MICROGATE

OPTOGAIT

User Manual

Manual Version 1.12.2

Software Version 1.12

Contents

1 DEVICE FUNCTIONS AND MAJOR FEATURES

OPTOGAIT is an innovative system for movement analysis and functional assessment of patients with normal or pathological conditions. The system is equipped with optical sensors working at a frequency of 1000 Hz and having an accuracy of 1 cm, detecting the relevant space and time parameters for gait, running or other test types. The objective measurement of such data, combined with an integrated video acquisition, allows to monitor a patient's condition on a constant basis, detecting problem areas, assessing mechanical inefficiencies and rapidly verifying the existence of asymmetries between the two legs. The software platform allows to easily store all tests carried out and recall them instantly, if necessary. This allows to develop a customized patient recovery. It is furthermore possible to compare very quickly and easily data of tests carried out at different times, in order to assess the validity and the efficiency of the methodology applied.

OPTOGAIT allows to:

- Assess objectively the patient's general physical conditions

- Identify deficiencies, postural problems and asymmetries on the basis of data and videos

- Develop and apply therapeutic-rehabilitation applications, rehab approaches and orthopedic solutions on the basis of precise data

- Prevention - thanks to immediate assessment of numerical values - of relapses, complications and involutions of the pathological or post-accident condition due to wrong evaluations or diagnosis

- Periodically verify the results and the efficacy of treatment

- Motivate patients giving them tangible proves of improvement

- Compare post- and pre-accident values if available

- Verify, in a dynamical situation, the efficacy of arch supports, insoles or functional tapes

- Compare various shoes and their effect on the patient's gait

Optogait is a system for optical detection made of a transmitting and a receiving bar (henceforth called TX and RX)." Each one contains 96 LEDs communicating on an infrared (890 nm) frequency with the same number of LEDs on the opposite bar. Once positioned on the floor or on the treadmill, the system detects the interruptions of the communication between the bars - caused by the patient's movement - and calculates the duration and position. During the execution of a running, gait or series of jumps test, the **contact and flight times** can be measured with an accuracy of 1 thousandth of a second and the **position of the interrupted LEDs** with a space resolution of 1.041 cm. Starting from these base data, the dedicated software measures in real-time a series of crucial data for the movement analysis. Optogait acquires numerical parameters in real-time for gait, running and jump tests, allowing to view them immediately.

Thanks to the possibility to create an easy-to-read report in a few seconds, containing all main data, asymmetries between the two legs are highlighted instantly.

Besides the below listed data, in each test average value, standard deviation, and variability coefficient are stated for each leg, where available. In this case, a difference between the two legs is shown in percentage

	Gait/Run Test	Gait Test on Treadmill	Run Test on Treadmill	Jump Test	Tapping Test	Reaction Test
Stance Time	X	X				
Swing Time	X	X				
Step Time	X	X	X			
Gait Cycle	X	X				
Single Support	X	X				
Double Support	X	X	X			
Loading Response	X	X				
Pre-swing	X	X				
Step Length	X	X	X			
Stride Length	X	X	X			
3 foot phase (contact, flat, propulsive)	X	X	X			
Cadence/Rhythm/Pace	X	X	X	X	X	
Speed	X					
Acceleration	X					
Flight Time	X		X	X	X	X
Contact Time	X		X	X	X	
Height	X		X	X	X	
Stride Angle	X		X			
Imbalance	X		X			
Specific power				X		
Jumping Point				X		
Jumping Point Gap				X		
Used Area				X	X	
Cycle Time (Flight + Contact)					X	
Reaction Time						X

KIT CONFIGURATION

OPTOGAIT is always sold in a KIT configuration comprising at least:

- 1 bar with interface RX

- 1 bar with interface TX

- (Optional for linear multiple-meter systems): n additional RX bars

- (Optional for linear multiple-meter systems): n additional TX bars

- USB cable for PC connection, 5 m

- Single Meter: 1 power supply certified for medical use + connection cable for second bar

- Linear Systems: 2 power supplies certified for medical use for recharging and current supply

- 2 professional webcams

- 2 USB cable extension cords, 5 m

- 2 webcam tripods

- Single-meter bag or trolley for 2-to-5-meter systems

- Quick installation guide (hard copy)

- USB stick containing software and user guide

Kits usually sold are:

- Single-Meter Kit

- Single-Meter Kit predisposed for the addition of more meters

- Additional Meter Kit

- 5-Meter Kit

- 10-Meter Kit

List of Accessories

- Logitech Pro 9000 webcam

- Digipod TR-257 tripod

- 220V FRIWO DT-50 (FW 7405M/24) power supply certified for medical use

1.1 Single Meter

In this configuration Optogait allows already to carry out various test types:

1.1.1 Jump Test

A series of exercises (squat jump, counter movement jump, drop jump, continuous jumps, jumps on one leg, etc.) and protocols ('Drift' for dynamic stability, '5 Dot Drill' for reactivity and endurance, 'Single Leg Three Hops' to verify the bending capacity and stability of the knee) are pre-configured. At the same time, the user can easily create customized tests or protocols.

1.1.2 Tapping/Frequency Test

This type of test is ideal for exercises where separate results are required for the left and right foot (e.g. tapping/frequency test, side movement, walking on the spot, etc.)

1.1.3 Reaction Test

This test detects the time between one optical/acoustic impulse and the patient's movement. It can be used to measure simple reactions or more complex movements.
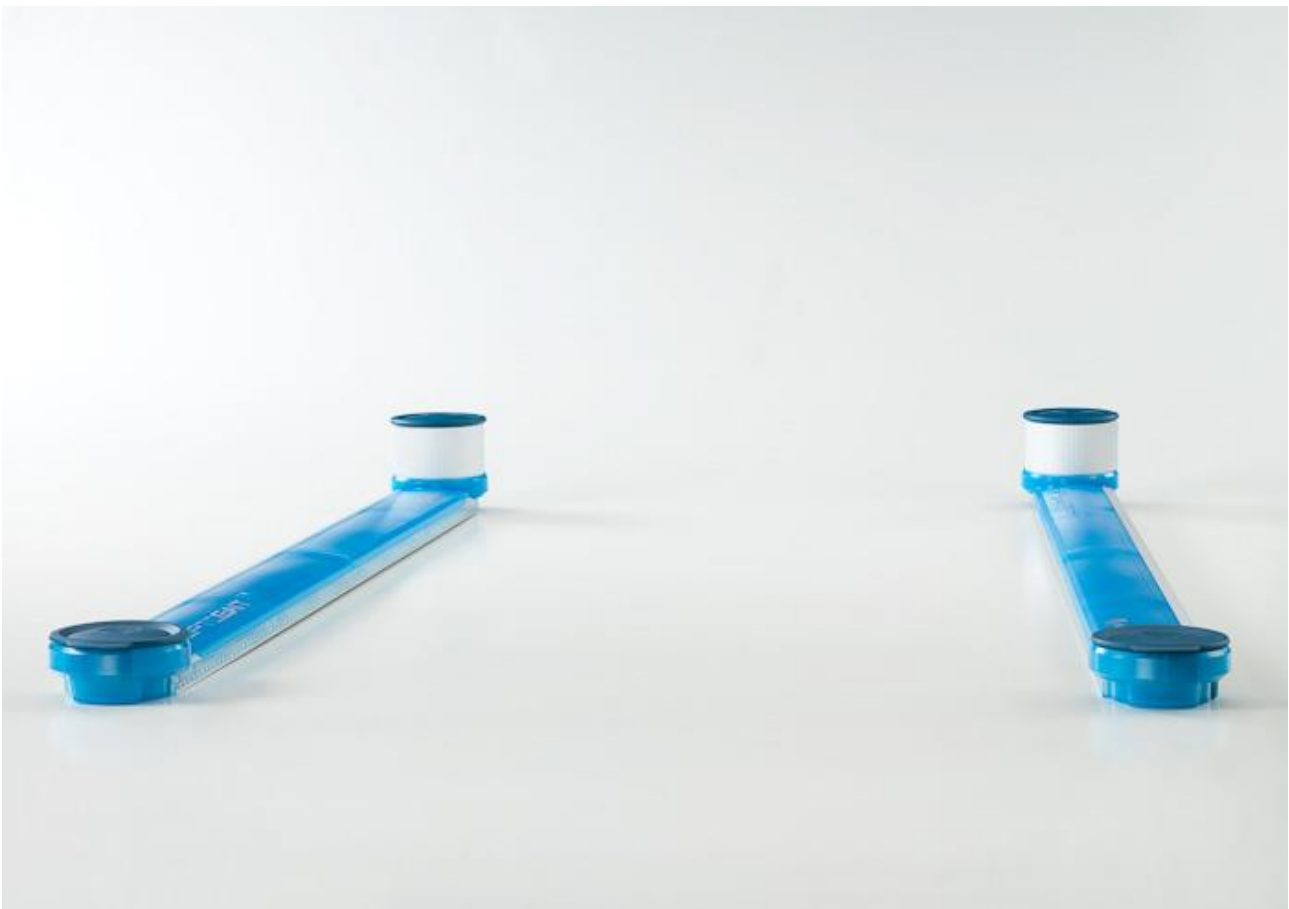
1.2 SINGLE METER ON TREADMILL

1.2.1 GAIT ANALYSIS, RUN ANALYSIS

Positioned on the side bars of a treadmill, OptoGait becomes a real portable lab for small spaces and with reduced costs. The system is compatible with the wide majority of treadmills and no synchronization is necessary to start and carry out a test.

1.3 THE MODULAR SYSTEM

In this configuration, OptoGait allows to carry out:

1.3.1 GAIT TEST

Gait tests can consist of simple exercises (moving from A to B), but also of more complex ones, such as 'roundtrip' or walking backwards. They can be more complex, if needed, adding obstacles (e.g. plastic cones) or actions to be carried out between the various gait phases (sitting down and getting up before coming back, for example) or simultaneously.

1.3.2 RUNNING TEST

Running tests, just like gait tests, can be carried out either starting from a stand or running, to analyse the various phases, how the incremental weariness acts on the patient at each round installing the system on a track, measuring the time of a change of direction and the following acceleration, and so on…

Thanks to the practical and innovative assembling system using caps, the modular system is assembled in a few minutes and does not require cables to connect the bars or further net adapters. The length goes from a minimum of 2 meters to a maximum of more than 10 meters.

1.4 THE TWO-DIMENSIONAL SYSTEM: OPTOGAIT 2D

Starting from version 1.7 of the OptoGait software it is possible to use a particular bar configuration for obtaining a two-dimensional measurement area. To the classic bars (which we will call X) more bars (Y) can be added to form a rectangle, where new information can be gathered for the gait tests:

- **Step width**: distance between the middle support point of each foot
- **Walking Base**: distance between the innermost foot support points (for superposed steps this value can be negative)
- **Walking Points**: middle points between the two support feet; their connection defines the gait progress (**Line of Progression**); conventionally it is expressed in positive values if there is a deviation towards left and negative with a rightward deviation
- **Walking Point Gap**: progressive variation of the current walking point with respect to the previous one
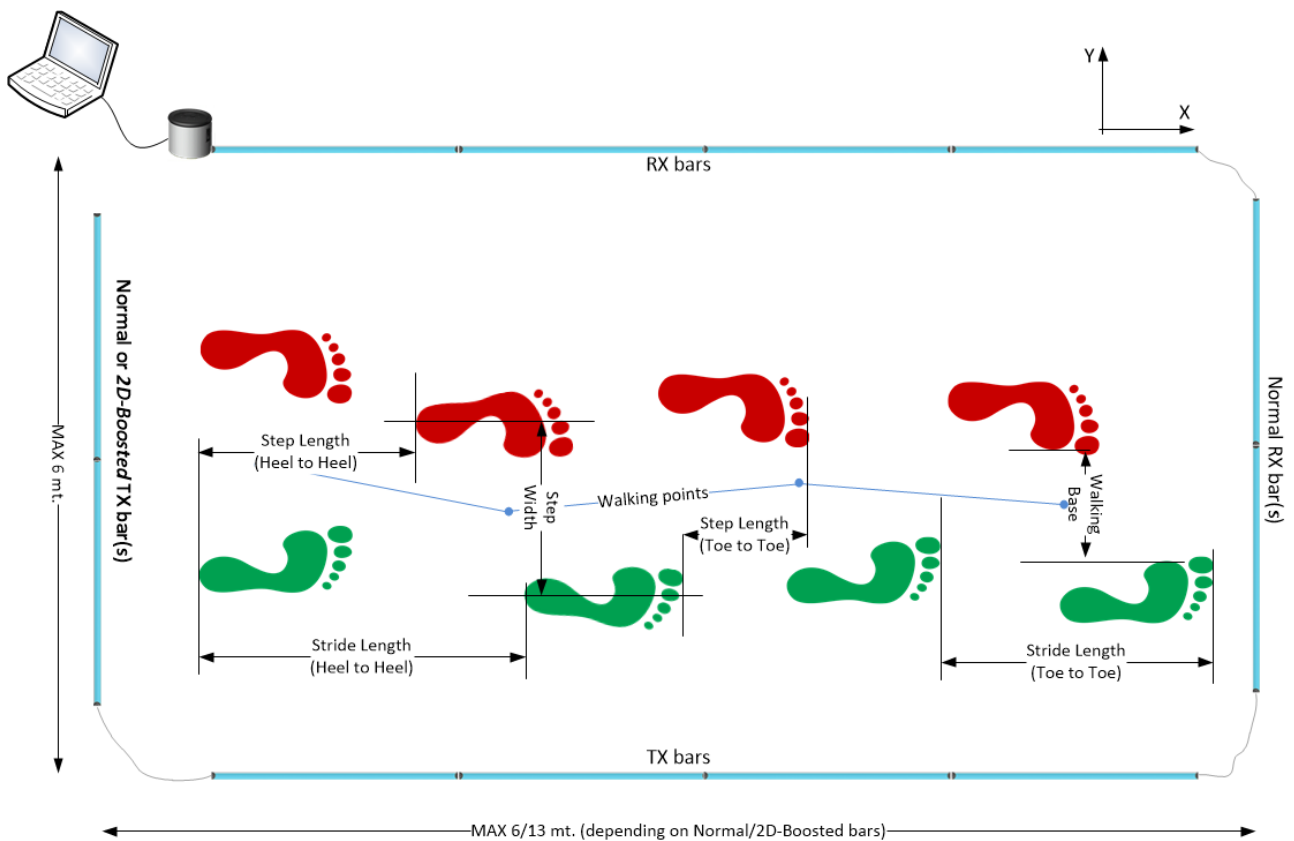
The regular OptoGait bars have a maximum transmission/reception distance of 6 meters; with this hardware you can use at the most 5 meters of 'X' bars and approx. 50 cm of room with the 'Y' bars.
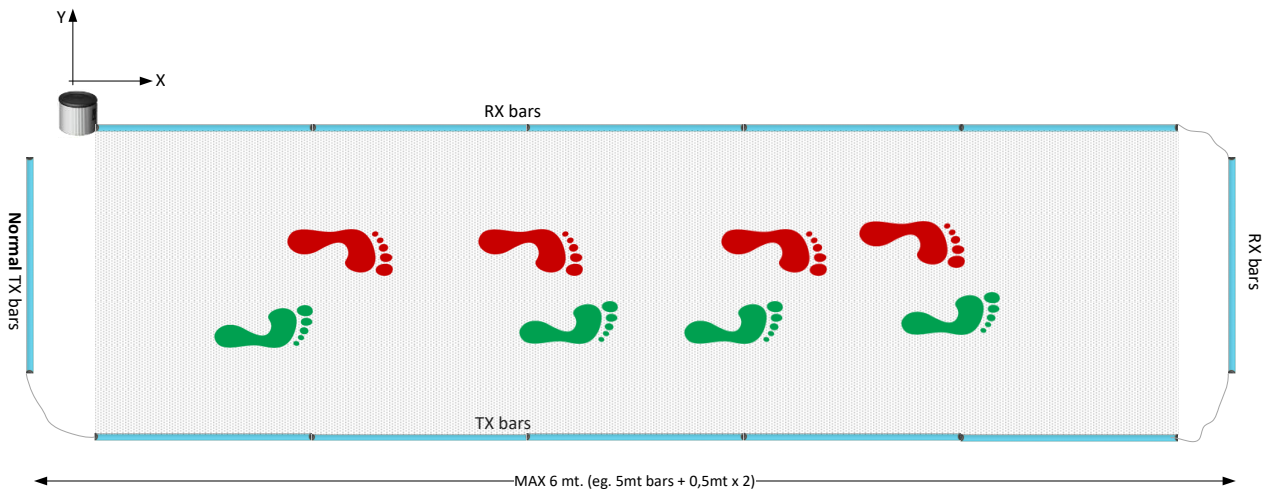
The regular closing Y TX bar is usually a bar WITHOUT interface drum. Updating the firmware of the TX bar with drum (already included with all articles having a **serial number higher than 00250**) this last hardware type can also be used. Therefore with a 5-meter modular system (Kit £OGA051) it is for example possible to use the complete hardware building a 4-meter-long linear gait system. For serial numbers lower than 00250 it is possible to ship the bar to Microgate or a distributor and receive a free update (shipping costs for sending and receiving are excluded). It is also possible to buy one or more additional single TX bars.
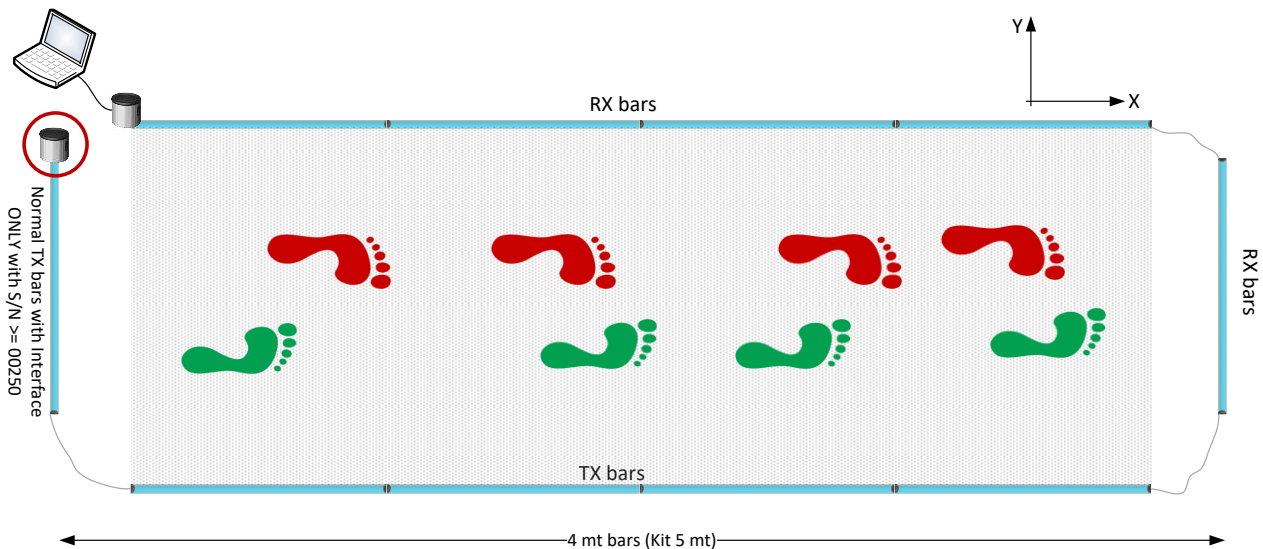
The maximum length of the 2D course can be increased up to **13 meters** purchasing one or more special Y TX bars called '**2D-Boosted**'. This kind of bar is equipped with stronger transmission LEDs compared to the others and has a front aluminium cover instead of the transparent lenses, in order to direct the narrow infrared LED beam. To help the Y bar alignment at great distances (especially with not perfectly smooth ground), the 2D-Boosted bar is equipped with mechanical trimming devices for applying micrometric elevation and inclination changes.
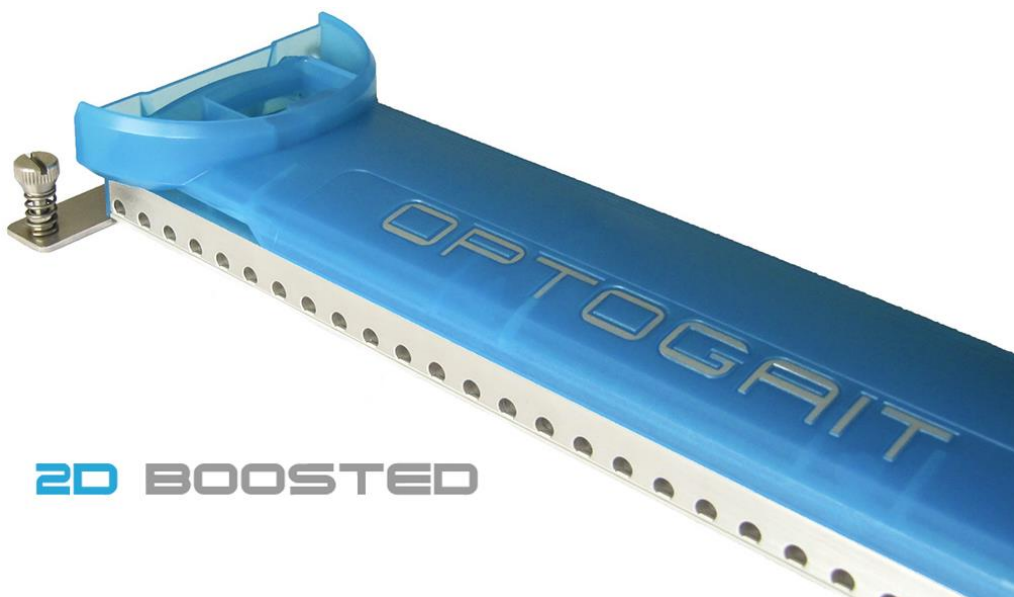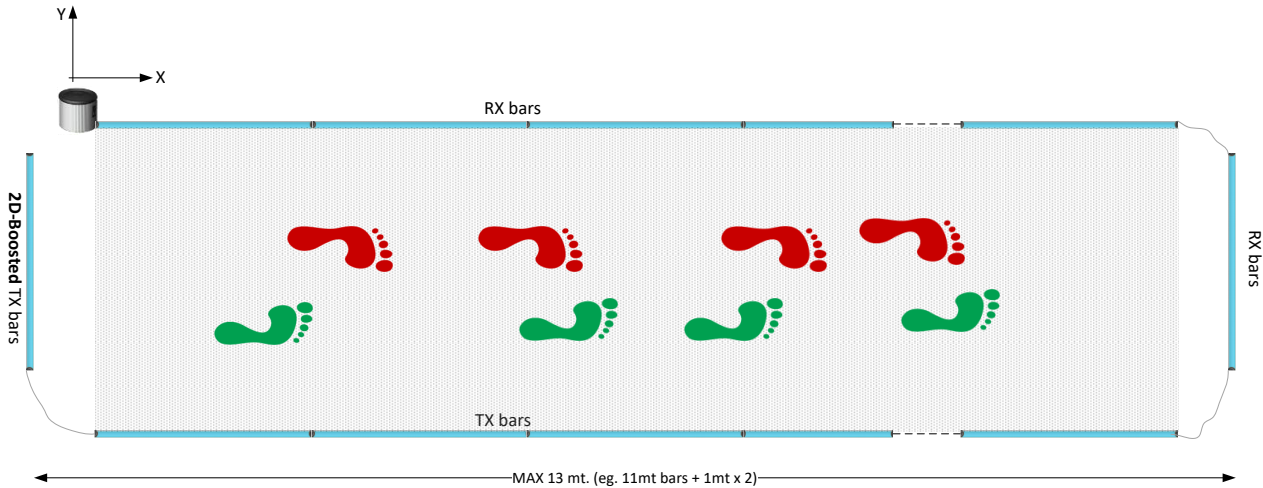
The bars situated on the perpendicular sides are connected using a variable-length cable (usually 1.5/2 m); this allows to distance the actual measurement area (the rectangle formed by the regular bars and highlighted in grey in the following picture) of the Y bars; this area allows the patient to leave the test area without having to jump over the bars or - more frequently - turn around by 180° and go back. In fact, the software allows to carry out an undefined number of back/forth courses recording a sufficient number of steps also in case of linear systems of only a few meters.
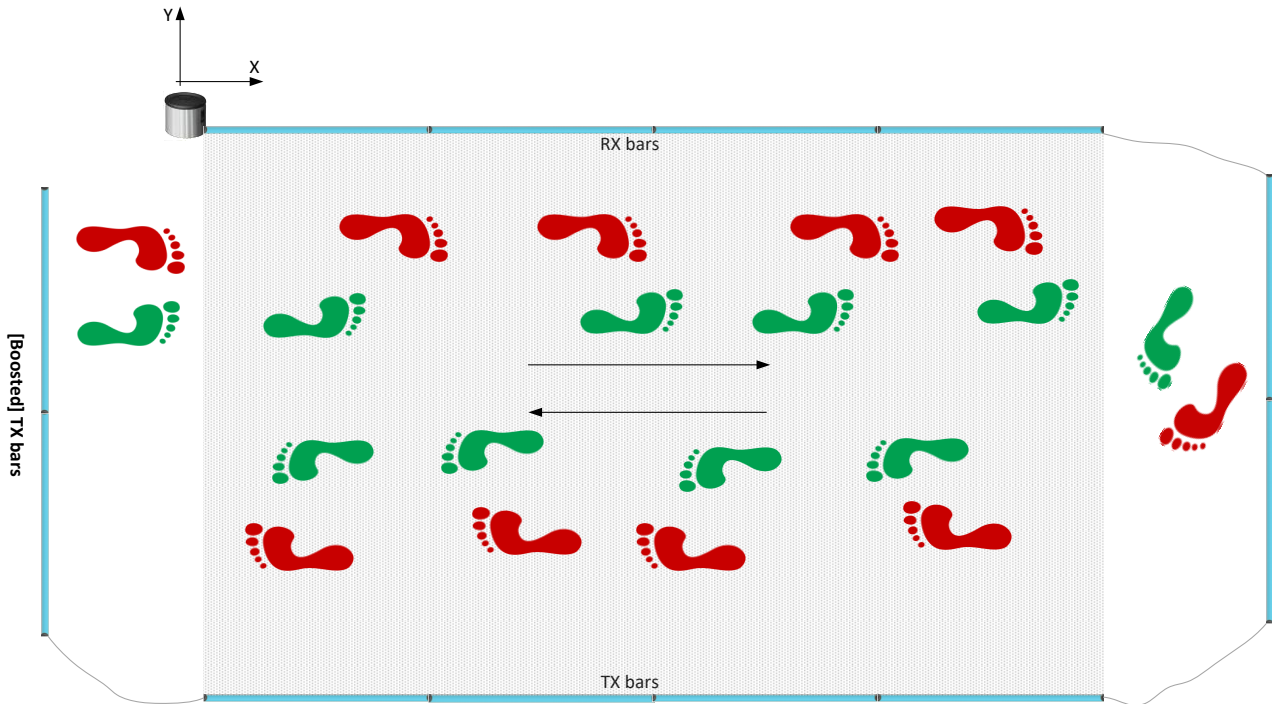
For those requiring fixed installations (which are also aesthetically appealing), a corner cover is available (without LEDs, only for protection) to cover cables running on the ground (see first picture).

1.5 THE GYKO INERTIAL SYSTEM

Gyko is a new tool, developed by Microgate, which enables obtaining information on the kinematics of any body segment while making a movement.

Gyko contains the latest generation components that are used for making accurate and repeatable measurements of acceleration, angular velocity and magnetic field in three dimensions.

- 3D accelerometer, to measure the linear accelerations to which the device is subjected.
- 3D gyroscope, to measure the angular velocities of the device.
- 3D magnetometer, to measure the magnetic field to which the device is subjected.

Gyko is able to provide the measured data up to 1000 times per second guaranteeing an extremely high temporal resolution of the data. The data can be transmitted to the PC via a Bluetooth connection or be stored on a MicroSD card.

From the measured data, through advanced software algorithms, it is possible to describe the kinematics of the body segment to which Gyko is fastened so as to provide the user with summary information about the quality of the analyzed movement.

Gyko can be used in combination with the OptoGait systems or independently.

1.5.1 GYKO TO ANALYZE WALKING, RUNNING AND MARCHING IN PLACE

Gait analysis is one of the most widely used methods to determine any disorders of the nervous and/or musculoskeletal system. With OptoGait you can estimate the space-time parameters of the gait and isolate individual phases of the step, then accurately describe the behaviour of the lower body.

Gyko, placed in the area beneath the shoulder blade by using a special bib with a comfortable 3-button fastening, enables naturally integrating the information measured on the ground with the kinematics of the trunk in order to provide accurate information on the stability and coordination of the upper body.

The movement of the trunk is analyzed in each phase of the step and, through advanced algorithms, specific parameters of the analyzed test are estimated such as:

- Antero-posterior and medio-lateral imbalance.
- Main directions and breadth of the movement of the trunk.
- Upper Phase Coordination Index (UPCI) that describes coordination in the rotation of the trunk.
- Phase difference between the lower body and the upper body.
- RMS, Harmonic Ratio and Harmonicity index describing gait stability.

For details on the various columns see Sect. 5.1.3.1

1.5.1.1 DYNAMIC STABILITY

In addition to graphics for Step, Stride, flight/contact times, etc. with Gyko there is another one called Dynamic Stability that can be activated from the legend on the left.

The graphic is **an ellipse** whose size represents:

- **how far the trunk rotates** along the Antero-Posterior (AP) and Medio-Lateral (ML) directions; the larger the area of the ellipse the more the trunk rotates.
- **in which direction the movement is prevalent**. If the ellipse is stretched towards AP or ML the movement of the trunk is prevalent in that direction.
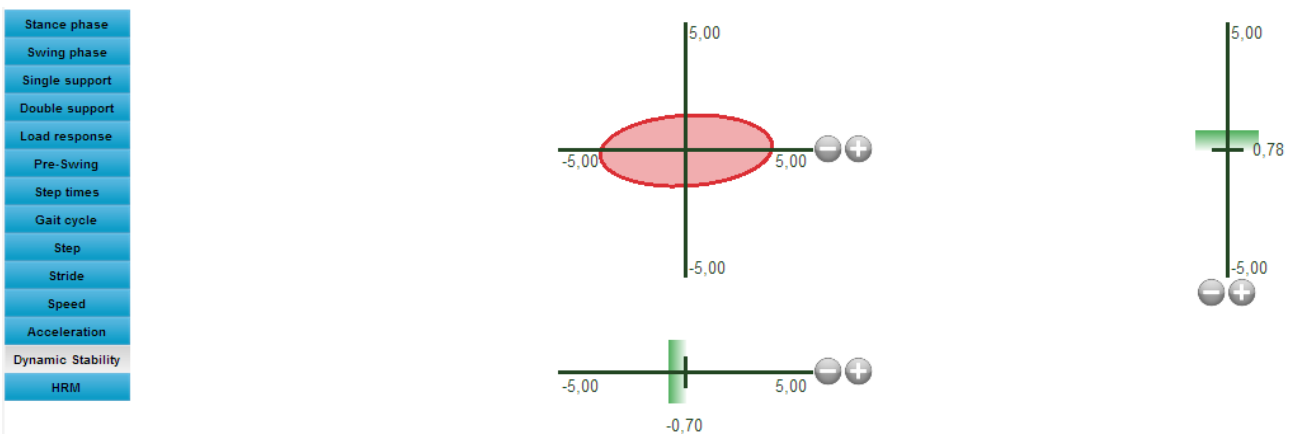
The two horizontal and vertical bars below and to the right of the ellipse represent respectively the offset of the ML/AP movement. The green/orange/red colour depends on the Bad and Warning thresholds set in the Configuration panel (Area Threshold affects the colours of the ellipse and the shades above for the gauges)

Set the Mode to "Dynamic Stability", the number of data on which to calculate the averages and the two pairs of thresholds (the first pair for the two gauges and the second pair for the ellipse).

Settings	
Mode	Dynamic Stability
Data window	3 DATA
Warning threshold [cm]	5,0
Bad threshold [cm]	15,0
Area warning threshold [cm²]	0,5
Area bad threshold [cm²]	1,5

1.5.2 GYKO FOR JUMP ANALYSIS

Using field tests and in particular vertical jump analysis has always been a widely used method for evaluating lower limb muscle strength. OptoGait is the instrument used to measure and objectify the main features of a jump such as flight and contact time.

Gyko placed near the centre of mass with a special belt enables enriching the temporal data with a variety of information regarding the dynamics of the jump. It is then possible to measure lower limb strength directly and, using appropriate algorithms, accurately and repeatably provide data relating both to the eccentric loading phase and to the concentric thrust phase.

The movement of the trunk during the flight and contact phase is analyzed and provides, among other things, the following additional parameters (for all the others see Sect. 5.1.2.1):

- Eccentric and concentric work and duration.
- Force, Velocity and Maximum Power.
- Rate of Force Development and Landing Rate.

1.5.3 GYKO FOR POSTURE ANALYSIS

Postural analysis is frequently used to evaluate the stability and balance of a quiet standing subject.

Gyko, placed on the trunk or at the level of the centre of mass, provides important information about the body sway of the subject and through appropriate protocols it enables evaluating the relative contribution made by the various components of the postural system (visual, proprioceptive of different origin, labyrinthine, etc.).

Gyko lets you simply and quickly obtain the best known indexes concerning the projection of the body's centre of gravity on the ground.

The main indexes returned are:

- Projection length and area.
- Projection travel speed.
- Sway frequency

In this case the graphic is a "projection" showing all the movements (the red dot indicates the position at the end of the test) and an overlay of the ellipse already seen in Sect. 1.5.1.1. To the right there are two graphs, one for the antero-posterior movements and the other for the medio-lateral movements with the time being the abscissa and the movement in mm the ordinate.
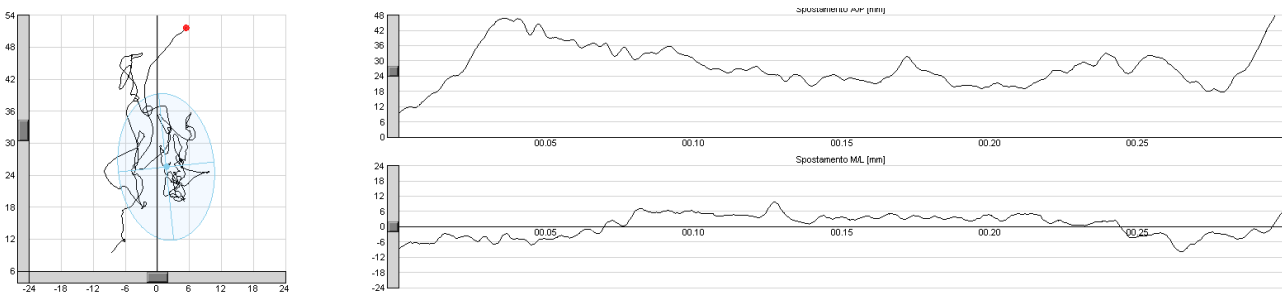
The test can be done with a custom "Static Test" (Sect. 5.1.7) or with the default Body Sway protocol (Sect. 6.8) For all the details shown in the Summary Data please see Sect. 5.1.7

Summary Data

Measure	Value
Area[mm²]	1892,831
Convex Hull Area[mm²]	1364,135
Length[mm]	467,608
Length AP[mm]	329,694
Length ML[mm]	246,252
Mean Distance[mm]	12,963
Mean Distance AP[mm]	8,734
Mean Distance ML[mm]	7,320
RMS Distance[mm]	14,376
RMS Distance AP[mm]	11,140
RMS Distance ML[mm]	9,087

1.6 ENVIRONMENTAL CONDITIONS AND DISCLAIMERS

⚠ The system is intended only for indoor. Operating temperature 0°C ~ +35°C

⚠ As of the manufacturer's specifications only the intended use is allowed.

The estimated product life cycle is of 20 years.

⚠ **Positioning of the bars on the ground**

To avoid interferences between the patient and the bars, we advise a distance of at least one meter between the bars and we advise to pay attention that bars don't hinder the gait. Maximum distance must not exceed 6 meters.

       OPTOGAIT
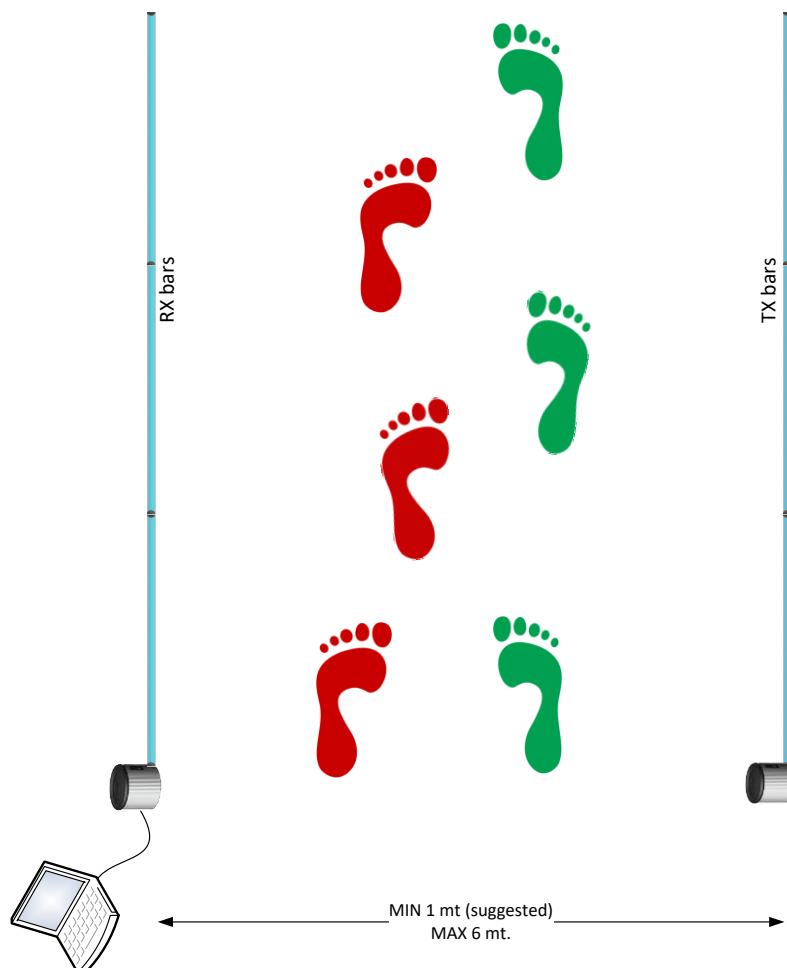
⚠️ **Positioning of the bars on the treadmill**

The bars must be positioned at the sides of the treadmill so that the minimal safety distance planned by the producer is obeyed. We recommend fixing "L" stirrups outside the chassis.

When mounting the bars on the treadmill ensure that vibrations caused by walking/running do not move or make the bars fall down or onto the mobile area.

2 SOFTWARE

The interface with which the OptoGait system is managed is divided into three main sections: Patients' Personal Data, Tests and Results.

2.1 INSTALLATION

Start the OptoGait.exe. setup program in the usual way for Windows.

In the first installation window the user is asked where to save the files for the installation of OptoGait. We advise you to leave the directory unchanged and to click on <Next> to continue.
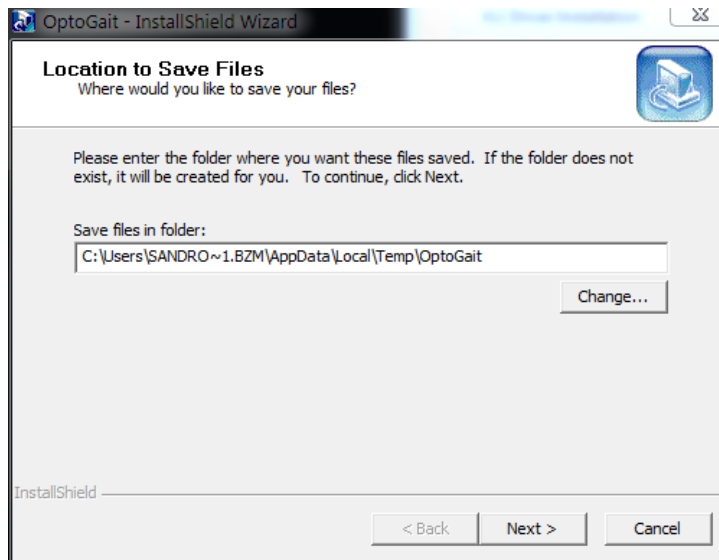
Figure 1 – Installation wizard

In the first installation program window click on <Next>.
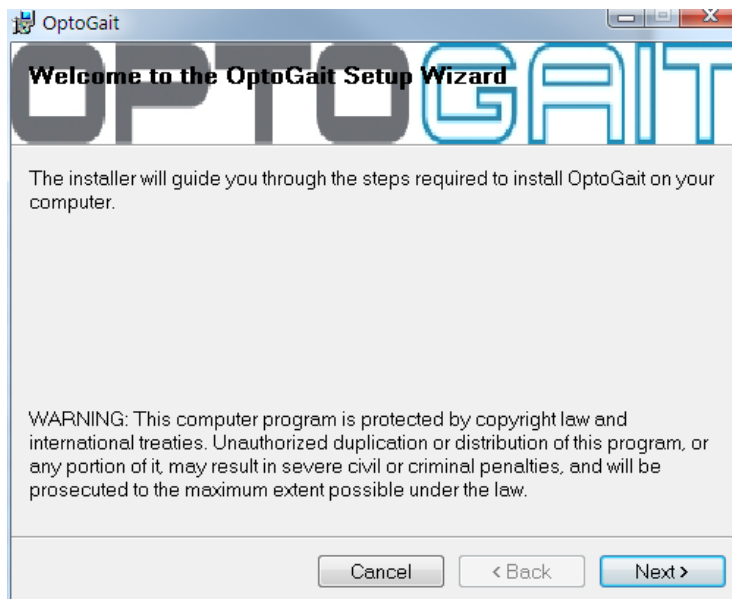
Figure 2 – Installation - welcome.

In the next window you can insert a folder where the software will be installed.

If you want everyone with access to the computer to be able to use the product, select "Everyone", otherwise select "Just me".

We advise you to leave the folder unchanged and select "Everyone". Click on <Next> to continue.
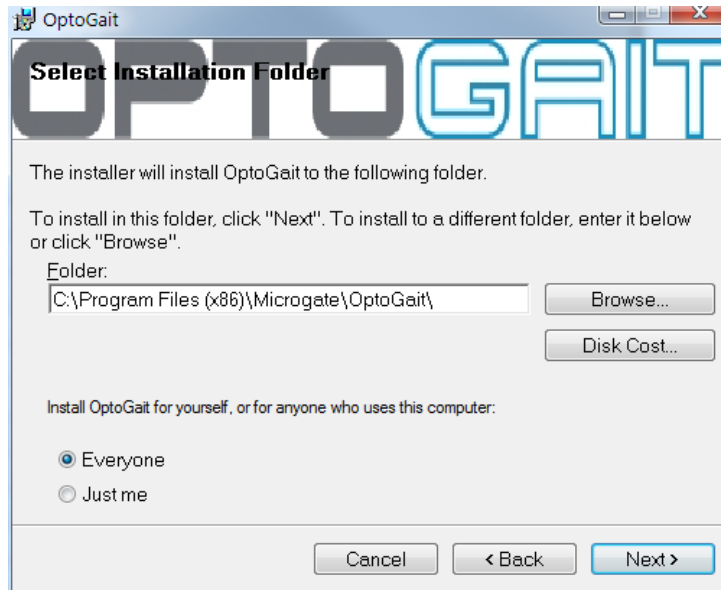
Figure 3 – Installation – data insertion.

The next window offers to launch software installation. If all the data is correct, click on <Next>.

Figure 4 – Installation – confirm installation

The setup program will install the product on the PC, showing state of progress.

During installation the OptoGait and Logitech webcam drivers will also be installed.

If for any reason this does not happen, please install the drivers separately. These are available on the Microgate USB key supplied with the hardware or on the www.optogait.com website in the support section.

Figure 5 – Driver Installation

Press <Next> to install the drivers and then <Finish> to complete installation.

Figure 6 – End of driver installation
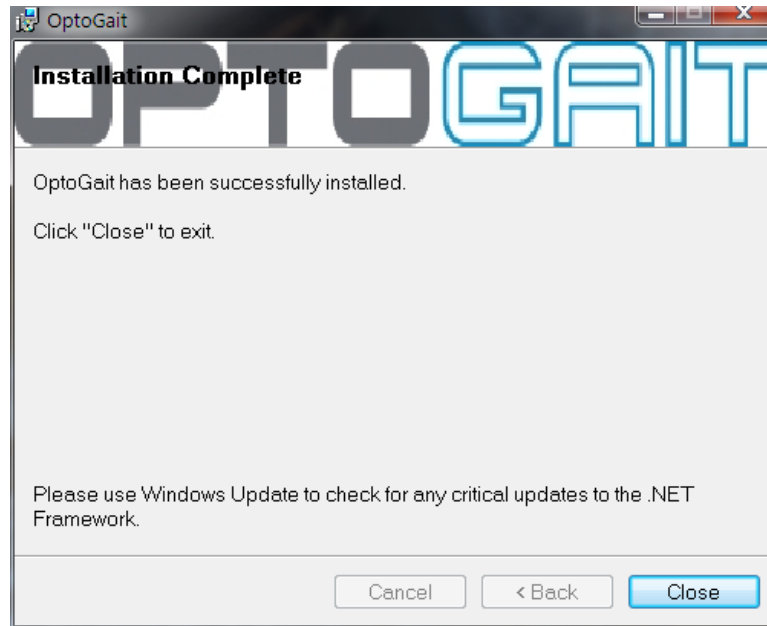
Figure 7 – Installation – completed.

By clicking on <Close> you exit the installation procedure.

During the entire installation procedure, it is possible to return to the previous window by clicking on <Back>.

2.2 DESCRIPTION

The welcome screen of the OptoGait software shows a horizontal bar with the most important menu items and an area with News and Events, which are automatically updated from the web site www.optogait.com in the appropriate language. In case of missing Internet connection, the information will not be downloaded; it is also possible to deactivate the Internet connection with a configuration parameter (see chap. 4.4.1.7). Click on a news title or an event to open the complete description in a browser window.

Figure 8 – First page

The interface with which the OptoGait system is managed is divided into three main sections: Patients, Tests and Results.

2.3 PATIENTS

This is the section where the patients' profiles are created and stored. A profile can contain all sorts of information: personal data, notes, patient photo, etc. Each patient can be added to one or more groups or subgroups. Therefore the Athletes' Personal Data can be fully customized and adapted to the user's requirements, and imported and/or exported from/to other programs or formats (xml, Excel, etc.).

2.4 TEST

This section is the software's nerve centre. It is accessed to devise and configure new tests (jump, reaction, running, etc.) and to perform tests by choosing from the pre-defined tests or those created by the user. It is furthermore possible to group several tests (protocols), if this is useful for measuring particular capacities or conditions (some protocols are already pre-configured, e.g. for measuring reactivity and dynamic stability).

During the test, the user receives three kinds of feedback in real-time: numerical, graphical and video (from one or two webcams). If the starting foot has been previously selected, the results are calculated assigning the values to the left or right leg. Once confirmed the test, all three types of data are stored and are available for immediate editing or further use in future. The user can also temporarily hide certain unnecessary information (e.g., if the video is of importance for the user, the images can be viewed full-screen).

2.5 RESULTS AND VIDEO ANALYSIS

The tests carried out previously can be recalled at any moment accessing the Results area. Selecting a test and clicking on 'View', (numerical or graphical) data can be compared with the images. The video is of great help to the user to detect immediately postural or motor problems, and, more in general, to carry out a qualitative analysis. In fact, thanks to the 'video memory', possible anomalies of the numerical data can be easily identified and motivated.

The video images are synchronized with the data. This allows to verify with accuracy what has happened at the time of acquisition of a certain value (e.g. if a contact time is extremely long, it is possible to look for the cause viewing the images of the instant, when the value has been recorded). Synchronization is carried out automatically by the software; no user action is necessary. The video reproduction speed can be reduced down to a still image, to view the video frame-by-frame. A video analysis utility is also provided, with traditional tools such as lines, arches, circles, text, ruler, goniometer to measure angles and other.

In the Results section two or more tests can be compared ('Compare' option) using the video as well as the data, having all necessary information at disposition. This allows to quickly and intuitively carry out an analysis of quantitative and qualitative differences between tests carried out at a different time (pre-/post- rehab, for example) or between different patients (healthy and rehab).

If more than two tests are to be compared, the 'History' function must be used, which allows to select an infinite number of tests to verify the parameters (indicated when a patient's progress must be measured constantly carrying out numerous tests).

All data, numerical and graphical, can be printed or exported to the most common formats).

2.6 REPORT

After having carried out and saved a test, two reports are immediately available:

Gait/Run Report – specific report for gait or running tests, with average values, standard deviation and variability coefficient of all typical parameters (*) for the left and right leg. Furthermore, any possible asymmetries and imbalances between the legs can be spotted instantly.

The same report type is available when selecting two tests, allowing for a quick comparison thanks to a graphically intuitive and clear interface.

Gait/Run reports show also if the patient's parameters are within the normal range of values.

Extended Report – contains all numerical and graphical data, stored step by step during the test.

In both report types it is possible to add screenshots taken with the video utility available in the 'View' option, as well as in the 'Compare' option.

The Software is currently available in 7 languages (Italian, English, German, French, Spanish, Japanese and Chinese), with translation in progress for others.

3 OPTOGAIT DRIVER AND HARDWARE INSTALLATION

3.1 DRIVER INSTALLATION

For correct functioning of the program, the respective drivers for the OptoGait hardware and the webcam must be installed.

The OptoGait software installation file already contains the required drivers.

With regard to the Vista operating system it has been found that if the installation program is not run as 'Administrator', the drivers are not installed. In this case, install the two drivers separately. These are available on the Microgate USB key supplied with the hardware or on the site www.optogait.com in the 'Support' section.

To verify that the drivers have been installed, connect the two devices (OptoGait hardware and webcam). If installation has not taken place, the operating system will signal an error. If this occurs, disconnect the hardware, reinstall the drivers and reconnect the hardware.

3.2 OPTOGAIT HARDWARE INSTALLATION

Attention must be paid when installing the OptoGait bars, particularly when inserting the caps for connecting the bars.

A distinction must be made between the Tx and Rx bars and additionally between bars with interface (silver drum at start of bar) and without interface. Only the interfaces have an OFF switch.
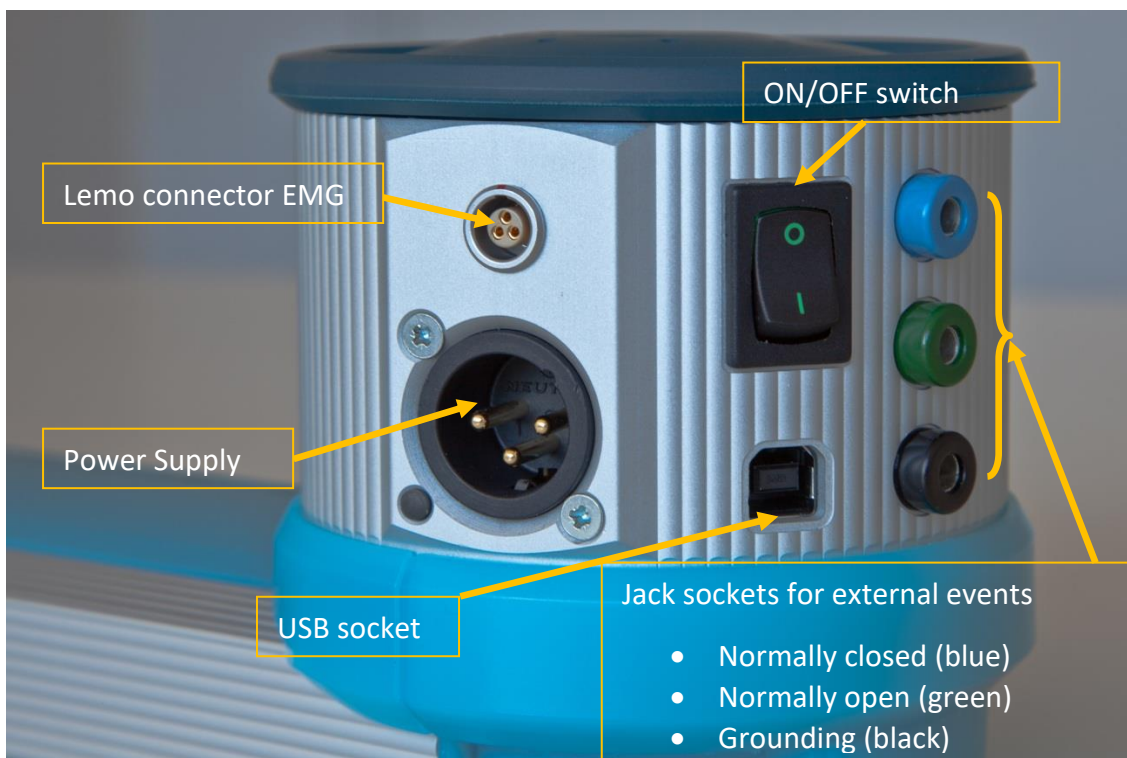

Figure 9 - Interface "drum"

Below is the step-by-step procedure for bar installation:

Switch off the OptoGait device

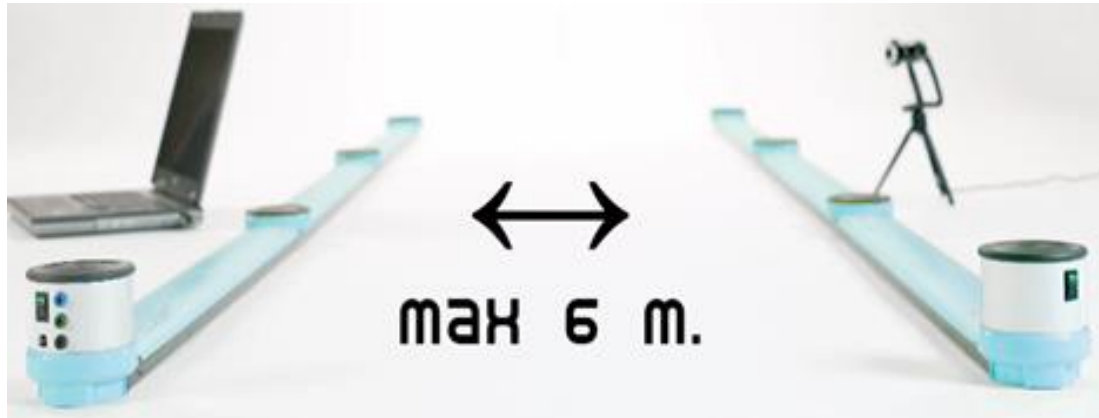Place the two OptoGait Rx and Tx bars facing each other at a minimum distance of one meter (maximum 6 meters)

Figure 10 – Maximum distance

If a number of bars connected together are used, pay attention to the insertion of the caps (see figures below). Check that the caps are firmly inserted. If insertion is incorrect, the software may not function correctly.

Figure 11	*Figure 12*	*Figure 13*	*Figure 14*
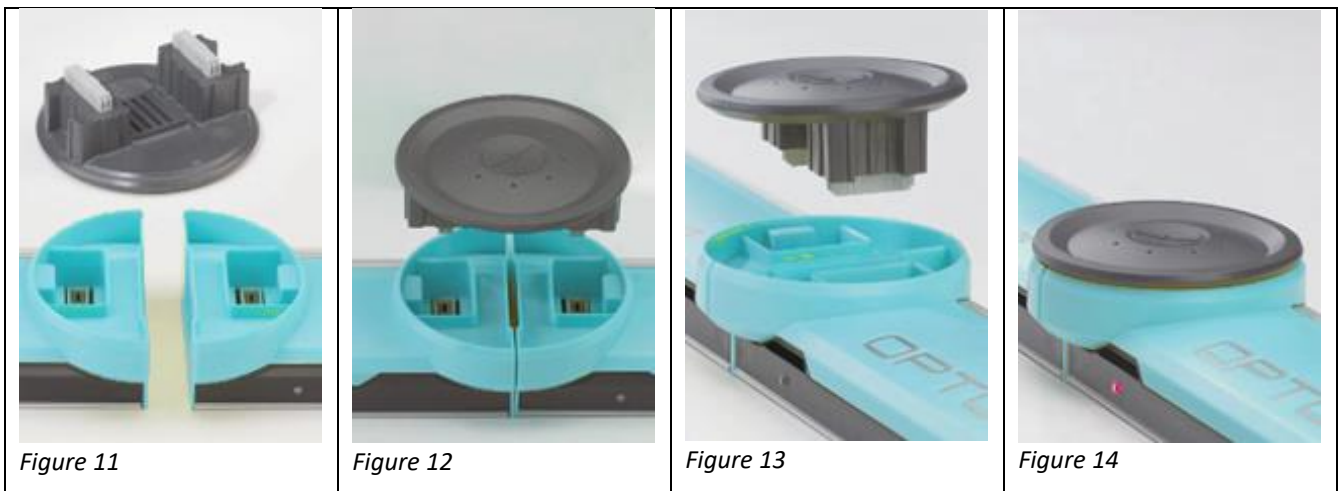
To **mount** the connection cap, insert the cap in the dedicated slots and apply light pressure on both sides until it has been completely inserted (make sure it is parallel with the two bars; the two connectors should slot in simultaneously).

The cap can only be inserted one way round. If you find that the cap will not go in, turn it 180°.

DO NOT force the cap if insertion is difficult: you run the risk of bending the connection pins.

Figure 15 – Cap mounting

Figure 16 – Inserting with light pressure

To **remove** the cap, grip the two side tabs and pull upwards symmetrically. Alternatively, you can firmly hold one of the 2 bars down and carefully lift the other until the cap comes off.

Figure 17 – Cap removal

Figure 18 – Alternative method for removing the cap

⚠️ Do not touch simultaneously the additional bars connectors (or the bars) and the patient

Connect the USB cable from interface Rx to the computer USB port. The USB port on the computer is marked with the symbol ⚡ .
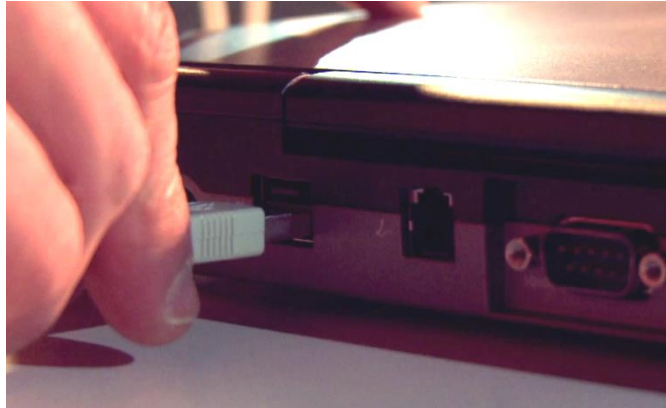

Figure 19 - PC connection

If more than three OptoGait meters are used (three Tx bars and three Rx bars), we recommend you use the adaptor.

Switch on the OptoGait device

Check that the bars are correctly positioned (Tx LED green)

Status indicator LED:
- Green: no LED interrupted
- Red: at least one LED interrupted

Figure 20 – Led indicator

If the software is being installed for the first time or being re-installed, the operating system will load the correct driver (see section above).

At this point, the OptoGait device is ready for use.

If other bars are connected, remember to switch the device off and switch it back on.

If you notice that the device is not working correctly, perform an OptoGait bars Test (see chap. 4.4.2 OptoGait HW Test).

NB: Do not mix RX and TX bars. The bars are clearly marked and distinguishable.

Figure 21 - RX bar   *Figure 22 - TX bar*

3.3 POWER SUPPLY

OptoGait runs on batteries with a life dependent on the number of bars connected. The blinking LED next to the adaptor connector shows the battery charge status:

Green-blinking = battery sufficiently charged

Red-blinking = low battery; the bars must be connected to the mains supply

Orange-blinking = battery being recharged

Figure 23- Battery charge status LED

To recharge the battery, connect the adaptor plug to the dedicated socket on the drum.

Use only one power supply and the cable connecting the supply adapter with the second bar to recharge the Single Meter (TX bar and RX with interface)

Figure 24- Adapter and cable for second bar

For the current supply and for recharging **multiple meter linear systems**, use two power supplies: one for the TX bar and one for the RX bar. The power supply is certified for medical use

Figure 25- Two power supplies for multiple-meter systems

The supplied power plug is specific for the customer's country (EU, USA, UK, Japan)

Figure 26 - Power cables for various countries

⚠ When using an external power supply, the device is disconnected from the power source pulling the plug.

⚠ In order to avoid an electrical shock, the device must be exclusively connected to grounded power sources.
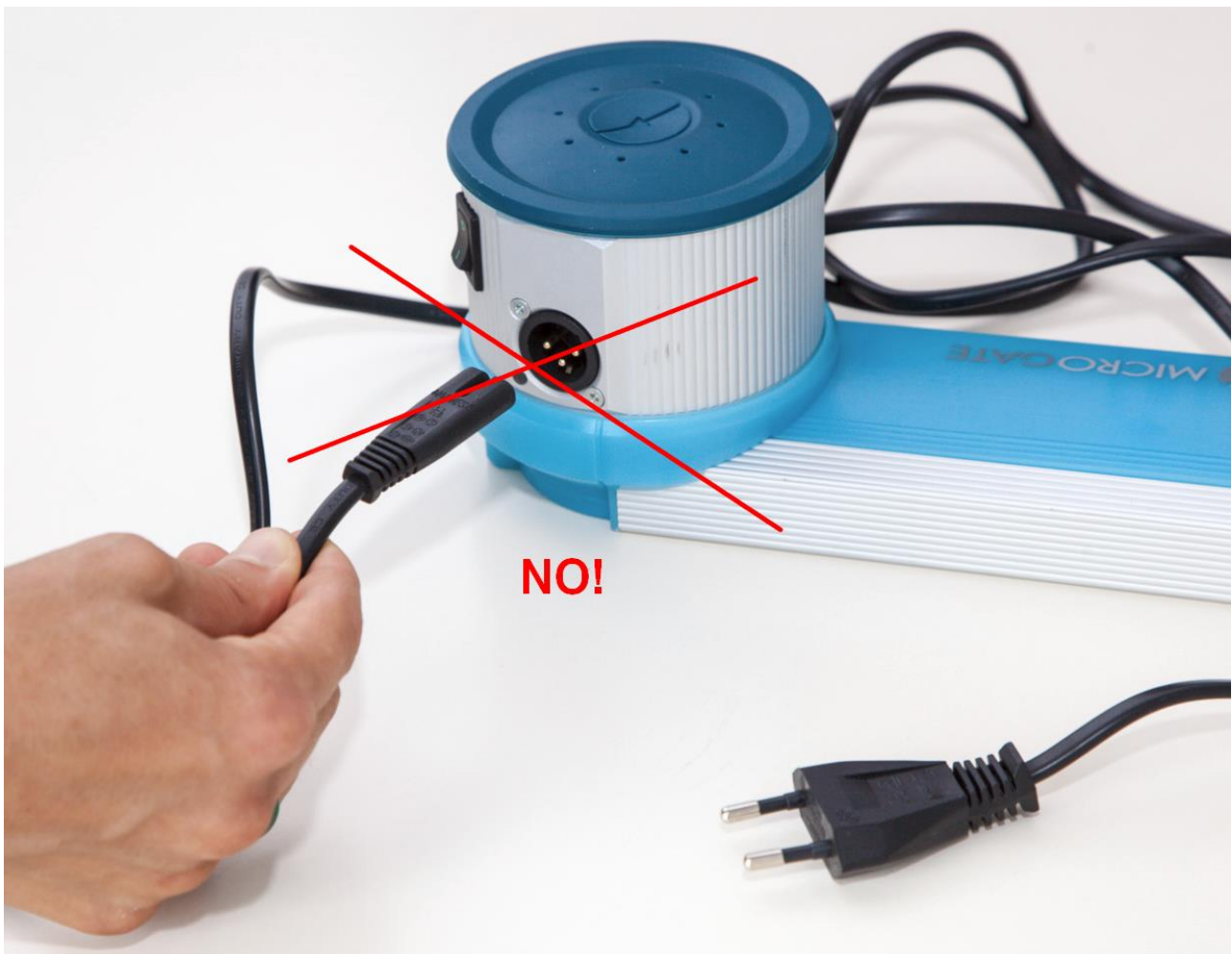
⚠ DO NOT use power supplies other than the one supplied with the product.

⚠ OptoGait contains rechargeable Li-Ion batteries (1800 mAh). Battery substitution must exclusively be carried out by authorized personnel.

⚠ DO NOT directly connect the cable to the 3-pole socket on the drum.

NO!

3.3.1 OptoGait Battery life

Battery life expressed in hours:

Bars	1	2	3	4	5	6	7	8	9	10
Theoretical Tx96	11.54	5.88	3.93	2.88	2.27	1.86	1.57	1.34	1.14	1.02
Theoretical Rx96	14.40	7.89	5.39	4.11	3.25	2.69	2.28	2.00	1.74	1.55

3.4 OptoGait Electromyography Connector

OptoGait can be used as a simple and non-invasive support for connection to EMG (Electromyography) devices. The OptoGait digital outputs (or alternatively analogue) can be used as "virtual footswitches", completely eliminating the need for contact sensors on the sole of the patient's foot.

This is a significant leap forward in terms of patient preparation speed and data reliability. The correlation of EMG data with the Gait Analysis data supplied by OptoGait provides a complete picture of the patient very quickly, on any natural surface or treadmill.

The OptoGait interface is equipped with a specific connection to enable the link with the EMG device. The default connector on the connecting cable is a LEMO connector on the interface side and a 3 poles 3.5mm Mini Jack on the EMG side. If you need another connector, please contact Microgate.

Please note that the transmission of the impulses has a fixed delay of 300 milliseconds. To ensure data accuracy, your EMG software will need to take this delay into account.

Also note that the OptoGait software must be run regularly even if the user does not need it. In example, if the user wants to perform an EMG on a treadmill, the OptoGait software will need to be set to perform a test on a treadmill (of the desired duration) and the test will need to be started and stopped regularly to ensure that the impulses are assigned to the correct feet and that the error filters are working properly. This of course also enables to perform EMG and gait analysis at the same time.

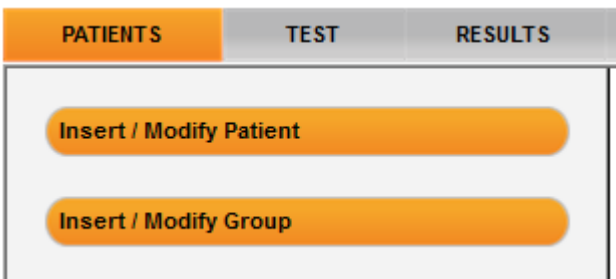*Figure 27 - EMG Lemo Connector*

Figure 28 - Cable Lemo-Jack 3.5mm

4 DESCRIPTION OF FUNCTIONS

In this chapter all the functions of every menu of the OptoGait program will be described, starting with the functions of the main menu.
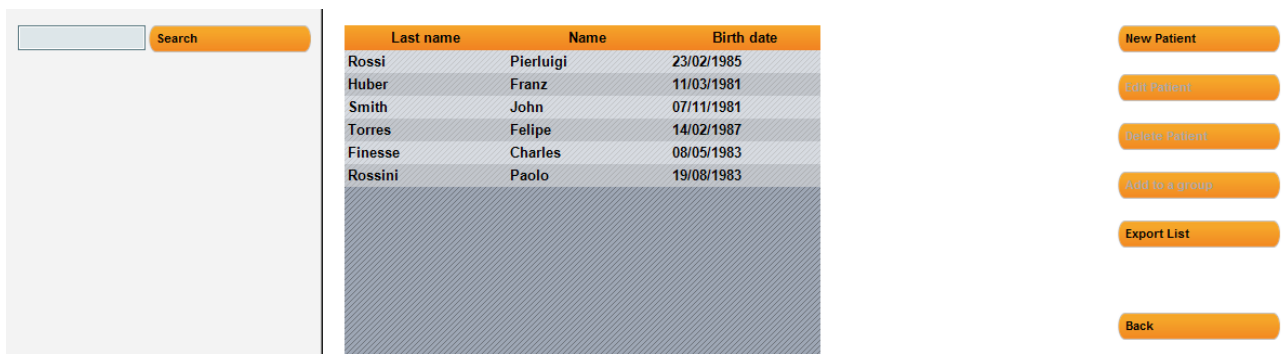

4.1 PATIENTS

4.1.1 INSERT / EDIT PATIENTS

In this section all the patients stored are displayed.

Figure 29 – Edit Patients

Click on the names of the columns (Last name, Name, Date of Birth) to order the list according to that field; clicking on the same column again reverses the order (A…Z, Z…A).

To search for a particular patient or to filter data (e.g. search for all patients beginning with "Ros"), insert the text in the box at the top left and press <Search>. To remove the filter press <Delete filter>.

Pressing the button <New Patient> opens a new panel in which the new patient's data must be inserted. Last name is the only compulsory field. Also, the weight (given in kg or pounds depending on the unit of measurement chosen in Basic Configuration) is necessary if you wish to use the tests to determine the value for total power or total energy.
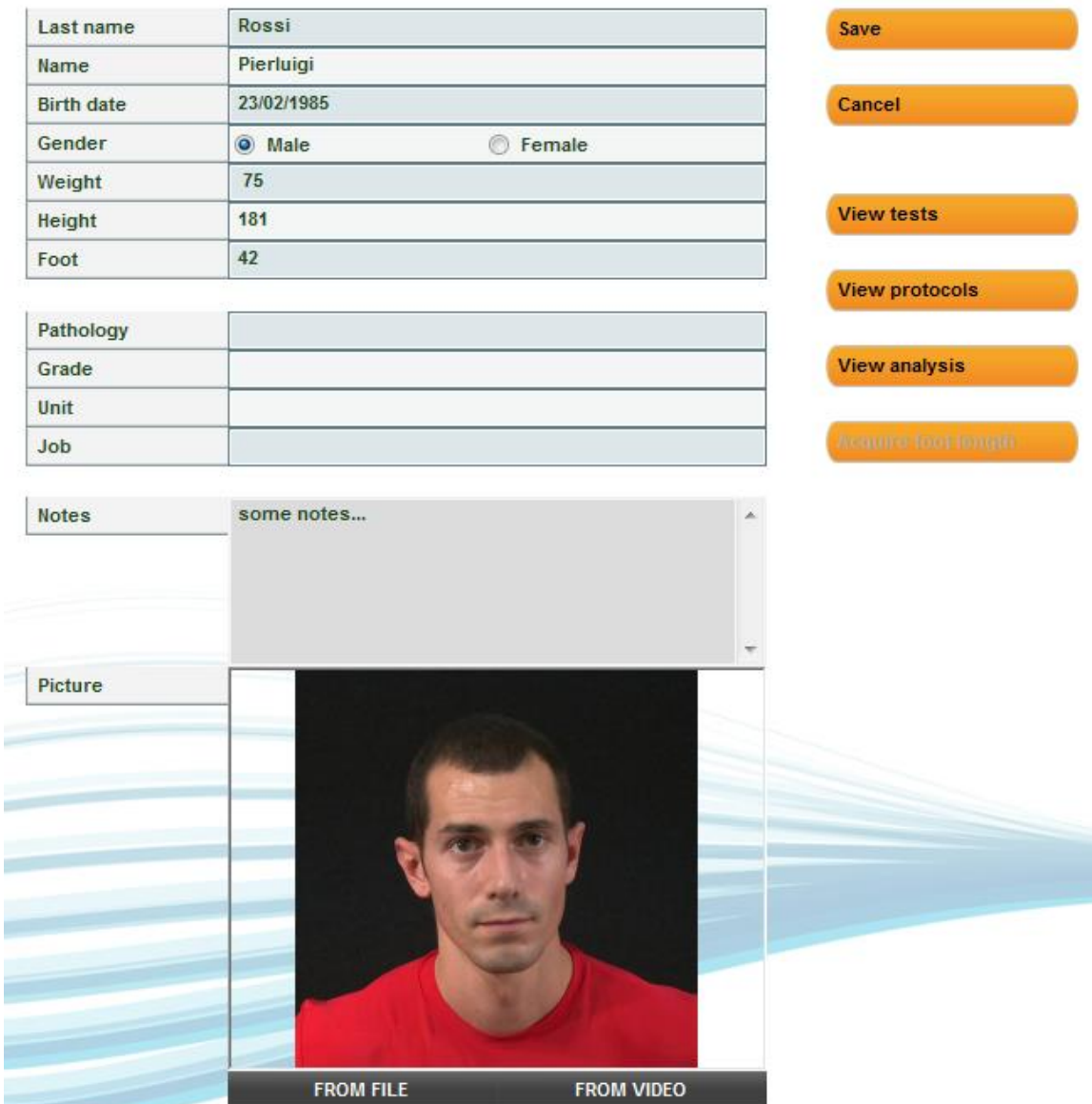

Figure 30 - Patient Data input mask

The function for associating each athlete with a photo is useful, especially for trainers and coaches with many athletes to assess. This can be taken from a file previously saved on disk (in .jpg or .bmp format), or taken 'on the spot' with a previously connected webcam. In the first case click on <From File> and select the desired photo from a folder; in the second case, click on <From Video>, wait for the Live image to appear, frame the patient and press <Acquire>.

4.1.1.1 PATIENT DATA INPUT MASK

To edit the data of a stored patient, select the entry with the mouse and press <Edit Patient>: within the patient data input mask, fields can be edited and saved (or cancelled, returning to the list).

Furthermore, three buttons allow the user to view tests, protocols, and analyses of the current patient (actually a filter is created as explained in section 4.3.1)

The command <Capture foot> measures the foot in cm (i.e. in 'number of LEDs', which are then converted into centimetres or inches according to the unit of measurement used). Click the button, position one foot inside the bars (parallel to them) and click <Confirm>. After a few seconds the measurement is displayed and can be confirmed or repeated.

The measurement is essential for the treadmill tests; the value is saved in the database associated with the patient and is displayed in the mask; the editable field 'foot' is only for personal data and can be used to write the measurement in any unit (e.g. 41 EUR, 7 ½ US, 8 UK, etc.).
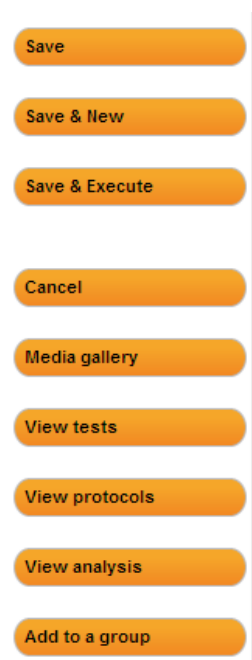

Figure 31- Commands in the Edit panel

In the patients list the following commands are available: To eliminate him/her, press <Delete Patient> (WARNING: When deleting a patient, all his/her tests, protocols, and analyses will be deleted without any possibility to restore them).

To insert a patient into a group, select from the list, press <Add to a group>, select the group to insert him/her in (possibly using the right arrow to select a dependent subgroup) and press <Add to a group> again. Press <Back> to return to the patients' list.

For the management of groups and other ways of associating with groups, we suggest you read the next section.

By pressing <Export>, patients' personal data can be exported to a file with the extension 'xml', which can be used with Excel (Excel versions XP, 2003, 2007 and 2010) or with other programs.

4.1.1.2 IMPORTING AND EXPORTING PATIENTS' PERSONAL DATA EXCEL

Once compiled in OptoGait, the Patients' Personal Data can be exported into an Excel-compatible format (XML Spreadsheet 2003). Press <Export List> and specify the name and location of the XML file. If you have Microsoft Excel installed on your computer, double-click on the file icon to launch the program and view the columns with all relevant patients' data.

If you already have a patients' list created with another software, it can be imported with OptoGait Next preparing a normal Excel file with the same format as the export file (number, location, column headers and format 'XML Spreadsheet 2003'). It is recommended to export an empty personal database to create a file template and then to fill it with the desired information. Attention must be paid to the birth date format (DD/MM/YYYY) and the 'Gender' field (M or F). The pre-configured fields 'Sort' and 'Discipline' can only be one of those available from the drop-down menu. Possible errors during the import are listed in a log window at the end of the import (if the error is not blocking, the patient is added anyway, but with any possible wrong fields empty).

4.1.1.3 RFID TAG MANAGEMENT

Witty·RFID is an automatic athlete/patient detection system that makes the trainer/therapist's work easier by not having to enter the name of the person about to perform a test in the software.

The **reader** used on the field or in the lab is also used via the OptoGait software to **write** the RFID tags (yellow bracelets) with the subject's identification number (that we will call the "bib" number). When a batch of bracelets is acquired, these are in fact sold without numbers, and it is the task of the "registry" to prepare the RFID tags (both "digitally" entering the bib number in it, as well as indicating the number in the provided white space using a marker pen or an adhesive number).

To program an RFID tag, switch on the Witty·RFID device and connect it to the PC via the supplied USB cable.

- Access the card of an athlete (new or already stored)
- Make sure that the bib number field is filled out correctly
- Press the button <Write RFID Tag>
- Bring the bracelet near until the LEDs on the reader turn green

The tag has now been correctly written as indicated by the dialogue box.

Last name	Doe
Name	John
Birth date	/ /
Gender	◉ Male ◯ Female
Weight [Kg]	80
Height	1 m 75 cm
Foot	26
ID	
Bib	4
Pathology	
Grade	
Unit	
Job	
School	
Foot length [Led]	25
Foot width [Led]	10
Notes	

Save

Save & New

Save & Execute

Write RFID

Media gallery

View tests

View protocols

View analysis

Add to a group

4.1.1.4 WEIGHT TREND

To evaluate changes in a patient's weight over time (e.g. between one check-up and the next), every time the card is changed and saved, their weight is saved in a separate table.

Click on <Weight Trend> to evaluate the trend in table or chart form.

If a weight is saved incorrectly more than once on the same day, click on X to the right of the line to cancel the record

Date	Weight
07/03/2018 18:01:40	68
14/02/2018 13:24:00	68
21/12/2017 15:12:00	71
02/09/2017 18:00:00	69
16/07/2017 10:01:00	68

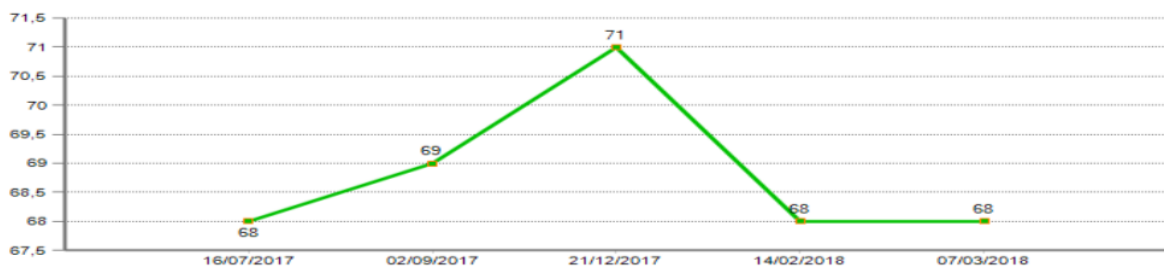**Print Weight**

Back
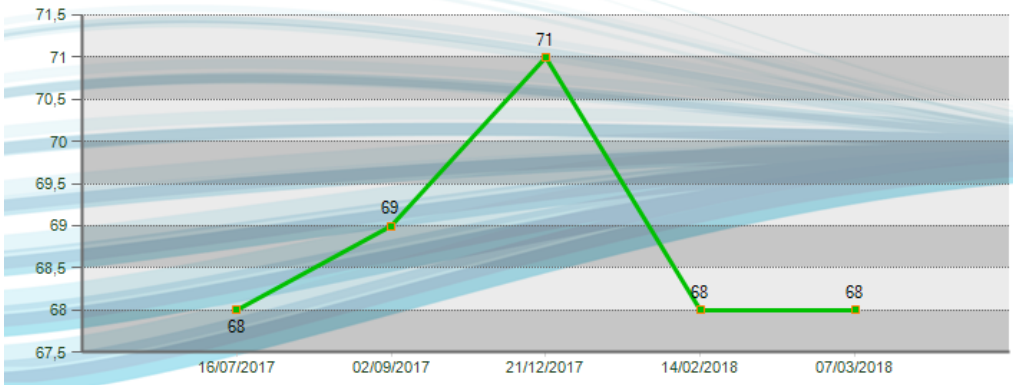
The <Print Weight> button produces a report with trend in chart form.

Pierluigi Rossi

16/03/2018 09:32:09

Weight [Kg]

Trend

4.1.2 INSERT / EDIT GROUP

In this section infinite groups and subgroups can be created, making it easy to manage the patients' personal data.
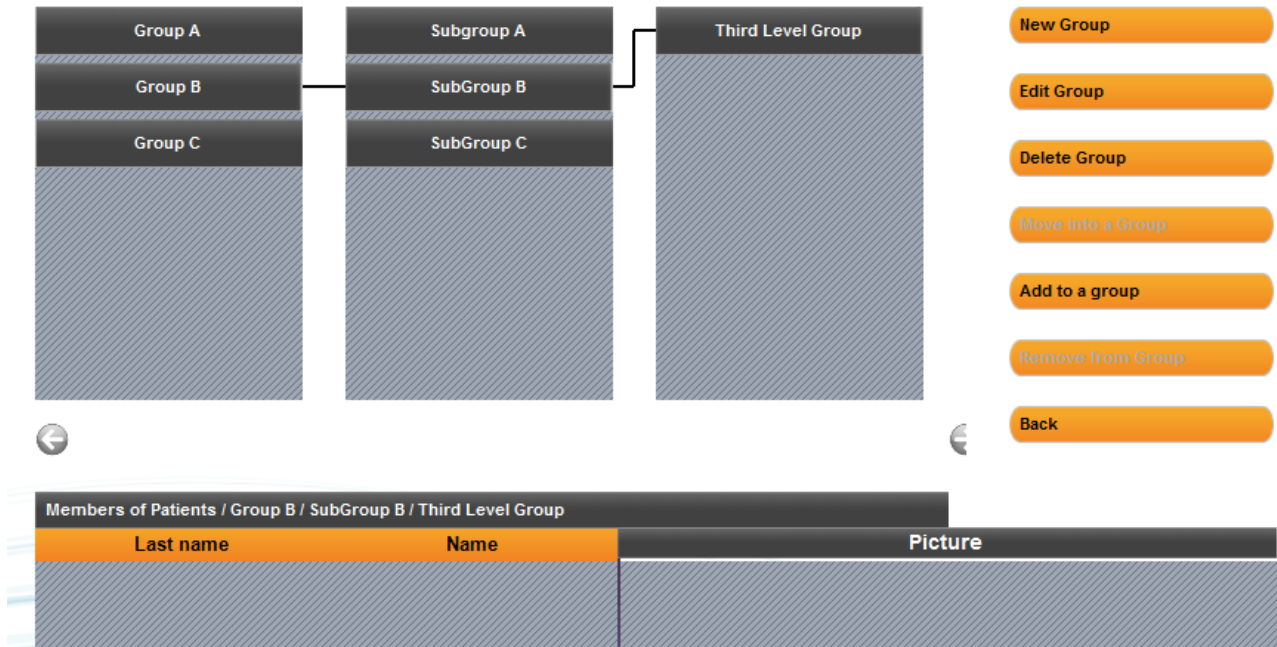

Figure 32 – Managing groups

As a default there is always a group called 'Patients' which is the Parent group of the ones we will subsequently create. All the patients we insert are automatically added to this group.

To create a subgroup, choose the parent group, press <New Group>, key in the name and confirm (e.g. if you want to create 'Group D' as a 2nd level group, select 'Patients' and press <New Group>, whereas if you want to create a 4th level group under 'Subgroup C', make sure to select it before pressing <New>).

When a group is selected, the grid below will show the patients belonging to the group chosen and its 'relationship'.

To add one or more patients to a group there are two other possibilities:

> Select the group to which you want to add a patient and press <Add to a Group>, select one or more patients by checking them in the grid and press <Confirm>. It is possible to use <Select All> or <Deselect All> to speed up checking operations. Press <Cancel> to exit this function without adding patients.

> Select the root group 'Patients' (which contains all patients), select one or two patients by clicking on them (see below) and drag them with the mouse (the classic drag 'n drop function) to the destination group. The message 'Done' will confirm that the operation has been successfully completed. To make multiple selections, use the SHIFT keys to select a range of patients (from… to…) or the CTRL key for selections that are not adjacent.

Members of Patients	
Last name ▲	**Name**
Durand	Pierre
Finesse	Charles
Huber	Franz
Rossi	Pierluigi
Rossini	Paolo
Smith	John
Torres	Felipe

Selecting a range. Click on 'Finesse', keep SHIFT pressed, click on 'Rossini'

Members of Patients	
Last name ▲	**Name**
Durand	Pierre
Finesse	Charles
Huber	Franz
Rossi	Pierluigi
Rossini	Paolo
Smith	John
Torres	Felipe

Selecting a number of non-adjacent patients: keep CTRL pressed and click on the patients

It is also possible to move patients from one group to another with these two methods:

- Select the source group of a patient you want to move, select one or more patients, press <Move into a Group>, select a destination group and press <Confirm move>. Press <Cancel> to cancel the operation in progress.

- Select the subgroup from which to transfer the patient or patients and perform the same drag 'n drop operations described above. The difference between operating from the root group "Patients" or from others is that in the first case the patients are always copied. When moved from one subgroup to another, they are transferred without copying.

With <Delete Group> the group selected and its dependent subgroups are eliminated (but not the patients that formed it), while with <Edit Group> its name can be changed.

With <Remove from Group> the patient selected in the grid is removed; the patient is not eliminated from the database. The button is disabled when no patient is selected or when the first level group "Patients" is displayed.

4.1.3 MEDIAGALLERY

The patient panel can be used to access the "MediaGallery" module: the aim of this section is to archive images and videos of postural situations without needing to carry out a test with the bars. You can take photographs, record videos and capture stills, making the patient assume various poses which are useful for evaluating his/her anthropometric measurements, posture or pathologies. The photos or still images can be processed with editing tools as described in chapter 5.4

Files of images already taken and downloaded to PC (jpg, png, bmp) can either be imported or recorded with the webcam used for normal tests. Here's how:

Enter the Personal Data panel of a patient and click the <MediaGallery> button.

To import existing photos, click the <Add media file> button, select 1 or more photograph files from the disk. The photos will be imported and displayed as thumbnails at the bottom of the screen, complete with entry date and time, while the full screen display shows the photo currently selected (marked with the orange border).

To view a photo, click its thumbnail; to scroll through the carousel of thumbnails use the right/left arrows on screen or on the keyboard. A title and description can be assigned to each photo simply by entering the information in the relevant fields (the information is saved automatically on exiting the fields).
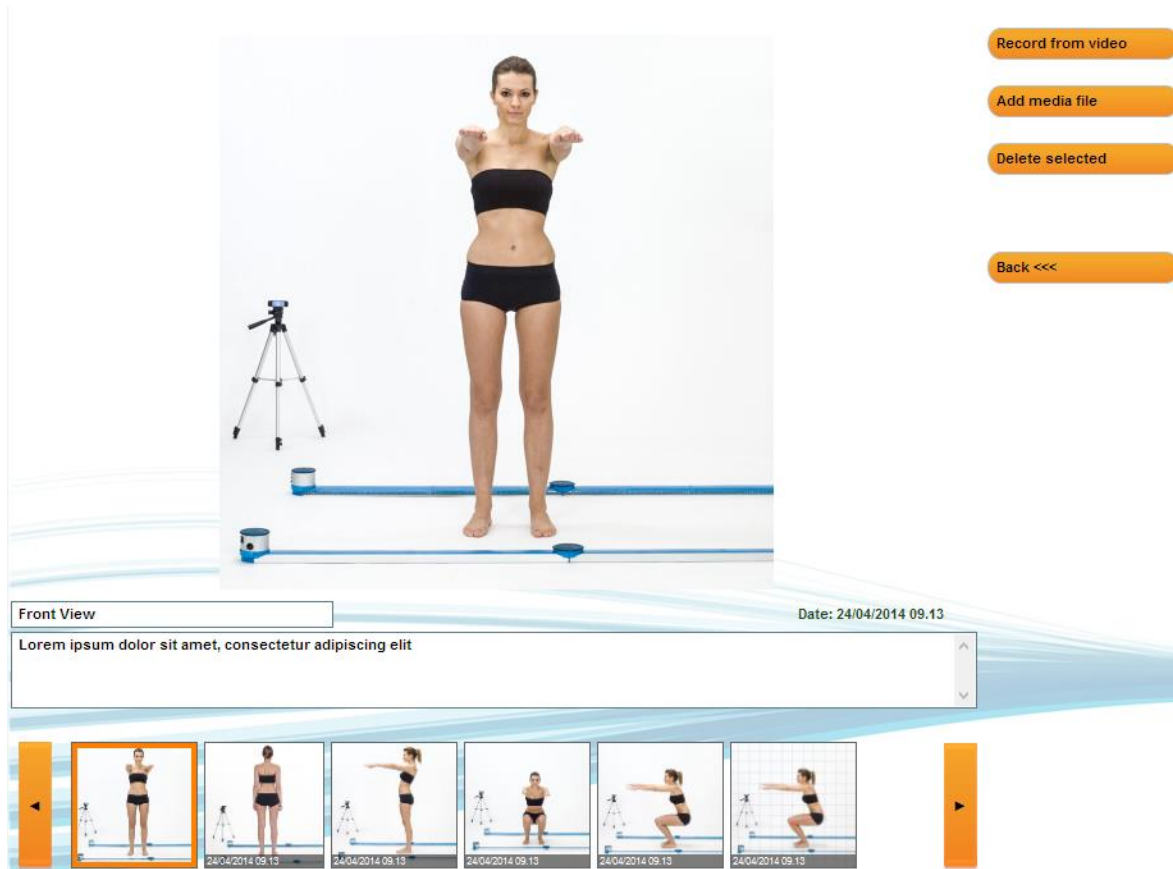

Figure 33 - MediaGallery module

If we want to see two photos side by side (to make a comparison, for example), click the thumbnail while pressing the CTRL key.
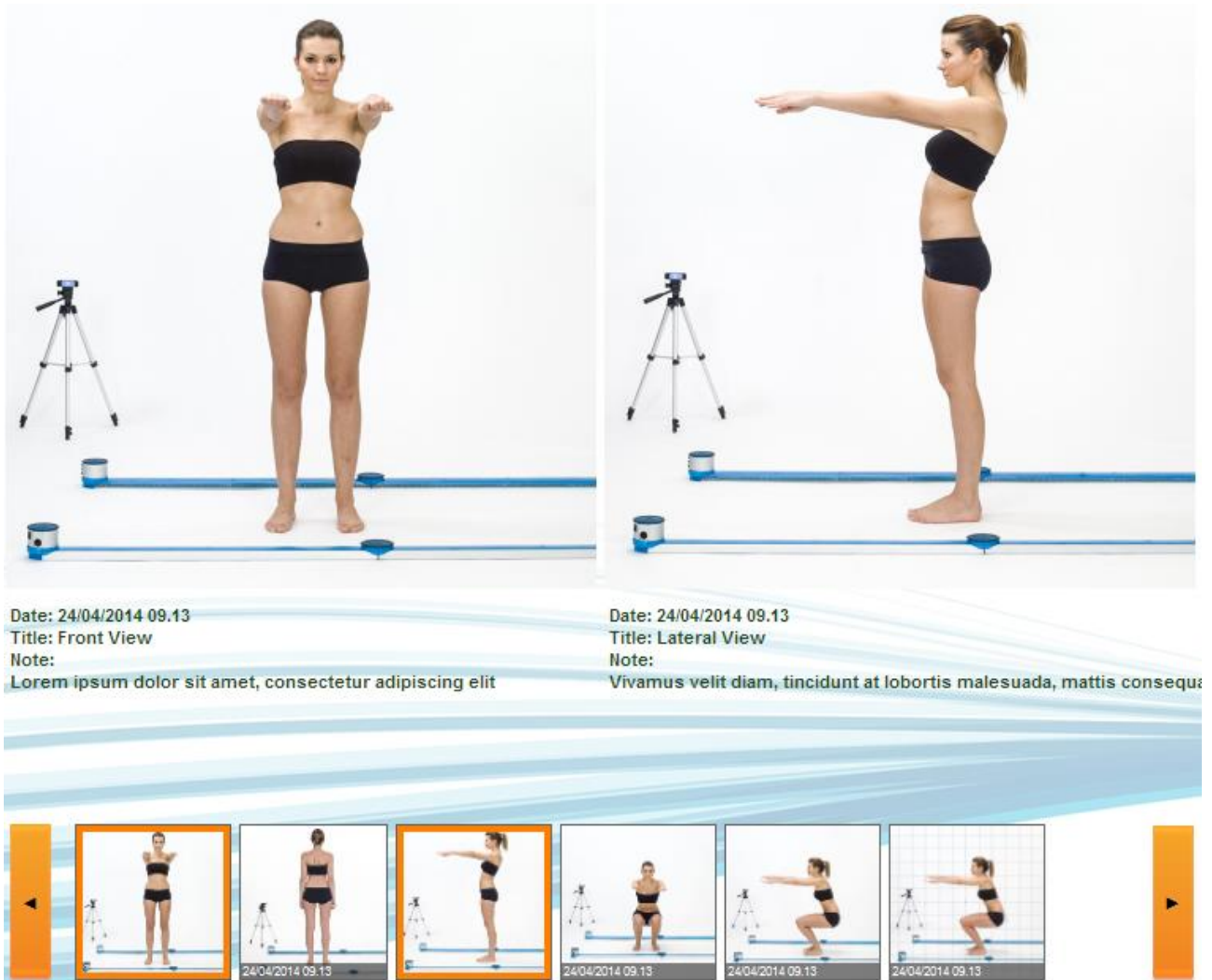

Figure 34 - Comparing two photos

When we are viewing a single image (or a still taken from a video), we can double-click - directly on the photo and not the thumbnail - to open the image editor with its various design tools, angles, etc. If we click Save, the image is saved with our annotations.

Figure 35 - Photograph edited in the Still Image Analysis tool

4.1.3.1 ACQUISITION FROM WEBCAM

If no photographs have been taken and are ready to import, we can make use of the installed webcam (perhaps setting it to the maximum resolution as described in chapter 4.4.1.4.2). Click <Record from Video>. The webcam frame preview will be displayed. Click <Photo acquisition> to take a photograph which will be automatically added to the carousel. Press <Start Video Recording> to begin recording; the button (which has become <Stop Video Recording>) flashes to indicate recording is in progress. When we click to stop the recording, the video is saved and added to the carousel.

Figure 36 - Record Video from Webcam

Once the video has been saved, its title and description can be edited by clicking on the thumbnail, while clicking on the video itself begins playback, with the following buttons appearing underneath:

- Slider for slow-motion playback (from 10% to 100%)
- Go to first frame
- Back one frame
- Play/Stop
- Forward one frame
- Go to last frame
- Save current still image

To delete a photo, video or still image, select it and click <Delete Selected>.

4.2 TEST
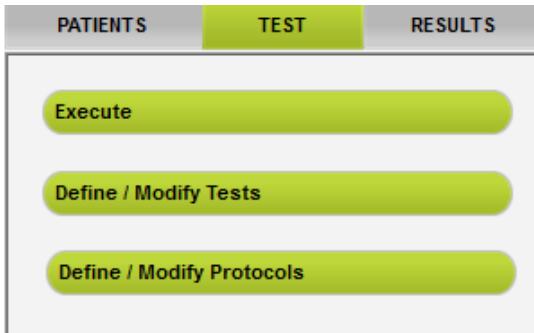
4.2.1 EXECUTE

In this section the pre-defined tests or protocols are carried out. To define a test or protocol, see the sections below. In addition, before performing a test, at least one patient must be inserted in the database.
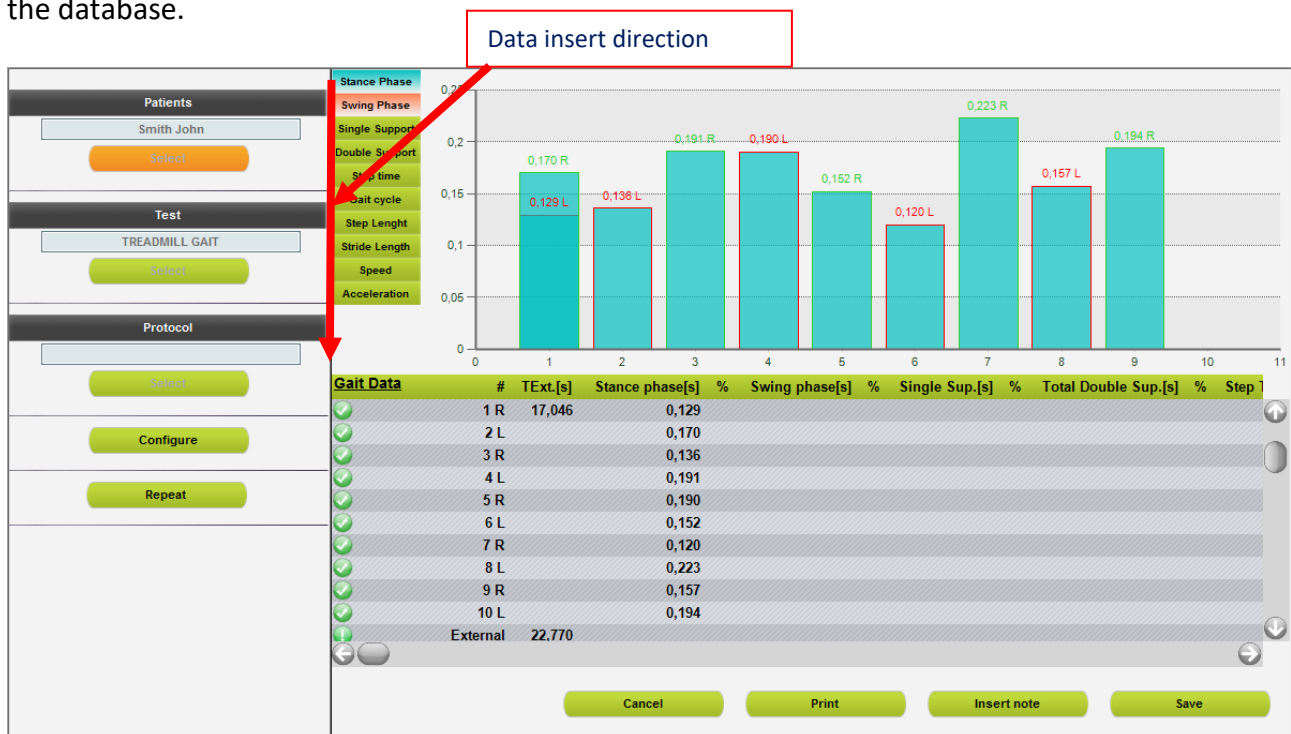
Figure 37 - Execute

To perform a trial it is advisable (but not obligatory) to follow the direction of the operations indicated by the red arrow at least the first time you enter this section.

The basic flow is

- select the patient
- select the test type (using tests or protocols)
- optionally configure some viewing parameters
- press Execute and have the patient perform the jump test or the running/gait test
- Save, Cancel or Repeat the test

Let's look at an example:

1. Choose one or more patients by pressing the orange <Select> button under the 'Patients' box, then tick one or more patients in the grid and press <Confirm>. Shortcuts are possible using the <Select All> and <Deselect All> buttons, whereas if the patient database has been organized in groups and subgroups, a group can be selected with <Select Group>. **When there is the Witty·RFID system, instead of manual selection, simply move the patient's bracelet to the reader and his/her name will automatically be selected**.

2. Select one or more tests by pressing the green <Select> button under the 'Test' box; then tick one or more tests in the grid and press <Confirm>.

2a. As an alternative to the selection of a number of tests, it is possible to select a pre-defined protocol. Click the green <Select> button under the 'Protocols' box, select the macro-typology and click on one of the protocols followed by the <Confirm> button. It is not possible to select more than one protocol at once. When the protocol has been chosen, the test list is compiled with the tests that define the protocol.

3. Check the configuration by pressing <Configure> (see chap. 4.2.1.1 Execute Configuration).

4. Execute the test by pressing <Execute> (or <Repeat> if a test has already been performed).

5. Wait for activation of the Webcam (if installed) and the sound signal that gives the 'all clear' to perform the chosen test.

6. Follow the instructions at the bottom left which, depending on the test definition, will tell you to 'enter' or 'exit' the test area (i.e. the space between the bars).

7. Save the test performed with <Save>, watch the video again with <Review> or cancel the test with <Cancel>. Press <Repeat> to have the patient repeat the test without moving to the next test (or the next patient). If <Repeat> is pressed before saving, the test will be deleted. Press <Insert Note> to add a note to the test that has just been completed.

Test cycle

We have seen that it is possible to select more than one patient and/or trials, using multiple selections or choosing a protocol, (a pre-defined sequence of pre-defined tests), and therefore have a 'cycle' of tests performed. In this case the ⬅➡ arrows will appear in the respective boxes for moving the selected data.

Let's suppose we select two patients ('Rossi' and 'Smith') and two tests ('Squat jump', 'Stiffness').

Depending on how the parameter 'Rotation based on…' is set, the following types of sequence can be set:
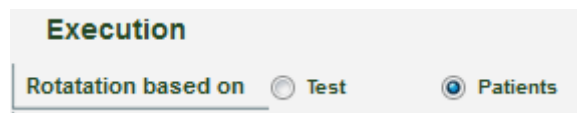
Rotation based on a **Test**	Rotation based on **Patients**
Rossi/Stiffness	Rossi/Stiffness
Rossi/Squat jump	Smith/Stiffness
Smith/Stiffness	Rossi/Squat jump
Smith/Squat jump	Smith/Squat jump

TIP: When patient, test or protocol selection is made, it is possible to double-click with the mouse on the line of the grid to select the single data item and confirm automatically.

The videos are always acquired in size 640 x 480, even if they are displayed small.
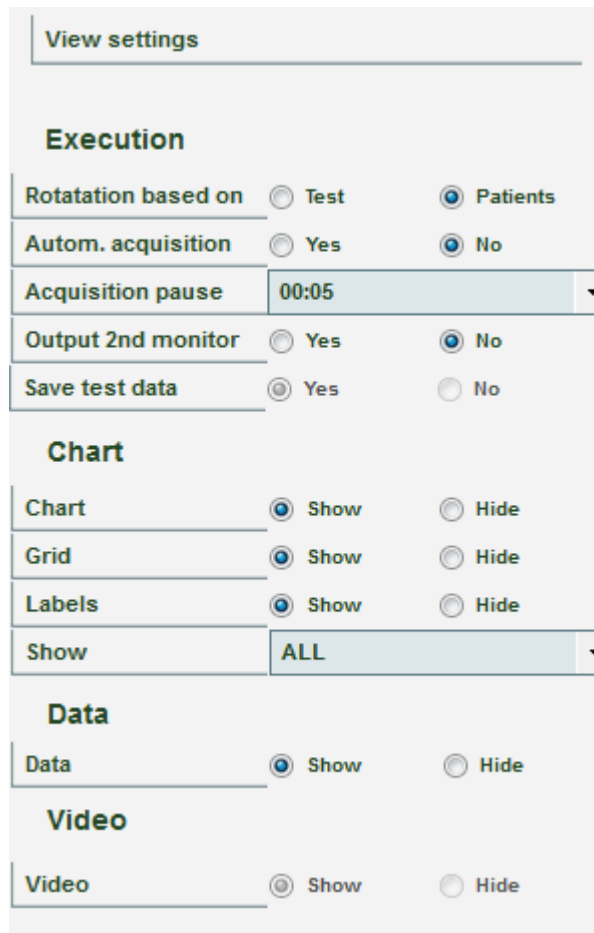
The test acquisition can be simulated even if the OptoGait hardware device is not connected. The keys that simulate the device are:

> **F8** – when pressed simulates the status "*inside the measurement area*", when released simulates the status "*out of the measurement area*"
>
> **F4** – every time it is pressed, it simulates an external impulse (e.g. photocell, etc.)

Note: the only function that cannot be simulated is the acquisition of a Sprint/Gait test: it is not possible to know the length of steps. While this type of test is allowed, it will finish without the acquisition of steps.

## 4.2.1.1 EXECUTE CONFIGURATION

Figure 38 – Execute Configuration

Test data viewing can be configured by the user. The parameters are:

Execution
- o **Rotation based on**: if more than one test or patient is selected, this indicates the chosen mode
  - ▪ **Test**: after each performance, the next test begins for the same patient
  - ▪ **Patient:** after each test performance this goes on to the next patient doing the same test
- o **Automatic acquisition:** if this parameter is set to Yes, it is possible to skip the manual saving phase at the end of each test; when the patient finishes a test, it is saved, then, after a few seconds (as configured in the parameter 'Acquisition Pause') the next test begins automatically (performed by the same patient or by another, depending on the settings).
- o **Acquisition Pause:** indicates the pause time between one test and another, which are acquired automatically. Used only if Automatic Acquisition = YES
- o **Output 2nd monitor and Save Test Data:** see chap. 4.2.1.2 on Video Feedback
- o **Metronome:** see chap. 4.2.1.3

Chart

- o **Chart**: shows/hides the chart during the execution; if 'show' is chosen, it is possible to choose which values to display (Flight times, Contact times, Height, Power, Pace, etc.) and how (bars or lines).
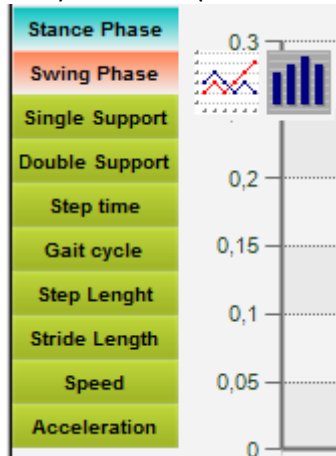
- o **Grid**: shows/hides the white-dotted lines forming a grid on the chart.
- o **Labels**: displays/hides the labels for the numerical values on each spot of the chart.
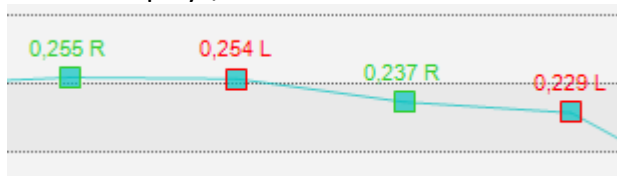
- o **View**: displays the last N-number of acquired data.
- o **Statistics Charts**: shows/hides the statistical pie chart based on warning and bad thresholds (see chap. 0).

Data

- o **Data**: shows/hides the numerical data table with its lines and columns.

Video

- o **Video**: shows/hides the videos acquired by the webcam.

4.2.1.2 VIDEO FEEDBACK

The main idea of this new feature is to show the patient directly some main parameters of the test he/she is carrying out. This allows to request real-time 'corrections' of some trial anomalies, making the test become an exercise, not only a diagnosis. Particular attention is paid to the concept of **asymmetry,** i.e. the difference between right and left foot (expressed in %) with respect to a particular parameter.

A classic example is a treadmill gait test, where the patient has a monitor in front of him/her (better if a large-screen TV), where the operator can choose which parameter among those available to display, depending on the pathology or rehabilitation.

During the gait test, the patient receives a numerical/graphical feedback (in the form of green/orange/red colours and up/down arrow symbols) indicating what is not 'working' and how to correct it (e.g. making the left gait longer or increasing the rhythm, etc.).

The new feature (available from version 1.7) is found in Test Module > Execute > Configure, with the two parameters 'Output second monitor' and 'Save Test Data'.

Execution

Rotatation based on	○ Test	● Patients		
Autom. acquisition	○ Yes	● No		
Acquisition pause	00:05			▾
Output 2nd monitor	● Yes	○ No		
Save test data	● Yes	○ No		

When the '**Output Second Monitor**' option is selected, a window is created on the second monitor (or on the same monitor, when the second one is not physically present), where the displaying of the absolute value or the test parameter asymmetry can be configured (e.g. the step length for a gait test) both as a numerical value and as a graphical bar display.

Instead the '**Save Test Data**' parameter is used (if set on **No**) when, as previously described, the patient must 'exercise' and it is not necessary to save the test at the end of the trial. In this case no data 'sampling' and, most of all, no webcam video sampling is carried out, thus reducing the used disk space (temporary video files and memory swap files) as well as CPU use.

The parameter to be displayed is configured in the main window on a side panel bar, which can be minimized (>> key). The panel appears when the type of test and the patient performing it are selected, because the values associated with the patient-test type pair are saved so that they can be recalled exactly as they are whenever the test is repeated.

Settings			**Settings**	
Mode	Asymmetry ▾	Mode	Absolute Value ▾
Type	Stance phase ▾	Type	Step ▾
Data window	5 DATA ▾	Data window	3 DATA ▾
Warning threshold	5% ▾	Reference value	75 ▾
Bad threshold	10% ▾	Warning threshold	5% ▾
Trend	Increase lower ▾	Bad threshold	10% ▾
Visualiz. Second Monitor	Normal ▾	Visualiz. Second Monitor	Normal ▾

The parameters, which can be set, are the following:

- **Mode**: select 'Absolute Value' (the values for the 'type' selected in the drop-down menu below are shown) or 'Asymmetry' (the two right and left values and the delta values are shown).
- **Type**: the parameter to be displayed (changes depending on the test type carried out; e.g. for a tapping test, the flight and contact times, rhythm, etc., for run tests, speed, acceleration, etc., whereas for gait tests, regular gait analysis parameters, such as stance, swing, single support, step length, etc.).

- **Data Window**: the amount of data used for calculating the asymmetry (the last N are used); the higher the data, the better the 'average' and the more real the value, but it will be more difficult for the patient to try and correct his/her asymmetry.
- **Reference Value**: only appears when Mode = Absolute Value and is the value taken as a reference when calculating the thresholds. Obviously it should be set in line with the type of measurement selected (e.g. 30 cm for height, 0.5 s for flight time, 70 cm for step length, etc.).
- **Warning Threshold**: if the asymmetry is lower than this percentage, the value is displayed on a **green** background, and if it is higher, the background colour is **orange**.
- **Bad Threshold**: if the asymmetry is lower than this percentage, the value is displayed on an **orange** background, and if it is higher, the background colour is **red**. Setting for example the warning threshold at 5% and the bad threshold at 10% the following background colours will be used:
  - 0 <= value < 5 = *green*
  - 5 <= value <10 = *orange*
  - >= 10 = *red*
- **Trend**: only appears if Mode = Asymmetry; if the asymmetry value exceeds the warning threshold, an indication for the patient is displayed with an arrow on the value bar. The indication can be to increase the lower value or to decrease the higher value.
- **View Type**: choose between 'normal' (below) or 'Opto 4 Kids' (see next chapter).
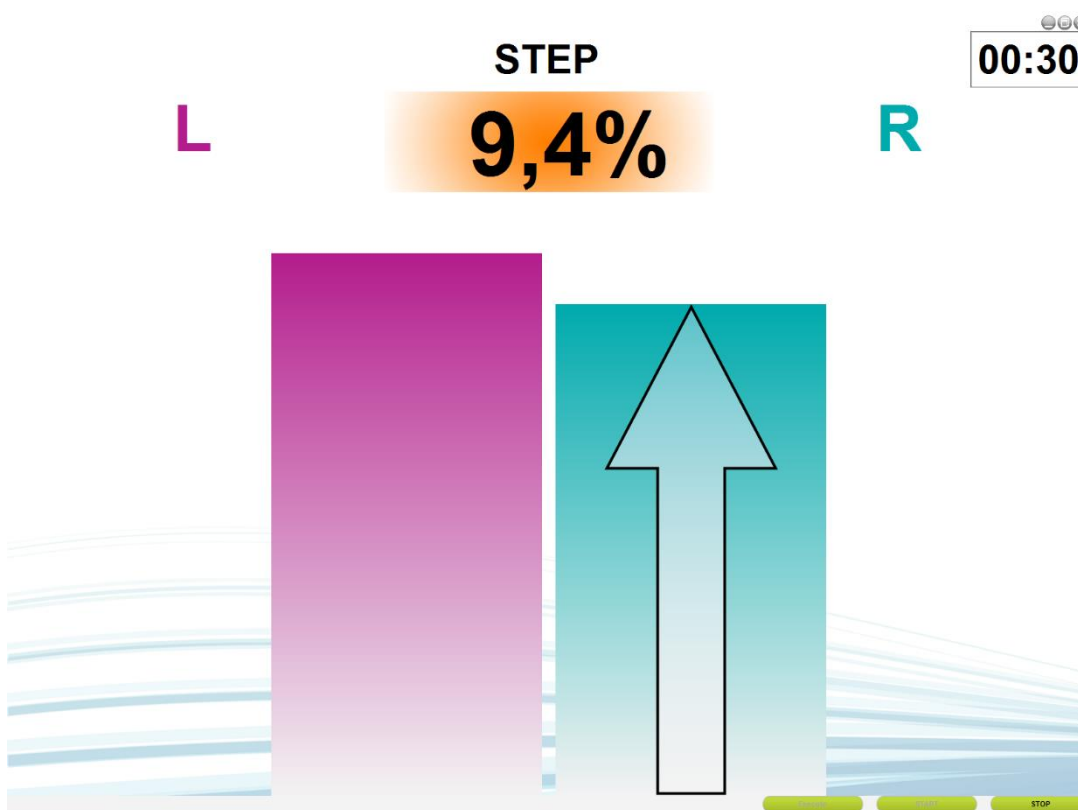
Figure 39 - Example Output 2nd monitor with Asymmetry on the Step Length, normal view

4.2.1.2.1 Opto 4 Kids

The special view 'Opto 4 Kids' is aimed at making tests fun for children, as they often get bored (especially during long tests on the treadmill) and their interest is not engaged.

Instead of showing numeric values or histograms, which can be difficult for them to understand, we have designed an animated cartoon-style background and a character who has to climb a mountain (a baby dragon in this first version, but in future versions it will be possible to select a favourite avatar).

The position and expression of the dragon indicate whether the exercise is being performed correctly: a sad dragon at the foot of the mountain means high asymmetry or absolute values far from the set reference values, while a happy dragon on top of the mountain means the target is being reached.

The type of measurement and the current value appear in the top left-hand corner (useful information for the adult operator running the exercise).

The operator (physiotherapist, doctor or technician) is responsible for encouraging the little patient to reach the top of the mountain by giving the necessary instructions (e.g. "try to take longer steps with your left leg", "try to speed up a bit"); the child will therefore be driven from a play perspective and should find the motivation to improve his/her condition and have fun while exercising.

Figure 40 - Test Start

STANCE PHASE
Valore: 4,6%

STANCE PHASE
Valore: 1,1%
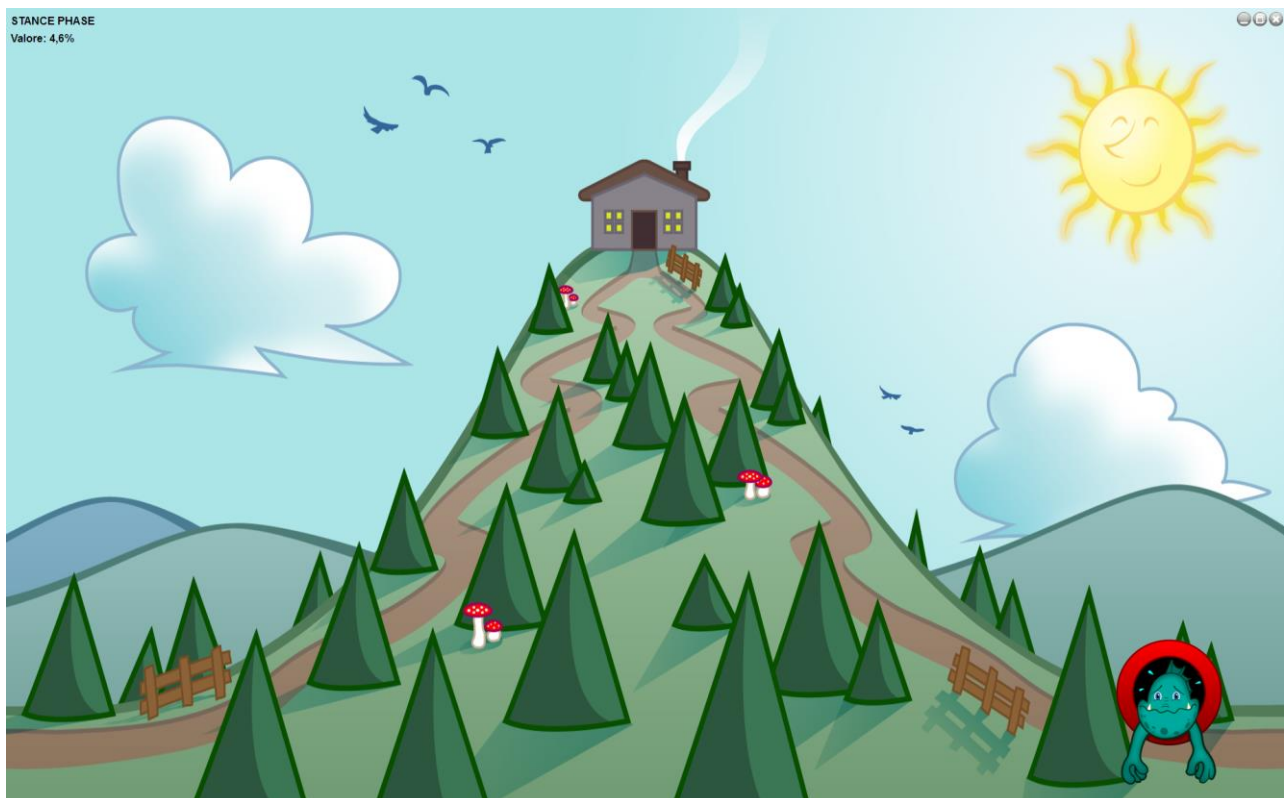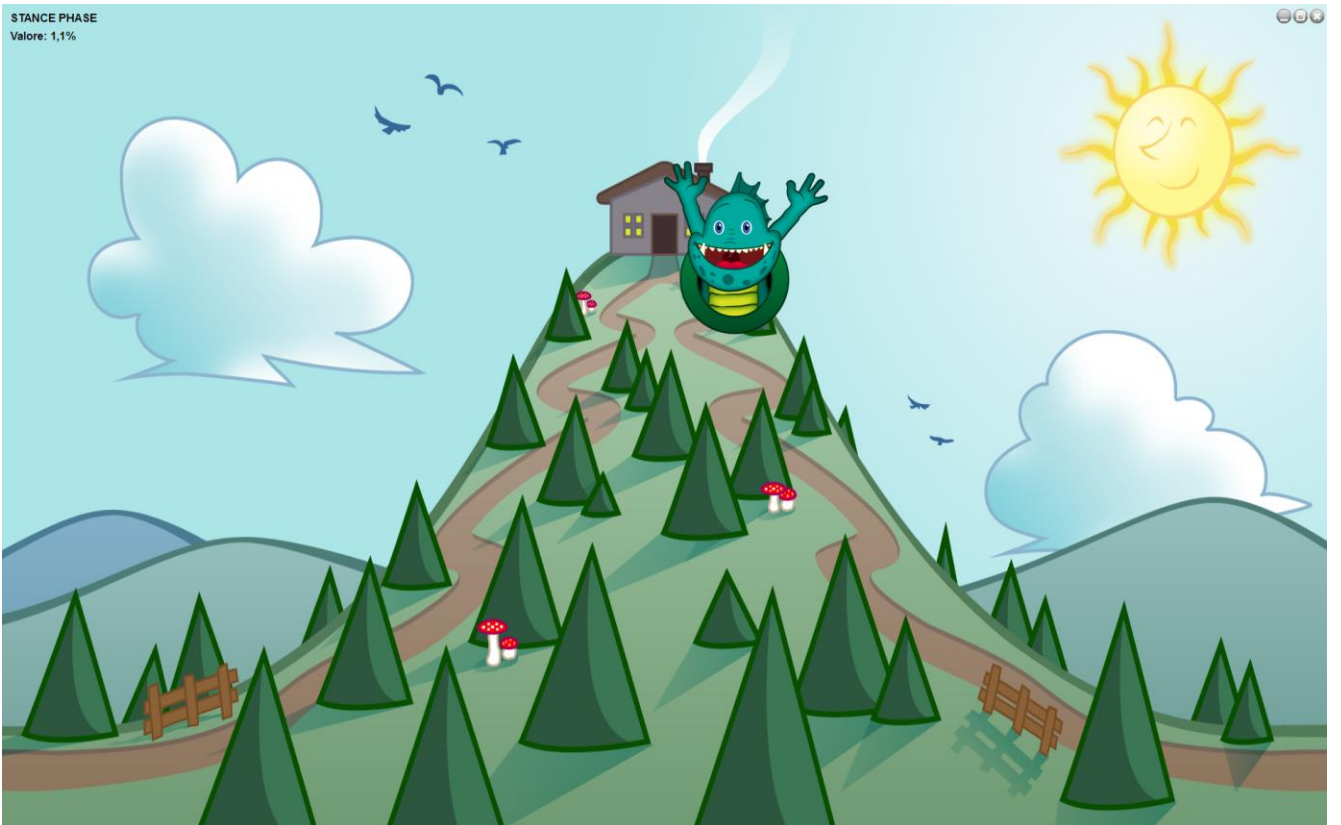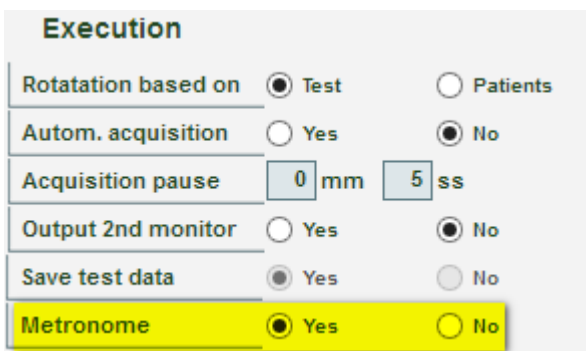
Figure 41 - Two phases of the Opto 4 Kids video feedback

4.2.1.3 METRONOME

While performing certain exercises (gait, walking on the spot, jumps), some patients find it easier to maintain a cadence if they are able to follow a constant rhythmic sound. OptoGait has a virtual 'metronome' function which can be used to set the cadence in bpm (beats per minute) and the tone (single or double).
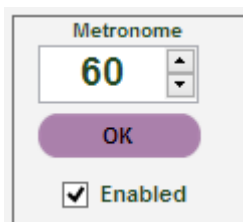
In this software version, the sound is generated and reproduced by the PC sound card, as a reference for the patient only; future releases should record metronome beats in addition to the test data, correlating it with various events (e.g. step cadence, jump, etc.) which take place.

To activate the metronome during a test, go to Test > Execute > Configuration and select the YES setting.

Once this option is activated, a small panel in the bottom left-hand corner will appear with each test:

To generate the sounds, click the ACTIVE check box (this function. The OK button flashes at the set rhythm.

The number of beats can be changed (between 10 and 200, in steps of 5) using the corresponding slider or by entering the figure directly <u>and confirming with OK</u>.

In Utility > Basic Settings it is possible to set a single or two-tone sound.

4.2.2 DEFINE / EDIT TESTS

In this section, the definitions of the tests to be performed can be defined or edited.

You can view the list of tests pre-defined by Microgate (in *italic*) or those you have added yourself in the grid (in the example below 'MY treadmill gait test' is a test added by the user).

Figure 42 - Define Edit Test

If the mouse is pointed on a test, its characteristics (which are those that will be used to define a new one) will be displayed.

By pressing <New Test>, the section for defining a test is opened.

The fields necessary for defining a test are the following:

- **Name:** name identifying the test type (e.g. 'left foot monopodalic' or 'continuous jumps 30 seconds', etc.)
- **Test Type:** this type indication is very important and conditions the fields below, which appear dynamically only after the type has been chosen from this drop-down menu:
  - **Jump Test:** type of test that measures flight time (and consequently height), as well as contact time during a series of jumps (in the former version this was called *Contact/Flight time*)
  - **Reaction Times:** measures the reaction time to a visual or sound stimulus
  - **Sprint and Gait Test:** test for the analysis of a run or walk; in addition to flight and contact times, step or stride length, other indicative parameters are also registered (in the former version this was called *Walkjump*)
  - **Treadmill Running Test:** test analysing running to be used on a treadmill (in the former version this was called *Rolljump*).
  - **Treadmill Gait Test:** test analysing gait to be used on a treadmill.
  - **Tapping Test:** frequency test registering separate data for each foot.
- **Notes:** Mnemonic general notes on the test definition.
- **Example movie:** with the webcam connected it is possible to acquire a movie clip that can be viewed in the future as a reminder. Press <Acquire> to acquire the movie and <Play> to view it.

4.2.2.1 MAIN AND SECONDARY PARAMETERS

The parameters of a given test type are divided into <u>Main Parameters</u> and <u>Secondary Parameters</u>. To switch from one mask to another, press the corresponding button on the right.

Secondary parameters are the same in the Utility menu under Basic Settings (chap.4.4.1.2, 4.4.1.3 and 4.4.1.5). When creating a new test definition, the values of these parameters are retrieved from the general data. It is possible to edit them for a specific test for particular needs. All tests of that type will then have the modified parameter. It is also possible to change one of these parameters in a SINGLE test (the test of Mario Rossi on April 12th), without influencing the test definition itself.

Therefore it is important to understand how the secondary parameters have a hierarchical structure and a sort of parent/child relation.

Basic Configuration Parameter

↓

Test Definition Parameter

↓

Single Test Parameter
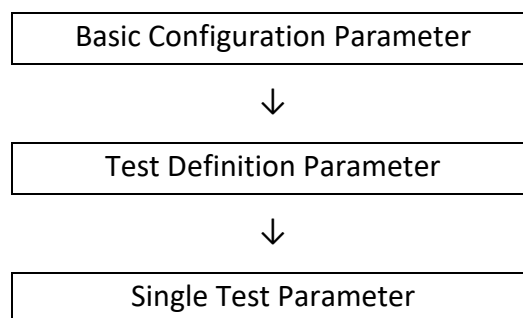
For example:

Under Utility/Basic Configuration set the 'Minimum contact time' to 60 ms. From this moment, every time new types of 'Jump Test' are created, they will have a default value of 60 ms. If this value is acceptable, no further changes have to be performed in 'Secondary Parameters'.

Figure 43 - Basic Configuration Parameters

Let's suppose that for special needs a new test type is needed (e.g., '*Three Jumps*') with a different value (e.g., 80 ms). Open <Secondary Parameters>, change the value, and save the test definition.

Figure 44 – Test Definition Parameters

Next, have the patient perform the test 'Three Jumps'. The single test, having inherited the values from its type, has the parameter 80 ms. Opening View Test (chap. 4.3.1) and pressing <Settings>, the following window is displayed:

Figure 45 – Single Test Definition Settings

However it might be necessary to change the parameter ONLY for this single test. Insert for example 75 ms and press <OK> or <Apply>. After all values have been recalculated, the data in the table with

the numeric results and the charts will change. If the results are acceptable, confirm by pressing <OK> and answer <YES> when asked to save the data (the difference between OK and Apply is that <OK> asks to confirm saving the new parameters and closes the function, whereas <Apply> does not close and allows to further adjust the parameters).

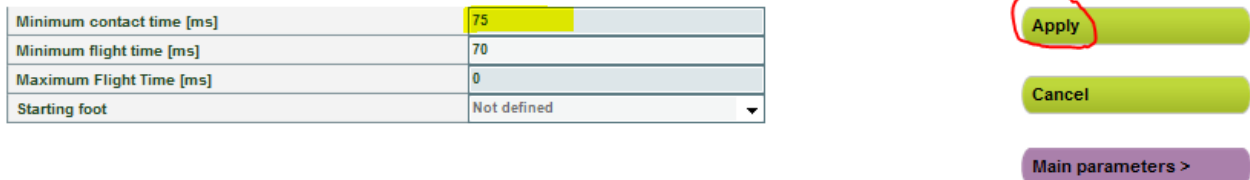If now the correct value proves to be 75 ms (all future tests should have this value), the parameter has to be changed in the test definition.

Figure 46 – Parameter editing in a Test Definition, when tests have already been performed with this definition.

TIP: With respect to Figure 44 the button is called <Apply> and not <Save>.
Now it is possible to decide whether this change should be applied to future tests (press <NO>) or if the change should be applied to all tests performed with this type (<u>overwriting</u> possible custom values set in the single tests); in the latter case, press <YES>.
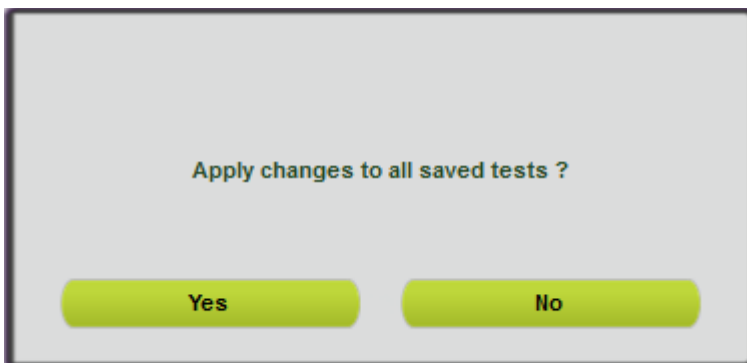

Figure 47 – Confirming the parameter application to tests that have already been performed

4.2.2.1.1 Parameter Template

The 'Template' field allows setting of secondary test parameters (in the definition but also at test level) following common usage cases. Let's suppose, for example, that a gait test is carried out on a modular system, with the athlete performing very short strides (typical of people who have had an injury), or shuffling the tip of the advancing foot. Instead of trying to change the parameters striving to find the best filter setting, you can choose one of the existing templates (i.e. 'shuffling gait') with parameters set automatically on the basis of our experience.

At present the templates apply only to the run/gait tests with modular systems, but in the future the concept will be extended to all test types and it will be possible to extend the template library via software upgrades.

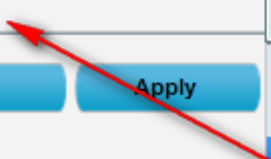The parameters changed by these first templates are those highlighted in the figure below.

Figure 48 – Parameters Template

The available fields for the different test types are the following:

4.2.2.2 JUMP TEST

Main Parameters

- **Start type**: indicates if the start of the test must take place with a 'status change' (i.e. entering or exiting the bars) or with an 'external impulse' coming from the jack sockets (start button, signal light, etc.).
- **Start:** indicates if at the beginning of the test the patient must be '*inside the area*' of the bars or '*outside the area*'.
- **Stop Type**: as for the start, the end of the test can take place because of a '*Status change*' or an '*external impulse*', or (in the case of time tests) the end of the test time (e.g. a test "Jumps 15 seconds" will have the Stop type = '*End of Time*').
- **Finish**: for the Stop type = '*Status change*' it is necessary to specify if, at the end of the test, the patient must be '*inside the area*' of the bars or '*outside the area*'; in the other two Stop type cases this field does not appear.
- **Number of Jumps**: appears only if the Stop type = '*Status change*' and specifies how many times the patient must jump (1 to 99).
- **Test Length**: appears only if Stop type = '*End of Time*' and specifies how many minutes:seconds the test must last (from 00:01 to 09:59).

Secondary Parameters

- **Minimum contact time [ms]**: allows you to set a minimum contact time in milliseconds; if the system registers a contact time shorter than this value, it is considered incorrect and added to the associated flight time (usually the previous one). This control can be enabled/disabled by inserting the value 0.
- **Minimum flight time [ms]**: allows you to set a minimum flight time in milliseconds; if the system registers a flight time shorter than this value, it is considered incorrect and added to the associated contact time. This control can be enabled/disabled by inserting the value 0.
- **Maximum flight time [ms]**: allows you to set a maximum flight time in milliseconds; if the flight time is higher, it is considered incorrect; if the system registers a flight time longer than this value, the time is not considered.
- **Starting foot:** if known, the foot with which the test starts ("right" or "left") can be indicated, otherwise leave as "not defined".
- **Overload Weight [Kg]:** is the value in Kg -or lb if the British unit of measurement is set- of a additional weight (e.g. of a lifting bar, kettlebell, etc.) if the athlete uses one during the jump test. Setting this parameter influences the calculation of Total [J] and Specific [J/Kg] Energy and Total [W] and Specific [W/Kg] Power.
- **Overload % body weight:** alternatively, a percentage of the athlete's body weight can be set. E.g. if an athlete weighs 70kg, entering 10% would be like defining an overload weight of 7kg in the previous field.

4.2.2.3 REACTION TIMES

Main Parameters

Start type: Indicates what type of reaction the test must assess, that is:
- ○ "*Visual stimulus*": on the PC screen a red circle becomes green after a random period of time; the patient must 'react' to this stimulus (e.g., by jumping)
- ○ "*Acoustic stimulus*": the reaction stimulus is a sound emitted by the PC (using either an internal loudspeaker or a sound board) after a random period of time.
- ○ "*Visual-Acoustic stimulus*": the visual (red/green circle) and the acoustic stimuli (beep from the PC) alternate randomly
- ○ "*External impulse*": the start to calculate the reaction time is given by a device (e.g. a start horn or a start button) connected to the jack sockets

Start: indicates if at the beginning of the test the patient must be '*inside the area*' of the bars or '*outside the area*'

Minimum pause: minimum pause time in minutes:seconds between one test and another (the pause will have this minimum value, but, being random, it will almost always be longer)

Number of repetitions: indicates how many repetitions (from 1 to 99) the test must consist of

Sequence type: the sequence can be '*Automatic*' (the test repetitions follow each other automatically) or '*Manual*' (at the end of each repetition the start of the next test must be confirmed)

Stop type: this can only happen by 'Status change'

Secondary Parameters

Minimum contact time [ms]: see above

Minimum flight time [ms]: see above

Maximum flight time [ms]: see above

Reaction time range [ms]: indicates the time frame in milliseconds within which the reaction signal must be given randomly.

4.2.2.4 SPRINT AND GAIT TEST

Main Parameters

- **Start type:** indicates if the start of the test must take place with a '*status change*' (i.e. entering or exiting the bars) or with an '*external impulse*' coming from the jack sockets
- **Start:** indicates if at the beginning of the test the patient must be '*inside the area*' of the bars or '*outside the area*'
- **Staring foot**: if known, the foot with which the test starts ("*right*" or "*left*") can be indicated, otherwise leave as "*not defined*"
- **Stop type:** indicates how the end of the test must be interpreted, (i.e. as '*External impulse*' like a photocell at the end of the lane) or as '*timeout*' (the number of milliseconds of Test timeout can be customized in Utility – Basic Settings)
- **Finish**: for the Stop type = '*Timeout*' it is necessary to specify if, at the end of the test, the patient must be '*inside the area*' of the bars or '*outside the area*'
- **Test Length**: appears only if Stop type = '*End of Time*' and specifies how many minutes:seconds the test must last (from 00:01 to 09:59)
- **Number of intermediate times**: indicates how many intermediate times are inserted between the start and the stop (0 to 99)
- **Template**: see chap. 4.2.2.1.1

Secondary Parameters

- **Minimum contact time [ms]**: see above
- **Minimum flight time [ms]**: see above
- **Maximum flight time [ms]**: see above
- **External signal hold off [ms]**: is the hold off time between two consecutive external signals. Caution has to be applied for this value, because it may depend on the type of test being carried out.
- **Entry point**: allows you to indicate if the entry point of the Sprint/Gait test is on the 'interface side' (drum) or the 'opposite side'. If 'automatic' is chosen, OptoGait automatically calculates the direction, considering the LED nearest the centre of the foot as the beginning of the LEDs.
- **Step length calculation**: allows you to choose whether to calculate step length as the distance between the tips of two following feet or as the distance between the heels of two following feet (see also Figure Figure 101).
- **Minimum gap between feet [cm]**: is the minimum gap between the tiptoe of one foot and the heel of the next foot.
- **Minimum foot length [cm]**: is the minimum foot length in centimetres (or inches), used to filter possible incorrect acquisitions.
- **Split 1 or 2 at distance [cm]**: insert at how many cm from the start the first or second split time will be taken; leave 0 to disable split times.

- **Test Timeout [ms]**: this is the end of test timeout in milliseconds; if during a Sprint/Gait test with 'Timeout' stop type no input or output signal is received from the measurement area by the OptoGait device for a period longer than or equal to the time set here, the test is considered completed.

- **3rd/6th/9th step speed reference:** insert the reference speed for the 3rd/6th/9th step in m/s; this option can be disabled by inserting the value 0.

- **Discard first step:** discard the first N steps (N=input value) when entering the area; this parameter (and the following) are useful when we want only consider the central part of the test and we do not want enter&exit (usually with lower speed) to affect the average.

- **Discard last steps:** discards the last N steps (N=input value) when exiting the area.

- **Foot filter at start/end of system**: if set to YES does not consider the steps in and out of the system if there are at least 2 obscured LEDs; in this way you avoid fingerprints half in and half out of the measurement area.

- **Filter GaitR IN and Filter GaitR OUT [LED]**: the two parameters expressed in number of sensors (LEDs) indicate the *minimum* number of sensors interrupted by the gait and triggering the start of the foot contact time (GaitR IN) and the end of the same time (GaitR OUT). See also chap. 5.1.6

For this test type the structure of the system has to be defined as well, (i.e., how many bars the system is composed of and whether there are gaps between the bars).

In the field 'Number of bars', the number of connected bars must be inserted. This field is necessary for correct test acquisition. If the inserted number of bars differs from the number of bars actually installed, the software will signal this error suspending the test currently in progress.

Example: A system is made of 20 meters of OptoGait bars, all connected, without gaps. The settings to make are the following:
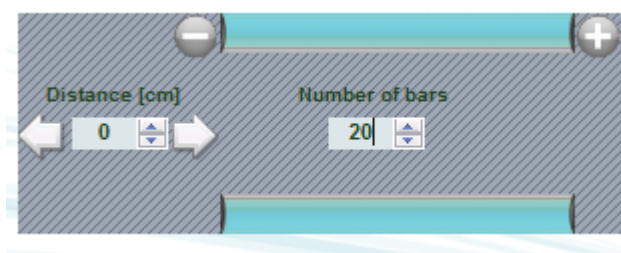
The ⊖ and ⊕ buttons are respectively for removing or adding blocks of OptoGait bars. This function can be used, for example, in hurdle jumping, where between one hurdle and the next one interruptions are made connecting bars with a flat cable.

The 'Distance' field is for indicating the distance between the blocks in centimetres. The first 'Distance' (D_0) corresponds to the distance between the patient's initial position and the first block. For example, in athletics, if the start is from the blocks, the distance from the springboard to the first block must be calculated. The other distances (D_1, D_2, etc.) indicate the distance between the last lens of a bar and the first lens of the following bar (end and beginning of the two half moons).
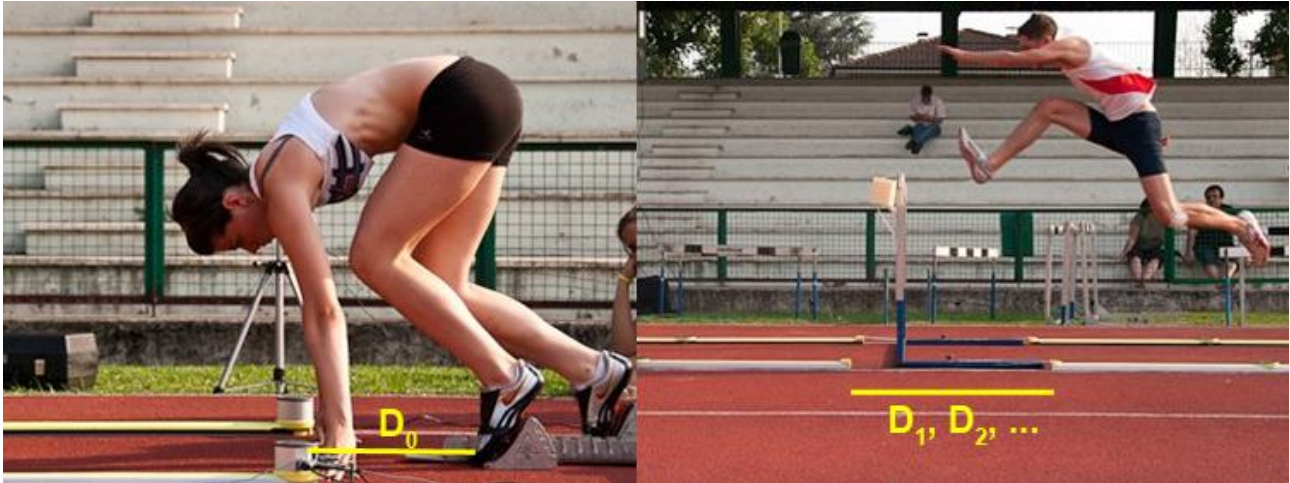
Figure 49– Example: bars with gap

A practical configuration example of a system of 30 m could be the following:

Starting block—50 cm – 13 meters OJ – hurdle – 8 meters – hurdle – 8 meters – hurdle – 1 meter

Figure 50 – Configuration of bar blocks

4.2.2.5 TREADMILL RUNNING TEST

Main Parameters

- **Start type:** this can only be '*Software command*' or '*External Impulse*'
- **Stop type:** this can be '*Software command*', '*End of Time*' or '*External Impulse*'
- **Starting foot:** see above
- **Test length**: appears only if Stop type = '*End of Time*' and specifies how many minutes:seconds the test must last (from 00:01 to 59:59)
- **Treadmill speed**: indicates the speed in km/h the treadmill is set at; the setting range is 0.1-20.0 km/h with steps of 0.1.
- **Direction**: indicates if the walking direction is 'Interface side' or 'Opposite side'. Therefore, if the interface drums are at the end of the treadmill choose 'Opposite Side', or vice versa.

Figure 51 - Direction: OPPOSITE Side

Figure 52 - Direction: IINTERFACE Side

Secondary Parameters

- **Minimum contact time [ms]**: see above
- **Minimum flight time [ms]**: see above
- **Maximum flight time [ms]**: see above
- **Step length calculation**: see above
- **Minimum gap between feet [cm]**: see above
- **Minimum foot length [cm]**: see above
- **Filter GaitR IN and Filter GaitR OUT [LED]**: see above

4.2.2.6 TREADMILL GAIT TEST

Main Parameters

- **Start type:** this can only be '*Software command*' or '*External Impulse*'
- **Stop type:** this can be '*Software command*', '*End of Time*' or '*External Impulse*'
- **Test length**: appears only if Stop type = '*End of Time*' and specifies how many minutes:seconds the test must last (from 00:01 to 59:59)
- **Treadmill speed**: indicates the speed in km/h the treadmill is set at; the setting range is 0.1-20.0 km/h with steps of 0.1.
- **Direction**: Indicates if the walking direction is 'Interface side' or 'Opposite side'. Therefore, if the interface drums are at the end of the treadmill choose 'Opposite Side', or vice versa.

Secondary Parameters

- **Minimum contact time [ms]**: see above
- **Minimum flight time [ms]**: see above
- **Maximum flight time [ms]**: see above
- **Step length calculation**: see above
- **Minimum gap between feet [cm]**: see above
- **Minimum foot length [cm]**: see above
- **Filter GaitR IN and Filter GaitR OUT [LED]**: see above
- **Automatic Data Filter**: from 10% to 90% (default = deactivated); activating this parameter, the user can check if the values for flight time, contact time, gait time, swing time, and step length are within the average value +/- the chosen percentage. If one of these data is out of range, the table line will be deleted from the calculation of average values and the values on the grid will appear in strike-through format (e.g. average = 0.8, filter = 20%, all values above 0.96 and below 0.64 will be deleted).

4.2.2.7 TAPPING TEST

Main Parameters

- **Start type:** indicates if the start of the test must take place with a '*status change*' (i.e. entering or exiting the bars) or with an '*external impulse*' coming from the jack sockets
- **Start**: can only be '*inside the area*'
- **Staring foot**: if known, the foot with which the test starts ("*right*" or "*left*") can be indicated, otherwise leave as "*not defined*"
- **Stop type:** indicates how the end of the test must be interpreted, (i.e., as '*External impulse*' like a photocell at the end of the lane) or as '*Timeout*'
- **Test Length**: appears only if Stop type = '*End of Time*' and specifies how many minutes:seconds the test must last (from 00:01 to 09:59)

Secondary Parameters

- **Minimum contact time [ms]**: see above
- **Minimum flight time [ms]**: see above
- **Maximum flight time [ms]**: see above
- **Minimum gap between feet [cm]**: see above
- **Minimum foot length [cm]**: see above

In order to perform a Tapping Test, it is important that the patient's feet are vertical to the OptoGait bars.

Figure 53 – Correct execution of a Tapping Test

4.2.2.8 Vertec Like Test

Main Parameters

- **Start type**: indicates if the start of the test must take place with a 'status change' (i.e. entering or exiting the bars) or with an 'external impulse' coming from the jack sockets (start button, signal light, etc.).
- **Start:** indicates if at the beginning of the test the athlete must be '*inside the area*' of the bars or '*outside the area*'.
- **Stop type**: as for the start, the end of the test can take place because of a '*Status change*' or an '*external impulse*', or (in the case of time tests) the end of the test time (e.g. a test "Jumps 15 seconds" will have the Stop type = '*End of Time*').
- **Finish**: for the Stop type = '*Status change*' it is necessary to specify if, at the end of the test, the athlete must be '*inside the area*' of the bars or '*outside the area*'; in the other two Stop type cases this field does not appear
- **Number of Jumps**: specifies how many times the athlete must jump (from 1 to 99)
- **Direction**: the only possible option is 'opposite side', i.e. the drums of the bars must be positioned   in   the   lower   part

Secondary Parameters

- **Minimum contact time [ms]**: see above
- **Minimum flight time [ms]**: see above
- **Maximum flight time [ms]**: see above

4.2.2.9 2D GAIT TEST

A new test type called '2D Gait Test' has been added from version 1.7 or higher. With this new type it is <u>NOT</u> necessary to specify the number of bars connected (X and Y), as this is detected automatically by the software (the only limitation is that the number of X bars must be >= Y bars).

Name	My 2D Gait Test
Test type	2D Gait test
Start type	Status change
Start	Outside the area
Starting foot	Automatic
Stop type	Software command
Template	Normal walking
Notes	

As highlighted, the measurement area is always the area covered by the X bars and not by the whole rectangle; this is very important with respect to the '**Start**' parameter; if the athlete starts inside the rectangle, but in any case before the beginning of the X bars, this must be defined as 'OUTSIDE the Area'.
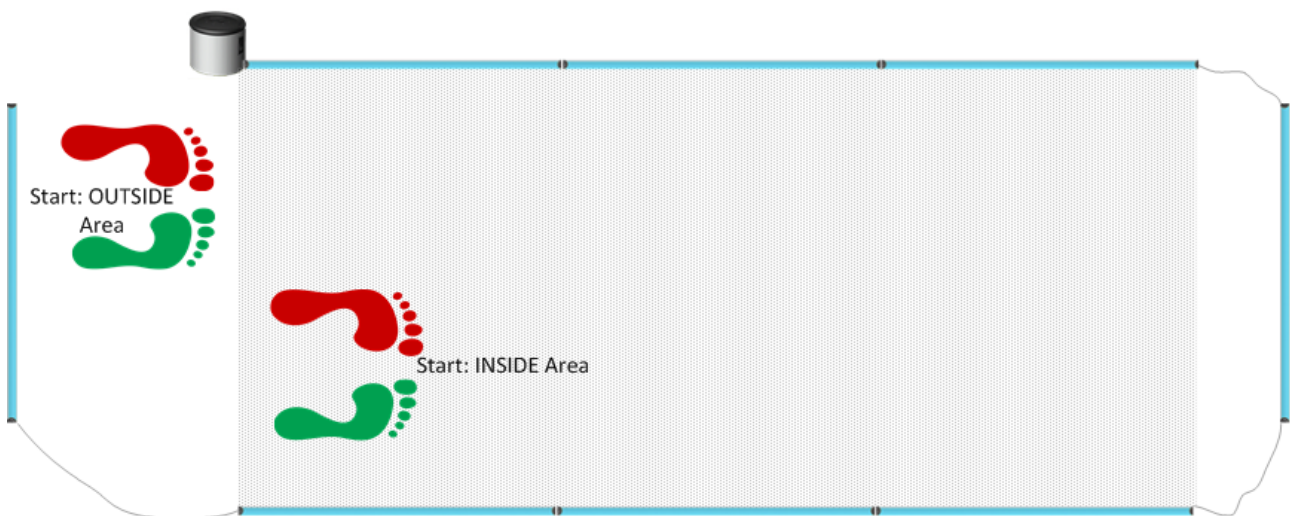
The '**Starting Foot**' field contains only the *Automatic* option and therefore it is no longer necessary to define beforehand if the gait begins with the right or left foot, as the Y bars detect it automatically.

For certain situations it is in any case still possible to change the starting foot during the test phase (Results > View) using previous methods (right click on the grid and 'Change Starting Foot' context menu) or via a new function with two buttons in the Gait Report section. Just press the icon of the required foot to set it as starting foot (the one currently used is coloured, whereas the other is greyed out).

The '**Template**' field, which previously contained various gait types besides the normal one (shuffling gait, short steps, short steps tip-tip, etc.) has been considerably simplified;

thanks to the greatly improved algorithms for the automatic recognition of various patterns, it has been possible to reduce the various types to only two, i.e. '*Normal*' and '*Superposed Feet*'.

Similarly to the foot change, a rapid method has been added for changing the template directly from the Gait Report using the relevant button.
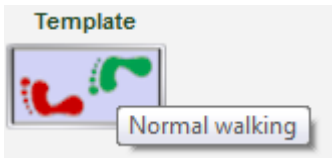
In the **Secondary Parameters** of the 2D Gait Test there are 4 new parameters, which can already be applied during test definition or during the trial analysis (<Parameters> button).

- **Minimum Distance Between Feet**: parameter required by the filter algorithms for specific cases
- **Minimum Foot Width**: similar to the minimum foot length; smaller measures are skipped, because they are considered spurious
- **GaitR In and Out Filter**: the two parameters expressed in number of sensors (LEDs) indicate the *minimum* number of sensors interrupted by the gait and triggering the start of the foot contact time (GaitR IN) and the end of the same time (GaitR OUT). See also chap. 5.1.6

Minimum contact time [ms]	10
Minimum flight time [ms]	10
Maximum flight time [ms]	1000
External signal holdoff [ms]	500
Entry point	Automatic
Step length calculation	Heel to heel
Minimum gap between feet [cm]	10
Minimum foot length [cm]	10
Minimum gap between feet (Width)[cm]	1
Minimum foot width [cm]	1
Split 1 at distance [cm]	0
Split 2 at distance [cm]	0
Test timeout [ms]	2000
3rd step speed reference [m/s]	6
6th step speed reference [m/s]	8
9th step speed reference [m/s]	9
Discard first steps	1
Discard last steps	No
Foot filter at start/end of system	Yes
Foot length [Led]	24
Foot width [Led]	11
Filter GaitR. In [Led]	3
Filter GaitR. Out [Led]	3
Template	Normal walking

4.2.2.10   SWAY TEST

Static (Sway) tests are the only ones that do not need OptoGait bars but only the Gyko inertial sensor.

The sensor is typically placed behind the patient's shoulder blades and measures the subject's antero-posterior and medio-lateral movements during the exercise (which can be bending on one foot, a squat, etc.)

Name	Body Sway	
Test type	Sway test	▾
Start type	Software command	▾
Stop type	End of time	▾
Test length	00.30	▾
Notes		∧
		∨

Main Parameters

- **Start type:** this can only be "*Software command*"
- **Stop type:** Indicates how to interpret the end of the test: with *"External Pulse"*, "*End of Time*" or "*Software Command*"
- **Test length**: appears only if Stop type = "*End of Time*" and specifies how many minutes:seconds the test must last (from 00:01 to 09:59)

After inserting the data, <u>remember to press</u> <Save> and return to the list of defined tests.

To review the parameters of a defined test, pass over them with the mouse, or double-click on them (this is equivalent to pressing <Edit Test>).

Editing a test definition is only possible if no tests using this definition have already been performed. The secondary parameters, on the other hand, can always be edited.

To delete a test definition, select it from the list and press <Delete Test>; all the tests connected to this definition will be deleted!

To duplicate a test definition (useful, for example, if a left-foot test has been defined and the same shall be applied to the right foot, or vice versa), select the test from the list and press <Duplicate Test>. This creates a copy of the test, which can then be renamed and fully edited.

The buttons <Import Test> and <Export Test> are for copying the definition of a test from one database to another. Press <Export Test> and save the XML file on your hard drive. Open another database (or create a new one) and press <Import Test> choosing the file previously saved.

The tests preconfigured by Microgate can be duplicated, but not edited or eliminated.

4.2.3 DEFINE / EDIT PROTOCOLS

In this section, the protocols to be performed can be defined or edited. The protocols can be considered as a pre-defined series of tests to be performed in sequence (e.g., one 'Squat jump' + one 'CMJ' + one 'Jumps 15 seconds').

To create a new protocol, ; select one of the three test macro-typologies (Performance, Gait Analysis, Rehab) and press <New Protocol>. Insert a mnemonic name and optionally general notes.

Select the tests (in the desired order) that will make up this protocol, using the symbol ⊙

If a mistake has been made or a test has to be removed from the protocol, use the symbol ⊙
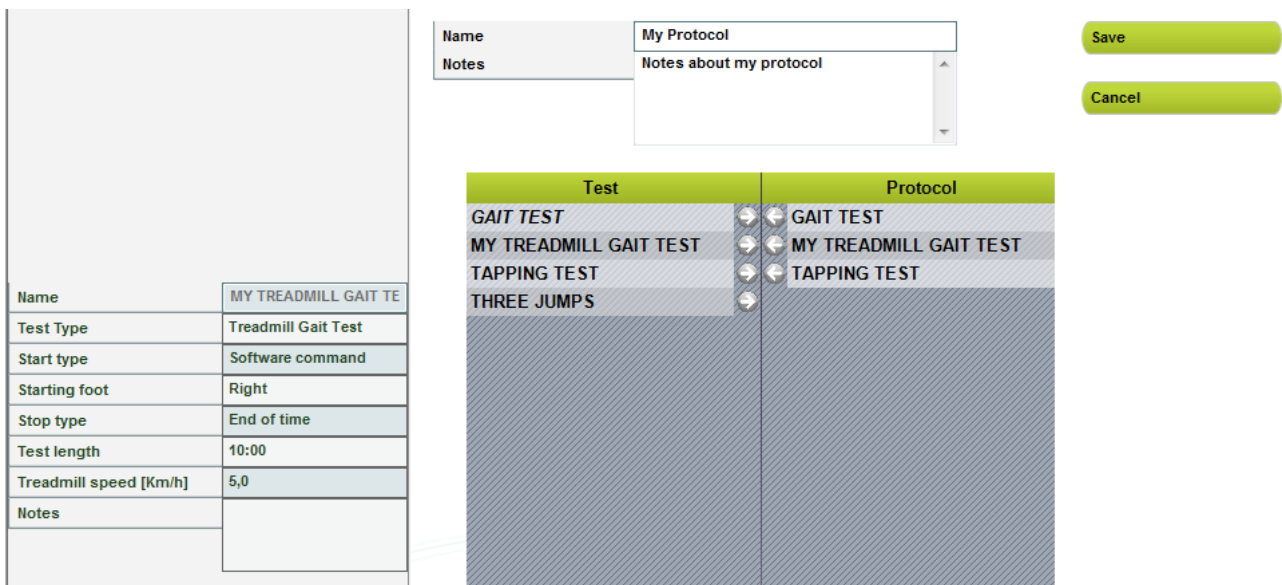
Figure 54 – Creation of a protocol

If you do not remember the parameters of a test definition, place the mouse cursor on it and its characteristics will be displayed.

After inserting the data, press <Save> and return to the previous section.

The command <Edit Protocol> allows you to edit its name and notes and change its composition.<Delete Protocol> deletes its definition. Unlike the deletion of a test definition, the deletion of a protocol does not cause the chain-effect deletion of all correlated tests but only the connection they had with the protocol. After its deletion, the tests performed by the patients will be found again as 'single tests', no longer related to the protocol.

4.3 RESULTS
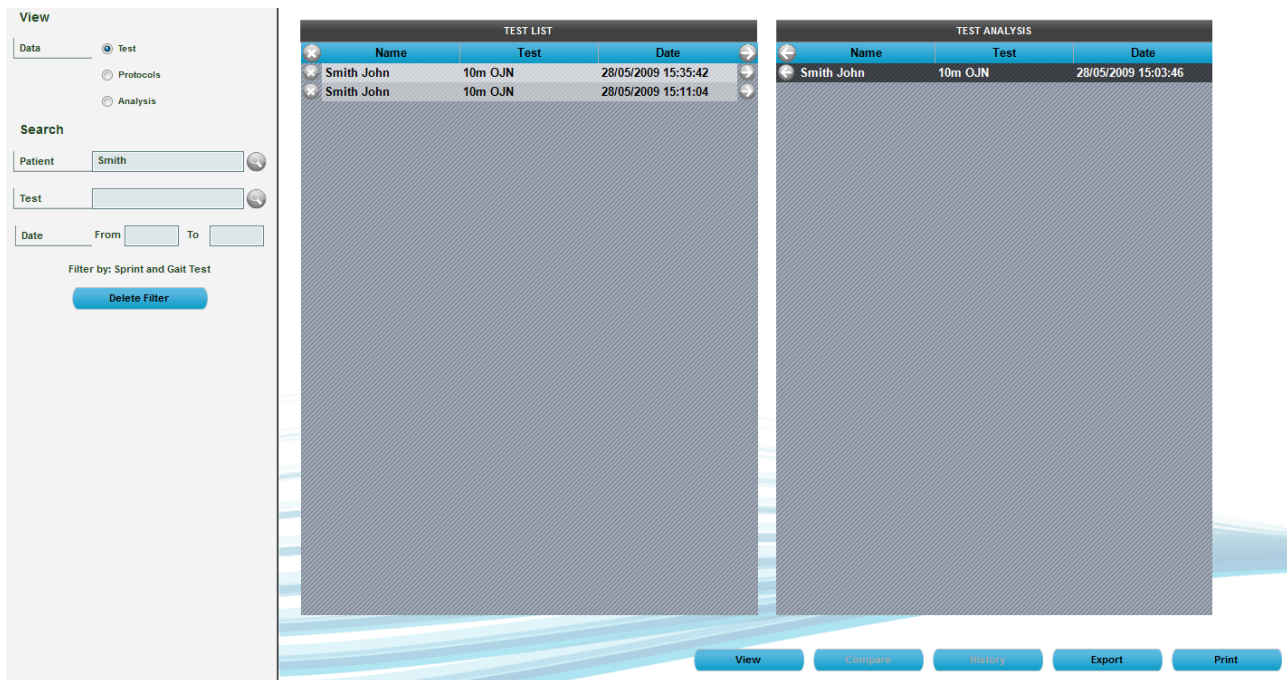
Figure 55 – Results

In the Results section, the performed tests or protocols are displayed. For better understanding, these three terms are defined as follows:

Test is a single test (e.g. 15" jumps) performed on a certain date by a single patient.

Protocol: is a pre-defined list of tests to perform in sequence.

Analysis: when a single test is displayed or when two tests are compared, certain configuration parameters may be set for the video, the table with numerical data, charts, reports, printouts, etc. It is furthermore possible to draw on still pictures, insert notes, 'sign', delete incorrect data, etc. All these operations can be saved in an *Analysis* (using a mnemonic name), which can then be recalled without having to reset all parameters.

The RESULTS window is divided into 3 parts (from left to right):

- FILTERS: panel for looking for a single test or for filtering according to various parameters
- TEST LIST: contains all the tests made, possibly filtered by your parameters; the same window also displays the list of saved analyses
- TEST ANALYSIS: contains the tests/analyses manually selected for viewing, comparing, printing, or exporting.

Filters Panel

With the 'Data' radio button, select whether single tests, protocols or analyses should be viewed.

In the latter case, with the ⊕ and ⊖ icons expand or collapse the tests contained in the protocols.

TEST LIST			
Name	**Test**	**Date**	→
Rossi Pierluigi	Balzi+CMJ	08/06/2010 15:32:54	→
	STIFFNESS	08/06/2010 15:32:54	→
	CMJ	08/06/2010 15:32:37	→
Rossi Pierluigi	Balzi+CMJ	23/04/2010 16:26:45	→

Figure 56 – Expanded Protocols List

Choosing 'Analyses', all saved analyses will be viewed with the saving date (which can be much later than the execution of the analysed tests).

ANALYSIS LIST		
Analysis	**Date**	→
Test Post-infortunio John Smith	23/04/2010 16:00:20	→
Confronto Stifness di Rossi Pierluigi	23/04/2010 15:59:36	→

Figure 57 – Saved Analyses

To look for a patient or a test/protocol, the data can be inserted manually into the search boxes (e.g., key in 'Rossi' in the Patient field or 'CMJ' in the Test field) or press 🔍 to display a list of patients or tests to choose from. Similarly, it is possible to filter by data by inserting a range of data with the calendar control.

The 'Test type filter' radio button can be used to apply an automatic filter to the test type: for example, if 'Jumps 15 seconds' is selected for test analysis, the list on the left-hand side will only show 'Jump Test' types and all others (gait, run, tapping, etc.) will be hidden. This makes it easier to select other tests of the same type for comparison or history purposes. If, on the other hand, you do not want to use this automatic filter (for example, when selecting a variety of tests to export), set the filter to 'Disabled'.

Filter Testtype   ◉ Automatic   ○ Disabled

To view all the tests and reset the various filters, press <Delete filter>.

Test List

Figure 58 – Test List Components

Click on the column names (Patient, Test, Data) to display the list in order according to that field. Press again to reverse the order (A…Z, Z…A).

To delete a test, press the ⊗ symbol on the corresponding line of the chosen test; to delete <u>all</u> displayed tests press ⊗ on the table heading.

To select a test to analyse, press the symbol ➲ on the corresponding line (or double-click with the mouse): the test will be moved from the LIST table to the ANALYSIS table and a filter will automatically be set on the type of test (e.g., if a 'Squatjump' test is chosen, the Test List is filtered in order to contain only 'Jump tests'; this allows you to choose only tests of the same type to submit to 'Comparison').

To add <u>all</u> displayed tests, press ➲ on the table heading.

To make multiple selections, use the **SHIFT** key to select a range of patients (from… to…) or the **CTRL** key for selections that are not adjacent, as explained in section. 4.1.2. Pressing ➲ will move only the selected tests, while pressing ⊗ will delete those lines.

Figure 59 – Multiple selection

From the test list, it is possible to perform two operations by **RIGHT-CLICKING** on one test line. More precisely:

- **Change person**: allows you to associate a test with another person, if the wrong association was made during execution; select the command and choose a patient from the displayed mask; press <Confirm> to choose the new person. This function is also available on the protocol list.
- **Edit note**: allows you to view/edit the note inserted immediately after test completion; the note will be printed on the report in the General Data section on the first page of the test.

Figure 60 – Context menu under a single test

Conversely, right-clicking on the list of saved analyses provides the following options:

- **Rename**: allows you to change the name of the analysis
- **Analysis Notes**: allows you to view/edit the note that has been entered; this note is printed at the bottom of the report

Figure 61 – Context menu under the saved analysis

If the Gyko inertial sensor was also used during the test, a special icon will signal it:

Test Analysis

To view a single test, select the corresponding line in the 'TEST ANALYSIS' table and press the button <View> (or double-click with the mouse). See chap. 4.3.1 View.

To compare two tests, enter the relevant tests in the 'TEST ANALYSIS' table and press <Compare>. See chap. 4.3.2 Compare. The button is disabled if the number of tests in the window is not two.

To remove a test from the analysis, press the ⟲ symbol on the corresponding line in the 'TEST ANALYSIS' table. To delete all the tests displayed, press ⟲ on the table heading.

To analyse the history, insert two or more tests in the 'TEST ANALYSIS' table and press the button <History>. See chap. 4.3.3 History.

To export the data to Excel, add at least one test to the 'TEST ANALYSIS' table and press <Export>. A dialog box asks if the extended version (for each data line the test heading and patient's data are repeated) or the simple version (only numerical test data) should be displayed.

Pressing <Print>, n-number of reports (to be printed directly or saved in PDF format) are generated; the number corresponds to the number of tests shown in the 'Test analysis' window. Before generating the output, the output directory for the above files must be selected.

TEST ANALYSIS		
Name	Test	Date
Rossini Paolo	STIFFNESS	01/07/2010 09:18:38
Rossini Paolo	STIFFNESS	01/07/2010 09:18:22
Smith John	STIFFNESS	23/04/2010 10:15:40
Huber Franz	STIFFNESS	23/04/2010 10:15:24
Rossi Pierluigi	STIFFNESS	25/03/2010 18:11:34
Rossi Pierluigi	STIFFNESS	25/03/2010 18:09:31

View   Compare   History   Export   Print

Figure 62 – Test list to analyse

4.3.1 VIEW

In this section the test selected is displayed.
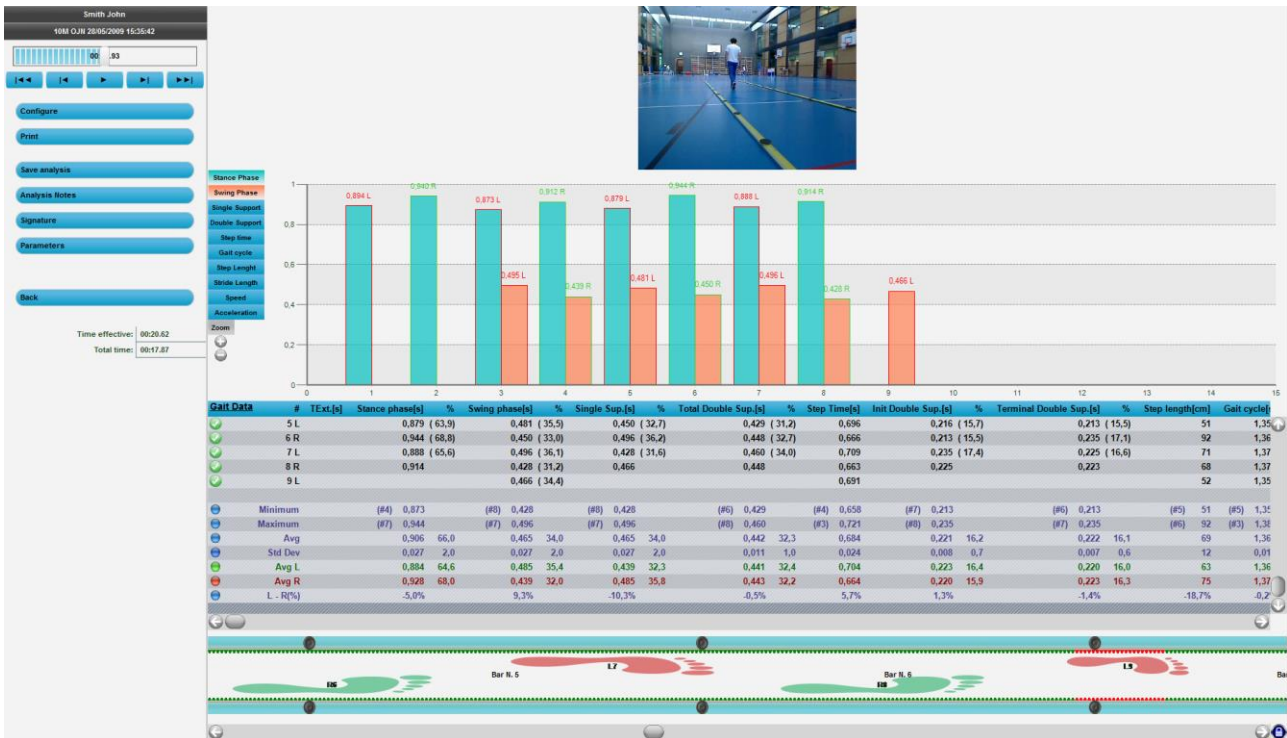
Figure 63 – View

The items on the left from top to bottom are the following:

- name of the patient
- test type and execution date
- VCR player with slider and commands for managing the acquired video(s)
- command buttons for activating various functions
- <Back> button to close the mask View and go back to the Test list
- total test data

On the right there are 4 types of information regarding the current test; each set of information can be shown/hidden using the configuration commands.

The items from top to bottom are the following:

- **Videos** acquired by (one or two) webcam(s); if the webcams are not connected when the test is performed, a fixed image with the Microgate logo will appear
- **Charts** displaying the results: it is possible to choose the chart type (lines or bars) and the measurement to be displayed (times, heights, powers, etc.)
- **Table of numerical data**: a grid with various lines and columns displays actually acquired data and calculated data; at the bottom of the table statistical and aggregated data are displayed (average, minimum, maximum, etc.)
- **OptoGait bars**: displays the n-number of bars connected at the time the test is carried out and which LEDs turn on during the test

The table shows the list of all the external, flight and contact times acquired during the test. The data has been processed to obtain further information such as jump heights, energy, developed power, etc. See chap.5.1 Definition of Result Columns.

In the case of Sprint/Gait test, step length, speed, and acceleration are also displayed.

By checking the various rows, invalid flight and/or contact times can be deleted. See chap. 5.3.

In the bottom left area total test data is displayed, such as:

Effective time [mm:ss.dd]: actual time of the test in the format minutes, seconds and milliseconds; this is the difference between the actual start of the test, calculated from the first event (e.g. the first take-off from the ground), and the end of the test.

Total time [mm:ss.dd]: total time of the test in the format minutes, seconds and hundredths of a second; this is the difference between the start of the test, signalled by the acoustic signal, and the end of the test. If, for example, 10 seconds pass between the two start beeps and the end of the test, and the patient begins to jump 3 seconds after the first beep, the two values will be Total time = 10 and Effective time = 7.

Specific energy [J/kg]: specific energy produced during the test calculated with the following formula:

$$\sum h_{jumps} \cdot g$$

Specific power [W/kg]: specific power produced during the test calculated with the following formula:

$$\frac{g^2 \cdot \sum T_v \cdot \left(\sum T_v + \sum T_c \right)}{4 \cdot n° \, jumps \cdot \sum T_c}$$

Where T_f= Flight Time, T_c= Contact Time

Patient's weight [kg or lb]: patient's weight in kg or pounds

Total energy [J]: if the patient's weight is available, this field contains the total energy expressed by the patient during the test (SpecificEnergy * PatientWeight)

Total power [W]: if the patient's weight is available, this field contains the total power expressed by the patient during the test (SpecificPower * PatientWeight)

The four values are influenced by the eventual presence of a value other than zero in one of two fields "Overload Weight" and "Overload % body weight" (see chap. 4.2.2.2).

At the top left (see figure below) is the command panel for checking test progress.
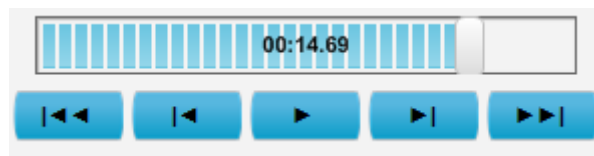
Figure 64 – Command panel

From left to right the commands available are:

Back to the start of the test

Back one frame

Play/Stop

Forward one frame

Forward to the end of the test

Move the progress bar (slider) by moving the cursor with the mouse.

Instead of the buttons Back/Next, the right and left arrow keys on the keyboard can be used to move forward/backward by single frames. The CTRL+Right Arrow and CTRL+Left Arrow can be used to move by a thousandth of a second.

Hold the Ctrl key and right click to scroll forward or back through the video to the desired millisecond.
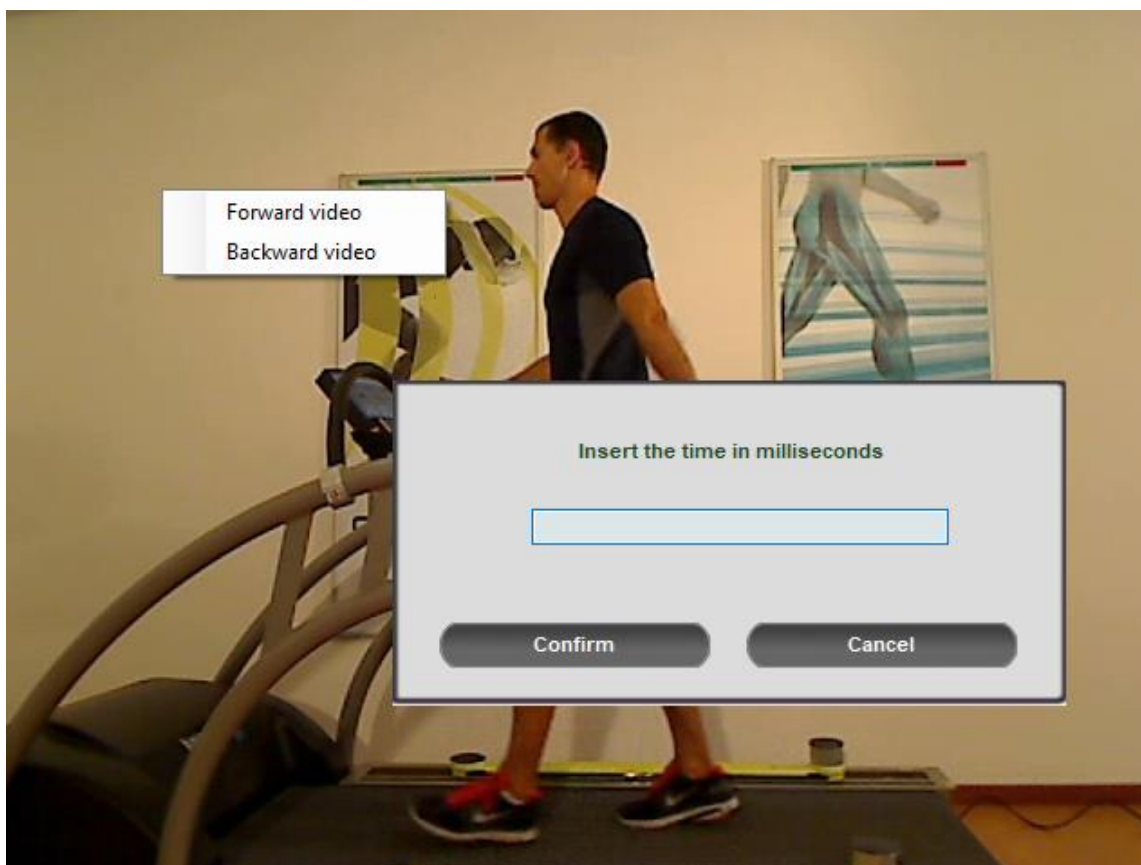
Figure 65 - Ctrl + Right Click

Right click on the video only (without Ctrl), instead, to display the video using the default player selected in MS Windows (Windows Media Player, VLC, etc.).
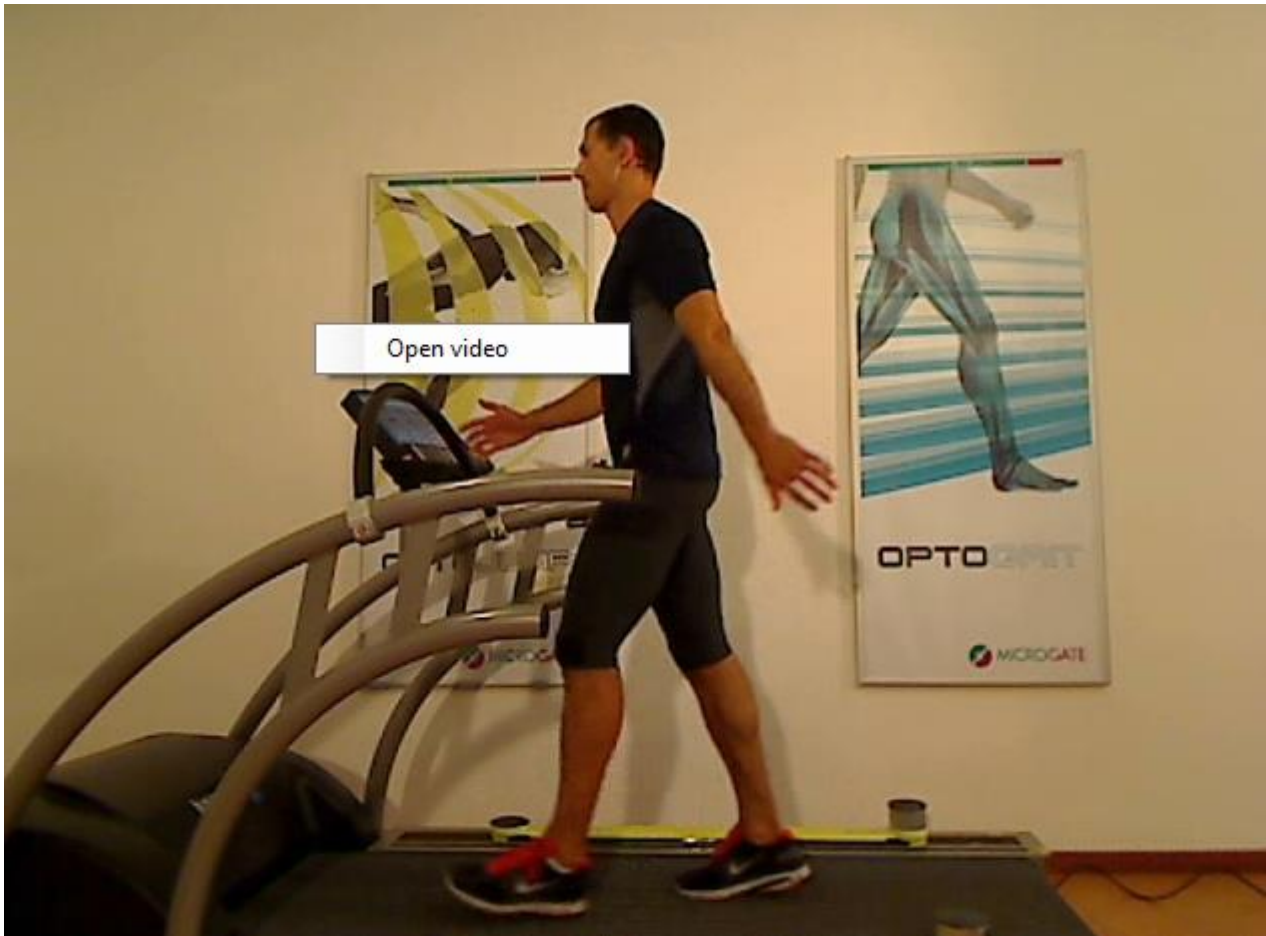
Figure 66 - Right Click on the Video

4.3.1.1 CONFIGURATION PANEL

Pressing <Configure> displays the choices available.
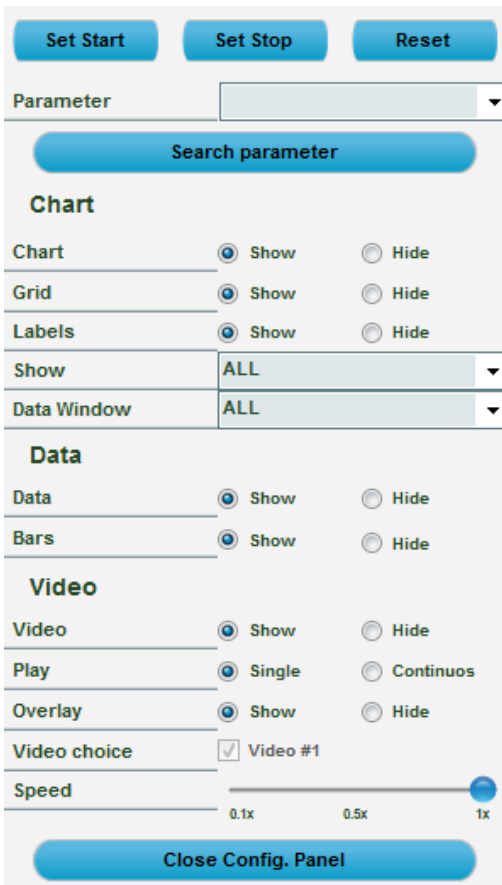
Figure 67 – Configuration Panel for the View test function

The <Set Start>, <Set Stop> buttons are for defining the start and end respectively of the part of interest. Place the cursor at the start and finish points of the desired movie clip and press <Set Start> and then <Set Stop>. Thus a part of the movie clip is isolated, deleting the uninteresting 'dead' periods.
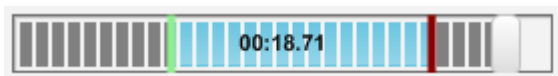
Press <Reset> to cancel the 'Start' and 'Stop' references and restore them to their initial values.

Double-clicking anywhere on the timeline, the positioning time can be entered. The value must be in milliseconds (i.e. for example 1871 to reach 18".71).

With <Search Parameters>, it is possible to look for a parameter selected from the 'Parameter' drop-down menu; e.g. select 'first flight time' and press Search Parameter: you will see the film clip and the slider used to move forward to the frame corresponding to the patient's first take-off from the ground. By using 'Next T.Flight', you will go forward to the next corresponding event. This function is very useful when comparing two tests.

The display of test data can be configured by the user:

> Chart

- o **Chart**: shows/hides the chart
- o **Grid**: shows/hides the dotted lines forming a grid on the chart
- o **Labels**: shows/hides the labels for the numerical values on the times on the chart
- o **View**: shows all the data acquired or only certain data; in this case, a scrollbar allows you to move to the right and left inside the chart
- o **Data Window**: the table of numerical data displays the n-number of data based on the window in blue shown in the chart. To move the window, <u>right-click</u> it with the mouse and drag it onto the chart.

Figure 68 – Display 10 events at a time and take 3 of them into consideration (blue window)

Data
- o **Data**: shows/hides the grid with numerical data
- o **Bars**: shows/hides the OptoGait bars

Video
- o **Video**: shows/hides the acquired video
- o **Play**: you can play 'Single' (only once) or 'Continuous' (looping the test)
- o **Overlay**: using graphical tools draw on a still picture and save this image as an overlay ( ); use this flag to show or hide it
- o **Video choice**: allows you to choose whether to show or hide one of the two videos
- o **Speed**: normal (1x) or slowed down by a factor from 0.1x to 0.9x

The Configuration panel can be closed (i.e., minimized) using the button **<<** in the upper left corner. Only the video commands (play, stop, ff-fw, rew, etc.) are available, allowing you to view the test. Use **>>** to open the panel again.
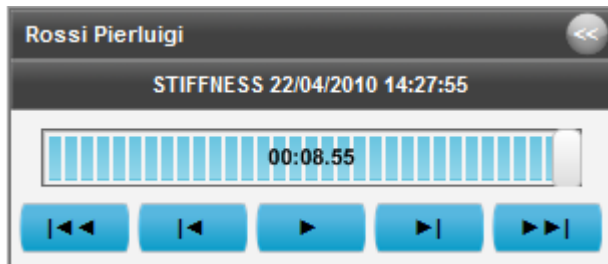
Figure 69 – Open Configuration panel

Figure 70 – Closed Configuration panel

4.3.1.2 CHARTS

In OptoGait charts there are various viewing options. (for example, in Figure Figure 71 'Stance' and 'Swing' are displayed). To change view type, left-click with the mouse on another option (such as 'Power' or 'Height'). The buttons have the same colours as the chart bars/lines and are therefore used as legend.

In addition, if you place your cursor on one of the buttons, the displayed chart type will appear on the right. It can be lines () or bars (). To change the chart type, left-click on the corresponding symbol.

By pressing the symbols under 'Zoom' you can increase () or reduce () the chart display.
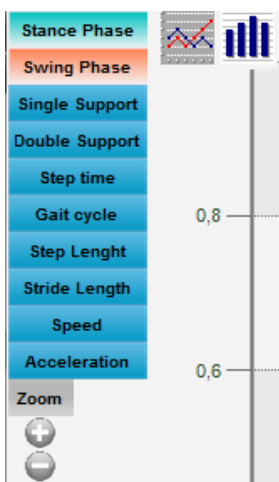
Figure 71 – Chart options

If a setting is not available, it is displayed in black. e.g. if no second webcam is connected, the option 'View video#2' is disabled).

The OptoGait software has a graphic tool for analysing images acquired by webcams. To enter this section, just <u>double-click with the mouse on the still picture</u> to process (see chap. 5.4 Video Analysis).

Press <Menu >> > to close the Configuration panel.

4.3.1.3 STATISTICS CHARTS

Both during a test and in the subsequent data viewing and analysis, instead of the charts described in the previous chapter, it is possible to view a pie chart depicting the division of time elapsed between specific thresholds defined previously.

The same panel used to configure the second monitor (see chap. 4.2.1.2) can also be used to indicate which value is to be taken into consideration (Stance, Swing, Step Length, Jump Height, etc.) and which warning threshold and bad threshold values are to be set.

The mode (Asymmetry or Absolute Value) is obviously the most important parameter to be set on the basis of what is to be monitored.

In the example below we want to see how asymmetric (right/left) the patient is during a treadmill gait test in terms of step length, in relation to the thresholds set:

Mode	Asymmetry
Type	Step
Data window	5 DATA
Warning threshold	5%
Bad threshold	10%
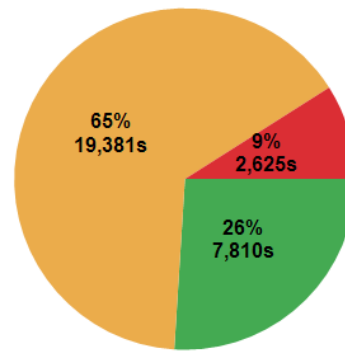
The statistics chart shows that in a total of approximately 30 seconds testing, 26% (7.8 s) showed asymmetry under 5%, 65% of the time (19.3 s) it was between 5% and 10%, and just 9% of the time (2.6 s) asymmetry was over 10%.

The Data Window allows us to decide every how many events a calculation to work out which of the three bands the patient falls into; e.g. by setting 5 DATA, every 5 steps (or jumps) the average of the selected measurement is calculated, compared with the reference value and the established thresholds and assigned to the good, warning or bad category.

In this second example, however, we see the use of 'Absolute Value' mode where, in a 'Jumps 60 seconds' test, the Height value is compared with a reference value of 30 cm: 31% of the time the patient jumped over 27 cm (30 cm – 10% of the warning threshold), 26% of the time he/she jumped between 24 and 27 cm, and 43% of the time he/she jumped under 24 cm.

Mode	Absolute Value
Type	Height
Data window	5 DATA
Reference value	30
Warning threshold	10%
Bad threshold	20%
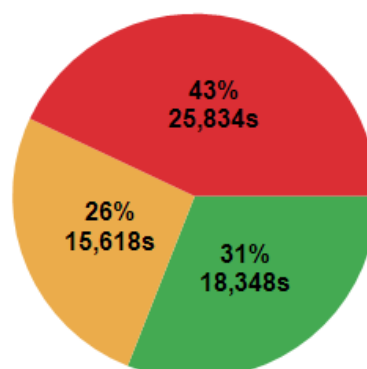
4.3.1.4 TABLE WITH NUMERICAL DATA

In 'Jump Tests' or 'Reaction Tests', the numerical data to display are few and therefore almost always fit into one screen.

On the contrary, in Sprint/Gait tests (regular or with treadmill), the table of numerical data has many columns (a horizontal scroll bar is shown); it was therefore decided to divide them into two pages, the first containing typical *Run Data* and the second containing *Gait Data*.

To switch from one screen to another, click on the link on the top left corner of the table.

Run Data	#	TExt.[s]	Time[s]	Dista	Gait Data	#	TExt.[s]	Stance phase[
✓	1 R				✓	1 L		0,89
✓	2 L		0,668		✓	2 R		0,94
✓	3 R		0,894		✓	3 L		0,87
✓	4 L		1,608		✓	4 R		0,91
✓	5 R		2,262		✓	5 L		0,87
✓	6 L		2,959		✓	6 R		0,94
✓	7 R		3,622		✓	7 L		0,88

Figure 72 - Run & Gait Data

There is also a third type of data depiction called 'Gait Report', which can be zoomed with the + and – button

Gait Report
Zoom

Lengths	Step length [cm]	Left	73,3±2,1 (CV 2,9%)
		Right	75,5±2,3 (CV 3,0%)
		Diff	-3,0%
	Stride length [cm]		148,8±2,7 (CV 1,8%)
Gait parameters %	Stance phase [%]	Left	71,7±0,8 (CV 1,1%)
		Right	70,6±0,6 (CV 0,9%)
		Diff	1,5%
	Swing phase [%]	Left	28,3±0,8 (CV 2,7%)
		Right	29,4±0,6 (CV 2,1%)
		Diff	-3,9%
	Single support [%]	Left	29,4±0,7 (CV 2,5%)
		Right	28,3±1,0 (CV 3,4%)
		Diff	3,6%
	Total Double support [%]		42,3±1,0 (CV 2,4%)
	Load response [%]	Left	20,3±0,7 (CV 3,6%)
		Right	21,9±0,9 (CV 3,9%)
		Diff	-7,8%
	Pre-swing [%]	Left	21,9±1,0 (CV 4,6%)
		Right	20,3±0,8 (CV 4,0%)
		Diff	7,3%
Time parameters	Step time [sec]	Left	0,539±0,010 (CV 1,9%)
		Right	0,534±0,012 (CV 2,2%)
		Diff	0,9%
	Gait Cycle [sec]		1,073±0,014 (CV 1,3%)
	Cadence [step/sec]		0,930±0,010 (CV 1,1%)
Speed parameters	Speed [m/s]	Left	1,39±0,03 (CV 2,2%)
		Right	1,39±0,02 (CV 1,4%)
		Diff	0,0%
	Average Speed [m/s]		1,39±0,03 (CV 2,2%)

.

In the Run Test (on a modular system or on a treadmill) there is another possibility, i.e. to view a dynamic report (**Run Report**) focusing on the asymmetry between the right and the left foot. Of course, the report can be viewed also under Results and in the print report. To view the report, click on the link highlighted in the upper left corner to toggle between Run Data, Gait Data, and Run Report.
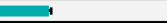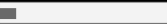
Lengths	Step length [cm]	Left	115±3 (CV 3,0%)
		Right	109±3 (CV 2,8%)
		Diff	5,5%
	Stride length [cm]		224±4 (CV 1,9%)
Time parameters	Flight Time	Left	0,080±0,008 (CV 10,0%)
		Right	0,073±0,007 (CV 9,6%)
		Diff	8,8%
	Contact Time	Left	0,290±0,006 (CV 2,1%)
		Right	0,289±0,006 (CV 2,1%)
		Diff	0,3%
	Contact Phase	Left	0,063±0,007 (CV 11,1%)
		Right	0,058±0,007 (CV 12,1%)
		Diff	7,9%
	Foot Flat	Left	0,146±0,007 (CV 4,8%)
		Right	0,142±0,007 (CV 4,9%)
		Diff	2,7%
	Propulsive Phase	Left	0,080±0,004 (CV 5,0%)
		Right	0,089±0,004 (CV 4,5%)
		Diff	-11,3%
	Height	Left	0,8±0,2 (CV 25,0%)
		Right	0,7±0,1 (CV 14,3%)
		Diff	12,5%
	Stride Angle	Left	1,579±0,283 (CV 17,9%)
		Right	1,388±0,248 (CV 17,9%)
		Diff	12,1%
Speed parameters	Speed [m/s]	Left	3,11±0,06 (CV 1,9%)
		Right	3,00±0,05 (CV 1,7%)
		Diff	3,5%
	Average Speed [m/s]		3,06±0,08 (CV 2,6%)

Figure 73 - Run Report

In **Tapping** Tests, four pages may be scrolled:

- Left and right foot results
- Left foot results
- Right foot results
- Comparison between right and left foot

At the bottom of the data, some statistical data are calculated:

- Minimum Value
- Maximum Value
- Average (µ)
- Standard Deviation (σ)
- Coefficient of Variation (CV: ratio of the standard deviation to the mean)

In some test types, values are calculated for each foot (left & right)

Minimum	(#24)	0,062	(#8)	0,374	(#8)	17,2	(#8)	20,94	(#2)	1,33
Maximum	(#8)	0,282	(#22)	0,579	(#22)	41,1	(#22)	107,27	(#12)	1,78
Avg		0,184		0,459		26,2		41,10		1,56
Std Dev		0,051		0,057		10,0		20,45		0,10
CV		27,7%		12,4%		33,3%		49,8%		6,4%
Avg L		0,189		0,464		30,0		40,16		1,56
Avg R		0,180		0,455		30,0		42,05		1,56
L - R(%)		4,8%		1,9%		0,0%		-4,7%		0,0%
CV L		18,5%		12,7%		33,3%		45,8%		5,8%
CV R		35,6%		12,5%		33,3%		55,1%		7,1%

Figure 74 – Calculated statistical data

4.3.1.4.1 Row Management Menu

When RIGHT-clicking on a table row a context menu appears with the following items:

Figure 75 – Data row management menu

- **Restore row**: allows you to reset a previously deleted row or a row connected to the row above or below as valid
- **Delete row**: deletes the selected row – deleted rows are not considered in the calculation of averages and of total values for the test; they are displayed in ~~strikethrough~~
- **Delete TCont.**: deletes a contact time from the selected row; as a consequence the associated contact and flight times are added to the flight time in the row above
- **Delete TFlight**: deletes the flight time from the line row; as a consequence associated flight and contact times are added to the contact time in the row below
- **Show marked rows**: allows you to show/hide deleted rows or rows with deleted flight or contact time
- **Change starting foot**: allows you to set the right foot or the left foot as starting foot. It is very useful to use the video to discern with which foot the patient has started. If you do not have video recordings and you do not remember the foot, specify 'Undefined'.

4.3.1.5 START FOOT

The Starting Foot can be defined during the creation of a test (see 'Define / Modify Test'), or afterward - keeping it as 'not defined' - during the analysis.

Sprint and Gait Test on modular systems:

- Starting <u>outside</u> the test area: the starting foot is *the first one to touch the ground inside the area;*
- Starting <u>inside</u> the test area: the starting foot is *the one with the first contact after the beginning of the test.*

Assigning the starting foot after a test has been carried out is done in the 'Results' area. From 'View', open the 'Configure' menu, select 'First Contact Time' from 'Parameter Research' and, viewing the first contact time from the 'Data' window, right-click on the relevant line. At this point, select 'Change starting foot' from the displayed menu and make your choice.

E.g. In the following picture the athlete enters the Optojump test area with his RIGHT foot (as you can see in the video) and then, using the menu, it is possible to assign that foot (confirmed by the green footprint below).
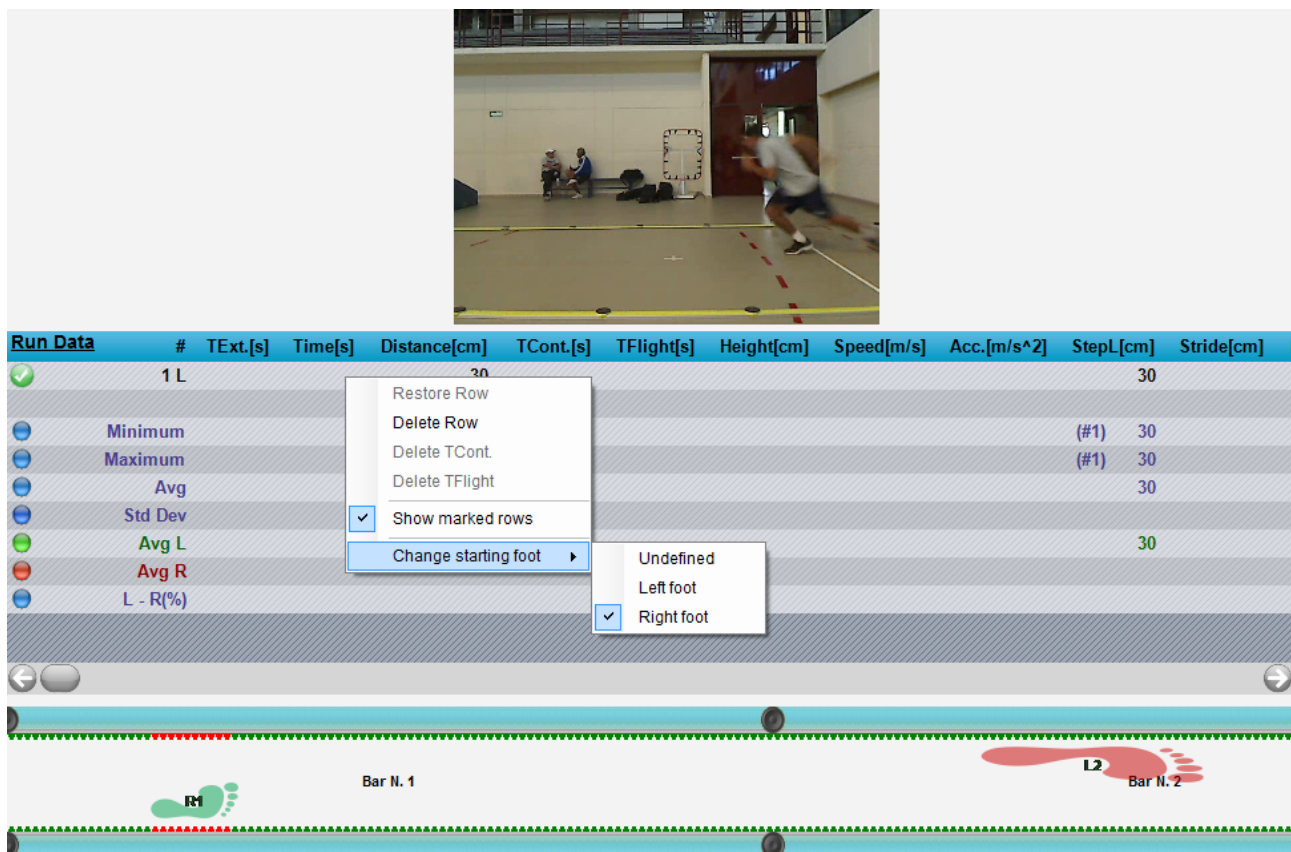
Figure 76 – Sprint and Gait Test: assigning the starting foot

Should you realize that the assigned starting foot is wrong, just follow the above-stated procedure and switch the selection.

Treadmill Running Test and **Treadmill Gait Test.**

In this case the foot *touching the ground **after** the START command* is assigned as starting foot.

If the START is assigned during a double support, as occurs quite often in Gait Tests, the starting foot is the one in front on the Treadmill.

Figure 77 - Defining the starting foot = right foot, pressing START at this moment

Assigning the starting foot before the test is of utmost importance when using OptoGait together with a surface electromyography, in which case, the EMG software needs to know the starting foot beforehand.

⚠️ **CAUTION**

See chap. 1.5 for correct positioning of the bars on the treadmill.

Of course it is possible to do this afterwards using the same method described above for the **Sprint and Gait Tests on modular systems** (even as regards possible foot assigning errors).
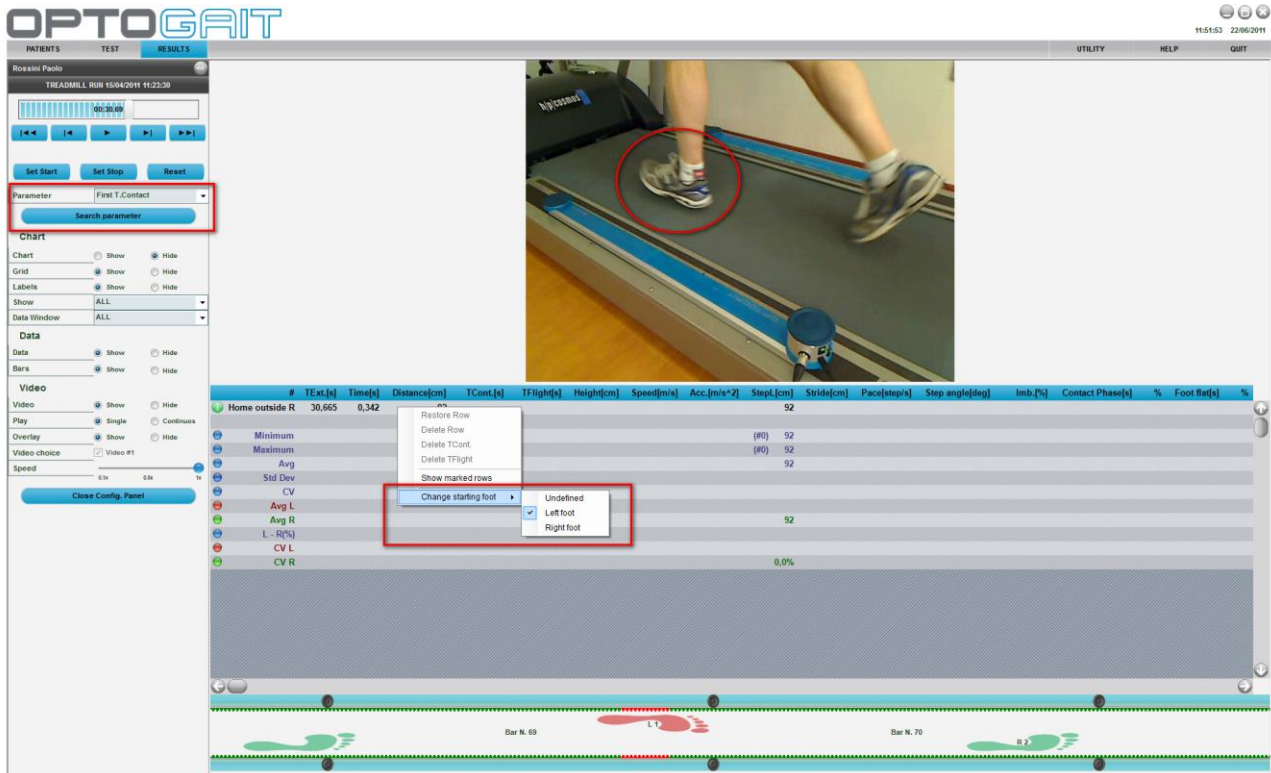
*Figure 78 - Treadmill **Running** Test: assigning the starting foot*
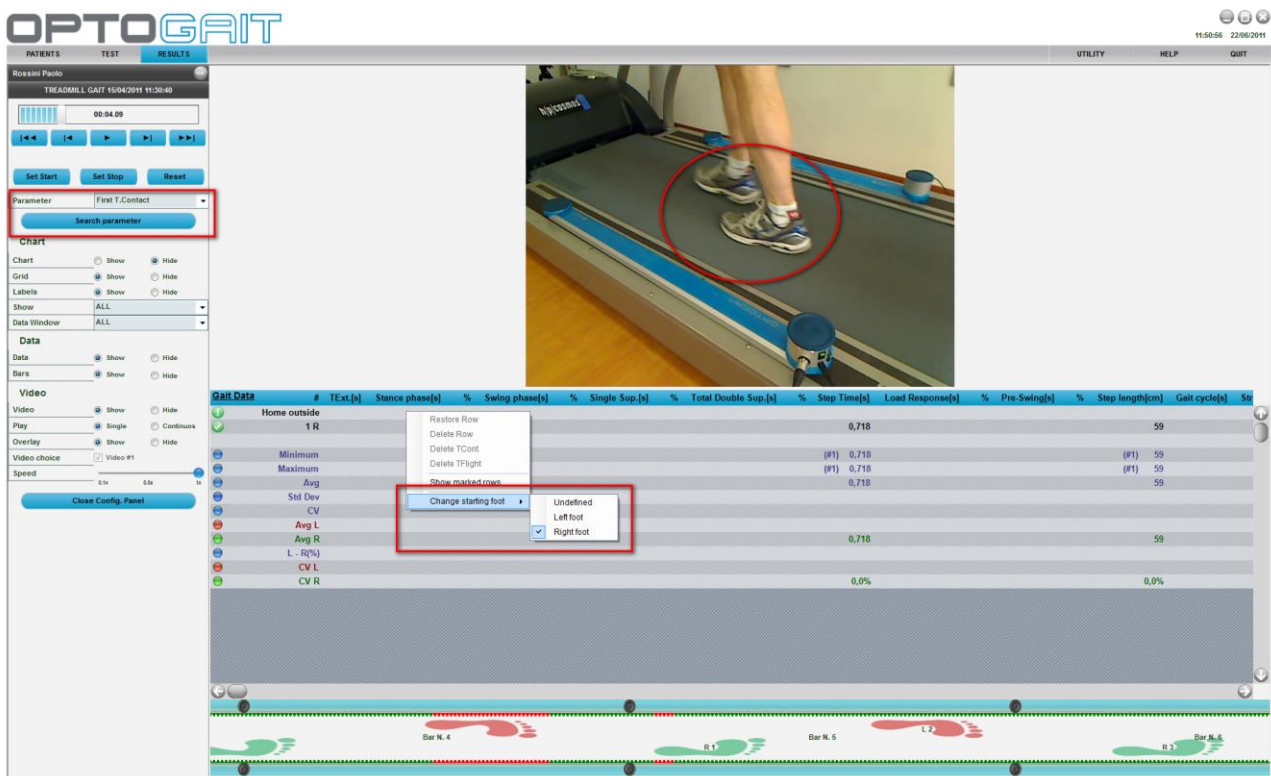
*Figure 79 - Treadmill **Gait** Test: assigning the starting foot (double support)*

The starting foot of run and gait tests with modular systems can be change several times. In a round-trip test, for example, it can be useful to change the foot with which the athlete has entered the area after having changed direction. By positioning the mouse on the footprint to be changed and pressing the right button 'Invert foot' is viewed. Choosing this option, all <u>following</u> feet of the chosen foot are changed (e.g. clicking on the footprint #7, the 7,8,9, etc. are inverted.).
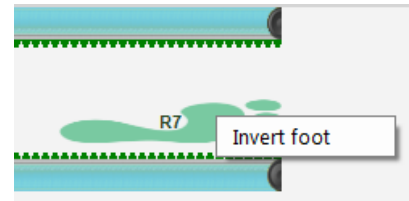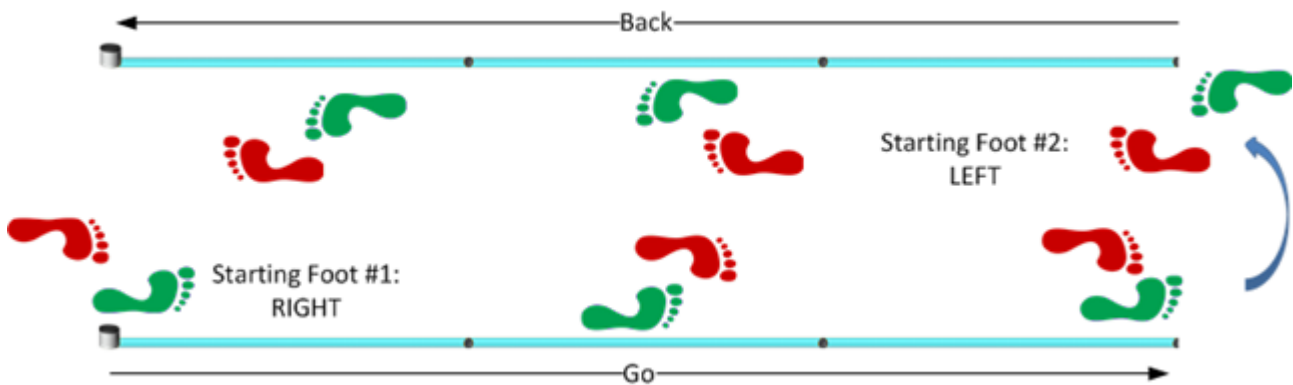
In the round-trip used in modular systems, assigning a maximum flight time **lower than** the time it takes the athlete to turn around in the test area, <u>the 'there' footprints are deleted</u> and substituted with the 'back' footprints. Therefore, set the maximum flight time based upon one's needs (i.e. if the 'there' and 'back' footprints are to be left superposed as shown in the figure, or the previous ones deleted).
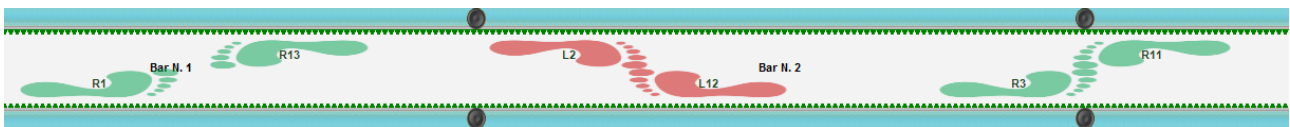
Figure 80 - There' and 'Back' footprints

4.3.1.6 VIDEO PREVIEW POPUP: FIRST STEP PREVIEW

While in the new '2D Gait' test the starting foot recognition (first step) is automatic, in other test types, such as Sprint and Gait (run and gait on linear systems), treadmill gait and treadmill running, the operator must decide which foot is the one that began the test.

In order to help the user in this operation, which is sometimes difficult because the patient is far away, a new feature called '*video preview popup*' has been added, displaying a popup window for N seconds (you can set N as you like), where the first frame of the trial is viewed, allowing the operator to understand if the entering foot is the one specified or if it is the opposite foot.

During these N seconds, by watching the preview of the two webcams it is possible to confirm or change the foot of the first step simply clicking on the right or left foot icon (or wait until the popup closes automatically confirming the choice).

In the example below, the patient enters with the left foot, whereas the test was set differently (or could have been set as 'undefined'). Clicking on the red icon of the left foot, the setting is immediately inverted, therefore it does not need to be done afterwards from the Results Module.
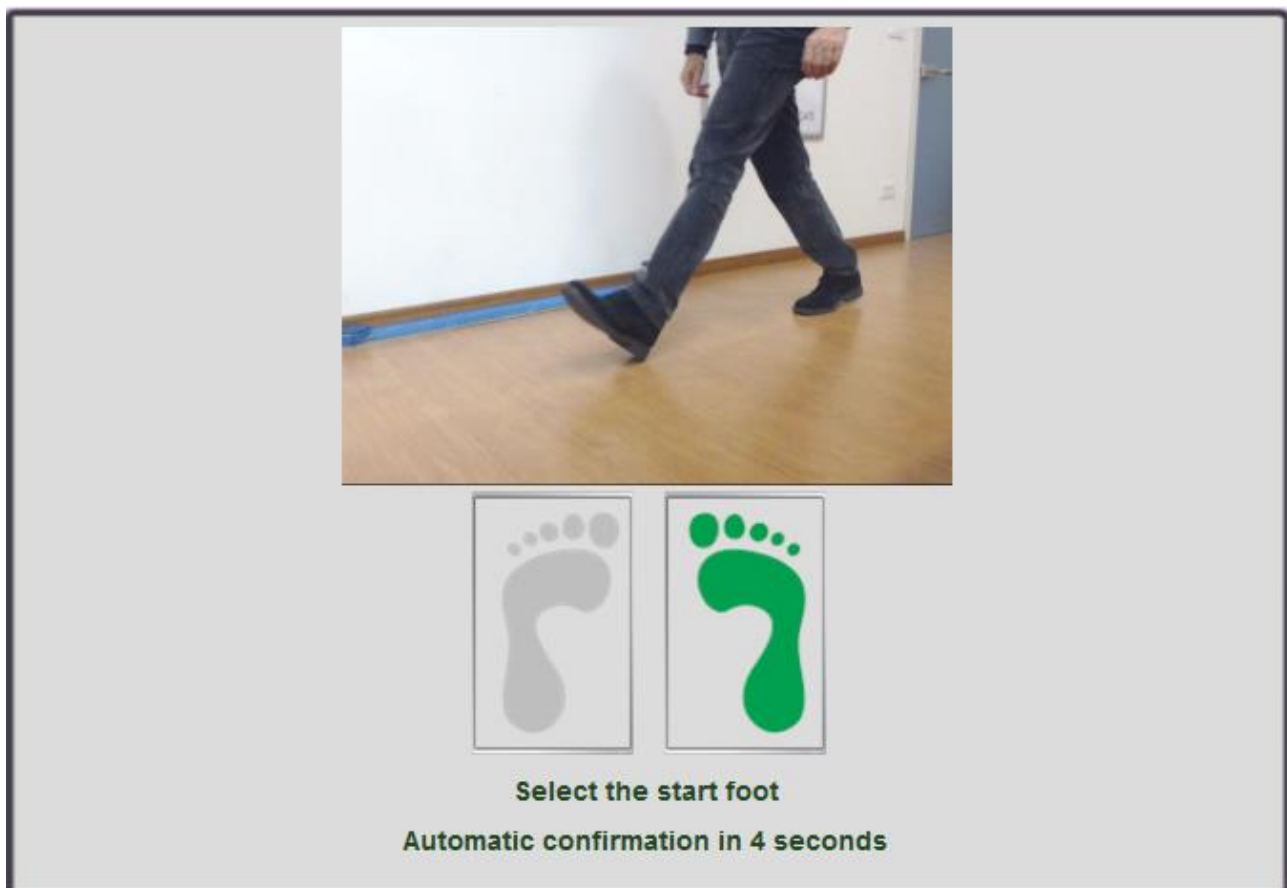
4.3.1.7 VIEWING OF THE OPTOGAIT BARS

The OptoGait bars allow you to view afterwards the LEDs that have been interrupted (in red) and, if a starting foot has been set, to view the footfall thanks to the graphical footprints. The footprint length is directly proportional to the number of interrupted LEDs.

Similarly, the labels of the numerical data chart and row values always display which foot they are referring to.
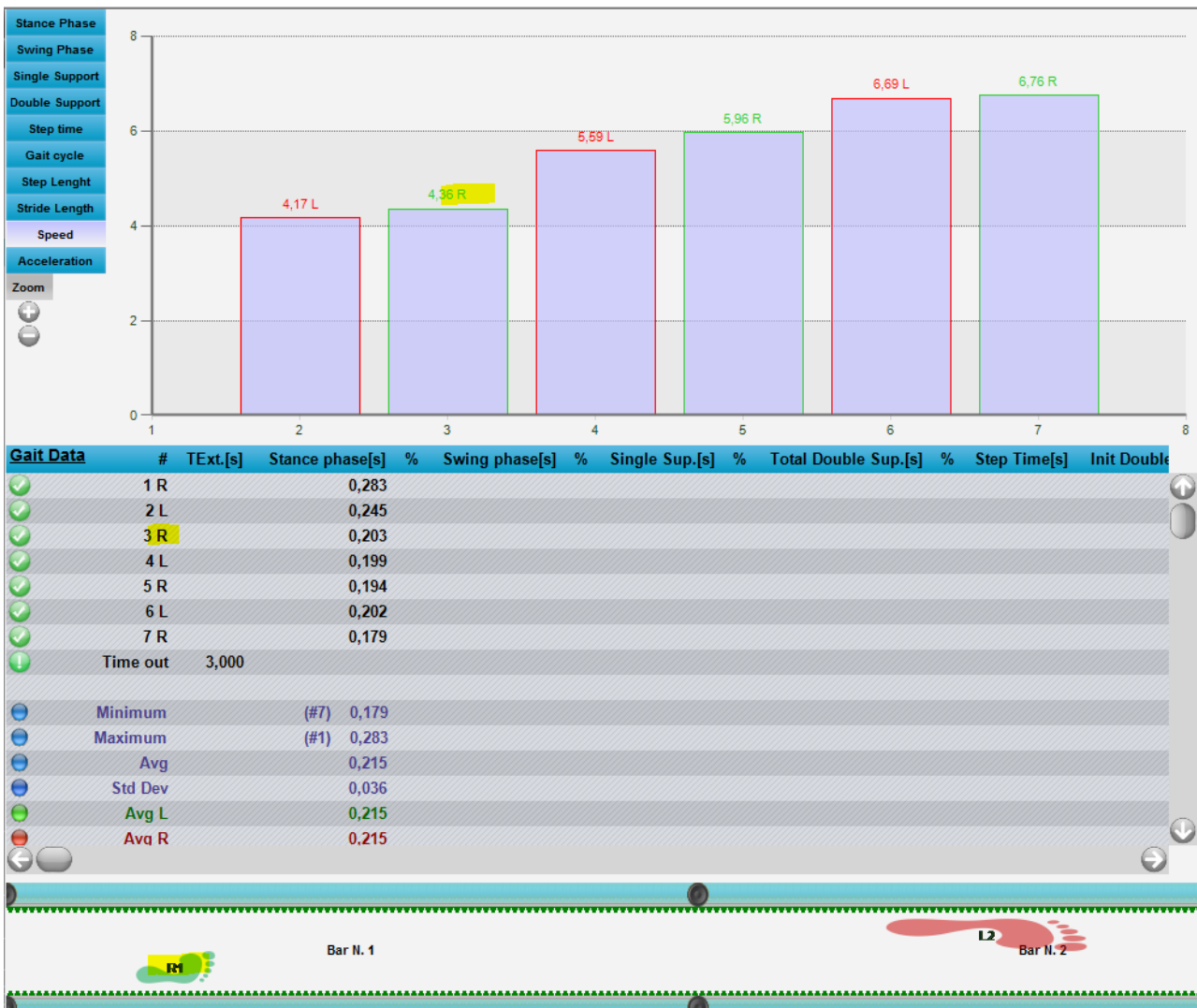
Figure 81 – Indicating the foot on charts, tables and bars

When watching a run/gait video of a modular system composed of many meters, as the time progresses, the bars scroll in synchronization with the video and the charts, allowing the user to follow the LEDs interrupted during the test.

Bar scrolling can be disabled by clicking on the lock icon in the bottom right corner. The button has a toggle function, so when clicked scrolling is enabled again.

From this view, a '**Measuring Ruler**' can been used to see how many centimetres (or inches) there are between a series of lit LEDs (or between two points). Double-click on the first LED and then on

the second LED to view the measure (the markers are green and red for the first and second point). Click anywhere on the bars and ESC to delete the measure.
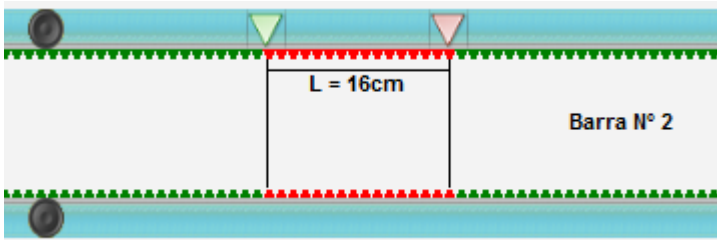
Figure 82 - Measure in cm or inches of the distance between two points

In this view you can also **temporarily delete a series of LEDs for a certain period of time**. Unlike the command <LED Filter> (see chap. 4.4.2), which excludes a series of LEDs for the entire test, this allows you to also work during the test analysis and exclude a series of contiguous LEDs (or one single LED) for a certain number of thousandths of seconds. Let us suppose, for example, that during a treadmill gait test you realise that the patient has shuffled his/her foot by mistake and you want to delete that series of LEDs for those 2 seconds: press and hold the CTRL key, click on the first incorrect LED and (without releasing the CTRL key and the mouse button) drag the selection as far as the second LED in your segment (a red-coloured area will indicate the part to be cancelled). Confirm by pressing YES when prompted, if you want to delete the LEDs, and indicate the number of thousandths of seconds for which the change is to be applied (in this example 2000), and the numeric data table will be displayed. If you want to save the data, press <OK> in the upper left corner. Otherwise, press <CANCEL>.
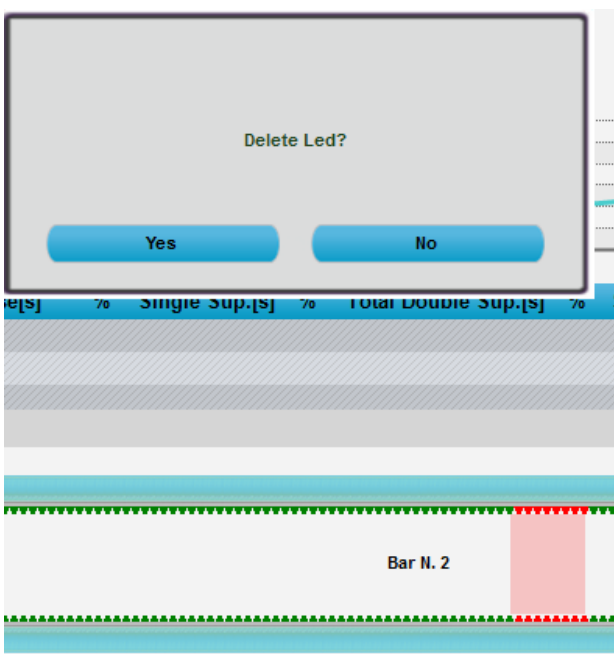
Figure 83 – Deleting LEDs for a certain amount of time

If you want to delete the whole series of LEDs (a complete footprint) for the entire test, press CTRL+right mouse click on any red LED of the footprint and then confirm the deletion by pressing YES. See also this article of our Knowledge Base for all the operations available in this view.

Zoom and Config Buttons on the Bars

Clicking on the "+" icon at the beginning of the displayed bars, the latter can be zoomed. Click on the "-" icon to go back to normal view.
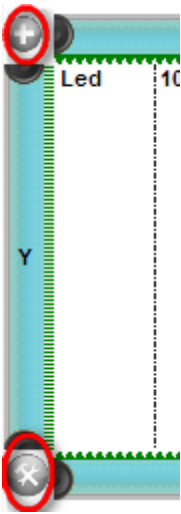
Using the Configure Bars button (useful mainly for run or gait tests) the information to be displayed can be set. Partial and progressive distances between one step and another have been added.
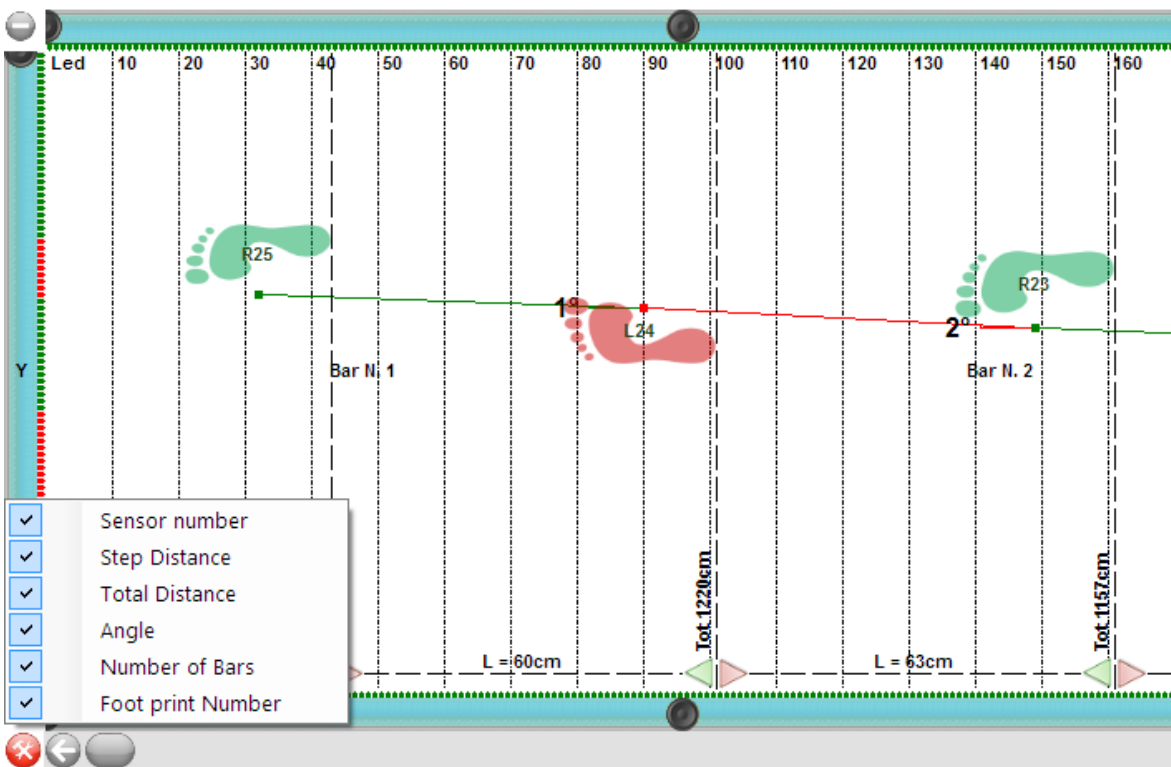
4.3.1.8 PRINT

When <Print> is pressed, a multi-page report is printed with the patient's data, summarizing (average) test data, numerical test data (times, heights, power, etc.) and all the charts of the previous window.

A box containing the index with the pages allows you (by clicking on each page) to rapidly select the desired section.
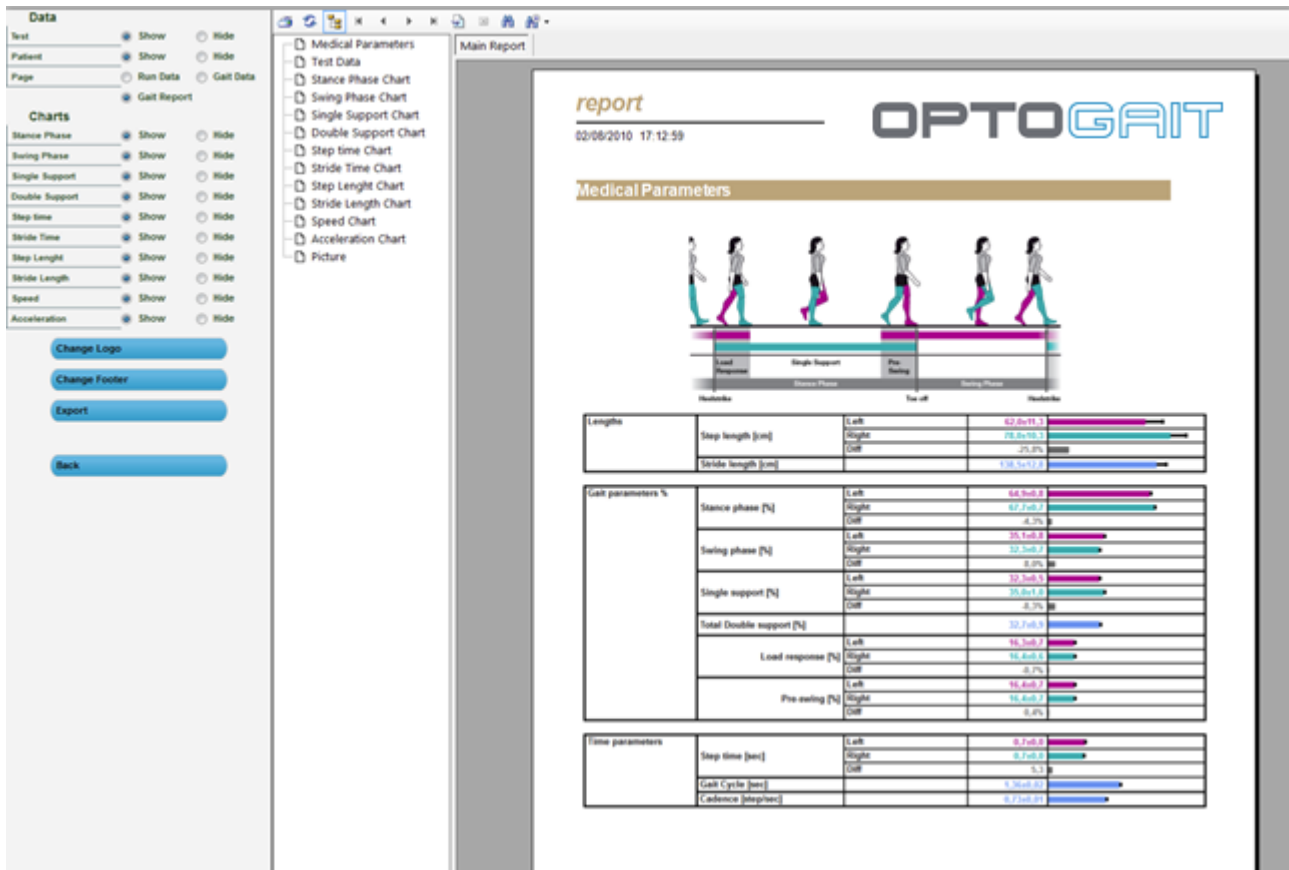
Figure 84 – Report Print

The radio buttons on the left allow you to show or hide particular sections of the report for both Data and Charts. Press <Apply> after changing any of the parameters to view the changes to the report.

The command toolbar above the report allows you to perform the following operations:

Figure 85 – Print Report Command Toolbar

- **Print** the report on the printer set in the dialog box
- **Refresh** the data
- **Show/Hide** the page index
- Go to **first** page
- Go to **previous** page
- Go to **next** page
- Go to **last** page

- Go to page **No.**
- **Close** the report
- **Search**
- **Zoom**

The buttons **<Change logo>** and **<Change footer>** allow you to customize the report adding your logo and your personal data (respectively printed in the top right corner and on the bottom line).

Press **<Export>** on the left to export the report in PDF, Excel, Word or Html format.

Choose the desired format from the drop-down menu, select the position, name the file, and press 'Save'.
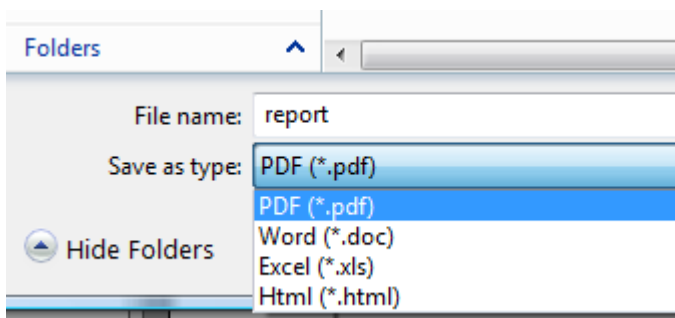
Figure 86 – Dialog box for saving a report

The functionality of Report creation, printing and saving are offered by the external Crystal Report component. If this does not work correctly, we advise you to check whether you have installed different versions or editions of this software. If you have, uninstall the old versions and re-install the OptoGait packet.

4.3.1.9 SAVE ANALYSIS

This function allows you to give the current settings configuration a mnemonic name, so that it can be recalled from the list of saved analyses for future use.

4.3.1.10   ANALYSIS NOTES

This function allows you to add a note, which will be saved with the analysis. This note (DIFFERENT from a note added immediately after completing the test) will be printed on the bottom line of the report in the provided section, whereas the 'test note' is printed on the first page with the General Data. Warning: the analysis note is saved with the analysis; by not storing it you will lose it.

4.3.1.11   SIGNATURE

The signature works in a way similar to the notes (e.g. '*Mario Rossi, orthopedic specialist*'). The signature is printed on the bottom line of the report and saved with the analysis.

4.3.1.12   PARAMETERS

As explained in chap.4.2.2.1, secondary parameters can be customized for each test based on specific needs.

4.3.1.13 USING MARKERS

In a test analysis, other markers besides Set Start and Set Stop can be added in certain spots of the video associating them to a note or a comment. The marker list (which can be created, edited and deleted freely) is also printed in the report showing minutes and comments.

Press the <Markers> button from the menu to the left of the screen.

Set the video to the required frame (using the arrow or CTRL+arrow keys) and press the button <New Marker>; in the pop-up, add a note or a comment for the instant marked by the marker.

In the list below a new record with minutes and the added note is created.
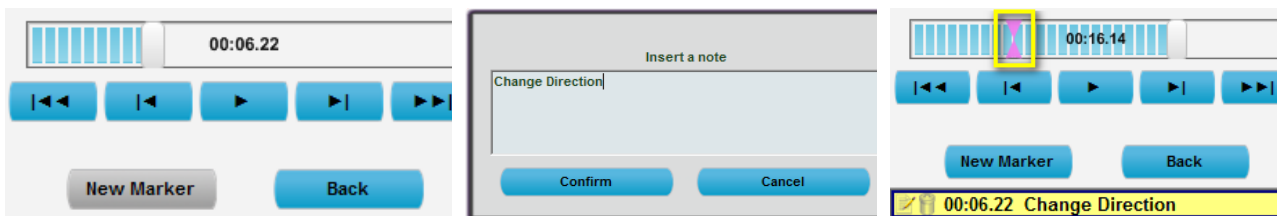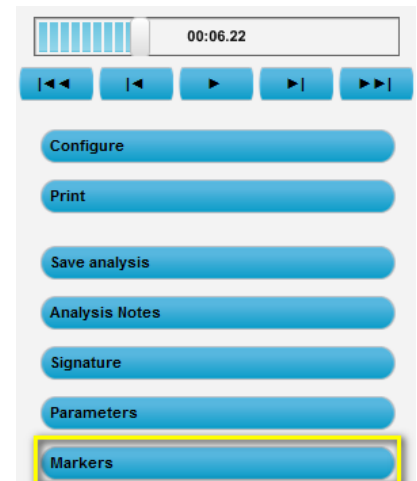
Figure 87 - Creation of a new marker

N markers can be created and managed from the list containing them; in particular you can:

- Double-click on one of them to skip to the marker time frame;
- Click on the first icon (Edit) to edit the note;
- Click on the second icon (Delete) to delete the marker (must be confirmed).

The list is printed in an appropriate Report section.
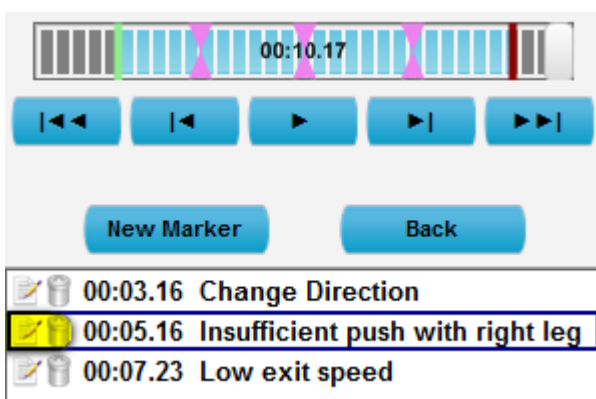
Figure 88 – Marker options   *Figure 89 – Report print*
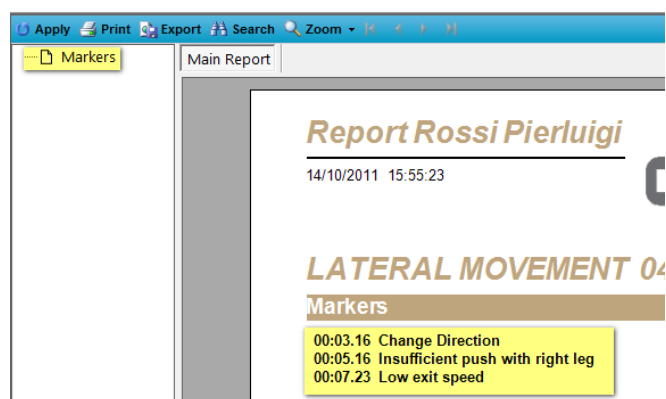
4.3.2 COMPARE

In this section two selected tests are compared. The display structure is similar to the one presented in the previous section. Due to lack of space it is not possible to simulate the bars with the LEDs, which is possible when viewing a single test.

To compare two tests, bring them together in the TEST ANALYSIS table and press <Compare>.
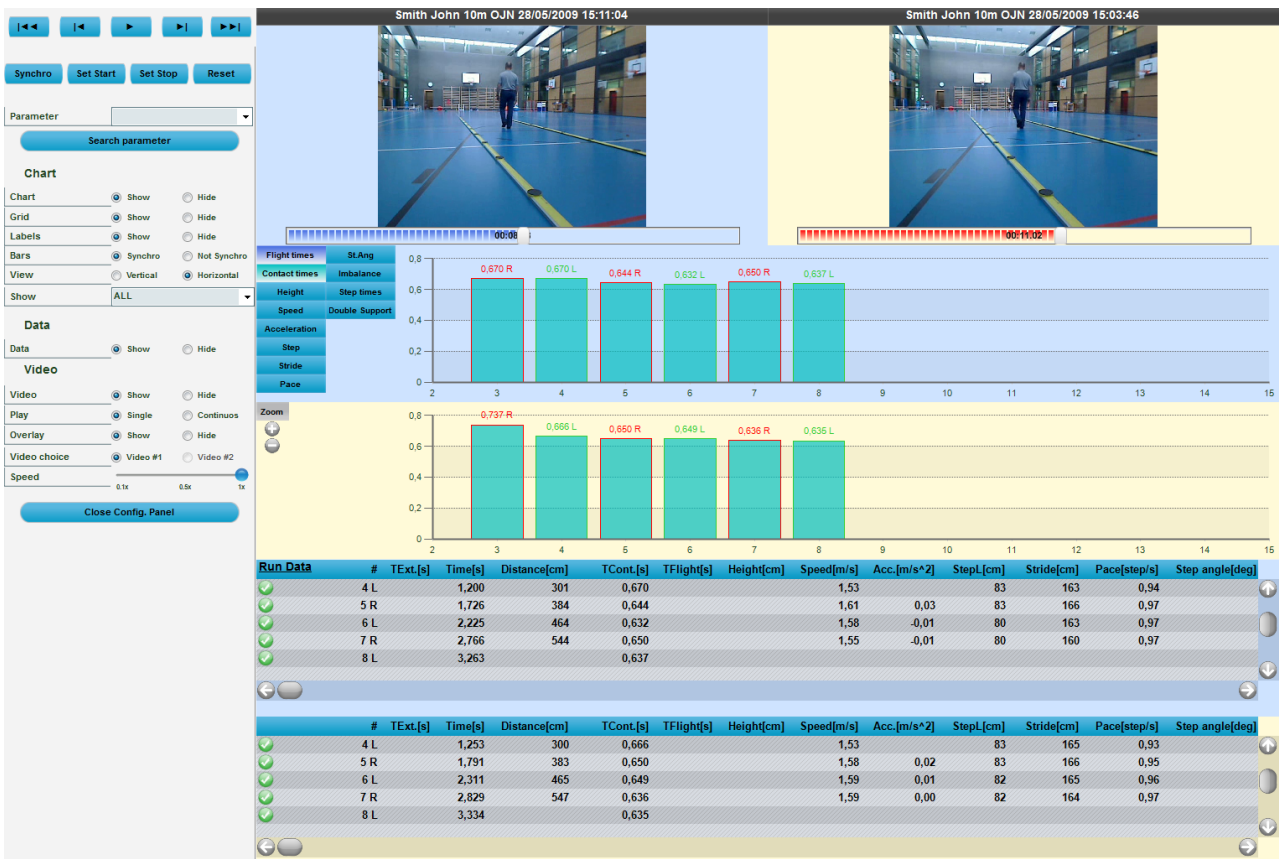
Figure 90 – Compare

Pressing <Play> on the command panel at the top, the two tests (in this example 'Blue Test' and 'Red Test' because of the colour of the two sliders below the video) will start running, allowing visual comparison.

The <Configure> button opens an options panel very similar to the one in the previous section (therefore only differences will be described).

The Search Parameter button, allowing you to spot a common point (e.g. the first take-off from the ground, called First T.Flight) of the two tests, is very important.

Besides the above-described commands <Set Start>, <Set Stop>, and <Reset>, there is also the **<Synchro>** command. Press this button to set the point on which the two tests should be synchronized.

For example: search for the First T.Flight with the command <Search Parameter> and press <Synchro>. Move the cursor of both tests slightly backward and press <Set Start>.Move it slightly forward (after the yellow Synchro marker) and press <Set Stop>.

A range to be analysed has been set and the two tests will be synchronized on the point of the yellow marker (i.e., when the two patients begin the test).

Another use of the <Synchro> button is to synchronize the two tests on a precise instant (e.g. 10 seconds after the beginning of the test). Set the yellow marker at 10 seconds for both tests; set the start (with <Set Start>) of the Red Test at 6 seconds and of the Blue Test at 8 seconds. Pressing the play button will play the Red Test only until the 8 seconds are over. At that moment the Blue Test will start and the two tests will play in synchronization until the end (or possibly until the point chosen with <Set Stop>).

NB: when you press <Synchro>, <Set Start> or <Set Stop>, make sure you have correctly positioned the two tests at the time chosen, as these actions are applied simultaneously to the two tests.
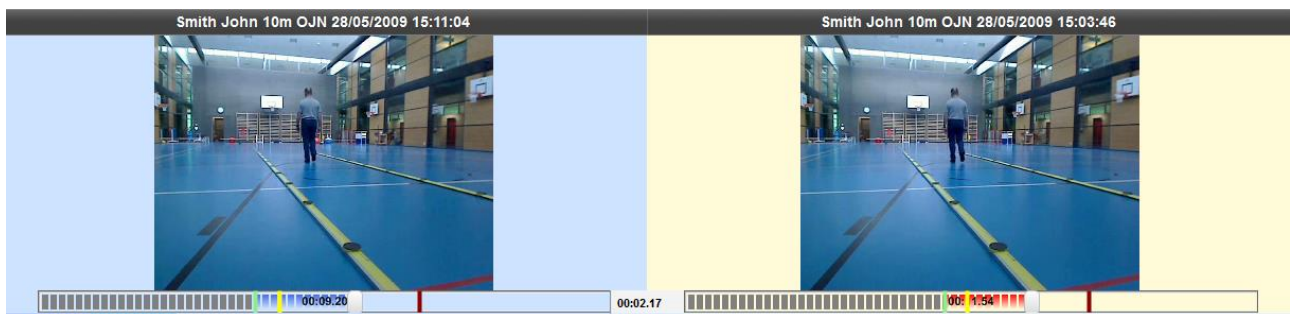
Figure 91 –Synchro, Start, and Stop Settings

Test data viewing can be configured by the user. These settings are similar to those explained in the previous section, except for:

Chart
  o **View**: data can be viewed horizontally (as in Figure Figure 90) or vertically. In this case the numerical values are scrolled horizontally.
  o **Bars**: synchronization of the bars means that if, for example, the Blue Test time slider is moved, the red bar for the Red Test time is automatically moved, too. If 'No Synchro' is chosen, the two scroll bars are disconnected and can be moved independently from each other.

Video
  o **Video choice**: if two movie clips have been acquired (i.e., two webcams are connected) for each test it is possible to choose which movie clip to view, 'Video#1' or 'Video#2'. It is not possible to view the Video taken by Webcam#1 for the Blue Test and the video taken by Webcam#2 for the Red Test (or vice versa).
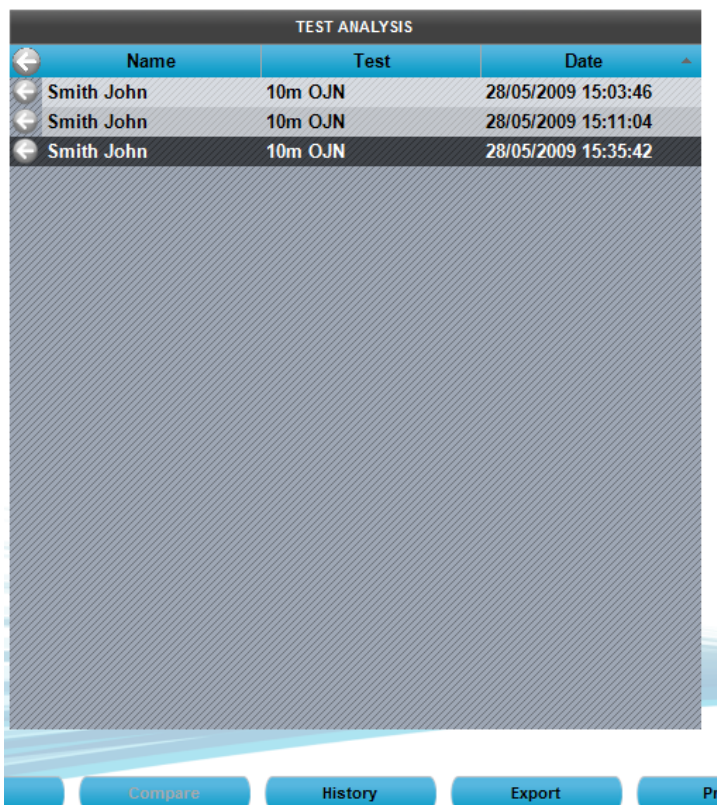
4.3.2.1 PRINT, ANALYSIS, NOTES, SIGNATURE

The options are mainly the same as those in the 'View' section. Printed data is obviously from the comparison between the two tests. Therefore the name of the test, the values, and charts referred to are always displayed at the top.

4.3.3 HISTORY

The History section allows you to analyse a patient's progress by graphically and numerically analysing a series of tests. Alternatively it can be used to analyse the members of a patient group by comparing them in a test of the same type.

Select two or more tests (generally of the same type or uniform in order to ensure plausible data) and press <History>. It is possible to first decide the sequence with which to view the progress in (usually chronological) by clicking on one of the column headers (e.g. Date) and then clicking on the <History> button.

Figure 92 –History analysis of three tests ordered by data

Pressing <Configure> allows you to choose which value to consider for progress analysis: it is possible to select one of the N jumps or he average, best, worst or standard deviation value.

If the tests had a defined starting foot, it is possible to view the data and progress graphs for only one foot or the difference of both feet.

Clicking on the column headers, data are ordered by measure and the graph is updated; this is very useful, for example, to order the team members from the worst to the best value of any parameter.

It is possible to use the History module also on a single test (usually a run/gait test where the starting foot has been set), where it is possible to spot asymmetries between the right and left foot using the option 'Diff%'.
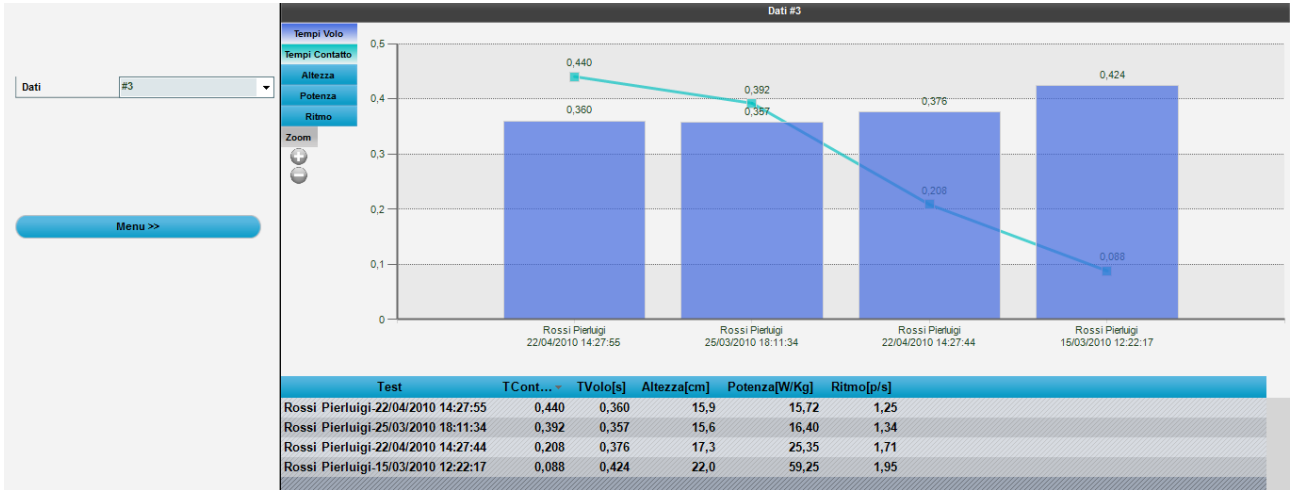
Figure 93 – History
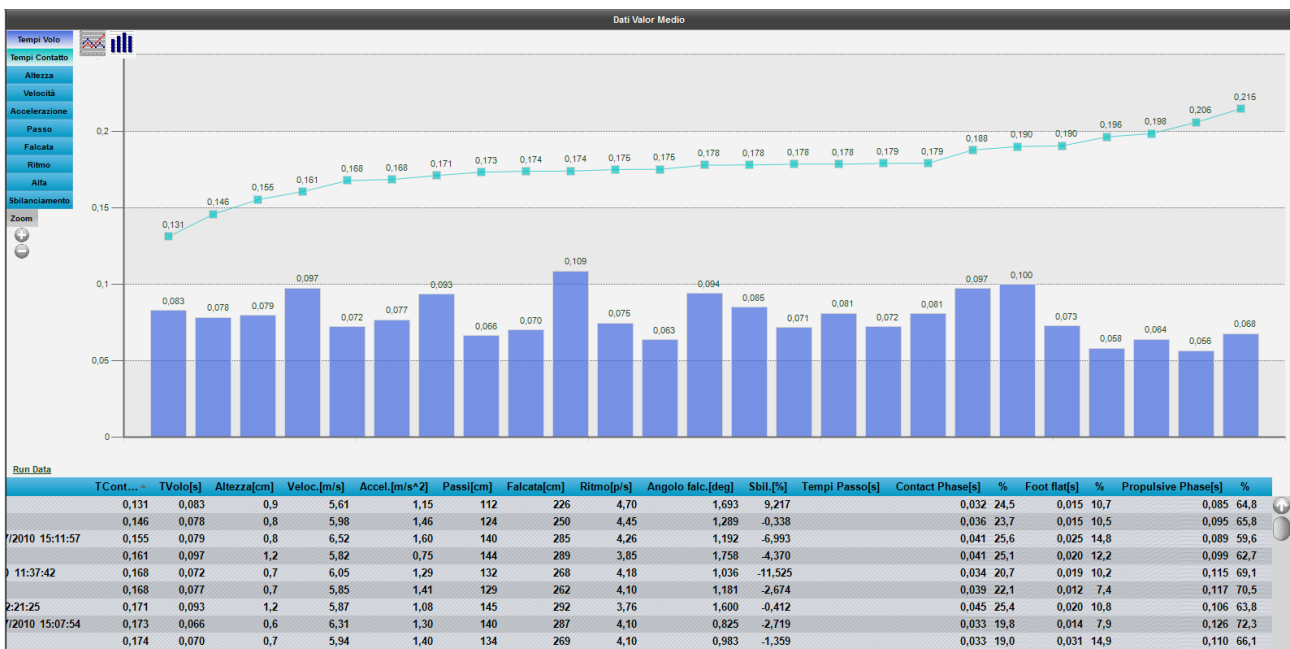
Figure 94 – Team analysis; tests ordered by contact time, from the best to the worst
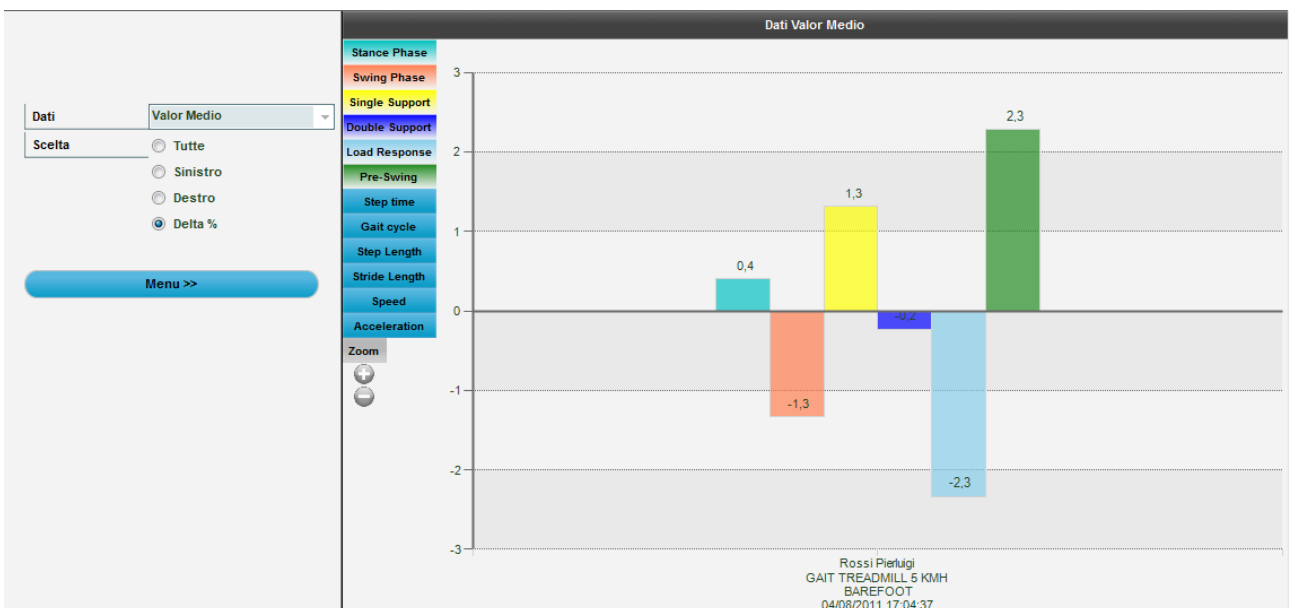
Figure 95 - History of a single test for right/left asymmetries

The <Print> option allows you to create a report to be printed or exported in pdf, Excel, Word or Html format.

4.3.4 EXPORT

To export data of one or more tests to Excel, add at least one test to the 'TEST ANALYSIS' table and press <Export>. You will be asked whether you want the extended version (for each row of data the test heading and the patient's data is repeated – this is useful for pivot tables) or the simple version (only numerical data for the test).

Figure 96 – Export result in Excel with the Extended version

It is also possible to export ONLY the selected tests in OJN format (a compressed file containing the database as well as video and images). Choose the required tests, press the Export button, and choose the option OJN.

Figure 97 - Export Formats

It is now possible to export a single protocol in Excel format. In addition to the classic feature of exporting data of single tests, now (in a second Excel worksheet) also core protocol data (a Drift Test in the example) is exported.

	A	B	C	D
1	Drift 2D Protocol	08/07/2013 17.46.12		
2		L	R	Delta%
3	Average height [cm]	6,6	7,0	-5,8%
4	Average power[W/Kg]	7,83	8,31	-6,1%
5	Average contact time[s]	0,467	0,547	-17,0%
6	Average flight time[s]	0,231	0,238	-3,1%
7	Average LEFT/RIGHT drift[cm]	-1,0	5,4	621,2%
8	Average FRONT/BACK drift[cm]	0,2	-2,7	1450,0%
9	Standard deviation LEFT/RIGHT drift[cm]	18,0	9,1	49,5%
10	Standard deviation FRONT/BACK drift[cm]	25,5	6,9	72,9%
11	Surface[cm²]	1834,4	251,1	86,3%
12				
13				
14				

OJ Data | **Protocol data** | ⊕

4.4 UTILITY

4.4.1 BASIC SETTINGS

The Basic Configuration section includes the following items:

4.4.1.1 GENERAL

Language: the language can be changed at any moment during the execution of the program. Select the desired language from the drop-down menu and press <Save>.

Unit of measurement: allows you to set the unit of measurement type for viewing test output values. In particular:

Table 1 - Units of Measurement

Type	International	US/UK
Height	cm	inch.decimal
Power	W	W
Specific power	W/kg	W/kg
Steps	cm	ft, inch.decimal
Speed	m/s	ft/s
Acceleration	m/s^2	ft/s^2
Weight	kg	lb
Energy	J	J
Specific energy	J/kg	J/kg
Distances	cm	yards, ft, inch.decimal
Step & Stride	cm	ft, inch.decimal

4.4.1.2 JUMP TEST CONFIGURATION

The flight and contact time configurations include (see 5.3 Invalid Times Management on page 200 for further information on how to use these values):

- **Minimum contact time [ms]**: allows you to set a minimum contact time in milliseconds; if the system registers a contact time shorter than this value, it is considered incorrect and added to the associated flight time (usually the previous one). This control can be enabled/disabled by inserting the value 0.
- **Minimum flight [ms]**: allows you to set a minimum flight time in milliseconds; if the system registers a flight time shorter than this value, it is considered incorrect and added to the associated contact time. This control can be enabled/disabled by inserting the value 0.

- **Maximum flight time [ms]**: allows you to set a maximum flight time in milliseconds; if the flight time is higher, it is considered incorrect. This is, for example, useful for a 'round trip' test, where the patient exits the measurement area, turns around and enters it again. The time for changing direction would be considered an abnormal flight time; this parameter allows you to prevent this.

4.4.1.3 REACTION TEST CONFIGURATION

Reaction time configurations include:

- **Reaction time range [ms]**: indicates the time frame in milliseconds within which the reaction signal must be given randomly.
- **Acoustic signal type**: allows you to choose whether to generate the acoustic signal using the sound card, which may not be present, or the internal loudspeaker, generally always available in personal computers.

4.4.1.4 VIDEO

After connecting the webcam(s) to the PC USB port and installing the drivers, the video camera can be tested. Under the heading 'Video', select a Logitech webcam from those available and press <Test>. The choice of webcams has been limited only to high-range Logitech webcams to prevent synchronization problems between OptoGait and video data. Webcams by other manufacturers are displayed in grey.

Figure 98 - Webcam choice

4.4.1.4.1 Video Test

After pressing <Test> the webcam configuration panel in basic mode with the commands for changing gain and exposure (shutter time) is displayed. For better quality and fluidity of videos we recommend using a brief exposure time, such as 1/100 or 1/200, and then adapting gain to obtain the correct image exposure (neither too bright nor too dark). We recommend not setting 'Auto' which could slow down the movie clip acquisition.

With <Device> you can recall the control panel of the webcam's standard driver.<Default> sets the standard value pre-defined by the manufacturer.
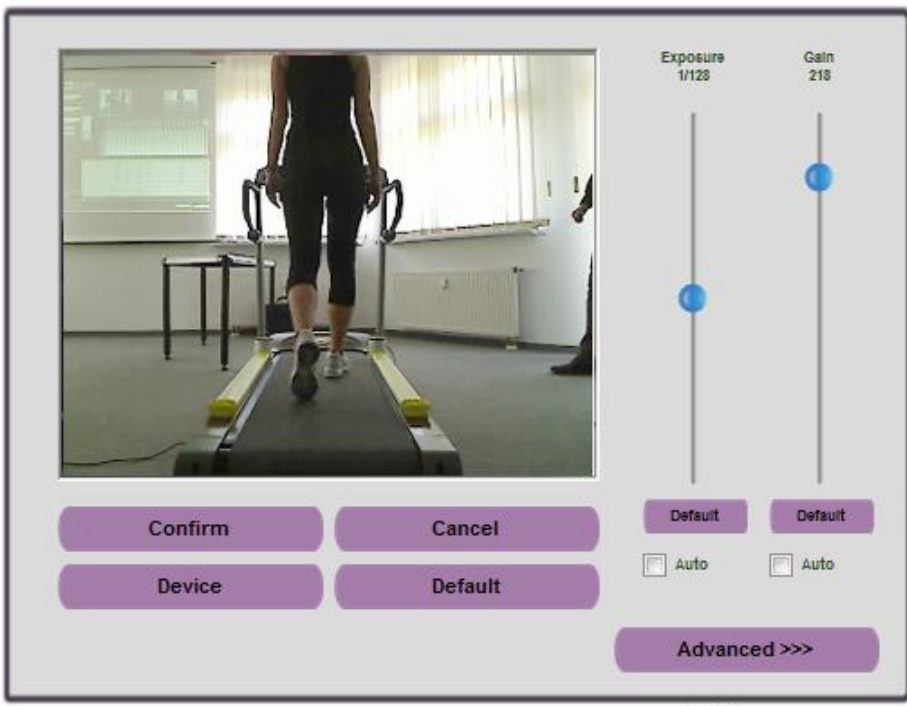
Figure 99– Basic Panel for Webcam configuration

Press the <Advanced> button to display other commands:

- **Zoom** allows you to apply a digital zoom via software.
- **Contrast, Brightness, Saturation, Sharpness** allows you to adapt the image; it is advisable to move the corresponding cursor to test the effects of the command.
- **White Balancing** is useful when working in closed rooms with very warm lights (e.g., tungsten, which gives a yellowish hue) or very cold lights (e.g., neon, which gives a bluish hue). You should something neutral (e.g., a sheet of paper) and then remove any dominant colours using the cursor.
- **Focus** allows you to focus manually in those rare cases when the autofocus does not work.
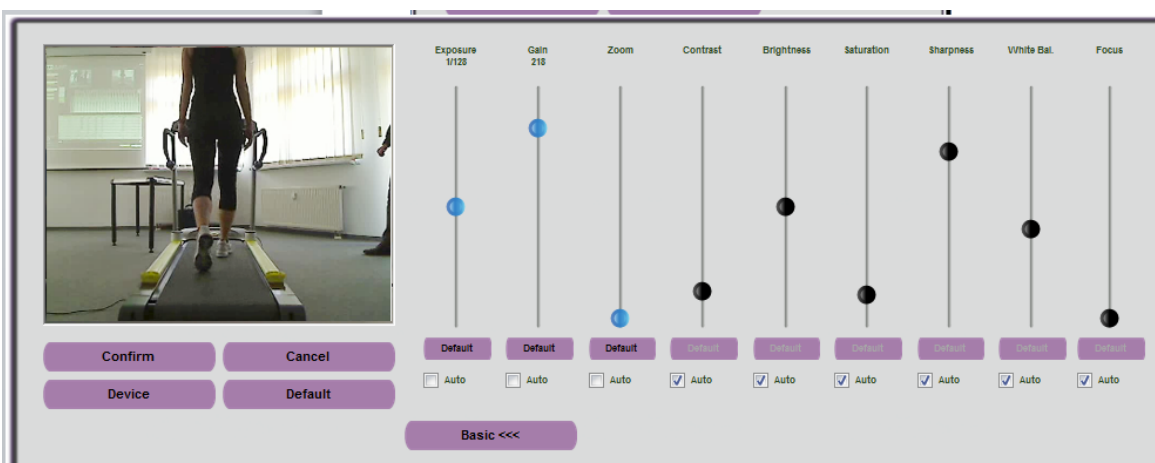
Figure 100– Advanced Panel for Webcam configuration

Remember to save changes by pressing <Confirm>.

4.4.1.4.2 Other video-related configurations

- **End of time video acquisition [s]**: this is the time between the end of the test and the end of video acquisition (i.e., a certain number of extra seconds are recorded after the end of the test).

- **Acquisition Format**: allows you to choose the format for saving videos, which can be in **ASF** (more compact and compatible with Windows Media Player), **AVI** (also compatible with other players but less efficient compression) **MJPEG** or **H.264** (the more compressed and efficient). Plus, depending on the webcam connected, it allows selection of different sampling resolutions (from the lowest 320x240 up to fullHD 1920x1080).

  > MJPG 1920x1080 30FPS HD ▼
  >
  > MJPG 640x480 30FPS
  > MJPG 800x600 30FPS
  > MJPG 1920x1080 30FPS HD
  > ASF 640x480 30FPS
  > ASF 320x240 30FPS
  > ASF WMV9 640x480 30FPS
  > ASF WMV9 320x240 30FPS
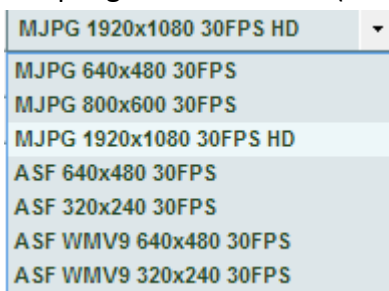
- **Preview First Step**: If enabled, the Gait Test required a visual confirmation, via a pop-up of the starting foot (see chap. 4.3.1.6).

- **Preview Time [sec.]**: After this number of seconds the preview window is closed automatically.

4.4.1.5 SPRINT/GAIT TEST CONFIGURATION

The configurations of this test type include:

- **Direction of entry**: allows you to indicate if the Running/Gait entry direction is from the 'interface side' (drum) or from the 'opposite side'. If 'automatic' is chosen, OptoGait automatically calculates the direction, considering the LED nearest the centre of the foot as the beginning of the LEDs.

- **Test Timeout [ms]**: this is the test end timeout in milliseconds; if during a test with 'Timeout' stop type no input or output signal is received from the measurement area by the OptoGait device for a period longer than or equal to the time set here, the test is considered completed.

- **External signal hold off [ms]**: is the hold off time between two consecutive external signals. Caution has to be applied for this value, because it may depend on the type of test being carried out.

- **Step length calculation**: allows you to choose whether to calculate step length as the distance between the tips of two successive feet or as the distance between the heels of two successive feet.
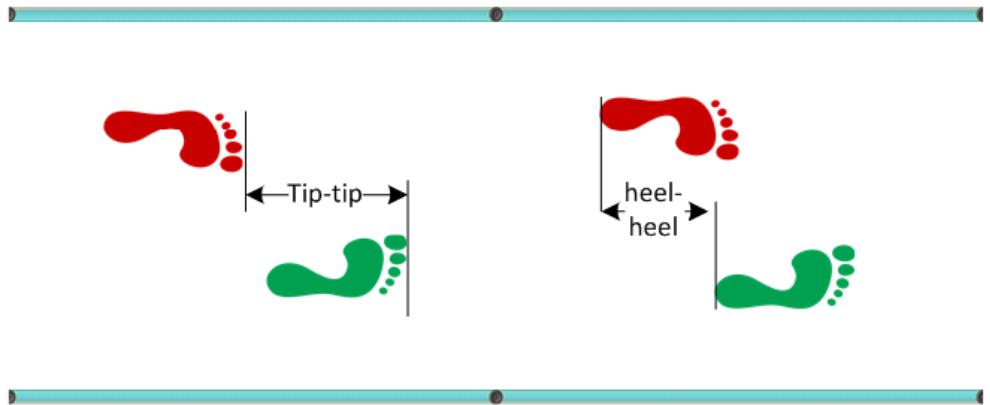
Figure 101 - Tip to Tip or Heel to Heel Step Length

- **Minimum gap between feet [cm or ft]**: is the minimum gap between tiptoe and the heel of the next feet.
- **3rd/6th/9th step speed reference:** insert the reference speed for the 3rd/6th/9th step in m/s; this option can be disabled by inserting the value 0.
- **Split 1/2 at distance [cm or ft]**: insert at how many cm from the start the first or second split time will be taken; leave 0 to disable split times.
- **Minimum foot length [cm or in]**: is the minimum foot length in centimetres (or inches), used to filter possible incorrect acquisitions.

4.4.1.6 SCREEN

The OptoGait software works on most desktop PCs and notebooks of the most recent generation, usually with a resolution of 1024x768 (the minimum recommended resolution). For users who desire to use computers with lower resolutions (e.g., netbooks which often have 1024x600) or computers with lower performance, we recommend that you select the **'Reduced' Screen** option; this will apply the following changes:

- In the tables with numerical data and the data lists, a smaller font is used in order to fit as much information as possible in the allotted space.
- In the Test|Execute module, the webcam, though connected, is not displayed in real-time during acquisition. In any case, the video is saved and can be played in the module 'Results'.
- In the module Results|View or Compare Test it is not possible to view charts and the table with numerical data simultaneously (either one or the other); furthermore, the bar display is disabled. In the configuration panel, the VCR Player control for the video is hidden.

4.4.1.7 NEWS & EVENTS

As described in chap. 2.2, when the software is launched, a series of news and events are displayed on the homepage, which are updated in real-time via the website www.optogait.com. If the computer is not connected to the Internet, the detection of missing connectivity may take a few

seconds. For PCs that are permanently disconnected from the Internet (e.g. fixed stations on the training field without Internet) it is useful to disable the updating of news and events, to prevent the updating timeout.

News & Events

Activation	◉ Enabled	○ Disabled

4.4.1.8 EMG ACTIVATION

If enabled, the output impulse is transmitted (with a fixed delay of 300 ms) through the LEMO connector (see chap. 3.4).

4.4.2 OptoGait HW Test

In this section, the connected hardware (OptoGait bars and/or webcam) can be checked. Opening the function, if the webcam(s) is (are) connected, the live image should be displayed. If one or both images do not appear, check that they have been selected in the Basic Configurations | Video (chap. 4.4.1.4) or that the drivers have been installed correctly.

To check the connection with OptoGait bars, press <Execute> to start the test. The test continues until <STOP> is pressed.

If there are no interrupted LEDs, the test ends with a positive result.

The test can now be repeated by pressing <Execute> and interrupting the LEDs manually (e.g., by placing your foot between the bars). Please note that some LEDs turn red, indicating interruption of the signal caused by entry of the foot. If <End> is pressed, the software will show the interrupted LEDs in the table below, indicating that the test has not had a positive result, because of this intentional interruption.

This test is also very useful to check (mainly in case of outdoor installations of long bar combinations) if there are obstacles, like leaves, stones, hills, etc. between the transmitting and the receiving bar. If the obstacles cannot be removed, it is possible to exclude them via the software: in this case, all interruptions of those LEDs will not be taken into consideration for the test. The figure below shows, for example, LED no. 24 on Bar #1, which has been interrupted with the request to exclude it from acquisition.
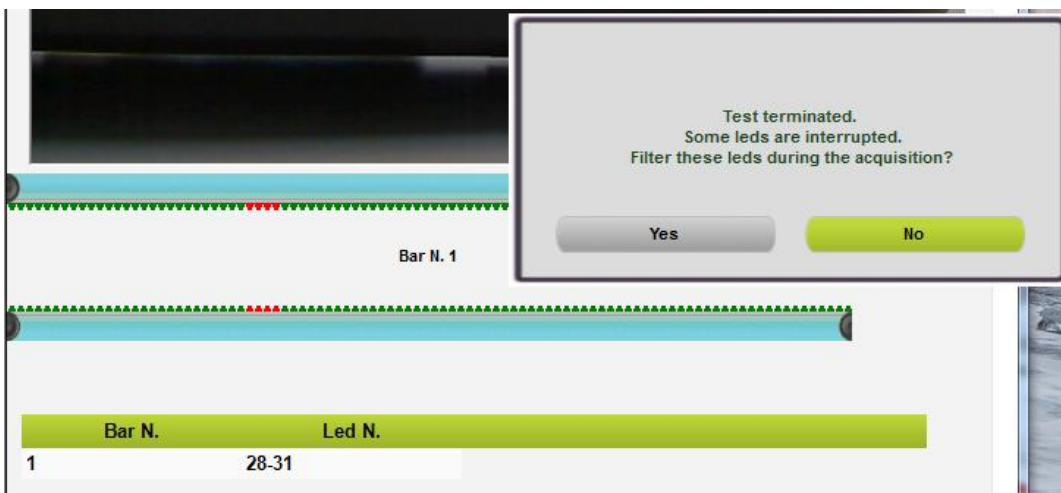
Figure 102 - Excluding an interrupted LED

If you reply YES, next time when using this function , the excluded LED will be BLUE and the button in the lower right corner, <Active LED filter>, will indicate that one or more LEDs have been excluded from the acquisition (the same button appears every time a new test is performed). Pressing the button, the filter can be removed and all LEDs of this bar can be taken into consideration again.

4.4.3 DATABASE

OptoGait stores all data (patients, tests, results, settings, etc.) in a database file (Sql Server CE format with the extension .SDF). Most users can use a single file to store all information, which by default will be called 'OptoGait.sdf', located in the following directory:

Documents\Microgate\OptoGait

The name of this directory changes depending on the operating system used and the language, but typing it in the address bar of an Explorer window will open the correct folder. Some examples follow (*<YourUserName>* is the user name for logging into Windows):

Windows XP in Italian: C:\Documents and Settings*<YourUserName>*\Documenti\Microgate\OptoGait
Windows XP in English: C:\Documents and Settings*<YourUserName>*\My Documents\Microgate\OptoGait
Windows VISTA/7: C:\Users*<YourUserName>*\Documents\Microgate\OptoGait
etc..
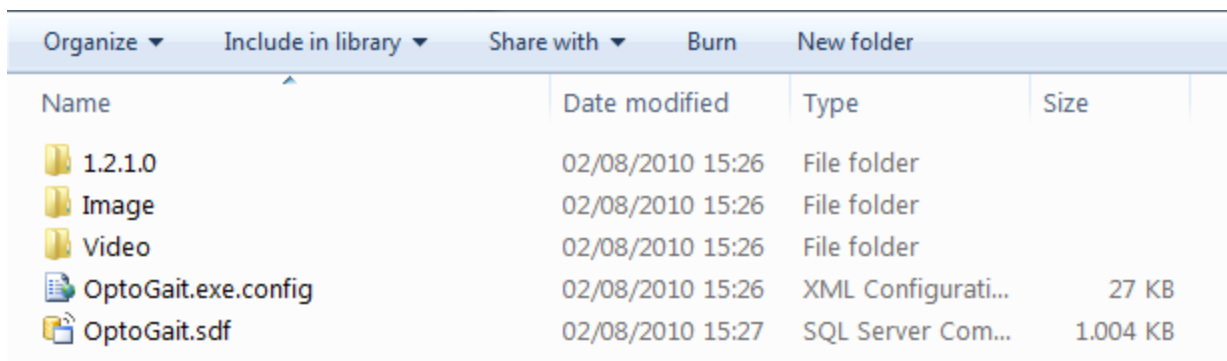
Figure 103 - Folder where by default all database, settings, video, and image files are located

The subdirectory VIDEO contains the videos (in .asf or .avi format depending on your choice in 4.4.1.4) acquired by the webcam. The subdirectory IMAGE stores all still pictures (.bmp files with possible graphical notes) and saves them via the Video Analysis module .

The name of the videos is formed using the following pattern:

VideoX_DD_MM_YYYY_HH_MM_SS_ZZZZZZZZ-ZZZZ-ZZZZ-ZZZZ-ZZZZZZZZZZZZ.EEE

Where

> X: webcam No. 1 or No. 2
> DD_MM_YYYY: day, month and year of acquisition
> HH_MM_SS: hour, minutes and seconds of acquisition
> ZZZZZZZZ-ZZZZ-ZZZZ-ZZZZ-ZZZZZZZZZZZZ series of univocal characters to avoid duplicates
> EEE_video format (ASF or AVI)

Example:

Video1_02_04_2009_12_32_16_1f74d384-4a7f-4c5b-a94c-1772fb608736.asf

Meaning:

Video taken by webcam No. 1 on 2/4/2009 at 12:32:16 in ASF format

The **images** (analysed still frames) saved using the command 'Save images in report' are located in the subdirectory Images and have the following similar format:

Image_DD_MM_YYYY_HH_MM_SS_ZZZZZZZZ-ZZZZ-ZZZZ-ZZZZ-ZZZZZZZZZZZZ.EEE

If there is an error when loading the database, OptoGait will notify you of it at program startup, suggesting you look for the database or continue. In the latter case, OptoGait will create a new empty database.

The software makes it possible to handle more databases (one at a time) for particular needs. For example, the trainer of a team can separate the tests of one season from another (warning: in this case he will not be able to do any comparisons or analyse the history). Also a free-lance professional, who does tests for various customers, can create a database for every team to be tested.

It is also possible to export database data in a compact format (one single file containing database, videos, and images) in order to transfer them from one PC to another or to hand them to the customer to review. Free software downloads are available at www.optogait.com.

The commands used for these purposes are the following:

4.4.3.1 CURRENT DATABASE

The path indicates which database is used; the commands below, <New> and <Select>, allow you to edit the directory and the file to use.

Database
C:\Users\sandror.BZMICROGATE\AppData\Roaming\Microgate\OptoGait\treadmill.sdf

4.4.3.2 NEW

Creates an EMPTY database and sets it as current; you will be asked in which folder to place it.

To organize the still images of a database it is useful to create an empty subdirectory (folder) for the database.

Example:

Create a folder called *MyTests* on your hard disk (in the root directory or under Documents\Microgate\OptoGait).

Then create a folder for each new (empty) database inside this folder. Now each database will be stored in a separate folder with its video and image files.
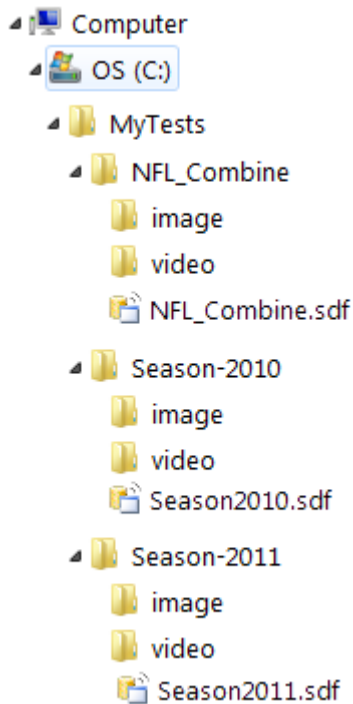
Figure 104 - Database organization example

4.4.3.3 SELECT

If more than one database has been created, you can choose (browsing on the hard disk) which database is ACTIVE.

4.4.3.4 CLEAR

Empties the current database of all Patients, Groups, Test Definitions, and Tests (tests, protocols, analyses) data. You will be asked which of the four tables to empty and further confirm (this operation is IRREVERSIBLE).

4.4.3.5 EXPORT

Exports the CURRENT database together with all videos and still pictures processed in a single compressed file with the extension .OGN; you will be asked in which directory (or on which drive, for example a USB stick with sufficient space) to create and store the file and how to name it. It is possible to export only the database, without videos and images, choosing 'Database (*.sdf)' from the File Type dropdown menu.
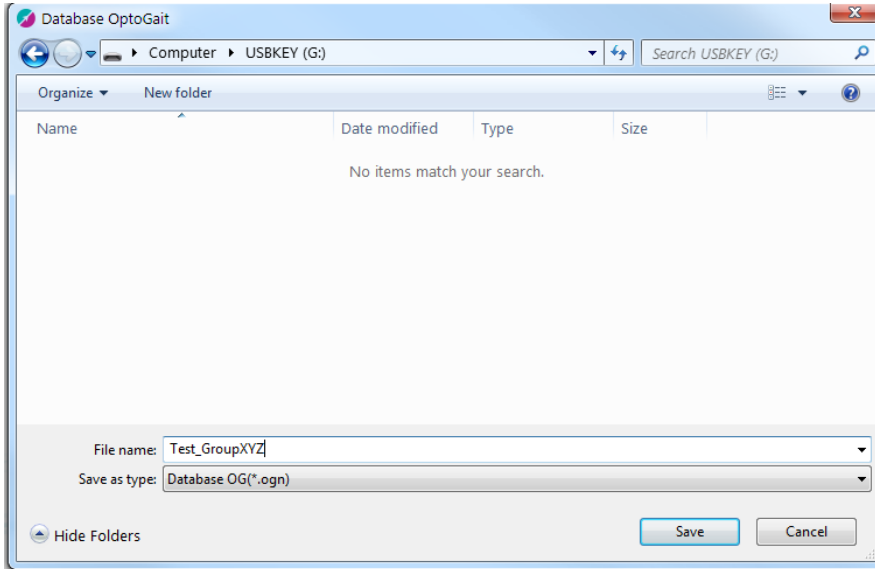
Figure 105 - Saving the OGN file

4.4.3.6 IMPORT

Imports an .OGN file previously exported to another PC or to the same PC, in case of data deletion or removal (restore).). This command can also be used to merge two databases into one database.

This operation is carried out in THREE steps:

- You will be asked if you want to import into a new database (Import) or the current one (Merge)
- The first dialog box asks you to locate the file with the extension .OGN to import
- The second dialog box (only if you clicked YES in the first message window) asks in which folder to extract the .OGN file and as a consequence to store the database file (.sdf) and its subdirectories Video and Images. It is recommended to use the suggested default destination directory, which is the local Documents folder.

Example: You want to import an .OGN export file saved on a USB stick extracting its files to the folder 'C:\My OptoGait Test':

Press <Import>, browse to the drive of the USB stick (in the following example J:) and select the file Test_TeamXYZ.OGN double clicking on it:
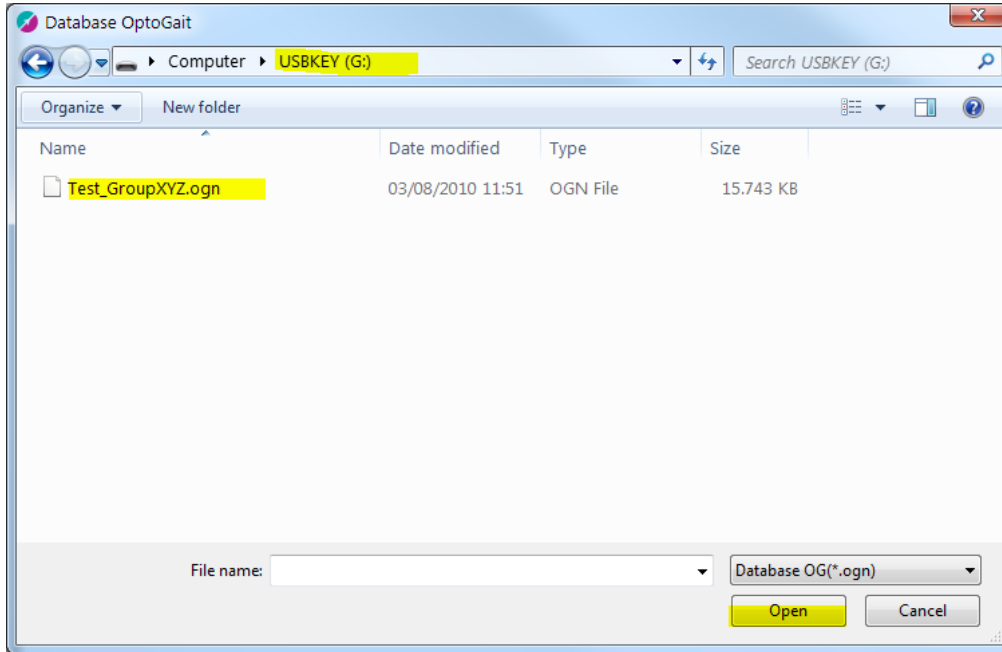
Figure 106 - Choosing the OGN file to import

Now choose the directory for the import; if not present, create it using <Make New Folder>.
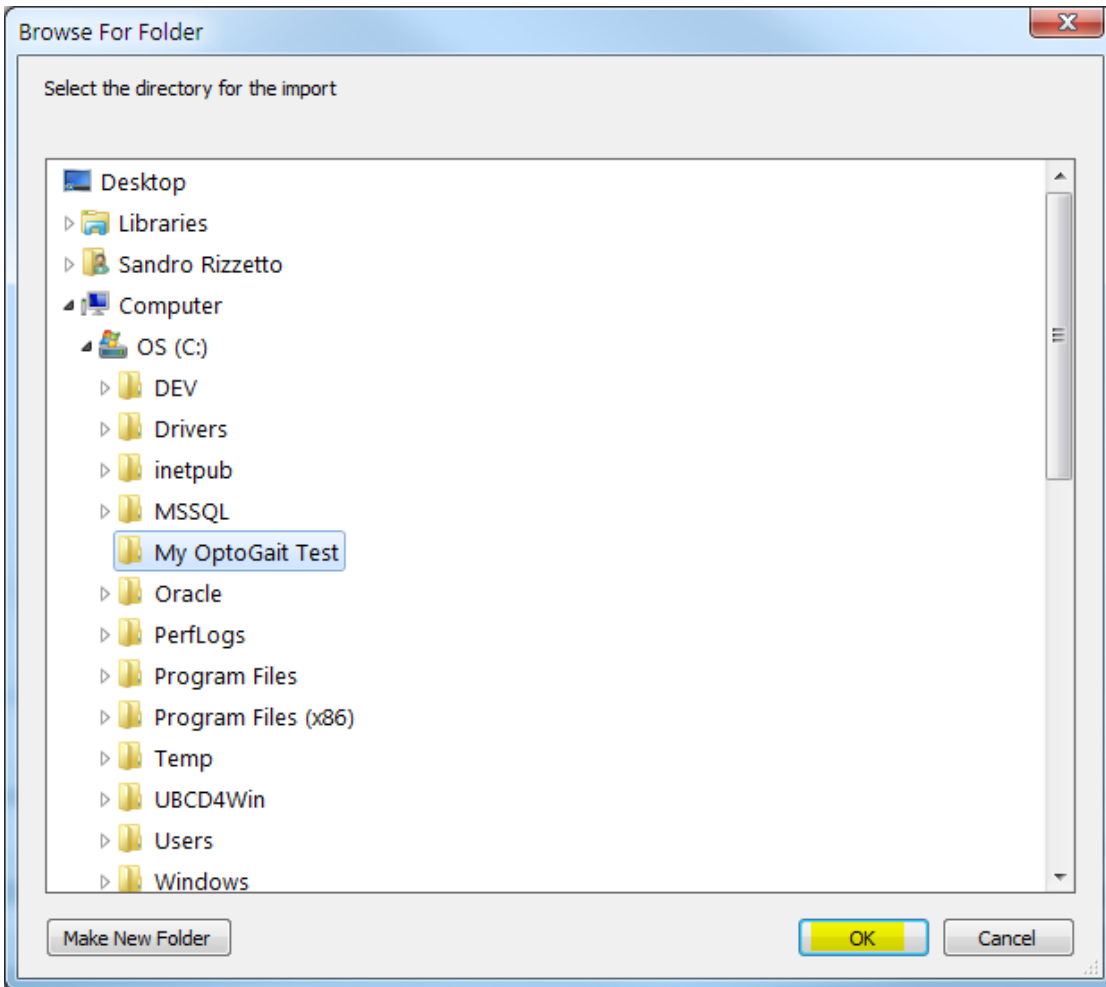
The selected folder will contain the extracted files.
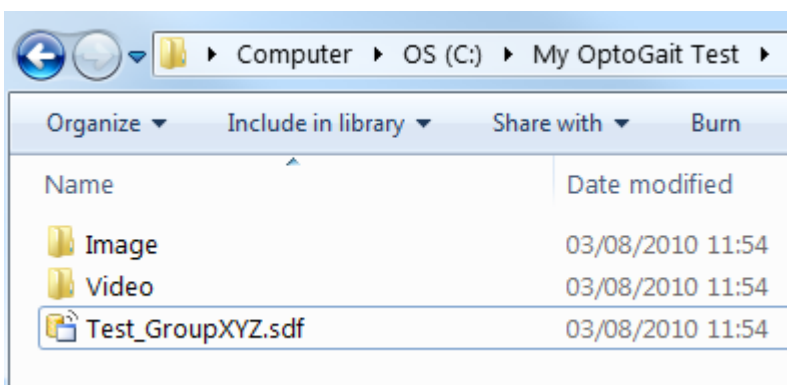
The database is automatically set as current, as you can see in the relevant field:
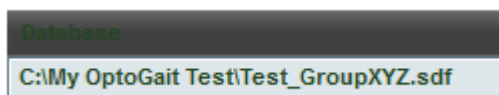
4.4.3.7 SAVE AS

This command allows you to DUPLICATE the CURRENT database. This can be useful for backups or to have a copy of the database in which you keep the data of Patients and Groups, but where you do not want test data (e.g., when beginning a new season). You will be asked in which directory to store the file and to name it. WARNING: only the SDF file is saved, not the videos or still images. WARNING: unlike the command Export Database (*.sdf), 'Save as' saves the sdf file and the videos and still images.

4.4.4 DEVICES

The Utility>Devices menu allows to manage various PC external devices (one being of course the OptoJump bars).
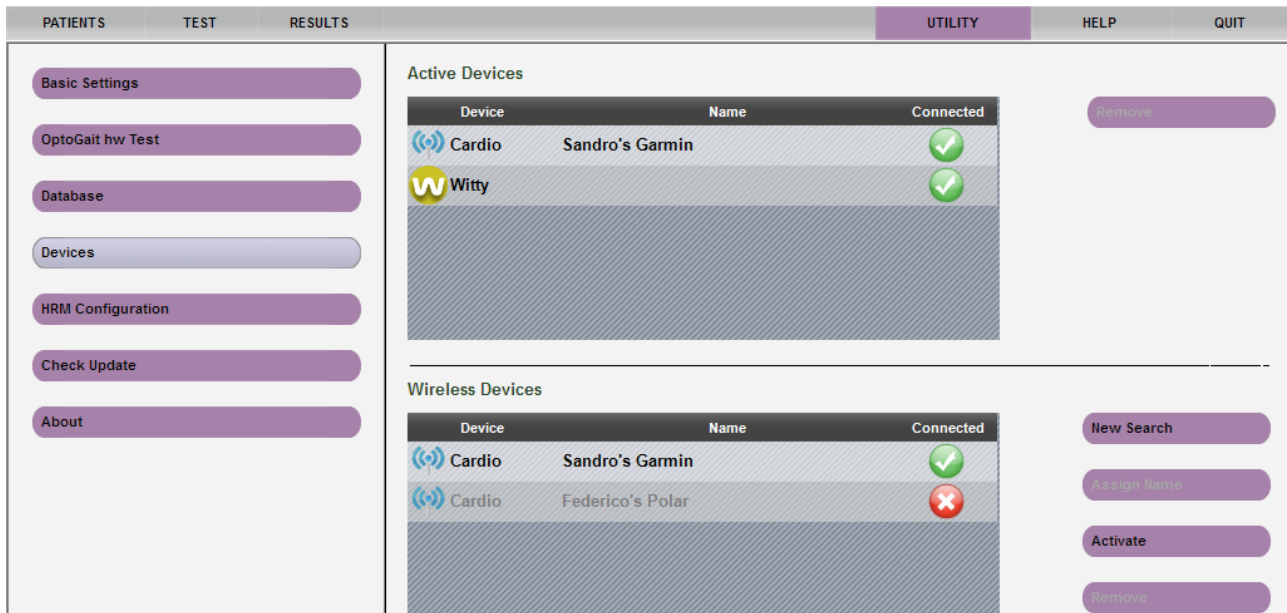
USB connected devices (at the moment OptoJump bars, Microgate Witty timer and variable speed Woodway treadmill) are automatically recognized and set as "active".

Wireless devices connected to the PC via USB/Bluetooth stick must be searched for, possibly named with a mnemonic name and finally set as active one at a time (see the following paragraph for a concrete example with a heart-rate monitor).

4.4.4.1 WITTY TIMER AND PHOTOCELLS

OptoJump Next may be used in combination with the wireless timer and photocell kit called Witty.

The photocells have the purpose of giving the external start impulse and to stop the test, as well as recording intermediate times during the sprint/run test with modular systems, if needed.

Let's look at a concrete example:

Timing a 30-m sprint with start and finish photocells, as well as intermediate times at 10 and 20 m.

Just set up the photocells at the required positions and connect the Witty timer to the PC with the OptoGait software.

The photocells will transmit the impulse, which will then interact with the software.
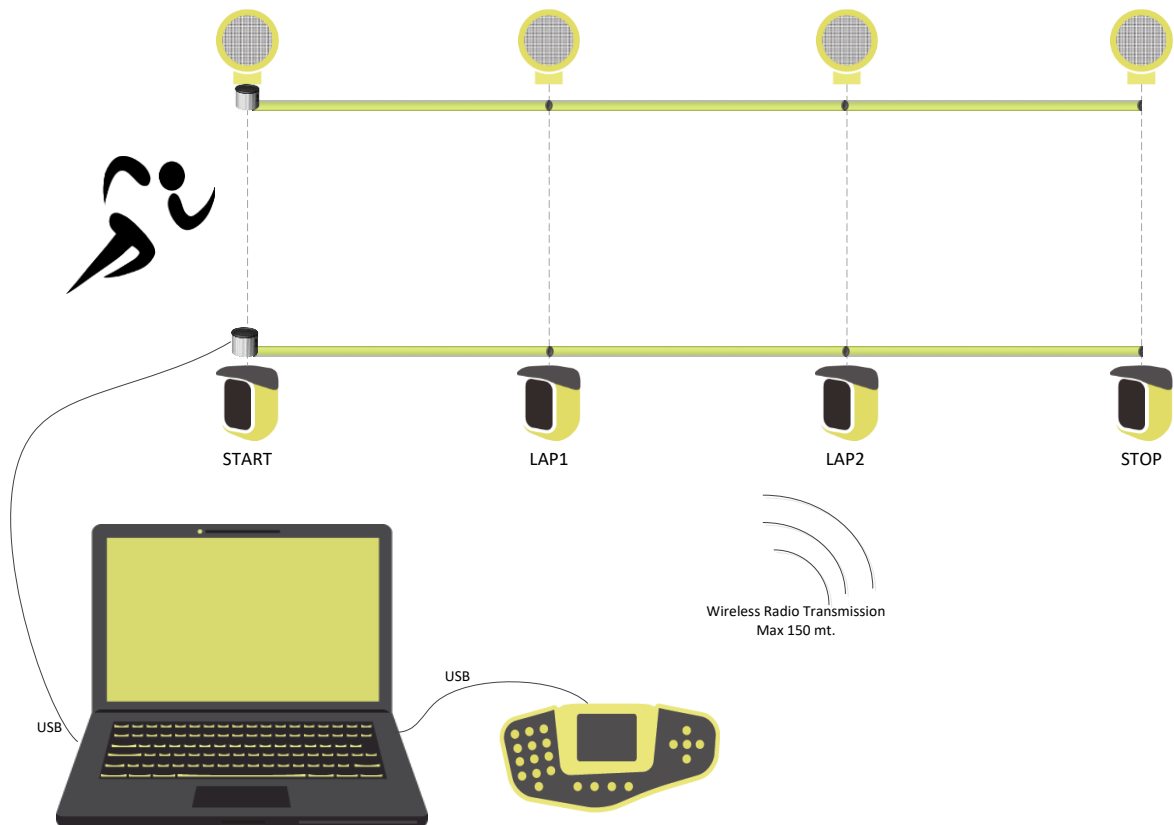
The test has to be set up as start and stop test = "External impulse" (which is given by the Witty timer when the athlete passes the photocells), with a number of intermediate times equal to the number of intermediate photocells of the system.

Name	Witty
Test type	Sprint and Gait Test ▾
Start type	External impulse ▾
Starting foot	Not defined ▾
Stop type	External impulse ▾
Number of intermediate times	0 ▾
Template	None ▾
Notes		^ ∨

4.4.4.2 WITTY RFID

The Witty·RFID device, an automatic athlete recognition system consisting of an RFID reader and identification bracelet, significantly speeds up and simplifies operation.

When the number of the bracelet the user is wearing is entered into the "Bib" field on the patient's card, each time the athlete moves the bracelet near the RFID reader, they are automatically recognized and their name is selected as the "next athlete" in Test > Run

Last name	Rossi
Name	Pierluigi
Birth date	13/11/1977
Gender	◉ Male ○ Female
Weight [Kg]	68
Height	1 m 74 cm
Foot	43
ID	
Bib	7

Figure 107 - Assigning a bracelet in the Bib field

Figure 108 - Scan bracelet #7
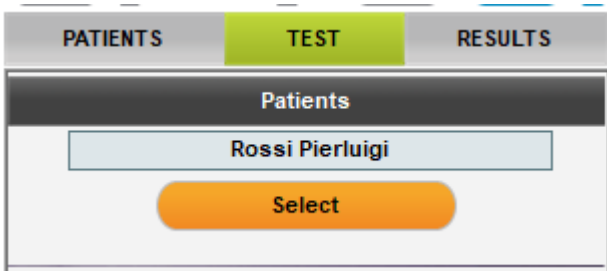
Figure 109 - As soon as the Witty RFID LEDs turn green, the patient's name is automatically selected

As far as the "empty" bracelet writing is concerned, see chap. 4.1.1.3

The Witty·RFID reader can be attached directly to the PC using a USB cable, or, if it needs to be placed 5 metres away, connect a Witty·Timer chronometer and then use radio transmission between the two devices.
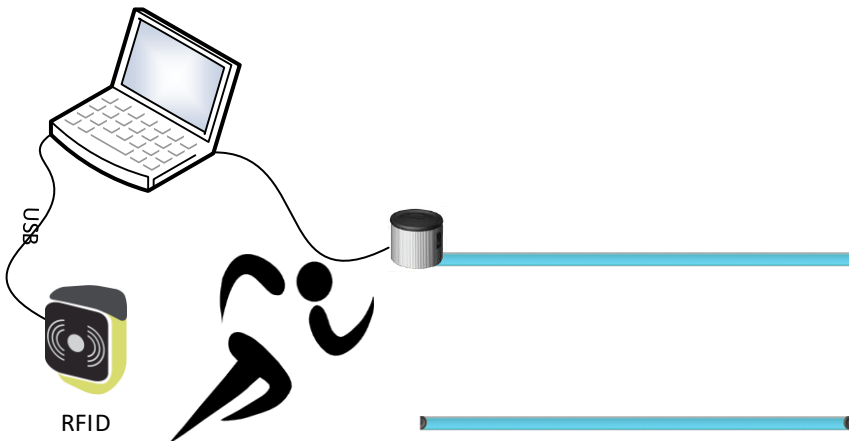
Figure 110 - Witty RFID directly attached to the PC using a USB cable
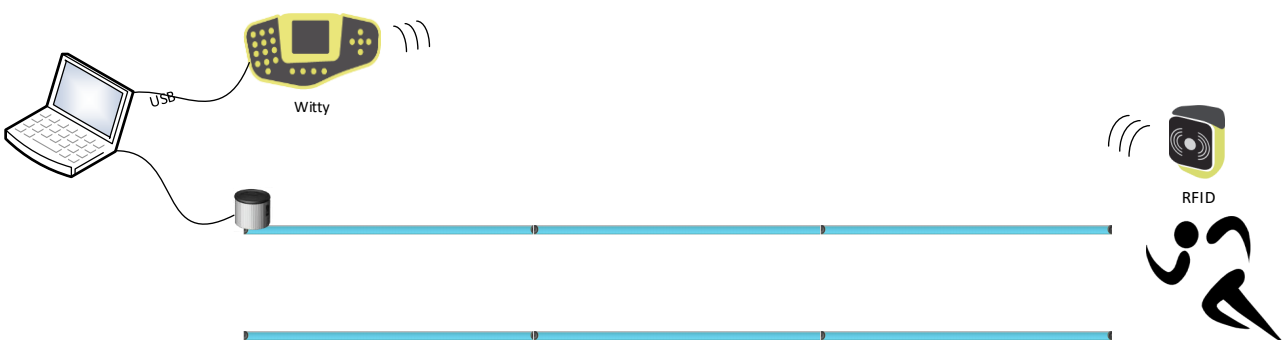
Figure 111 - Witty RFID communicates by radio through a Witty Timer with USB attachment

4.4.5 HEART-RATE MONITOR

Some of the first wireless devices handled are the Polar and ANT+ cardio wraps (Garmin, Suunto, etc.).

If the patient wears the cardio wrap during the test, his/her heart rate will be recorded and temporarily associated with the events of the test itself (e.g. with a jump, a step, etc.).

Starting from version 1.8, the OptoGait software can handle a series of external devices, among which heart-rate monitors.

At present the following manufacturers and technologies are supported:

Polar WindLink:

USB stick using Polar W.I.N.D. technology 2.4 GHz for transmission; compatible wraps

- Polar H2 (Hybrid 5kHz e 2,5Ghz)
- WearLink®+ W.I.N.D.

ANT+

USB stick with ANT+ receiver (type ANTUBS2 or ANTUSB-m) developed by the ANT Consortium

An example for a manufacturer using this technology is Garmin (with direct distribution of the stick under the name of USB ANT Stick™, compatible with the Garmin Premium Heart-Rate Monitor wrap).

Our software supports all products of all members of the ANT+Alliance.

4.4.5.1 INSTALLATION AND SETUP

Insert the stick into a USB port and wait until the relevant manufacturer drivers have been installed.

Ask the athlete to put on the wrap following the manufacturer's instructions (e.g. moisten the part touching the chest).

From the Utility menu press the <Devices> button and from the Wireless Devices selection press <New Search>. If installed correctly, the device will be identified by our software with its internal code.
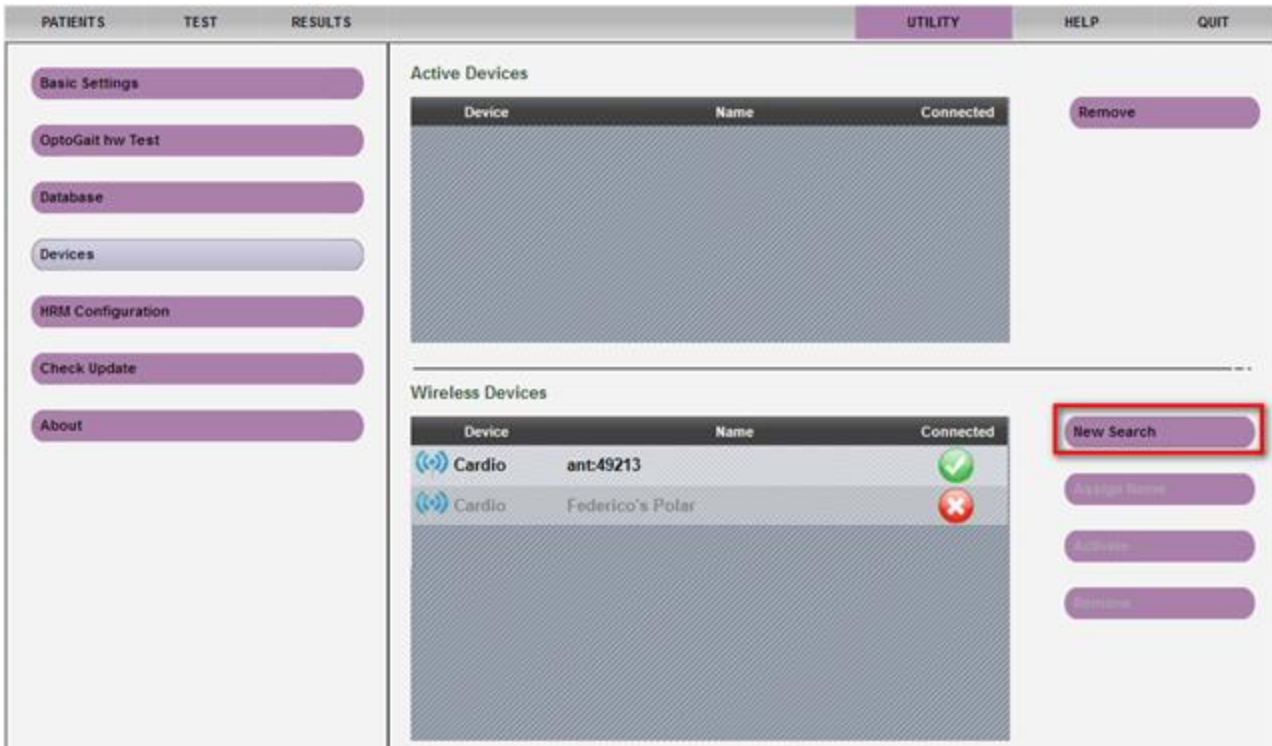
To recognize it later and find it among other chest wraps, it is advisable to name it using a mnemonic name (e.g. "*AthelteName Garmin Wrap*" or "*Polar#42*" if you have numbered the wraps progressively, etc.) using the <Assign Name> function.

Repeat for all the devices that you want to use; the icon near the name indicates if the device is currently connected or not.

During the test session it is possible to ACTIVATE only one registered heart-rate monitor at a time. To do so, select the device and press the <Activate> button. The device will move to the top of the list and is ready for use.

4.4.5.2 SportZone Setup

From the Utility menu you can configure how the so-called "SportZone" will be displayed on graphs of executed tests. There are 3 possible settings:

- 5 coloured bands (with customizable names), each one being a percentage of the athlete's **Maximum Heart Rate**
- 5 coloured bands (with customizable names), each one being a percentage of the athlete's **Resting Heart Rate**
- 3 coloured bands (with customizable names), respectively below, within and above the set bottom and top limits

Sportzone

⦿ Max Heart Rate (%HRMax)
◯ Heart Rate at rest (%HRR)
◯ HR Max and Min

	Sportzone	Minimum		Maximum
🟥	Maximum	⊖ 85%	⊕ ⟷	100%
🟨	Intense	⊖ 75%	⊕ ⟷	84%
🟩	Moderate	⊖ 65%	⊕ ⟷	74%
🟦	Light	⊖ 55%	⊕ ⟷	64%
⬜	Very Light	⊖ 45%	⊕ ⟷	54%

Sportzone

◯ Max Heart Rate (%HRMax)
◯ Heart Rate at rest (%HRR)
⦿ HR Max and Min

	HR value
🟥	Superior Zone
🟩	Working Zone
⬜	Inferior Zone

The percentages of the various bands of course refer to the frequency of every single athlete and must be entered in the relevant fields of each athlete's card.

Open an athlete's card, press <Next>>> in the lower right corner to go to the second page of the card and edit the 4 required values. Press <Save> to confirm the changes.

Max Heart Rate	190
Heart Rate at rest	60
Anaerobic HR Max	160
Anaerobic HR Min	120

The correct configuration and assigning of a heart-rate monitor is shown in the Test > Execute section.

Selecting any test and pressing Execute, in the lower section a pulsing heart icon and the current heart rate are displayed. Furthermore, the label HRM is added to the legend of values displayed in the graphs. Similar to others, it can be turned off and on again by clicking on it and changed from bar to line view (only in single display mode, if other measures are displayed, the graph always shows lines).
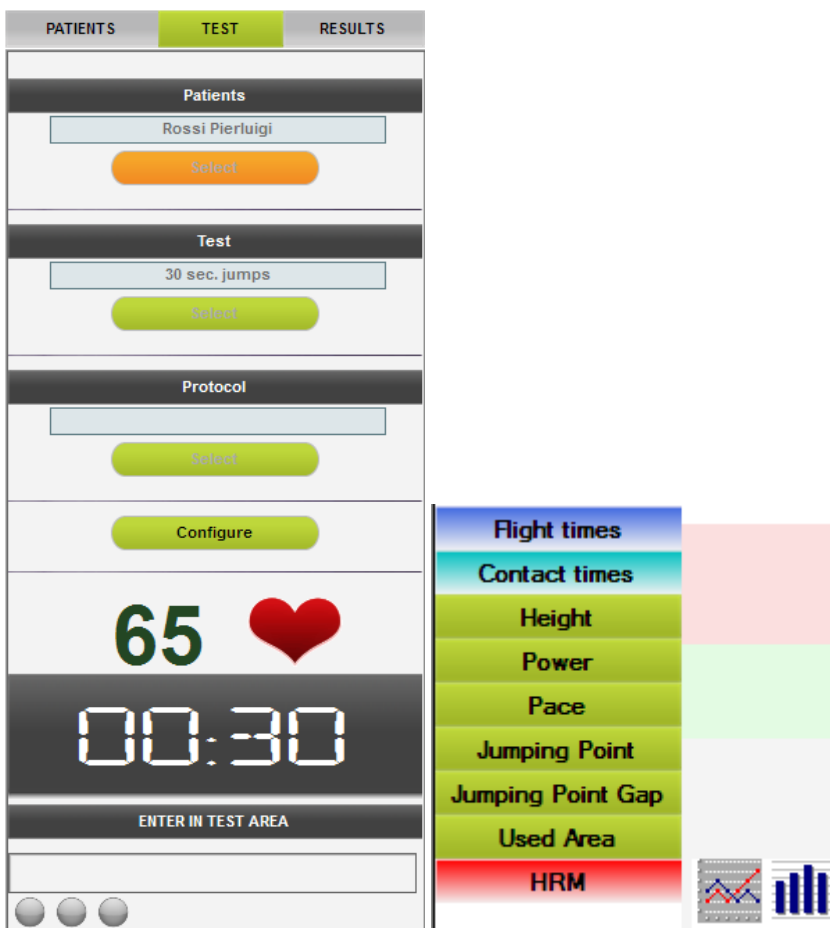
Of course the coloured band viewing mode is the configuration function of the above-mentioned "SportZone" configuration. Changing the mode, the band values, colours and any customized labels change.

The athlete's max/min frequency values refer to the moment of the text execution. If the values on the athlete's card are changed, only future tests will be affected and not those already executed.

Figure 112 - Viewing only the heart rate with SportZone %FcMax
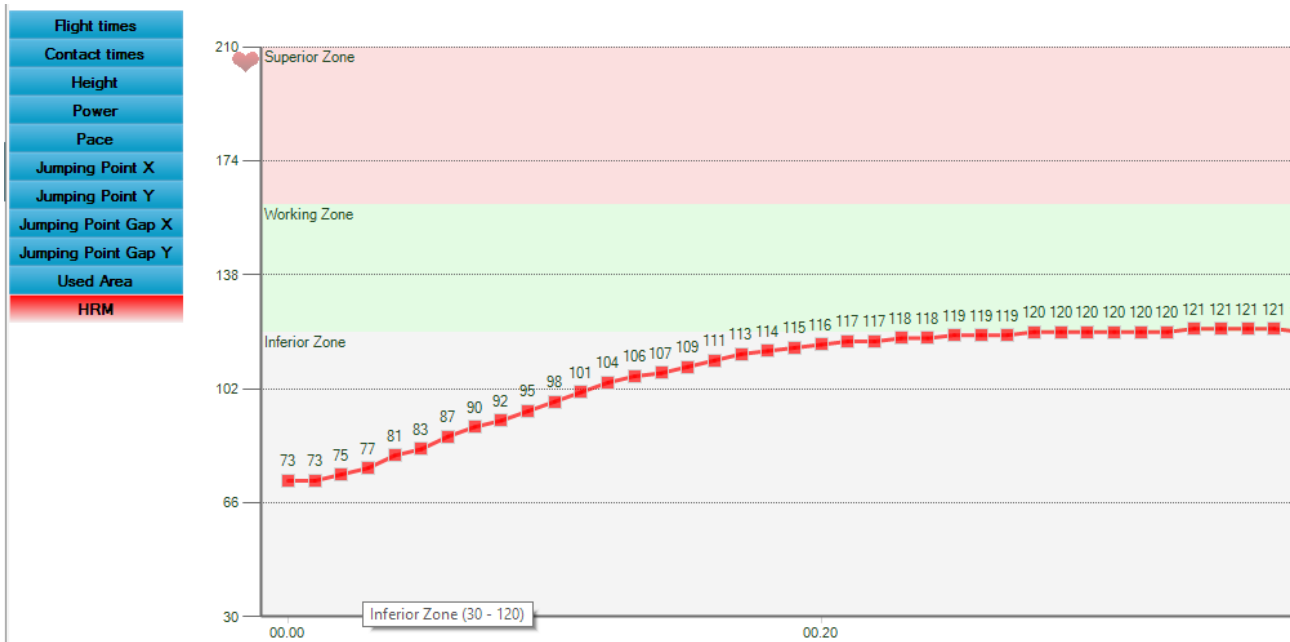
Figure 113 - Viewing the HRM with bottom and top SportZone FC

4.4.6 CHECK UPDATE

This checks if the installed version is the most recent one. If not, OptoGait suggests you download the newest version from the site.

NB: before pressing <Check Update> check that the Internet connection is active.

4.4.7 RESET TO DEFAULT VALUES

By pressing this button, all the Basic Configuration parameters are reset to the default values, which are the ones we would find in a new database.

4.4.8 ABOUT

This section displays respectively:

- Hardware and software characteristics of the computer
- Version of the OptoGait software and the video component
- Version of the OptoGait bars, LED definition (10 mm or 30 mm) and system structure (number of bars in X and Y)

If our Support Team asks you to provide this data, select the whole field with the cursor, right-click on it and select COPY. Then send an e-mail in which you PASTE the copied data.
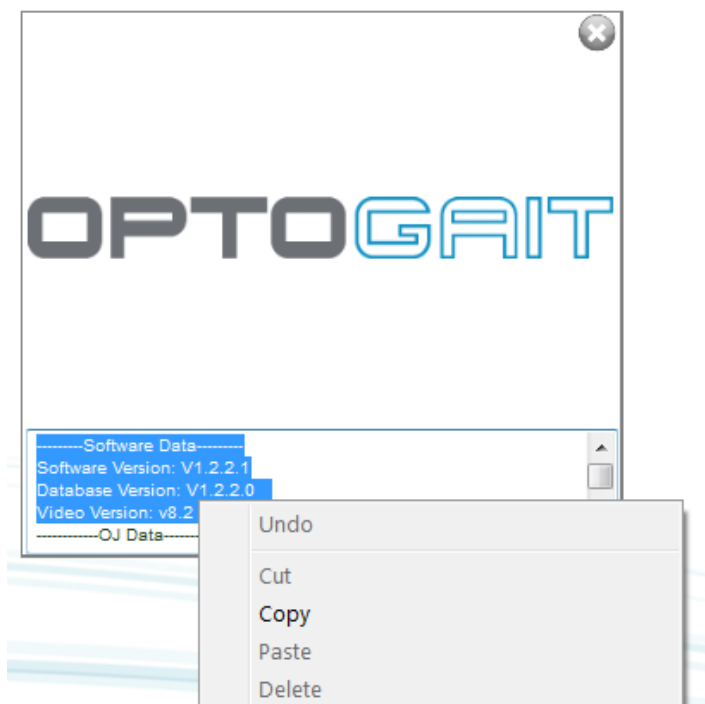
Figure 114 - About window showing the technical data for the Support Department

4.5 BIOFEEDBACK

The BioFeedback module (available as of version 1.10) was inspired by the "Video Feedback" feature (Sect. 4.2.1.2) where the user can see some basic test parameters in real time on a second monitor (usually a large TV or a screen/tablet placed in front of the treadmill).

By trying to optimize these parameters while performing the test, for example by minimizing asymmetries or lengthening the stride, the patient "trains" and uses the system as a working tool instead of as an instrument of diagnosis.

The main difference compared to the normal tests described in the previous sections is that data are NOT saved in the BioFeedback module and are NOT paired with any user; it is just a very fast "start & run" module with a minimal user interface, designed also to be used directly by the end patient instead of by the technician/operator.

First you are asked which of the three types of currently available tests you want to perform: clicking on one of the three buttons on the second monitor (or on a new window if you have only one monitor) shows the BioFeedback user interface.
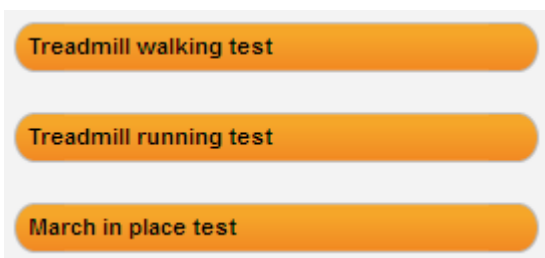
At top centre we see the parameter that we want to monitor, by clicking on the triangle to its right we can change it with one of those available (the parameters vary depending on the type of test we chose).

Reference value: 0,60[s]

Stance phase ▽

NEW
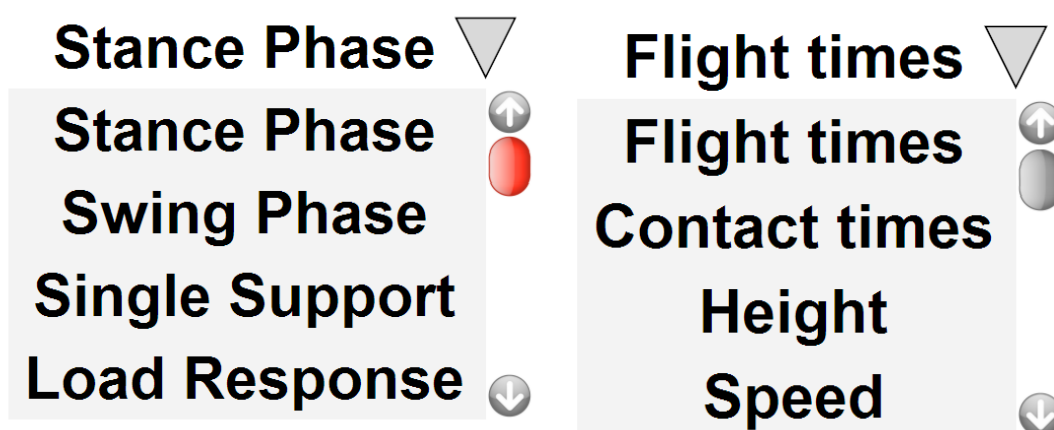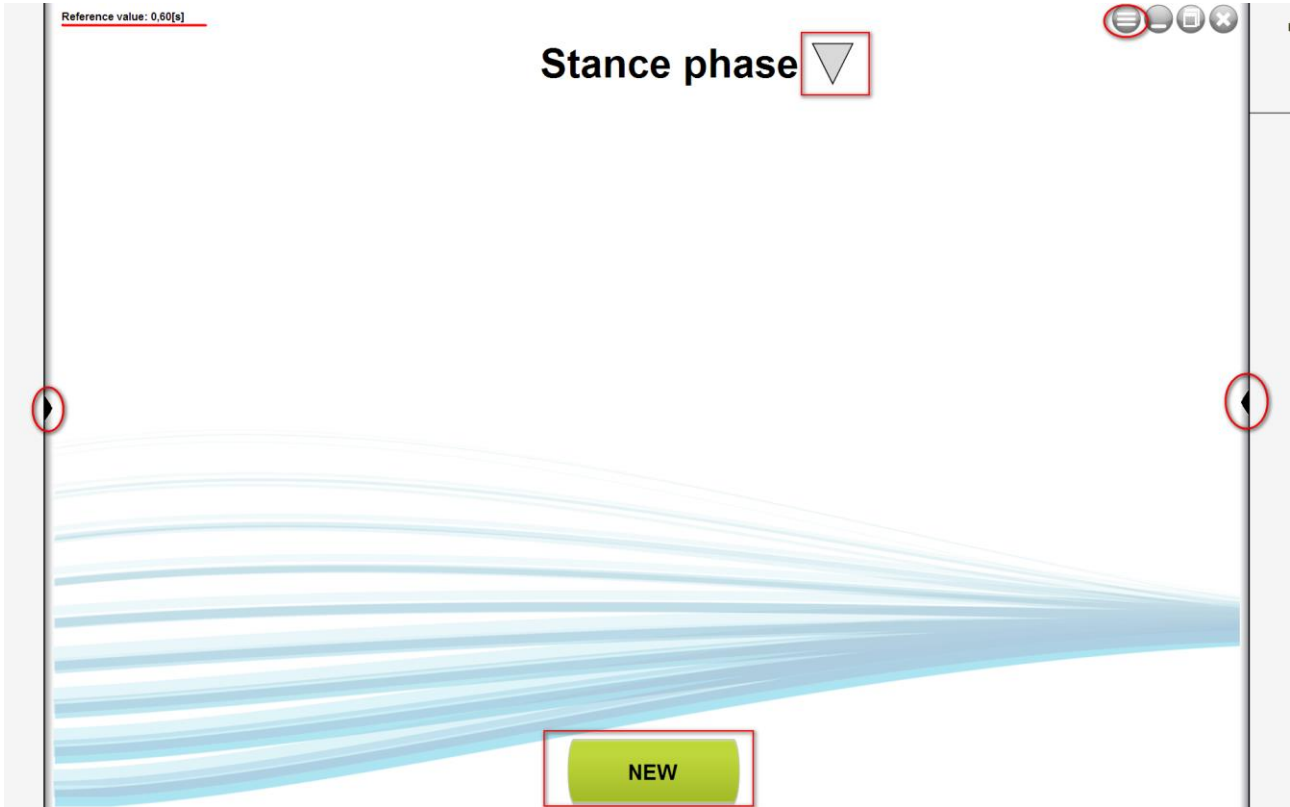
By clicking on the Menu command ⬚, we can decide whether to work in Asymmetry or Absolute Values Mode, whether the data are updated with a window containing few data or longer (the changes will then be "slower") and whether we want to view the standard user interface (red/green/orange bars) or the one for children Opto4Kids (Sect. 4.2.1.2.1).

Mode
○ **Asymmetries**
● **Absolue values**

Data window
● **Short**
○ **Long**

View
● **Normal**
○ **Opto For Kids**

OK   CANCEL

Clicking on the black triangle to the left opens the "Thresholds" panel, that is, you can set the Bad Threshold (red) and the Warning Threshold (orange) percentages by dragging the dividing border up or down.
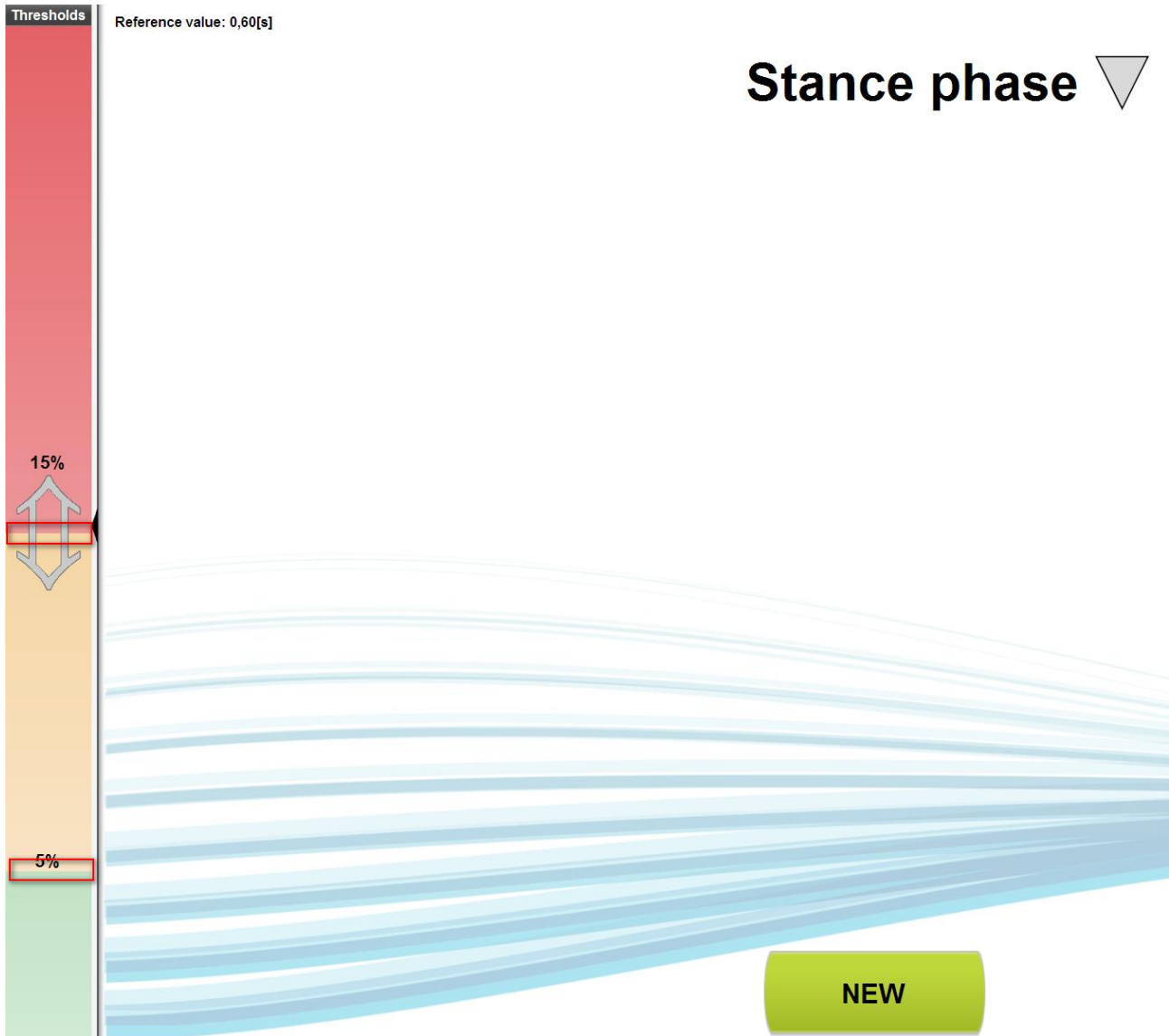
Whereas, clicking on the black triangle to the right opens another panel with which we can set other parameters. From top to bottom, we have:

- If we have chosen "Absolute Value" mode, here we can set the "**Reference Value**" that we need to follow. Obviously its should be set in line with the type of measurement selected (e.g. 30 cm for height, 0.5 s for flight time, 70 cm for step length, etc.).
- **Feet**: since, as in normal tests, you are not asked for the starting foot, with this mini-tool we can easily pair the correct foot that is walking, running or marching in place. You can act in two ways: during this test you will see the right or left foot icon which will illuminate according to the pulse that comes from the Optogait bars; if it matches what the patient is actually doing you do not have to do anything, but if the wrong foot lights up (right instead of left or vice versa) then just click on the "Swap Feet" icon.

  A second alternative way is to turn on an audible flag with the specific command; the PC will emit a sound when the patient has to put down the RIGHT foot.
- **Treadmill Speed:** set the same speed that we set on the treadmill on which we are running or walking.
- **Metronome**: click <u>on the number</u> of beats per minute (bpm) to turn the virtual metronome on/off; click on the + and – icons to change the value of bpm in steps of 5 beats.
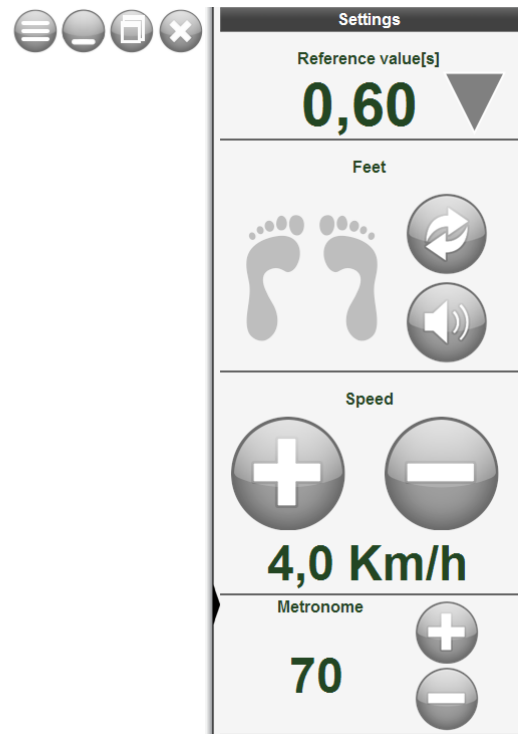
To start a test press the <NEW> button, wait if Gyko or other devices need to initialize and press the <START> button

Depending on the mode (Asymmetry or Absolute Value) we will see one or two bars with the values and colours depending upon how far they are from the set thresholds and/or reference values.

To end the test, press <STOP>

4.6 GMF MODULE (GAIT MUSCLES & FUNCTIONS)

This new module, available starting from version 1.11 of the OptoGait software, displays a form of multimedia "encyclopaedia" related to muscles and all the functions involved when walking.

The module, currently available only in English (although all muscle names have their scientific notation, which is derived from Latin), can be activated by pressing the related button on the main menu.

4.6.1 GENERAL VIDEO

The first screen (or if you chose the "General Video" tab) will **display a general video** where an animated anatomical model shows muscle activation throughout the various gait phases. Press the Play button to start the video.
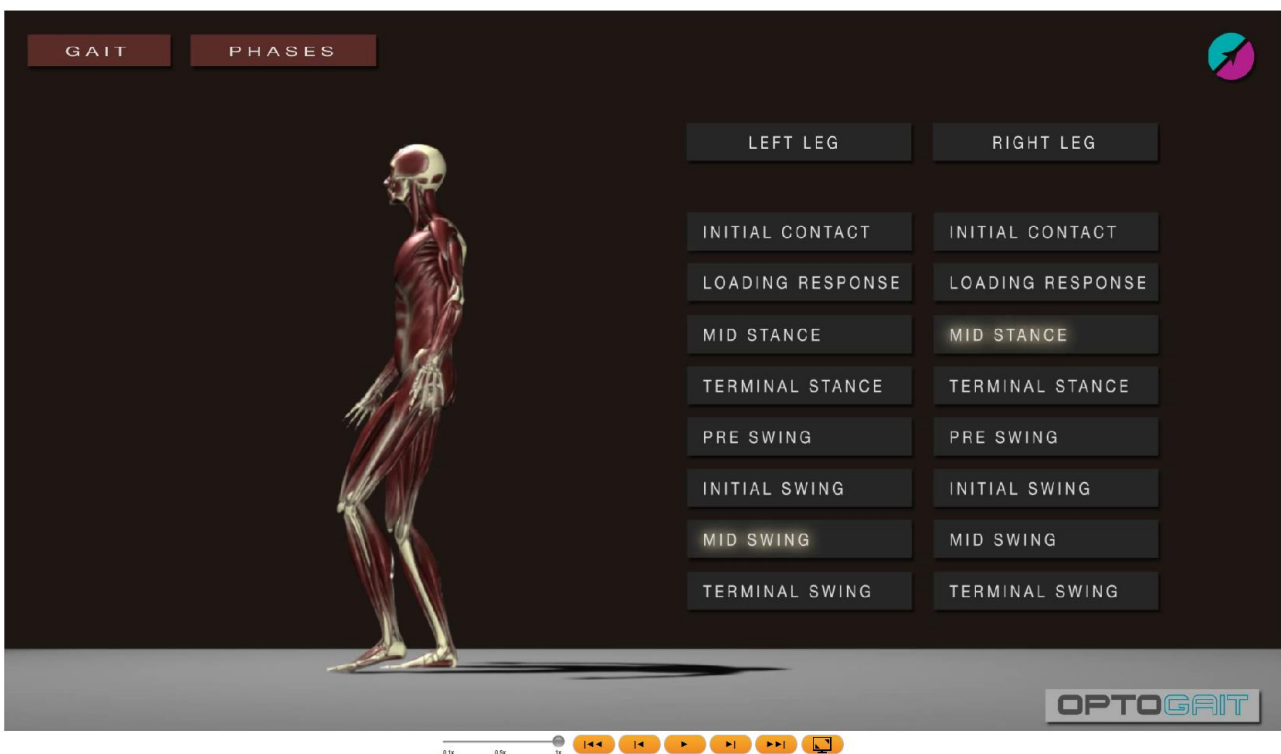
The controls below the video (which can be found in all the videos of each phase) are the classic ones:

- Slider to slow down playback speed from 0.1x to 1x
- Go to first frame
- Back one frame
- Play/Stop
- Forward one frame
- Go to last frame
- Full screen

In the upper left corner, thanks to a drop-down menu, you can choose one of the 5 phases (Stance, Swing, Single Support, Loading Response or Pre-Swing) of the gait cycle:

If, instead, you are viewing the results of a gait test (1D or 2D, on the treadmill or on a modular system), you can click the corresponding lens icon in the Gait Report.

For each of the 5 phases, you can view:

4.6.2 MUSCLE ACTIVATION

For each body "district" (the three *body parts*, namely, calf, pelvis and thigh), the muscles involved are listed. The activation timing of each of these is also specified, in relation to the total of the phase.

Example: let's take the *Pre-Swing* phase into consideration, which, according to medical-scientific literature, corresponds to 12% of the total of the *Gait Cycle*, intervening between 50 and 62% of the duration of the latter.

Within this 12%, the Soleus calf muscle is concerned immediately to begin with (Start=50%) and lasts for only 2% of the cycle. The Gannt chart below shows the different muscles when they intervene in relation to others:
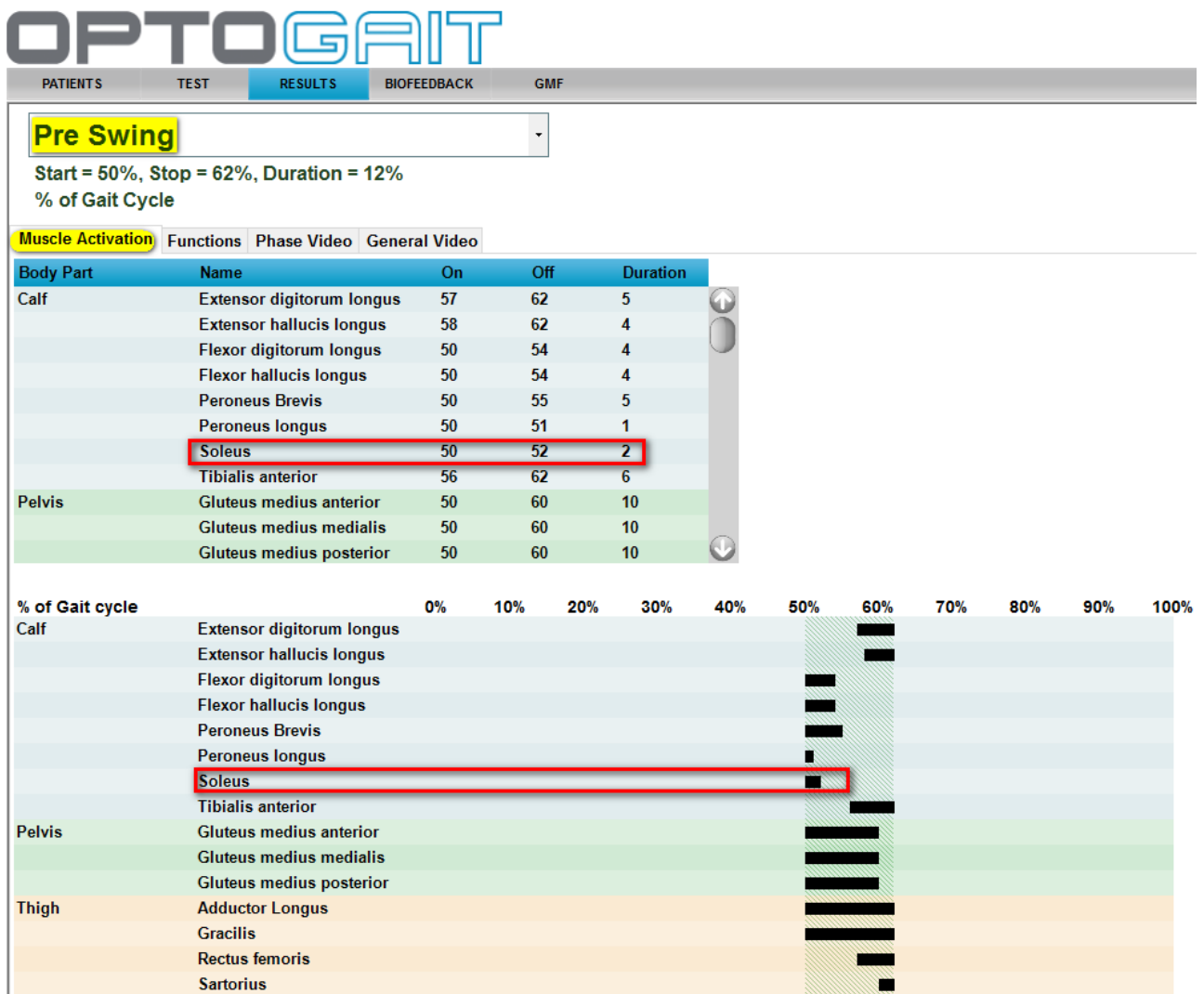
Figure 115 - Muscle Activation

4.6.3 Functions

By clicking the Functions tab, all the possible "motor functions" are listed (plantar flexion, dorsiflexion, rotation, eversion, etc.), which are associated with that phase for each body part.

By clicking a single row of the grid, the individual muscles are shown with the related activation times. There is also a short video showing only the body part in question and the chosen gait phase.

In the example below, the Pre-Swing phase and the body part Knee have been selected and, in the table, we can see that the muscles activated are only the Gracilis (for the whole phase from 50% to 62%) and the Sartorius (only at the end from 60% to 62%).

The colours next to the muscle names serve as key for the colours shown in the model in the video.
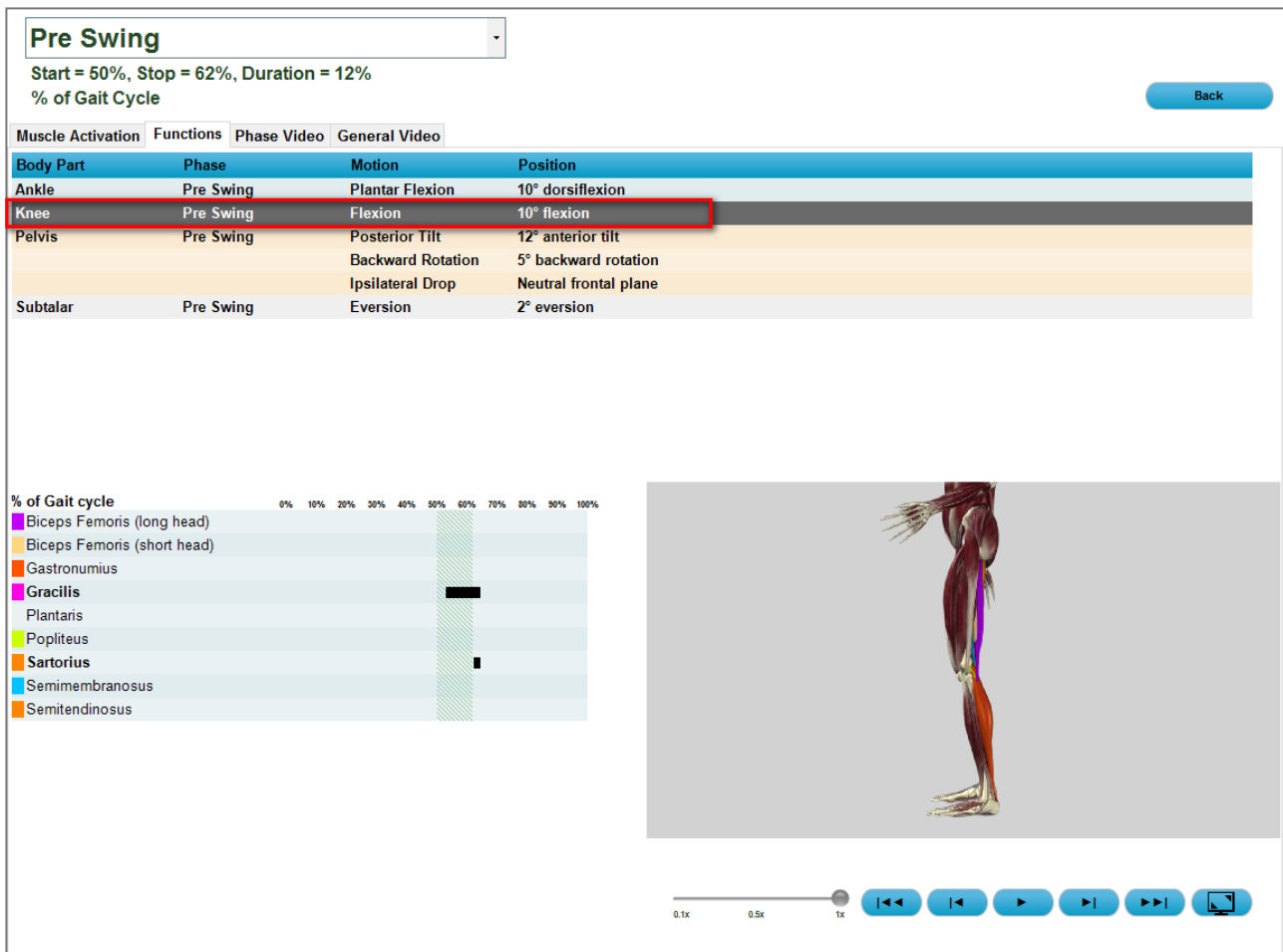
Figure 116 - Functions

4.6.4 DEVIATIONS (DEVIATIONS TAB)

Click on the "Deviation" tab to list possible "deviations" from normal physiology, divided by the different parts of the body. Select a single line to display the possible underlying causes and the practical meanings at the bottom. Note that this instrument should be used solely as an encyclopaedia, never as a diagnostic tool.

4.6.5 PHASE VIDEO

The third tab displays the video only of the part related to the chosen phase, where you can see the muscles activated with the exact timing (if they are "flesh-coloured" they are not activated, whereas, if coloured, they are activated).

Here, for example, we can see two still frames with deactivation of the left thigh muscles and activation of the right vastus medialis.

5 OPERATING PRINCIPLES

5.1 DEFINITION OF RESULT COLUMNS

5.1.1 GENERAL INFORMATION

Column #: contains information on the various row types. The following values are possible

- o **External**: row with a time generated by an external or end of test signal with a timeout or end of time.

- o **1,2,….no. (progressive number)**: valid row. Each row represents a jump and can contain a contact + flight/step time or only flight/step time.

- o **Averages**: average values for the various columns. The average is not calculated for all columns; it is calculated using only the times of valid rows (indicated with a progressive number).

- o **Std**: standard deviation of the column compared to the average, the standard deviation is not calculated for all columns.

- o **Interrupted**: if a test is interrupted prematurely by the user, the test finishes with this warning message.

- o **Error**: in a reaction test, if single repetition fails this is signalled with Error.

- o **Deleted**: row with contact and/or flight/step times deleted from displays and calculation of average and total values (see Management of invalid times for more details).

- o **Tc not valid**: row with invalid contact time; contact + flight/step times for this row are therefore added to the flight/step time of the row above (see Management of invalid times for more details).

- o **Tf not valid**: row with invalid flight time; contact and/or flight/step times for this row are therefore added to the contact time of the line below (see Management of invalid times for more details).

- o **No step**: in a running/gait test, when the number of steps acquired is lower than the number of rows with contact + flight times, excessive rows are signalled like this.

- o **Suspended**: indicates that a treadmill type test was suspended for a certain time and then resumed.

- o **Split**: time passed from the Start to the reception of an external split signal, valid only for running/gait tests.

5.1.2 JUMP AND REACTION TEST

- **TCont. [s]**: Contact times
- **TFlight [s]**: Flight times
- **Height [cm or in]**: Height of jumps calculated with the following formula

$$h = \frac{T_v^2 \cdot g}{8}$$

- **Power [W/kg]**: Expressed power calculated with the following formula

$$P = g^2 \cdot T_v \cdot \frac{(T_v + T_c)}{4 \cdot T_c}$$

g = gravity acceleration, T_v = Flight Time, T_c = Contact Time

- **Rhythm [p/sec]**: Rhythm expressed in jumps (or steps) per second
- **RSI[m/s]**: Reactive Strength Index, defined as Height (in m) / Contact T.
- **Jumping Point [cm]**: This is the distance between the beginning of the bar (drum) and the middle support point. In the case of jumps with both feet perpendicular to the bars, it will show where the centre of gravity is.
- **Jumping Point Gap [cm]**: Distance between the current centroid and the previous centroid, i.e. how much the centroid is displaced with respect to the previous jump. A value = 0 indicates the perfect repeatability of a jump (useful mainly for one-leg jumps), negative values indicate a displacement towards the drum (to the left for example), positive values indicate displacements in the opposite direction (to the right in this figure); in jumps with feet parallel to the bars indicate forward/back displacements.
- **User area [cm]**: Difference in cm between the first and the last activated LED; indicates how much the legs are apart.
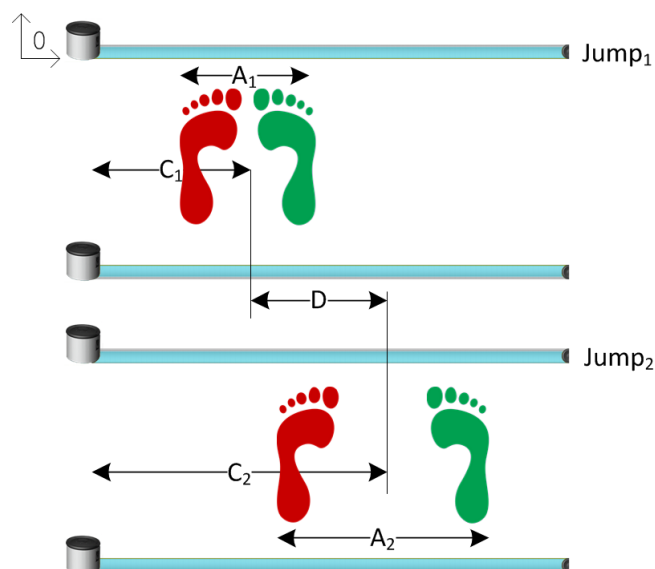
Figure 117 –Jumping point (C), Jumping point Gap (D), and User Area (A)

5.1.2.1 GYKO

If the jump test was performed using the Gyko inertial sensor as well (usually at the height of the belt), other columns are added to the previous values.

The most important ones are those highlighted in the figure below:

>>	#	HRM	TExt.[s]	TCont.[s]	TFlight[s]	Height[cm]	Power[W/Kg]	Pace[step/s]	RSI[m/s]	DurationConc[s]	DurationEcc[s]	RFD[N/kg/s]
	6	72		0,322	0,494	29,9	30,10	1,23	0,93	0,165	0,160	73,94
	7	72		0,334	0,502	30,9	30,21	1,20	0,92	0,170	0,165	0,00
	8	72		0,322	0,504	31,1	31,08	1,21	0,97	0,165	0,155	27,24
	9	72		0,328	0,518	32,9	32,12	1,18	1,00	0,170	0,160	42,30
	10	72		0,334	0,498	30,4	29,82	1,20	0,91	0,170	0,165	22,49
	11	72		0,322	0,494	29,9	30,10	1,23	0,93	0,165	0,155	87,80
	12	72		0,328	0,498	30,4	30,15	1,21	0,93	0,170	0,160	98,20

By clicking on the >> button you can view additional columns:

DurationConc[s]	DurationEcc[s]	Fmax[N/Kg]	Vmax[m/s]	Time2Fmax[s]	RFD[N/kg/s]	Pmax[W/Kg]	WorkConc[J/Kg]	WorkEcc[J/Kg]	Fmax land[BW]	Time2Fmax land[s]	LoadingRate[BW/s]
0,170	0,165	6,24	2,46	0,005	0,00	6,55	0,77	-0,77	0,63	0,165	3,80
0,165	0,155	4,53	2,47	0,060	27,24	6,32	0,61	-0,72	0,79	0,115	6,90
0,170	0,160	6,18	2,54	0,010	42,30	6,69	0,78	-0,76	0,84	0,100	8,42
0,170	0,165	4,98	2,44	0,015	22,49	6,94	0,64	-0,79	0,82	0,095	8,67
0,165	0,155	5,21	2,42	0,030	87,80	5,34	0,57	-0,69	0,71	0,115	6,19
0,170	0,160	5,16	2,44	0,025	98,20	7,98	0,59	-0,67	0,77	0,110	6,96

Let's take as an example a Counter Movement Jump (CMJ) where we can divide the jump into two phases: Pre-Jump (Blue Area) and Landing (Green Area)
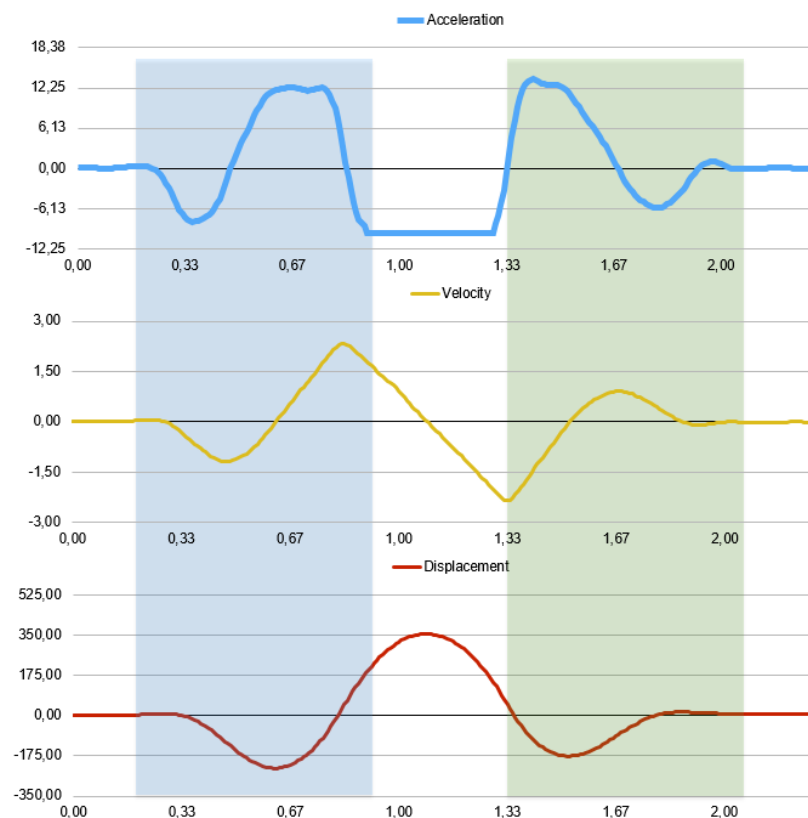

Figure 118 - Stages of a jump

5.1.2.1.1 Pre-Jump
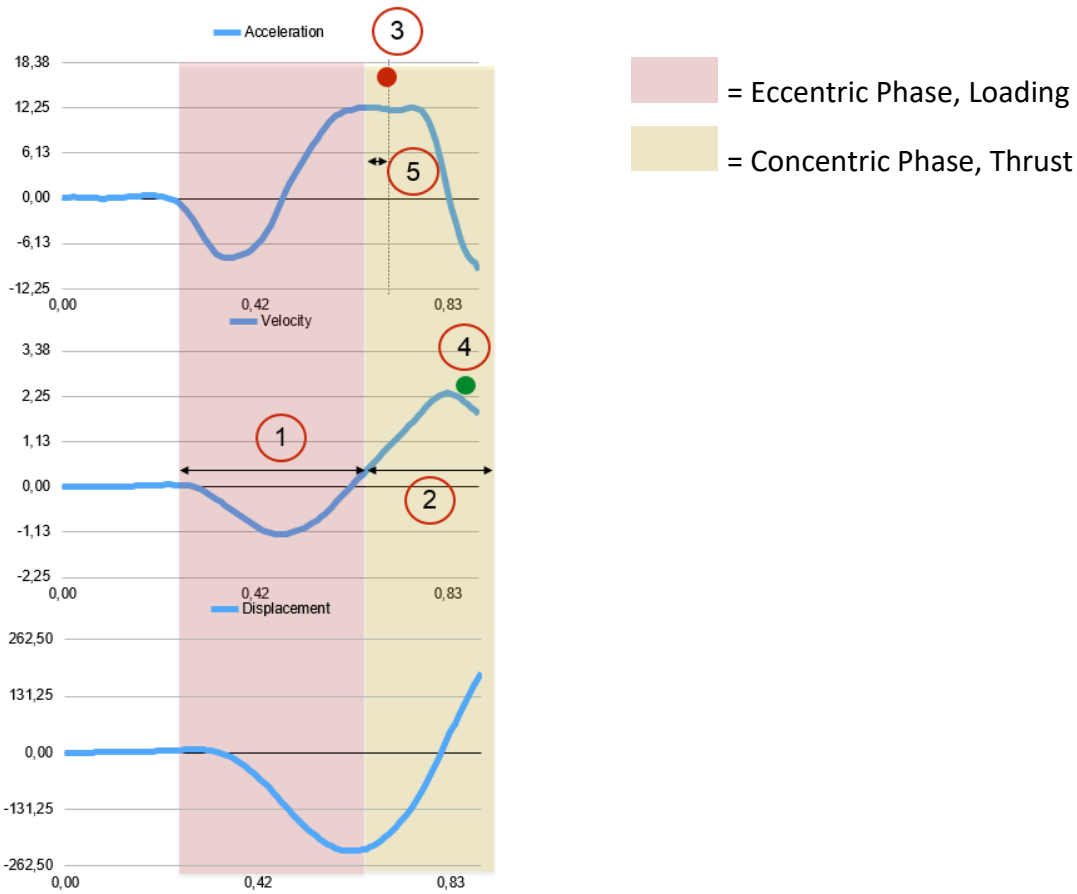
#	Parameter	Description
1	Concentric phase duration **DurationConc [s]**	The duration from the moment when the speed becomes > 0 until the moment of separation
2	Eccentric phase duration **DurationEcc [s]**	The duration from the start of the movement to the instant before that when the speed becomes > 0
3	Maximum force **Fmax [N/kg]**	The peak in Force before separating from the ground
4	Maximum velocity **Vmax [m/s]**	The peak in Velocity before separating from the ground
5	Time to maximum Force **Time2Fmax [s]**	The time it takes to reach peak force starting from the moment of the beginning of the concentric phase
6	Rate of Force Development **RFD [N/kg/s]**	This is the ratio between the maximum Force and the time taken to reach it starting from the beginning of the concentric phase. The higher it is the more explosive I am. RFD is a significant parameter for the Squat Jump
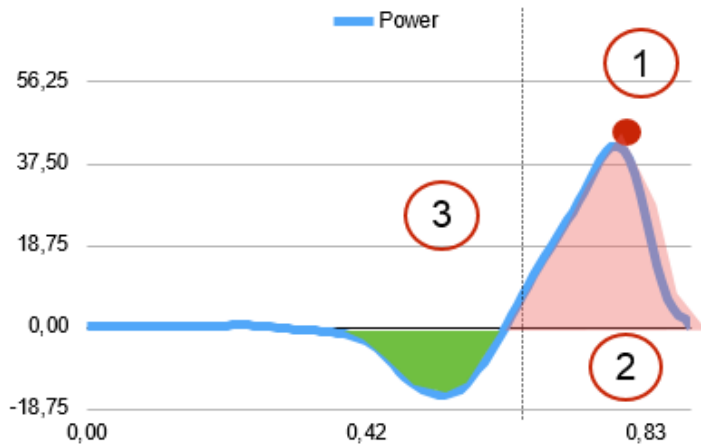
#	Parameter	Description
1	Maximum power **Pmax [W/Kg]**	The peak in Power before separating from the ground (Force/kg * Velocity)
2	Concentric Work **WorkConc [J/Kg]**	Area of the concentric part of the power curve. Similar to P * deltaT
3	Eccentric Work **WorkEcc [J/Kg]**	Area of the eccentric part of the power curve.

5.1.2.1.2 Landing
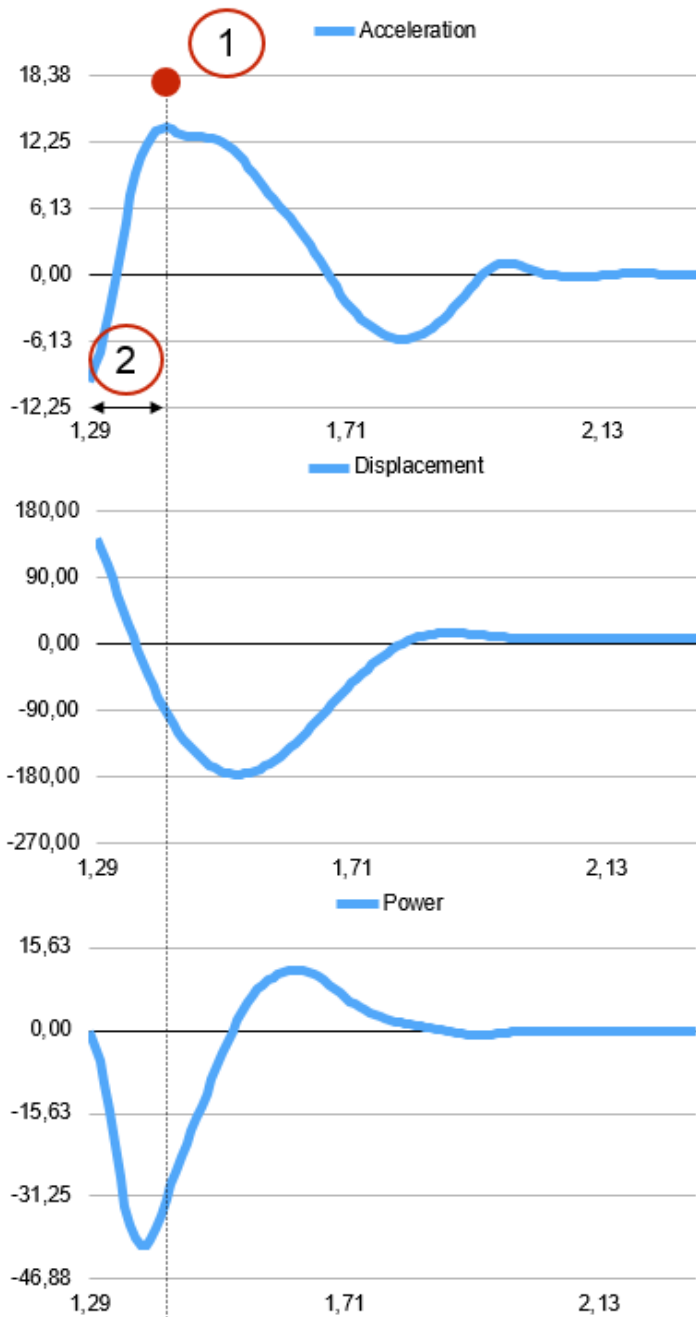
#	Parameter	Description
1	Maximum landing force **Fmax Land [BW]**	The peak in Force at impact, expressed as BodyWeight. 2BW is equivalent to 2 times body weight
2	Time to Maximum Landing Force **Time2Fmax Land [J/Kg]**	The time it takes to reach peak force starting from the moment of contact after jumping
3	Loading Rate **Loading Rate [BW/s]**	The ratio between the maximum Force and time to reach it. Similar to RFD at separation. It indicates shock-absorbing capacity. The higher it is the lower the capacity to absorb shock.

5.1.3 SPRINT/GAIT TEST

The following are some useful definitions to explain the values displayed on the table with numerical data.

Step: the distance between the tip (toe) of two subsequent feet or the distance between the heel of two subsequent feet depending on the settings in the parameter 'Step length calculation' (see chap. 4.4.1.5).
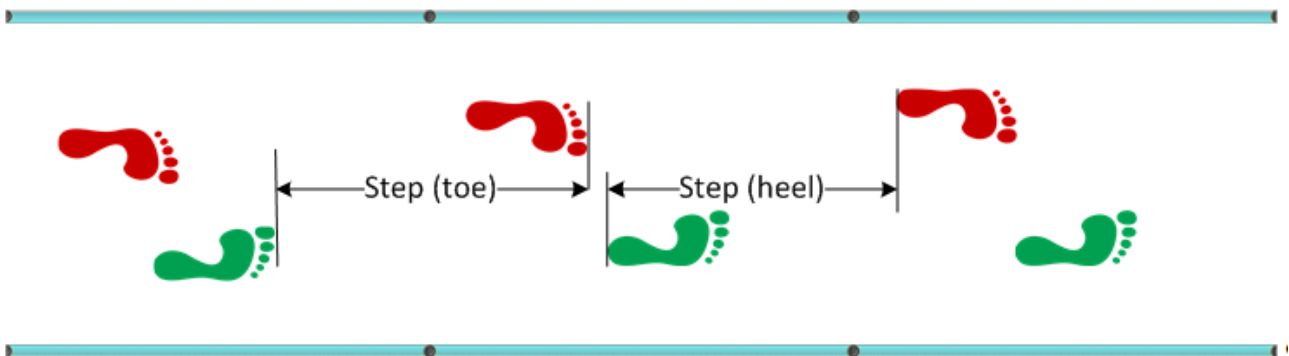
Figure 119 - Step definition

Stride: the distance between the tip of two subsequent footprints of the same foot or the distance between the heel of two subsequent footprints of the same foot depending on the settings in the parameter 'Step length calculation' (see chap. 4.4.1.5).
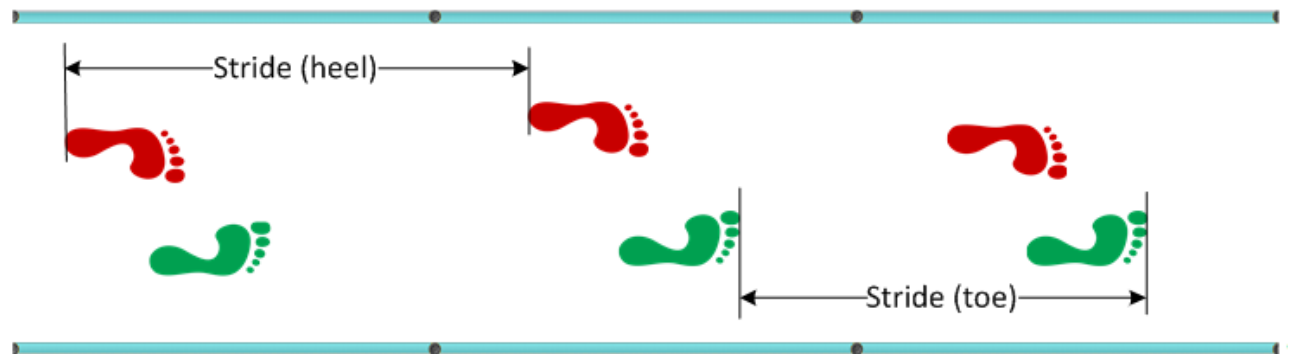
Figure 120 - Stride definition

Speed: is the relation between the distance between the two feet and the sum of the first Contact time (T_c) and the Flight time (T_v).
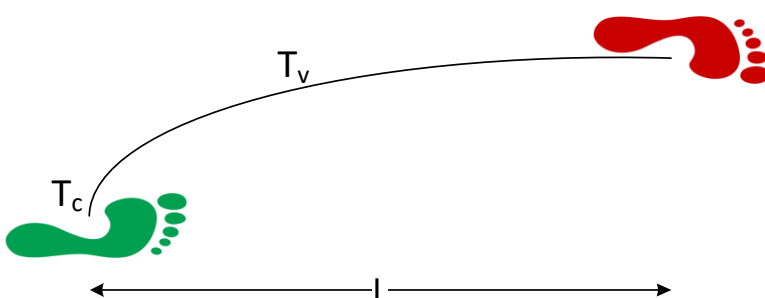
$$V = \frac{L}{T_c + T_v}$$

Figure 121 - Speed calculation

Acceleration: is calculated as the relation between speed delta of the two steps and the sum of the contact (T_c) and flight time (T_v)
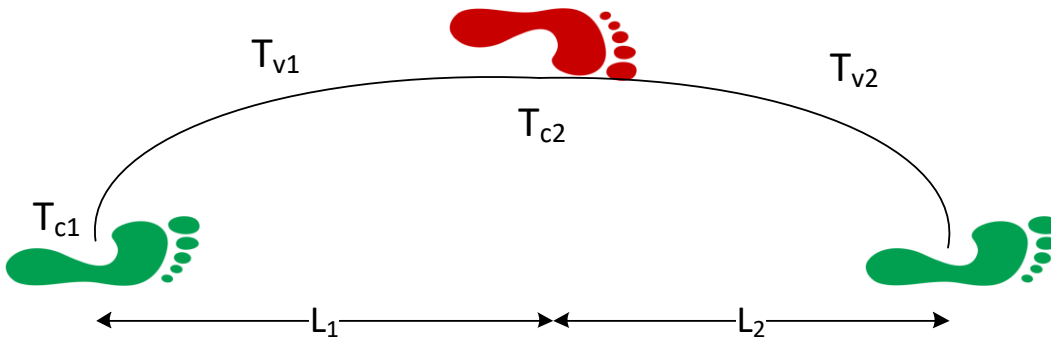
Figure 122 - Acceleration calculation

$$a = \frac{V_2 - V_1}{T_{c1} + T_{v1} + T_{c2} + T_{v2}}$$

Stride Angle: This is the angle of the parable tangent deriving from the movement of a stride (L=stride length, h=height to which the foot is risen).
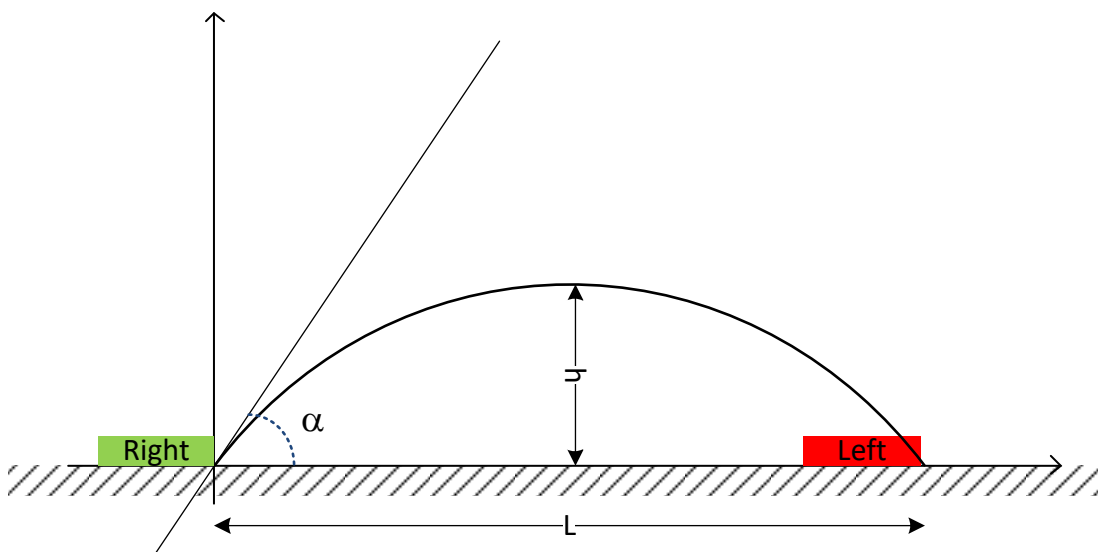
Figure 123 - Stride angle

5.1.3.1 GYKO

If the test was performed using the Gyko inertial sensor as well (usually at the height of the shoulder blade), there are the following in addition to the previous values:

- **Area [cm²]:** The Area parameter provides a dimension of how much the subject moves his/her trunk. The greater it is and the broader are the antero-posterior and medio-lateral rotations. In numerical terms it represents the area of the ellipse of confidence (95%), which is the ellipse that contains approximately 95% of the points of the trajectory.
- **Ant/Post [mm]**: Antero-posterior displacement (positive values = anterior, negative ones = posterior)
- **LH/RH [mm]**: Medio-lateral displacement (positive values = to the right, negative ones = to the left)
- **Control strategy**: AP, ML or NEUTRAL depending on the values mentioned above (AP if the axis of the Ant/Post ellipsoid is greater than the medio-lateral one; ML, vice versa. If the axes are equal the strategy is called "neutral")

Summary Data

Measure	Value
Area[cm²]	14,524
Front/Back[cm]	0,95
Left/Right[cm]	0,05
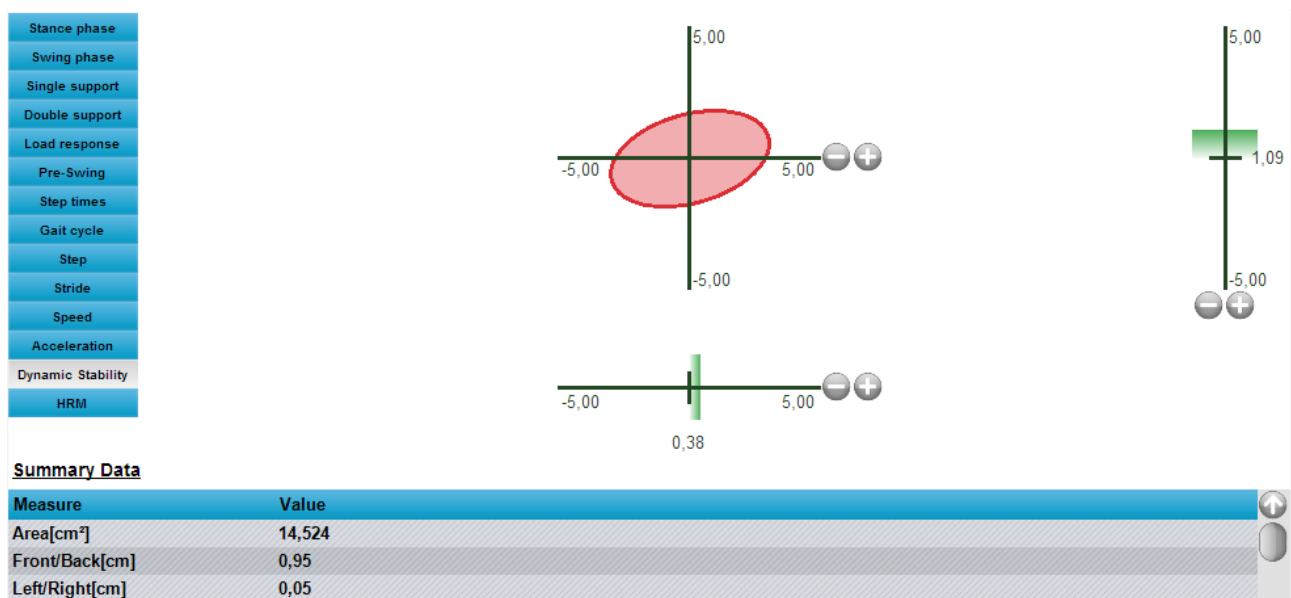
5.1.4 REFERENCE INDEXES

In the Sprint and Gait Test parameters (chap. 4.4.1.5) the speed of an 'ideal' athlete (the so-called 'super athlete') during the 3rd, 6th, and 9th step can be indicated. These are in fact the three most interesting moments of a sprint; important studies have proven that:

- the speed of the 3rd stride is strongly related with the use of **burst power**
- the 6th-stride speed depends on the **phase of transition** between the burst power and elastic recovery
- the 9th-stride speed depends more on pure **elasticity**

Therefore the following indexes have been created and calculated as follows:

Burst index: real speed at 3rd step / ideal reference speed at 3rd step * 100

Transition index: real speed at 6th step / ideal reference speed at 6th step * 100

Elasticity index: real speed at 9th step / ideal reference speed at 9th step * 100

Example: supposing that the three speeds of reference have been set at 6, 8, and 9 m/s, the athlete's sprint is taken into consideration and his indexes are shown:
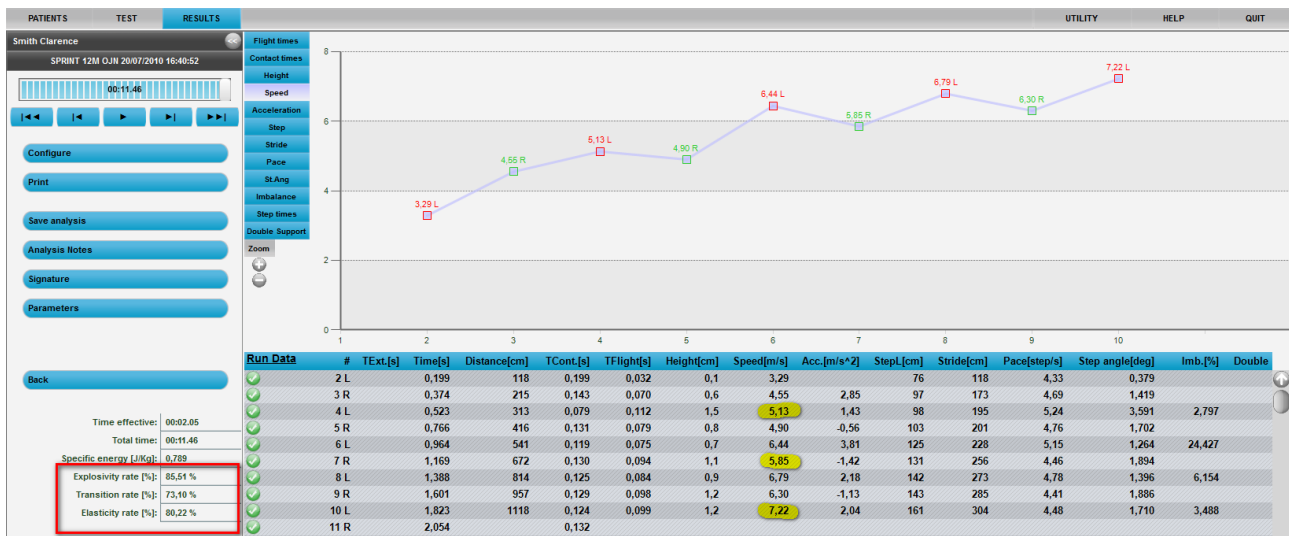
Figure 124 - The three reference indexes in the lower left part

Of course it is possible to change the three speeds of reference - as for any other secondary parameter - in any single test of a certain type or in general (see chap. 4.2.2.1).

Figure 125 - Input of 3 speeds of reference

5.1.5 Imbalance Index

The Imbalance Index column (Imb%) in sprint tests (Run Data) is an indicator of running 'asymmetry' between the right and the left.

At first a linear interpolation of two supports the same type can be assumed.

Consequently, the contact time of an ideal athlete's support would be halfway between the previous and the following; whereas in a real run there will always be a certain difference, the deviation between two times indicating asymmetry.

After having calculated the difference between ideal and real time, the relation between the difference and the ideal time (expressed in %) can be defined as **imbalance index**.
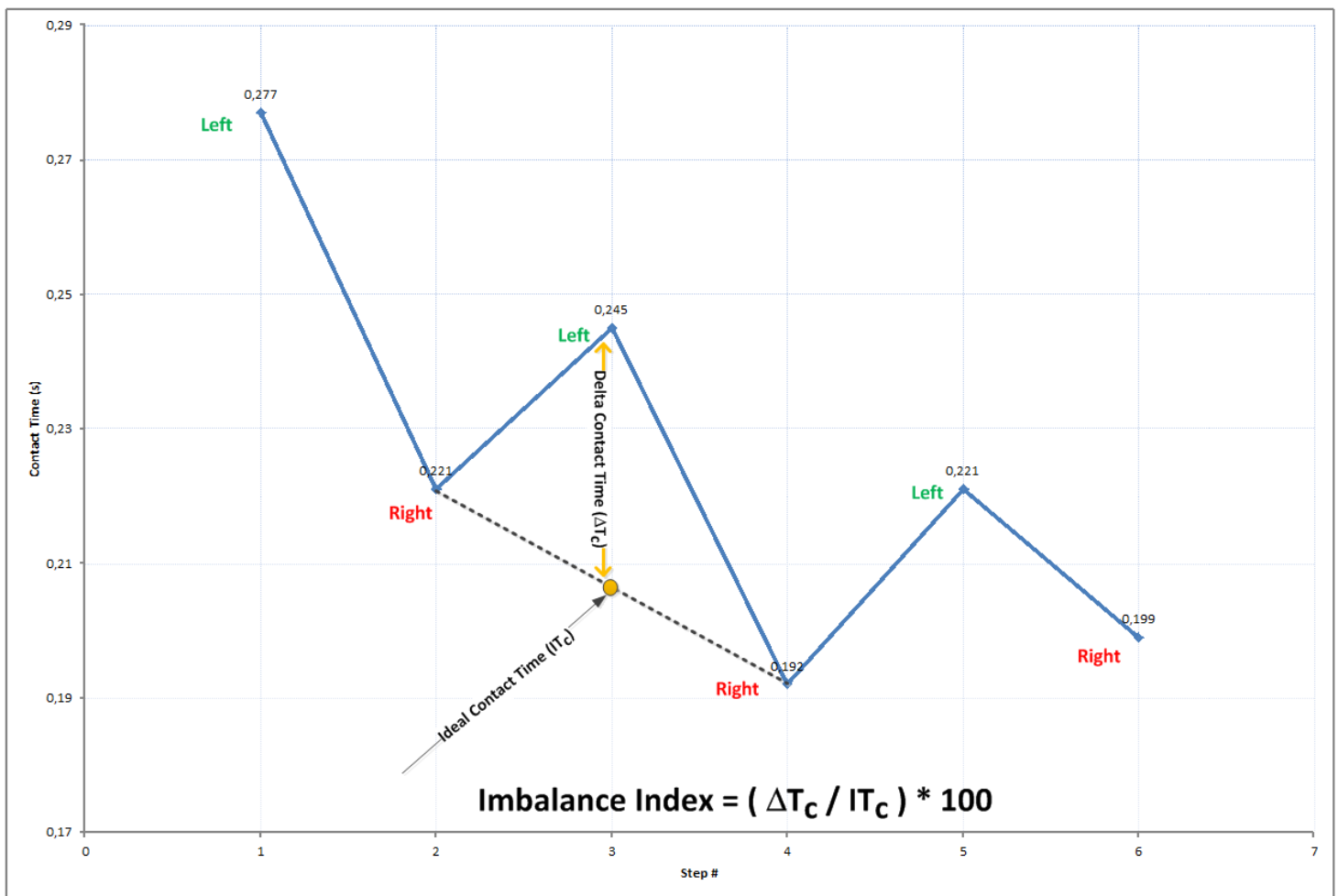
Figure 126 - Definition of imbalance index
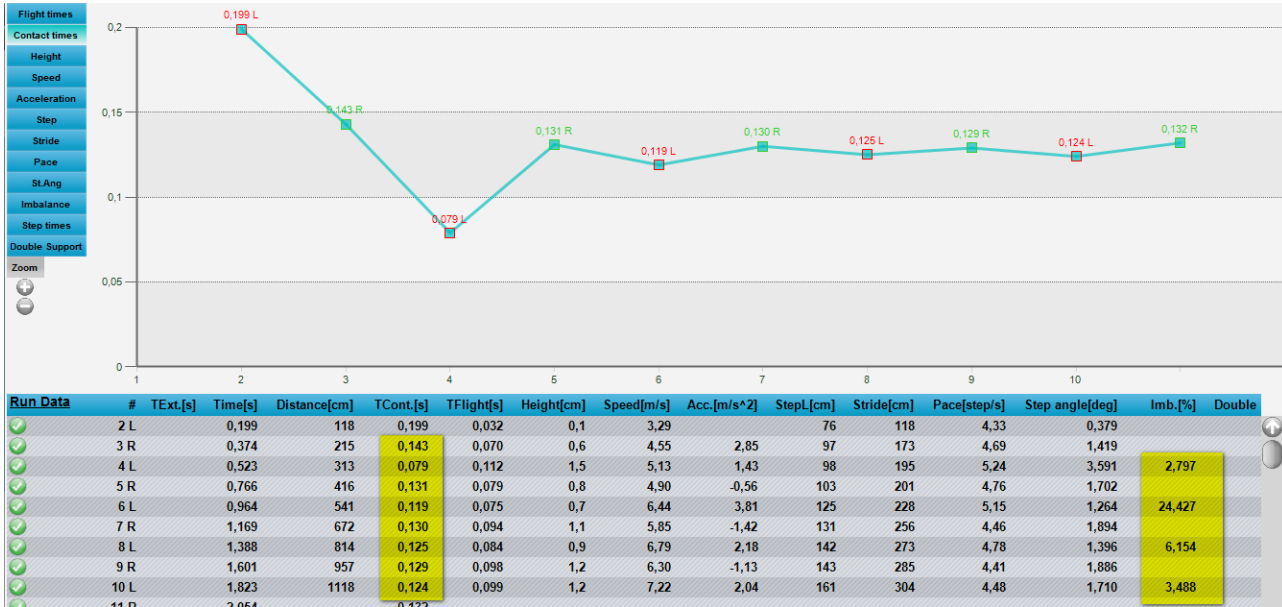
Figure 127 - Example of imbalance index in Run Data

5.1.6 GaitR IN And OUT Filter

Because of the particular configuration of the OptoGait hardware bars with sensors for detecting interruptions set at a few millimetres from the ground, in some cases the results will not correspond or match the power and/or pressure blocks, which by default are set at ground level.

In fact, when the heel of the foot touches ground during the Load Response phase, the LED is interrupted a few milliseconds before contact with the ground and similarly, when the toe is lifted from the ground during the Pre-Swing phase, interruption is postponed.

If this feature is necessary (e.g. for validation and comparison tests) use this parameter, which increases the MINIMUM number of LEDs to be interrupted for triggering the contact event.

Setting, for example, the parameter at 3 LEDs, only when 4 consecutive LEDs are interrupted (and not only 1, as by default), the support is considered valid. The gap between the lighting of N LEDs instead of only one allows to decrease (or eliminate, if possible) the discrepancies with the measurement on blocks.
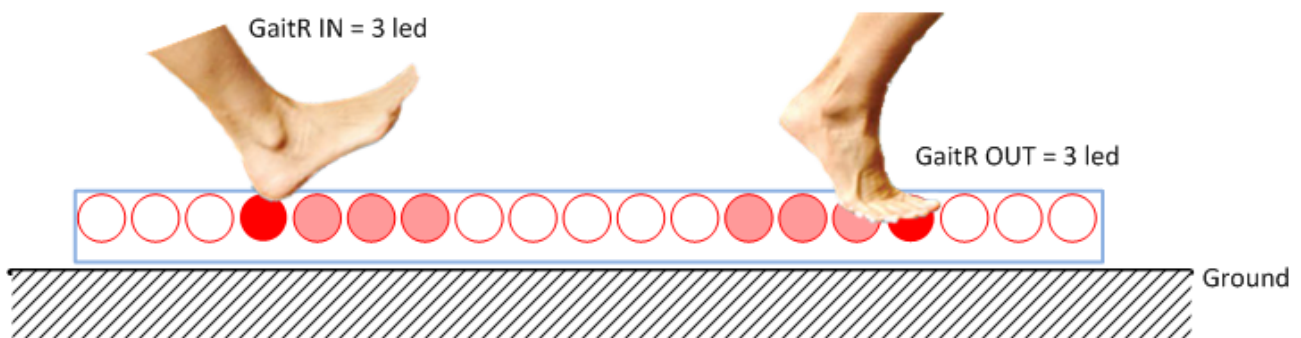
The parameter can be set in the test definition or in the parameters of the single trial in the Results module.

Filter GaitR. In [Led]	3
Filter GaitR. Out [Led]	3

5.1.7 STATIC TESTS (SWAY)

In the Test Data columns we find these values:

- **Time [s]**: Progressive time
- **LH/RH [mm]**: Medio-lateral displacement (positive values = to the right, negative ones = to the left)
- **Ant/Post [mm]**: Antero-posterior displacement (positive values = anterior, negative ones = posterior)

Test Data	#	HRM	Time[s]	Left/Right[mm]	Front/Back[mm]
✓	22	81	2,200	-3,465	3,025
✓	23	81	2,300	-3,774	4,042
✓	24	81	2,400	-3,540	4,995
✓	25	81	2,500	-3,746	5,768
✓	26	81	2,600	-4,417	6,477
✓	27	81	2,700	-4,595	7,567
✓	28	81	2,800	-4,727	8,721
✓	29	81	2,900	-4,257	9,163

Clicking on the Test Data link takes you to the Summary Data section where the data are displayed that we also find in the default Body Sway Protocol (see Sect.6.8). Click on the Summary Data link to return to the previous data.

Summary Data

Measure	Value
Area[mm²]	1892,831
Convex Hull Area[mm²]	1364,135
Length[mm]	467,608
Length AP[mm]	329,694
Length ML[mm]	246,252
Mean Distance[mm]	12,963
Mean Distance AP[mm]	8,734
Mean Distance ML[mm]	7,320
RMS Distance[mm]	14,376
RMS Distance AP[mm]	11,140
RMS Distance ML[mm]	9,087
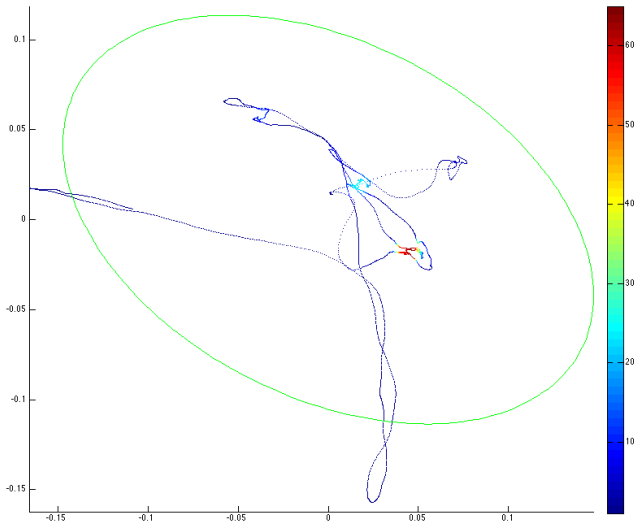
Let's take as an example a trajectory of a Posture (Sway) test. The graph is slightly different to the one used in the software but it gives us a better understanding of the data (the colour scale that describes the density of points by area – blue = low density, red = high density – is not present in the software).
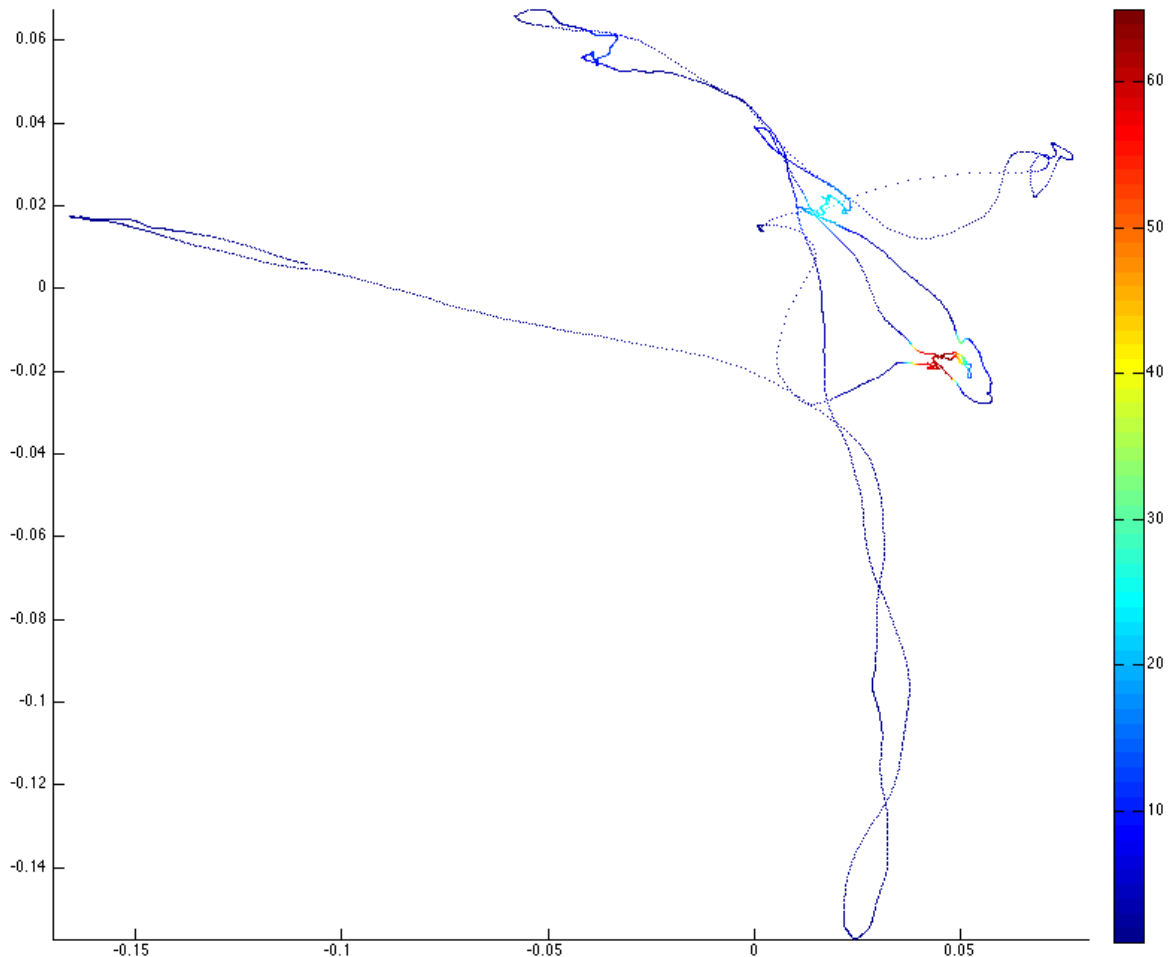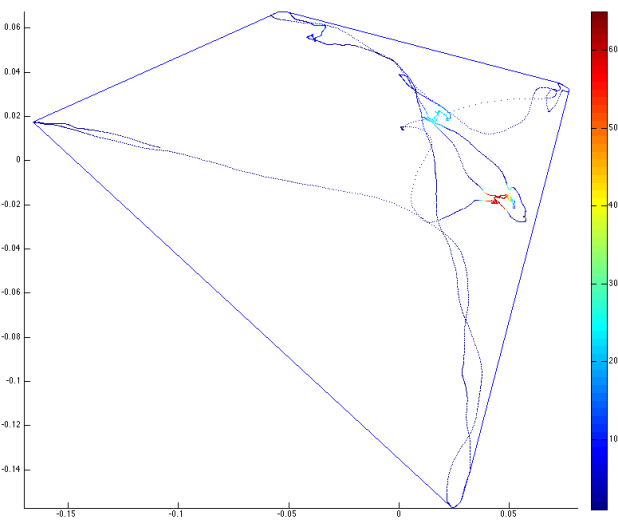
On the x there is the medio-lateral trajectory (left/right) and on the y the antero-posterior trajectory (forwards/backwards).
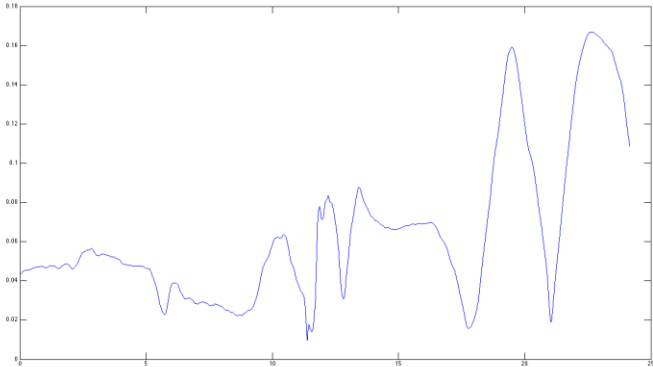
[ref. Prieto et al, Measure of Postural Steadiness, Transaction on Biomedical Engineer, 1996]
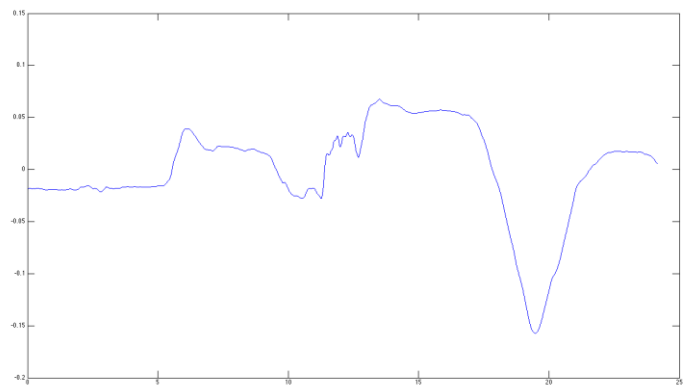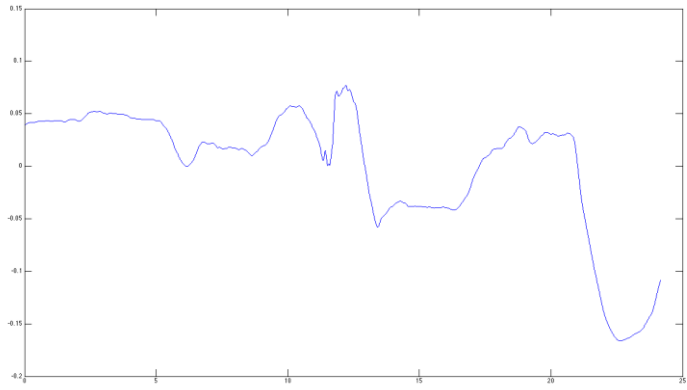
5.1.7.1 AREA

	Area [mm²]:	Area of the ellipse of confidence (95%): the 95% ellipse of confidence is the ellipse that contains approximately 95% of the points of the trajectory. The output parameter is the area of the ellipse.

	Convex Hull Area [mm²]:	The Convex Hull is the smallest polygon that contains all the points of the trajectory.
		Compared to the ellipse, it is more strongly affected by the presence of outliers.

5.1.7.2 LENGTHS

M - Modulus	Length [mm]:	This is the total length of the trajectory obtained as the sum of the distances from one point to the next. (The sum of the points on the curve in the figure) $$L=\sum_{i=1}^{n-1} \sqrt{(AP[i+1]-AP[i])^2 + (ML[i+1]-ML[i])^2}$$

AP - antero-posterior	AP length [mm]:	The AP length is the total distance in the antero-posterior direction given as the sum of the absolute distances between two consecutive points in the AP direction (the sum of the points on the curve in the figure) $$L_{AP} = \sum_{i=1}^{n-1} |AP[i+1] - AP[i]|$$
ML - medio-lateral	ML length [mm]:	The ML length is the total distance in the medio-lateral direction given as the sum of the absolute distances between two consecutive points in the ML direction. (The sum of the points on the curve in the figure) $$L_{ML} = \sum_{i=1}^{n-1} |ML[i+1] - ML[i]|$$

Trajectories

M - modulus - $M = \sqrt{AP^2 + ML^2}$
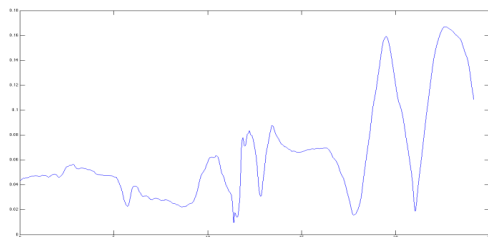
AP – antero-posterior

ML - medio-lateral
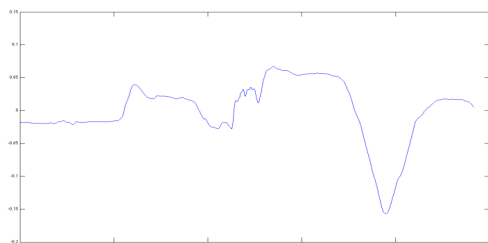
$$= \sqrt{(AP[i+1]-AP[i])+(ML[i+1]-ML[i])}$$
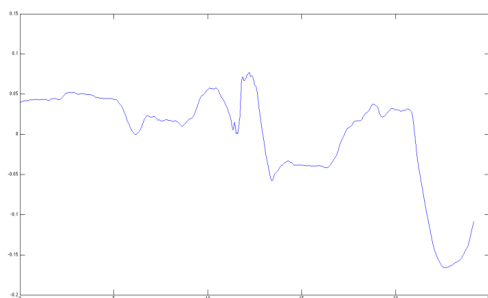
$$= |AP[i+1]-AP[i]|$$

$$= |ML[i+1]-ML[i]|$$

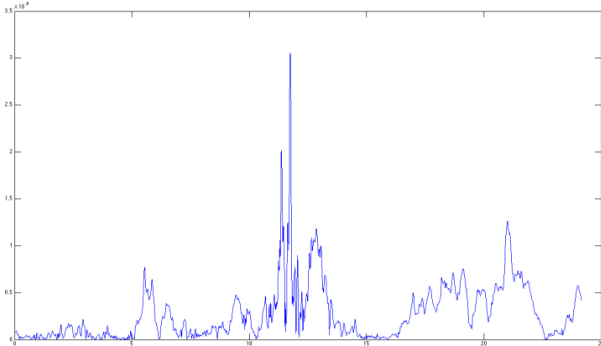# Distances

DM - Modulus
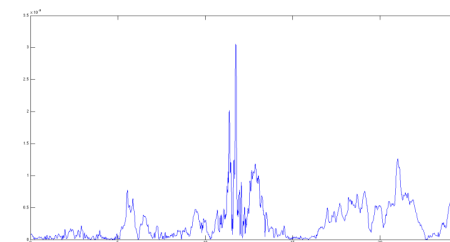
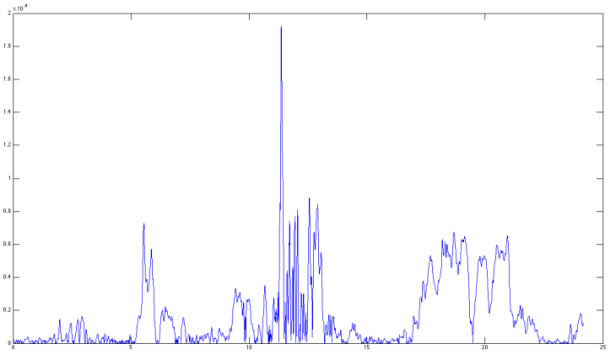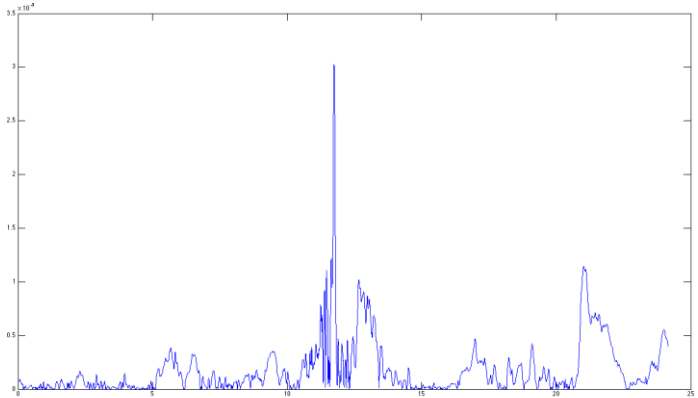**DAP – antero-posterior**

DML – medio-lateral
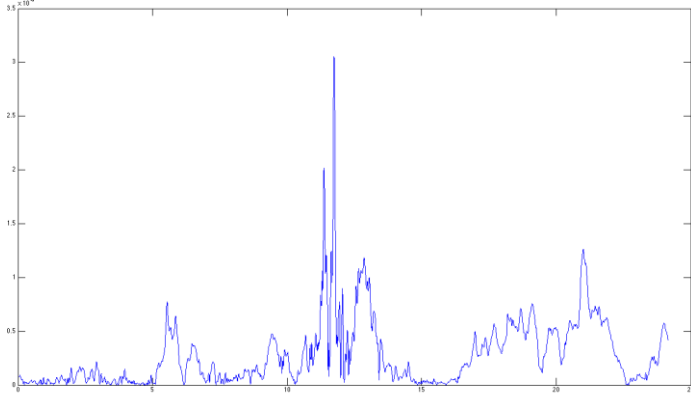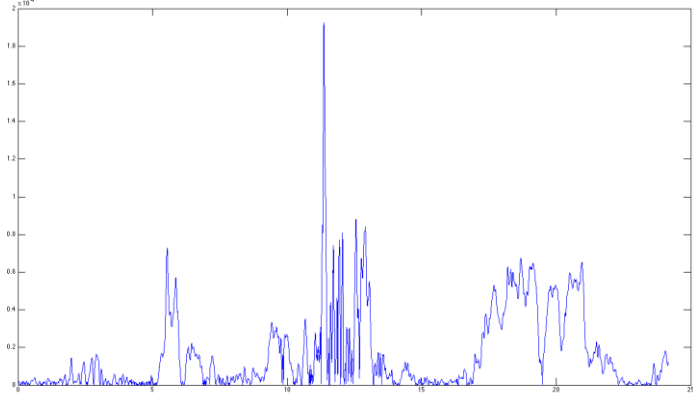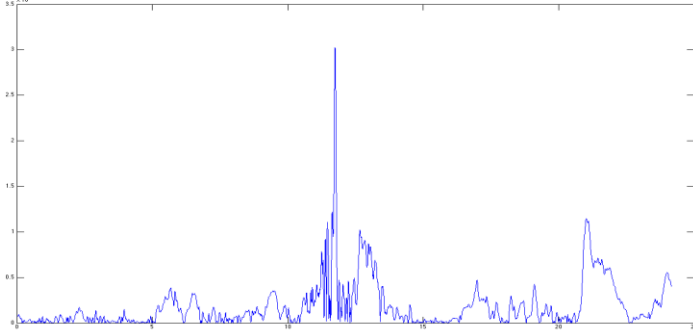
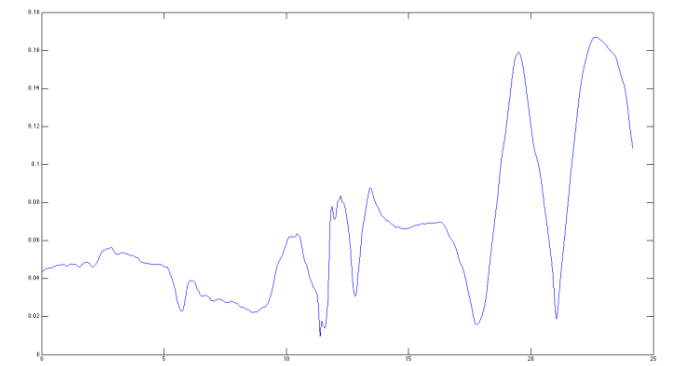| M - Modulus	Mean Distance [mm]:	This is the mean distance from the midpoint of the trajectory. It is the average of the curve in the figure. $$Dist = \frac{1}{N}\sum_{i=1}^{n} DM[i]$$

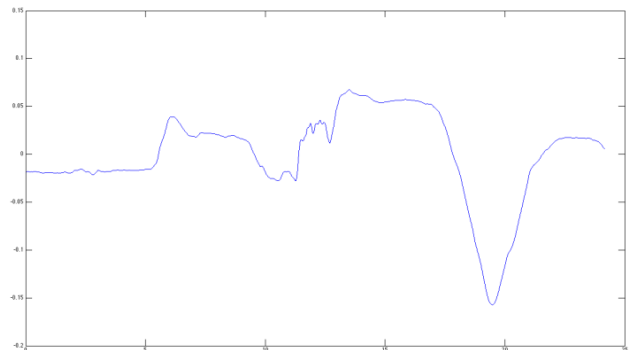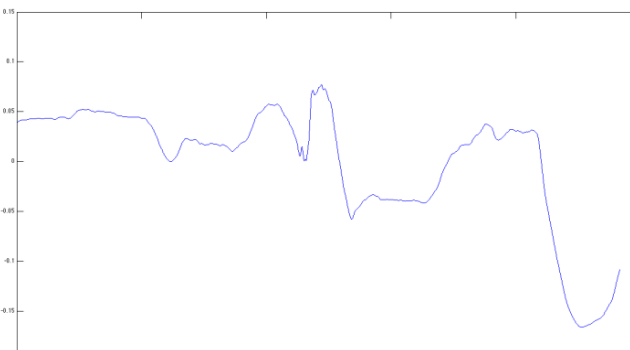| AP - antero-posterior	Mean AP Distance [mm]:	This is the mean distance from the midpoint of the antero-posterior trajectory. It is the average of the curve in the figure $$Dist_{AP} = \frac{1}{N} \sum_{i=1}^{n} |DAP[i]|$$
ML - medio-lateral	Mean ML Distance [mm]:	This is the mean distance from the midpoint of the medio-lateral trajectory. It is the average of the curve in the figure $$Dist_{ML} = \frac{1}{N} \sum_{i=1}^{n} |DML[i]|$$

5.1.7.4 ROOT MEAN SQUARE (RMS)

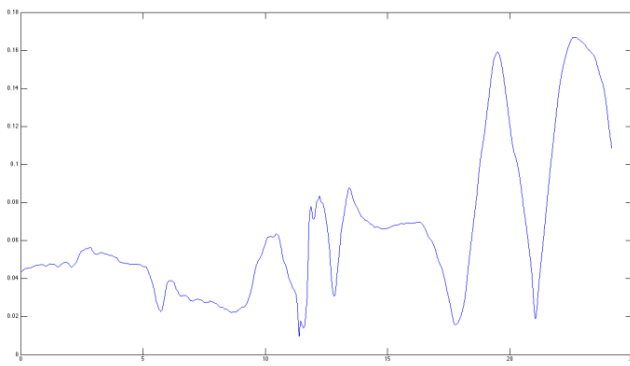| DM - Modulus	RMS [mm]:	This is the dispersion of the distance (root mean square). In this case, as the points are centred on the mean, it is equivalent to the Standard Deviation
		$$RMS = \sqrt{\frac{1}{N} \sum_{i=1}^{n} DM[i]^2}$$

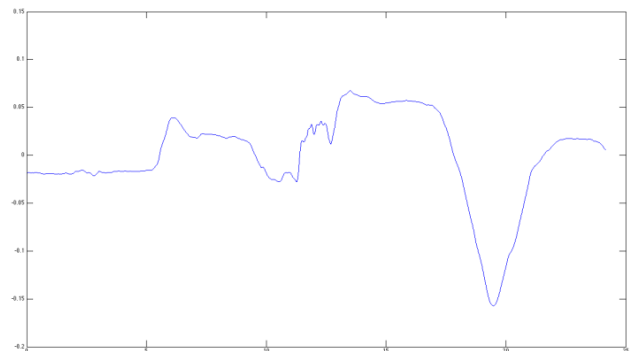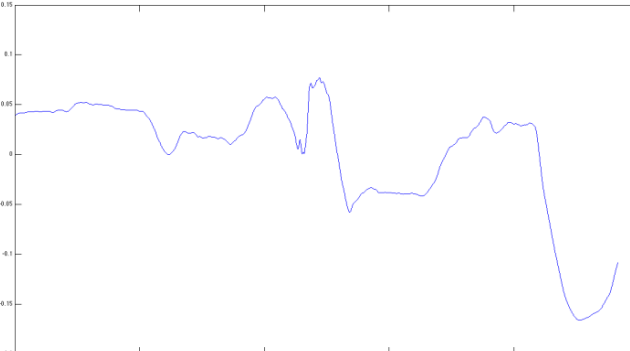| DAP - antero-posterior	AP RMS [mm]:	This is the mean distance from the midpoint of the antero-posterior trajectory. It is the average of the curve in the figure $$RMS_{AP} = \sqrt{\frac{1}{N}\sum_{i=1}^{n} DAP[i]^2}$$
DML - medio-lateral	ML RMS [mm]:	This is the mean distance from the midpoint of the medio-lateral trajectory. It is the average of the curve in the figure $$RMS_{ML} = \sqrt{\frac{1}{N}\sum_{i=1}^{n} DML[i]^2}$$

5.1.7.5 MEAN FREQUENCY

M - Modulus	Mean Frequency [Hz]:	The mean frequency is the frequency of rotation of the centre of pressure (COP) considering as if the COP had travelled the total length of the trajectory on a circle whose radius is the mean distance $$FREQM = \frac{L}{2 \cdot \pi \cdot Dist \cdot T} = \frac{V}{2 \cdot \pi \cdot Dist}$$

| **AP - antero-posterior**	**Mean AP Frequency [Hz]:**	This is the frequency of a sinusoidal oscillation of mean value equal to the mean AP distance and total length equal to the AP length
		$$FREQM_{AP} = \frac{L_{AP}}{\sqrt{4 \cdot 2 \cdot Dist_{AP} \cdot T}} = \frac{V_{AP}}{\sqrt{4 \cdot 2 \cdot Dist_{AP}}}$$
ML - medio-lateral	**Mean ML Frequency [Hz]:**	This is the frequency of a sinusoidal oscillation of mean value equal to the mean ML distance and total length equal to the ML length
		$$FREQM_{ML} = \frac{L_{ML}}{\sqrt{4 \cdot 2 \cdot Dist_{ML} \cdot T}} = \frac{V_{ML}}{\sqrt{4 \cdot 2 \cdot Dist_{ML}}}$$

5.1.7.6 VELOCITY

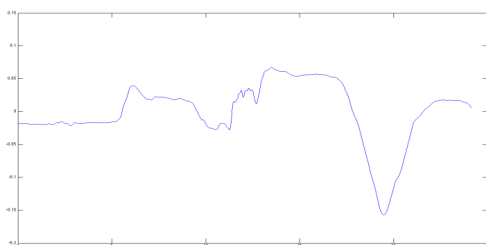| M - Modulus	Mean Velocity [mm/s]:	This is the mean travel velocity of the trajectory.
		$$V = \frac{L}{T}$$

AP - antero-posterior	Mean AP Velocity [mm/s]:	This is the mean travel velocity of the trajectory in the antero-posterior direction $$V_{AP} = \frac{L_{AP}}{T}$$
ML - medio-lateral	Mean ML Velocity [mm/s]:	This is the mean travel velocity of the trajectory in the medio-lateral direction $$V_{ML} = \frac{L_{ML}}{T}$$

Trajectories
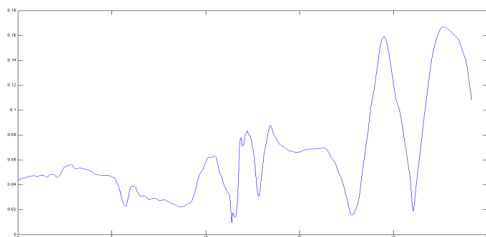
Power spectrum (PSD)
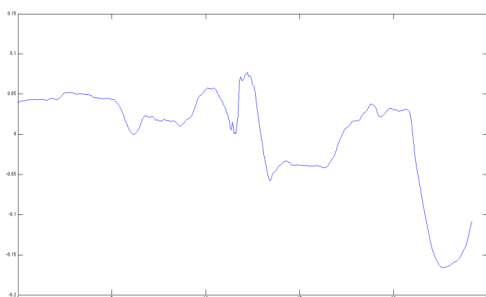
M - modulus - $M = \sqrt{AP^2 + ML^2}$
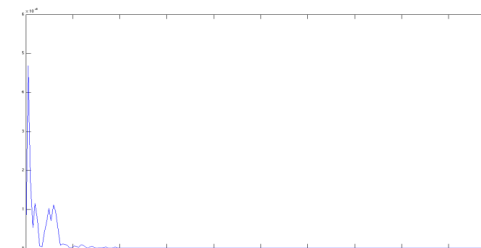
FM - Modulus

AP – antero-posterior

FAP – antero-posterior
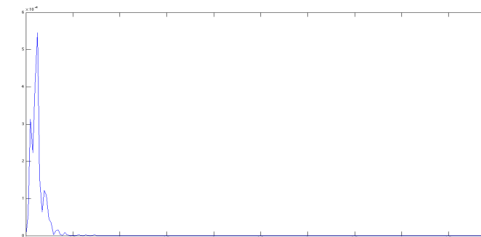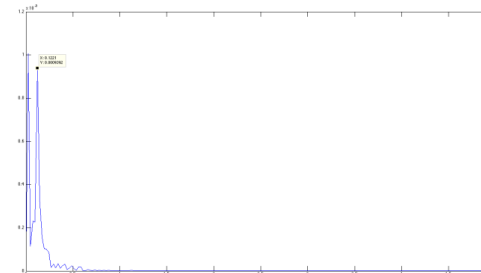
FFT

The tests are analyzed in the frequency range 0.15 Hz to 5 Hz

ML - medio-lateral

FML – medio-lateral

5.1.7.7 TOTAL POWER

We define for the modulus, AP and ML:

$$G[m]$$
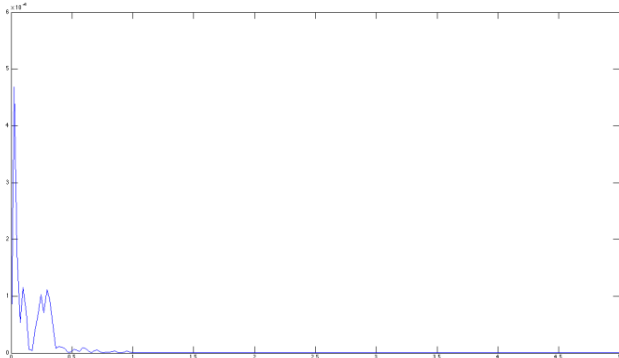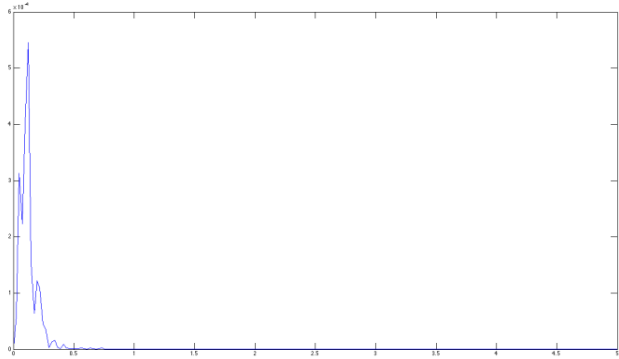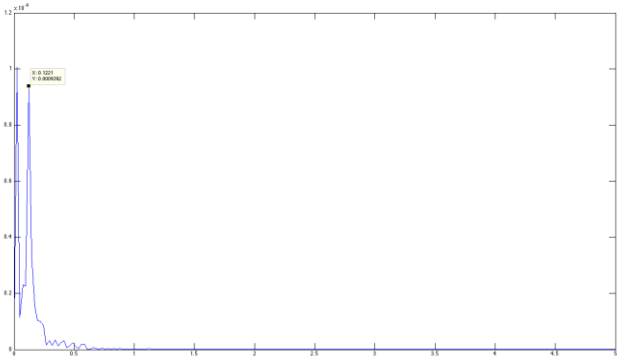
the power spectrum at the frequency f[m] (power spectral density)

$$\Delta f$$

the discrete increase in frequency in fft

$$\mu_k = \sum_{m=i}^{j} (m\Delta f)^k \cdot G[m]$$
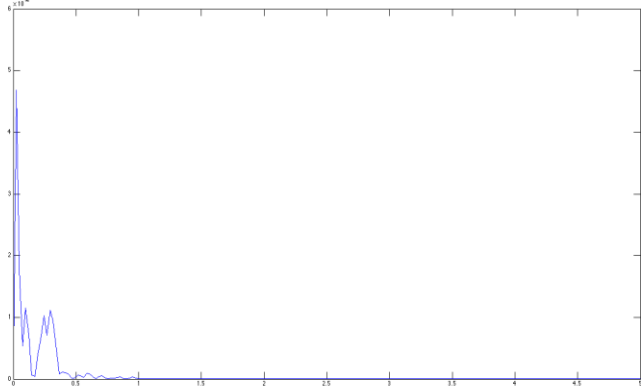
the spectral moment
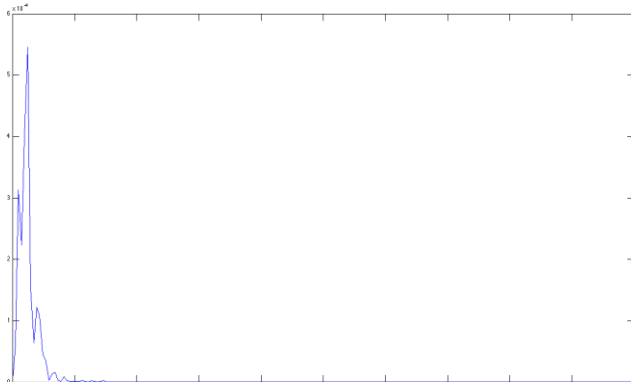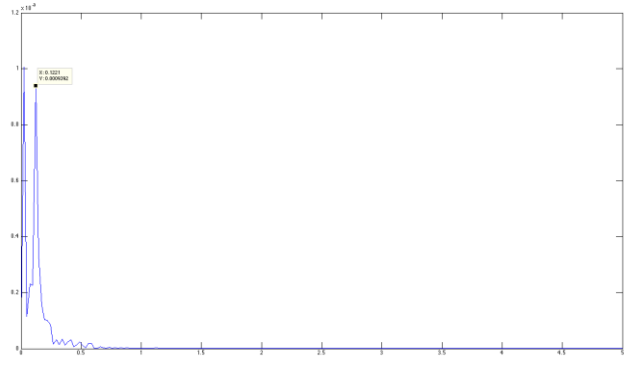
$$\mu_0 = \sum_{m=i}^{j} \cdot G[m]$$

M - Modulus	Total Power [mm²]:	This is the area of the power spectrum in the range 0.15 - 5Hz. Also equal to μ_0
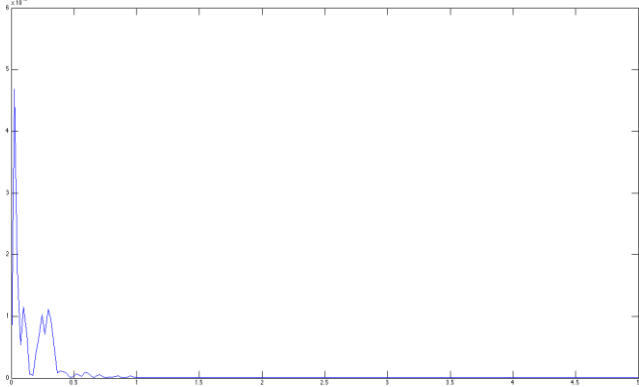
AP - antero-posterior	Total AP Power [mm^2]:	This is the area of the power spectrum in the range 0.15 - 5Hz of the AP trajectory. Also equal to $_{A\Pi 0}$
		This is the area of the power spectrum in the range 0.15 - 5Hz of the ML trajectory Also equal to $_{M\Lambda 0}$
ML - medio-lateral	Total ML Power [mm^2]:	
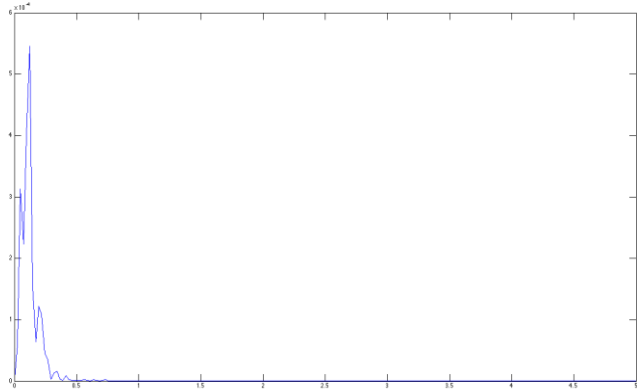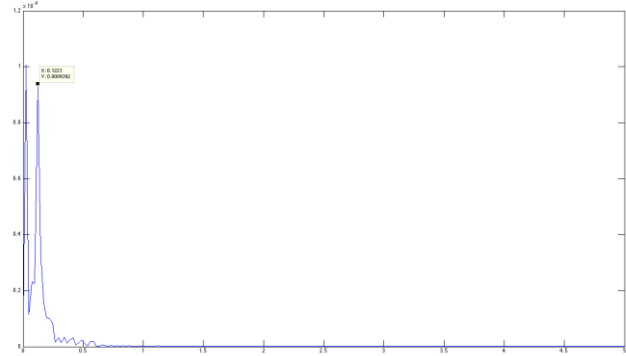
5.1.7.8 50% POWER FREQUENCY

M - Modulus	50% Power Frequency [Hz]:	The frequency below which 50% of the total signal power is contained $$\sum_{m=i}^{u} \cdot G[m] \geq 0.5 \cdot P \rightarrow F50 = u \cdot \Delta f$$
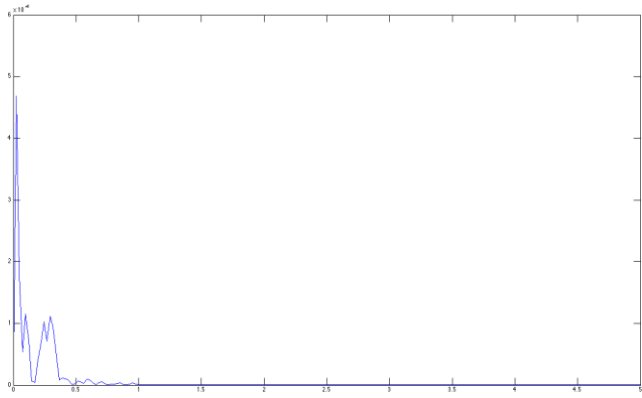
AP - antero-posterior	50% AP Power Frequency [Hz]:	The frequency below which 50% of the total AP signal power is contained
		$$\sum_{m=i}^{u} \cdot G_{AP}[m] \geq 0.5 \cdot P_{AP} \rightarrow F50_{AP} = u \cdot \Delta f$$
ML - medio-lateral	50% ML Power Frequency [Hz]:	The frequency below which 50% of the total ML signal power is contained
		$$\sum_{m=i}^{u} \cdot G_{ML}[m] \geq 0.5 \cdot P_{ML} \rightarrow F50_{ML} = u \cdot \Delta f$$
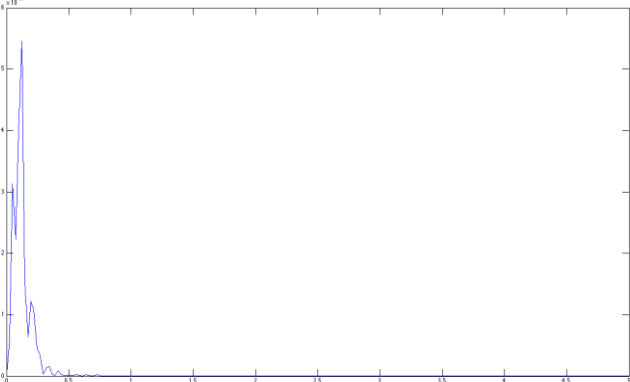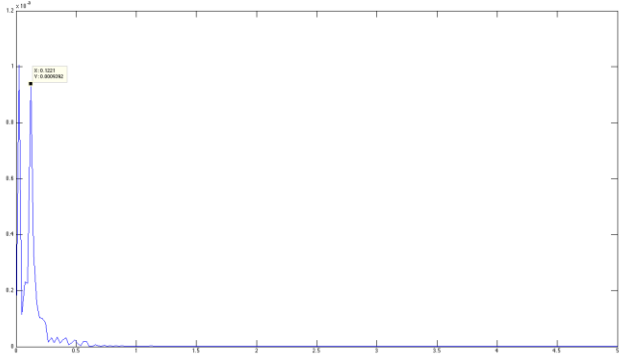
5.1.7.9 95% POWER FREQUENCY

M - Modulus	95% Power Frequency [Hz]:	The frequency below which 95% of the total signal power is contained
		$$\sum_{m=i}^{u} \cdot G[m] \geq 0.95 \cdot P_i \rightarrow F95 = u \cdot \Delta f$$

AP - antero-posterior	95% AP Power Frequency [Hz]:	The frequency below which 95% of the total AP signal power is contained $$\sum_{m=i}^{u} \cdot G_{AP}[m] \geq 0.95 \cdot P_{AP} \rightarrow F95_{AP} = u \cdot \varDelta f$$
ML - medio-lateral	95% ML Power Frequency [Hz]:	The frequency below which 50% of the total signal power is contained $$\sum_{m=i}^{u} \cdot G_{ML}[m] \geq 0.95 \cdot P_{ML} \rightarrow F95_{ML} = u \cdot \varDelta f$$

5.1.7.10   CENTROIDAL FREQUENCY
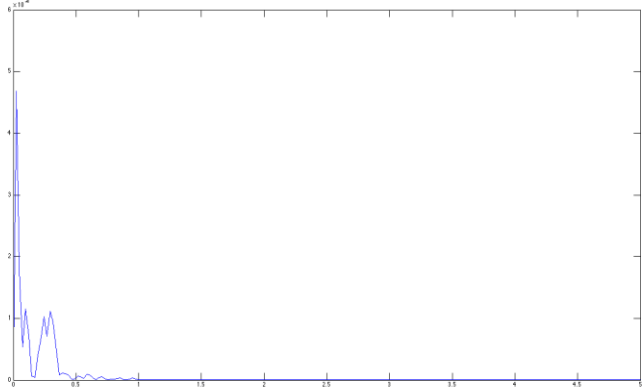
M - Modulus	Centroidal Frequency [Hz]:	This is the frequency at which the "spectral mass" is concentrated $$CF=\sqrt{\frac{\mu_2}{\mu_0}}$$

AP - antero-posterior	AP Centroidal Frequency [Hz]:	This is the frequency at which the "spectral mass" in the AP direction is concentrated $$CF_{AP} = \sqrt{\frac{\mu_{AP2}}{\mu_{AP0}}}$$
ML - medio-lateral	ML Centroidal Frequency [Hz]:	This is the frequency at which the "spectral mass" in the ML direction is concentrated $$CF_{ML} = \sqrt{\frac{\mu_{ML2}}{\mu_{ML0}}}$$

5.1.7.11   FREQUENCY DISPERSION

$$\mu_k = \sum_{m=i}^{j} (m\Delta f)^k \cdot G[m]$$

M - Modulus	Frequency Dispersion	This is a measurement between 0 and 1 of the content variability in frequency of the power spectrum $$FD = \sqrt{1 - \frac{\mu_1^2}{\mu_0 \cdot \mu_2}}$$
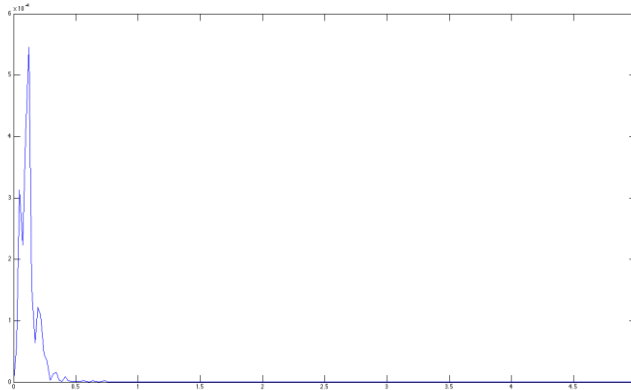
AP - antero-posterior	AP Frequency Dispersion	This is a measurement between 0 and 1 of the content variability in frequency of the power spectrum in the AP direction
		$$FD_{AP} = \sqrt{1 - \frac{\mu_{AP_1}^2}{\mu_{AP_0} \cdot \mu_{AP2}}}$$
ML - medio-lateral	ML Frequency Dispersion	This is a measurement between 0 and 1 of the content variability in frequency of the power spectrum in the ML direction
		$$FD_{ML} = \sqrt{1 - \frac{\mu_{ML_1}^2}{\mu_{ML_0} \cdot \mu_{ML2}}}$$
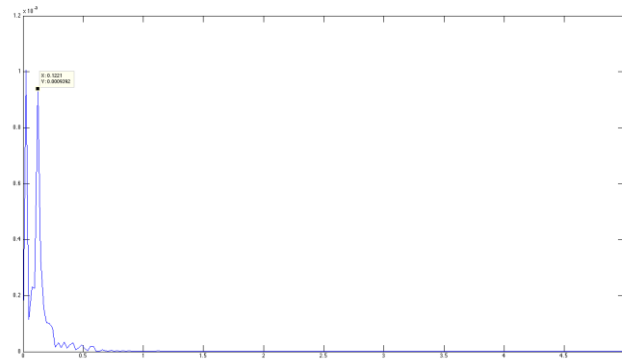
5.2 GAIT ANALYSIS DEFINITION

Note: The names of these measurements are used in English, because the English terms are standard technical Gait Analysis terminology. Terms such as Single Support, Double Support, Stance, Swing, etc. are well known among professional; therefore these terms are not translated in any language.

The following are some useful definitions to explain the values displayed on the table with numerical data.
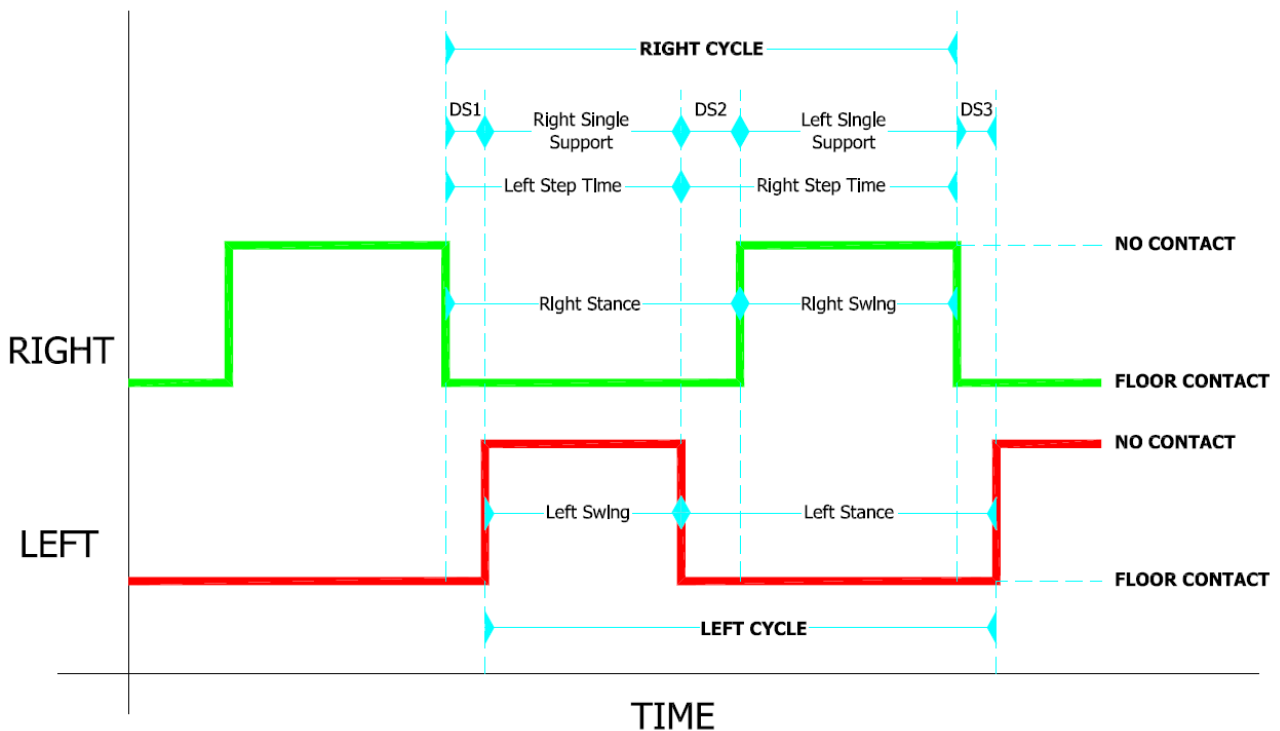
Figure 128 - Gait analysis terminology

The **Gait Cycle** begins when the heel of one foot touches the ground and ends when the same foot, after having executed one step, is set down. The cycle begins with the **Stance** phase (the heel-to-toe contact sequence of the foot) and continues with a **Swing** phase, where the foot is suspended and proceeds in the air (on average the stance phase accounts for 60% and the swing phase for 40%).
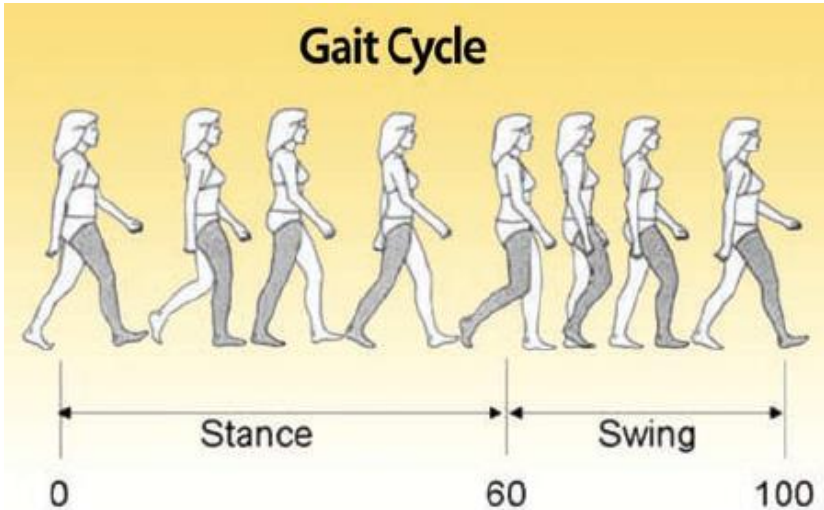
Figure 129 - Gait Cycle: Stance & Swing

Each Gait cycle consists of two phases, where both feet are in contact with the ground, called **Double Support**: the first Double Support (DS1 in Figure Figure 128 referring to the right foot) is also called "**Load Response**", whereas the second (DS2) is called "**Pre Swing**". When only one foot is in contact with the ground, this is called **Single Support**.
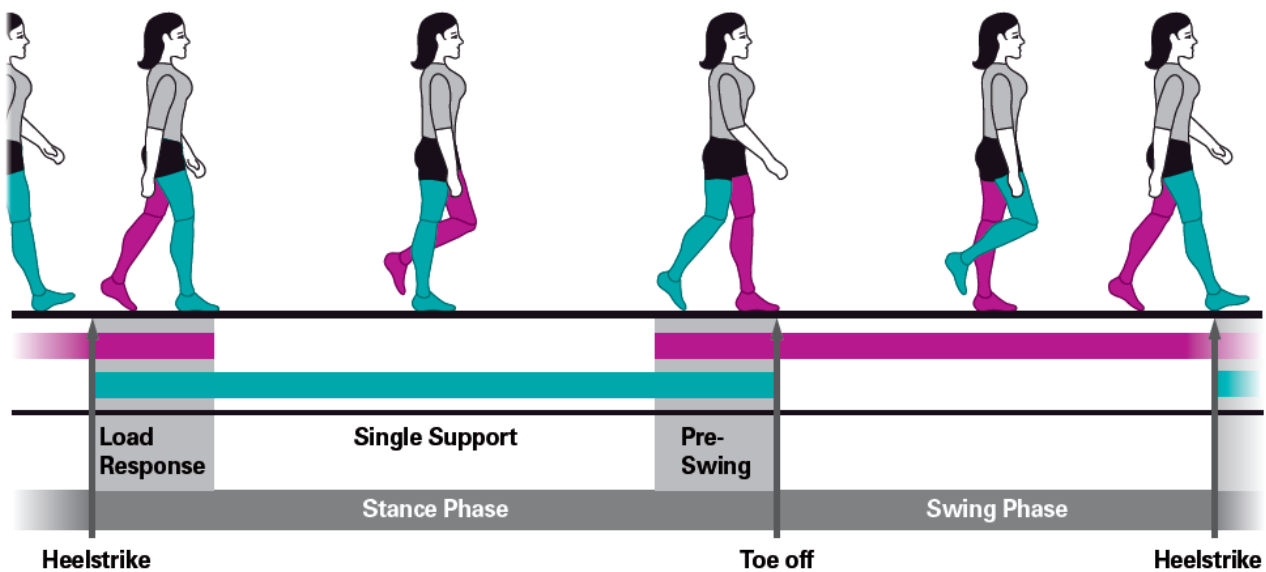
Figure 130 - Stance and Swing Phases

The definitions of **Step** and **Stride** correspond respectively to those of Step and Stride explained in the section above.

Run Data Columns

- **TExt. [s]**: External time: available only for external impulse. This is the time between the event (start/stop) of the impulse and the entry/exit into/from the OptoGait bars; it can also comprise split times
- **Time [s]**: progressive time (split) from the test beginning
- **Distance [cm]**: progressive distance walked/run by a patient
- **TCont. [s]**: Contact times
- **TFlight [s]**: Flight times
- **Height [cm or in]**: Variation of the centre of gravity height during the execution of jumps/runs
- **Speed [m/s or ft/s]**: Average speed of a single step (see Fig. Figure 121)
- **Accelerations [m/s² or ft/s²]**: Speed variations of the two preceding steps
- **Steps [cm or ft]**: Step length (see definition above)
- **Stride [cm]**: Stride length (see definition above)
- **Pace [step/s]**: Rhythm expressed in steps per second
- **Stride Angle [deg]**: Alpha angle of the stride parable
- **Imb. [%]**: imbalance indices of the run between right and left step
- **Double Sup [s.]**: Double Support: Period of time when both feet touch the ground
- **Step Times [s]:** time between the first contact of one foot and the first contact of the opposite foot
- **Contact Phase [s | %]:** the time between the first contact of the heel and the complete support of the foot; the percentage indicates the value with respect to the total contact time
- **Foot Flat [s | %]:** the time the foot completely touches the ground; the percentage indicates the value with respect to the total contact time
- **Propulsive phase [s | %]:** the time between the lifting of the heel to the complete set off of the tip of the foot; the percentage indicates the value with respect to the total contact time

Gait Data Columns

- **TExt. [s]**: External time: available only for external impulse. This is the time between the event (start/stop) of the impulse and the entry/exit into/from the OptoGait bars; it can also comprise split times
- **Stance phase [s | %]**: The stance phase is the weight phase supporting phase of each gait cycle. It begins with the contact of the heel and finishes with the set off of the tip of the same foot. It is therefore the time between the first and the last contact of two consecutive supports of the same foot. It is also presented as a percentage of the total gait cycle.
- **Swing Phase [s | %]**: The swing phase begins when the tip of the foot leaves the ground and finishes with the contact of the heel. It is therefore the time between the last contact of the first support of the foot and the first contact of the following support. It is expressed in seconds (sec) and as a percentage of the gait cycle of the same foot. The swing time of one foot corresponds to the single support time of the other foot.
- **Single Sup. [s | %]**: Single Support: This is the time between the last contact of the current support and the first contact of the following support of the same foot (i.e., the time when only one foot touches the ground). The single support corresponds to the swing time of the opposite foot. It is expressed in seconds and as a percentage of the total gait cycle time.
- **Total Double Sup [s | %]**: This is the sum of two partial double supports, defined DS1 and DS2 in Figure 128
- **Step Time [s | %]**: This is the time between the first contact of a foot and the first contact of the opposite foot (it corresponds to the Step Time in the Run Data)
- **Load Response [s | %]**: This is the first Double Support Time (DS1 in Figure 128)
- **Pre Swing [s | %]**: This is the second Double Support Time (DS2 in Figure 128)
- **Step Length [cm]:** Step length (see definition above)
- **Gait cycle [s]**: This is the time between the first contact of two consecutive steps of the same foot
- **Stride Length [cm]:** Stride length (see definition above)
- **Speed [m/s]:** Average speed of a single step (see Figure 121)
- **Accel. [m/s²]:** Speed variations of the two preceding steps (see Figure 122)
- **Cadence [step/s]:** Rhythm expressed in steps per second
- **Total dist. [cm]**: Progressive distance walked/run by a patient
- **Contact Phase [s | %]:** The time between the first contact of the heel and the complete support of the foot; the percentage indicates the value with respect to the total contact time
- **Foot Flat [s | %]:** The time the foot completely touches the ground; the percentage indicates the value with respect to the total contact time
- **Propulsive phase [s | %]:** The time between the lifting of the heel to the complete set off of the tip of the foot; the percentage indicates the value with respect to the total contact time

5.3 INVALID TIMES MANAGEMENT

There are cases where during a test the program may acquire invalid times. The main cases are:

The OptoGait device is not installed correctly: if during a performance of a test, the OptoGait device is badly positioned on the ground, or the ground is particularly uneven, invalid flight or contact times may occur;

The patient knocks against the device: if during the test the patient knocks against the device without causing it to lose its alignment, this may only temporarily generate some invalid times;

The patient exits the measurement area: in very long tests, the patient may exit the measurement area for one jump and then re-enter the area.

In these cases it may be convenient to keep the test and make a manual/automatic correction to times rather than repeat the test itself.

In fact, the OptoGait program contains an automatic and manual system for managing spurious times acquired during a test. Checking for spurious times is only done on flight, step, and contact times, with any external times always considered as valid.

The basic criterion is that acquired times are always coupled with (contact time) + (flight time or step time). Flight or step times without a corresponding contact, flight or step time are only possible at the beginning or end of a test contact (because of the start or finish type set in the test).

In the case of a very brief contact, flight or step time, there is an automatic procedure that identifies any invalid times, (i.e., below a certain threshold). This threshold can be set or deactivated (see chap. 4.4.1.2 Jump Test Configuration).

If there are other errors that are not automatically deleted, it is possible to manually correct them: select the row with the invalid contact, flight or step time and delete the entire row (and thus the contact-flight time couple). As a result, such values will not be considered in the calculation of average values and will not appear in the charts.

In these cases add the contact-flight time couple to the flight time of the previous contact-flight time couple, if it is the contact time that is not average, or add the contact-flight time couple to the contact time of the following contact-flight time couple, if it is the flight time that is not average.

The following chart clarifies this concept:

Invalid contact time (delete contact time):

Cont. time	Flight time is	Cont. time	Flight time
0.35	0.43	0.35	0.43
0.30	0.15	0.30	0.45 (0.15+0.05+0.25)
0.05 (inval.)	0.25		
0.32	0.41	0.32	0.41

Invalid flight time (delete flight time):

Cont. time	Flight time is	Cont. time	Flight time
0.35	0.43	0.35	0.43
0.10	0.05 (inval.)		
0.15	0.42	0.30(0.10+0.05+0.15)	0.42
0.32	0.41	0.32	0.41

The command 'Show marked rows', accessible from the Row Management Menu (see chap.) allows you to remove the deleted rows from the view (and only from the view) in order to analyse only the data of interest.

Note: if the OptoGait device is not installed correctly and consequently generates spurious times during a test, it is better for the user to correct the installation of the device to eliminate spurious times beforehand rather than to filter invalid times afterwards. Correct installation can be checked using the OptoGait bars Test (see chap. 4.4.2 OptoGait HW Test).

5.4 VIDEO ANALYSIS

Figure 131 – Video Analysis

To analyse a still video picture, double-click with the mouse on the video window. In a Compare analysis or in a test, where two webcams are used, use CTRL+double-click to edit the two images.

Available commands are the following, from top to bottom:

From left:

- Delete all
- Load an image stored on disk
- Save the image on disk in .BMP format
- Save the image in the report; you will be asked to name the image, which will be appended at the end of the report
- Save the added graphical elements (grids, rows, angles, texts, etc.) as overlay in the video
- Delete the items added with the previous command as overlay of the video
- Select items To select more than one item keep CTRL pressed
- Pan: Moves all added items
- Move: Moves the selected item
- Undo
- Redo
- Set the current colour
- Set the font and other text features
- Draw a grid with the set features on the image
- Sample ruler: allows to set a known length (e.g. the height of a step)
- Draw single line
- Draw connected lines (ESC to close the drawing)
- Draw circumference through two points
- Draw centre-radius circumference

- Draw two-point arc

- Draw centre-radius arc

- Draw three-point arc (Start / End / Include)

- Draw three-point arc (Start / End / Include)

- Draw lines viewing internal angle

- Draw lines viewing external angle

- Text tool

- Line with measure: draw a line with length indication calculated after having used the tool Measurement Ruler. WARNING: the measurement must be taken on the same level as the item measured previously. E.g. have the patient stand sideways to a step of a known height, use the tool 'Sample Ruler' to measure the step, then measure the patient with this tool.

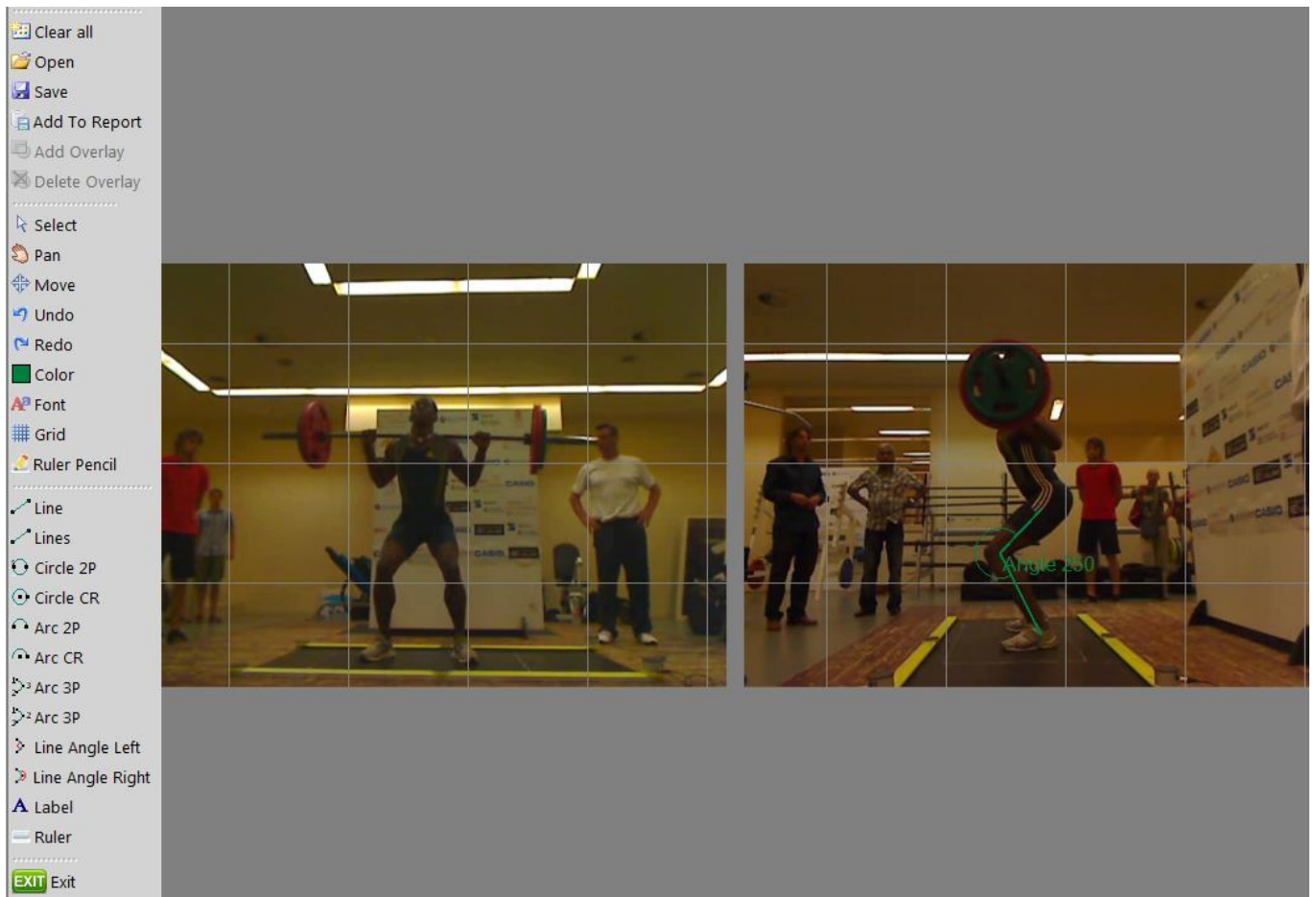To exit press the EXIT symbol at the end of the tool bar.

Figure 132 - Toolbar and double image under analysis
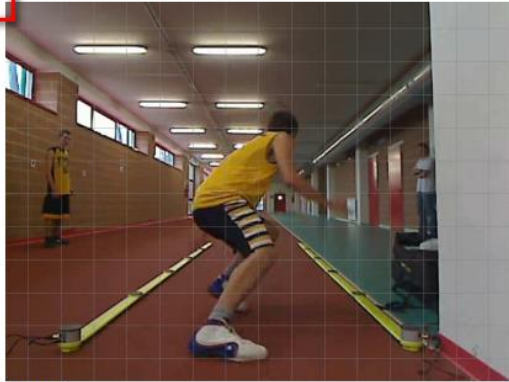
5.5 MANAGING IMAGES

When saving an image (or two images in the case of video frames of a test comparison) it is possible to add a caption (i.e. a short name used as title) and a note (a larger field for an image description).

Images are managed (caption and note editing, changing of order of appearance and possible deletion) using the button <Images> in the Print section (chap. 4.3.1.8).

In this area there is a list of images added to the report in chronological order, each one having two icons - edit and delete - for editing captions and notes, and for deleting images from the report.

The order of appearance can be changed selecting the photo to be moved (a selected picture has a black frame) and clicking <Move up> or <Move down> in the left button bar.

6 DEFAULT TESTS AND PROTOCOLS

Most tests are well-known standard tests (such as Squat Jump, Stiffness, Counter movement Jump) for which it is enough to follow the instructions on the screen (enter/exit test area, carry out a given number of jumps, wait for sound signal at the end of the test etc.).

In this section you will find default tests and protocols which might raise some doubts as regards their initial setup and execution.

6.1 DRIFT PROTOCOL

The Drift Protocol is a test developed for verifying an athlete's or a patient's '**dynamic stability**' by having him/her carry out 4 tests one after another on one leg measuring his/her displacement (drift) on the vertical and horizontal axis.

Go to Test > Execute, choose an athlete and from the protocol list select 'Drift Protocol'.

In the Test field the following sequence is automatically filled-in:

- 5 jumps with RIGHT leg and feet PARALLEL to the OptoJump bars
- 5 jumps with LEFT leg and feet PARALLEL to the OptoJump bars
- 5 jumps with RIGHT leg and feet PERPENDICULAR to the OptoJump bars
- 5 jumps with LEFT leg and feet PERPENDICULAR to the OptoJump bars
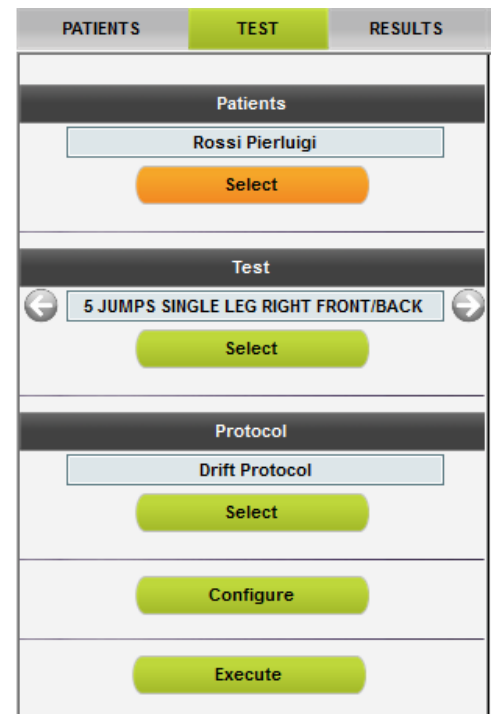
Figure 133 - Choosing a protocol
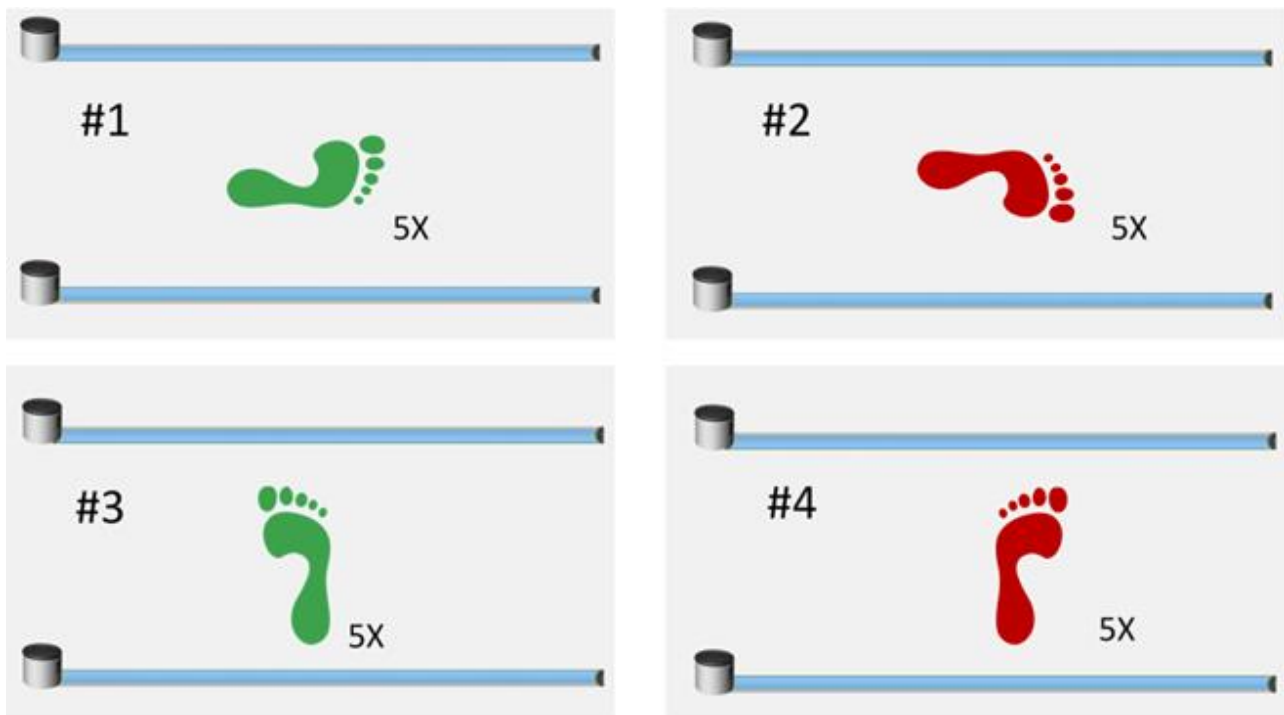
Figure 134 - Drift Protocol sequence

Carry out the 4 tests reminding to press SAVE at the end of each test before moving on to the following test.

At the end of the protocol go to Results, select the option 'Protocols' from Display>Data and choose the protocol which has just been executed, with the symbol ⊙
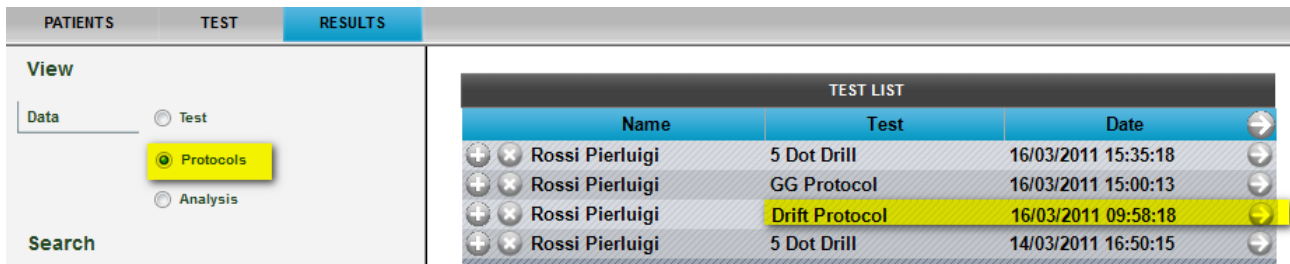
Figure 135 - Selecting a protocol to be printed

Double-click on the protocol to be analysed (or click the button <Display>); a report will be displayed showing the average jump values divided into right and left leg and, what's even more important, two graphs allowing to quantify very rapidly the displacements and their direction.

Each jump is displayed as a yellow dot (if you can not see 10 dots per leg some might be superposed); the two large red and green dots (left and right) represent the athlete's **tendency** to move into a certain direction (e.g. upwards to the right), whereas the dotted triangle indicates the '**stability area**'.

The position of the red and green dots with reference to the origin of the two Cartesian axes gives a first indication of the athlete's *average* landing point compared to the starting point. As these represent an average, their position could be misleading: for example, given the absurd assumption that an athlete carries out a perfectly central jump, two completely to the right and two completely to the left with two displacements of exactly the same entity, the dot will be placed exactly in the centre giving the impression that the athlete always jumped perfectly.

But in this case the rectangle with the dotted area representing the **standard deviation** of jumps can be helpful. The larger the displayed area, more has the athlete drifted (moving away from the point of origin) when landing, and as a consequence his dynamic stability is lower.

Drift Protocol

	L	R	Delta%
Average Height [cm]	12,1	10,9	9,4%
Average Power[W/Kg]	11,52	10,97	4,8%
Average Contact Time [s]	0,640	0,633	1,0%
Average Flight Time[s]	0,313	0,297	5,3%
Average LEFT/RIGHT Drift[cm]	4,7	6,1	-31,0%
Average FRONT/BACK Drift[cm]	3,4	-0,6	119,1%
Standard Dev LEFT/RIGHT Drift[cm]	28,6	9,4	67,1%
Standard Dev FRONT/BACK Drift[cm]	6,3	4,7	26,0%
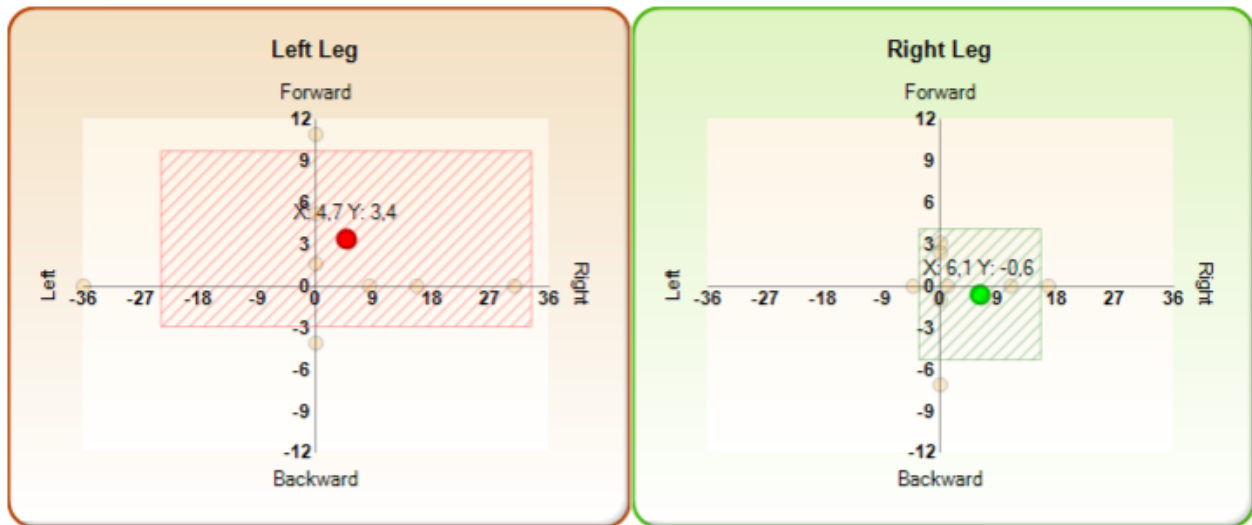
Figure 136 - Drift protocol report output

6.1.1 2D DRIFT PROTOCOL

With its two-dimensional system (even the minimum 1 x 1 meter will suffice), the protocol can be significantly simplified by making the patient perform just 10 jumps (5 with the right and 5 with the left).

It is recommended to use this direction always in order to have correctly-oriented axes and therefore a correct interpretation of the concepts of Forward/Backward and Left/Right
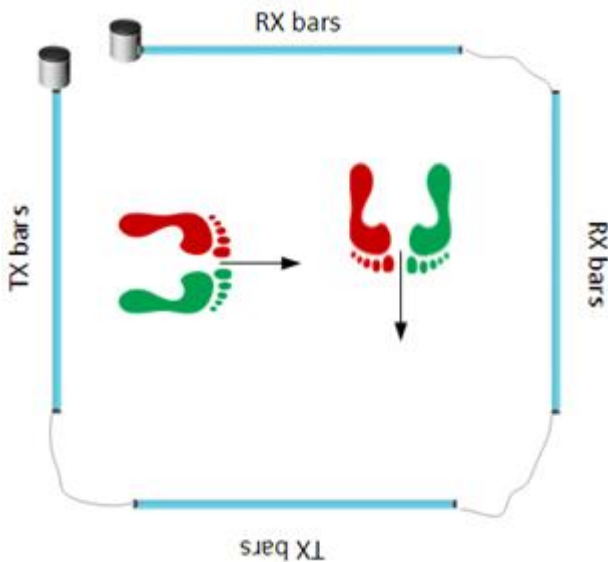
If you notice you have not performed the test in this way, you can rotate the acquisition through 180°: view one (or both) of the tests comprising the Protocol (Right or Left Leg)

	TEST LIST	
Name	**Test**	**Date**
Doe John	Drift 2D Protocol	27/03/2015 10.20.21
	5 JUMPS SINGLE LEG RIGHT 2D DRIFT	27/03/2015 10.19.53
	5 JUMPS SINGLE LEG LEFT 2D DRIFT	27/03/2015 10.20.21

Click with the right mouse button on the bar area and select "Rotate Acquisition 180°"
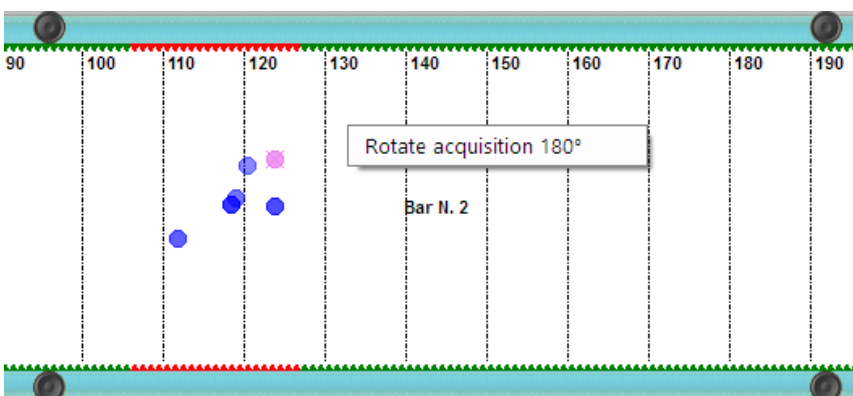
6.2 FIVE DOT DRILL PROTOCOL

The Five Dot Drill protocol (exercise with 5 circles) is a very well-known and popular test in the United States for improving ones agility and rapidity.

Draw a rectangle of 60x90 cm (2x3 ft) and place five circles of 10 cm (4") each inside it, as shown in the picture. Alternatively you can buy a nonskid mat from the famous chain BFS Bigger Fast Stronger, developed especially for this test and contributing to its standardization.

Place the two OptoJump Next bars outside the longer side of the rectangle with the drum at the test entrance.
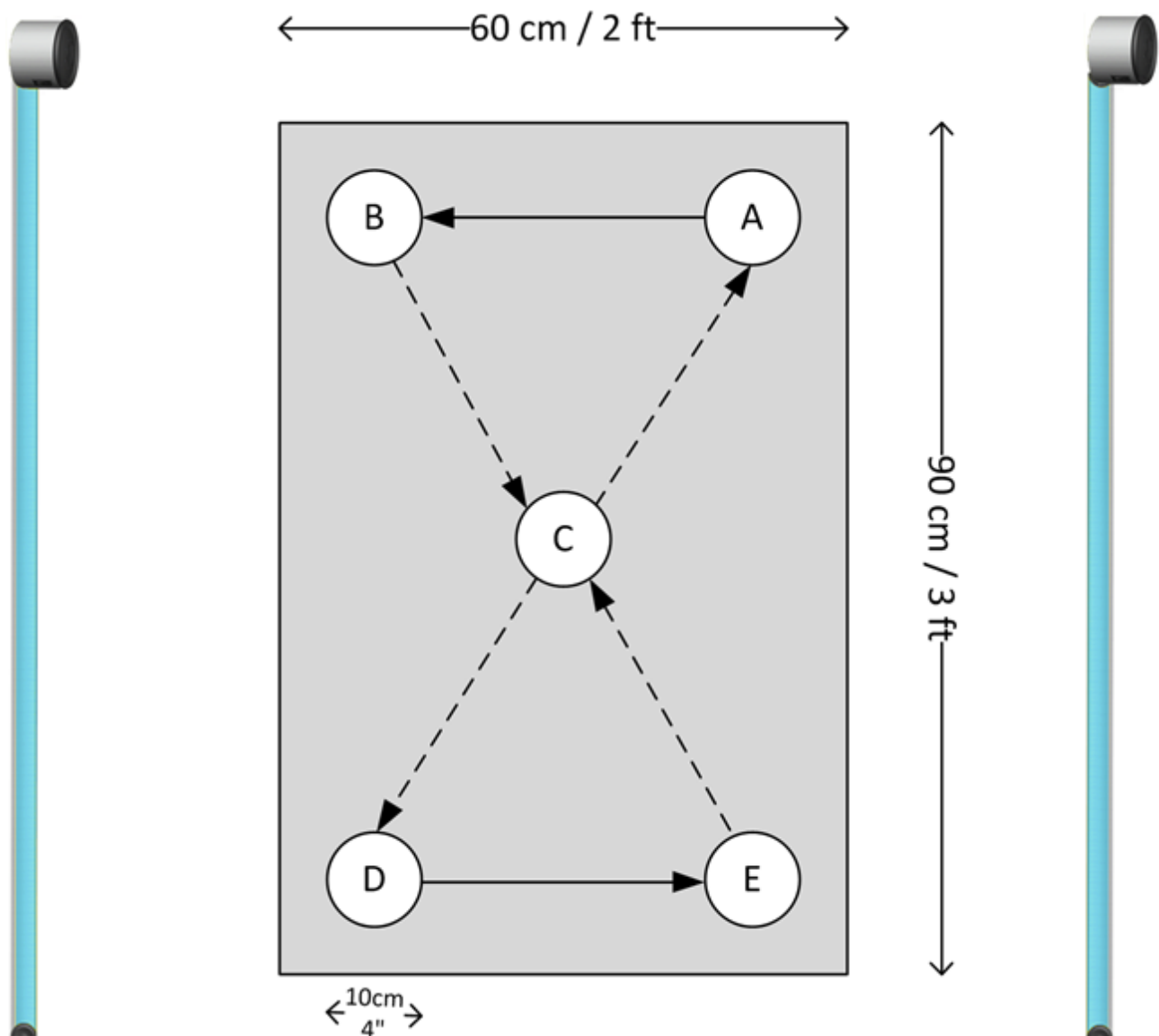
Figure 137 - 5 Dot Drill circuit and positioning of bars

The protocol is made of 5 different exercises to be carried out 6 times WITHOUT PAUSES. The main test output is the TOTAL time of all 5 exercises and this is why they must be executed as fast as possible.

The 5 tests are carried out as follows (a video explaining the exercise is available on our website):

Up & Back

1. Start with feet on A and B
2. Jump rapidly with both feet on C
3. Jump putting one foot on D and one on E
4. Jump back to the starting point
5. Repeat 5 times (6 times in total)

Right Foot

1. Your feet are now on A and B
2. Jump on C with your right foot
3. Jump with your right foot on D, E, C, A, B
4. Repeat 5 times (6 times in total)

Left Foot

1. The previous exercise ends with your right foot on B
2. Now jump on C with your left foot
3. Jump with your right foot on D, E, C, A, B
4. Repeat 5 times (6 times in total)

Both Feet

1. The previous exercise ends with your left foot on B
2. Jump with both feet on C
3. Jump with your left foot on D, E, C, A, B
4. Jump back to the starting point
5. Repeat 5 times (6 times in total)

Turn Around

1. The previous exercise ends with both feet on B
2. Jump with both feet on C
3. Jump putting one foot on D and one on E, just like in exercise #1
4. Turn around clockwise 180° (your feet will still be on E and E)
5. Jump on C with both feet and then with one on A and one on B
6. Turn again around to the left (anti-clockwise) 180° and start again
7. Repeat 5 times (6 times in total)

Even though this is a single test, it must be carried out as PROTOCOL, because this allows to have a particular print report showing the 'level' based on the following table:

DOT DRILL STANDARDS	
Less than 50 seconds	Super Quick
50-60 seconds	Great
60-70 seconds	Average
70-80 seconds	Need work
Over 80 seconds	Slow
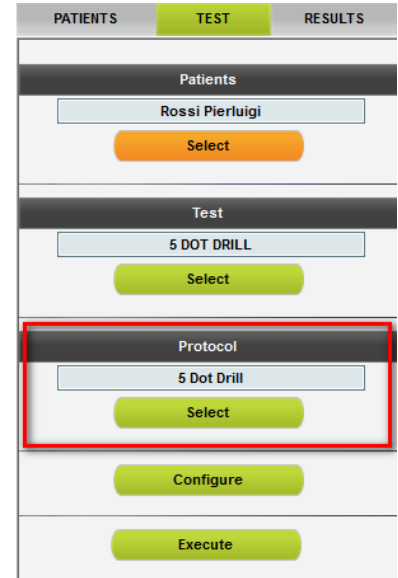
Figure 138 - 5 Dot Drill protocol

The test ends when you stay outside the test area for more than 3 seconds.

To display the test results go to Results, select the option 'Protocols' from Display>Data and choose the protocol with the symbol ⟳ and double-click or use <Display> from the Test Analysis list.
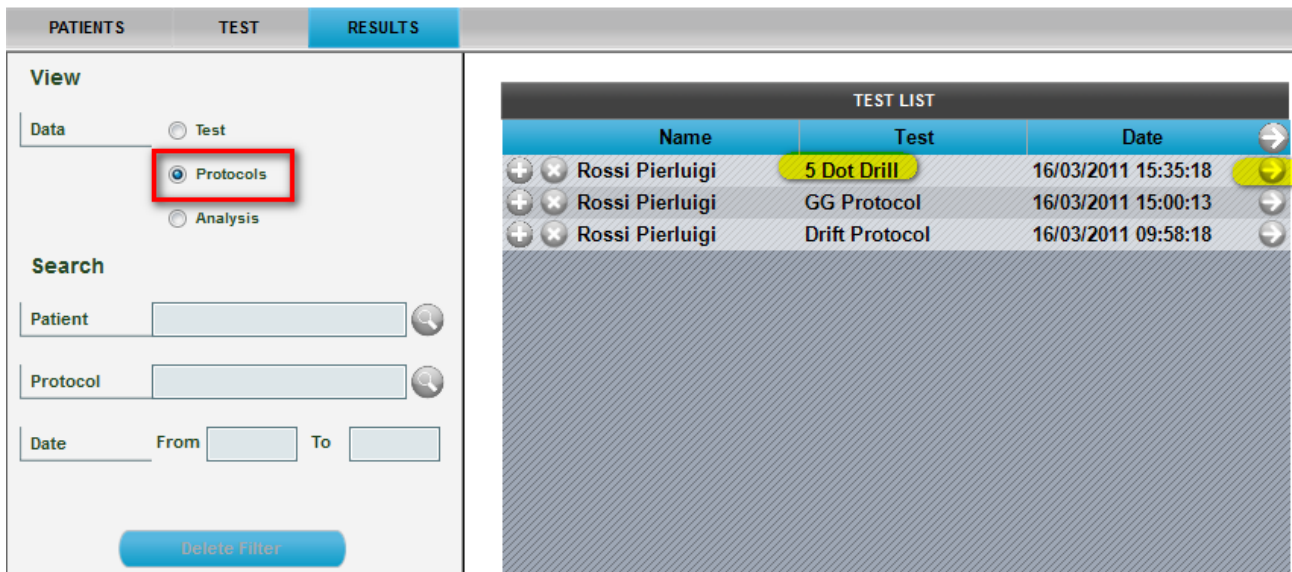
Figure 139 - Selecting a protocol to be printed

The printed report includes total time and result, as well as average flight and contact times of all 5 tests, total time deviation as percentage and fatigability index.

5 Dot Drill Protocol

Time 42.824 Super Quick

	UP AND BACK	RIGHT FOOT	LEFT FOOT	BOTH FEET	TURN AROUND	TOTAL
Time[s]	8.328	9.596	9.745	8.438	6.717	42.824
% Compared Average	-2.8%	12.0%	13.8%	-1.5%	-21.6%	8.565
Average Contact Time [s]	0.123	0.082	0.092	0.098	0.119	0.099
Average Flight Time[s]	0.237	0.186	0.161	0.141	0.140	0.170
Fatigability	-46.4%	19.6%	-18.9%	8.2%	7.1%	
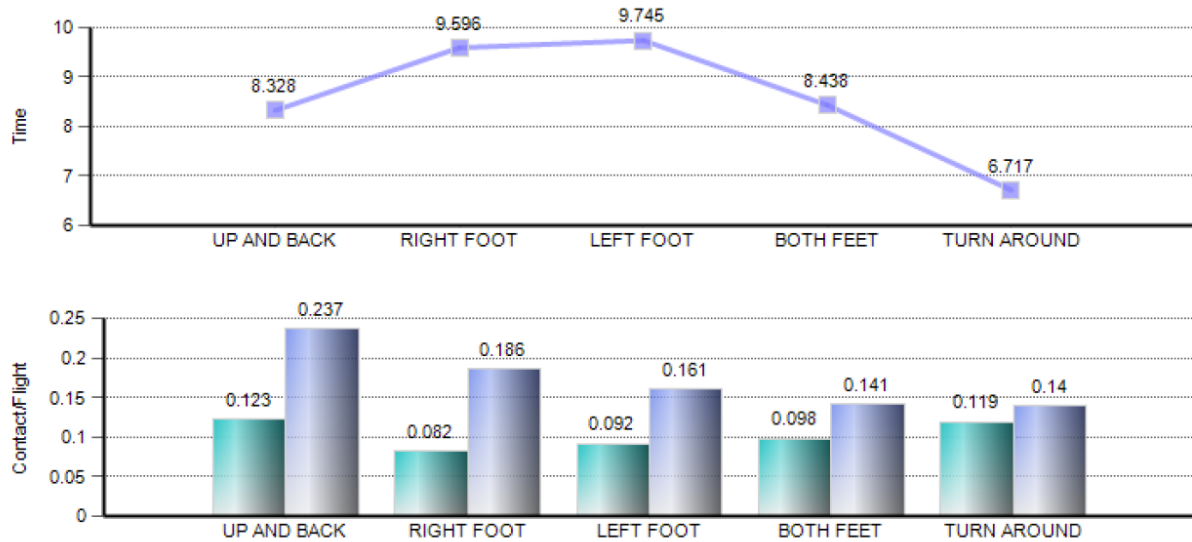
Figure 140 - 5 Dot Drill report output

The parameter '% Compared average' is calculated as difference between the average of all 5 tests and the average value of each single test.

E.g. for Up & Back: (8.328 – 8.565) / 8.328

The fatigability index is calculated using the average of the first 6 contact time values and compared to the average value of the last 6 contact times.

$$Fatigability = \frac{Avg\_Last\_6\_Ct \ - \ Avg\_First\_6\_Ct}{Avg\_First\_6\_Ct}$$

6.3 'GG' PROTOCOL

This protocol (whose name is based on the initials of its inventors) is made of the following test series with the object of an initial athlete evaluation to be used during scouting phase.

1. Treadmill Gait Test at 5 kmh (usually for 30 seconds)
2. Squat Jump with both legs (5 jumps)
3. Squat Jump with the right leg (5 jumps)
4. Squat Jump with the left leg (5 jumps)
5. Ski Test 15 seconds
6. Sound reaction test with the left leg (3 times)
7. Sound reaction test with the right leg (3 times)

At the end of the protocol a report summarizes the main test data highlighting possible asymmetry and differences between the right and left leg.

GG PROTOCOL 16/03/2011 15:00:13

Athlete Data

Athlete

Last name:	Rossi	First name:	Pierluigi
Birth date:	23/02/1985	Gender:	M
Weight:	75	Height:	181
Foot size:	42	Notes:	some notes...

Treadmill Gait Analysis at 3 mph or 5 Km/h

	L	R	Delta%
Stance[s]	0,693	0,668	3,6
Swing [s]	0,271	0,287	-5,9

SquatJump 2 legs 5 jumps

Average Power (jumps 2,3,4) [W/Kg]	19,98		
Knee angle [Deg]	75		

SquatJump Single Leg 5 Jumps

	L	R	Delta%
Average Power (jumps 2,3,4) [W/Kg]	10,81	11,44	5,5%
Average Height (jumps 2,3,4)[cm]	11,2	12,1	7,6%

Ski Test 15 sec

	L	R	Delta%
Average Contact Time [s]	0,552	0,554	-0,4
Average Flight Time[s]	0,118	0,106	10,2

Acoustic Reaction Single leg

	L	R	Delta%
Average Reaction Time[s]	0,678	0,641	-5,9%

Figure 141 - Output of the Report

The 'Knee angle' parameter is an index which can be derived 'manually' from a video still image. Once the parameter with had been defined using the dedicated graphic tools, the value can be entered to the 'Indexes' section and will be showing in your print.

Example:

Expand the GG protocol, find the 'SquatJump 2 Legs' test and display it as a single test

Find the desired spot in the video, double-click on the video and enter Video Analysis. With the 'Line Angle Right' tool draw two lines and read the value of the angle measure.

Press the 'Indexes' button and enter the measured value:

6.4 SINGLE LEG 3 HOPS PROTOCOL

This protocol allows evaluation of the functionality of the anterior cruciate ligament with two one-leg jumps consisting of 3 forward jumps each (possibly after post-injury rehabilitation) as regards power, as well as stabilization.

Have the athlete carry out 3 forward hops (starting slightly out of the test area on the interface drum side) first with the left leg and then with the right leg.
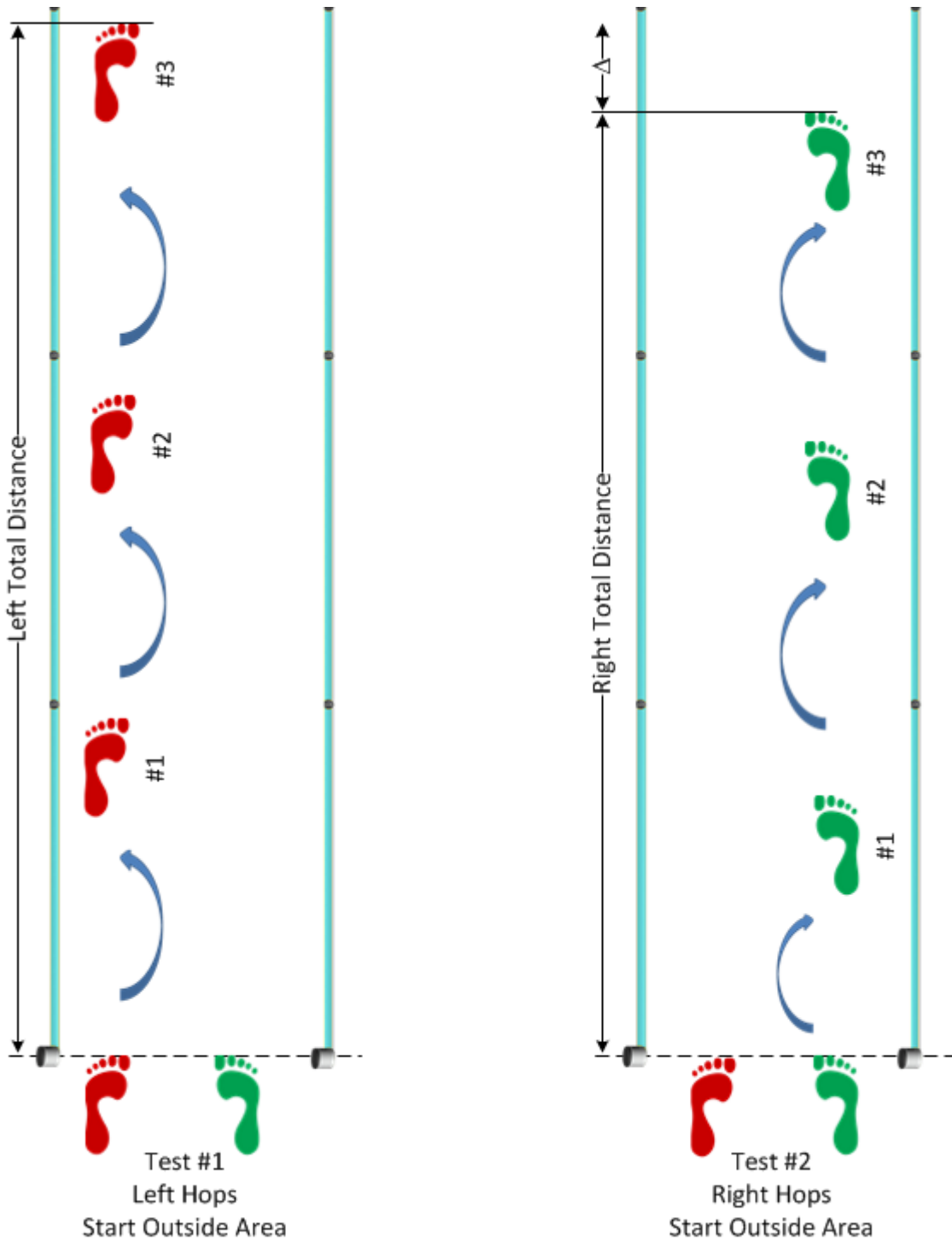
Figure 142 - Single Leg 3 Hops Protocol – Execution mode

At the end of the test, a report can be viewed under 'Results', showing the main values divided by leg and differences in %.

SINGLE LEG 3 HOPS PROTOCOL 04/08/2011 16:33:09

Athlete Data
Athlete

Last name:	Rossi	First name:	Pierluigi
Birth date:	13/11/1977	Gender:	M
Weight [Kg]:	68,0	Height:	178
Foot size:	43	Sport:	Athletics
Discipline:	Long jump		

Single Leg 3 Hops Protocol

	L	R	Delta%
Distance[cm]	346	313	9,5%
TCont.[s]	0,288	0,297	-3,1%
TFlight[s]	0,398	0,401	-0,9%
Height[cm]	19,4	19,7	-1,8%
StepL[cm]	115	104	9,5%
Speed[m/s]	1,94	1,73	10,7%
Acc.[m/s^2]	0,36	0,36	0,4%
Step angle[deg]	30,460	33,435	-9,8%
Stride[cm]	231	208	10,0%
Pace[step/s]	1,46	1,43	1,8%

Figure 143 - Single Leg 3 Hops Protocol Report

Of course, it is possible to see the details of a test by expanding the protocol and selecting 'View' in a test or 'Compare' to compare two tests.

Rossi Pierluigi	Single Leg 3 Hops Protocol	30/06/2011 15:47:17
	SINGLE LEG 3 HOPS LEFT FOOT	30/06/2011 15:46:41
	SINGLE LEG 3 HOPS RIGHT FOOT	30/06/2011 15:47:17

6.4.1 2D Single Leg 3 Hops Protocol

If performed with a two-dimensional bar system, the report also provides information relating to side movement.
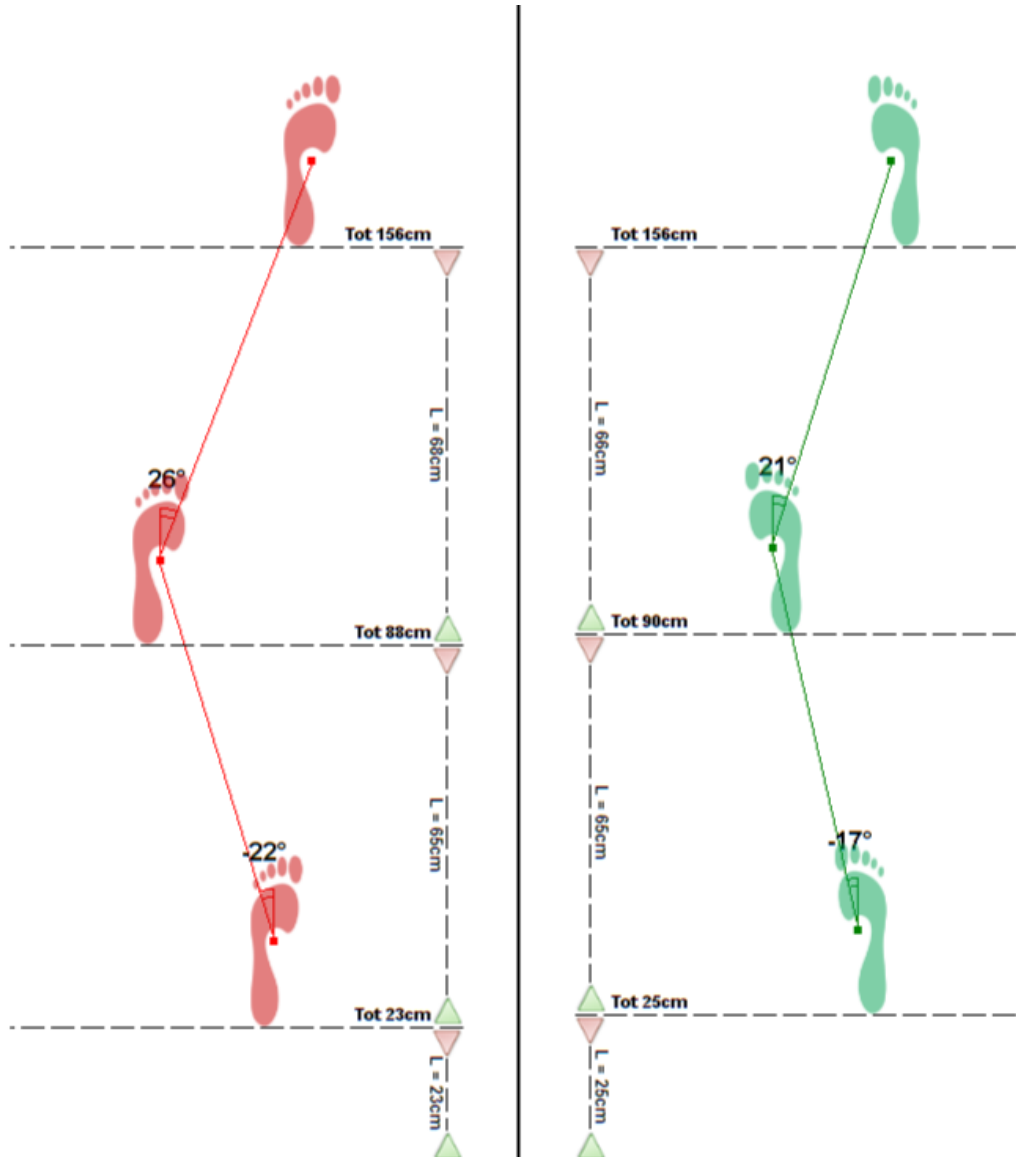
6.4.2 2D 4H3C and 4H3C Protocol

The two protocols are the same as the previous ones, but require 4 jumps forward instead of 3 (4H3c = 4 Hops, 3 Contacts).

6.5 MIP (MARCH IN PLACE) PROTOCOL

The MIP protocol consists of two tests in which the patient must march on the spot for 30 seconds, the first time with his/her eyes open and the second with his/her eyes closed.

The test is defined with a starting point INSIDE the area and the right foot as the starting foot (the patient should therefore begin the test BY LIFTIING the right foot first).

Using a two-dimensional system, the report will provide information relating to both forward-backward and middle-side movement for the two tests (obviously with a linear system we would only have one of these measurements).

Under the figures, we can see the data relating to the last point (end of test), or rather the forward-backward movement, middle-side movement, distance and Alpha angle measured as described later on.

MIP

	Eyes open	Eyes closed	Delta%
Average contact time[s]	0,763	0,767	-0,6%
Average flight time[s]	0,455	0,486	-6,9%
Asymmetry contact time[L - R %]	-1,5	-0,8	-0,7%
Asymmetry flight time[L - R %]	1,7	1,4	0,3%
CV contact time[L - R %]	2,9	3,3	-0,4%
CV flight time[L - R %]	4,0	4,5	-0,6%

Eyes open — O LAST POINT (F/B = 5,7; L/R = -8,4; DIST = 10,2; ALPHA = -55,8°

Eyes closed — O LAST POINT (F/B = 29,1; L/R = -8,9; DIST = 30,4; ALPHA = -17,0
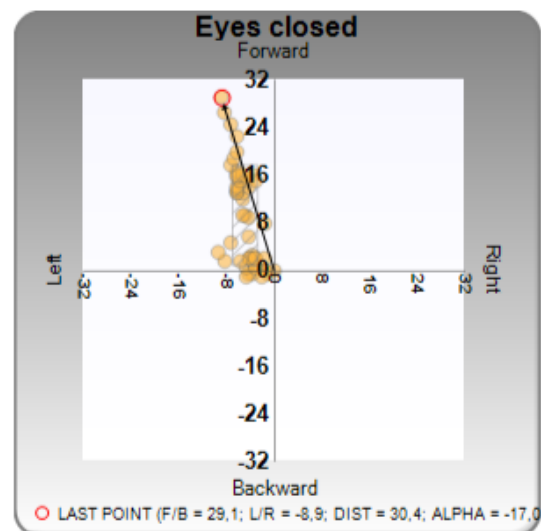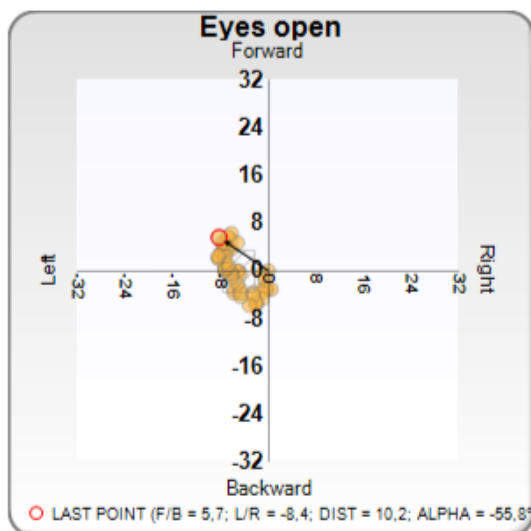
The Alpha angle is normally defined as follows:
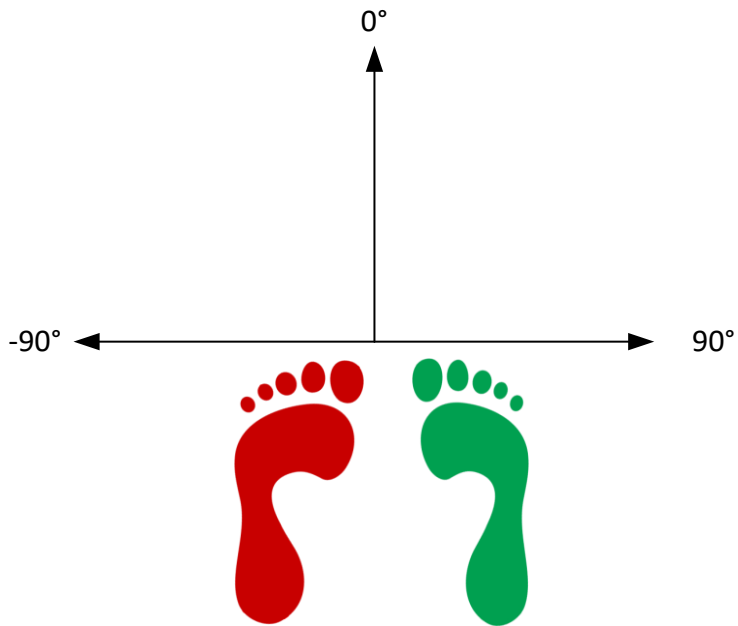
6.6 VERTEC LIKE TEST

This test allows simulating the use of the famous VERTEC tool to analyse vertical jumps with one arm extended. A meter (or two meters for athletes jumping higher than 100 cm) can be attached to a wall with double-sided adhesive tape or mounted on a tripod with fixing clamps. It is important that the interface drums are positioned in the lower part and at the right height depending on the athlete's jump elevation.

At the beginning of the test, the software prompts to extend one arm upwards closing the bar contacts (red led) to measure the athlete's height; it is recommended to carry out the measuring holding the hand near one of the two bars. If the test must be repeated several times (with the same bar setup) it is useful to save the measurement; of course, if the bar height changes, the measure must be changed.

Then the athlete can jump from a standing position (e.g. touching the wall with the attached bars) or with run-up through the virtual portal created by OptoJump (maybe simulating a complex athletic gesture like for example a volleyball spike).

The software displays the jump height as difference between the two measures.

Figure 145 - How to carry out a height measurement

Figure 144 - VERTEC LIKE test setup

6.7 SKI TEST

This test must be carried out with both feet parallel to the bars jumping sideways from one foot to the other (usually for 15 seconds). The main objective is to compare the contact and flight times, as well as the power of the right and left foot.

Figure 146 - Ski Test: side jumps from one foot to the other
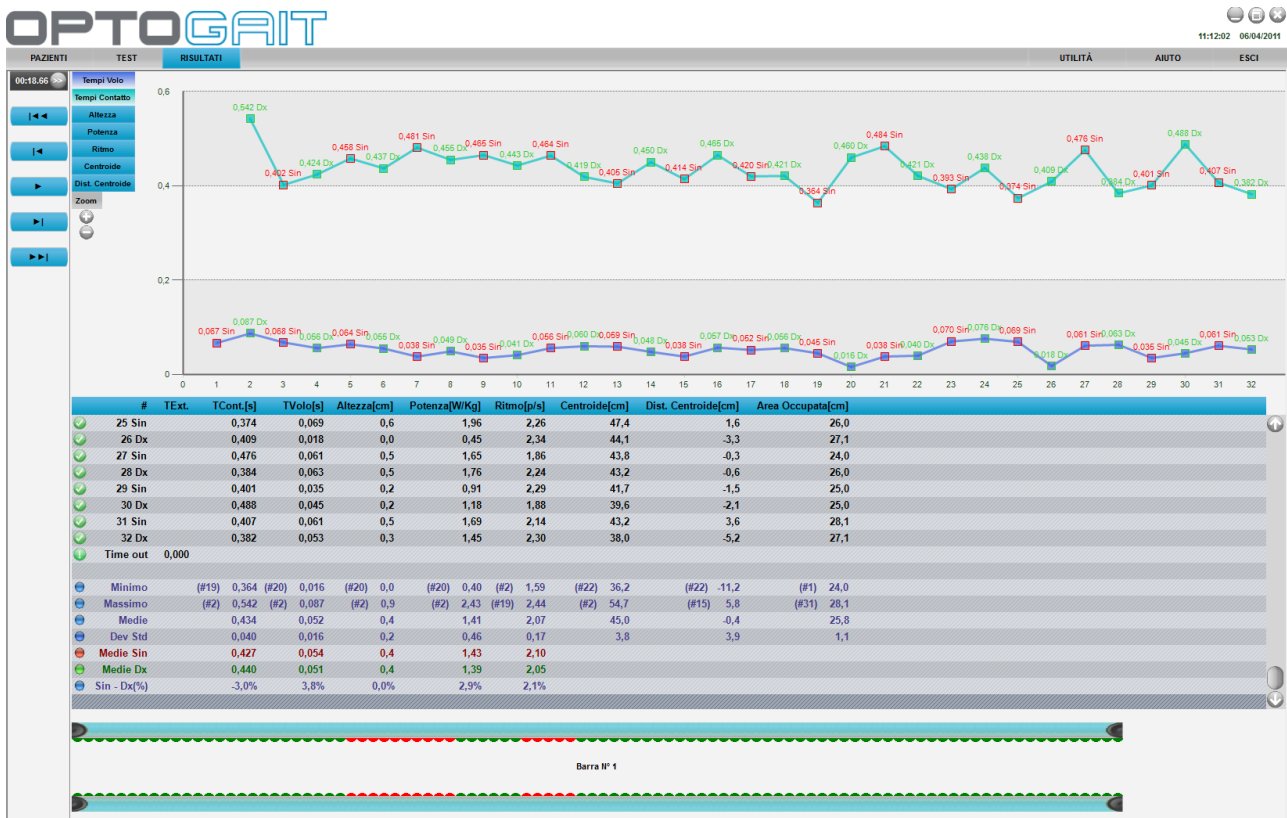
Figure 147 - Ski Test results with separate times for right and left foot

6.8 BODY SWAY PROTOCOL

The "Body Sway" protocol consists of two static (Sway) tests in which the patient must stand as motionless as possible for 30 seconds, in the first test with eyes open and in the second one with eyes closed.

There is no need for the OptoGait bars, but only the Gyko inertial sensor.

At the end of the protocol you can view a report that gives all the data described in par. 5.1.7 comparing the eyes open test with the eyes closed test.

Report Doe John

27/03/2015 10.25.22   OPTOGAIT
WWW.OPTOGAIT.COM

BODY SWAY PROTOCOL

Patient data

Patient

Last name:	Doe	First name:	John
Gender:	M	Weight [Kg]:	80,0
Height [cm]:	175	Height Gyko [cm]:	150
Foot size:	26		

Body Sway Protocol

	Eyes open	Eyes closed	Delta%
Area [mm²]	447,428	784,004	-75,2%
Convex Hull Area [mm²]	403,552	556,672	-37,9%
Lenght [mm]	205,952	253,816	-23,2%
Lenght AP [mm]	152,032	211,218	-38,9%
Lenght ML [mm]	111,712	101,791	8,9%
Mean Distance [mm]	5,876	13,523	-130,1%
Mean Distance AP [mm]	4,348	12,743	-193,1%
Mean Distance ML [mm]	2,939	3,607	-22,7%
Rms Distance [mm]	7,425	16,271	-119,1%
Rms Distance AP [mm]	6,443	15,582	-141,8%
Rms Distance ML [mm]	3,689	4,682	-26,9%
Mean Velocity [mm/s]	10,298	12,691	-23,2%
Mean Velocity AP [mm/s]	7,602	10,561	-38,9%
Mean Velocity ML [mm/s]	5,586	5,090	8,9%
Mean Frequency [Hz]	0,278	0,149	46,4%
Mean Frequency AP [Hz]	0,309	0,146	52,6%
Mean Frequency ML [Hz]	0,336	0,249	25,8%
Total Power [mm²]	12,624	16,497	-30,7%

6.9 SLANT BOARD PROTOCOL

This is a protocol composed of 10 Sway tests (static-postural) to be done on a "Slant Board" (we recommend a 15° slant).

The scapular tests to be done with Gyko (remember the anteroposterior and mediolateral body movements are evaluated, not the angles of the ankles, see chap. 4.2.2.10) are as follows:

- Flat Right   (Sway on the rt foot outside the floor board)
- Right Dorsum Flexion   (Sway on the rt foot on the board with plantar flexion)
- Right Plantar Flexion   (Sway on the foot on the board with dorsiflexion)
- Inversion Right   (Sway on the rt foot on the board in inversion)
- Eversion Right   (Sway on the rt foot on the board in eversion)
- Flat Left   (repeat for the left foot)
- Left Dorsum Flexion
- Left Plantar Flexion
- Left Inversion
- Left Eversion
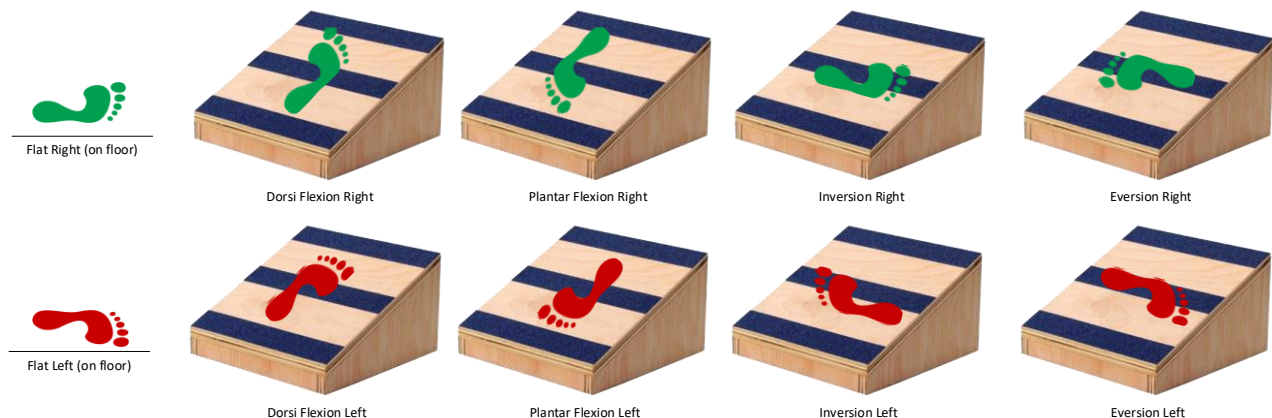
At the end of the 10 tests, a report is created showing characteristic information from the Sway test (see chap. 5.1.7)

Slant Board Protocol

| Test	Area [mm²]	Convex Hull Area [mm²]	Length [mm]	Mean Dist. [mm]	RMS Dist. [mm]	Mean Vel. [mm/s]
#1 FLAT RIGHT	5311,058	3639,246	583,345	35,018	38,756	56,691
#2 DORSIFLEXTION RIGHT	9073,204	6178,025	774,459	35,936	38,934	75,410
#3 PLANTAR FLEX RIGHT	2047,083	1615,136	611,821	13,944	15,351	59,550
#4 INVERSION RIGHT	10225,626	7420,731	1066,568	30,150	36,471	103,772
#5 EVERSION RIGHT	1756,516	1682,123	751,553	12,514	14,472	73,208
#6 FLAT LEFT	5682,370	3626,453	760,235	24,944	27,217	73,953
#7 DORSIFLEXTION LEFT	4399,280	2376,014	620,632	25,862	26,976	60,467
#8 PLANTAR FLEX LEFT	3497,430	2645,968	761,126	18,308	20,661	74,155
#9 INVERSION LEFT	78982,130	57785,557	3014,165	95,177	136,904	292,922
#10 EVERSION LEFT	16015,402	8798,720	938,968	56,949	63,970	91,464
Medie	13699,010	9576,797	988,287	34,880	41,971	96,159
Dev Std	23343,536	17117,739	727,170	24,809	36,374	70,634
CV	170,4%	178,7%	73,6%	71,1%	86,7%	73,5%
Minimo	(#5)1756,516	(#3)1615,136	(#1)583,345	(#5)12,513	(#5)14,471	(#1)56,690
Massimo	(#9)78982,130	(#9)57785,557	(#9)3014,164	(#9)95,177	(#9)136,903	(#9)292,921

Test	Mean Freq. [Hz]	Total Power [mm²]	50% Power Freq. [Hz]	95% Power Freq. [Hz]	Centroidal Freq. [Hz]	Freq. Dispersion
#1 FLAT RIGHT	5311,058	3639,246	583,345	35,018	38,756	56,691
#2 DORSIFLEXTION RIGHT	9073,204	6178,025	774,459	35,936	38,934	75,410
#3 PLANTAR FLEX RIGHT	2047,083	1615,136	611,821	13,944	15,351	59,550
#4 INVERSION RIGHT	10225,626	7420,731	1066,568	30,150	36,471	103,772
#5 EVERSION RIGHT	1756,516	1682,123	751,553	12,514	14,472	73,208
#6 FLAT LEFT	5682,370	3626,453	760,235	24,944	27,217	73,953
#7 DORSIFLEXTION LEFT	4399,280	2376,014	620,632	25,862	26,976	60,467
#8 PLANTAR FLEX LEFT	3497,430	2645,968	761,126	18,308	20,661	74,155
#9 INVERSION LEFT	78982,130	57785,557	3014,165	95,177	136,904	292,922
#10 EVERSION LEFT	16015,402	8798,720	938,968	56,949	63,970	91,464
Medie	13699,010	9576,797	988,287	34,880	41,971	96,159
Dev Std	23343,536	17117,739	727,170	24,809	36,374	70,634
CV	170,4%	178,7%	73,6%	71,1%	86,7%	73,5%
Minimo	(#5)1756,516	(#3)1615,136	(#1)583,345	(#5)12,513	(#5)14,471	(#1)56,690
Massimo	(#9)78982,130	(#9)57785,557	(#9)3014,164	(#9)95,177	(#9)136,903	(#9)292,921

And a chart for each of the 12 measurements.

Convex Hull Area[mm²]
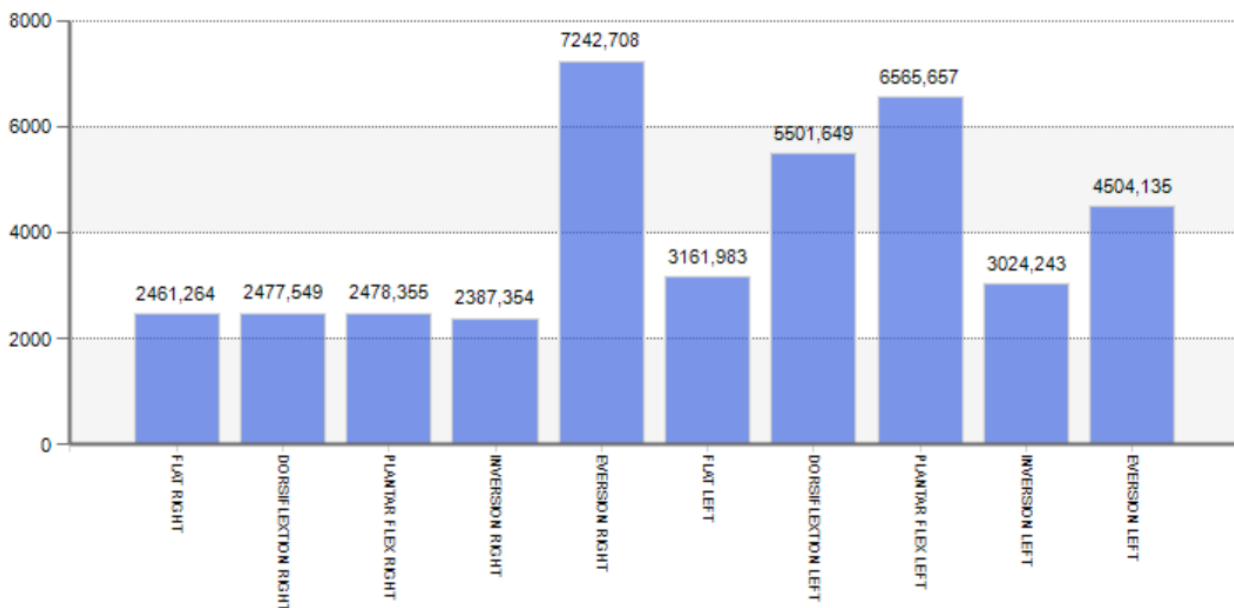
6.10 REPS PROTOCOL

The Reps protocol is comprised on the following tests:

- **Reaction Reps**
  - The optical impulse reaction test with 3 repetitions
  - 10/average Reaction Time [s.] is taken as score S1
- **Power Reps**
  - 3 Jump Test
  - The average Power [W/Kg] is taken as score S2
- **Speed Reps**
  - 10 second Tapping Test
  - The Average Rhythm [p/m] / 6 * Coefficient of Contact Time Variability [s.] is taken as score S3

A final **Reps Score** consisting of S1 + S2 + S3 is calculated at the end of the three tests

REPS PROTOCOL

Patient data

Patient

Last name:	Rossi	First name:	Pierluigi
Birth date:	13/11/1977	Gender:	M
Weight [Kg]:	68,0	Foot size:	43

Reps Protocol

Reps Score	58,19

Reps data

Reps React	24,51
Reps Power	32,42
Reps Speed	1,26

7 TECHNICAL DATA

7.1 TECHNICAL DATA TX/RX BARS

Internal power supply (range of measurement from 1 to 5 m)	Rechargeable Li-ion battery 7.4V 1800mAh
External power supply (range of measurement from 1 to 10 m)	24VDC ±5%
Infrared wave length	890 nm
Number of optical sensors	96 per meter
Space resolution	1.041 cm
Sensor height (from the optical centre of the sensor to the lower edge)	3mm
Time accuracy	1 millisecond
Operational temperature	0°C ~ +35°C
Storage temperature	-25°C ~ +70°C
Max. distance between transmitter (Tx) and receiver (Rx)	6m
Dimensions of TX - RX with integrated interface	1100mm x 100mm x 100mm (W x D x H)
Dimensions of Tx - Rx	1000mm x 100mm x 45mm (W x D x H)
Dimensions of Tx - Rx with integrated interface	2kg
Weight of additional Tx and Rx bars	1.5kg

7.2 PC MINIMUM REQUIREMENTS

A 'regular' desktop or notebook PC with Microsoft Windows 10 is usually enough for running the OptoGait software without any problems. We recommend to perform a Windows Update before setting up the software.

Minimum hardware requirements:

	MINIMUM	SUGGESTED
Operating System	Win 8	Win 8/10 (32 or 64 bit)
CPU	i3	i5/ i7
RAM	4 GB	8 GB
Hard Disk	40 GB	160 GB
Graphic Board	Integrated	Dedicated (512 Mb or higher)
Display resolution	1024x768	1600x900 or higher
USB Ports	1	3 (OptoGait + 2 webcam)

On lower-performance PCs or not particularly powerful PCs (e.g. netbooks) it is anyhow possible to run the software, but refraining from using real-time viewing via the webcam (the video is recorded and saved anyhow, and can be viewed later)

OptoGait requires the installation of Microsoft .NET Framework (installed automatically during the setup, if not found)

8 TABLE OF USED SYMBOLS

	CAUTION symbol

DICHIARAZIONE DI CONFORMITÁ
DECLARATION OF CONFORMITY

Il fabbricante
The manufacturer

MICROGATE s.r.l.
Via Stradivari, 4 – 39100 Bolzano (BZ) - Italy

DICHIARA che il prodotto
DECLARES that the product

Descrizione/Modello
Description/Model
Tipo
Type

OPTOGAIT

$OGA001, $OGA002, $OGA003, $OGA004

Classe I
Class I

Destinazione d'uso: OPTOGAIT è un sistema di analisi del movimento e di valutazione funzionale di un individuo in condizioni normali o patologiche. Il dispositivo deve essere usato in ambiente chiuso e, durante l'utilizzo, non è previsto alcun contatto con il paziente

Intended use: *OPTOGAIT is an innovative system for movement analysis and functional assessment of patients with normal or pathological conditions. The device must be used in a closed environment and, during use; there is no contact with the patient*

è conforme alle direttive:
- **Direttiva 93/42CEE (Direttiva per Dispositivi Medicali) aggiornata con la successiva 2007/47/CE del 25/10/2007 attuata con D.lg. 37/10**

is in accordance with the following Directives:
- **93/42** *EEC Directive (Medical Devices Directive)* **with the subsequent date of 25/10/2007 2007/47/EC implemented by Legislative Decree 37/10**

e che sono state applicate tutte le norme e/o specifiche tecniche di seguito indicate
and that all the following standards have been applied

CEI EN 60601-1 (62-5): 2007-05 Apparecchi elettromedicali. III Edizione. Parte 1: Prescrizioni generali relative alla sicurezza fondamentale e alle prestazioni essenziali.
CEI EN 60601-1 (62-5): 2007- Medical electrical equipment Part 1: General requirements for basic safety and essential performance

CEI EN 60601-1-2 (62-50):2007-08 Apparecchi elettromedicali. II Edizione. Parte 1: Prescrizioni generali per la sicurezza - Norma collaterale: Compatibilità elettromagnetica - Prescrizioni e prove.
CEI EN 60601-1-2 (62-50):2007-08 Medical electrical equipment Part 1: General requirements for basic safety and essential performance - Collateral standard: Electromagnetic compatibility - Requirements and tests

DIRETTIVA 2014/35/UE DEL PARLAMENTO EUROPEO E DEL CONSIGLIO EUROPEO del 26 febbraio 2014 - Direttiva Bassa Tensione o Direttiva LVD (Low Voltage Directive), concernente il ravvicinamento delle legislazioni degli Stati membri relative al materiale elettrico destinato ad essere adoperato entro taluni limiti di tensione (Bassa tensione).
DIRECTIVE 2014/95/EC OF THE EUROPEAN PARLIAMENT AND OF THECOUNCIL As of December 2010 of 26 February 2014 on the approximation of the laws of the Member States relating to electrical equipment designed for use within certain voltage limits (Low Voltage)

Bolzano, 26/06/2018
Il rappresentante legale / *The legal representative*
Vinicio Biasi

Copyright

Copyright © 2010-2020 by Microgate S.r.l.

All rights reserved

The software and manuals are available in the following languages: Italian, English, German, French and Spanish.

Microgate S.r.l.

Via Stradivari, 4

I-39100 Bolzano

ITALY

Tel. +39 0471 501532 - Fax +39 0471 501524

info@microgate.it

http://www.microgate.it

http://www.optogait.com