SOFTWARE
myoRESEARCH®3.10

NORAXON™
MOVEMENT › DATA › PEOPLE

myoFORCE™ SOFTWARE USER GUIDE

Table of Contents

Section 1: Introduction to the Technology

Noraxon's myoFORCE™ module allows the integration of commercial 1D and 3D force plates into the NORAXON multi-device myoRESEARCH® 3 (MR3) software. This integration can be operated with an analog connection using the Noraxon Analog Input System (AIS) A/D board – or analog AIS in specific instances. We currently provide the following synchronized digital integrations:

	Analog Integration AIS	Digital Integration USB
Bertec INC USA	Yes	Yes – requires digital amp.
AMTI INC USAYes	Yes	Yes – requires GEN5 amp.
Kistler AG Switzerland	Yes	Summer 2017

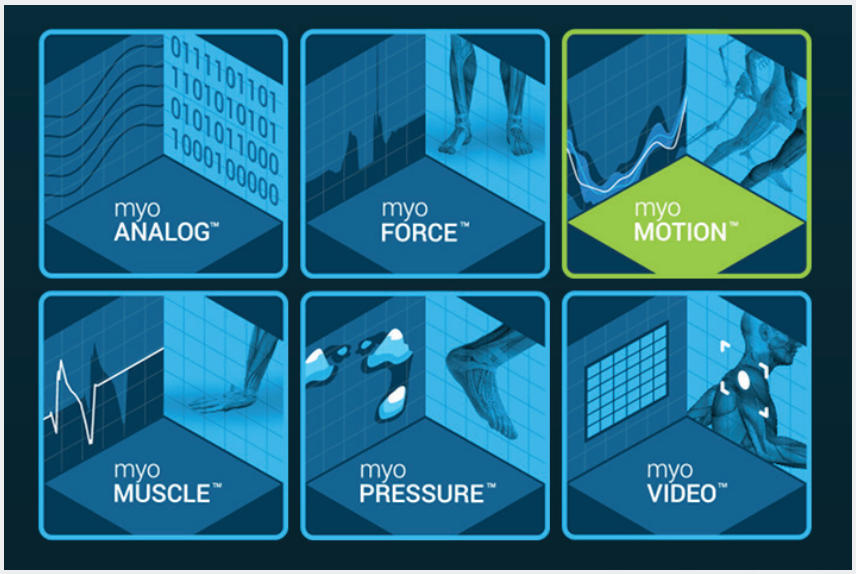
1D force plates with powered analog-out signals can directly be connected the Noraxon AIS board. For the integration of other force plate types not listed here please contact Noraxon support. Also, please note:

- Digital integration requires the Noraxon myoSYNC™ synchronization system if used in multi-device measurement setups (like force plate, video, 3D Kinematics etc).
- Kistler analog integration requires a special Noraxon Kistler control box to reset the plate and define the measurement range.
- Any of the above listed 3D force plate models will be integrated so that 6 resulting measurement channels are available for recording:

  3 force dimensions: Fx, Fy and Fz
  3 moments: Mx, My, Mz

- With the myoFORCE module, you can integrate 3D force plate data for impulse based jump analysis. (COP / balance analysis will be available in the next release of MR3 by end of 2017).

myoFORCE applications can be combined at any time with any of the other 5 available modules of the Noraxon MR3 multi-device concept:



This multi-device setup allows you to directly combine ground reaction force analysis with EMG (**myoMUSCLE**™ module), 3D Motion analysis (**myoMOTION**™ module), High Speed Video (myoVIDEO™ module).

Section 2: Set-Up

Software Installation

Before you launch the MR3.10 software platform: please connect all hardware devices that you plan to use with the MR3.10 software to your computer.

1. Insert the installation USB Flash Drive or use the MR3.10 download file and start the installation with **Noraxon.mr.3.x.x.exe** (x is the latest version release number).

2. Follow the steps in the Installation Wizard menu and click Finish to close the Installation Wizard window. A new Icon will appear on your desktop:

3. Double click on the icon to start the MR3.10 software.
   - The first screen will prompt an Activation dialog box.

Note: the MR3.10 software platform can be started 30 times in "Demonstration Mode" without an Activation code. In Demonstration Mode, users will have access to all modules and all functions. Once MR3.10 is activated, only purchased modules will be functional.

To activate enter your license ID, press **Activate** and again press **Activate by Internet.** If no internet connection is available please contact your local distributor or Noraxon customer support at support@noraxon.com.

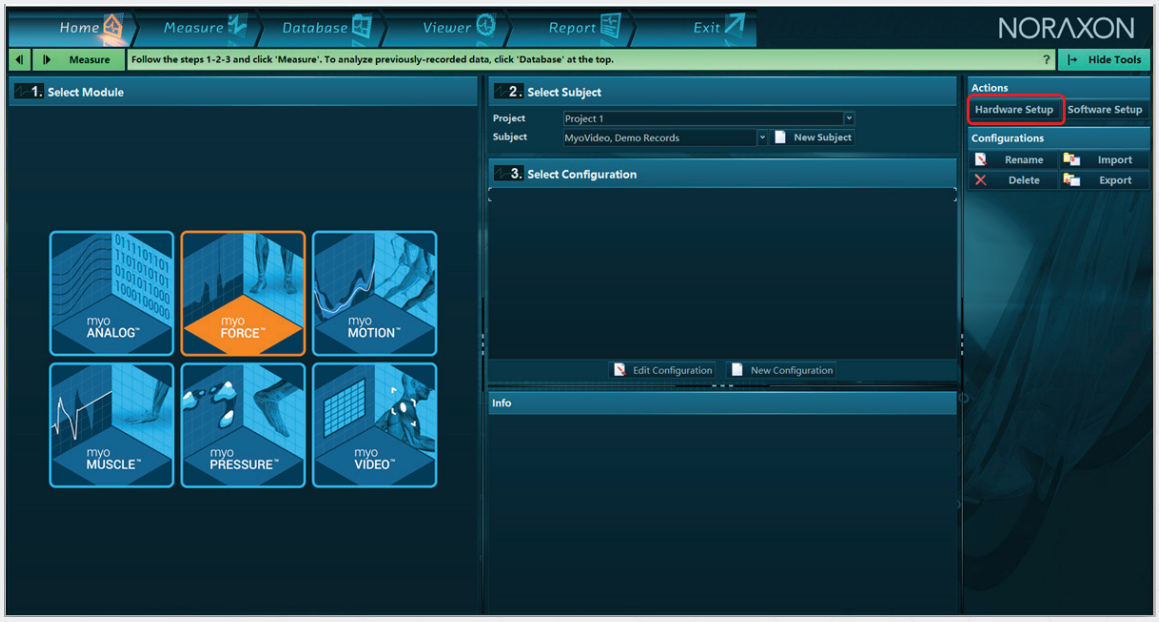
Hardware Setup for Digital Force integration

Please note! Digital is the recommended integration. The digital driver will automatically preset all channel and calibration values. Your force plate will be ready to measure after setup. Please refer to the following for installation of specific force plates.

Digital integration of Bertec force plate

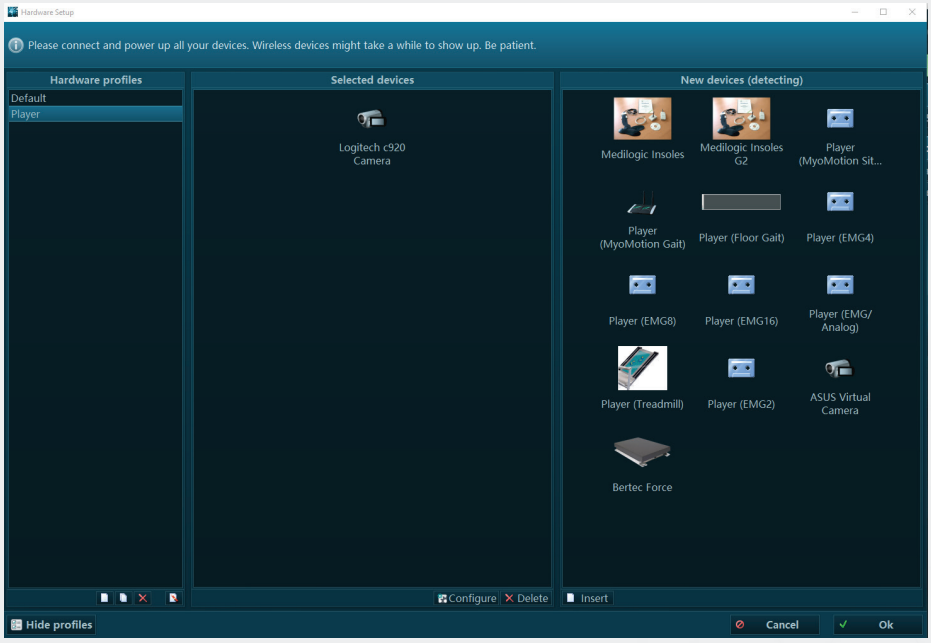
Install the Digital Acquire software supported by Bertec via CD ROM or internet download (http://bertec.com/uploads/files/BertecAcquire4Setup_build411.exe) and execute the Bertec installation program. Make sure that the force plate is connected by USB to the PC and start MR3.

Next, click on the **Hardware Button** found on the Right Tool bar:



The Hardware menu is split into two sections:

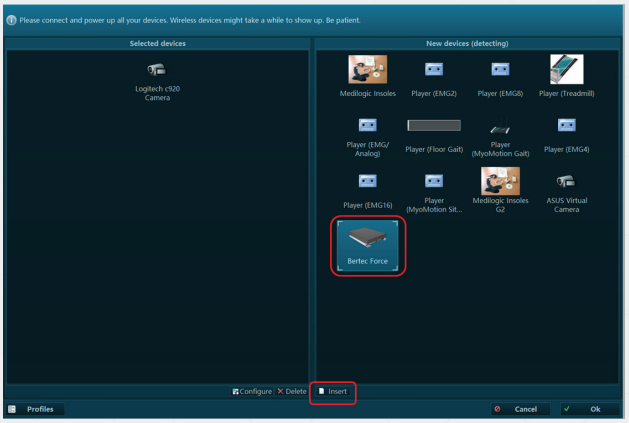
- Selected devices (left screen)
- New devices (detecting)



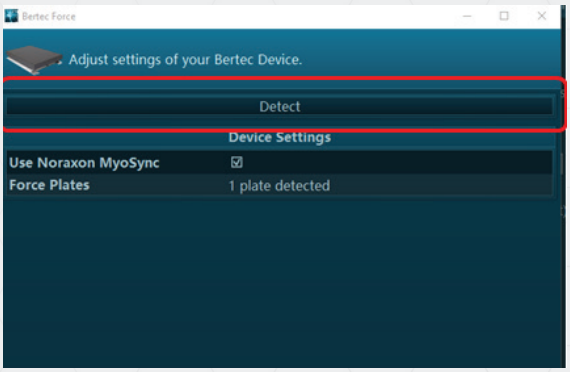
The right side shows ALL devices recognized by MR3 via USB connection.

Please Note! MR3 identifies a list of "**Player**" devices which are virtual demonstration drivers to simulate an EMG, **myoMOTION** or pressure plate recording without connected hardware. These cannot be used for measurement. Furthermore, there are two pre-installed **Medilogic** Insole System icons as well as build-in camera icons if available. These devices will always show up.

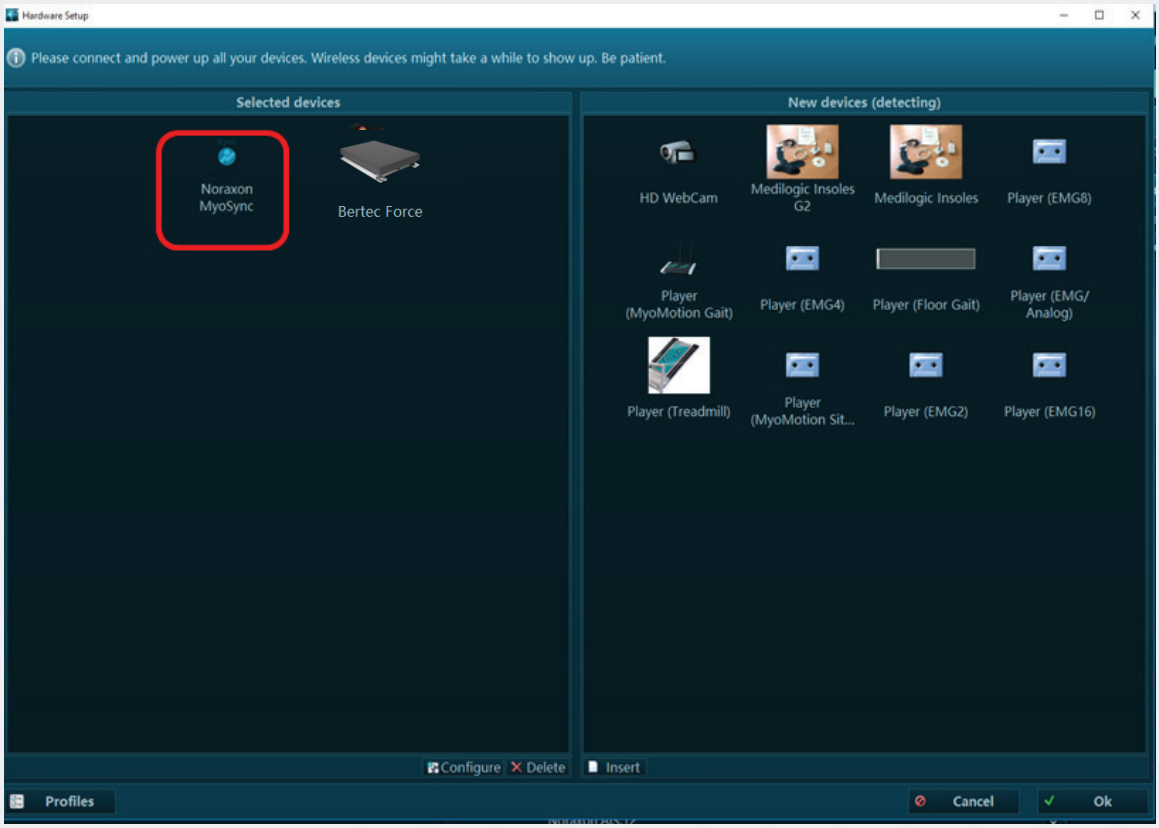
Now, select the Bertec force plate device and click Insert to move it to the left side **Selected devices.**



A new sub menu will show up:



The switch Use **myoSYNC** only needs to be turned on to be able to synchronize the force plate with other MR3 compatible devices. The myoSYNC board must be plugged into the computer via USB and the force plate hardwire synced from a myoSYNC sync out port to be synchronized.

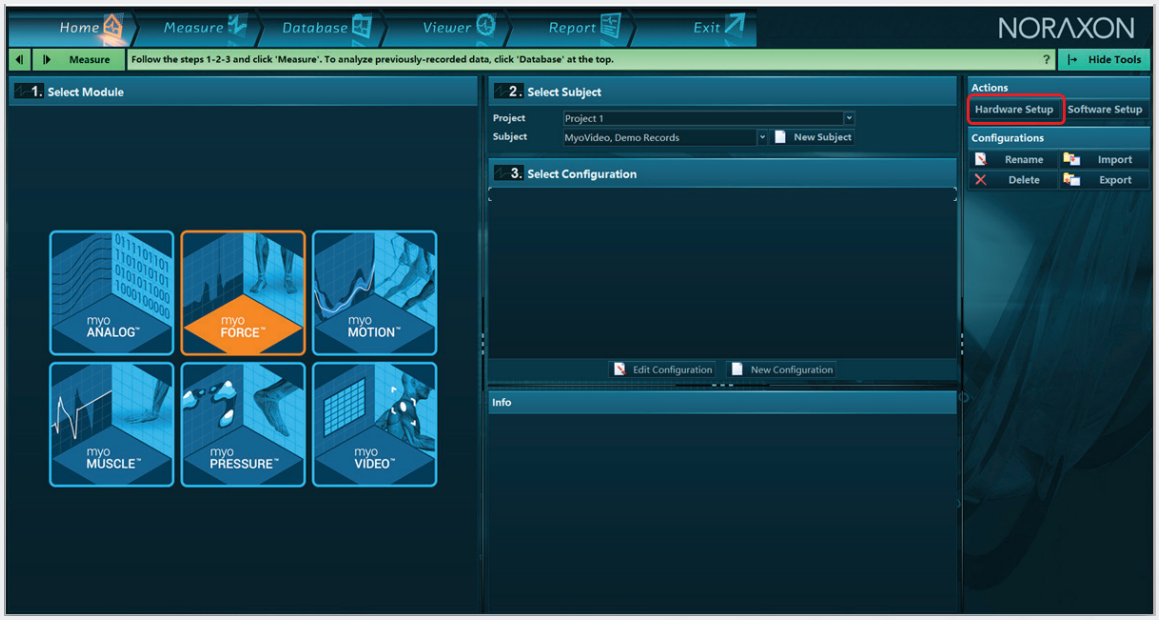


When done with these settings press OK. The 3D force plate is ready for measurement.

Digital integration of AMTI force plate

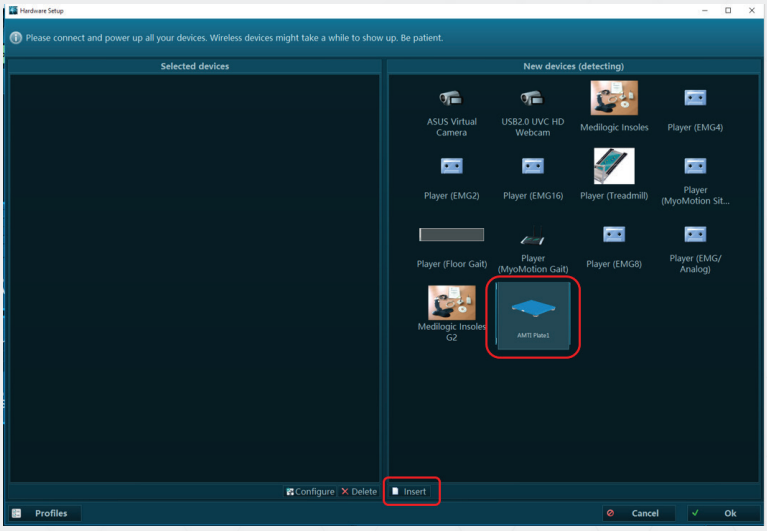
Install the AMTI software that was delivered with your plate and GEN5 amplifier. Make sure that the force plate is working correctly with their software, then start MR3.

Next, click on the **Hardware Button** in Right Tool bar:



The Hardware menu is split into two sections:

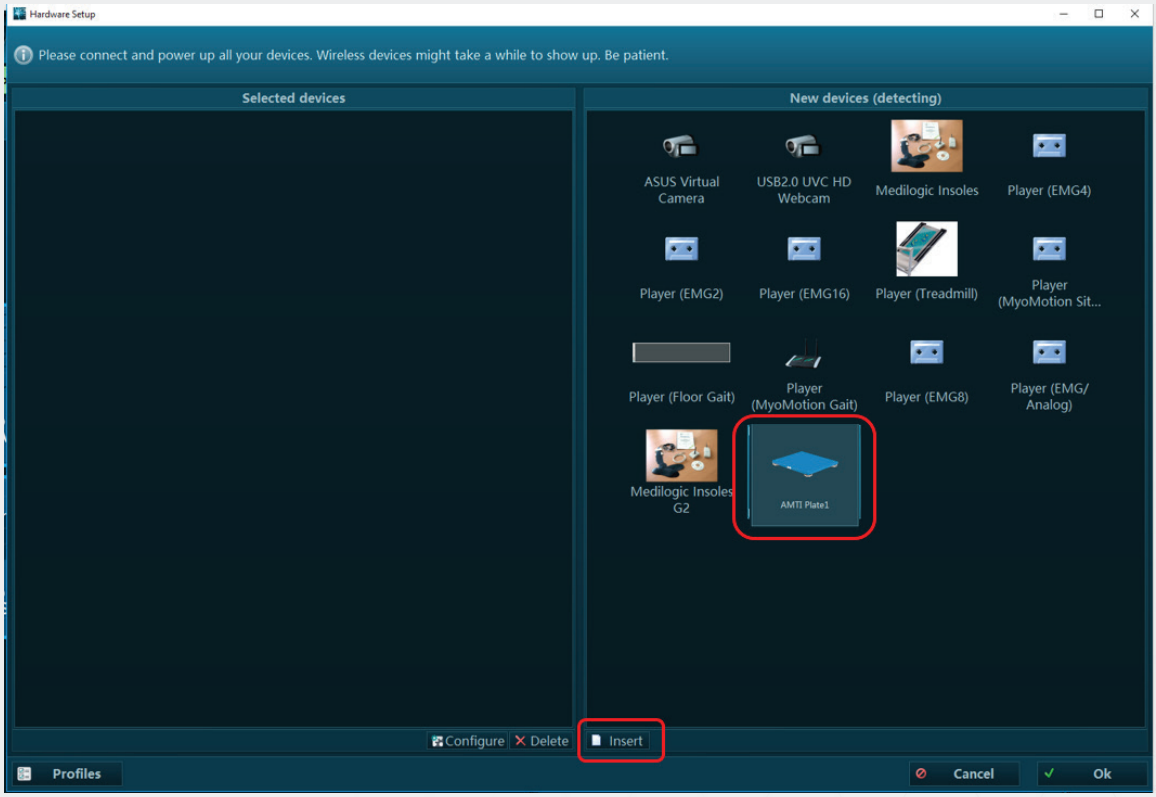
- Selected devices (left screen)
- New devices (detecting)



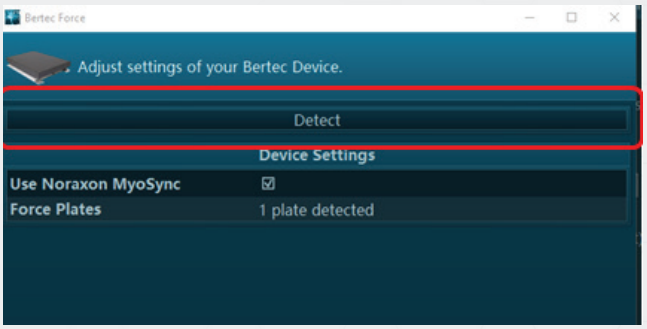
All available devices that MR3 could automatically identify are listed on the right-side panel.

All available devices that MR3 could automatically identify are listed on the right-side panel.

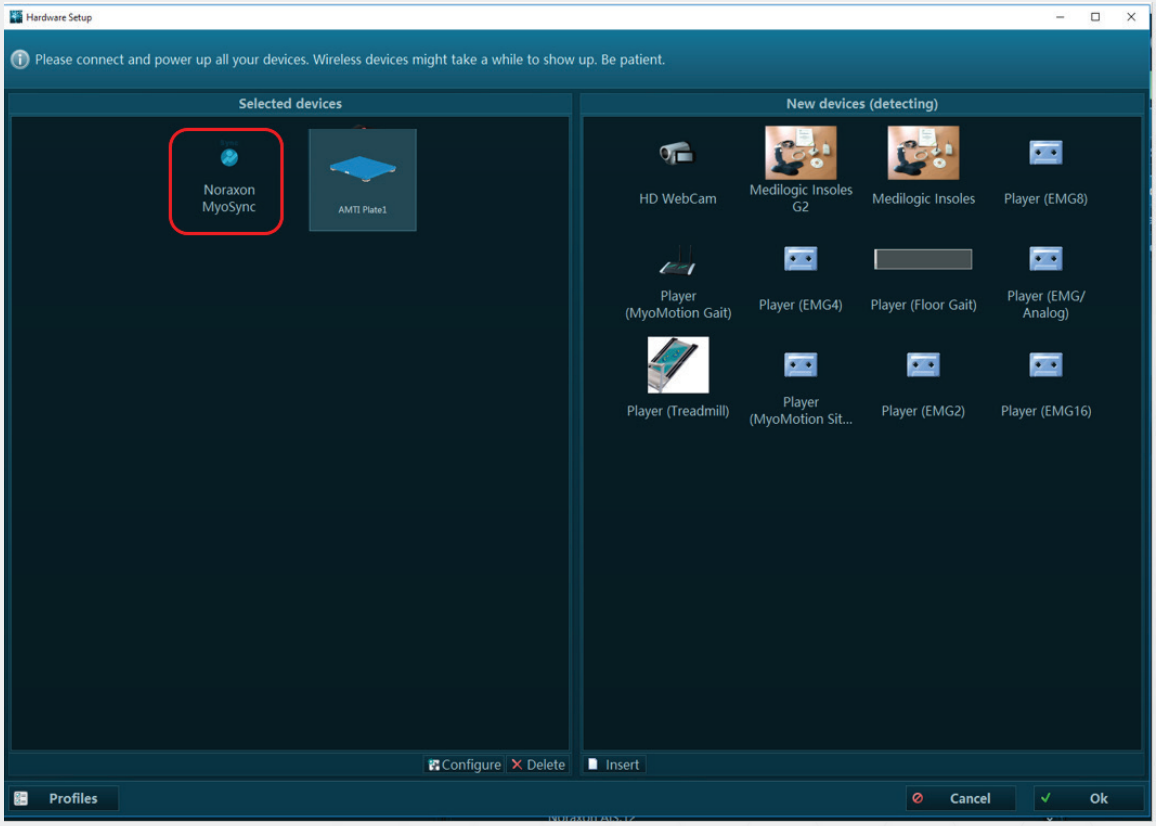
Select the Bertec force plate device and click Insert to move it to the left side Selected devices panel.



A new sub menu will show up



The switch Use **MyoSYNC** only needs to be turned on to be able to synchronize the force plate with other MR3 compatible devices. The MyoSYNC must be plugged into the computer via USB and the force plate hardwire synced from a MyoSYNC sync out port to be synced.



When done with these settings press OK.

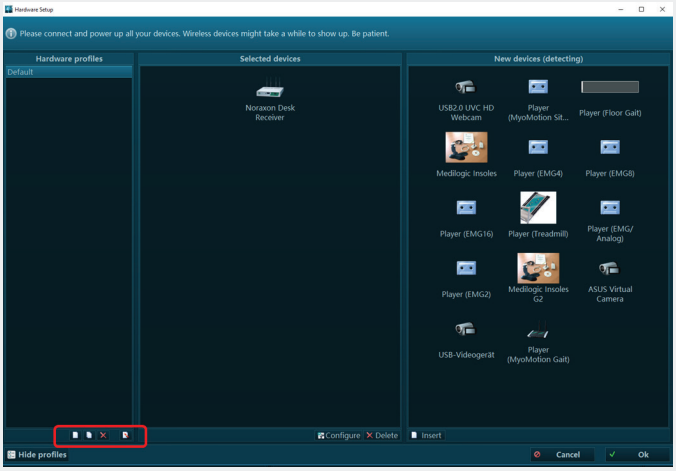
Analog Integration of 3D Force plates

***Analog integration is possible. Please refer to the appendix for instructions.

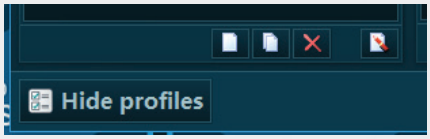
Hardware Profiles

The MR3 software platform allows multiple hardware profiles. This allows the user to save specific hardware setups and device configurations, which is useful when one or more EMG and biomechanical sensors are combined in certain constellations or special multi-device setups.

To create Hardware Profiles, click on the **Profiles** button in lower left corner of the **Hardware setup screen**. A new column **Hardware profiles** will appear:



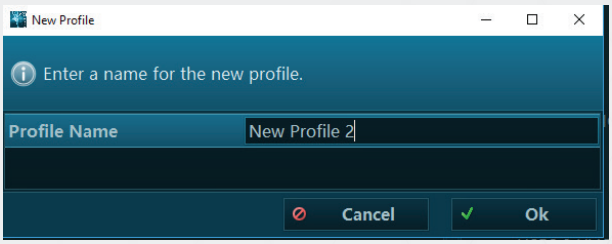
Below the list section four buttons will be presented:



Functions from left to right button:

- **Create** a new item (Profile)
- **Copy** a selected item (Profile)
- **Delete** marked item(s)
- **Rename** marked item(s)

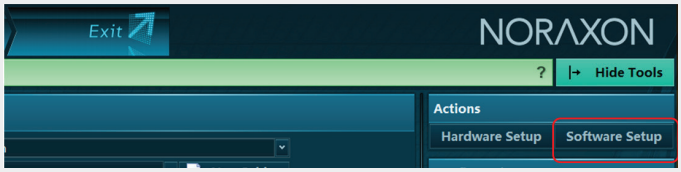
When the **Create New Item button is pressed, a sub-dialog prompt is presented:**

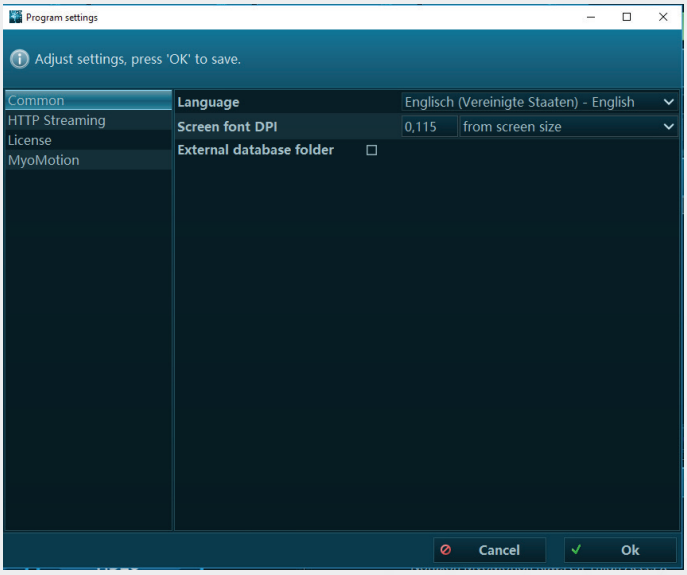


Enter a Profile Name and confirm by selecting **OK.**

Software Setup

In the Software setup, you can access general software settings as well as some module specific functions:





Common

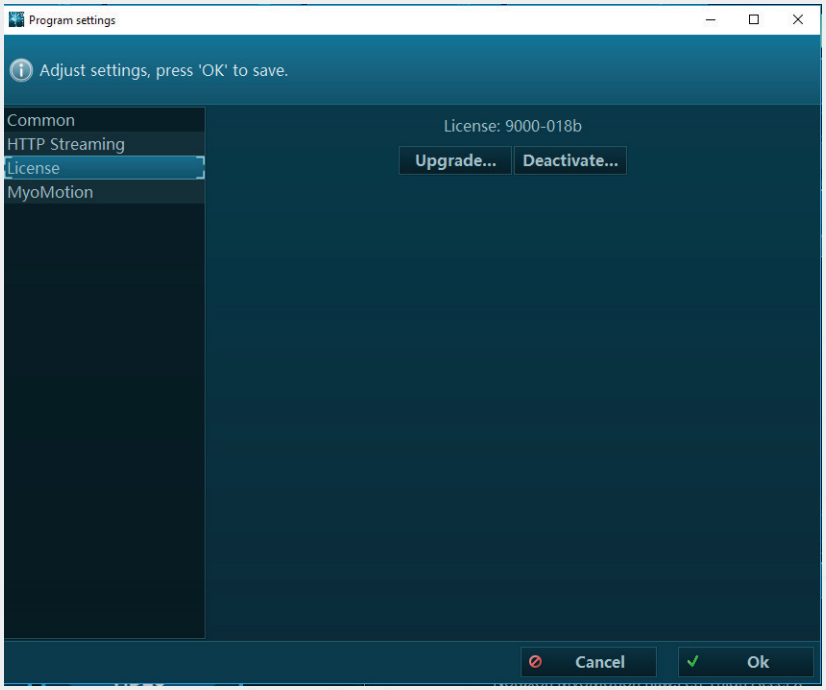
Language allows you to change the language. The default language is the language of your installed Windows Operating system. There are four languages currently supported by MR3: English, German, Chinese, and Japanese.

Screen font DPI allows you to change the font dots per inch (DPI). 3 options are available:

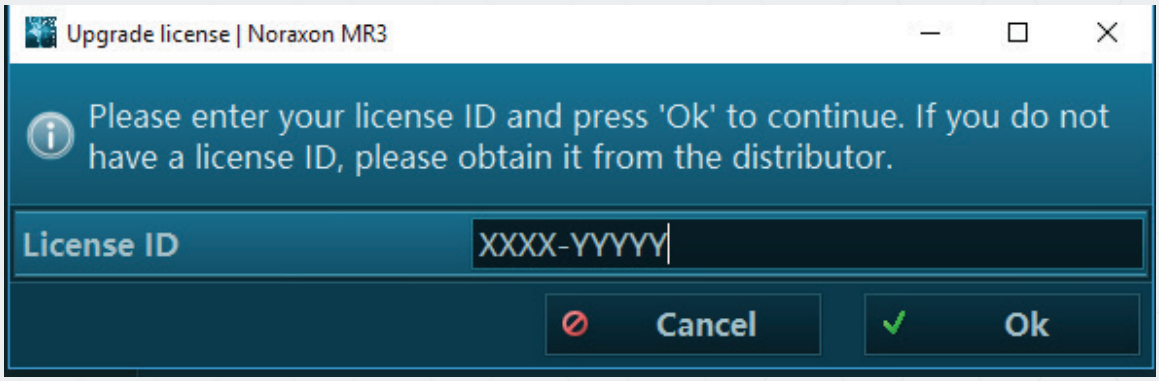
From screen size	Recommended setting. The resolution is scaled in proportion to screen size and auto scales if MR3 is moved to a window or if the screen size temporarily changes (i.e. when connected to a lower resolution LCD screen projector).
Fixed	This option allows users to manually select a font resolution in DPI.
From System	This option checks the general font size of operating systems and will also use it for the MR3 software.

Software License

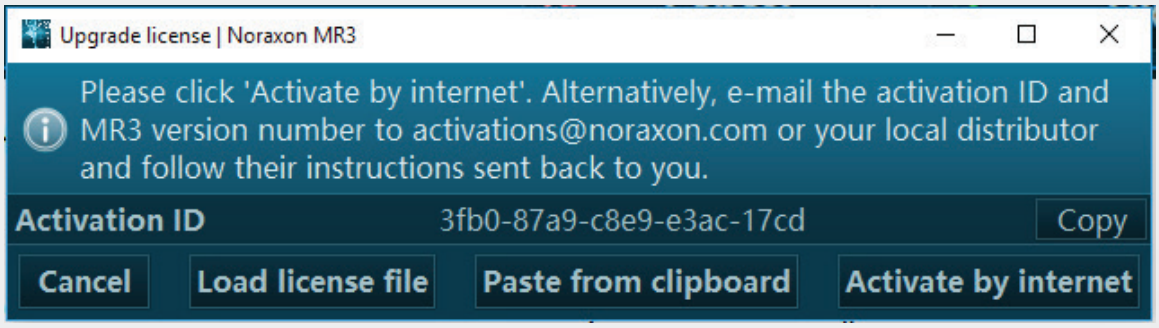
The MR3 software platform and each module purchased within the platform are license protected. If you wish to upgrade an existing license with a new module, click Upgrade and follow the on-screen instructions. For example: if your installed MR3 software license includes myoMUSCLE module and you need to add video data analysis, you must upgrade your license to add the myoVIDEO module.



A License ID is pre-populated by the initial activation when installing the software. Change this only if instructed by a Noraxon customer service engineer.



Click on OK to continue.

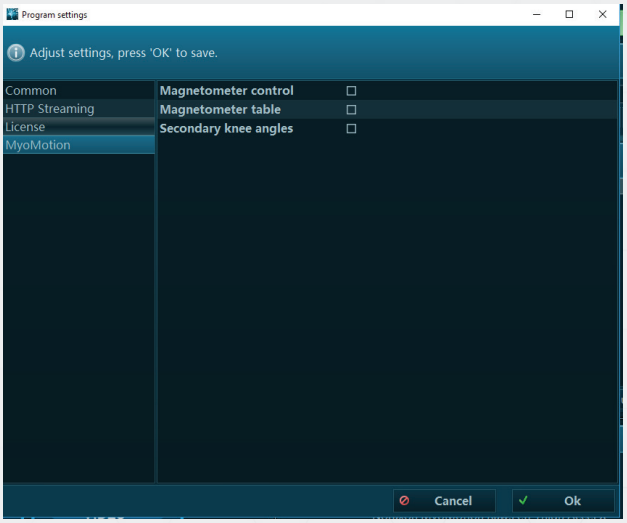


Several options are available now to activate your software.

The easiest way is to connect the PC to internet and use **Activate by internet** option. Alternatively, if you are unable to activate by internet, you may request activation via e-mail by contacting support@noraxon.com and providing them with your activation ID. They will either provide you with a text file or a large activation code. If you receive an activation code, copy it to your clipboard and select **Paste from clipboard** to load it into MR3. If you received an activation file, select **Load activation** file and choose the file provided to you.

myoMOTION Software Module

This section is only operational for the MyoMOTION 3D inertial sensor system. Ignore it in case of using EMG only.



NOTE: All 3 of the following functions are meant to be used by inertial sensor specialists only! They require a deeper knowledge of inertial sensor technology and kinematic application

Magnetometer control	when checked, the right tool bar menu of the measurement screen will receive a new button: Magnetometer On/Off. It allows you to manually control the magnetometers of all inertial sensors.
Magnetometer table	when checked, a table will be shown in right tool bar of myoMOTION measurement screen. These data show the magnetometer vector magnitude and dip angle with their delta values related to the given overall weighted mean value.
Secondary knee angle	this option allows you to switch the knee joint from 1D (Flexion – Extension) when unchecked, to 3D (plus rotation and varus/valgus) when checked. **Note:** the latter two angles are heavily influenced by sensor fixation techniques and temporary soft tissue motions with a given activity.

Section 3: Software Navigation Overview

The Main Navigation Bar

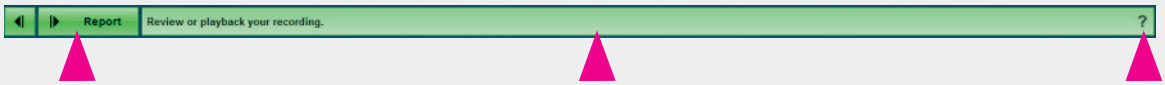
On top of the software screen there is a software navigation bar that visualizes the work flow of a typical recording from the Home screen (start) to Report (analysis):

The tab/menu you are currently operating in is highlighted with an orange color and bright background. This navigation bar allows you to directly “jump” into a certain menu if needed.

NOTE: Some menus can only be accessed from the previous one in work flow, i.e. a record can only be viewed (Viewer Tab) if a record was selected in the previous Database Tab.

Main Operation and Instruction Bar

Indicated by a green color, this bar appears at the top of the software screen underneath the navigation bar. On the left side of this bar is the main operation button in bright green. MR3 is designed so that by pressing this button you automatically operate the next logical step in the work flow. Please read the short instructional text to the right of the operation button to learn which steps or options are available or necessary to continue to the next step.



Operation button

Instructional text

Help button

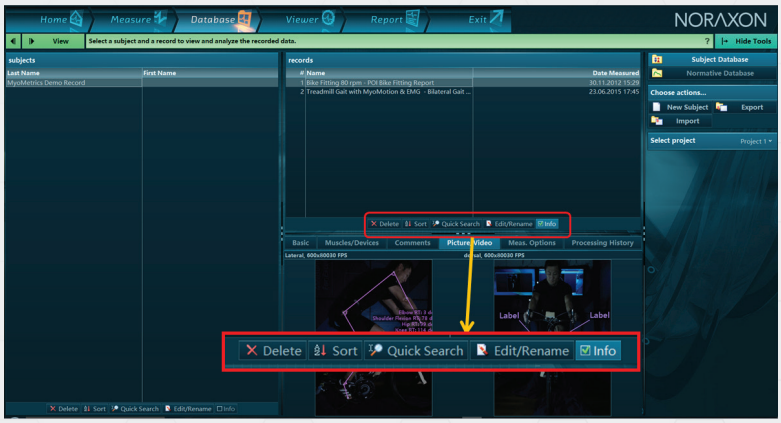
The question mark "?" to the left of the tool bar is the Help button. When this button is pressed, a pop-up dialogue box will appear with information about the currently displayed tab in the software.

Tool Bar

MR3 offers a set of optional tools to adjust or fine tune certain selections, operate menu specific options, or apply optional processing steps to your records. At any time, the Tool Bar (located on the right side of the screen) can be opened or closed with the Hide Tools or Show Tools button on the right side of the green instruction bar.

Local Menu Element Controls

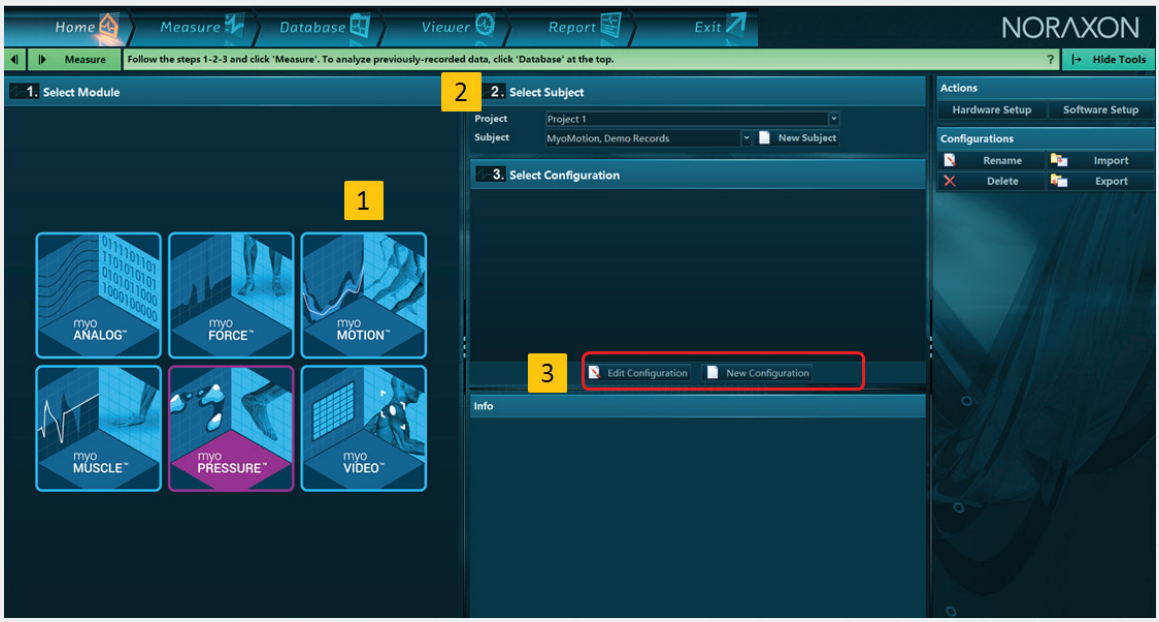
Each menu consists of a set of menu elements, which are equipped with a set of local control tools. You can use these local tools to perform element specific selections and operations as shown for the Database Menu:



Section 4: Home Tab

Introduction

The Home screen menu consists of 3 sub steps that allow you to select a measurement module and select or create a subject and measurement configuration. To do this, simply perform steps 1 through 3 on the Home screen:

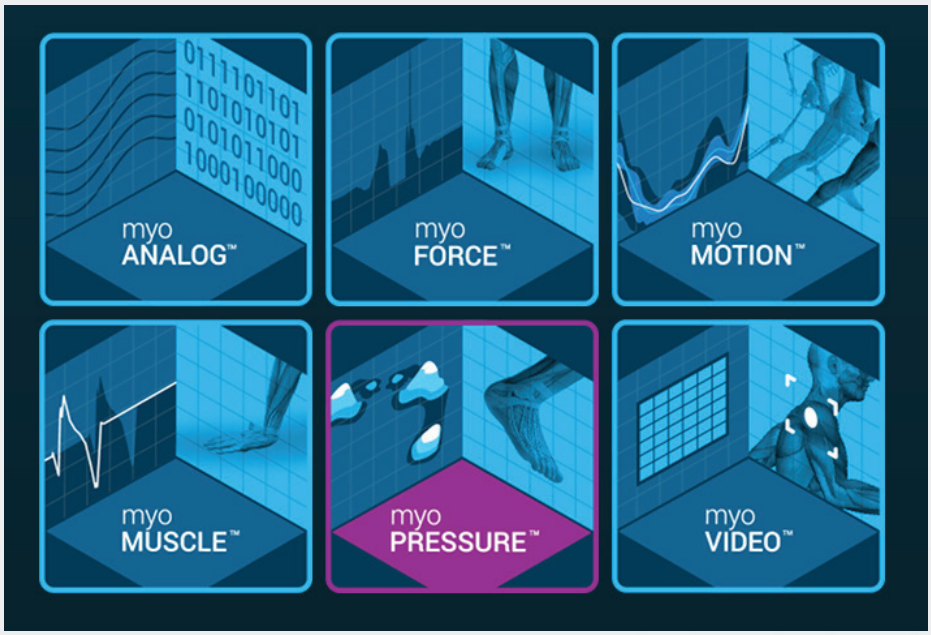


Select a Module

MR3 is multi-functional software that can operate numerous sensors and devices. Each of these can function as a stand-alone device or module or be used in combination with each other. Step 1 allows you to select the module you would like to use for the measurement. The Modules are:

- myoMUSCLE, for EMG recording
- myoMOTION, for 3D motion analysis
- myoPRESSURE, for integrated foot pressure analysis
- myoVIDEO, for 2D motion capture
- myoFORCE for 3D force plates/jump testing
- myoANALOG for typical use of Noraxon's AIS AD board

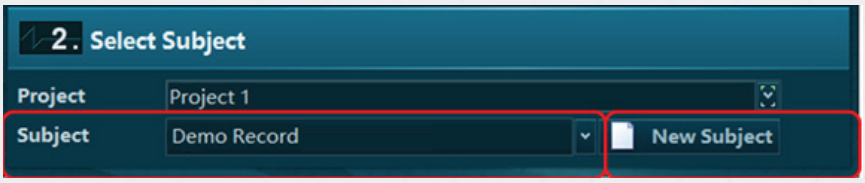
Modules become available once they are purchased, licensed, and unlocked by the user.



For this section select myoPRESSURE as the measurement module.

Select or Create a Subject

Each record will be saved under the subject. There are an unlimited number of subjects that may be saved to the MR3 database. Subjects may be selected from the drop-down menu in step 2. Next to the drop-down menu is also the button to create a new subject.



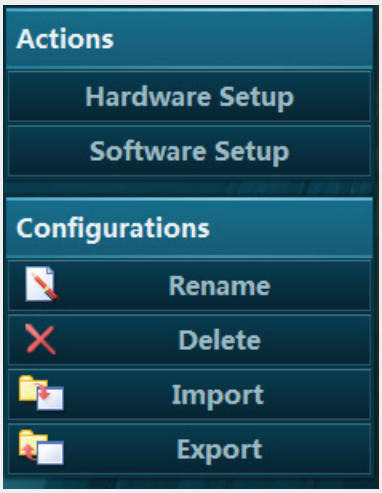
Note: Subjects are saved under Projects. A Project may be selected using the down arrow. Projects can be created, renamed, or delete under the Database menu.

Select or Create a Configuration

Next the user will select, edit, or create a new configuration. Please see the next section for details on Measurement Configurations.

Right Side Tool Bar

Each tab will have different tools available in the tool bar. For the Home tab, the tools are described below.



Actions

This section includes the **Hardware** and the **Software** Setup menus as explained in the previous chapters.

Configurations

Rename	Allows the user to rename the highlighted software configuration.
Delete	This will delete the highlighted configuration.
Import	Use this function to import external configurations to the existing version.
Export	Use this function to export configurations to external locations.

Section 5: Create a New myoFORCE Measurement Configuration

Introduction

1) Click on the myoFORCE module icon.

2) Select an existing subject from the database list (use the small pull-down arrow to see full subject list) or create a **New Subject.**

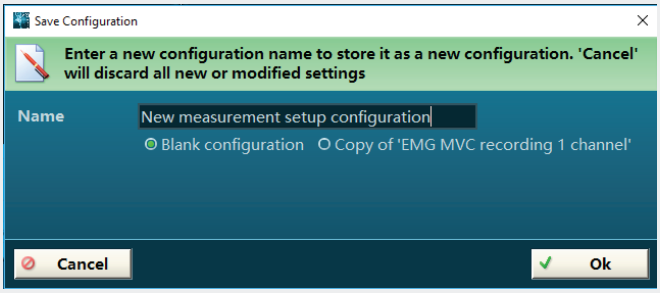
3) Click on **New Configuration.**

NOTE: Clicking **New Configuration** will bring you to the measurement setup menu. New measurement configurations are stored under the selected module under a user defined name and will be listed under the configuration menu.

Clicking Edit Configuration allows already existing configurations to be modified.

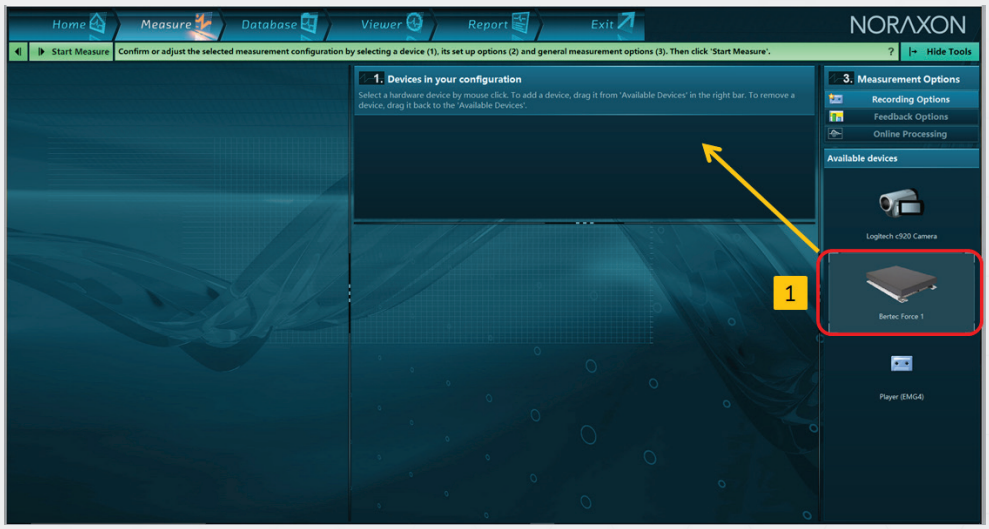
Create or edit a measurement configuration

After clicking **New Configuration,** a small dialog will appear prompting you to enter a name for the new measurement configuration:



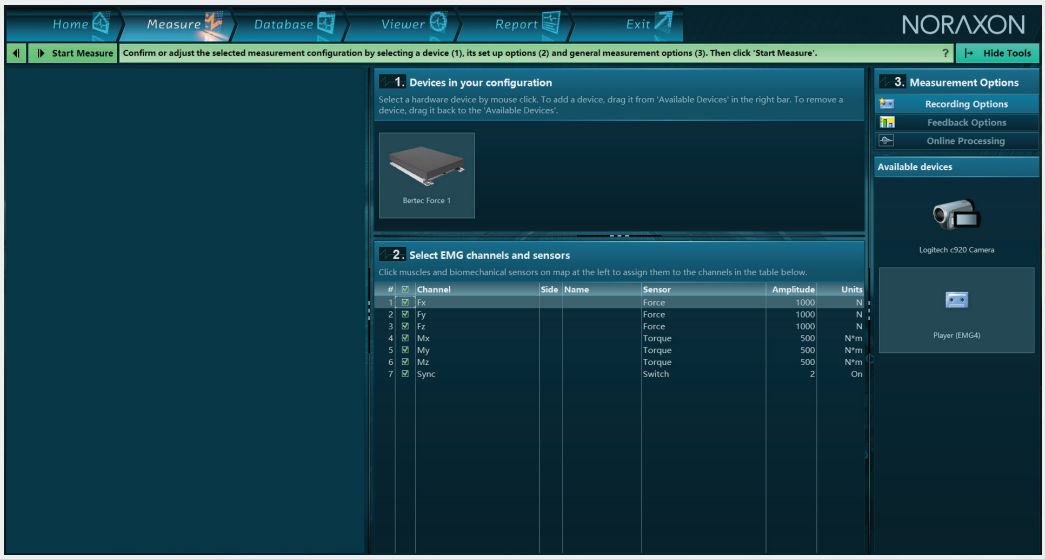
Enter any suitable file name and confirm it with Ok.

The measurement setup screen will appear:

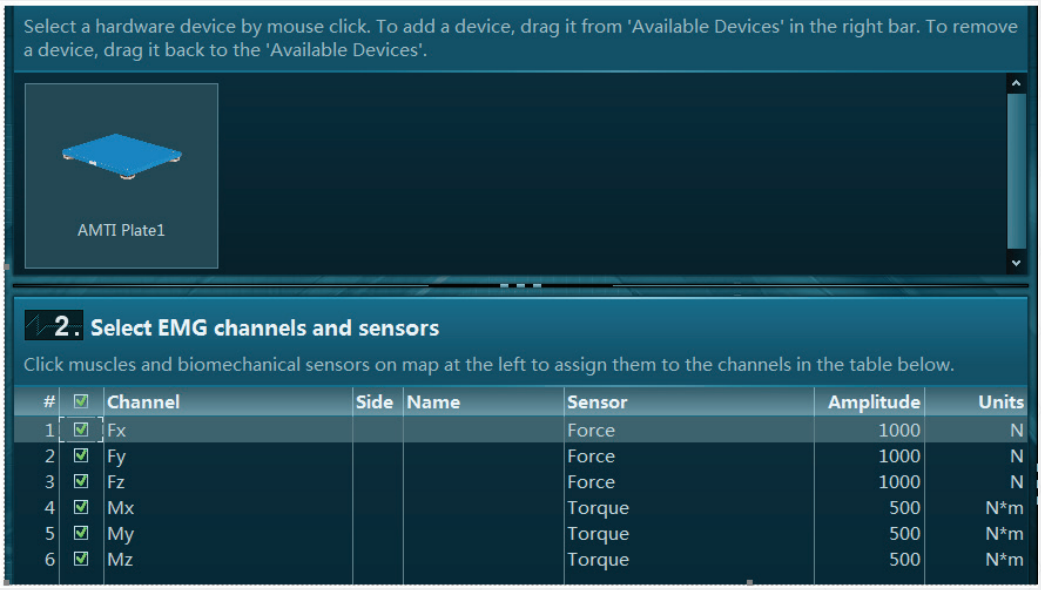


Icon differs in case of AMTI

All measurement/recording devices that were inserted in the initial **Hardware Setup** dialog menu are listed on the right-hand side in **Available Devices**. Click on the Pressure plate system icon and use the mouse to drag it to the section **1. Devices in your configuration**. In section two Select EMG channels and sensors there will be a list of 6 force plate channels plus one sync channel. Check all of them and continue with measure to start measurement.



AMTI shows a similar screen:



Note: the sync channel is optional but helpful if you want to check the validity of this sync channel to other sync channels from other devices.

Amplitude scaling can be changed within measurement but if you want to preset scaling to certain values just enter them in the column **Amplitude**.

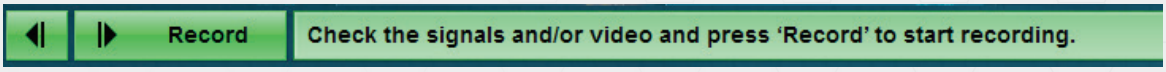
Section 6: Measure Menu

Make sure that the force plate is unloaded and Start Measure button to continue to the measurement screen. The plate is auto-calibrated to zero.

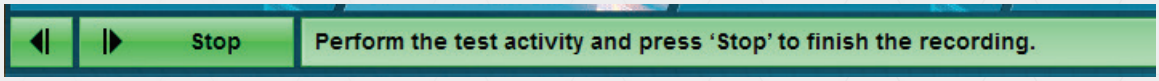
If the baseline amplitude value is not at zero level please click “Calibrate Baselines” in the right tool bar to correct zero line offsets.

Recording Measurements

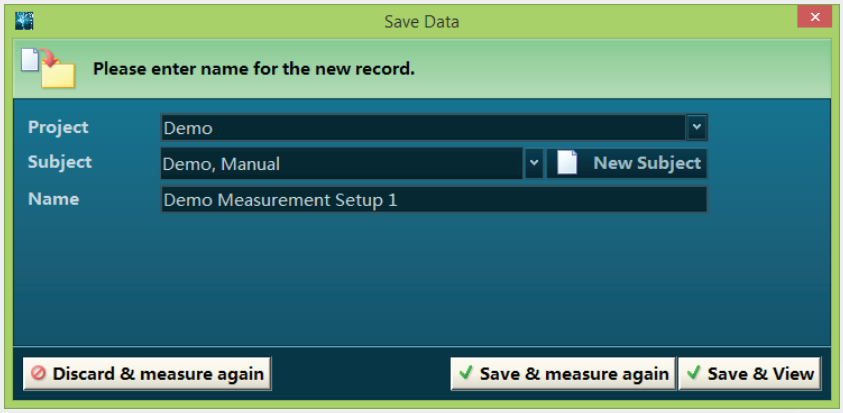
The system is now ready to take measurements. Any ground/plate contact made by the test subject will be animated by the 3-D isobar graphs in real time.



To start a recording press Record, perform the desired activity and press Stop:



The Save Data dialog will appear and a **Name** can be entered in the third line:



The second line **Subjects** allows the user to change, create or confirm the previously selected subject name. The first line **Project** allows you to select another project. After pressing **Ok**, the record can be reviewed in the record **Viewer**.

Discard &measure again	Deletes the current recording and goes back to measure.
Save & measure again	Stores the current recording under entered name and goes back to measure.
Save & View	Stores the current recording and goes back to the Record Viewer.

Screen Layouts

For multi-device setups, it may be helpful to use the customizable screen layout system of the Measure menu. The layout system is explained by using a multi-device setup including myoPRESSURE pressure analysis, myoMOTION 3D motion analysis, and myoMUSCLE EMG analysis.

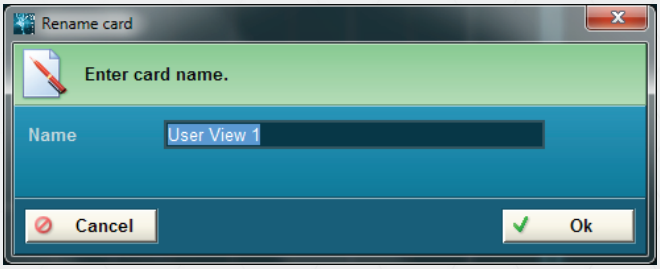
Generally, each device will have its own specific tab:

The myoMOTION software module can receive up to 3 tabs:

- Anatomical angles
- Orientation angles
- Accelerations

Any signal from any signal tab section can be dragged into any other existing device tab or into the empty "+" **Tab**.

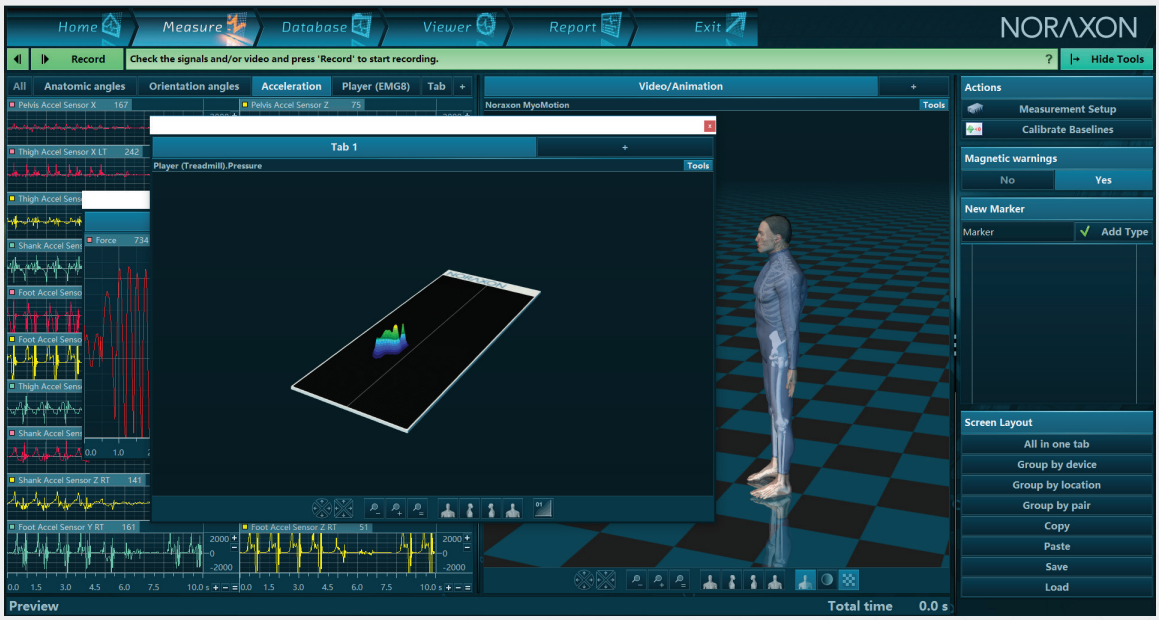
At any time, any tab can be renamed by right-clicking on the **Tab Name.**
A new dialog box will open:



Just enter any new/suitable name for continues use.

This screen layout system allows the user to create as many signal selections or new user views as needed. A similar system is available for the **Video/Animation** window:

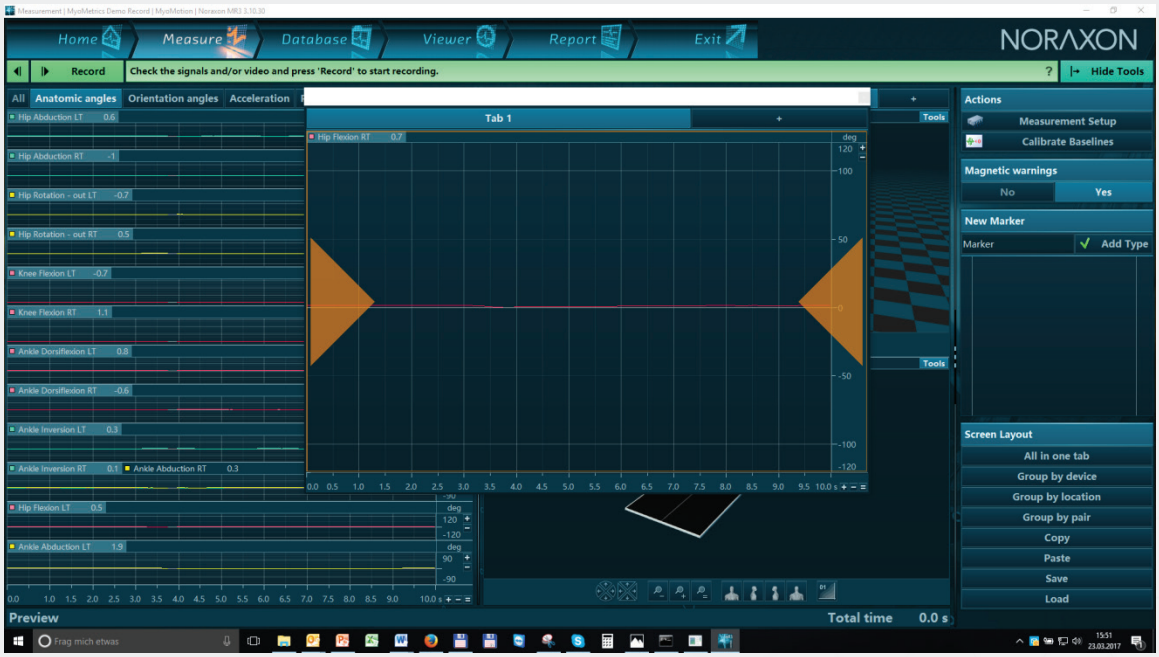
Double clicking on a given signal name moves this signal into a pop-up window:



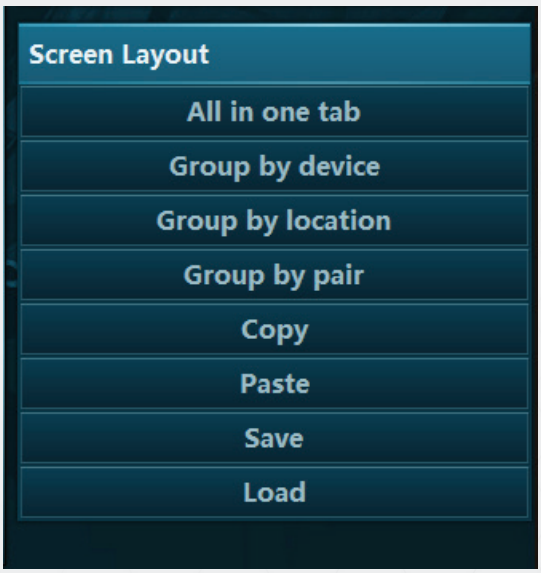
The small red X button in the upper right corner of the window title line will close the pop-up window and move back the signal to its original tab location.

If you hold the CTRL key and double click on a second channel title from the source tab you can insert more channels to the pop-up window. This can also be accomplished by simply clicking and dragging windows into the desired tab:

If you click on a channel name and drag it over another channel, orange arrow buttons will appear indicating of you overlay the dragged channel with the existing (arrow points to the middle):

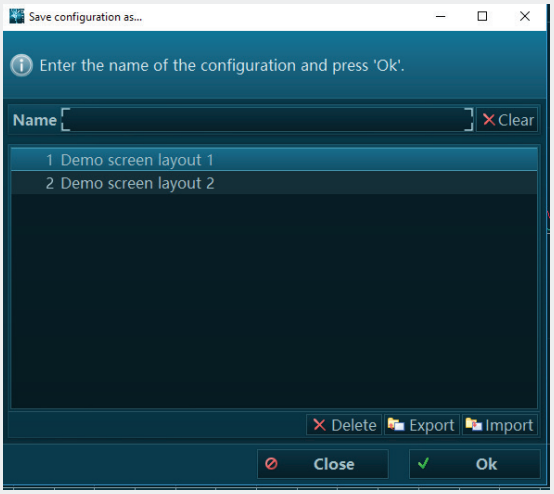


If you want to insert a channel above the existing one, move mouse up until upper arrow shows up. The same procedure works also for dragging channel below an existing channel (arrow shows down).



Whenever a certain screen/window layout arrangement is established you can **Save** it in the **Screen Layouts** section of the right tool bar.

Click on **Save** and enter a suitable name for your channel layout configuration and it will appear in empty space shown below:



To load a screen layout, press the Load button in right tool bar.

Other options in **Screen Layouts** are the following:

All in one tab	all signals from one tab will be shown (again) on one shared screen.
Group by device	each device and signal category is shown in separated tabs (this is the default).
Group by Pair	it will overlay all left and right channels from a given device
Group by location	will overlay all available signal dimensions of a given sensor, e.g. all 3 acceleration signals from the right-side Thigh sensor
Copy	will copy a layout to clipboard
Paste	will paste the selection when needed

NOTE: The channel layout which was setup in the Measurement menu will be the same in the Viewer menu. However, all layout and channel arrangement functions are still available in the Viewer menu as well.

Other Optional Measure Menu Functions

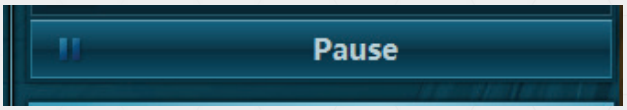
The right tool bar of the **Measurement** menu includes a section titled Actions. This section is only meant to be used for myoMOTION and myoMUSCLE signal screens and is not active (or needed) for pressure distribution measurements.

If EMG or 3D kinematic motion data have been added, the following optional functions are available:

Measurement Setup	directly goes back to measurement setup (configuration) screen.
Calibrate Baselines	this option is only needed if EMG and other biomechanical sensors from the TELEmyo G2, DTS, or Analog Input System (AIS) were included in the recording. For such signals, you may be required to correct zero-line offset shifts via recalibration prior to recording.

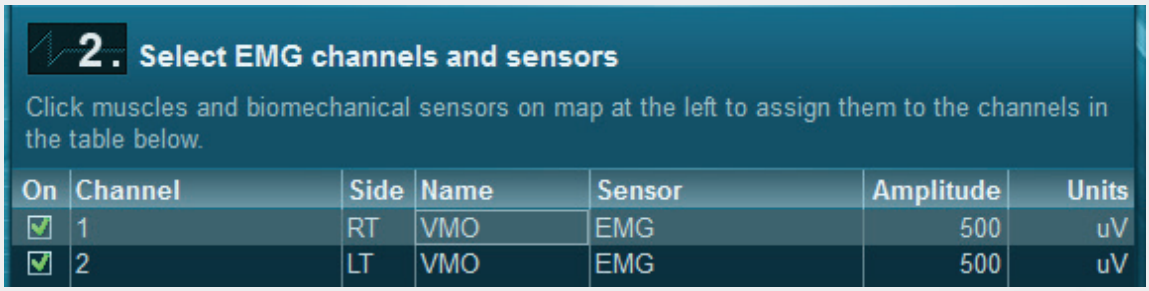
Record	this button is only available in EMG device stand-alone measurements (no other device, video camera included, is measured). It toggles with a **Pause** button.

This button allows you to pause and continue the recording (press right tool bar **Record** button again) so that all recording data are recorded into one file but the pause sections are excluded. To stop the right-side tool bar **Record/Pause** loops, press the green **Stop** button on top left corner.

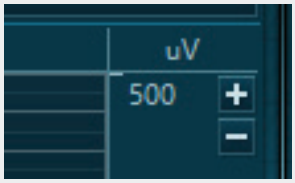


Local amplitude zoom function

By default, the amplitude scaling for EMG and other signals is predefined in the measurement setup column **Amplitude**:



On	Channel	Side	Name	Sensor	Amplitude	Units
☑	1	RT	VMO	EMG	500	uV
☑	2	LT	VMO	EMG	500	uV



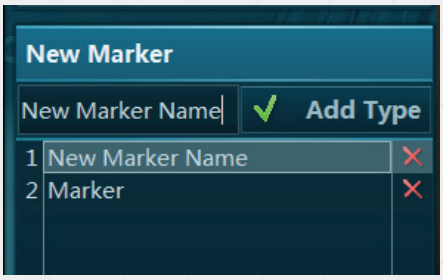
In measurement and recording the given amplitude (Y-axis) scaling can be changed by using the local zoom plus/minus buttons

If you hold the Shift Key on the keyboard and click on the plus/minus buttons, scaling is applied to all measured channels of the same type.

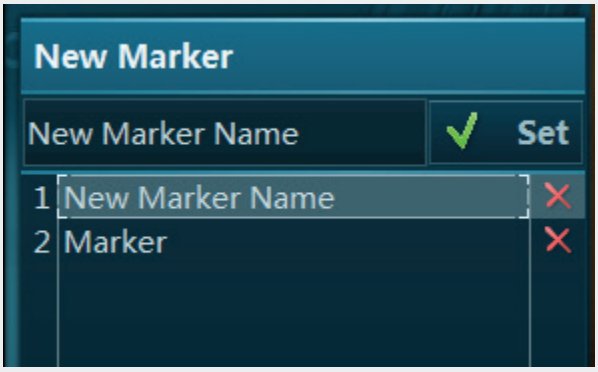
Real Time Marker Menu

With the Real-Time Marker menu, you can create marker names and manually mark or comment on events in your recording.

The default marker name is Marker. If you want to create a new marker name, double click on the Marker name entry box and overwrite the existing one, click the green check mark button, and this new marker name will be inserted to the list of available marker labels:



To use a marker name from the list double click on it (don't use the green Add Type button). To delete a marker from the marker label list, click on the red X right side to each marker name.
As soon as you change measurement preview mode to recording mode (by pressing on the green Record button), the Add Type button will change to a Set Button:

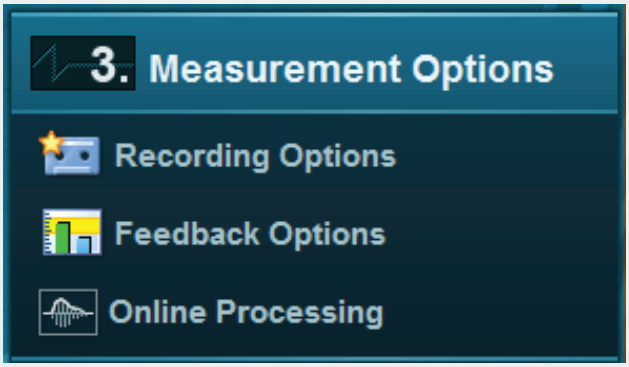


Once recording has started, clicking the Set button will place a marker in the record (displayed in the Viewer menu) as well as provide an audio cue. A successfully placed marker is indicated by a short tone. Alternatively, the space bar can be used to place a marker in the recording.

Measurement Setup/Configuration – Measurement Options

Some additional options to manage, control and operate a measurement are available here. For detailed explanations please look to the chapters below.

On the right-side tool bar are the Measurement Options including: Recording Options, Feedback Options, and Online Processing.



Recording Options:

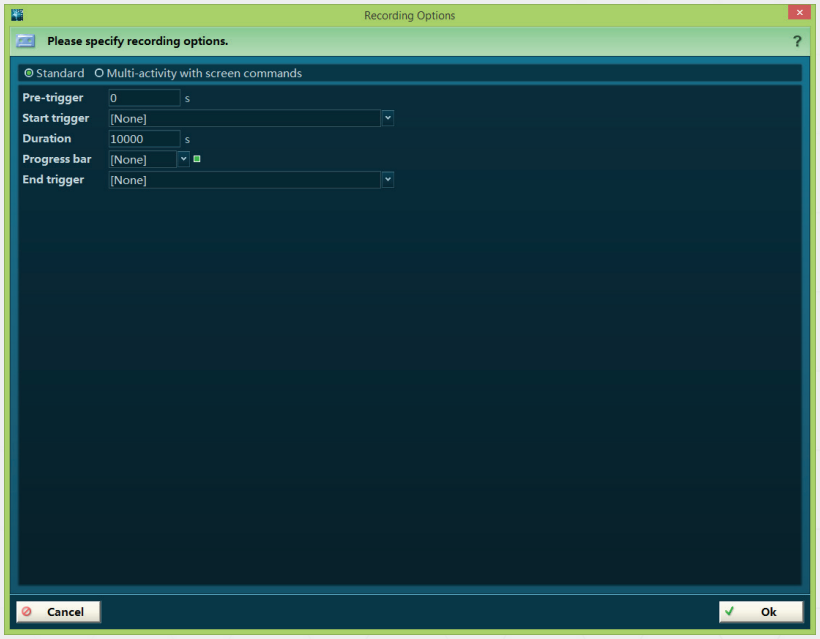
After pressing this option, you can select between two different recording modes:

- Standard
- Multi-activity with screen commands

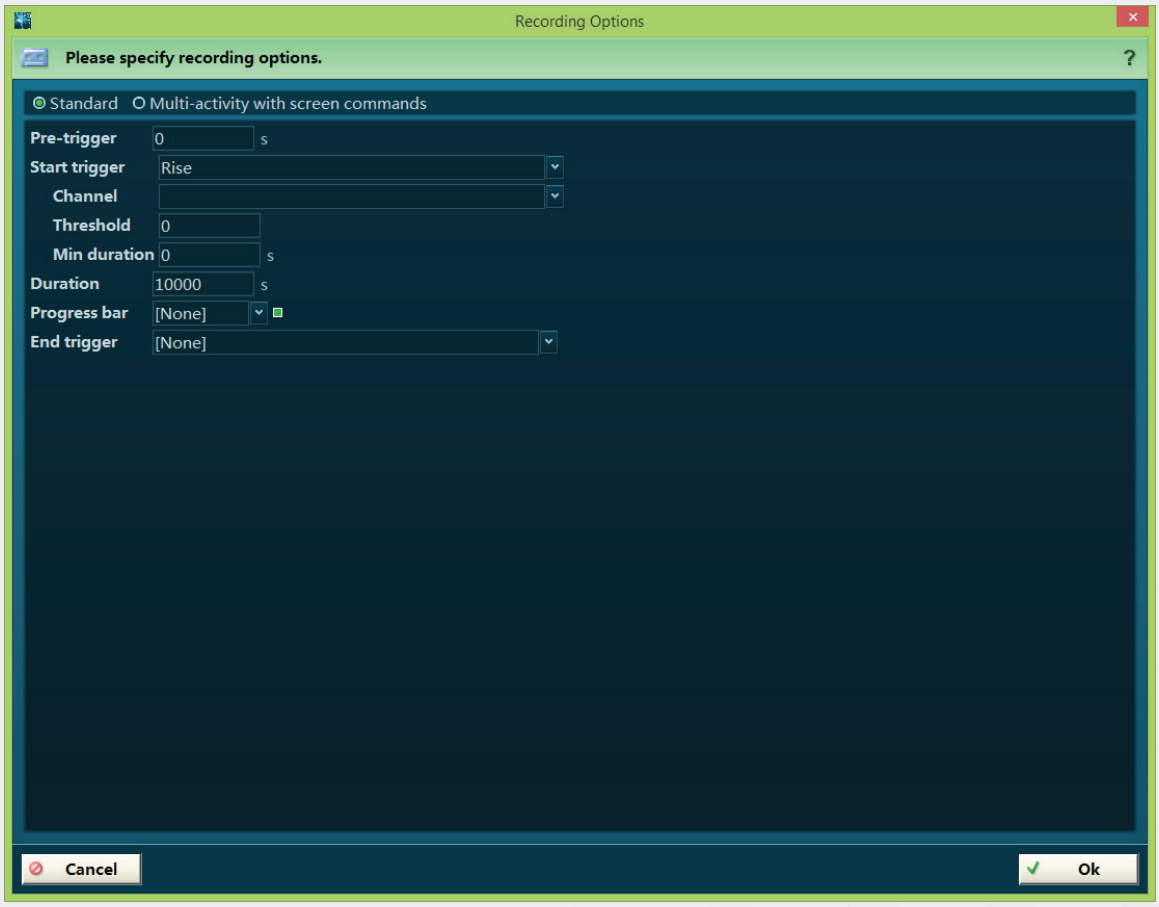
Standard Recording Option:

This sub menu manages Trigger start and Pre-trigger settings.

Pre-trigger	Specifies the recorded portion before trigger is initiated.
Start Trigger	Defines the TTL type: Rise or Fall.
Channel	Determines the trigger channel.
Threshold	Defines the amplitude value that must be exceeded or passed to initiate the trigger.
Duration	Is a predefined time for the overall recording; also works without triggered recording start.
Progress Bar	Activates a progress bar just below the signals screens to indicate the overall remaining time of recording.



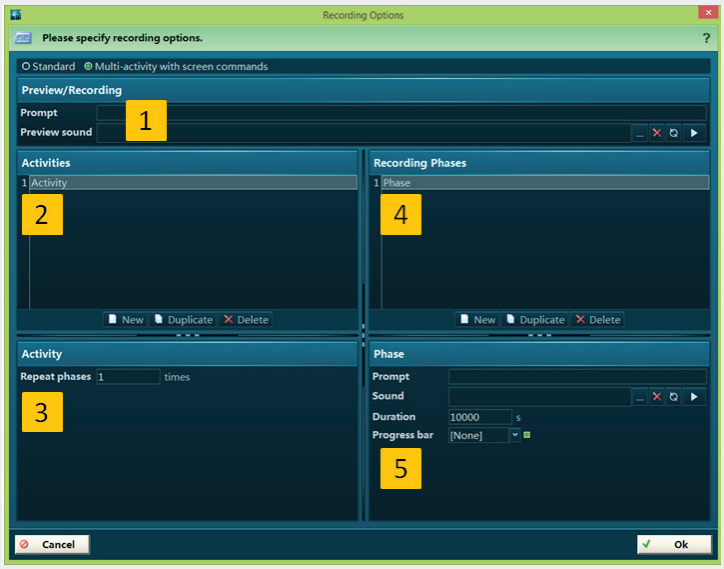
The user can set the recording to have a starting trigger and end the recording by another trigger, or the user can record for a specified duration of time. The triggers are set according to the rise or fall of the signal on the specified channel.



Once the channel is selected, choose a threshold and a minimum duration the channel must stay above to activate the trigger.

Multi-activity with Screen Commands

This menu allows you to create and define screen command assisted recordings containing sequences of test activities. In addition to the screen commands, voice commands can also be integrated. This function is meant to be used for standardized test sequences with predefined activities, duration, and repetitions.



1. Preview/Recording

You can create a screen Prompt and Preview Sound for the "prepare" period prior to beginning recording.

2. Activities

A set of activities can be created here. Each activity again consists of a sequence of motion phases like extension or flexion.

The controls New, Duplicate, and Delete allow you to edit phase operations.

3. Activity

The entry Repeat Phases allows you to repeat the whole activity and its motion phases a selected number of times.

4. Recording Phases

In this section, you can create a set of motion phases for a given activity.

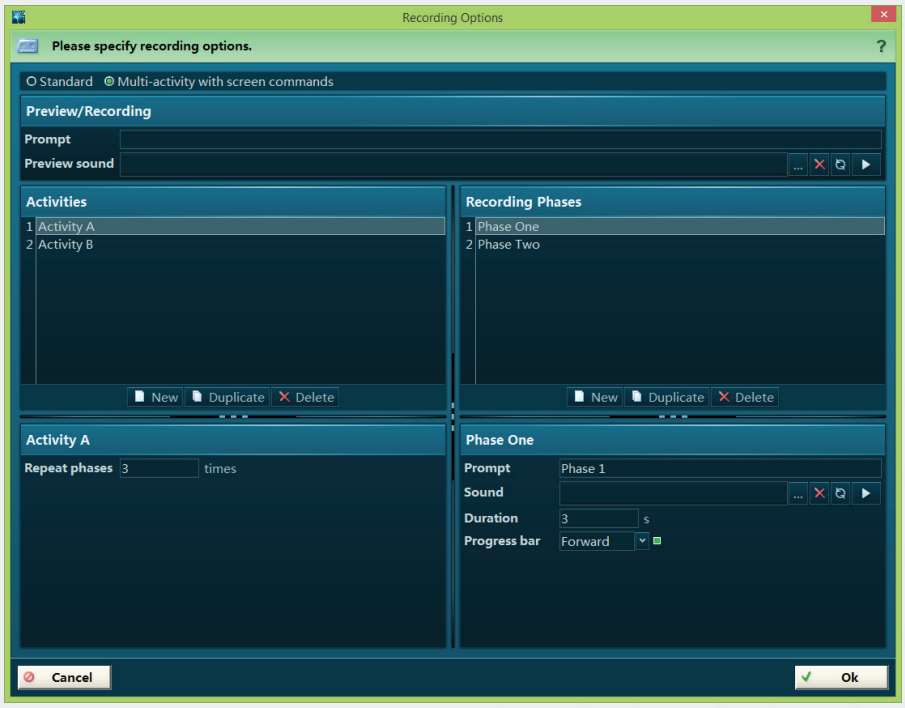
The controls **New, Duplicate, and Delete allow you to edit phase operations.**

5. Phase

In this section, you can define:

Prompt	Screen command for the given phase.
Sound	Sound for the given phase.
Duration	Duration of the given phase.
Progress Bar	Progress bar indicator and its direction.

Setup example:



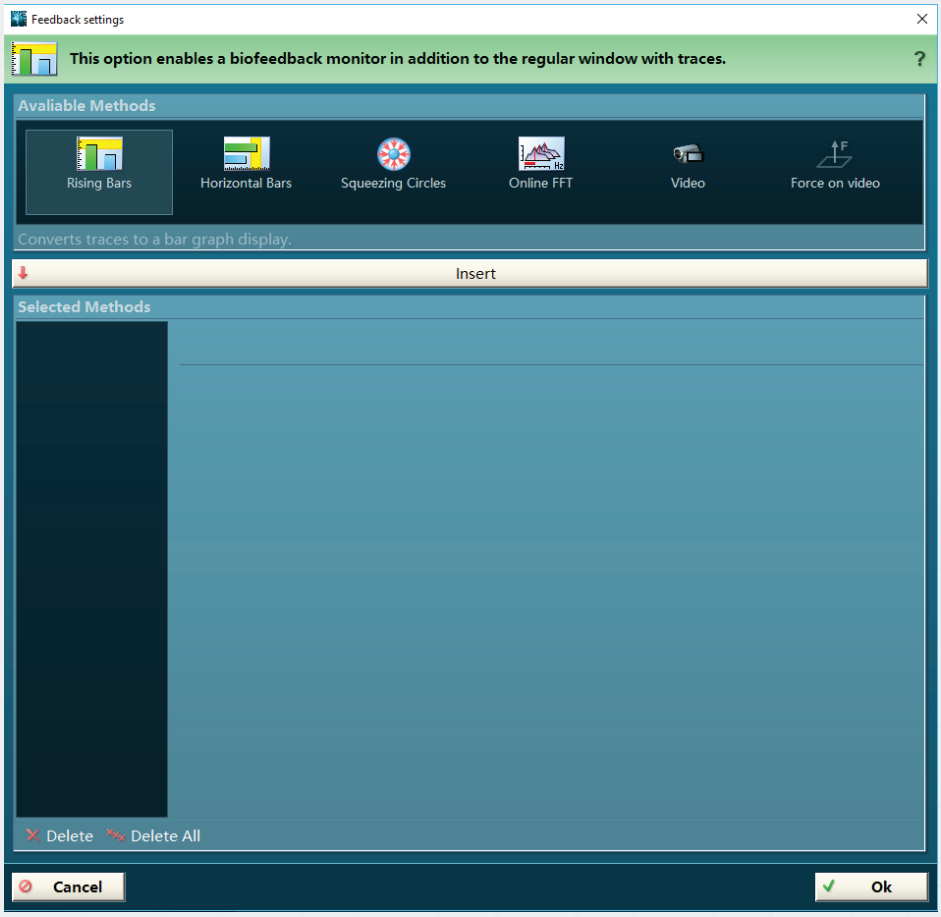
Measurement Screen example:

1. Phase 1	Name of the running phase in setup.
2. Activity A	Name of the running activity, first run of 3 (as defined in Repeat phases).

2. Phase One	Screen prompt of running phase (as defined in Prompt for phase).
3. Progress bar	Forward, as defined for this running phase.

Feedback Options:

Feedback options will convert the signals into one of the three available signals based feedback display options. An additional fourth feedback method refers to video replay.



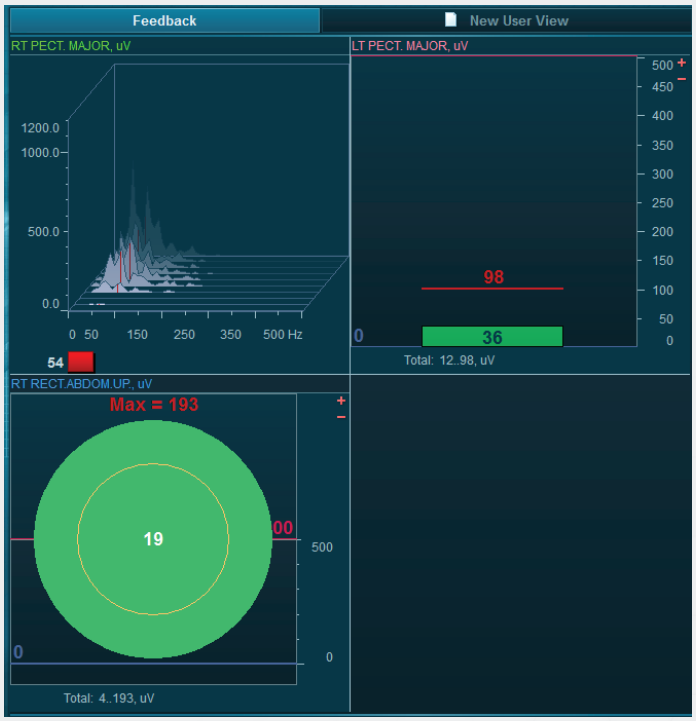
Note: Force on video is only available if MyoFORCE Module was purchased

The signal from any sensor can be used for biofeedback via rising/falling bar graphs, shrinking cycles (designed for incontinence training), or real time FFT analysis via cascading power spectrums.

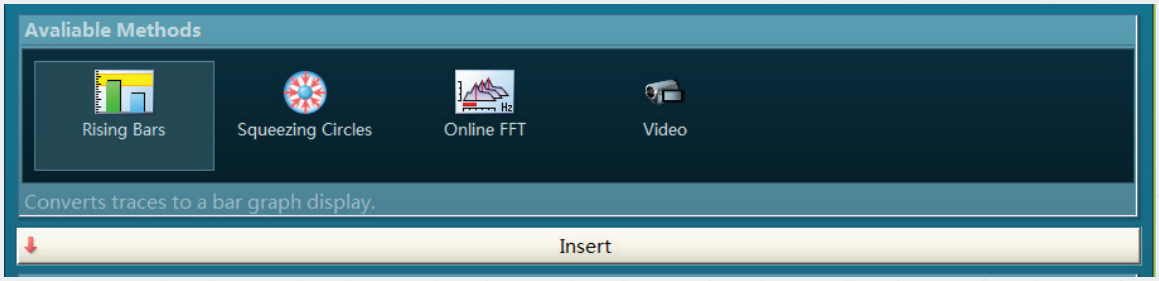
The basic idea of biofeedback is to present the signal amplitudes in easy-to-read displays and threshold ranges to provide a target for EMG activation or relaxation or joint angle movement. Currently two types of biofeedback modes are available: **Rising Bars,** which can be used for general purposes, and **Squeezing Circles**, which is a special signal presentation for pelvic floor muscle training.

The **Online FFT** is a special form of biofeedback because it cannot be directly controlled by voluntary efforts. It displays changes in the EMG frequency during contraction.

This graph shows all three signal related biofeedback modes:



To select a feedback mode, click on it and press Insert to load it to the list of selected operations:



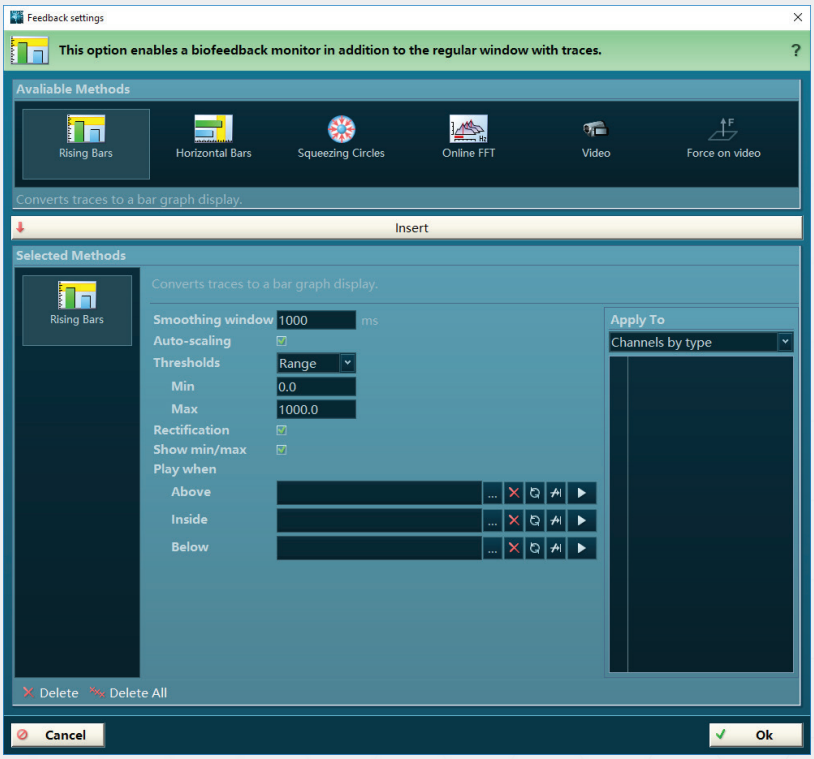
NOTE: Feedback methods can be loaded several times if needed.

Once a feedback option is selected, the settings for that feedback option will be displayed. Here, the user can change options such as smoothing, thresholds, audio cues, and choose which channels to apply the feedback signal(s) to.

Rising/ Horizontal Bars

Biofeedback is used to present signal amplitudes in easy-to-read displays and threshold ranges to provide a target for EMG activation or relaxation, or joint angle movement. Rising Bars can be used for general purposes (for example, "Up" training for EMG innervation)

Horizontal Bars can be used for e.g. left / right rotation angles of MyoMOTION angles and Squeezing Circles, which is a special signal presentation for pelvic floor muscle training.



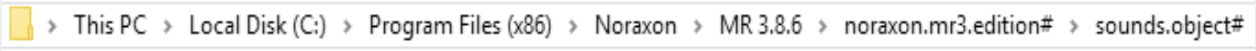
Smoothing Window – Typically, EMG signals are visually highly variable and it may be necessary to "smooth" them in both speed and amplitude.

Use the **Smoothing window** to define a time range to apply a moving average to. Factor that slows down the EMG spikes and makes it easier for the subjects to control the activation within a certain level. This smoothing is strictly a display feature for the bar graph and does not affect the recording and signal processing of the data.

Auto scaling – If active, the optimal amplitude scaling for the bar graph is calculated by the software and used.

Thresholds – Both range threshold and single line/value thresholds are supported. You can add a threshold range to the bar graph display by defining a minimum and maximum threshold range value. The threshold range is displayed as a yellow background area and typically serves as a target area for the EMG activation or amplitude level of any other selected signal type.

The "play when" feature section allows you to set an audio signal to play when the signal is above, within, or below the threshold range/value identified in the Thresholds section.



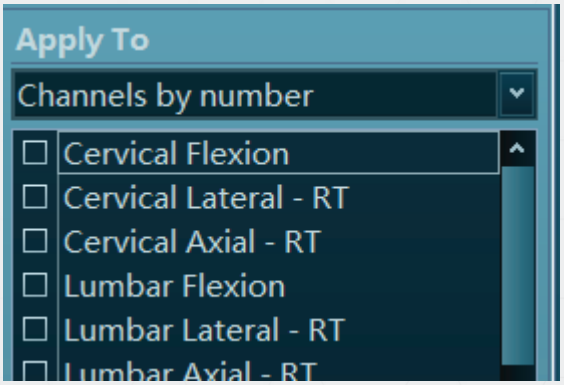
There are several pre-loaded sounds in the Noraxon directory. However, you may upload any sound file you wish by copying it into the "sounds.object#" folder, which can be found via the directory path shown below.

Your sound clips must be in the *.wav file format to be used.

Rectification

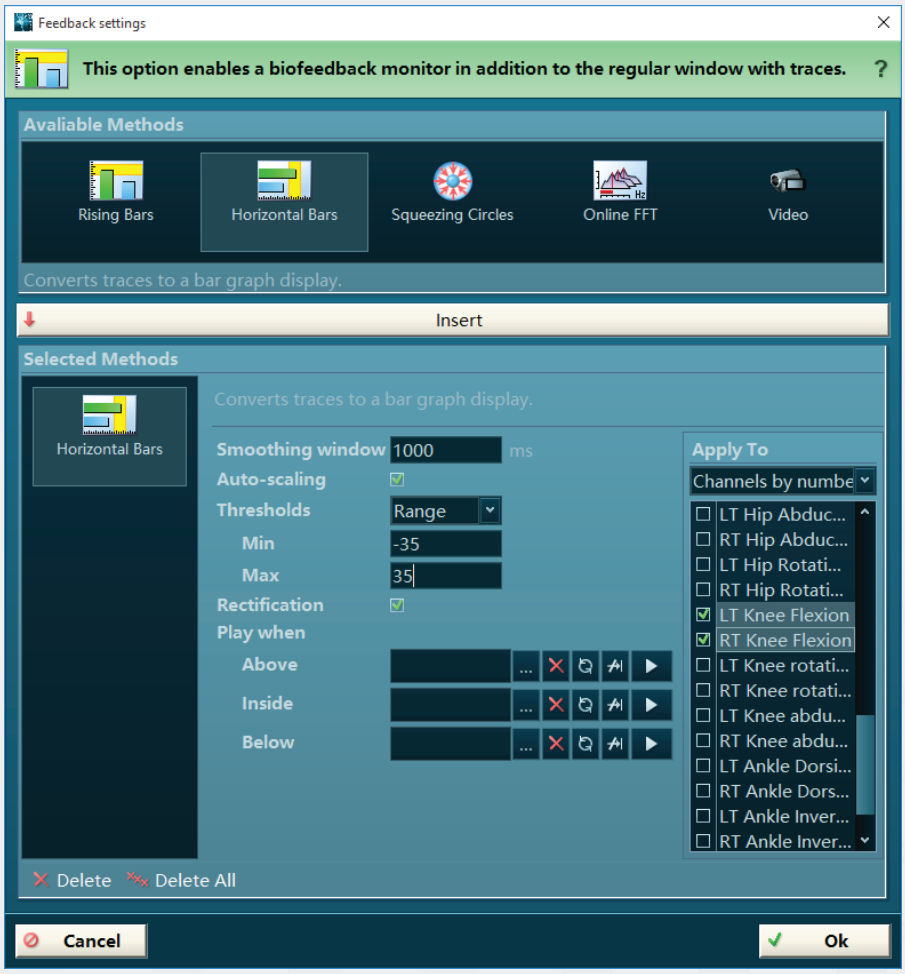
If checked, bipolar signals and their negative portions will automatically be rectified; the bars can only rise from zero to positive values. Uncheck this control if you want to have biofeedback bars move to negative (below zero) and positive range.

Apply To – This control allows you to activate (enable) the biofeedback display for a given channel type or a physical channel number. To access specific channels, use the small down arrow on the right side to change from Channels by Type to Channels by Numbers.



Horizontal bars

For some signals, like MyoMOTION trunk lateral flexion to the left and the right side, it may be more appropriate to use a horizontal orientation of bars.



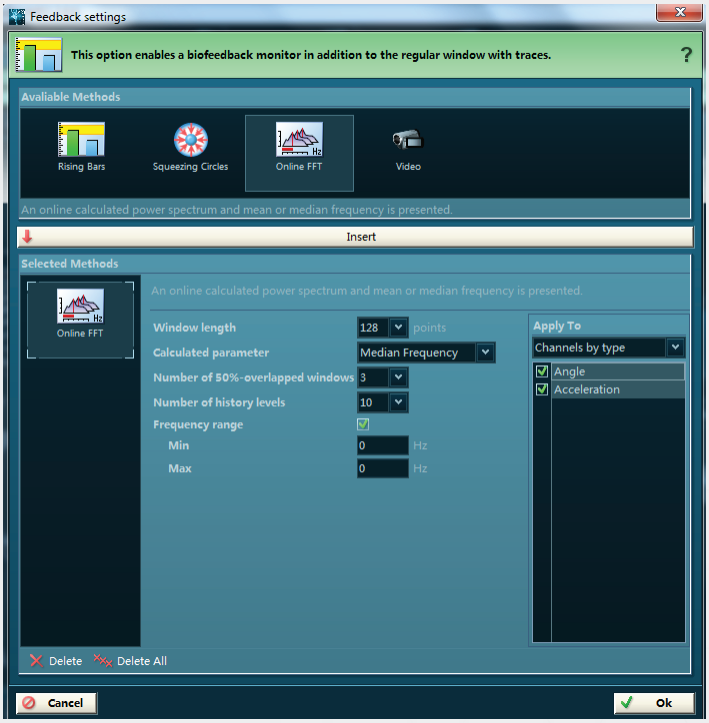
The setup menu for horizontal bars is the same as for Rising bars.

Squeezing Circles

This feedback type has the exact same functionality as the Rising Bars described above. The only difference is that any amplitude increases or decreases the diameter of the circle. This feedback style is designed for pelvic floor training, e.g. incontinence training, and should reflect the contraction of vaginal or anal muscle rings.

Real Time FFT

A real-time frequency analysis is performed while monitoring/recording the data. Depending on the FFT window length, there will be a brief time delay for this calculation.



Calculated parameter	You can choose between the mean and the median frequency.
Number of 50%-overlapped windows	The amount of window overlapping can be specified here. This switch has a smoothing effect in the FFT display.
Number of history levels	This number defines how many power spectrums are shown in the cascading window.
Apply to	The real-time FFT can be applied to channel types or selected channel numbers.
Window length	This is determined by the number of data points used for the FFT, anywhere from 62 to 4096 data points are supported. The calculation time will increase with increasing number of data points.

Video Feedback

With this option, you can select a video clip and let it play whenever the threshold criteria are fulfilled. If the signal leaves the threshold range video play was assigned to, it stops playing and will continue as soon as the signal reaches threshold range again.

Force on Video

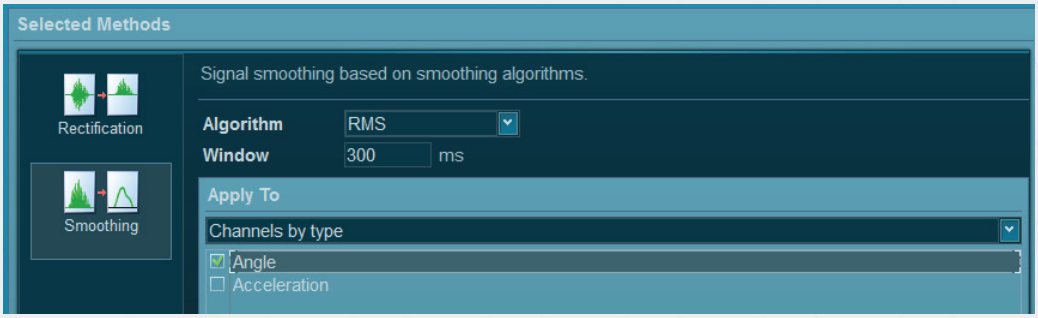
Attention: not compatible with the myoMUSCLE software

This feedback mode was designed for 3D force plates and it creates a force vector /video overlay.

Real Time Processing

Real time processing is identical to the Signal Processing menu in the record viewer menu. As the name indicates, all processing is operated in real time while data are recorded. This function can be very helpful in certain feedback tasks (e.g. training subjects in real time or simplifying the recording and analysis process via automated real time processing).

For more information please check the Record Viewer / Signal Processing chapter below.



Online Processing

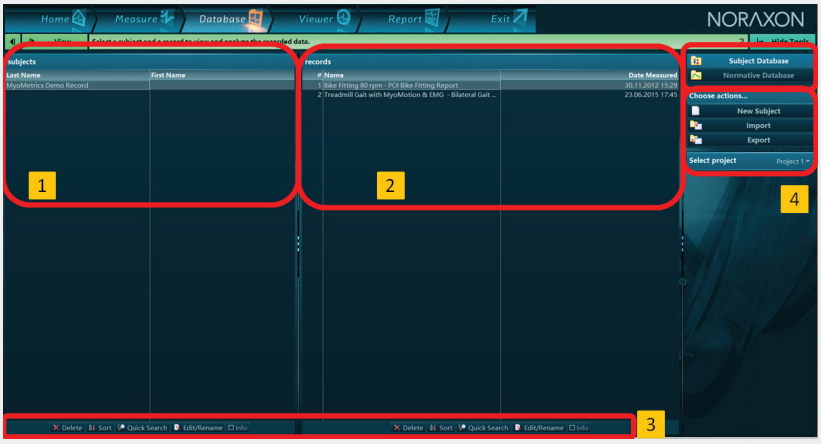
Real time processing is identical to the Signal Processing menu in the record viewer menu. As the name indicates, all processing is operated in real time while data are recorded. This function can be very helpful in certain feedback tasks (e.g. training subjects in real time or simplifying the recording and analysis process via automated real time processing).

For more information please check the Record Viewer / **Signal Processing** chapter below.

Section 7: Database Tab

Introduction

As indicated by its name the **Database** tab manages all functions around data file management, like selection, editing, exporting and importing.



1. Lists Section Subjects
2. Lists Section Records
3. Local List Functions
4. Right Tool Bar Menu

1 & 2 – List sections

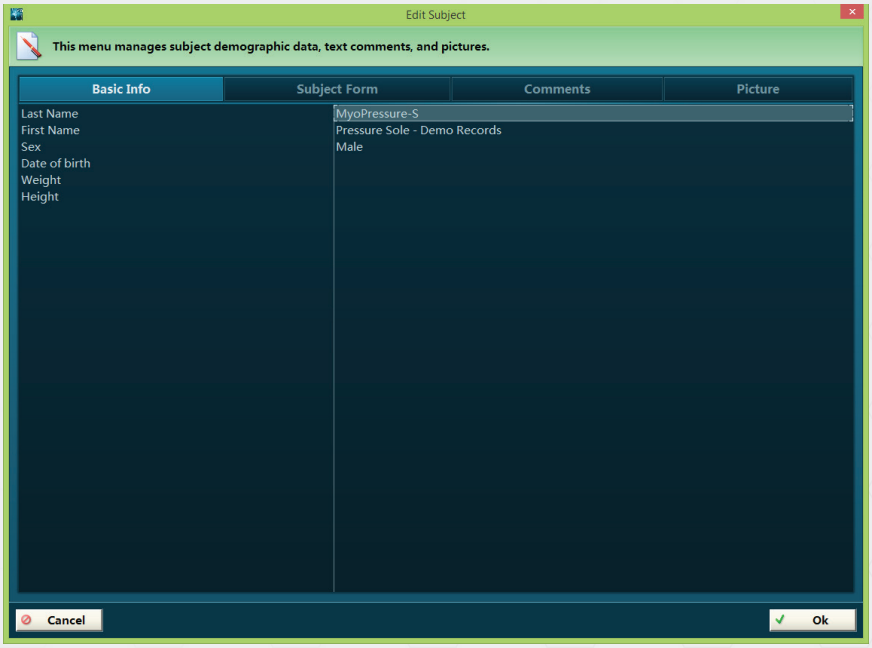
The screen is split into two sections, reflecting the organization of records into Subjects (left list section) and Records (right list section) stored under a given subject name.

3 – Local List Functions

Below each list is a set of list functions:

Edit/Rename	Here you can change the subject name and add additional information associated to your subject such as subject properties, comments or pictures
Delete	Here you can delete your subject and all records stored under this subject **Note:** deleted subject data and records cannot be restored.
Quick Search	If you have a very large database it may be helpful to use a search function to quickly find a certain subject
Sort	This entry allows you to sort your database by first or last name in ascending or descending order
Info	If this button is pressed/box is checked, the subject properties window with Basic info, Subject form, Comments and associated pictures is permanently visible

The info section of subjects contains a set of register cards management associated information around the Basic subject information:



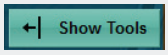
Double click on any of them to open a Window mode to view and edit subject properties:

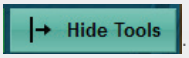
Basic Info	This tab section contains basic subject information like Name, Sex, Birth date weight and height
Subject Form	This is an expanded list of patient properties and data.
Comments	Here you can enter or edit patient comments. It is possible to use a text clip system and/or paste text from Clipboard
Picture	Here you can enter a subject picture by pasting it from Clipboard or loading a picture file from the Hard disk

A similar set of list functions is available for the records list screen as well. The record Info button ☑ Info shows important record property details:

Basic	A summary of basic record properties like file name (editable), size, date, duration etc.
Muscles/Devices	Only for EMG and sensor records, shows a list of selected sensors
Comments	Each record can receive a record specific comment which can be created or reviewed here
Picture/Video	This info tab is very helpful if you have recorded data together with video. The first picture of the video is shown here to help you find and identify a record
Meas. Options	Not activated yet
Processing History	In case any signal processing was applied to your original record, all processing steps are documented here

4 - Right Tool Bar Menu

If you click the 

button on the right side of the green instruction bar, the Database Tool bar will show up. To remove, click 

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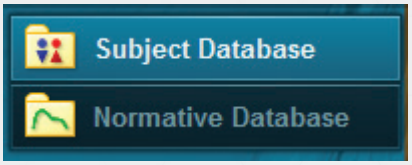
Besides the Subjects Database there is another database section called Normative Database



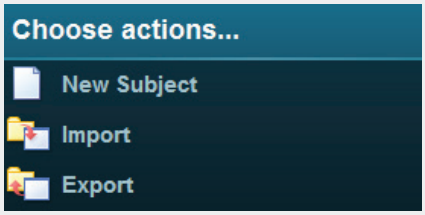
It contains all normative data records that were compiled via the “Add to Normative” function within the Report Menu (see chapter report).

All database functions described below are also available for normative records.

Note: The normative sample file “Natural floor gait reference curve” is not meant to be used for any medical diagnosis or similar purposes. It only serves as an educational example on how to use or operate normative data.

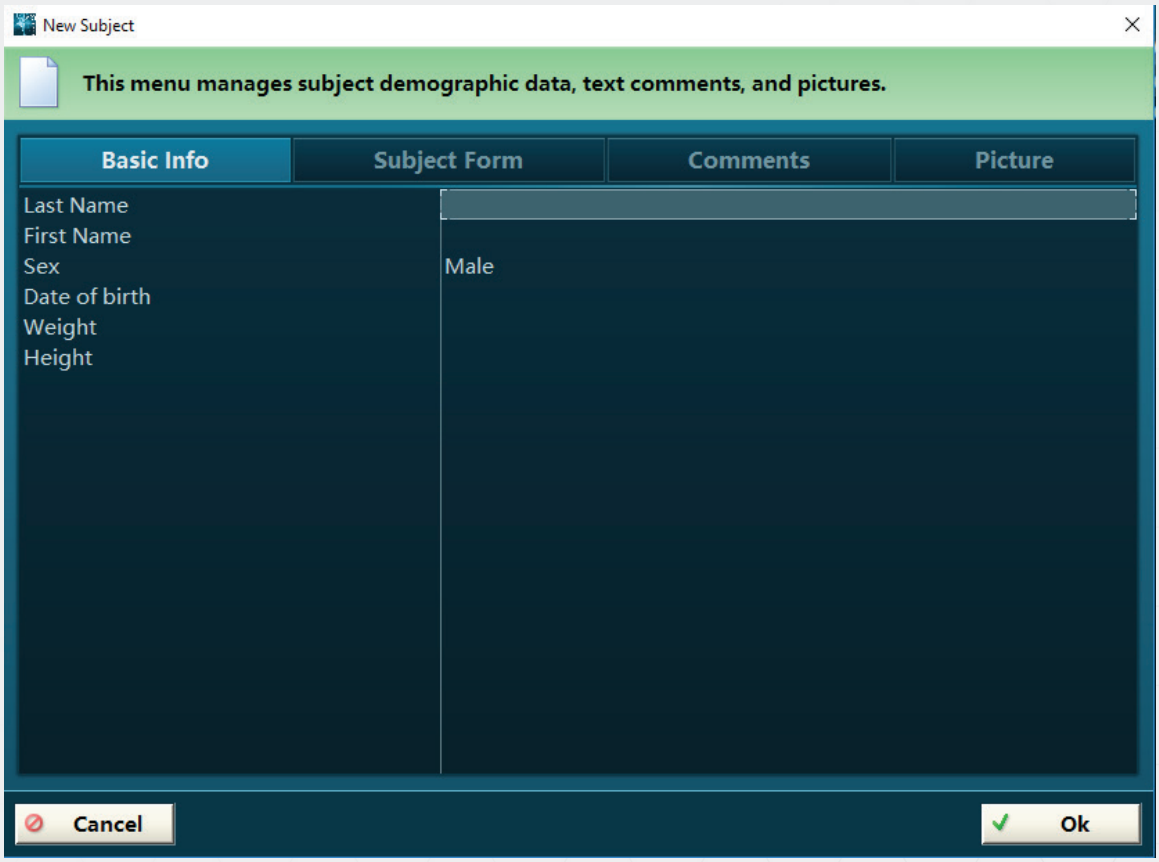
Choose actions

In the **Choose actions** section you can create a **New Subject** and **Import** or **Export** subjects and records.



New Subject

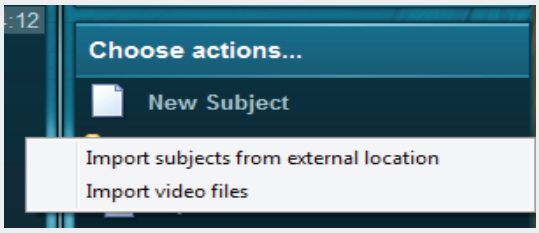
By selecting **New Subject** you can create a new subject in your database. When selected, a sub menu similar to the Subject properties / Edit screen opens:



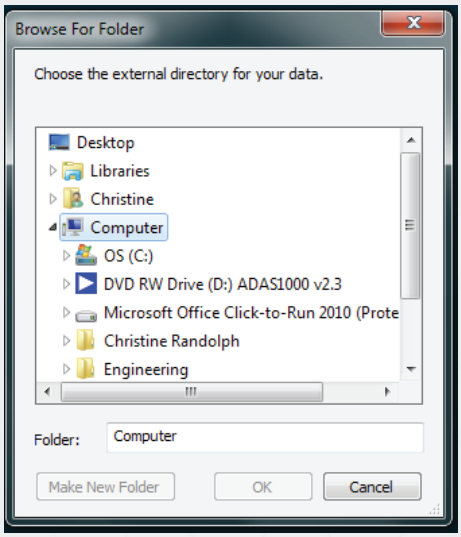
The minimum information to be entered is the Last Name; any other entry is optional. If needed, Basic Info, a subject form, comments or picture can be added.

Import Records

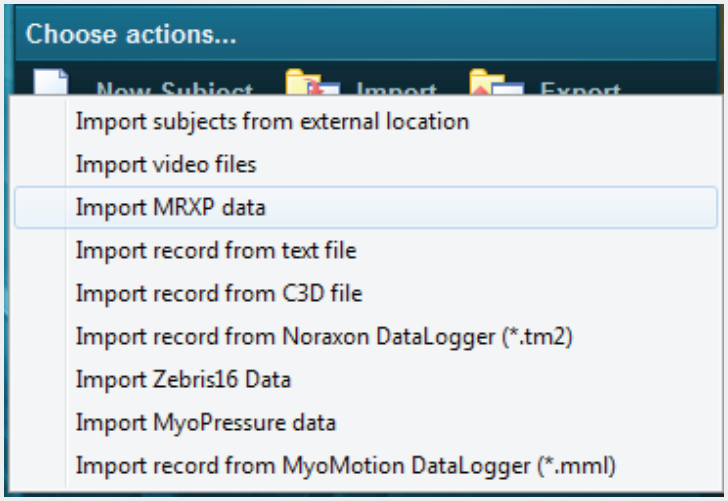
You can import records from external locations such as a previous version on your PC, backup data from external hard drives or network folders:



To import myoMUSCLE EMG or multi-device records select Import, then Import subjects from external location and set a path to the external directory (e.g. a net drive or external hard disk directory).



Other import options include:



Import video file	Externally recorded video files in avi format can be imported
Import MRXP data	Import of records from the outdated myoRESEARCH XP (version MRXP)
Import record from text file	Imports Ascii or txt formatted records. Attention, only MR3s ascii data or similar arrangements are supported (see export file to ascii)
Import of C3D file	C3D format used by most Motion capture companies is supported and allows for import of kinematic, force and EMG data recorded there
Import record from Noraxon Datalogger (*.tm2)	Data logged files from the Telemyo G2 and Telemyo DTS belt receiver can be imported here
Import Zebris16 Data	Imports pressure data recorded with Zebris old 16Bit systems (FDM, FDMT)
Import myoPRESSURE data	Data recorded with the myoPRESSURE Software from Zebris can be imported here
Import record from MyoMOTION Datalogger (*.mml)	Imports data recorded with MyoMOTION inertial sensor data logger

Export Records

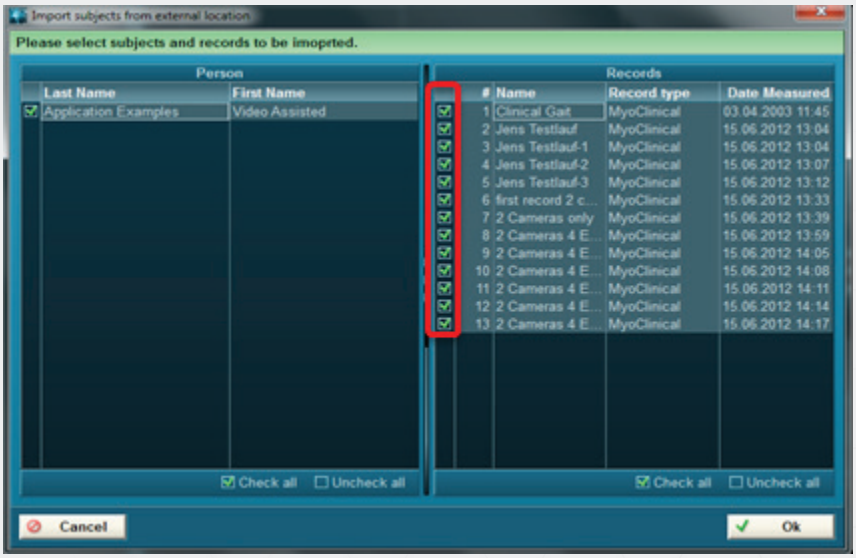
You can export MR3 records in their native format to an **External location** on your PC, or to another Subject or Project within your running version:

Export to external location	Exports your chosen subject from MR3 to another location outside of MR3
Export records to another subject	Allows you to copy a record from one subject directory to another inside your myoMUSCLE version
Export subjects to another project	Allows you to copy a record from one project directory to another project directory inside your MR3 version

Other supported export formats are listed in this table:

Export record to text file	Numerical Data (signals) can be exported to ascii compatible format
Export to CSV file	Numerical data can be exported to Excel compatible CSV format
Export record to C3D file	Numerical Data (signals) can be exported to C3D format
Export record to Excel (.slk) file	Numerical Data (signals) can be exported to excel compatible SLK format
Export record to MatLab file	Numerical Data (signals) can be exported to Matlab format
Export pressure data to XML	Export of pressure data to XML (access to all single cell data of each step)
Export myoMOTION data to Biovision BHV	Export of myoMOTION data (full body required) to BHV
Export Medilogic data to CSV	Export of Medilogic foot print data to CSV

The following menu dialog allows you to select subjects and records:



Just use the check or uncheck controls to select the desired subjects and records shown in the list and click OK.

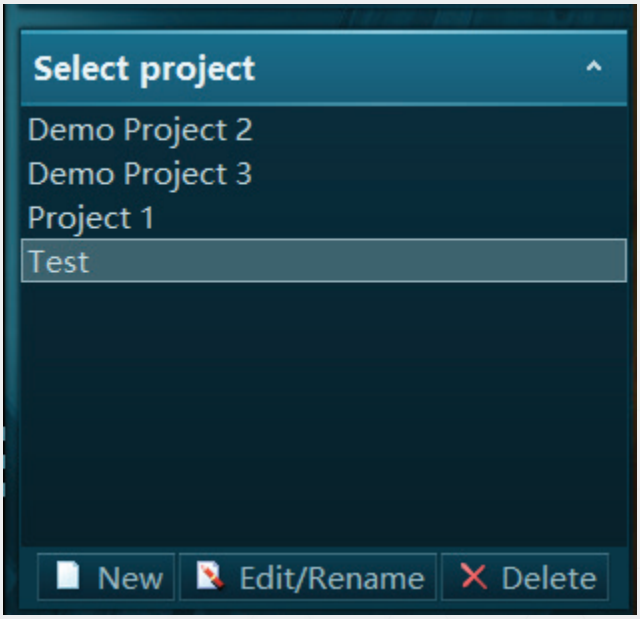
Attention: Don't use the Windows Explorer to move or send MR3 data files directly from their data directory on hard disk: you will lose important index files and data may become unreadable. To copy data always use the Export/to external location function of the database/right tool bar!

Select Projects

MR3's database system is organized in hierarchy levels:

- Projects
- Subjects
- Records

Projects is the highest database level. Projects can include an unlimited number of Subjects, which can include an unlimited number of records.



The drop-down arrow to the right of the project name allows you to switch to another project. If you want to create a new project, or rename or delete an existing project, click on **More**.

New	creates a new project
Edit/Rename	renames a project
Delete	deletes all project data, subjects inside a project with all recordings

Attention: Carefully use the Delete function. Projects that are deleted cannot be restored

Section 8: Viewer Tab

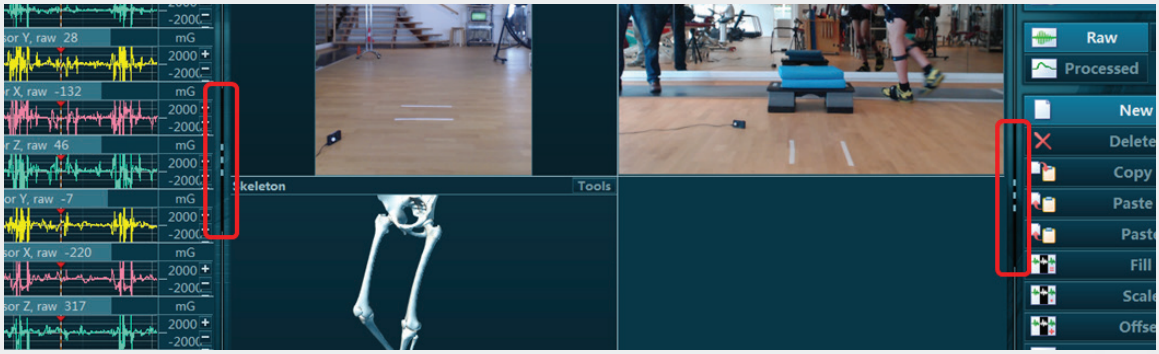
Introduction

Each successfully stored recording will automatically be loaded to the record Viewer. Data will be presented in the same channel layout scheme that was used for recording. The main goal of the Viewer menu is to inspect the quality and details of a record, apply signal processing, place markers (for analysis period definition) and prepare the record for further analysis (=> Report).

Dependent on the multi-device setup used in measurement the record viewer will show curves and elements from all selected modules:

SOFTWARE
myoFORCE™ MODULE

A very important display tool of the Viewer menu are the splitter lines that separate the screens sections within the viewer screen:



These lines can be drag with left pressed mouse button and allow to resize the given screen element.

As an overview the following menu elements are potentially available

Channels and view functions:

1. Register Tab system to separate/sort devices
2. Channel and View Functions
3. Time line
4. Video control/replay and POI Analysis
5. Video and animation windows
6. Tool bar menus
7. Screen layout section

Note: In the example above a raw EMG record is shown. With multi-device setups, the record **Viewer** can show signals from all measured devices plus video, pressure and motion animation avatars, dependent on which Device tab (1) is selected. The addition of multi-device modules also adds functions to the right-side tool bar, e.g. myoVIDEO based video recording adds two more sub menus; Video analysis and Video Options

1) Device register card system

By default, the measurement signals of all connected devices are grouped by the given device. Click on the desired Device tab to see the measurement signals. Per mouse drag to the channel name or tab name signals/tabs can be moved into other tabs or new tabs.

The Viewer menu presents all recorded data exactly in the same screen layout arrangements as they were measured. Because of the multi-device nature of MR3, numerous signal, animation video and biofeedback screens can occur which require a sophisticated screen element management. As described in the measurement menu/section screen layouts, in the case of multi-device setups each device will be shown in its own tab section.

The following channel display, zoom and overlay functions are available:

- Local X and Y axis +/-, = buttons allow for zooming operations of amplitude and time
- Double click on channel name maximizes a channel to a pop-up window
- CTRL – Double click adds a second or third (....) channel to the pop-up window
- Pop-Up windows can be moved to a second monitor
- Left mouse drag of the channel name to another signal creates an overlay of both signals
- Any number of signals can be mouse dragged to a new tab
- Any given screen layout arrangement can be stored as a configuration available in the right tool bar

  (See the Measurement chapter for more detailed descriptions and examples)

Mouse based channel view functions:

Left mouse button

Double click on signal screen places a marker
Click and hold left mouse button marks an area (for zooming, for period definition in report)

While dragging an interval with left mouse button, three small fly-out windows will appear indicating the time point of interval begin and end (lower values) and duration (upper value):

Middle mouse wheel & button:

If a certain signal portion is zoomed in time (click on the plus sign "+" in the timeline or turn the mouse wheel) and middle mouse wheel button is pressed, mouse movement to left and right pans the signal through time

If middle mouse (wheel) button and Shift key is pressed, the mouse movement up / down pans the amplitude/zeroline position.

If mouse wheel is scrolled up the signals are zoom out, if wheel is scrolled down the signal is zoomed in.

If mouse wheel is turned with pressed CRTL button is pressed, the amplitude of the channel below mouse arrow is zoomed in or out

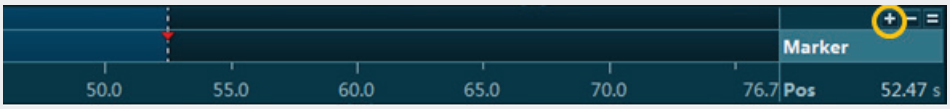
Right mouse button

If right mouse button is pressed, context sensitive commands are available (in development). Currently, the function Delete markers is supported.

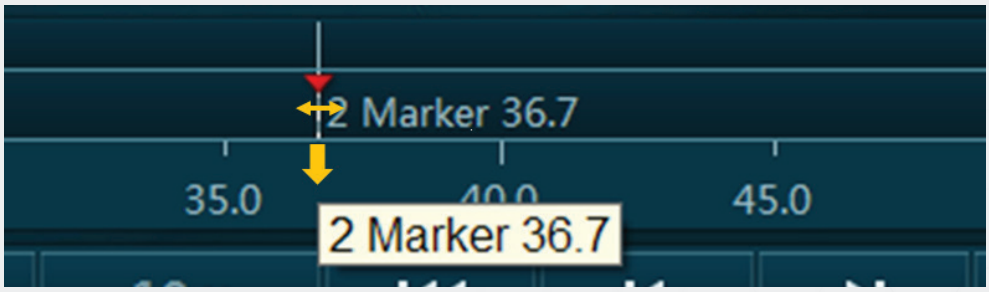
3) Time Line

The time line indicates the cursor and marker time positions, marker labels and the location of the analysis periods (see the Report chapter for details). The time line can be used to mark areas within the record and zoom them up with the plus button on right side of time line:

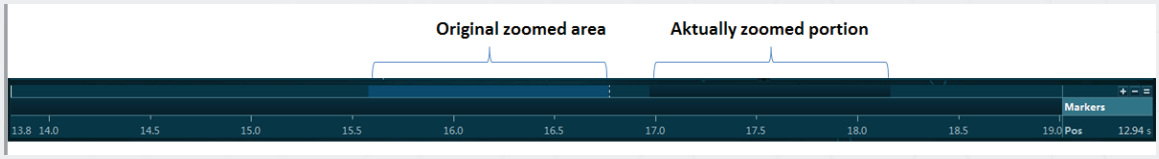
The marked area is highlighted in light blue, both in the timeline and in the signal screen. Alternatively, the area can be marked directly in the signal screen. The plus "+" minus "-" and equal "=" screen icons can be used to zoom in and out during the period selection, and to show the full recording:



A left mouse double click places a marker to the record. In case a marker is placed its position is shown both in the signal screen and the time line. By pressing the left mouse button you can move marker to the left or right side or drag it down to the next line to delete it:



The upper area of the time line can be used to step (view) through a recording with a predefined interval length. To do so, first mouse mark an interval in the timeline or signal screen, then zoom in by clicking the plus zoom but on right side.

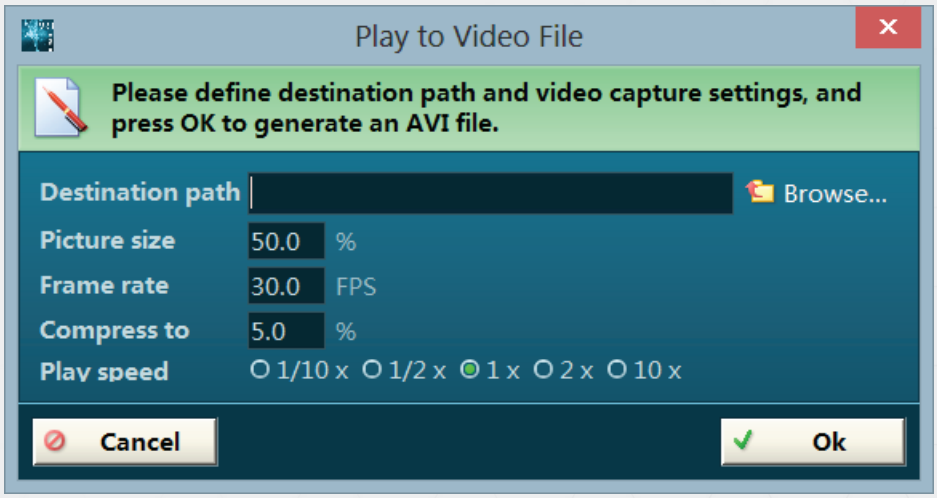


Now you can use the page up/down buttons to scroll through the measurement with the selected interval length or drag it with pressed left mouse button.

4) Video control/replay and POI Analysis

At any time you can replay a video and all available animations (like skeletal avatar of myoMOTION or pressure Isobards of myoPRESSURE) by using the video controls:

Play	Plays all visible videos on the screen at the same time
1/10 x, 1/2 x, 1x, 2x, 10x	Control the play speed.
Arrows	Their function follows standard video control functions: Go to the beginning of the video clip, go one picture back, one picture forward or go to the end of the video clip
Play to Video File	This is MR3s video/screen recorder function and allows you to record any video, screen animation, time synchronized measurement signals, etc. (e.g. EMG, auto-tracked angles) to an .avi file. A small menu dialog allows you to define file destination directory, video size, frame rate and compression factor



The screen recorder function **Play to video** requires users to: set a path (**Browse**), define the **Picture size** (select 100% for best quality), select a **Frame rate** (recommended setting is 30 Hz), set **Compression ratio** (Compress to – recommended is 5%) and set **Play speed**.

Attention: Do not operate any other action while the screen recorder is running!

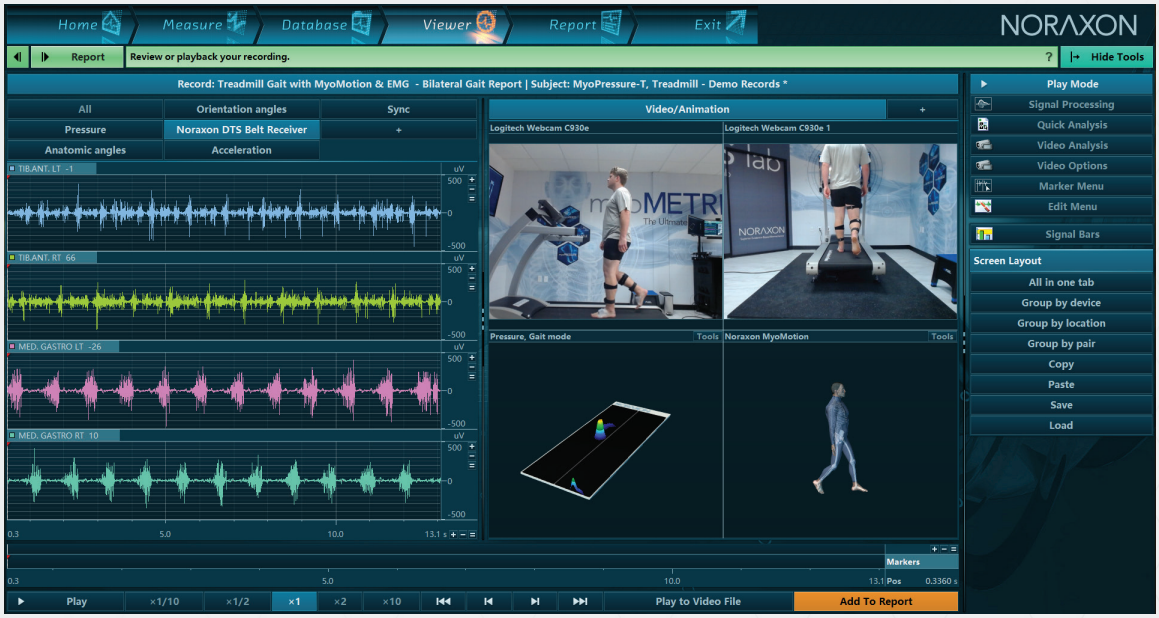
Recording intervals can be limited to a blue highlighted area in the time line (see below). To select a section within the video time line, click on the beginning of the desired recording interval, then hold down the shift key and click a second time at the end of the interval. You can also accomplish this by clicking on the beginning of the desired interval and dragging over the timeline until the end of the desired recording interval.

Add to Report	Whenever you want to insert a video picture (with or without angle drawings) to the report, press this button. This **point of interest** (**POI)** based analysis allows you to watch a video, stop at any point of interest, analyze it (see below) and click **Add to Report** to mark it for the video analysis report. Any POI created by this function receives an orange Report marker label in the marker/time line shown below.

The time line shows a seconds-based time scale and a marker label line. MR3 operates an intricate system of markers related to biomechanical event triggering, manual marker labeling or POI based ("Add to report") labeling. Any created marker line is shown here and can be used to identify events, motion phases, interesting analysis sections, etc.

5. Video and animation window section

In case of multi-device setups including MyoMOTION, MyoPRESSURE data are visualized with 3D animation graphs:

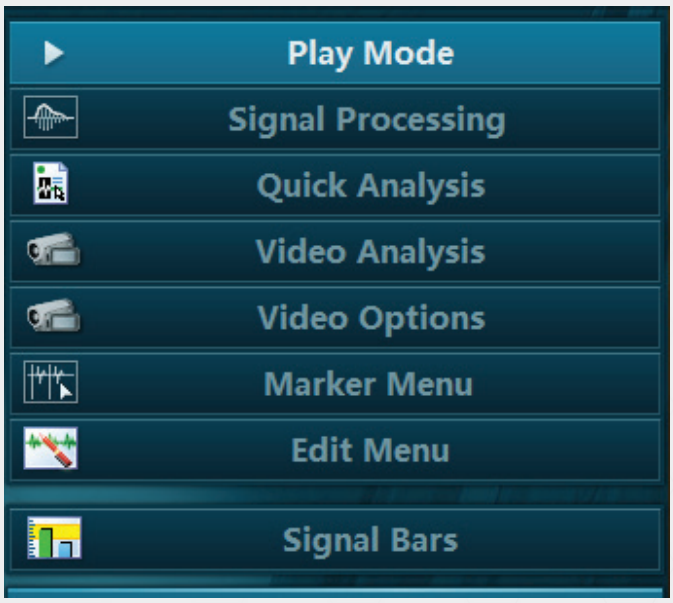


Several view and perspective buttons (left side) are available and already described in the measure menu.

Each of these animation windows has local tools which are described in their own manuals.

6) Right Tool Bar Options

The tool bar offers a set of optional sub menus, by default the Play mode is active. This is the standard mode to visually inspect, zoom and record. Click on the desired sub menu to activate it and use more sub menu functions.



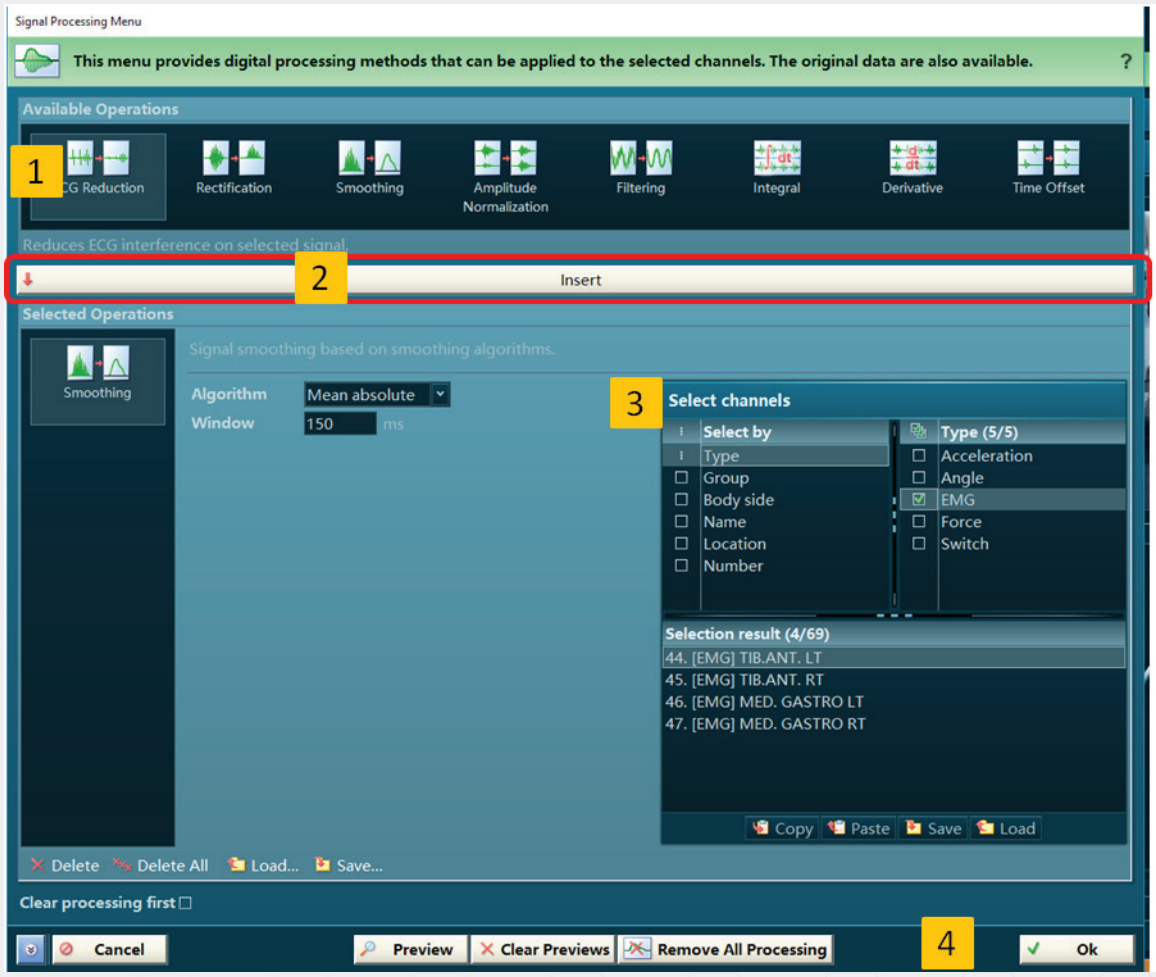
Signal Processing	A collection of standard processing operations such as signal rectification, smoothing, digital filtering, amplitude normalization, etc.
Video Analysis	(requires the module MyoVIDEO)
Video Options (optional)	Consists of a set of video adjustment tools
Marker Menu	Several modes for marker labeling and auto marker settings for trigger and angle channels.

Note: Markers can be manually set in the signals by double clicking the left mouse button.

Signal Processing

Signal processing is a collection of commonly used processing modes for biomedical signals. Especially bipolar raw EMG recordings require post processing prior to analysis.

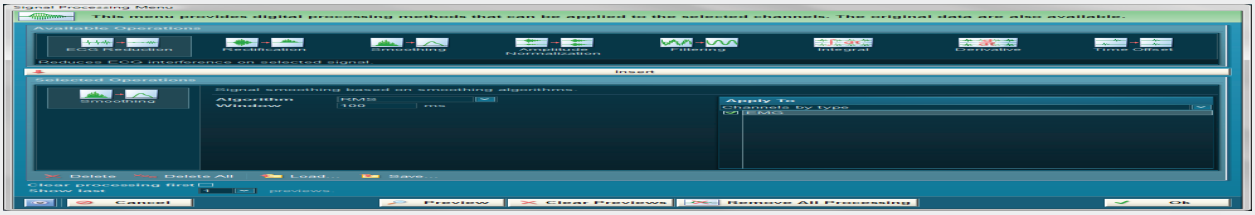
The menu is operated in 3 basic steps:



1) Select a processing method
2) Click insert to add it to the processing pipeline
3) Apply a channel filter to select specific channels for the selected processing
4) Preview, remove processing of confirm selected processing with OK

Operation Tools

Basic operation tools, independent from selected processing mode.

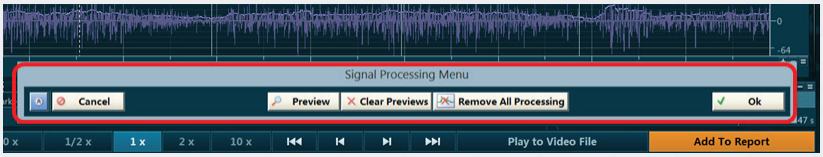


Lower Red Operation Buttons (Delete, Load, Save):

- **Delete** – a method in the list of Selected Operations can be deleted from the list
- **Delete All** – deletes all selected operations from the list
- **Load/Save** – a sequence of Selected Operations can be stored and loaded for repeated use. To Save a configuration, give it a recognizable name, optionally load a picture icon for it and click Ok. Load will open a window showing all available signal processing configurations.

    - **Clear processing first** – t**his function will remove all previously operated processing** and reload the original raw data.

When preview is operated the signal processing menu is minimized to a tool bar line:



This is done to give full view to all processed signals. To maximize the signal processing menu, press the arrow up

Press OK if the preview of processing shows satisfying results.

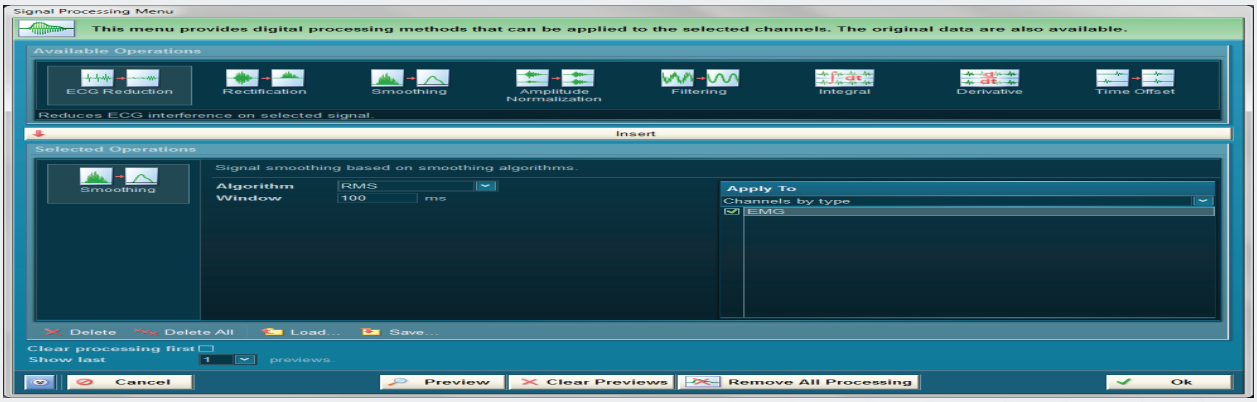
Remove all Processing

This function will restore the raw data and remove all processing operations from the signals.

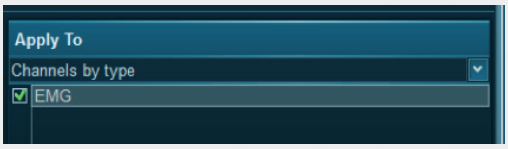
Available Operations

Eight Signal Processing methods, listed under Available Operations, can be loaded to a sequence of processing commands **(Selected Operations)**. You can easily create any sequence and/or order of processing methods and load them several times, if needed.

Click on a selected processing method and hit Insert to add it to the lower operation pipeline.



- **Apply To** – Each processing method has an Apply To option. This allows the user to selectively apply the processing operation to specific channels. Channels can be chosen according to channel type, i.e. EMG, Anatomical Angles, etc. or by specific channel numbers.



ECG Reduction

MR3 is equipped with a unique algorithm to detect and selectively eliminate ECG artifact spikes. The main benefit is the original EMG power is not significantly affected, only the ECG spikes are removed. The algorithm for this is a combination of pattern recognition and adaptive filtering.

- **Select interval by first activity** is currently not activated and can be discarded.
- **Select interval from beginning** < time interval> means that this recording section right after recording start is taken to determine the shape of the ECG artifact. To achieve satisfactory results, it is important that the patient is as relaxed as possible and only the spikes are visible on the EMG baseline.

The quality of this "ECG cleaning" can vary depending on the EMG recording quality and artifact conditions. This ECG removing function can be very helpful in relaxation studies, especially where ECG spikes can greatly influence the outcome results.

Rectification

This very popular processing method multiplies all amplitude values in a signal with +1, with the effect that all negative values become positive; i.e. all amplitudes below the zeroline become positive amplitudes. The purpose of this operation is to achieve positive amplitude curves that allow you to calculate parameters like mean amplitude, area under the curve, etc.

Smoothing

Typically, for amplitude based calculations and analysis, the raw EMG is smoothed by digital filters, root mean square or moving average algorithms. The effect is that non-reproducible EMG spikes are eliminated and the mean trend of the EMG innervation is used. As described above, another benefit is easier reading of the EMG patterns, which is useful for clinical tests, biofeedback oriented treatments or trainings.

- **Algorithms** – the following smoothing Algorithms are supported:
    - » RMS – Root Mean Square
    - » Mean – the moving average
    - » Mean absolute – the moving average with combined rectification
- **Window** – allows you to define the window for each algorithm (in milliseconds)

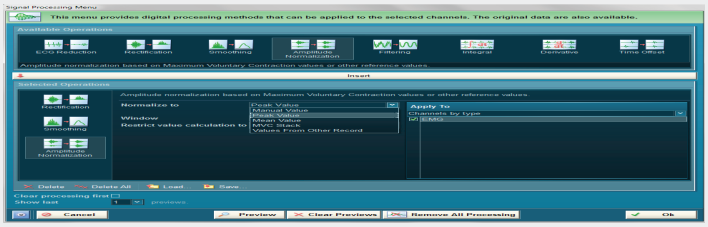
Please refer to the **ABC of EMG** booklet for more information on how to use smoothing algorithms.

Amplitude Normalization

This feature allows amplitude normalize microvolts based EMG recordings. Amplitude normalization post-processing is similar to online processing offered in the Measurement Configuration setup, with a few additional options.

Usually Amplitude normalization is used after rectification and smoothing of data:

Normalize to – normalization routines are available in the pull-down list



- **Manual Value** - Here the normalization value can be entered manually. You can apply manual values per channel (see Apply to).

- **Peak value** - This is the main method of finding MVC (Maximum Voluntary Contraction) values within MVC records. The entry Window defines a window for the MVC value calculation. The mean value of this window is taken as the MVC value. An automatic algorithm calculates each selected channel separately, where the highest mean window is located in the channel and indicates the signal portion with a green color. When done, a prompt appears that asks you to Update the MVC stack. The MVC stack is an internal memory that keeps these MVC values, as long as it is filled by the next Peak value normalization operation.

    - » **Peak Normalization**: When confirmed with Yes, these MVC values are available for the next normalization routine: MVC Stack (see below).

    - » **Restrict calculation to**: Click **Pick** to use the mouse to mark a signal portion in the record with the result being the MVC calculation is done only in this marked area. This function may be helpful in measurement designs, where an MVC recording period is part of a given record, e.g. at its very beginning. Click **Clear** to clear any previously selected areas.

- **Mean Value** – In this normalization method the amplitude mean value is calculated for each channel and taken as a reference value for the normalization. This type of normalization is often used in gait analysis where time normalized EMG patterns are amplitude normalized again, each to its own mean value.

- **MVC-Stack** – This method loads the current MVC values from the stack. This can be repeated as many times as needed, e.g. to normalized records and trials done after the MVC record of a subject. The MVC values remain in the stack, even if the computer is shut down.

In summary, normalizing to Peak value creates MVC values, normalizing to MVC Stack loads MVC values for the normalization of other records (of the same subject).
When amplitude based normalization is loaded to the signal processing pipeline the storing dialog after processing will prompt you to save MVC data to the MVC stack **(Update MVC stack**). Confirm this dialog with **Yes** to make these MVC values available for the trial records and the amplitude normalization mode normalized "**To MVC Stack**".

Values from other records – This method accesses normalization values found or applied from this "other" record. Only records for the same subject are listed (Normalization to another subject's muscle activation would not make sense). Please verify (see processing history in the Database Record Info Section) that the proper normalization routine was performed on this "other" record. Typically, this is the MVC trial of one subject, which is used to calculate/find the MVC values within the maximum contraction series. If you choose a record that was not normalized by any method, this operation cannot be performed.

Restrict value calculation to – allows the user to pick a section of the record to apply amplitude normalization by highlighting the section of the record using the mouse.

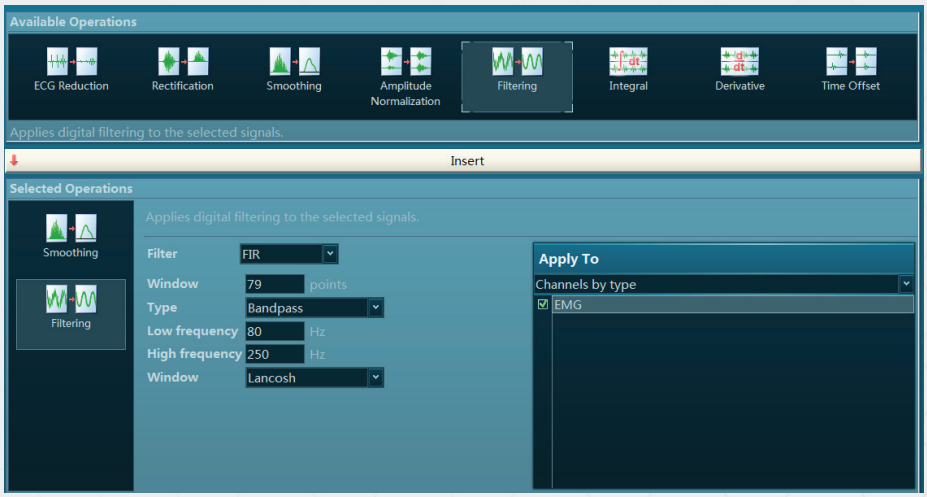
Filtering

A set of commonly used digital filters is available in this processing method:

Filter: Selects the filter type: FIR, IIR, Median

FIR - Finite Impulse Response filter

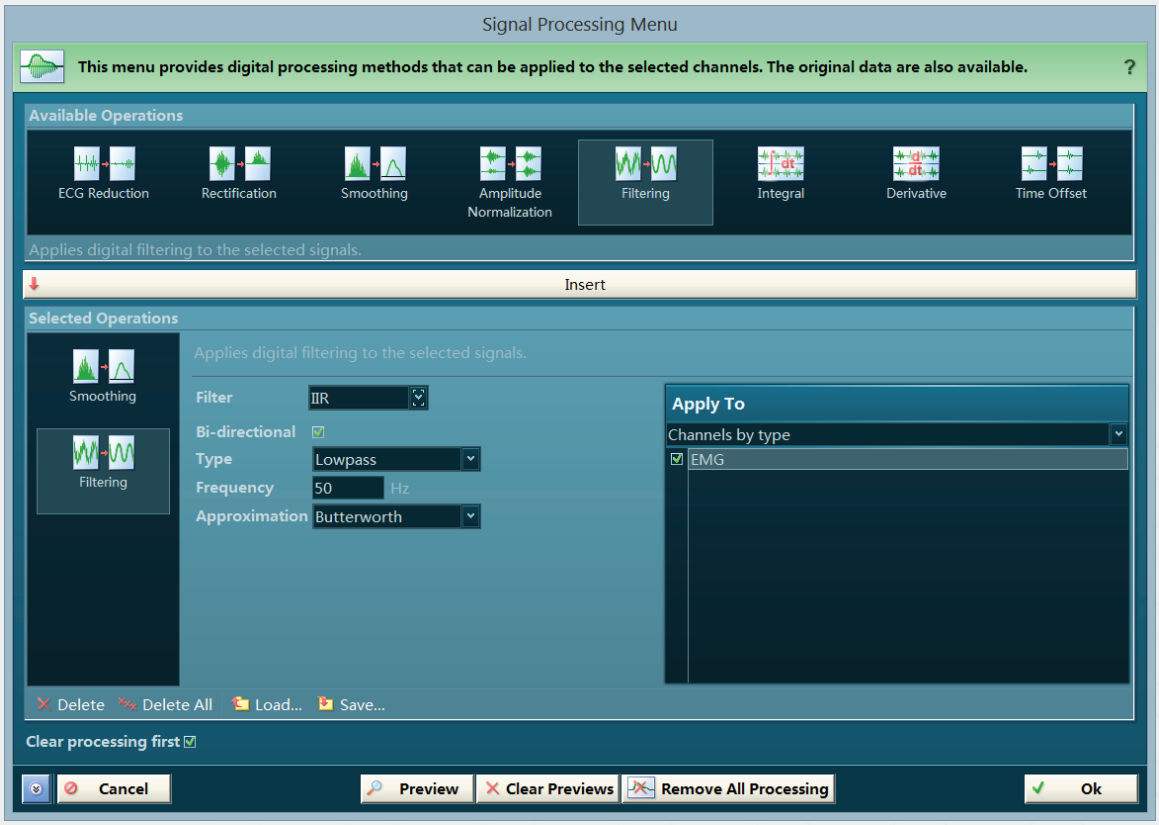
Window: Number of points used to process the data. With longer windows the quality improves. Recommended default values is 79.



Type: The filter can act as a low, high, band pass or rejecter filter. Use the **Low/High frequency:** controls to specify the filter range.

Window (below frequency): sub type selection, to define the window edge fading

IIR - Infinite Impulse Response Filter



Bidirectional: use this mode to avoid phase lags created by the filter.

Type: The filter can act as a low pass, high pass or rejecter filter

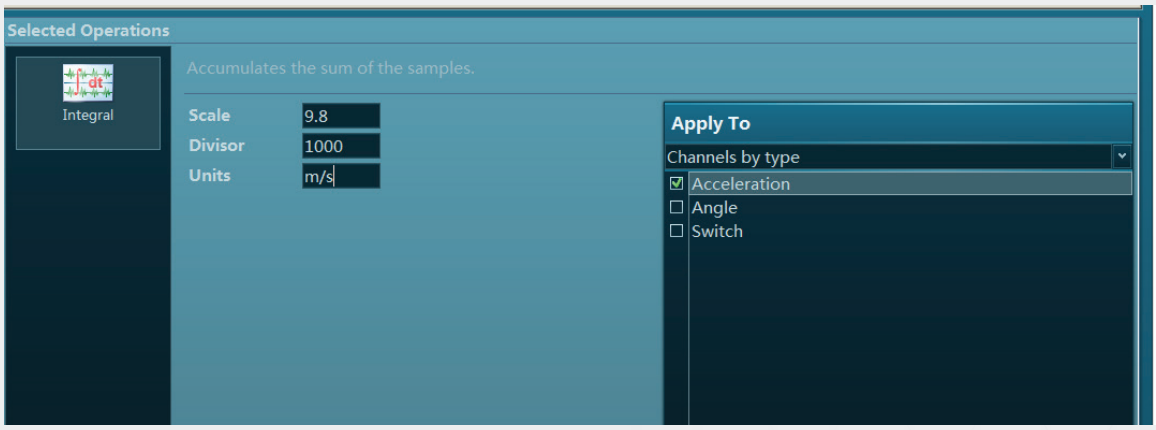
Frequency: The edge Frequency can be entered in Hz.

Approximation: Defines the sub type of filter

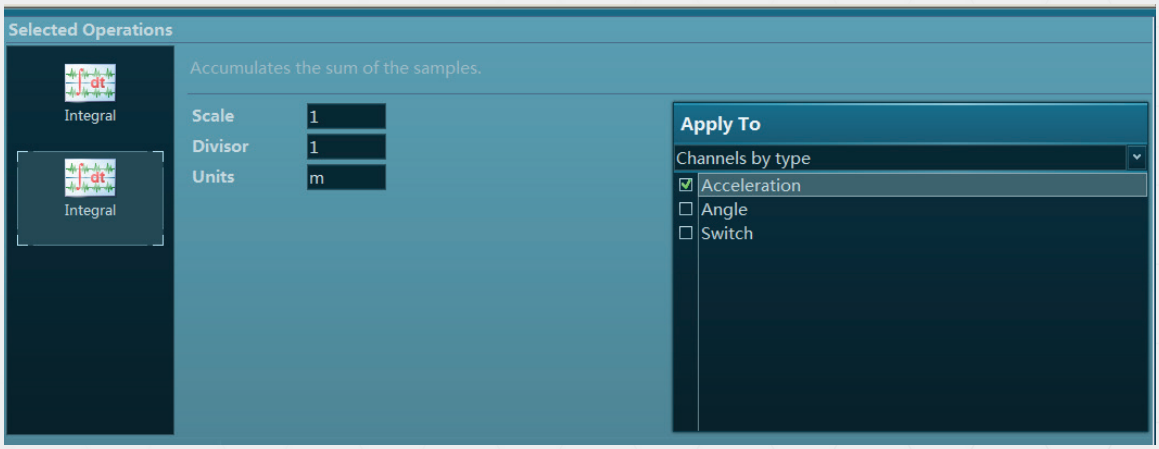
Median - Filter

The median filter is an excellent spike cleaner for analog signals: it removes spikes from e.g. force/ angle curves without affecting the original signal shape.
Window: Defines the amount of data points used for the filter algorithm

Integral:
This operator calculates the integral of a given signal. E.g. if you want to calculate velocity out of a MyoMOTION acceleration signal, enter these settings (source data are expressed in mG):



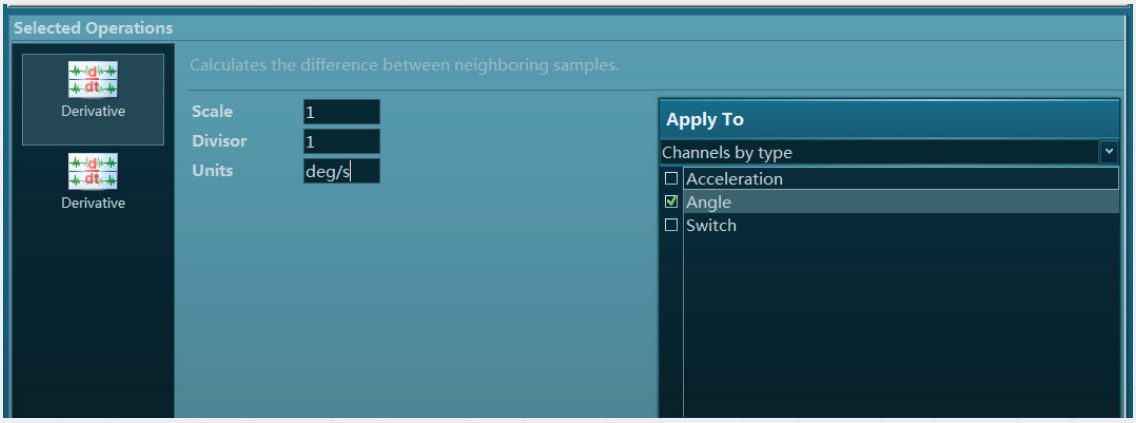
To operate a double integration from acceleration to distance, enter these settings in the second integral operator:



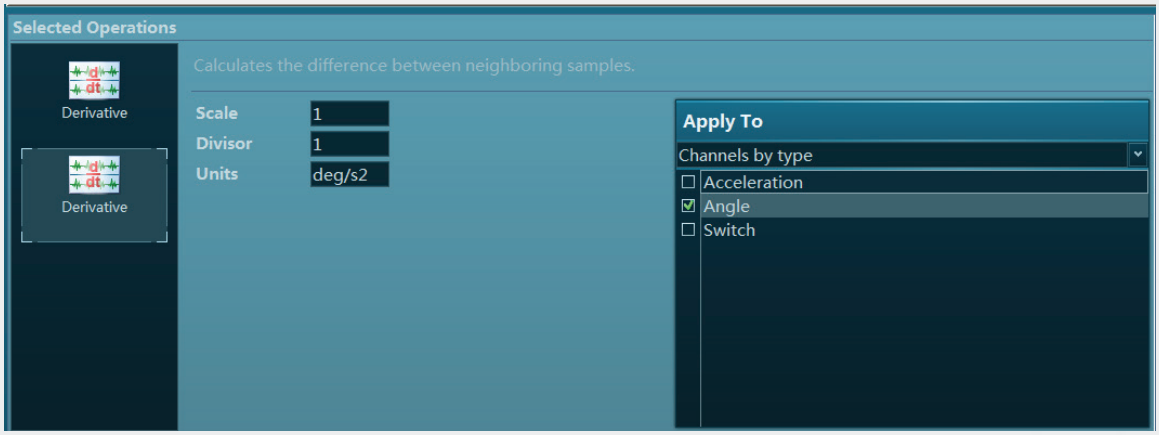
This is a preview screen of double integrated MyoMOTION acceleration signal:

Derivative

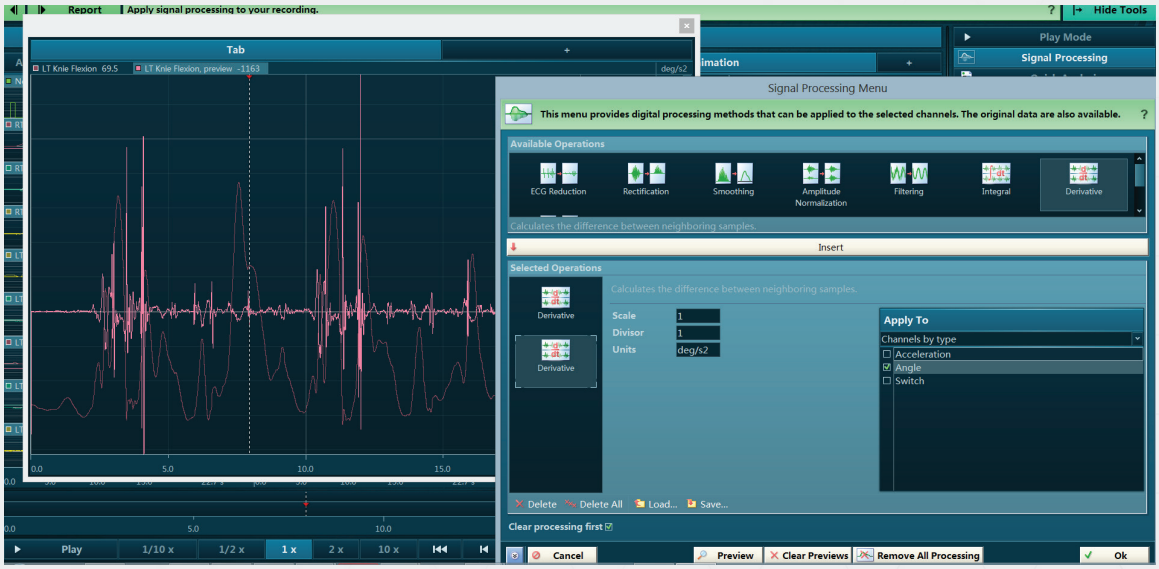
Alternatively, the derivative can be calculated based on an angle signal to reach angular velocity:



If operated a second time, the acceleration is derived:



Example of a double differentiated angle signal to angular acceleration:



Configuration List

Any signal processing configuration saved under a user defined name will be listed here in alphabetical order. Just click on the desired configuration to automatically apply it to the displayed signals. The signal processing menu will be minimized to give free look at all previewed processes:

If the result indicated by preview is okay, confirm the processing with **OK**.

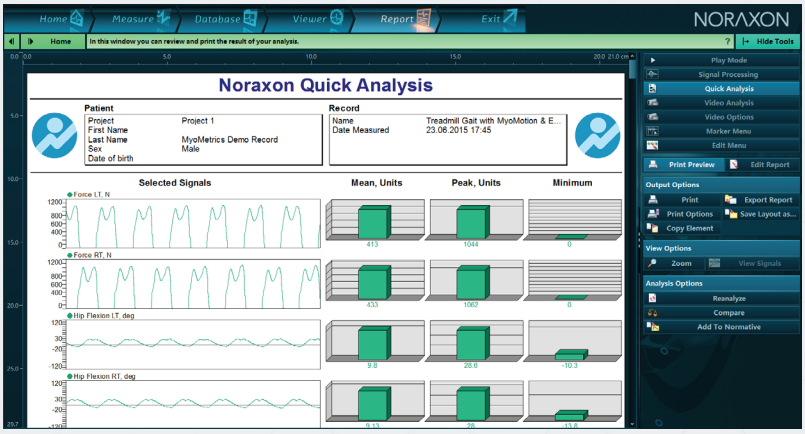
Three predefined configurations are installed by default:

Make MVC	finds and stores MVC values in MVC records
RMS EMG	a standard processing, that produces smoothed/rectified EMG curves, based on RMS at 100 ms
Use MVC	smoothes (RMS 100 ms) and normalizes the records to the MVC values loaded to the normalization stack (see above)

Quick Analysis

Quick analysis allows you to make an adhoc analysis of the whole record or a mouse marked area (press left mouse button to drag a selected interval).
After clicking on Quick Analysis MR3 stops at the channel selection dialog. It allows you to include or exclude certain channels from Quick Analysis:

When complete, and confirmed with Next in the green main command line, the **Quick Analysis report** opens:

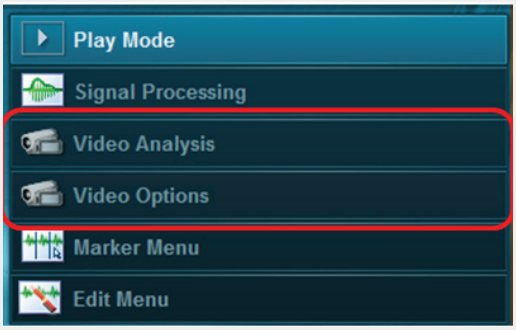


It contains some basic amplitude calculations for the selected interval. Parameters can be changed by double clicking on the report analysis element and entering **Diagram Statistics.**

More explanations on Report function are given in the local report help text.

Video Analysis and Video Options

These options are only displayed if you have purchased the myoVIDEO module and recorded a video. A more comprehensive description of functions is given in the local myoVIDEO help text which is available when you entered the Video Analysis menu.



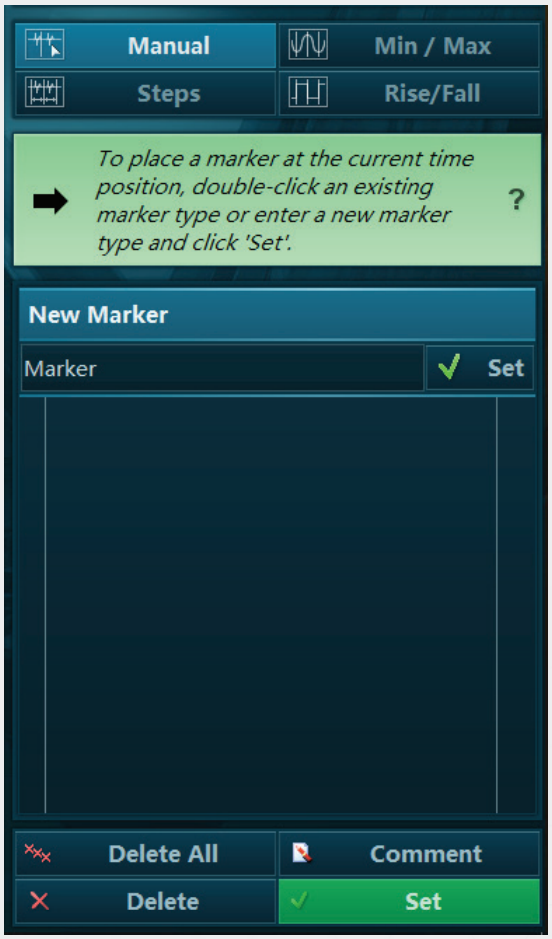
Marker Menu

The marker menu manages all operations to place labeled markers in your recording. The main purpose of markers is to define analysis periods for reports. Markers can be placed by three major actions:

- in real time, by pressing the **Mark** button while recording
- in the **Record Viewer** by double clicking a signal portion (left mouse button)
- by using the auto-marker algorithms presented in this menu

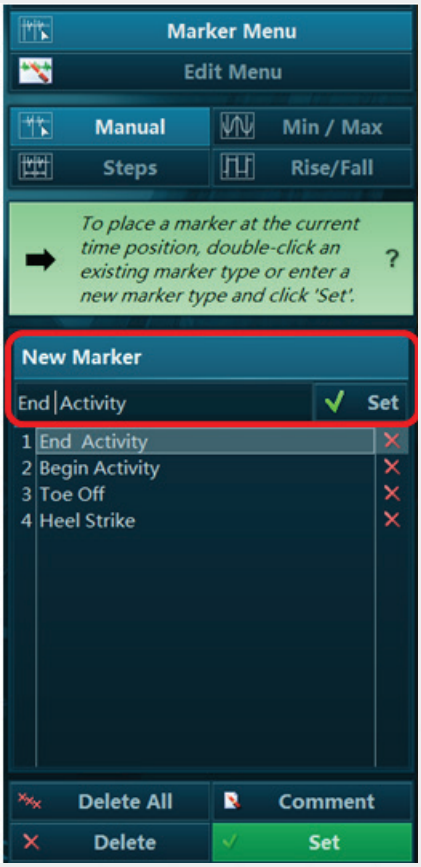
The markers and periods system is needed to fulfill the complex task of analyzing selected signal portions, TTL triggered periods, timing related onsets, or sub phases in gait analysis, just to name some examples. MR3 offers four marker methods to place markers in a record:

- Manual/Mouse
- Steps
- Min/Max by trigger channel
- Rise/Fall by trigger channel



Manual

By default, a left mouse double click on any signal portion in the channel screens will place a marker named Marker to the record. Alternatively, you can use a list of pre-configured user-defined markers by just double clicking on the desired marker label in the list. To create a new marker label, overwrite the existing name shown in the entry box below the New Marker label and click the green Set button to apply it. When complete, the label will automatically be placed into the signal screen/timeline and be added to the marker label list below:



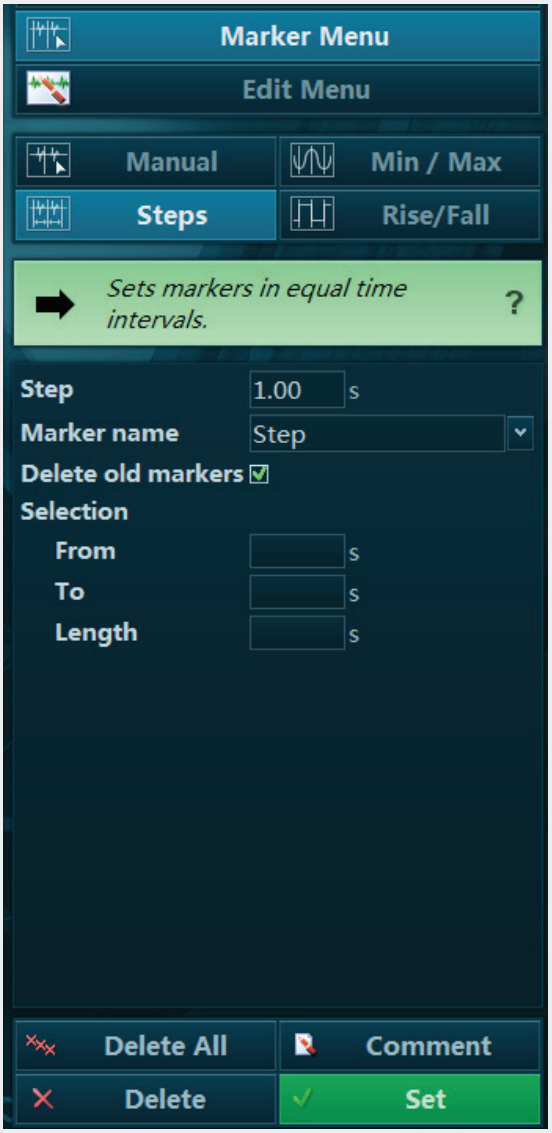
If you want to delete a given marker label from the list just click on the red X to the right of each label.

Any labeled marker can become a POI marker for the POI report (see report section of help text) by just clicking on it and press **Add to Report.**

Steps

This method is used for continuous records or signal portions where the time domain changes of any curve parameter are analyzed in a sequence of fixed intervals (Steps). First, it is necessary to define a signal portion in your record that you would like to be marked and analyzed by the step method:

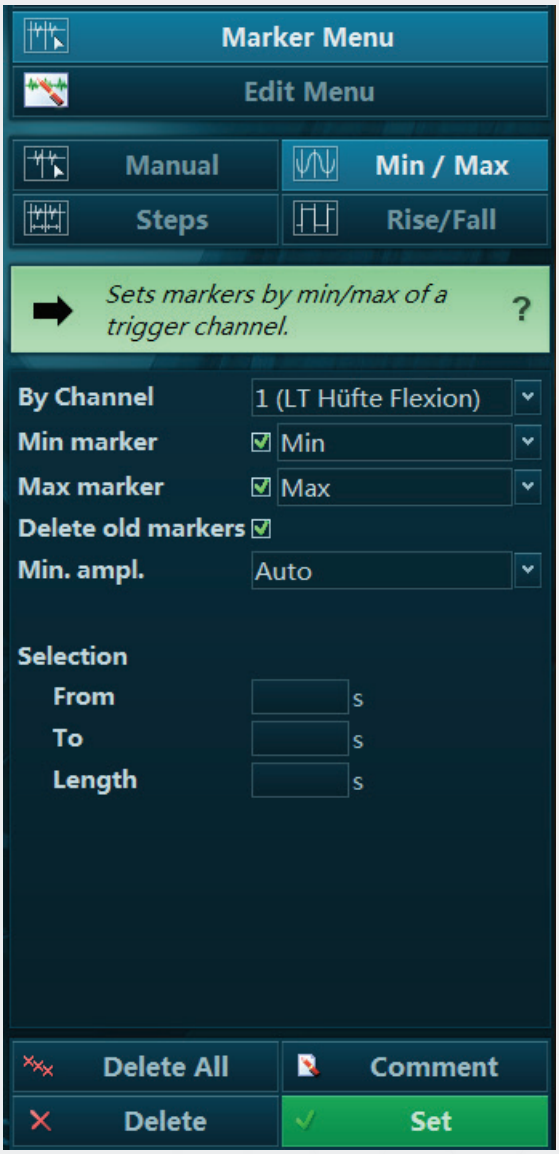
- by default, the whole record is selected
- mouse marked areas are recognized and the mouse mark can be used to define the signal portion
- Selection entries within the menu box, see the example on the next page:



Step	defines the step size in seconds.
Marker name	labels all step markers.
Delete old markers	deletes all previously placed markers.
Selection	allows you to enter a precise start point (From) and an end point (To), Length indicates the duration of the selected interval in which the auto-marker routine is operated.

Min/Max by Trigger Channel

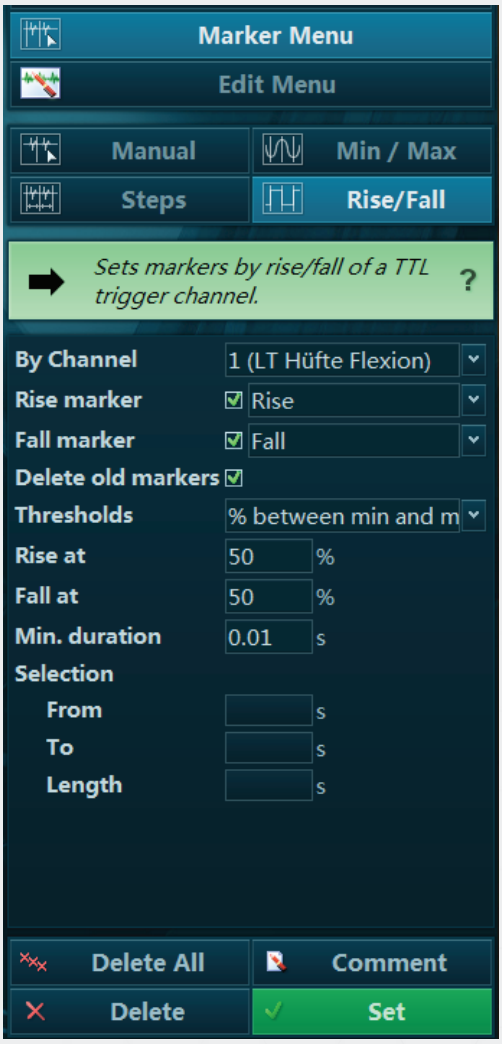
For records including an angle / goniometer / inclinometer signal, this special method can automatically detect the local minimums and maximums with this curve. Typically, the local events represent a start, point of return and end position within a movement sequence.



By Channel	defines the channel which should be used for the automarker routine.
Min / Max Marker	this check box allows for the user to include the local Minimum and/or Maximum value of the signal.
Delete old marker	removes the existing markers.
Min. ampl.	The default mode Auto tries to automatically check it by analyzing the highest range found within the record and accepting local ranges higher than 50% of this maximum range. In case this does not give sufficient results, a manual value for the minimum range between Min and Max can be entered that must be exceeded to identify a local Min/Max value.
Selection	allows you to enter a precise start point (From) and an end point (To), **Length** indicates the duration of the selected interval in which the auto-marker routine is operated.

Rise/Fall by Trigger Channel

For records including a TTL based trigger signal (e.g. foot switches), this method is used to identify the trigger up (Rise) and down (Fall) events. There are numerous applications that use this trigger function; e.g. in gait analysis, the trigger represents the heel strike and toe off events in the gait cycle. A trigger up can be a synchronization impulse between two measurement devices (to achieve time synchronization), etc.



By Channel – defines the channel which should be used for the auto-marker routine.

Rise/Fall marker – adds the Rise and/or Fall event marker to the auto markering.

Delete old markers – removes the existing markers.

Threshold has two modes:

% Between Min and Max – the TTL range and places markers at a user defined percentage position between the rise and fall level. This location can be customized by the controls Rise at and Fall at < XY> % between min and max (TTL level).

Absolute – works in the same mechanism but uses the given channel dimension for the desired Rise and Fall event level (instead of %).

Minimum duration – defines the minimum duration a TTL event needs to last below or above the specified threshold level to be recognized by the algorithm. This switch can help to avoid wrong marking by artifact spikes (typically spikes of very short duration).

> **Note:** For very short trigger events like jump ground contacts, this "anti-rattle" duration must be adjusted to lower values!

Selection - allows you to enter a precise start point (From) and an end point (To), Length indicates the duration of the selected interval in which the auto-marker routine is operated.

Lower Menu Operation Buttons

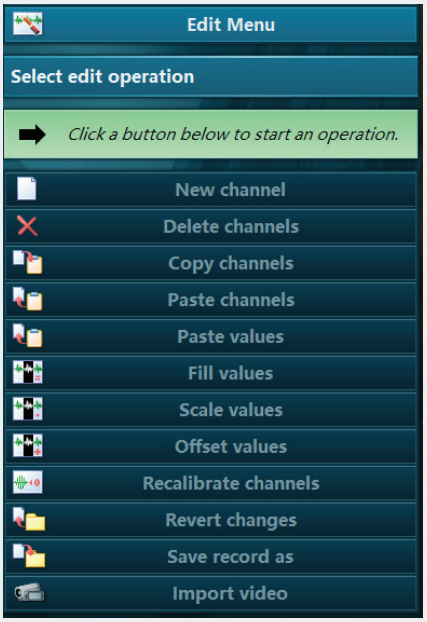
Ok	Executes the applied marker settings
Delete	Deletes the selected marker
Delete All	Deletes all markers in the Signals screen
Set	Applies the selected marker/method. Previewed in the **Signals** screen.

Edit Menu

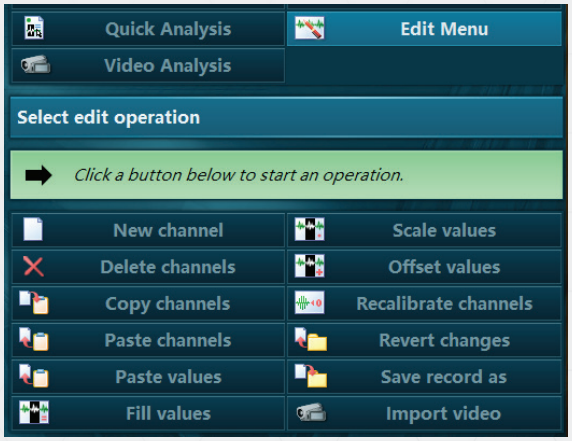
Unlike Signal Processing, all Edit operations physically change the record data set and the original recording cannot be restored. Therefore, it is generally recommended to first make a backup or a copy of your data. Alternatively, save any changes done in Edit mode with the option **Save as**...., which allows you to create a new record file (including all your edit changes) while keeping the source record in its original status.

Dependent on given screen resolution it may be needed to resize the Right Tool bar to make all functions and entry lines visible in Edit Menu:

Small arrangement:



Wide arrangement:



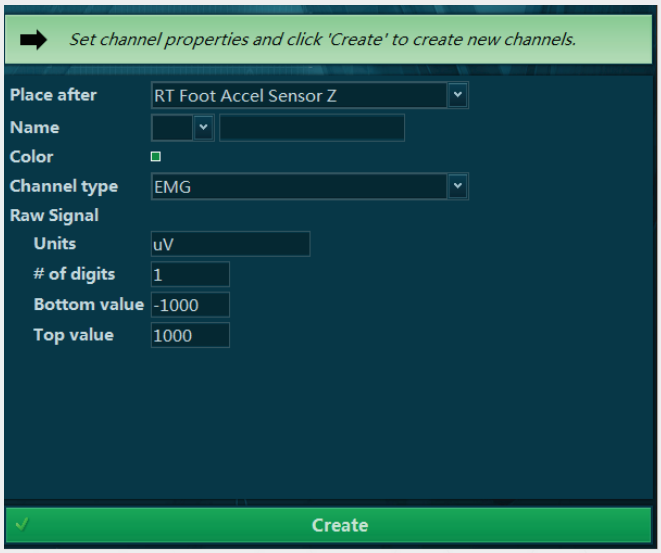
At the top of the Channel Tools box there are 3 iconized View Modes of the signals:

- **Raw** – show the original unprocessed signal (signal processing is removed)
- **Processed** – show the signal only in its processed version (signal processing included)
- **Both** – show an overlay of both raw and processed

Depending on the selection done here, any channel tool operation refers to this selection. For example, to copy a raw channel to clipboard and paste it to another location the **Raw** signals mode must be used.

New channel(s)

This function allows you to create new channel lines at any location in your record.

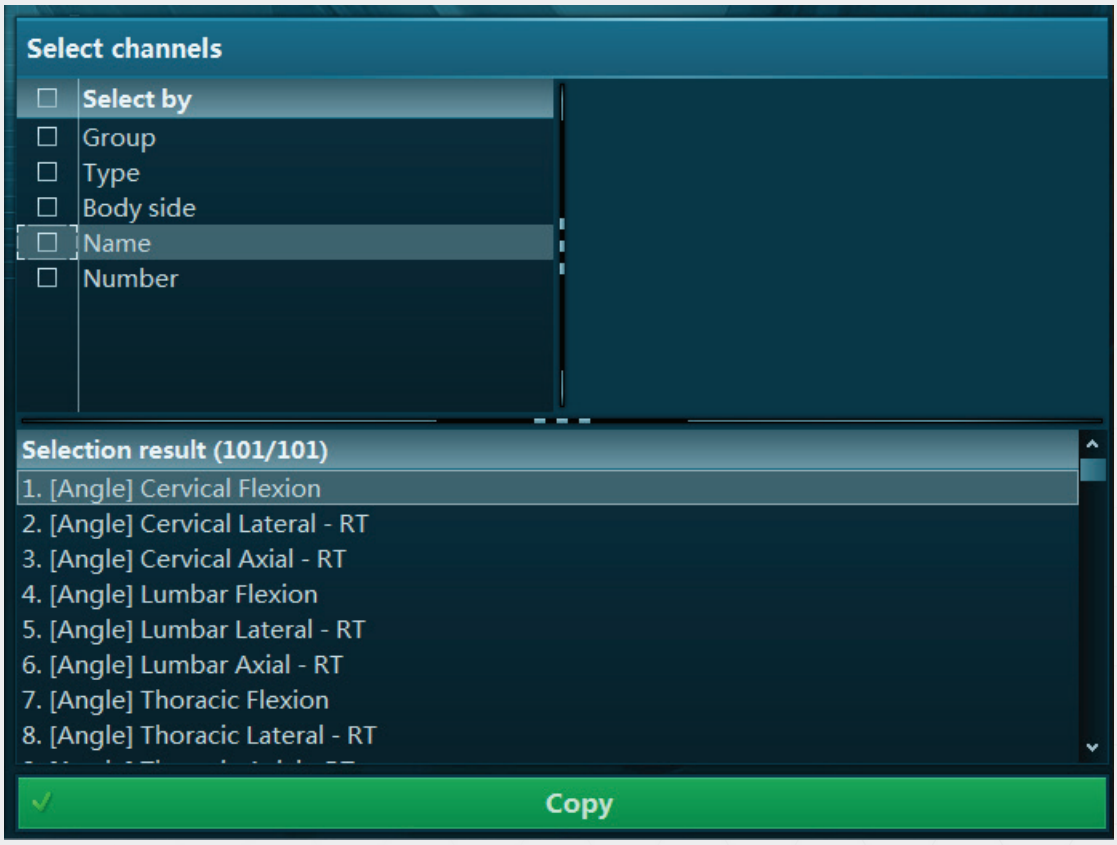


Place After – can be used to define a certain location for the insertion in the channel order.
Name – edits the name of the channels.
Color – loads a color palette to define a trace color for this channel.
Channel type – offers a pull-down list of all available channel types for the new channel.
Raw Signal –organizes the amplitude scaling settings for the new channel.

> **Units** – define the physical channel unit.
> **# of digits** – is the decimal value when showing the actual amplitude value.
> **Bottom value/ Top value** – the lowest (Bottom) and highest (Top) amplitude scaling value for the Y-axis.

Delete, Copy and Paste Channels

All three options have the same functionality. The selection for the given operation is done via the **Select By** section of this sub menu. By default, all recorded channels are selected if there is no **Select By** method chosen:



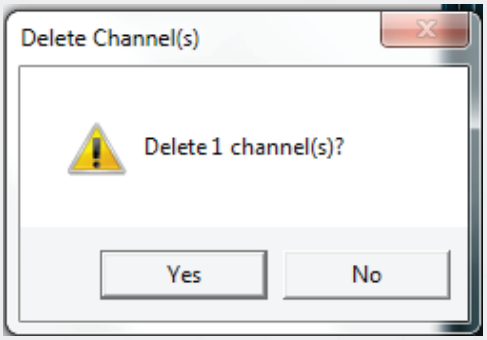
To reduce the selection of channel for the given **Edit** operation you can use these selection modes:

Select by:

- **Group** select channels by register tab groups
- **Channel type** select channels by type, e.g. EMG, force, etc.
- **By body side** select left or right side labeled channels
- **Name** selection via muscle, segment name
- **Channel number:** select by the channel list number

Note: All 3 modes can be combined with each other.

Delete – physically erases a channel



Note: after the confirmation, which appears when leaving the record viewer menu, this channel cannot be restored!

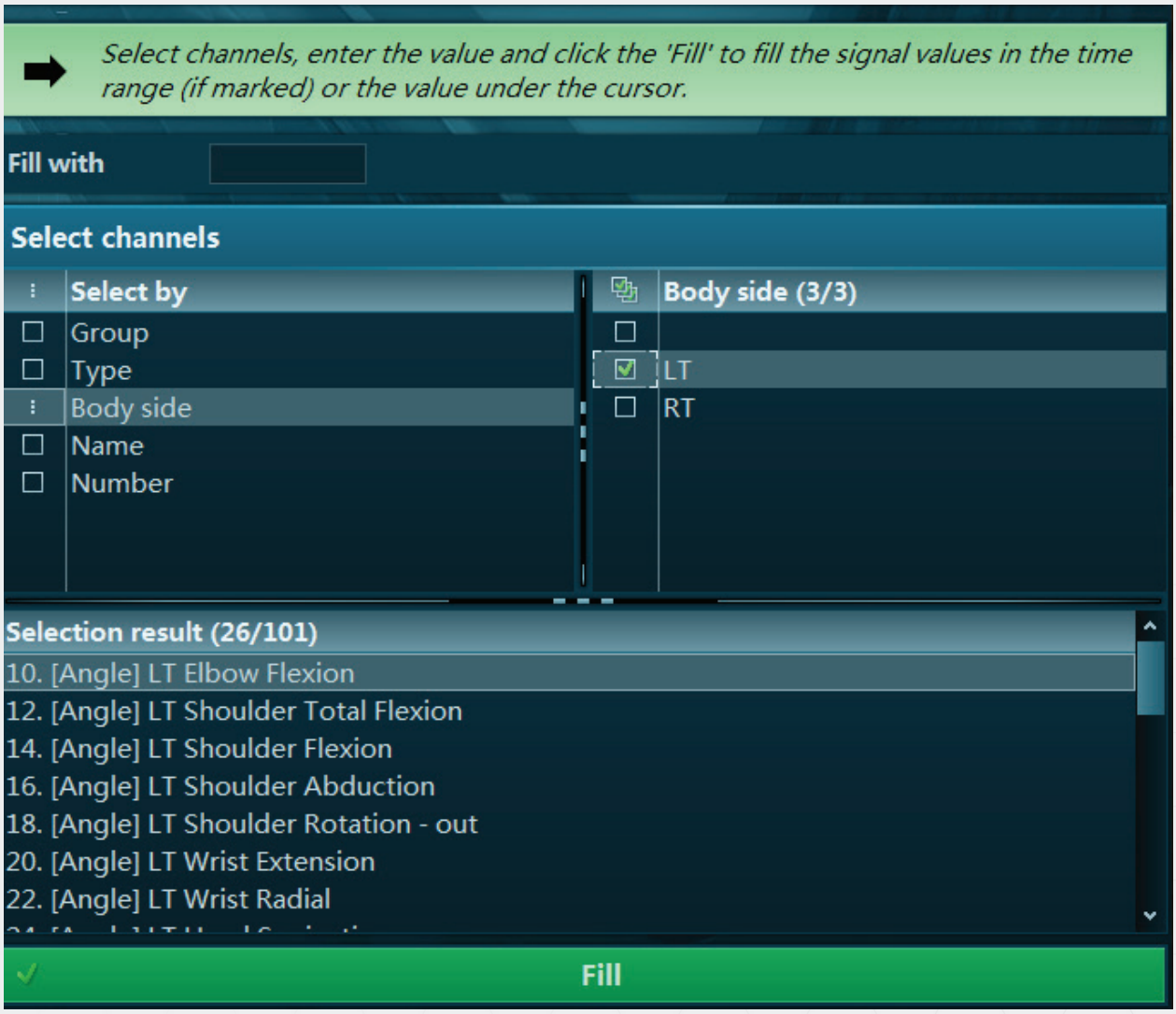
Copy channels – copies the selected channel data to the clipboard

Paste values – fills channel data coming from the clipboard to the selected target channel

Paste channels – pastes channels copied to the clipboard below the last channel

Fill Values

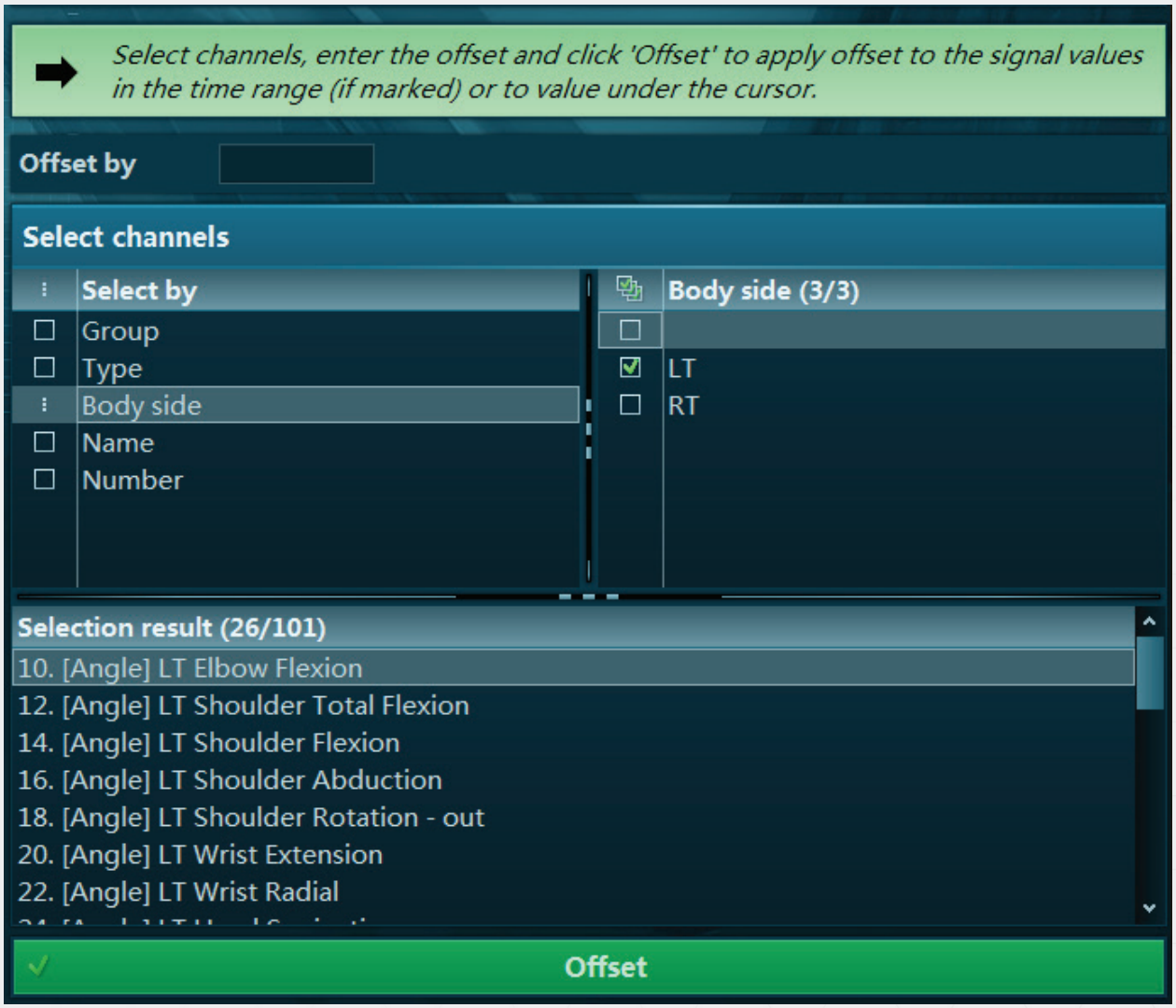
The Fill Values function is an editor for amplitude values. Based on a mouse mark signal portion, any amplitude value can be entered and will overwrite the existing values. For example, this function can be used to manually eliminate artifact spikes or other invalid data portions within a channel.



Note: this operation will physically change the data of your source signal so back up your files to prevent the loss of raw data.

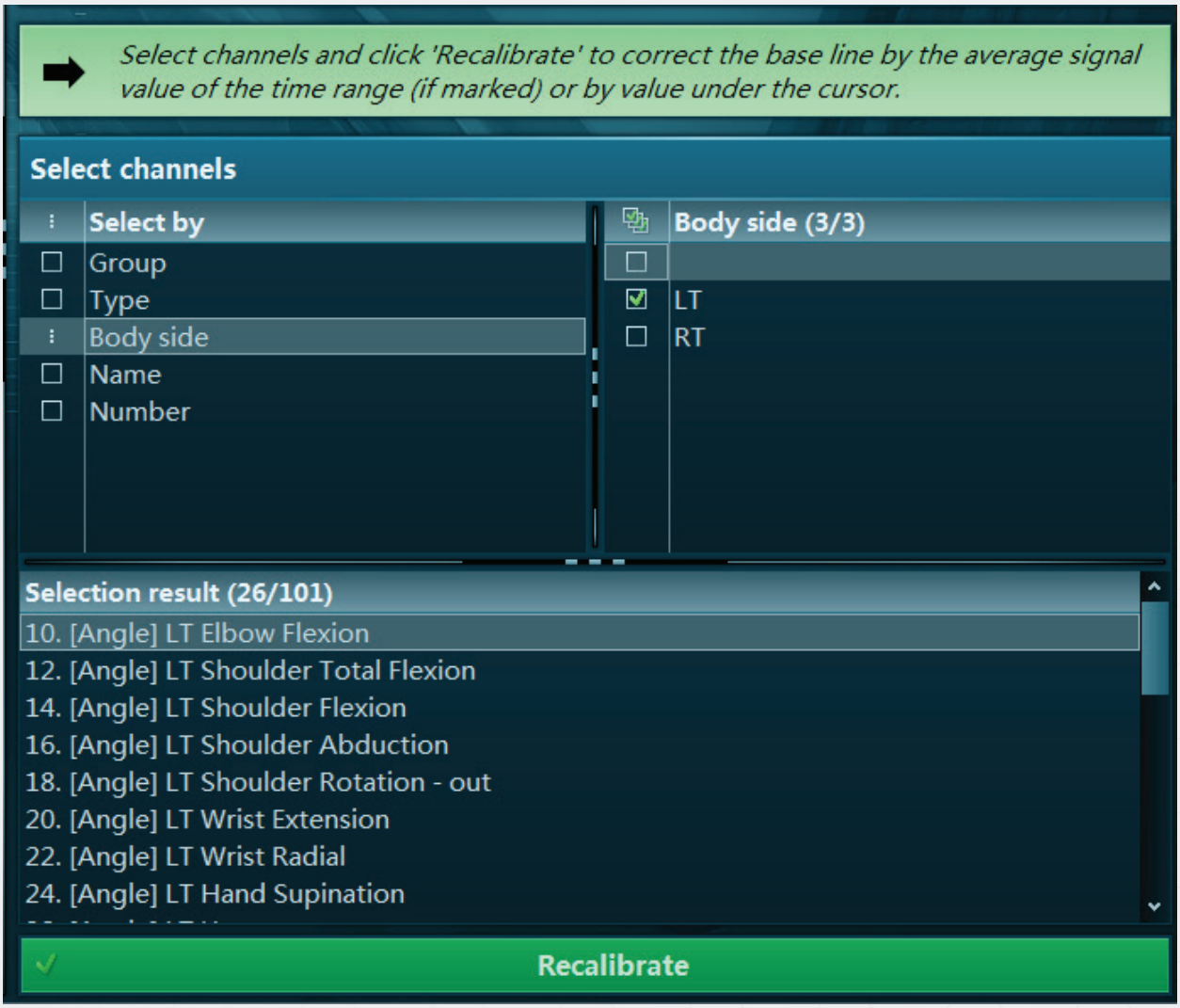
Offset Values

This edit function is designed for manual correction of the baseline to any desired value:



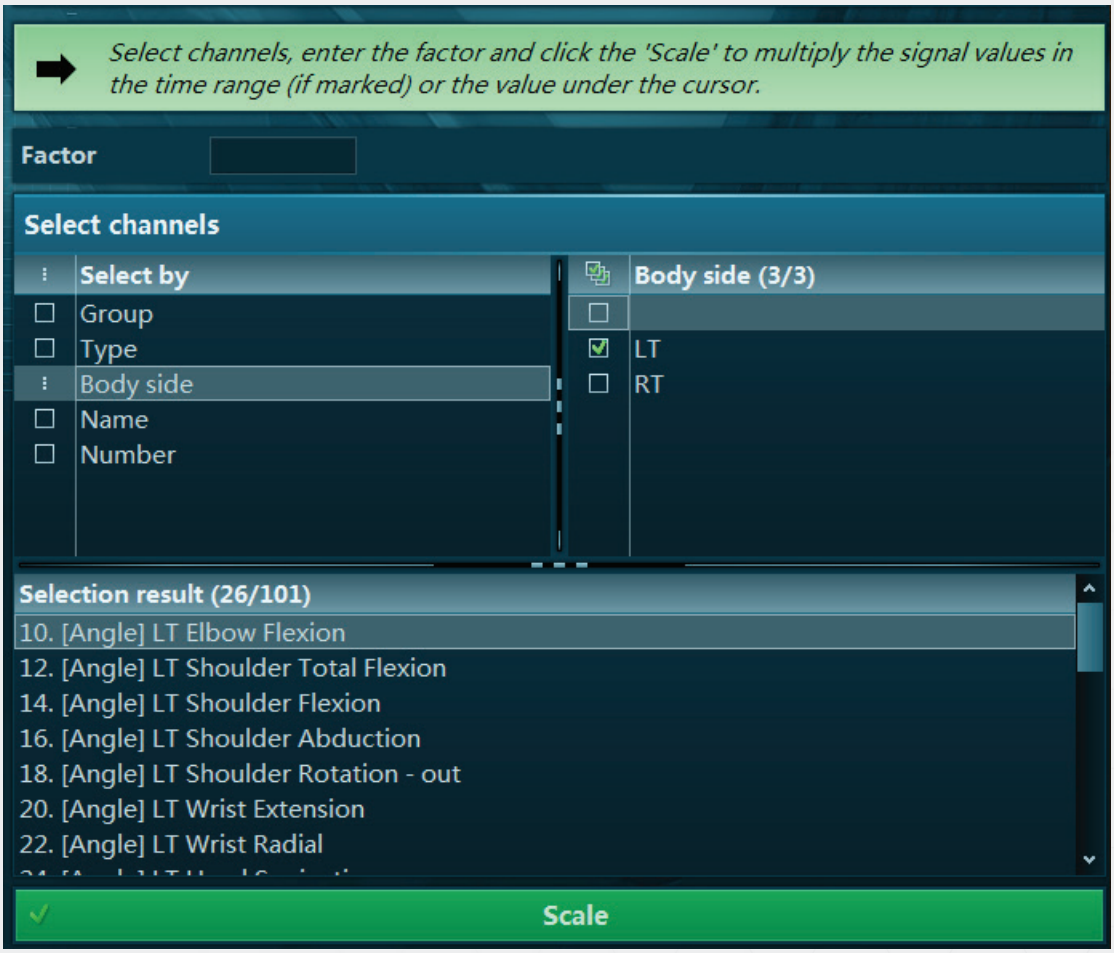
Recalibrate Channels

This function corrects EMG baseline shifts by determining the amplitude mean value of a mouse selection signal portion. Because raw EMG is a bipolar signal with equal value distribution to plus and minus, its mean is typically zero.



Scale Channel(s)

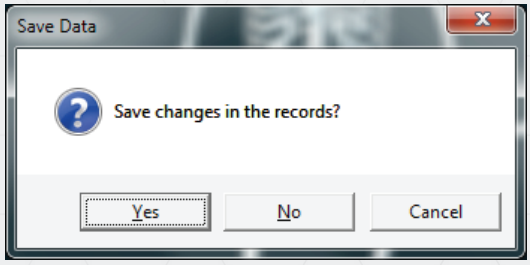
This function allows you to multiply the selected amplitude data of a given channel by any factor:



For example: This function can be used to mathematically “amplify” (scale) the signal up or scale it down to lower values.

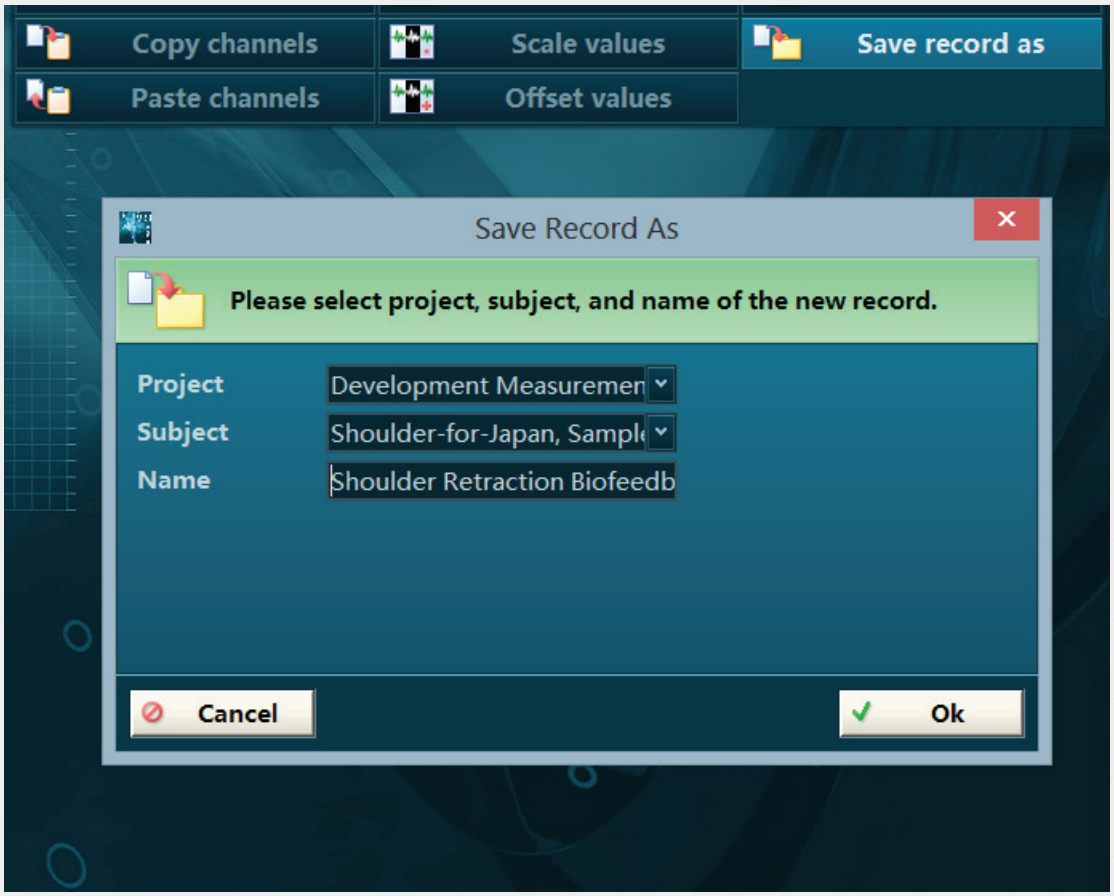
Revert Changes

Any edit operation done thus far on the currently loaded record can be reverted to the original as long as the record is not confirmed to be changed when leaving the Edit/Viewer Menu:



Save Record As

This function allows you to safe an edited record under a new name and keep the original record as it is.

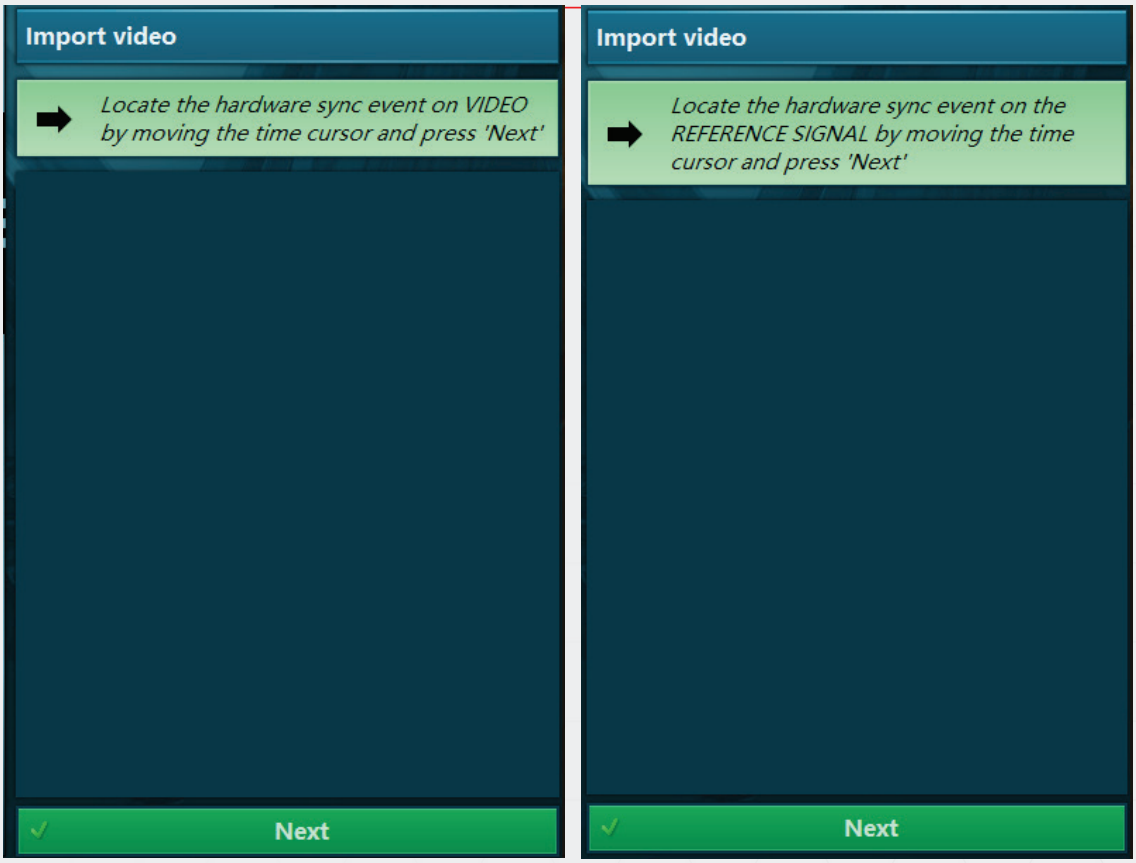


This function is highly recommended for any edited record, because editing operation cannot be restored to original version.

Function can also be used to just duplicate a given record.

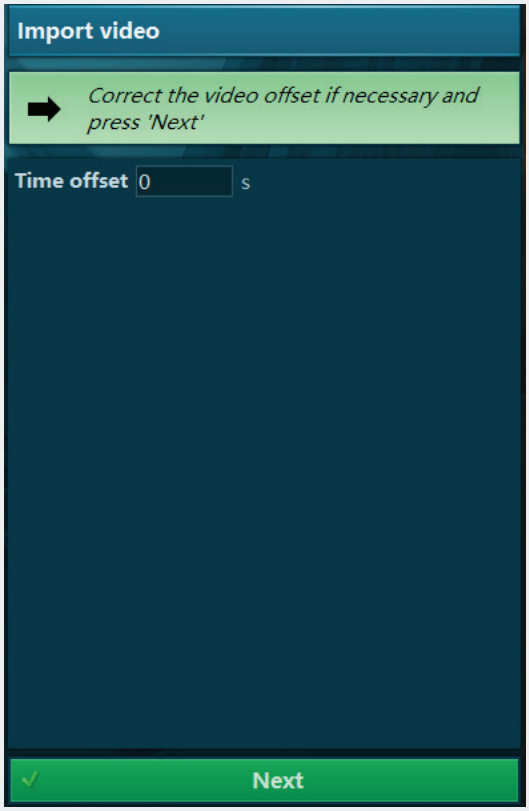
Import Video (only available in myoVIDEO module)

This function allows you to import externally recorded videos to an existing MR3 record. To merge the external video, it is recommended that both video and MR3 record share the same sync information. This is best arranged by connecting the LED Sync light to the myoSYNC synchronization system, and record its illumination with external video right after recording start. You must also turn on the sync channel of the given device so that it is seen as an extra channel in recording. Now external video and MR3-enabled recording can run independently. Later, in the merging dialog of import routine there is a two-step scheme that allows you to align the external video with the internal MR3 recording:



In first dialog on left side there is a possibility to enter a hardware sync (e.g. = the illumination of the sync light) and align it in next step with the sync event shown in the Sync channel of MR3 recording.

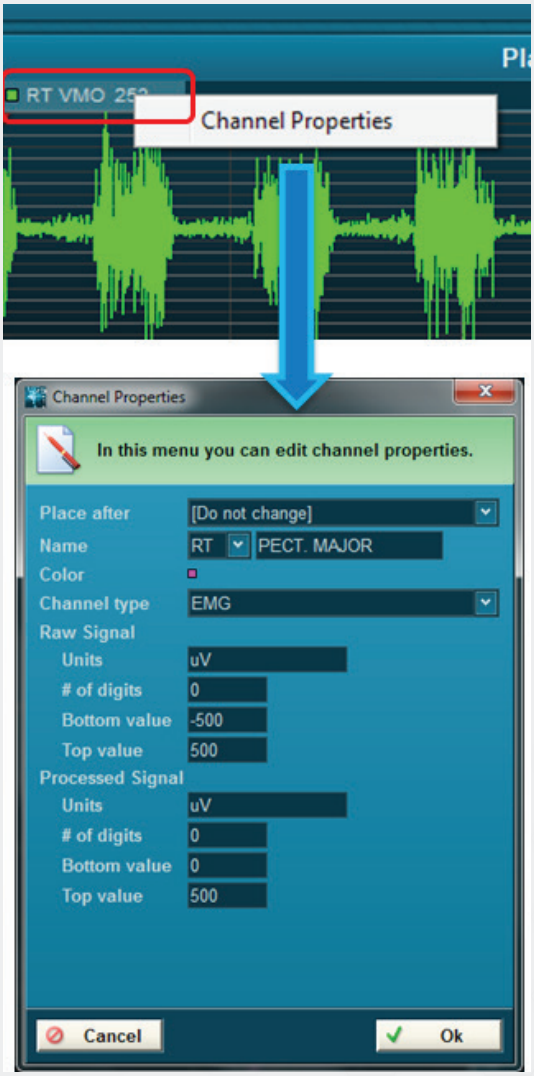
This is shared sync scheme was not available, just skip first two dialog screens by pressing **Next** and optionally enter an offset value if known:



When done press Next to check the result in the record viewer.

Edit Channel Properties

This menu can be started by right clicking on channel name in the signal screens:



Place after can be used to move a selected channel after another one. Use this function to re-order channels.

Name changes the current channel name and side indicator.

Color loads a color palette to define trace colors for this channel.

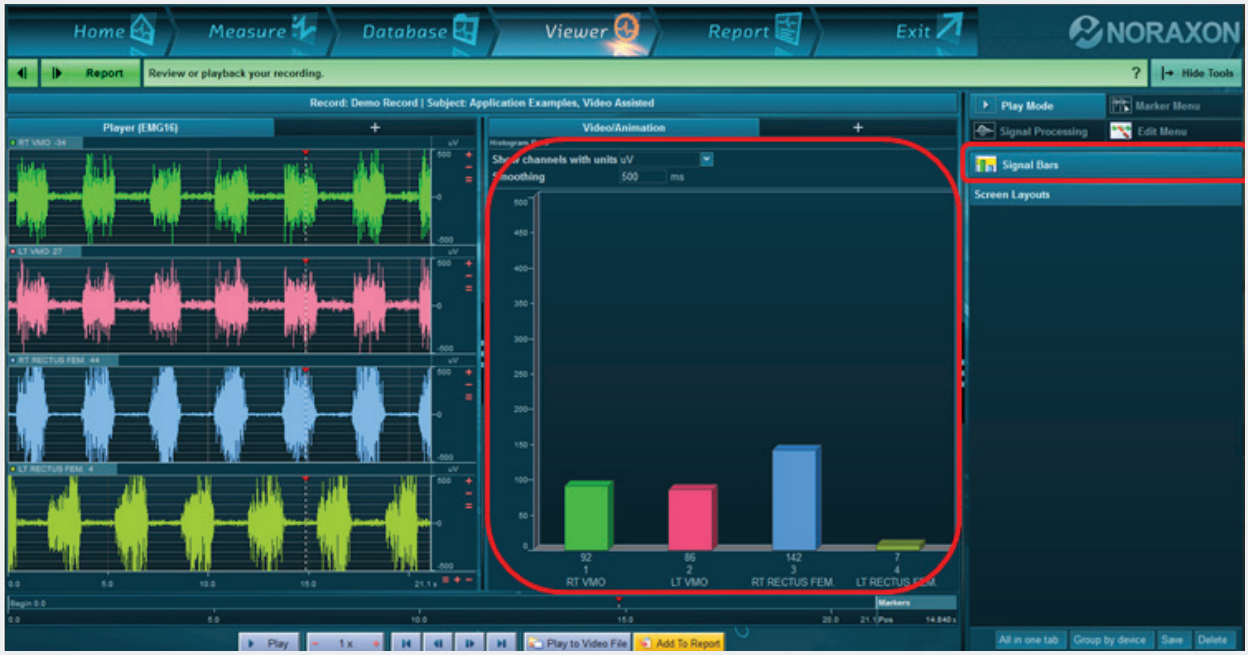
Channel type offers a pull-down list of all available channel types to be selected for the new channel.

Raw Signal / Processed Signal section organizes the amplitude scaling settings for the selected channel.

> **Units** defines the physical channel units.
> **# of digits** is the decimal value when showing the actual amplitude value.
> **Bottom value** is the lowest and **Top value** is the highest amplitude scaling value for the Y-axis.

Signal Bars

This button adds a new screen window showing the amplitude data at cursor position as a bar graph:



Show channels with unit < > – allows the user to select what type of signal/channel will be displayed as a bar graph

Smoothing – the value entered here defines a smoothing interval based on the mean value of this selected interval

7) Record Viewer Screen Layout System

The screen layout system is identical to the one already described in Measure menu.
Please refer to this chapter to learn more about the possibilities to customize signal and animation screens and create, store and load different screen layouts.

Section 9: Report Tab

Introduction

The myoFORCE module is shipped with a universal jump analysis report that can automatically analyze these jump types:

- Drop jump
- Counter movement jump
- Squat jump

To get accurate data it is important to instruct/check the quality of jumps and give precise instructions on how jumps should be performed (see appendix for a jump instruction guide).

From the **Viewer** menu, click on the 

button in the top navigation bar or green Report button in the main action bar:

When done, the **Select Report** menu is opened. Depending on the number of installed modules, a selection of ready to go analysis reports are displayed.

1) Report Module Selection

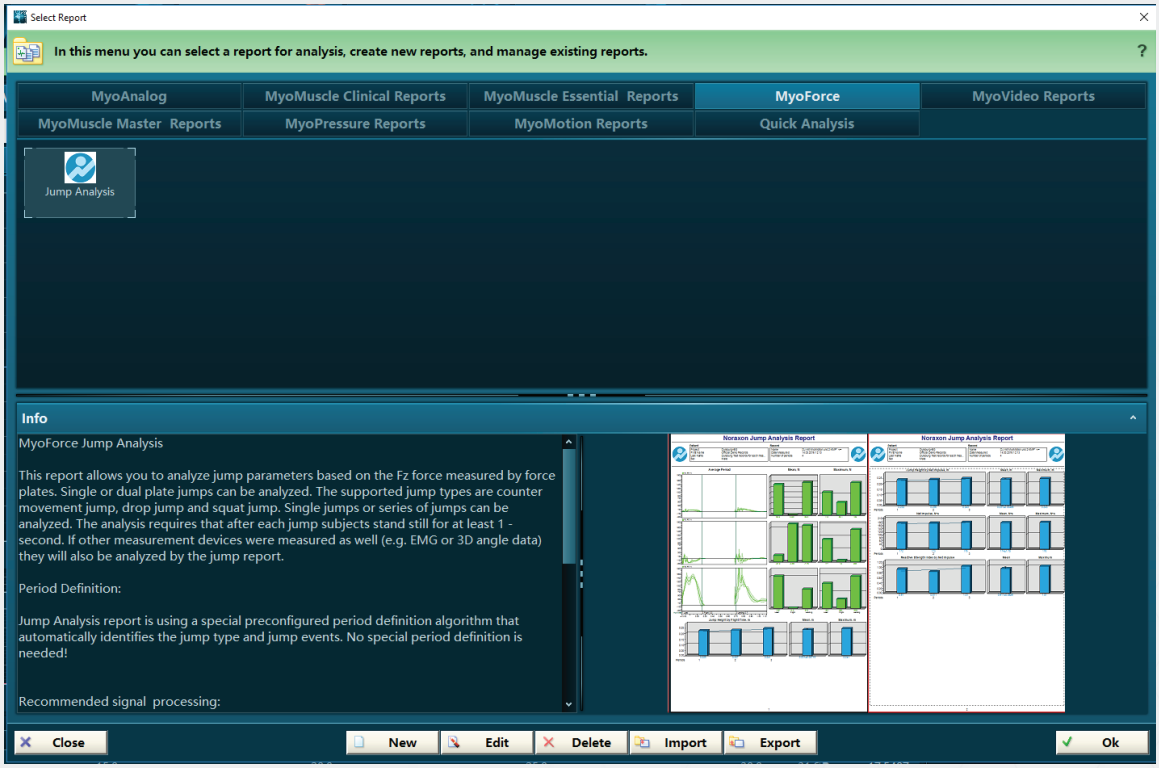
Reports are sorted in seven tabbed sections. Accessibility of these tabs is dependent upon the equipment and modules installed:

- **myoMUSCLE** (Essential, Clinical, Master) – for all myoMUSCLE EMG and sensor records
- **myoMOTION** – for all myoMOTION based 3D kinematic records
- **myoPRESSURE**– for all pressure related records
- **myoVIDEO** – for myoVIDEO 1 and 2 video camera records
- **myoFORCE** – for all 3D force plate related recordings
- **Quick Analysis** – default report for the Viewer based Quick Analysis

The list of available default reports may grow with new program updates.

2) Report Selection

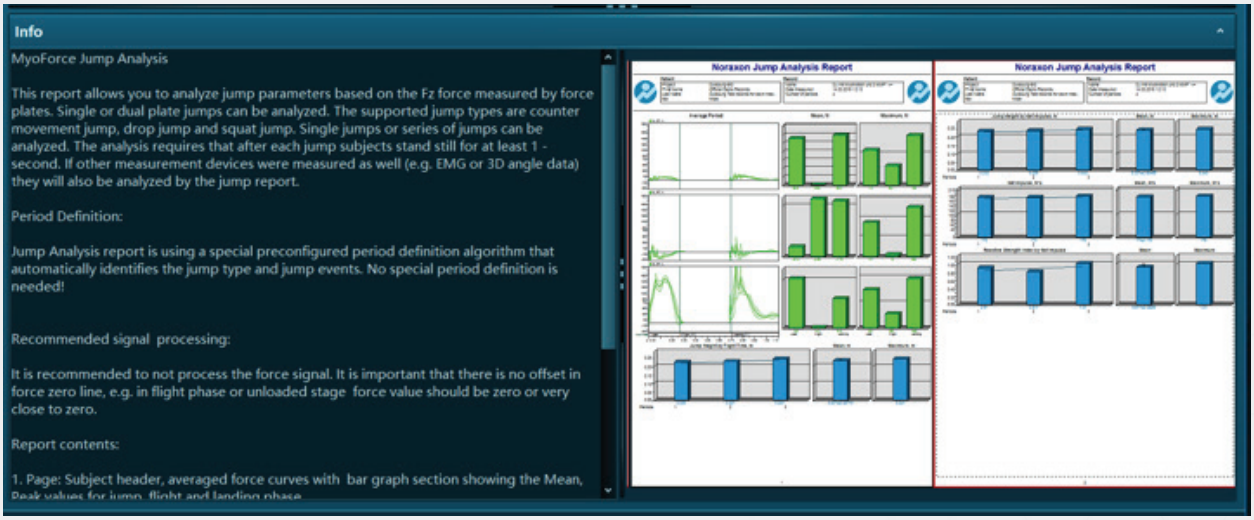
The myoFORCE tab/report section consists of 1 jump analysis report:



Select Jump Analysis and press OK to continue to report.

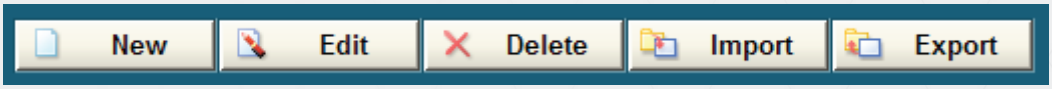
3) Report Info with Report Preview

Here you can find a brief description of the selected report with a description of its main purpose, the way analysis periods are defined (Period Definition), analysis elements, and typical signal processing steps. On the right side of the Info section you can see a preview of the report pages.



NOTE: Please carefully review the information about the predefined period definition selected for each report (marker based, trigger signal based, sub modes, etc.).

4) Select-Report Options

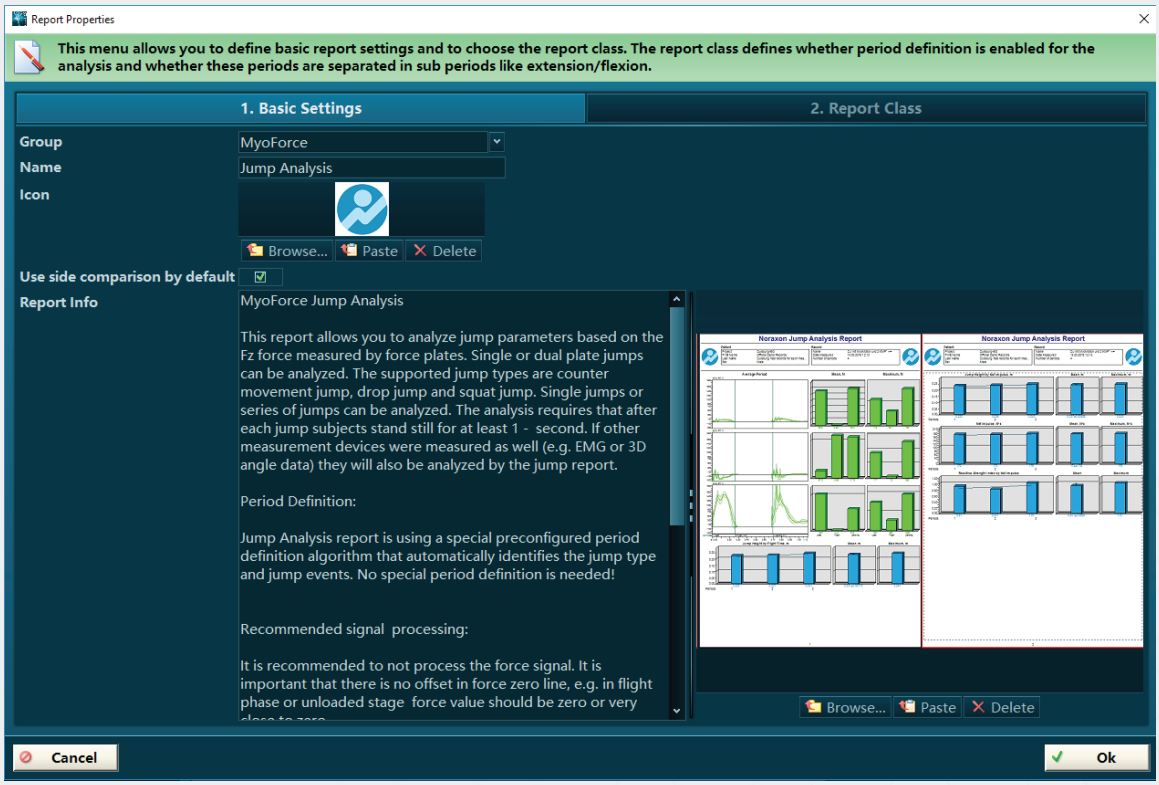


New

You can create your own reports by selecting a report class and manually choosing analysis, layout, and info elements. A description of this Report Generator module is given in an additional document.

Edit – Basic Settings

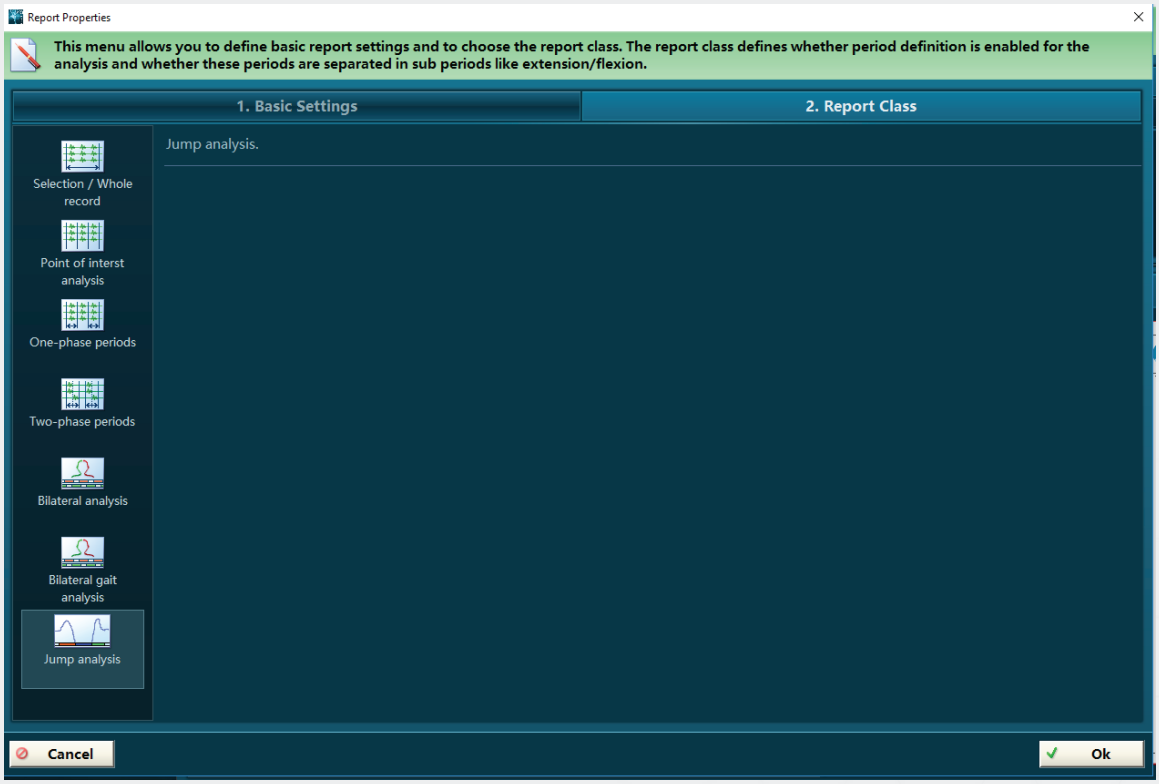
If needed, a report's title, tab sections, description text, and preview window can be changed with this edit menu:



Use side comparison by default – this option will automatically create a comparison overlay plot of left / right signals which is helpful when two force plates for bilateral jumps are used.

Edit – Report Class

The report class editor is meant to be used for experienced report designers only. Reports can vary in complexity in terms of periods and phase definition. For example, some reports do not require any period or phase definition because the whole record or a mouse marked area is analyzed (e.g. Clinical coordination report or Spectrum report). Other reports, like Unilateral Gait in the MyoMuscle Application Reports, need a foot switch triggered period definition with 2 phases (stance and swing phase) to properly analyze the gait cycle. Even more complex are the Bilateral gait setups which add more sub phases to the gait cycle. The current MR3 suite offers six levels of complexity to manage these differing tasks:



Selection / Whole record – The whole record or the mouse marked area will be analyzed.

Point of Interest – Only single points of interest, marked with the button Add to Report in Viewer menu, will be included in the report (designed for Video Analysis).

One-phase periods – A sequence of markers or event based (defined by trigger channels) periods without additional sub phases will be analyzed.

Two-phase periods – A sequence of periods with two sub phases will be analyzed (e.g. extension/flexion, stance/swing phase, etc.). You can freely name the first and second phase (default names are Pre-and Post-event).

Bilateral analysis – This class is designed for left to right comparison analysis in bilateral gait measurements and splits the period definition into left and right side periods.

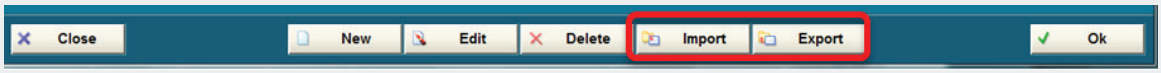
Bilateral Gait analysis – A sub version of Bilateral analysis and needed for myoPRESSURE recordings.

Jump Analysis – A special report class equipped with an automatic jump detection algorithm

Delete

This function will delete a record without a possibility of restoring it. Carefully use this option and consider first making a backup to an external location using the Export function.

Export/Import



Here you can export or import reports from/to external locations such as other HDD drives, network directories, etc. An exported report is automatically stored in a container directory called **Noraxon MR3 data**. To import reports set a path to the location where this directory is located.

NOTE: Do not attempt to change the contents of the **Noraxon MR3** data folder. If you wish to keep track of multiple projects or subjects please create folders for those projects and save the respective **Noraxon MR3** data folder into the individual project folder.

OK

This operates the selected report. Once the correct report has been selected press OK to continue.

After selecting a report, click OK to enter the next step to run a report

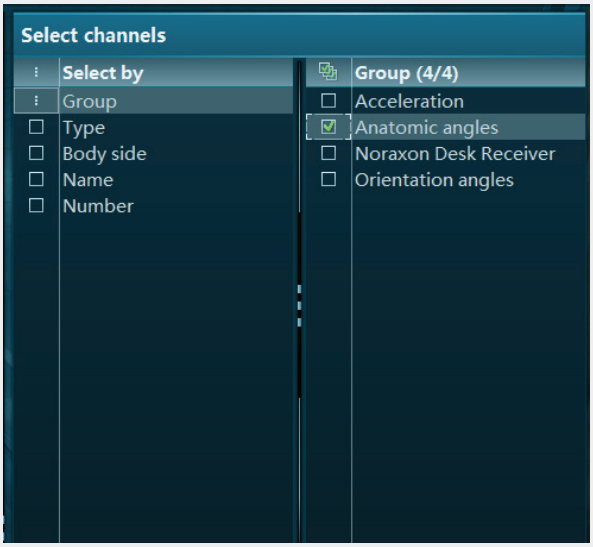
Run a report

Before a report starts, 2 preparational steps are required, which are described below.

Report channel selection step

The Select channels option allows you to specifically select Groups and Types of channels. This feature is especially helpful in multi-device setups with many available measurement channels.

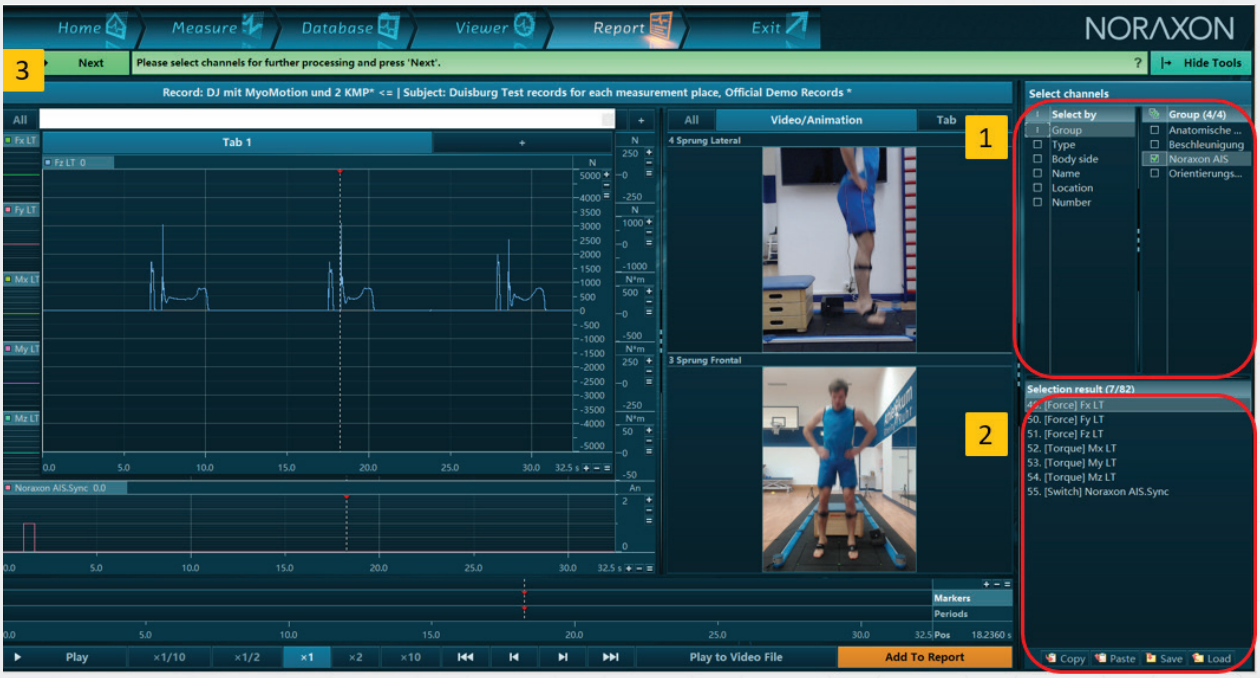
Note: for Jump analysis, at least the Fz force channel must be selected



The following operators are available:

Select by:

Group -- Select channels by register tab groups.
Channel type -- Select channels by type, e.g. EMG, force, etc.
By body side -- Select left or right side labeled channels.
Name -- Selection via muscle, segment name.
Channel number – Select by the channel list number.



When done, click Next in the green main action bar to continue.

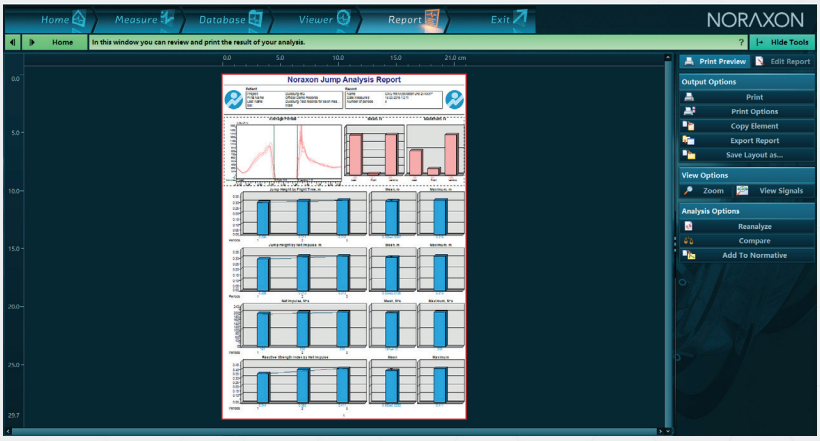
Report Period Definition Step

The jump analysis report is using a special algorithm to detect the jump type as well as the jump phases. To work properly it is important that in squat and CMJ the subject is standing still (=calculation of body weight line), and in all jumps, it is important as well that subjects stand still after each jump (=weight line calculation for DJ). It is recommended to zoom up the Fz channel and control the quality of pre- and post-jump. The jump phases are visualized with 3 colored bars visible in the time line:

Red is impulse generating take off phase, yellow is the flight phase, green is the landing phase to stand still position (=body weight line). At the very end there is another blue phase, which is the global body weight calibration phase. The algorithm is looking for the most stable 1 second period of body weight base line right after the last detected jump.

If jumps must be excluded, drag the jump down to time line area and will be deleted (note the cursor symbol changes). Alternatively, prior to operating step two, a certain portion within the record can be mouse marked, which would automatically limit the jump detection to mouse marked area.

Report Preview

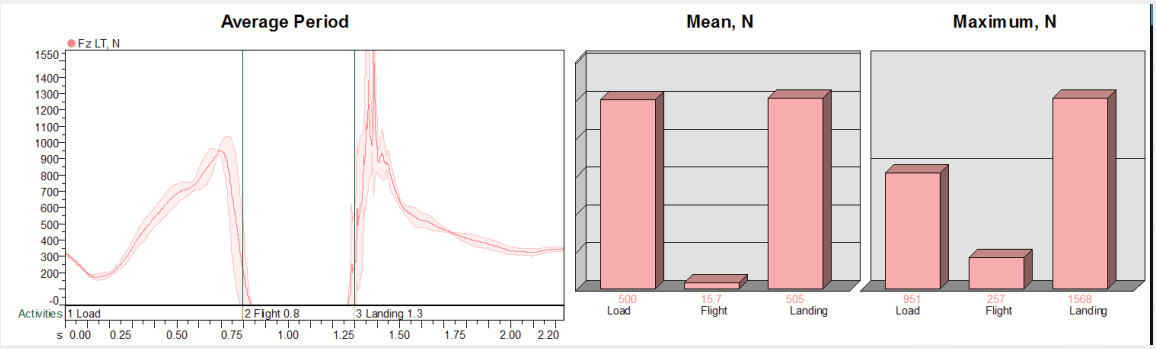


Once a report is chosen and the analysis periods have been set, a preview of the report will be generated. At this point, there is also the option for printing, exporting, or further editing and analysis.

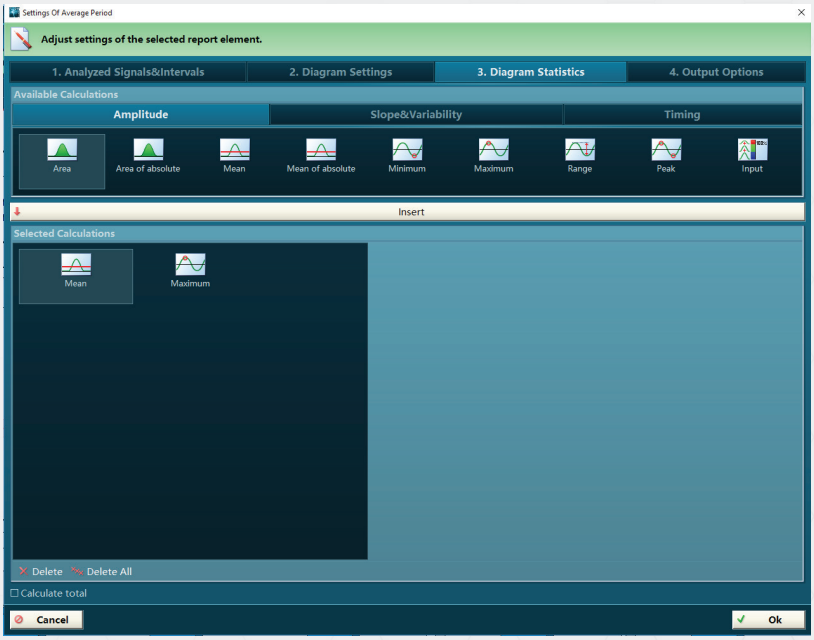
Explanation of Jump Report Elements

The Rump Report consists of two major report elements:

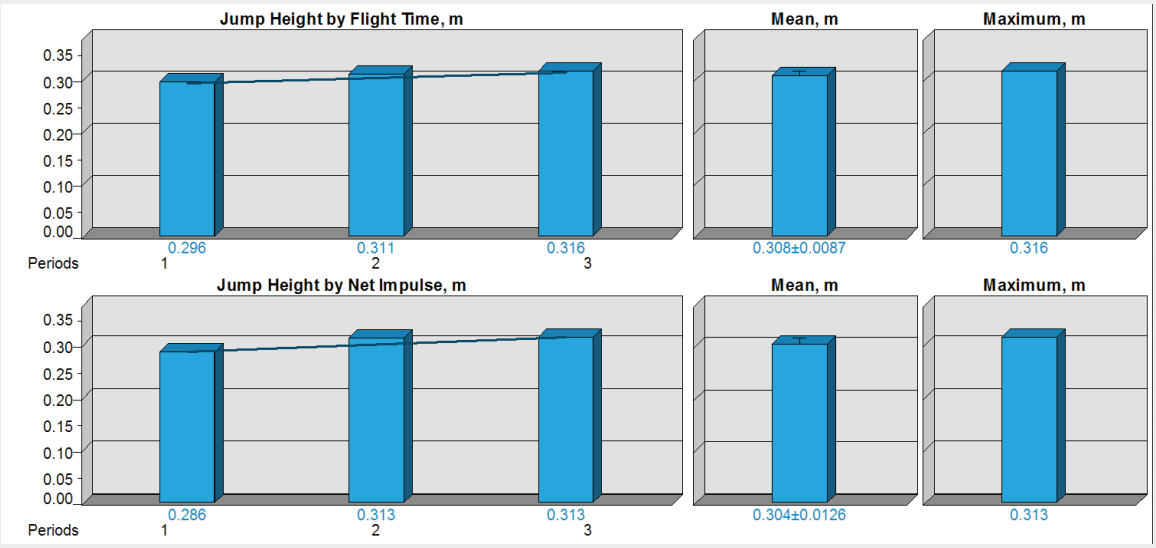
- line graph diagram showing the averaged jump curve of all analyzed jumps +/- 1 standard deviation on left side
- diagram statistics parameters on right side
-



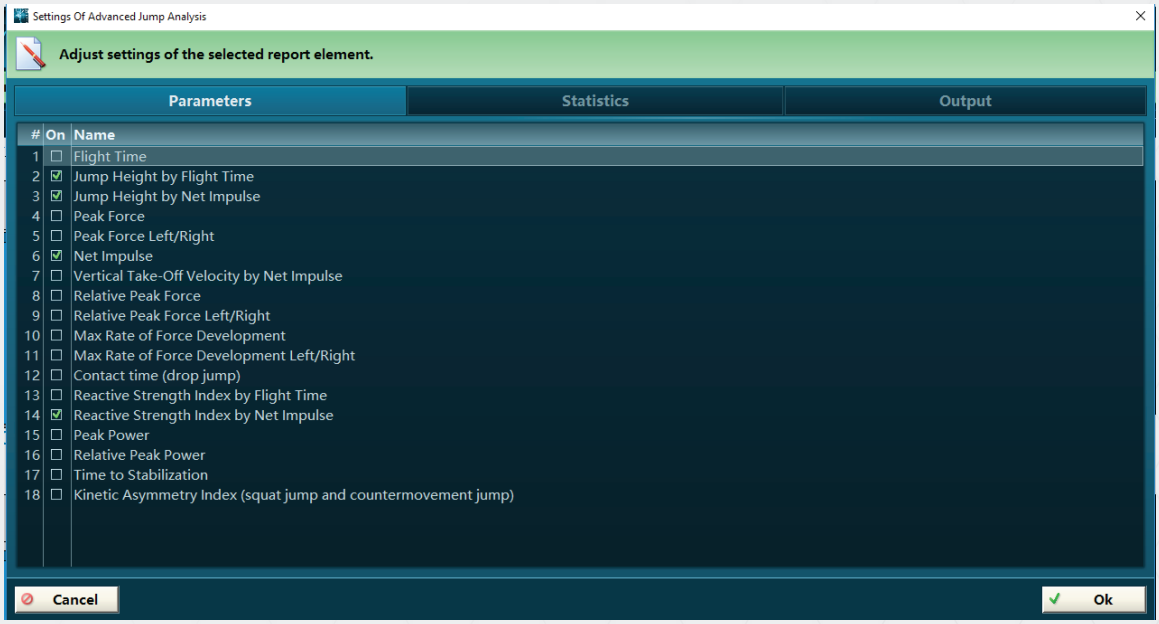
The line diagram can be used to study the characteristics, average jump curve, and variability. Mean and Maximum force value of each jump phase are calculated on the right side. By double clicking on this section the selection of analysis parameters and entering report element setup tab **3) Diagram Statistics** the parameter can be changed:



Jump Report element number two is a bar graph diagram showing the selected jump parameter of each jump as well as 2 statistics parameters on the right side:

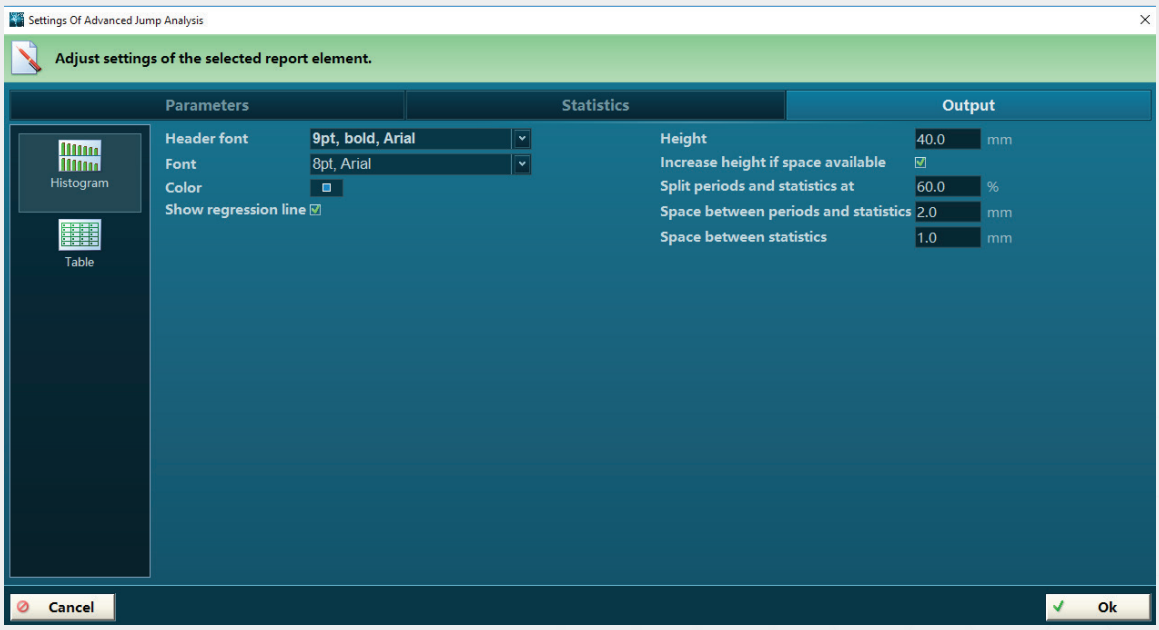


They allow you to automatically calculate the mean and max jump parameter value.
By double clicking on the bar graph diagram a setup menu will open which allows you to select or unselect certain jump calculations:



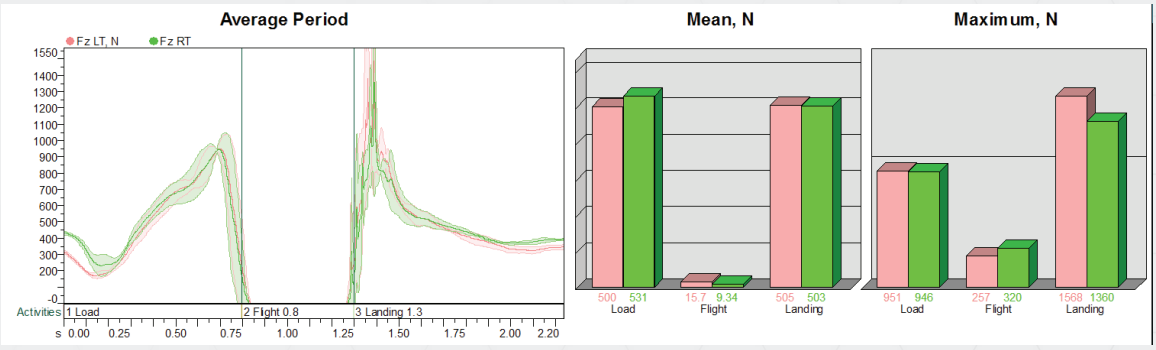
A comprehensive description of jump parameters can be found in the Appendix section.

The register tab **Statistics** allows you to modify the diagram statistics value. The tab Output allows to adjust Layout settings for the diagram, like conversion from bar graph to table for resizing or recoloring elements



2 Force Plate Analysis

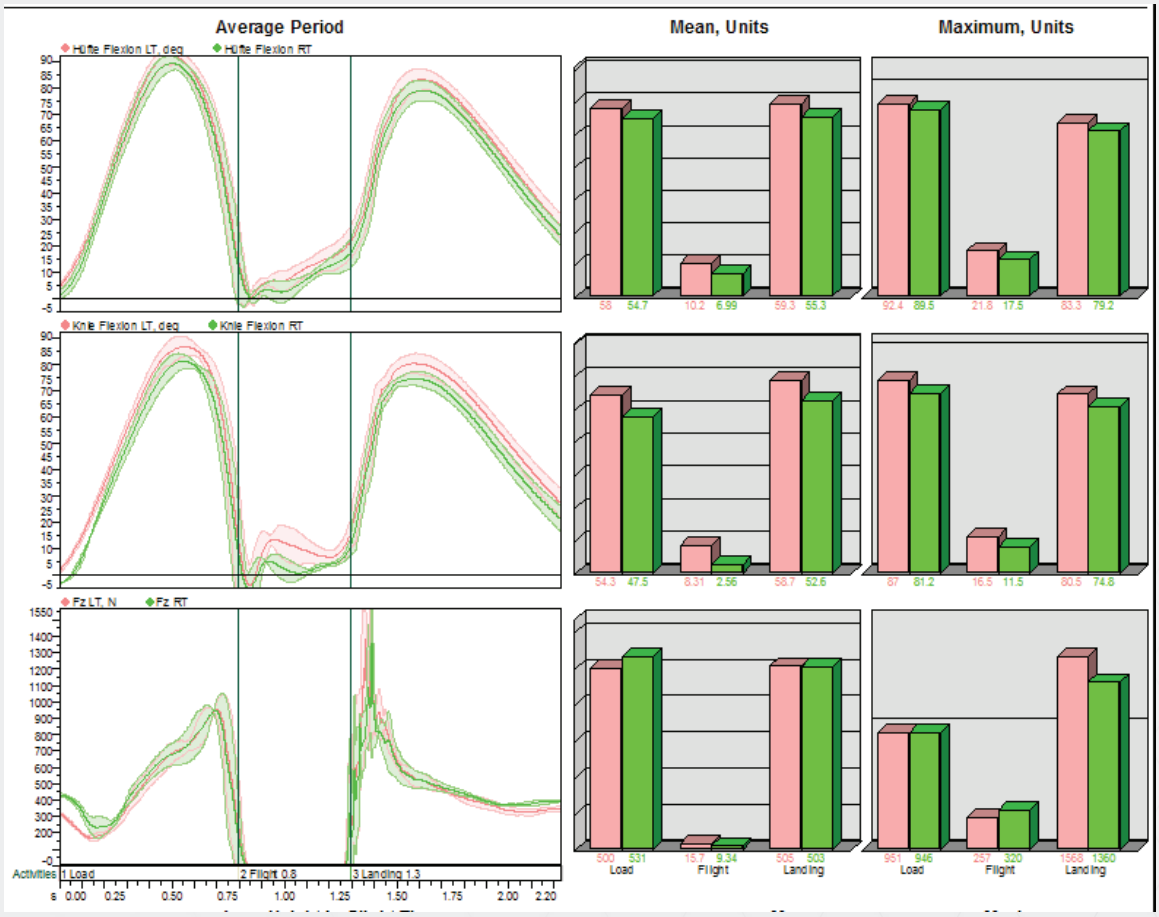
If two force plates where measured to separate left and right leg/force data, the jump analysis report will automatically overlay the force curves:



Make sure that in the step channel selection of report setup both Fz channels are selected.

Multi-device recordings

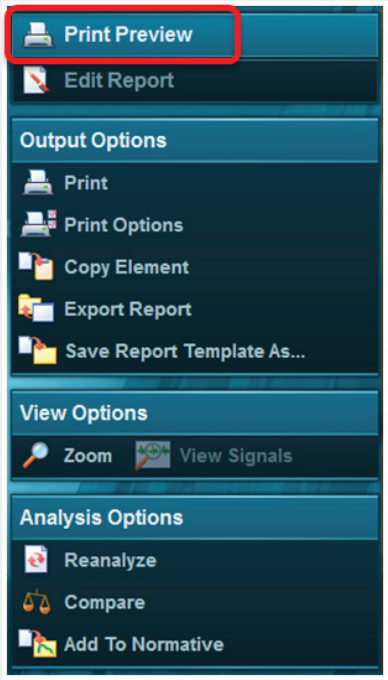
3D Force plate measurements can be combined with other measurement devices like EMG (requires module MyoMuscle), 3D Motion (requires MyoMOTION) and e.g. high speed video. Any measurement channel selected in the report step channel selection will automatically be included in the jump analysis report:



In the example above 2 lower leg kinematic angles were included in the analysis.

Report Right Tool Bar Options

On the right-side tool bar, you will find several helpful report-related options. The report options exist in two modes: Print Preview and Edit Report. The user can toggle between the two to access different report options and customize the report.



Print Preview

The Print Preview mode has three available option groups: Output, View, and Analysis.

Output Options

- **Print/ Print Options** – print the report or format the report including which available printer to print to, page size and orientation, and margin size.
- **Copy Element** – any elements (graphs, tables, etc.) of the report can be selected by clicking on the element. Selecting Copy Element will send the element to the clipboard to allow for pasting into other programs such as word, paint, or excel.
- **Export Report** – sends the report to clipboard or saved as an HTML, Text, or Excel file in a specified location.
- **Save Layout As** – the user can save customized report templates for later use. The original report/layout will stay unchanged.

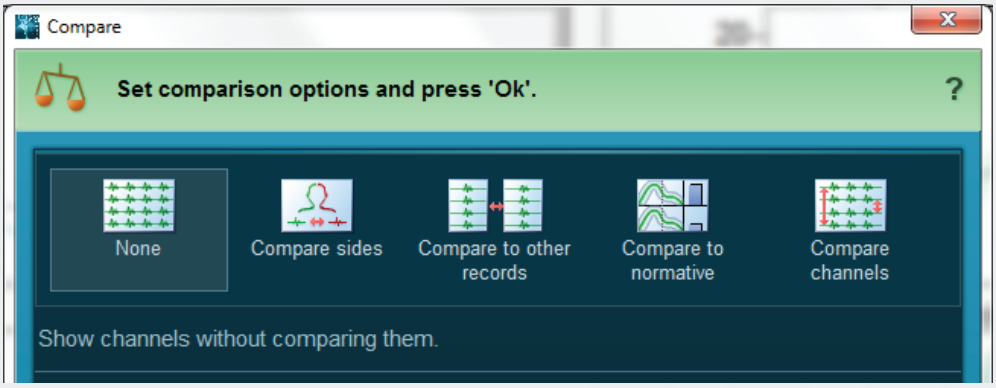
View Options

- **Zoom** – the user can zoom to a percentage of the report, size the report to fit vertically or horizontally, or choose to view the report one or two pages at a time.
- **View Signal** – the user can view the signals of a selected element. Clicking on this will display the selected element in the Viewer window. To return to the report preview, hit the back arrow button or click on the Report tab.

Analysis Options

- **Re-analyze** – This option allows you to modify the report setup steps Channel Selection and Period definition. Reanalyze – will take the user back to the preview Report - Viewer menu to change the channel selection and period definition as described above.

- **Compare** – Click on **Compare** in the right tool bar menu to start the Comparison Menu. MR3 supports four major comparison routines for report data:



- Compare sides
- Compare to other records
- Compare to normative (if available)
- Compare channels (within the same record)

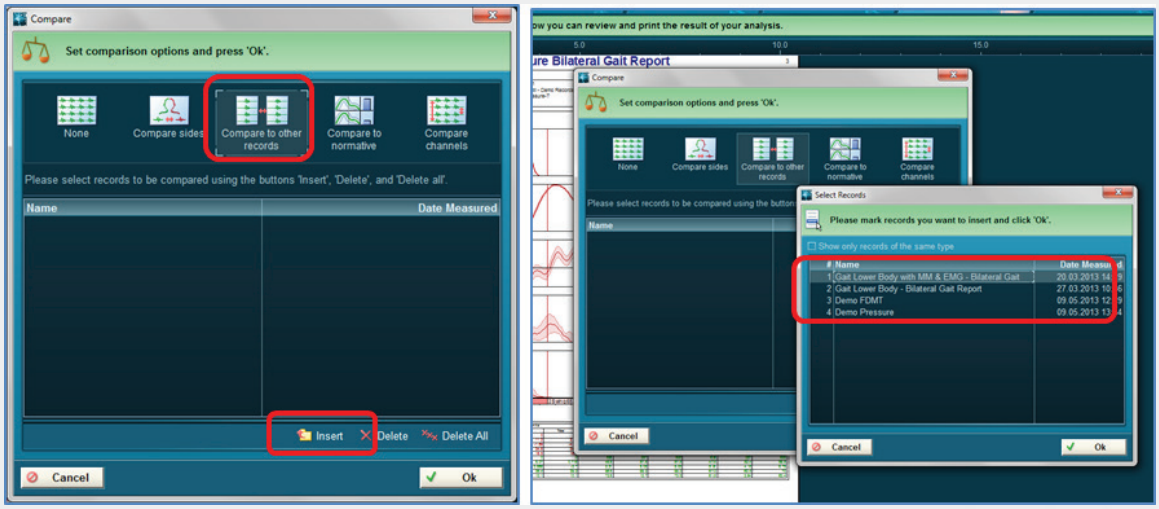
Compare sides

In records measuring both sides of a muscle group, the Measurement Setup Menu allows each muscle group a side indicator (LT and RT, see Measurement Setup Menu). If this comparison mode is chosen, muscles/channels of the same name but with differing side indicator **RT** and **LT** are automatically compared. This function works independently of the channel numbers and arrangements, all channels of the same channel name but with LT and RT indicator are automatically compared!

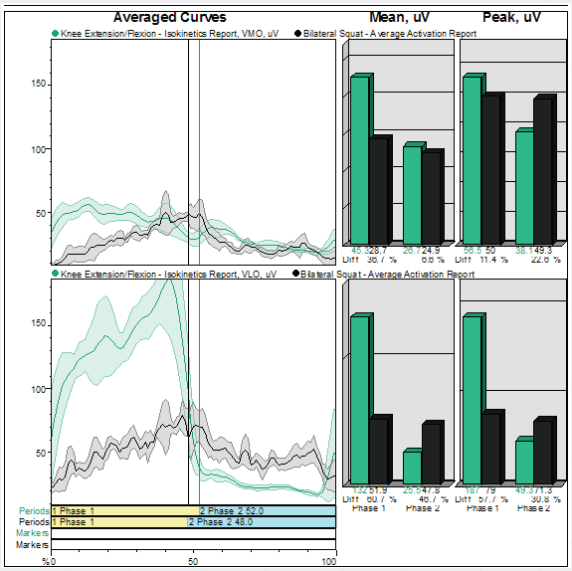
Compare to other records

Compares the record to another record previously stored in the database and analyzed in the Report menu.

Note: In order to compare records, the records must have been analyzed with the same report and report setup options, especially related to period definition.



After confirming the record selection with ✓ **Ok**, both record data will be shown side by side or as an overlaid signal in each report element:



It is possible to compare to several records at the same time.

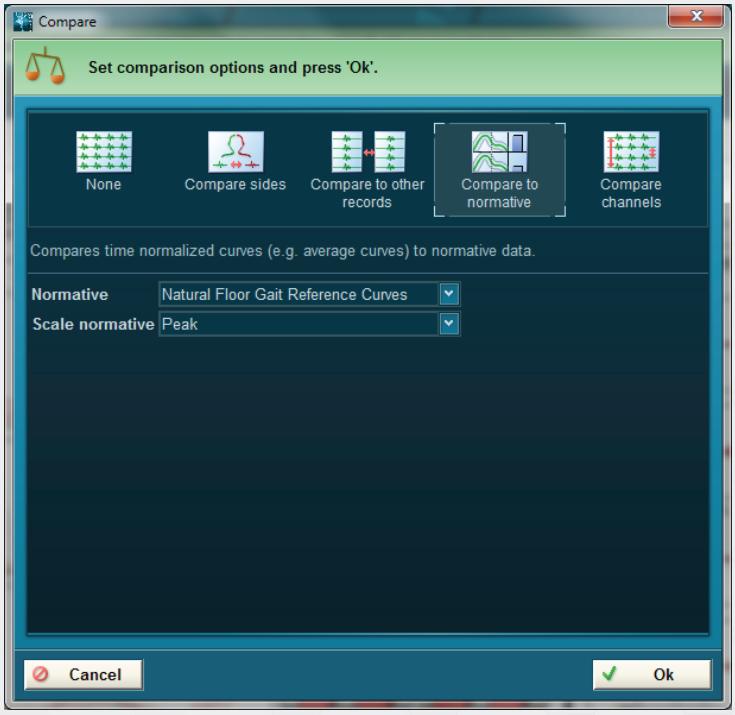
Compare to normative (curves)

This menu option is explained base on EMG recordings. For Jump Analysis, no normative curves/ data are available and if needed they must be created by own research.

MR3's unique normative data system can be used to compare a current record to a normative record. Normative records are usually time normalized averaged curves of single healthy subjects performing a repetitive sequence of the analyzed activity. To create a normative curve, first the single subject performs a repetitive sequence, and then each repetition period in this sequence is averaged in time normalized cycles. Finally, 10 or more of these individual time normalized records are averaged again in MR3's normative database in a group or normative curve. Once done and available in the normative database, a current patient curve can be compared to this group curve to show differences, such as differences in the EMG pattern.

Note: Only records of the same type and analyzed with the same report and channel settings can be compared.

The selection box **Normative** has a pull-down list of all available normative curves available in the current project. Choose a suitable normative record from this list. All normative files that were created with the right tool bar function "Add to normative" are listed here.

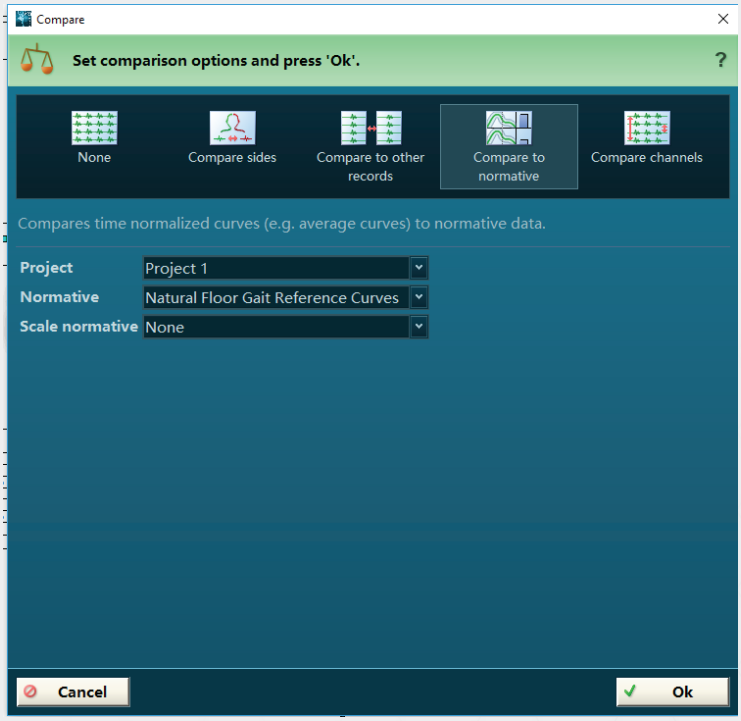


MR3 is equipped with one sample normative file for floor walking.

Scale normative – If EMG based normative data were not amplitude normalized via Signal processing in the Viewer menu, the amplitude data may heavily vary. This function allows you to amplitude normalize both the selected patient record as well as the normative file to its **Peak** or its **Mean** value. This procedure enables a better fit between curves and allows more detailed inspection of curve behavior and other characteristics.

- **Add to Normative** – adds to normatives in the database, or creates and adds to new normatives in the database.

  MR3 has a powerful normative data generator. It is designed for records analyzed with averaged curves reports like Gait, Average Activation, Isokinetics, etc. All these records have a time normalized ensemble average curve with plus/minus 1 SD. The time normalization in cycle from 0 to 100% enables a standardized format for comparison files of different phase duration.



Note: The only normative included with the MR3 software is the Natural Floor Gait Reference Curves. It is meant to be used as demonstration data set and has no diagnostic meaning. All other normative data must be created and saved by the user. Only the time normalized averaged curves are stored to the given normative file.

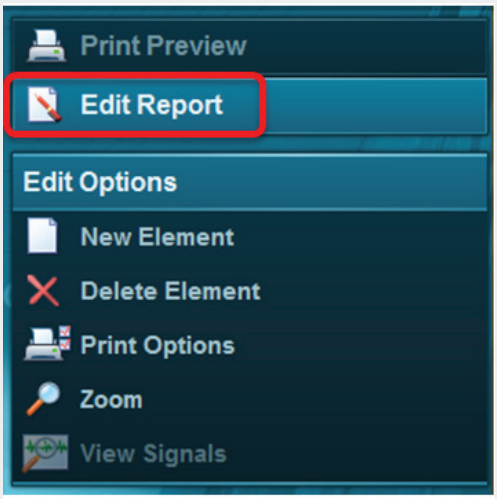
Any successfully generated averaged curve can create a New normative file or it can be added (**Add**) to an existing one:

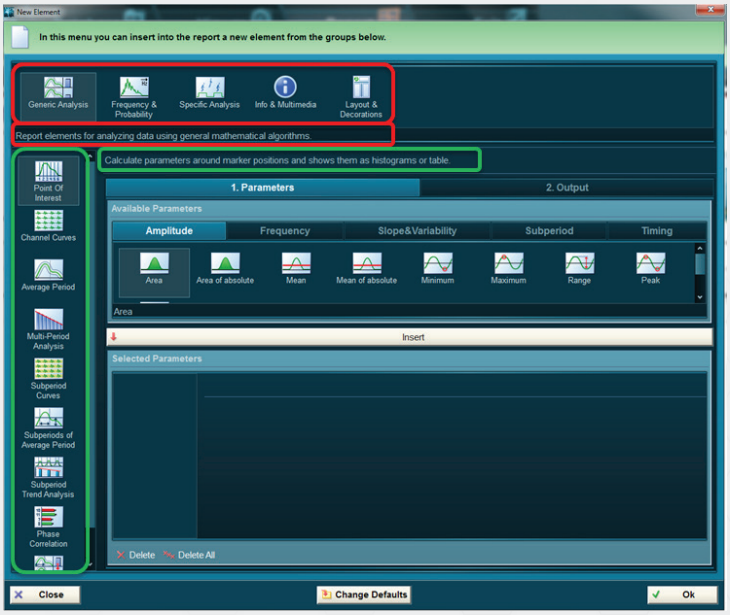
All normative files are listed in the Normative Data base section of the Database menu. They are also available as normative **comparison** files in the report Comparison option described above.

Edit Report

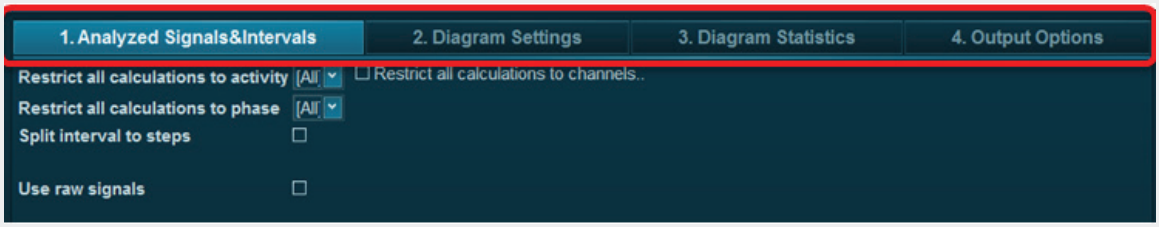
Edit Report options allow the user to customize the report by adding or deleting elements. These edit functions should only be operated by skilled users. This chapter gives a quick overview for report edit functions. For me detailed descriptions please contact the Noraxon support.

- **New Element** – This function creates areas for the user to insert new elements. The user must then double click within one of the dashed areas with the text "Double-click here to insert an element." The new element box will appear:





The user can determine which element they need by reading the descriptions provided in the box. Each element will have different available parameters and output options for how the element information will be displayed, i.e. table, graph, or combination of the two.



Note: Any elements in the report can be edited by double clicking the element.

Delete Element – To remove an element from the report, simply click on the element and select "Delete Element." This will prompt the user with a confirmation message, and if "Yes" is selected the element will be removed from the report.

APPENDICES

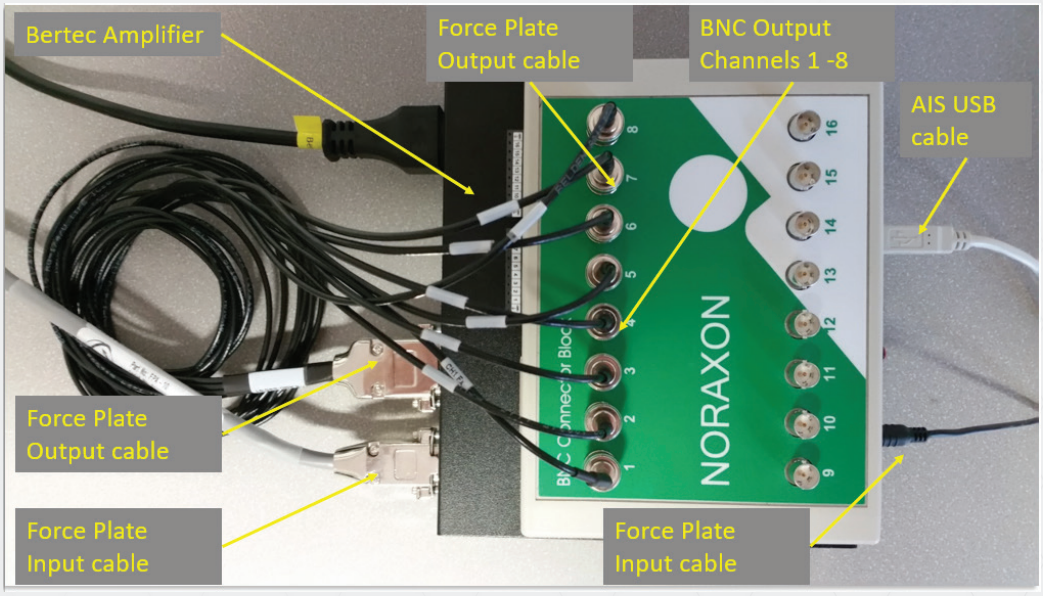
Appendix A: Analog Integration of Bertec 3D force plates

Introduction

Bertec 3D force plates in conjunction with the analog out amplifier support 6 ready to go analog output signals that can directly be connected to Noraxon AIS board. This appendix describes on how to setup the AIS board channels and how to create a measurement configuration for one or two Bertec force plates

A) Connect the Bertec force plate to Noraxon AIS board

1) Connect the force plate output cable the Bertec analog amp input port.
2) Connect the force plate output cable to Noraxon AIS BNC input connectors
3) Connect the MyoSYNC sync cable to Sync in with Rising TTL
4) Connect the AIS board USB cable to the MR3 PC



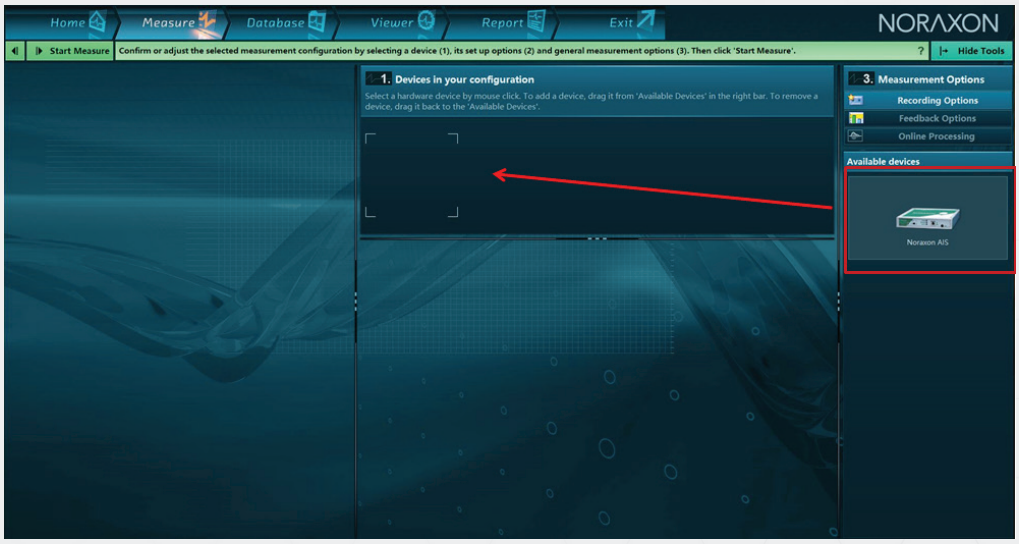
The recommended order of connection channels is:

1= Fx
2= Fy
3= Fz
4= Mx
5= My
6= Mz
7= Zero
8= Sync (if available in the Bertec cable – optional - not needed)

In case of two Bertec plate just continue with channel 9 up to 16 in the same order

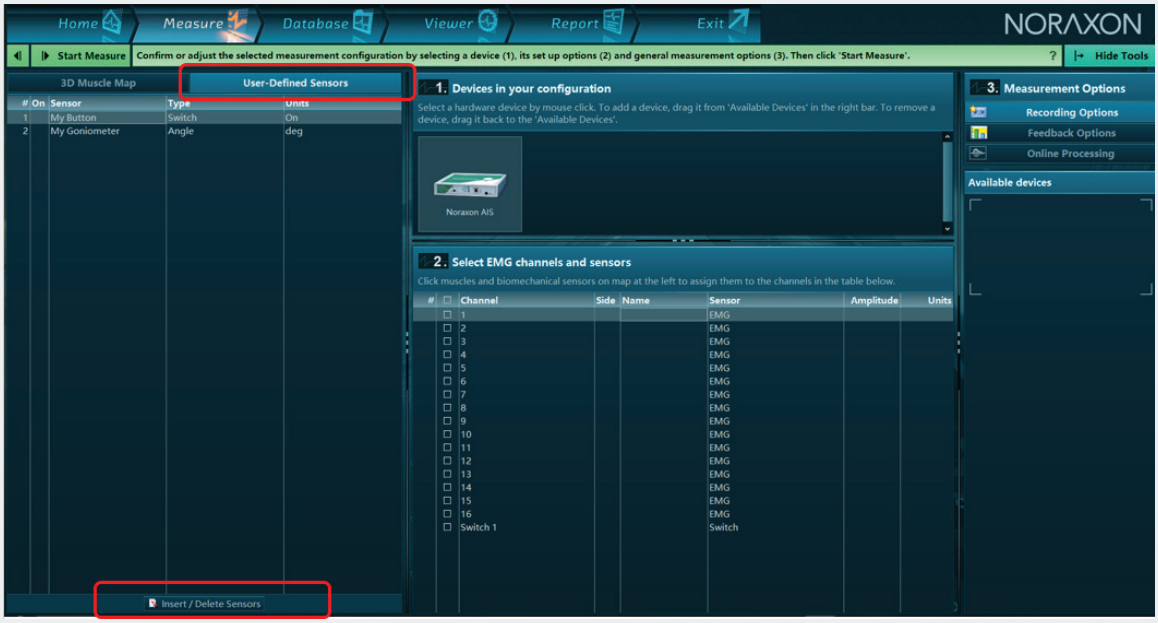
B) Create a measurement setup for Bertec Analog force plate

Starting from **Home screen**, click on **New configuration** and enter the measurement setup screen:

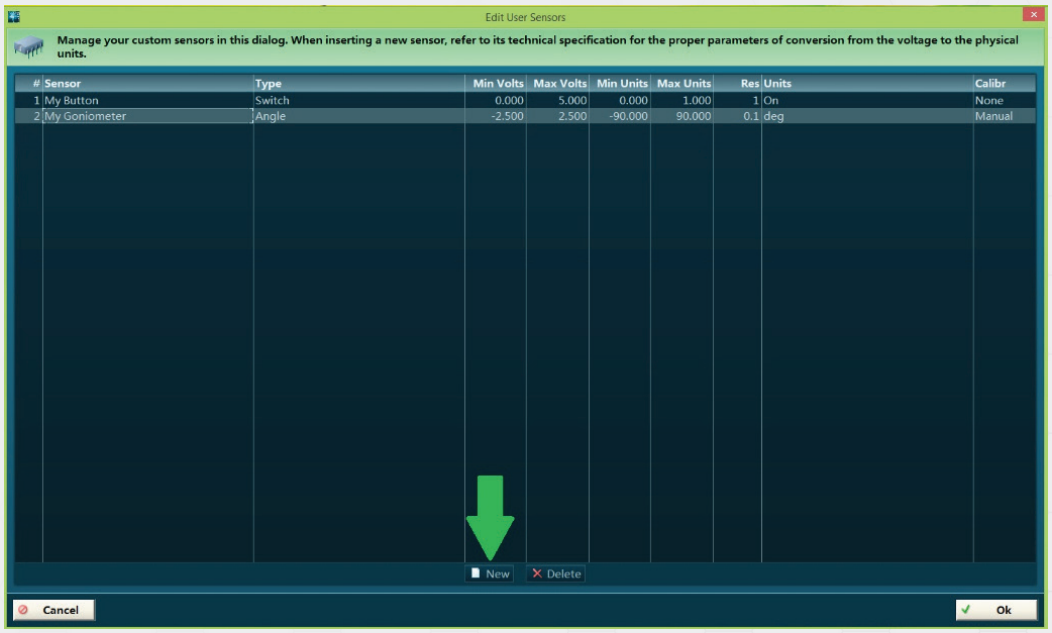


Mouse drag the Noraxon AIS icon from the right tool bar section **Available devices** to the section 1) **Devices in your configuration**.

Select User **Defined Sensors** and press **Insert/Delete** Sensors:



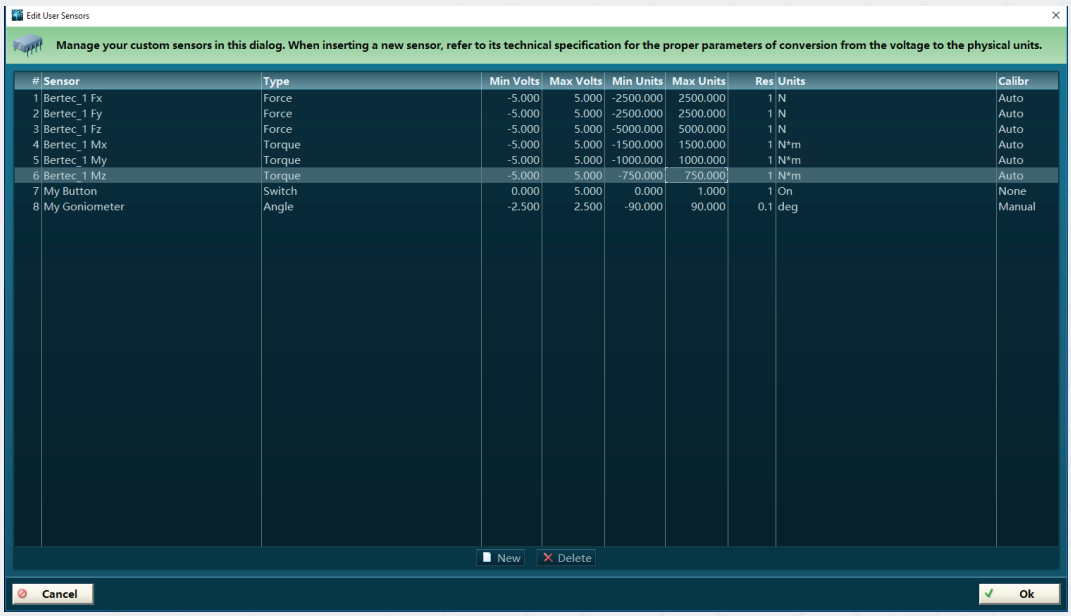
Now a new window pops up to enter your sensors with name, type, voltage and unit range, units and calibration type. Now you can insert new channels by pressing **New**:



For a **Large** (**90cm by 60 cm**) force plate, arrange the table like the above image (with special focus on column Min and Max units):

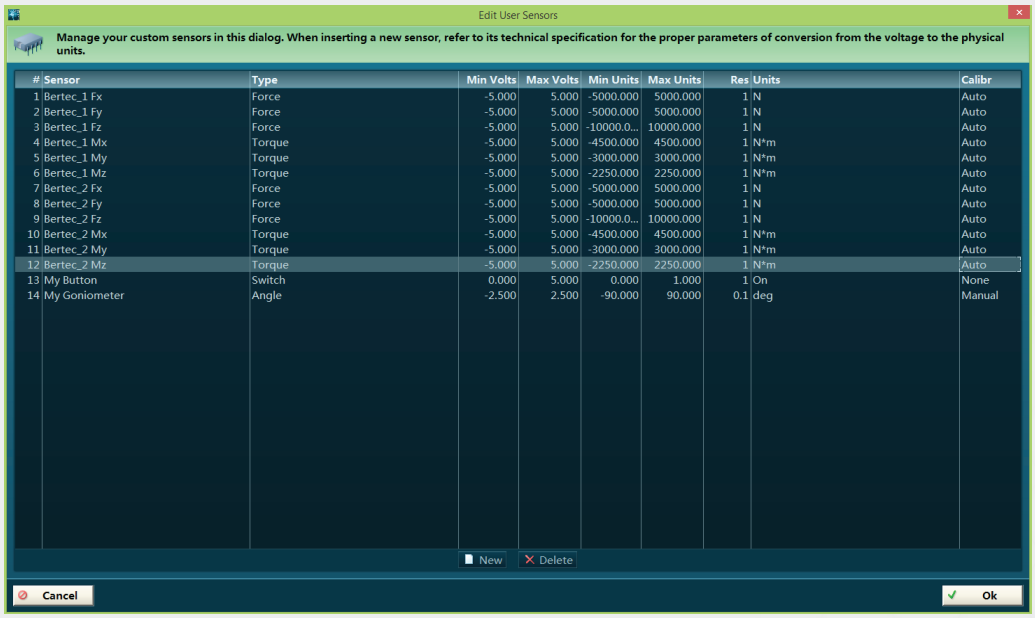
#	Sensor	Type	Min Volts	Max Volts	Min Units	Max Units	Res	Units	Calibr
1	Bertec_1 Fx	Force	-5.000	5.000	-5000.000	5000.000	1	N	Auto
2	Bertec_1 Fy	Force	-5.000	5.000	-5000.000	5000.000	1	N	Auto
3	Bertec_1 Fz	Force	-5.000	5.000	-10000.0...	10000.000	1	N	Auto
4	Bertec_1 Mx	Torque	-5.000	5.000	-4500.000	4500.000	1	N*m	Auto
5	Bertec_1 My	Torque	-5.000	5.000	-3000.000	3000.000	1	N*m	Auto
6	Bertec_1 Mz	Torque	-5.000	5.000	-2250.000	2250.000	1	N*m	Auto
7	My Button	Switch	0.000	5.000	0.000	1.000	1	On	None
8	My Goniometer	Angle	-2.500	2.500	-90.000	90.000	0.1	deg	Manual

For a **Small** (**60cm by 40 cm**) force plate, the table should look like this:



#	Sensor	Type	Min Volts	Max Volts	Min Units	Max Units	Res	Units	Calibr
1	Bertec_1 Fx	Force	-5.000	5.000	-2500.000	2500.000	1	N	Auto
2	Bertec_1 Fy	Force	-5.000	5.000	-2500.000	2500.000	1	N	Auto
3	Bertec_1 Fz	Force	-5.000	5.000	-5000.000	5000.000	1	N	Auto
4	Bertec_1 Mx	Torque	-5.000	5.000	-1500.000	1500.000	1	N*m	Auto
5	Bertec_1 My	Torque	-5.000	5.000	-1000.000	1000.000	1	N*m	Auto
6	Bertec_1 Mz	Torque	-5.000	5.000	-750.000	750.000	1	N*m	Auto
7	My Button	Switch	0.000	5.000	0.000	1.000	1	On	None
8	My Goniometer	Angle	-2.500	2.500	-90.000	90.000	0.1	deg	Manual

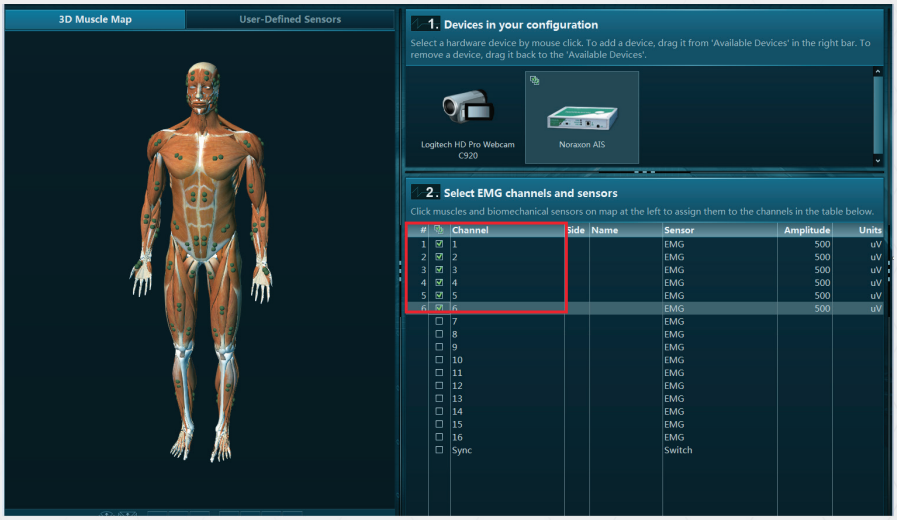
In case of using 2 plates repeat this table but use the sensor name **Bertec_2**, e.g.:



#	Sensor	Type	Min Volts	Max Volts	Min Units	Max Units	Res	Units	Calibr
1	Bertec_1 Fx	Force	-5.000	5.000	-5000.000	5000.000	1	N	Auto
2	Bertec_1 Fy	Force	-5.000	5.000	-5000.000	5000.000	1	N	Auto
3	Bertec_1 Fz	Force	-5.000	5.000	-10000.0...	10000.000	1	N	Auto
4	Bertec_1 Mx	Torque	-5.000	5.000	-4500.000	4500.000	1	N*m	Auto
5	Bertec_1 My	Torque	-5.000	5.000	-3000.000	3000.000	1	N*m	Auto
6	Bertec_1 Mz	Torque	-5.000	5.000	-2250.000	2250.000	1	N*m	Auto
7	Bertec_2 Fx	Force	-5.000	5.000	-5000.000	5000.000	1	N	Auto
8	Bertec_2 Fy	Force	-5.000	5.000	-5000.000	5000.000	1	N	Auto
9	Bertec_2 Fz	Force	-5.000	5.000	-10000.0...	10000.000	1	N	Auto
10	Bertec_2 Mx	Torque	-5.000	5.000	-4500.000	4500.000	1	N*m	Auto
11	Bertec_2 My	Torque	-5.000	5.000	-3000.000	3000.000	1	N*m	Auto
12	Bertec_2 Mz	Torque	-5.000	5.000	-2250.000	2250.000	1	N*m	Auto
13	My Button	Switch	0.000	5.000	0.000	1.000	1	On	None
14	My Goniometer	Angle	-2.500	2.500	-90.000	90.000	0.1	deg	Manual

Once all sensor data are entered, press OK to confirm and store all settings and go back to measurement setup screen.

Now select 6 channels for a single force plate. For 2 force plates please select 12 channels. **ATTENTION**: The selected channels **MUST** agree with connected channel numbers on the NORAXON AIS Board.



#	Channel	Side	Name	Sensor	Amplitude	Units
1	1			EMG	500	uV
2	2			EMG	500	uV
3	3			EMG	500	uV
4	4			EMG	500	uV
5	5			EMG	500	uV
6	6			EMG	500	uV
	7			EMG		
	8			EMG		
	9			EMG		
	10			EMG		
	11			EMG		
	12			EMG		
	13			EMG		
	14			EMG		
	15			EMG		
	16			EMG		
	Sync			Switch		

In the next step, double click on the Sensor type (red box) and select the Sensors as shown in the drop-down shortlist. The columns 'Amplitude' and 'Unit' will automatically be populated.

Also enter the names Fx, Fy, Fz, Mx, My, Mz (green box) for the corresponding selected channels. This is especially important for the force vector overlay function!

2. Select EMG channels and sensors

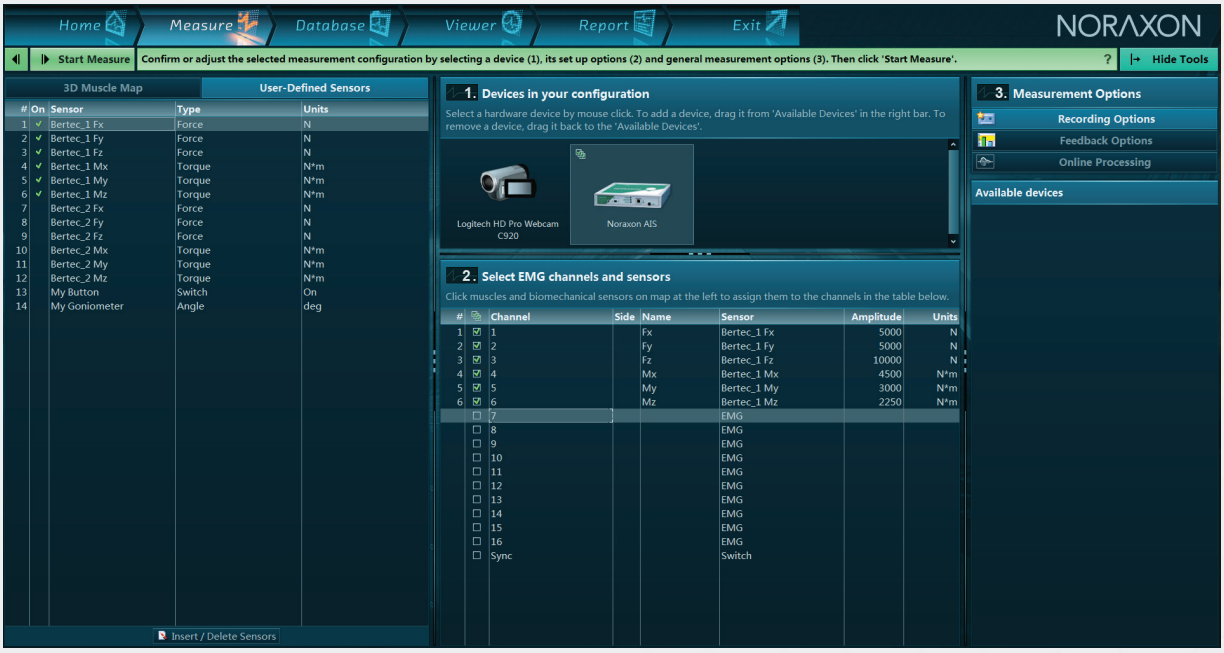
Click muscles and biomechanical sensors on map at the left to assign them to the channels in the table below.

#		Channel	Side	Name	Sensor	Amplitude	Units
1	☑	1		Fx	Bertec_1 Fx	2500	N
2	☑	2		Fy	Bertec_1 Fy	2500	N
3	☑	3		Fz	Bertec_1 Fz	5000	N
4	☑	4		Mx	Bertec_1 Mx	1500	N*m
5	☑	5		My	Bertec_1 My	1000	N*m
6	☑	6		Mz	Bertec_1 Mz	750	N*m

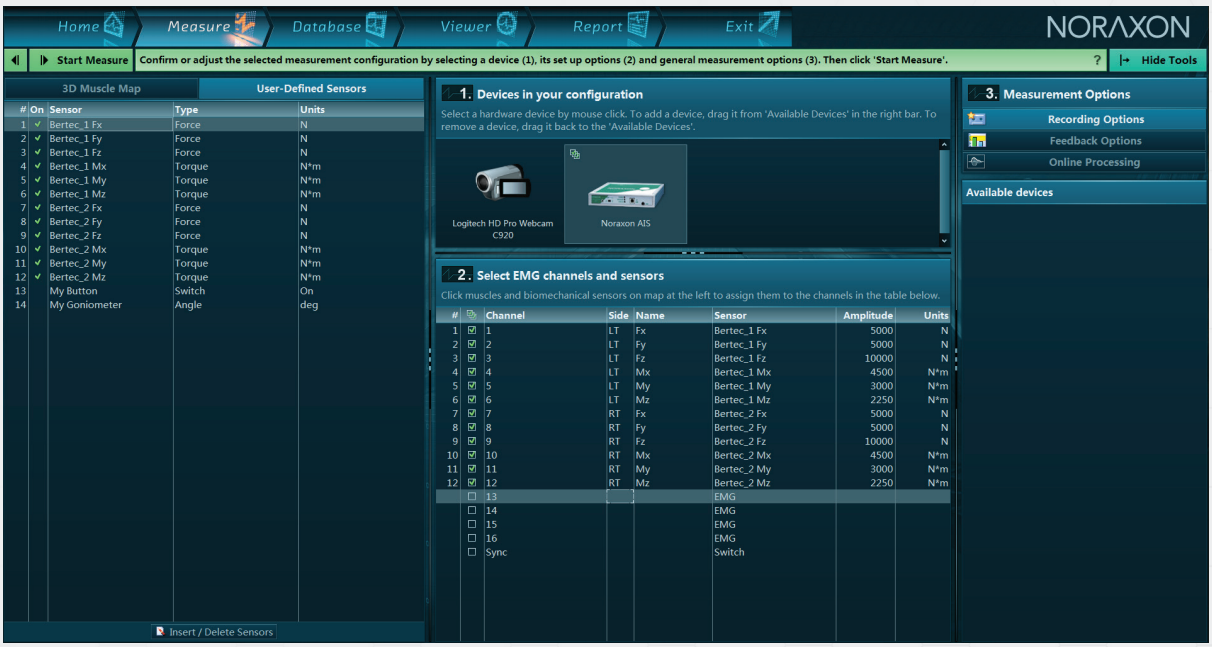
For two force plates: In addition to the setup for a single force plate, also select either LT for the left or RT for the right force plate, depending on the hardware layout.

#		Channel	Side	Name	Sensor	Amplitude	Units
1	☑	1	LT	Fx	Bertec_1 Fx	2500	N
2	☑	2	LT	Fy	Bertec_1 Fy	2500	N
3	☑	3	LT	Fz	Bertec_1 Fz	5000	N
4	☑	4	LT	Mx	Bertec_1 Mx	1500	N*m
5	☑	5	LT	My	Bertec_1 My	1000	N*m
6	☑	6	LT	Mz	Bertec_1 Mz	750	N*m
7	☑	7	RT	Fx	Bertec_2 Fx	2500	N
8	☑	8	RT	Fy	Bertec_2 Fy	2500	N
9	☑	9	RT	Fz	Bertec_2 Fz	5000	N
10	☑	10	RT	Mx	Bertec_2 Mx	1500	N*m
11	☑	11	RT	My	Bertec_2 My	1000	N*m
12	☑	12	RT	Mz	Bertec_2 Mz	750	N*m

The screen should now look like this for a setup with one force plate



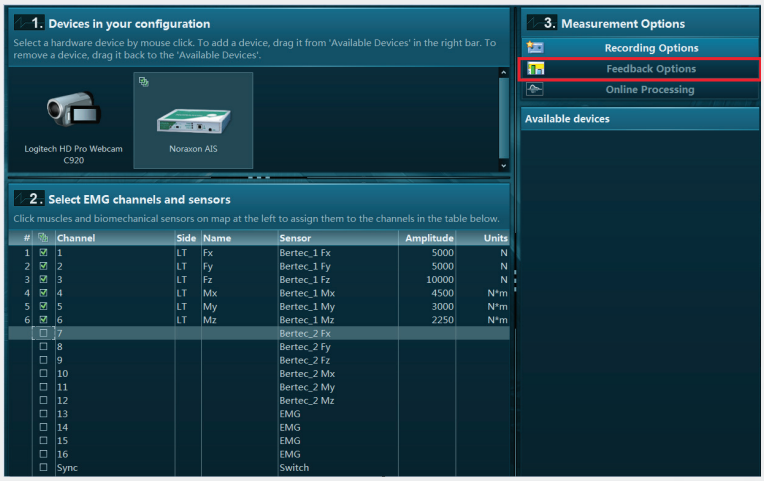
For two force plates:



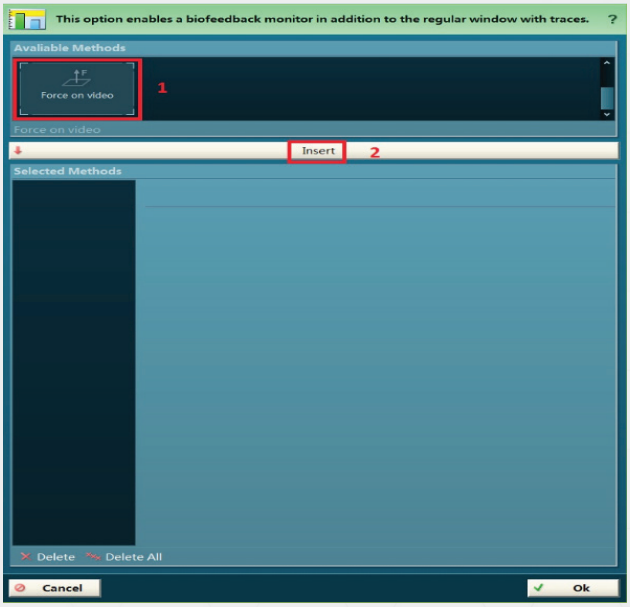
Now the setup is ready for measurements and you can press **Start Measure to start a measurement.**

Real time force vector overlay

Note: This function requires the MyoVIDEO Module

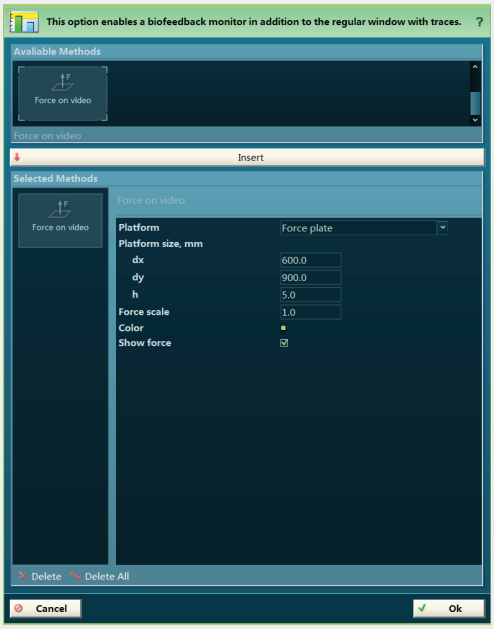


2. In the following you will get instructions to integrate the force vector overlay function.
2.1 Press “Feedback Options”:



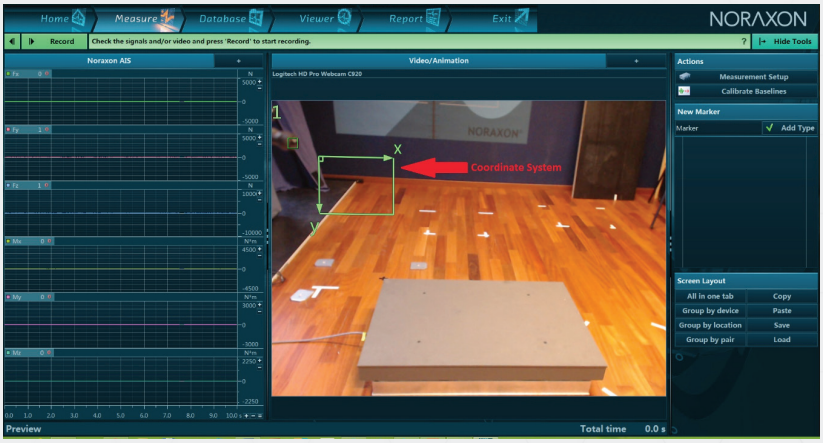
2.2 Now a new window pops up to enter different feedback options. Please select “Force on Video” and press “Insert”:

Please enter the dimensions of the force plate in mm. After this your screen should look like the following image

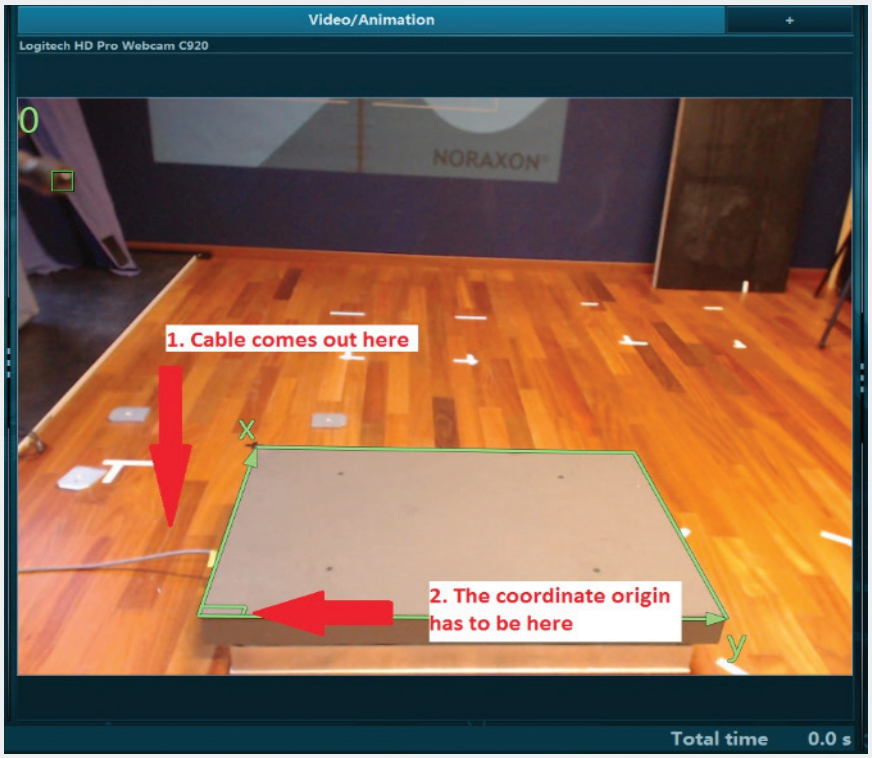


Please press “Ok” and start the measurement.

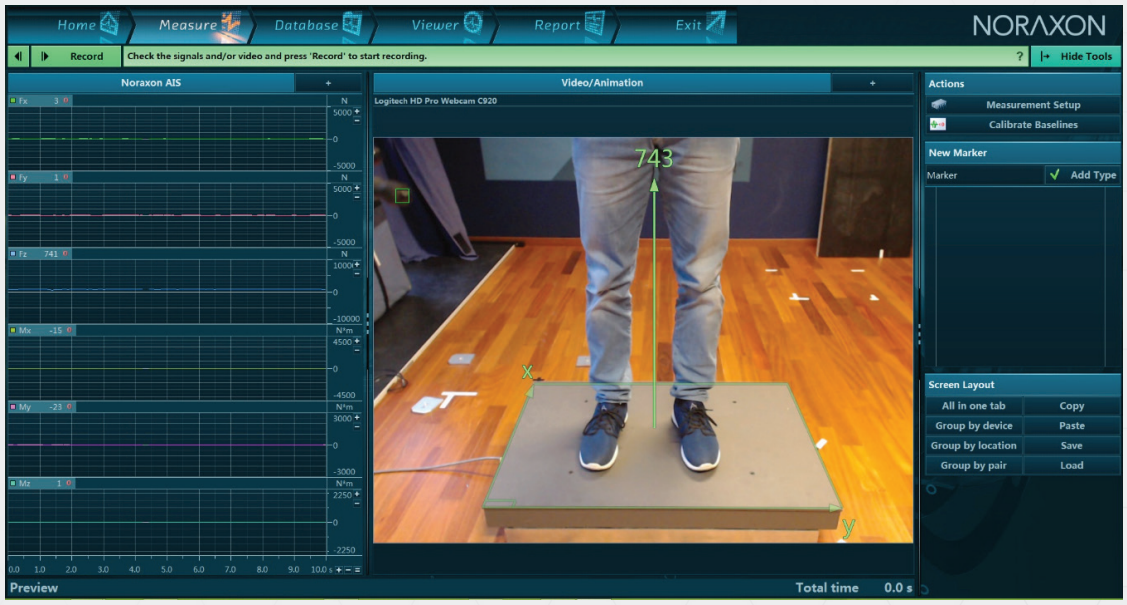
2.3 Your screen will look like this:



Adjust the corners of the green frame as perfect as possible to the corners of the force plate:



Congratulations! You can start now with your measurements.



Appendix B: Analog Integration of AMTI 3D force plates

Introduction

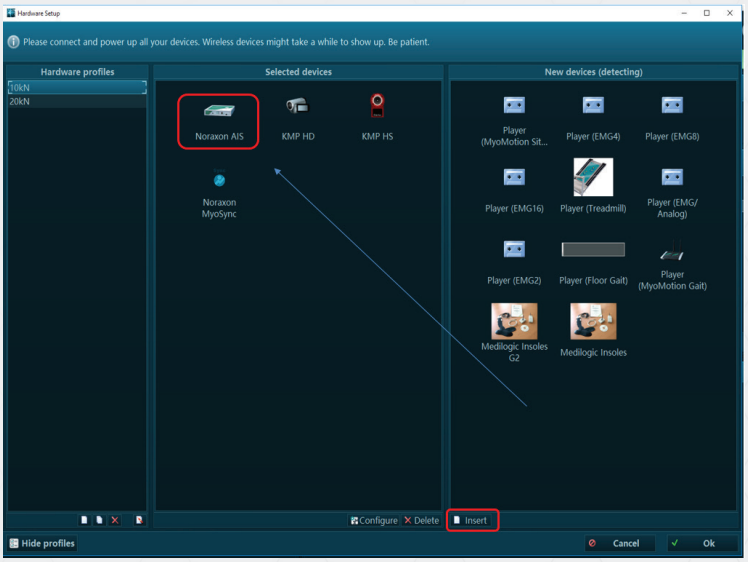
On default AMTI 3D force plates output 8 signals. These signals need to be calculated to the 3 resulting forces and 3 moments. This calculation is done in special mode of Noraxon AIS board. This mode converts the AIS board from regular AD input board to a AMTI plate specific input board with above mentioned calculations as well as a calibration matrix table which is required to receive correct physical dimensions. This calibration data is specified and delivered with each AMTI plate and need to be manually entered to the AMTI plate setup menu.

A) Instructions to connect an AMTI plate via analog output cable

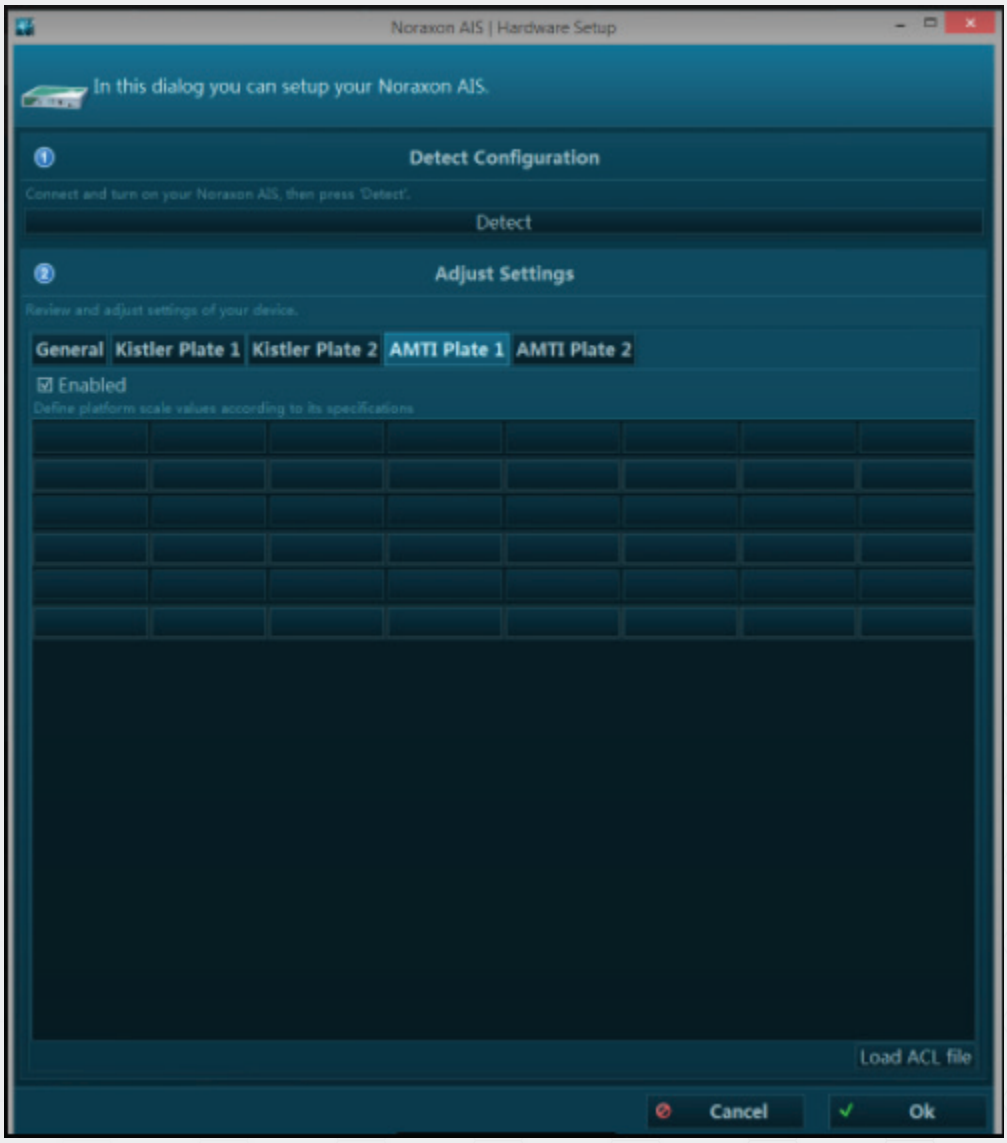
1. Connect the AMTI plates via DB25 or BNC to the Noraxon AIS board/ DB 25 analog input connector
2. Connect the sync cable coming from the MyoSYNC unit to the sync in port of AIS – switched to rising TTL
3. Connect the USB output cable from the AIS to the MR3 PC

B) Setup of Noraxon AIS board in AMTI mode

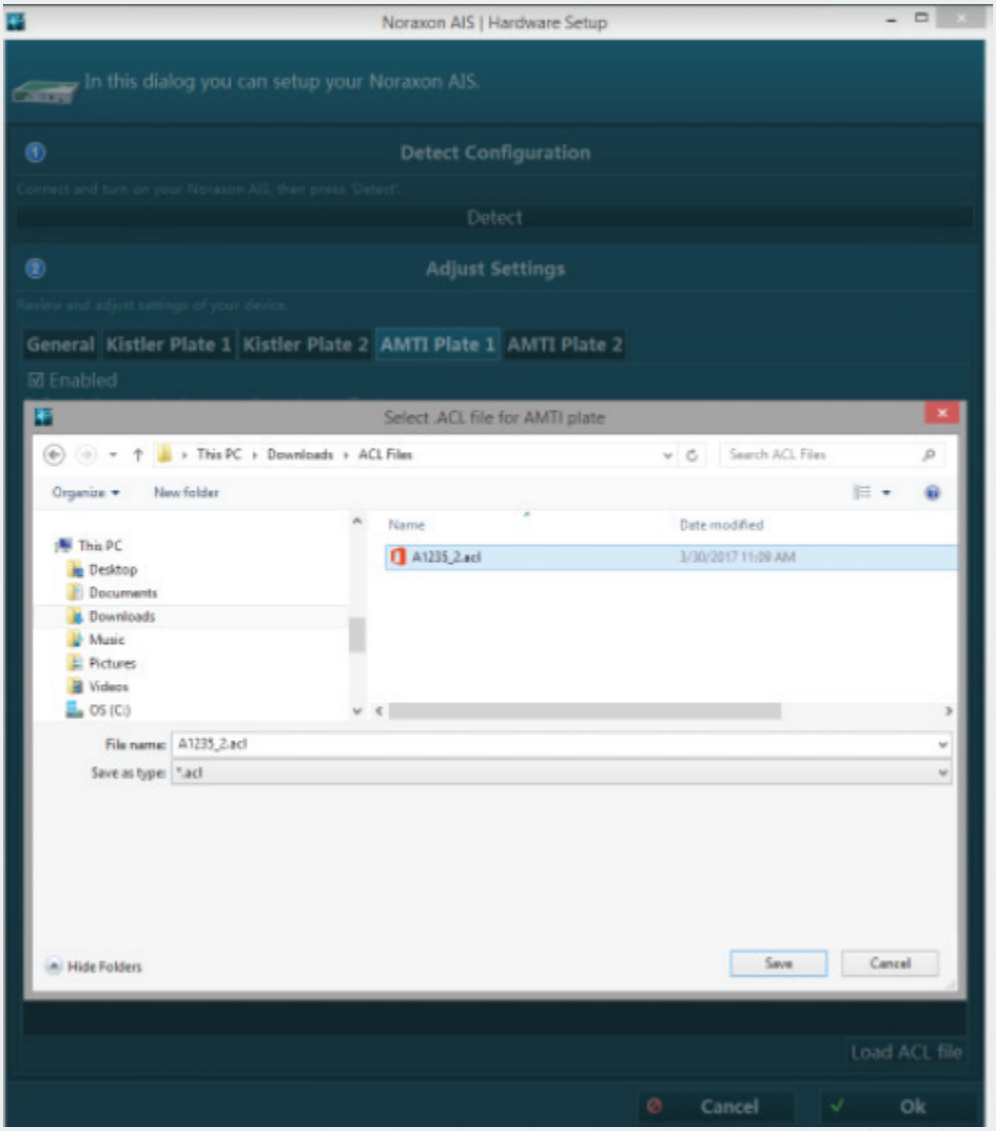
Make sure that Noraxon AIS board is connected to the PC. Open the Hardware Setup menu from MR3 Home screen.



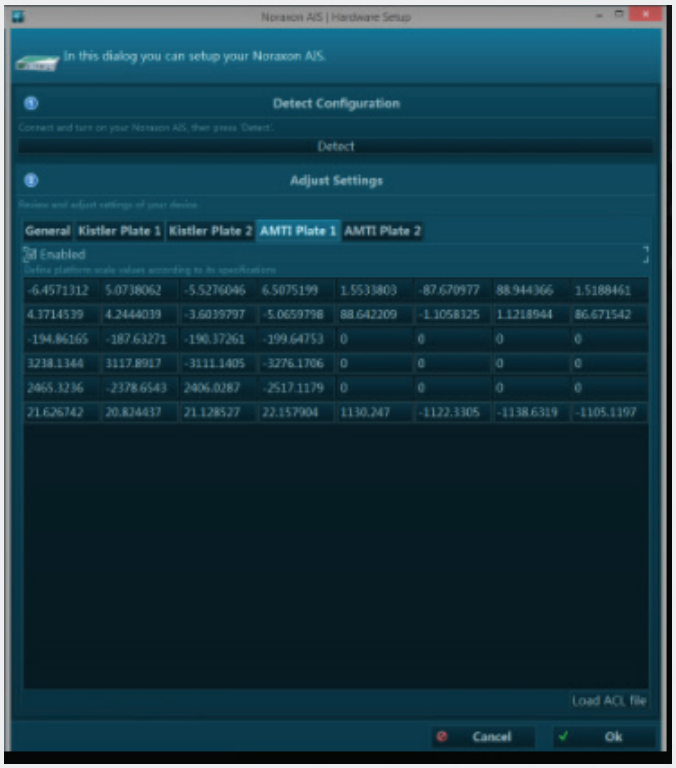
1. Select the Noraxon AIS board icon and click Insert to move it to the section **Selected devices.**
2. Double click on the **Noraxon AIS icon** or click **Configure** to open the AIS configuration menu
3. Click on Detect to establish the connection to AIS board

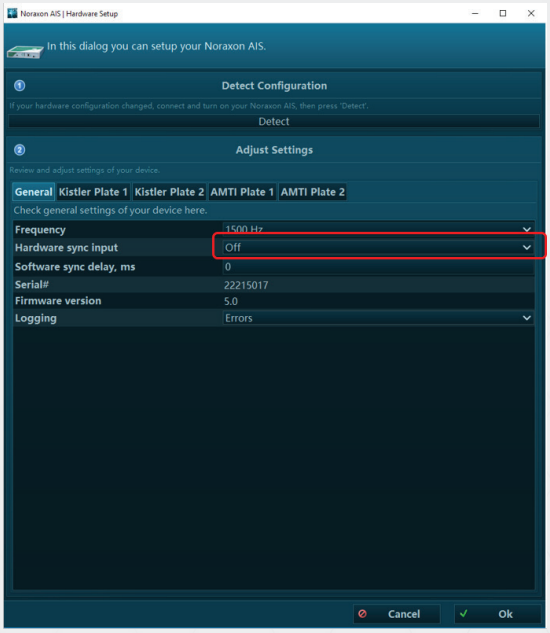


Make sure you have the AMTI plate selected and hit “Load ACL File.” The following screen will appear:



Select the file from AMTI, it will look like this:

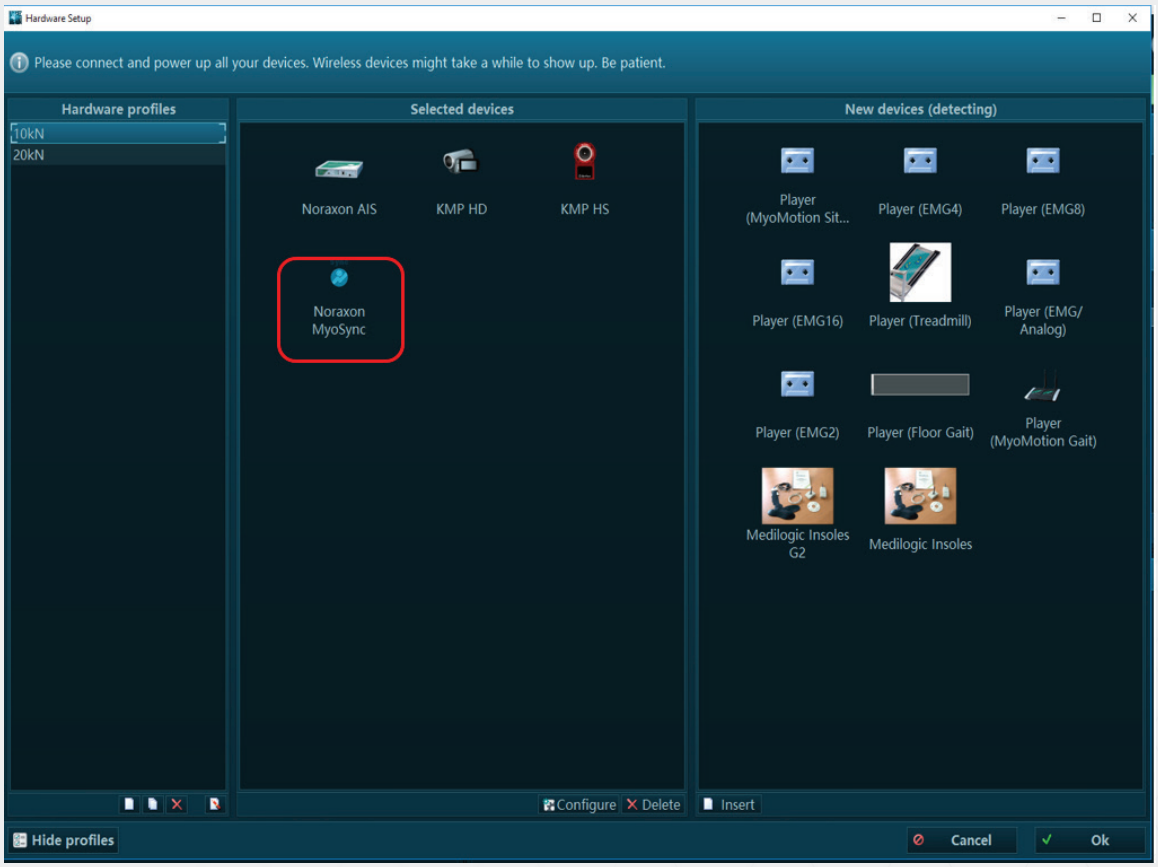




If the AMTI plate is used in multi-device combinations, e.g. together with Video, EMG or 3D inertial sensor measurement devices, MyoSYNC must be activated in the Tab section general, click on **Hardware Sync input** and select **Noraxon MyoSYNC** in.

Confirm with **OK** and go back to Hardware setup main screen.

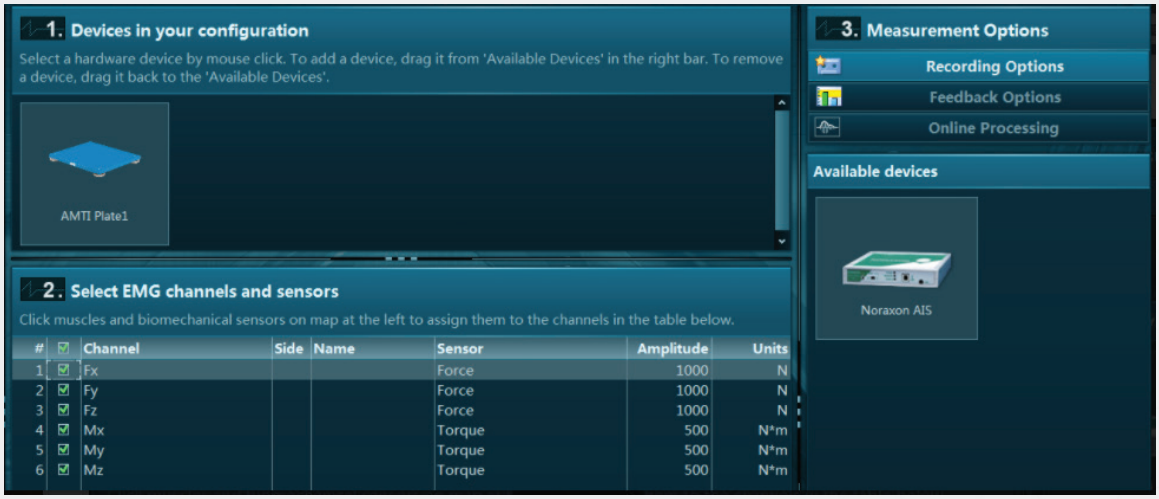
Make sure that MyoSYNC is connected to the PC via USB cable and inserted in the section Selected devices in Hardware setup menu:



When done confirm all settings with OK and leave hardware setup.

Create a measurement configuration for AMTI plates

Starting from **Home screen**, click on **New configuration** and enter the measurement setup screen:



- Mouse drag the AMTI Plate 1 icon from the right tool bar section Available devices to the section 1) **Devices in your configuration**.
- Check the channels in section 2) Select EMG channels and sensors.

**For jump analysis at minimum Fz must be checked, for video force vector overlay all forces and all moments must be checked.

Appendix C: Analog Integration of Kistler 3D force plates

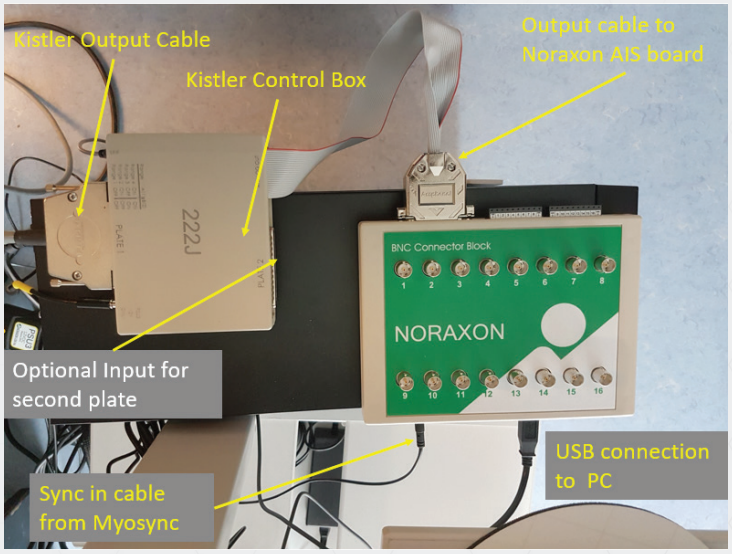
Introduction

On default Kistler 3D force plates output 8 signals. These signals need to be calculated to the 3 resulting forces and 3 moments. This calculation is done in special mode of Noraxon AIS board. This mode converts the AIS board from regular AD input board to a Kistler plate specific input board with above mentioned calculations as well as a calibration matrix table which is required to receive correct physical dimensions. This calibration data is specified and delivered with each Kistler plate and need to be manually entered to the Kistler plate setup menu.

Additionally, Kistler plate require an operation reset as well as a selection of measurement range. This is operated by a Noraxon build Kistler control box. It resets the Kistler plate and selects the max range of the Kistler pre-amplifier.

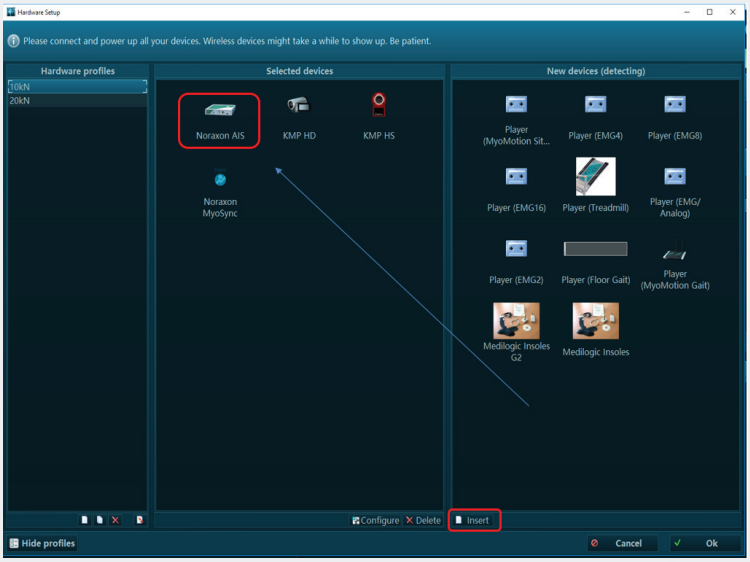
A) Instructions to connect a Kistler plate via analog output cable

1. Connect the Kistler output cable to the Noraxon Kistler control box at port “Plate 1” If available a second Kistler plate can be connected to “Plate 2” port of Noraxon Kistler control box.
2. Connect the control box to Noraxon AIS board/ DB 25 analog input connector
3. Connect the sync cable coming from the MyoSYNC unit to the sync in port of AIS – switched to rising TTL
4. Connect the USB output cable to the MR3 PC

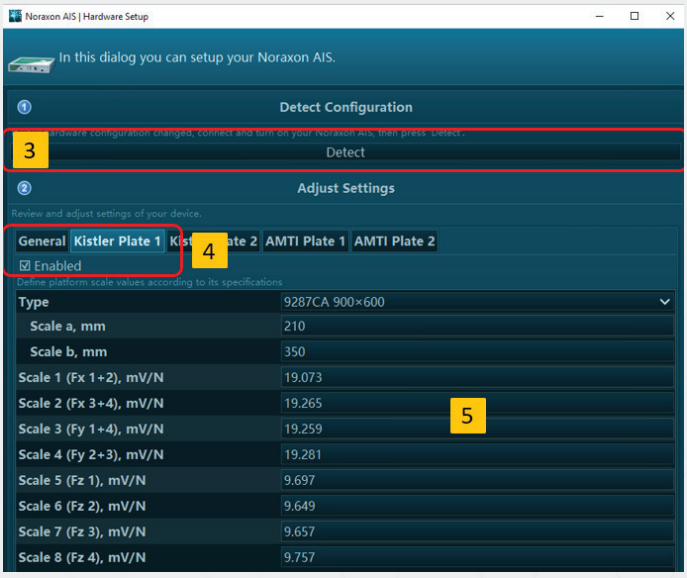


B) Setup of Noraxon AIS board in Kistler mode

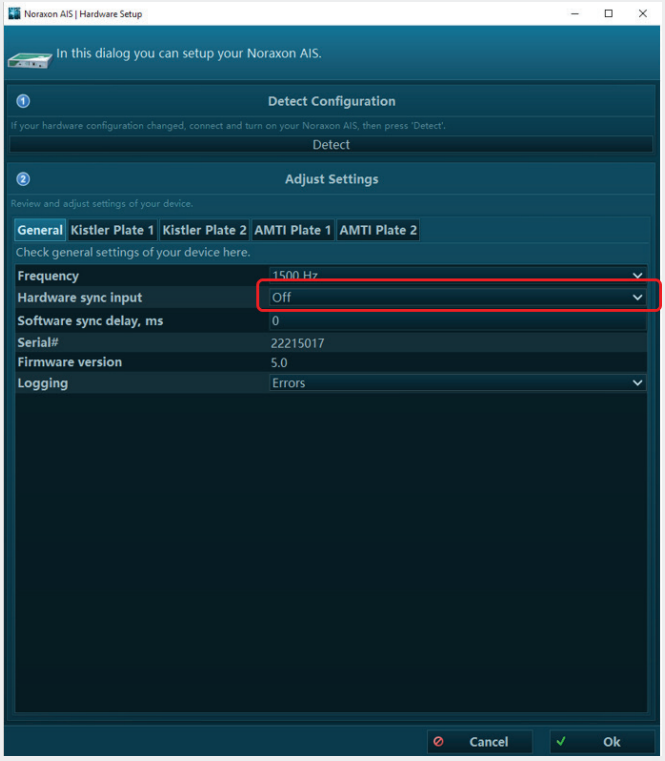
Make sure that Noraxon AIS board is connected to the PC. Open the Hardware Setup menu from MR3 Home screen.



1. Select the Noraxon AIS board icon and click Insert to move it to the section **Selected devices.**
2. Double click on the **Noraxon AIS icon** or click **Configure** to open the AIS configuration menu



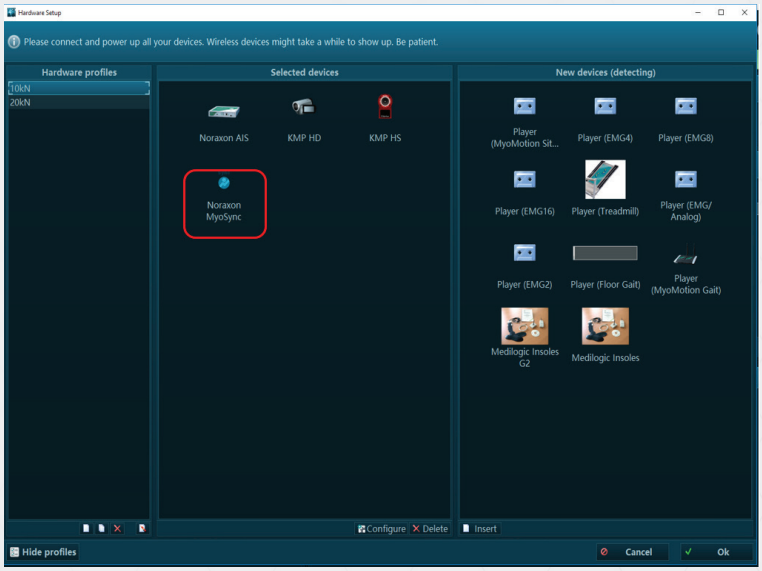
3. Click on Detect to establish the connection to AIS board
4. Click on the **Kistler Plate 1** tab and check the **Enabled** command
5. Enter the calibration values delivered from Kistler calibration data sheet



If the Kistler plate is used in multi-device combinations, e.g. together with Video, EMG or 3D inertial sensor measurement devices, MyoSYNC must be activated in the Tab section general, click on **Hardware Sync input** and select **Noraxon MyoSYNC** in.

Confirm with **OK** and go back to Hardware setup main screen.

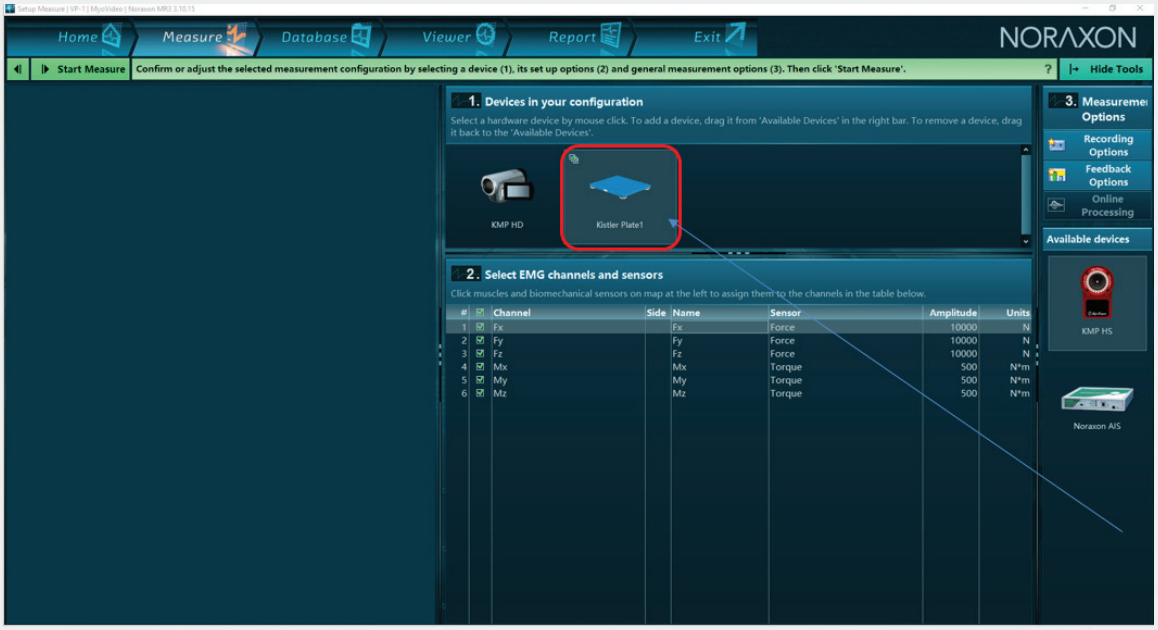
Make sure that MyoSYNC is connected to the PC via USB cable and inserted in the section Selected devices in Hardware setup menu:



When done confirm all settings with OK and leave hardware setup.

Create a measurement configuration for Kistler plates

Starting from **Home screen**, click on **New configuration** and enter the measurement setup screen:



Mouse drag the Kistler Plate 1 icon from the right tool bar section Available devices to the section 1) **Devices in your configuration**.

Check the channels in section 2) Select EMG channels and sensors.

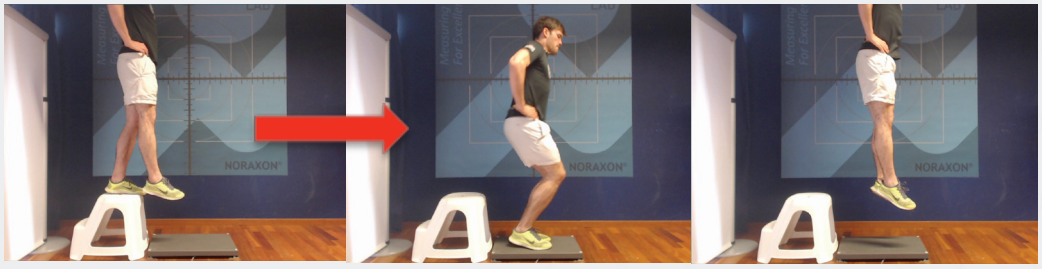
For jump analysis at minimum Fz must be checked, for video force vector overlay all forces and all moments must be checked.

Appendix D: Jump instructions

There are three different supported jump types in the MR3 Software – Drop Jump, Counter Movement Jump and Squad Jump.
The following sections provide examples of how each jump should look, including a brief explanation of the major keys and the supported parameters in the reports.

Attention:
After the last jump in each measurement, the subject **MUST** stand still for at least **1 second** to detect an even force distribution for the weight calculation, which is highly necessary to calculate the correct impulse and therefore the corresponding jump height and other parameters.

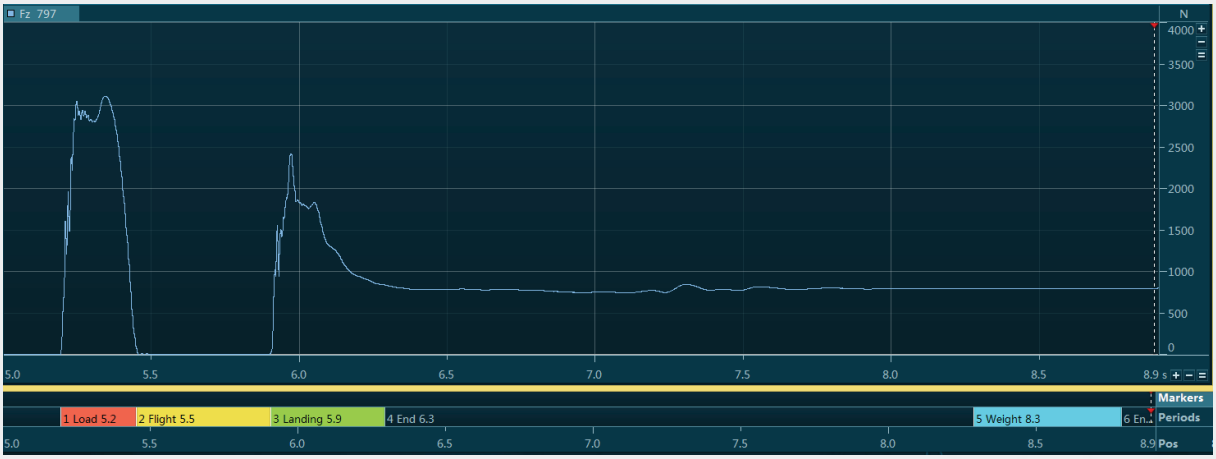
Drop Jump (DJ):



Key factors:

- Hands in the hips
- "Fall" off the stepper, do not jump upwards!
- Land and take off with both feet as synchronously as possible
- After landing, stand still on both feet
- Repeat the jump with a break of at least one second (let the subject breath in deeply)
- After the last jump wait and stand still for <u>one second</u> for weight calibration

Inspection of the Fz signal:



Key points:

- Baseline needs to be zero at flight phase or unloaded plate
- Stable weight line right after landing
- Stable weight line at the end of the record (blue zone)
- Jitter, spike, local peaks strongly depend on mounting quality of plates

Supported report parameters:

- Jump Height by flight time
- Jump Height by Impulse
- Maximum Force Impulse
- Impulse (jump related)
- Vertical take-off velocity by impulse
- Relative Force Peak
- Maximum Force rate/increase
- Flight Time
- Contact Time
- Reactive Strength by flight time
- Reactive Strength by impulse
- Mechanical Power COM
- Relative Mechanical Power COM
- Time to stabilization

Counter Movement Jump (CMJ):

Key factors:

- Hands in the hips
- Bend the knees 90° before accelerating upwards
- Take off and land with both feet as synchronously as possible
- After landing, stand still on both feet
- Repeat the jump with a break of at least one second (let the subject breath in deeply)
- After the last jump wait and stand still for one second for weight calibration

Inspection of the Fz signal:

Key points:

- Stable baseline before loading phase
- Stable weight line right after landing
- Stable weight line at the end of the record (blue zone)
- Jitter, spike, local peaks strongly depend on mounting quality of plates

Supported report parameters:

- Jump Height by flight time
- Jump Height by Impulse
- Maximum Force Impulse
- Impulse (jump related)
- Vertical take-off velocity by impulse
- Relative Force Peak
- Maximum Force rate/increase
- Flight Time
- Mechanical Power COM
- Relative Mechanical Power COM
- Relative Strength index
- Time to stabilization
- Kinetic Asymmetry index (two force plates only)

Squad Jump (SJ):

Key factors:

- Hands in the hips
- Bend the knees 90°
- After bending the knees, hold the position for brief period
- To take off only do eccentric movement, do not gain extra momentum!
- Take off and land with both feet as synchronously as possible
- After landing, stand still on both feet
- Repeat the jump with a break of at least one second (let the subject breath in deeply)
- After the last jump wait and stand still for one second for weight calibration

Inspection of the Fz signal:

Key points:

- Stable baseline before loading phase
- Stable weight line right after landing
- Stable weight line at the end of the record (blue zone)
- Jitter, spike, local peaks strongly depend on mounting quality of plates

Supported report parameters:

- Jump Height by flight time
- Jump Height by Impulse
- Maximum Force Impulse
- Impulse (jump related)
- Vertical take-off velocity by impulse
- Relative Force Peak
- Maximum Force rate/increase
- Flight Time
- Mechanical Power COM
- Relative Mechanical Power COM
- Time to stabilization
- Kinetic Asymmetry index (two force plates only)

4. General advice:

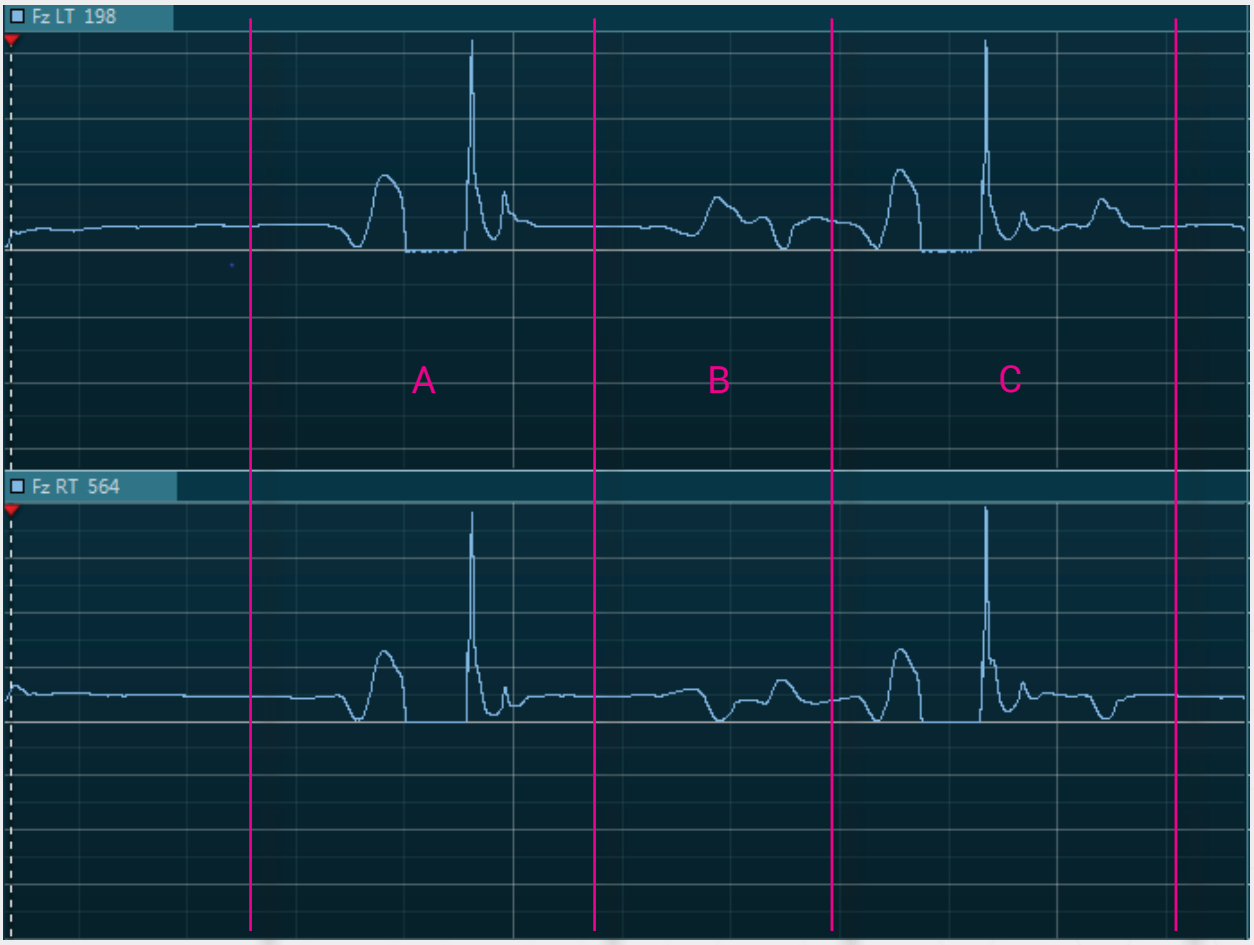


Figure 1: Two CMJ with two Force Plates

In Figure 1 one can see two Counter-Movement-Jumps recorded with two force plates. The first jump (section A) is very clean and easy to analyze. In section B, the subject was moved and transferred weight from one leg to the other. As this happens, the algorithm cannot cleanly detect the start of the second CMJ as to see in section C. To avoid this to happen, make sure the subject stands still for about one second prior each jump.

Appendix D: Jump parameters

Definitions – Phases of Jump

Loading Phase

Definition: During the loading or preparatory phase, the body is lowered, using eccentric contractions of prime movers to decelerate the body. Once the body is decelerated muscle contractions become concentric, rapidly accelerating vertically as the hip and knee extend.

Flight Phase

Definition: The flight phase of a vertical jump is the time where the individual is no longer expressing force into the ground and have accelerated into the air. The end of this phase is marked at the time they begin to decelerate from the projectile motion, where the individual contacts the ground.

Landing Phase

Definition: The landing phase of a vertical jump is the time between when they re-contact the ground until they have stabilized their body weight, within 5%.

Variable Definitions – Loading Phase

Net Impulse

Definition: Using the "force over time" information, you can identify the change in momentum an individual undergoes prior to flight phase. Starting from a still position, subtract the individuals body weight from the waveform, then integrate.

Relevance: Calculated the change in momentum over time during eccentric and concentric phases of the jump.

Units: N*s

Vertical Take-Off Velocity by Net Impulse

Definition: From the Net Impulse, we can use the change in momentum equations to solve for takeoff velocity.

$$\Sigma Ft = mv_f - mv_i$$

$$mv_i = 0$$

$$\frac{(\Sigma F/f)}{m} = v_f$$

$$f = recording\ frequency$$

Relevance: This can be used as the assessment of their ability to absorb and rapidly express force. This value can also be used to calculate the center of mass displacement.

Units: m/s

Peak Force

Definition: The maximum achieved force an individual can produce during the loading phase of a jump.

Relevance: The provides insight into the amount of force the body can express and/or absorb

.

Units: N

Relative Peak Force

Definition: The maximum achieved force an individual can produce during the loading phase of a jump, relative to their body weight.

Relevance: This allows for the Peak Force statistic to be normalized to body weight, allowing for group to group comparison to occur.

Units: N/kg

Max Rate of Force Development

Definition: Max rate of force development (mRFD) is determined by the capacity to produce maximal voluntary activation in the early phase of an explosive contraction.

Relevance: The peak RFD has a strong association with the ability to control or accelerate a mass.

Units: N/s

Variable Definitions –Jump Characteristics

Jump Height by Flight Time

Definition: Using the "force over time" information, you can identify the duration an individual is airborne. Using this duration, we calculate the peak center of mass displacement by using projectile motion equations. Assuming there were no external forces acting on the individual during the flight phase of the jump.

Equation: $$d = \frac{1}{2} g \left(\frac{t}{2}\right)^2$$

Units: m

Jump Height by Net Impulse

Definition: Using the "force over time" information, we calculate vf, vertical velocity at take-off, which is then use this within the projectile motion equation to calculate max displacement.

$$v_f^2 = v_i^2 + 2gd$$

$$\frac{v_f^2}{2g} = d$$

The above calculated value represents the peak vertical center of mass displacement by takeoff velocity.

Equation: $$d = \frac{v_f^2}{2g}$$

Units: m

Modified Reactive Strength Index

Definition: Jump Height / Load Phase Duration (Load phase time is defined from initial decrease in GRF to take-off, aka "Time to Take-Off" TtT)

Relevance: RSI_{mod} is a simplified measure that is calculated as the ratio of CMJ height to time to take-off (TtT). RSI_{mod} indicates how much jump height one achieves for how much time it takes one to flex and extend the legs during the CMJ. Represent or measure the level of "explosiveness" that an athlete possesses. A higher RSI_{mod} is suggestive of more power. Plyometric exercises, such as tuck jumps, have a higher RSImod than added weight dumbbell jumps because the force is so much more for possibly the same amount of time to take off. RSImod can be used to assess plyometrics with a countermovement jump, where there is a less identifiable ground contact and a more identifiable eccentric and concentric portion.

Units: Unitless

Variable Definitions – Flight Phase

Flight Time

Definition: Duration of flight phase.

Relevance: This can be used to calculate jump height.

Units: Sec.

Variable Definitions – Landing Phase

Peak Power

Definition: The maximal instantaneous value of the power curve, which is the product of the force and the velocity curves.

Relevance: This is a key indicator of performance for a multitude of sports, as well as fundamental movement patterns like running and multi-directional cutting.

Units: Watts (W)

Relative Peak Power

Definition: The maximal instantaneous value of the power curve, which is the product of the force and the velocity curves.

Relevance: This is a key indicator of performance for a multitude of sports, as well as fundamental movement patterns like running and multi-directional cutting. Using this normalized interpretation of the Peak Power, research can compare across subjects.

Units: Watt/Kilogram (W/N)

Variable Definitions - Hopping

Time to Stabilization (TTS)

Definition: The time it takes a subject to stabilize Fz to within 5% of body mass for 0.5 sec. following a vertical hop.

Relevance: This has been shown to be an indicator of ankle stability and has been used as a return to play indicator.

Units: Sec.

Variable Definitions – Drop Jump

Reactive Strength Index by Flight time

Definition: $\frac{(Jump\ Height\ by\ Flight\ Time\ (m))}{Ground\ Contact\ Time\ (sec.)}$

Relevance: Represents an individual's ability to rapidly change from eccentric to concentric muscle action. This is typically measured during a drop jump where there is an identifiable ground contact time.

Units: Unitless

Reactive Strength Index by Impulse

Definition: $\frac{(Jump\ Height\ by\ Impulse\ (m))}{Ground\ Contact\ Time\ (sec.)}$

Units: Unitless

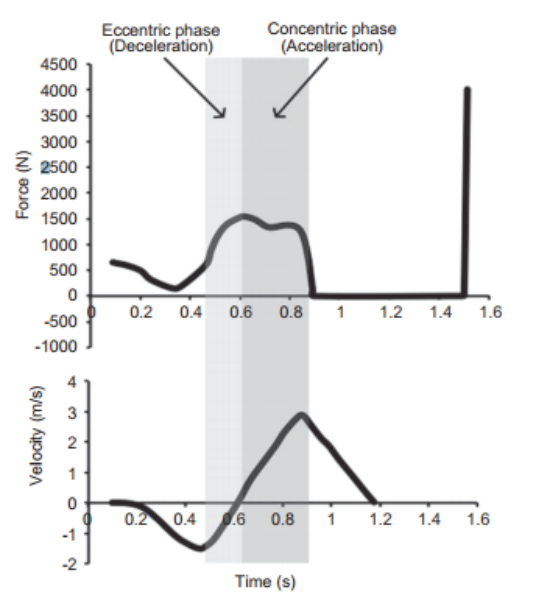
Variable Definitions – Duel Force Plate

Kinetic Asymmetry Index (Eccentric Phase)

Definition: R vs L impulse

Relevance: Identifies the N*s produced during the eccentric phase of the counter-movement jump. This allows for the asymmetry to be identified in the individual's ability to absorb and counter-act momentum, rapidly decelerating the body during the jump.

The eccentric phase of a CMJ is defined as the deceleration phase of task, which is the identifiable span of time from the maximum negative Center of Mass vertical velocity until the COM vertical velocity is 0 m/s.



Kinetic Asymmetry Index (Concentric Phase)

Definition: R vs L impulse

Relevance: Identifies the N*s produced during the concentric phase of the counter-movement jump. This allows for the asymmetry to be identified in the individual's ability to produce momentum and accelerate the body upward during the jump.

The concentric phase of a CMJ is defined as the acceleration phase of task, which is the identifiable span of time when the Center of Mass vertical velocity is above 0 m/s until take-off or flight phase.