SOFTWARE
myoRESEARCH®3.10

NORAXON™
MOVEMENT › DATA › PEOPLE

myoMOTION™ SOFTWARE USER GUIDE

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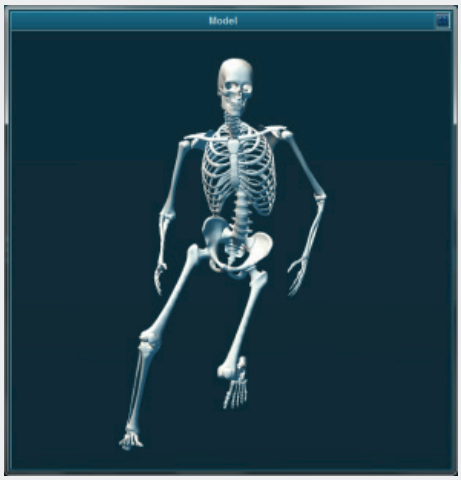
Section 1: Introduction to the Technology

Description

Noraxon's 3D Motion Capture and Analysis system consists of a set of (1 to 16) sensors using **Inertial Measurement Unit (IMU) technology**. Using "fusion algorithms", the information from system consisting of a 3D accelerometer, gyroscope, and magnetometer is used to measure the 3D rotation angles of each sensor in absolute space ("yaw-pitch-roll", also known as orientation or navigation angles).



The main advantage of this technology is it is easily set up and use, fully portable, and may be integrated with independent external cameras.

Noraxon's IMU technology mathematically combines and filters incoming source signals on the sensor level and transmits the 4 quaternions of each sensor. Users also have the option to transmit the 3D linear acceleration of each sensor depending on which version of the Motion Capture System is installed.

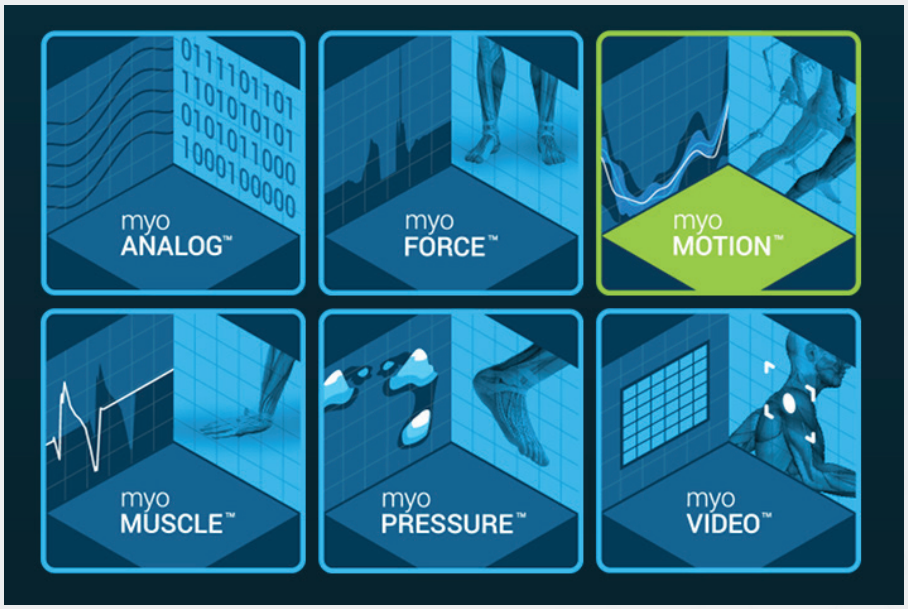
Noraxon's MR3 Software automatically converts the quaternion data into anatomical angles using a rigid body model with 16 joint segments. The MR3 software also allows for the recording of each sensor's orientation angles and linear acceleration. These options are also available for object sensors which can be attached to items such as a backpack or racquet. Programmers may also use an SDK interface, which is sold separately, to directly stream sensor data into their own application.

The basic use of the system is to quantify angular changes of the involved joints, typically in 3 degrees of freedom (3DoF). Potentially, translational components (X, Y, Z displacements in space) can be mathematically derived out of the linear acceleration data. Application reports for this 6DoF approach are currently under development. Skilled users can use MR3s signal processing tools to export the acceleration data to achieve 6DoF data. Integrators can directly access data via SDK.

Noraxon's 3D myoMOTION analysis system is part of a unique multi-device concept called the Noraxon myoMOTION lab, where other biomechanical technologies such as telemetric EMG, pressure plates/soles, force plates, video and high-speed video, and other devices can directly be added via plug & play technology.

SOFTWARE
myoMOTION™ MODULE

This is operated by a set of 6 available modules that need to be ordered by customers:



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.

SOFTWARE
myoMOTION™ MODULE

Hardware Setup

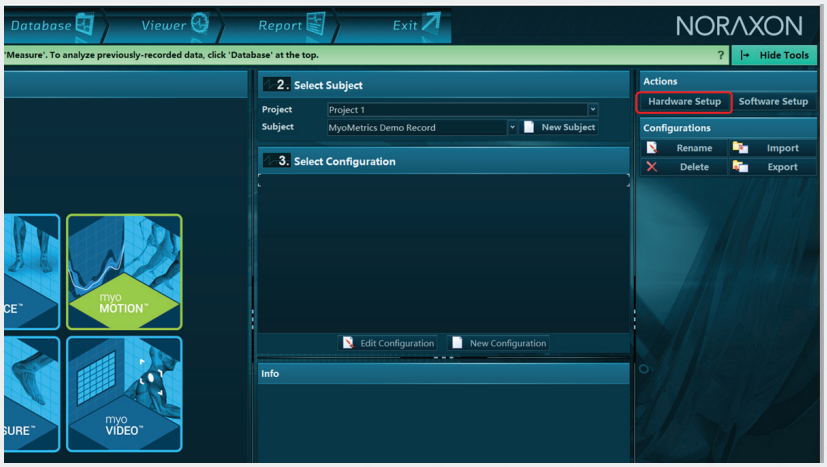
Before the MR3 software can take and store measurements, you must configure the installed software through the Hardware and a Software setup menu. Follow these steps:

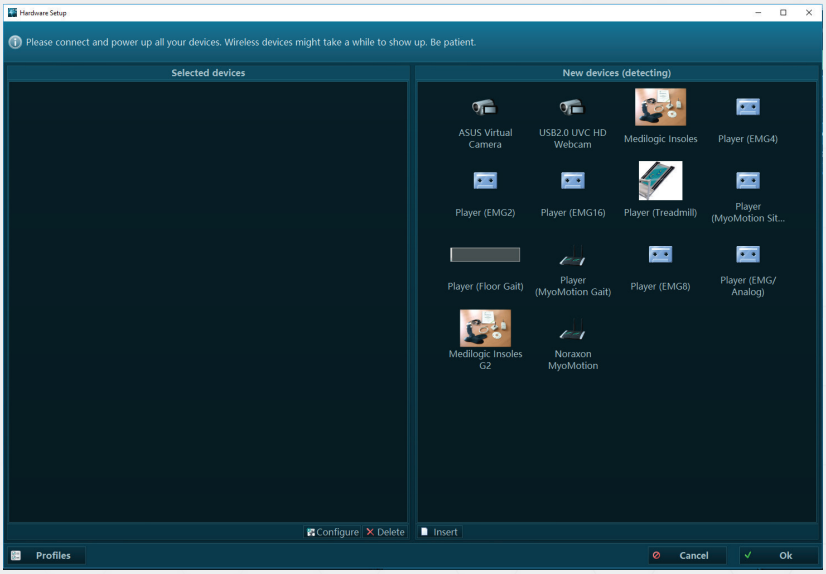
1. Connect all your measurement devices to the PC by using a USB cable. Power them on.

2. Click on the **Hardware Setup button** located in the Right Tool bar:

The Hardware menu is split into two sections:

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





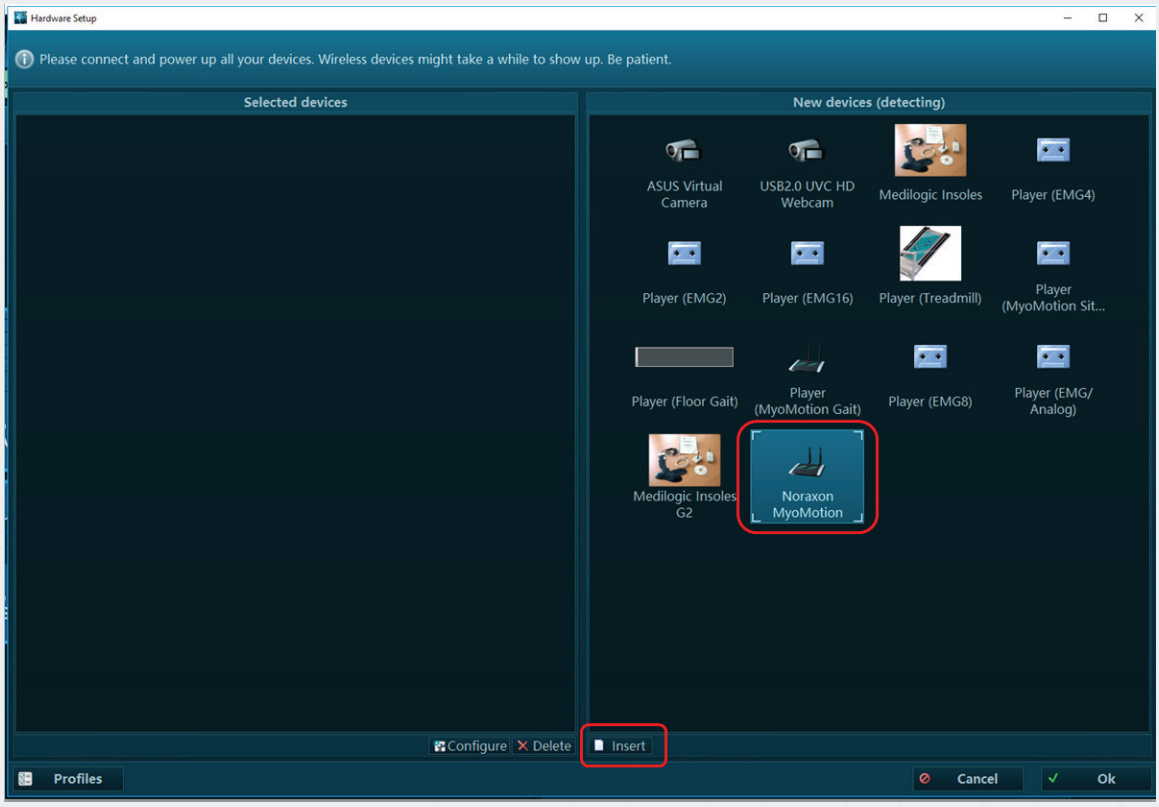
Select the Hardware System or Device you plan to use (for this example, the **Logitech HD Pro Webcam c920** is selected).

Each Device has a specific **Device Configuration** menu which is detailed below. Typically, the configuration is preset to settings suitable or required for normal recording. Experienced Users may choose to fine tune their configuration and hardware settings.

When finished with the Insert Device routine, go back to the Home Screen by clicking **OK.**

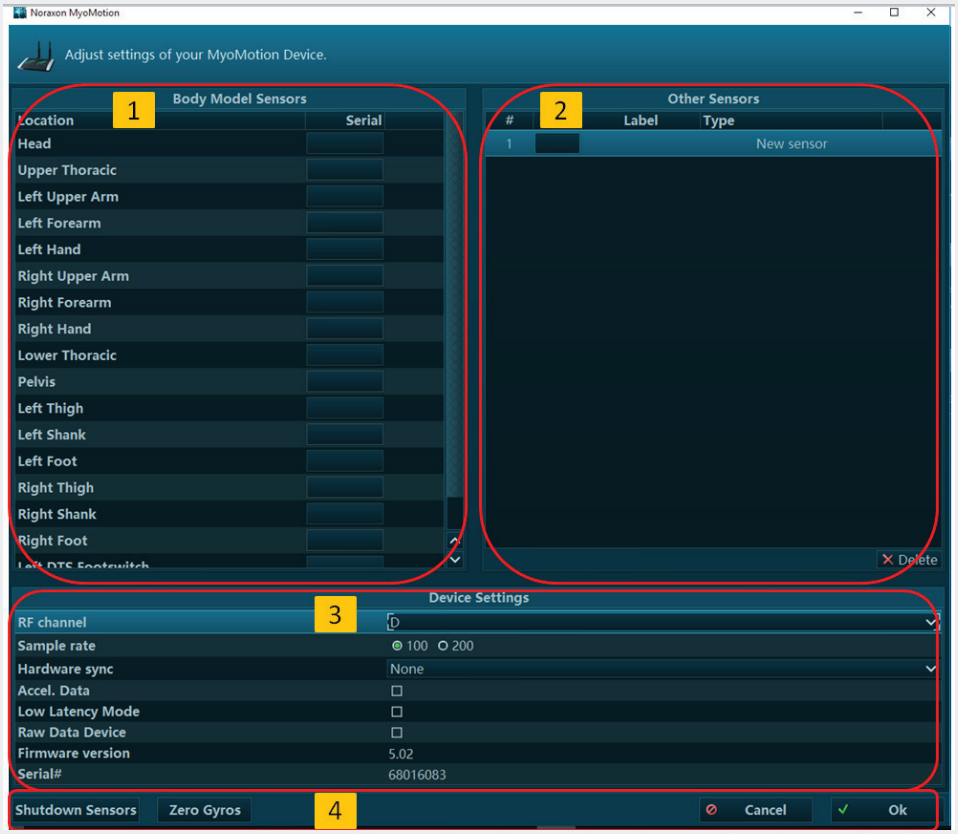
Select the hardware system or device you with to use. Here, we will choose the Noraxon myoMotion.

Select Noraxon myoMotion and press Insert to move it to left side list of Selected devices:



When done, a device specific configuration menu will open which consists of 4 major sections:

- Body Model Sensors
- Other Sensors
- Device Settings
- Lower Button bar



Section Body Model Sensors

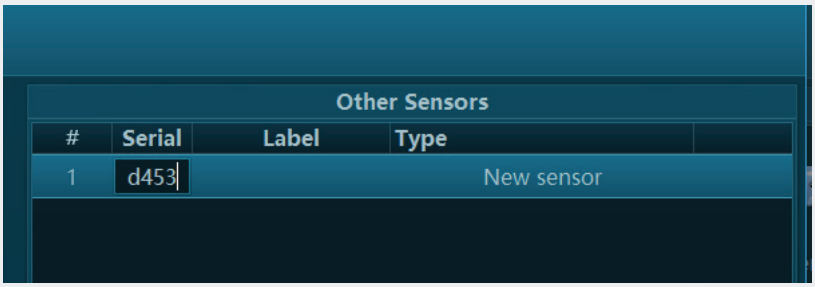
The first time the myoMOTION Motion Capture system is configured it will be necessary to assign each inertial sensor to one of the 16 available body segments. The sensors are assigned using the 5-digit serial code for research system (4-digit for the research Pro system), comprised of a combination of letters and numbers located in the lower left-hand corner of the sensor or within the sensor front label. To enter the serial code, click in the **Serial column** and enter the code for the selected body segment. Only body segments assigned with a sensor will appear during measurement. To delete a sensor ID, just double click the ID number press delete on your key board.

Section Other Sensors

On the right side of this screen is the area for the Object sensors. Object sensors can be measured in addition to Body Model sensors. In the measurement setup menu, an object sensor can be assigned to a body sensor and angular data between them can be measured

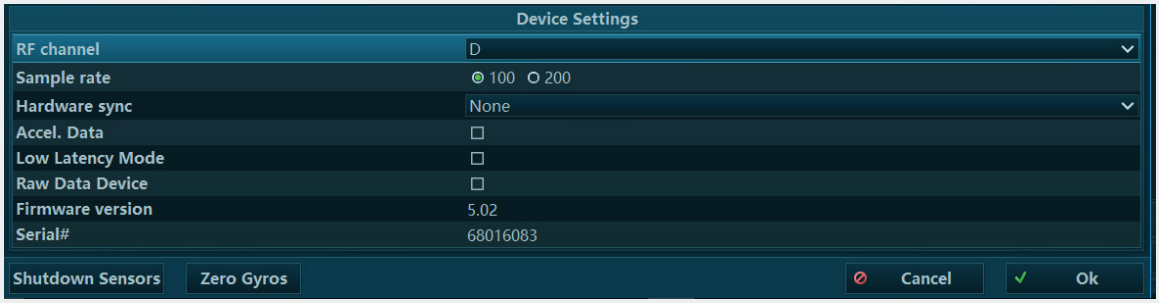
and analyzed. Any available inertial sensor can become a Body Model or an Object sensor. Enter the ID number in the first line of Other sensor to use it as an object sensor:

The amount of Object sensors is only limited by the amount of available IMUs ordered with the system.



Section Device Settings

The Device Settings section allows for some more important and/or helpful settings to best fit the IMUs to their intended use:



Explanation of Device Settings Options

RF channel The radio channel can be changed. Overall 8 different radio channels are available and it is recommended to try another one in case of poor transmission performance. Up to 8 different radio channels can be selected

Sample rate The overall sampling rate (for all sensors) can be changed from 100 Hz to 200 Hz. The available max sampling rate depends on the number of sensors, transmitted signals (Quaternion/Angles only or accelerations included), and the number of receivers. One receiver can transmit 9 sensors at 100 Hz with both angles and accelerations turned on. If accelerations are disabled, one receiver can transmit the angles from 9 sensors at 200 Hz. See Appendix E for a table that provides the various hardware/signal configurations one may use to record.

Hardware Sync If the Motion Capture system is used together with other Noraxon multi-device components, like EMG or pressure, one must use the **myoSYNC** master sync and change the hardware sync to **Noraxon myoSYNC** (**Input).**

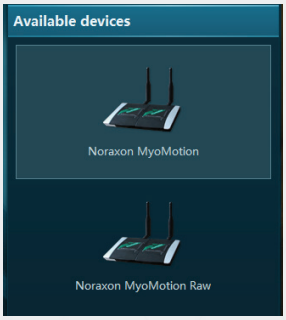
Accel. Data If the 3D linear acceleration data of each sensor are needed (e.g. for calculation of impact, velocity, or distance), select this option.

NOTE: the max sampling rate must be reduced to use this option. Please refer to Appendix E to view the configurations available.

Low Latency Mode For Biofeedback or other critical real-time tasks (typically related to animation projects) it may be helpful to decrease the system latency to 36 ms. It is recommended to not use low latency mode for regular biomechanical studies as higher latency means more stable Wi-Fi transmission and ultimately better data.

Raw Data Device Mathematical experts may desire to apply their own fusion algorithms and/or Kalman filtering. This mode allows directly access to all 9 unprocessed raw sensor data.

NOTE: This mode creates 2 selectable devices in measurement setup menu (see chapter 5). Due to WiFi bandwidth limitation only regular (Quaternion) mode or Raw Data mode can be used via selecting the right device from right side Tool Bar in measurement setup menu:



To run them simultaneously is not possible

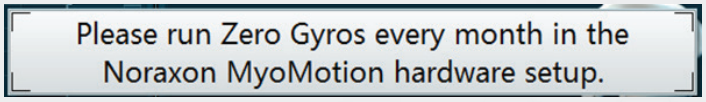
Firmware version This identifies your receiver firmware version. Please use our website to assure your receivers are up-to-date.

Serial# This identifies your receiver serial ID number, which may be important in certain service cases.

Section Lower Button bar

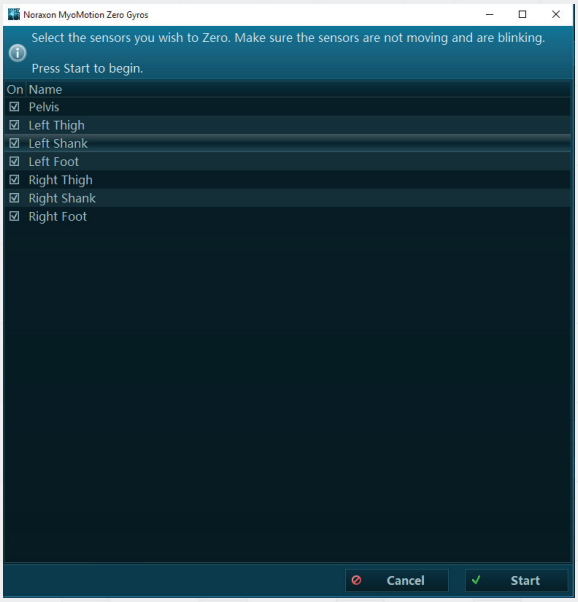
Shutdown Sensors
In regular use outside the charger cradle or within an unpowered charger cradle, the MyoMOTION sensors automatically enter a sleeping mode (slow green blinking). The sensors are still on and can only be completely shut down by pressing the **Shutdown Sensors** button. Once shut down, the sensors can only be turned on again by being placed in a powered charging cradle. Please shut down the sensors when they are not being used for long periods of time.

Zero Gyros
The ongoing use of MyoMOTION requires a **monthly** reset of the Gyro sensor. You will be automatically prompted to perform "Zero Gyros" when necessary:



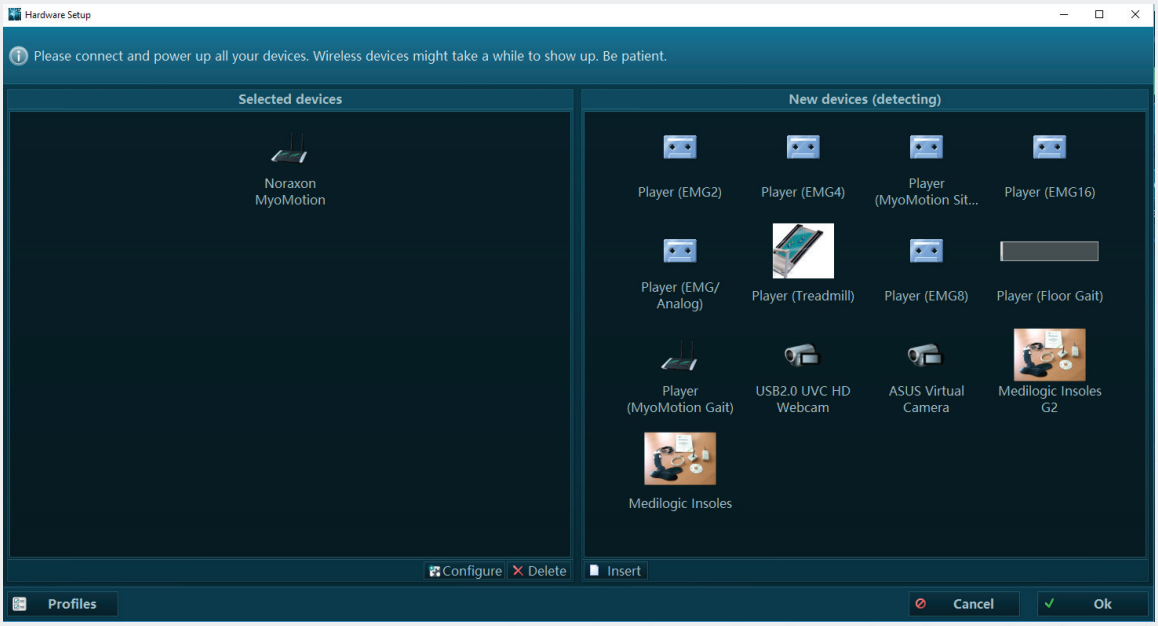
If prompted, place all sensors in the *unpowered* charger cradle in an area that will not be disturbed by external motion. Click the **Zero Gyro** button to recalibrate the gyros of all assigned sensors:

Press Start to run the re-calibration and make sure that the sensors are not moved while calibrating (approx. 1-2 minutes).



Finishing the hardware setup routine

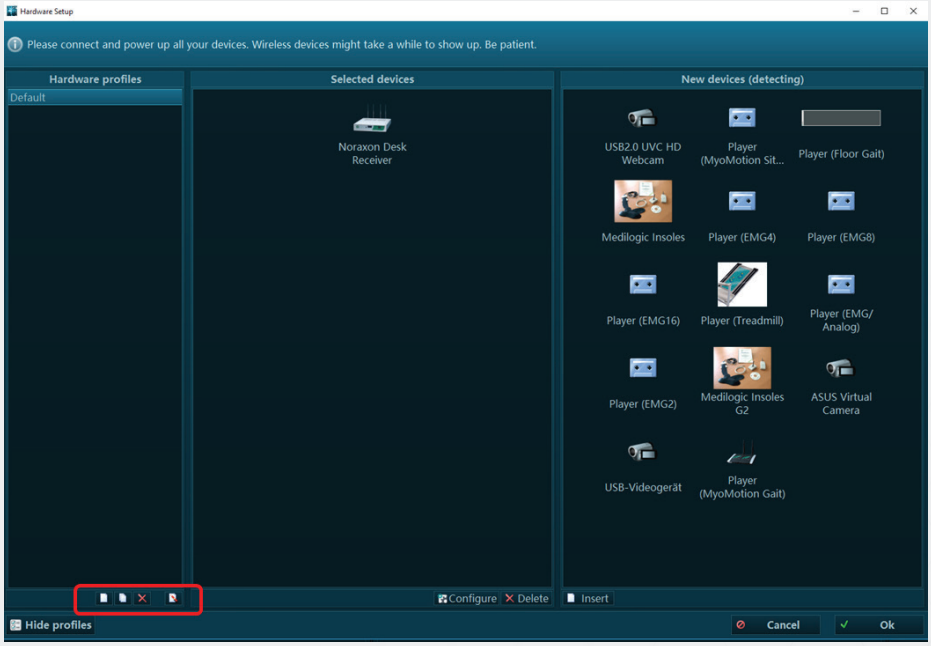
Once all settings described above are completed, press **OK**. This will return the user to the **Hardware Setup** start screen. Now, the Noraxon **myoMOTION** icon should be present on the left side section, **Selected devices:**



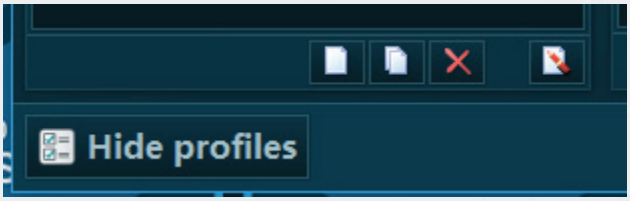
If this needs to be changed, click **Hardware settings** on the Actions menu in the top right corner of the home screen and double click the device to be changed.

Hardware Profiles

It is possible to save various hardware profiles. This allows the user to have specific hardware setups and device configurations saved. This is especially useful if 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 **Hardware** setup **screen**. A new column **Hardware profiles** will appear:



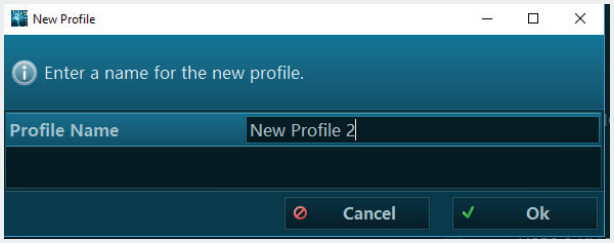
Below the list section four buttons will be presented:



Functions from left to right button:

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

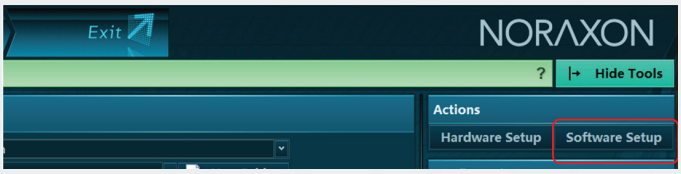
When the new item button is pressed, a sub-dialog is presented:



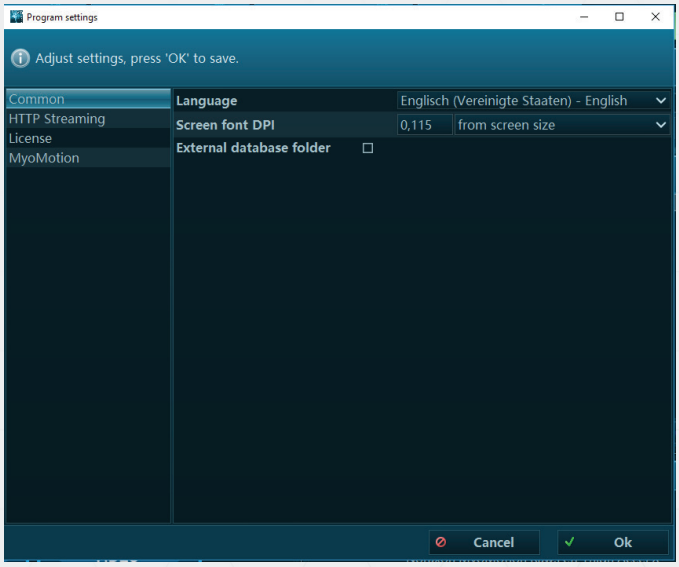
Enter a Profile Name and confirm it with OK.

Software Setup

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



See next page for continued software setup instructions.



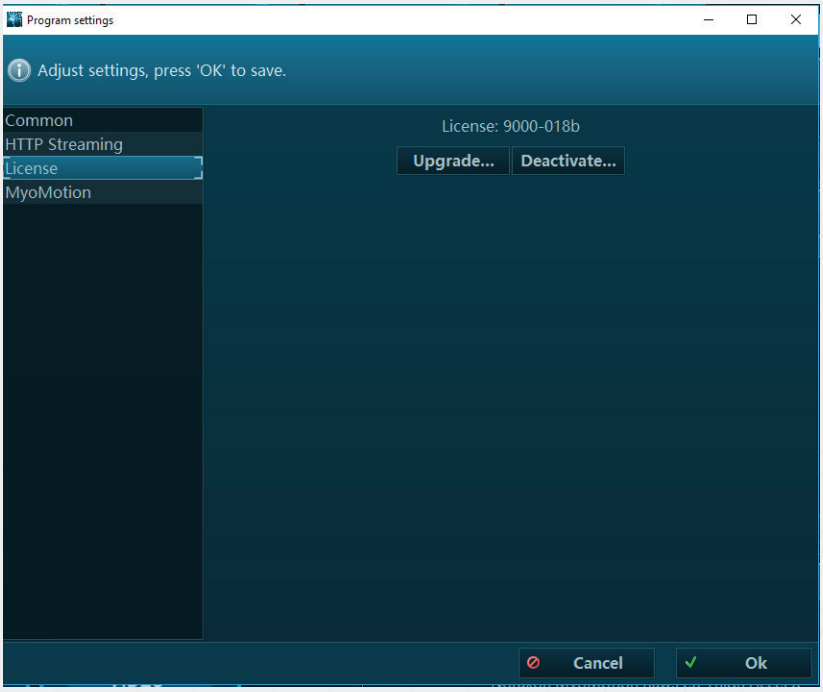
Language allows you to change the language. The default language is the language of your installed Windows Operating system. There are four languages currently supported by MR3: English, German, Chinese, and Japanese.

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

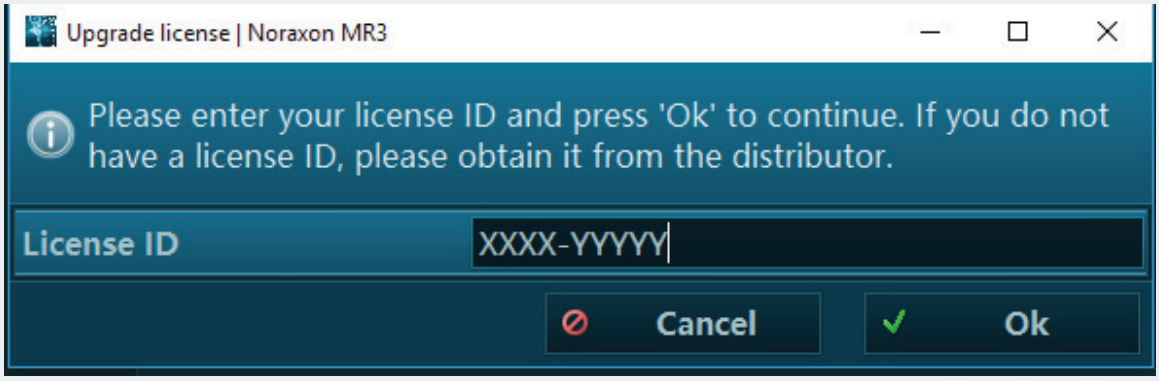
From screen size	Recommended setting. The resolution is scaled in proportion to screen size and auto scales if MR3 is moved to a window or if the screen size temporarily changes (i.e. when connected to a lower resolution LCD screen projector).
Fixed	This option allows you to manually select a font resolution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

License

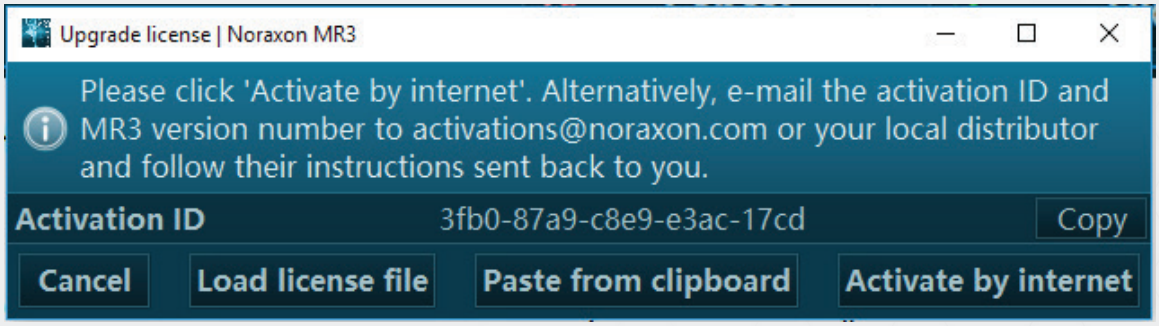
The software and each purchased module within is license protected. If you wish to upgrade your existing license with a new module (e.g. if a myoMUSCLE-only license needs to be upgraded to also include the myoVIDEO module), click **Upgrade** and follow the on-screen instructions.



Your license ID will be pre-filled by the initial activation when installing the software. If you need to change it, enter your new license and hit “ok.”



Click on OK to continue.



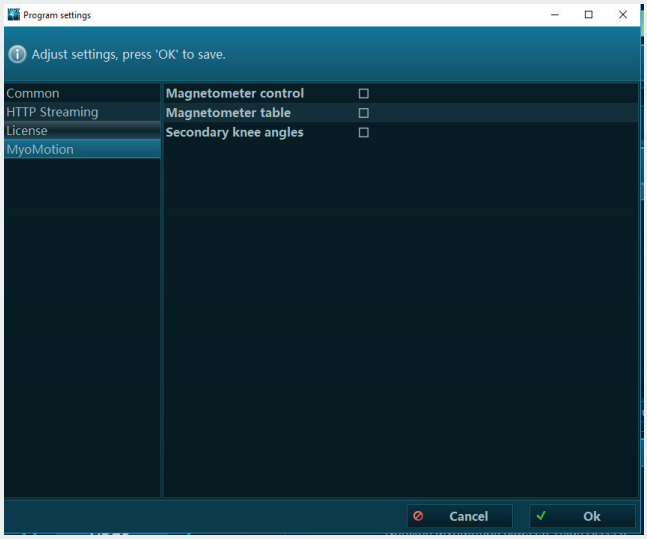
Several options are available now to activate your software.

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

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 techniques. Please contact Noraxon support before using these features.



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

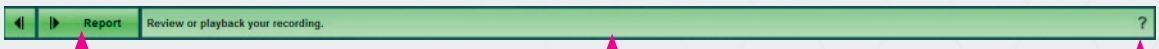
On top of the software screen there is a software **navigation bar** that visualizes the work flow of a typical recording from the Home screen (start) to Report (analysis):

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

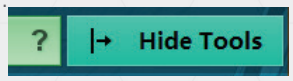
Instructional text

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.

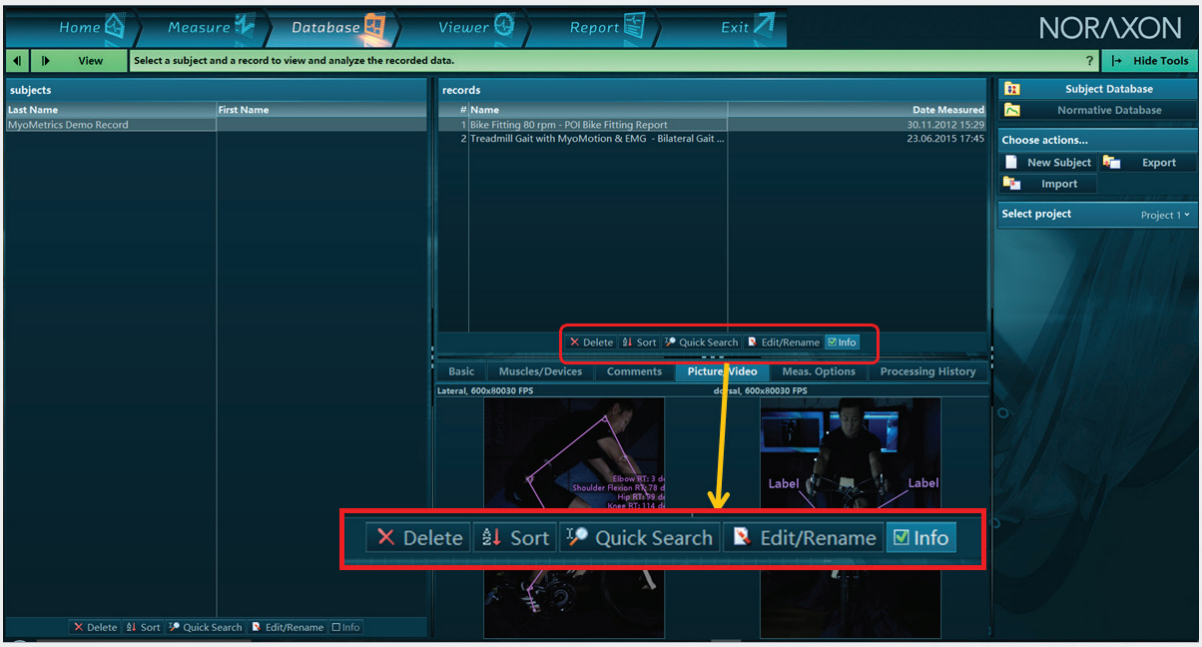
Tool Bar

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

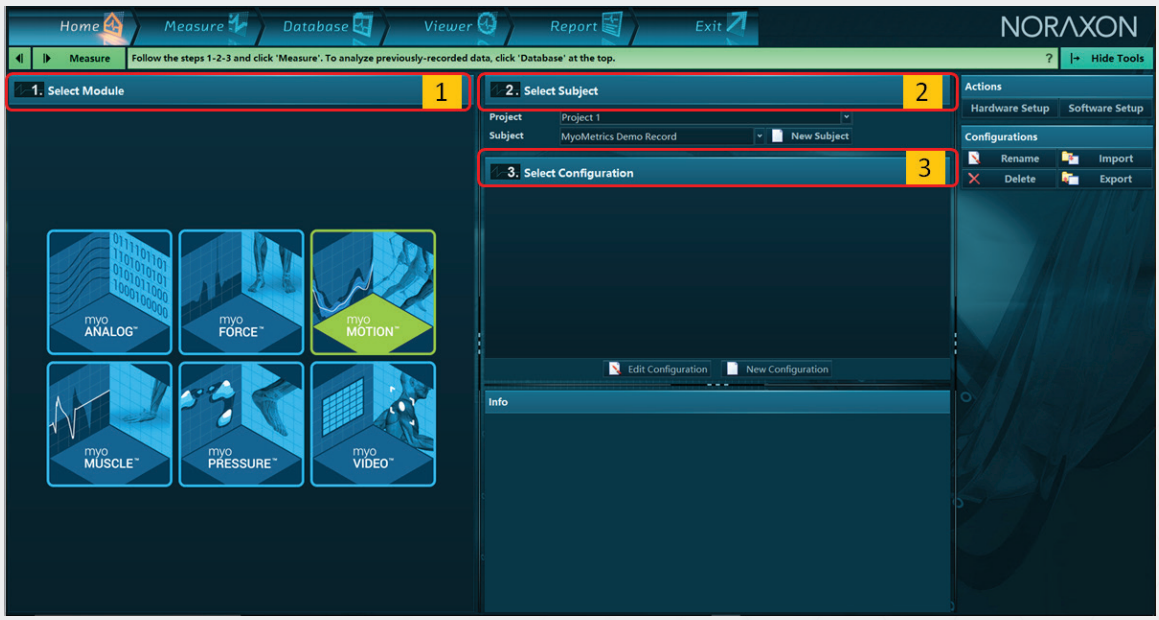
Each menu consists of a set of menu elements, which are equipped with a set of local control tools. You can use these local tools to perform element specific selections and operations as shown for the Database Menu:



Section 4: Home Tab

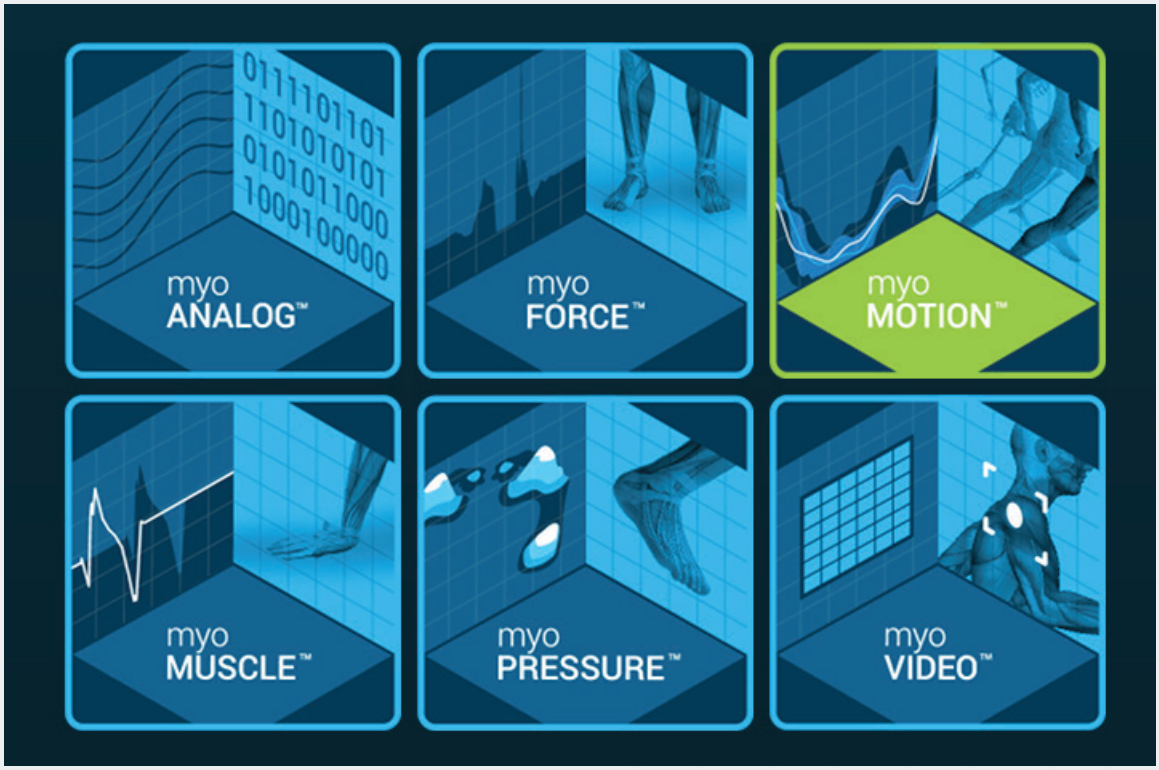
Introduction

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, perform steps 1 through 3 on the Home screen:



Select a Module

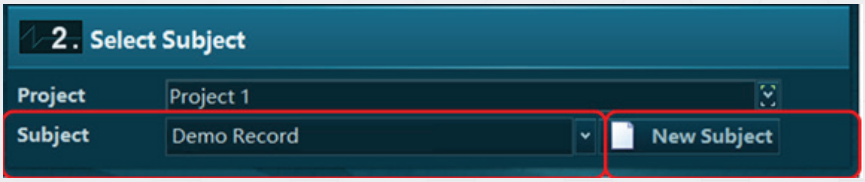
MR3 is multi-functional software that can operate numerous sensors and devices. Each of these can function as a stand-alone device or module or be used in combination with each other. Step 1 allows you to select the module you would like to use for the measurement. The Modules include myoMUSCLE™, for 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 and myoANALOG™, for typical use of Noraxon's Analog Input System (AIS) analog-to-digital conversion board. Modules become available once they are purchased and unlocked by with activation key(s).



For this section select myoMuscle 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.



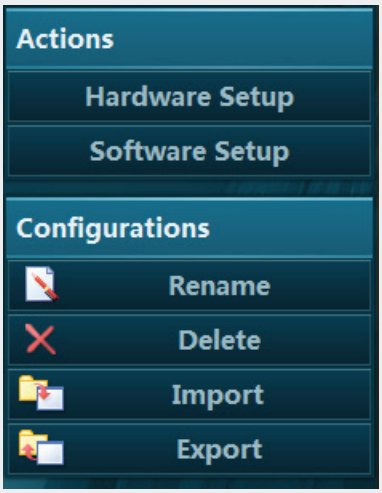
Note: Subjects are saved under Projects. A Project may be selected using the down arrow. Projects can be created, renamed, or delete under the Database menu.

Select or Create a Configuration

Next the user will select, edit, or create a new configuration.

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.

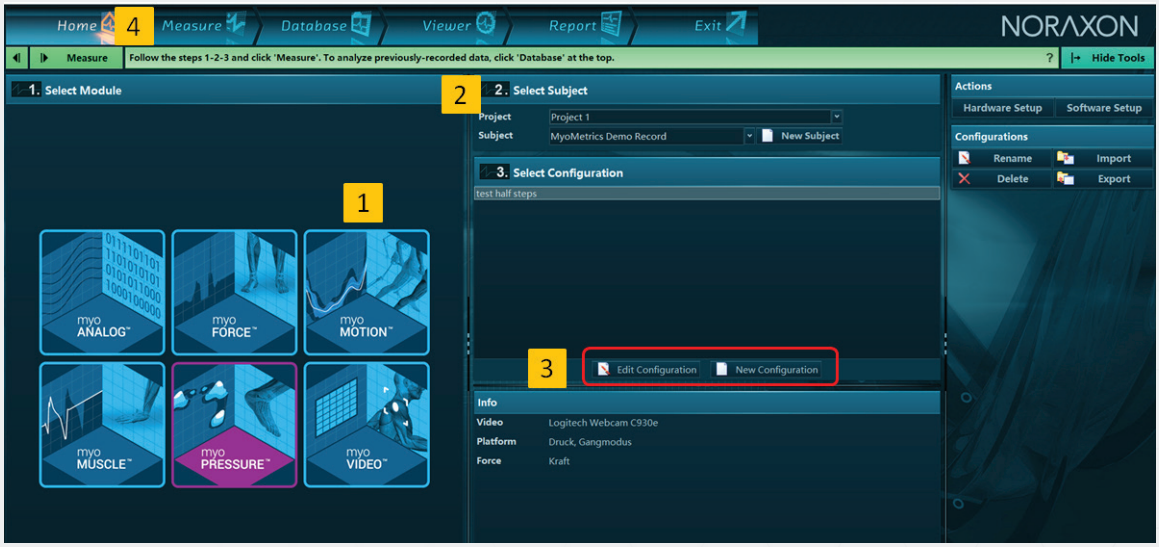
Section 5: Create a New myoMOTION Measurement Configuration

Introduction

1. Click on the myoMOTION 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. Select an existing configuration or click Edit Configuration or New Configuration

.

NOTE: Clicking New Configuration will bring users 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.



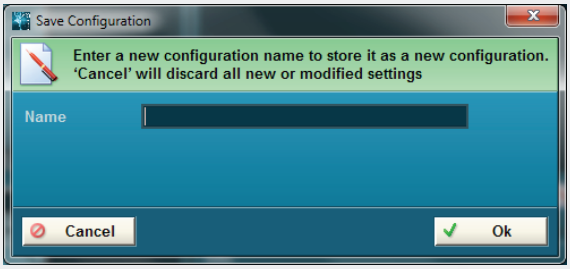
Clicking **Edit Configurations** allows already existing configurations to be modified.

4. Click on the green Measure button once the correct module, subject, and configuration have been chosen.

(-) Extension 0° Flexion (+)

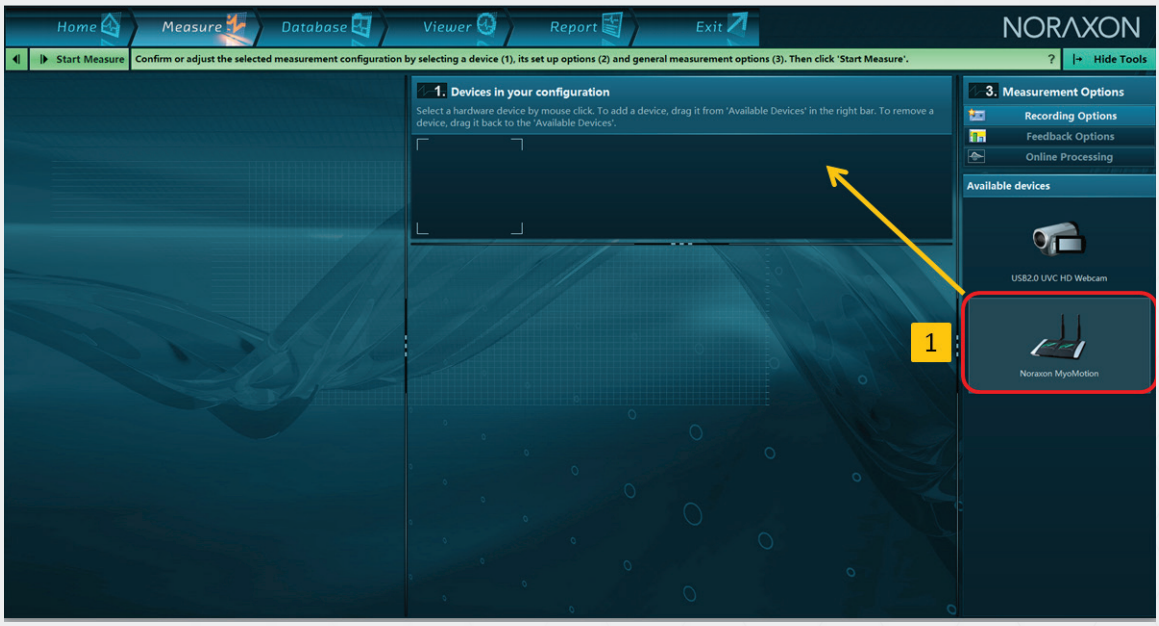
Create or Edit Measurement Configuration

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

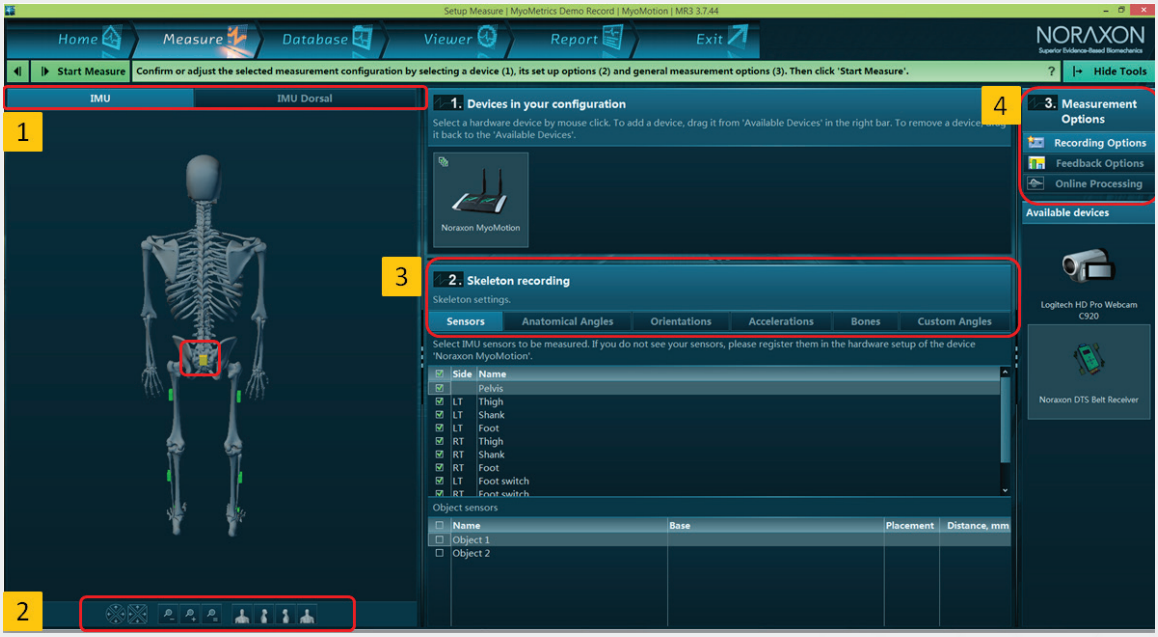


Enter any suitable name and confirm it with **Ok**.

The measurement setup screen will appear:



All measurement/recording devices that were inserted in the initial **Hardware Setup** menu are listed on the right-hand side in **Available Devices**. Click on the myoMOTION icon and mouse drag it to the section **1. Devices in your configuration**. When done, the myoMOTION sensor selection screen will appear:



1. Sensor Location

You can choose two different sensor maps:

IMU	this map is a 3D free rotational map
IMU Dorsal	this is a static map view from dorsal

click on the bone segment sites you would like to measure.

Use the sensor location map/skeletal avatar and click on all sensors that should be activated for the recording. In the example above the pelvic sensor was selected in the map (yellow sensor) and a check mark is automatically set in the main Sensors list.

Note: Only the sensors assigned in the hardware device setup menu will (see hardware manual) appear on the map. In the above example, all sensors from a 7 sensor lower body system were assigned and are selectable in the map.

2. Zooming and rotation tools for 3D skeleton map

These tools allow you to zoom, center, change view and freely rotate the skeleton. Alternatively, you can use mouse buttons:

- Left Click: 3D rotation around avatar
- Click Scroll Wheel: Move avatar in plane of page.
- Scroll Wheel: Zoom in and out.

3. Skeleton recording

Sensors tab

Each available sensor (assigned in Hardware setup) will automatically be inserted to the list of selectable sensors. Sensor can be selected via skeleton map (see 1) or directly here in this list. Once a sensor is selected, anatomical angles and other parameters are selectable in the other tabs, see below.

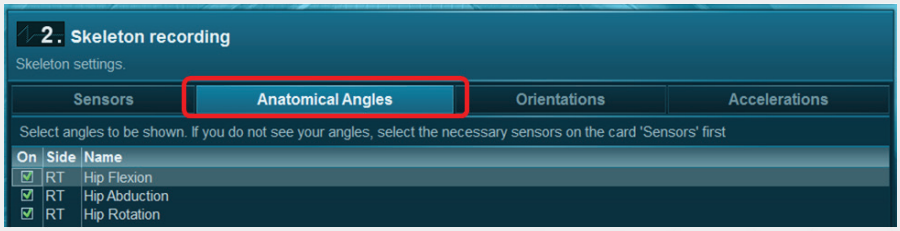
If Object sensors were defined in Hardware Setup menu of Home Screen menu, they will be listed here. Object sensors are sensors outside the biomechanical standard model consisting of 16 bones (as visualized in the 3D sensor selection map). Object sensors can measure the rotation angles of objects, tools or sports equipment in relation to a **Base** sensor of the regular avatar. It is also possible to use another object sensor as base sensor in case this is needed.

To visually position object sensors in relation to the skeletal avatar, **Placement** and **Distance** can be defined.

NOTE: Object sensors do not deliver anatomical angles! You must turn on orientation angles (see register tab 3) to see the angular deviation of object sensors in relation to the base sensor.

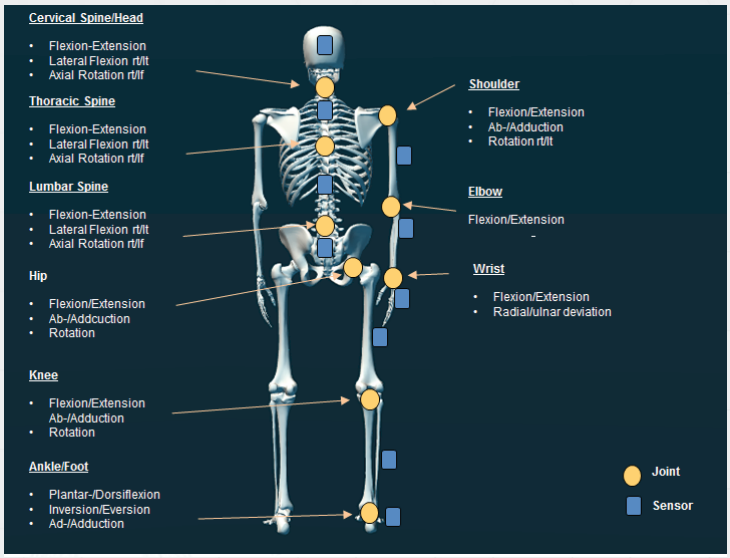
Anatomical Angles Tab

As soon as two sensors surrounding a joint are selected, they automatically compile up to three joint related anatomical angles. In the example above the Pelvic and Right Thigh sensor were selected, which results in right side Hip –Flexion, –Abduction and –Rotation.

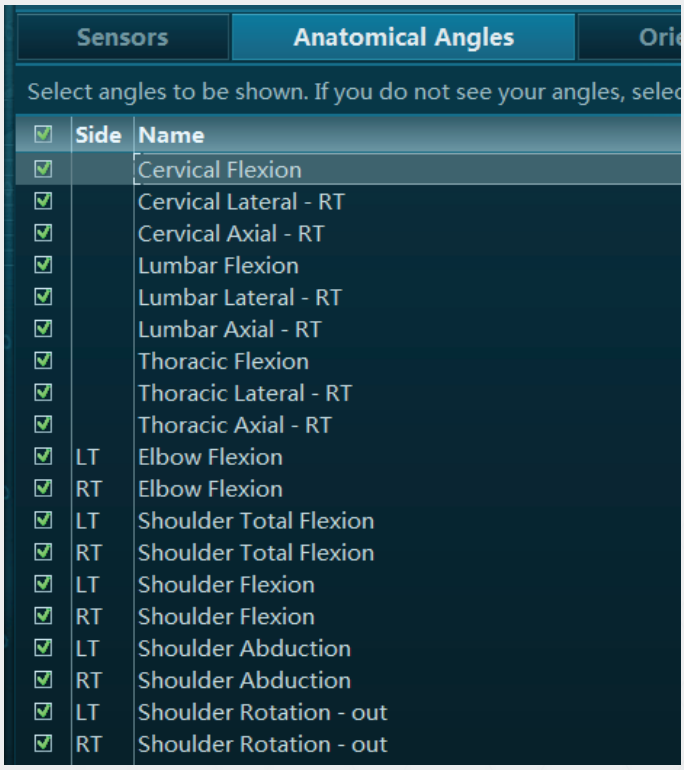


Definition of Anatomical Angles

The definition of anatomical angles follows the rules and regulations of the medical neutral/zero method. The underlying principle is that in a normal upright standing position all joints are at the zero position, even if they already have an offset angle; e.g. the ankle joint while standing straight up is at a 90° orientation, but the anatomical definition is 0°. These angles/dimensions are measured by a full body model:

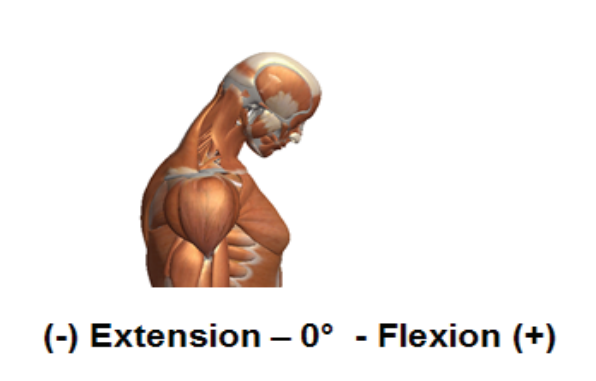


The polarity (positive or negative data in the angle curves) of the movement is dependent on the plane of motion; each anatomical angle motion is comprised of a positive and negative component. The motion direction written in each channel name equals to the positive part of the curve:



I.e. “Cervical Flexion” means the flexion motion is positive, and the cervical extension motion is negative:

Example: Cervical flexion



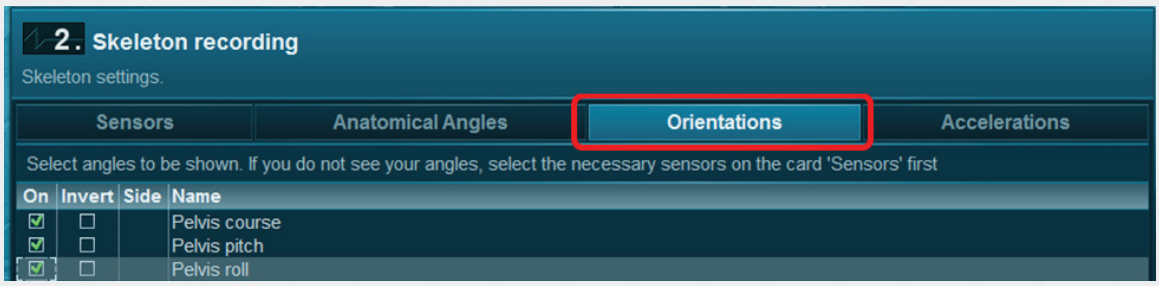
Starting from the neutral zero position, or zero line, flexion at the neck joint causes positive signals and extension causes negative signals. A more detailed description of all anatomical angle and polarity definitions is given in Appendix C.

For lower body and trunk angles the underlying Cardan rotation sequence follows the recommendations given by the International Society of Biomechanics **(ISB)**. E.g. the rotation order of knee joint is flexion, abduction, and rotation. For shoulder joints, the algorithm is using planar angle calculations, since ISB recommends adjusting rotation matrices to the primary motion plane of a given activity. On default knee joint is locked to 1D. In this condition the, the axial rotation of the thigh segment is corrected to match the orientation of the shank, so that the resulting knee angles is always pure flexion. The same concept is applied to the elbow joint.

For more information around the biomechanical model and applied algorithms please refer to IMU tech report and additional material in the addendum section.

Orientations Tab

If only one sensor is selected, there is no anatomical angle listed. Single sensor data can only be shown as acceleration and/or orientation angles Course, Pitch, Roll:

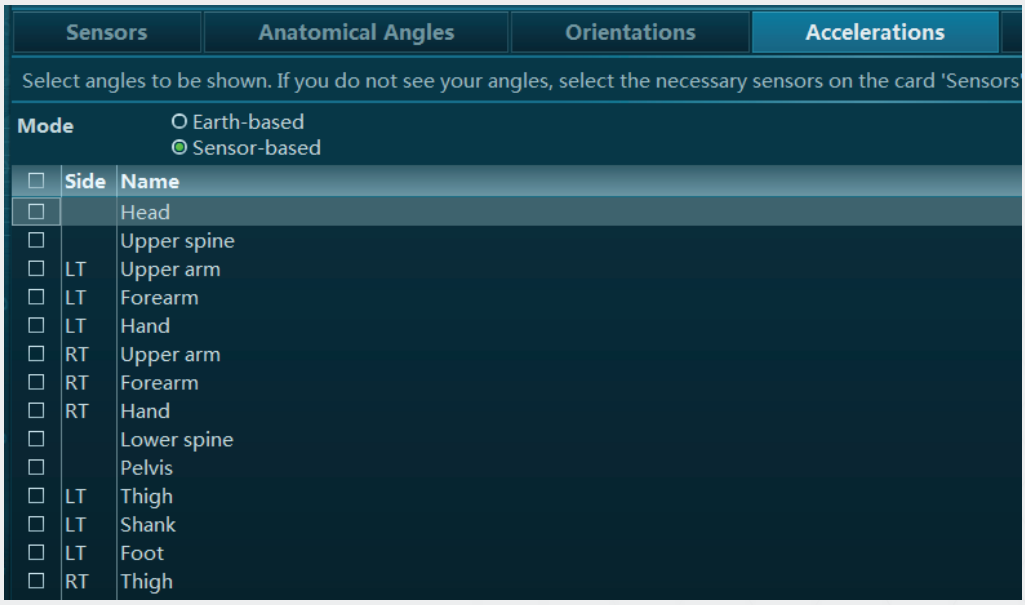


These so-called orientation or navigation angles describe the angular displacement of the sensor in space. This can be visualized via an airplane flight maneuver:

NOTE: The **course angle is equal to yaw** and is sometimes called heading. Orientation angle recording is turned off by default but can be activated for each dimension with the check box. **Invert** changes the orientation polarity. By double clicking on the orientation names the default names can be overwritten with user defined names.

Accelerations Tab

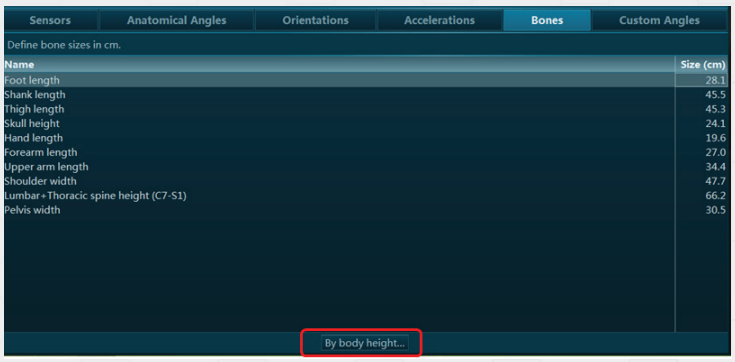
For each selected sensor (see Sensors Tab above) acceleration data are available if the data streaming of accelerations was enabled in the Hardware setup menu (see Home Screen help/ Setup). The acceleration data can be calculated in reference to world coordinates **(Earth based)** or sensor axis **(Sensor based).**



Acceleration data will be recorded and displayed for each selected sensor in the X-, Y-, and Z-axis.

Bones Tab

To allow for more realistic animation of motion via skeletal avatar, you must define the body height of the subject. Based on the height, the individual bone lengths are calculated. If body height was not entered in the Subject properties, click "By body height...." at the bottom of the screen to enter the subject's height.

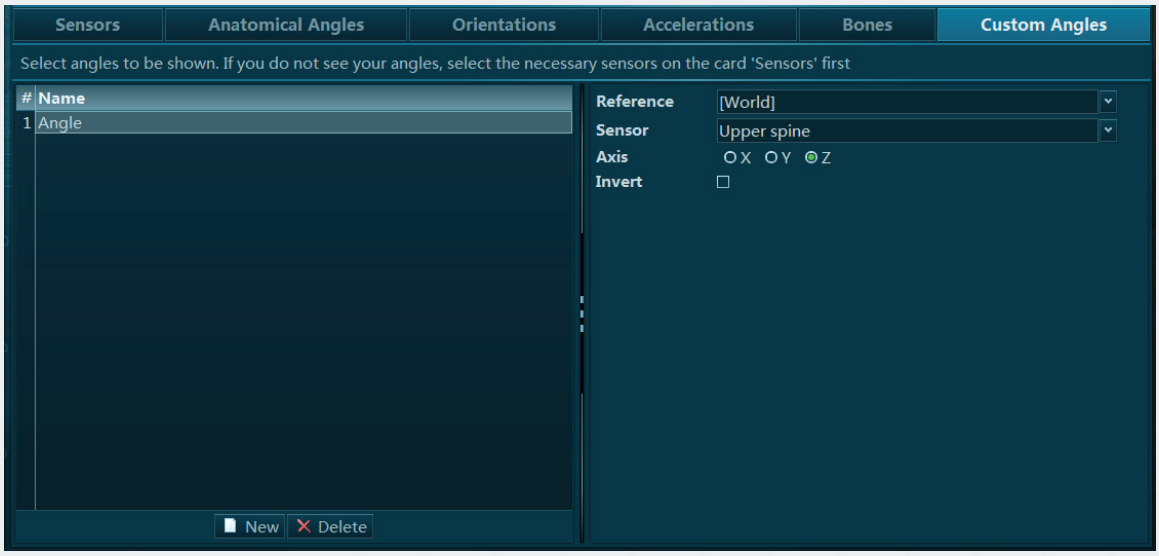


Alternatively, individual bone data can directly be entered the column Size (cm).

NOTE: Bone lengths do not affect the angular calculations. The bone lengths are only used for a more realistic avatar animation.

Custom Angles Tab

A special version of orientation angles is available in this tab. Each available rotation axis (X, Y, Z) can be specifically assigned as a first rotation axis. The benefit here is that singularity points (which produce data clipping) are avoided, and sensor data can freely rotate infinitely. The angles can be expressed in **Reference** to World or any available **Sensor** in the given measurement setup:



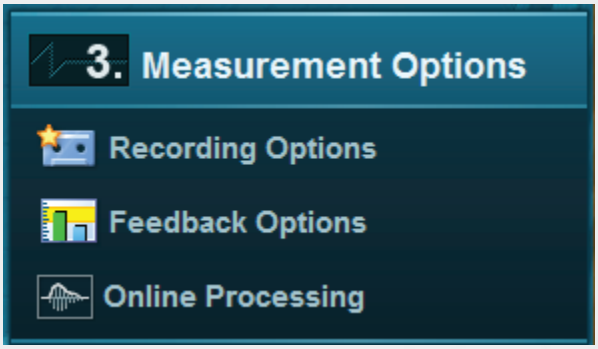
Axis allows you to define the main axis and only this axis will be shown as an angular trace. The other axis can be shown by creating a new custom angle and select the same sensor again. Invert will change the polarity of the angle curve. You can define as many custom angles as needed.

NOTE: Please follow our update announcements for more mathematical models to calculate angles (planar angles, helical axis, and selectable Cardan sequences).

4. 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.



Attention:

Not all measurement options are compatible with MyoMotion due to the nature of data or special requests due to device initialization:

Record options	Multi-activity recording is not compatible
Online processing	not compatible due to the quaternion nature of data

Recording Options:

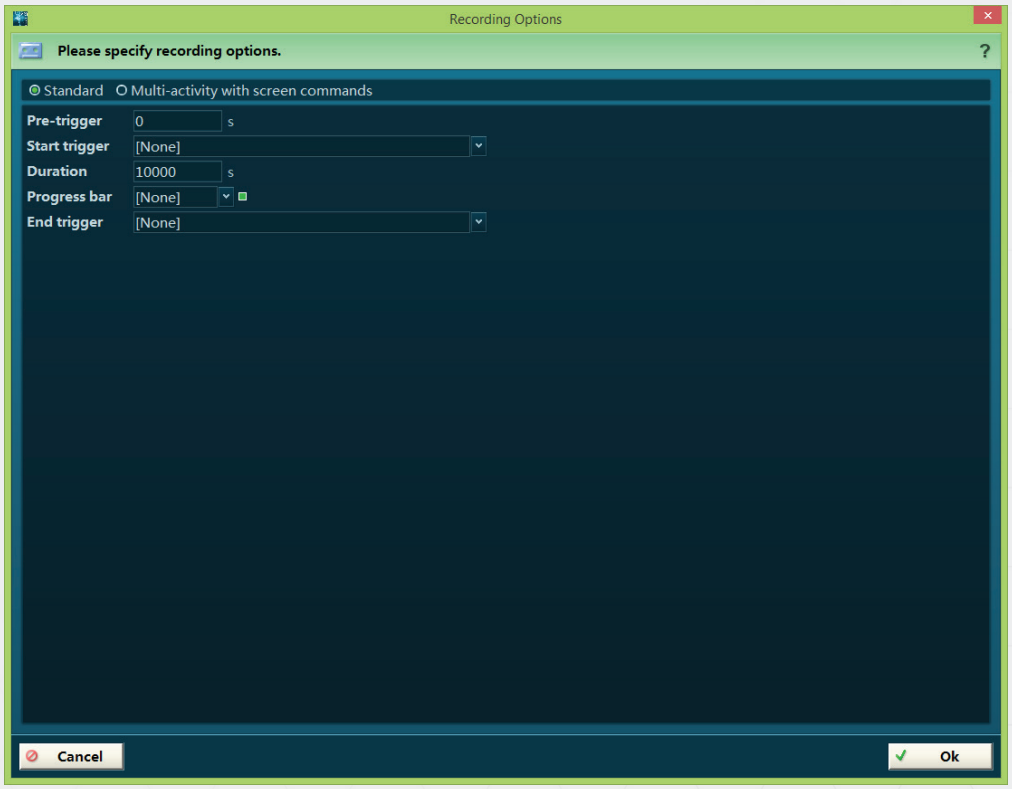
After pressing this option, you can select between two different recording modes:

- Standard
- Multi-activity with screen commands

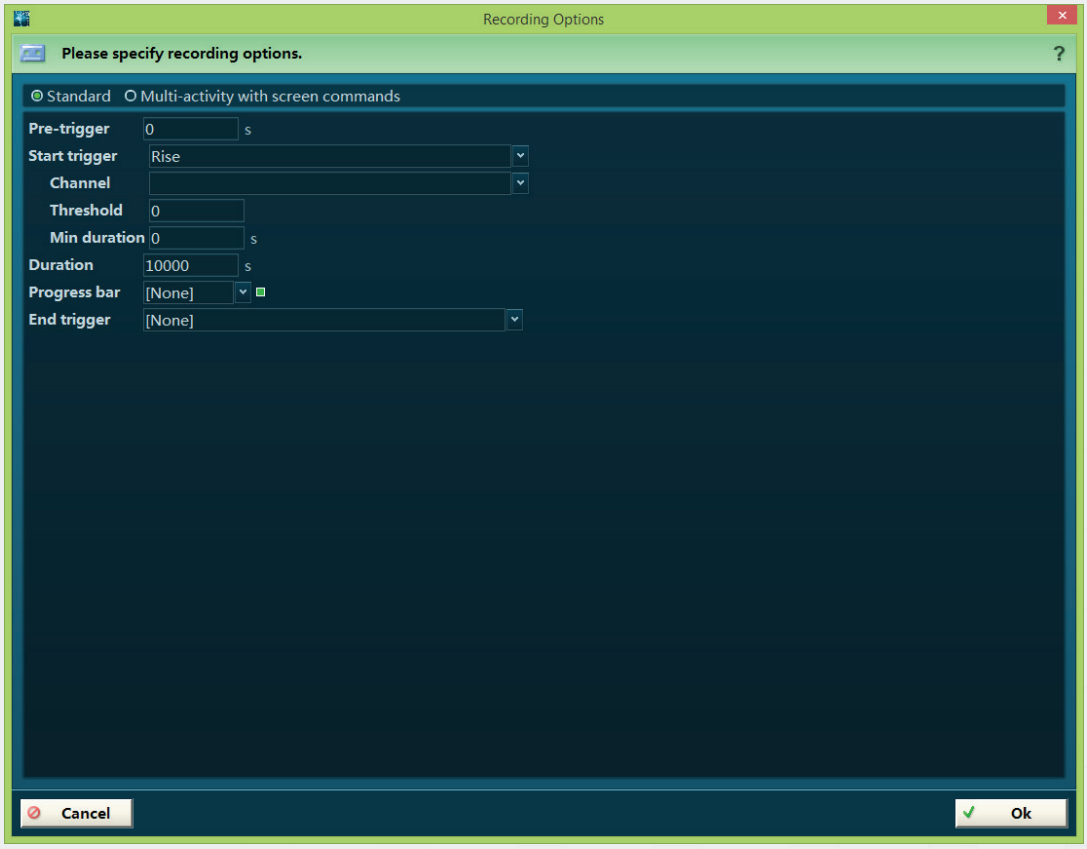
Standard Recording Option:

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.

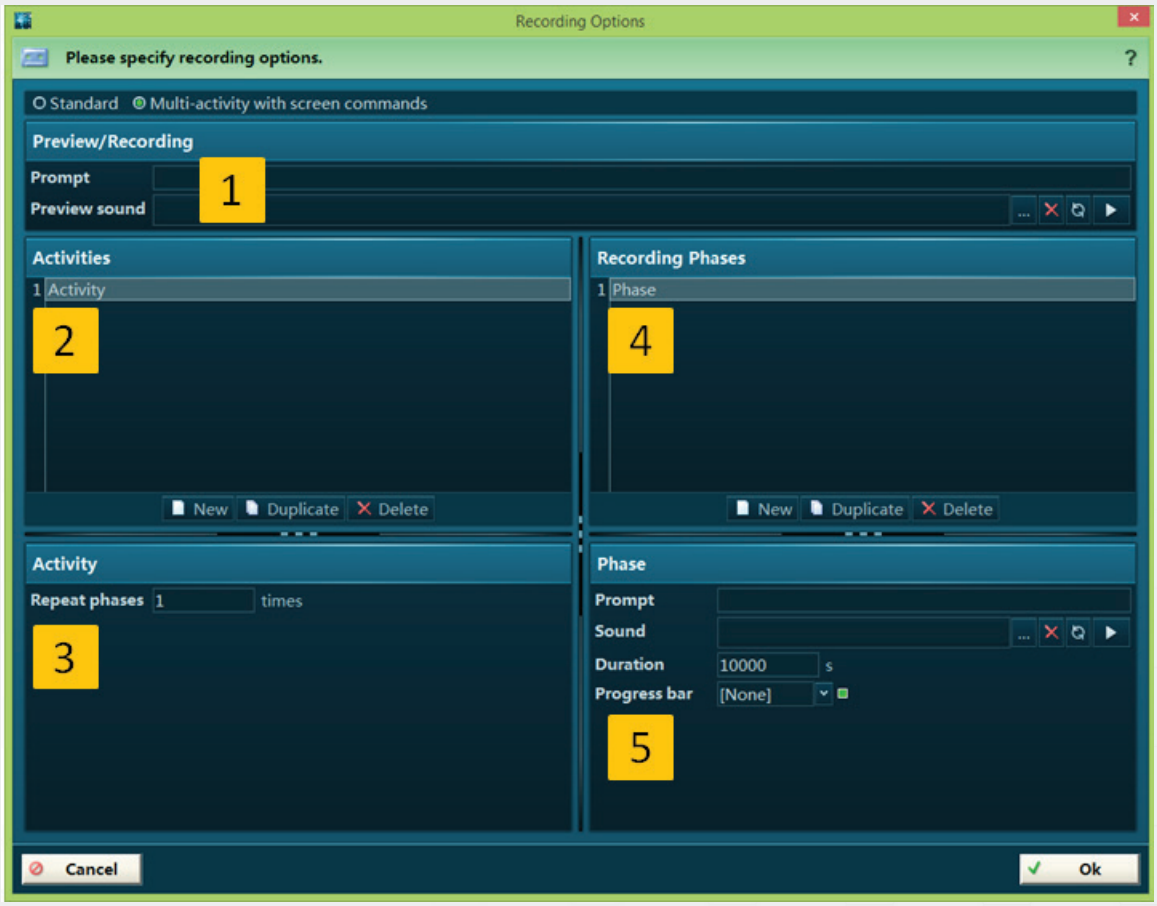


Once the channel is selected, choose a threshold and a minimum duration the channel must stay above to activate the trigger.

Multi-activity with Screen Commands

Not compatible with MyoMotion!

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.

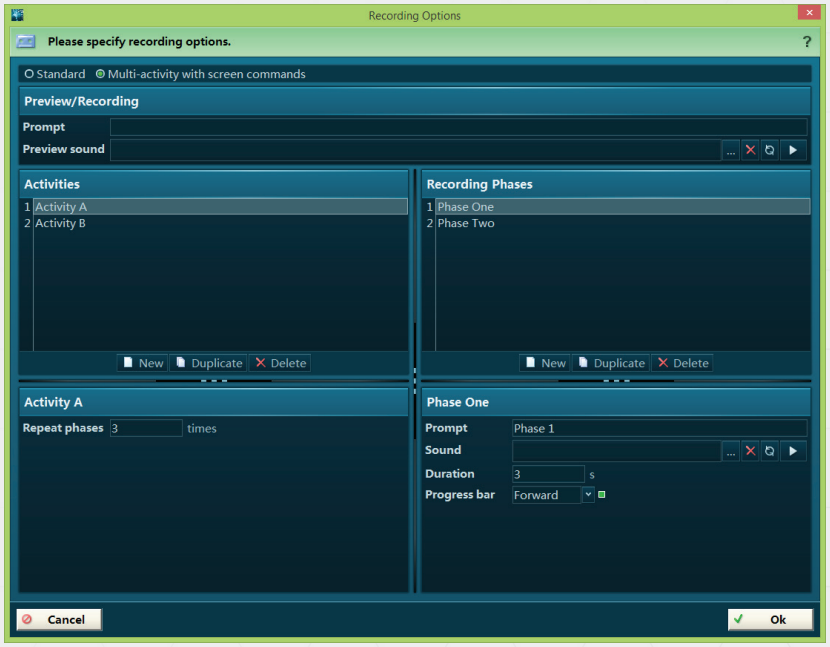
The controls **New, Duplicate,** and **Delete** allow you to edit phase operations.

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:

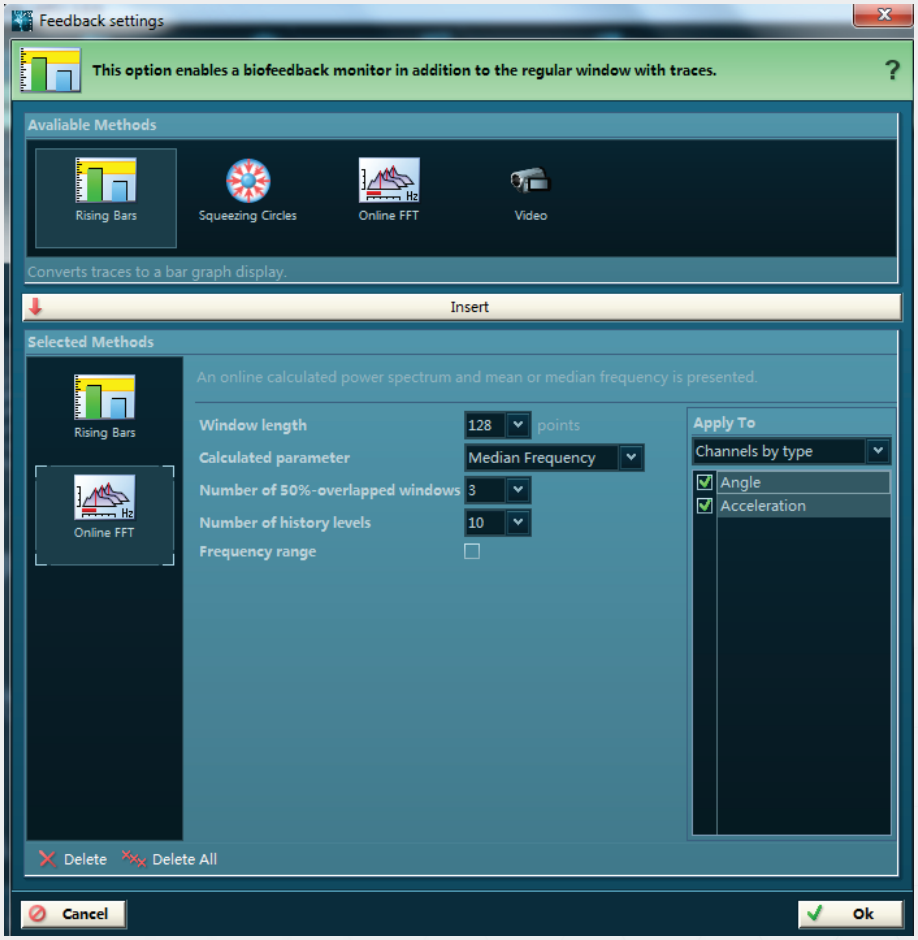


Measurement Screen example:

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.

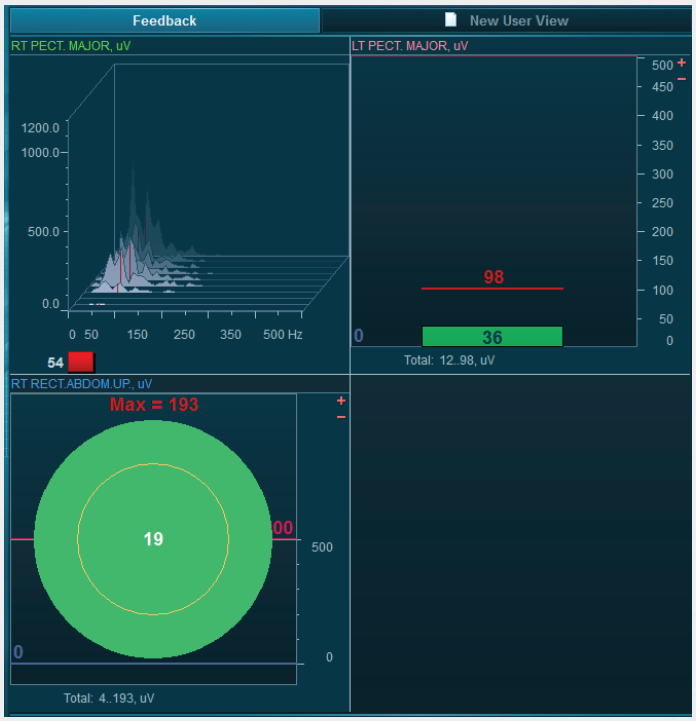


The signal from any sensor can be used for biofeedback via rising/falling bar graphs, shrinking cycles (designed for incontinence training), or real time FFT analysis via cascading power spectrums.

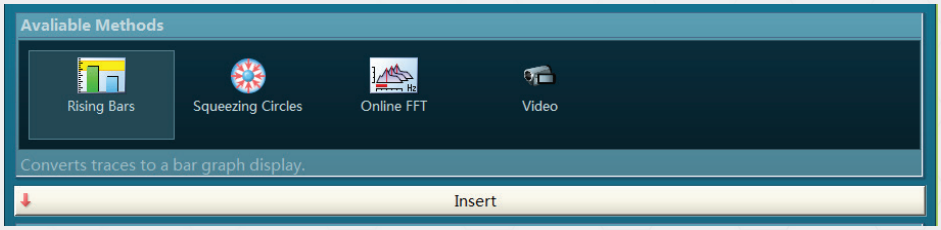
The basic idea of biofeedback is to present the signal amplitudes in easy-to-read displays and threshold ranges to provide a target for EMG activation or relaxation or joint angle movement. Currently two types of biofeedback modes are available: **Rising Bars**, which can be used for general purposes,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

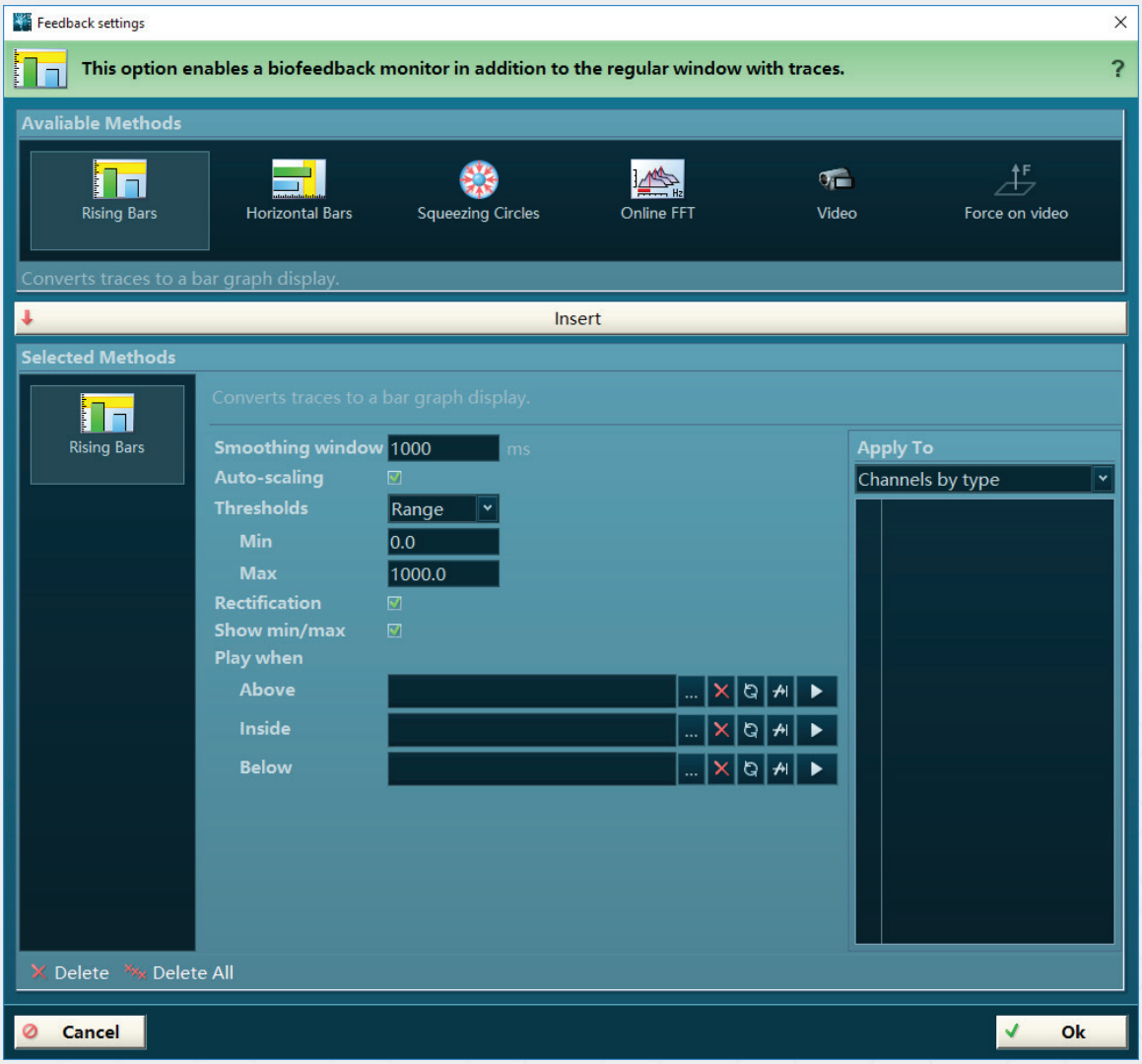


NOTE: Feedback methods can be loaded several times if needed.

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

The basic idea of biofeedback is to present the signal amplitudes in easy-to-read displays and threshold ranges to provide e.g. a target for EMG activation or relaxation, or joint angle movement. **Rising Bars** can be used for general purposes (e.g. "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.

› This PC › Local Disk (C:) › Program Files (x86) › Noraxon › MR 3.8.6 › noraxon.mr3.edition# › sounds.object#

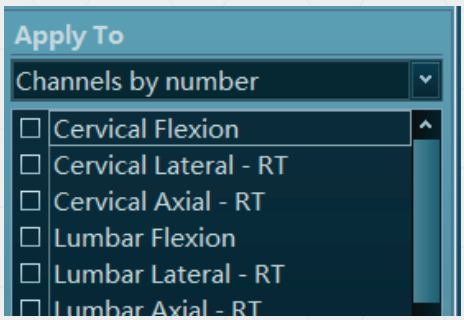
There are many pre-loaded sounds in the Noraxon directory. However, you may upload any sound file you wish by copying it into the "sounds.object#" folder, which can be found via the directory path shown below.

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

Rectification

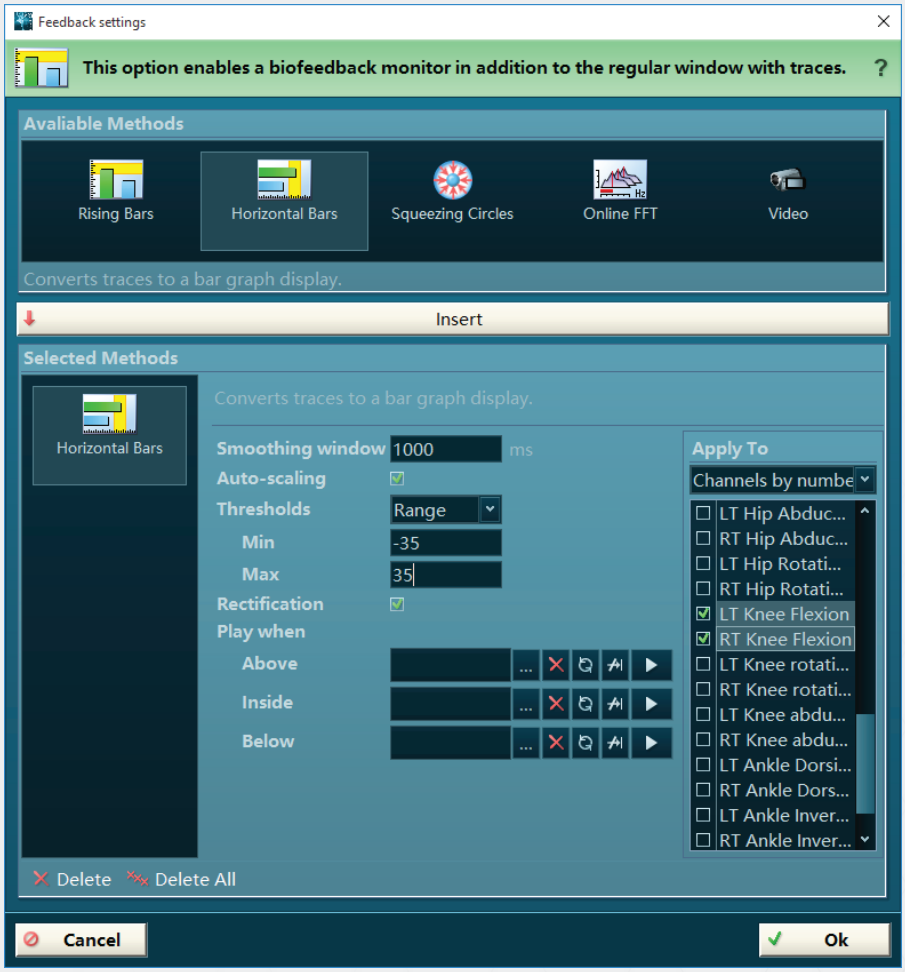
If checked, bipolar signals and their negative portions will automatically be rectified; the bars can only rise from zero to positive values. Uncheck this control if you want to have biofeedback bars move to negative (below zero) and positive range.

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.



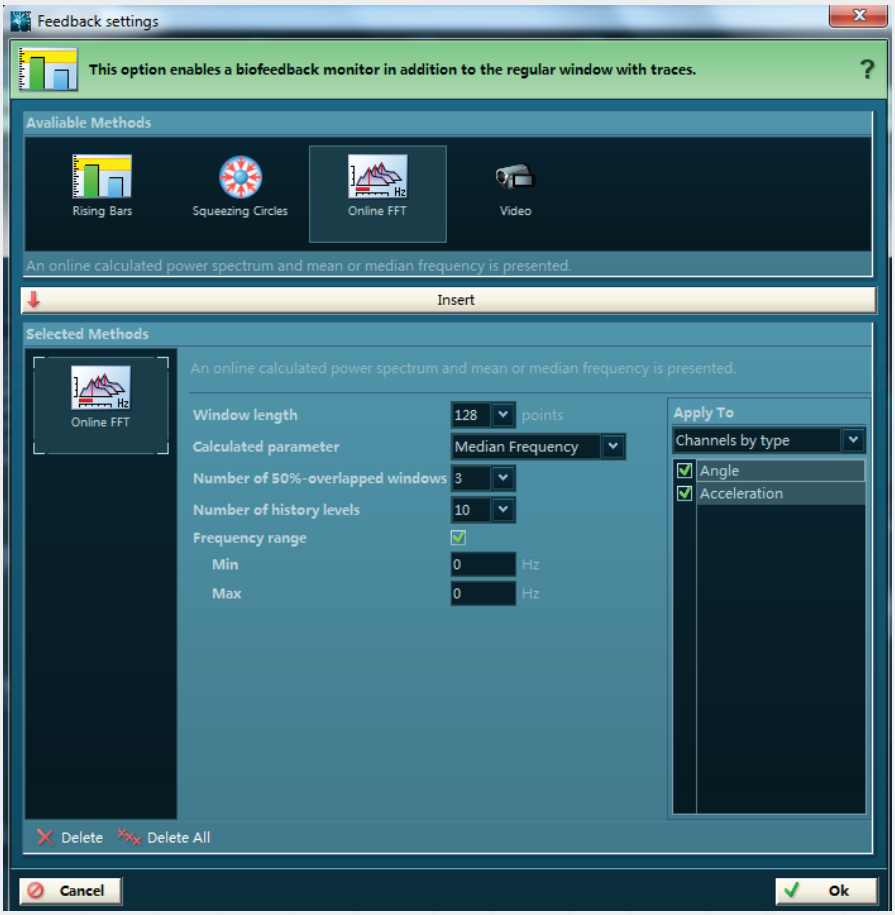
The setup menu for **Horizontal bars** is the same as for **Rising bars.**

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.



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.

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.

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

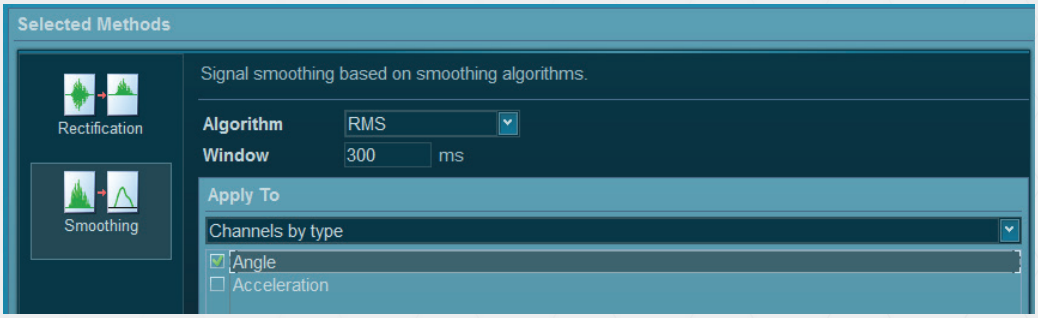
Attention: not compatible with MyoMotion

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.

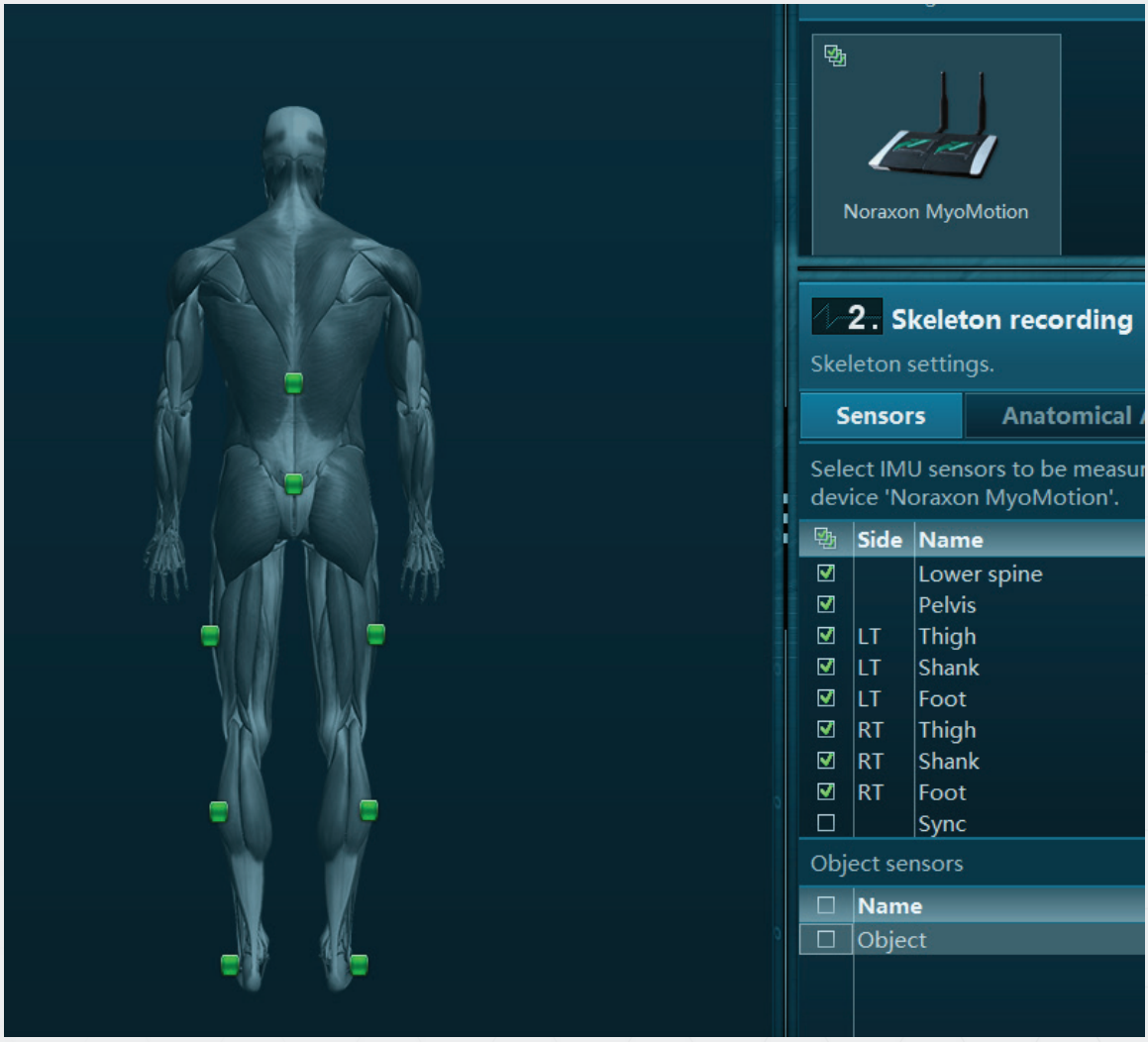


Section 6: Measure Menu

Introduction

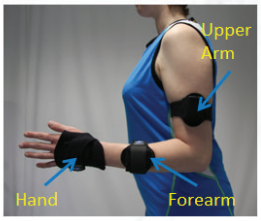
Sensor attachment

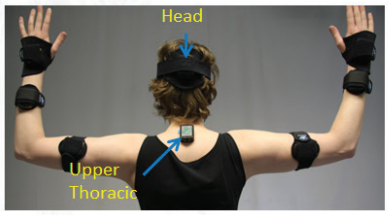
Prior to calibration and measurement, the MyoMOTION sensors need to be attached to the body segments of interest. The number of sensors is directly related to the activated sensors in the measurement setup menu. In the figure below the lower body sensors are activated:

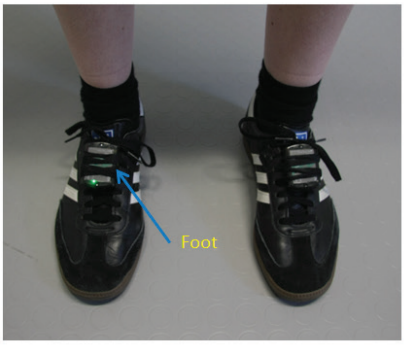


Noraxon delivers special elastic Neoprene straps for all areas of the body (except pelvis and lower thoracic, which are belts), allowing for easy adornment of the sensors.

Sensor	Media	Remarks
Head	Elastic strap	Position in middle of the back the head
Upper Thoracic	D-pad/shoulder belt	Sensor is located below C7 along the spinal cord, but high enough to not be affected by upper trapezius muscle movement
Lower Thoracic	Trunk belt	Sensor is located on the spinal cord at approximately L1/T12; the strap belt on front body side must be positioned on lower ribs
Pelvic	Pelvic belt	Sensor must be attached on bony area of sacrum
Upper Arm	Elastic strap	Lateral and longitudinal to bone axis midway between the shoulder and elbow joints
Forearm	Elastic strap	On lower section of segment (less muscle belly)
Hand	Elastic strap	At mid portion of upper hand
Thigh	Elastic strap	Frontal attachment on lower quadrant of quadriceps, slightly above the knee cap, and area of lowest muscle belly displacement in motion
Shank	Elastic strap	Frontal to slightly medial to best hit the tibia bone
Foot	Elastic Strap	On top of the upper foot, slightly below the ankle







Technically, inertial sensors can be located on any place of a given segment, but certain guidelines should be followed to assure higher data quality and fidelity:

- Avoid bony prominences or areas that are susceptible to muscle bellying (movement of the sensor via muscle contraction). Ideally, the sensor is placed on a flat portion of the body segment with the least muscle tissue between the bone and sensor.
- Try to apply sensors symmetrically on each body sides so that they measure under the same condition.
- Reduce the "wobbling" factor of muscle tissue by using underlying bandages, physiotape, and/or support pads, which enlarge the contact area of the sensors and diminish the "tilting" during motion.

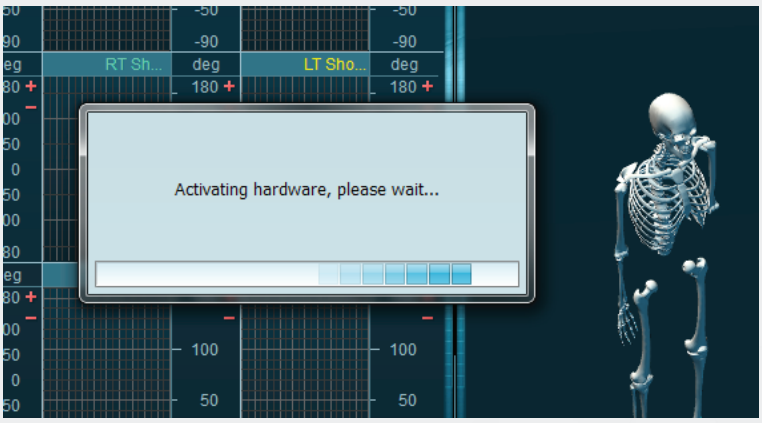
More details concerning sensor placement can be found in **Appendix D.**

NOTE: Due to the increased risk of soft tissue artifacts (especially muscle belly motion) on the quadriceps, measuring 3D knee angles requires special attention. For example, the thigh sensors could be further secured using physiotape and support pads. We leave it to user discretion to obtain the best data possible by troubleshooting various sensor placements.

Taking a Measurement

After selecting an existing configuration or creating a new configuration, continue to the measurement screen by clicking the **Start Measure Button** in the green operation line:

A sensor activation dialogue will appear on the next window:



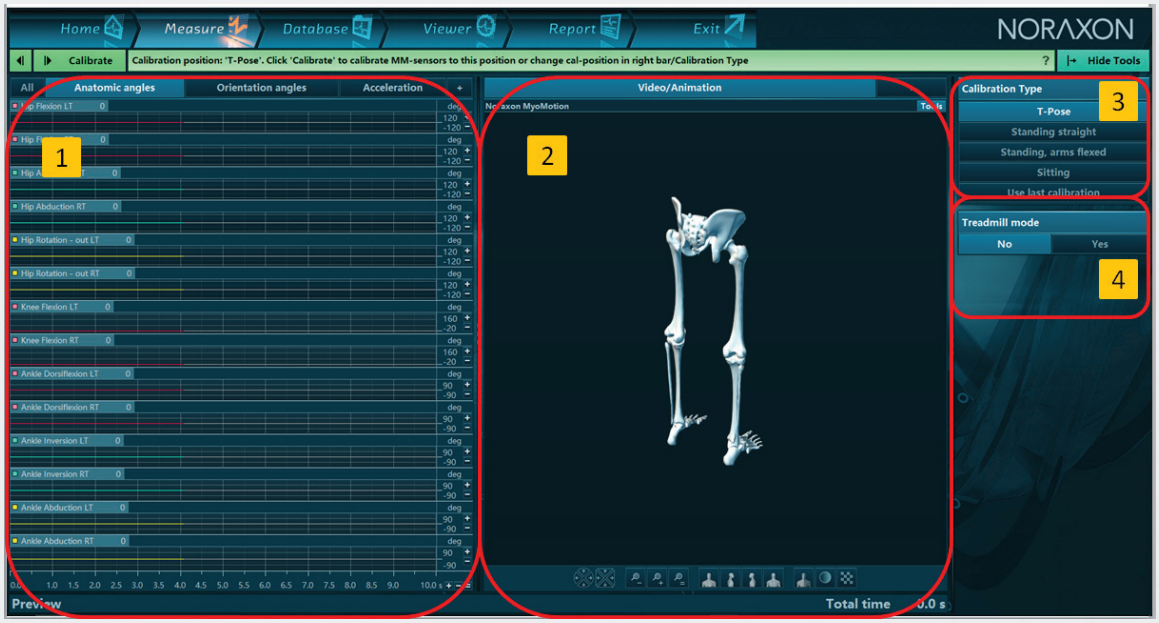
After approximately 20 seconds, the time needed to “wake up” the sensors, the final measurement screen will appear.

Preview Screen

The Measure screen will automatically display a preview of the data supplied by the sensors. The sensors and avatar will start in calibration mode and as such will not provide data until after calibration. The sensors are compared to a known starting position (calibration type) of all the body joints. The body segments assigned to the sensors during configuration are represented by a skeletal avatar.

Calibration - Overview

Calibration mode consists of four important screen sections:



1. **Signal screen** – Displays the signal for the measurement options chosen during configuration. Dependent on measurement setup settings, it consists of several register tabs: anatomical angles, orientation angles, and/or accelerations.

   NOTE: The signals are inactive during calibration mode.

2. **Calibration position preview** – Visualized by a skeletal avatar, this shows the selected calibration position.
   Includes the important **Magnetic Warning Function** (see below)

3. **Calibration type** – Choose the appropriate calibration position; there are 3 different positions available. The default position is standing straight, as seen in the screen shot above.

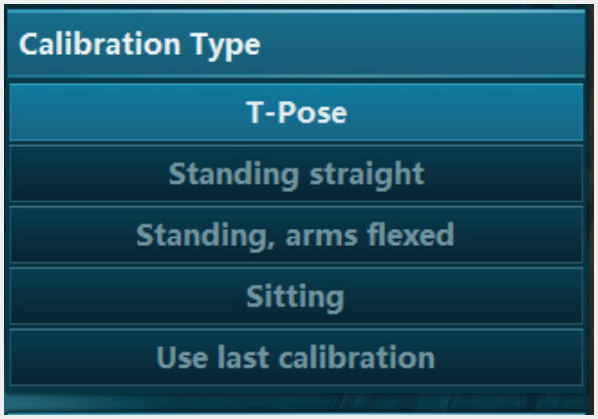
4. **Treadmill Mode - No/Yes**. The Treadmill mode allows you to measure gait activities in the areas of significant magnetic distortion that occur when using a treadmill.

Calibration – Operational steps and instruction scheme

Please carefully read all information and study our addendum material and hardware manual on how to use myoMOTION sensors in applied setups.

Step 1: Select calibration position

Select an appropriate calibration position or **Use Last Calibration** if available. The recommended standard calibration pose is **Standing straight:**



Alternative positions:

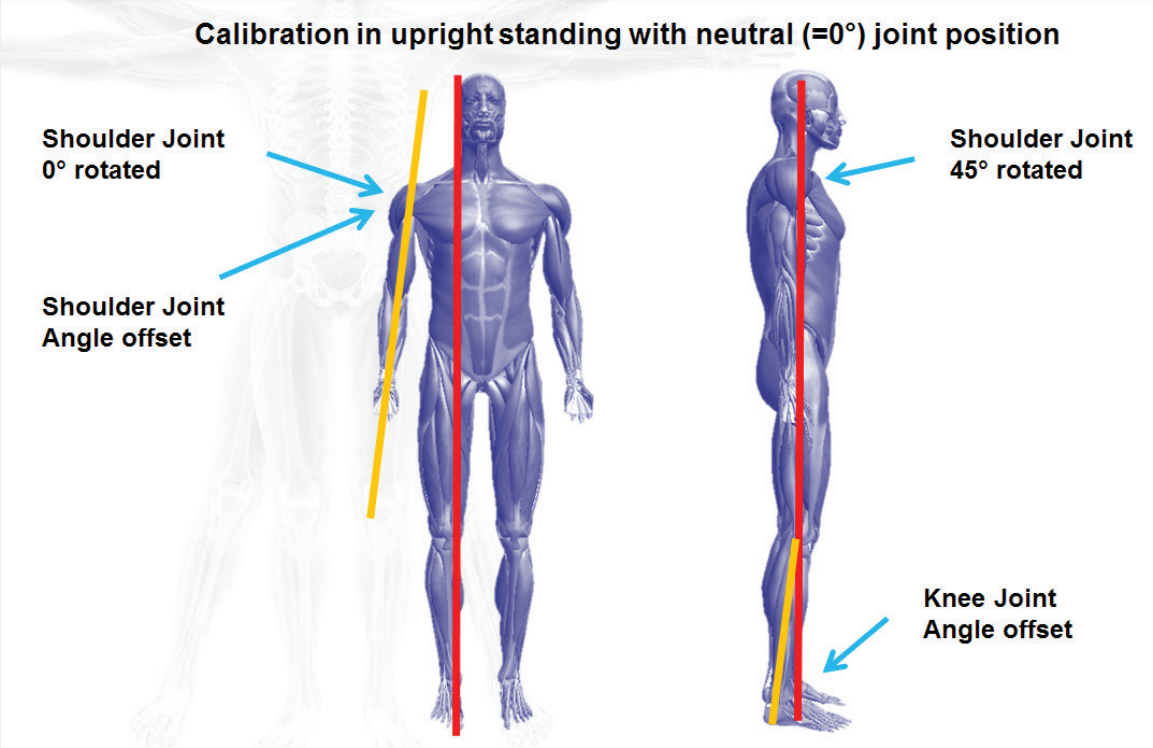
Standing with elbow flexed at 90°

Seated with elbow, hip and knee flexed at 90°

NOTE: The elbow flexed and seated positions are helpful for subjects that cannot stand straight with all joints at the anatomical zero position.

If a second measurement is performed a fourth option is presented - **Use last calibration.**
Remarks for the Calibration Position:

Carefully study the quality and details of the calibration position of your subject. It may happen that some joints cannot reach the true anatomical zero position and an offset is subtracted or added to the angle data. For example, if the shoulder joint of a m uscular male subject cannot reach a 0° adduction position and offsets by 10°, in both the angle data and the skeletal avatar visual, 90° shoulder abduction will appear as 80° shoulder abduction:

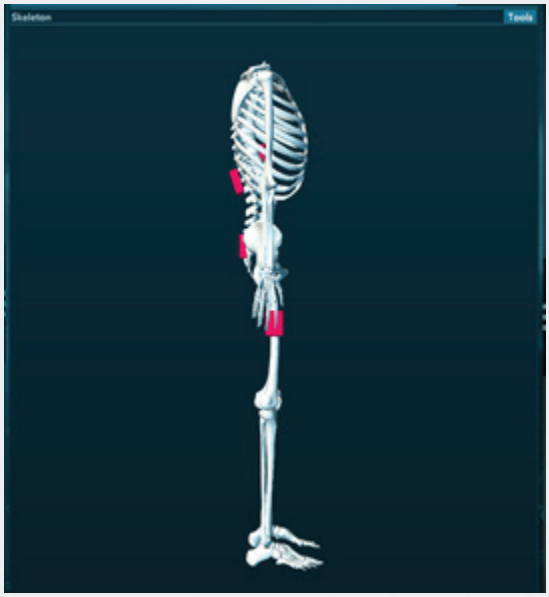


The validity of the absolute angle data is dependent on any offset created by the calibration position.

Step 2: Check magnetic warning status on avatar screen

This step is another important check for the quality of any Inertial Sensor based measurement:

The calibration procedure MUST be operated in magnetic distortion free environments. To see if a given calibration spot is distortion free, a special magnetic warning function is implemented so that if a sensor is distorted it becomes visible as a red cube on the skeletal avatar:



In the example above, the right thigh, pelvic, and lower thoracic sensors are distorted, while the others are stable. If a sensor passes the magnetic distortion test, it does not show up in the skeleton.

NOTE: the magnetic test requires a static position. It does not work in dynamic conditions!

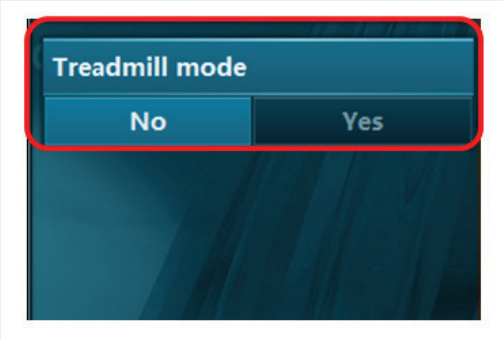
In general, it is recommended to stay away about 1 – 2 meters from metal objects, walls, doors, or metal devices. To clean the distortion condition for the feet sensors (distortion from floor metal components) it is recommended to let the subject stand on a wooden box or stair about 30 to 40 cm tall.

NOTE: You must to calibrate in distortion free conditions!

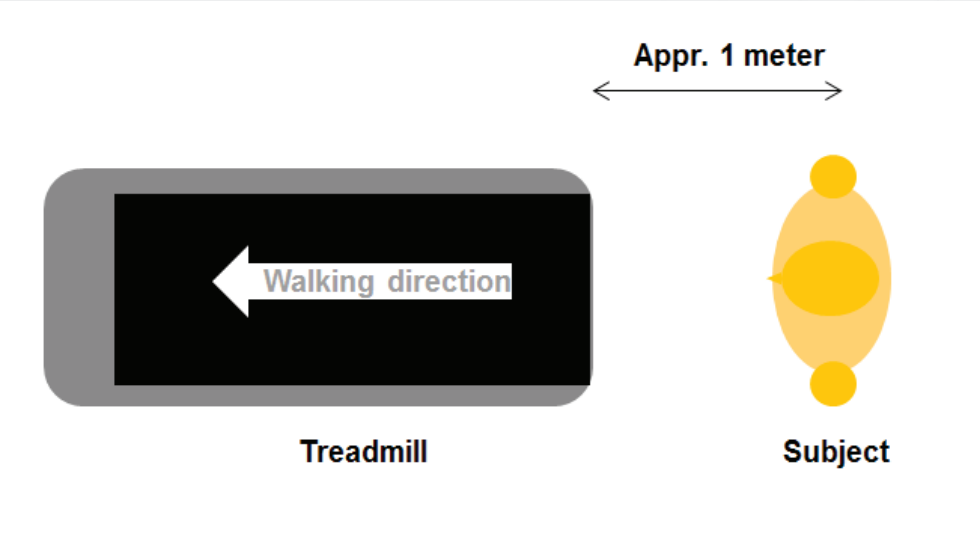
Step 3: Turn Treadmill mode on or off

Use Gait mode only for treadmills!

Most commercial treadmills will cause magnetic distortion of at least the foot sensors. To enable gait and running analysis on treadmills, Noraxon has a developed a unique **Treadmill mode**. It can be activated during the Calibration mode in the right tool bar of the **Measurement screen** by clicking on the **Treadmill Mode** Yes button:



When Treadmill mode is activated, perform calibrations in a standing position. The subject should stand approximately 1 meter behind and parallel to the treadmill, facing in the walking direction. Try to replicate the whole-body orientation as it would be when standing on the treadmill.



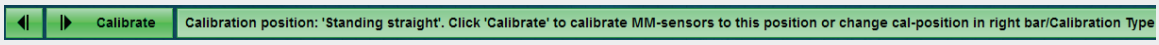
Calibration should again be completed in a distortion free area near the treadmill, but not on it. When calibration is complete, the subject may get on the treadmill and start walking. Local sensor related distortions will automatically be rejected.

NOTE: Gait mode normalizes the range of motion (ROM) to the calibration position. Most affected are horizontal rotations, like foot abduction. This mode may alter the true ROM if it is constantly moved away from the calibration ROM range. Use Treadmill mode only for gait and normal

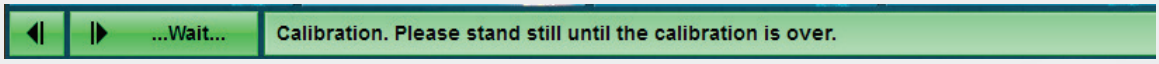
running activities!

Step 4: Operate the calibration procedure

Once the subject is in the desired calibration position, instruct the subject to stand still and not move, click on **Calibrate** in the main operation line:



The anatomical joint positions of the selected calibration position are calculated. The calibration procedure starts with ...**Wait… and an audio start tone. The process lasts about 11 seconds…**

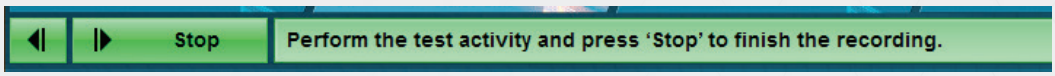


and stops with an audio stop tone. The status prompt will change to Record.

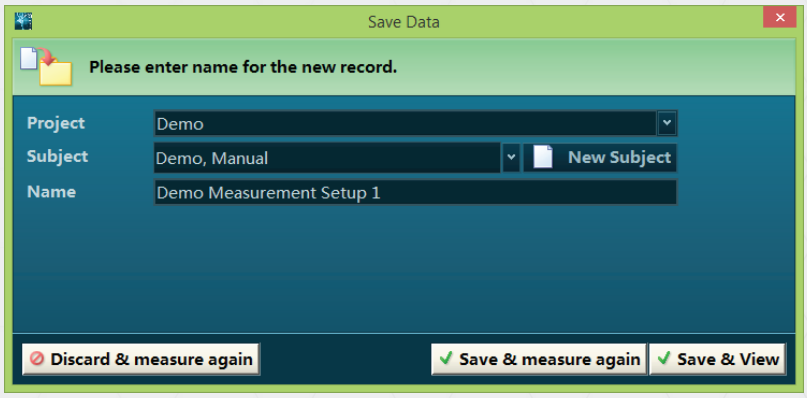
Recording Measurements

The system is now ready to take measurements. Any movement made by the test subject will be animated by the skeletal avatar and the angle signals start running 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:

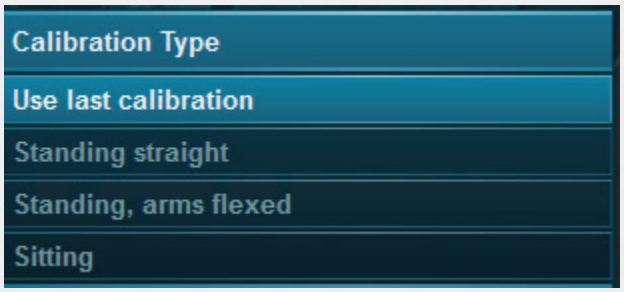


The second line, **Subject**, allows the user to change, create, or confirm the previously selected subject name. The first line **Project** allows you to select another project. After pressing **Ok**, the record can be reviewed in the record **Viewer.**

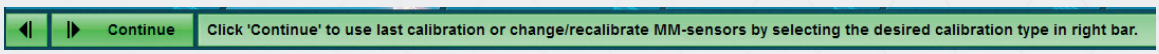
In the lower button line, you will find 3 choices to continue:

Discard &measure again	Delete the current recording and goes back to measure.
Save & measure again	Stores the current recording under entered name and goes back to measure. This mode skips the calibration step and allows for continuous recording trials without calibration in between.
Save & View	Stores the current recording and goes back to the Record Viewer.

For repeated measures, there is an additional calibration option available in the Calibration type option in the right tool bar:

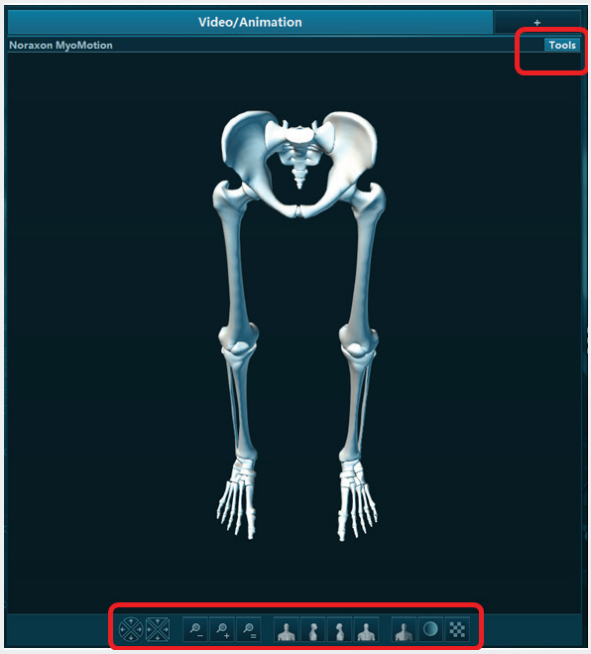


Use last calibration allows for fast sequences of repeated measurements. As long as the sensors are not moved on the subject's body, the last calibration data can be used for the next measurement. Click on Continue to operate the next measurement with the same calibration:



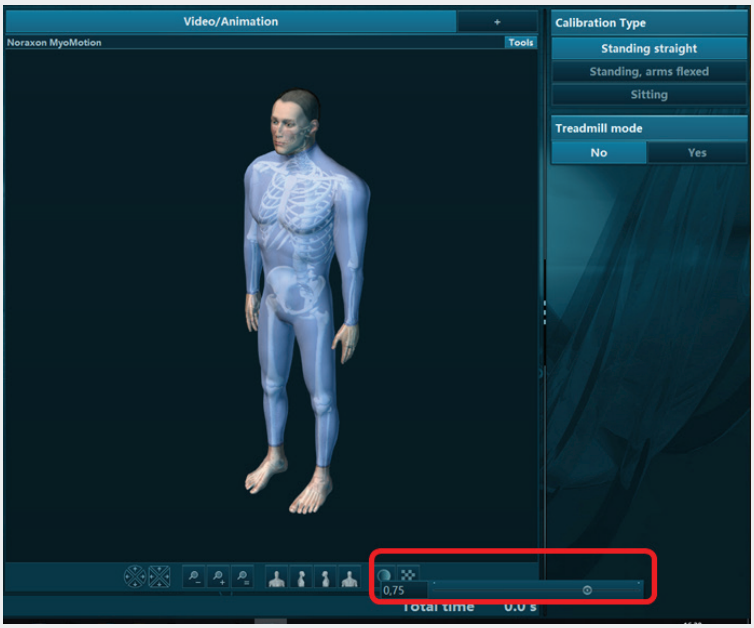
Avatar Display Tools

The main function of the avatar animation is to visualize the angle measurement curves on the left side of measurement screen. The avatar moves exactly in relation to the measured curves. It may be helpful to adjust the view and perspective. If not visible on the lower section of the screen, click on Tools in the upper right corner to make the avatar view tools visible:

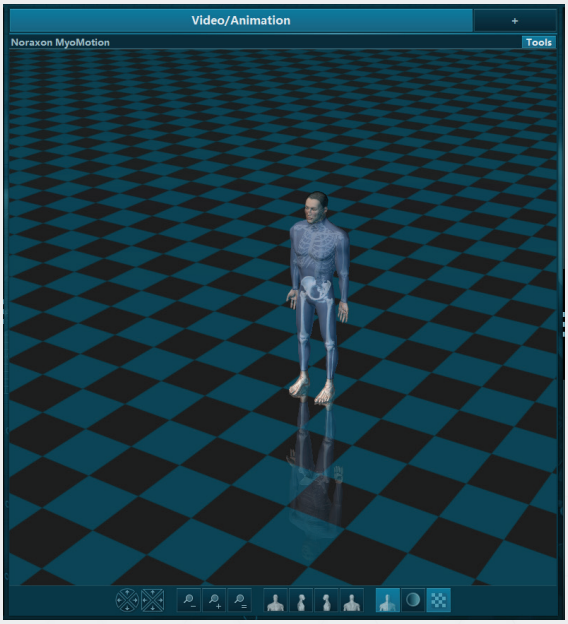


Function of the tools from left to right:

Arrow circle	Rotates avatar (=like left pressed mouse button)
Arrow square	Moves avatar up/down and left/right (pressed mouse wheel button)
Magnifying Glass (+/-)	Zoom in or out (mouse wheel)
Magnifying Glass (=)	Best view in case avatar moved out of view
Human Profile Symbols	Different view left/right, back/front
Half Human Profile Symbol	Complete half or partial body avatars to full avatar model. Undetected segments are grayed-out and do not move
Shaded circle	It opens the transparency slider that allows you to change the avatar from skeleton to surface model with any transparency gradient with.



Chess board: This button turns on the floor and animates walking and running (accurate only on moderate speed). The avatar will start to walk over the floor



Magnetic distortion table

Dependent on the MyoMotion related software setup settings (see Home screen menu) magnetic distortion can also be shown in a numerical table appearing in the right tool bar:

The amount of distortion is expressed as a vector value and dip angle. The magnetic warning is based on a delta value related to the given reference value. This reference value is compiled out of the mean magnetic orientation for all sensors. If a sensor exceeds the predefined tolerance range it is indicate with red color (both in avatar animation as well as in the table).

Note: the magnetic warning table is only available before calibration.

Magnetic warning within recording

The magnetic warning function can also be used to test if a given activity area is heavily distorted or "clean". Turn on the function Magnetic warnings in the right tool bar of measurement screen (after calibration):

Just move the subject to the position or spot of interest and let him stand still!

If no red sensor is shown in the avatar animation window it means it means no significant distortion is found.

Attention: the magnetic warning only works in static positions!

Magnetometer No / Yes

This optional function can be turned on or off in the MyoMotion software settings of Home screen menu.

To manage measurements in certain distortion environment, it may help to turn off the magnetometers.

Attention: this function is only meant to be used by specialists. It should not be used in dynamic activities with significant accelerations.

Screen Layouts

For multi-device setups, it may be helpful to use the customizable screen layout system of the Measure menu.

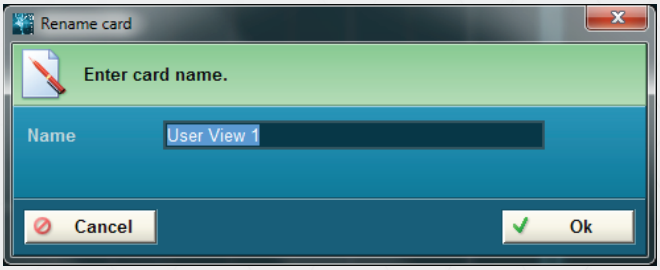
Generally, each device will have its own specific tab:

MyoMotion can receive up to 3 tabs:

- Anatomical angles
- Orientation angles
- Accelerations

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

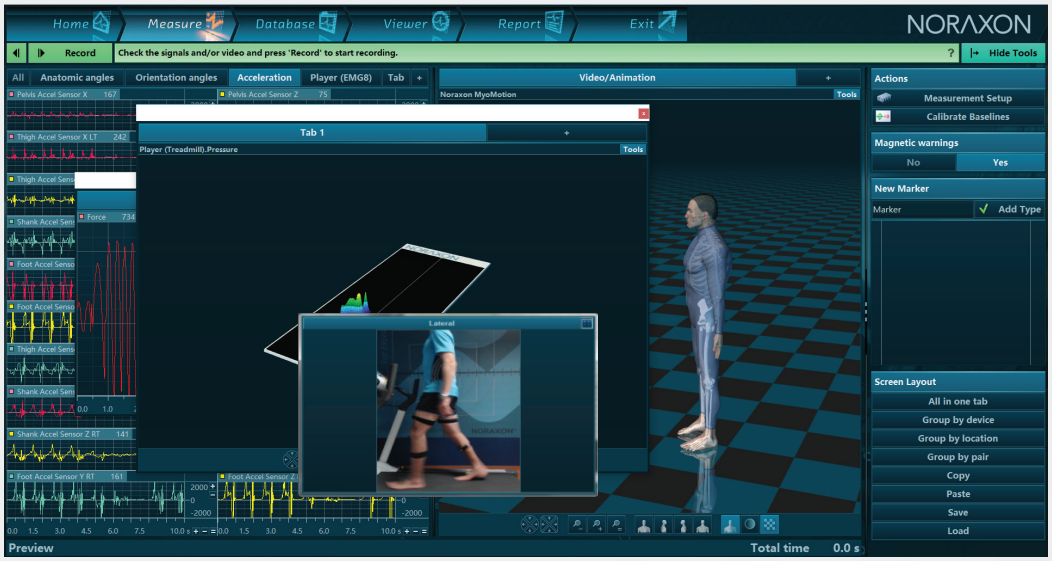
At any time, any tab can be renamed by right-clicking on the tab name. New dialog will open:



Just enter any new/suitable name for continues use.

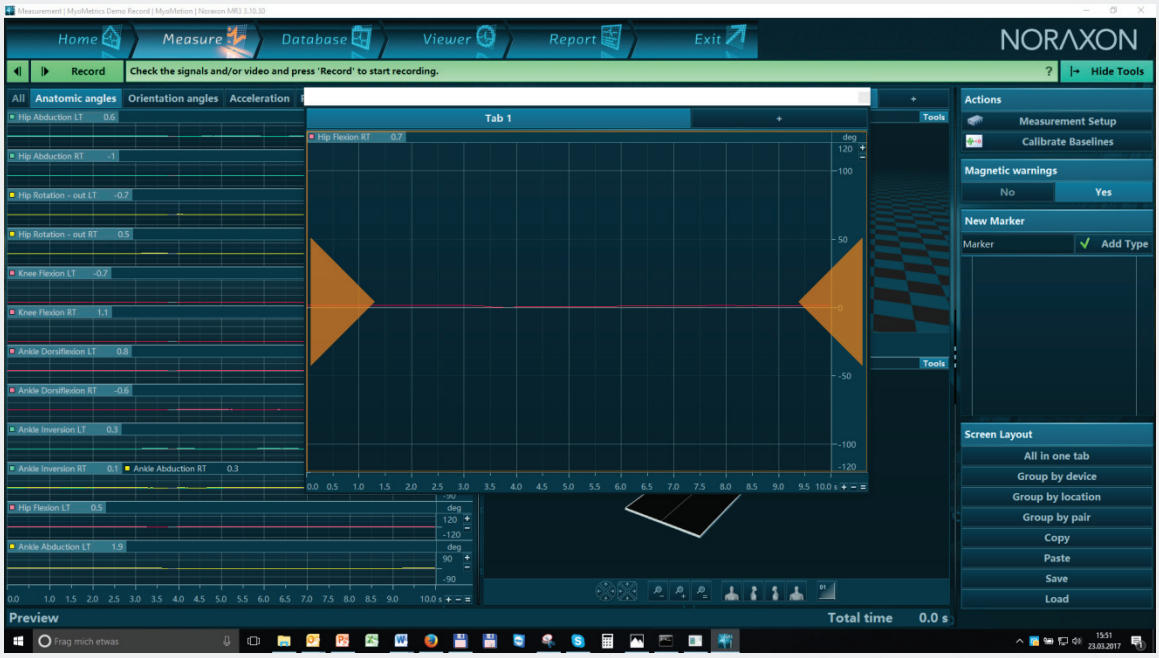
This screen layout system allows the user to create as many signal selections or new user views as needed. A similar system is available for the **Video/Animation** window:

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



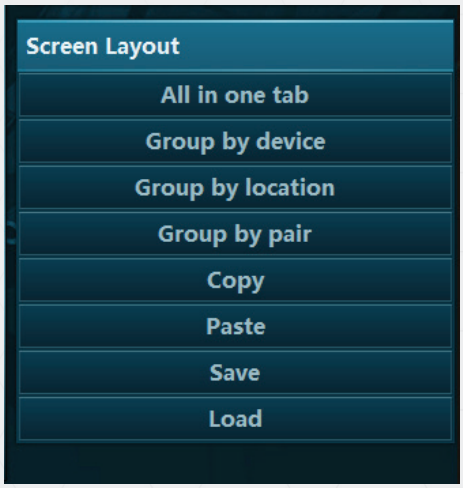
The small red X button in the upper right corner of the window title line will close the pop-up window and move back the signal to its original tab location.
If you hold the CTRL key and double click on a second channel title from the source tab you can insert more channels to the pop-up window. This 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):

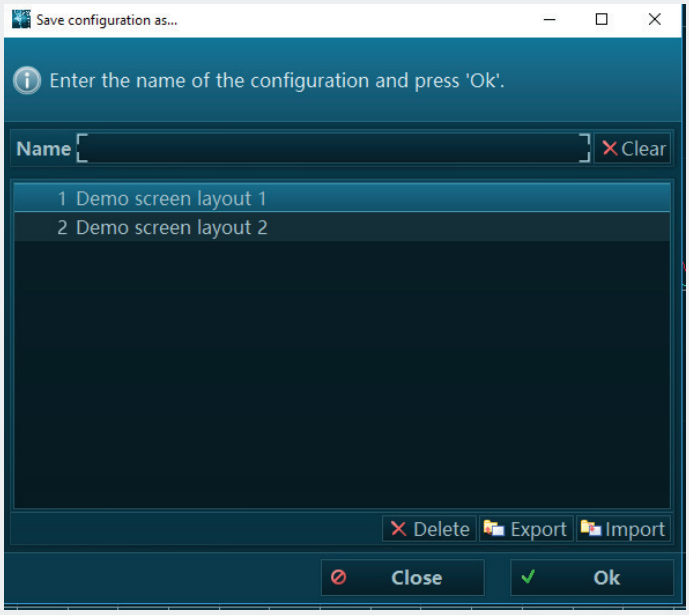


If you want to insert a channel above the existing one, move mouse up until upper arrow shows up. The same procedure works also for dragging channel below an existing channel (arrow shows down).

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 it 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.

Measure Menu Functions

Local Amplitude Zoom Function

During measurement and recording the given amplitude (Y-axis) scaling can be changed by using the local zoom plus/minus buttons as shown in the red box on the figure to the left.

Actions Tool Bar

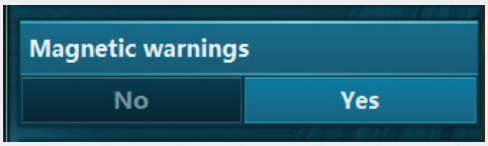
The right tool bar of the **Measurement** menu includes a section titled Actions (shown below). This tool section is only meant to be used for myoMOTION and myoMUSCLE signal screens and is not active (or needed) for pressure distribution animation in myoPRESSURE.

Measurement Setup – Redirects you back to the measurement setup/configuration screen. Please see below for more details about this setup and options.

Calibrate Baselines – this option is only needed if EMG and other biomechanical sensors from the TELEmyo G2 or DTS system are included in the recording. For such signals, it may be required to correct zero-line offset shifts via recalibration by clicking this button.

Magnetic warnings

Magnetic warnings are meant to be used in calibration position to approve if a given spot is clean enough to calibration all sensors

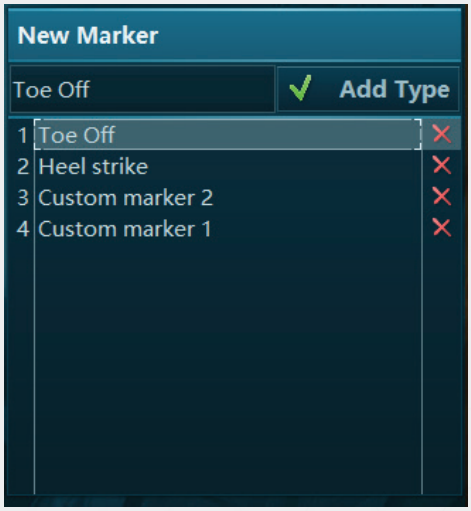


Once a given calibration spot is approved to be clean, magnetic warning can be switched off. Magnetic waning will not work in dynamic conditions, but can be used to find clean spots.

Markers

With this 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 Add Type 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:

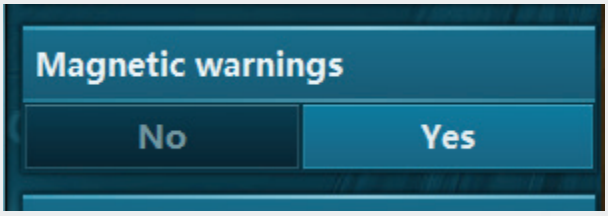
Once recording has started, clicking the Set button will place a marker in the record (displayed in the Viewer menu) as well as provide an audio cue. A successfully placed marker is indicated by a short tone. Alternatively, the space bar can be used to place a marker in the recording.

Error Warnings

Several device specific warnings such as low sensor battery, missing sensors in wake-up routine, etc. may appear during operation. To solve the problem, simply follow the on-screen commands.

Magnetic Distortion Testing after calibration routine

The magnetic warning function can also be used to test if a given activity area is heavily distorted or "clean". Turn on the function Magnetic warnings in the right tool bar of measurement screen (after calibration):



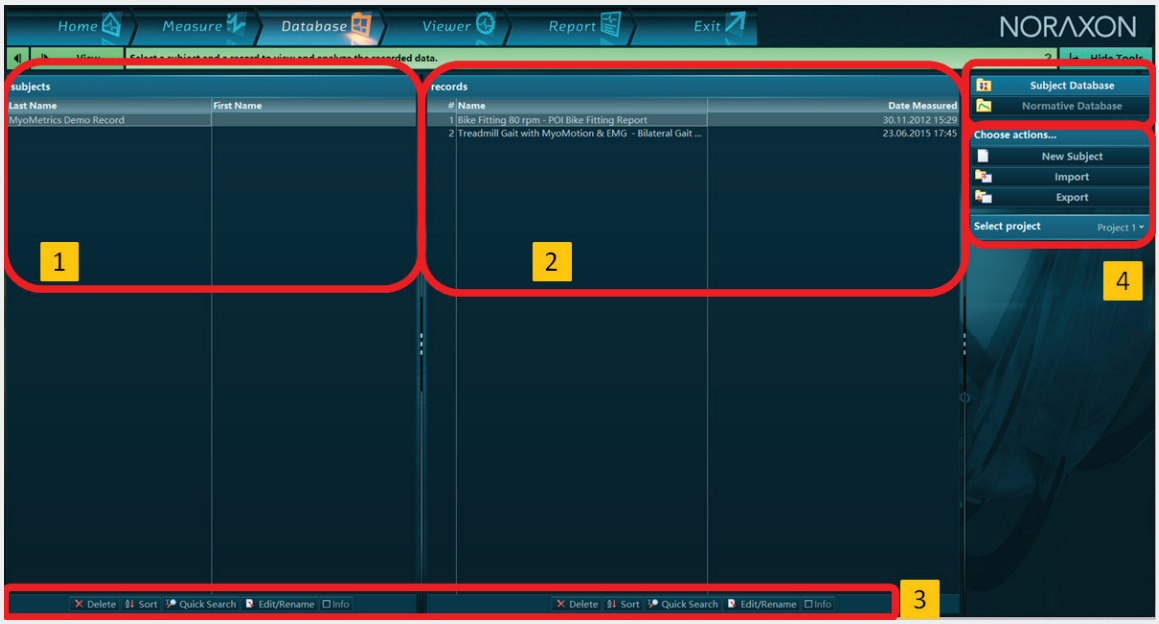
Simply move the subject to the position of interest and let him stand still.

NOTE: the magnetic warning only works in static positions!

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

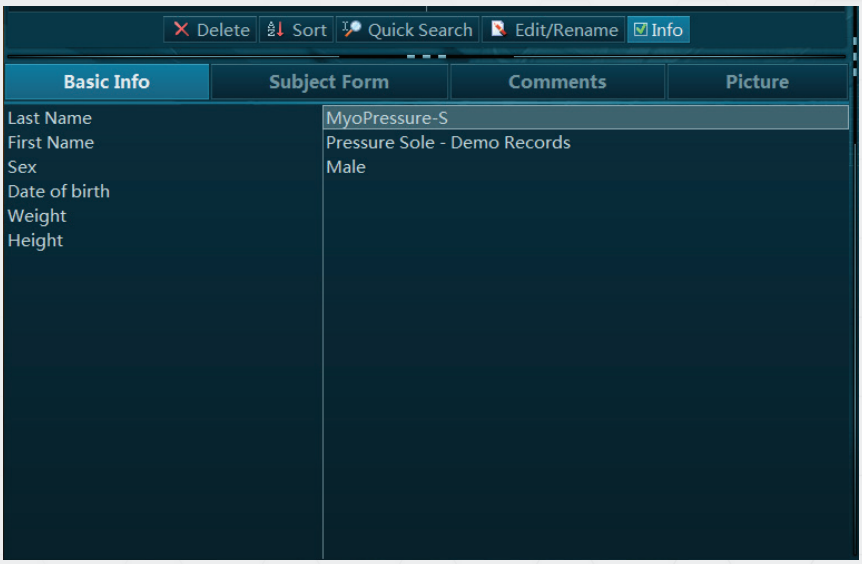
The screen is split into two sections, reflecting the organization of records into Subjects (left list section) and Records (right list section) stored under a given subject name.

3 – Local List Functions

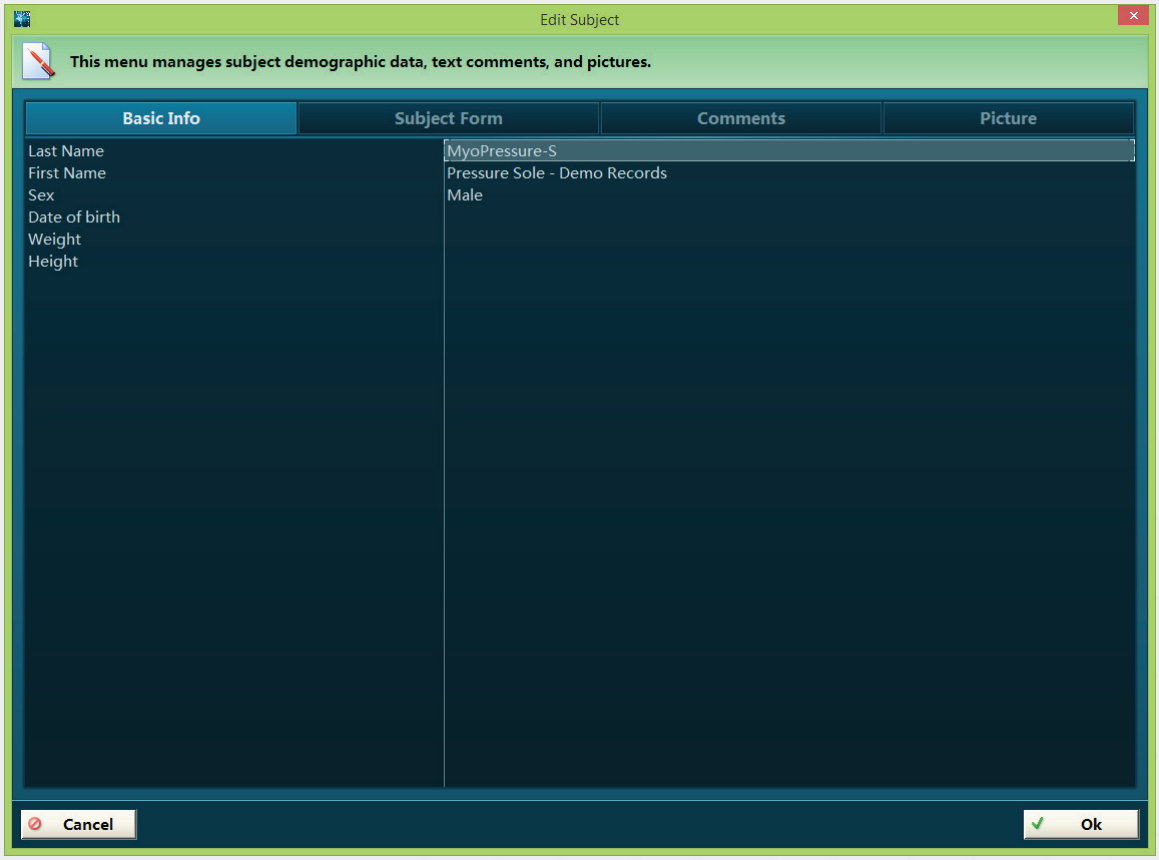
Below each list you find a set of list functions:

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:

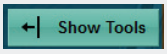


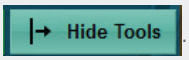
Basic Info	This tab section contains basic subject information like Name, Sex, Birth date weight and height
Subject Form	This is an expanded list of patient properties and data.
Comments	Here you can enter or edit patient comments. It is possible to use a text clip system and/or paste text from Clipboard
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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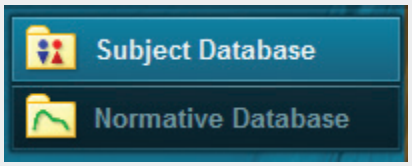
Besides the **Subjects Database** there is another database section called **Normative Database**



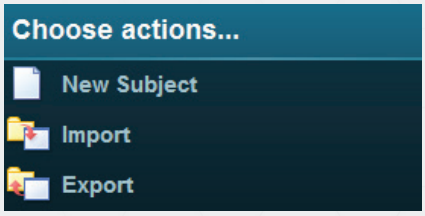
It contains all normative data records that were compiled via the “Add to Normative” function within the **Report Menu** (see chapter report).

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.

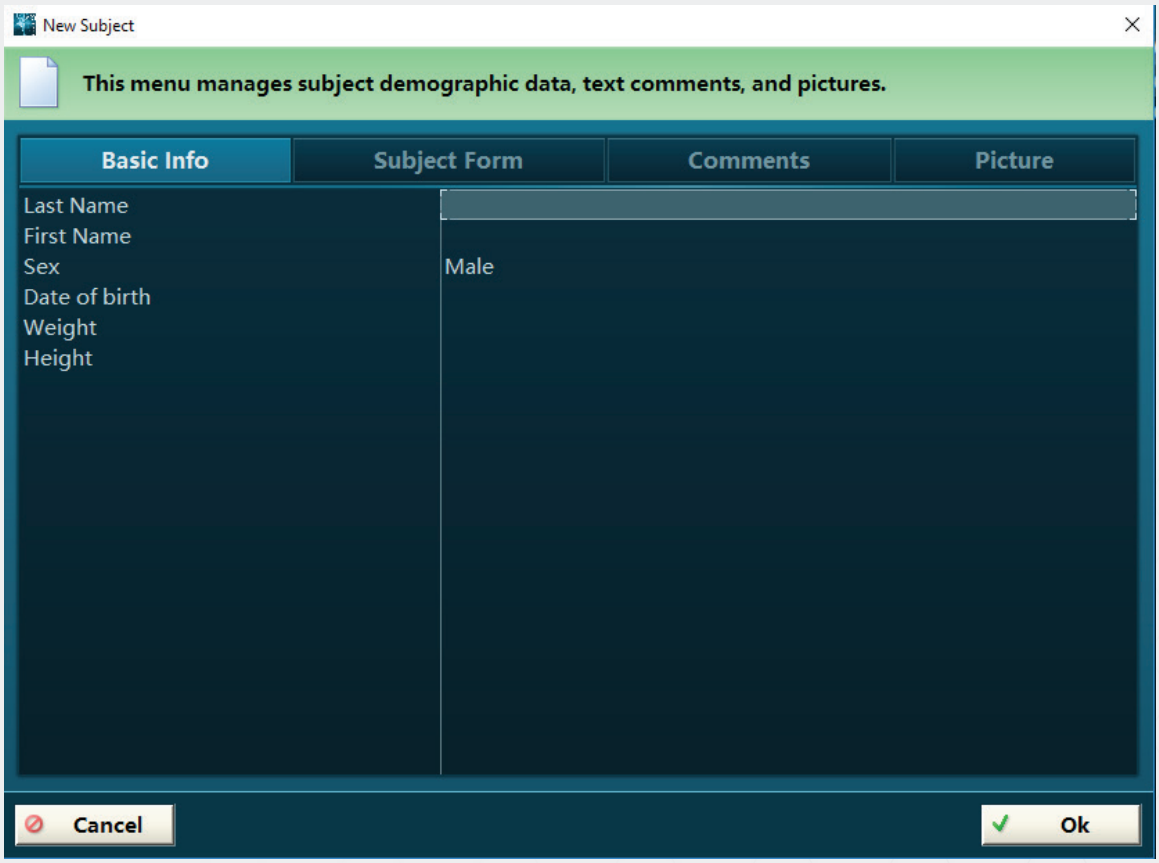
Choose actions

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



New Subject

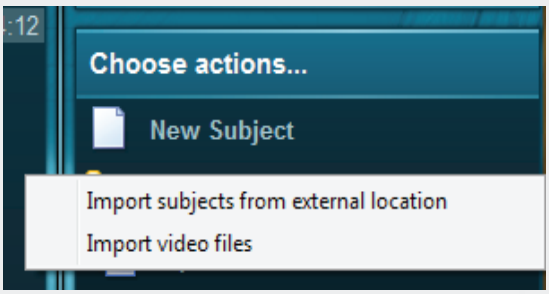
Here you can create a New Subject in your database. Click on the **New Subject** button to open a sub-menu similar to the Subject properties / Edit screen:

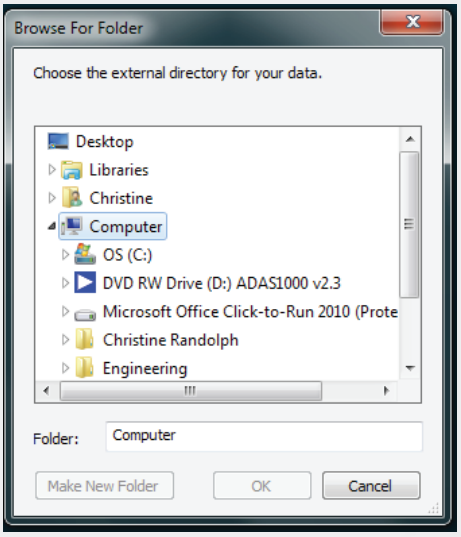


The minimum information to be entered is the **Last Name**, any other entry is optional. If needed, **Basic infos**, a **subject form**, comments or **picture** can be added to the subject information

Import Records

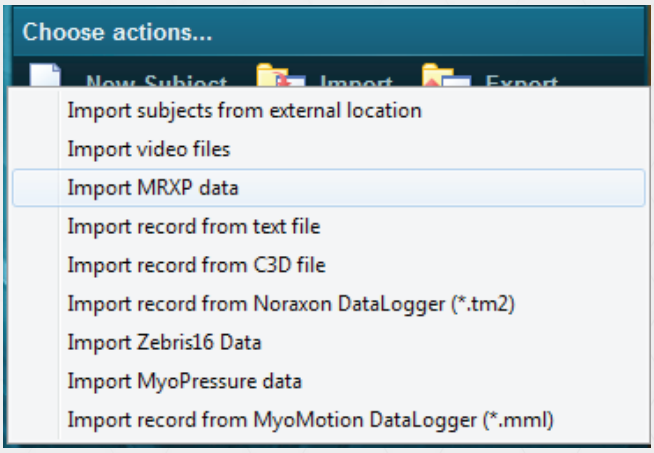
You can import records from external locations such as a previous version on your PC, backup data from external hard drives or network folders:





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 prior myoRESEARCH® XP version
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

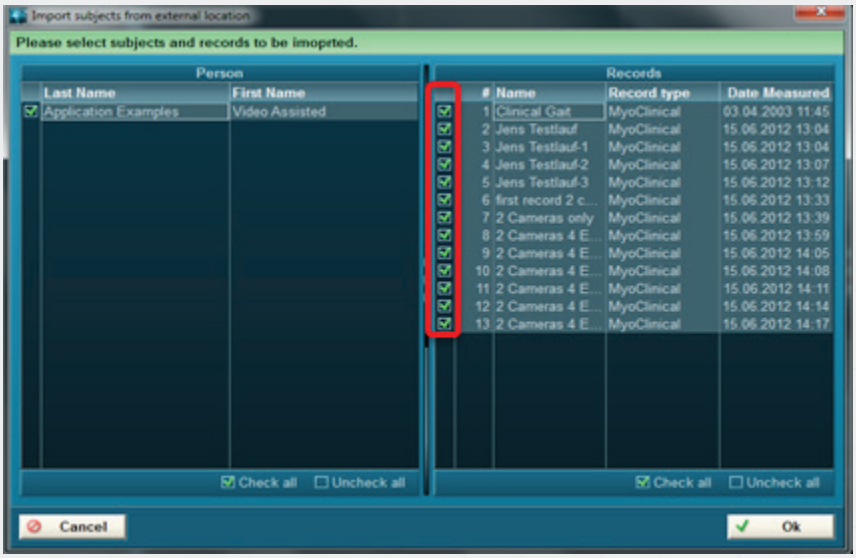
You can export MR3 records in their native format to an **External location** on your PC, or to another Subject or Project within your running version:

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 Biovison 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.

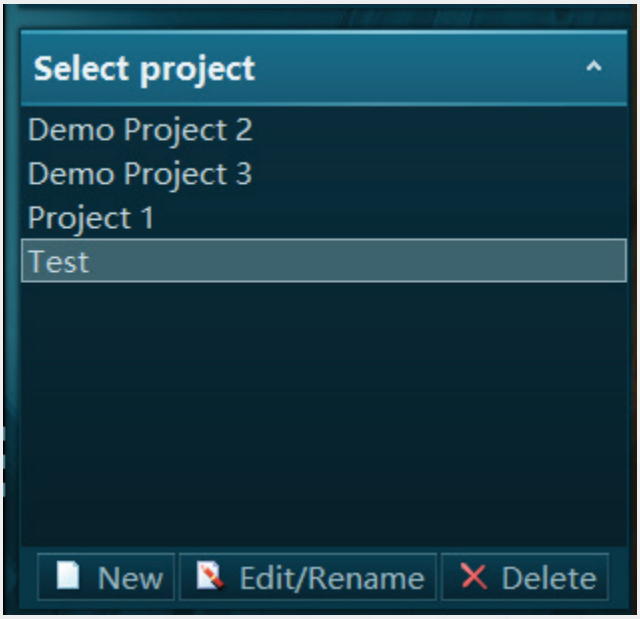
Attention: Don't use the Windows Explorer to move or send MR3 data files directly from their data directory on hard disk: you will lose important index files and data may become unreadable. To copy data always use the ***Export/to external location*** function of the database/right tool bar!

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

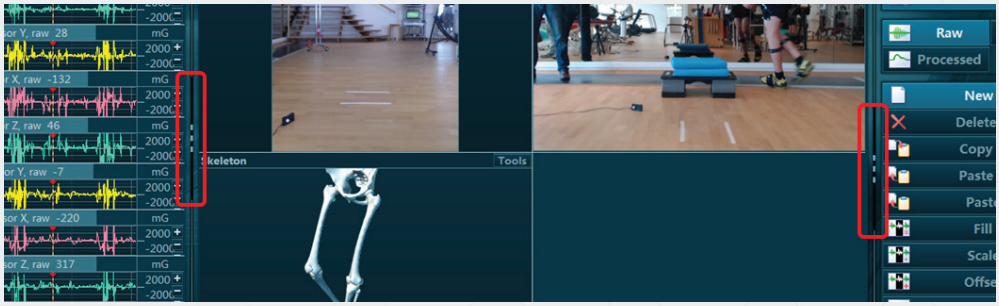
Section 8: Viewer Tab

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).

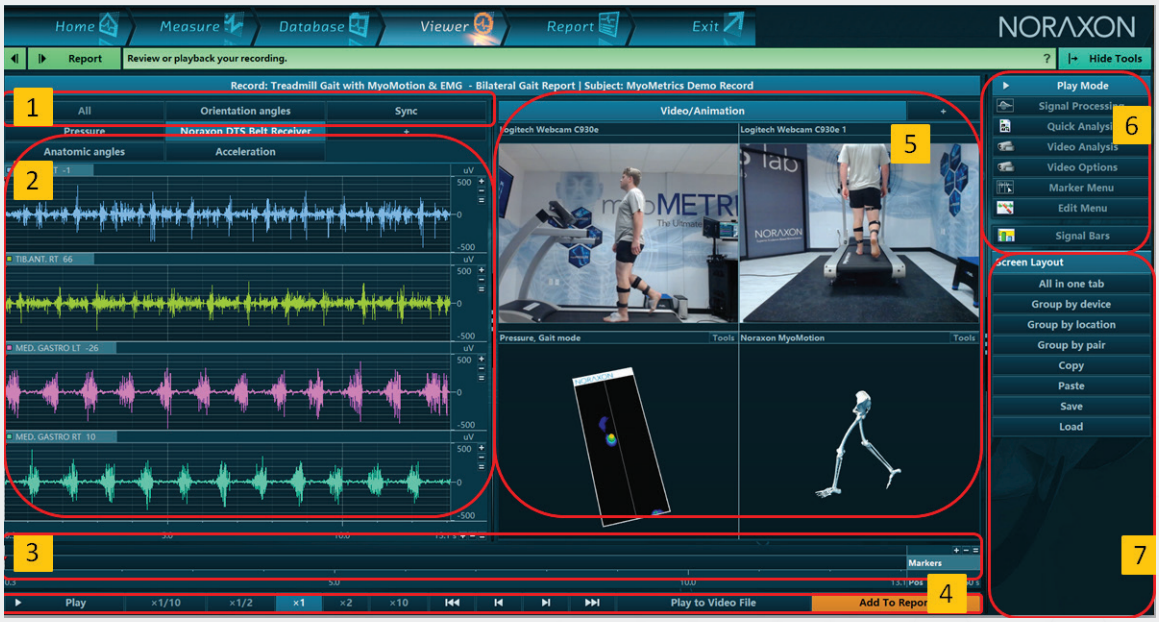
Dependent on the multi-device setup used in measurement the record viewer will show curves and elements from all selected modules:

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 time line or turn 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

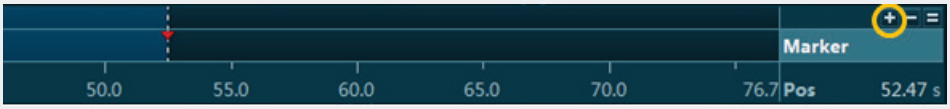
Right mouse button

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

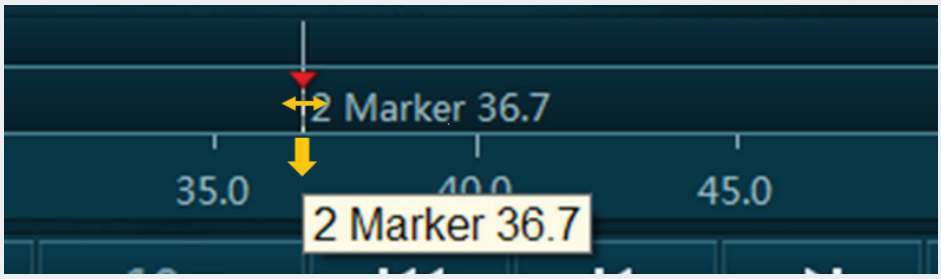
3) Time Line

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:

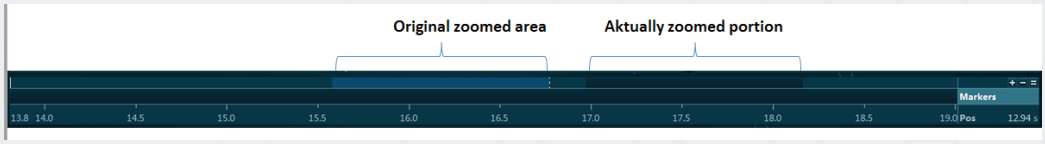
The marked area is high-lighted (colored in lighter blue color) both in time line and in the signal screen. Alternatively, to time line the area can be marked directly in the signal screen. The plus/ minus and equal sign screen icons can be used to zoom in and out the period selection and to show the 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. With pressed 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.

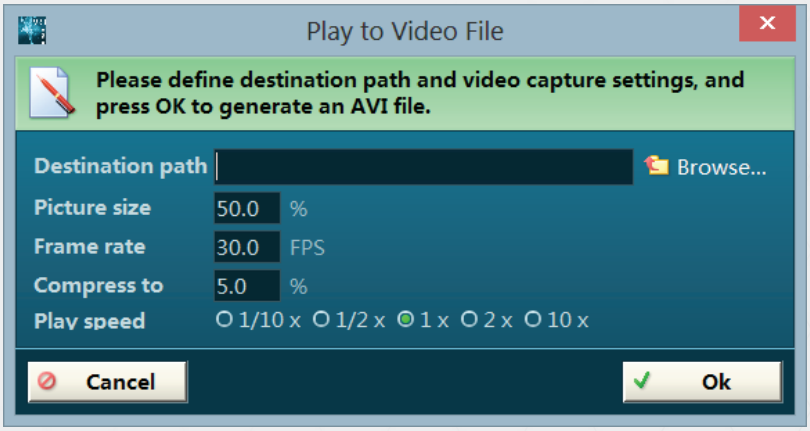


Now you can use the page up/down buttons to scroll through the measurement with the selected interval length or drag it with pressed left mouse button.

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
1/10x, 1/2x, 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 to set a path **(Browse)**, define the **Picture size** (selected 100% for best quality), **Frame rate** (recommend is 30 Hz), **Compression ratio** (Compress to – recommended is 5%) and Play **speed.**

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

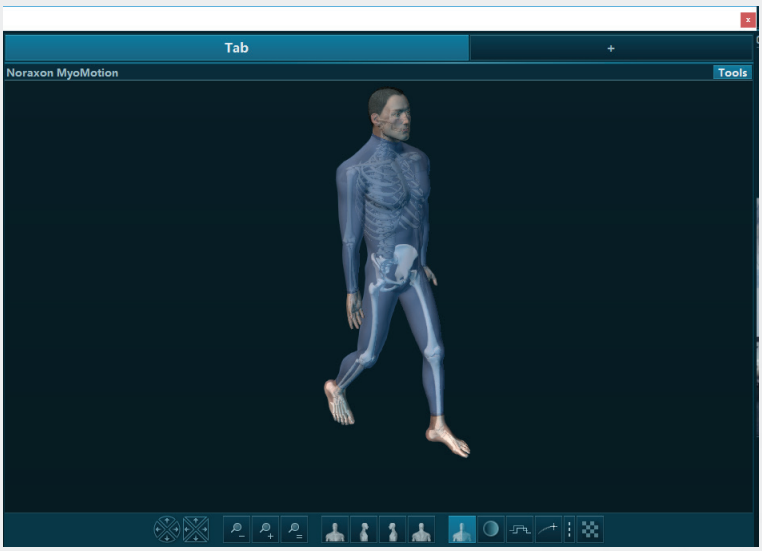
Recording intervals can be limited to a blue highlighted area in the time line (see below). To select a section within the video time line, click on the beginning of the desired recording interval, then hold down the shift key and click a second time at the end of the interval. You can also accomplish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

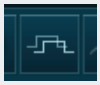
5. Video and animation window section

As already described in the measure menu, the kinematic data are animated via a skeletal avatar:



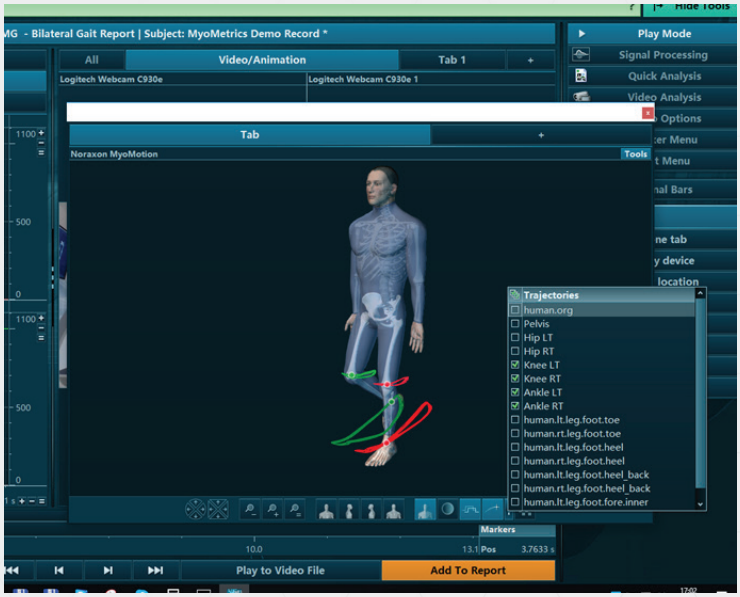
Several view and perspective buttons (left side) are available and already described in the measure menu.

In record viewer replay 3 very important new functions are available

The Contacts button  will create a virtual foot contact signal for left and right-side foot. This function requires that acceleration data were turned on in measurement setup and foot sensors are part of the model. Based on special algorithms utilizing the accelerations and gyro velocity of foot sensors heel strike and toe off in gait and running are estimated. Once clicked there will be a new tab in the signals screen called Contacts:

Later, in period definition of MyoMotion Foot Switch gait report these contact signals can be use as trigger signals for the gait phase definition.

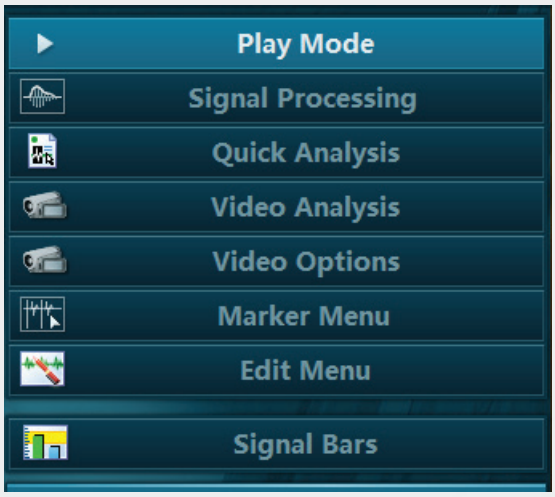
The next two buttons right side to Contact button will define and turn on/off the joint trajectories:



This function can be used to nicely visualize motion patterns and motion symmetry in all kind of activities.

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

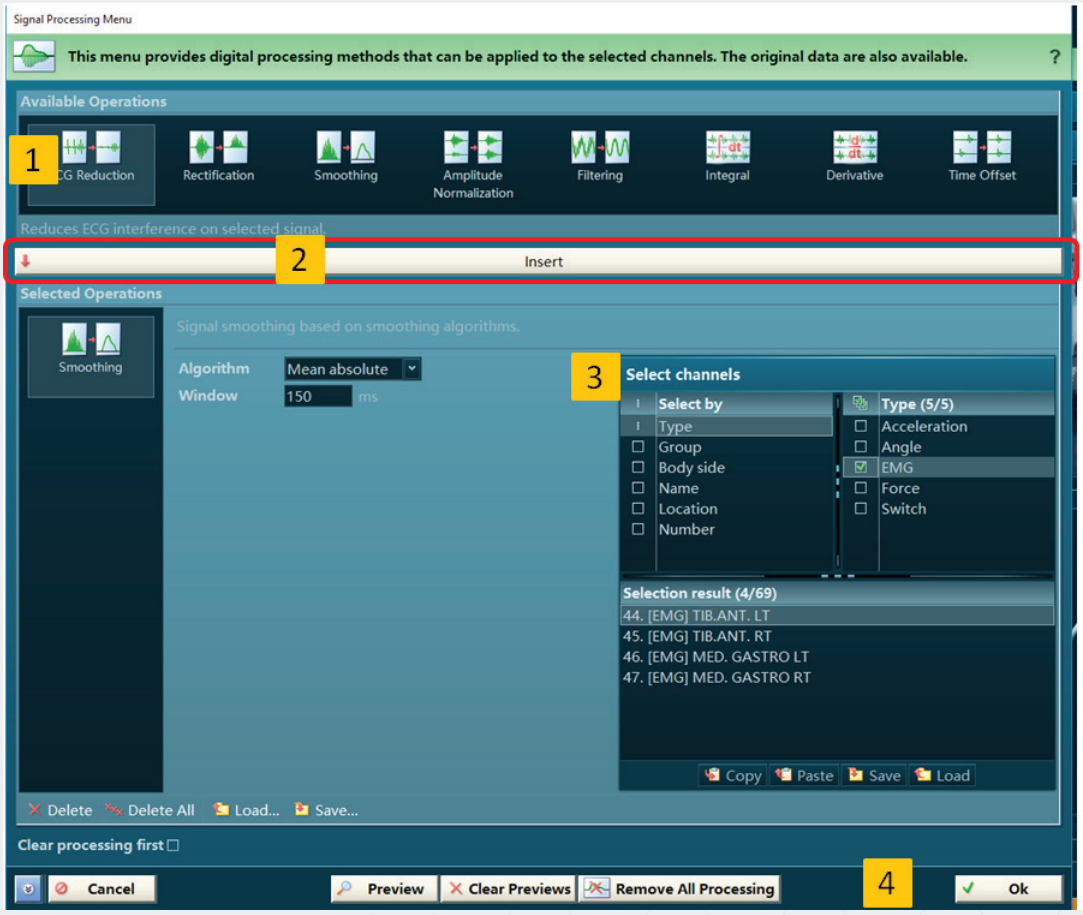
Marker Menu
Several modes for marker labeling and auto marker settings for trigger and angle channels.

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.

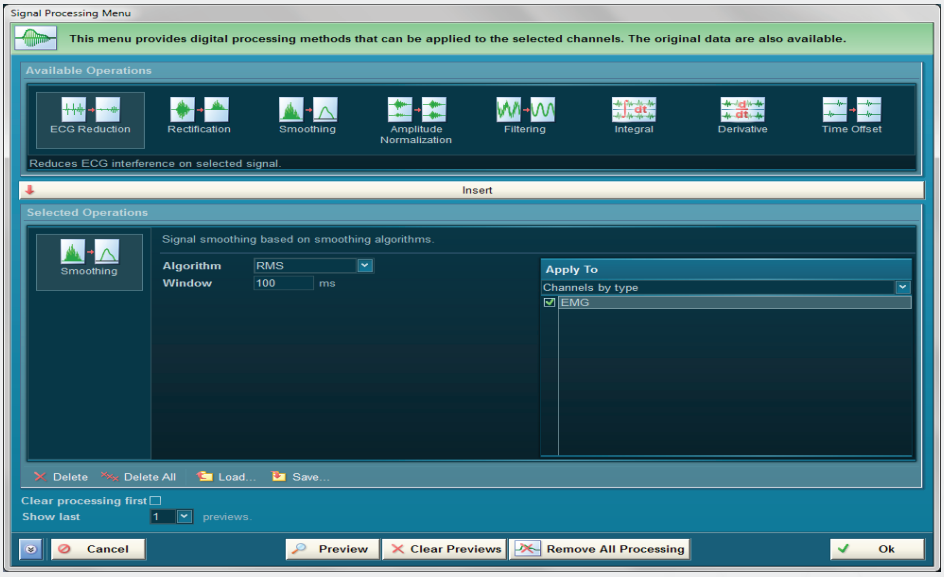
The menu is operated in 3 basic steps:



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.

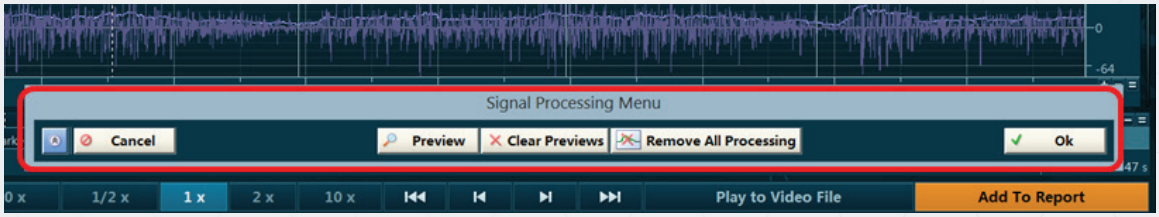


Lower Red Operation Buttons (Delete, Load, Save):

- **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** – this 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.

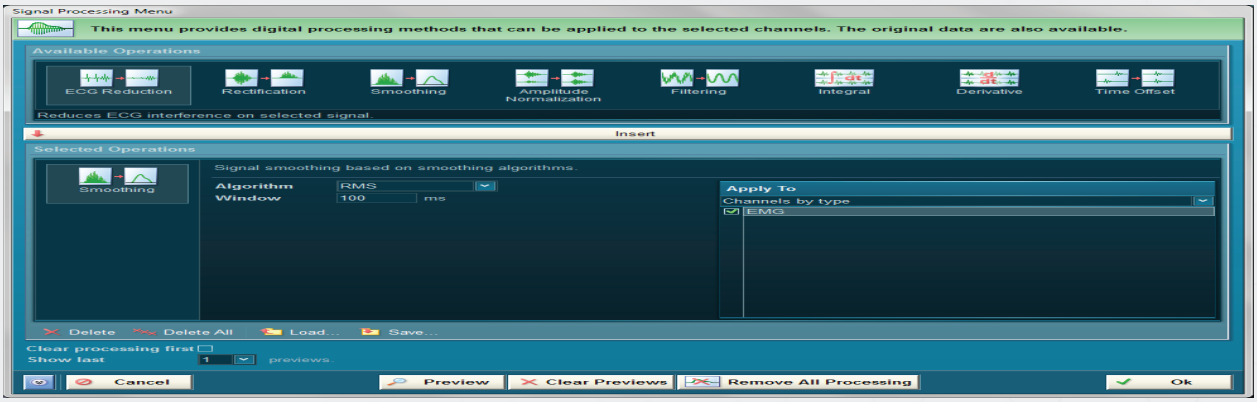
Remove all Processing

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

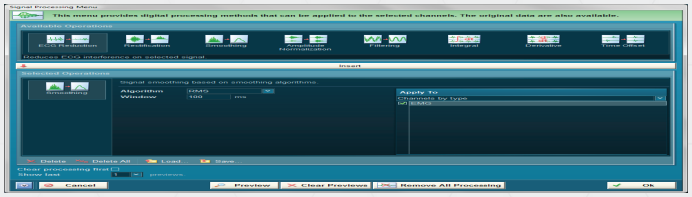
Available Operations

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 zero-line 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)

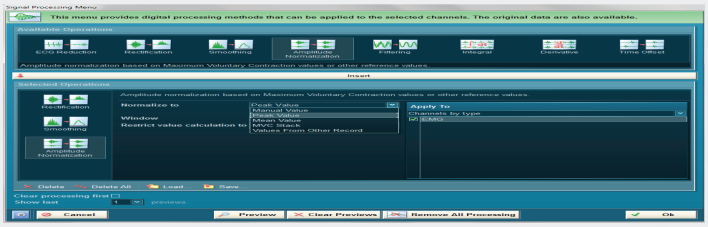
Please refer to the **ABC of EMG** booklet for more information on how to use smoothing algorithms.

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.

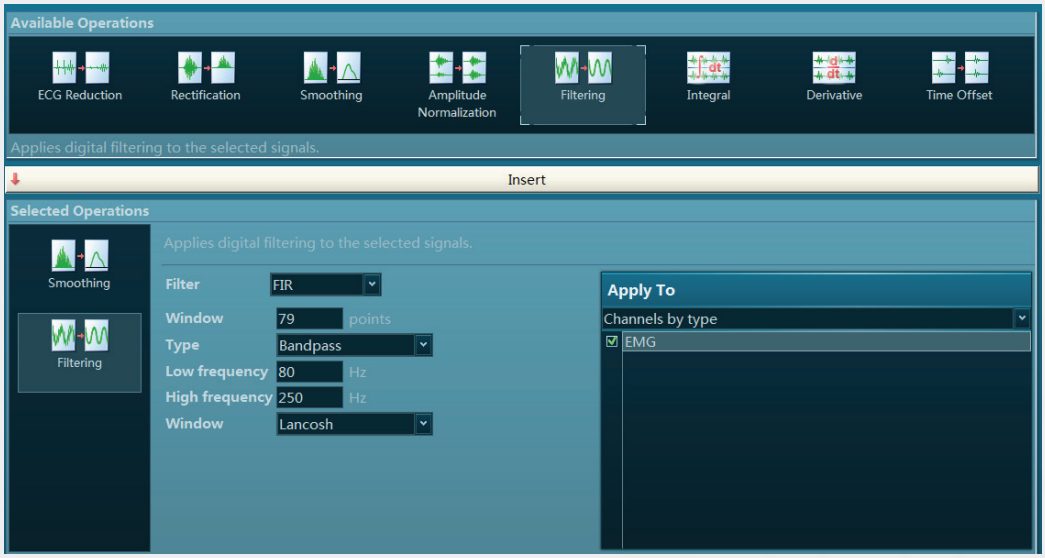
Filtering

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

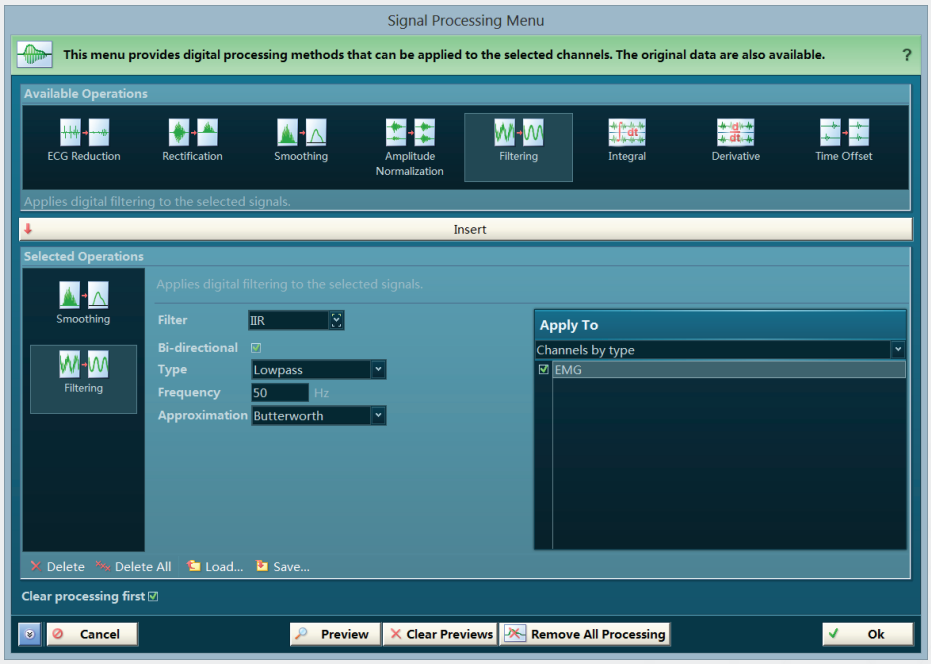
Window: Number of points used to process the data. With longer windows the quality improves. Recommended default values is 79.



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.

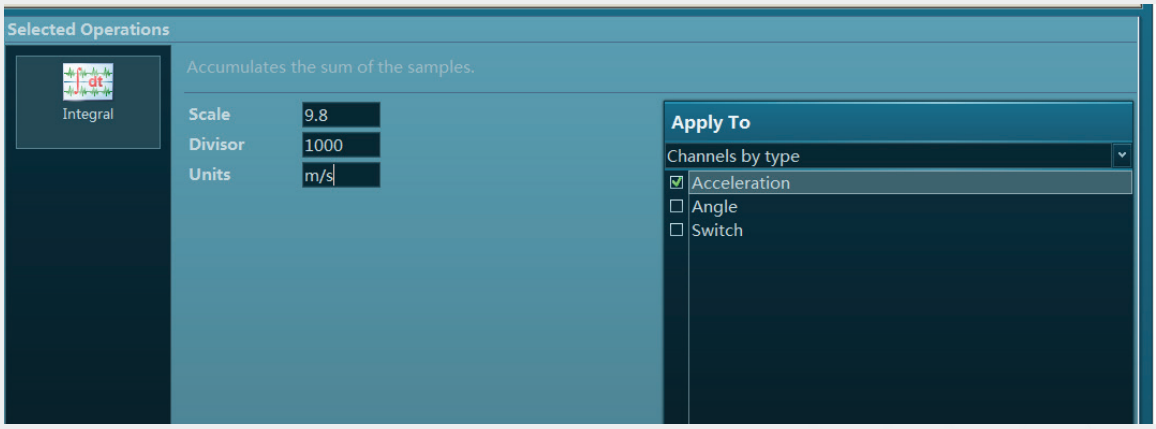
Approximation: Defines the sub type of filter

Median - Filter

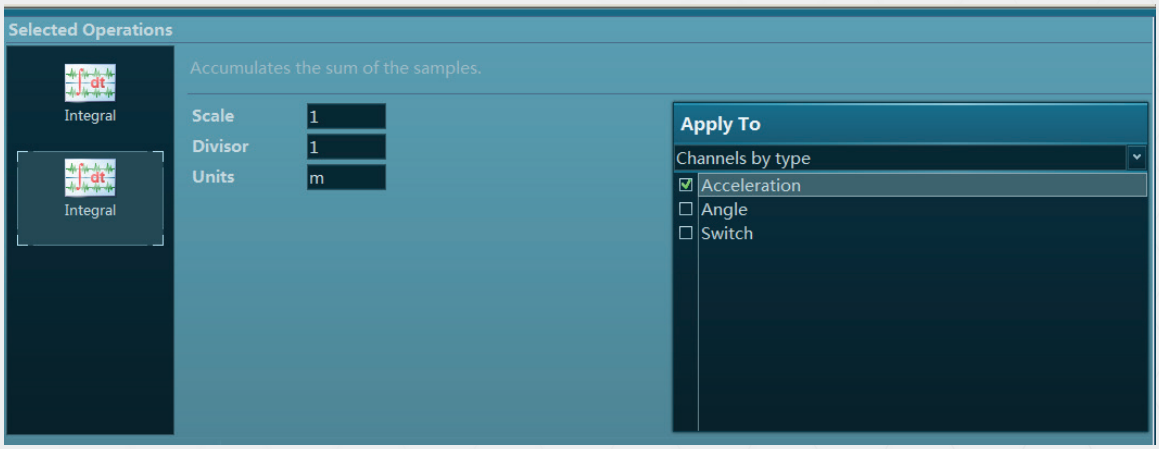
The median filter is an excellent spike cleaner for analog signals: it removes spikes from e.g. force/ angle curves without affecting the original signal shape.

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):



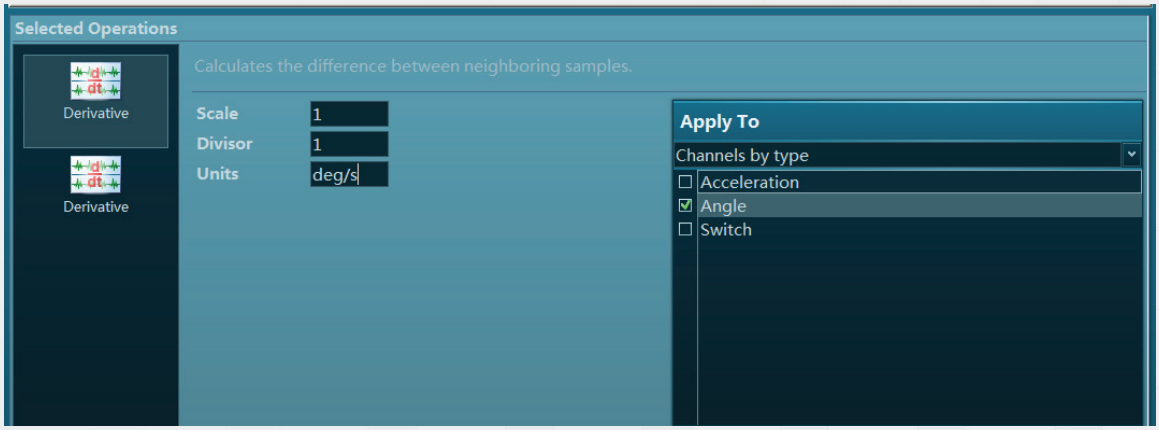
To operate a double integration from acceleration to distance, enter these settings in the second integral operator:



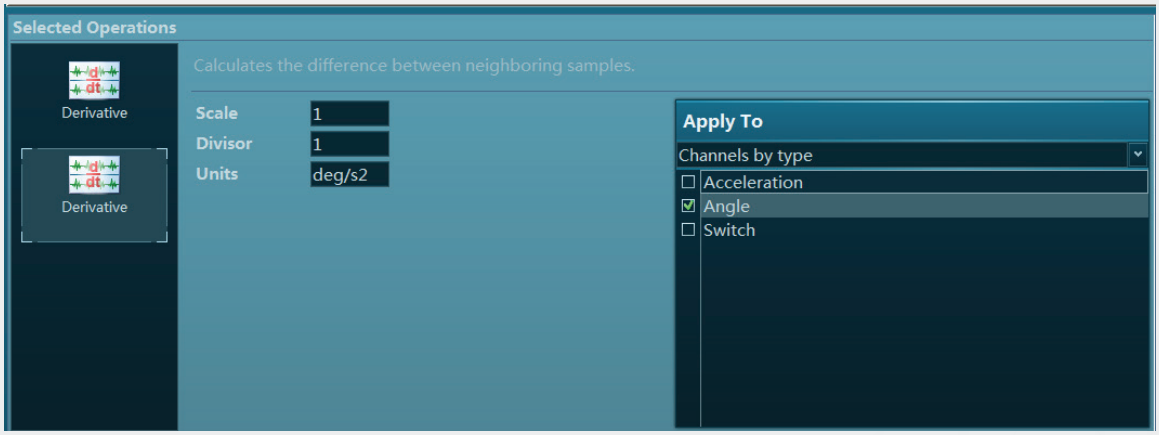
This is a preview screen of double integrated MyoMotion acceleration signal:

Derivative

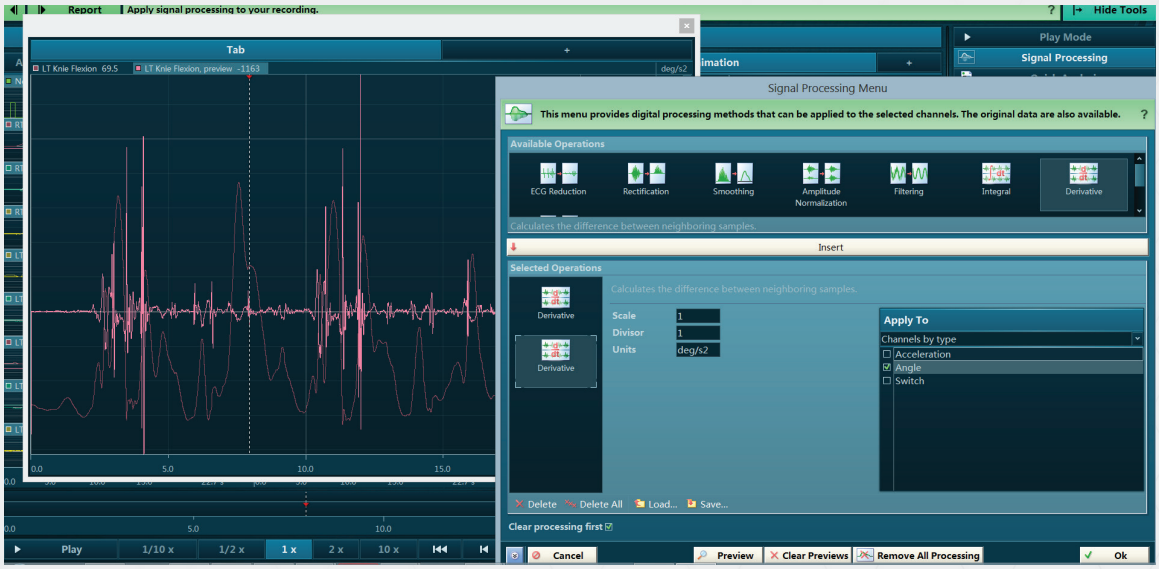
Alternatively, the derivative can be calculated based on an angle signal to reach angular velocity:



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.**

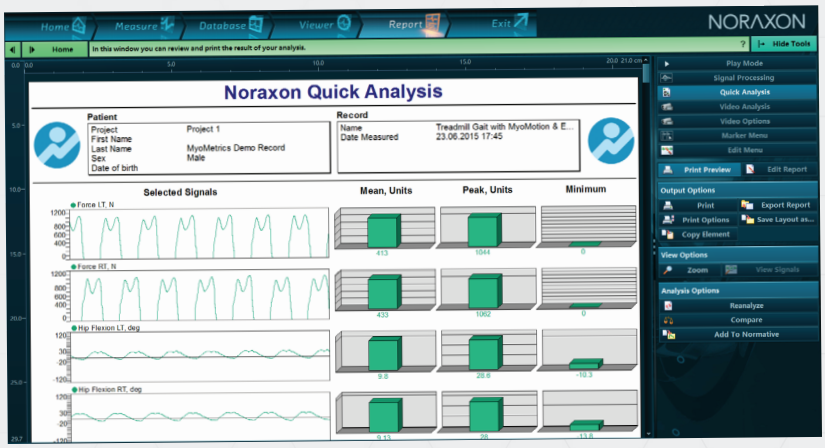
Three predefined configurations are installed by default:

- **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:

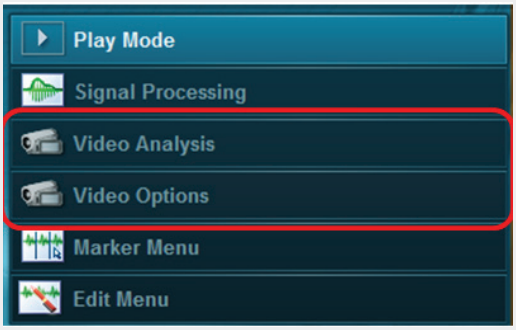
When done and confirmed with Next in the green main command line the Quick Analysis report opens:



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:

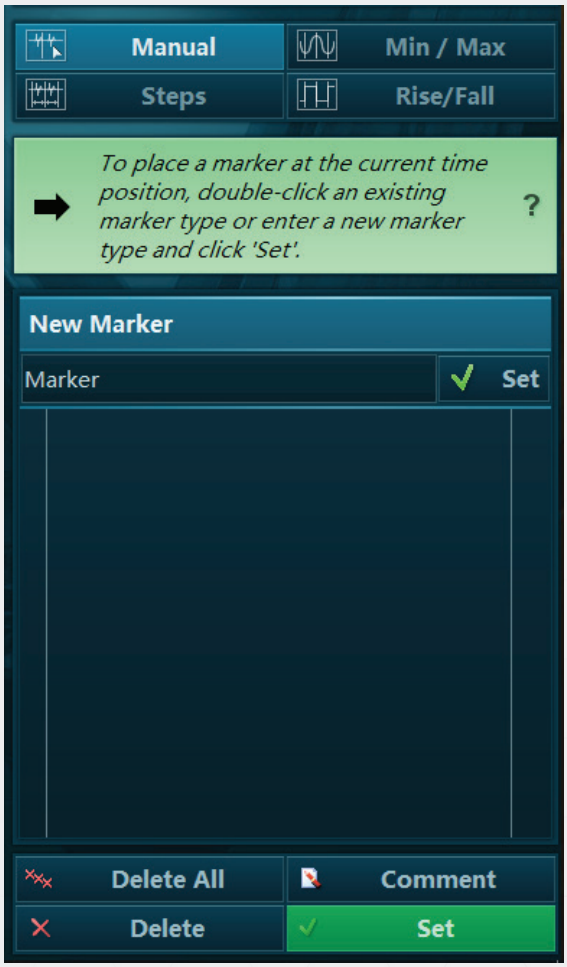
- in real time, by pressing the **Mark** button while recording
- in the **Record Viewer** by double clicking a signal portion (left mouse button)
- by using the auto-marker algorithms presented in this menu

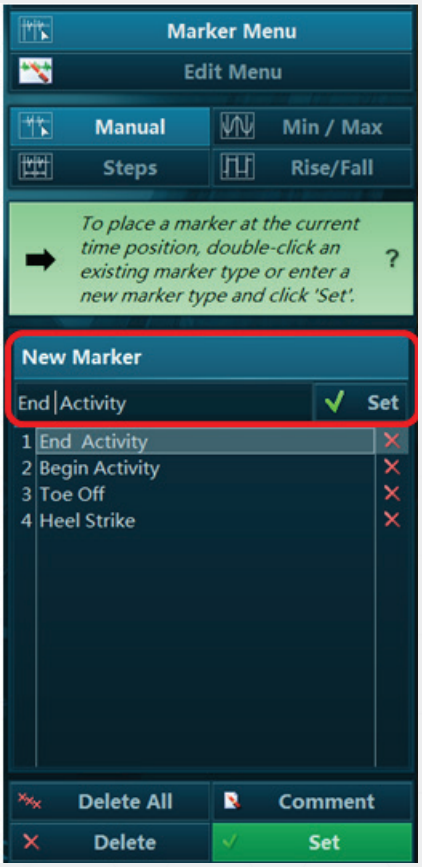
The markers and periods system is needed to fulfill the complex task of analyzing selected signal portions, TTL triggered periods, timing related onsets, or sub phases in gait analysis, just to name some examples. MR3 offers four marker methods to place markers in a record:

- 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 done it will automatically be placed to signal screen/timeline and be added to the marker label list below:





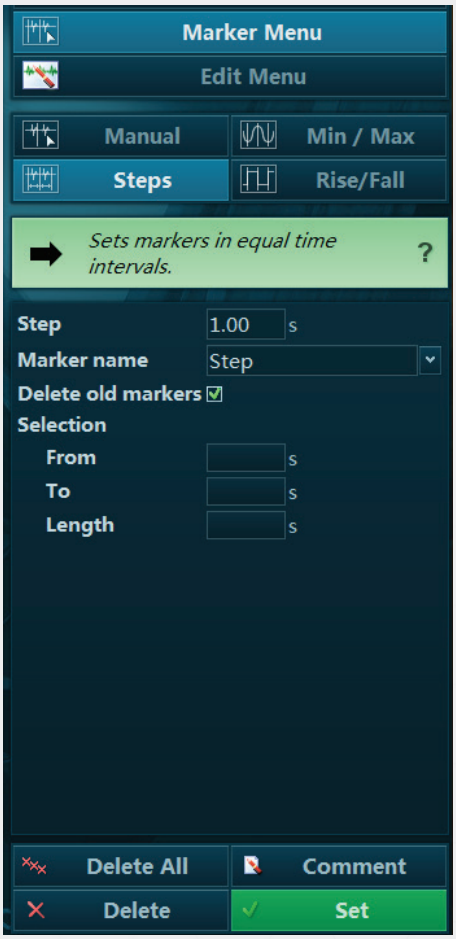
If you want to delete a given marker label from the list just click on the red X to the right of each label.

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.

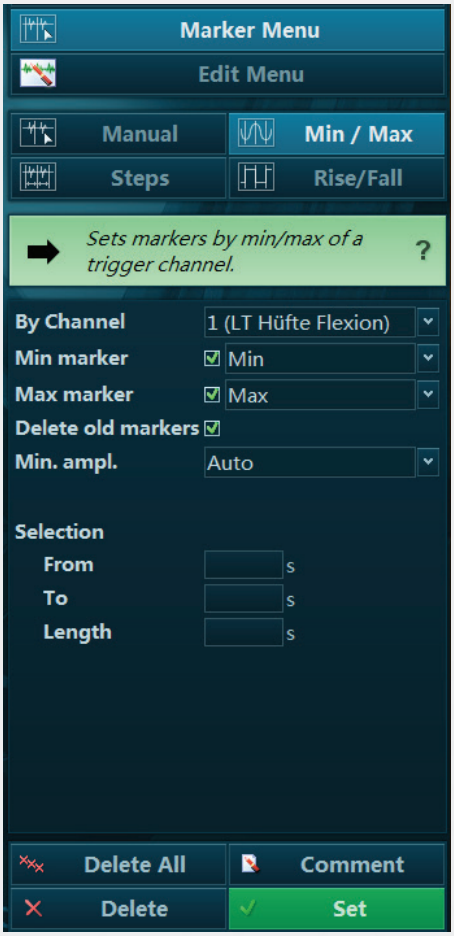
Marker name – labels all step markers.

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.

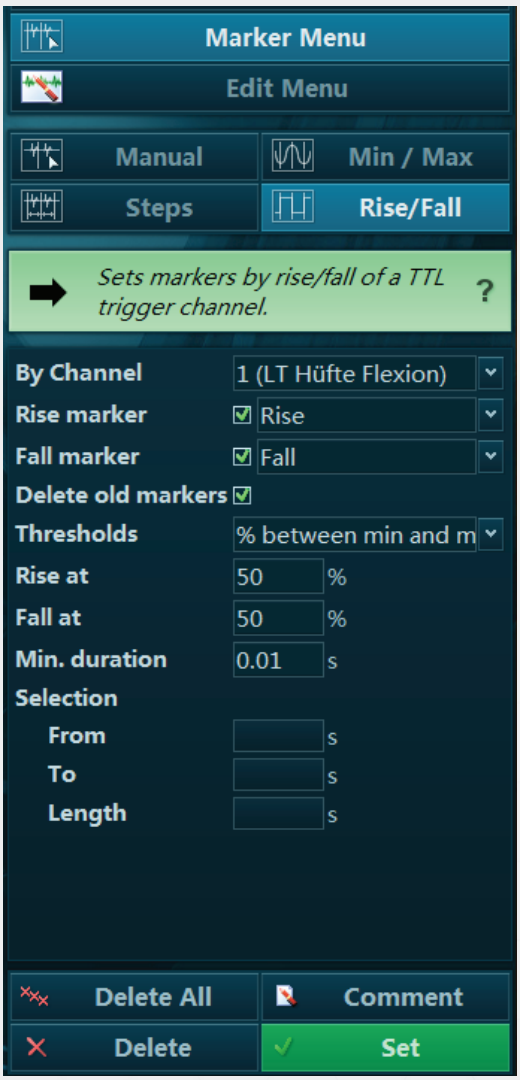
Delete old marker – removes the existing markers.

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 can 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

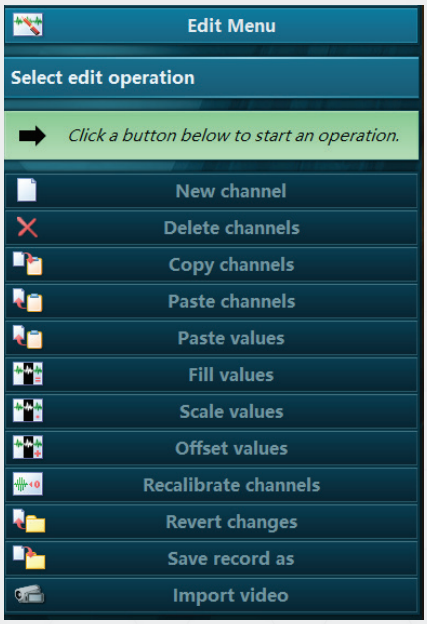
Ok	Executes the applied marker settings
Delete	Deletes the selected marker
Delete All	Deletes all markers in the Signals screen
Set	Applies the selected marker/method. Previewed in the **Signals** screen.

Edit Menu

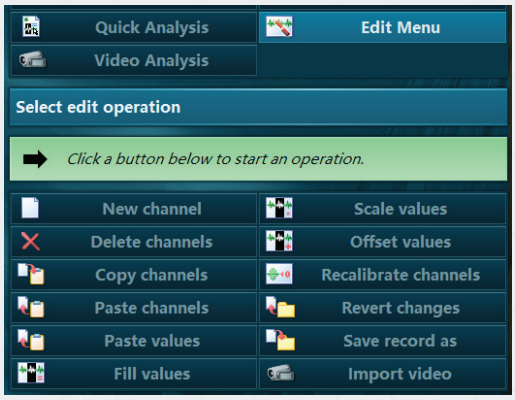
Unlike Signal Processing, all Edit operations physically change the record data set and the original recording cannot be restored. Therefore, it is generally recommended to first make a backup or a copy of your data. Alternatively, save any changes done in Edit mode with the option **Save as....**, which 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:



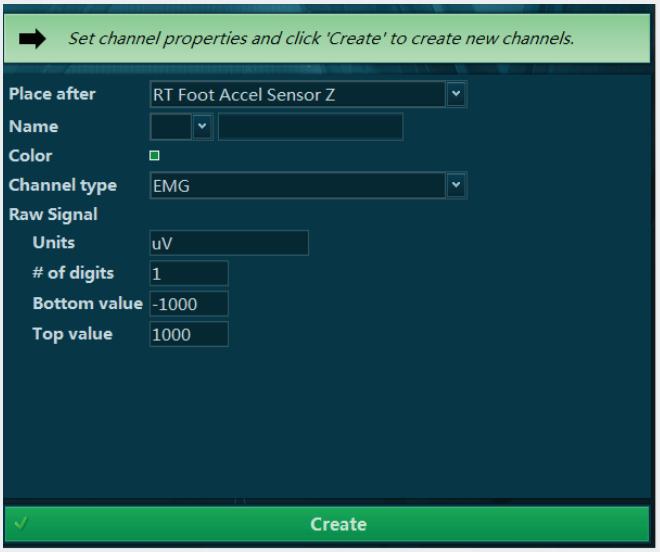
At the top of the Channel Tools box there are 3 iconized View Modes of the signals:

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 to be selected for the new channel.

Raw Signal –organizes the amplitude scaling settings for the new channel.

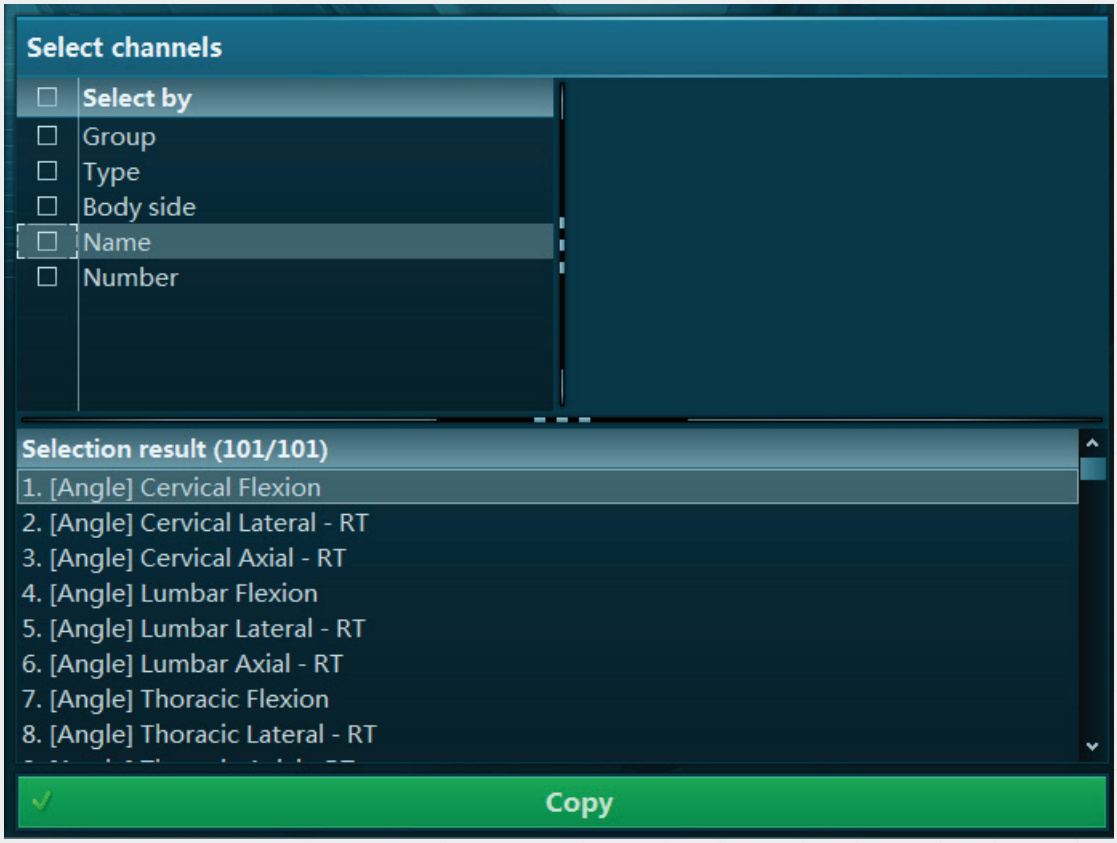
Units – define the physical channel unit.

# 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:



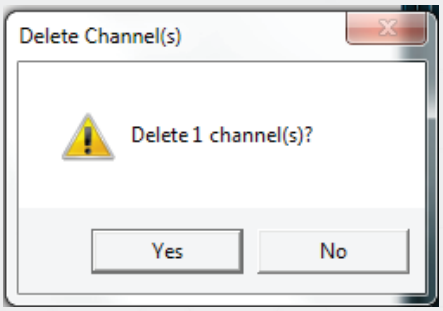
To reduce the selection of channel for the given **Edit** operation you can use these selection modes:

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!

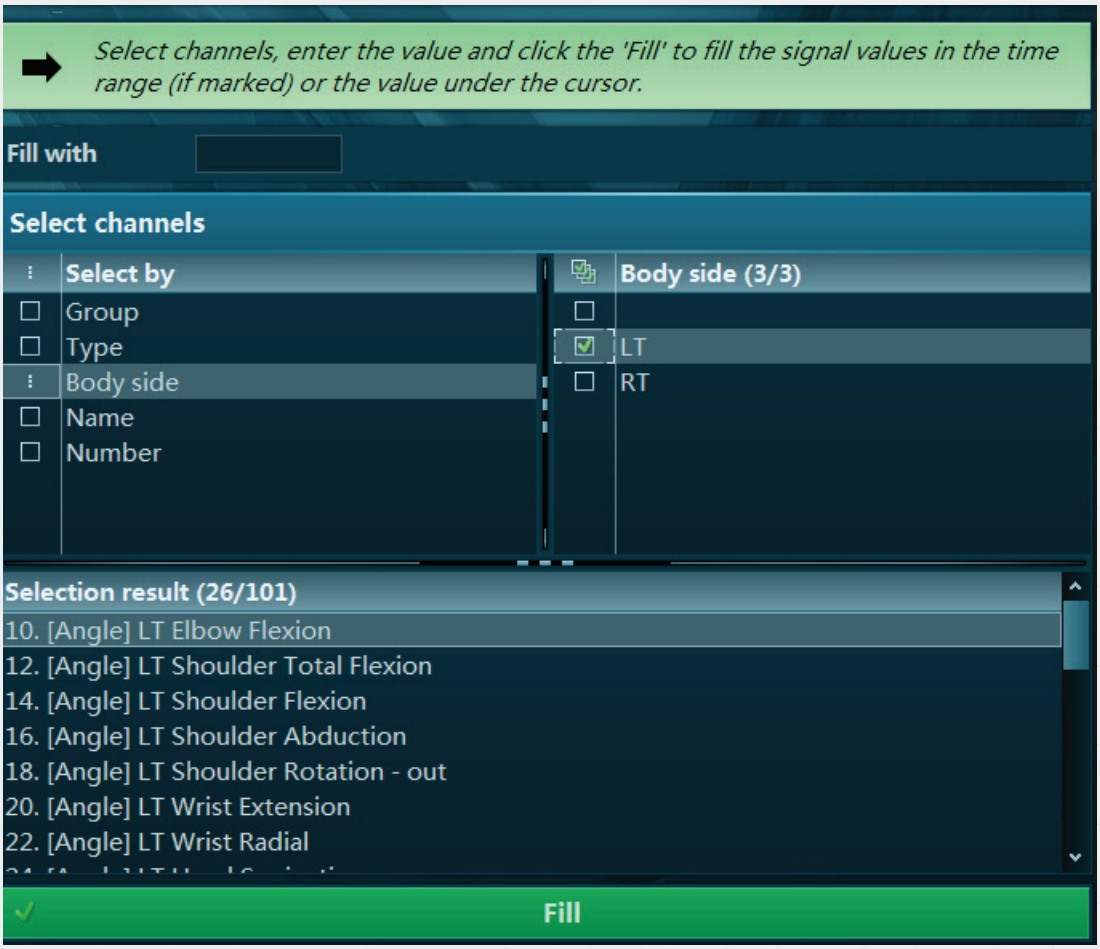
Copy channels – copies the selected channel data to the clipboard

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

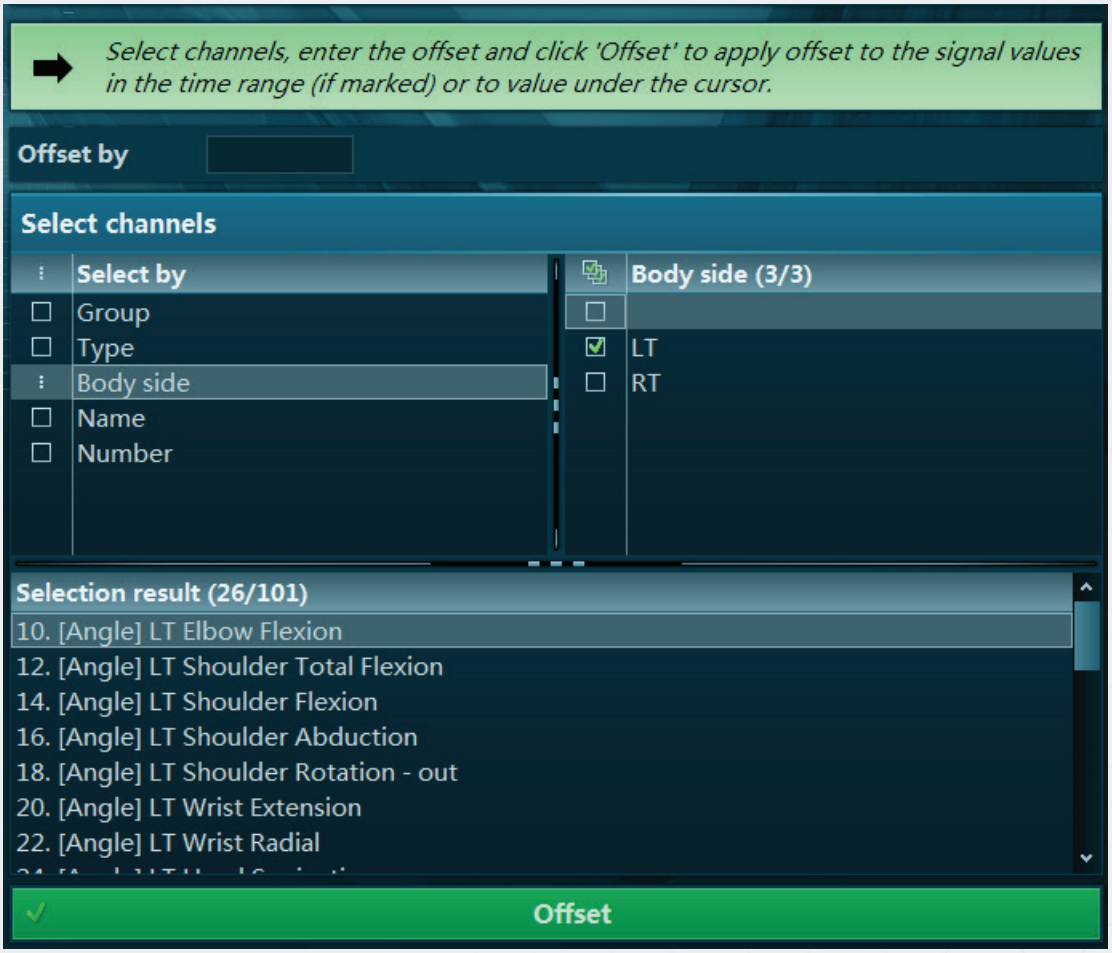
The **Fill Values** function is an editor for amplitude values. Based on a mouse mark signal portion, any amplitude value can be entered and will overwrite the existing values. For example, this function can be used to manually eliminate artifact spikes or other invalid data portions within a channel.



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

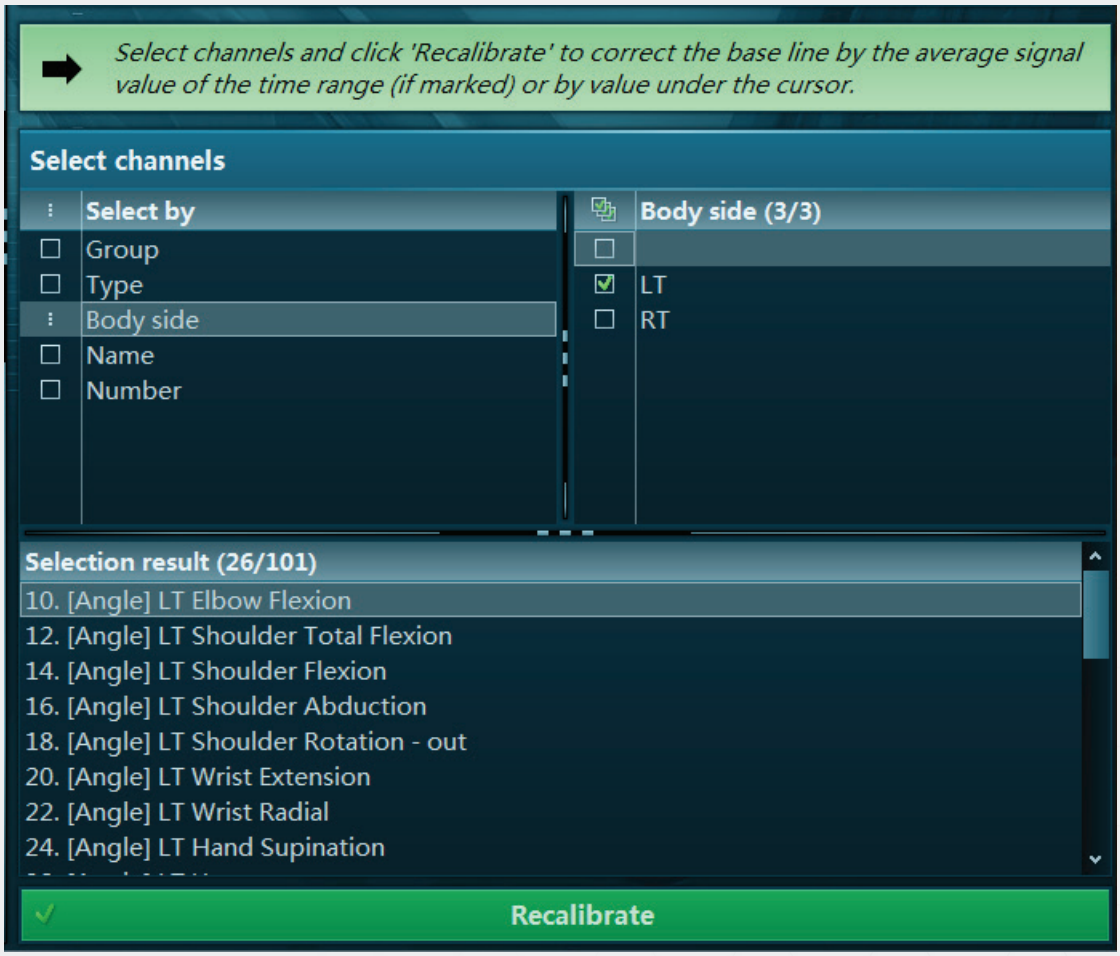
Offset Values

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



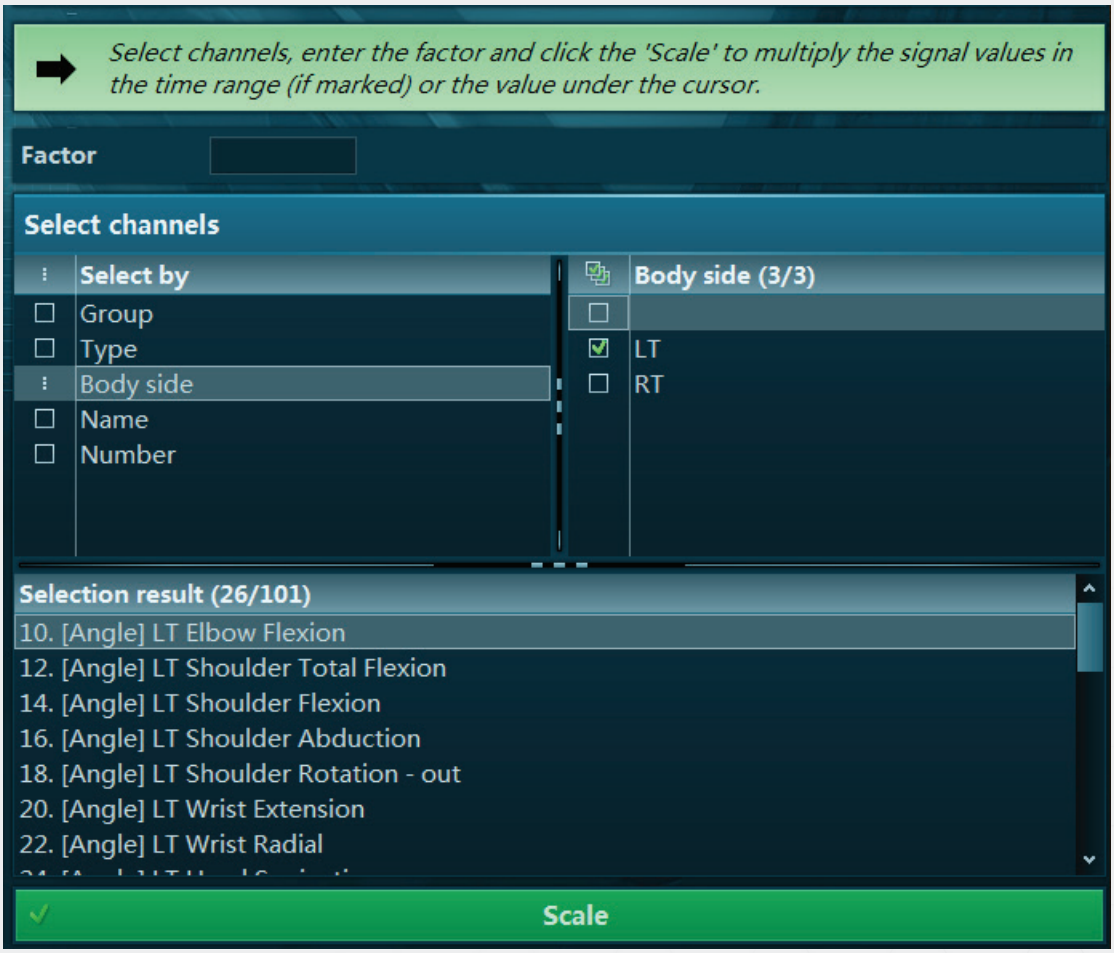
Recalibrate Channels

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)

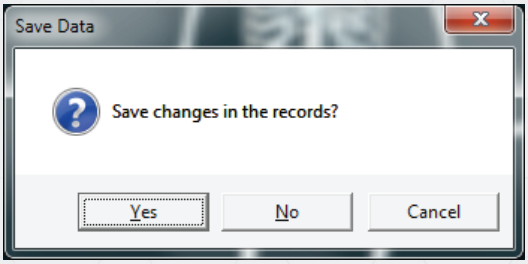
This function allows you to multiply the selected amplitude data of a given channel by any factor:



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

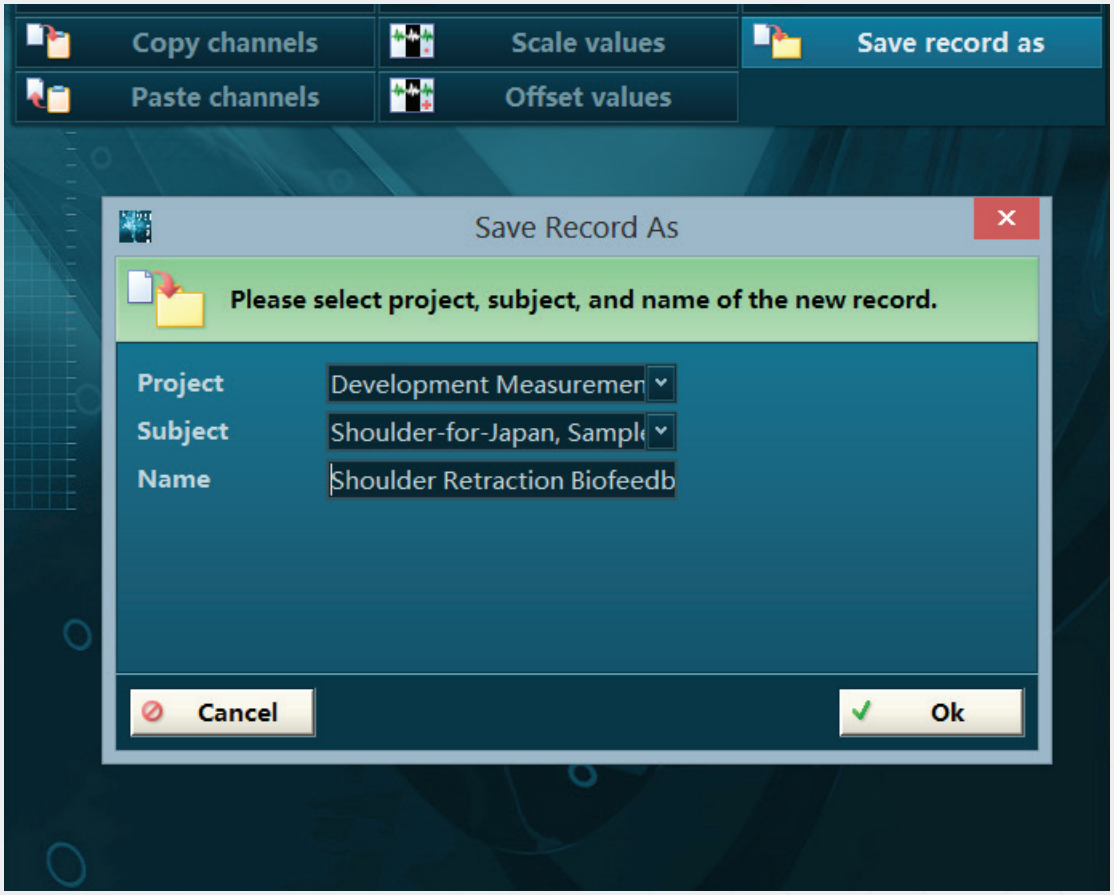
Revert Changes

Any edit operation done thus far on the currently loaded record can be reverted to the original if 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.



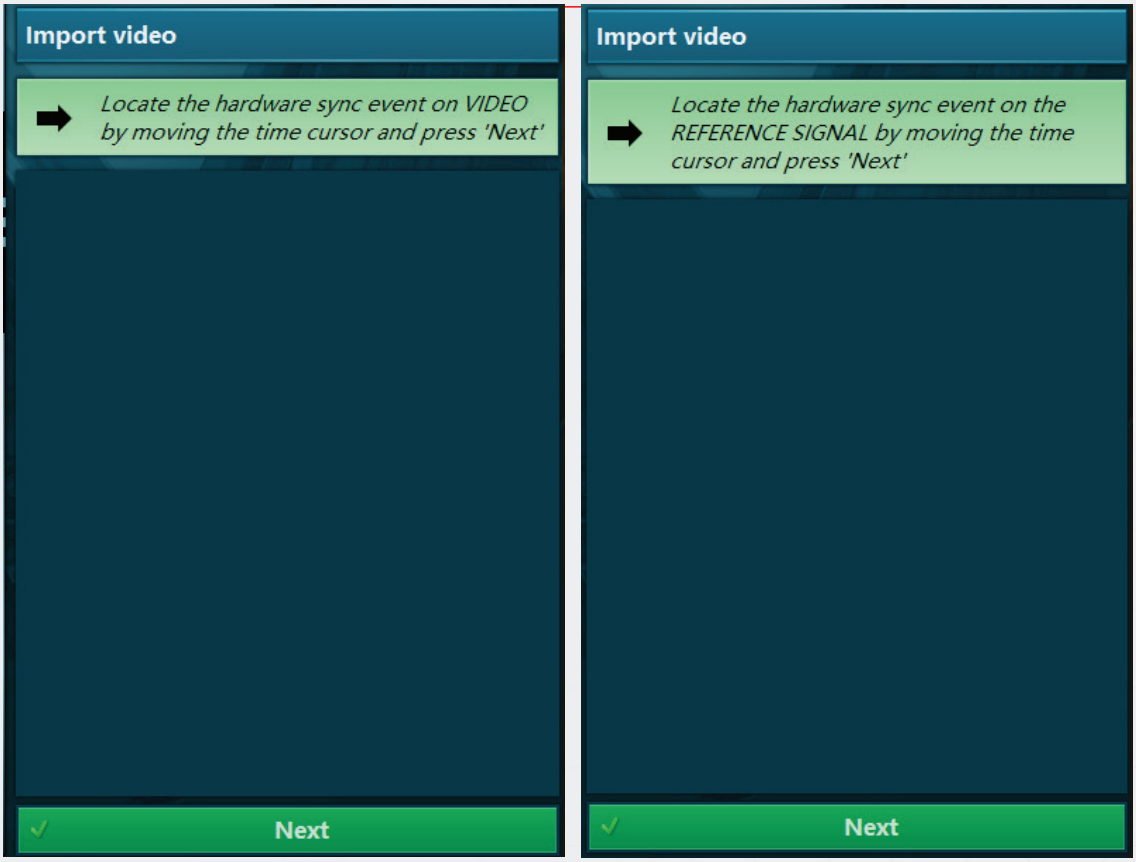
This function is highly recommended for any edited record, because editing operation cannot be restored to original version.

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

Import Video (only available in myoVIDEO module)

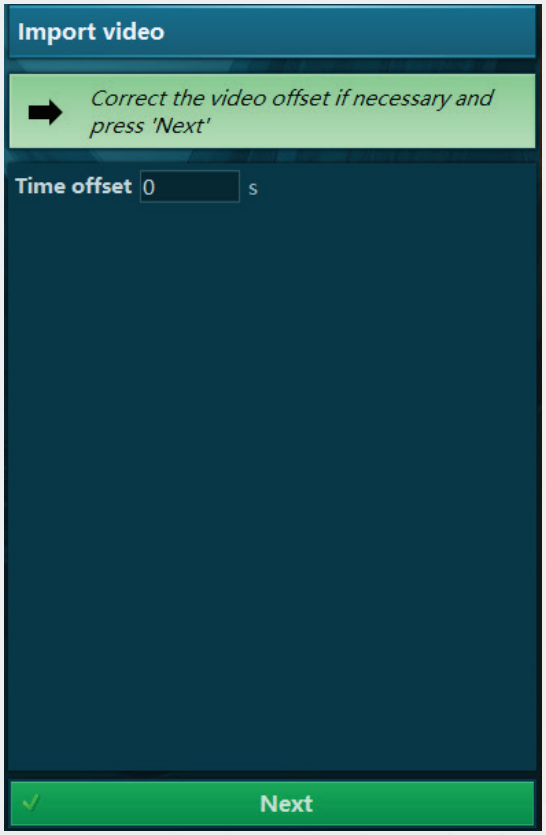
This function allows you to import externally recorded videos to an existing MR3 record. To merge the external video, it is recommended that both video and MR3 record share the same sync information. This is best arranged by connecting the LED Sync light to the myoSYNC™ Synchronization system and record its illumination with the external video right after recording

start. It is also needed to turn on the sync channel of the given MR3 device so that it is seen as an extra channel in recording. Now external video and MR3 based 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.

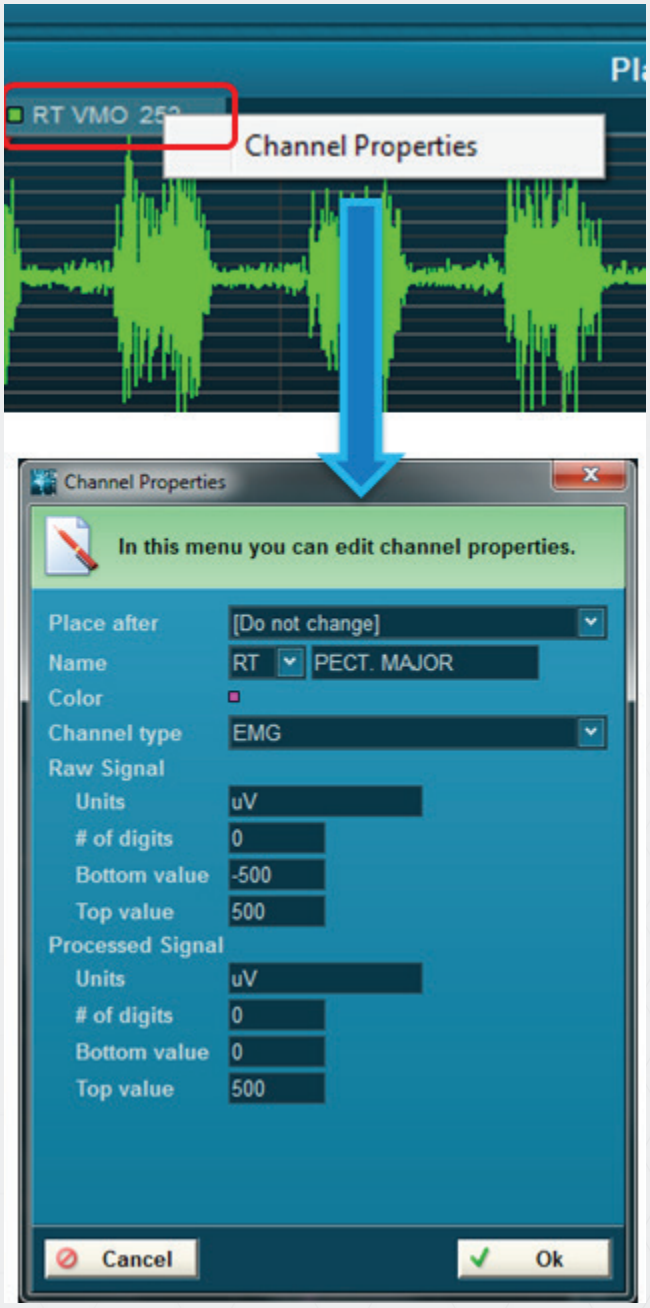
This is shared sync scheme was not available, just skip first two dialog screens by pressing **Next** and optionally enter an offset value if known:



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.

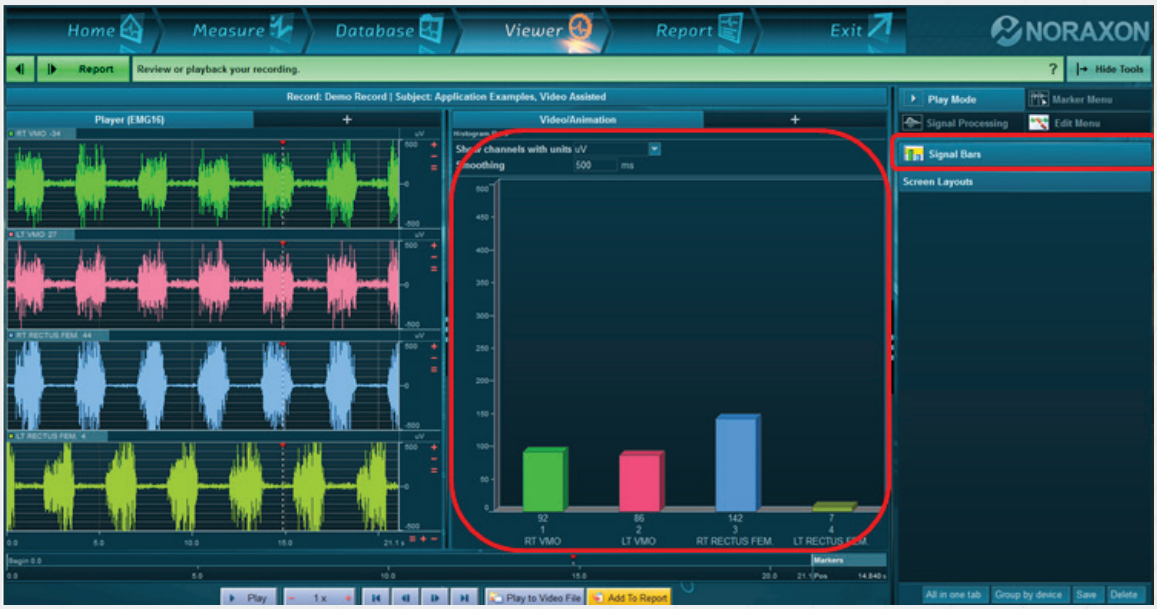
Channel type offers a pull-down list of all available channel types to be selected for the new channel.

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

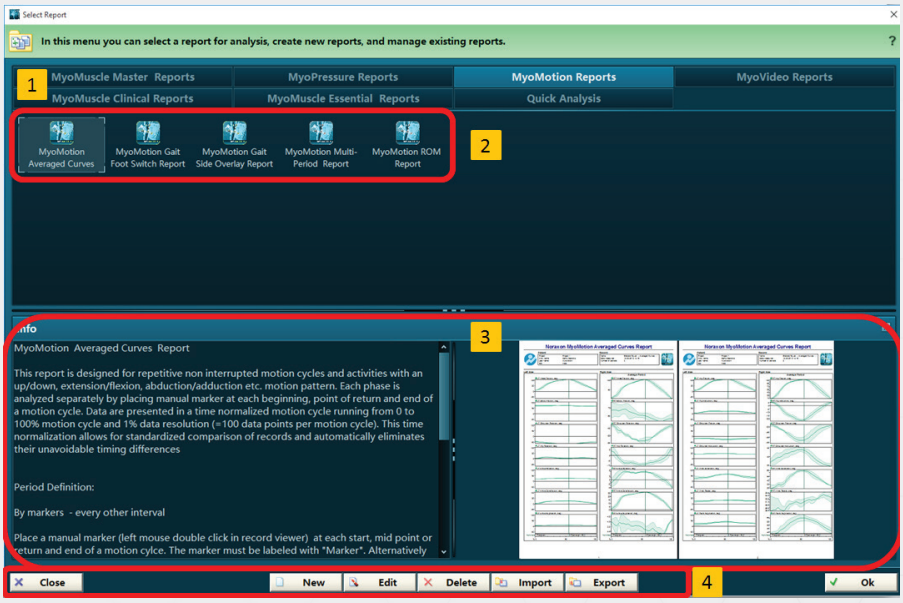
The screen layout system is identical to the one already described in Measure menu.
Please refer to this chapter to learn more about the possibilities to customize signal and animation screens and create, store and load different screen layouts.

Section 9: Report Tab

Introduction

From the **Viewer** menu, click on the **Report** 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 group selection organized in module tab system

2. Selection of reports within a module group

3. Report info section with report preview

4. Report Options

1) Report Module Selection

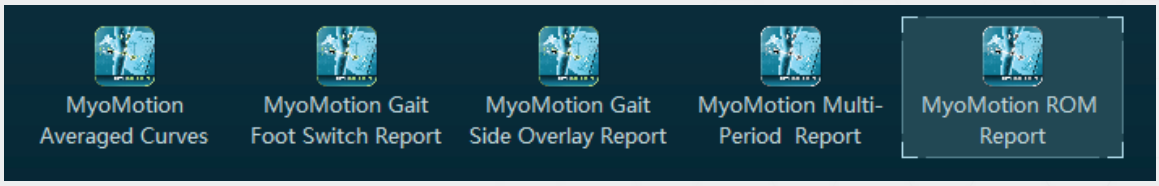
Reports are sorted in seven major tab sections. The accessibility of these tabs is dependent upon the equipment and modules installed.

- **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
- **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

If myoMOTION is used as a stand-alone device or together with EMG/telemetry sensor data it is recommended to use the reports listed in the myoMOTION report tab. There are 5 standard report options:

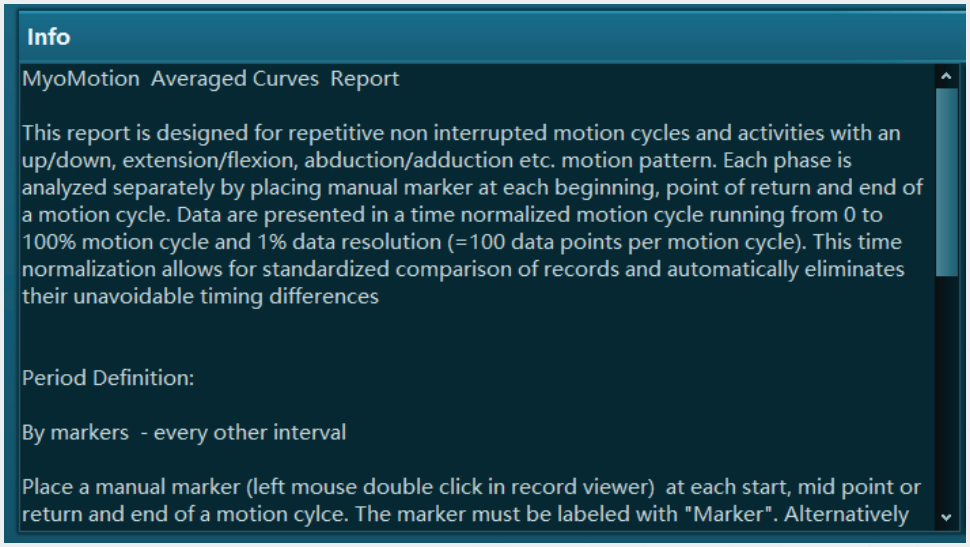


Each myoMOTION report is pre-configured to a period definition mode best suitable for the task:

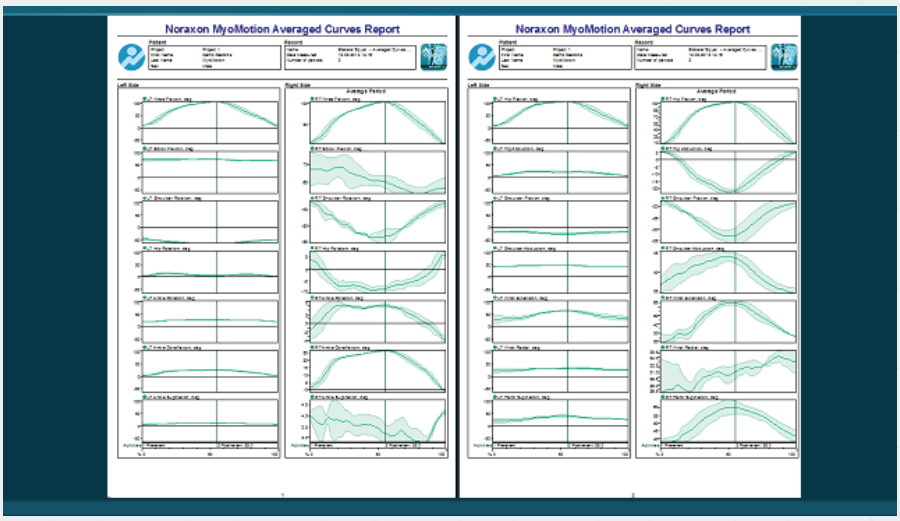
MyoMotion Report	Default period definition
Averaged Curves Report	Manually placed markers at each start point of an event and end point of each repetition.
Gait Foot Switch Report	Period definition mode “Rise/Fall by trigger channel” method, using “Rise to Rise with event” mode.
Gait Side Overlay Report	Period definition mode “Rise/Fall by trigger channel” method, using “Rise to Rise with event” mode.
Range of Motion Report	A start marker and an end marker define the analysis period.
Multi-Period Report	A start marker and an end marker define beginning and end of each analysis period.

3) Report Info with Report Preview

Here you can find a brief description of the selected report addressing its main purpose, the way analysis periods are defined (Period Definition), analysis elements, and typical signal processing steps.

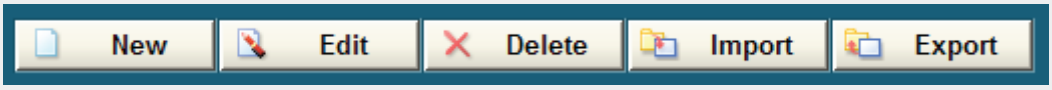


Below is a typical example of an average curves report.



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

4) Select-Report Options

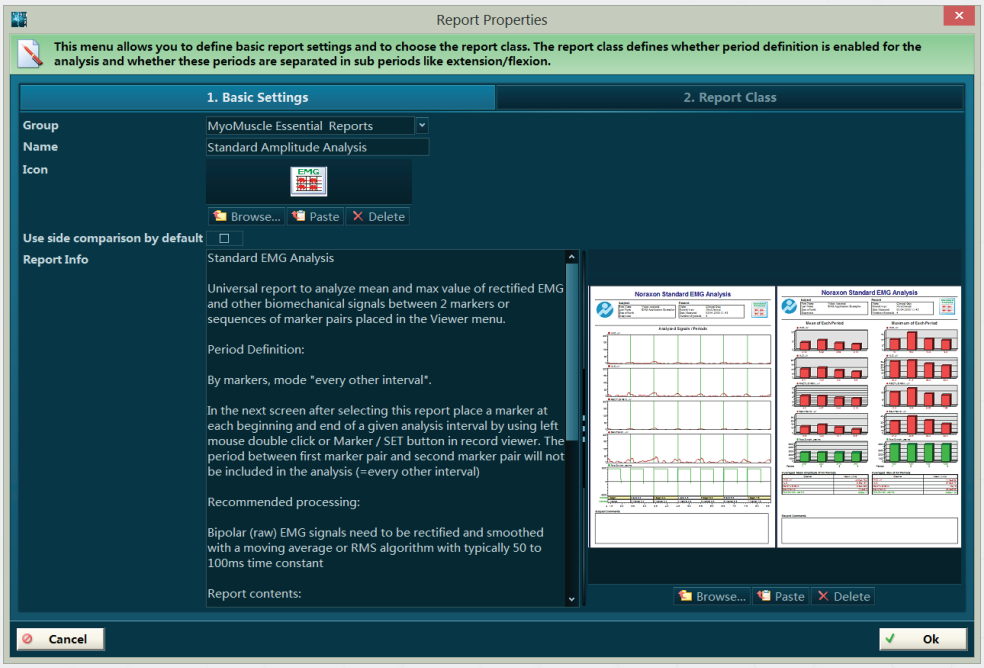


New

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

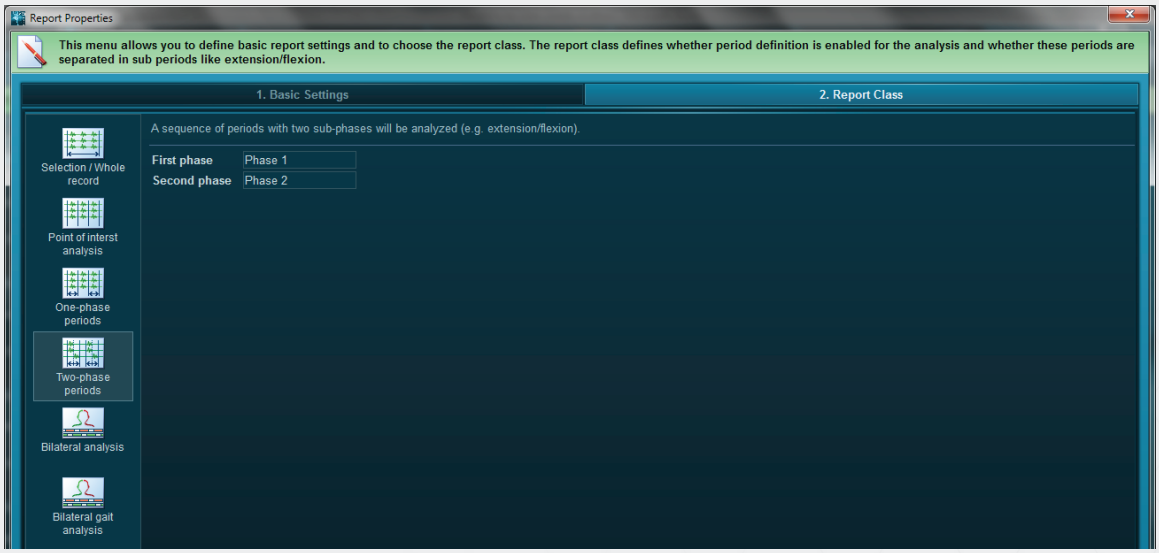
If needed, a report's title, tab sections, description text, and preview window can be changed with this edit menu:



Use side comparison by default – this option will automatically create a comparison overlay plot of left / right signals (see MyoMuscle Clinical – Symmetry Report)

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 /MyoMuscle version 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).

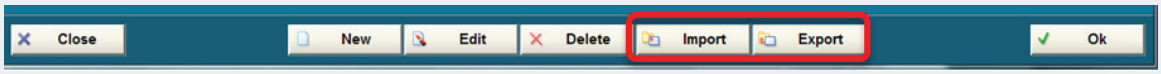
Bilateral analysis – This class is designed for left to right comparison analysis in bilateral gait measurements and splits the period definition into left and right-side periods.

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

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.

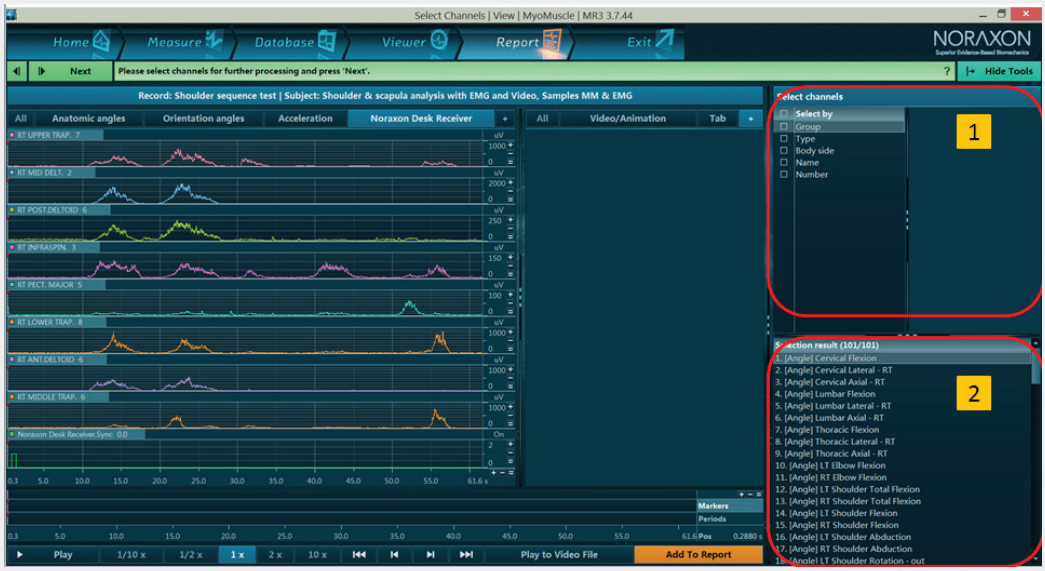
After selecting a report, click **OK** to enter the next step to run a report

Run a report

Once a report is selected, the next step is channel selection. Because of its multi-device nature, many signals may be available in the record and a selection of specific channels is required, which can be organized in the next step.

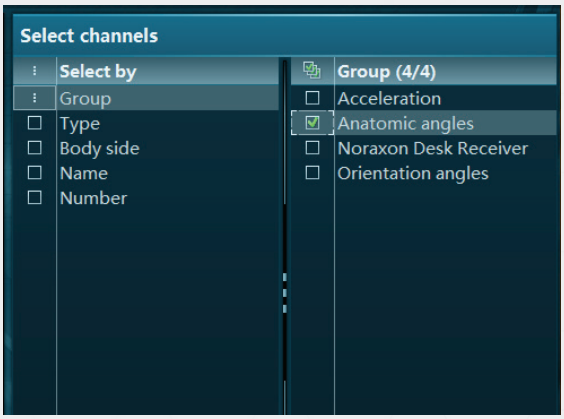
Report channel selection step

By default, all channels available in a record are preselected for the analysis (see section 2):



In the above multi-device example, three Tab groups from the Motion Capture system and another tab Group from myoMUSCLE Desk receiver is available, which delivers up to 101 possible analysis signals.

The **Select Channel Option** allows you to specifically select Groups and Types of channels:

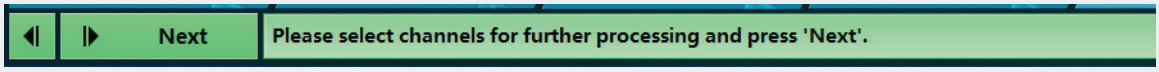


The following operators are available:

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.

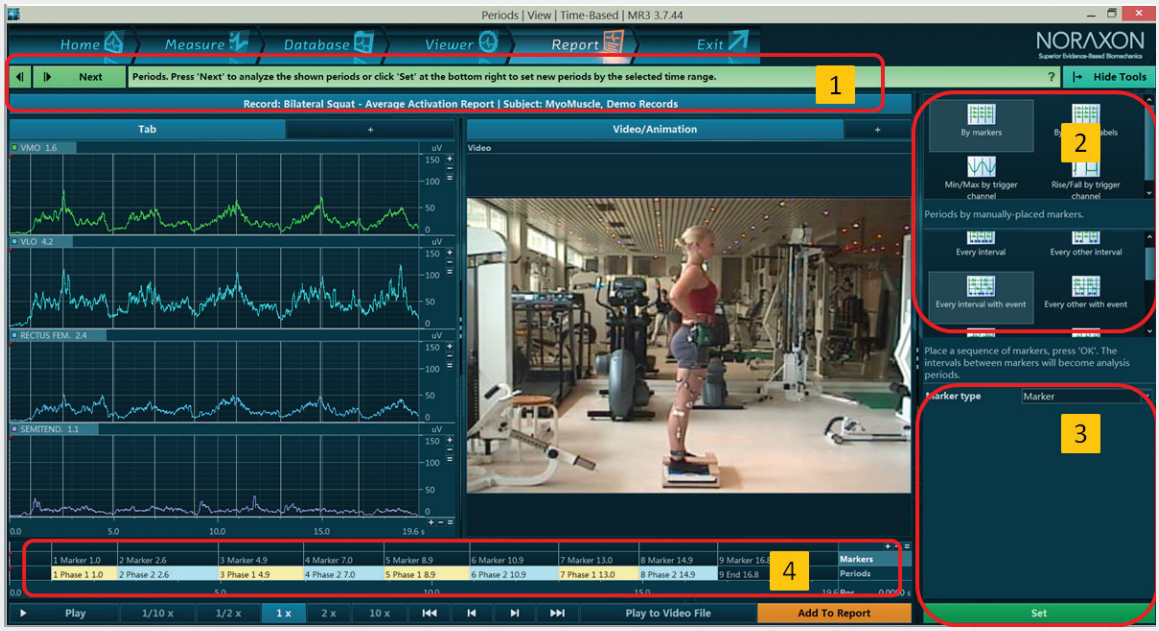


Report Period Definition Step

Before the report is shown, MR3 must define **Period Definition** (for analysis periods), operated via the Viewer Menu.

Whenever a report analyzes phases or multiple periods, these phases/periods must be defined via manual marker, point of interest markers (video analysis), or auto period definition routines.

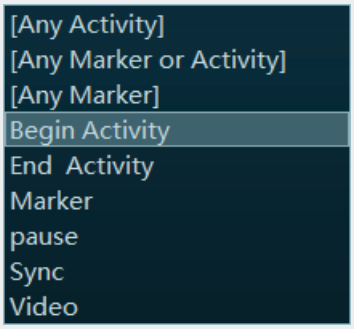
Overview of main screen elements:



1. **Instruction text** – Carefully read the instruction given here to navigate report wizard.

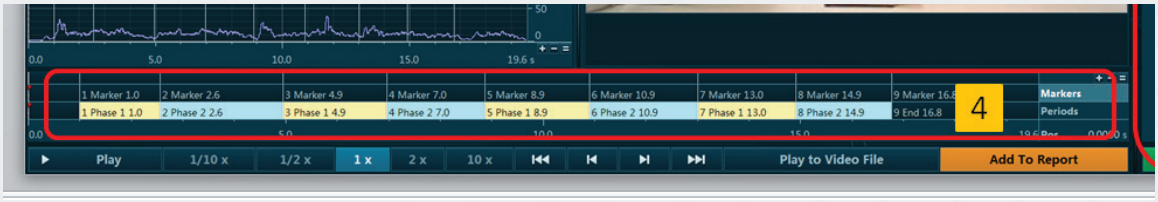
2. **Period Definition Mode** -- Several methods are offered here: using markers, angles signals, or TTL/switch signals. Each Report is pre-configured to a certain period definition mode. The Period Definition for each given report is pre-filled here as defined in the explanations given in the **Report Info.**

3. **Marker Type** – Several marker types can be used to define the analysis periods:



In this example **Begin Activity** and **End Activity** are customized markers, the default marker type is **"Marker"** – this marker type appears whenever you manually add a marker into the record.

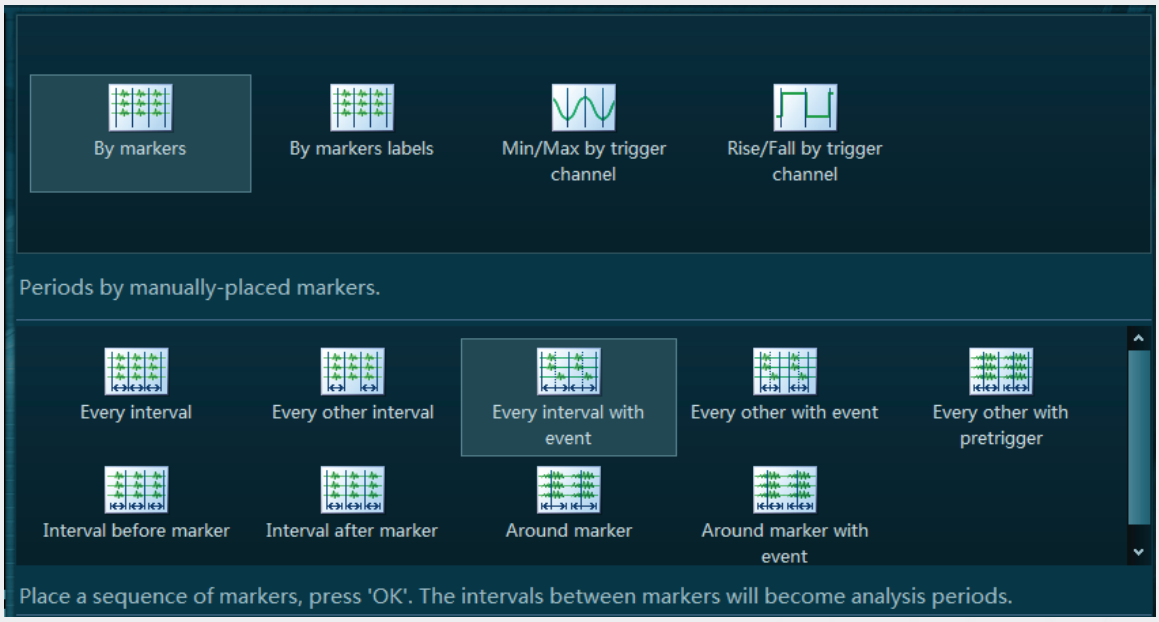
When the period definition mode and marker type are selected press **Next** in the green main action bar and check the periods found in the record. They are indicated by yellow or blue yellow (for gait analysis green-right and red-left side) period bars:



A given colored period can be mouse dragged to the bottom of screen to remove it from the selection sequence. This function is important in gait analysis and foot switch based period definition when some invalid steps that should not be analyzed need removed.

Create a new or change an existing period definition

A comprehensive set of period definition modes is presented that allows for the selection of alternative period definition modes and sub-modes. Some reports don't offer the option to change period definition because they are assigned to the mode "Selection/Whole record" by their report class definition in the report selection/properties menu. For this report class only the mouse marked area can be changed.



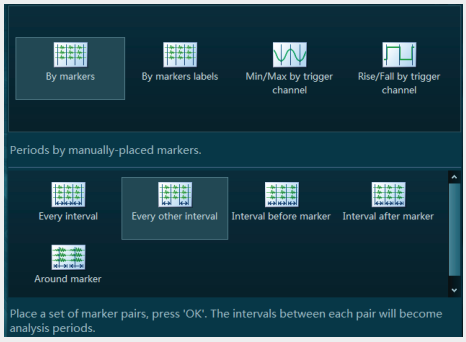
MR3 supports 4 major period definition methods

By Markers

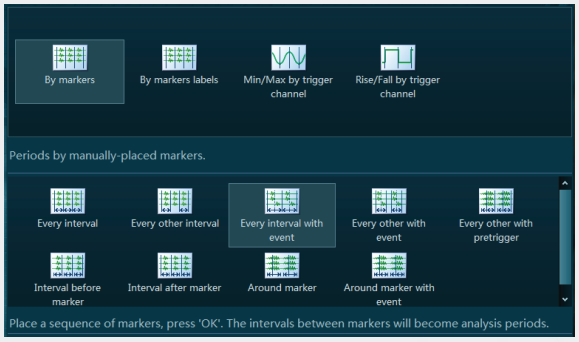
This is the default mode for most reports. Markers are set by left mouse double click or by using the Marker Menu in the Viewer menu. The default name for these is **Marker,** but the marker menu allows you to create other marker names. Individual marker names can be used with the second method, **By marker labels.**

If the report class is a **One Phase** (e.g. Standard Amplitude) or **Two Phase** (e.g. Average Activation) report, a set of sub modes are presented in the sub mode column:

One phase reports:

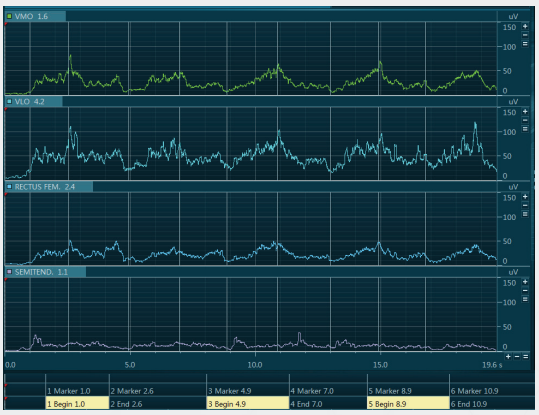


Two phase reports:



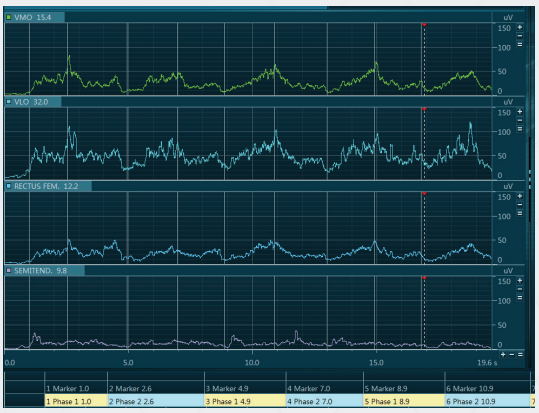
The result of any auto period definition routine is visualized by horizontal periods bar just below the signal screen:

One phase reports:



Selected sub mode: - Every other interval

Two phase reports:

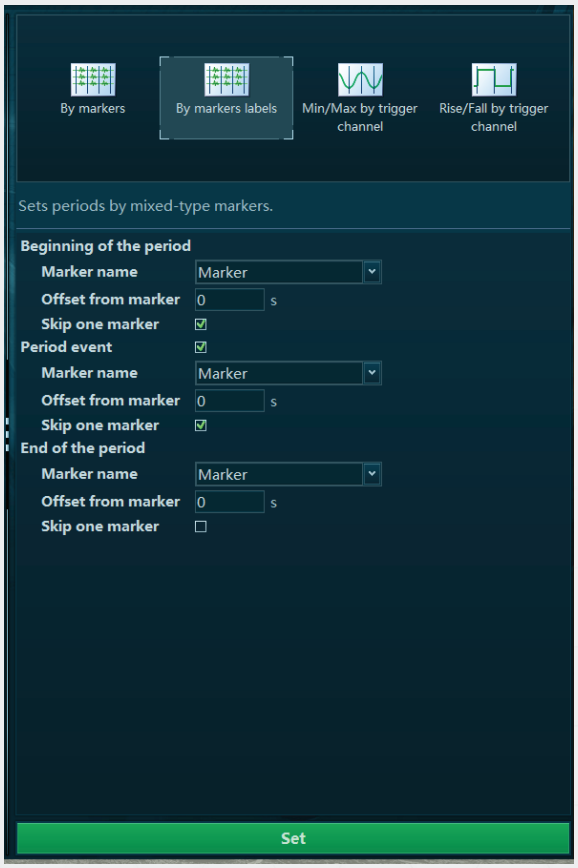


- Every interval with event

Check if one of the offered sub modes is more suitable to your task and select it by confirming **OK**. Pressing the **Preview button** allows the user to see the periods in the signal window before selecting **OK.**

By Marker Labels

Markers can freely be named by any label (see Viewer, Marker Menu). If special marker names were used in record viewer or in imported files (C3D gait event markers) the period definition can specifically use these marker labels for period definition. For example, all “Heel strike” markers can be used for the beginning of a 2-phase cycle (step), and all “Toe” markers as “event marker.”



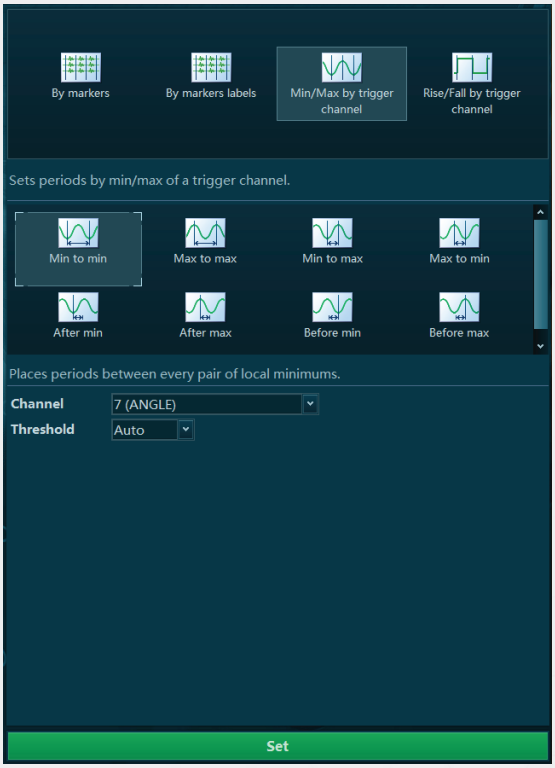
Choose the marker type in the pull-down list **Marker name.**
Offsets from markers will add a pre-marker period, a setting that is helpful for event markers in jump testing (pre-activation period before hitting the ground).
Skip one marker is needed in case there are undesired interruptions within un-interrupted motion cycles (e.g. gait).

Min/Max by trigger channel

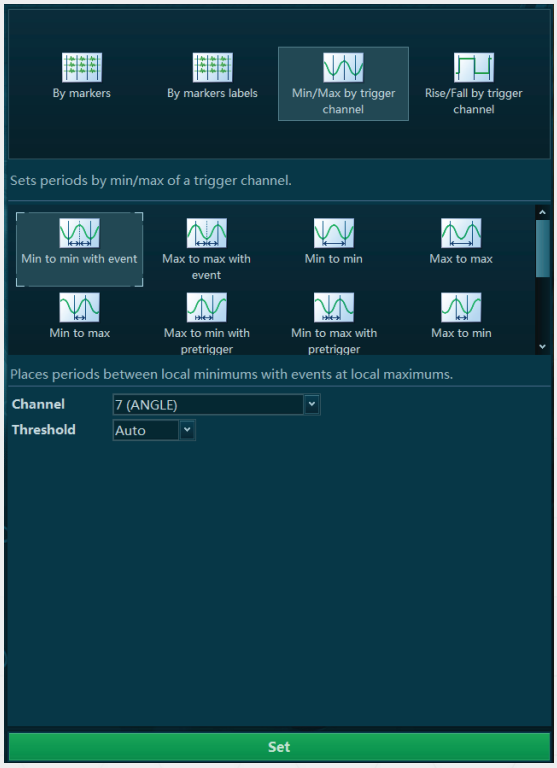
This period definition type is designed for angle plots and similar signals that should be used as a motion trigger signal. It detects local Min and Max values in the selected trigger channel.

If the report class is a **One Phase** (e.g. Standard Amplitude) or **Two Phase** (e.g. Average Activation) report, a set of sub modes are presented in the vertical sub mode column:

One phase reports:



Two phase reports:



Channel – select the trigger channel to be used for the auto-period detection
Threshold – regular angle signals can be analyzed by the **Auto** mode. In unique cases, it may be required to select a **Manual** mode. Here you need to enter suitable value that define the minimum range that must be found between Max and Min angle value to accept it as a local event.

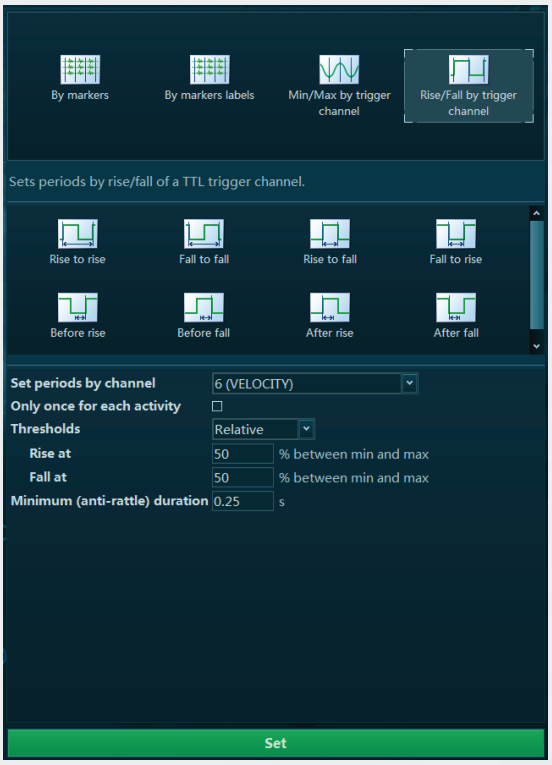
Check if one of the offered sub modes is more suitable to your task and select it by confirming **OK.**

Rise/Fall by trigger channel

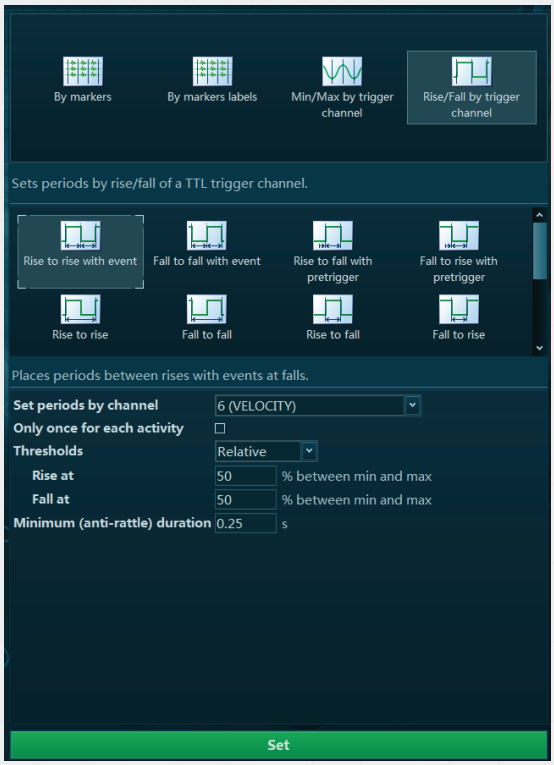
The Rise/Fall auto detection is designed for classical TTL styled signals and foot switch on/off signals with a sharp rising edge going to high TTL and sharp falling edge going back to low.

If the report class is a **One Phase** (e.g. Standard Amplitude) or **Two Phase** (e.g. Average Activation) report, a set of sub modes are presented in the vertical sub mode column:

One phase reports:



Two phase reports:



Set period by Channel – select the trigger channel to be used for the auto-period detection.

Only once for each activity – designed for multi-activity recordings which interrupt a recording via a pausing period.

Threshold

Relative tries to automatically detect every **Rise** and **Fall** of the trigger signal by checking the TTL range and placing markers at the 50% position between the rise and fall level. This location can be customized by the controls **Rise at** and **Fall at** between low and high (TTL level).

Absolute takes the amplitude values entered in **Rise at** and **Fall at** as threshold lines and uses them for the period definition. Each time the TTL signal passes the defined threshold line, it is assumed that this event can be used to define a period.

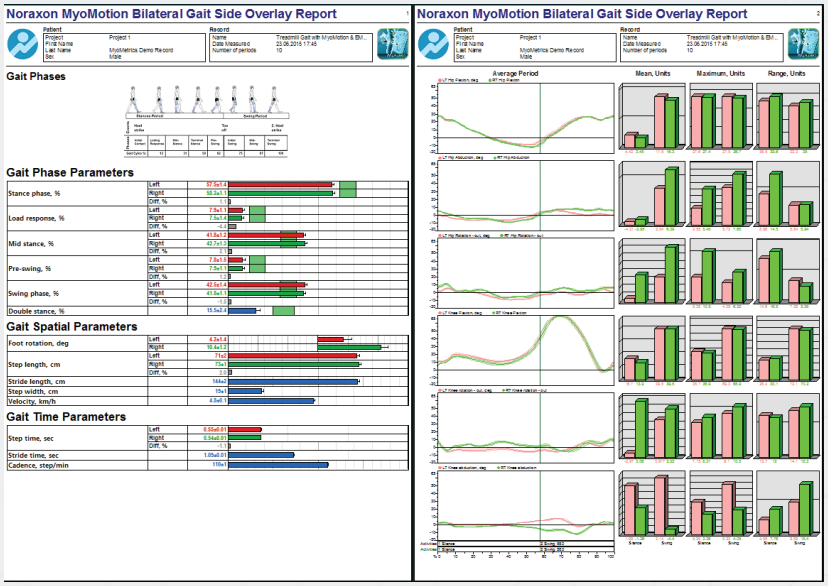
Minimum (anti-rattle) duration defines the minimum duration a TTL event must last to be recognized by the algorithm. This switch can help avoid incorrect selections caused by artifact spikes (typically very short spikes).

NOTE: For very short trigger events like jump ground contacts, this anti-rattle duration needs to be adjusted to lower values!

Check if one of the offered sub modes is more suitable to your task and select it by confirming **OK.**

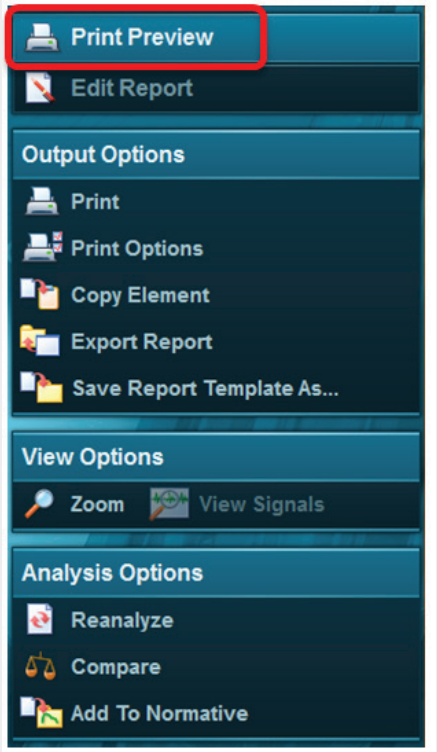
NOTE: We recommend choosing the basic settings pre-configured for this report and only entering the period definition tool bar menu if experiencing problems, such as noisy signals. An incorrectly selected and operated period definition will result in an inaccurate analysis of the default myoMOTION report.

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.

In the right-side tool bar are 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

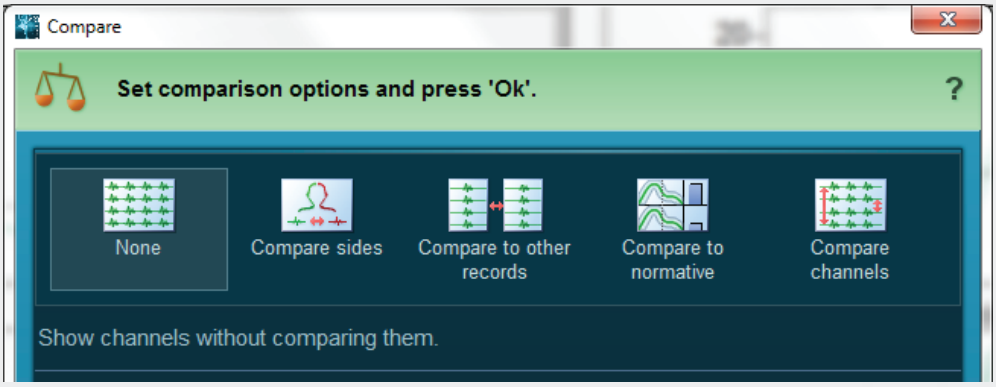
- **Zoom** – the user can zoom to a percentage of the report, size the report to fit vertically or horizontally, or choose to view the report one or two pages at a time.

- **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:



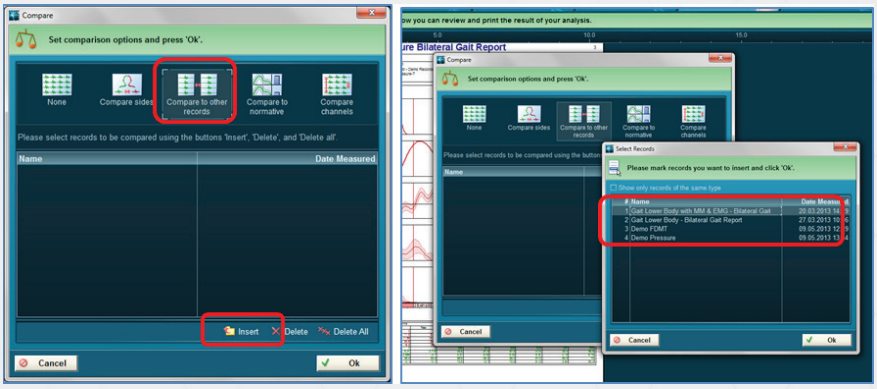
- Compare sides
- Compare to other records
- Compare to normative (if available)
- Compare channels (within the same record)

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!

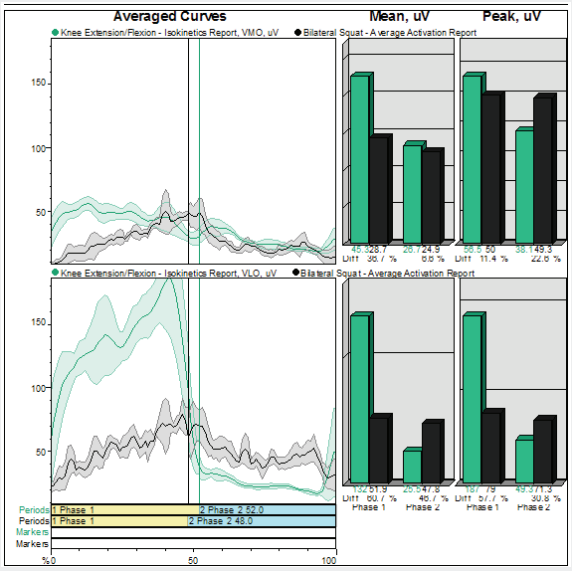
Compare to other records

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:



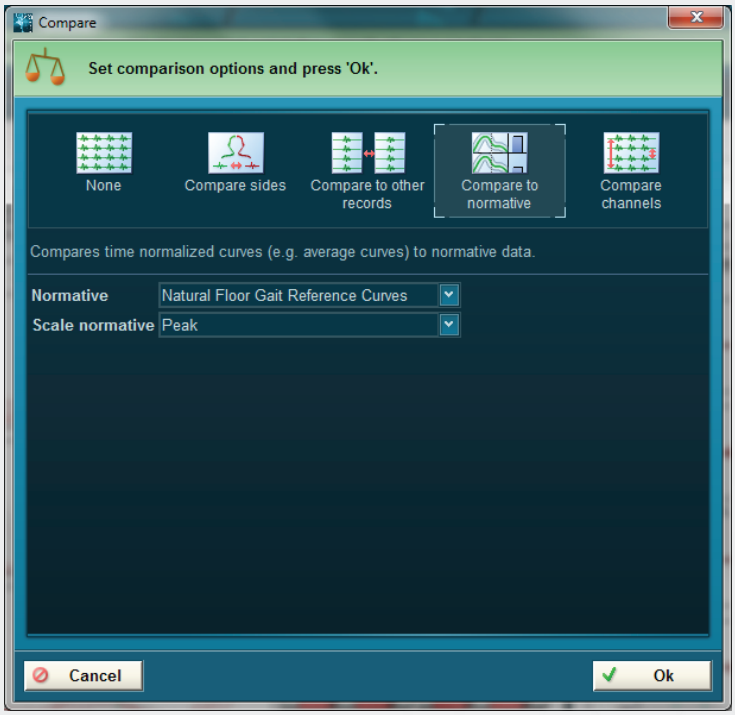
It is possible to compare to several records at the same time.

Compare to normative (curves)

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.

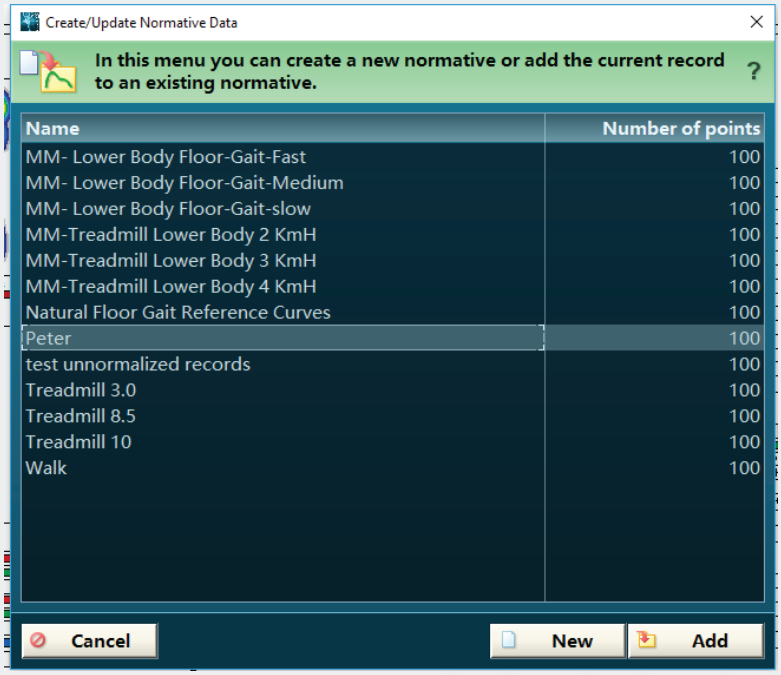
Scale normative – If EMG based normative data were not amplitude normalized via Signal processing in the **Viewer** menu, the amplitude data may heavily vary. This function allows users to amplitude normalize both the selected patient record as well as the normative file to its **Peak** or its **Mean** 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.

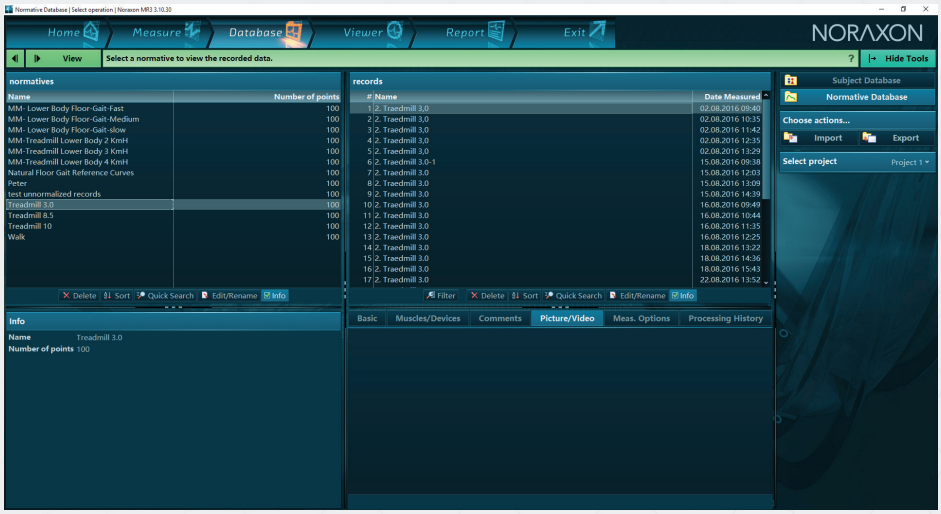
MR3 has a powerful normative data generator. It is designed for records analyzed with averaged curves reports like Gait, Average Activation, Isokinetics, etc. All these records have a time normalized ensemble average curve with plus/minus 1 SD. The time normalization in cycle from 0 to 100% enables a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

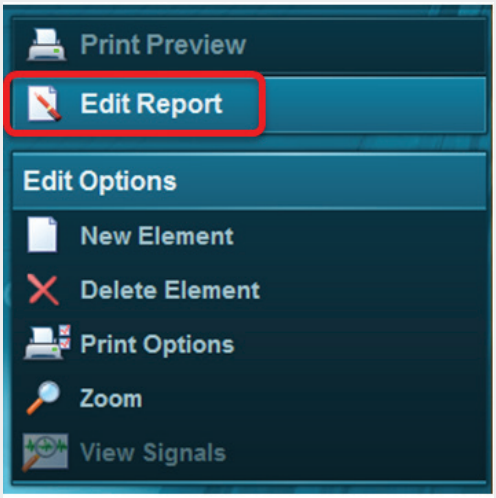
Any successfully generated averaged curve can create a **New** normative file or it can be added **(Add)** to an existing one:



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.

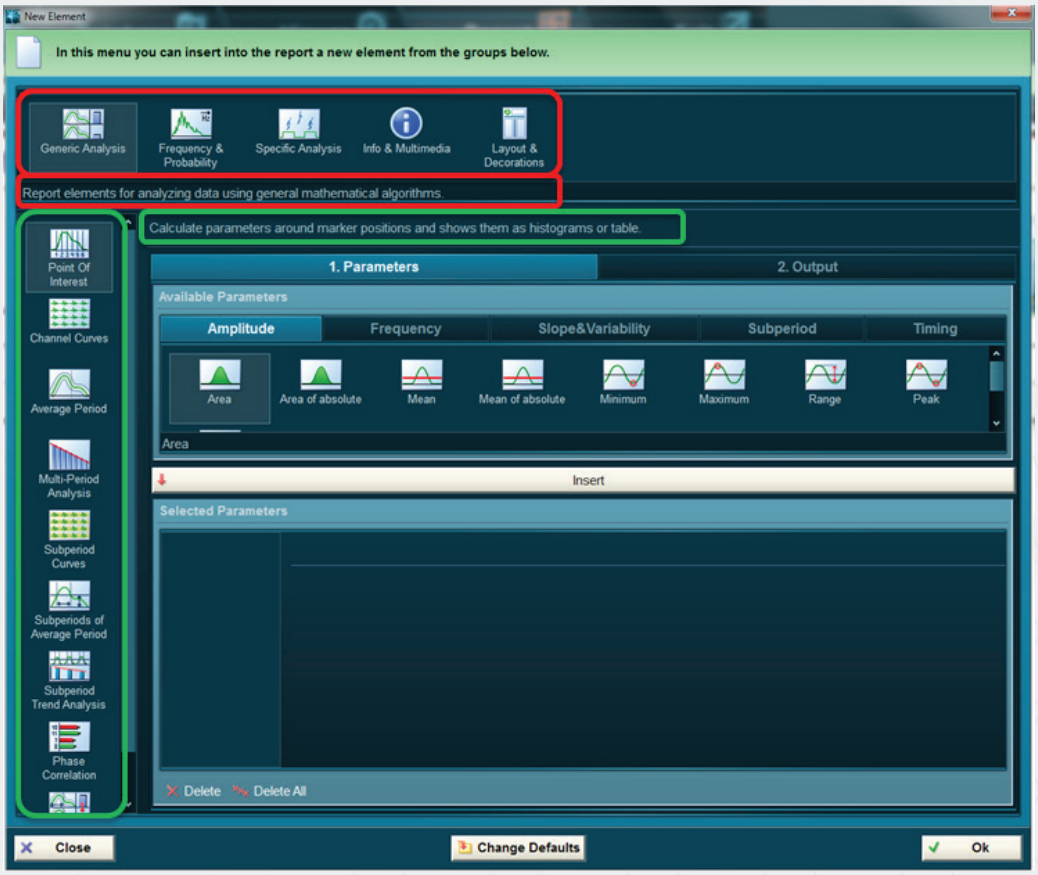


Edit Report

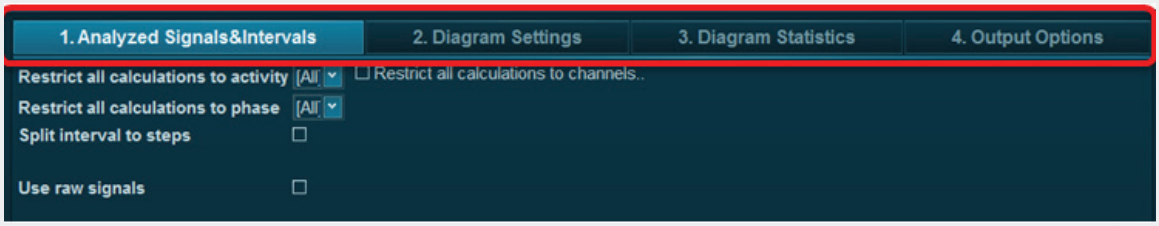


Edit Report options allow the user to customize the report by adding or deleting elements.

- **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: Report Descriptions

MyoMotion Averaged Curves Report

This report is designed for repetitive, non-interrupted motion cycles and activities with an up/down, extension/flexion, abduction/adduction motion pattern. Each phase is analyzed separately by placing a manual marker at each beginning, point of return and end of a motion cycle. Data are presented in a time normalized motion cycle running from 0 to 100% motion cycle and 1% data resolution (100 data points per motion cycle). This time normalization allows for standardized comparison of records and automatically eliminates their unavoidable timing differences.

Period Definition:

By markers - every other interval

Place a manual marker (left mouse double click in record viewer) at each start, mid-point, or return and end of a motion cycle. The marker must be labeled with “Marker.” Alternatively, the period definition mode can be changed and “Auto-marking” of trigger or motion signals (min and max of a given angle) used to define the motion phases.

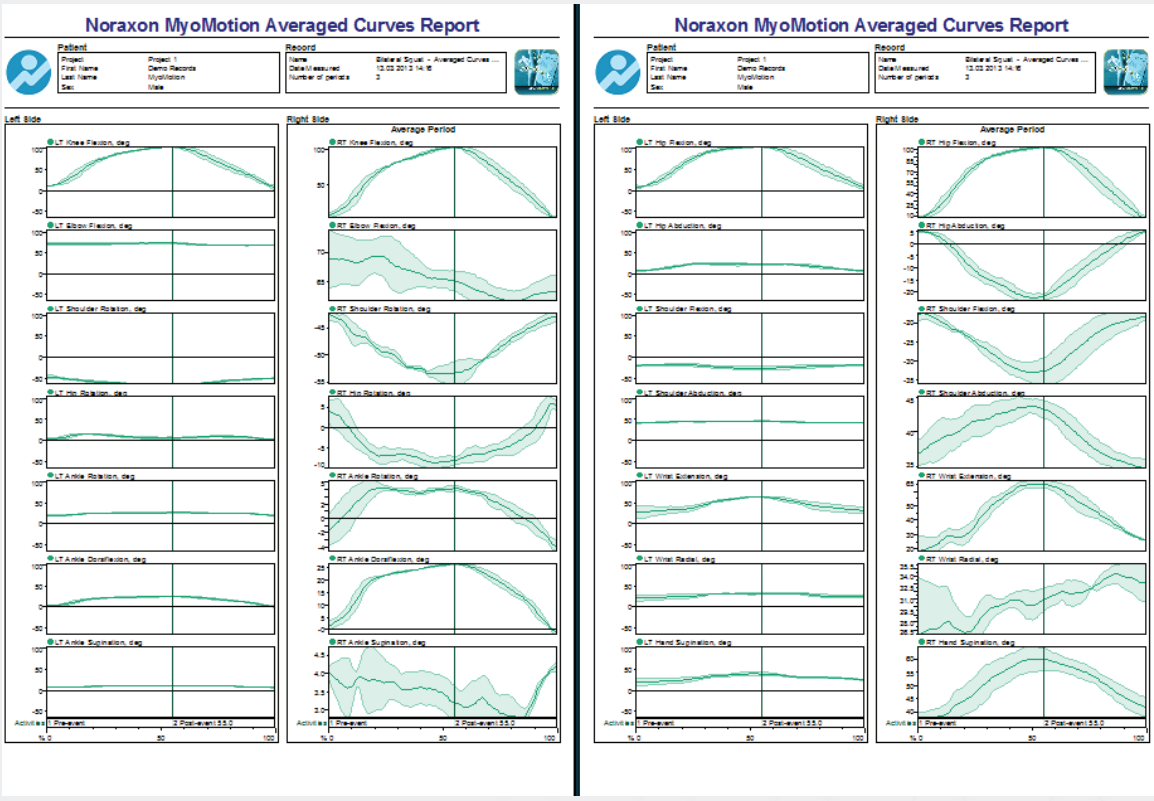
Report contents:

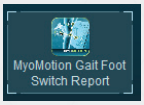
1. Page: Subject Header, angle curves separated to left and right side shown as time normalized averaged curves plus/minus 1 standard deviation.

2. Page: Depending on the number of joints, the analysis curves and data are contained and an angle amplitude parameter table containing min, max, and range of motion values.

3. Page: If video analysis was added via Point of Interest analysis (pressing “Add to report” button in record viewer), all POI related video pictures (and video drawings) are shown here.

Analysis and Interpretation:





MyoMotion Gait Foot-Switch Report

This report is designed for repetitive, un-interrupted motion cycles and activities with an up/down, extension/flexion, abduction/adduction motion pattern. Each phase is analyzed separately by placing manual marker at each beginning, point of return and end of a motion cycle. Data are presented in a time normalized motion cycle running from 0 to 100% motion cycle and 1% data resolution (100 data points per motion cycle). This time normalization allows for standardized comparison of records that automatically eliminates the unavoidable timing differences.

SOFTWARE
myoMOTION™ MODULE

Period Definition:

By markers - every other interval

Place a manual marker (left mouse double click in record viewer) at each start, mid-point, or return and end of a motion cycle. The marker must be labeled with “Marker”. Alternatively, the period definition mode can be changed and “Auto-markering” of trigger or motion signals (= min and max of a given angle) are used to define the motion phases.

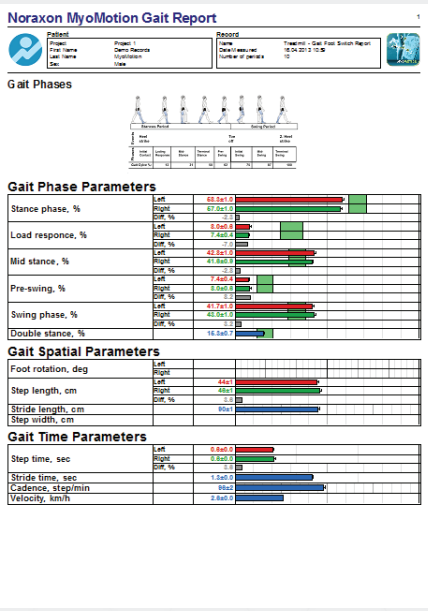
Report contents:

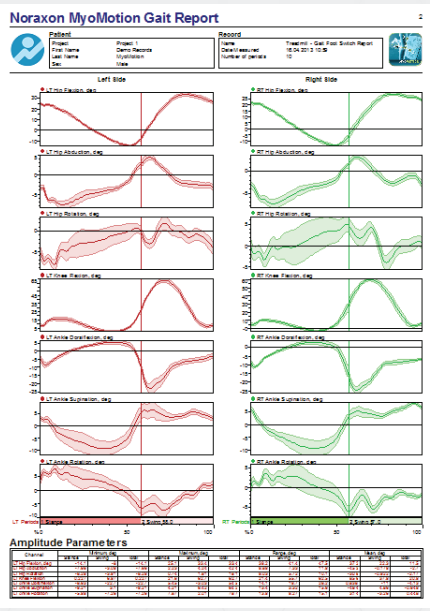
1. Page: Subject Header, angle curves separated to left and right side shown as time normalized averaged curves plus/minus 1 standard deviation.

2. Page: Depending on the number of joints, the analysis curves and data are contained and an angle amplitude parameter table containing min, max, and range of motion values.

3. Page: If video analysis was added via Point of Interest analysis (pressing “Add to report” button in record viewer), all POI related video pictures (and video drawings) are shown here.

Analysis and Interpretation:





The focus is to study angle patterns in repeated motion cycles and derive the main angle parameters. Because of the applied time normalization, the comparison to other records can be easily applied by using the comparison option in the right tool bar of the Record Viewer.

MyoMotion Gait Side Overlay Report

This report is designed for gait activities operated with a foot sole or foot switch trigger system to detect gait phases and events. Based on the foot switch events, stance and swing phase and gait sub-phases are determined. Spatial gait parameters based on a predefined walking distances are calculated as averaged values. Kinematic angles curves are averaged in a time normalized gait cycle from 0 to 100° and shown as averaged curves plus or minus one standard deviation. EMG data are automatically included in case they were included in the recording. An additional amplitude parameter table supports min, max, and range calculation separated to stance and swing phase. The report creates a left/right side curve overlay by default.

Period Definition:

Rise/Fall by trigger channel – rise to rise with event

Trigger channels are the foot switch signals: the report setup is preconfigured to automatically analyze the gait events based on left and right foot switch signals.

Each stance phase (dark color) and swing phase (bright color) of each detected stride is marked in red (left side) and green (right side) bars. Period definition mode can be adjusted with “Change Period Definition” in the right tool bar of record viewer after selecting the report.

Report contents:

1. Page: Subject Header, angle curves separated to left and right side shown as time normalized averaged curves plus/minus 1 standard deviation.

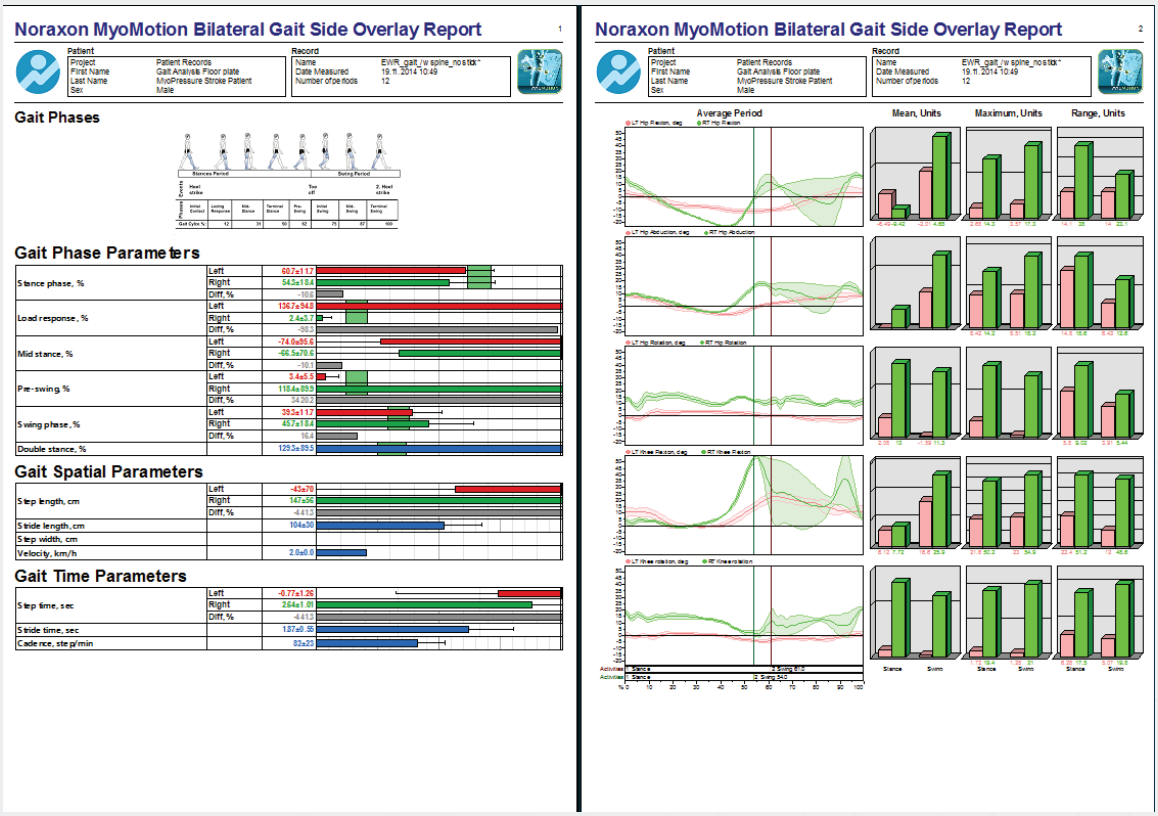
2. Page: Depending on the number of joints, the analysis curves and data are contained and an angle amplitude parameter table containing min, max, and range of motion values.

3. Page: If video analysis was added via Point of Interest analysis (pressing “Add to report” button in record viewer), all POI related video pictures (and video drawings) are shown here.

SOFTWARE
myoMOTION™ MODULE

Analysis and Interpretation:

The focus is to study angle patterns in repeated motion cycles and derive the main angle parameters. Because of the applied time normalization, the comparison to other records can be easily applied by using the comparison option in the right tool bar of the Record Viewer.



MyoMotion Multi Period Report

This report is designed for myoMOTION records that analyze multiple periods within one activity. The start and end point of each period is defined by a manually placed Marker. The minimum and maximum angle as well as total range is calculated for all measured joints. Up to 6 periods can be marked for one report. The report is meant to be used for video assisted records that are used to define the start and the end of an interested activity period. A video picture from the mid-point of each phase is automatically added to the report.

Period Definition:

The default procedure is to place a marker (left mouse double click) at the beginning and end of each phase.

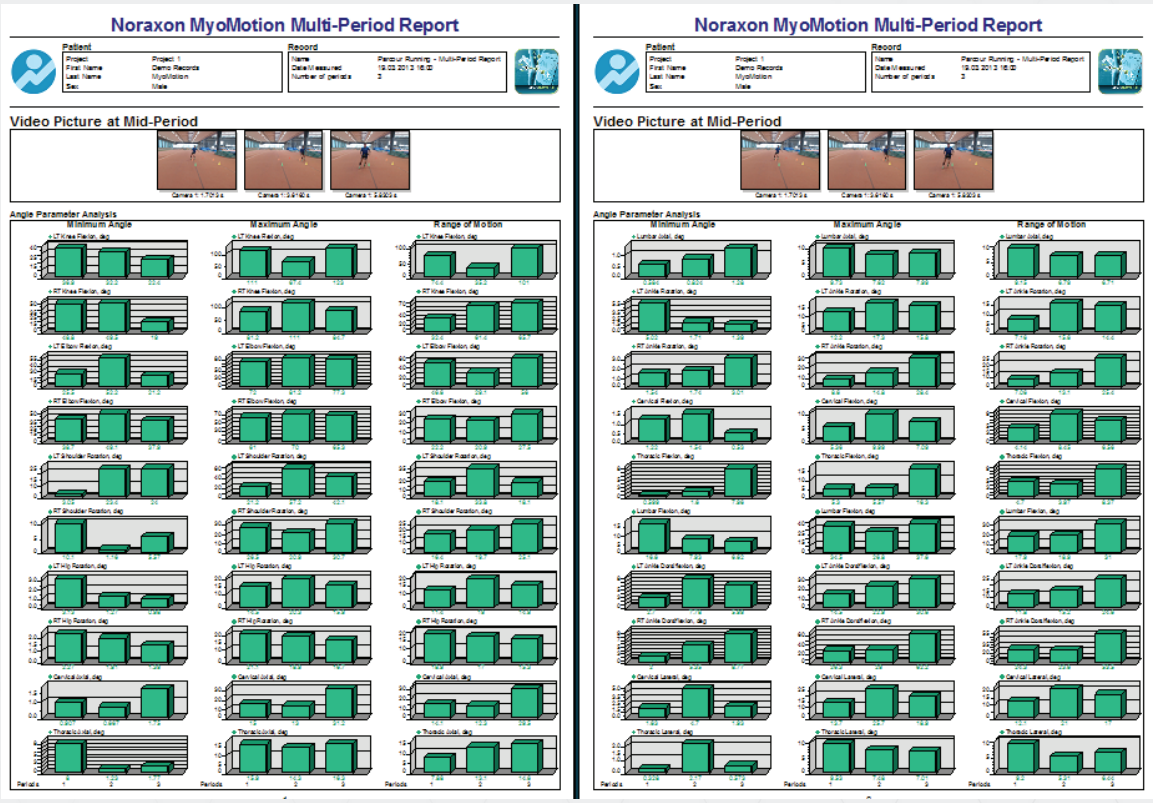
Report contents:

1. Page: Subject Header, angle curves separated to left and right side shown as time normalized averaged curves plus/minus 1 standard deviation.

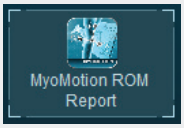
2. Page: Depending on the number of joints, the analysis curves and data are contained and an angle amplitude parameter table containing min, max, and range of motion values.

3. Page: If video analysis was added via Point of Interest analysis (pressing “Add to report” button in record viewer), all POI related video pictures (and video drawings) are shown here.

The focus is to study different phases of a given activity and compare the changes of angle parameters.



MyoMotion Range of Motion (ROM) Report



This report is designed for myoMOTION records analyzing a single activity or exercise. The start and end point of the given activity is defined by a manually placed Marker. The minimum and maximum angle as well as total range is calculated for all measured joints. If EMG was added to the recording, the EMG traces will automatically be added to the kinematic angle analysis.

Period Definition:

The default procedure is to place a marker (left mouse double click) at the beginning and end of the activity.

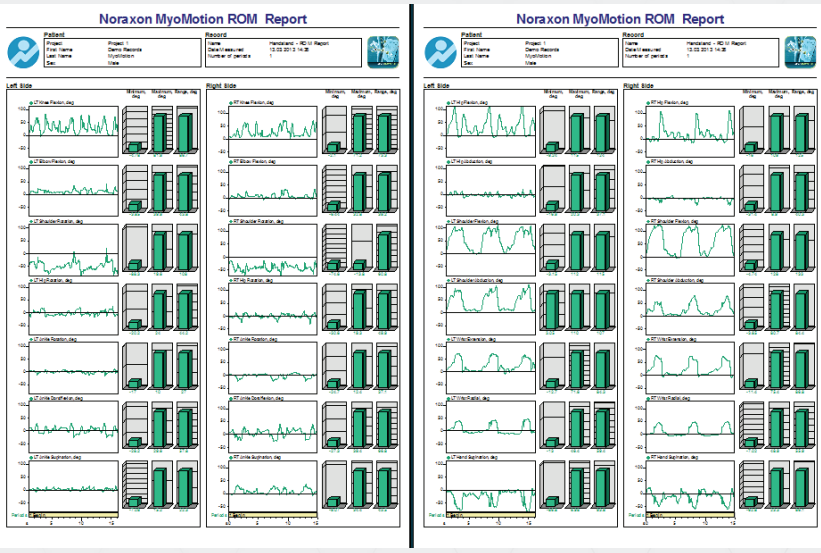
Report contents:

1. Page: Subject Header, angle curves separated to left and right side shown as time normalized averaged curves plus/minus 1 standard deviation.

2. Page: Depending on the number of joints, the analysis curves and data are contained and an angle amplitude parameter table containing min, max, and range of motion values.

3. Page: If video analysis was added via Point of Interest analysis (pressing “Add to report” button in record viewer), all POI related video pictures (and video drawings) are shown here.

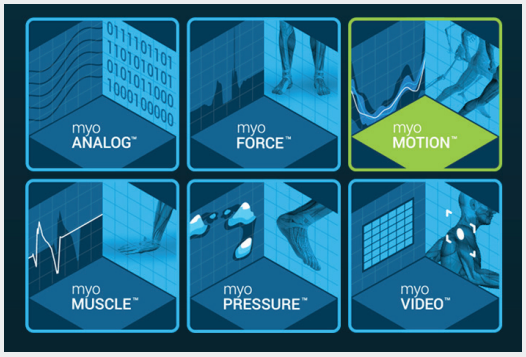
Analysis and Interpretation:



The Main focus of this report is to study angle patterns and the main angle parameters for a given activity. Comparison to other records can be applied by using the comparison option in the right tool bar of record viewer.

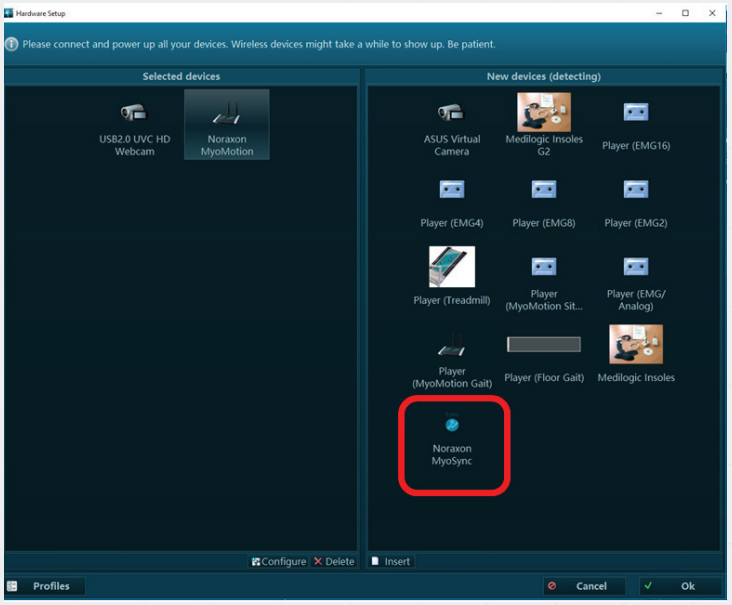
Appendix B: Multi-Device Configurations and Master myoSYNC System

Whenever myoMOTION is used with other Noraxon devices like myoPRESSURE, myoMUSCLE, or myoVIDEO systems, it is recommended that the **Master myoSYNC System** be purchased and activated.



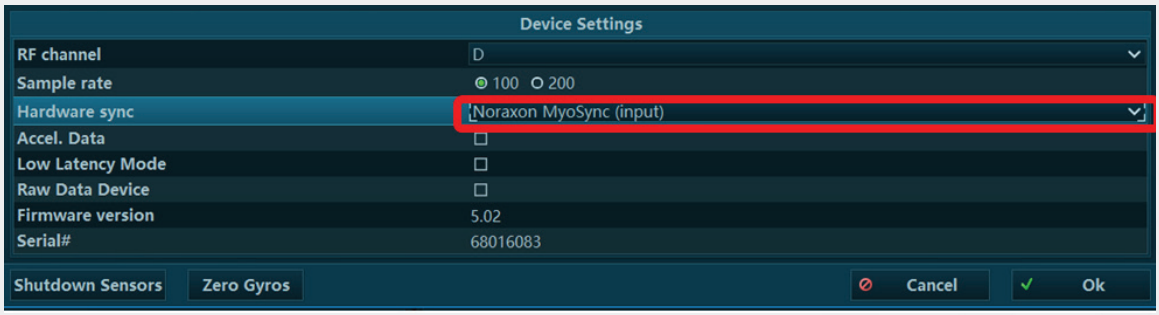
The Master Sync is a special sync device with 5 output ports and 1 input port. It needs to be inserted as a device in the device setup menu:

Make sure that the Master Sync device is connected to your PC prior to opening the Insert Devices menu:



Once the Master Sync is inserted as a device, it will automatically send a synchronization pulse to all other Noraxon devices. This pulse is generated and sent 1 second after start of recording. For setup with a myoMOTION device for master sync mode please refer to the instructions in the hardware manual.

The next step is to enter myoMOTION hardware device setup and activate the **Hardware Sync:** Noraxon myoSYNC (input):



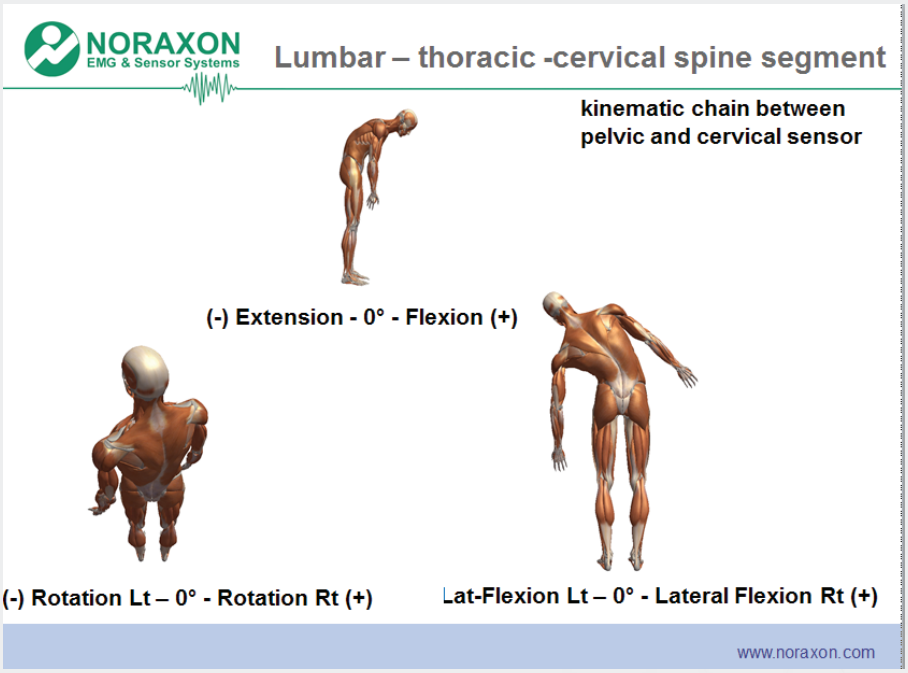
The activation of the external sync in needs to be repeated in all other devices as well (see their specific hardware/software manuals).

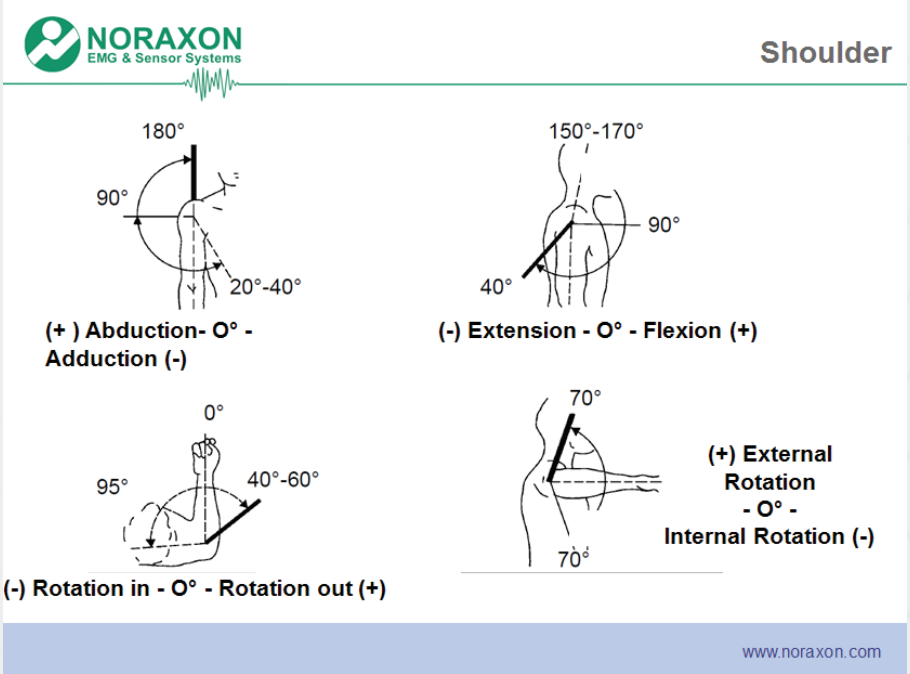
The last step is to connect the stereo jack sync cable shipped with myoSYNC to:

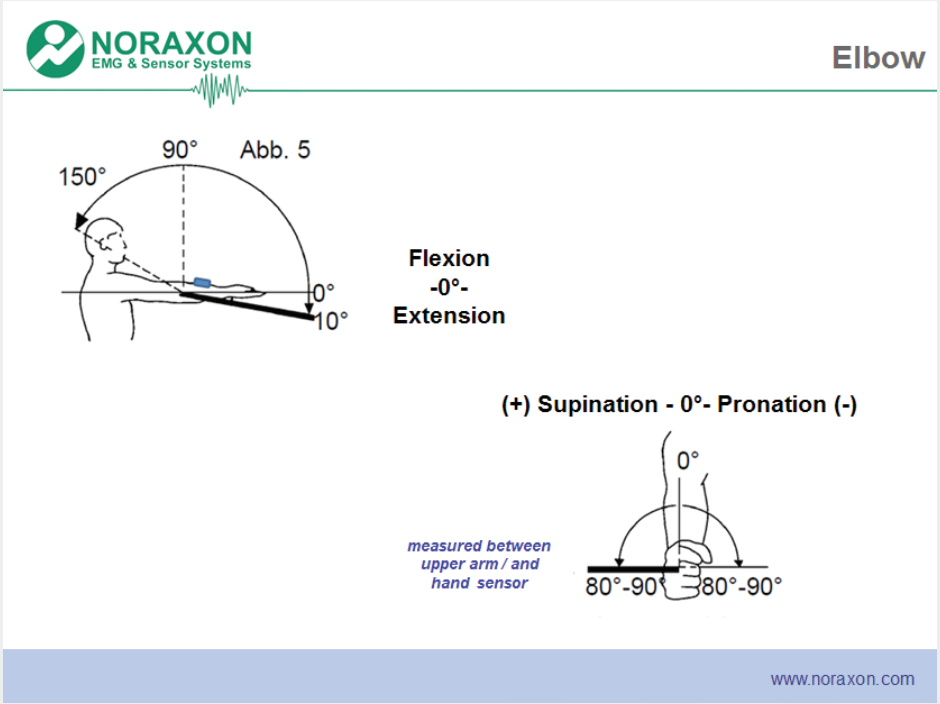
- Sync out connector 1-5 (any free connector will work) of the Master Sync
- Sync in connector of myoMOTION

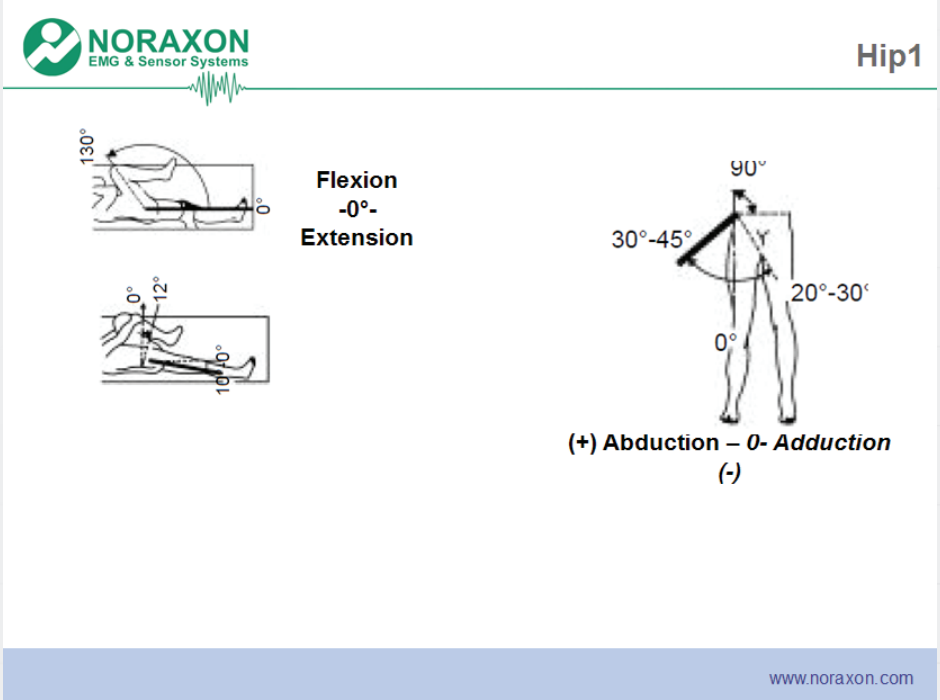
Once these settings are arranged, all multi-device recordings will be automatically synchronized via the Master Sync.

Appendix C: Definition and Motion Plane of Anatomical Angles



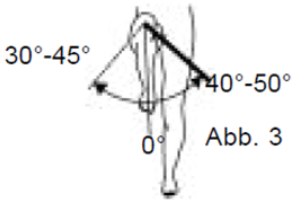



NORAXON
EMG & Sensor Systems
Elbow
90°
Abb. 5
150°
0°
10°
Flexion
-0°-
Extension
(+) Supination - 0°- Pronation (-)
0°
measured between
upper arm / and
hand sensor
80°-90°
80°-90°
www.noraxon.com

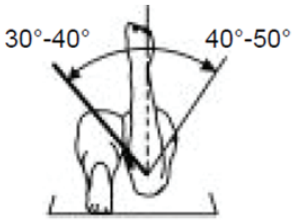

NORAXON
EMG & Sensor Systems
Hip1
130°
0°
Flexion
-0°-
Extension
0°
12°
10°
90°
30°-45°
20°-30°
0°
(+) Abduction – 0- Adduction
(-)
www.noraxon.com

NORAXON
EMG & Sensor Systems

Hip2



(+) Out Rotation– *0- In Rotation (-)*



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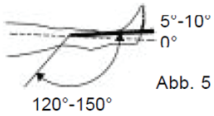
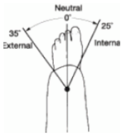
NORAXON

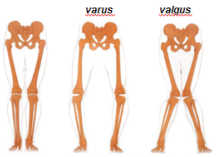
Knee



(-) Extension - 0°- Flexion (+)



(-) In rotation *-0°-* out rotation (+)



(-) Adduction/Varus *-0°-* Abduction/Valgus (+)

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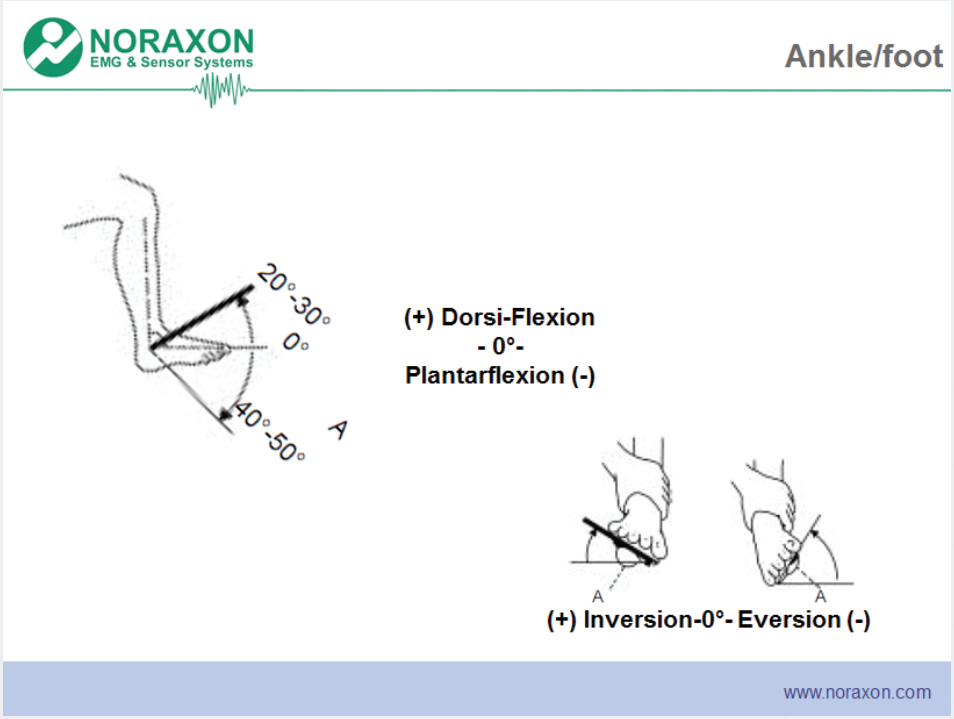
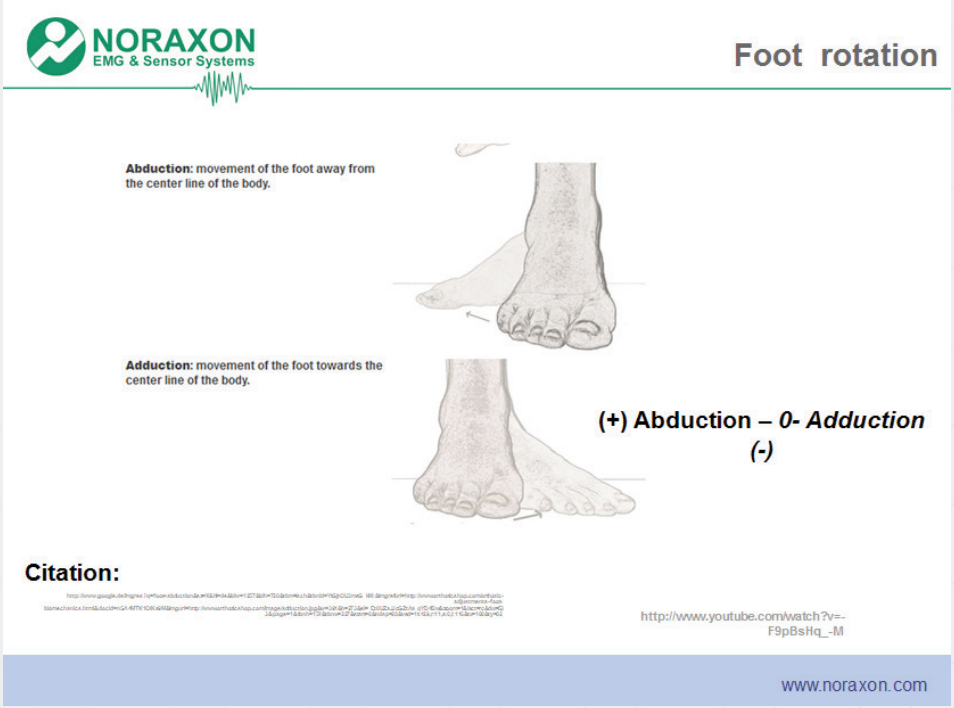
Knee varus/valgus and rotation needs to be unlocked in the software setup menu -

www.noraxon.com


NORAXON
EMG & Sensor Systems
Ankle/foot
20°-30°
0°
40°-50°
A
(+) Dorsi-Flexion
- 0°-
Plantarflexion (-)
A
A
(+) Inversion-0°- Eversion (-)
www.noraxon.com


NORAXON
EMG & Sensor Systems
Foot rotation
Abduction: movement of the foot away from the center line of the body.
Adduction: movement of the foot towards the center line of the body.
(+) Abduction – 0- Adduction (-)
Citation:
http://www.youtube.com/watch?v=-F9pBsHq_-M
www.noraxon.com

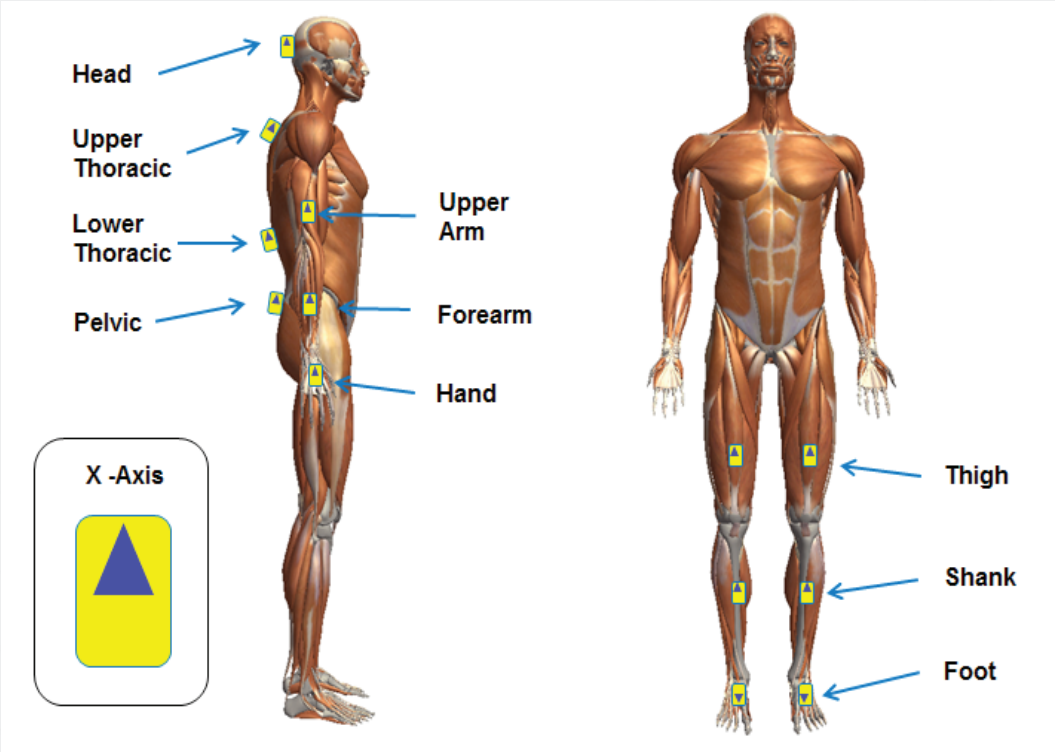
Appendix D: Sensor Application

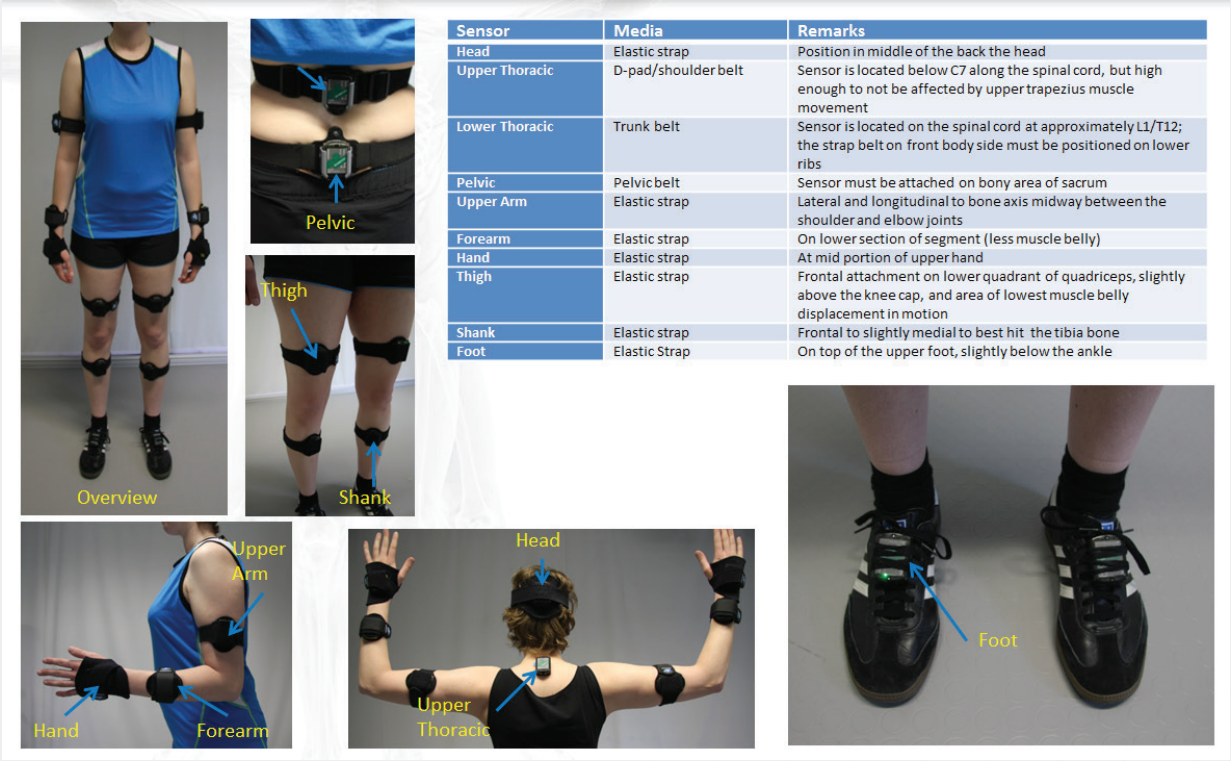
Each sensor has a label indicating the X, Y, and Z–axis in the lower right-hand corner of the sensor. Generally, all sensors are positioned so that in normal standing position the X-axis vector on the sensor label is pointing vertically up. The only exception to this is the foot sensor: The X-axis vector is pointing toward the toes.

> **NOTE:** When no pelvis or upper thoracic sensor is included in the system, extra care needs to be taken to ensure that the sensors are in line with the underlying bone segment and pointing in the correct direction. When the pelvic sensor is used, an exact sensor positioning is not required. For data stability and symmetry, it is recommended to always place sensors in symmetrical arrangement between left and right side.

When placing the sensors on the bone segments, it is important to find a location where the muscle belly will not dislocate the sensor in relation to the underlying bone. This may vary from person to person. The elastic straps delivered with the system will significantly help to minimize the dislocation of sensors against the bone axis in motion. It is recommended to use them whenever it is possible and place them directly on skin.

Please see the sensor placement recommendations below for the best tracking results.





Sensor	Media	Remarks
Head	Elastic strap	Position in middle of the back the head
Upper Thoracic	D-pad/shoulder belt	Sensor is located below C7 along the spinal cord, but high enough to not be affected by upper trapezius muscle movement
Lower Thoracic	Trunk belt	Sensor is located on the spinal cord at approximately L1/T12; the strap belt on front body side must be positioned on lower ribs
Pelvic	Pelvic belt	Sensor must be attached on bony area of sacrum
Upper Arm	Elastic strap	Lateral and longitudinal to bone axis midway between the shoulder and elbow joints
Forearm	Elastic strap	On lower section of segment (less muscle belly)
Hand	Elastic strap	At mid portion of upper hand
Thigh	Elastic strap	Frontal attachment on lower quadrant of quadriceps, slightly above the knee cap, and area of lowest muscle belly displacement in motion
Shank	Elastic strap	Frontal to slightly medial to best hit the tibia bone
Foot	Elastic Strap	On top of the upper foot, slightly below the ankle

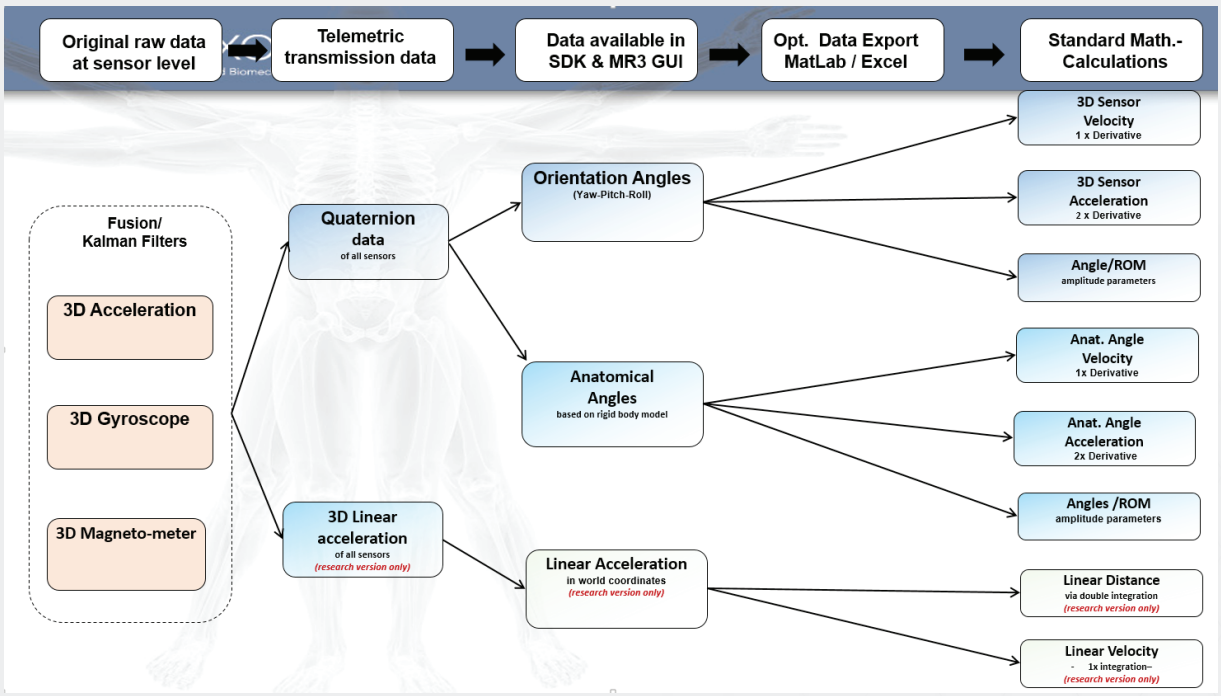
Appendix E: Receiver / Frequency Table

This table shows the max sampling rate for a given sensor/receiver configuration with respect to transmitted signal:

Number of Receiver Modules	Number of IMU Sensors Supported			
	3D Orientation Only		3D Orientation Plus Linear Acceleration	
	100 sps/sensor	200 sps/sensor	100 sps/sensor	200 sps/sensor
1	9	9[3]	9[3]	4[3]
2	18	18[3]	18[3]	8[3]
3	27	27[3]	27[3]	12[3]
4	36	36[3]	36[3]	16[3]

[4] Maximum configuration offers limited ability for retransmission of wireless data from IMU sensors.
This restriction can be mitigated by adding additional receiver modules or reducing the number of sensor measured.

Appendix F: Data Organization in MyoMOTION



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