk, Yandex.Disk, etc.) to your computer and select the required computer folder to save exams (Fig. 8.34). In this case all exams copied to this folder will be automatically uploaded to cloud storage in Internet that can be accessed from anywhere in the world. If you keep your exams in the cloud storage in Internet, they can be accessed by several users at any time using any device with Internet connection.

8.3. Adjusting EEG Review

On “Examination review” page of “Review” section (Fig. 8.35) you can set EEG review parameters when opening the exam. For example, you can set the montage and all exams will be opened in this montage (by default the exam is opened in the montage, it is recorded). Also some parameters of EEG display and navigation can be specified.

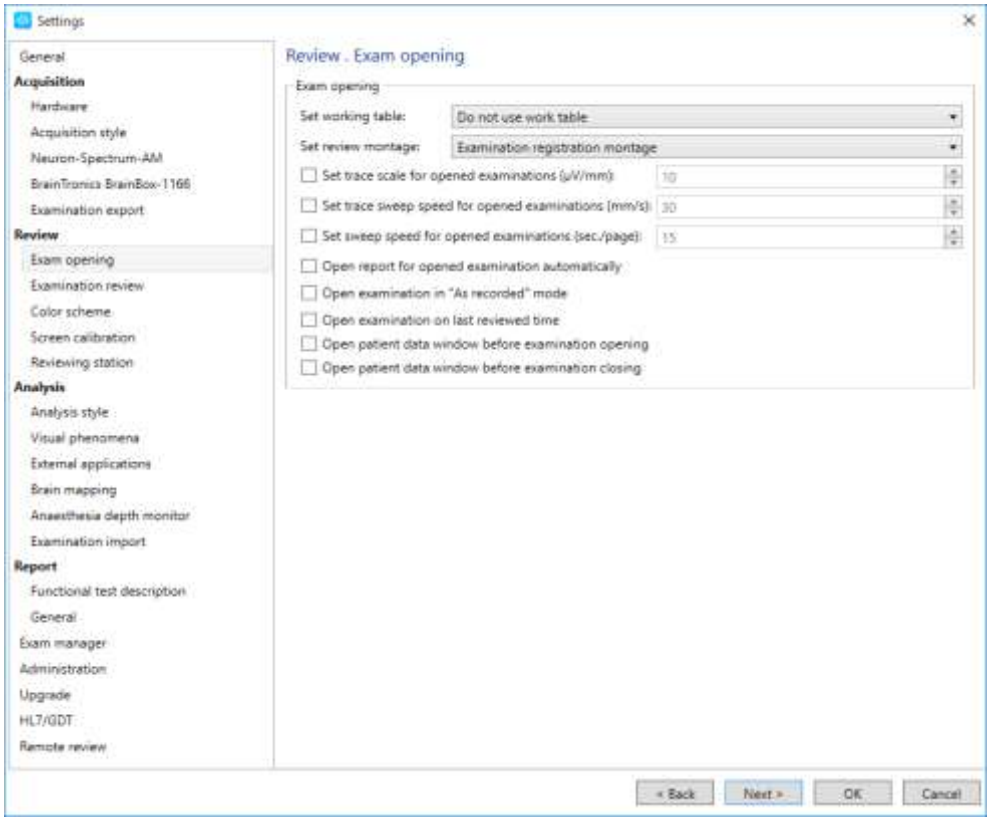


Fig. 8.35. Adjusting EEG review.

You can also activate the automatic trace scaling during EEG acquisition. This option is especially useful at PSG exam acquisition when amplitude of signals from some sensors depends on patient and changes from exam to exam.

Note: DirectX smoothing can require the updating of video card drivers. If the traces are vizualized improperly, disable the DirectX smoothing.

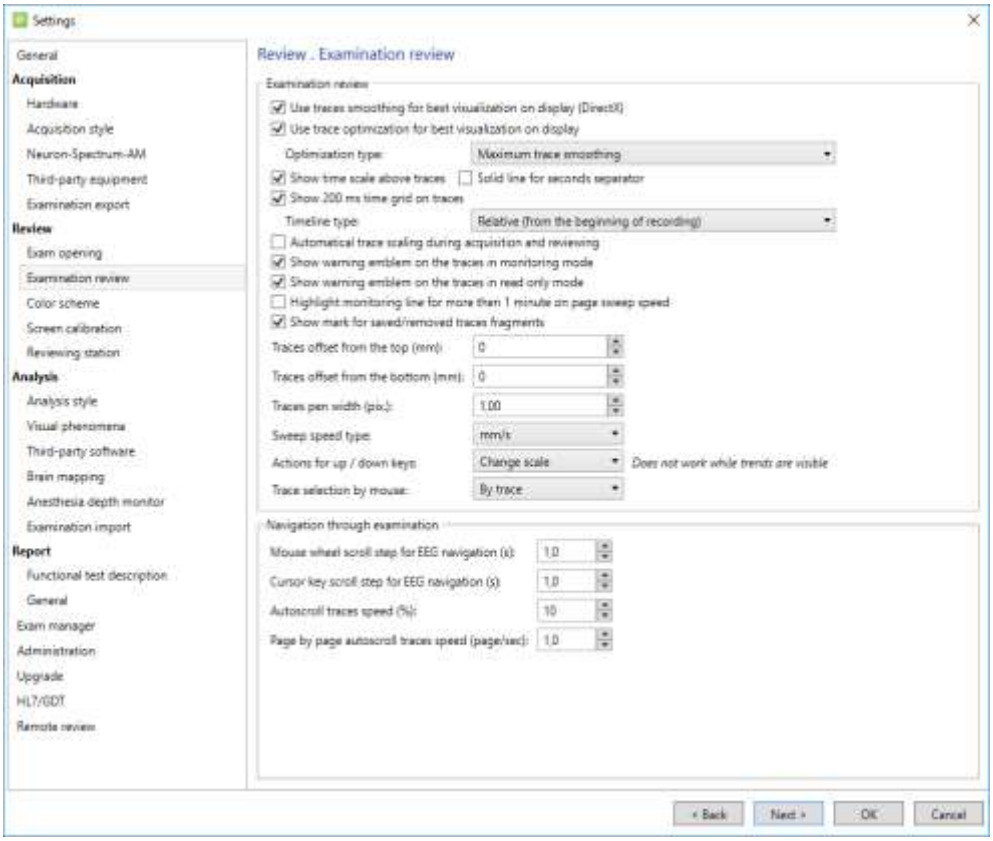


Fig. 8.36. Examination review.

On this page, you can enable/disable the function of trace smoothing and trace optimization for best visualization on display, select the optimization type, specify offset of traces from the top and bottom, change pen width to draw traces, specify a sweep speed type, select navigation through examination (e.g., select mouse wheel scroll step and cursor key scroll step for EEG navigation from the drop-down list, etc.)

8.4. Color Scheme

On “Color scheme” page (Fig. 8.37) you can change the current color scheme or create your own color scheme. The colors of all program elements visible on the screen are defined in the color scheme. You can select the color of EEG trace background, the color of the selected fragments, the color of the event markers, analysis epochs, etc. If you have several color schemes, which are set differently, you can switch quickly between them at any moment of operation with the program to change its external view.

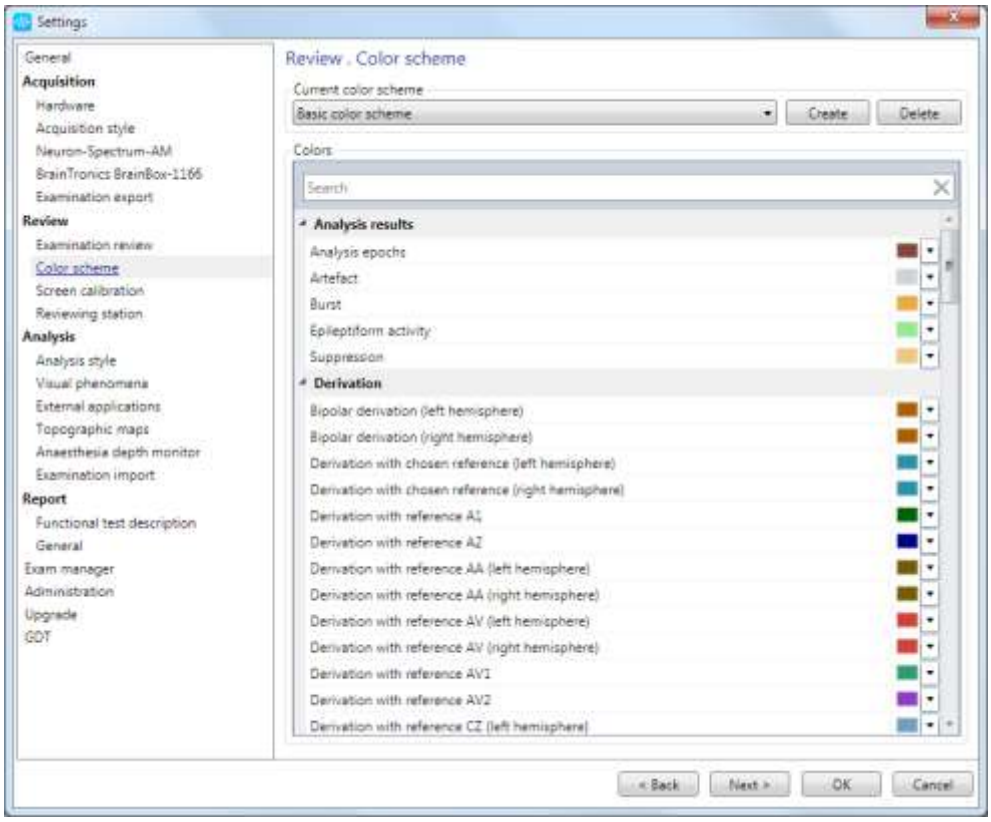


Fig. 8.37. Adjusting current color scheme.

8.5. Screen Calibration

At EEG traces displaying on the monitors of different sizes the preset sweep speed and the scale of the traces can differ from the specified ones. To adjust the scale of your computer monitor, use “Screen calibration” page (Fig. 8.38) of “Settings” window. The divisions of vertical and horizontal scales on the scale bar should coincide with the measuring scale divisions. To calibrate the screen, apply the ruler to the screen, and obtain the scale bar coincidence with the ruler using the mouse. If you know the sizes of your monitor in millimeters, enter its width and height in the corresponding input boxes. After the screen scale setup, EEG scale and sweep speed should completely correspond to the specified parameters. You can check it using the ruler.

By default, the program is adjusted to operate with 19” monitor. If you work on the computers with other monitor sizes, preset the screen scale beforehand.

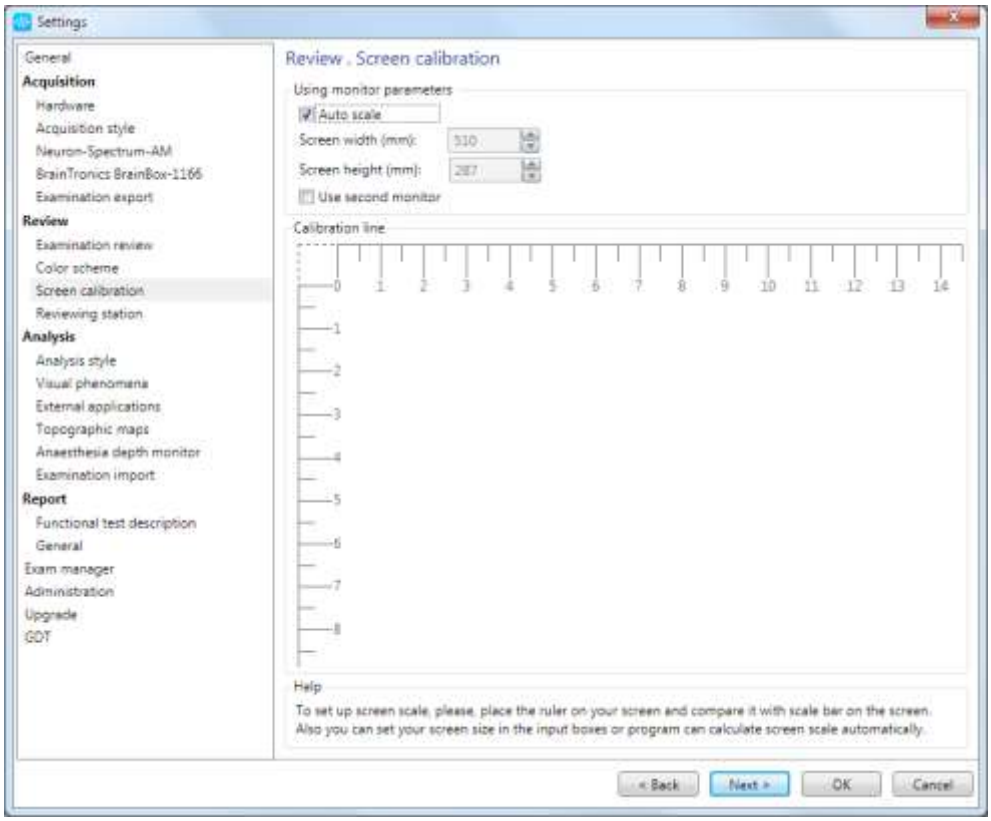


Fig. 8.38. Adjusting screen scale.

Often if you open several analysis windows, the working area of the monitor is not enough to review EEG and analysis results simultaneously. **Neuron-Spectrum.NET** software allows to use several monitors for more convenient EEG review and analysis. In case you select “Use second monitor” checkbox, **Neuron-Spectrum.NET** will automatically expand into all connected monitors if two or more monitors with the same resolution are available. The use of two monitors allows to review EEG on one screen and the analysis results or video on the other screen simultaneously.

8.6. Reviewing Station

On “Reviewing station” page (Fig. 8.39) you can review desktops of all computers in LAN where **Neuron-Spectrum.NET** software is run. For example, using the computer of head physician you can review the process of EEG acquisition being run on any computer in LAN of medical establishment. This option is also useful to control the acquisiton quality, for example, during long-term or night exams when a nurse or technician has an access to all EEG/PCS recording stations (computers) in the department.

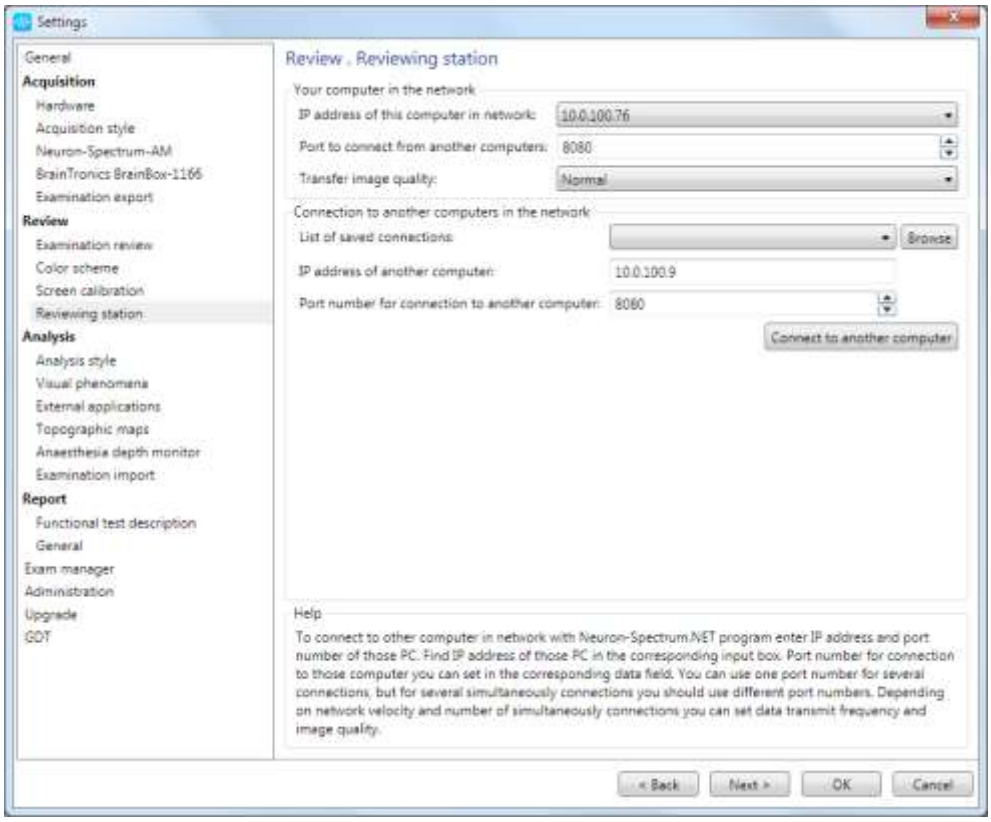


Fig. 8.39. Adjusting reviewing station.

To connect to another computer within LAN, enter its IP address, connection port and press “Connect to another computer” button. In some time (required for the connection) the window with selected computer desktop icon will appear. IP address of your computer and access port are indicated in the corresponding input boxes. To find out IP address of other computer within the LAN, start Neuron-Spectrum.NET software and open this window. The number of your computer port should coincide with computer port you are connected to. It is recommended to use 8080 port, but you can change it. IP address of your computer can not be changed.

In the list of saved connections you can choose one PC to which you have recently connected. It is possible to connect to several computers, for example, to monitor the quality of acquired signal of several exams simultaneously (reviewing station), but for each connection its unique port number should be specified (8080, 8081, 8082, etc.) (Fig. 8.40).

Fig. 8.40. Network connection list editor.

The port numbers of PC to connect to should be as follows: first – 8080, second – 8081, etc. You can use **Settings|Network connections for reviewing stations** main menu item for the quick connection to other computers.

Note: if Windows firewall is enabled, this option may function improperly. To ensure proper operation of this option, disable Windows firewall or adjust it properly. Besides antivirus software and firewalls may also lock network connections and should be adjusted properly. If a PC has an Internet connection it is not recommended to turn Windows Firewall off. In this case it is required to add the permission for incoming network connections for Neuron-Spectrum.NET software.

Besides built-in network access tools you can use third-party software not only for acquisition process observation, but also for its management. Such programs as TeamViewer, LiteManager allow user to connect to remote PC and manage it. For example, free LiteManager software (http://litemanager.ru/, http://www.litemanager.com/) has server and client parts. Server part is installed on the PC with the connected EEG system used for EEG acquisition. Server part makes it possible to connect to PC from another PC's of the network and transfer control to them. Client part is installed on PC from which you plan to perform remote control of acquisition procedure. Client part can be connected to several servers and vise versa, several clients can be connected simultaneously to one server. Thus, you can simultaneously control several acquisition procedures. You can control remote PC both by local network and via Internet. So, you can connect to several exams simultaneously, observe acquisition process, check impedance, change acquisition parameters from any PC within local network or via Internet.

8.7. Analysis Mode Settings

On the “Analysis style” page of “Analysis” section (Fig. 8.41) you can select and edit the current analysis style (see section 8.7.1 “Analysis Styles”). All settings of analysis mode (analysis epoch size, bandpasses of standard EEG rhythms, analysis result visualization, etc.) are stored in the analysis style. You can select the current analysis style from the combo-box. When analysis style is selected, all settings of analysis mode is downloaded from this style. Thus, you can switch quickly between different settings of the analysis mode during the exam performing directly. You can select the current analysis style before the beginning of each new exam (Fig. 4.4). To edit the current analysis style, use “Change” button located rightward of the drop-down list.

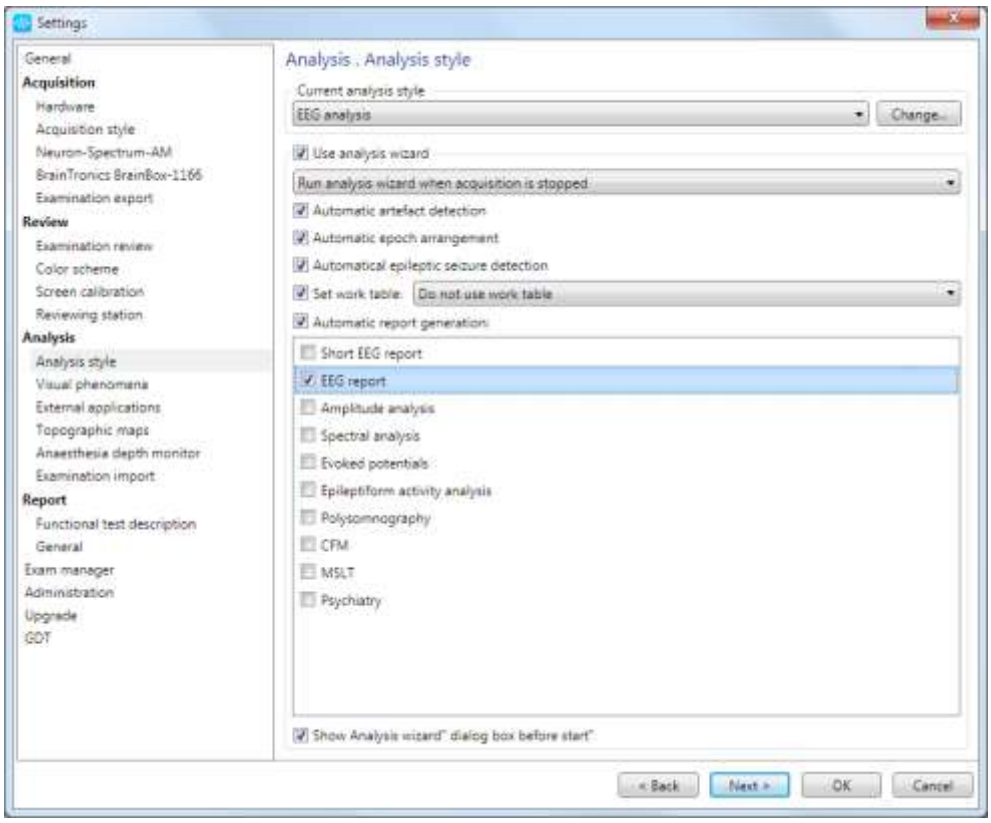


Fig. 8.41. Analysis style settings.

8.7.1. Analysis Styles

All program settings connected with EEG analysis are combined into the analysis styles. The use of several analysis styles allows to switch quickly between different sets of analysis mode settings. You can set the current used analysis style using **Set-up|Change…** item of main program menu (Fig. 8.41) or before the beginning of new exam (Fig. 4.4). During an exam performing you can change the current analysis style using **Analysis|EEG analysis styles** item of main program window.

In “EEG analysis styles” window (Fig. 8.42) you can change the existing analysis styles and create your own ones. To get an access to “EEG analysis styles” window, use “Change” button on the “Analysis. Analysis style” page (Fig. 8.41) or **Analysis|EEG analysis styles|List…** menu item directly during exam performing. Also, you

can select the current analysis style and edit it before the beginning of each new exam (Fig. 4.4).

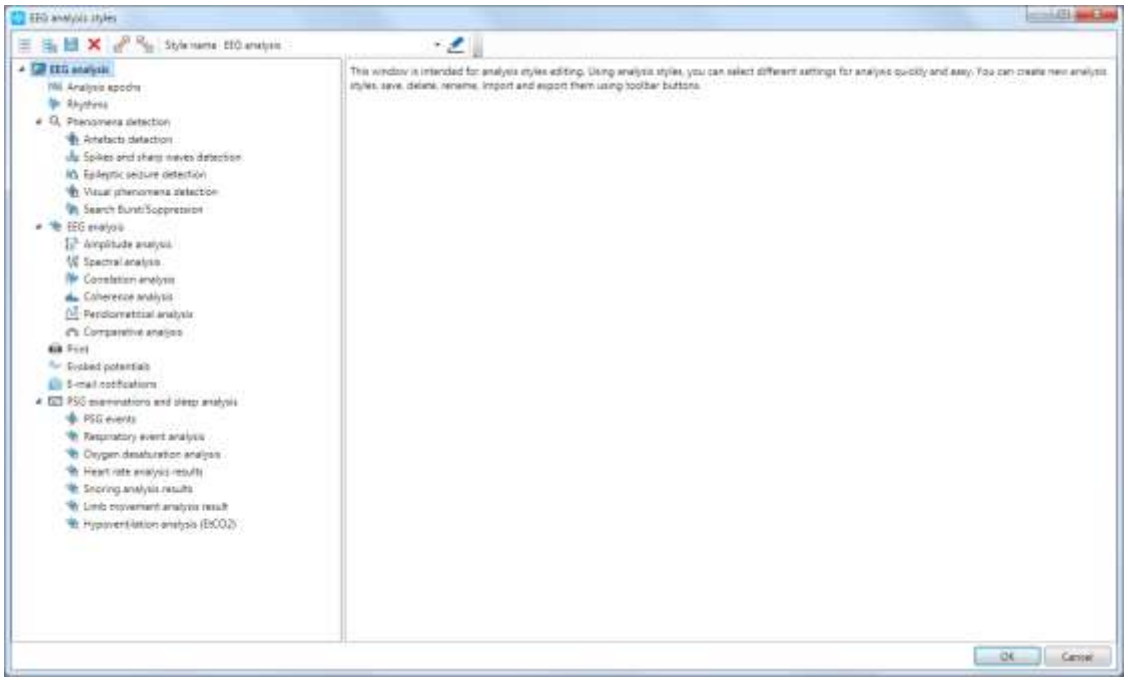


Fig. 8.42. Editing analysis styles.

In the middle part of toolbar of analysis style manager you can see the name of the current style. Using the combo-box, you can select other style for editing. Also, you can create new styles (including on the basis of the current one), save introduced changes, remove the styles, export them to file and import them from file (for example, to move to other computer) using the toolbar buttons. Besides, you can rename the style.

The working area of the window is divided into two parts:

- “Analysis style settings” – it contains the settings elements.
- “Item properties” – it contains the description of the current element of the settings tree with the possibility to change its parameters.

Further all elements of analysis style settings will be described.

The “Analysis epochs” page (Fig. 8.43) contains the settings to arrange analysis epochs (see section 5.12 “Arrangement of Analysis Epochs”). You can set the duration of analysis epoch, maximum percentage of epoch overlapping (when epochs are arranged near artifacts), the arrangement area (along the record or by selected functional tests) and other parameters.

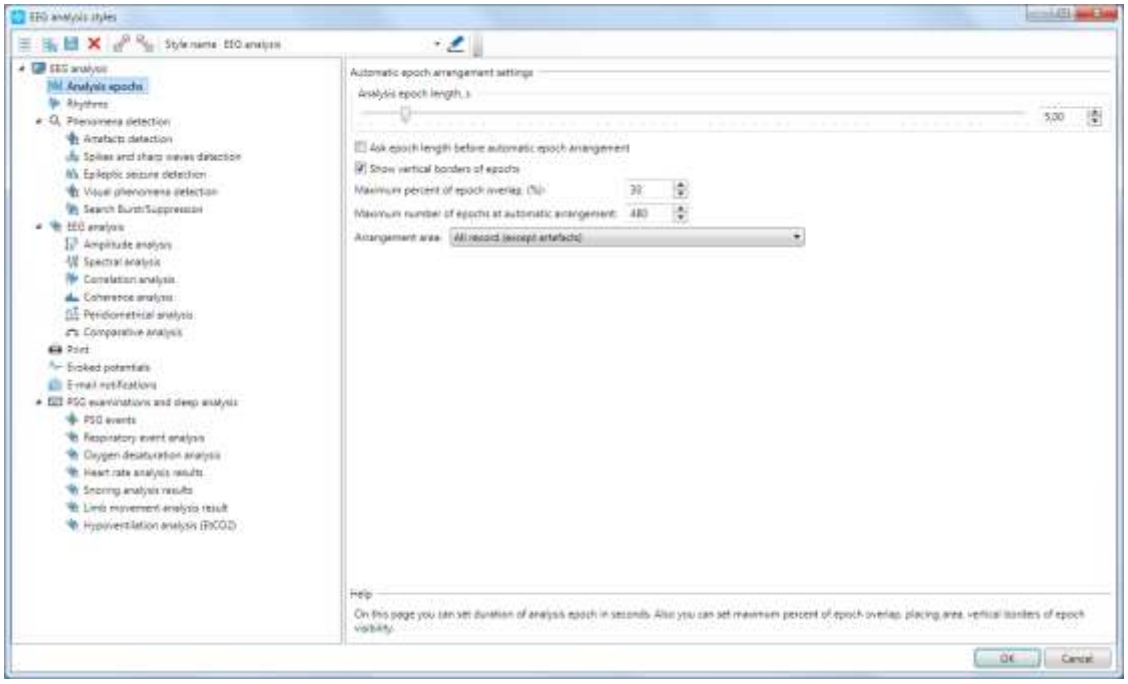


Fig. 8.43. Adjusting analysis epochs.

The “Rhythms” page contains the parameters of EEG wave rhythms. Using the editable table, you can change the frequency borders of wave rhythms. For each rhythm you can set the minimum amplitude showing rhythm presence on EEG. Besides, you can add your own standard EEG rhythms, which will be considered at visualization of graph spectrum and spectra trends.

On “Amplitude analysis” page (Fig. 8.44) you can set up EEG amplitude analysis parameters. You can select the way of amplitude calculation (from peak-to-peak or from isoline to peak), minimum amplitude of EEG wave to be considered in the analysis, quantity of topographic maps in “Amplitude Scanning” window (see section 6.4.5 “Amplitude Scanning”) and step to change the border values of color palette.

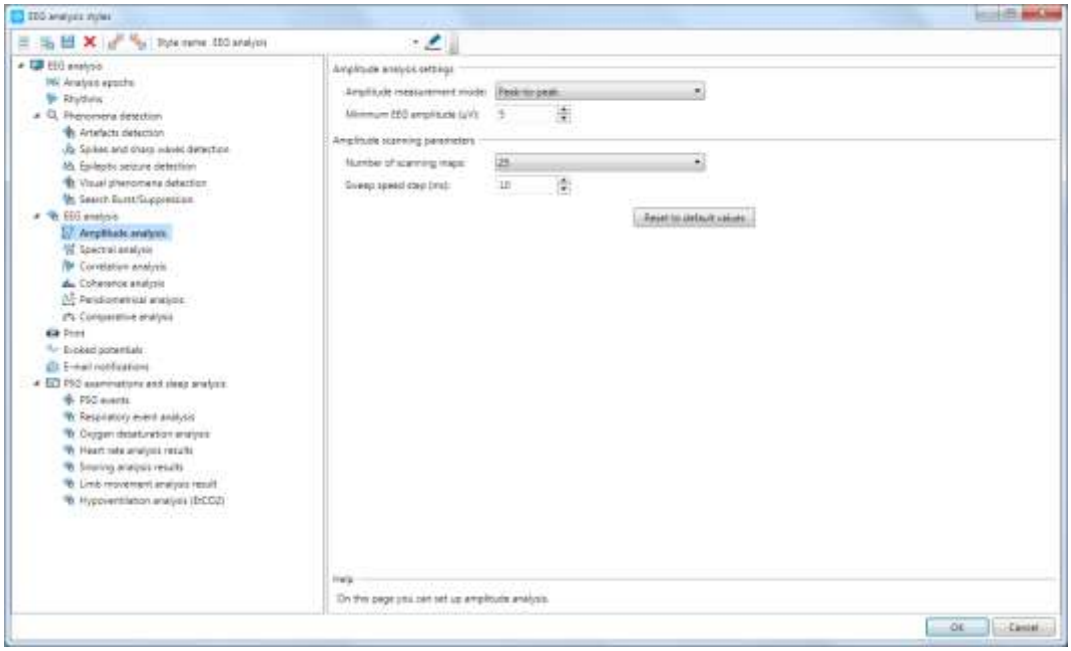


Fig. 8.44. Adjusting amplitude analysis parameters.

The “Spectral analysis” page (Fig. 8.45) contains the parameters of spectral analysis. You can set the window function (to smooth the edge effects), analysis parameter (amplitude or spectrum power), the scale of the spectrum graphs (see section 6.4.7 “Spectrum Graphs”). Also for the spectrum graphs, you can indicate the frequency range which is visible on them.

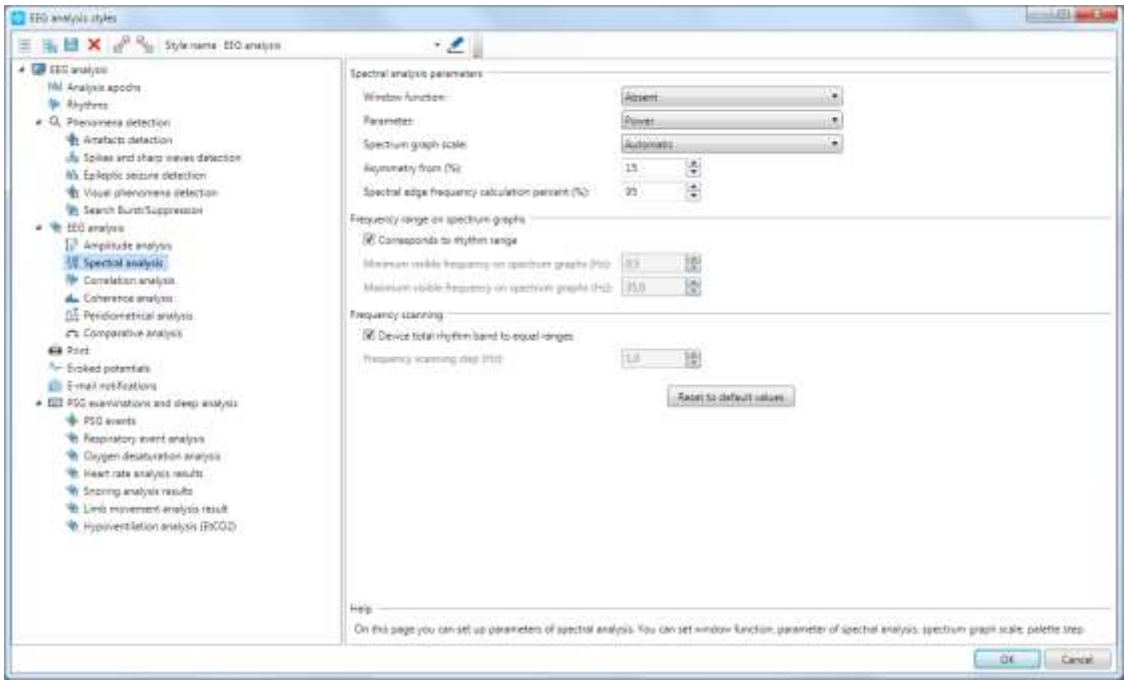


Fig. 8.45. Adjusting parameters of spectral analysis.

The “Print” page (Fig. 8.46) contains the parameters of EEG printing (see section 5.13 “EEG Printing”). At EEG printing the information about a patient, the parameters of EEG acquisition and visualization can be displayed in the bottom part of each page. On this page you can select what kind of information it is necessary to display at EEG printing. Also on this page you can set up the printer parameters if it is connected directly to your computer or is available in the network. **Neuron-Spectrum** program provides the possibility to print EEG directly during the acquisition but the delay of recorded data visualization during the printing is possible on the slow computers. That is why the printing settings have an option of the delayed EEG printing during the acquisition. If this checkbox is selected, you can use  button on the toolbar, the corresponding menu command or **[Ctrl+P]** key combination but EEG printing will not occur. However, after the acquisition end all EEG fragments selected by you on EEG will be printed. If the delayed printing checkbox is unchecked, EEG printing will occur directly during EEG acquisition. All printed EEG pages are marked with “Start/End printing” service marker. The list of EEG fragments sent to print can also be seen in “Exam inspector” window. Using the context menu, you can print these fragments again. If you use black-and-white printer, you can select “Convert colors to black-and-white during printing” checkbox. In case this checkbox is unchecked, the traces will be printed in a way they are displayed on the monitor screen.

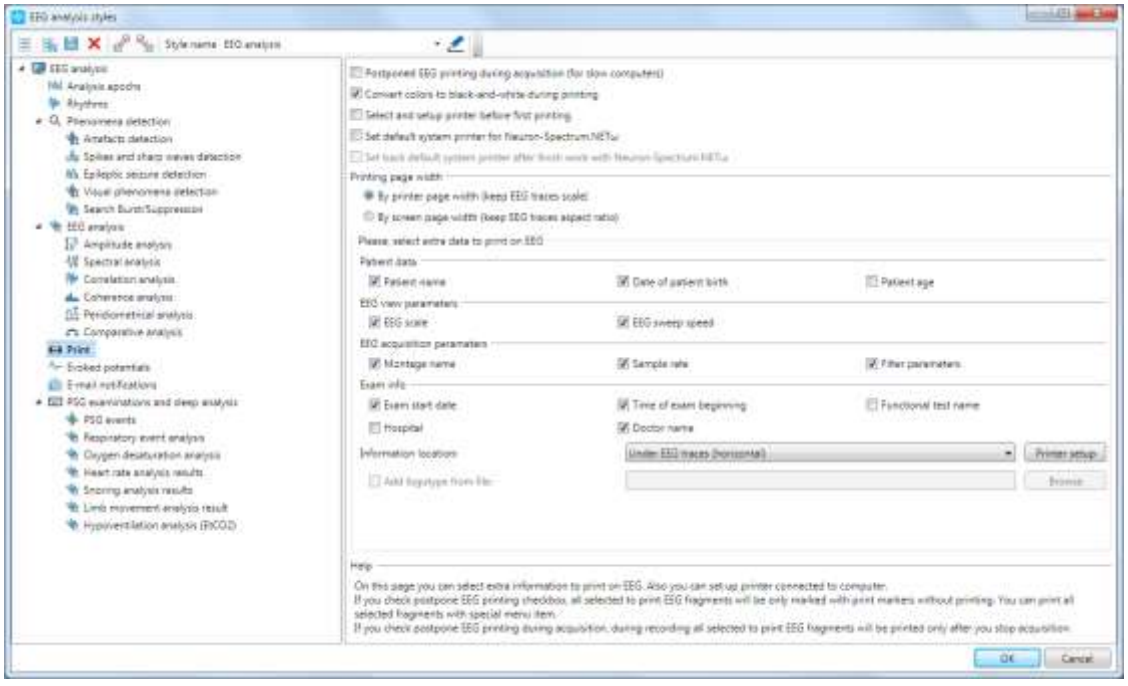


Fig. 8.46. Adjusting parameters of EEG printing.

On “Evoked potentials” page (Fig. 8.47) you can set up the parameters of averaging and visualization of the evoked potentials (see chapter 9 “Neuron-Spectrum-LEP.NET”). You can set the analysis epoch length which will be used by default. During an exam you can change the analysis epoch at any moment, at that the analysis results will be automatically updated. Also, you can set the delay of averaging beginning, for example, to cut the stimulus artifact. The averaging delay can be also negative if it is required to average trace fragments preceding stimulus delivery. If the artifacts rejection level is different from zero, then only those trace areas are included in the averaging which values do not exceed the indicated threshold. On this page you can indicate the scale, the sweep speed, the arrangement (consequently or by “10-20” system), the visibility and the color of EP traces by default. During an exam you can also change them.

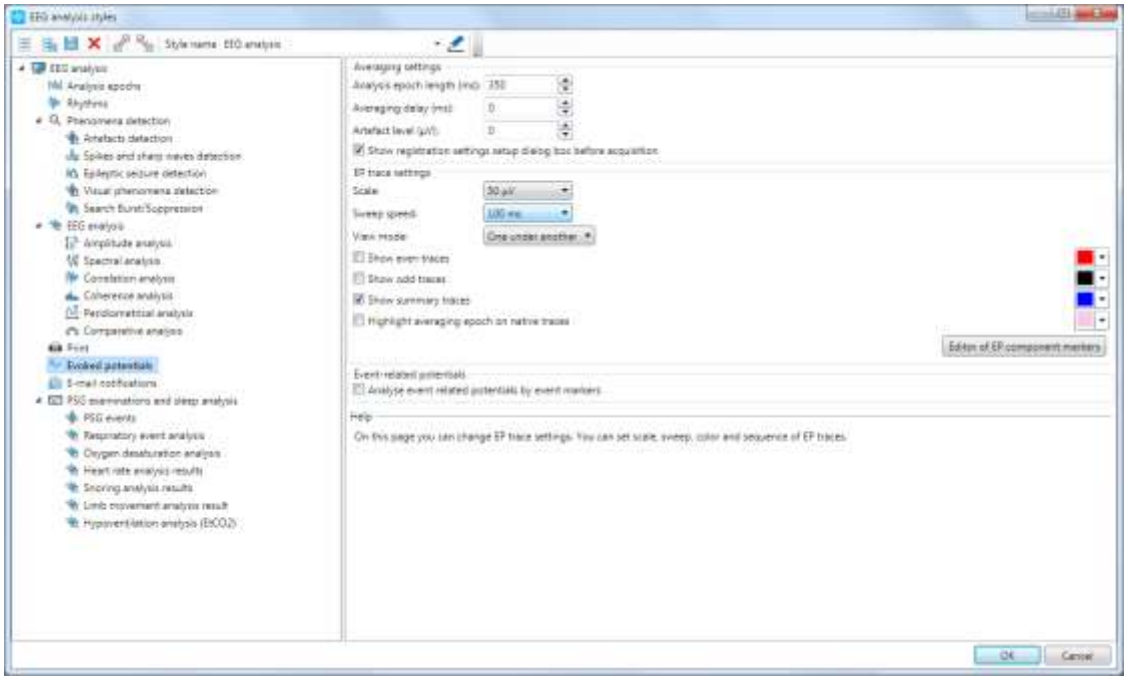


Fig. 8.47. Adjusting evoked potentials.

On “E-mail notifications” tab (Fig. 8.48) you can set up the system of e-mail notification sending by e-mail. If you do it, the software will automatically generate and e-mail you notifications of such events as paroxysmal activity, breath and heart rate over-ranging, decreasing of oxygen saturation level. Also you can get the notifications of hardware and software errors occurred during an exam and information on exam progress within specified period (for example, once per hour) to ensure the remote control of the exam. The software screenshot with obtained traces and analysis results (for example, trends) is attached to the exam report. To use this option you should specify the electronic address of the recipient and parameters of e-mail box from which these notification will be send. In case you meet with difficulties while filling the form, address your IT administrator or other specialist. Check if the entered data is correct using “Test mail” button.

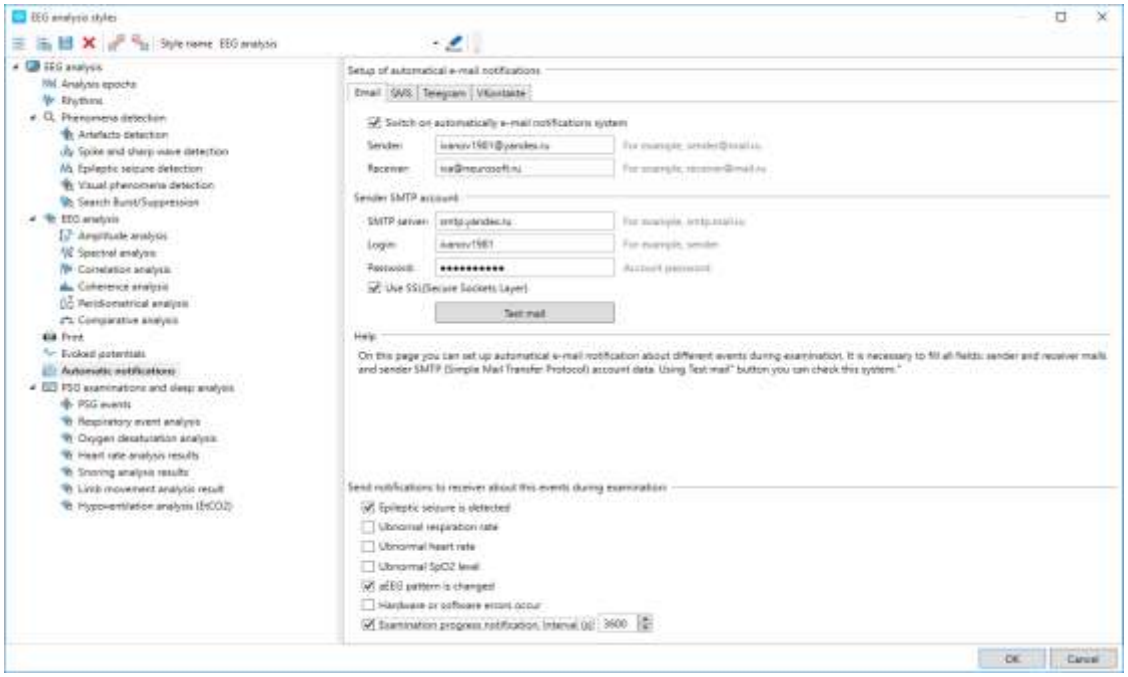


Fig. 8.48. E-mail notification.

E-mail notification is a convenient tool to get remote access to exam (including via Internet), however Internet connection realibitity depends on the connection channel between recipient and sender. Neurosoft Company can not ensure the delivery of all sent notifications and is not responsible for the delivery time.

On “Polysomnography” page (Fig. 8.49) page you can set up the parameters of sleep stage analysis. You can specify the duration of analysis epoch, sleep stage scoring system. Also, you can set the number of sequential epochs for detection of sleep onset and persistent sleep onset.

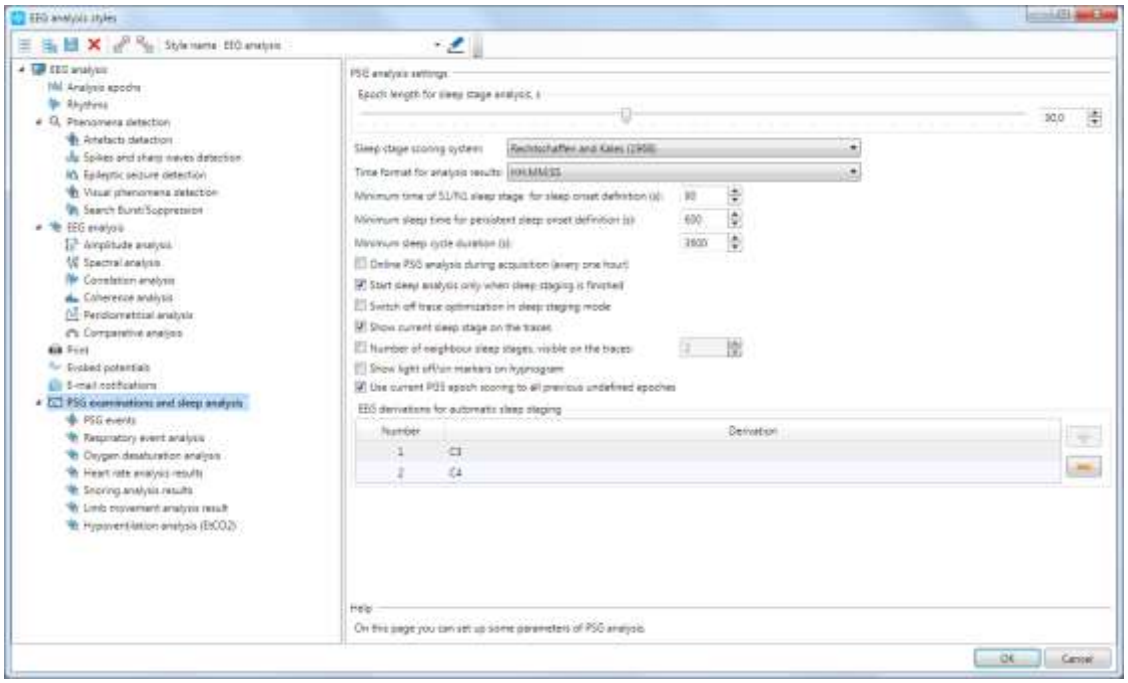


Fig. 8.49. Adjusting sleep stage analysis.

On “PSG events” page (Fig. 8.50) you can see the list of PSG events built-in **Neuron-Spectrum.NET** software by default. Besides, you can add your own PSG events. You can select the trace type for each event. When you select the trace fragment of the specified type, the context menu with the list of PSG events defined for the trace of this type displayes on the screen. You can indicate the selection color for your own PSG events. The color of the typical PSG events is defined by the current color scheme (see section 8.4 “Color Scheme”).

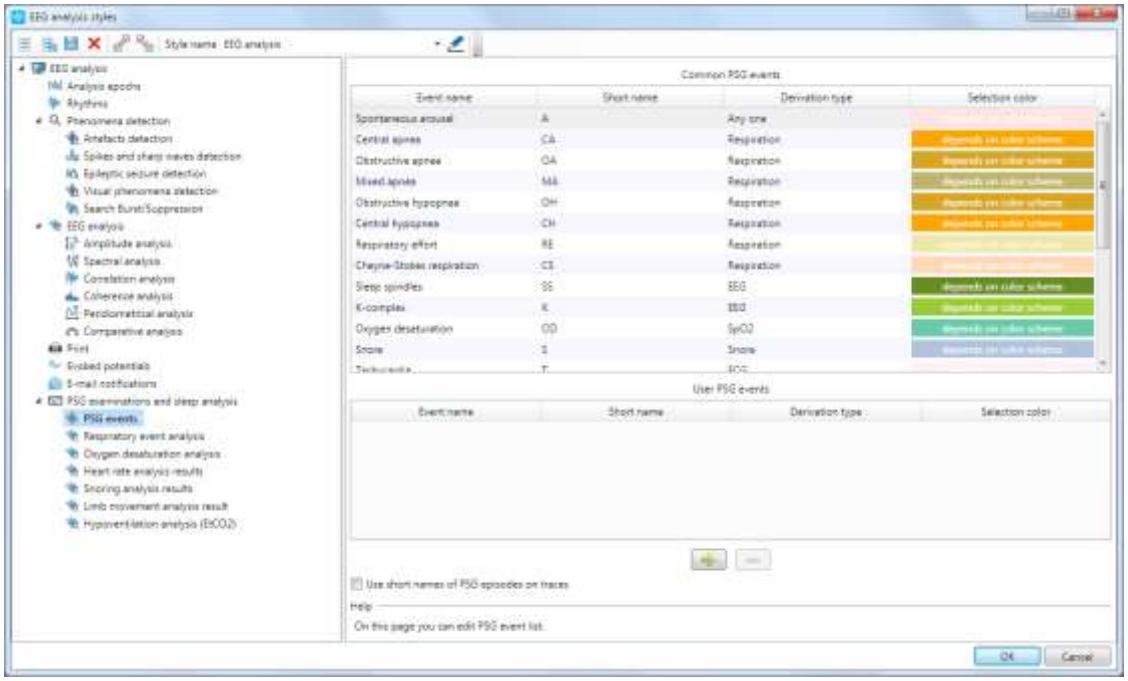


Fig. 8.50. Adjusting PSG events.

8.7.2. Visual EEG Phenomena

“Visual phenomena” page (Fig. 8.51) is intended to edit the list of available visual phenomena (see section 5.10 “Selection of EEG Fragments”). The elements of visual phenomena table can not be changed. You can add your own visual phenomena to this table. The phenomenon color on EEG can be specified for each visual phenomenon. The color of common phenomena depends on the selected color scheme (see section 8.4 “Color Scheme”). The arbitrary color can be set for user phenomena.

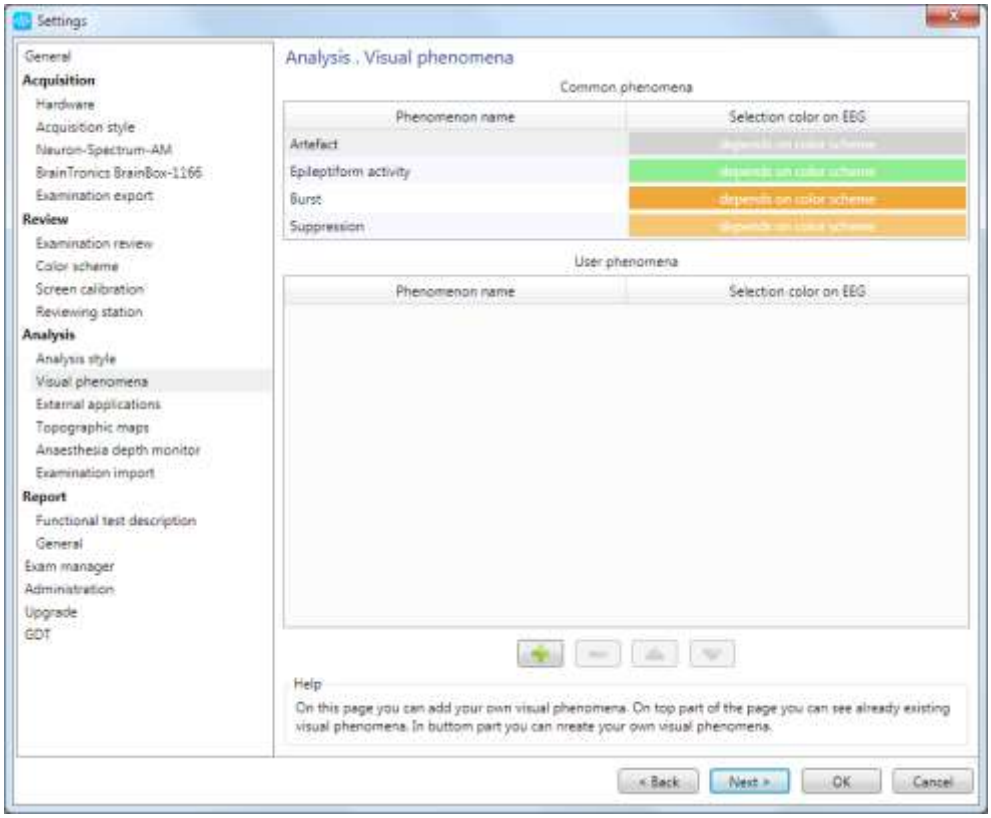


Fig. 8.51. Adjusting visual phenomena.

8.7.3. Brain Mapping

On “Brain mapping” page (Fig. 8.52) you can set the parameters of mapping. For amplitude maps you can choose the quality: from low (to speed up the visualization) up to ideal one (for detailed displaying). The maps can be 2D or 3D.

The color palette can be also selected from drop-down list or your own color palette for mapping can be created. You can indicate whether it is required to arrange electrodes on maps or to show mapped values.

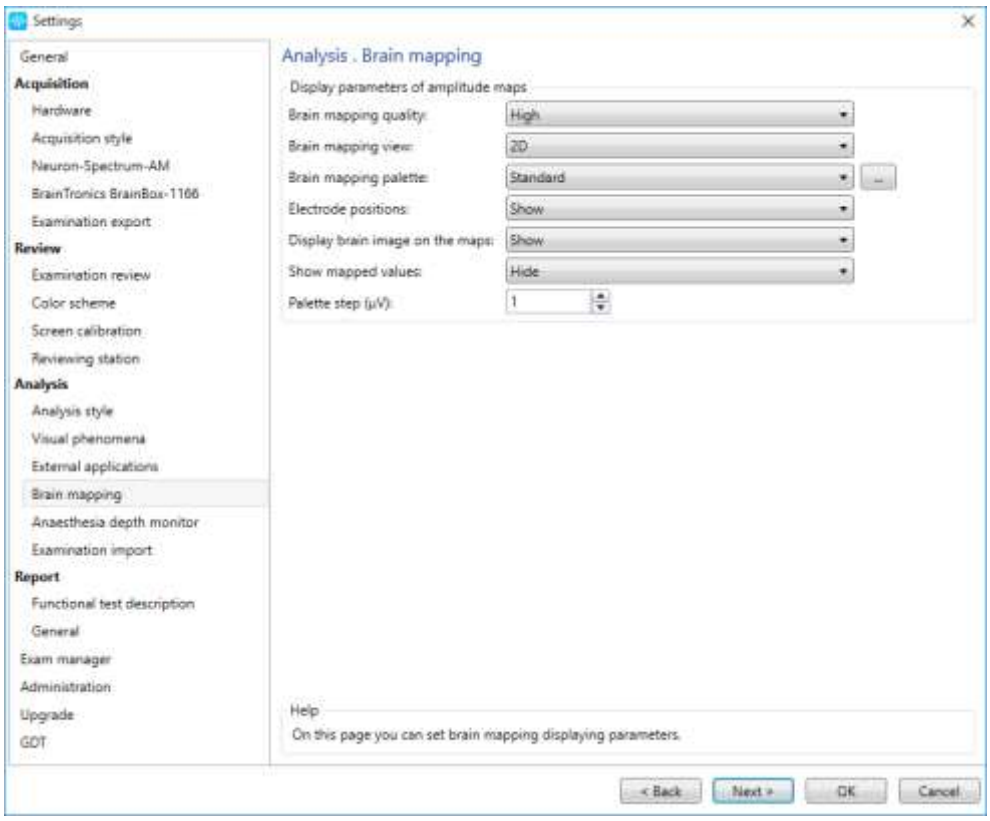


Fig. 8.52. Brain mapping.

8.8. Report

The “Report” section contains two pages (Fig. 8.53). On “General” page you can indicate whether it is required to display the dialog box with the request of report naming before its generation or show “Glossary” window automatically. Also you have an access to the report templates (see section 7.2.1 “Editing of Report Templates”). Here you can specify the font used in reports by default and, if it is required, a folder to copy all created exam reports automatically.

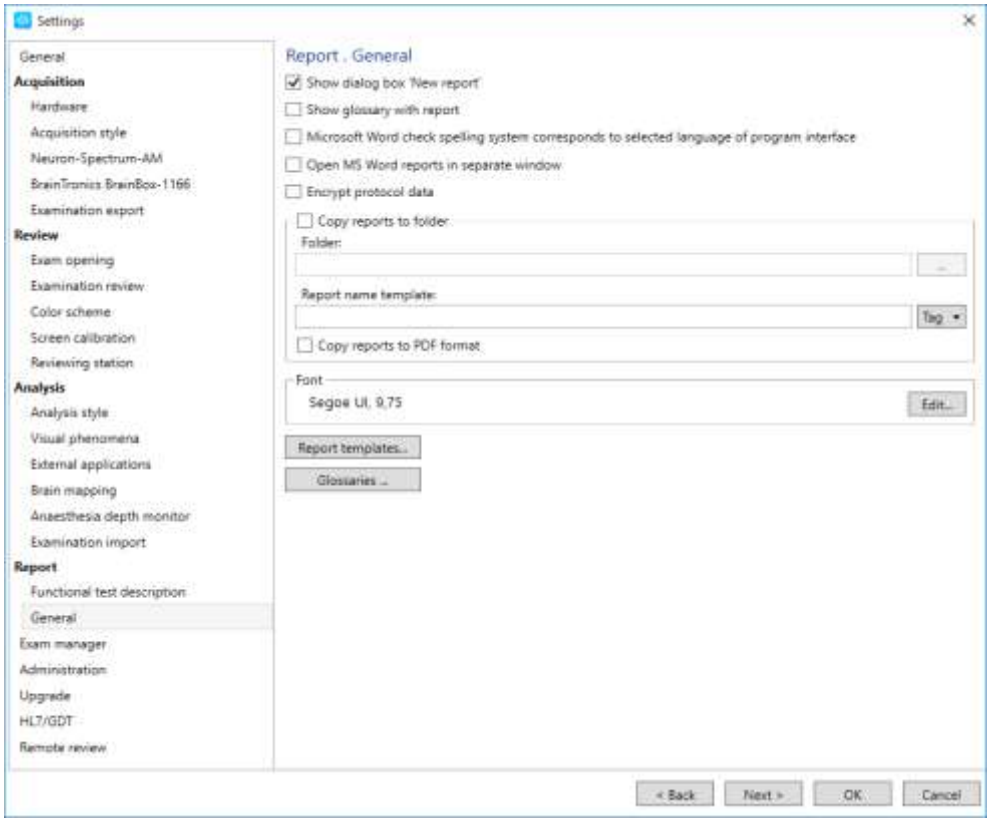


Fig. 8.53. Adjusting exam report.

On “Functional test description” page (Fig. 8.54) you can choose information to be added to a report by selecting rhythms separately for each functional test. To include information on performed functional tests to the report template, open “Functional test cycle” drop-down menu that contains two other tabs: “Functional test name” and “Functional test description” (see chapter 7 “Creation of Exam Reports”). The “EEG report” report template already contains these tabs. To adjust the functional test description in the report on the basis of this template, select what type of information and which wave rhythms should be added to the report for each test (see section 7.2.1 “Editing of Report Templates”).

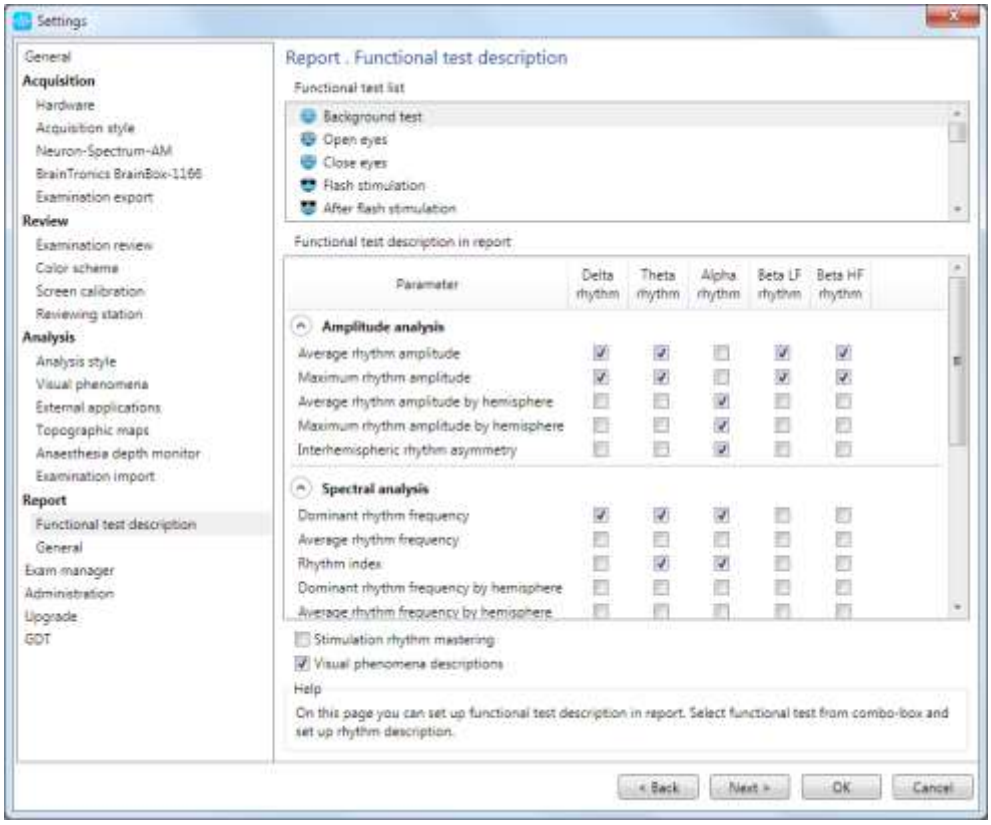


Fig. 8.54. Adjusting functional test description in the exam report.

8.9. Exam Manager

Some settings of “Exam manager” (see chapter 3 “Operation with Exam Manager”) are displayed on the corresponding page. You can indicate the folder for the temporary exam storage and the media size to archive and keep the data.

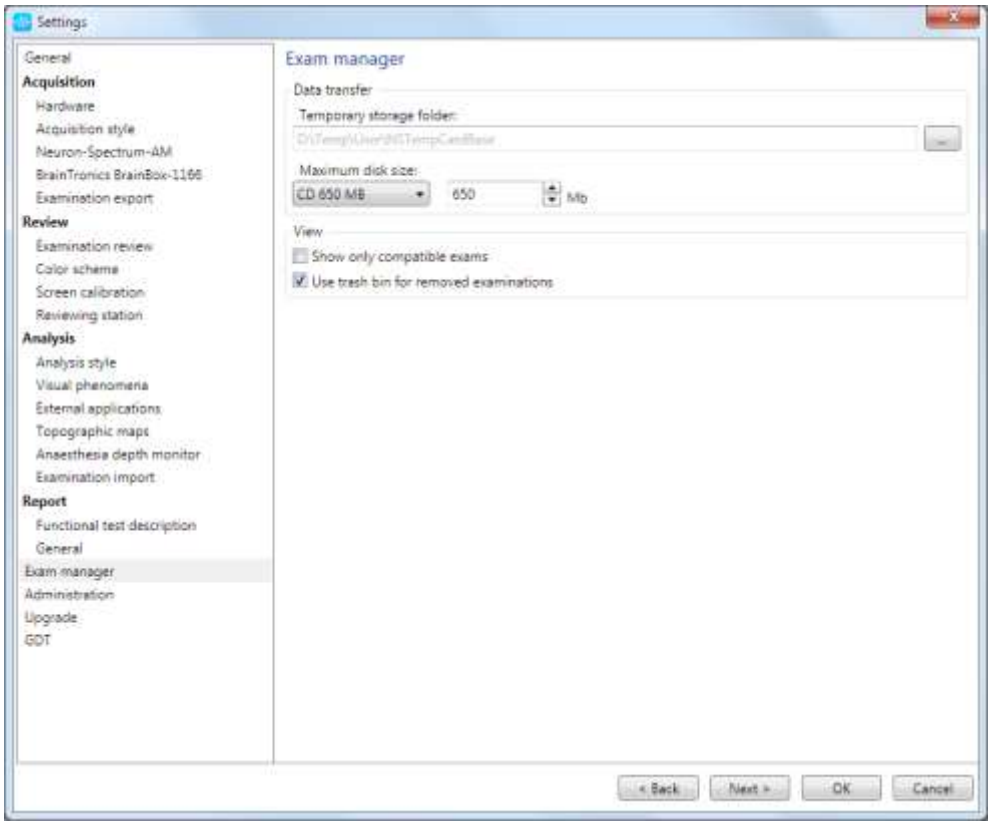


Fig. 8.55. “Exam manager” page.

8.10. Administration

Only administrator of **Neuron-Spectrum.NET** software has an access to “Administration” page (Fig. 8.56). Here the administrator can set the visibility of some input boxes for new exam window, define the additional parameters to enter when creating an exam, indicate patient’s sex by default. Administrator can add program users.

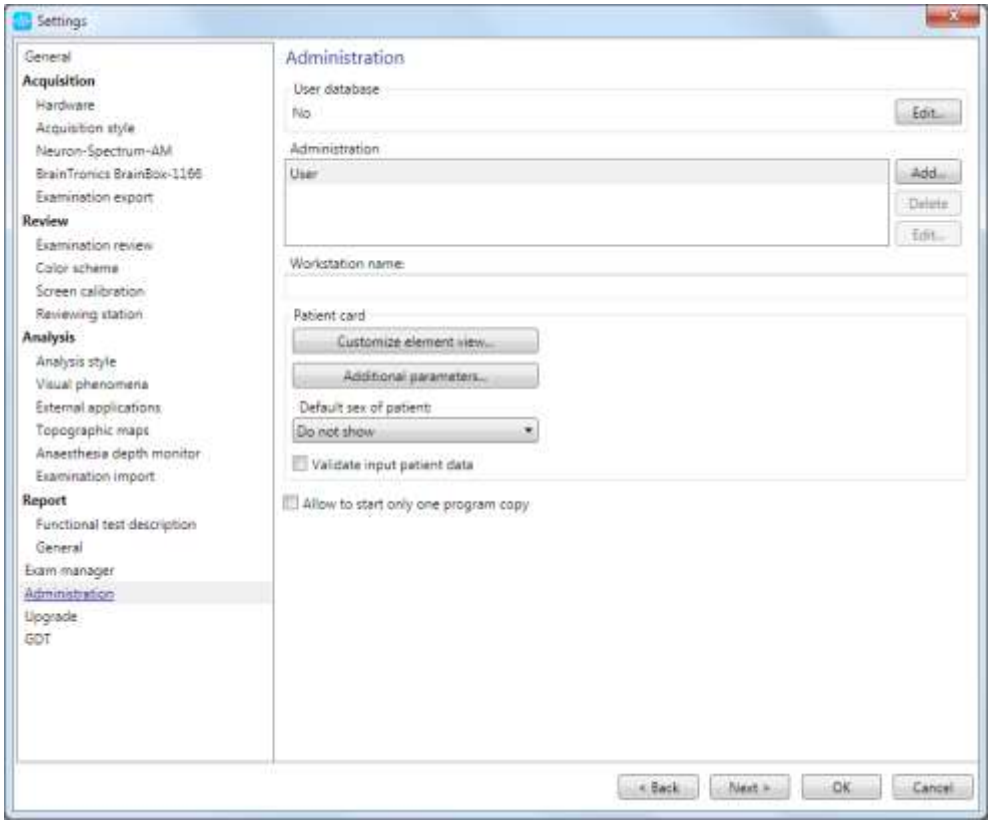


Fig. 8.56. “Administration” page.

8.11. Software Upgrade

Only administrator of **Neuron-Spectrum.NET** software has an access to “Upgrade” page (Fig. 8.57). Here an administrator can set the parameters of automatic updating of **Neuron-Spectrum.NET** software versions.

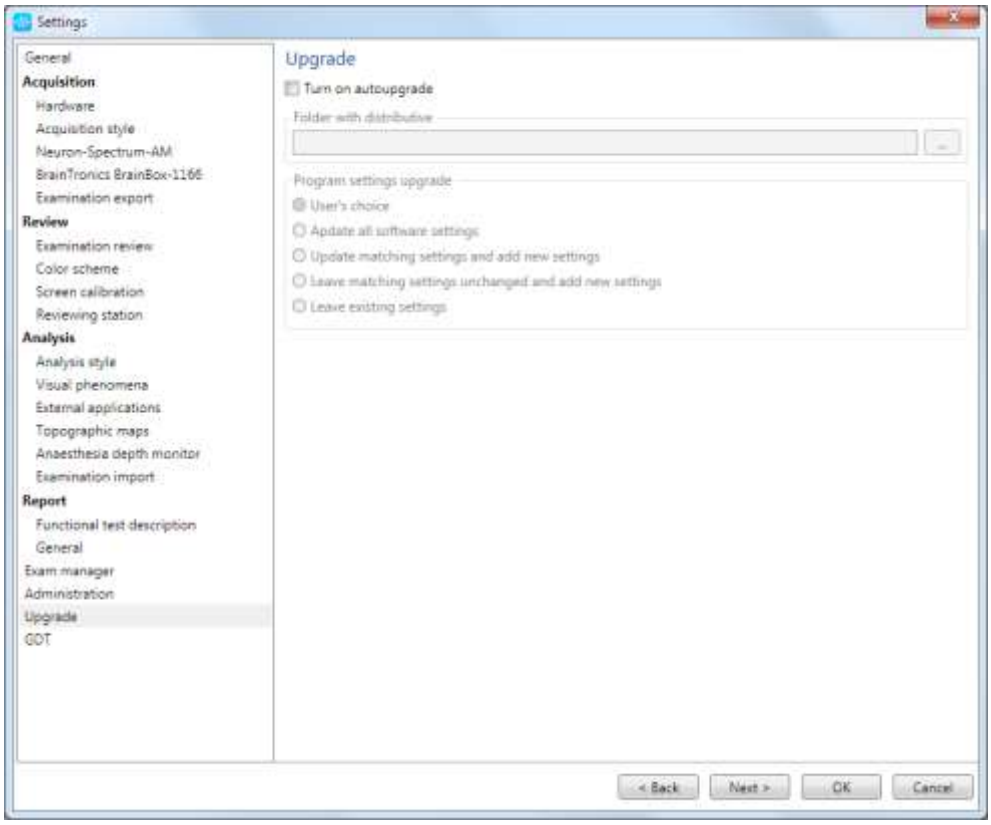


Fig. 8.57. “Upgrade” page.

8.12. GDT

On “GDT” page (Fig. 8.58) you can indicate the parameters of exam information exchange for GDT international protocol.

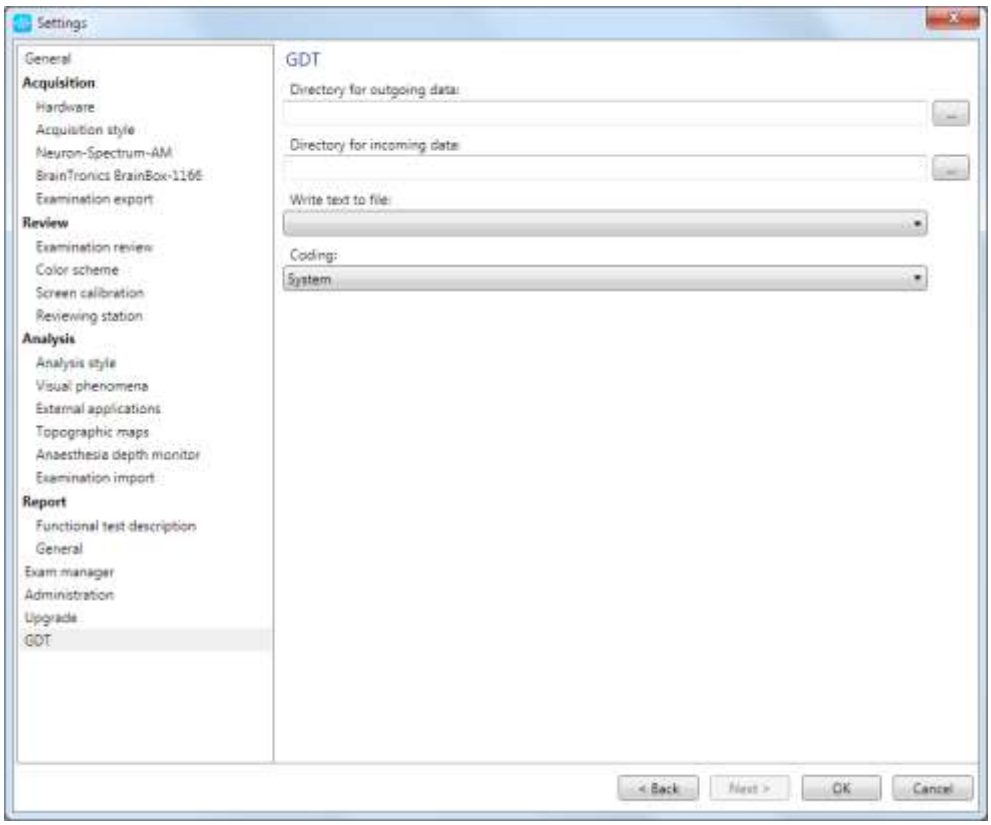


Fig. 8.58. “GDT” page.

8.13. Toolbar Setup

Neuron-Spectrum.NET software provides the possibility to change the size of toolbar buttons (from small ones up to huge ones), its visibility, arrangement and view. The arrangement of the windows on the screen for EEG reviewing and analysis with current settings of toolbar is stored in the current work table (see section 5.15. “Work Tables”). By switching between work tables, you can change the interface of the program. As a rule, the work table of the acquisition (with windows and buttons for EEG acquisition control) is used for EEG recording and the work table of the analysis (with windows and buttons for the analysis control) is done for the review and analysis. The visible toolbars, the buttons visible on them, its sequence and size are defined for each work table. Even if you do not use the work tables at the operation with program, you can set up the current toolbars.

To set up the toolbar, right-click on any toolbar. In the context menu choose **Setup…** item. In the appeared window (Fig. 8.59) you can set up the visibility of the toolbar. Select the checkboxes of those toolbars, which should be visible on the screen. To set up each toolbar separately, select it and choose the button view, its size and text width.

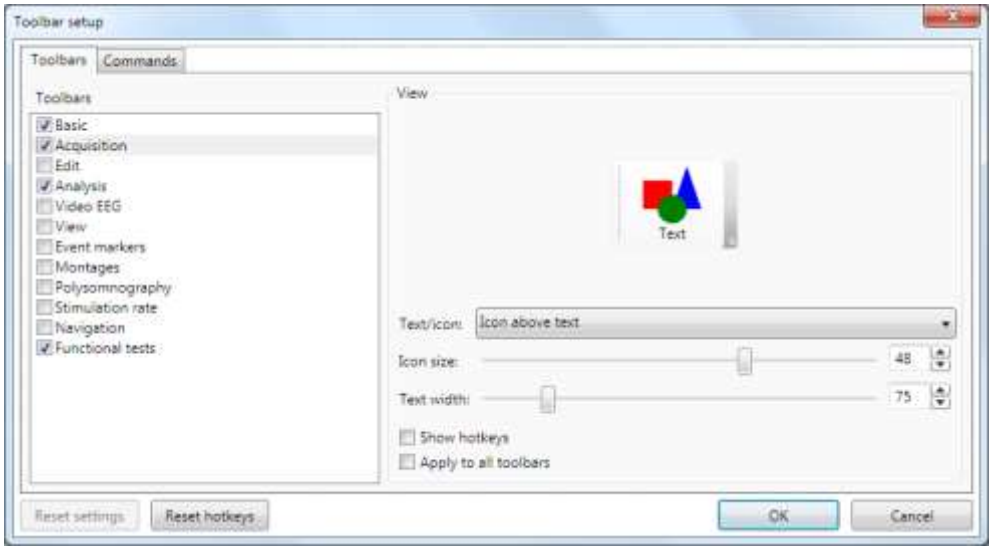


Fig. 8.59. Adjusting toolbar visibility.

Using “Commands” page of “Toolbar setup” window (Fig. 8.60) you can control the visibility of each button separately. The commands are combined into groups, for example, commands for acquisition, navigation, report. In the right part the list of available commands of selected group can be seen. To add a command to toolbar, just drag it with the mouse (or use touchscreen) on the toolbar you want to add it. If it is required to remove the command from the toolbar, use the mouse.

Fig. 8.60. Adjusting toolbar.

By changing the set of buttons being visible on the screen, you can control not only graphic interface of the program but also impact its functionality. For example, for a nurse performing EEG acquisition, the program can contain only several big buttons for an exam creation, impedance measurement, acquisition start and functional tests. For a doctor performing an analysis of the recorded exam, the program can contain the buttons for navigation, control of analysis windows visibility and preparation of exam reports.

8.14. Key Combinations

The key combinations are intended to speed up the operation with the program. All main operations at an exam performing have its own key combinations (see the Annex 1). If you work with program everyday, it is very convenient to memorize key combinations for the main operations. It will allow to decrease the time spent for an exam performing and its further analysis and get rid of the necessity to use menu and program toolbar.

Many **Neuron-Spectrum.NET** commands can be duplicated with already preset key combinations. You can specify your own key combinations for each command. Also you can set the key combinations for your own montages, functional tests, event markers.

To set or change the key combination for the selected command, press “Hotkey” button near the selected command (Fig. 8.60). In the appeared window (Fig. 8.61) you can choose the key combination for the selected command. Even several key combinations can be specified for each command. To add new key combination, select the corresponding input box and press the key combination on your keyboard. If the entered key combination is already used for other commands, you will be informed on it and other variants will be offered. The available key combinations are listed in the hidden drop-down menu in the right part of the window.

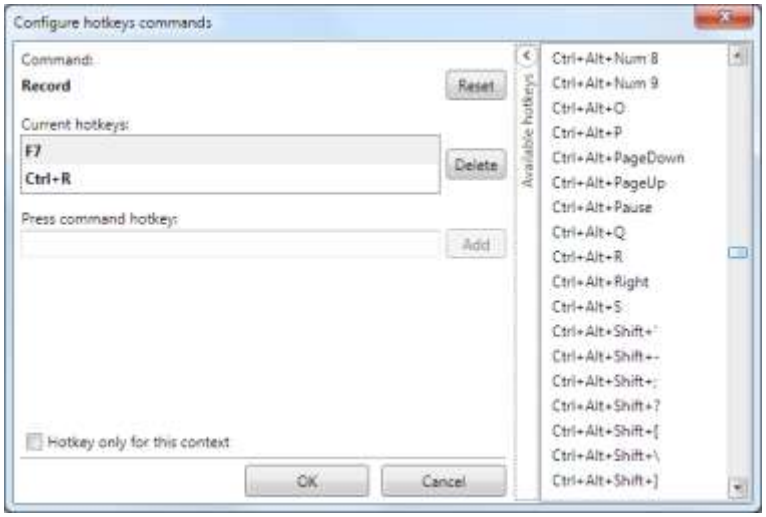


Fig. 8.61. Adjusting hotkey combinations for commands.

9. Neuron-Spectrum-LEP.NET

Neuron-Spectrum-LEP.NET program allows to record and analyze the evoked potentials. It is protected by a special software key, which allows to use it only with the definite device. The key is the file with **.nskey* extension, it is located in the work directory of a program. If the key file for the connected device is not found in the work directory of the program and on root disks of a computer, you will not be able to record the evoked potentials. The key file is supplied with the program distributive and installed automatically at the program setup. If it is necessary, you can order the key file from your dealer or **Neurosoft** Company directly.

Neuron-Spectrum-LEP.NET program allows to register and analyze the following evoked potentials:

- Flash and pattern visual evoked potentials.
- Long-latency auditory evoked potentials.
- Long-latency somatosensory evoked potentials.
- Event evoked potentials (averaging of EEG fragments marked by user's event markers).
- Endogenous and cognitive evoked potenitals (P300, MMN, CNV, "Bereitschaftspotential" readiness potentials on patient's button pressing, GoNoGo).
- Advanced ERP (Event-Related Potentials) are evoked potentials intended for customization of stimulation and averaging settings for researchers. It is possible average patient's response using three types of stimuli).
- ERP are evoked potentials connected with events of following paradigms: P300, MMN, CNV, TOVA (Test of Variables of Attention), Mathematical, Stroop Task, VCPT (Visual Continuous Performance Task), OddBall.

The program allows averaging of the fragments both with repetitive and single pulse stimulation.

Any fragment of EEG record with the stimulation can be averaged as EP (see section 4.13 "Stimulation during EEG Acquisition"). Besides, you can create special tests with the stimulation of the required modality using the functional test manager (Fig. 8.19). To do it, change the settings of the current acquisition style (see section 8.2.2 "Acquisition Styles").

To visualize and analyze the results of averaging, use "Evoked potentials" window. You can show or hide this window using **Analysis|Evoked potentials** menu command or the corresponding button on "Analysis" toolbar (see the Annex 1). Also, to

control the visibility of this window, use **[F12]** key of your computer keyboard. The view of “Evoked potentials” window is shown in Fig. 9.1.

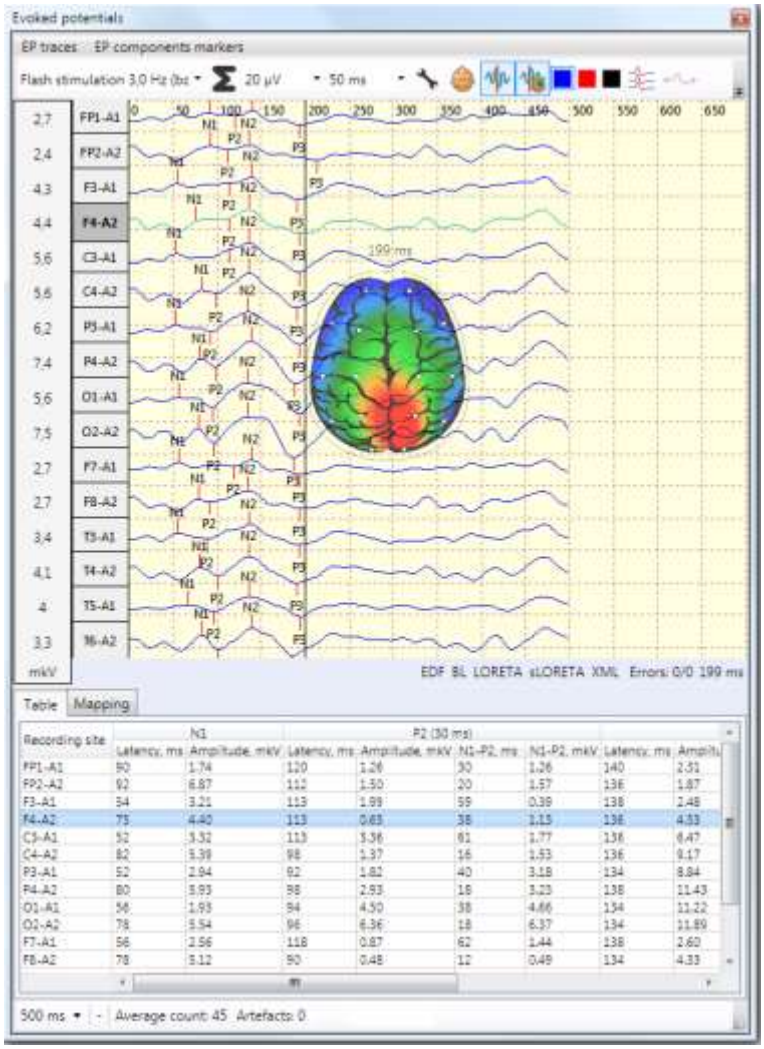


Fig. 9.1. The “Evoked potentials” window for EP visualization and analysis.

The settings of EP trace displaying are downloaded from the current analysis style (see section 8.7.1 “Analysis Styles”).

In the top part of “Evoked potentials” window, you can see the toolbar. Using this toolbar you can select the functional EP test for the analysis, change the scale (also “+” and “-” keys), trace sweep (also “*” and “/” keys). Besides, using the toolbar buttons you can activate the evoked potentials settings window (Fig. 9.2), change the arrangement of traces (by sequence or by “10-20” system), change the visibility of the measuring marker and instant values map, change the visibility of total, odd and even traces. Also, you can activate the EP trace shift mode. In this mode you can move EP traces vertically relative to each other using the mouse. It is convenient to use this mode for the comparison of several traces.

In “EP settings” window (Fig. 9.2) you can indicate the length of the averaging epoch, delay of averaging beginning relative to the stimulus moment (for example, to cut the stimulus artifact; the delay can be negative to start averaging before stimulus), the artifacts rejection level (trace fragments, which have the values exceeding this

level, will not be included in the averaging). At zero artifact rejection level all parts of traces will be included in the averaging except those which are marked by a user as artifacts. Also in “EP settings” window you can indicate the scale, the sweep speed, the arrangement of the traces, the visibility of total, odd and even traces and its color. To create or edit the markers of EP components you should switch to the corresponding editor (Fig. 9.3).

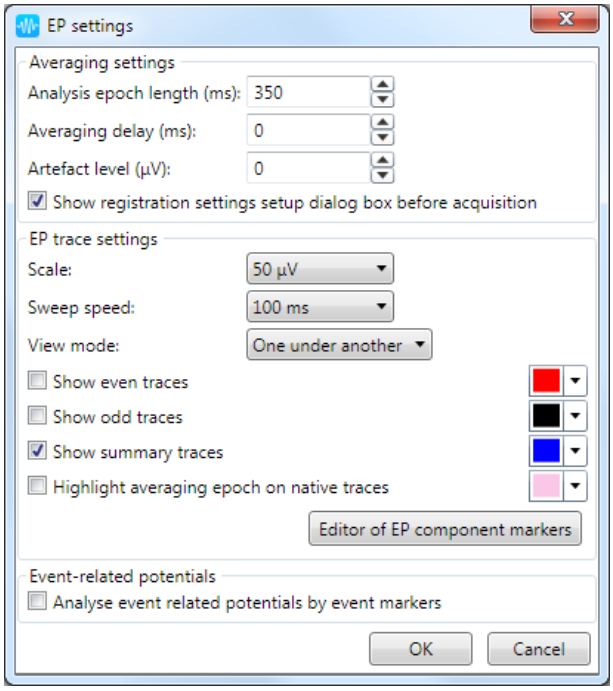


Fig. 9.2. The settings to display evoked potentials.

Using EP component marker editor you can create you own component markers and edit the existing ones (Fig. 8.57). In the left part of the window you can see the list of the available component markers, in the right one you can observe the settings of the selected marker. Using the toolbar buttons under the list, you can create new EP component markers, change their sequence in the list and remove them. In the settings of each component marker you can indicate the minimum and maximum latency of a component, the peak direction and the admissible noise level (or minimum peak amplitude). The component markers will be arranged on EP trace automatically. After the automatic arrangement of EP component markers you can change the position of each of them manually.

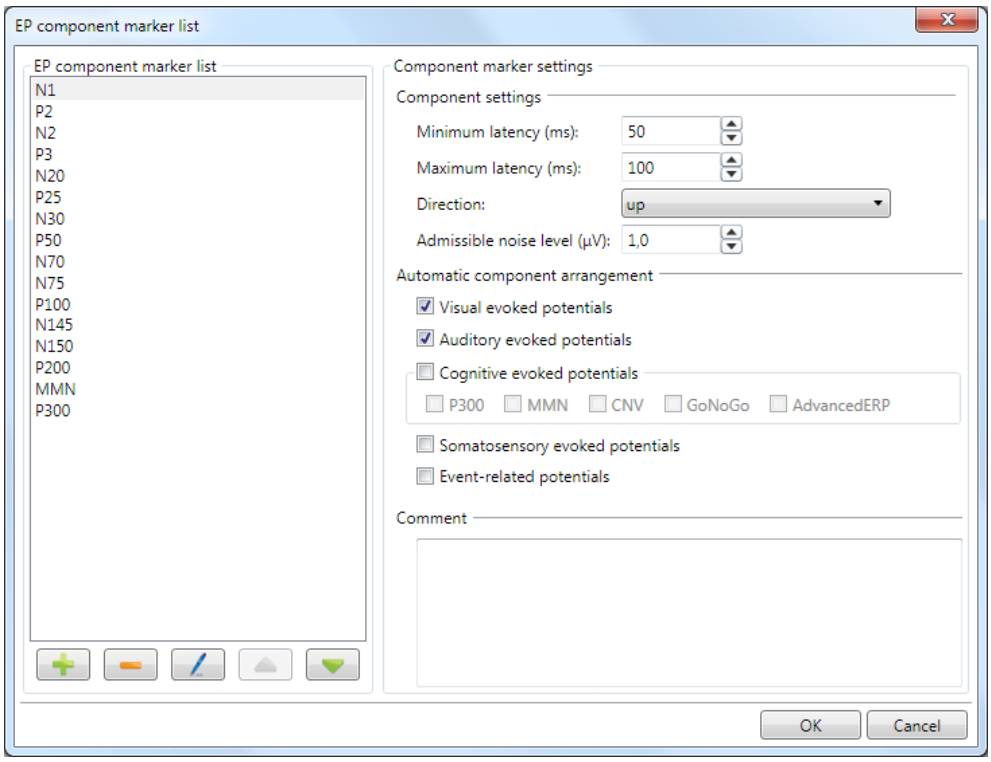


Fig. 9.3. Creating and editing EP component markers.

In “Evoked potentials” window, EP traces can be arranged sequentially or by “10-20” system. In the first case EP traces are placed one under another as they follow in the montage. In this mode you can use the measuring marker and instant values map (Fig. 9.1, Fig. 9.4). If you shift the measuring marker using the mouse, the instant amplitude values are displayed in the left part of the window. Also, the instant value map can be displayed on the screen. The running time of the measuring marker is shown in the right bottom corner of the window.

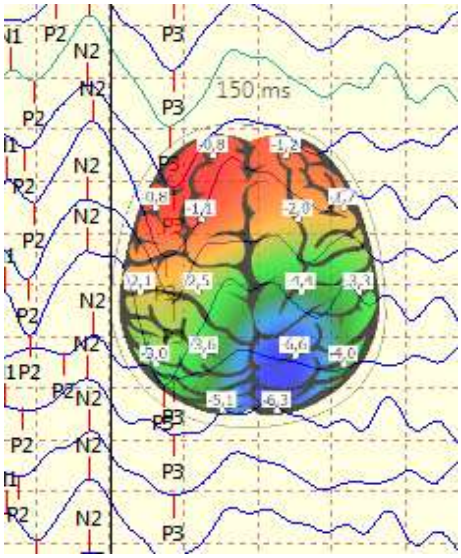


Fig. 9.4. Measuring instant amplitudes of evoked potentials.

If you have a big quantity of EP traces, the most convenient trace arrangement is by “10-20” system (Fig. 9.5). At such arrangement, each EP trace is displayed in individual limited area according to the position of EEG electrode. Using the context menu, you can copy EP traces in the current position of active exam report.

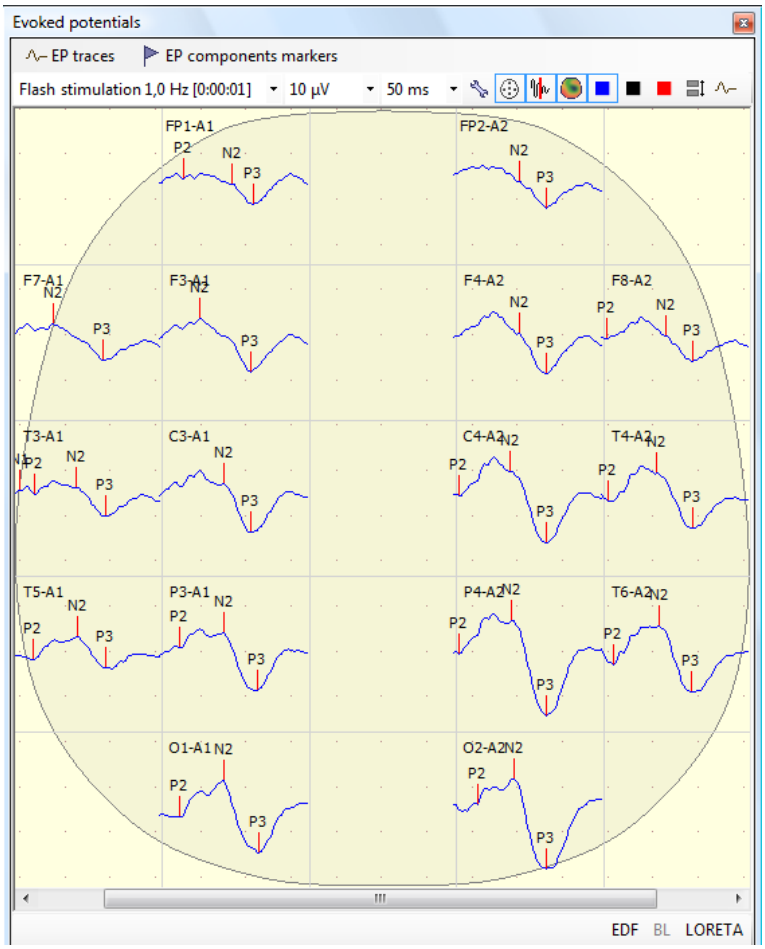


Fig. 9.5. Arranging EP traces by “10-20” system.

The panel of EP component markers is located under EP traces in “Evoked potentials” window (Fig. 9.6). Using “EP component markers” drop-down menu (Fig. 9.7) you can show/hide the component markers on EP traces, hide the panel of component markers. Also, using this menu you can open EP component marker editor (Fig. 9.3).

Fig. 9.6. The panel of component markers.

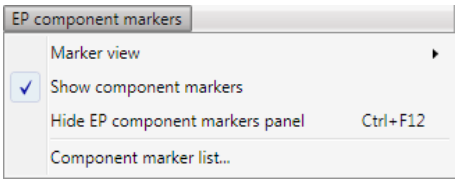


Fig. 9.7. The control menu of EP component markers.

The panel of component markers contains two tabs. The comparative table of markers of EP trace components by latency and amplitude in shown on “Table” tab. Using the context menu you can change the visibility of the table columns and copy the table to the current position of exam report.

The topographic maps of latency and amplitude of EP components (Fig. 9.8) or intervals between the markers (Fig. 9.9) are shown on “Mapping” tab.

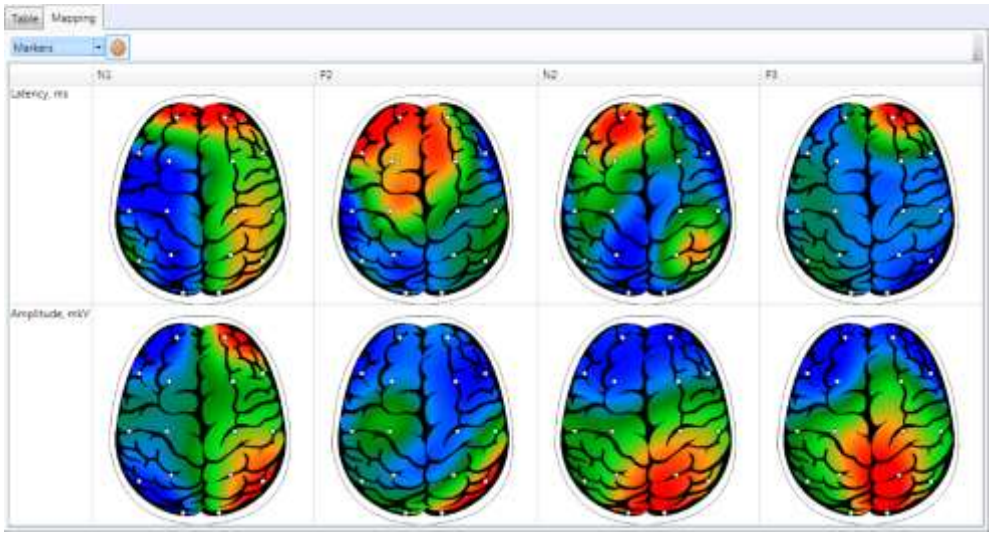


Fig. 9.8. The mapping of latency and amplitude of EP components.

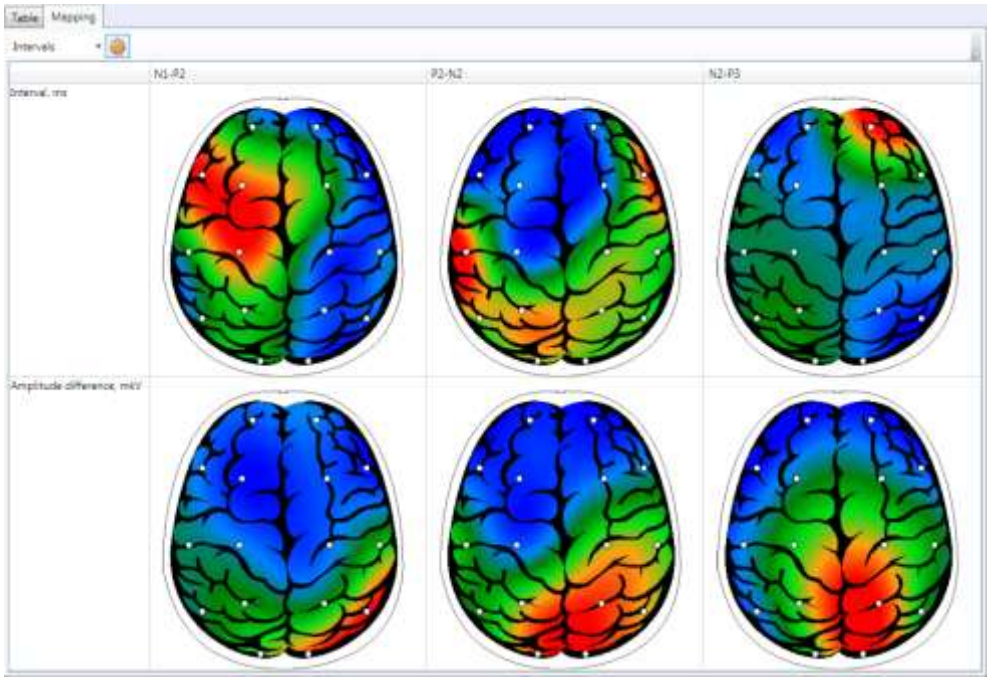


Fig. 9.9. The mapping of latency and amplitude of intervals between EP components markers.

Using the context menu, you can change the visibility of maps and copy them to the current position of active exam report. The panel of component markers can be hidden with the use of “Hide EP components markers panel” menu command (Fig. 9.7). Besides, to control the visibility of panel of component markers, you can use **[Ctrl+F12]** key combination.

The current length of analysis epoch (the change of epoch length is possible directly from the status line), the stimulation description, the number of averagings and the number of removed stimuli are displayed in the status line located in the bottom part of “Evoked potentials” window (Fig. 9.1).

If “Evoked potentials” window is visible during EEG acquisition, the averaging results of the current EP test are displayed in it in the real-time mode. As soon as you stop the acquisition, the list of the recorded EP tests is available on the toolbar of “Evoked potentials” window and in “Exam inspector”. When you select EP test from the list, the averaging results are updated automatically. Besides, at EEG scrolling the results of EP test averaging correspond to EEG test in “EEG” window.

Any fragment of EEG record with the stimulation can be treated as the functional EP test. Also special functional tests for the acquisition of the evoked potentials are created in **Neuron-Spectrum.NET** software. The typical tests with the stimulation for EP acquisition are provided in the program settings by default. Besides, each program user can create her/his own functional tests with the stimulation for the acquisition of the evoked potentials (Fig. 8.18). If EP test contains the stimulation program, the stimulation of the required modality is started automatically at the test recording. The settings of stimulators in this case are defined by the stimulation program commands. The functional test can contain the stimulator settings for the manual stimulation (Fig. 8.19); in this case the stimulation is not run automatically but is started by a user command. In this case the stimulator settings are already downloaded to the device according to the test settings. It is convenient to start the stimulation from “Stimulation” window (Fig. 4.19). Also, in this window you can select any connected stimulator from the combo-box, set up its parameters and start the repetitive or single pulse stimulation. At every start of new stimulation, new averaging will be performed in “Evoked potentials” window.

All data from Evoked potentials” window (traces, tables, topographic maps) can be copied to the current position of an active exam report using the context menu. For the automatic paste of EP analysis results at the exam report generation, you can use the special blocks for the insertion of EP traces, tables and maps. It is recommended to use these blocks in “Functional test cycle” block. In this case, the EP analsys results for each test with the stimulation will be pasted to an exam report (see section 7.2.1 “Editing of Report Templates”).

You can export EP traces to EDF+ format.

So far, there are a lot of programs allowing to generate arbitrary sequence of stimuli for patients (including animated stimuli, simultaneous audio and video stimuli). Using flexible abilities of these programs you can implement not only standard paradigms, but also create your own patterns to deliver stimuli of different modalities. The example of such third-party program is Presentation software (http://www.neurobs.com/), which is now widely known and used in various scientific researches. As a rule (but it is not necessary), Presentation software is launched on a separate PC on which a patient is working, and a device, acquiring patient’s response to delivered stimuli is working on another PC. So, the question on how to synchrone stimulation program and program to average patient’s responses may arose. If you use Presentation stim-

ulation program as a stimulating program and Neuron-Spectrum.NET program as a averaging one, you can synchronize two PCs by connecting them with COM-to-COM cable, which connects two serial ports of different computers. Modern computers are rarely equipped with COM ports, so a user should apply USB-to-COM adapter, which is used as virtual COM port. At that you should specify COM port used for stimulus information transmission in the Presentation software settings (Fig. 9.10).

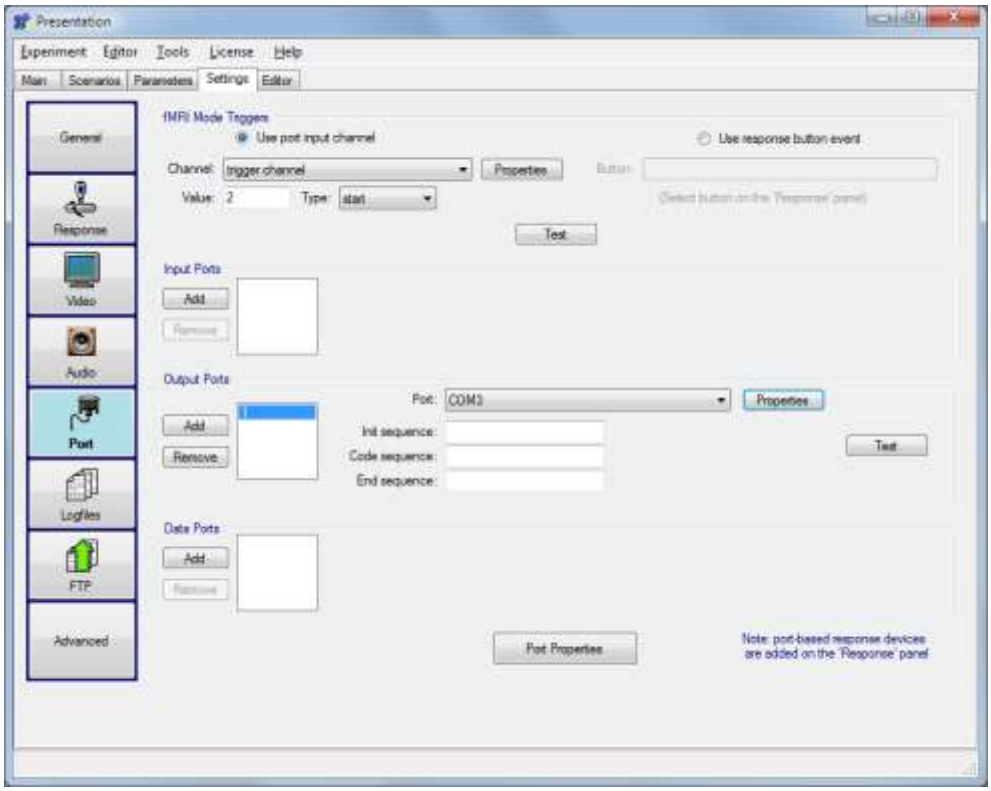


Fig. 9.10. Choosing COM port to transmit information about stimuli.

You should set up COM port as it is shown in Fig. 9.11 by pressing “Properties” button.

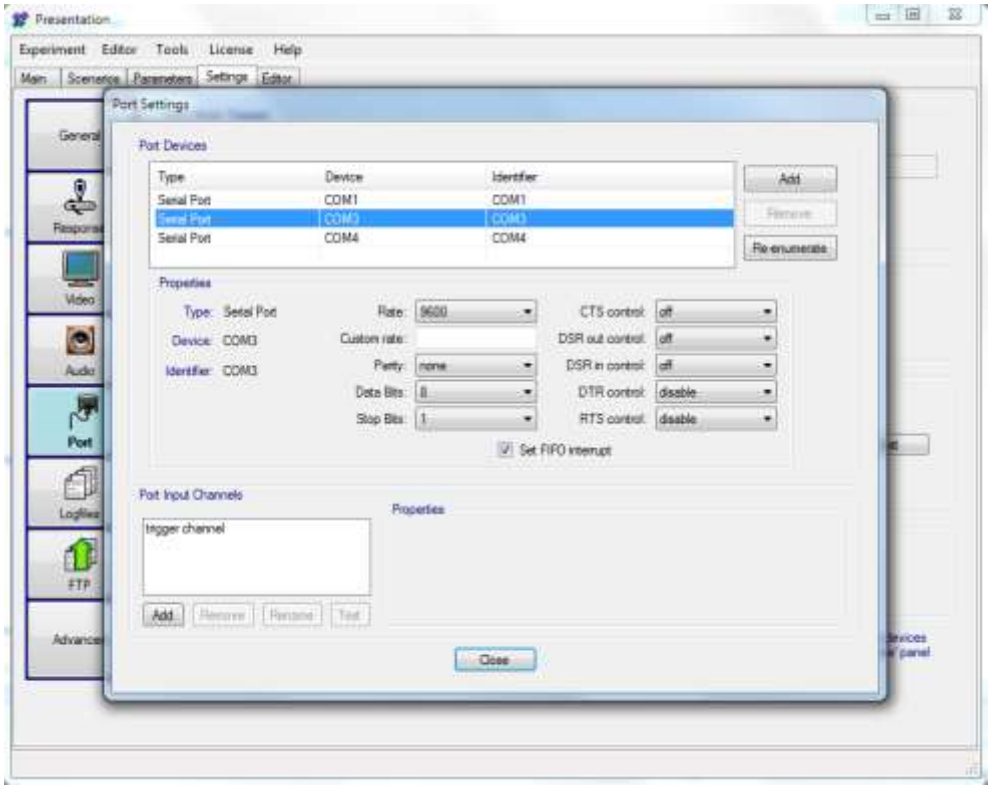


Fig. 9.11. Adjusting COM port to transmit information on stimuli.

According to stimulation scenario used in Presentation software it is necessary to send codes of corresponding stimuli to chosen COM port.

Neuron-Spectrum.NET software can receive codes of stimuli by COM-to-COM cable and place corresponding event markers. For this purpose the program has virtual stimulator called Presentation stimulation. In its settings you should specify the COM port from which the program receives codes of stimuli (Fig. 9.12).

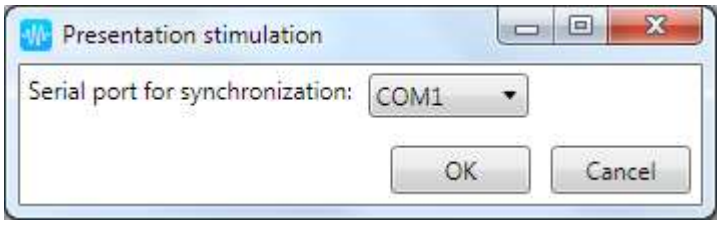


Fig. 9.12. Setting up Presentation stimulation.

So, when you run “Presentation stimulation” test or choose “Presentation stimulation” stimulator as an active one in “Stimulation control” window (Fig. 4.19) and start stimulation, you also start monitoring of chosen COM port. All codes of stimuli received by this port from Presentetion software will be displayed in **Neuron-Spectrum.NET** software as event markers with codes of stimuli. If you enable the possibility to average event evoked potentials (Fig. 9.2) in “Evoked potentials” window (Fig. 9.1) you can average traces for each code of stimulus separately.

10. Neuron-Spectrum-Video.NET

During long-term EEG/PSG monitoring use automatic saving option to keep data backups during acquisition (see Fig. 8.28)

Neuron-Spectrum-Video.NET program adds the possibility of video and audio recording synchronously with recorded EEG. After the exam performing, you can edit the recorded video and audio and save the most interesting fragment in the exam. **Neuron-Spectrum-Video.NET** supports up to three simultaneously working video cameras and the same number of audio recording devices. The program is protected by a special software key, which allows to use it only with the definite device. The key is the file with **.nskey* extension, it is located in the work directory of a program. If the key file for the connected device is not found in the work directory of the program and on root disks of a computer, you will not be able to record video at exam recording. The key file is supplied with the program distributive and installed automatically at the program setup. If it is necessary, you can order the key file from your dealer or **Neurosoft** Company directly.

10.1. Setup of Equipment for Video and Audio Recording

To perform the video recording of a patient during an exam, at least one video camera should be connected to a computer. The setup of the connected video devices is carried out in the editing window of the current acquisition style (Fig. 10.1).

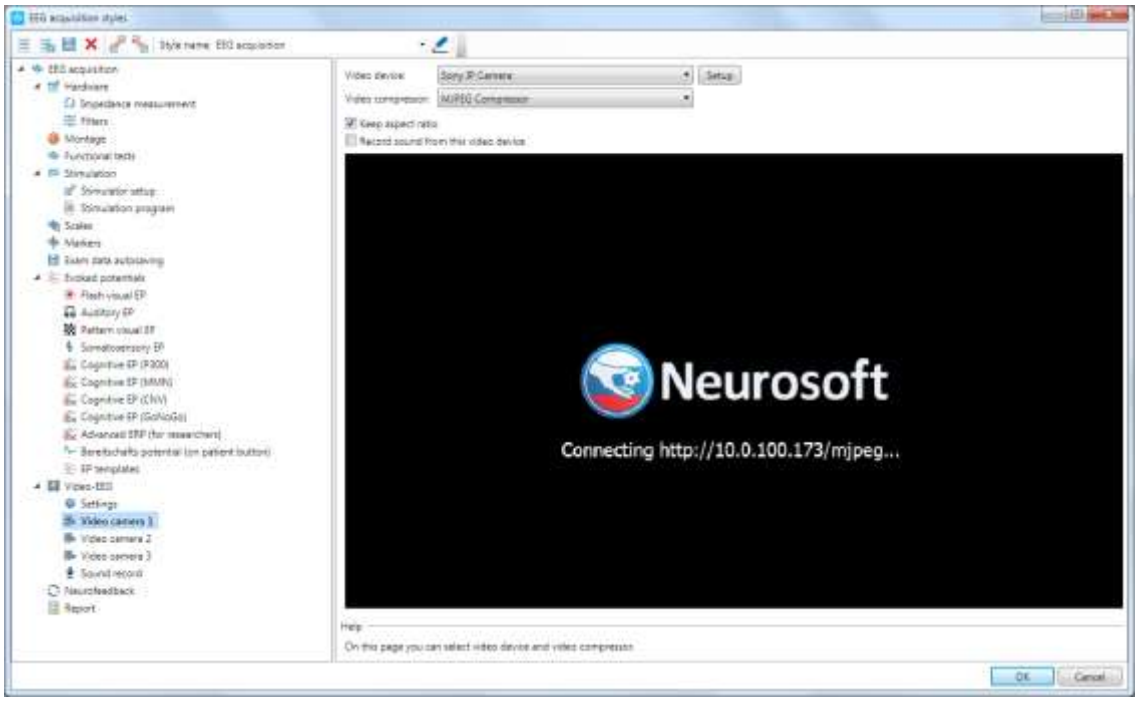


Fig. 10.1. Adjusting video recording.

In “Video device:” combo-box you can select one of the video cameras connected to the computer (the driver of the video camera should be installed beforehand) for video recording. Select the program for video signal compression in “Video compressor:” combo-box. The compression program is intended to decrease the memory capacity required for video storage. It is recommended to use Microsoft MPEG-4 Video Codec V1 video codec.

Using “Setup” button you can change the parameters of the selected video camera. Also, you can select the checkboxes to save the proportions of video and uncheck them if a picture will be stretched out all window area.

In recent times IP cameras which are connected to PC via Ethernet local network or Wi-Fi wireless interface have a wide distribution. The advantage of IP cameras is that video transmitting distance is unlimited. To connect an IP video camera to Neuron-Spectrum.NET software, install the software supplied with video camera. Camera can be used with Neuron-Spectrum.NET software only if corresponding DirectShow video filter for it is installed. Universal software (for example AZcendant IP Camera Filter or IPCamAdapter (MJPEGCamera) allows to connect almost every IP camera to PC. To connect the program to IP camera, choose manufacturer, camera model, its network, IP address, user and password (if the access to the camera is protected with password) on “Settings” page (Fig. 10.2).

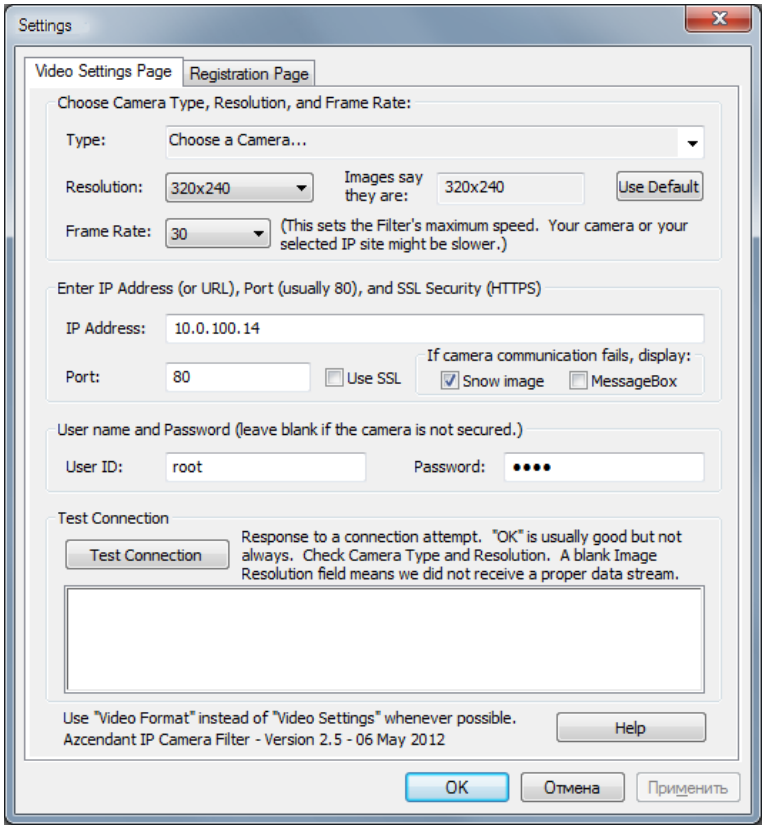


Fig. 10.2. Adjusting connection to IP video camera.

The network cameras manufactured by Axis Company (http://www.axis.com/) should be connected using Axis Streaming Assistant software. You can download the latest software version from manufacturer's website. Axis Streaming Assistant software automatically discovers all Axis IP-cameras on the network and integrates the special DirectShow video filter. In this case the network cameras can then be used with Neuron-Spectrum.NET software. IP cameras with installed Axis Streaming Assistant software can support both video and audio streams via built-in microphone. To enable audio option, select "Record sound from this video device" checkbox (Fig. 10.1).

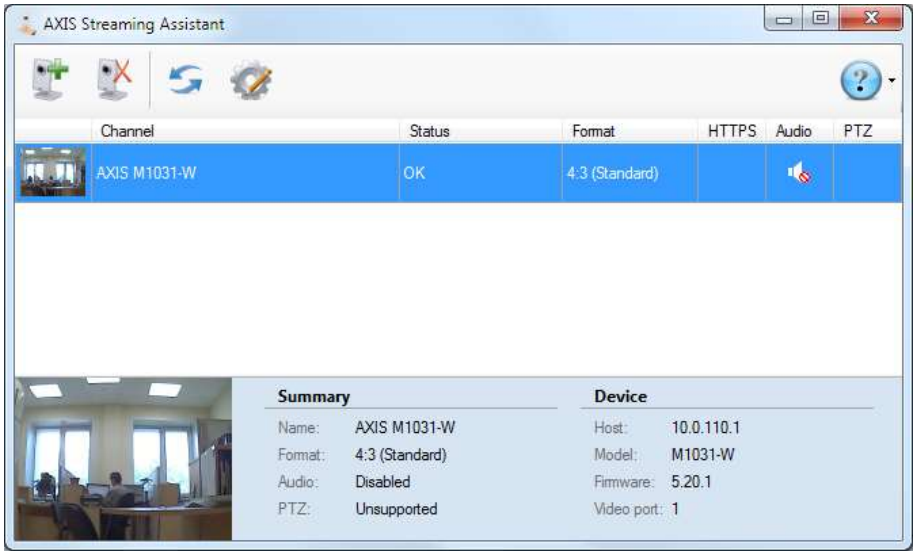


Fig. 10.3. Adjusting connection of Axis network comera using Axis Streaming Assistant software.

Besides DirectShow video filter you can use other facilities integrated to Neuron-Spectrum.NET software to connect network video cameras (Fig. 8.31).

During exam (at the video recording synchronously with EEG) the program automatically divides the video record to the fragments of a definite length to provide the possibility to edit them. On "Settings" page (Fig. 10.4) you can indicate the duration of one fragment of video record. After the acquisition end, you can save only those video record fragments which can represent any interest to decrease an exam volume. Also you can indicate whether to start the video recording automatically at EEG acquisition start.

If the camera selected by you supports the control from a computer, you can indicate the video camera control protocol and computer port to which the control cable in connected.

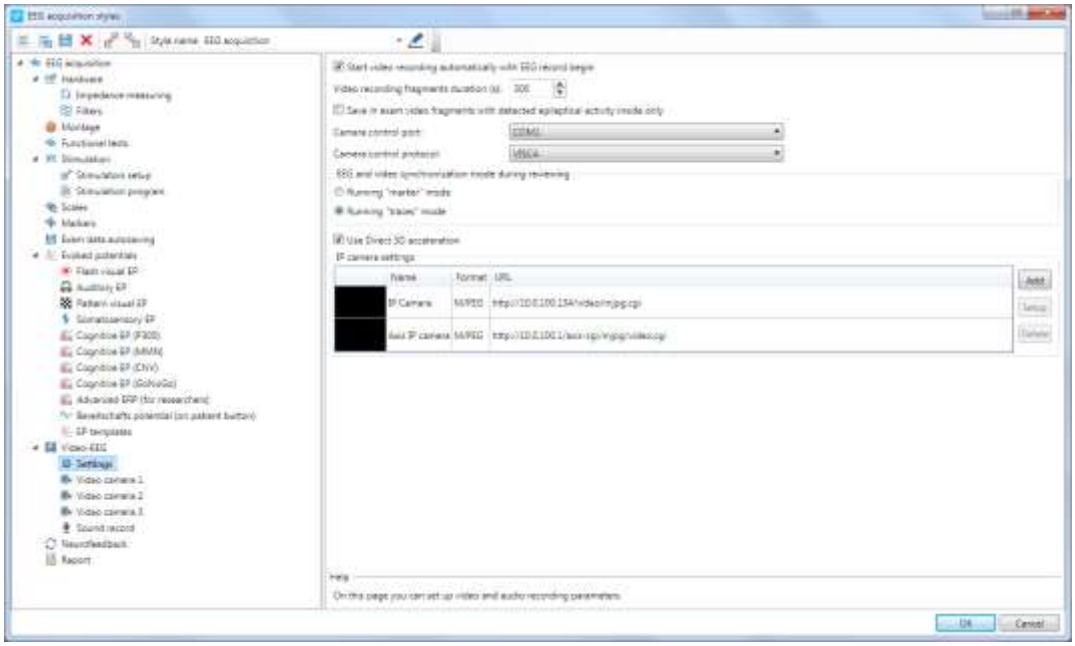


Fig. 10.4. Adjusting video signal recording parameters.

To record the sound during an exam, the microphone should be connected to computer and set up. To set up the parameters of the sound recording, use “Sound record” page (Fig. 10.5). Using the combo-boxes you can select one of connected devices for sound recording and program for sound compression. The sound compression program is intended to decrease the memory capacity required for audio storage. It is recommended to use Microsoft ADCPM program for the sound compression. Using “Setup” button you can change the parameters of selected device for sound recording.

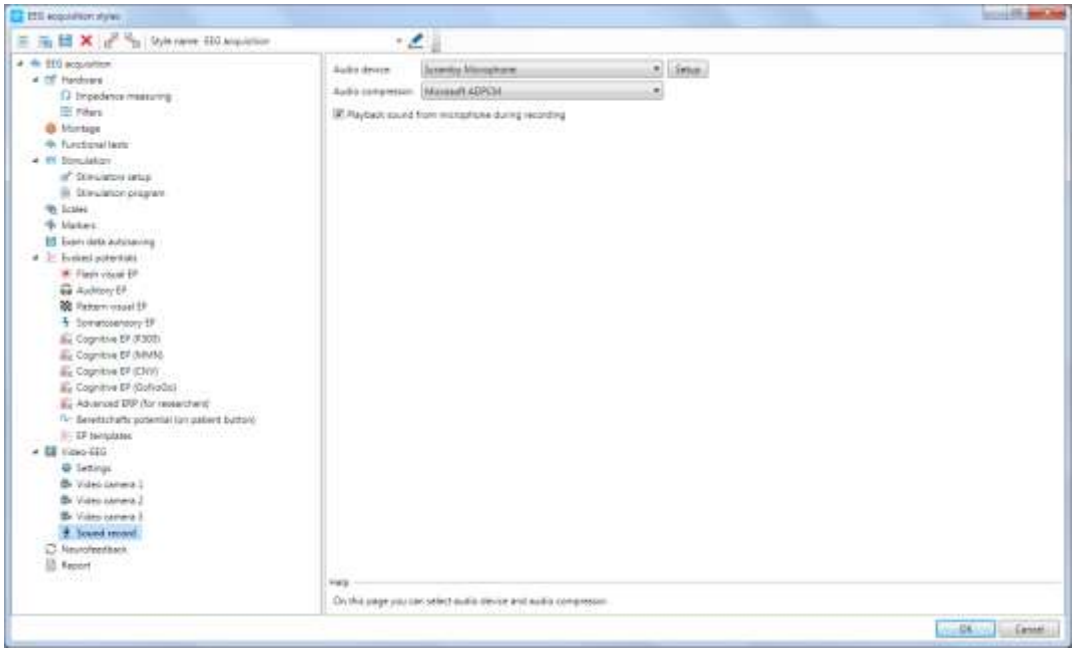


Fig. 10.5. Adjusting sound recording parameters.

10.2. Recording of Video and Audio During Exam

The “Video EEG (video camera 1)”, “Video EEG (video camera 2)” and “Video EEG (video camera 3)” windows (Fig. 10.6) are intended to record, review and edit video and audio during an exam. To show or hide these windows, use **Video EEG** menu command or the corresponding buttons of “Video EEG” toolbar (see the Annex 1).

Before the record beginning, you can select and set up the devices for video and audio recording, also choose the programs for its compression (by default these settings are downloaded from current acquisition style) using the toolbar of “Video EEG” window. The recording of video can be run automatically at EEG acquisition start or by pressing the button located in the left bottom corner of the window. During the acquisition, you can stop and renew the video recording using this button. If you stop EEG recording, the recording of video is terminated automatically.

Under the video picture you can see the current time scale with the indication of the current position for the current fragment of video record, the button of sound volume control at playing back and the buttons of video picture zooming in/out.

The buttons for recording, playing back, navigation over the video record, controls of playing back speed, saving of current frame to file or exam report are located in the bottom part of the window.

Fig. 10.6. The recording of video and audio during exam.

On EEG acquisition completion, video recording is automatically stopped and you can view the recorded video together with EEG traces in “Video EEG” window. If during the review you should see an image from video camera again, use “Live” button.

If the video camera supports the possibility to control it from the computer and the cable of video camera control is connected to the computer port, you can use the video camera control window (Fig. 10.7).

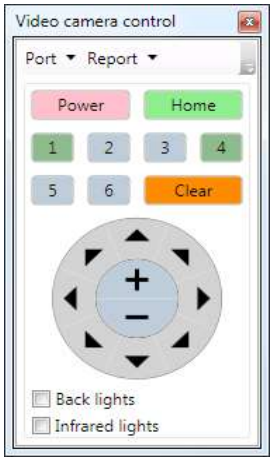


Fig. 10.7. The control of video camera from the computer.

The port and the protocol of video camera control are set in the current acquisition style (Fig. 10.4), but you can change them using the menu of this window. Using video camera control window you can switch on/off the camera, change the angle of view, zoom and remember the current position of camera and restore the positions saved before, activate highlighting.

When you play back the video record, the marker of synchronization with video appears on EEG traces. If you move the marker on the traces and move over EEG, the image is changed synchronously with video in “Video EEG” window. The position on EEG traces is synchronized automatically with the current video fragment in “Video EEG” window at the video playing back.

Using the buttons in the right bottom corner of the window you can set the proportions of the video image and the visibility of the video fragment list in the right part of the window (Fig. 10.8). Using the toolbar buttons of video fragment list, you can both remove and protect from deleting the video and audio signal of each fragment separatly and all fragments at once. For example, if you plan to select the record fragments, which should be saved in an exam, they should be protected from the removal, and then you can use the button to remove all fragments. After that, all fragments which were not protected from the removal, will be deleted. The fragment protected from the removal can be deleted only individually after the supplementary confirmation.

Fig. 10.8. Editing video and audio record fragments.

When you select the fragment in the list, the navigation to its beginning in EEG window is performed automatically. The fragment size is displayed under the list for the selected fragment. Using toolbar buttons you can export current image to file or exam report or save the whole video to file. You can carry out the navigation over the recorded video fragments using “Exam inspector” (see section 5.14.1 “Exam Inspector”).

When you view the video, you can use the window transparency to see simultaneously the video and traces. The window transparency is available for floating windows and is set with the special button in the right top corner (Fig. 10.9).

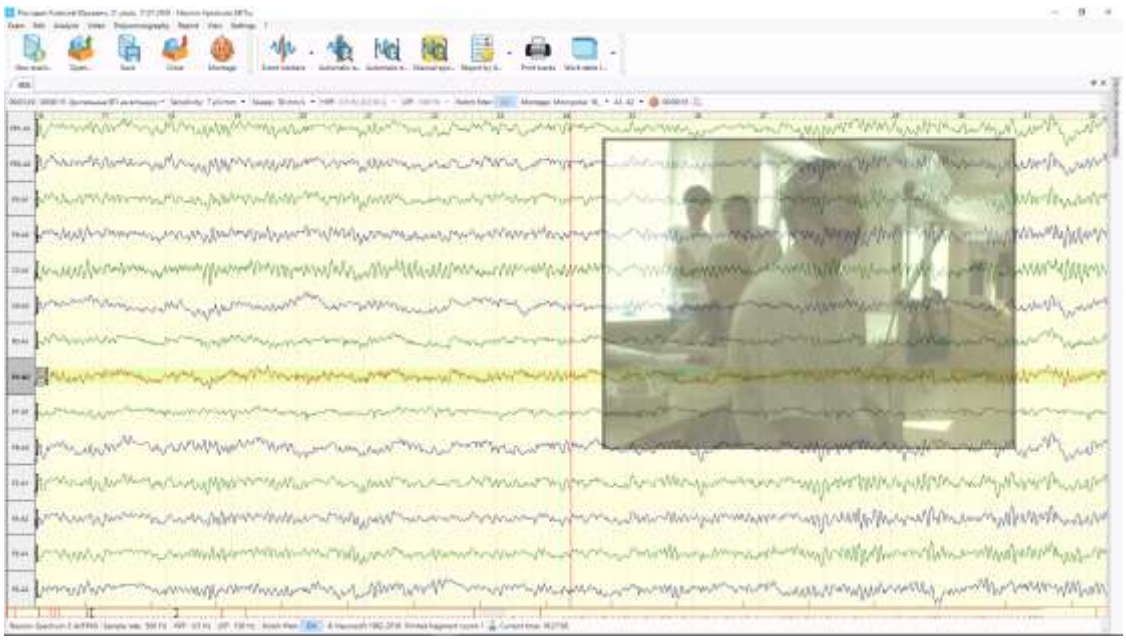


Fig. 10.9. The view of video data in semitransparent window.

When the IP video camera connected via LAN or Wi-Fi is used, the transport delay at video stream transmitting may occur. In this case the video image may lag from the

current trace fragment. As a rule, the duration of such lag is constant for the used LAN. In “Video EEG” window you can specify the LAN transport delay duration under the list of video fragments. Record the flash stimulus and measure it. The flash on the video should correspond to the stimulus onset marker on the traces.

11. Neuron-Spectrum-PSG.NET

While performing the long-term recording, use the function of automatic exam saving during the acquisition (see Fig. 8.28).

Neuron-Spectrum-PSG.NET software is protected by a special license key, which allows to use it only with the definite device. The key is the file with **.nskey* extension, it is located in the work directory of a program. If the key file for the connected device is not found in the work directory of the program and on root directories of hard disks of a computer, you will not be able to use it. The key file is supplied with the program distributive and installed automatically at the program setup. If it is necessary, you can order the key file from your dealer or **Neurosoft** Company directly.

The way to place PSG electrodes and sensors to perform full-range PSG study is described in Annex 4.

Neuron-Spectrum-PSG.NET program allows to analyze both sleep structure and respiratory events during a sleep. The example of **Neuron-Spectrum-PSG.NET** analysis window arrangement is shown in Fig. 11.1.

Fig. 11.1. Sleep stage analysis.

11.1. Acquisition Montage

Depending on the used digital EEG and EP system you can select either the default montage or create your own PSG montage (see section 8.2.1 “Montage Editing”). For Neuron-Spectrum-4/P digital system we provide the default PSG montages. The electrode and sensor placement on a patient during PSG exam is described in the Annex 4 of this manual. To facilitate the attachment of PSG electrodes and sensors, you can use the coloured trim for the front panel (Fig. 11.2).

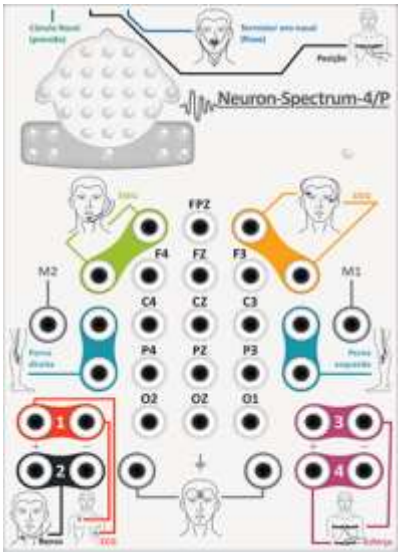


Fig. 11.2. The trim for Neuron-Spectrum-4/P front panel to perform PSG exams.

The system can be equipped with the special patient unit Neuron-Spectrum-PU5 to ensure quick temporary disconnection of a patient from EEG and EP system (for example, to leave the ward) and connection to it during an exam.

11.2. Placement of Electrodes and Sensors

The detailed instruction on how to place the electrodes and sensors is given in Annex 4 of this manual. Besides, the “Electrode Placement Tip” window is added to Neuron-Spectrum.NET program to facilitate the workflow of untrained PSG technicians (Fig. 11.4).

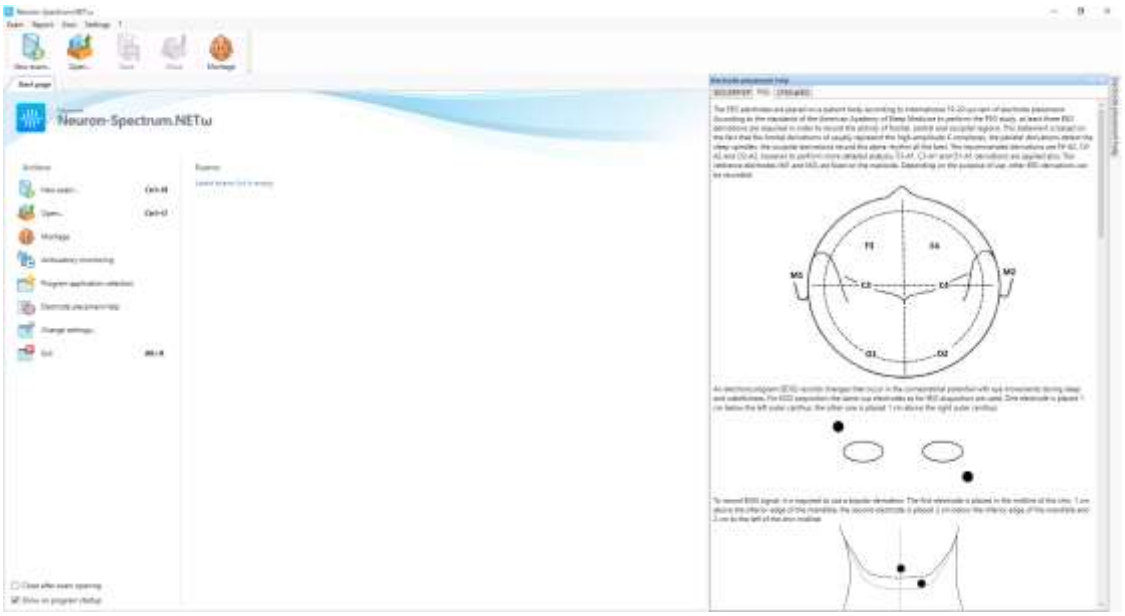


Fig. 11.3. PSG electrode placement tips.

By default this window title is located in the right part of the main program window. To open the window, left-click the title with the mouse.

11.3. Hypnogram

The results of sleep stage scoring are displayed in “Hypnogram” window (Fig. 11.4). To show or hide this window, you can use **Sleep analysis|Hypnogram** menu command or the corresponding button on “Polysomnography” toolbar (see Annex 1).

Fig. 11.4. Hypnogram.

The vertical red line indicates the current position on the record. Using the context menu, you can copy the hypnogram to the current exam report.

The event bars can be displayed together with the hypnogram in this window:

- Arousals – arousal events during sleep.
- Respiration – respiratory events (hypopnoea, obstructive, central and mixed apnea).
- HR – cardiac events (tachycardia, bradycardia, asystole).
- Desaturation/SpO_2 – oxygen desaturation events.

- Snoring – snoring events.
- Limb movements – limb movement events.

You can control the visibility of the above-mentioned event bars using the context menu of “Hypnogram” window, which is available by the right-click. Besides the event bars, other EEG and PSG trends (see section 6.4.11 “Trends”) can be displayed in this window including respiratory trend, heart rate trend, SpO_2 trend, etc.

Using the buttons of “Hypnogram” window toolbar, you can set the sleep stages manually (both after the end of the exam recording and during the recording). Besides, you can also use the computer keyboard:

- **[1]** – first sleep stage.
- **[2]** – second sleep stage.
- **[3]** – third sleep stage.
- **[4]** – fourth sleep stage (only for classification of “Rechtschaffen and Kales” (1968); in classification of American Academy of Sleep Medicine (2007) the fourth stage of slow sleep is absent).
- **[5]** or **[R]** – REM sleep.
- **[W]** or **[0]** – wake stage.
- **[M]** – movement time.
- **[→]** (right arrow button) or **[PgDn]** – the shift to the next analysis epoch. If the next analysis epoch is not marked and the program is in the hypnogram marking mode, it will be automatically detected as the previous marked analysis epoch.
- **[←]** (left arrow button) or **[PgUp]** – the shift to the previous analysis epoch.
- **[U]** – reset of markers of current analysis epoch.
- **[Alt+U]** – shift to the next unselected analysis epoch.

Neuron-Spectrum.NET allows the simultaneous storage of several scorings of hypnograms. At that, any several scorings can be displayed at the same time. Usually, it is convenient to store manually marked hypnogram or hypnogram marked by a trainee and by an expert for the further comparison. At that, the active hypnogram marking which is taken for the calculation of PSG analysis results is always one. To control the hypnogram scorings, use “Scoring” item of “PSG” drop-down list. Using the drop-down list of this button commands, you can create new scorings of the hypnogram, remove the unnecessary one, select the active scoring to calculate the results of PSG analysis. Also, you can open several scorings to compare them. The pressed  button indicates that the hypnogram marking mode is switched on (it is switches on automat-

ically at “Hypnogram” window displaying). In this mode one PSG analysis epoch is displayed in EEG window (by default, its length is 30 seconds) and hot keys to start sleep stages scoring. If you release button, the hypnogram marking mode will be switched off.

Using “Hypnogram” window toolbar, you can clean the current hypnogram scoring, perform the navigation by analysis epochs (also to navigate by epochs, you can use **[←]**, **[→]**, **[PgUp]**, **[PgDn]** buttons of your keyboard). Using button, you can switch to the next unmarked analysis epoch (**[Alt+U]** keys of the keyboard).

In hypnogram scoring mode one analysis epoch is displayed on the computer screen (by default its length is 30 seconds), but sometimes it is convenient to see the previous and next analysis epochs at the scoring. Using button of “Hypnogram” window toolbar, you can set the sweep speed to review several analysis epochs.

Also using the toolbar buttons, you can set the markers of light switch on and off , patient body position change during a sleep (it is required only if a body position sensor is missed). Using button with drop-down list, you can open any windows with PSG analysis results.

Using button of “Hypnogram” window toolbar you can set up the time interval for the hypnogram being visible on the screen. By default whole hypnogram irrespective of its duration is seen in the window.

Besides the hypnogram, different event bars and EEG/PSG trends can be displayed in this window with **Analysis|Trends** main menu item. The example of “Hypnogram” window with several event bars and PSG trends is shown in Fig. 11.5.

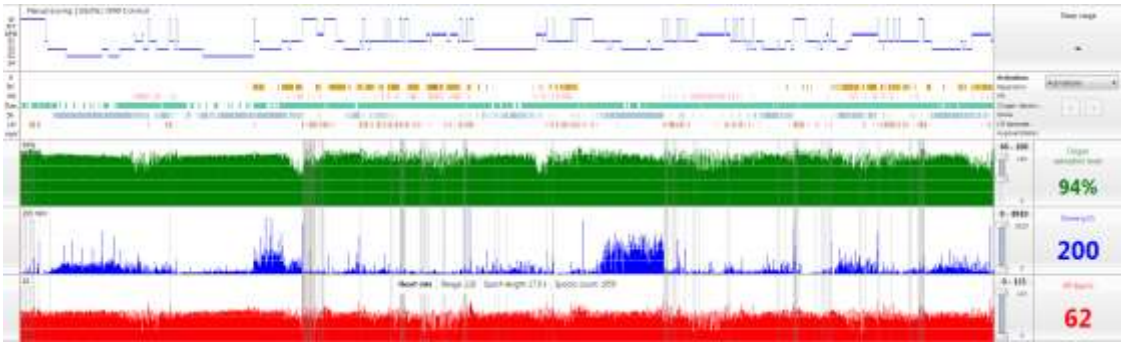


Fig. 11.5. Hypnogram with events and trends.

CPAP button located on the toolbar is intended for manual entering of CPAP pressure in case CPAP device is not connected to digital EEG and EP system via DC channel or airflow pressure sensor (nasal cannula). To obtain CPAP pressure automatically, connect CPAP device to your digital EEG and EP system using direct current channel. In this case the used DC channel should be included to the montage (see section 8.2.1 “Montage Editing”). Besides CPAP connection to DC channel you can use nasal pressure channel (Cannula) to obtain CPAP pressure. To do it, connect CPAP to can-

nula and add one more “Cannula” derivation with “CPAP pressure” derivation type to the montage. If CPAP is connected to electroencephalograph using DC channel or cannula channel, the program arranges treatment pressure titration markers automatically during the exam. CPAP systems manufactured by BMC company can be connected to PC COM port. In this case you can control its work with the help of Neuron-Spectrum.NET software.

Using  button, you can set the separate review mode for EEG and PSG traces with different sweep speed (Fig. 11.6).

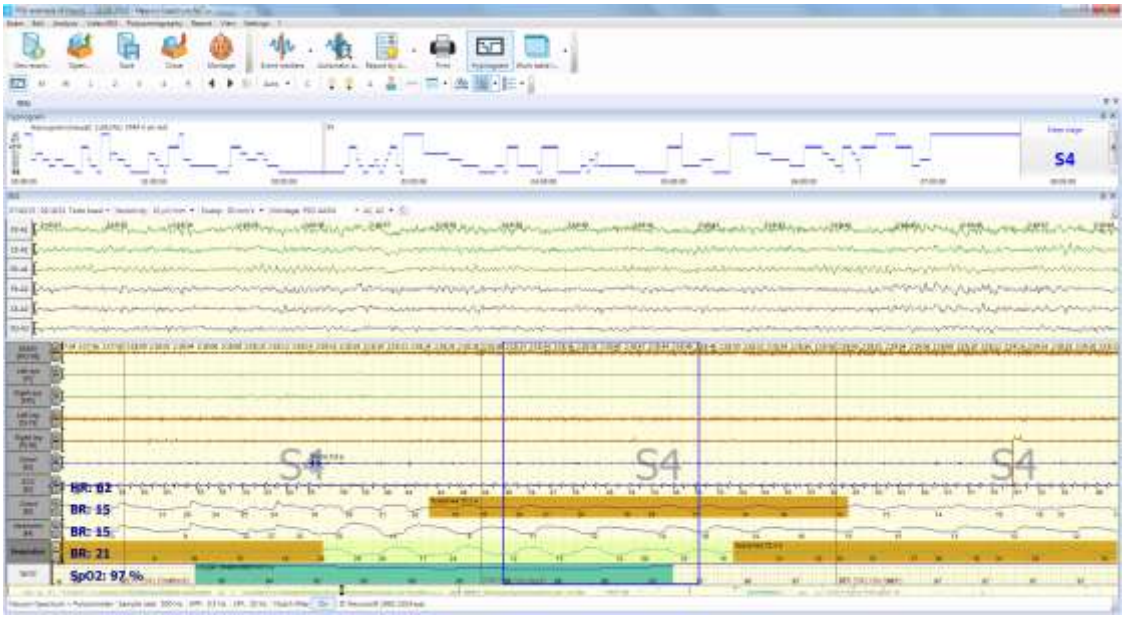


Fig. 11.6. Review of EEG and PSG traces with different sweep speed.

In this mode EEG traces are displayed in the top part of the screen with sweep speed specified for EEG. In the bottom part of the screen all traces with PSG sweep speed (one or several PSG epochs per screen) are displayed. EEG and PSG windows are synchronized, i.e. if you move over EEG traces, PSG traces are moved automatically and vice versa. The blue rectangle in PSG window indicates the record fragment being visible in EEG window.

11.4. PSG Trends

“EEG and PSG trends” analysis window (Fig. 11.5) (see section 6.4.11 “Trends”) allows to follow the dynamics to estimate the changes of specified values during an exam. To open or hide “PSG trend” window, use **Analysis|Trends** menu command.

In “EEG and PSG trend” window the following trends can be shown:

- SpO_2 trend – trend of oxygen saturation level during exam (Fig. 11.7).
- Respiratory trend – shows respiratory rate changes of a patient during an exam.

- Abdominal effort trend – shows peak-to-peak amplitude changes of “Abdom” trace.
- Thorax effort trend – shows peak-to-peak amplitude changes of “Thorax” trace.
- Heart rate trend – shows heart rate changes during an exam (Fig. 11.8).
- Limb movement trend – shows amplitude changes of limb movement traces (Fig. 11.9).
- Snoring trend – shows amplitude changes of snoring trace.
- Body position trend – shows body position changes of a patient during an exam.
- Eye movements trend – shows amplitude changes of eye movement trace during an exam.
- EMG amplitude trend – shows amplitude changes of EMG trace during an exam.
- CPAP pressure trend – shows CPAP pressure changes during an exam.
- PTT (pulse transit time) – shows PTT changes during an exam.
- Light trend – shows light changes during an exam.
- Temperature trend – shows patient’s temperature changes during an exam.
- PSG events – shows PSG events detected during an exam (apnea, desaturation, snoring, tachycardia, etc.).

Fig. 11.7. SpO_2 trend.

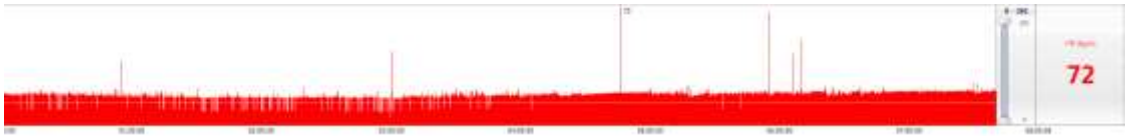


Fig. 11.8. HR trend.

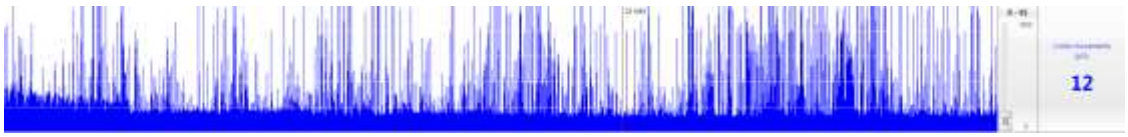


Fig. 11.9. Limb movement trend.

The vertical red line with instant amplitude on the trend indicates the current position in exam. Using the input box located in the right part of the window, you can control the border values of a trend. Using button, you can open the unlimited number of additional trends for their simultaneous review.

The information panel with the current trend value is displayed in the right part of the trend (Fig. 11.10). For example, the current respiratory rate is visualized on the information panel of the respiratory trend. The information panel can be used both during the acquisition and during the exam review.

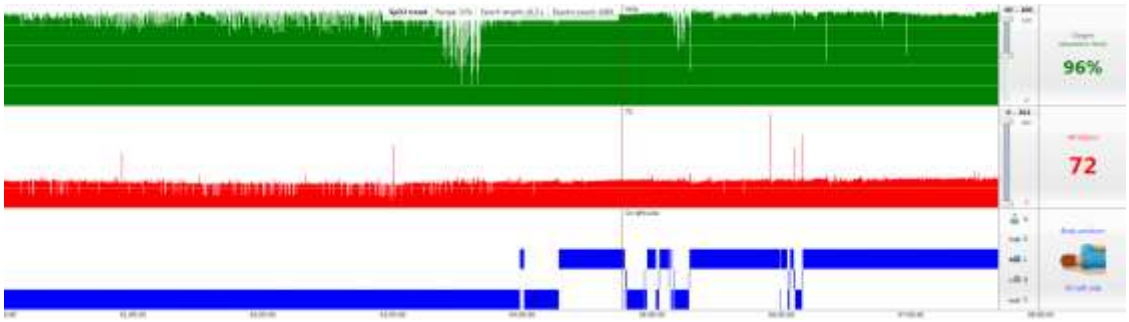


Fig. 11.10. The example of PSG trend information panel.

11.5. Arrangement of PSG Events

During polysomnography analysis the search and detection of different phenomena is very important, for example respiratory events, cardiac events, snoring events and limb movement events.

Neuron-Spectrum.NET allows to detect them manually. To do it, select the required trace fragment and choose the required phenomena type in the drop-down list (Fig. 11.11).

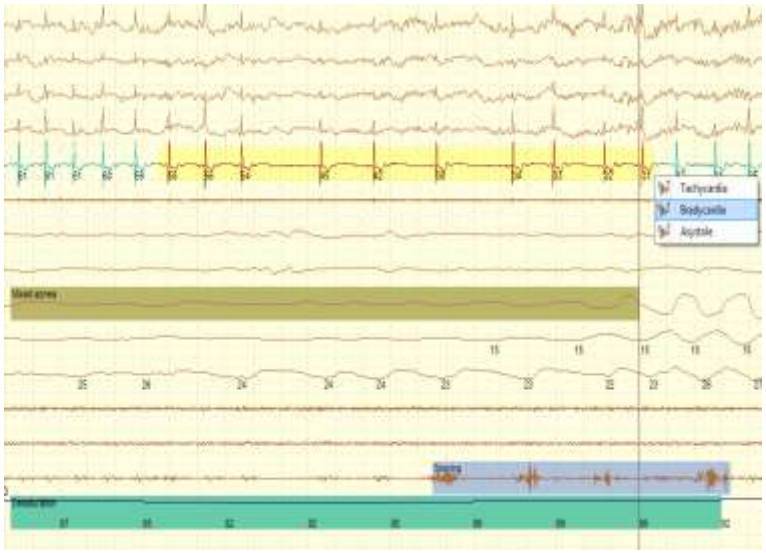


Fig. 11.11. Manual arrangement of PSG events.

The separate list of admissible events is defined for each trace type, but you can supplement this list with your own events on “PSG events” tab in analysis style editing window (Fig. 8.50). To speed up the manual arrangement of events, the event selection menu is displayed only once when detecting the first event for this derivation. At next selection the events of this derivation are identified automatically as previous one. To activate the menu of available phenomena while selecting, hold **[Ctrl]** key of your computer. After each phenomena selection the corresponding analysis results

are automatically updated. There is a tab to review the list of corresponding PSG events in each PSG analysis window.

To review all selected PSG events of all types, use “PSG events” window (Fig. 11.12). To show or hide this window, use **Polysomnography|Sleep analysis results|PSG events** menu command.

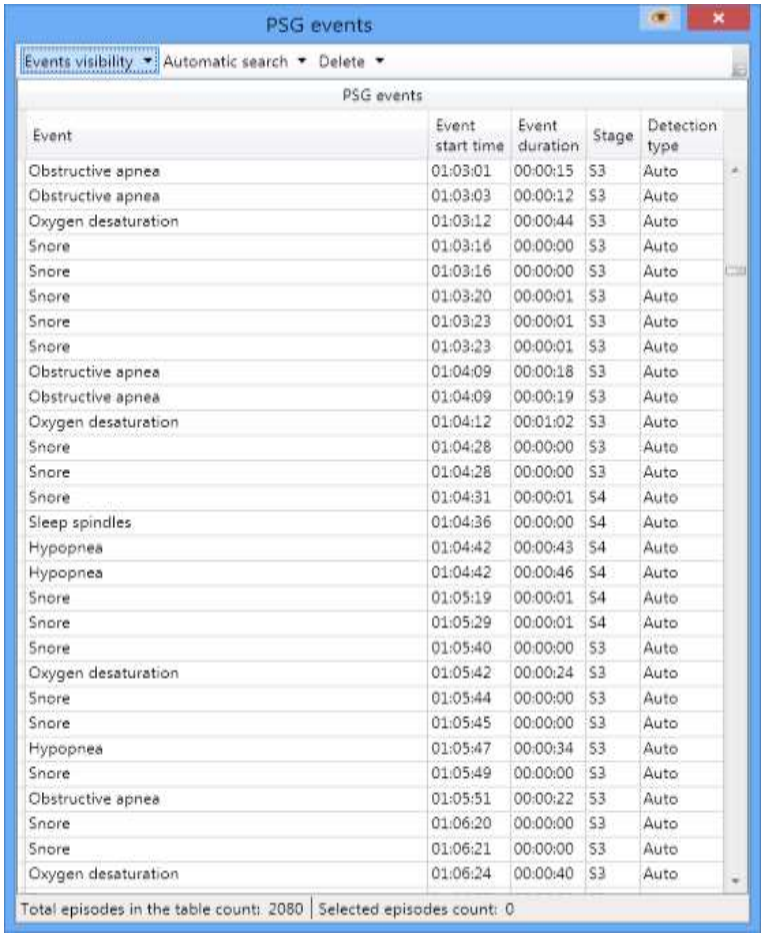


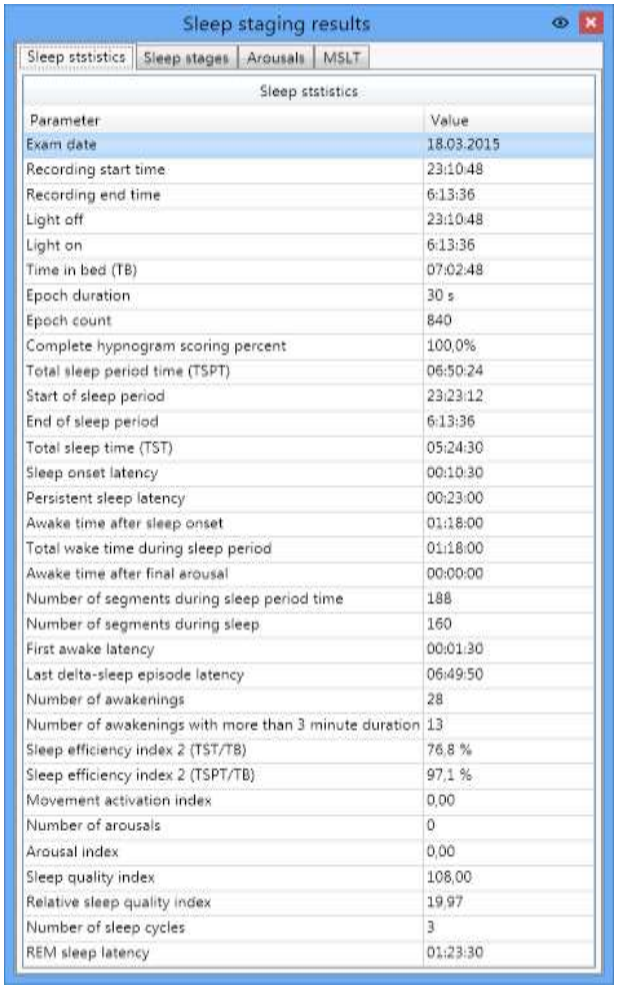
Fig. 11.12. PSG events.

You can see the list of all selected PSG events in this window. The name, the duration, the sleep stage and the detection way are displayed for each event. If you click the table column name with the mouse, this parameter will be sorted in ascending/descending order. In case you click the event with left mouse button, the automatic navigation to the selected event occurs. Using drop-down list you can control the visibility of different event types, remove events using the toolbar.

11.6. Sleep Structure Analysis

When the marking of the current hypnogram is over (see section 11.3 “Hypnogram”), the results of its analysis are displayed in the “Sleep staging results” window (Fig. 11.13). To show or hide this window, use **Polysomnography|Sleep analysis results|Sleep stage analysis** menu command. The window contains three tabs. The “Sleep statistics” tab contains the table of calculated parameters of sleep structure. Using the context menu, you can copy the table to the current position of the active exam report or in MS Excel (if MS Excel is installed on your computer). Also using

the context menu you can set up the visibility of the table rows (for example, if some table lines contain uninteresting information, you can hide them).



Sleep ststistics

Parameter	Value
Exam date	18.03.2015
Recording start time	23:10:48
Recording end time	6:13:36
Light off	23:10:48
Light on	6:13:36
Time in bed (TB)	07:02:48
Epoch duration	30 s
Epoch count	840
Complete hypnogram scoring percent	100,0%
Total sleep period time (TSPT)	06:50:24
Start of sleep period	23:23:12
End of sleep period	6:13:36
Total sleep time (TST)	05:24:30
Sleep onset latency	00:10:30
Persistent sleep latency	00:23:00
Awake time after sleep onset	01:18:00
Total wake time during sleep period	01:18:00
Awake time after final arousal	00:00:00
Number of segments during sleep period time	188
Number of segments during sleep	160
First awake latency	00:01:30
Last delta-sleep episode latency	06:49:50
Number of awakenings	28
Number of awakenings with more than 3 minute duration	13
Sleep efficiency index 2 (TST/TB)	76,8 %
Sleep efficiency index 2 (TSPT/TB)	97,1 %
Movement activation index	0,00
Number of arousals	0
Arousal index	0,00
Sleep quality index	108,00
Relative sleep quality index	19,97
Number of sleep cycles	3
REM sleep latency	01:23:30

Fig. 11.13. Sleep structure analysis.

The “Sleep statistics” table contains the following parameters:

- Exam date – the date of exam performing.
- Recording start time – the astronomical time of record beginning.
- Recording end time – the astronomical time of record finishing.
- Light off – the astronomical time of light switching off. If the “Light off” event marker is not set, than the time of the record beginning is considered.
- Light on – the astronomical time of light switching on. If the “Light on” event marker is not set, than the time of the record beginning is considered.
- Time in bed (TB) – the total time from the “Light off” marker up to “Light on” marker.
- Epoch duration – the duration of analysis epoch (by default its duration is 30 seconds).

- Epochs count – the number of epochs in the record.
- Total sleep period time (TSPT) – the time from the moment of sleep onset up to final awake considering the wakes during the sleep.
- Start of sleep period – the astronomical time of sleep period onset.
- End of sleep period – the astronomical time of sleep period end.
- Total sleep time (TST) – the time from sleep onset up to final awake without considering the wake periods during the sleep, i.e. total time of all sleep stages without wake stages.
- Sleep onset latency – the time from the “Light off” event marker up to beginning of first of the three consecutive epochs of the first sleep stage or the first epoch of any other sleep stage.
- Persistent sleep latency – the time from the first “Light off” event marker up to occurrence of 20 continuous epoch (set in the analysis style) of any sleep stage.
- Wake time after sleep onset – the total time of wakefulness from the first epoch of steady sleep up to “Light off” event marker.
- Total wake time during sleep period – the total time of wakefulness after the sleep onset up to moment of final awake.
- Wake time after final arousal – the total time of wakefulness from the final wake up to “Light off” event marker.
- Number of segments during sleep period time – the total number of segments during the sleep period. The segment on the hypnogram is considered to be the consequence of analysis epochs (one epoch is also possible) with similar sleep stage.
- Number of segments during sleep – the total number of segments during the sleep.
- First awake latency – the time from the sleep onset up to the first awake during the sleep.
- Last delta-sleep event latency – the time from the sleep onset up to the beginning of last delta epoch. Delta sleep – the sleep on the third and fourth stages.
- Number of awakenings – the number of awakes after sleep onset (the number of segments of wake stage).
- Number of awakenings with more than 3 minute duration – the number of awakes with more than 3-minute duration after sleep onset.
- Sleep efficiency index (TST/TB) – the relative index of sleep efficiency calculated as the ratio of total sleep time to time in bed, in percents.

- Sleep efficiency index 2 (TSPT/TB) – the relative index of sleep efficiency calculated as the ratio of total sleep period time to time in bed, in percents.

- Movement activation index – the number of movement time segments which results in the change of the current sleep stage in terms of one sleep hour.

- Number of arousals – the number of arousal events per total sleep time.

- Arousal index – the ratio of arousal number to total sleep time measured in hours, i.e. the arousal number per sleep hour.

- Number of sleep cycles. The first sleep cycle is the period from the first sleep epoch up to the last epoch of first REM (Rapid eye movement) sleep. All periods of REM-sleep emerging within 60 minutes after the first one are included into the first cycle. The second and all other sleep cycles are the periods from the first epoch of any sleep stage (except REM) which follows the last REM period included in the previous sleep cycle before the next REM period ending (also REM periods within 60 minutes from it are included in it). If the period is not ended with REM, it is not considered to be a sleep cycle (for example, if the wake does not occur from REM).

- REM sleep latency – the time from the sleep onset to first epoch of REM-sleep.

On the second tab of “Sleep stages” window (Fig. 11.14) the parameters of sleep stages and wake periods are given. Using the context menu, you can copy the table and the graph to the current position of active exam report. Besides, the table can be copied to MS Excel (if MS Excel is installed on your computer). Also, using the context menu, you can set up the visibility of the table columns and rows (for example, if some table columns or rows contain uninteresting information, you can hide them).

As soon as you selected the table row with the use of left mouse button, the graph located in the bottom part of the window is updated. The values of the selected table row are displayed on the graph.

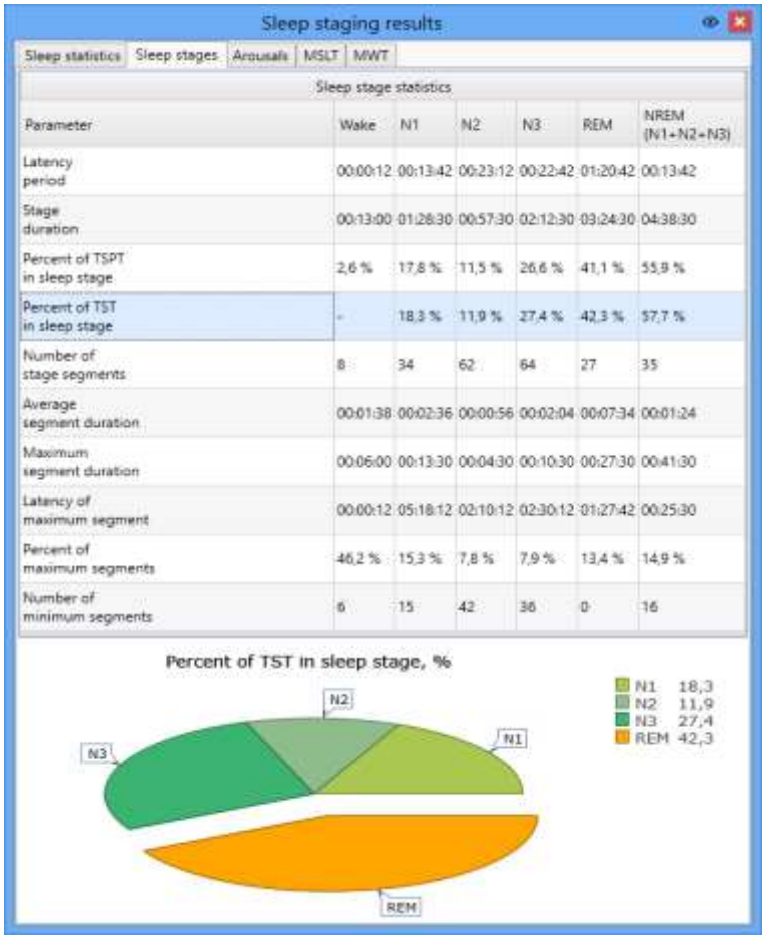


Fig. 11.14. Parameters of sleep stages.

The table contains the following columns:

- Wake – wakefulness state.
- NREM – non-rapid eye movement sleep.
- N1 – first stage of NREM sleep.
- N2 – second stage of NREM sleep.
- N3 – third stage of NREM sleep.
- REM – rapid eye movement sleep.
- S (supine) – supine position.
- NS (non-supine) – non-supine position.

The “Sleep stage statistics” table contains the following parameters:

- Latency period. For the first sleep stage is the time from the light off up to sleep onset, for the rest ones is the time from sleep onset up to the corresponding sleep stage occuring.
- Stage duration – the total duration of wakefulness period (after the sleep onset) and each sleep stage. Delta sleep is the third and fourth sleep stages. NREM are sleep stages from first one up to the fourth one.
- Percent of TSPT in sleep stage – the ratio of stage duration to the sleep period time, in percents.
- Percent of TST in sleep stage – the ratio of sleep stage duration to the total sleep time, in percents.
- Number of stage segments – the number of segments of each stage.
- Average segment duration – the average duration of segments of each stage.
- Maximum segment duration – the maximum duration of segments of each stage.
- Latency of maximum segment – the latency period of maximal segment of each stage, i.e. the time from light switching off up to the maximum segment occurrence.
- Percent of maximum segments – the ratio of maximum segment duration of each stage to the total duration of all segments of this stage, in percents.
- Number of minimum segments – the number of minimal segments of each stage. The minimal segment is considered to be the one with one analysis epoch duration.

On the third tab of “Sleep staging results” (Fig. 11.15) the result of arousal analysis during an exam is shown. The arousal events are arranged manually.

For each arousal type total number of arousal during a sleep and index can be calculated. Also the quantity and index of arousals during NREM and REM stages and separately for supine and nonsupine positions are calculated.

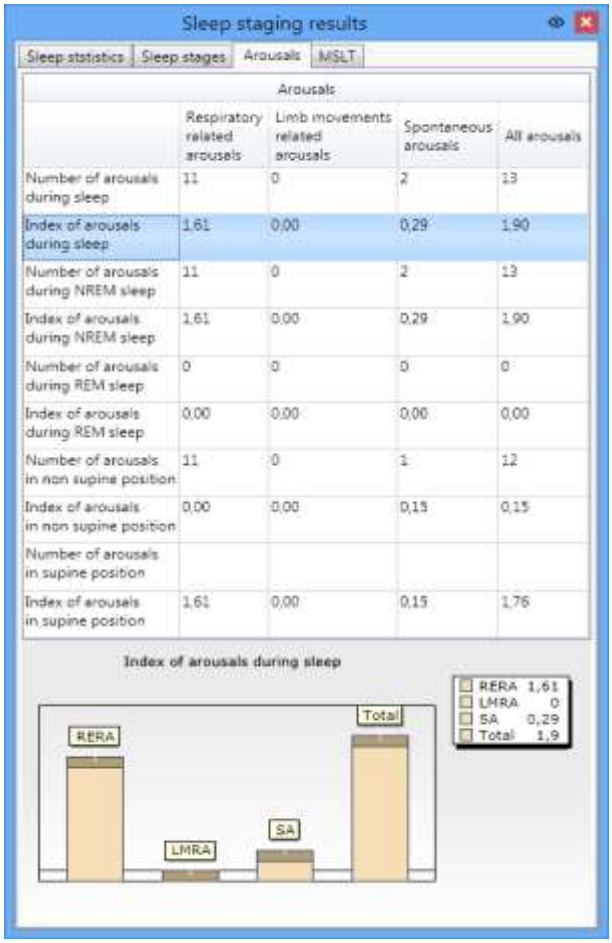


Fig. 11.15. Analysis of arousals.

Using the context menu, you can copy the table and the graph to the current position of active exam report. Besides, this table can be copied to MS Excel (if MS Excel is installed on your PC). You can adjust the visibility of columns and rows of this table (for example, if some table columns or rows contain uninteresting information, you can hide them) with the context menu. If you left-click a table row, the graph in the bottom part of the window is updated. The values of selected table row are displayed on this graph.

The Multiple Sleep Latency Test (MSLT) allows estimating the daytime sleepinesss of patients with sleep disorders. As a rule the MSLT is performed the next day after the night PSG study and consists of the several scheduled naps. Each time the test measures how long it takes you to fall asleep and latency of all sleep stages. The table with the results of daytime nap analysis and graphs on each parameter is shown in “Sleep structure analysis” window of “MSLT” tab.

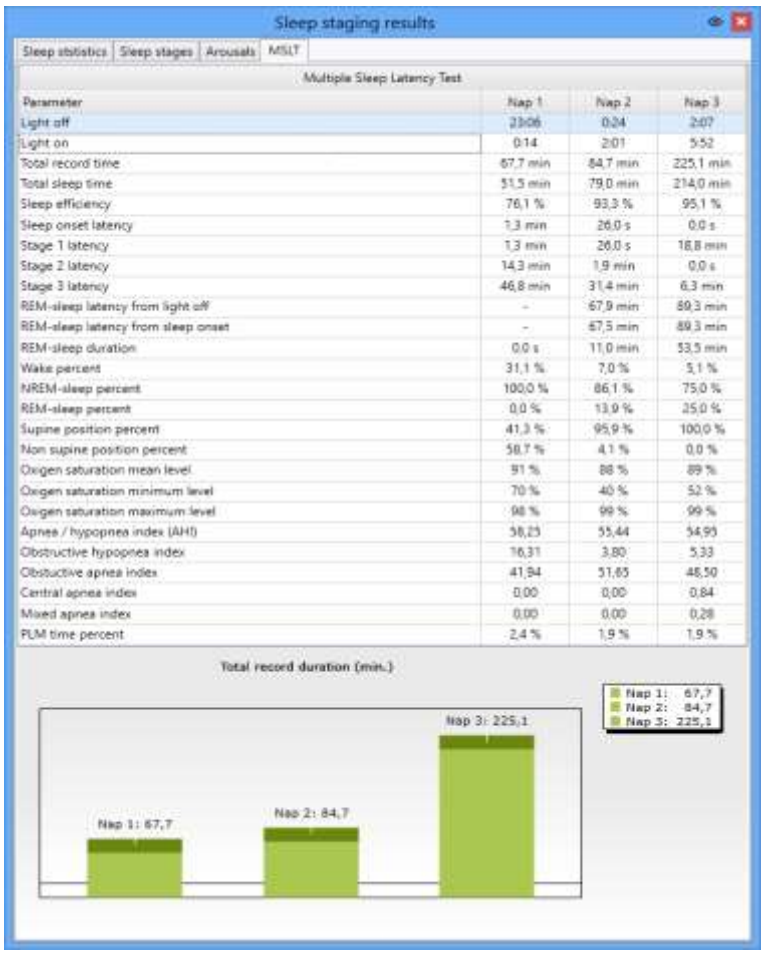


Fig. 11.16. “MSLT” tab.

To specify each nap onset/offset during the test, use the “Light on/off” markers respectively. The related checkbox to show the light on/off markets can be found in “Hypnogram” window settings. Besides these markers, the daytime naps (Fig. 11.19) shall be highlighted in “Hypnogram” window.

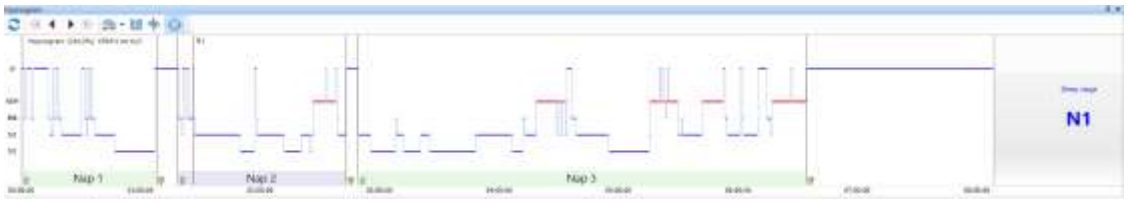


Fig. 11.17. Highlighting the daytime naps during MSLT.

Using the context menu you can copy the table and the graph to the current position of the exam report. Besides, the table can be copied to MS Excel (if MS Excel is installed on your computer). Also, using context menu you can adjust the visibility of the table columns and rows (for example, if some table columns or rows contain the information you are not intereted in, you can hide them). As soon as you left-click a particular table row to select it, the graph in the bottom part of the window is updated. The selected table row values are sown on the graph.

11.7. Respiratory Analysis during Sleep

To review the respiratory events during a sleep, you can use the “Respiration analysis during sleep” window” (Fig. 11.18). To show or hide this window, use **Polysomnography|Sleep analysis results|Respiration analysis during sleep** menu command. The window contains several tabs. The first tab “Respiratory events” (Fig. 11.18) shows the results of analysis of respiratory events as table and graphs.

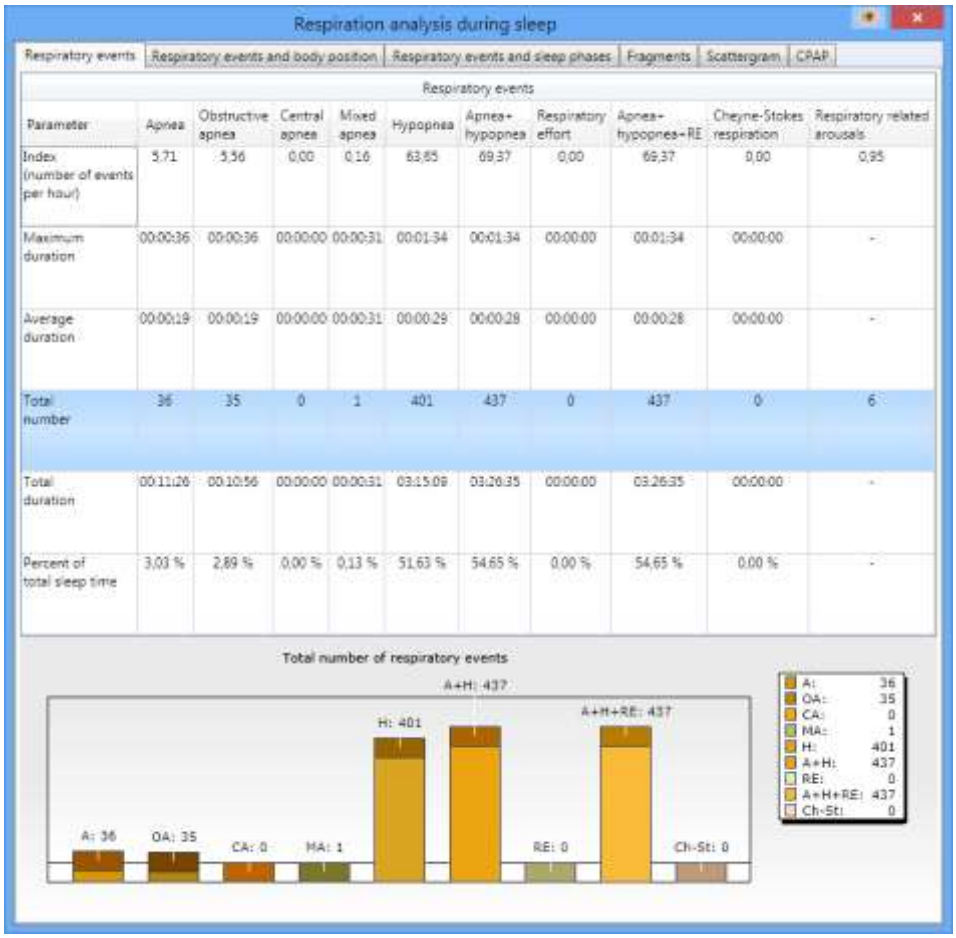


Fig. 11.18. Respiratory analysis results during sleep.

In **Neuron-Spectrum.NET** you can select such respiratory events as hypopnea, obstructive apnea, central apnea, mixed apnea. The search of the indicated events is carried out using the airflow, thoracic and abdominal efforts traces. In the context menu of airflow, thoracic and abdominal efforts traces you can calculate the breath rate and display it on traces for more convenient analysis.

Also using the menu of “Respiratory analysis results” window, you can set up the visibility of table rows and columns, copy the table or graph to exam report.

As soon as you selected the table row with the use of left mouse button, the graph located in the bottom part of the window is updated. The values of the selected table row are displayed on the graph.

The results of the respiratory event analysis depending on a body position are shown on the second tab (Fig. 11.19).

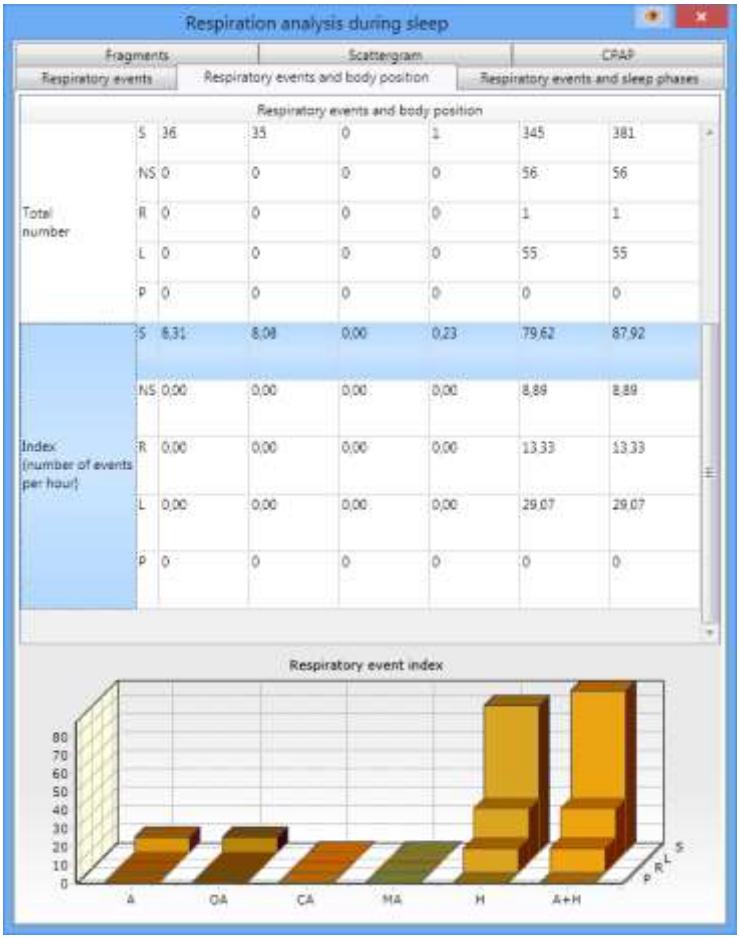


Fig. 11.19. Respiratory events and body position.

Each row in the table has the following subrows:

- S (supine) – supine position.
- NS (non-supine) – non-supine position.
- R (right) – right lateral position.

- L (left) – left lateral position.
- P (prone) – prone position.

The results of respiratory events analysis depending on sleep stages are shown on the third tab of “Respiratory analysis during sleep” window

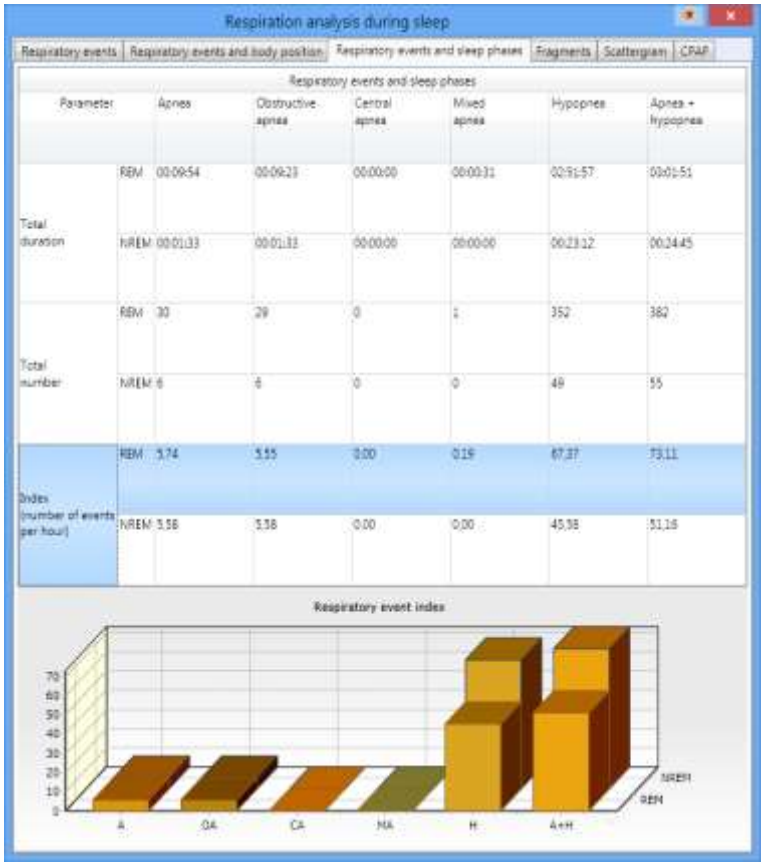
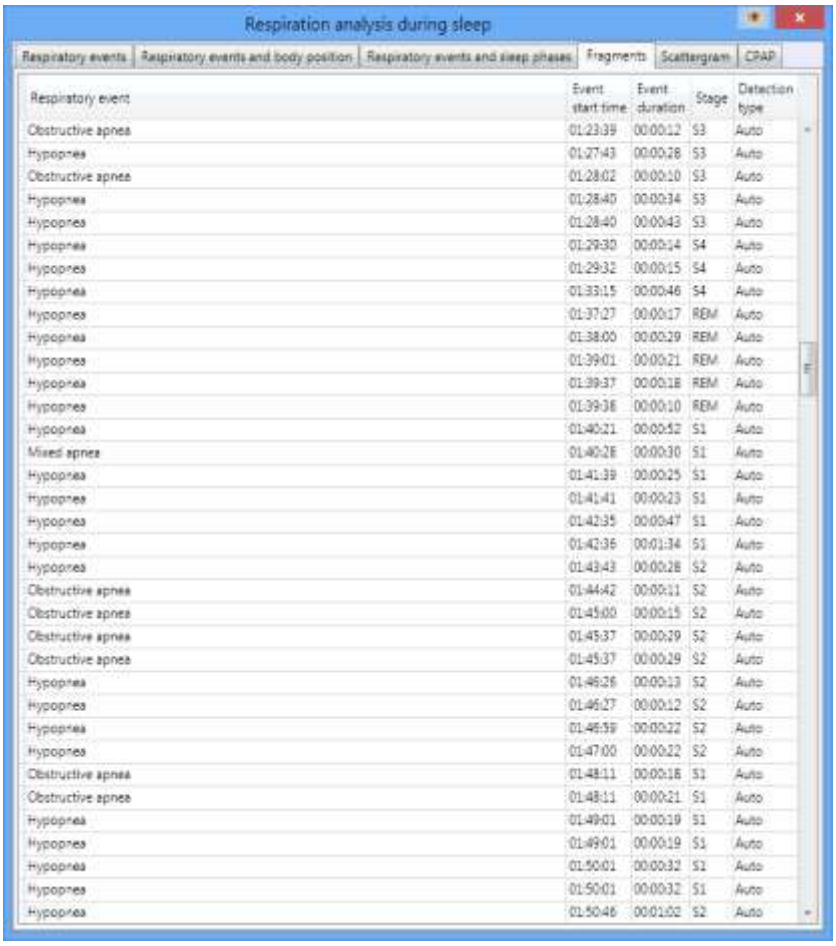


Fig. 11.20. Respiratory events and sleep stages.

The list of all selected respiratory events is given on the fourth tab (Fig. 11.21). Using this list you can navigate over the respiratory events. If you left-click on the column names of this list, you can sort it in different order, for example, by increase or decrease of event duration, by sequence in the recording, by type.



Respiratory event	Event start time	Event duration	Stage	Detection type
Obstructive apnea	01:23:39	00:00:12	S3	Auto
Hypopnea	01:27:43	00:00:28	S3	Auto
Obstructive apnea	01:28:02	00:00:10	S3	Auto
Hypopnea	01:28:40	00:00:34	S3	Auto
Hypopnea	01:28:40	00:00:43	S3	Auto
Hypopnea	01:29:30	00:00:14	S4	Auto
Hypopnea	01:29:32	00:00:15	S4	Auto
Hypopnea	01:33:15	00:00:46	S4	Auto
Hypopnea	01:37:27	00:00:17	REM	Auto
Hypopnea	01:38:00	00:00:29	REM	Auto
Hypopnea	01:39:01	00:00:21	REM	Auto
Hypopnea	01:39:37	00:00:18	REM	Auto
Hypopnea	01:39:38	00:00:10	REM	Auto
Hypopnea	01:40:21	00:00:52	S1	Auto
Mixed apnea	01:40:28	00:00:30	S1	Auto
Hypopnea	01:41:39	00:00:25	S1	Auto
Hypopnea	01:41:41	00:00:23	S1	Auto
Hypopnea	01:42:35	00:00:47	S1	Auto
Hypopnea	01:42:36	00:01:34	S1	Auto
Hypopnea	01:43:43	00:00:28	S2	Auto
Obstructive apnea	01:44:42	00:00:11	S2	Auto
Obstructive apnea	01:45:00	00:00:15	S2	Auto
Obstructive apnea	01:45:37	00:00:29	S2	Auto
Obstructive apnea	01:45:37	00:00:29	S2	Auto
Hypopnea	01:46:26	00:00:13	S2	Auto
Hypopnea	01:46:27	00:00:12	S2	Auto
Hypopnea	01:46:59	00:00:22	S2	Auto
Hypopnea	01:47:00	00:00:22	S2	Auto
Obstructive apnea	01:48:11	00:00:18	S1	Auto
Obstructive apnea	01:48:11	00:00:21	S1	Auto
Hypopnea	01:49:01	00:00:19	S1	Auto
Hypopnea	01:49:01	00:00:19	S1	Auto
Hypopnea	01:50:01	00:00:32	S1	Auto
Hypopnea	01:50:01	00:00:32	S1	Auto
Hypopnea	01:50:46	00:01:02	S2	Auto

Fig. 11.21. The list of respiratory events.

The dependence of respiratory events on CPAP pressure is shown on the “CPAP” tab (Fig. 11.22). Using this table you can assess for what CPAP pressure values the number of respiratory events is decreasing to the acceptable level.

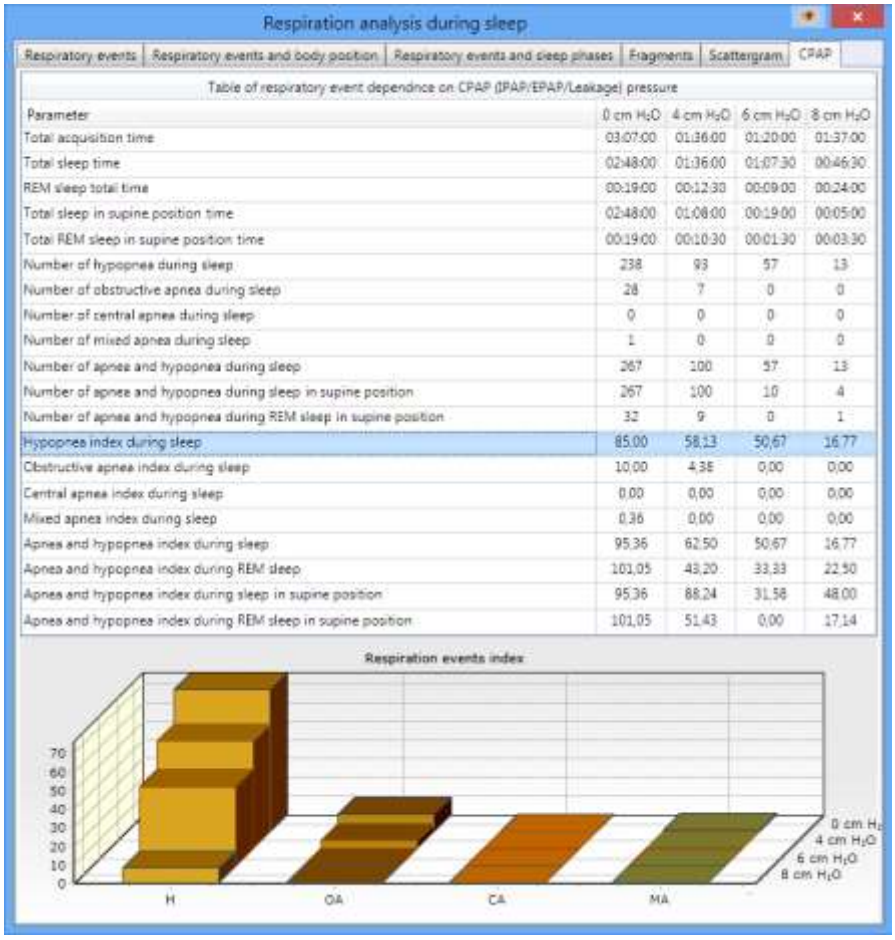


Fig. 11.22. The dependence of respiratory events on CPAP pressure.

On “PAP statistics” tab (fig. 11.23) the cases of CPAP use are listed top-down and the same is done also with IPAP/EPAP for BiPAP devices. The sleep disorder index per hour is calculated for each pressure level.

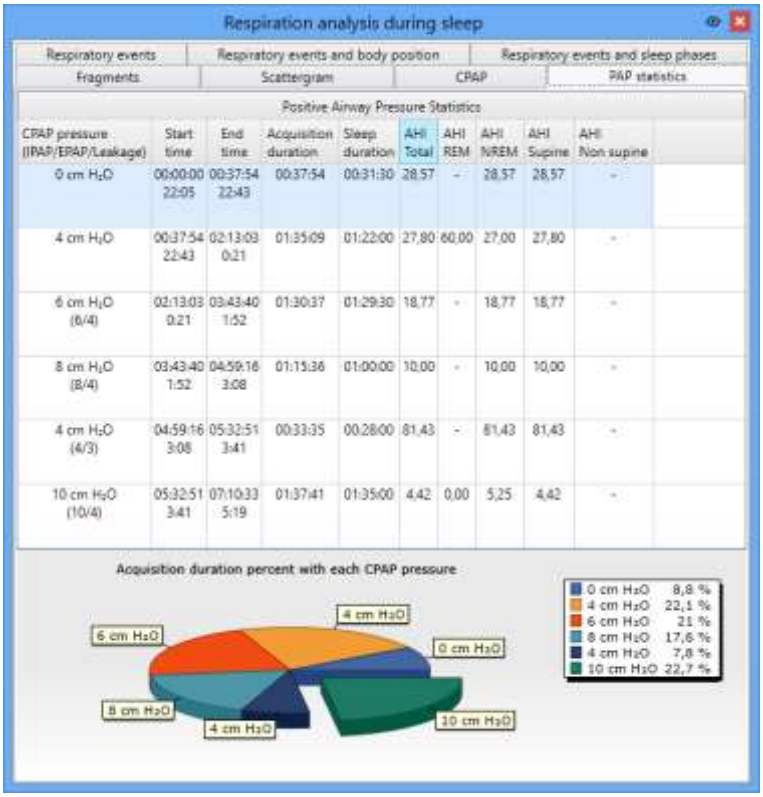


Fig. 11.23. The CPAP use list during the test.

11.8. Oxygen Desaturation Analysis during Sleep

To analyze the oxigen saturation, use “Oxygen desaturation analysis results” window (Fig. 11.24). To show or hide this window, use **Polysomnography|Sleep analysis results|Oxygen desaturation analysis** menu command. The window contains several tabs. The results of oxygen saturation analysis during a sleep are shown as table on the first tab (Fig. 11.24).

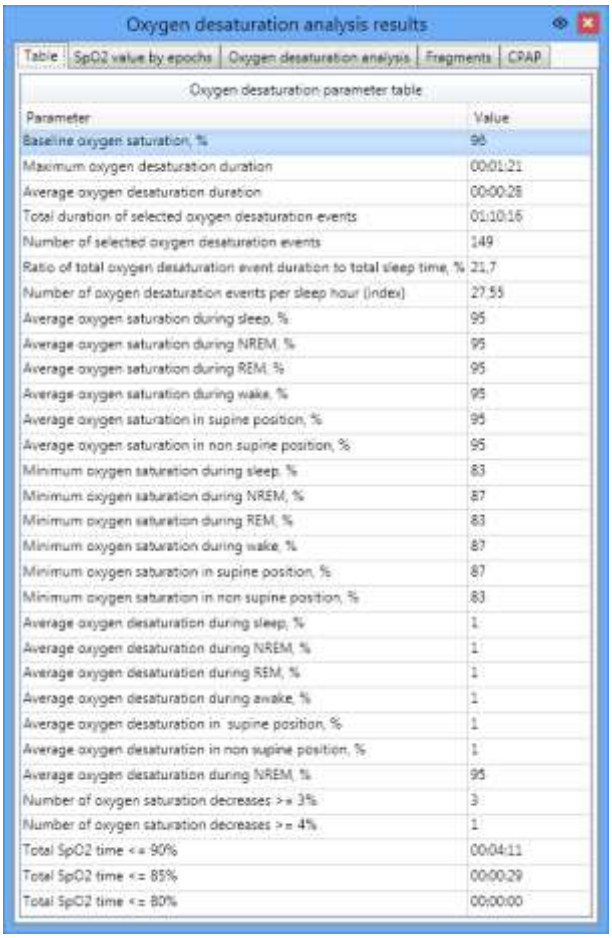


Fig. 11.24. Oxygen desaturation indices.

You can change the settings of oxygen desaturation analysis using the context menu (Fig. 11.25).

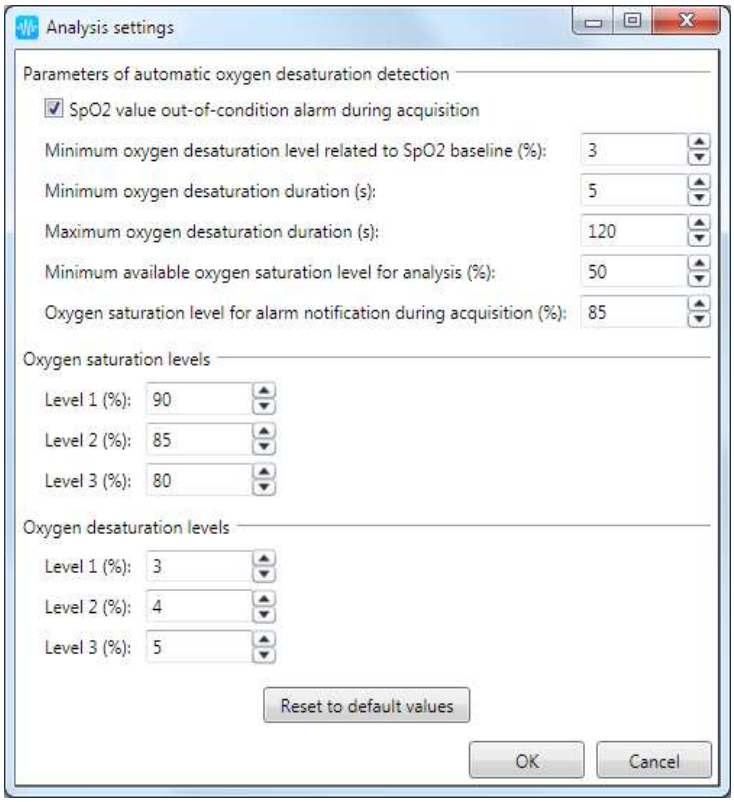


Fig. 11.25. The parameters of automatic oxygen desaturation detection.

Also using the context menu you can copy the table to the current position of active exam report or MS Excel (if MS Excel is installed on your computer). The visibility of table rows can also be set up using the context menu.

The list of all analysis epochs with averaged saturation value for each epoch is given on the second tab (Fig. 11.26). If you left-click the column names of this table, the epochs will be arranged either in ascending order of oxygen saturation (Fig. 11.27) or in descending order.

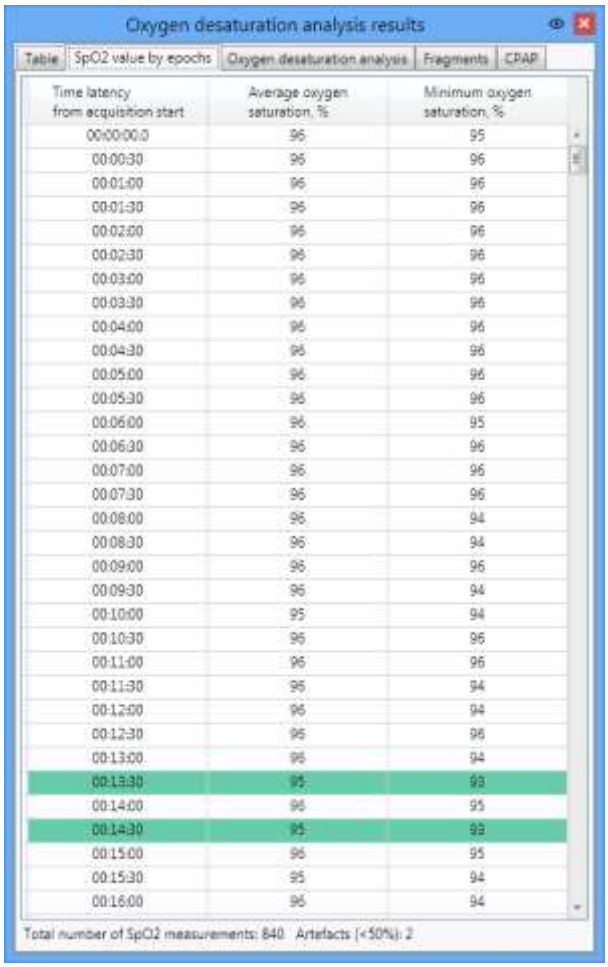


Fig. 11.26. The oxygen desaturation value for epochs.

Using the row selection in this table, you can navigate over the exam traces. Thus, if you sort the saturation epochs in ascending order and select the first row, you will move to the epoch with minimal saturation.

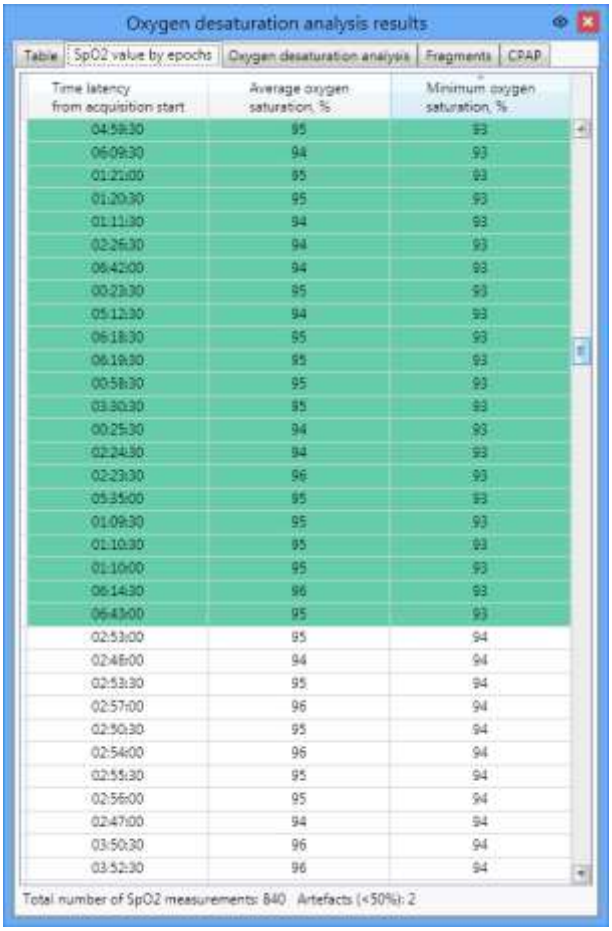
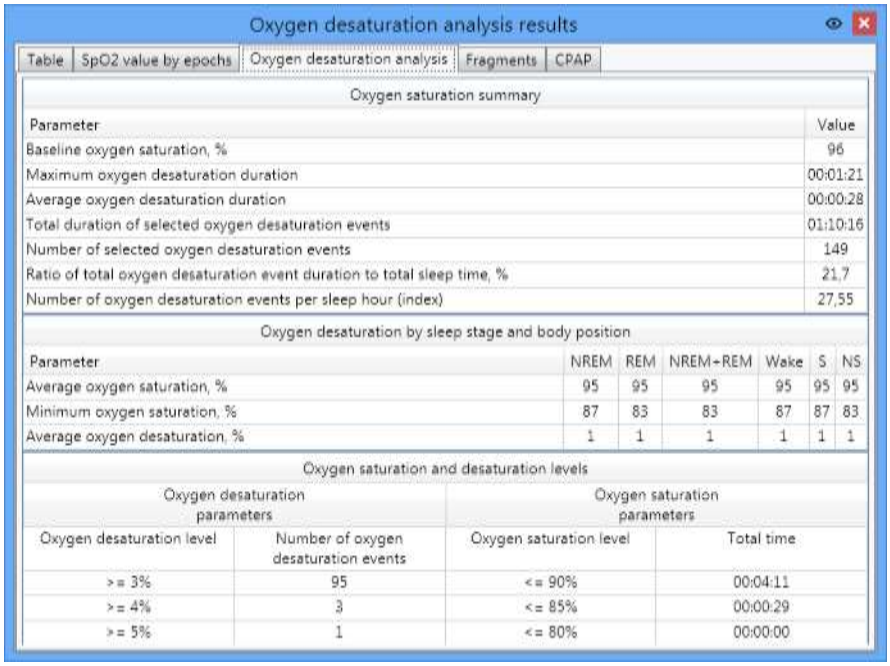


Fig. 11.27. The saturation values sorted in ascending order.

The results of oxygen saturation analysis during a sleep are given on the third tab (Fig. 11.28) but they are structured for more convenience. Using the context menu of this table you can copy the data of this table to an exam report.



Oxygen saturation summary

Parameter	Value
Baseline oxygen saturation, %	96
Maximum oxygen desaturation duration	00:01:21
Average oxygen desaturation duration	00:00:28
Total duration of selected oxygen desaturation events	01:10:16
Number of selected oxygen desaturation events	149
Ratio of total oxygen desaturation event duration to total sleep time, %	21,7
Number of oxygen desaturation events per sleep hour (index)	27,55

Oxygen desaturation by sleep stage and body position

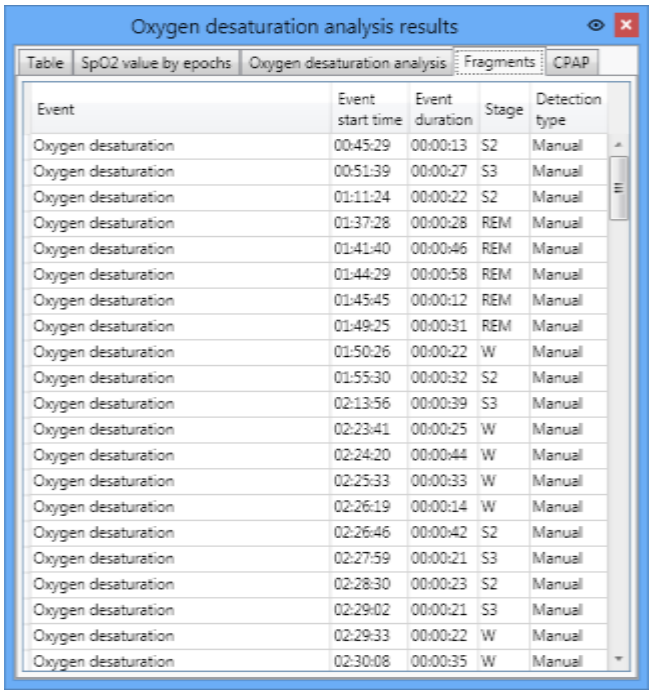
Parameter	NREM	REM	NREM+REM	Wake	S	NS
Average oxygen saturation, %	95	95	95	95	95	95
Minimum oxygen saturation, %	87	83	83	87	87	83
Average oxygen desaturation, %	1	1	1	1	1	1

Oxygen saturation and desaturation levels

Oxygen desaturation parameters		Oxygen saturation parameters	
Oxygen desaturation level	Number of oxygen desaturation events	Oxygen saturation level	Total time
>= 3%	95	<= 90%	00:04:11
>= 4%	3	<= 85%	00:00:29
>= 5%	1	<= 80%	00:00:00

Fig. 11.28. Desaturation analysis.

The list of all selected oxygen desaturation events is given on the fourth tab (Fig. 11.29). Using the left mouse button, you can select events in the list and navigate over them. If you left-click on the column names of this list, you can sort it in different order, for example, by increase or decrease of event duration.



Event	Event start time	Event duration	Stage	Detection type
Oxygen desaturation	00:45:29	00:00:13	S2	Manual
Oxygen desaturation	00:51:39	00:00:27	S3	Manual
Oxygen desaturation	01:11:24	00:00:22	S2	Manual
Oxygen desaturation	01:37:28	00:00:28	REM	Manual
Oxygen desaturation	01:41:40	00:00:46	REM	Manual
Oxygen desaturation	01:44:29	00:00:58	REM	Manual
Oxygen desaturation	01:45:45	00:00:12	REM	Manual
Oxygen desaturation	01:49:25	00:00:31	REM	Manual
Oxygen desaturation	01:50:26	00:00:22	W	Manual
Oxygen desaturation	01:55:30	00:00:32	S2	Manual
Oxygen desaturation	02:13:56	00:00:39	S3	Manual
Oxygen desaturation	02:23:41	00:00:25	W	Manual
Oxygen desaturation	02:24:20	00:00:44	W	Manual
Oxygen desaturation	02:25:33	00:00:33	W	Manual
Oxygen desaturation	02:26:19	00:00:14	W	Manual
Oxygen desaturation	02:26:46	00:00:42	S2	Manual
Oxygen desaturation	02:27:59	00:00:21	S3	Manual
Oxygen desaturation	02:28:30	00:00:23	S2	Manual
Oxygen desaturation	02:29:02	00:00:21	S3	Manual
Oxygen desaturation	02:29:33	00:00:22	W	Manual
Oxygen desaturation	02:30:08	00:00:35	W	Manual

Fig. 11.29. Desaturation events.

Using the context menu of SpO_2 trace you can display the text with current saturation value on the traces.

The dependence of oxygen desaturation events on CPAP pressure is shown on “CPAP” tab (Fig. 11.30). Using this table you can assess for what CPAP pressure values the number of oxygen desaturation events is decreasing to the acceptable level.

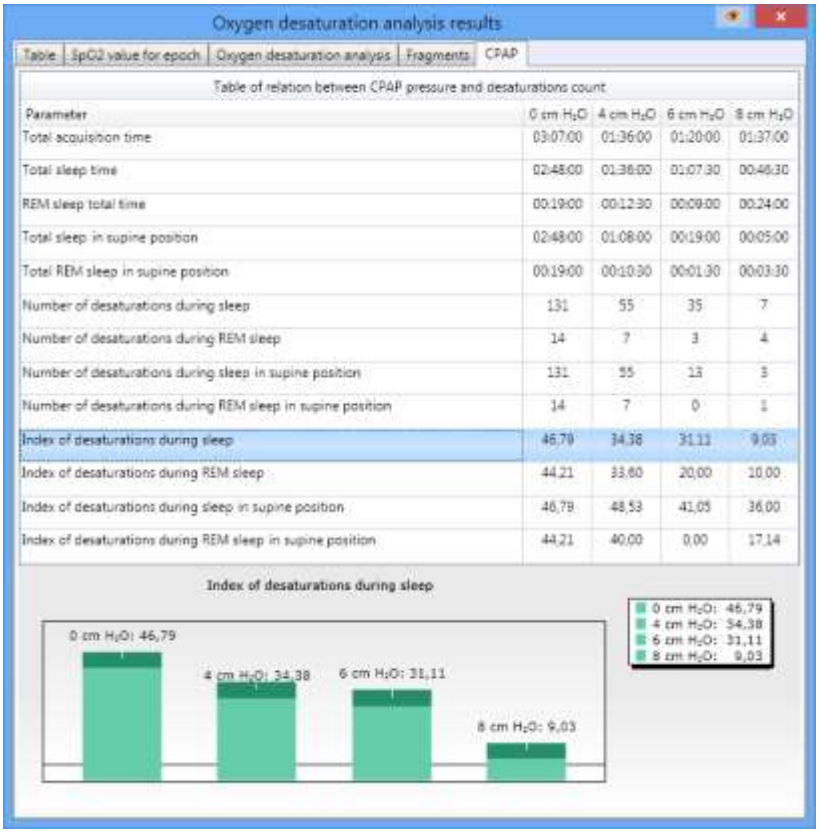


Fig. 11.30. The dependence of oxygen desaturation events on CPAP pressure.

11.9. Heart Rate Analysis during Sleep

To analyze heart rate results during a sleep, use “Heart rate analysis results” window (Fig. 11.31). To show or hide this window, use **Polysomngraphy|Sleep analysis results|Heart rate analysis** menu command. The window contains four tabs. The results of heart rate analysis during a sleep are shown as table and graphs on the first tab (Fig. 11.31).

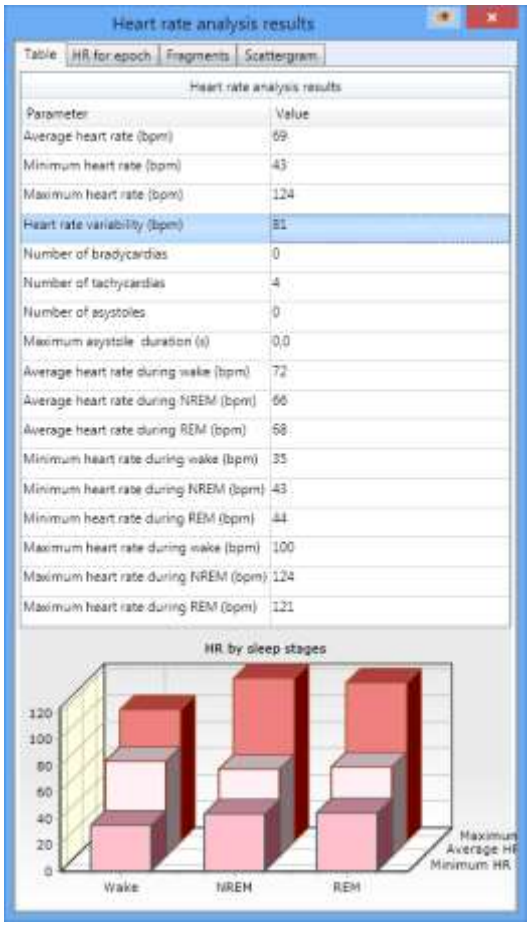


Fig. 11.31. Heart rate analysis.

Also using the context menu you can copy the table and the graph to the current position of active exam report. Besides, the table can be copied to MS Excel (if MS Excel is installed on your computer). Also you can change the settings of heart rate analysis (Fig. 11.32).

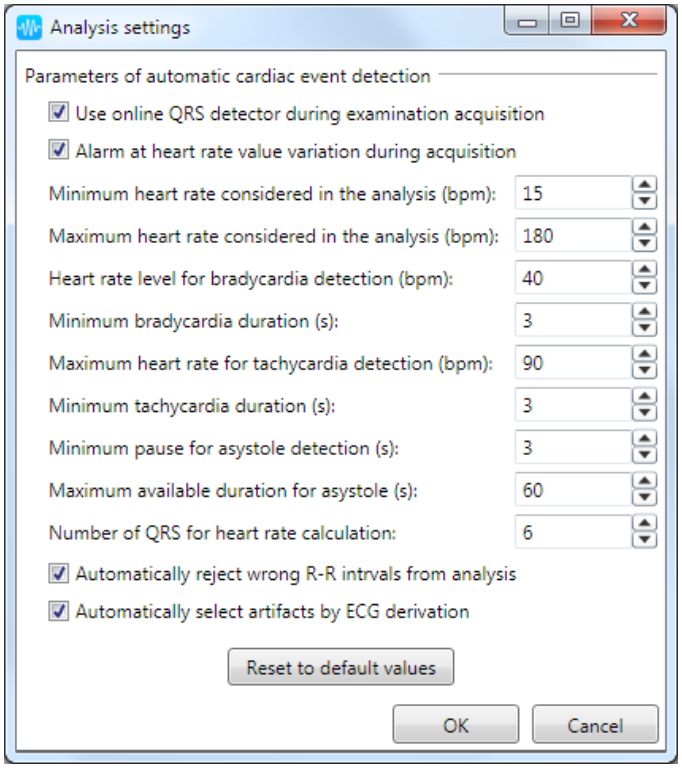


Fig. 11.32. The parameters of heart rate analysis.

Neuron-Spectrum.NET allows to select tachycardia, bradicardia and asystole events in manual mode. Using the context menu of ECG trace you can recalculate the positions of QRS markers if they were not arranged during exam recording. Also, using the context menu of ECG trace you can display the current heart rate (HR) value on the trace.

The visibility of table rows can be changed with the use of context menu. The selection of table rows results in graph updating and in several cases (if it is possible) in navigation over exam traces.

The list of analysis epochs with averaged HR value for each epoch is given on the second tab (Fig. 11.33). If you left-click the column names of this list, you will sort the list in HR descending/ascending order (Fig. 11.34).

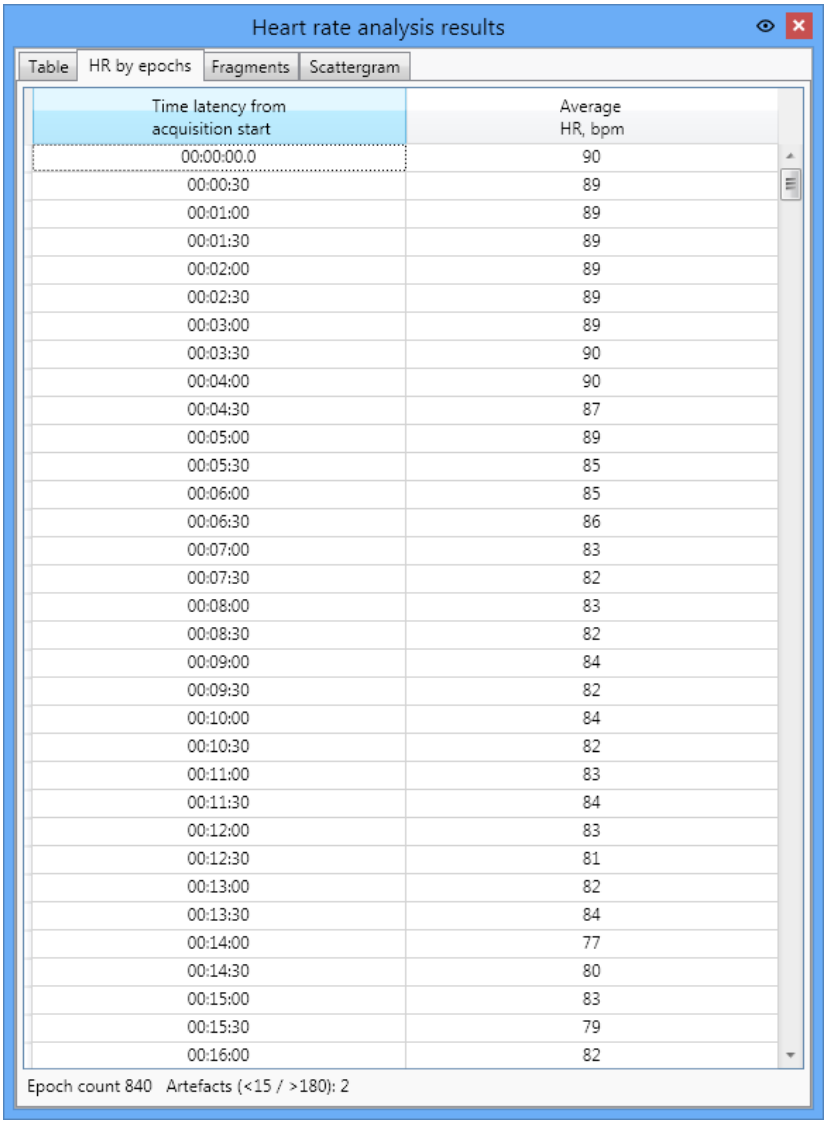


Fig. 11.33. HR for epochs.

Using the row selection in this table, you can navigate over the exam traces. Thus, if you sort the HR epochs in descending order and select the first row, you will move to the epoch with maximal HR (Fig. 11.34).

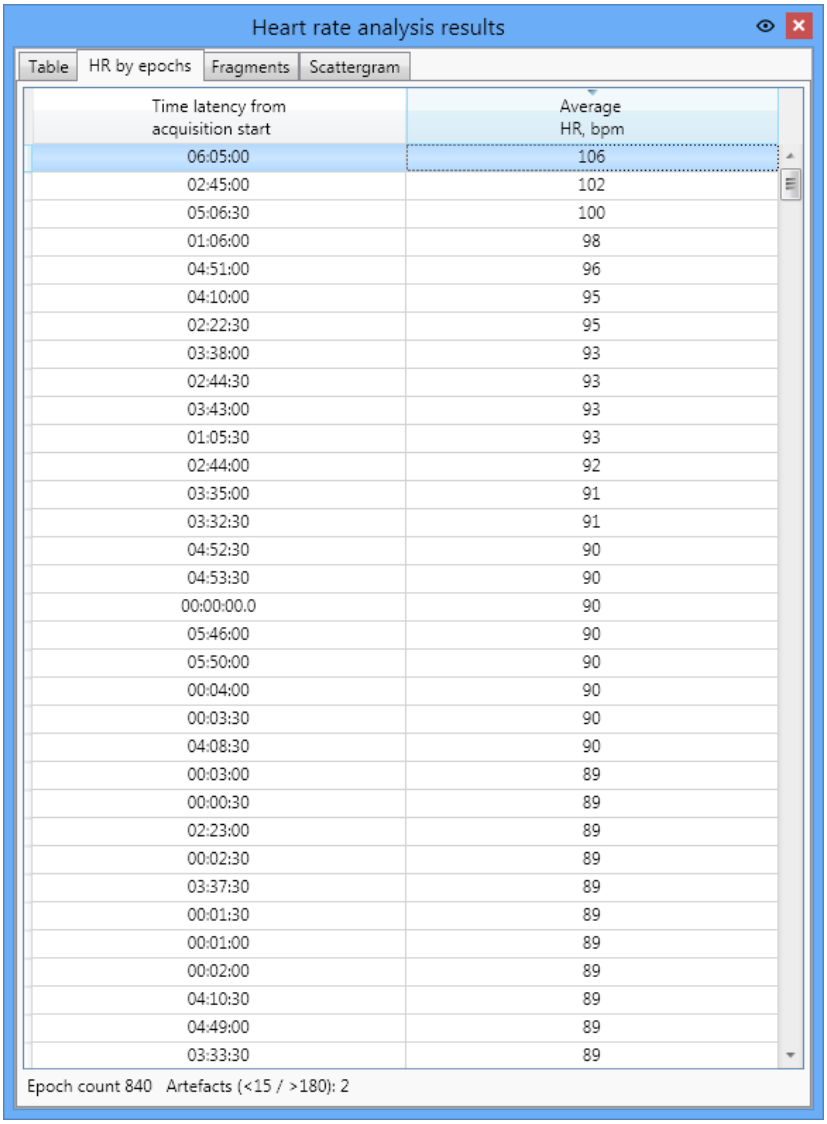
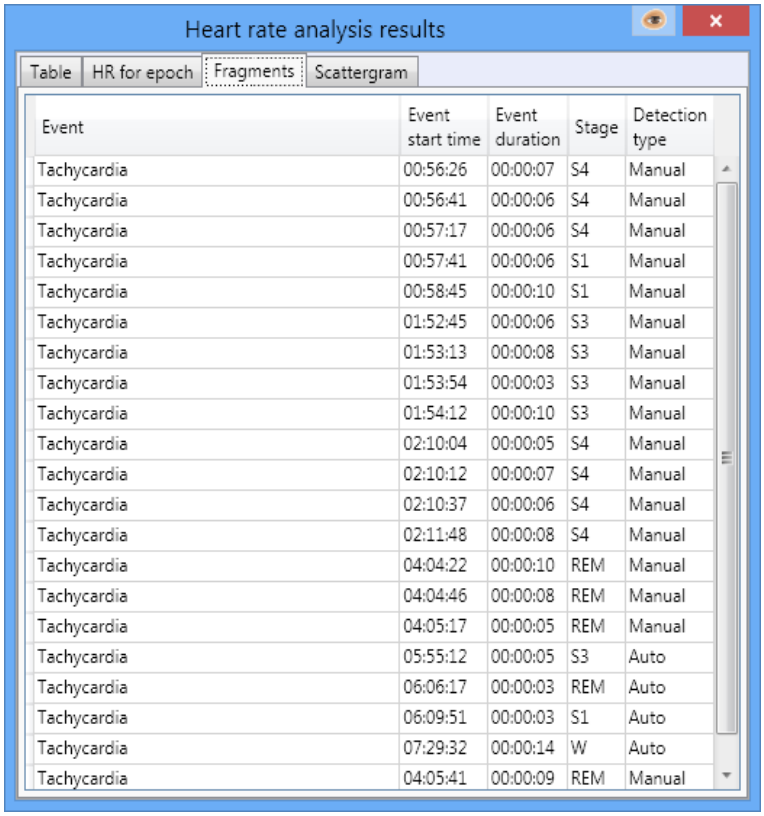


Fig. 11.34. HR epochs in descending order.

The list of all selected cardiac events is given on the third tab (Fig. 11.35). Using the left mouse button, you can select the events in the list and navigate over them. If you left-click the column names of this list, you can sort it in different order, for example, by increase or decrease of event duration, by sequence order or by event type.



Event	Event start time	Event duration	Stage	Detection type
Tachycardia	00:56:26	00:00:07	S4	Manual
Tachycardia	00:56:41	00:00:06	S4	Manual
Tachycardia	00:57:17	00:00:06	S4	Manual
Tachycardia	00:57:41	00:00:06	S1	Manual
Tachycardia	00:58:45	00:00:10	S1	Manual
Tachycardia	01:52:45	00:00:06	S3	Manual
Tachycardia	01:53:13	00:00:08	S3	Manual
Tachycardia	01:53:54	00:00:03	S3	Manual
Tachycardia	01:54:12	00:00:10	S3	Manual
Tachycardia	02:10:04	00:00:05	S4	Manual
Tachycardia	02:10:12	00:00:07	S4	Manual
Tachycardia	02:10:37	00:00:06	S4	Manual
Tachycardia	02:11:48	00:00:08	S4	Manual
Tachycardia	04:04:22	00:00:10	REM	Manual
Tachycardia	04:04:46	00:00:08	REM	Manual
Tachycardia	04:05:17	00:00:05	REM	Manual
Tachycardia	05:55:12	00:00:05	S3	Auto
Tachycardia	06:06:17	00:00:03	REM	Auto
Tachycardia	06:09:51	00:00:03	S1	Auto
Tachycardia	07:29:32	00:00:14	W	Auto
Tachycardia	04:05:41	00:00:09	REM	Manual

Fig. 11.35. Cardiac events.

The heart rate scattergram of a patient is given on “Scattergram” tab (Fig. 11.36).

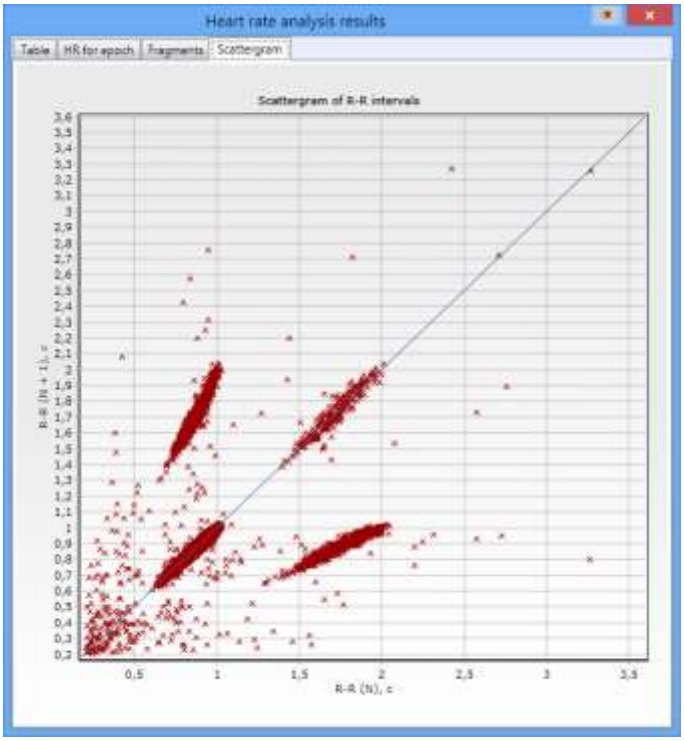


Fig. 11.36. R-R intervals scattergram.

11.10. Snoring Analysis during Sleep

To review the snoring analysis results during a sleep, use “Snoring analysis results” window (Fig. 11.37). To show or hide this window, use **Polysomnography|Sleep analysis results|Snoring analysis** menu command.

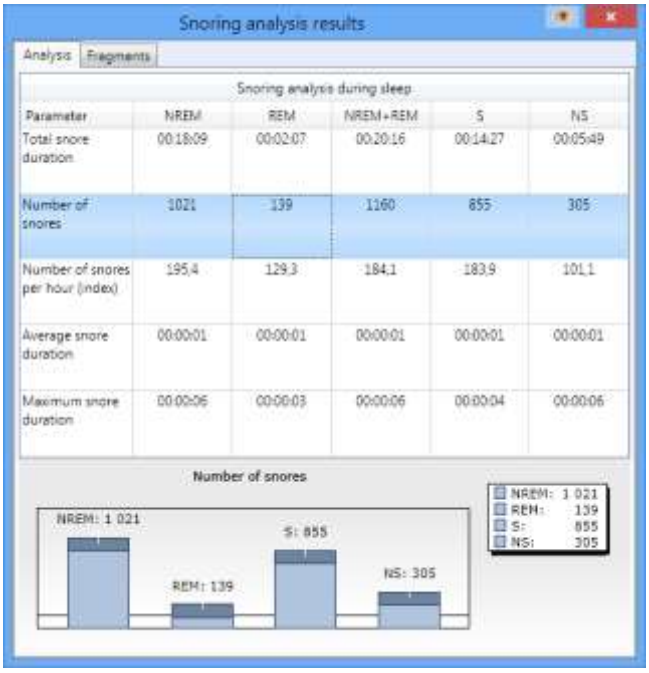


Fig. 11.37. Snoring analysis.

The window consists of table and graphs. If you select the table row, thus, you will change the visible graph. The values of the selected table row are displayed on the graph.

The table contains the following columns:

- NREM – non-rapid eye movement sleep.
- REM – rapid eye movement sleep.
- S (supine) – supine position.
- NS (non-supine) – non-supine position.

Also using the context menu you can change the visibility of table rows, and if you wish, copy the table to the current position of active exam report or to MS Excel (if MS Excel is installed on your computer).

All manually selected snore events are listed on “Fragments” tab (Fig. 11.38).

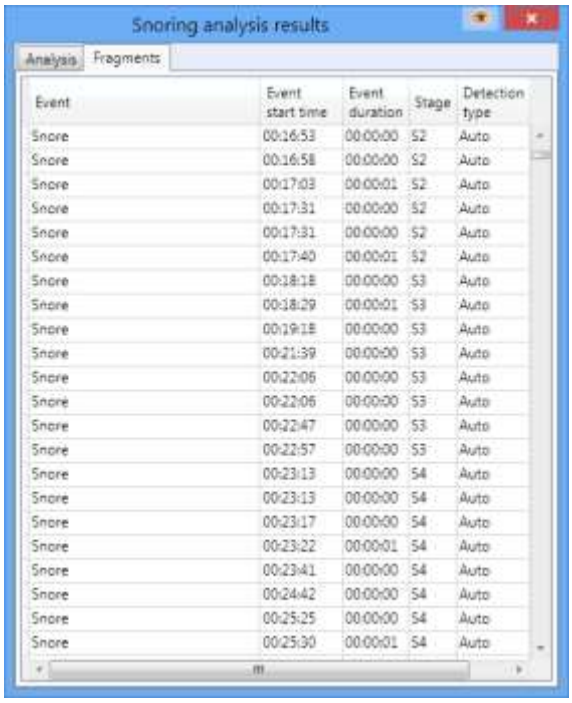


Fig. 11.38. Snoring events during a sleep.

11.11. Limb Movement Analysis during Sleep

To review the limb movement analysis results during a sleep, use “Limb movement analysis results” window (Fig. 11.39). To show or hide this window, use **Polysomnography|Sleep analysis results|Limb movement analysis** menu command.

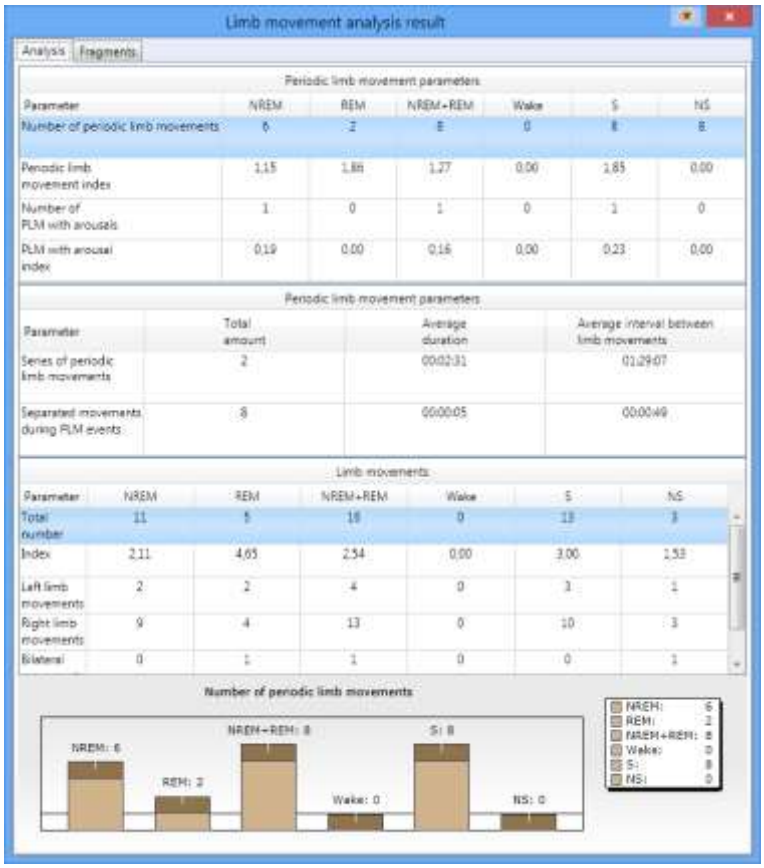


Fig. 11.39. Limb movement analysis results.

The table contains the following columns:

- NREM – non-rapid eye movement sleep.
- REM – rapid eye movement sleep.
- Wake – wakefulness state.
- S (supine) – supine position.
- NS (non-supine) – non-supine position.

The “Analysis” tab consists of three tables with limb movement analysis results and a graph. The values of the selected row of one of the tables are shown on the graph. The visibility of table rows and columns can be changed with the use of context menu. Besides, using the context menu, you can change the settings of limb movement analyzer (Fig. 11.40).

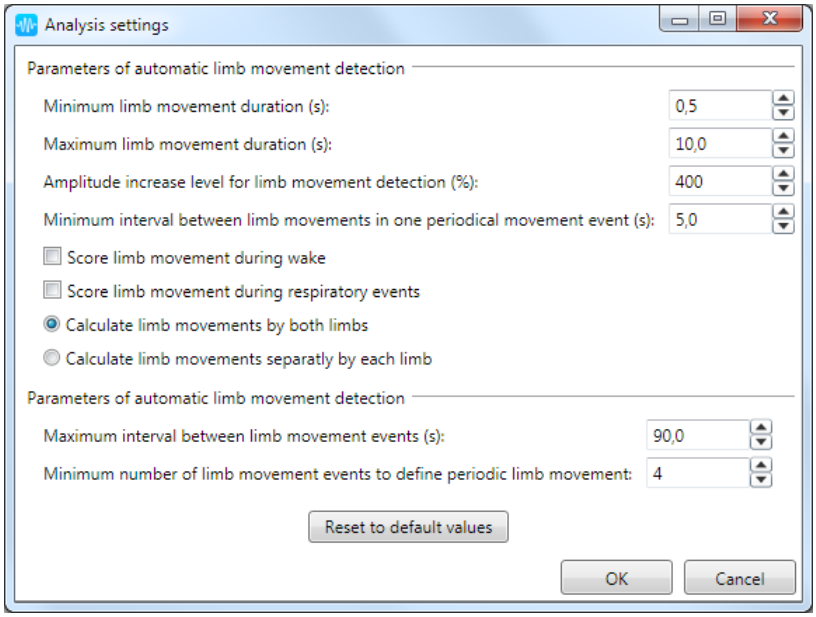


Fig. 11.40. The parameters of limb movement analysis.

Each table can be copied to the current position of active exam report or to MS Excel (if MS Excel is installed on your computer). The graph can also be copied to the exam report.

11.12. Body Position Analysis

To review a patient's body position analysis results, use "Body position analysis results" window (Fig. 11.41). To show or hide this window, use **Polysomnography|Sleep analysis results|Body position analysis** menu command.

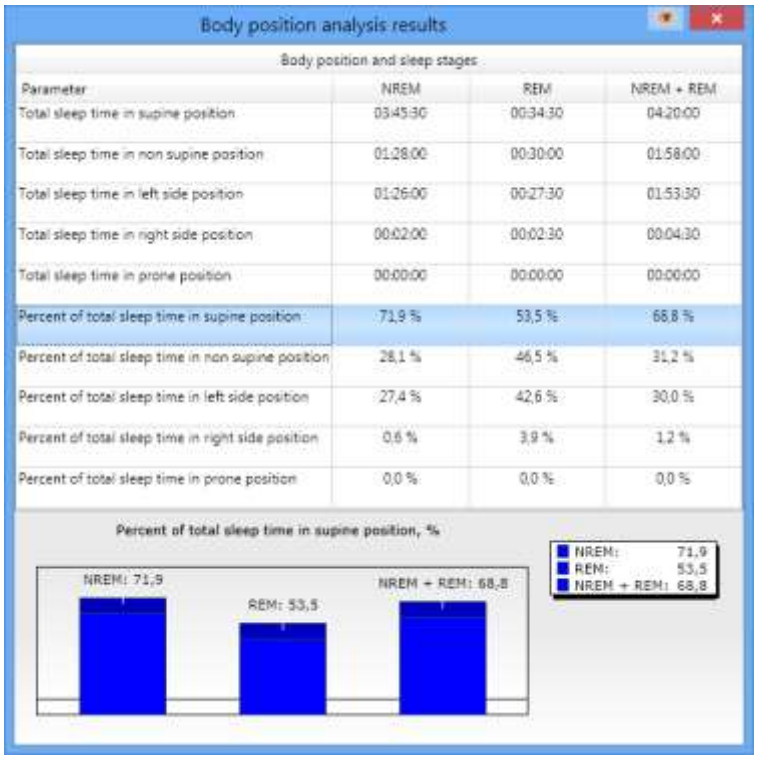


Fig. 11.41. The body position analysis during a sleep.

The table contains the following columns:

- NREM – non-rapid eye movement sleep.
- REM – rapid eye movement sleep.

The window consists of the table and the graph. The values of the selected table row are indicated on the graph. The visibility of table rows can be changed with the use of context menu. Also using the context menu you can copy the table and graph to the current position of active exam report. The table can be copied to MS Excel (if MS Excel is installed on your computer).

The body position of a patient is analyzed using data of body position trace received from the corresponding sensor. If the body position trace is missed in the current montage, the analysis is performed by body position markers arranged during the exam or on the basis of exam video record.

11.13. “Sleep Analysis” Exam Report Template

The “Sleep analysis” report template (Fig. 11.42) is preset in **Neuron-Spectrum.NET** program for the automatic generation of polysomnographic exam reports.

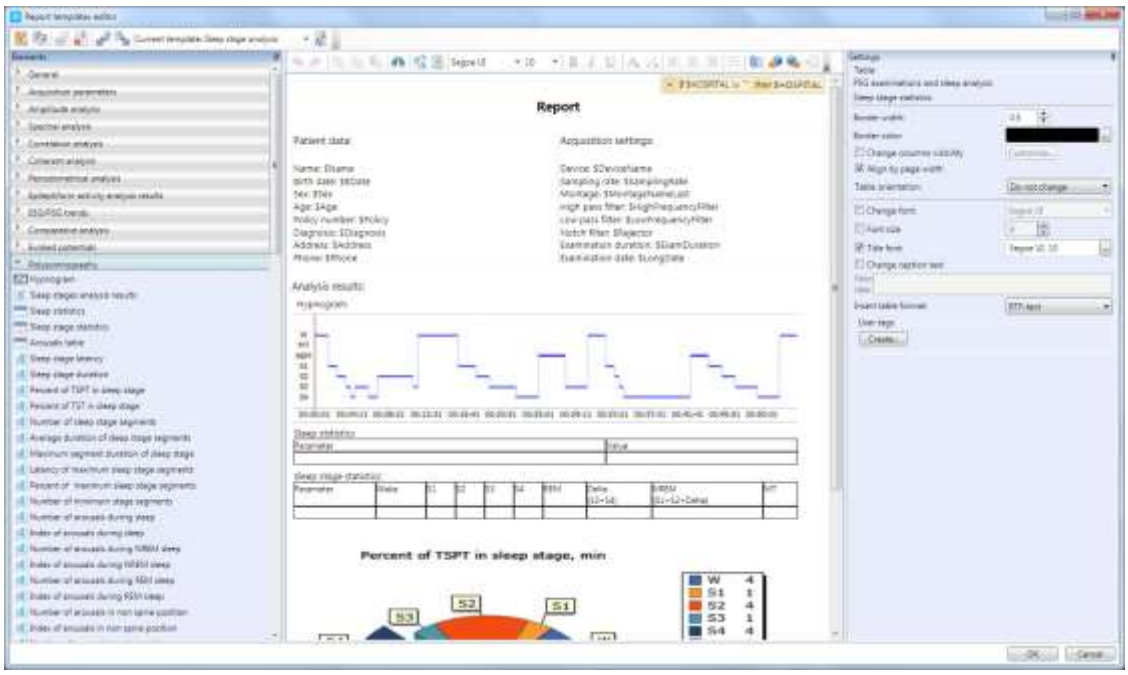


Fig. 11.42. “Sleep analysis” report template.

Each user of the program can change this report template or create the new report template for polysomnographic exams. The procedure of report template creation is described in details in chapter 7 “Creation of Exam Reports”.

The exam elements which can be inserted to report template are listed on “Polysomnography” tab of “Report templates editor” window (Fig. 11.42). Except all PSG analysis tables and graphs available in the program you can add the text blocks with the description of this or that analysis results to the report (for example, “Sleep stage analysis text block”, “Respiratory analysis text block”). Each such text block provides the special tags to add different exam data to the report. The detailed information concerning the use of tags in the exam reports is given in chapter 7.6 “Use of Tags in Report Templates”.

The example of PSG exam report generated on the basis of “Polysomnography” template is shown in Fig. 11.43.

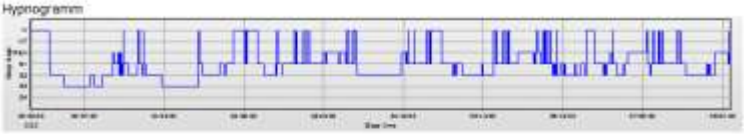
PSG Report

Patient data:
Patient name: Rubens Carlos Peguin
Date of birth: 17.08.1957
Sex: Male
Policy number:
Age: 52 years
Diagnosis:
Address:
Phone number:

Acquisition settings:
Device name: Neuron-Spectrum
Sampling rate: 500 Hz
Montage name: PSG montage
High pass filter: 0.5 Hz
Low pass filter: 35 Hz
Notch filter: On
Exams duration time: 08:06:00

Analysis results:

Hypnogramm



Sleep statistics

Parameter	Value
Exam date	22.10.2009
Recording start time	21:28:58
Recording end time	5:34:58
Lights off	21:28:58
Lights on	5:34:58
Time in bed (TIB)	08:06:00
Epoch duration	30 s
Epoch count	972
Total sleep period time (TSPT)	07:53:00
Start of sleep period	21:41:28
End of sleep period	5:34:28
Total sleep time (TST)	07:00:00
Sleep onset latency	00:12:30
Persistent sleep latency	00:12:30
Wake time after sleep onset	00:53:30
Total wake time during sleep period	00:53:00
Wake time after final arousal	00:00:30
Number of segments during sleep period time	160
Number of segments during sleep	122
First awake latency	00:51:30
Last delta episode latency	01:18:30
Number of awakenings	38
Number of awakenings with more than 3 minute length	4
Sleep efficiency index 2 (TST/TIB)	86,4 %
Sleep efficiency index 2 (TSPT/TIB)	97,3 %
Movement activation index	0,00
Number of arousals	0
Aurousal index	0,00
Sleep quality index	102,30
Relative sleep quality index	14,61
Number of sleep cycles	3
REM sleep latency	00:44:30

Sleep stage statistics

Parameter	Wake	S1	S2	S3	S4	REM	Delta (S3+S4)	NREM (S1+S2+Delta)	MT
Latency period	00:51:30	00:12:30	00:01:00	00:10:30	-	00:44:30	00:10:30	00:00:00	00:00:00
Stage duration	00:53:00	02:39:00	02:34:30	00:49:00	00:00:00	00:57:30	00:49:00	06:02:30	00:00:00
Percent of TSPT in sleep stage	11,2 %	33,6 %	32,7 %	10,4 %	0,0 %	12,2 %	10,4 %	76,6 %	0,0 %
Percent of TST in sleep stage	-	37,9 %	36,8 %	11,7 %	0,0 %	13,7 %	11,7 %	86,3 %	0,0 %
Number of stage segments	38	70	34	3	0	15	3	50	0
Average segment length	00:01:23	00:02:16	00:04:32	00:16:20	00:00:00	00:03:50	00:08:10	00:05:47	00:00:00
Maximum length of segment	00:08:00	00:09:30	00:31:00	00:25:30	00:00:00	00:13:00	00:25:30	00:44:30	00:00:00
Latency of maximum segment	02:20:30	03:13:30	03:46:30	01:31:00	00:00:00	06:55:00	01:18:30	00:00:00	00:00:00
Percent of maximum segments	15,1 %	6,0 %	20,1 %	52,0 %	0,0 %	22,6 %	52,0 %	12,3 %	0,0 %
Number of minimum segments	25	19	11	0	0	3	0	9	0

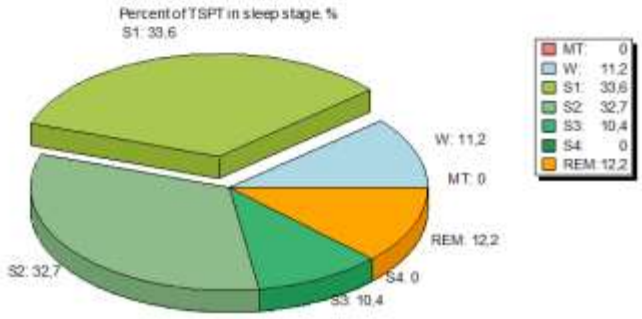


Fig. 11.43. The example of PSG exam report.

11.14. Direct Current Channels

Devices of Neuron-Spectrum series may have direct current channels. These channels can be applied to connect the direct current sensors during PSG studies. The direct current sensors can be of two types: with continuous signal level and stepwise signal level. The sensors with continuous output signal level, such as airflow sensor (for example, cannula, CPAP pressure), are intended to measure the value which continuosly varies with time. The potential difference at outputs of such sensors is, as a rule, proportional to measured signal level. The maximal/minimal output voltage level of such sensors is regulated by the manufacturer and is indicated in the corresponding documentation. This information should be specified in the derivation settings using this channel. For example, it is required to connect the cannula to the first DC channel, the voltage of this cannula sensor can vary from -300 to 300 mV. In this case in DC1 derivation settings indicate the channel type (respiration), signal type (continuous signal) and output signal level (Fig. 11.44). Besides, you can set filters for sensors with continuous signal level depending on the type of measured signal.

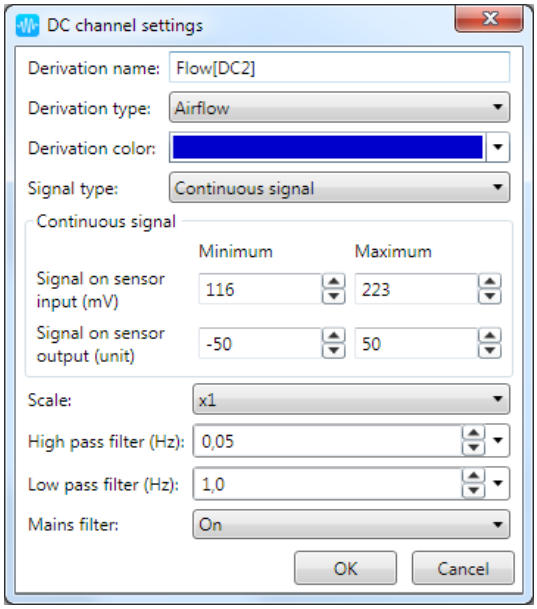


Fig. 11.44. Setup of DC channel for continuous signal.

The sensor with stepwise signal level such as body position sensor has some stepped output signal instead of continuously changing one. Each step level is defined by the manufacturer and is indicated in the corresponding documentation. The example of body position sensor setup is shown in Fig. 11.45.

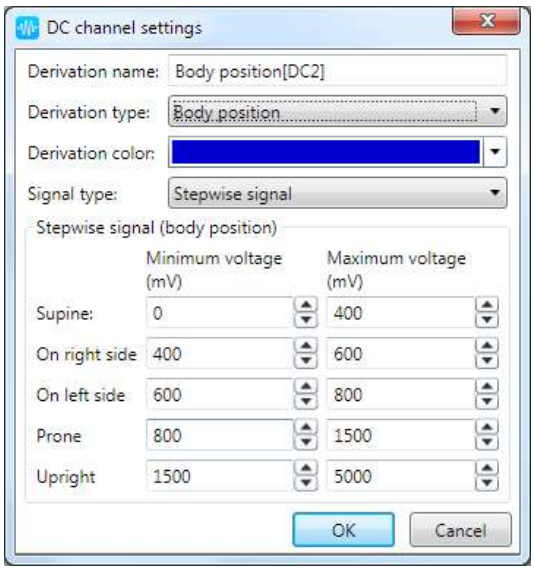


Fig. 11.45. Setup of DC channel for stepped signal.

DC sensors, as a rule, have internal power sourse (batteries). In some time the batteries should be replaced to new ones.

Sometimes it happens that DC sensor does not have the corresponding documentation or the output signal level does not correspond to the indicated one, for example, because of batteries discharge. In this case you can detect the output signal level experimentally by creating the exam and changing the settings of the corresponding derivation till you adjust the correct values. To make it automatically, **Neuron-Spectrum.NET** ensures automatic calibration of DC sensors. To run it, use the context menu of the corresponding trace (Fig. 11.46).

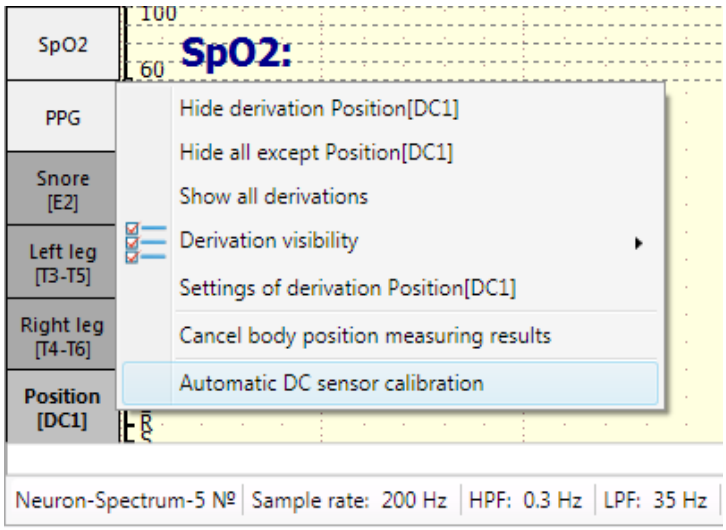


Fig. 11.46. Automatic calibration of DC sensor.

Before the first use of any DC sensor it is recommended to perform its prior automatic calibration. If the sensor is equipped with the built-in power supply, the calibration should be regularly repeted upon its discharging. In some time the built-in power supply must be replaced.

Annex 1. Main Menu Command Description

Command	Icon	Key Combination	Command Description
Work with Exam			
New…		Ctrl+N	Start of new exam (for new patient or the one whose card already exists in the database).
Open…		Ctrl+O	Opening of an existing exam from exam database (with the possibility to create a new exam).
Import…			Exam opening from file in EDF+ format.
Save		Ctrl+S	Saving of opened exam to the database (all changes introduced into exam are saved).
Save as…			Saving of opened exam to file in EDF+ format, as a clip or set of graphical files.
Save to removable disk			Saving of opened exam to CD, DVD, flash disk or any other data carrier in EDF+, NSDAT formats, as a clip or set of graphical files.
Send…			Sending of the current exam by e-mail.
Close			Closing of the current exam (if some changes were made in an exam, the program will send an inquiry whether to save the introduced changes or not).
Information…			Review and change of exam parameters and patient card.
Clinical state			Opening of clinical state window (with the possibility to edit it).
Conclusion			Opening of the interpretation window (with the possibility to edit it).
Exit		Alt+X	Program exit.
EEG Acquisition			
Sampling rate			Setup of sampling rate for the acquisition of a new exam (is possible only before the acquisition beginning).
Filters			Setup of filter parameters (high pass filter, low pass filter, notch filter).
Impedance		Ctrl+I, F5	Electrode impedance measurement (is possible both before the acquisition and during EEG acquisition).
Calibration signal monitoring		Ctrl+C, F3	Monitoring of calibration signal.
Calibration signal record		Ctrl+Alt+C, F4	Recording of calibration signal.

Command	Icon	Key Combination	Command Description
Calibration signal level			Setup of calibration signal amplitude.
Monitoring		Ctrl+M, F6	EEG recording.
Record		Ctrl+R, F7	EEG acquisition.
Postponed record			Postponed exam acquisition.
Acquisition stop		Ctrl+T, F8, Esc	Acquisiton/monitoring stop.
Reset filters		F9	Reset of internal state of filters.
Photic stimulation		Alt+F	Start/stop of photic stimulation (using the built-in flash).
Auditory stimulation		Alt+A	Start/stop of auditory stimulation (using the built-in auditory stimulator).
Pattern stimulation		Alt+P	Start/stop of pattern stimulation (using the built-in pattern stimulator).
Magnetic stimulation		Alt+M	Start/stop of magnetic stimulation (using Neuro-MS/D magnetic stimulator connected to computer USB port).
Increase stimulation frequency		Alt+↑	Increase of stimulation frequency by step (the step of stimulation frequency change is defined in the acquisition style).
Decrease stimulation frequency		Alt+↓	Decrease of stimulation frequency by step (the step of stimulation frequency change is defined in the acquisition style).
Hyperventillation		Alt+H	Start/stop of hyperventilation.
Stop		Alt+Space	Stop of all types of stimulation.
Stimulation program			Start of stimulation program defined in the current acquisition style.
Next functional test		Alt+N	Recording of next functional test from the list defined in the current acquisition style.
Automatic test acquisition		Alt+Shift+F	Automatic acquisition of all functional tests from the list defined in the current acquisition style.
Event markers			Setup of event markers on EEG (list of available event markers is defined in the current acquisition style).
Acquisition styles			Setup of acquisition styles.
Navigation over EEG			
To begin		Home	Move to exam beginning.

Command	Icon	Key Combination	Command Description
Play forward		Ctrl+PgUp	Automatic play of exam to beginning.
Play forward by page		Shift+PgUp	Automatic page-by-page playing of exam to beginning.
Previous page		PgUp	Move to previous EEG page.
Previous second		Left	Move to previous second of record.
Next second		Right	Move to next second of record.
Next page		PgDn	Move to next EEG page.
Play reverse		Ctrl+PgDn	Automatic play of exam to the end.
Play reverse by page		Shift+PgDn	Automatic page-by-page playing of exam to the end.
To end		End	Move to exam end.
EEG Analysis			
Wave measurement		Ctrl+Alt+W	Switch on/off the wave measurement mode.
“As recorded”		Ctrl+Alt+Z	Switch on/off “As recorded” mode.
Measuring markers		Ctrl+Alt+M	Switch on/off measuring markers mode.
New epoch		Ctrl+Shift+E	Creation of new analysis epoch.
Manual epoch arrangement		Ctrl+Alt+Shift+E	Manual arrangement of analysis epochs.
Delete all epochs			Removal of all analysis epochs.
Amplitude table			Displaying of “Amplitudes table” window with the results of epochs analysis.
Amplitude mapping			Displaying of “Amplitude mapping” window with the results of epoch analysis.
Rhythm amplitudes			Displaying of “Waves rhythms amplitudes” window with the results of epoch analysis.
Spectrum graphs			Displaying of “Spectrum graphs” window with the results of epoch analysis.
Frequency table			Displaying of “Frequency table” window with the results of epoch analysis.

Command	Icon	Key Combination	Command Description
Spectrum mapping			Displaying of “Spectrum mapping” window with the results of epoch analysis.
Functional test mapping			Displaying of “Functional test mapping” window.
Evoked potentials			Displaying of “Evoked potentials” window.
Hypnogram			Displaying of “Hypnogram” window.
Select the whole record		Ctrl+A	Selection of whole EEG record.
Select current page			Select visible EEG fragment.
Save visible EEG page in exam		Alt+S	Save visible EEG page in exam (see section 5.16 “Native EEG Editing”)
Selected fragment			Work with the selected EEG fragment.
EEG print		Ctrl+P	Printing of selected fragment or current EEG page.
Preview		Ctrl+Shift+P	Preview before printing of the selected fragment or current EEG page.
Save fragment to file			Saving of selected EEG fragment as a clip or set of graphic files.
Copy to report			Copying of selected EEG fragment to the current exam report.
Identify fragment			Identification of a selected fragment as an artifact, an epoch for analysis, epileptiform activity fragment, functional test or visual phenomena from the list of the available visual phenomena.’
Visual phenomena list			Displaying of visual phenomena list editor.
Export to EDF+			Saving of selected EEG fragment to file in EDF+ format.
Analysis styles			List of analysis styles available for setup.
Operations with Exam Report			
New…			Creation of new empty exam report, switching to report window.
Open			Opening of the existing report for editing, switching to report window.
Report by default			Creation of report using the template specified in acquisition style of this exam type.
Delete			Removal of current exam report.
Templates			List of available templates for reports generation.

Command	Icon	Key Combination	Command Description
Glossary		Ctrl+Q	Opening of the list editor of standard phrases and expressions to insert to exam report.
Copy conclusion			Copying of report text (from “Conclusion” window) to the current exam report.
Use Microsoft Word			The checkbox to use Microsoft Word program for reports editing (Microsoft Word 2007 or later version should be installed on the computer).
Properties…			Opening of window with the description of current exam report.
Program Interface Controls			
Exam inspector		F11	Showi/hide “Exam inspector” window.
EEG			EEG traces view.
Montages			The list of available montages.
Filters			Adjusting EEG filters.
Trace scales			Adjusting scale of EEG traces.
Sweep			Adjusting EEG sweep speed.
EEG trace optimization			EEG trace optimization on/off.
Event markers			List of event markers for arrangement on EEG.
Acquisition parameters			Show/hide “Acquisition parameters” window.
Functional tests			Show/hide “Functional tests” window.
Stimulation control			Show/hide “Stimulation control” window.
Event markers			Show/hide “Event markers” window.
Analysis windows			Access to the list of windows for EEG analysis.
Bandpass filter			Show/hide “Bandpass filter” window.
Amplitude analysis			Access to the list of windows for amplitude analysis.
Instantaneous amplitude			Displaying of marker on EEG traces to measure instantaneous amplitudes.
Amplitude table			Show/hide “Amplitude table” window.
Amplitude mapping			Show/hide “Amplitude mapping” window.

Command	Icon	Key Combination	Command Description
Amplitude scanning			Show/hide “Amplitude scanning” window.
Amplitude of wave rhythms			Show/hide “Wave rhythm amplitude” window.
Spectral analysis			Access to list of windows for spectral analysis.
Spectrum graphs			Show/hide “Spectrum graphs” window.
Frequency characteristics			Show/hide “Frequency characteristics” window.
Spectrum mapping			Show/hide “Spectrum mapping” window.
Functional test mapping			Show/hide “Functional test mapping” window.
PSG			Access to list of windows for polysomnography.
Hypnogram			Show/hide “Hypnogram” window.
PSG trend			Show/hide “PSG trend” window.
Sleep structure analysis			Show/hide “Sleep structure” window.
Respiratory analysis			Show/hide “Respiratory analysis results” window.
Desaturation analysis			Show/hide “Oxygen desaturation analysis results” window.
Heart rate analysis			Show/hide “Heart rate analysis results” window.
Limb movement analysis			Show/hide “Limb movement analysis results” window.
Snoring analysis			Show/hide “Snoring analysis results” window.
Body position analysis			Show/hide “Body position analysis results” window.
EEG trend			Show/hide “EEG trend” window.
Current montage			Show/hide “Current montage” window.
Event list			Show/hide “Event list” window.
Navigator			Show/hide navigation bar under EEG traces.
Calibration cuts			Show/hide the calibration cuts.
Status line			Show/hide the status line.
Acquisition panel			Show/hide the “Acquisition panel”.
Extra EEG window			Show/hide “Extra EEG window” window.

Command	Icon	Key Combination	Command Description
Current functional test			Show/hide current functional test name on EEG traces.
Astronomical time			Show/hide astronomical time of record on EEG traces.
Evoked potentials		F12	Show/hide “Evoked potentials” window.
Video EEG			Show/hide “Video EEG” window.
Program Settings			
Change…			Opening of “Setup” window to adjust program settings.
Download…			Downloading of program settings saved beforehand from file.
Save…			Saving of program settings to file.
Language…			Changing of program interface language.

Annex 2. Electrode Placement to Record EEG

Electroencephalography is a brain study technique based on the acquisition of its electrical potentials. Electroencephalography has both wide application in clinical practice to assess the functional state of brain and in the fundamental researches related to the study of mechanism of higher nervous activity or general questions of physiology of the central nervous system.

The bioelectrical activity of brain can be recorded from any point of head surface using the electrodes connected to digital EEG and EP system. However, to compare the records and exam results obtained in different patients and in different laboratories, it is important to use the standard scheme of electrode placement on patients' head. In clinical electroencephalography the international 10-20 system of electrode placement (Fig. A3. 1) is used. It was offered by H. Jasper [1] and is recommended by International Federation of Societies for Electroencephalography and Clinical Neurophysiology. The points of electrode placement in 10-20 system are defined in the following way. The distance along the sagittal line from the nasion to the inion is supposed to be 100%. The central vertex electrode (Cz) is set in the middle of this line, in the vertex area and frontal midline (Fz) and parietal midline (Pz) electrodes are placed from Cz at a distances of about 20% of total line length from the nasion up to the inion. The second main line is extended from the ear canal of one ear via vertex (Cz) up to the ear canal of the opposite ear. To fix the mid temporal electrodes (T3, T4) step back from the ear canal at 10% distance of this line. The central electrodes (C3, C4) are placed from Cz at 20% distance of biaricular line length. The parasagittal and the temporal lines pass via T3, C3, C4 points. All the rest electrodes are placed on them at equal distances (occipital (O1, O2), parietal (P3, P4), posterior temporal (T5, T6), frontal (F3, F4), prefrontal (Fp1, Fp2)). The distance between the peripheral electrodes is defined as 10% of the head circumference measured just above the eyebrows and ears. In some cases the additional scalp electrodes can be applied. For example, to fix the frontopolar electrode (Fpz) and the occipital (Oz) electrode leave the nasion (for Fpz) or the inion (for Oz) at 10% of sagittal line length. The odd digital indices correspond to the electrodes located over left cerebral hemisphere and the even ones correspond to the electrodes located over right hemisphere.

To perform the routine EEG exam, sometimes the modified schemes with less number of electrodes are applied. To perform the more detailed EEG analysis, the extended scheme of 10-10 system of electrode placement with larger quantity of electrodes is applied.

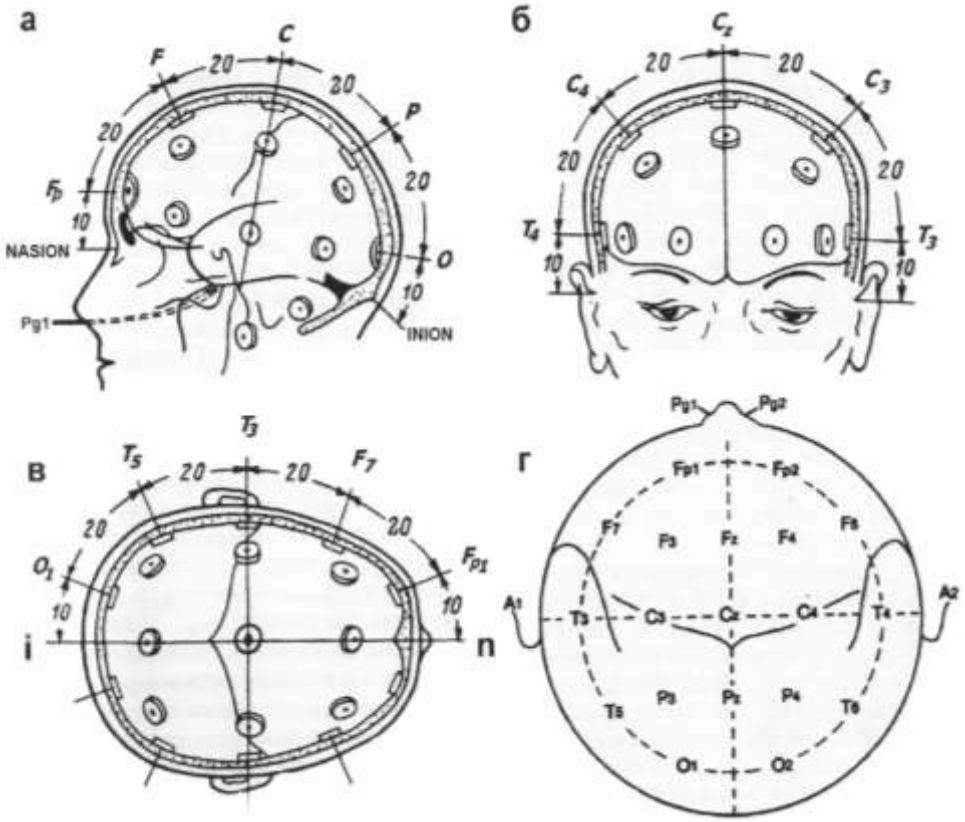


Fig. A3.1. The International 10-20 system of electrode placement.

The EEG derivation shows the difference of electrode potential between two points of head surface of a patient. There are monopolar and bipolar derivations. With the monopolar derivation one of the electrodes – reference one – is placed on an area where the number of signals emitted by cortical neurons is less, i.e. the changes of the potential that is considered to be zero. Most often the reference electrodes are fixed with the special clips on earlobes (A1 and A2), the skin is preliminary degreased. When both electrodes are located above the active brain areas, the derivation is called the bipolar one. Using **Neuron-Spectrum.NET** software, you can create the montages with the bipolar and the monopolar electrodes placing arbitrary reference electrodes for them (see section 8.2.1 “Montage Editing”). During the EEG acquisition and recording you can change arbitrary the montage, for example, the exam recorded in the monopolar montage can be reviewed in any bipolar montage. In this case the derivation recount is executed by the program automatically. When you use **Neuron-Spectrum-1**, **Neuron-Spectrum-2**, **Neuron-Spectrum-3**, **Neuron-Spectrum-4** devices, it is recommended to apply ipsilateral ear electrodes as reference ones. If you record EEG by means of electrode cap, use Cz electrode as a reference one.

EEG acquisition is performed with the use of electrodes varying both by form and by fixation type. The most widely spread electrodes for the routine examinations in

the laboratories are bridge ones. Before the exam, soak them in 0.9% sodium chloride solution (physiological solution) for 5-10 minutes. The electrodes are fixed under the bands of the special helmet (the helmets of three sizes are included in the base delivery set of digital EEG and EP system). Depending on the size of a patient's head, the helmet sizes are adjusted by tightening and weakening the rubber bands. The electrode positions are defined according to the system of electrode placement. The skin area where the electrode is to be set is degreased preliminary by rectified ethyl alcohol. By means of electrode cable with "alligator" clip the electrode is connected to the corresponding device connector.

The EEG recording quality depends directly on the electrode impedance that should not increase 40 kΩ (ideally it should be less than 20 kΩ). In case of high impedance values, it is recommended to degrease the skin area under the electrode once again and wet the electrode surface wrapped in the gauze with a physiological solution using the cotton or pipette. In some cases the skin area is processed by the abrasive paste. The use of bridge electrodes allows placing the electrodes on a patient's head very quickly. The drawback of bridge electrodes is that it is impossible to use them for the long-term exam (more than 40 minutes) as far as the electrodes and the helmet press upon patient's head causing inconvenience and additional noises. Besides the bridge electrodes dry in some time and the impedance increases. It decreases the acquisition quality considerably.

If the long-term exam is planned, use the cup electrodes. The electrode cup is filled with the electrode gel or paste. The electrode is fixed on a degreased skin area and fixed on a patient's head using the helmet and collodion (fast-drying substance on the basis of ether) or, if it is possible, with the use of plaster. The electrode fixation by means of collodion is done the following way. Prepare in advance and cover the cup of the electrode and its cable with a piece of thick gauze which size is a bit larger than the electrode itself. Lubricate the gauze with collodion (e.g., with the help of a brush or you can drop collodion on the gauze using a pipette). Press the electrode to the head tightly and dry the gauze using a fan. The electrode should be fixed on the head. The electrode cable is plugged into the corresponding device connector. All EEG electrodes fixed on a patient's head must be placed in such a way that its cables will be directed to the top of the head and further you can gather them in one bundle. It allows achieving the minimal level of noise and artifacts evoked by cable fluctuations. To remove collodion and take away electrodes after the study it is recommended to use the collodion remover. The use of collodion ensures the good electrode fixation along the exam, however the procedure of electrode placement/removal increases the exam duration.

EEG electrode caps are also used for the long-term EEG exams. It is very easy and simple to use these caps. The electrodes are already built into them according to 10-20 system of electrode placement. The electrode gel is injected to the electrodes via the syringe with the blunt needle. Irrespective of the type of used electrodes, place the ground electrode. The ground electrode can be fixed at any part of the body, but most often it is done at a patient's forehead.

Annex 3. Placement of Electrodes and Sensors on a Patient to Perform PSG Study

For a long time the analysis of the polysomnography studies in adults was performed according to the manual under the direction of Rechtschaffen и Kales [2]. In 2007 considering the obtained experience of the American Academy of Sleep Medicine [3] the new rules and recommendations for the analysis of the sleep structure, its phenomena and also sleep-related motor and cardiorespiratory disturbances were presented.

When performing different types of polysomnography (PSG) studies, it is often required to execute the simultaneous and long-term acquisition of neurophysiological and cardiorespiratory parameters during several hours and most often during the whole night. The quality of the reliability of placement of electrodes and sensors impact greatly the record quality and so the accuracy of the results being obtained.

Electroencephalogram (EEG)

The EEG electrodes are placed on a patient body according to International 10-20 system of electrode placement (Fig. A3. 1) [3]. According to the standards of the American Academy of Sleep Medicine to perform the PSG study, at least three EEG derivations are required in order to record the activity of frontal, central and occipital regions. This statement is based on the fact that the frontal derivations of usually represent the high-amplitude K complexes, the parietal derivations detect the sleep spindles, the occipital derivations record the alpha-rhythm all the best. The recommended derivations are F3-M2, C3-M2 and O2-M1. Buckup electrodes should be placed at F3, C3, O1 and M2 to allow display of F4-M1, C4-M1 and O1-M2 if electrodes malfunction during the study. The reference electrodes (M1 and M2) are fixed on the mastoids. Depending on the purpose of use, other EEG derivations can be recorded.

To record EEG, the cup electrodes are applied as a rule. Before placing an electrode degrease with alcohol the place of its location. After that apply adhesive paste on inner surface of the cup electrode and press it to the head. To fix the electrode collodion, fast-drying substance on the basis of ether, is usually used. For this purpose, prepare in advance and cover the cup of the electrode and its cable with a piece of thick gauze which size is a bit larger than the electrode itself. Lubricate the gauze with collodion (e.g., with the help of a brush or you can drop collodion on the gauze using a pipette). Press the electrode to the head tightly and dry the gauze using a fan. The electrode should be fixed reliably on a patient’s head.

All EEG electrodes fixed on a patient’s head must be placed in such a way that its cables will be directed to the top of the head and further you can gather them in one bundle. It allows achieving the minimal level of noise and artifacts evoked by cable fluctuations.

Reference electrodes (A1 and A2) are placed on mastoid bones and fixed by plaster or adhesive tape. To avoid artifacts occurred during jaw movement and vessels pulsation do not place reference electrodes too low.

To remove collodion and take away electrodes after the study it is recommended to use the collodion remover. Ground EEG electrode is placed in the same way as the recording ones. The electrode can be placed, for example, in Fpz position.

EEG electrode caps can be also used to record EEG.

Electrooculogram (EOG)

An electrooculogram (EOG) records changes that occur in the corneoretinal potential with eye movements during sleep and wakefulness. For EOG acquisition the same cup electrodes as for EEG acquisition are used. One electrode is placed 1 cm below and 1cm lateral to the left outer canthus, the other one is placed 1 cm above and 1cm lateral to the right outer canthus (Fig. A4. 1).

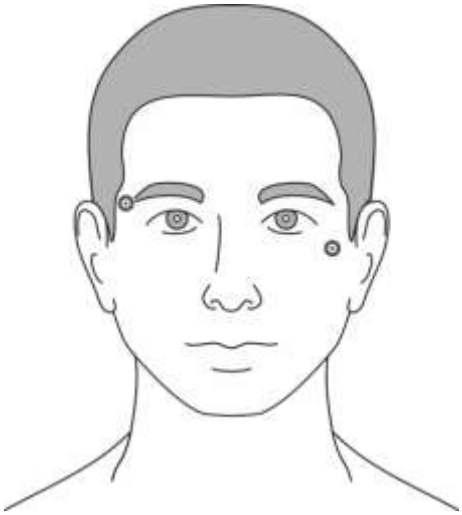


Fig. A4.1. The scheme of active electrode placement for EOG acquisition.

The EOG derivations are usually recorded relative to the reference electrode (M1 or M2). With such derivations the eye movements are recorded as synchronous antiphased deviations in left and right EOG channels (Fig. A4. 2). That is why it is easy to separate real eye movements from artifacts during PSG analysis. To EOG recording disposable or cup electrodes could be used. The cup of the electrode is filled up with adhesive conductive paste as well as the cup for EEG derivations. The electrodes are fixed on the skin by plaster or adhesive tape. The EOG derivations are usually recorded using EEG channels of the device.

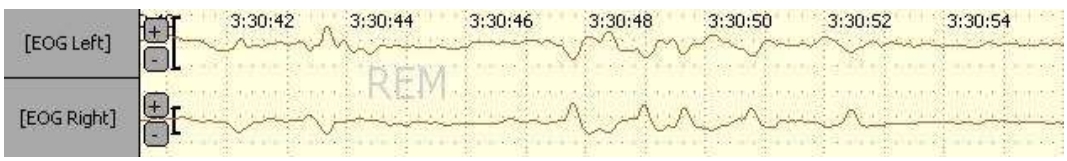


Fig. A4.2. The eye movement on EOG.

Chin Electromyogram (EMG)

To record EMG signal, it is required to use a bipolar derivation. The first electrode is placed in the midline of the chin, 1 cm above the inferior edge of the mandible, the second electrode is placed 2 cm below the inferior edge of the mandible and 2 cm to the left of the chin midline (Fig. A4. 3). To record chin EMG, you can use either the additional polygraphic channel or two EEG channels.

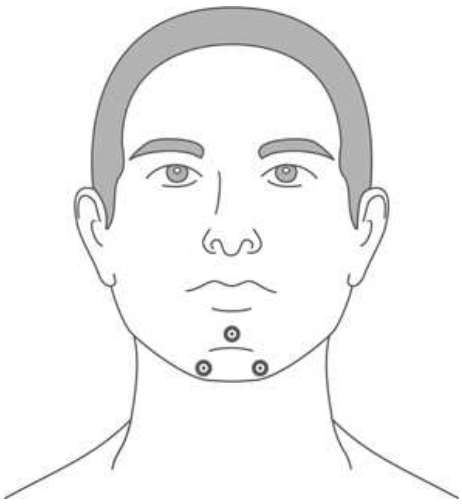


Fig. A4.3. The scheme of electrode placement to record chin EMG.

According to the American Academy standards it is recommended to use third additional electrode and to fix it 2 cm below the inferior edge of the mandible and 2 cm to the right of the midline. In many cases the additional electrode is not placed, however it is a backup electrode to allow for continued display of EMG activity if one of the primary electrodes malfunctions. In case three electrodes are applied, it is required to use three EEG channels as far as it is easy to commutate them both before the acquisition and after it.

For chin EMG acquisition the cup electrodes are also used. The fixation of electrodes on the skin is made in the same way as the fixation of EOG electrodes or, if a patient has a beard, as the fixation of EEG electrodes.

Electrocardiogram (ECG)

To control the heart rate during the PSG, it is required to record electrocardiogram. The American Academy of Sleep Medicine recommends to record single modified electrocardiograph Derivation II using torso electrode placement (Fig. A4. 4). The negative electrode should be placed below the right clavicle at the mid-calavicular line and the positive electrode on the left low chest at the anterior axillary line in the 6th or 7th intrercostal space. To record ECG, you can use either additional polygraphic channel or two EEG channels. You can use a single modified ECG Lead II and torso electrode placement.

In this case you can use both ECG connector and any other unused EEG channel. The electrode is fixed in the same way as EOG electrode.

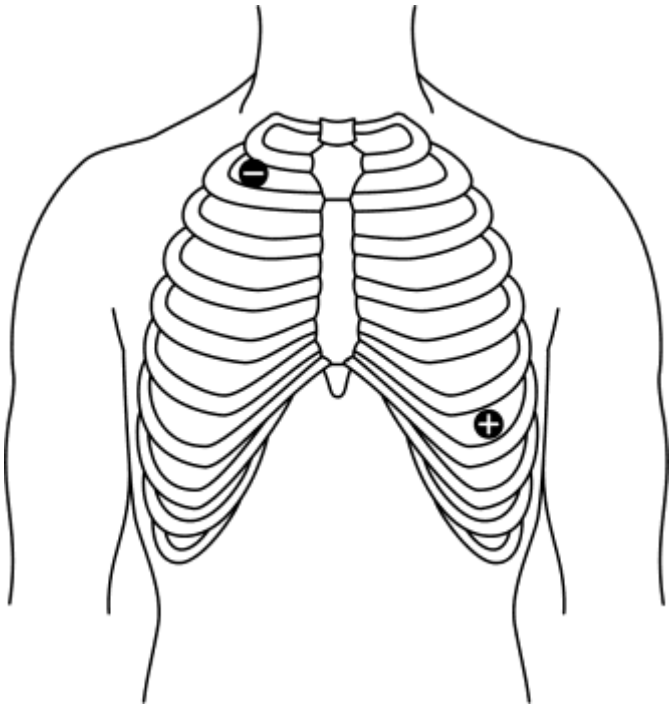


Fig. A4.4. The scheme of electrode placement to record ECG.

Airflow Pressure Sensor (Flow, Cannula)

To record the airflow you can use the airflow sensor based on the thermal resistor (Flow) or the nasal cannula (Cannula) connected to airflow pressure sensor. The nasopharyngeal airflow sensor based on the thermal resistor is located over the upper lip so the sensitive elements are to be located under the nose and in the mouth area to provide the airflow recording via the nasal and oral cavities. Fix the cable of the sensor behind patient's ears and tighten the loop under the chin (Fig. A4. 5). Connect the sensor to the respiratory channel (BR) on the amplifier. Fix the nasal cannula on a patient in a standard way (Fig. A4. 5) and plug into the airflow pressure sensor connected to the direct channel (DC) of a device. The airflow sensor cables and the cannula may be fixed if it is necessary on a patient's face by means of plaster or adhesive tape.

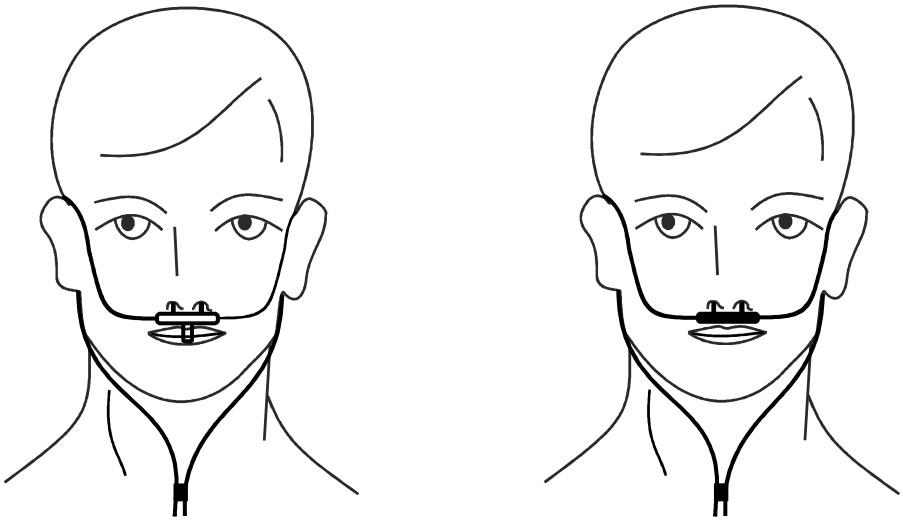


Fig. A4.5. The scheme of placement of the airflow sensor based on the thermal resistor and nasal cannula.

Thoracic and Abdominal Respiratory Efforts Sensor (Chest, Abdom)

The respiratory efforts are accompanied by the changes of thoracic (Chest) and abdomen (Abdom) volume. This phenomenon is used to record the respiratory efforts during PSG. To record the thoracic and abdominal excursion, the piezoelectrical sensors with cables are applied. The sensor is fixed on the regulated belt ending with the velcroes. When performing PSG study, two piezosensors are used: one sensor is fixed at axillary creases (to record the thorax excursion) and another one is a bit higher the iliac crest (to record the abdominal excursion) (Fig. A4. 6) by means of belts. The respiratory effort sensors are connected to the polygraphic channels. The selection of the polygraphic channel depends on the used montage.

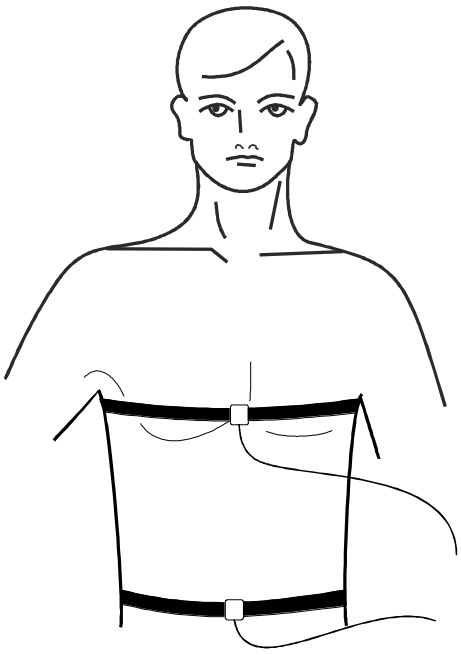


Fig. A4.6. The placement of thoracic and abdominal respiratory efforts sensors.

Body Position Sensor (Body position)

To record the position of a patient, the body position sensor is used. It allows identifying five positions of patient's body: supine, right side, left side, abdominal, standing/sitting. The sensor with cable is placed on a waist and fixed on a patient's thorax or abdomen so the pointer drawn on the sensor case to be directed up and located on a sensor side that does not contact patient's body (Fig. A4.7). The body position sensor can be also fixed at the belt with the thoracic respiratory effort sensor (Fig. A4.7). The body position sensor should be connected to the 1st direct current (DC) channel of the amplifier.

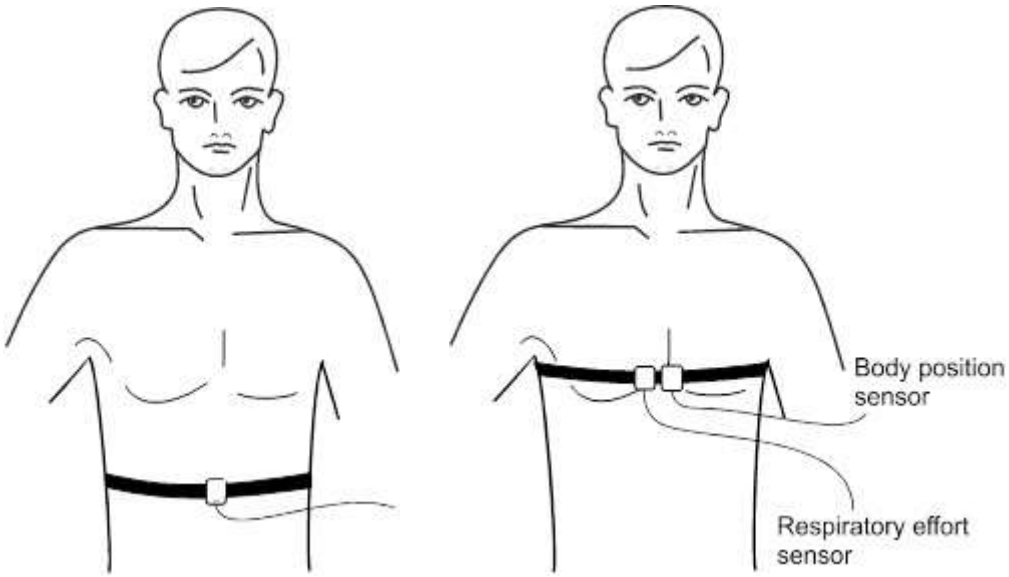


Fig. A4.7. The scheme of body position sensor placement.

Snoring Sensor (Snore)

To install the snoring sensor, ask a patient to imitate the snoring. While a patient is imitating the shoring, find a point at patient's neck where the vibration is palpated best of all. This is the best place to fix the snoring sensor. The snoring sensor is the piezoelectrical microphone that is why it is not required to lubricate it with any pastes or gels. The sensor is fixed with the pieces of the plaster or the adhesive tape (Fig. A4.8). The snoring sensor is connected to the polygraphic channel of the amplifier that is specified in the exam montage.

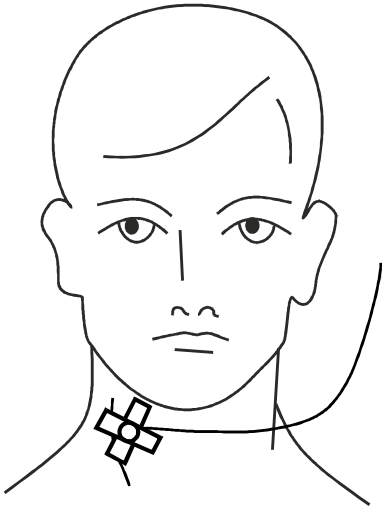


Fig. A4.8. The scheme of snoring sensor placement.

SpO_2 Sensor

The oxygen saturation sensor (SpO_2) is fixed on a finger of a patient. The **Neuron-Spectrum-PSG** delivery set includes the reusable silicone sensor, however you can use both reusable and disposable plastic, rubber and paper sensors. The sensor is fixed on a finger (Fig. A4.9). If it is necessary, you can fix the sensor cable on a backside of a hand by means of the plaster of the adhesive tape. The sensor is connected attached to separate SpO_2 unit plugged into the USB port of a computer.

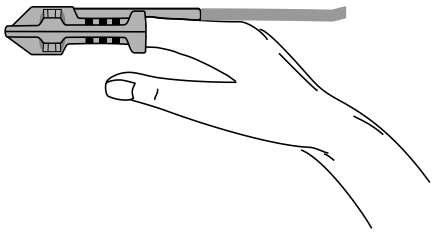


Fig. A4.9. The scheme of SpO_2 sensor placement.

Electrode Placement to Record EMG from Lower Limb Muscles (LML, LMR)

In some cases during the PSG study the leg movements of a patient are analyzed to detect the restless legs syndrome (RLS) or the periodic limb movement (PLM) disorder. To do this, the bipolar derivation is used. Disposable electrodes and cup electrodes could be used. The electrodes (with the extended cable) are fixed longitudinally and symmetrically along the middle of the muscle so that they are 2 to 3 cm apart or 1/3 of the length of the anterior tibialis muscle, whichever is shorter (Fig. A4.10). The recommended distance between the electrodes is so the stable resting of the EMG for the relaxed anterior tibialis muscle is to be not more than 10 μV between negative and positive deflection for signal (approximately 2-3 cm). To record EMG from the lower extremity muscles, you can use four EEG channels or two polygraphic channels that should be specified in the exam montage.

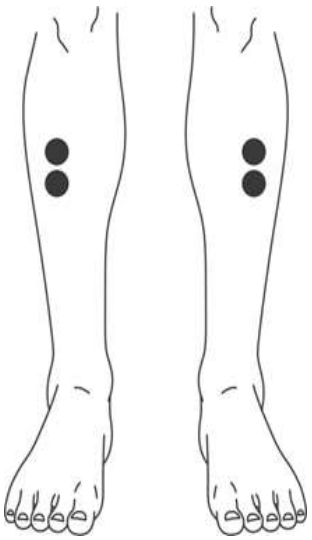


Fig. A4.10. The scheme of electrode placement at EMG acquisition from the lower extremity muscles.

References

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