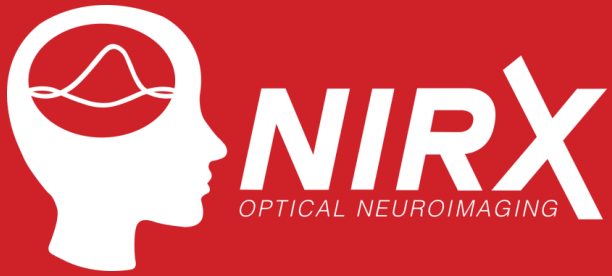


NIRStar

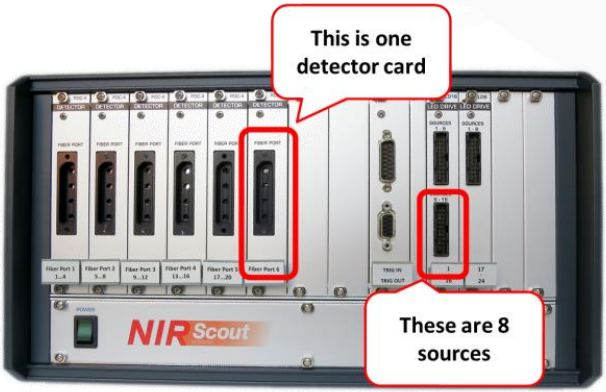
Getting Started Guide

Overview

Setting up the system

1. Connect your NIRSport or NIRScout system to your laptop, PC or tablet with the provided USB cable. Wait for the device to be recognized.
2. If your laptop, PC or tablet has already been configured by NIRx, simply launch the NIRStar application, by clicking the NIRStar application icon.
3. If using the NIRSport, **make sure it is not connected to a power source and is running from battery.** The laptop or tablet should be only battery powered as well.
4. If you want to install the NIRStar acquisition software on another PC, please download the latest version from the NIRx help center at http://nirx.net/nirx-help-center or contact NIRx at support@nirx.net. Follow the installation instructions throughout the process. Only reboot your system at the end of the installation. NIRStar runs on Windows XP, 7, 8 and 10. For a detailed list of system requirements, please consult the *NIRStar User Manual*.
5. When you are using your system for the first time, or when you have modified its hardware, you need to set the configuration.

   For NIRScout users only: the number of available sources and detectors needs to be specified, as well as whether the system



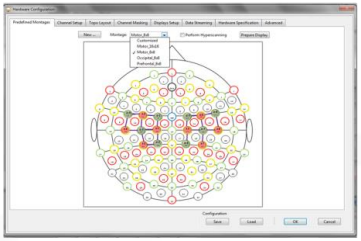
This system has 6 detector cards and 24 sources!

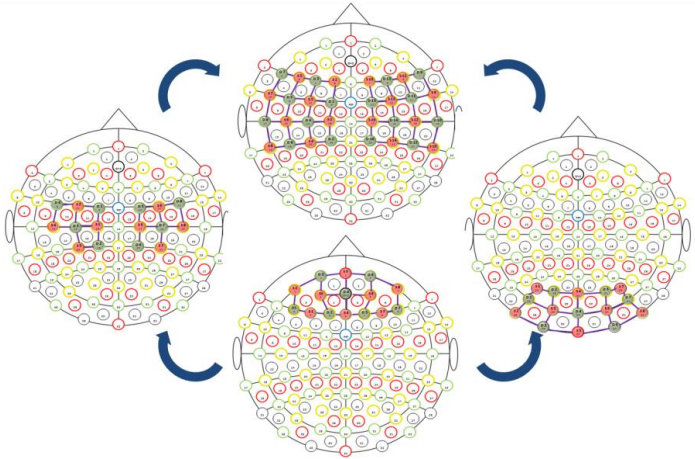
presents avalanche photodiode (APD) detector cards. NIRSport users do not have to do this. Open the “Configure Hardware” menu item and select the “Hardware Specification” tab. Please enter **the total number** of source and detector cards available (**not the sources and detectors you will use within a specific experiment**). Each detector card accommodates 4 detectors. In addition, please check the box in case the NIRScout system presents APD detector cards. Once this has been set, it should not be changed, unless the configuration of the system changes, for example because new sources or detector cards are added to the system.

For NIRSport users only: NIRSport only have to specify whether dual-tip active detectors are available. NIRScout users do not have to do this.

Let's get started

1. Open the "Configure Hardware" menu item. The "Predefined Montages" tab should be selected and activated.
2. From the dropdown menu, choose the montage that best suits your target area. For the NIRx Headband the default 8x8 montage can be selected. For all other montages, the location of the sources and the detectors will be displayed conforming to 128 standard EEG positions (an extension of the international 10/20 system). Depending on the NIRScap you have chosen, all or some of the slits in the cap will already be pre-populated with optode holders, denoted by a colored label and a number. The same colors and numbers can be also recognized in the montage templates.

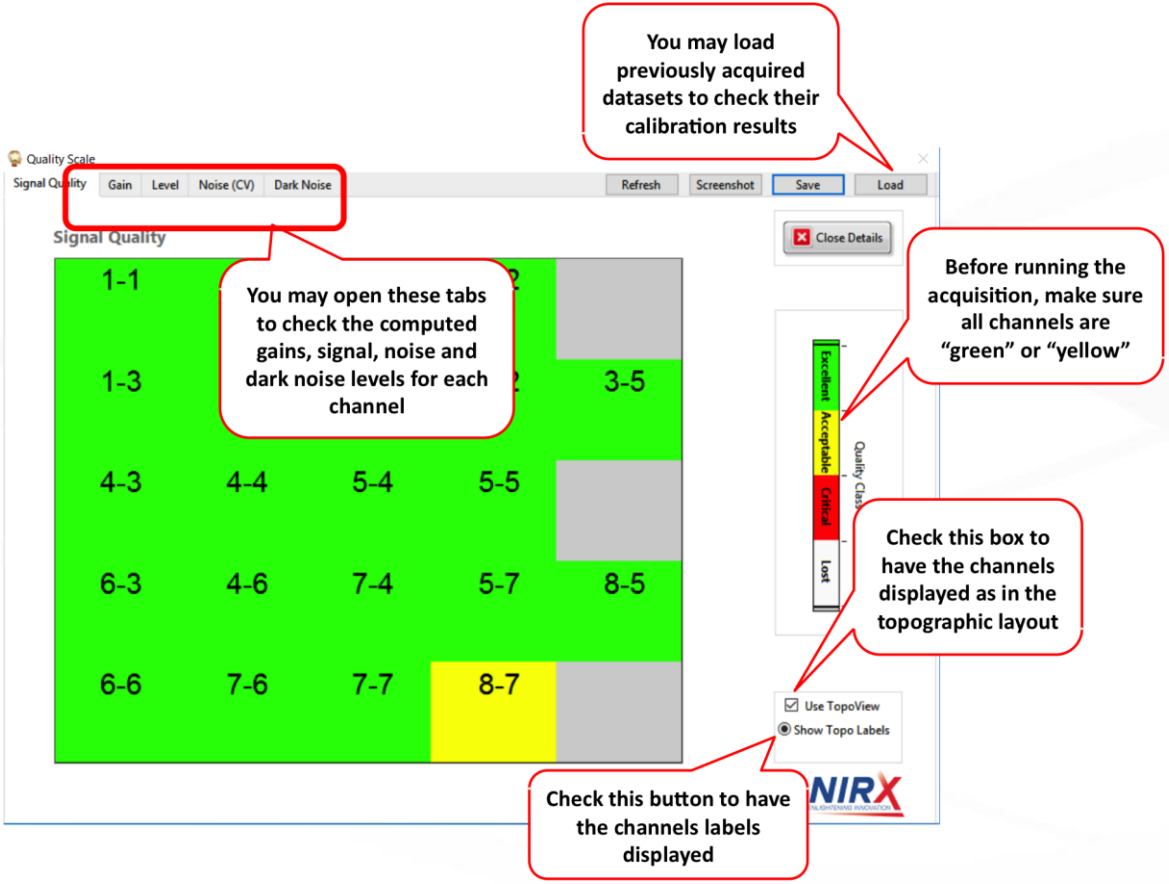




3. Everything has been setup to start the acquisition! You can now place the NIRScap on your subject. Place the optodes on the cap according to the chosen montage. Please refer to the *NIRScap Getting Started Guide*.
4. **If using the NIRSport, make sure it is not connected to its charger and is running on battery. The laptop or tablet should also be only battery powered.**

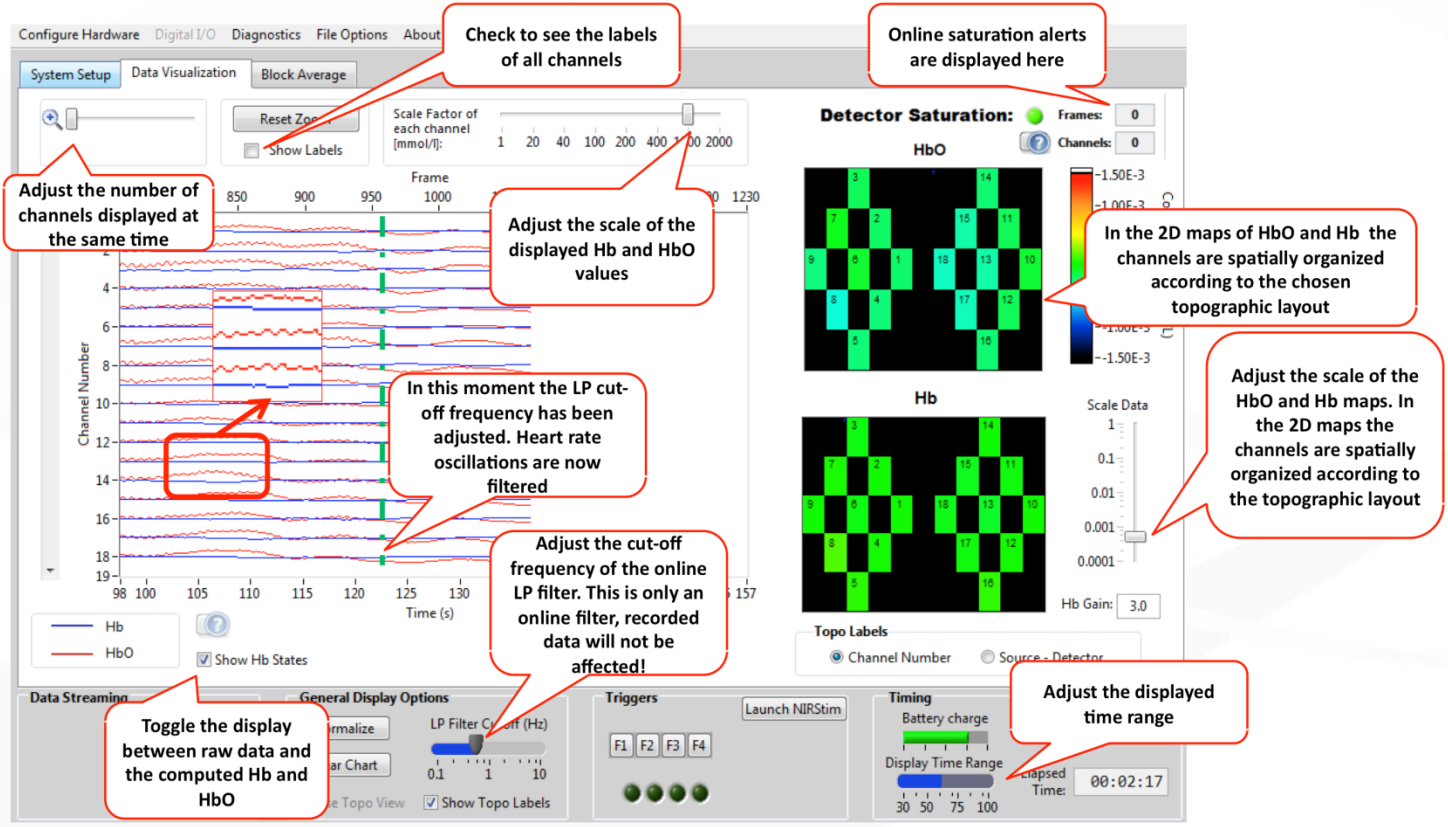
   Before every acquisition, it is necessary to run a calibration. After all optodes are in place and the subject is in resting state, press the "CALIBRATE" button. During the calibration, NIRStar automatically assigns the most appropriate amplification level to each detector. For each channel included in the montage an indicator of the signal quality is displayed.

5. The signal quality depends on many factors, including the identified amplification level of the photo-detectors, the mean signal level and the estimated level of noise. The estimated level of noise may in turn depend on factors such as possible environmental light interference, the stability of the optical contact between the optode and the skin, and the inter-optode distance between sources and detectors. NIRStar makes it easy for you to understand the signal quality of each channel by computing the quality index, which takes the above mentioned factors into account. Once the calibration is completed, the signal quality will be displayed for each channel in the chosen montage.


You may load previously acquired datasets to check their calibration results
Quality Scale
Signal Quality
Gain
Level
Noise (CV)
Dark Noise
Refresh
Screenshot
Save
Load
Close Details
Signal Quality
1-1
1-3
3-5
4-3
4-4
5-4
5-5
6-3
4-6
7-4
5-7
8-5
6-6
7-6
7-7
8-7
You may open these tabs to check the computed gains, signal, noise and dark noise levels for each channel
Before running the acquisition, make sure all channels are "green" or "yellow"
Excellent
Acceptable
Critical
Lost
Quality Class
Check this box to have the channels displayed as in the topographic layout
Use TopoView
Show Topo Labels
Check this button to have the channels labels displayed

6. Please carefully examine the results displayed in the “Signal Quality” tab. If the “Use TopoView” checkbox in the bottom right corner is checked, the results should be displayed to you in the same spatial arrangement as identified by your topographic layout (for a better understanding of the NIRStar Topo Layout concept, please refer to the section Adding more montages. Make sure that the signal quality for each channel is either “excellent” (green) or “acceptable” (yellow). There are several reasons why a channel might be displayed as "critical" (red) or "lost" (white):
    - The optical contact between the skin and the optode tip might not be good enough. Please remove the corresponding optode or optodes and try to improve the contact, as described in the *NIRScap Getting Started Guide*. Tip: After checking the “Show Topo Labels” radio button, it will be much easier to identify the channels and their position on the head. In the denomination x-y displayed for each channel, the first number identifies the source, the second identifies the detector.
    - If you still see some "critical" or "lost" channels, it might be that sources and detectors have not been placed correctly, as suggested by the chosen montage. Please make sure that the number of each source and each detector matches the corresponding number in the chosen montage.
    - Check if the inter-optode distance between the source and the detector of each channel which is denoted as "critical" or "lost" is not greater than 3 cm.
    - If all channels are “lost” there might be something wrong with the connection. Please make sure that both sources and detectors are properly plugged into the device.
    - For a more comprehensive review on signal quality and how to improve it, please consult the *Troubleshooting Signal Quality - Getting Started Guide*.

7. Everything is now ready to start recording. Before recording, you may preview your data to visually inspect the signal quality by clicking the “PREVIEW” button.
8. After clicking the “RECORD” button all data will be saved in the folder specified under “File Options”. Make sure to set the desired output directory before recording. The default output directory is always C:\NIRx\Data.
9. To finish recording, click the "STOP" button.


Configure Hardware
Digital I/O
Diagnostics
File Options
About
System Setup
Data Visualization
Block Average
Reset Zoom
Show Labels
Scale Factor of each channel [mmol/l]:
1 20 40 100 200 400 1000 2000
Frame
Channel Number
Time (s)
Hb
HbO
Show Hb States
Detector Saturation:
Frames: 0
Channels: 0
HbO
Hb
-1.50E-3
Scale Data
1
0.1
0.01
0.001
0.0001
Hb Gain: 3.0
Topo Labels
Channel Number
Source - Detector
Data Streaming
General Display Options
LP Filter Cut-off (Hz)
0.1 1 10
Show Topo Labels
Triggers
Launch NIRStim
F1 F2 F3 F4
Timing
Battery charge
Display Time Range
30 50 75 100
Elapsed Time:
00:02:17
Check to see the labels of all channels
Online saturation alerts are displayed here
Adjust the number of channels displayed at the same time
Adjust the scale of the displayed Hb and HbO values
In the 2D maps of HbO and Hb the channels are spatially organized according to the chosen topographic layout
In this moment the LP cut-off frequency has been adjusted. Heart rate oscillations are now filtered
Adjust the scale of the HbO and Hb maps. In the 2D maps the channels are spatially organized according to the topographic layout
Adjust the cut-off frequency of the online LP filter. This is only an online filter, recorded data will not be affected!
Toggle the display between raw data and the computed Hb and HbO
Adjust the displayed time range

Adding more montages

NIRStar 15.0 comes with a set of ready to use montages, but it also offers you the possibility to create your own, according to your specific application and the number of sources and detectors available.

With the unique measurement strategy of NIRx devices, every possible combination of sources and detectors can form a measurement channel. However, only channels formed by pairs of sources and detectors with an interoptode distance equal to or lower than approximately 3 cm will have a sufficient signal to noise ratio. These channels consist of sources and detectors which are the nearest neighbors. The spatial arrangement of these channels is what constitutes a topographic layout, a 2D representation of the physical montage.

Before creating a new montage in NIRStar, please use NIRSite to design your montage, by placing sources and detectors into the available positions, as explained in the *NIRSite Getting Started Guide*. NIRSite will generate the files you need to add a montage in NIRStar.

1. Open the "Predefined Montages " tab and click the "New" button. You will be prompted to enter a name for the new montage and the number of sources and detectors. Here you may choose to add optional files, including a graphical sketch of your montage that you may create. For a detailed explanation on the meaning and the structure of the optional files, please consult the *NIRStar User Manual*.
2. After clicking the "OK" button, you will be prompted to locate the topographic layout (and optionally the probeInfo file) file that you previously exported with NIRSite. After confirming its location, your montage will be created.

Please remember that a montage is not necessary to start a recording, but a topographic layout is. After creating a Topo Layout or loading previously created one, you may simply proceed with the calibration and recording, without

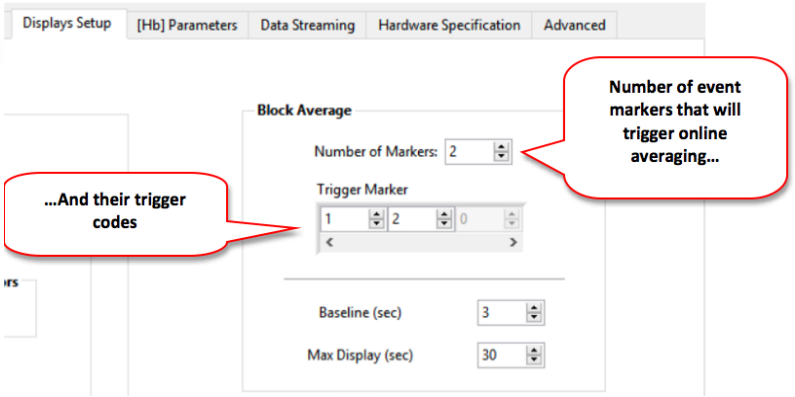
choosing a montage. NIRStar always stores the last applied settings, so if you always use the same montage or the same topographic layout you do not need to make any changes in the "Configure Hardware" every time you launch NIRStar.
The advantage of using a montage with respect to using only a topographic layout, which can be part of a montage, is that its structure is more complex. While topographic layouts only define the channels consisting of neighboring sources and detectors included in the measurement, the montages may also include information about their location with respect to the head anatomy, making the analysis of your data in nirsLAB straightforward. However, this information is not necessary for the recording and can be added at any time later on.

Getting more advanced

When using presentation software, recording devices or stimulation devices, it is important that all acquisition is synchronized. All NIRx devices provide trigger inputs, and thus allow synchronization. Please follow these steps to make sure trigger markers are correctly recognized and saved by NIRStar.
The NIRSport and the NIRScout systems provide four parallel, positive-edge triggered digital TTL input lines, through a 10 pin IDC connector. Both instruments are provided with a cable that connects the IDC trigger input to a standard PC parallel port (25-pin sub-D female connector). The NIRScout Extended systems provide eight parallel digital inputs (TTL level, positive edge triggered), through a digital male 15-pin, D-Sub connector. The instrument is supplied with a 3-m long, 15-lead flat ribbon cable which may be used to connect the trigger input to a standard PC parallel (LPT) port, mapping LPT output lines (bits) 0..7 to trigger inputs 1..8. For more information on trigger input ports and safety issues, please consult the *NIRSport User Guide* or the *NIRScout User Guide*.

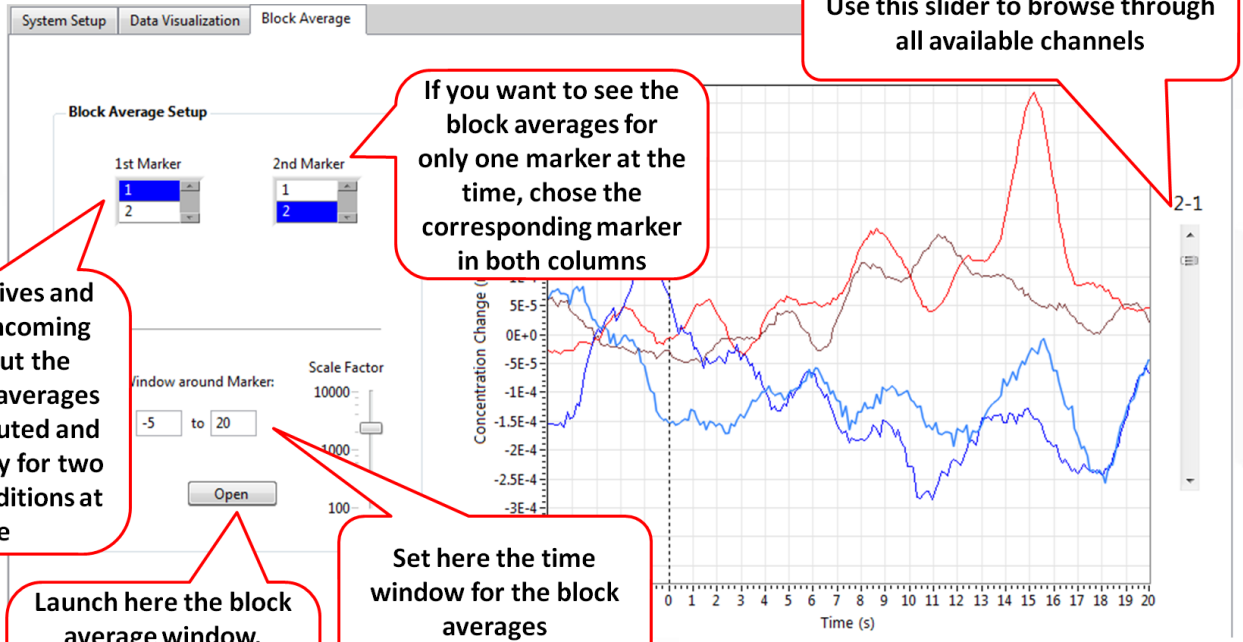
To ensure proper communication, your presentation PC (or other device, for example a stimulator) needs to be connected to the trigger input of the NIRx device. Please make sure that the pinning of the trigger output is compatible with the pinning of the trigger cable provided by NIRx.
If the trigger cable has been setup properly, sent trigger markers should be visible in NIRStar as dotted vertical lines, both in preview and recording mode.
NIRStar 15.0 has a "Block Average" feature. In order to use this feature properly, you need to specify the event marker codes that trigger the event-related averaging.

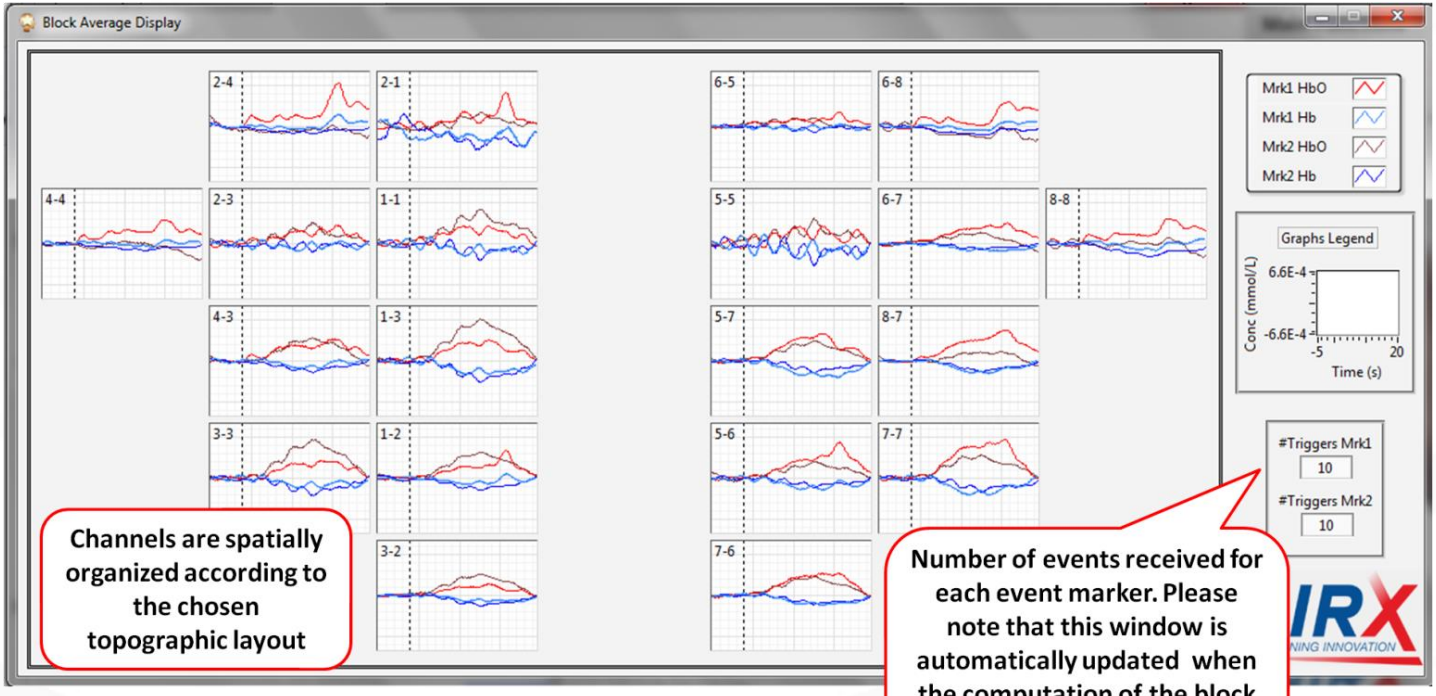
1. Before starting the recording, open the "Configure Hardware" menu item and select the "Displays Setup" tab. The settings for the online Block Average are located in the right top corner of the window. Please specify the number and the codes of the relevant event markers (i.e. the number of conditions) that should trigger the online averaging. After having entered the number of conditions, please enter their code. As mentioned, the NIRSport and NIRScout have 4 bit trigger inputs, thus allowing 16 different marker codes (0-15). The NIRScout extended has an 8 bit trigger input, thus allowing 256 different marker codes (0-255). Please keep



in mind that you can you use all marker codes, however, online block averages can only be displayed for two markers at a time.

2. Please set the Baseline time and the Max Display time in seconds. Event-related averaging is computed relative to a pre-stimulus baseline period, which has a user-specified duration between 3 and 10 seconds. The events will be displayed in the time window delimited by the entered max window time (up to 120 seconds). Confirm your settings by clicking "OK", the “Configure Hardware” window will close.
3. You can now start recording, and access the Block Average view through the “Block Average” tab.
4. While NIRStar will record all permitted incoming markers regardless of their trigger code, only the block averages of the two previously defined marker events will be displayed at the same time. Please select the relevant marker event codes under “1st Marker” and “2nd Marker”. Please note that it is also possible to display only the averages triggered by one marker, by choosing the corresponding event code under both “1st Marker” and “2nd Marker” columns.
5. Before launching the “Block Average” window, you might want to adjust the time window and the applied scale factor for the display of the computed Hb and HbO values. The applied changes will be immediately visible in the window on the right.
6. The block averages can either be viewed one by one, in the “Block Average” tab (use the slider to browse among channels) or all at once, in the “Block Average Display”. The Block Average Display can be launched by clicking “Open” in the “Block Average Setup” panel, located on the left in the “Block Average” tab. In the Block Average Display view, the channels are spatially organized according to the chosen topographic layout.


System Setup
Data Visualization
Block Average
Block Average Setup
1st Marker
2nd Marker
Scale Factor
10000
1000
100
-5
to
20
Open
2-1
Concentration Change
Time (s)
Use this slider to browse through all available channels
If you want to see the block averages for only one marker at the time, chose the corresponding marker in both columns
NIRStar receives and records all incoming markers, but the online block averages can be computed and displayed only for two markers/conditions at a time
Set here the time window for the block averages
Launch here the block average window, which displays the block averages for all channels simultaneously


Block Average Display
2-4
2-1
6-5
6-8
4-4
2-3
1-1
5-5
6-7
8-8
4-3
1-3
5-7
8-7
3-3
1-2
5-6
7-7
3-2
7-6
Mrk1 HbO
Mrk1 Hb
Mrk2 HbO
Mrk2 Hb
Graphs Legend
Conc (mmol/L)
6.6E-4
-6.6E-4
-5
20
Time (s)
#Triggers Mrk1
10
#Triggers Mrk2
10
Channels are spatially organized according to the chosen topographic layout
Number of events received for each event marker. Please note that this window is automatically updated when the computation of the block averages is updated after each incoming marker

NIRStar 15.0 introduces the “Lab Streaming Layer” (LSL) feature. LSL is a protocol that allows real-time data and triggering streaming, as well as multi-modal time-synchronization. Given the great range of possibilities that LSL offers, we have incorporated its protocol into NIRStar 15.0. In order to use this feature properly, you need to enable LSL streaming in NIRStar.

1. Before starting the recording, open the “Configure Hardware” menu item and select the “Data Streaming” tab. In the left panel, click on ‘Enable LSL-streaming’.
2. In addition, you may select the type of data you wish to stream to the LSL protocol. By using the drop-down menu “Data Type”, it is possible to stream either “Raw Data”, “Hb States” or “Both”. Note that “Hb States” corresponds to hemodynamic changes calculated based on the modified Beer-Lambert law parameters chosen by the user. For more information on choosing modified Beer-Lambert law parameters, please see section 5.6 of the *NIRStar User Manual.*
3. Confirm your settings by clicking "OK", the “Configure Hardware” window will close.
4. You can now start recording, and recorded data (of your choice) as well as trigger information will be automatically streamed to the LSL protocol.

A thorough understanding of the LSL protocol is essential in order to use it. Please consult the *NIRStar User Manual* for more information, as well as references to the LSL protocol and examples.

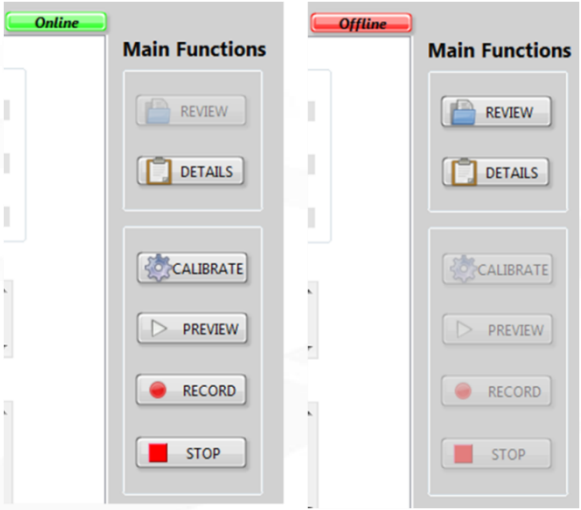
Review your data

NIRStar 15.0 operates in two modes: online and offline. You can switch between the two modes with the toggle button, which at the same time indicates the currently active mode.

When in offline mode, your NIRx device does not need to be connected to your PC, laptop or tablet. The offline mode allows you to review previously acquired data.

By clicking the "REVIEW" button, you will be prompted to browse for the dataset you want to review. If you do not change the default settings, all data are saved to C:\NIRx\Data and organized according to the acquisition date.

You will be able to review full calibration results, the entire recording and block averages, if these were calculated during recording. Please remember that in the review mode, recorded data will be displayed with the same settings as applied online. For example, if the online LP filter was turned on, this will apply to recorded data under review too. However, this is only for visualization purposes. The raw data is not affected by online display options such as the LP filter.



NIRX is a world-leader in providing integrated solutions for fNIRS neuro-imaging. In 1988 we introduced the concept of tomographic imaging (i.e., multi-distance measurements) in dense scatted media base on diffusely scattered light. This approach has since been widely adapted and has served to launch the modern day field of fNIRS tomography.

Through our offices in Berlin, Los Angeles, New York and São Paolo, our engineers and grant-funded investigators are providing a growing number of research teams world-wide with comprehensive technology solutions for the most demanding investigative applications.

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