



GYKO•REPOWER

# User Manual

Version 1.1.1.10

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## 1 DISCLAIMER

Any warranty is void in the event of use which is abusive, illegitimate, unauthorized or not in conformity with the instructions for use of the device or legal provisions applicable within the location in which it is used.

GykoRePower and its software provide information about muscle performance which cannot be deemed a medical diagnosis under any circumstances. In the event of problems with your sensor device unit and/or software, please contact your distributor.

GykoRePower measures linear accelerations and angular velocities that athletes produce during movement. If they do not correctly follow the instructions for use and information supplied, the results of the measurements carried out by GykoRePower may be inaccurate.

Athletes' health and physical condition must be such that they can carry out the movements and exercises required to use GykoRePower. The services of a professional, recognized coach must always be used to confirm this.

If an athlete feels any physical discomfort during movements and exercises carried out using GykoRePower, he or she must immediately stop the movement or exercise in question, and consult his or her doctor and coach. MICROGATE accepts no liability for any injuries sustained practicing your sport, moving fitness machines or carrying out tests. In all cases, MICROGATE liability is limited to product replacement.

## 2 INTRODUCTION

GykoRePower – a technological solution for the assessment and monitoring of joint mobility, muscle strength and body fluid balance (optional) during the rehabilitation and training program.

### 2.1 GYKOREPOWER'S APPLICATION FIELD

Rehabilitation, functional recover, return to play, physical training, fitness,

### 2.2 PROFESSIONALS TO WHOM GYKOREPOWER APPLIES

Physiotherapists, graduate in Sports Science and expenditures of the sport.

### 2.3 BRIEF DESCRIPTION OF GYKOREPOWER'S GENERAL CHARACTERISTICS

The GykoRePower's software implements protocols for assessment and monitoring of joint function and muscle strength during the rehabilitation of a certain district of the musculoskeletal system.

For the evaluation of joint mobility and muscle strength, the software interface in real time with the unit hardware GyKo via Bluetooth dongle (GykoRePower's protocols using the device is on weight stack machines from muscle by magnetic pocket, both of a body segment of the subject (upper arm, arm, leg, thigh, etc.) through an appropriate fixing system);

### 2.4 GYKOREPOWER'S FUNCTIONALITY

GykoRePower offers to the user to:

1. quantify the deficit in terms of joint function between a limb and the contralateral (**module RANGE OF MOTION**)
2. quantify the deficit between a limb and contralateral to the normal machines with overload (iso-inerziale) (**module STRENGTH RECOVERY**)
3. Monitoring exercise intensity with visual biofeedback in real time using a threshold of work set to the user's choice.
4. Tracking and reporting the recovery of the subject during the duration of the rehabilitation program by reporting functionality.

### 3 HARDWARE UNIT



ON/OFF button with StatusLED



Automatic clips to vest and belt



Micro SD Memory card

Micro USB for charge and communication

Audio Jack for feedback and I/O



### 3.1 USE OF THE DEVICE AND STATUS LED

- turn on the device using the ON / OFF button (1): If the device is charged, the LED will flash green;
- insert the Bluetooth dongle supplied with the system in the PC (the software will not open otherwise);
- run the software;
- connect the software to the device (see p. 15): If connected, the LED will flash alternately blue and green;

NOTE: during the data acquisition during the test, the LED will flash only blue.

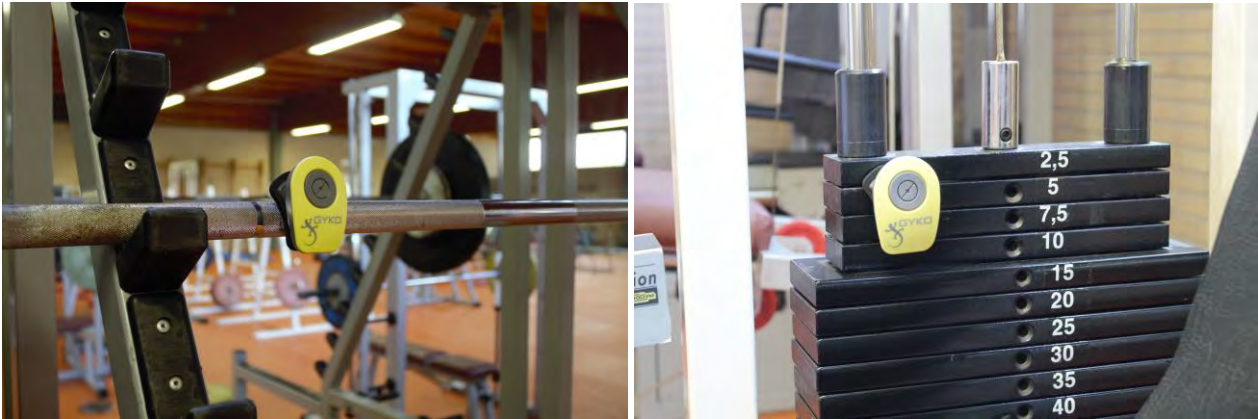
### 3.2 RECHARGE OF THE DEVICE:

- when the hardware unit is low (LED flashing red) you have to put in charge by connecting the device to the PC or to the power supply via the USB cable supplied with the kit using the USB connector (3) of the device;
- when the device is charging, the LED will flash green slowly;
- when the device is charged, the LED will be green;

NOTE: you may use the software with the device while it is being charged by connecting it via USB cable to your PC.

## 4 SUPPORTS FOR THE DEVICE AND METHOD OF APPLICATION

### 4.1 MAGNETIC POCKET



#### 4.1.1 NOTE ON THE PLACEMENT OF THE POCKET

With isoinertial machines, apply the device in any orientation in order to adapt also to machines characterized by a weight stack shielded or otherwise difficult to reach.

On weightbar, place the device being careful to put the barbell itself in the space between the two magnets on the back of the pouch. During use the pocket can be subjected to rotations of 360°.

**NOTE:** For a better fixation and in order to prevent the sensor detaches from the barbell during sudden movements it is advisable to use an additional fixation with another band or elastic as shown:



## 4.2 ELASTIC BELT



To be applied in waist, tight, possibly skin or otherwise making sure we did not clothing or objects interposed that may introduce artifacts of movements of the device relative to the body of the subject. It is advisable not to get your hands on the wing to the subject during the execution of a jump test. The belt should be positioned so that the device is in the hollow back.

### 4.2.1 NOTE ON THE PLACEMENT OF THE BELT

- Tighten the belt directly around the waist, not interpose, therefore, no garment between the belt and the skin of the subject.
- Tighten the belt around his waist preventing, pulling back on the sensor, this would break away from the body over 2-3 cm.
- Do not put your hands on the belt while performing a jump. Place both hands below the belt.

### 4.2.2 NOTE ON THE PLACEMENT OF THE DEVICE IN THE BELT

The device must be inserted into the pocket of the belt with the led upward and outward.

### 4.3 VEST



To be applied on the upper body, tight, possibly skin or otherwise making sure we did not clothing or objects interposed that may introduce artifacts of movements of the device relative to the body of the subject. It is advisable not to get your hands on the wing to the subject during the execution of a test. The vest should be positioned so that the device is at the height between the shoulder blades.

## 5 THE SOFTWARE

### 5.1 SOFTWARE AND LICENSE INSTALLATION

To install the software and license please refer to the booklet of first installation provided along with the kit paper format or in electronic format also present in the USB pen drive.

### 5.2 AUTOMATIC SOFTWARE UPDATE

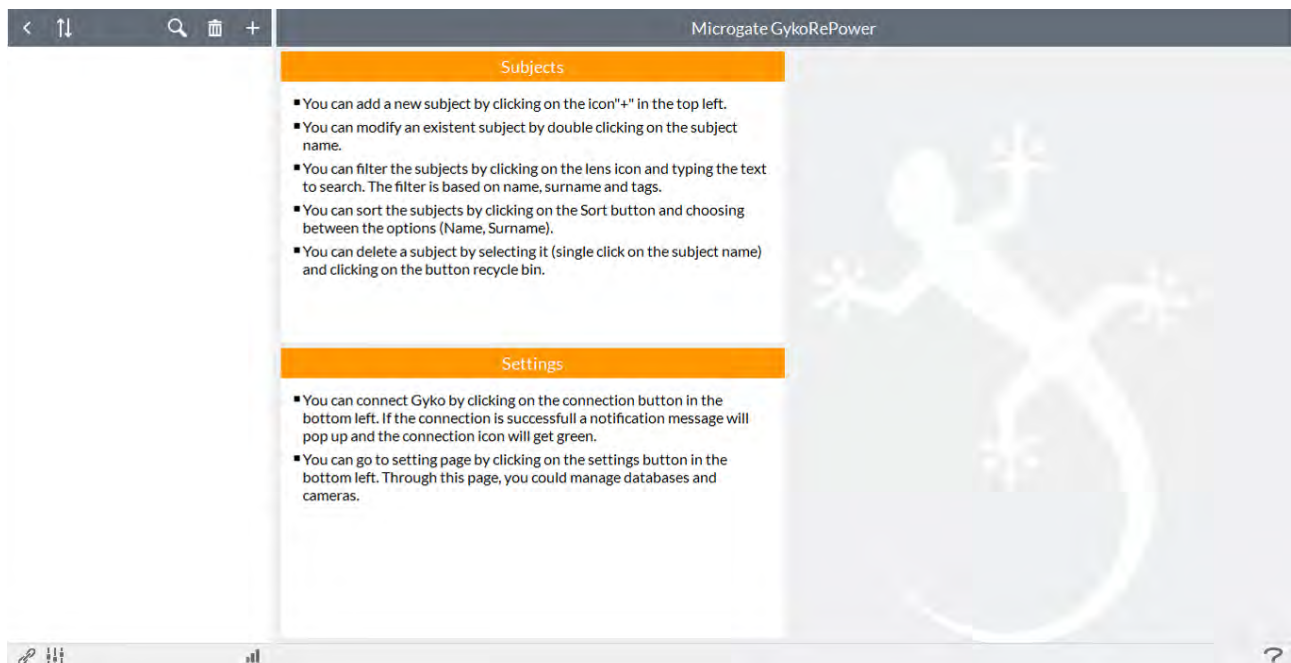
After starting the software, with PC connected to the Internet, the software automatically checks if the current version is consistent with the last one that is on the server Microgate. If not, the software notification with a pop-up that there is a newer version of the software, with instructions for downloading and updating to the latest version of the program.

### 5.3 USING GYKOREPOWER

GykoRePower involves the combined use hardware unit (please refer to the appropriate section of the user manual of GykoRePower for information about the operation of the hardware) and a PC with software installed on board. To use the wireless transmission you must install a license, provided by Microgate and make sure that the unit's battery is sufficiently charged.

### 5.4 HARDWARE AND SOFTWARE STARTUP

After starting the software, the main interface of the software looks like this:



1. click the "Connect" icon at the bottom left:



At this point an animated connection image will appear in foreground. A connection established, a message "Connected" will appear green overlay and the connection symbol in the lower left will turn green.

2. now is possible starting to use the GykoRePower.

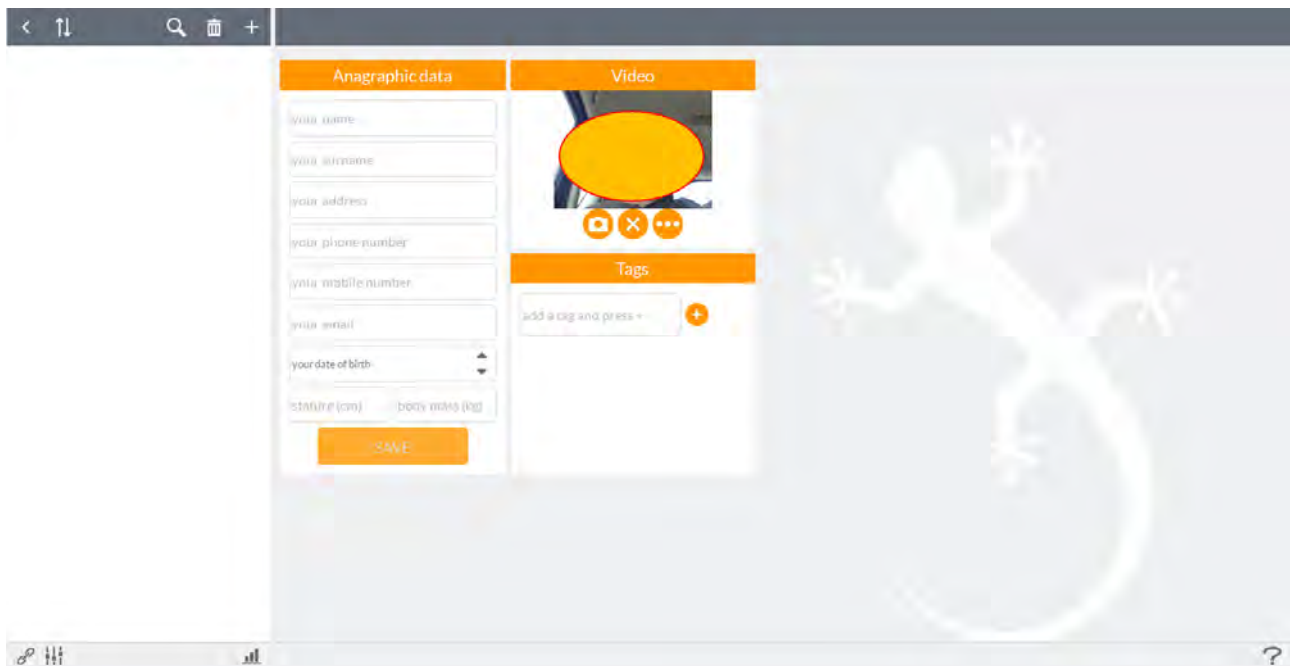
## 6 USE THE SOFTWARE

### 6.1 ADD A SUBJECT

The first step is to add the subjects that you want with GykoRePower. To add a subject just press the button "**Add subject**" on the top left of the home page of the software:



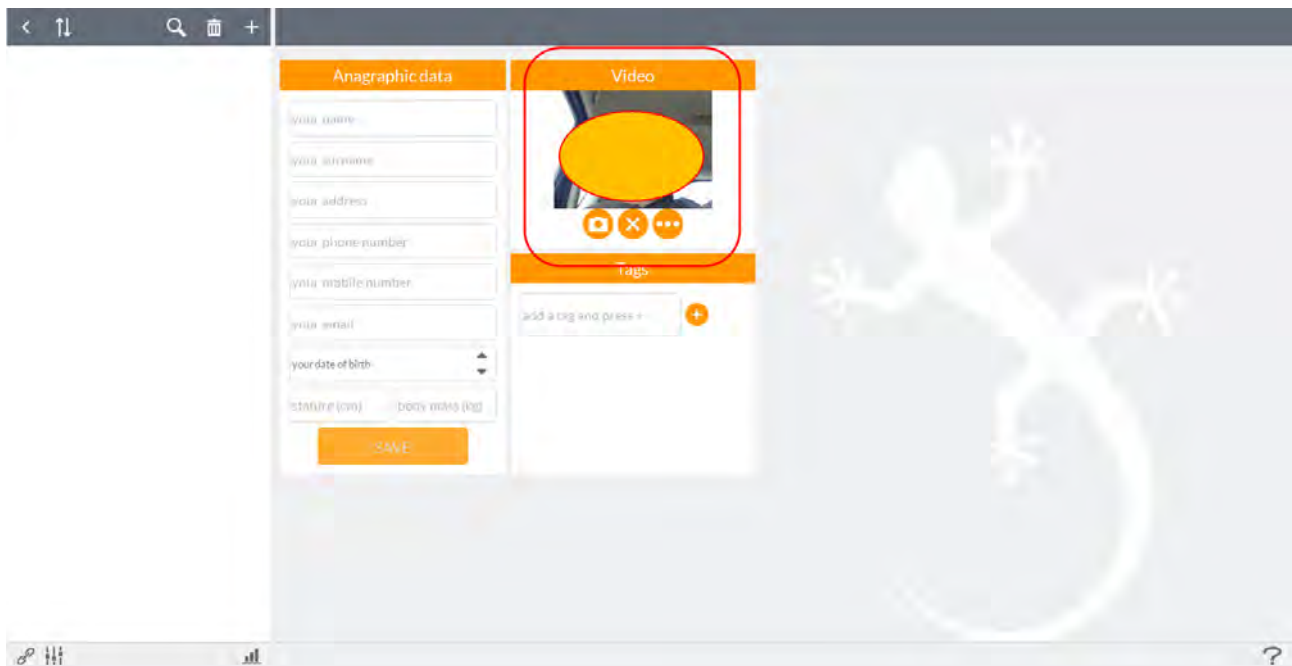
At this point will be displayed the following fields:



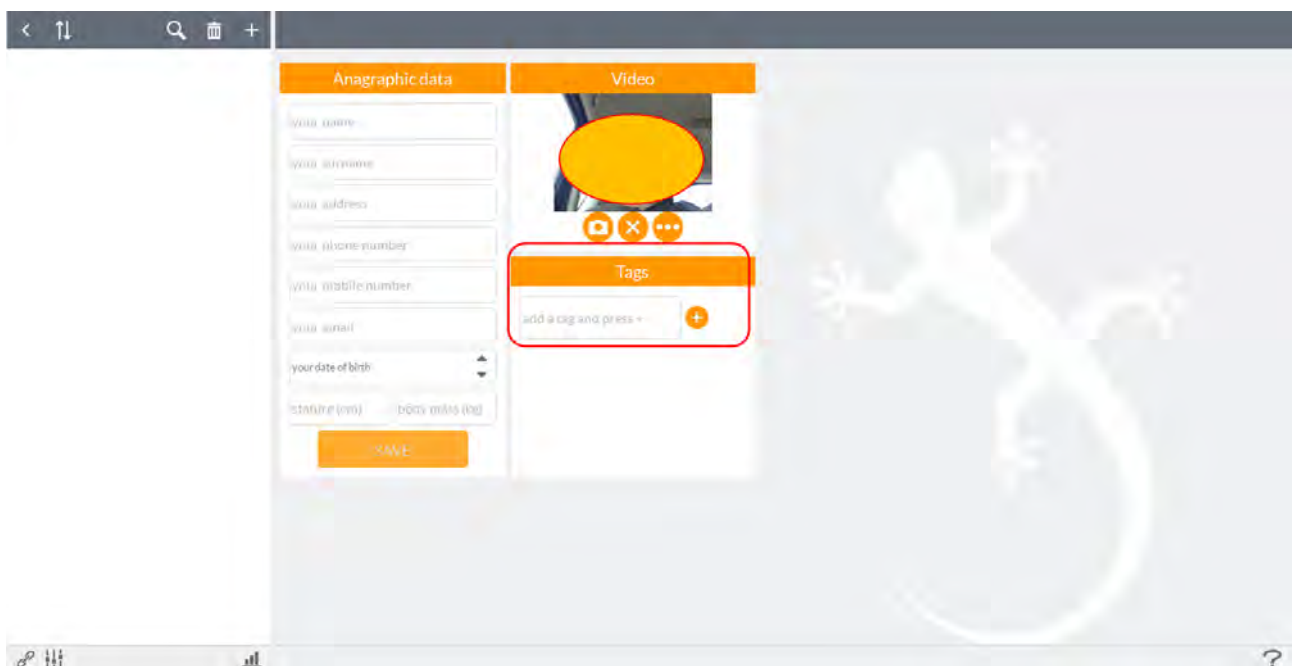
The text contained within these fields will disappear as soon as you click inside the field.

Simply fill in the two fields "**Name**" and "**Last Name**" to activate the "**Save**" button to record the subject in the database.

In the registry card subject you can add a photo of the subject from the camera in use (default is set to the camera's PC, to change the camera, see paragraph 7.6.3) or select one from PC:



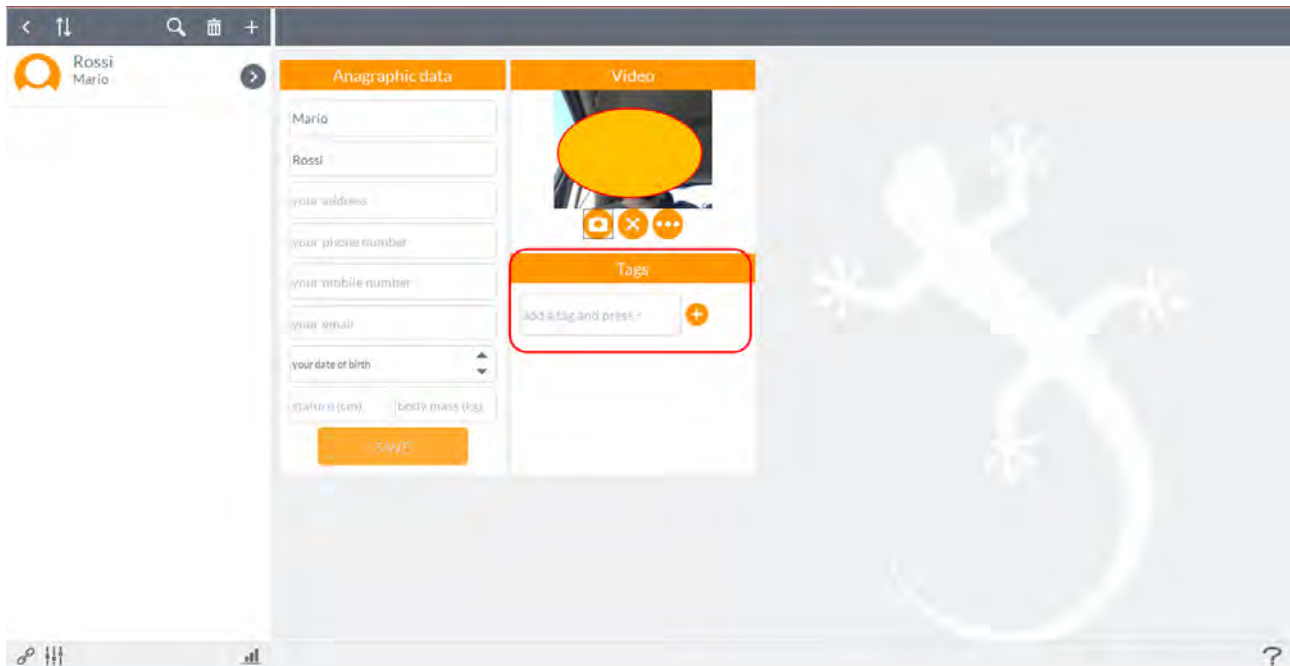
It is also possible to add one or more tags that characterize the subject (for example, the sport of origin, the job, the type of injury) and that will be indexed to the filter function of the automatic search:



Simply press the "+" button to add the tags.

Pressing the button "**Save**" on the subject will be recorded in the database of the software and will populate the patient list to the left of the database interface software:

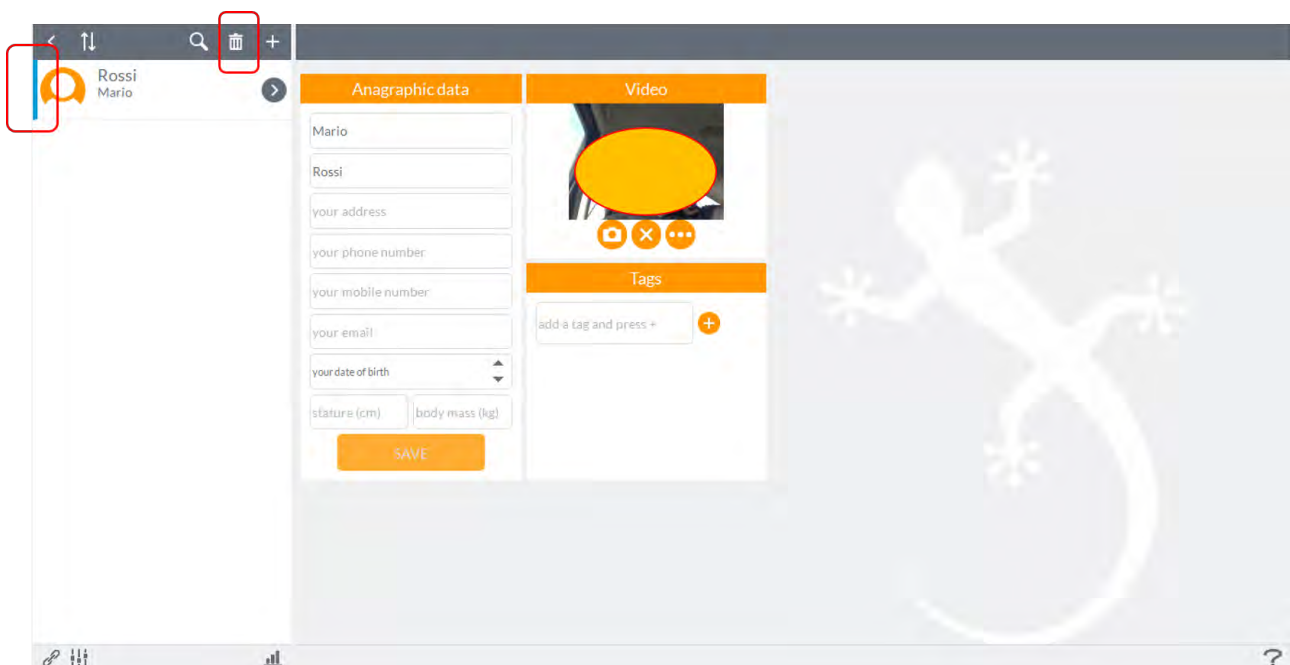




To change the data relating to the subject simply double click on the name of the subject and will reopen again the registry card;

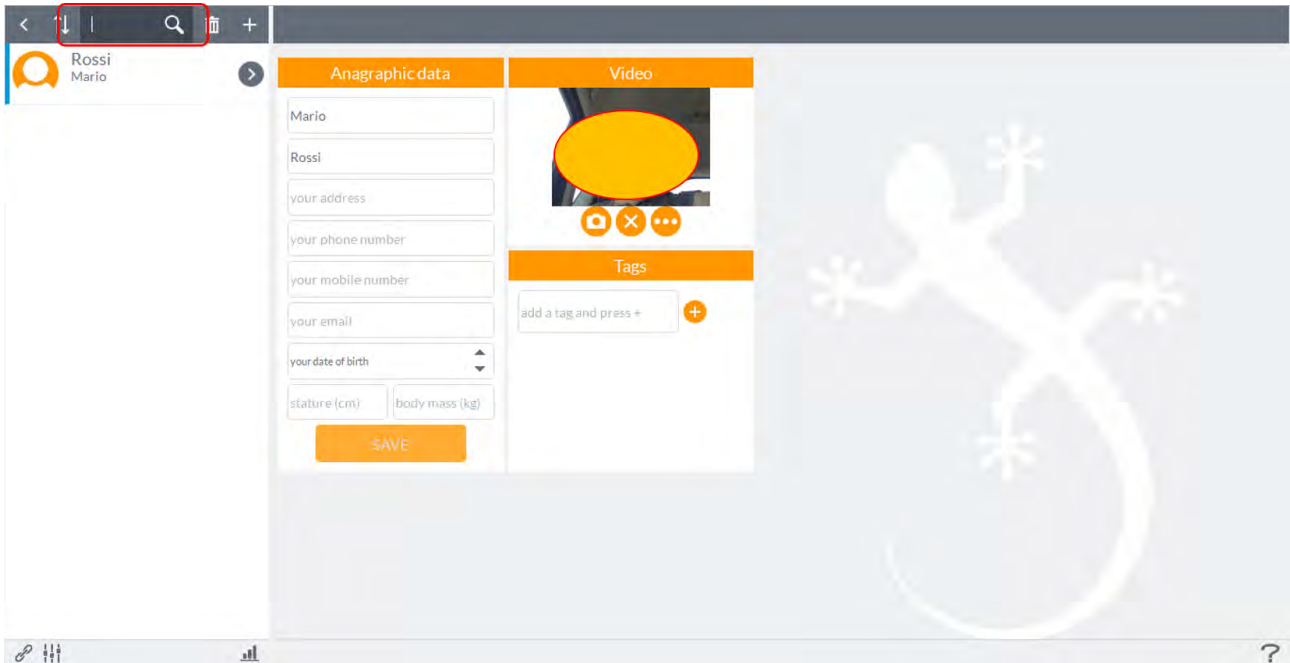
### 6.1.1 DELETE A SUBJECT

To remove a person must select it with a click, paying attention to appear a blue marker to the left of the picture of the subject and then press the "**Delete**" at the top:



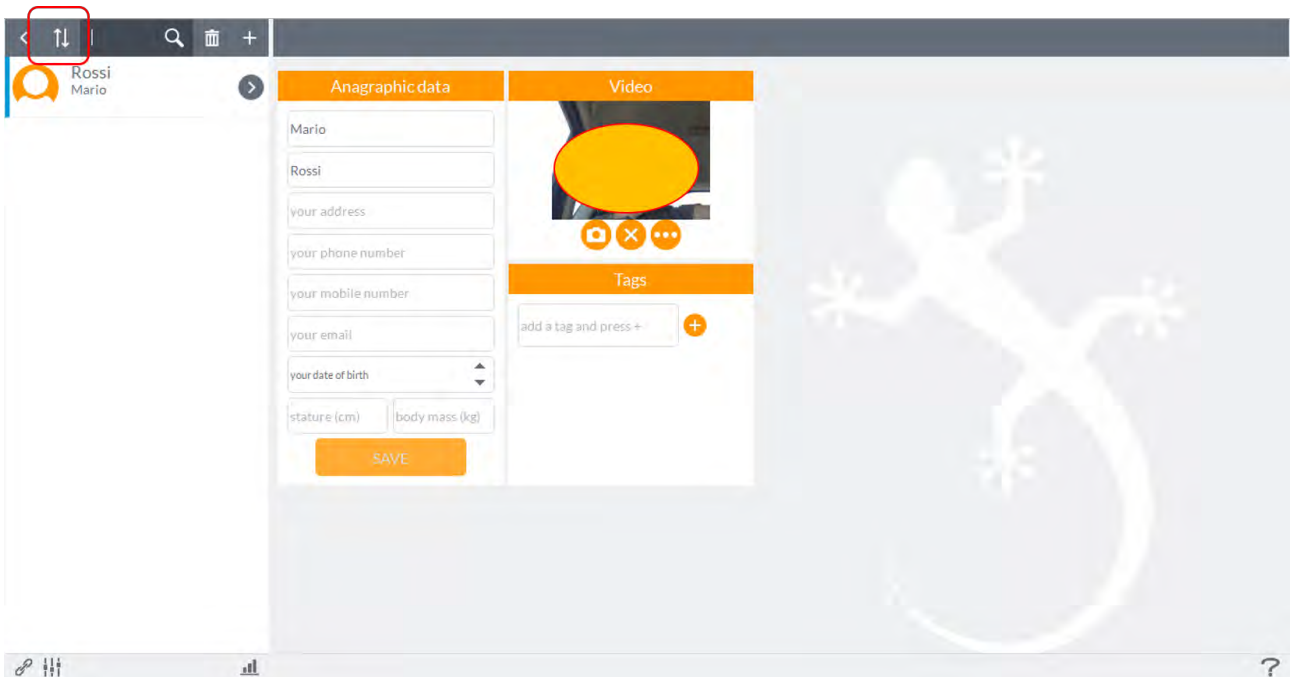
### 6.1.2 AUTOMATIC SEARCH FILTER

On top of the box in which shows the patient list there is a search field that automatically filter out patients in three fields of the registry card that are indexed by the software: name, surname and tags:



Just click on the magnifying glass and type in a keyword (contained in the data sheet of the subject that you are searching for) to perform the function of the filter. In the following example, you typed the word "basketball" (which is a tag associated with the subject Mario Rossi) to filter all patients who present the database name, surname or tags linked to this word.

Another tool to diversify the visualization of the subjects is the use of two arrows in the upper left allowing variations in alphabetical order, according to the first or last name, the list of subjects (in this case the display has been chosen by name).

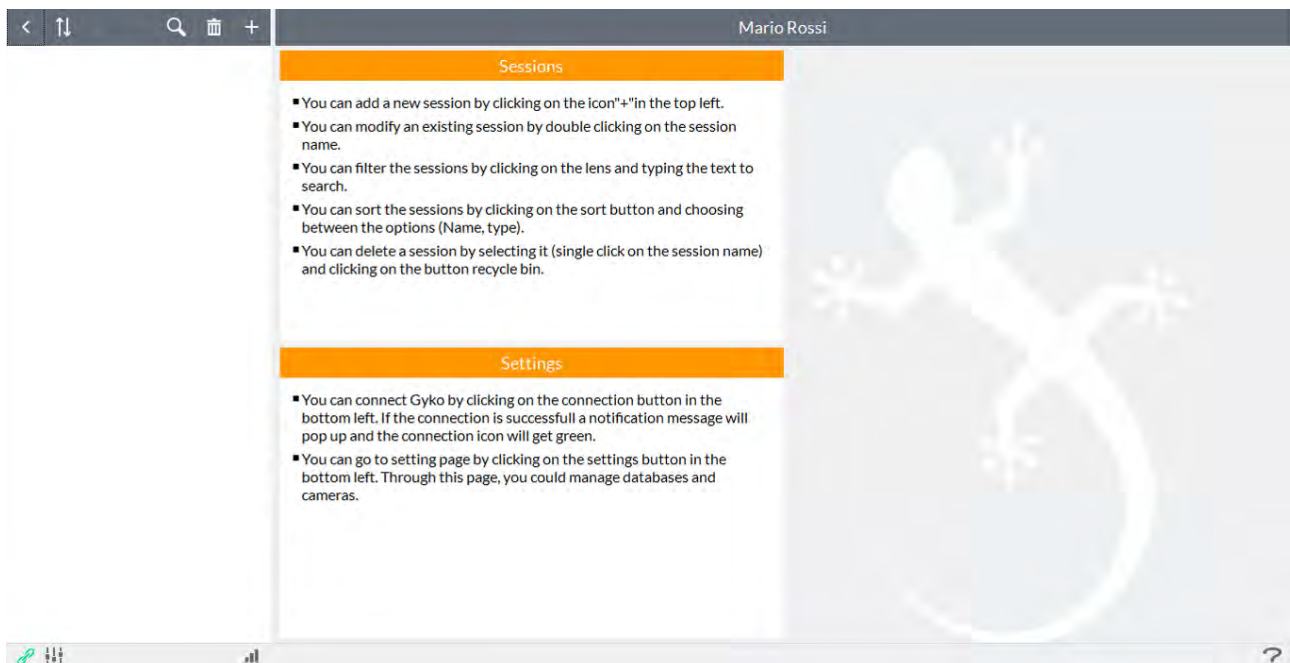


## 6.2 ADD AN ASSESSMENT SESSION

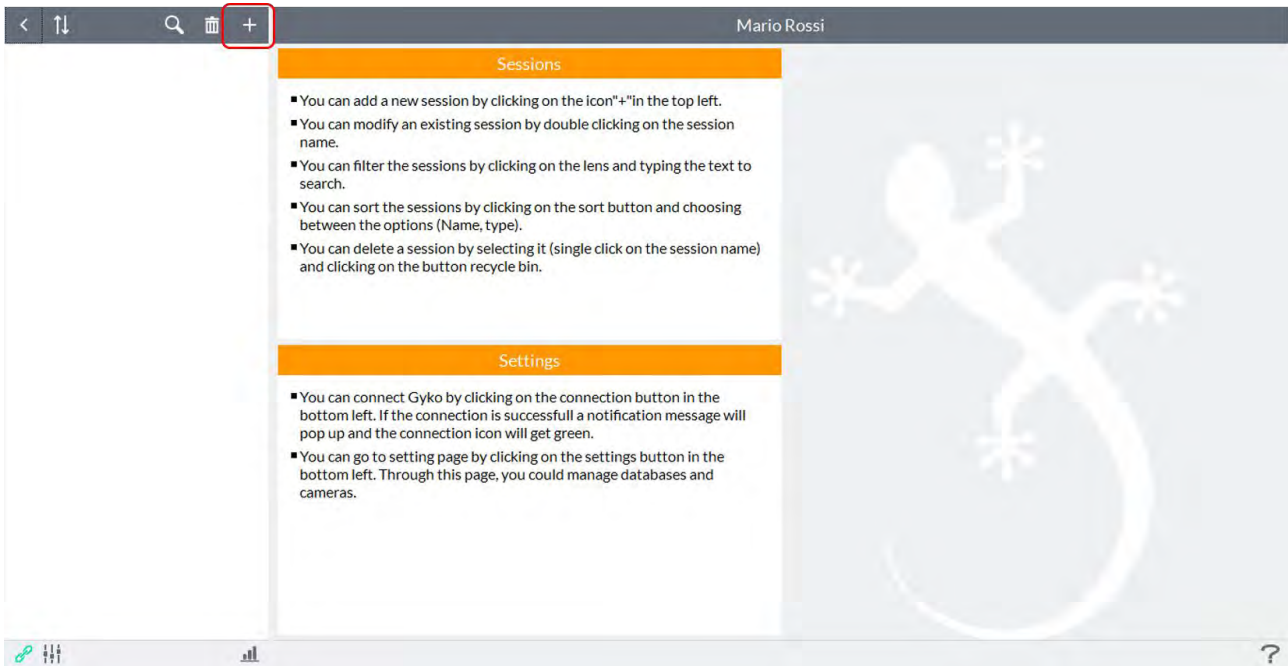
After creating the subject, the next step is to add and associate with that person an assessment session. To add a rating to a subject you first need to "enter" in the subject by pressing the button near to the name of the subject:



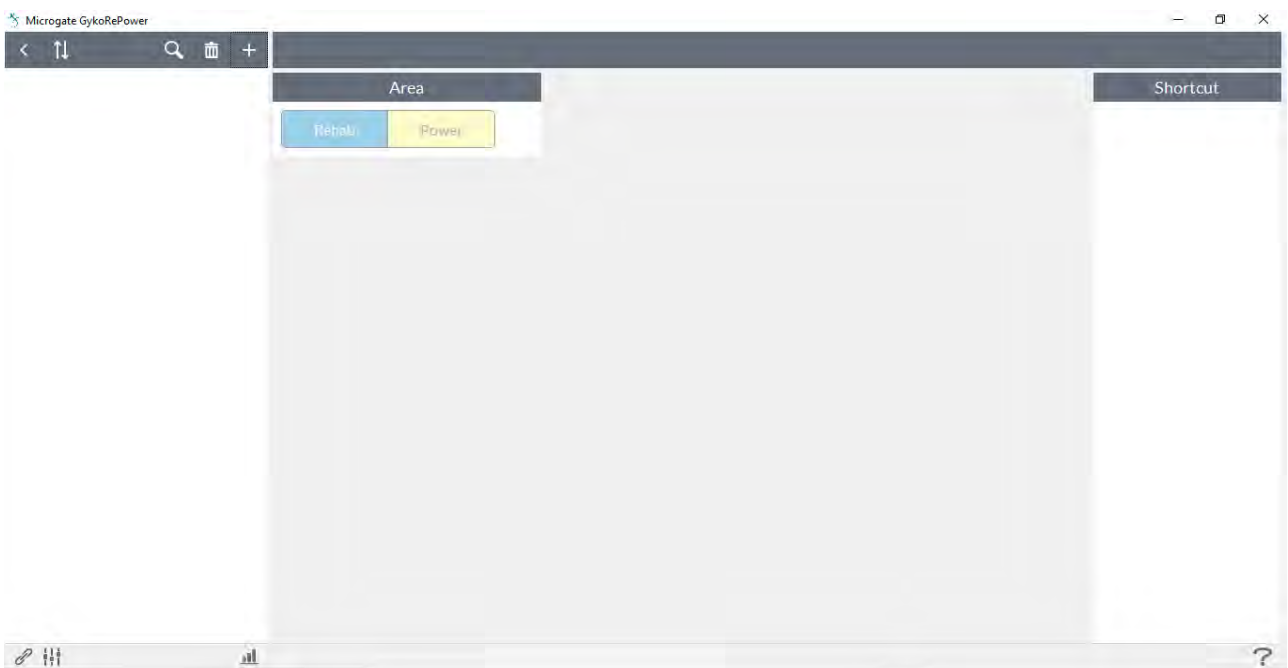
The screen that appears is this:



Now you can add to the selected subject, an assessment session by pressing the "+" shown below:



The screen for creating an evaluation session will be as follows:



**NOTE** This empty page will appear only at the first start of the software.

From this screen you can choose the mode of assessment of the subject between "**Rehab**" and "**Power**" by clicking the corresponding label.

"**Rehab**" offers the opportunity to evaluate and monitor the joint function and muscle strength during rehabilitation, while "**Power**" is specifically dedicated to the evaluation and monitoring of athletic performance in the field.

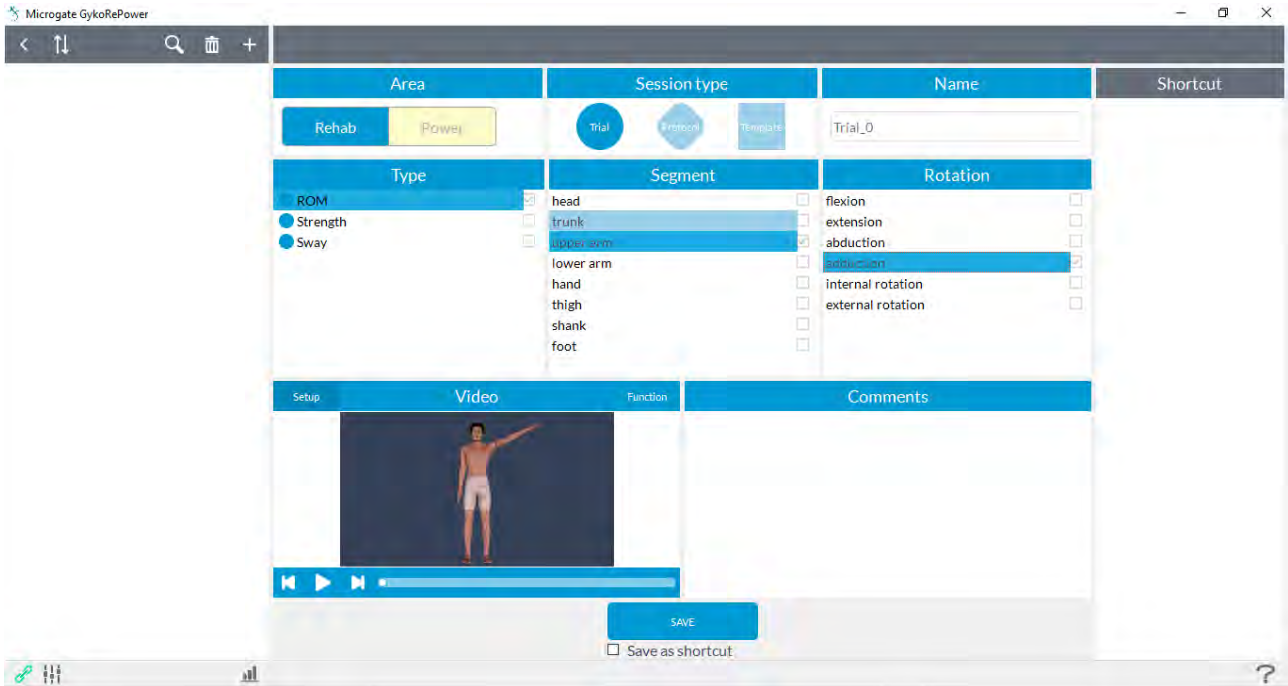
## 6.3 REHAB

By clicking on "**Rehab**" you can create an evaluation session by performing the following steps:

- Choose session type among:
  - **Trial**: execution of a single test among:
    - **ROM**: assessment of the joint mobility;
    - **Strength**: assessment of muscle strength of a limb;
    - **Sway**: evaluation of postural stability;
  - **Protocol**: execution of a protocol that contains more tests to comparison between a limb and the contralateral and for the long-term monitoring:
    - **ROM Symmetry**: assessment of the asymmetries of joint mobility between a limb and the contralateral;
    - **ROM Evolution**: assessment of joint mobility for long-term monitoring with respect to a target;
    - **Strength Symmetry**: assessment of asymmetries of muscle strength between a limb and the contralateral;
    - **Strength Evolution**: assessment of muscle strength for long-term monitoring with respect to a target;
  - **Template**: through this session you can create protocols including more tests for the evaluation of various aspects. By default you have already entered some ROM protocols including all movements for each joint segment. See paragraph [6.3.2](#);
- Enter the name of the test, the software set-default for the name is "Trial\_0", "Protocol\_0" or "Template\_0" with increasing numbering to follow;
- Choose the type of trial, protocol or template;
- Choose the body segment (trial and/or protocol) interested in the head, trunk, arm, forearm, hand, thigh, leg and foot using the appropriate menu;
- Choose the rotation of the segment you want to test using the appropriate menu (which are pre-loaded main and most common degrees of freedom);

These last two options are optional.

After the choice of these two parameters will also be a video of what should be the movement to be executed and where you should put the device:

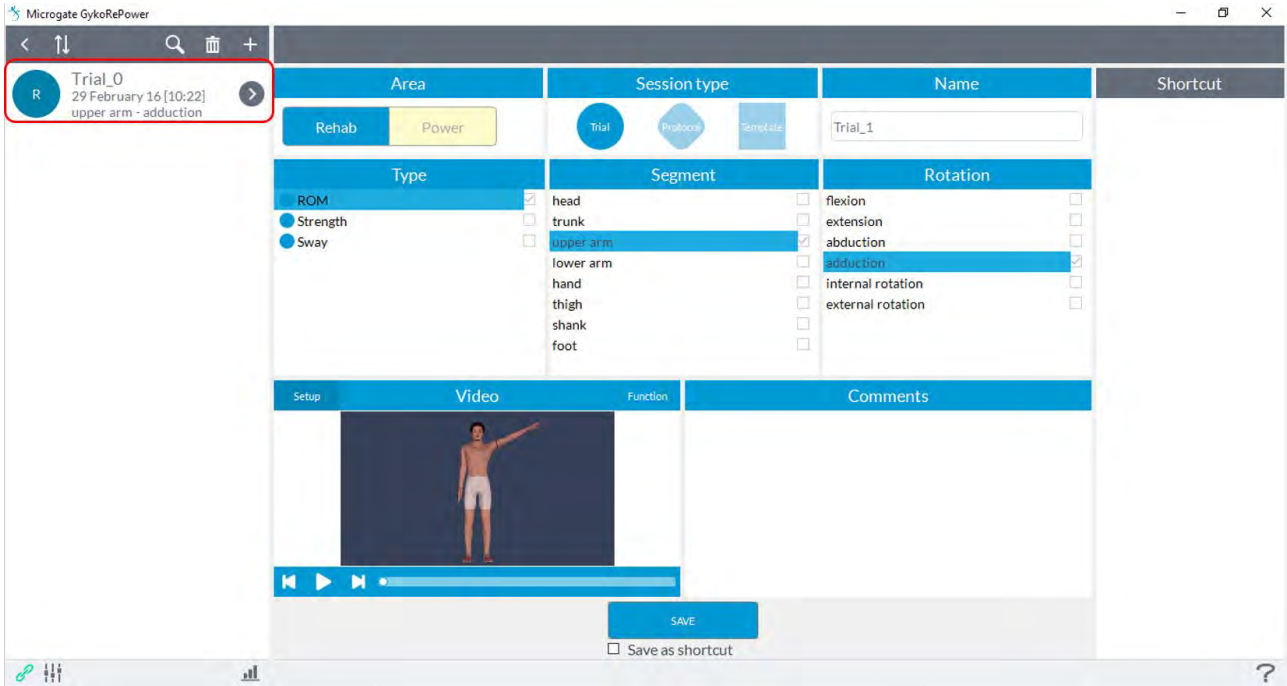


By clicking on "**Function**" it will display the same movement but showing the muscles involved in this type of movement.

**NOTE:** If you select **Protocol** will add an additional option "**Side**" where you can choose between "**Right**" and "**Left**" which will be the limb of reference used by the software to provide data of the comparison.

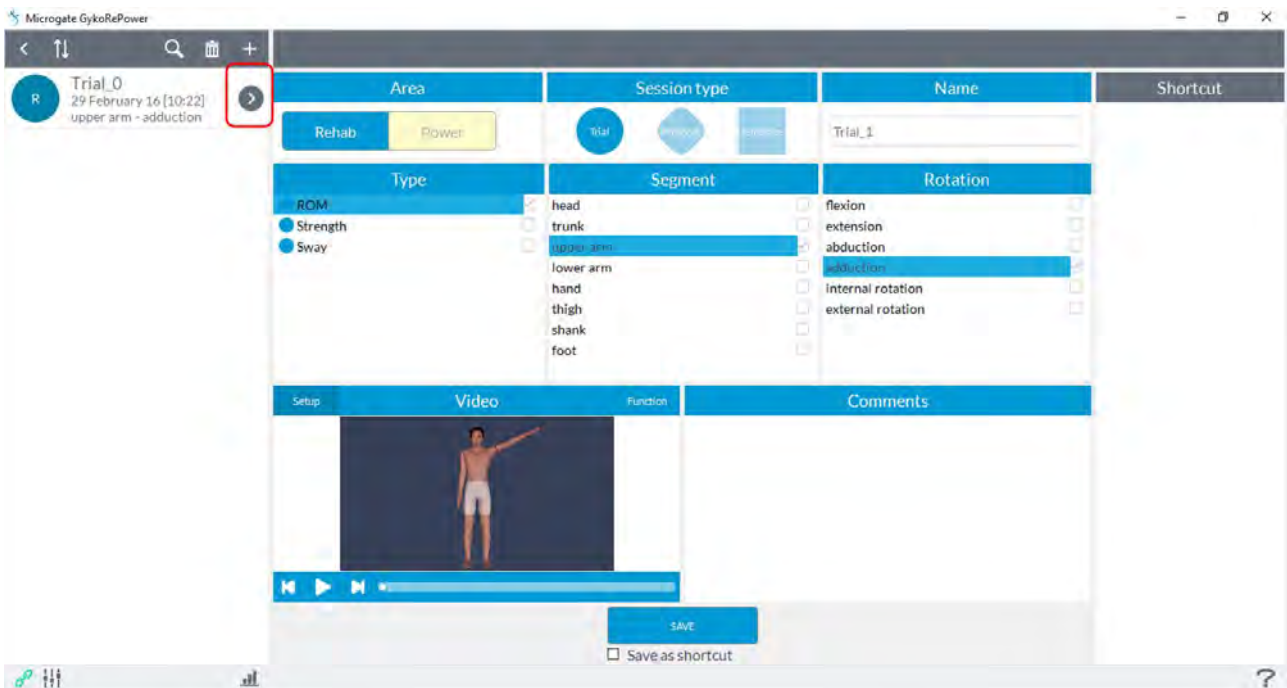
**NOTE:** The moment you create, within the same subject, the sessions of ROM Evolution and/or Strength Evolution, they shall contain the tests conducted in previous sessions (ROM Symmetry/ROM Evolution and Strength Symmetry/Strength Evolution respectively) if they are created with the same segment and the same type of movement survey of previous sessions. For example: create a session of ROM SYmmetry-> armrest> Flexion are acquired two tests; if later it creates (always in the same subject) session ROM Evolution-> armrest> Flexion, you will see the "**Target List**" populated by tests conducted earlier in the session ROM Symmetry, for further information please refer to paragraph 7.2.2.

Press the "**Save**" button and it will be created the assessment session choice that will populate the list of assessments associated with the person to the left of the screen of the software. The name of the assessment will be made up of the initials of the type of session selection (RS = ROM Symmetry, RE = ROM Evolution etc.) in colored dot, the name given to the session, the date of creation of the session, the body segment and the type of chosen movement:



In case the user wants to analyze more degrees of freedom, you can use one of the templates already created which have already implemented all the movements of each individual limb. Refer to paragraph [6.3.2](#).

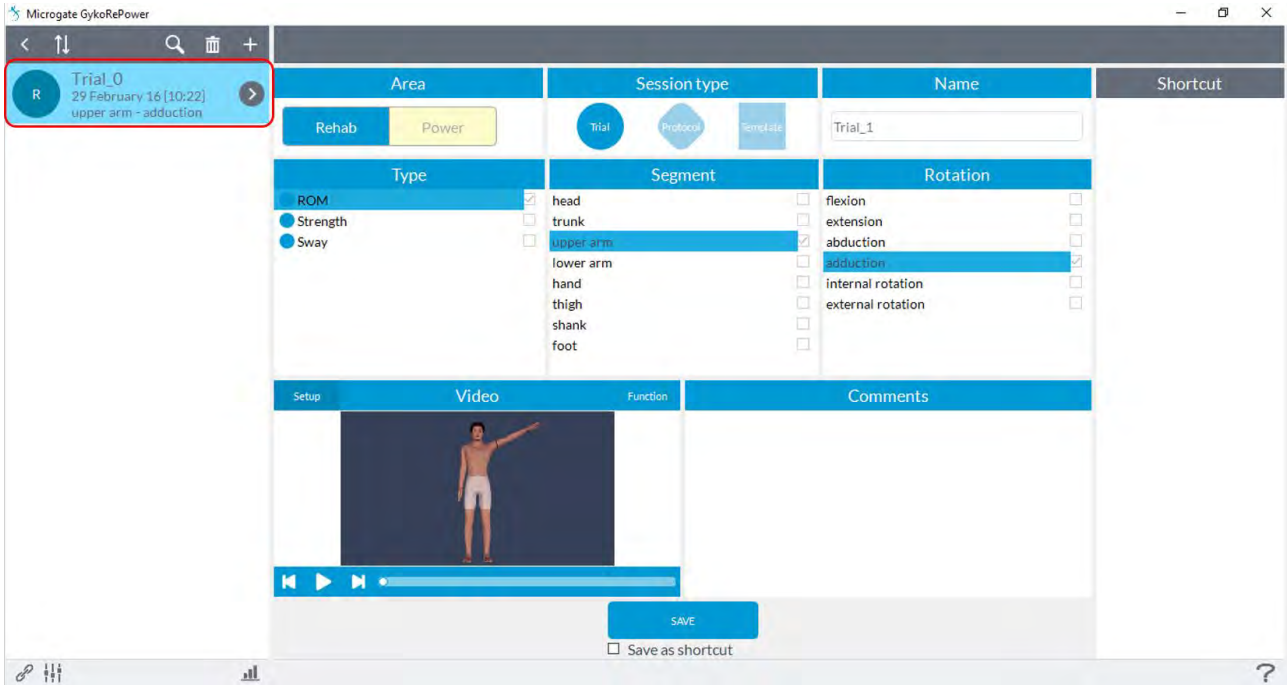
After creating an evaluation session for a specific subject selected, the name of the session you just created will appear in the list on the left evaluations of the software screen. To access the evaluation session you just created and start testing it is necessary to press the arrow button located next to the name of the evaluation (the list on the left):



Depending on the type of session created appear different screens.

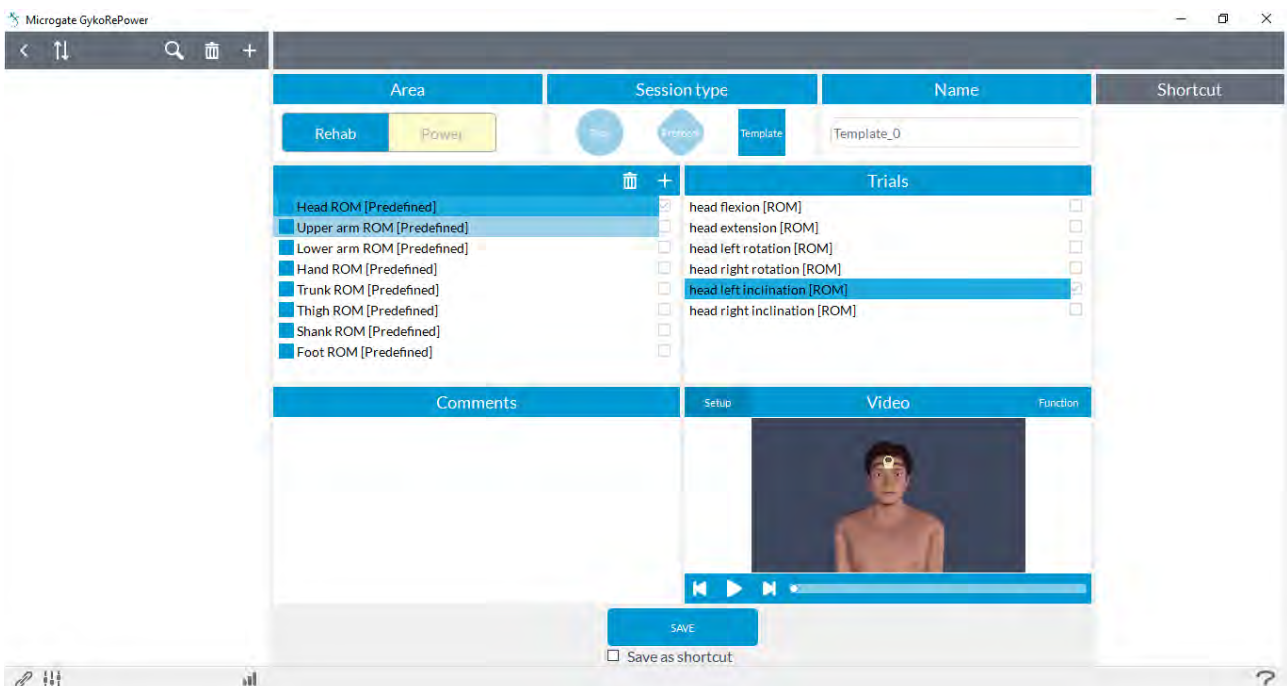
### 6.3.1 DELETE AN ASSESSMENT SESSION

To remove a session must select it with a click so that it is highlighted and then press "Delete" at the top:



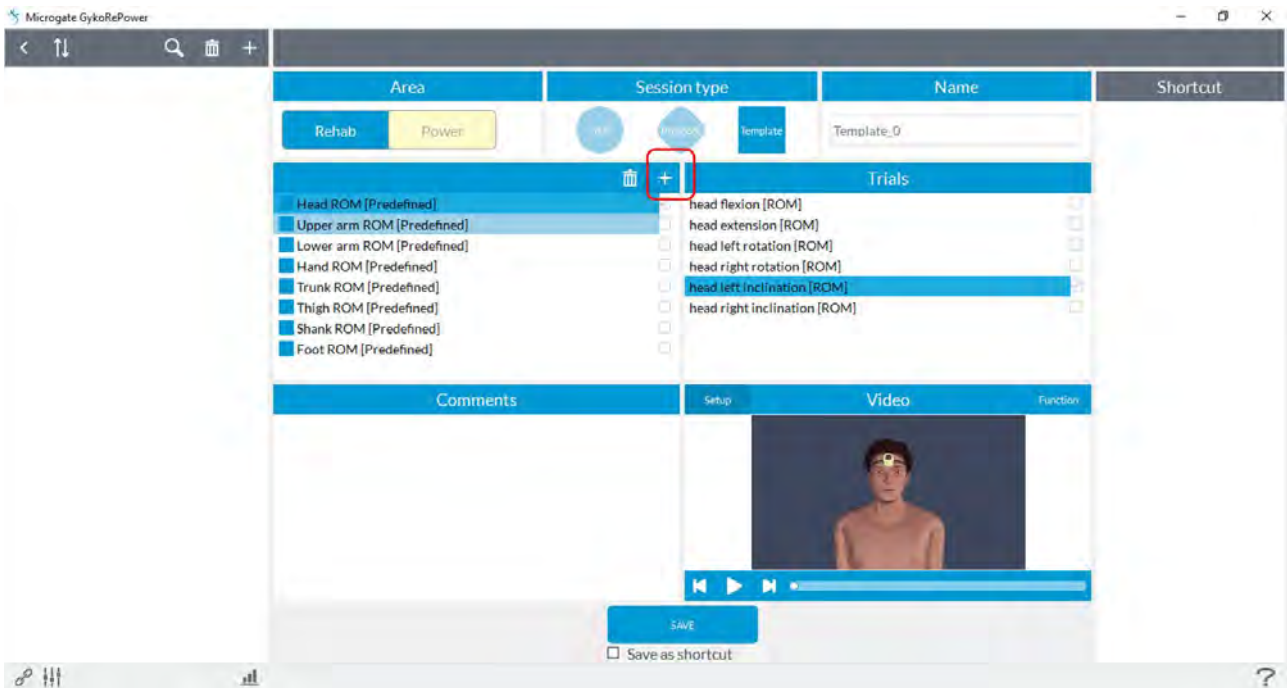
### 6.3.2 TEMPLATE

Using "Template" session you can create a custom protocol by adding different types of tests present within the "Rehab". By default there are already a few examples that include all the movements for each segment, such as selecting "ROM head" will be shown in the box to the right, the associated tests:

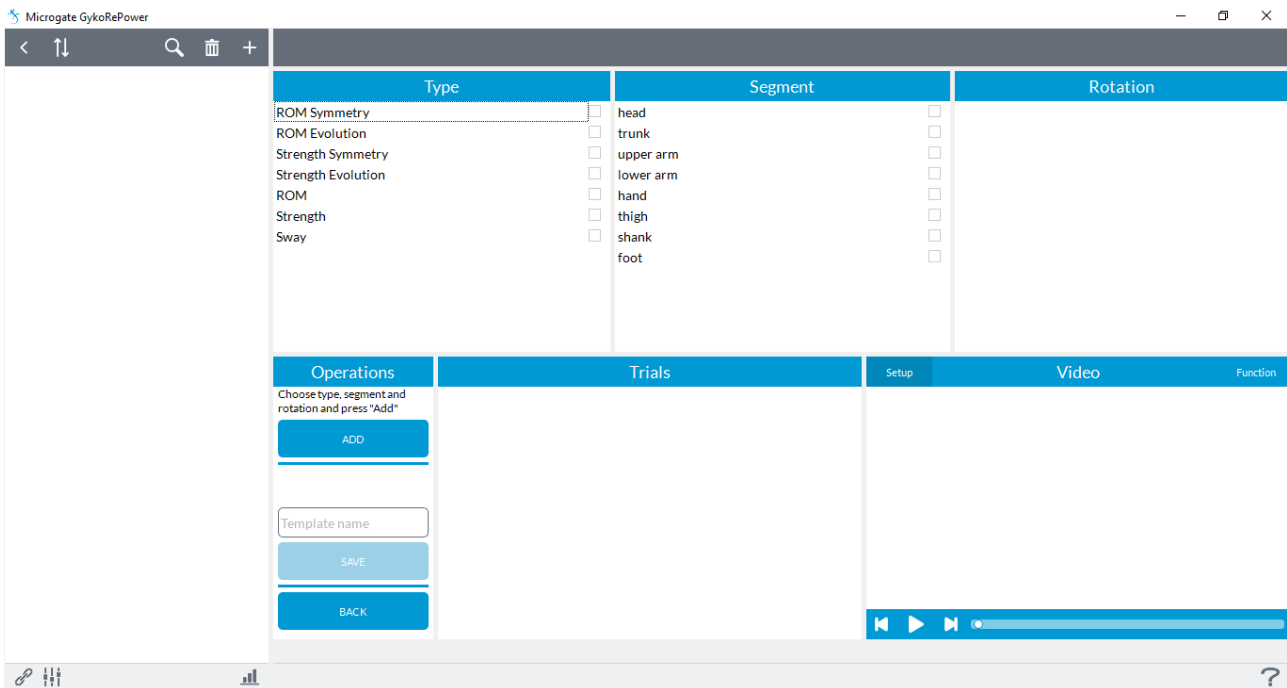




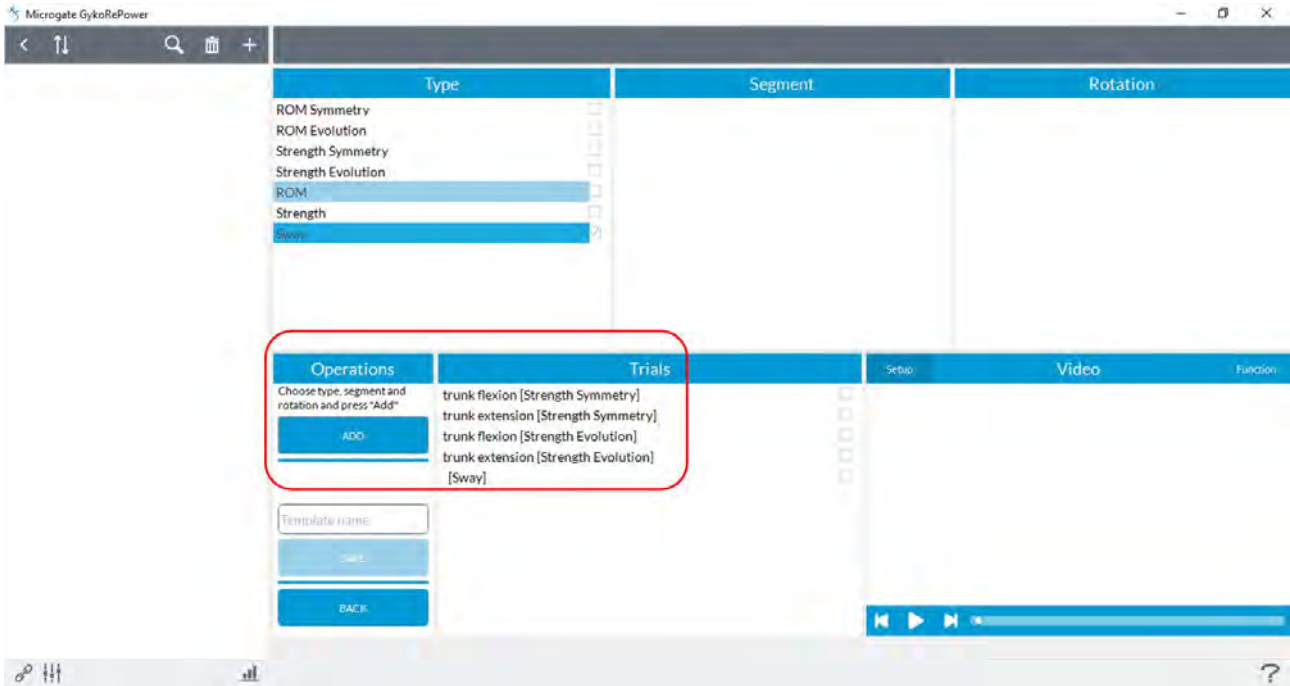
To create a new template press on “+” at the center of the screen:



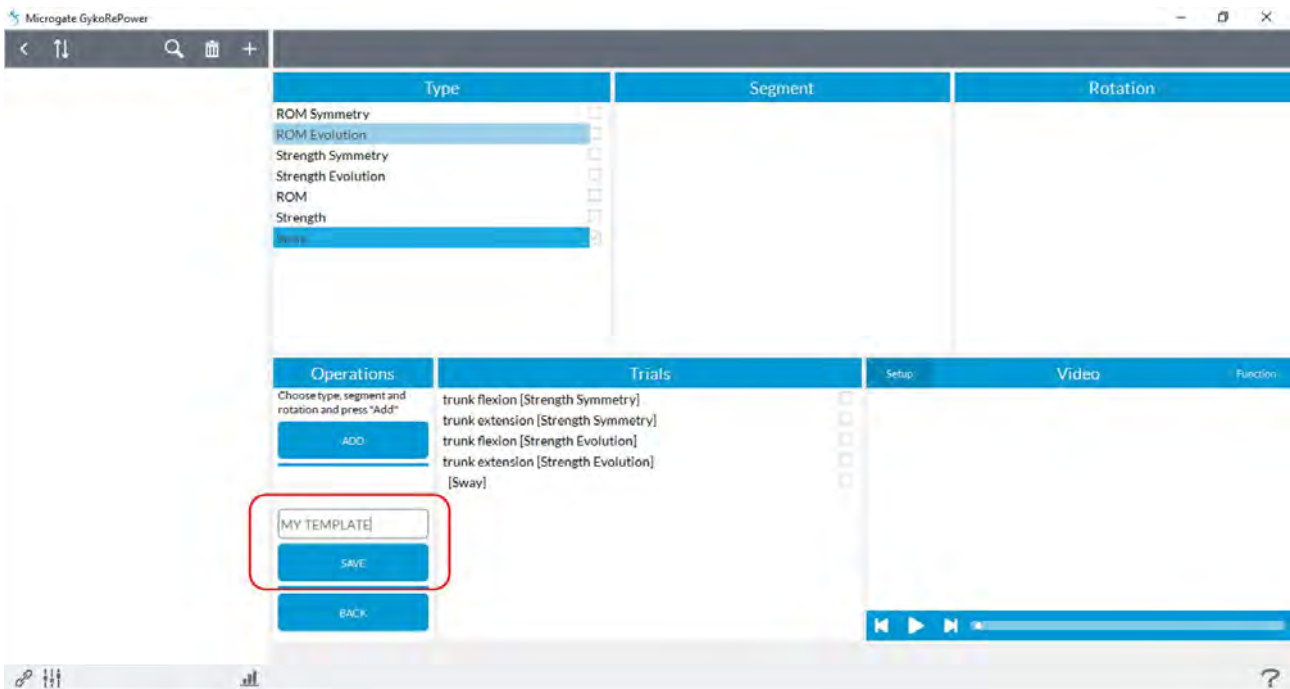
A new screen will be open:



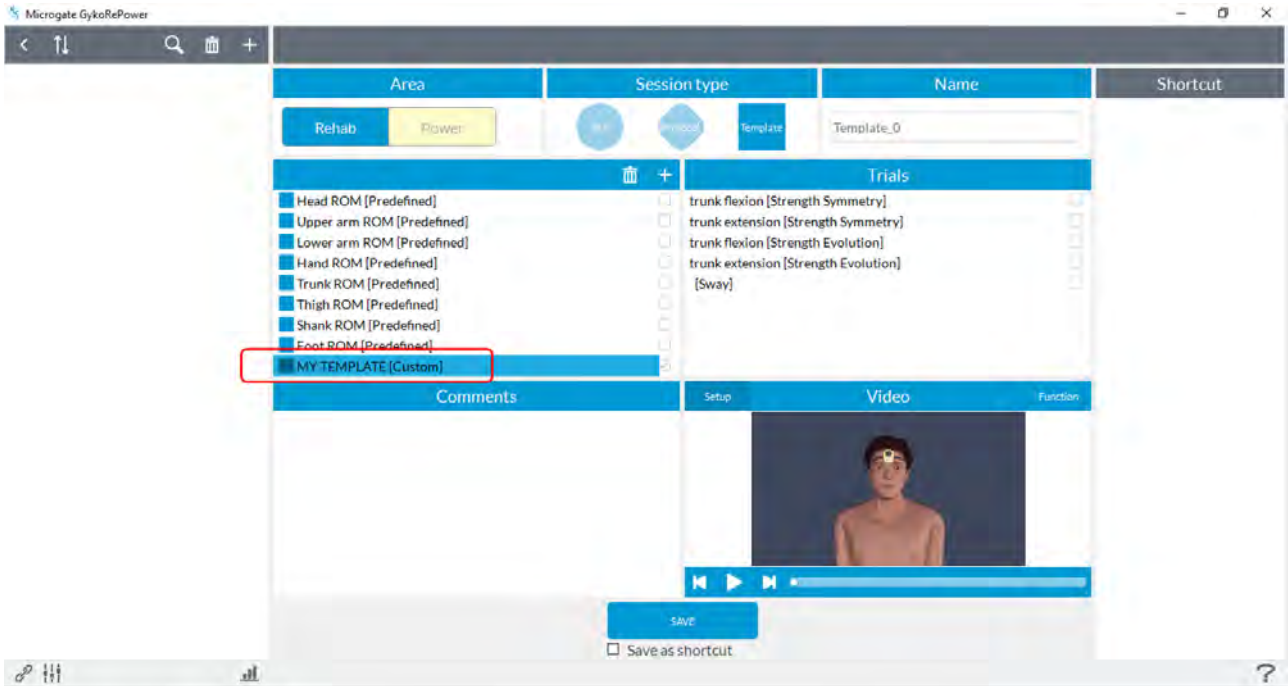
Now you can simply select the type of test, segment and rotation and click "Add" to build the custom template:



At this point you must enter a name and will activate the "Save" button:

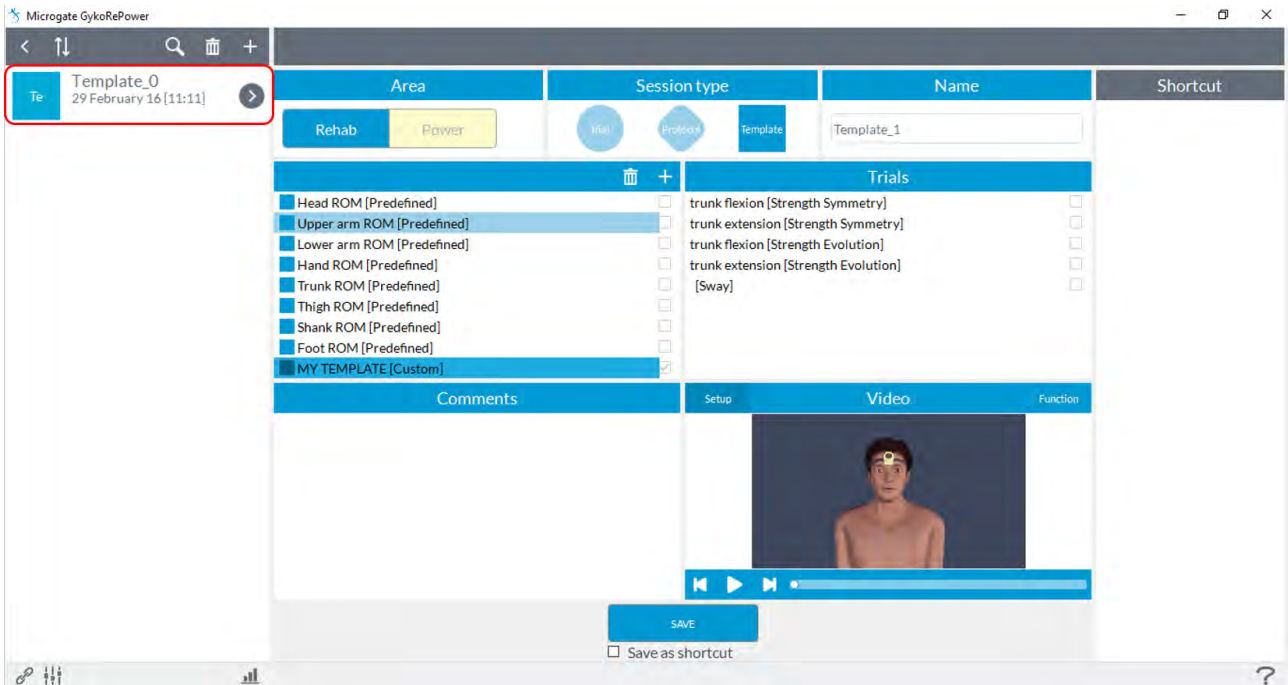


After registering the new Template, it will be added to the list along with those already present with the word **[Custom]**:

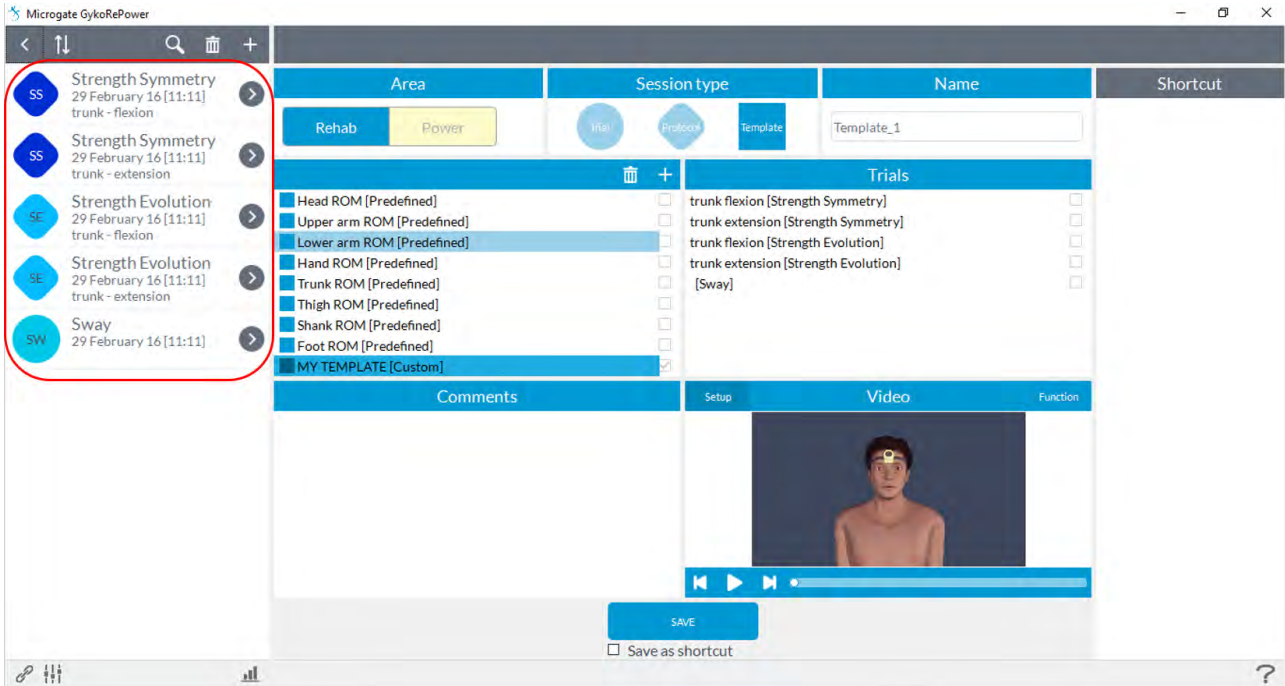


**NOTE** Once created, the template will be used for all subjects in the database so without having to replicate each time the procedure.

In order to use the new template you have to select it and press the **"Save"** button, in this way the Template will populate the list on the left side of the screen:



At this point, pressing the arrow next name of the Template you will have the list of tests to be performed on the left side of the screen:



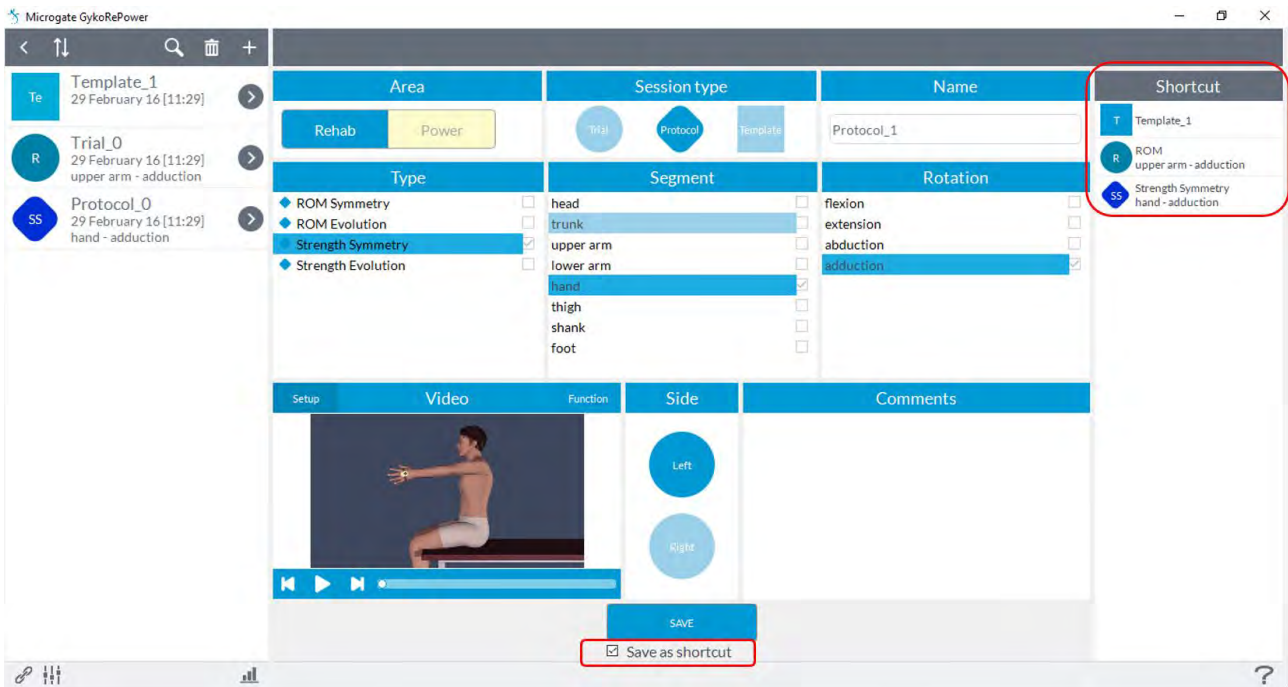
### 6.3.3 SHORTCUT

Through the "**Shortcut**" function, you can create "dedicated lanes" for the creation and use of the evaluation sessions.

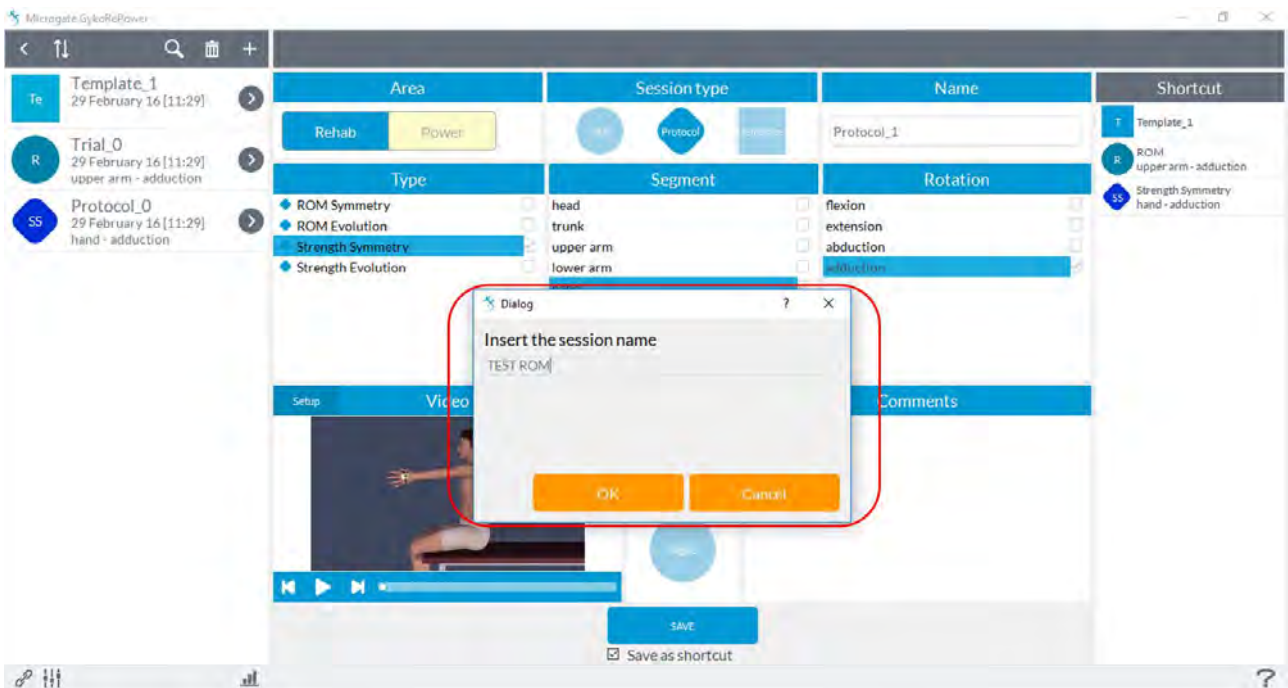
**NOTE** With the "Shortcut" you can also switch more quickly from an evaluation session "**Rehab**" to a "**Power**" because the list of "Shortcut" has no distinction between the two areas.

For example, if the user would use always, or at least very often, a specific type of evaluation, in order not to create each time the same session (Exercise, Protocol or Template) for all subjects, it is possible (after you have created it for the first time) save it as a "**Shortcut**" and have it available for all subjects in the list to the right of the screen.

To create a "**Shortcut**" just add ticking the words "**Save as shortcut**" under the "**Save**" button when you save the new session (Exercise, Protocol or Template) and the session will also appear in the list on the right of the screen :

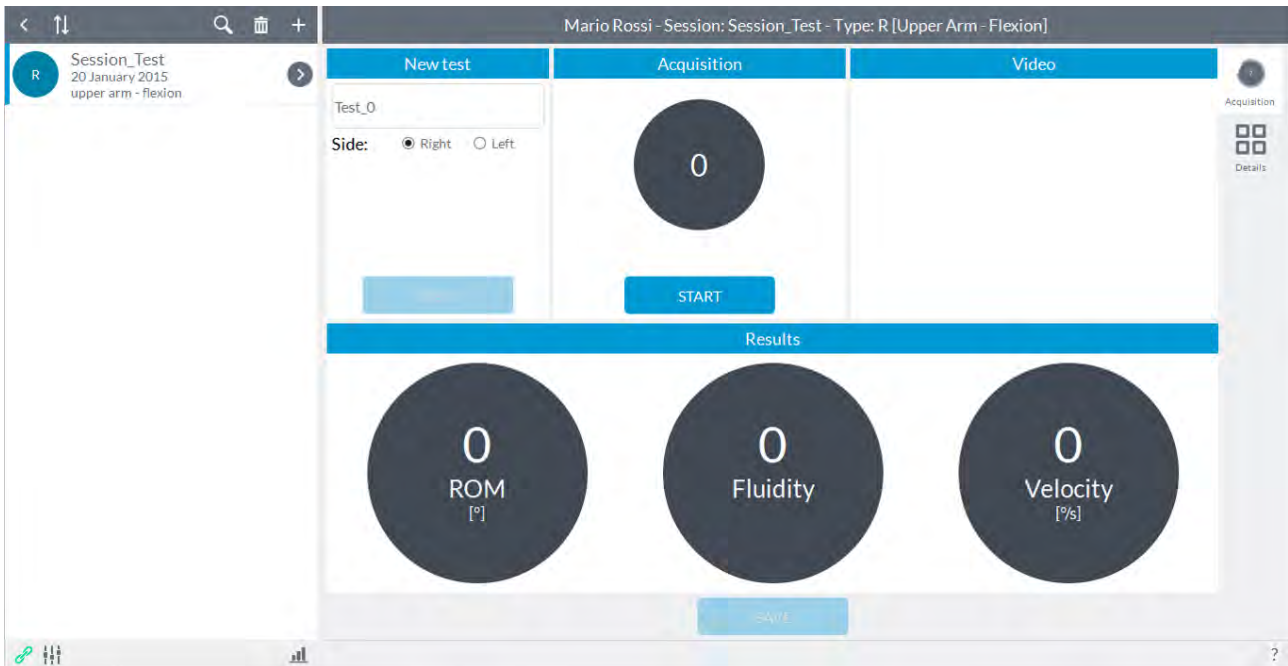


At this point in any other subject it will be displayed shortcuts and double-clicking the left mouse button on one of these will create the evaluation session. You only have to give a name from the window that appears. So it will not be necessary to have to create each time the session:



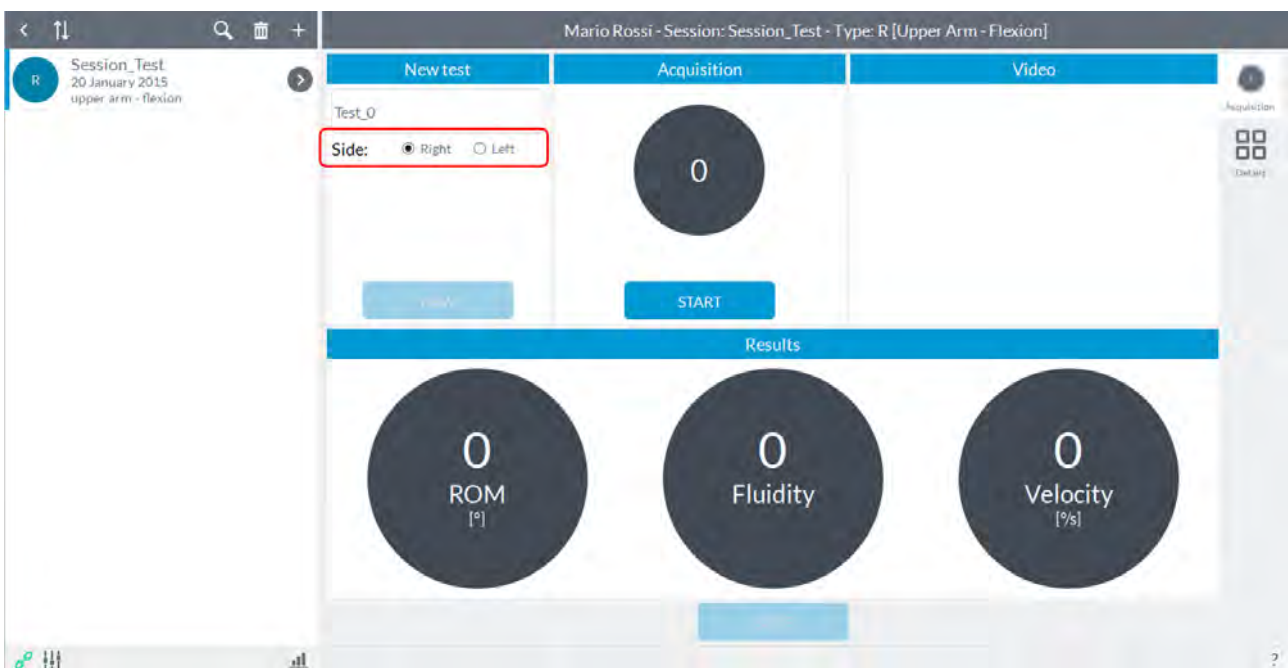
### 6.3.4 ROM

Recording a session of "ROM" will see the following screen:



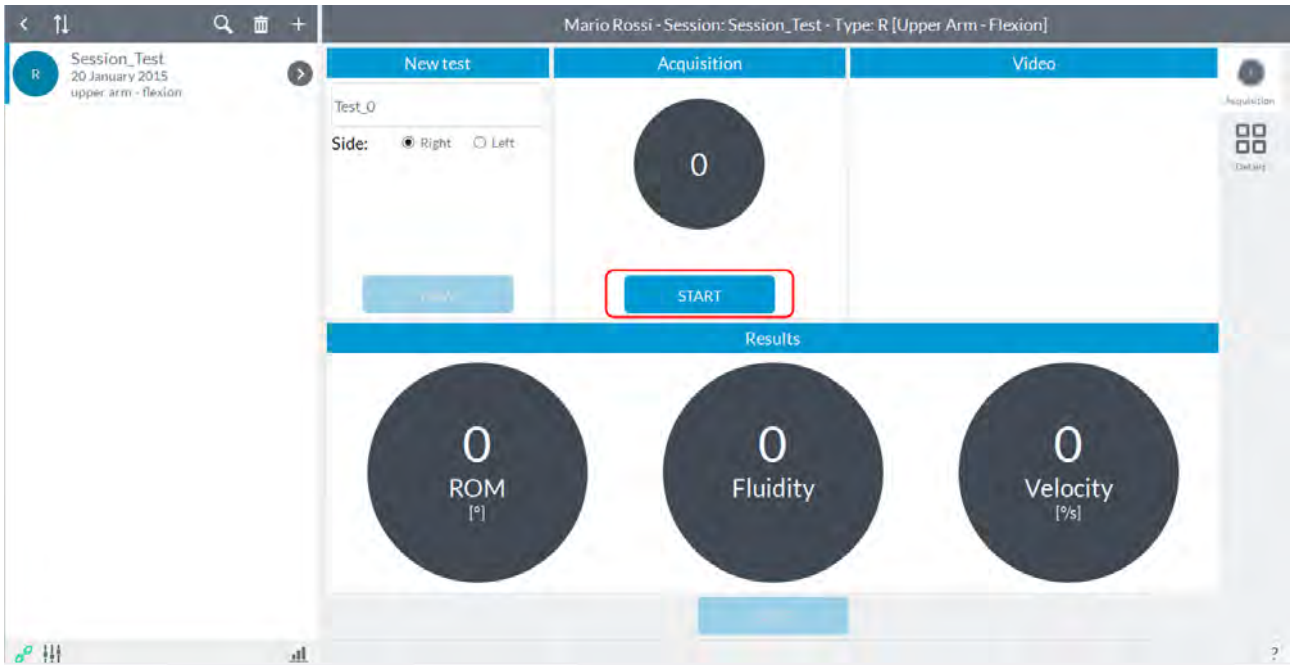
The user can enter notes in the "New Test" in the upper left (this will be shown as a label for the year in view of the results in report mode and details) is set as the default name of the test "Test\_0" with increasing numbering subsequent tests.

The aim of this module is to assess the joint mobility of a limb for a given movement in terms of range of motion, fluidity and angular velocity. Prior to testing, position the unit within its hardware support (elastic band) and secure the stand on the applicable segment according to the articulation you want to evaluate. At this point you need to select, via the switch on the upper left, the "side" you are going to evaluate between "Right" and "Left".



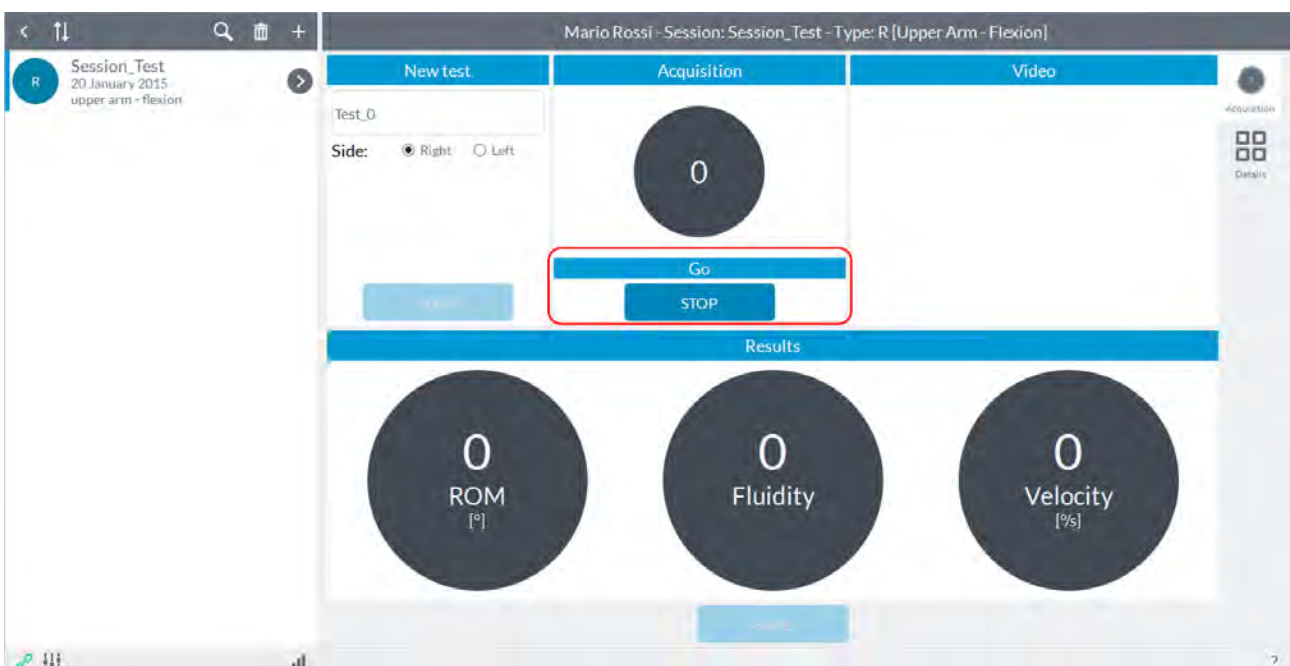
Refer to [Appendix A](#) to have a reference to where to place the device and how to perform the movements as a function of the degrees of freedom which will be analyzed for a given articulation.

Once the subject is ready, before starting the acquisition ensure that the body segment on which the device has been placed is stationary. At this point the user can press the button to start acquisition "**Start**" and give the start to the subject (the user will see an indication of "**Go**" on the "**Start**" button) that can perform the predetermined movement as soon as the software will give an audible signal ("beep"):

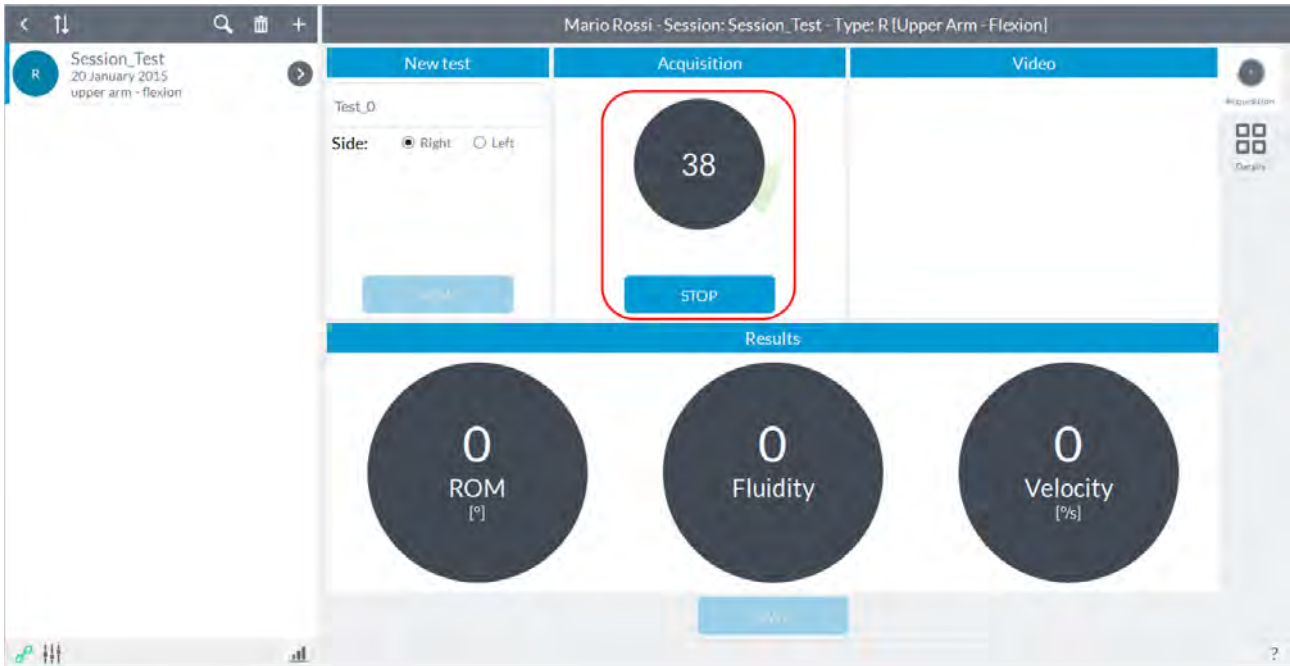


**NOTE:** the acoustic signal will be generated only if the software identifies a initial static phase, that is, if the subject keeps holding the segment on which the device is placed before starting to perform the movement. If the "**Start**" button is pressed while the subject is even slightly moving the segment, the software will wait until the segment is completely stopped before giving the acoustic signal.

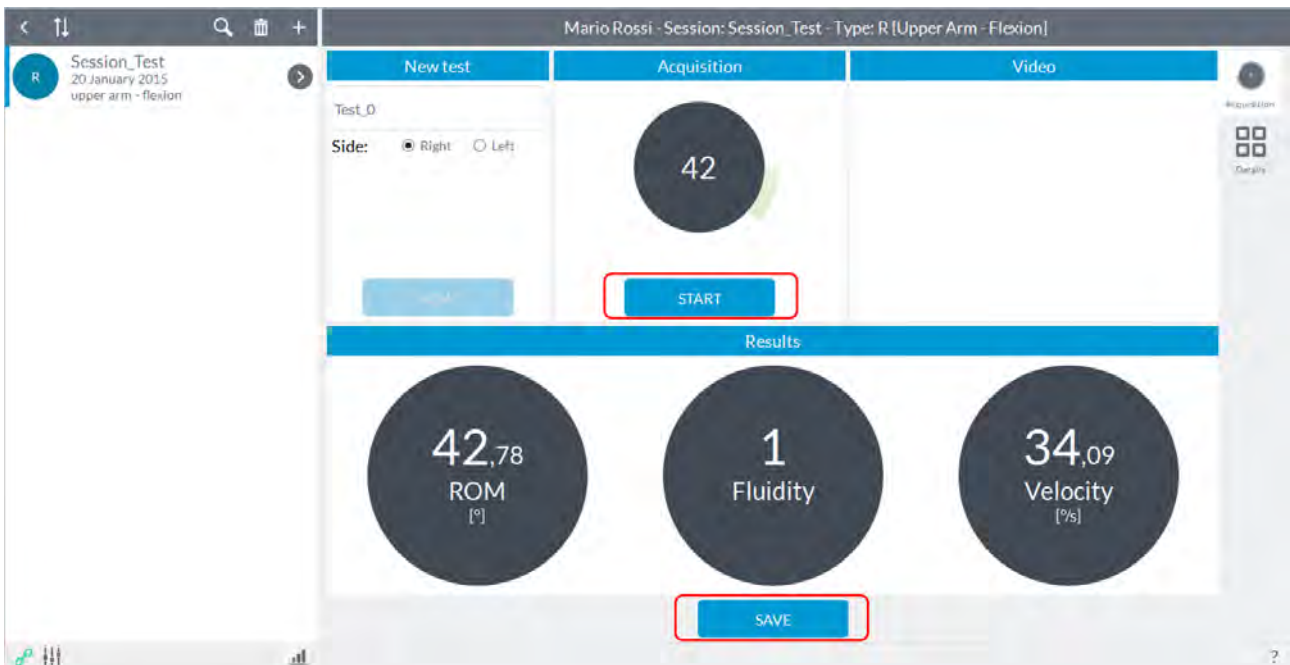
At the acoustic signal the "**Start**" button will change its state automatically to "**Stop**":



In the box will be shown in real time the ROM (in degrees). When the subject has finished moving, the user must press the button **"Stop"** which is activated after starting the acquisition:



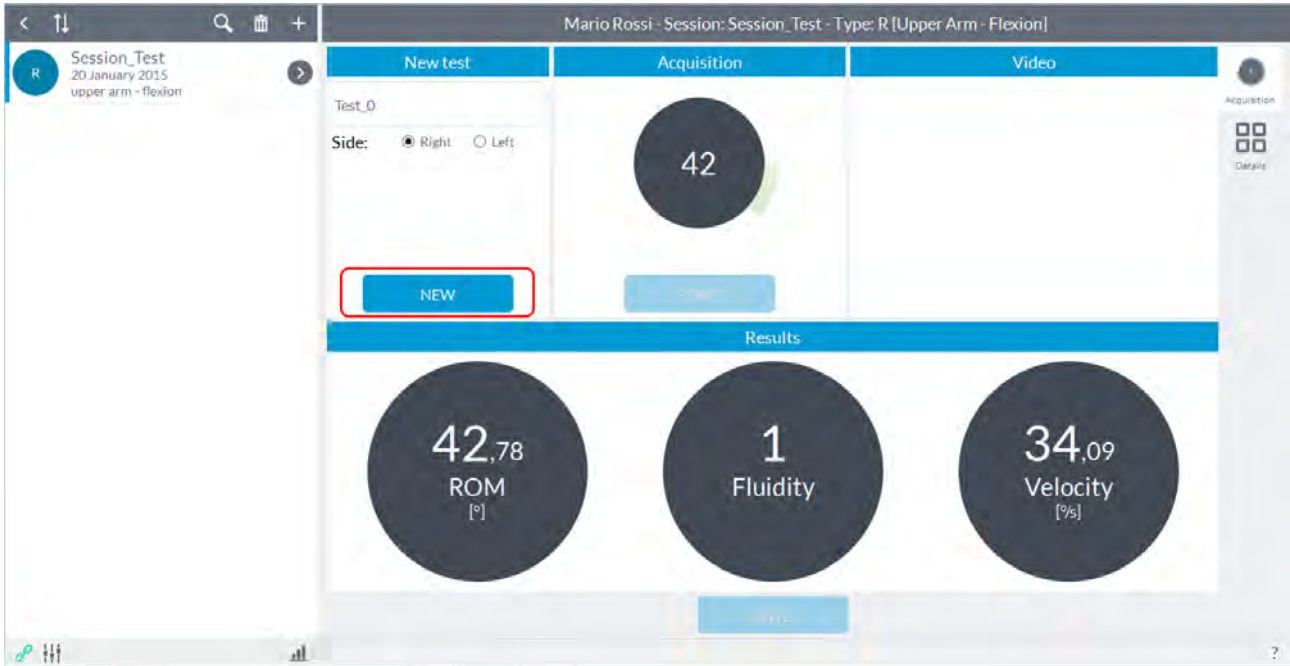
After completing the acquisition, the software simultaneously activate the **"Save"** button to save the test just ended and re-enable the **"Start"** button in case you want to repeat the acquisition of joint motion just ended, or switch acquisition on the other limb, in these cases the test data just ended will not saved:



In the lower box will show the values in terms of ROM, fluidity and angular velocity.

After pressing the **"Save"** button, the results for the test just ended will be saved and will reactivate the **"New"** button:

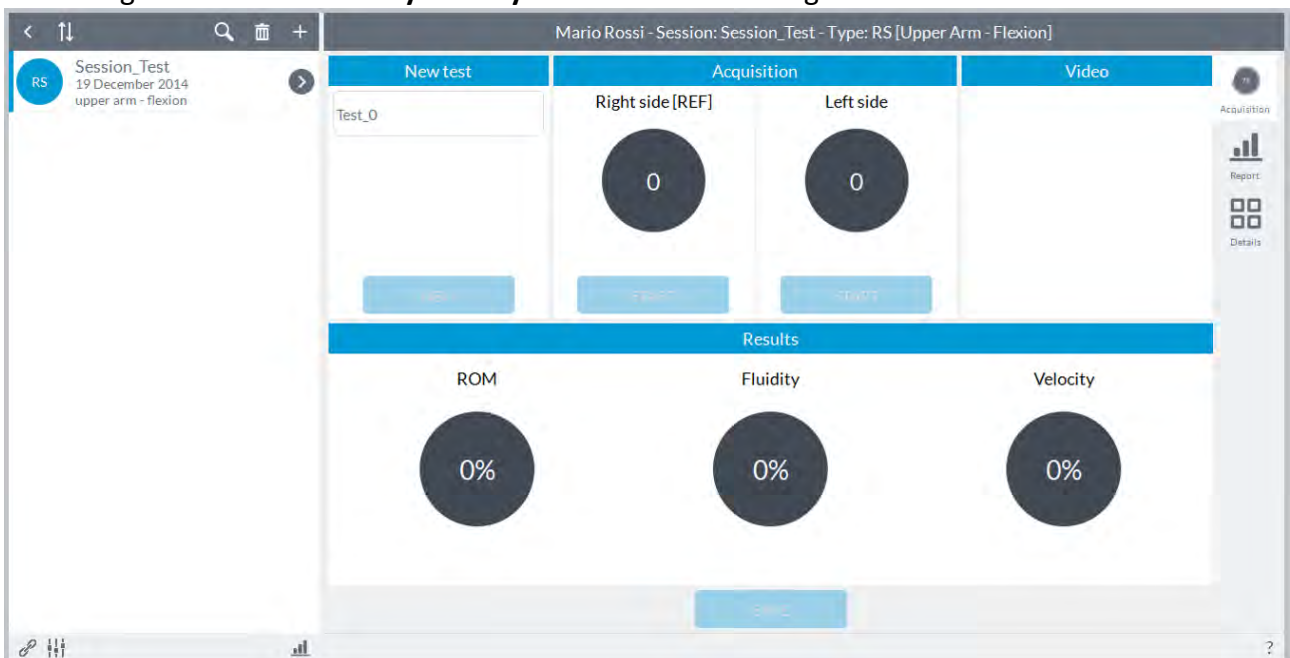




Pressing the "New" button will reset the values and will be reactivated the two keys "Start" to proceed with a new acquisition.

### 6.3.5 ROM SYMMETRY

Recording a session of "ROM Symmetry" will see the following screen:



The user can enter notes in the "New Test" in the upper left (this will be shown as a label for the year in view of the results in report mode and details) is set as the default name of the test "Test\_0" with increasing numbering subsequent tests.

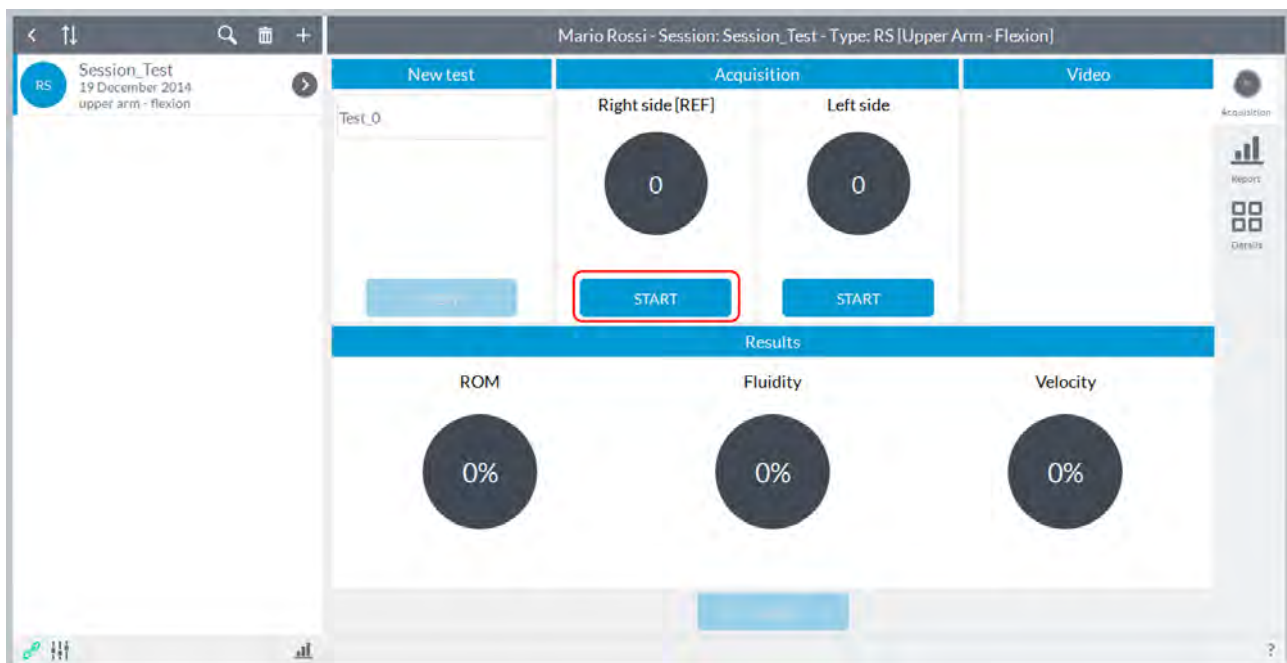
The aim of this module is to assess any deficit between right limb and left limb or just make an initial screening of joint mobility of the subject.

Prior to testing, position the unit within its hardware support (elastic band) and secure the stand on the applicable segment according to the articulation you want to evaluate.

Refer to [Appendix A](#) to have a reference to where to place the device and how to perform the movements as a function of the degrees of freedom which will be analyzed for a given articulation.

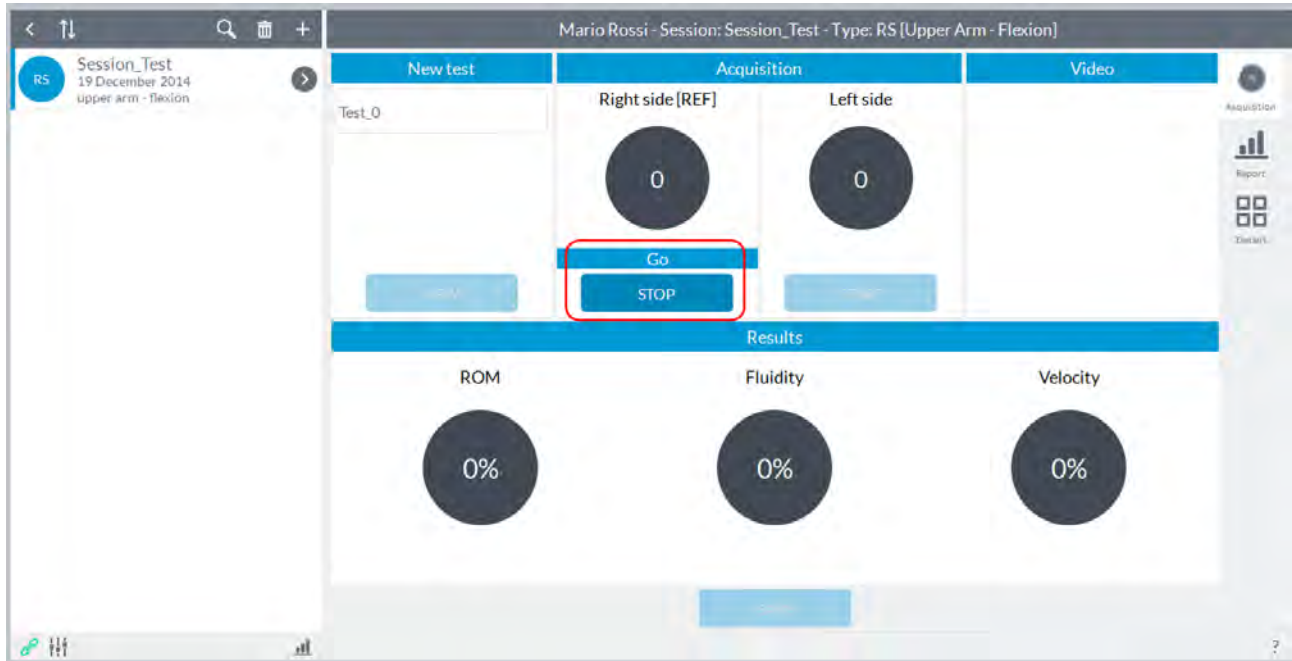
**NOTE:** you can start the acquisition with the right limb or with the left limb.

Once the subject is ready, before starting the acquisition ensure that the body segment on which the device has been placed is stationary. At this point the user can press the button to start acquisition "**Start**" located in box of the segment of investigation and give the start to the subject (the user will see an indication of "**Go**" on the "**Start**" button) that can perform the predetermined movement as soon as the software will give an audible signal ("**beep**"):

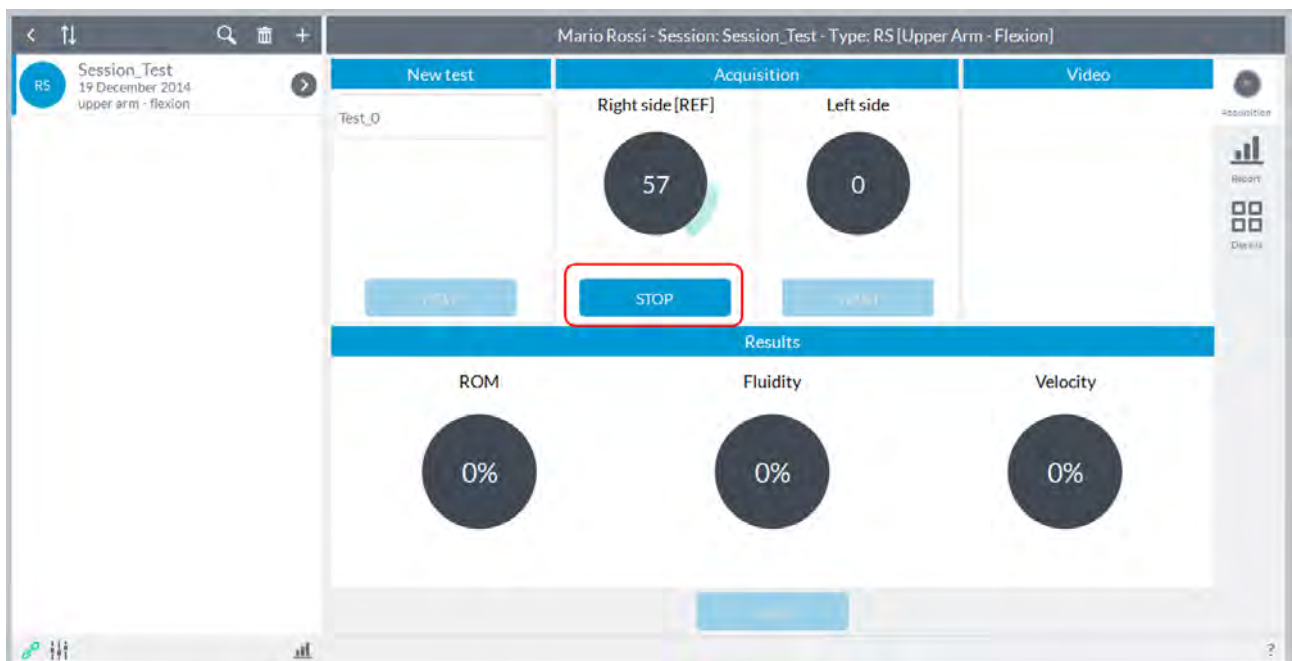


**NOTE:** the acoustic signal will be generated only if the software identifies a initial static phase, that is, if the subject keeps holding the segment on which the device is placed before starting to perform the movement. If the "**Start**" button is pressed while the subject is even slightly moving the segment, the software will wait until the segment is completely stopped before giving the acoustic signal.

At the acoustic signal the "**Start**" button will change its state automatically to "**Stop**":



In the box will be shown in real time the ROM (in degrees). When the subject has finished moving, the user must press the button "**Stop**" which is activated after starting the acquisition:

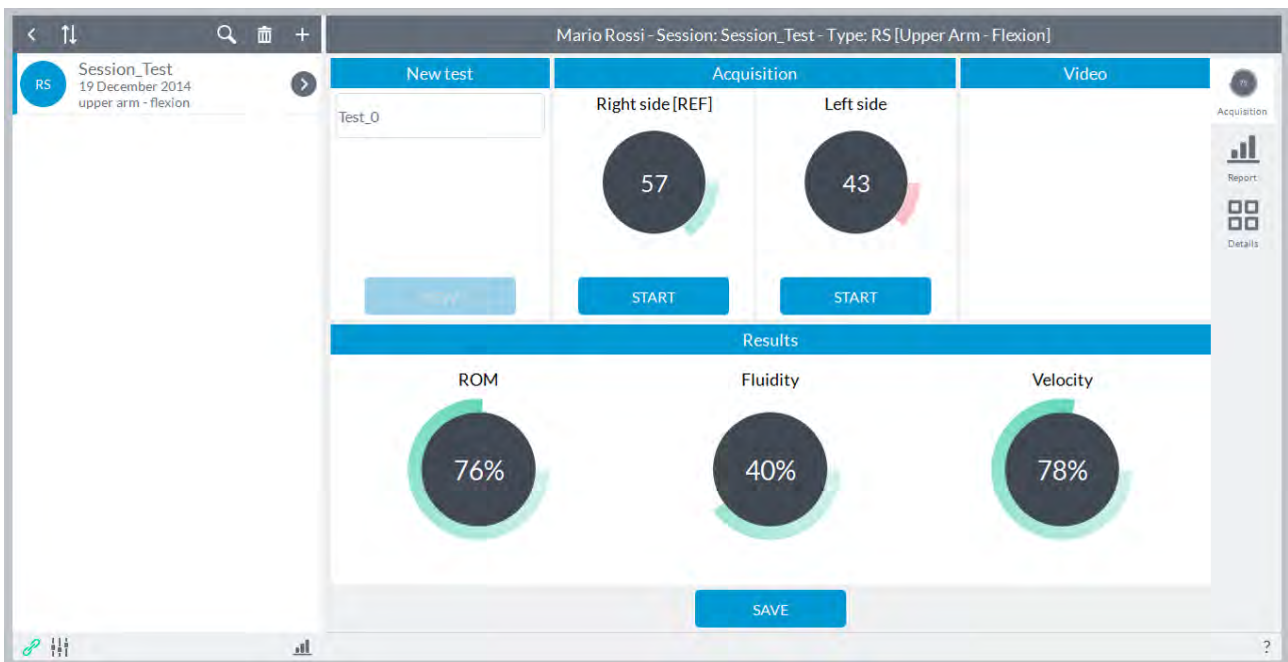


After completing the acquisition, the software automatically re-enable both keys "**Start**" if you want to repeat the acquisition of joint motion just turning or want to go to the acquisition on the other limb:



Now the user must remove the device and fix it on the contralateral (in the example image on the left) and, as described above, start capturing by pressing the start button acquisition in the other box (in this case "**Left Side**").

At the end of the movement of the contralateral, the user must press the button "**Stop**" to end the acquisition. After pressing this button, the software will automatically show a comparison between the two limbs. The comparison will be a percentage of the limb that we have chosen as a reference to the creation of the session (in this case the "**Right**"):



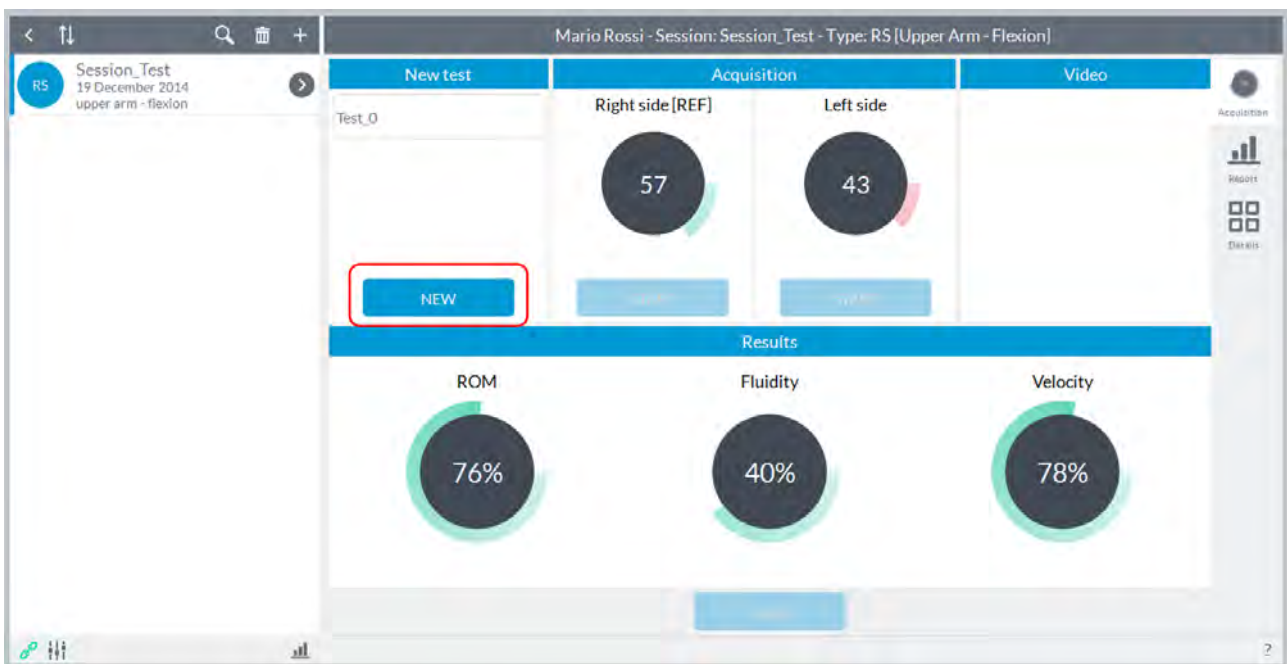
The comparison is represented in terms of angular excursion, fluidity of movement and speed of execution. A value of 100% represents the performance obtained from the limb of the reference (in this case the "**Right**").

**ATTENTION:** Of course you can also obtain values higher than 100% because it is possible that the limb of reference has obtained a performance lower than the contralateral. In the case reported here, for example, if the left limb had executed a larger movement of the right and consequently the ROM had been increased, the first percentage, representative precisely the ROM, would be greater than 100%.

In case the ROM of a joint is much greater than the contralateral, this could result in a greater duration of the motion only in virtue of the fact that the ROM is increased. For this reason, the duration of the movement is compared to equal ROM obtained: for example, if the ROM of the joint left was 60° against the right side of the joint 120°, the duration of the movement of the right side is considered until the ROM obtained from the joint left.

After completing the acquisition of the movement of both limbs, the **"Save"** button at the bottom center will be activated and the user can record the test or it can repeat the test by pressing one of two buttons to start acquisition **"Start"**.

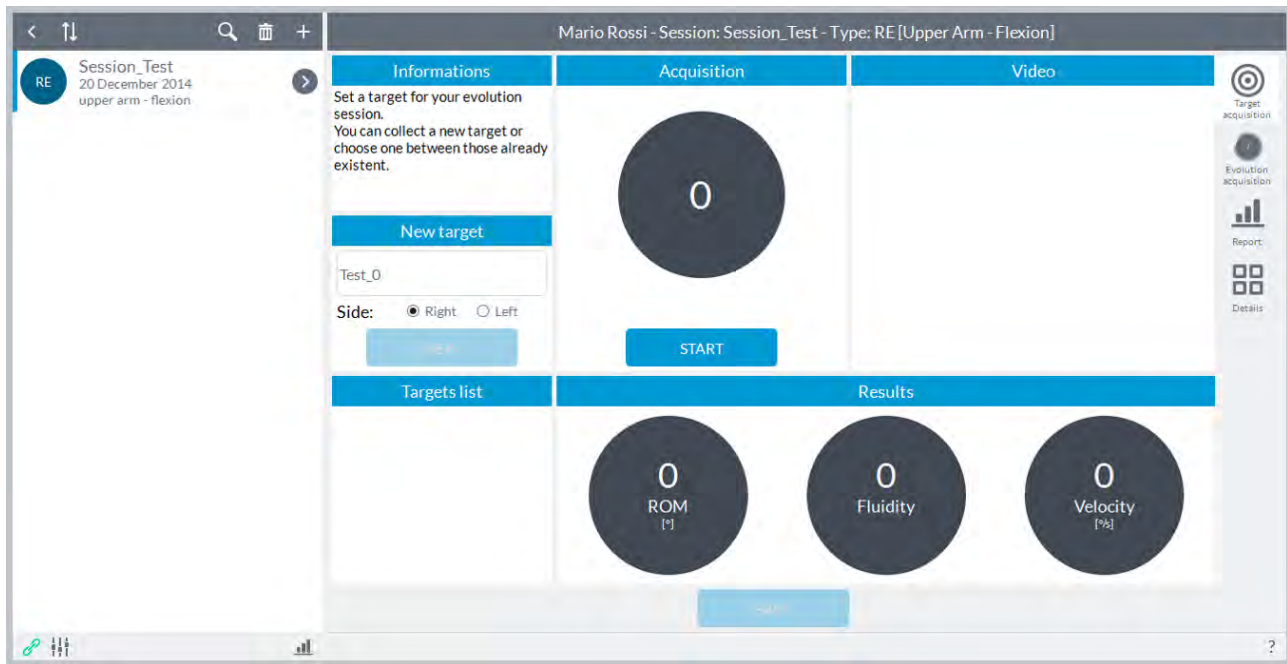
After pressing the **"Save"** button, the results for the test just made will be saved and will reactivate the **"New"** button:



Pressing the **"New"** button will reset the values and will be reactivated the two keys **"Start"** to proceed with a new acquisition.

### 6.3.6 ROM EVOLUTION

Recording a session of **"ROM Evolution"** will see the following screen:



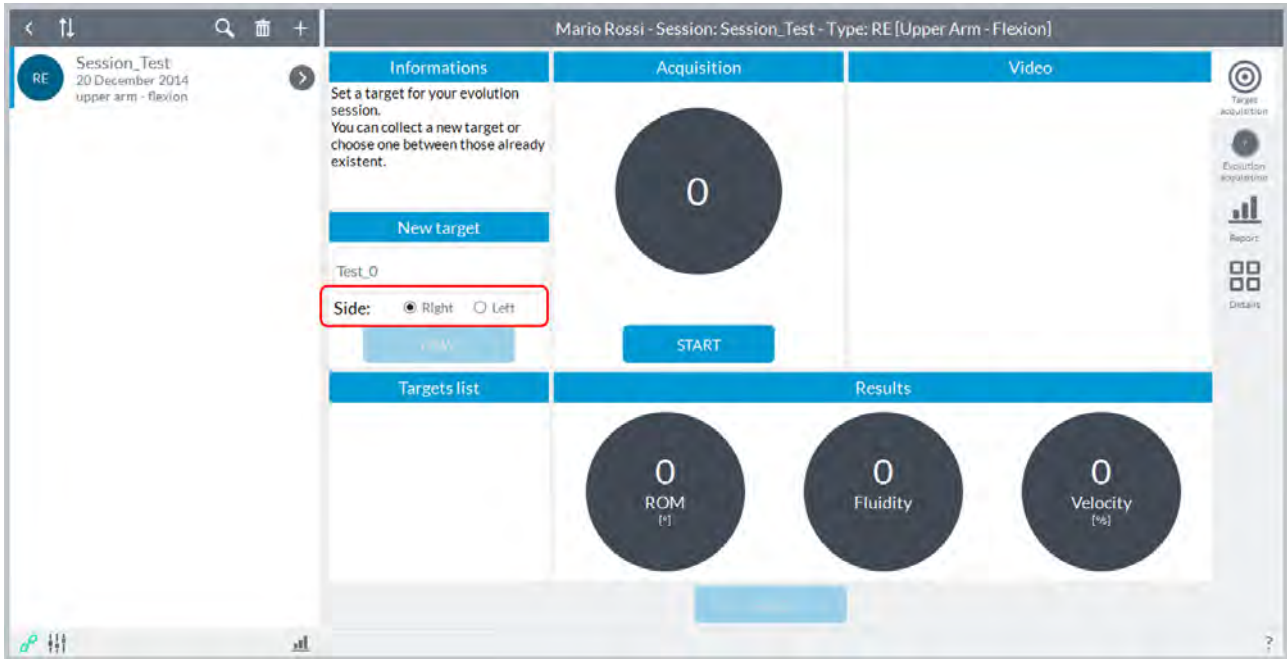
The user can enter notes in the "New Test" in the upper left (this will be shown as a label for the year in view of the results in report mode and details) is set as the default name of the test "Test\_0" with increasing numbering subsequent tests.

The aim of this module is to evaluate deficits mobility compared to a target and monitor, during the time, the evolution of the recovery from the selected target. The target, for example, can be the value of the articulation of the contralateral healthy or can be a test recorded before an accident. The second case is the reason why, creating a session of "Evolution" with the same segment and the same movement, the software automatically imports also tests eventually performed previously in a similar session of "Symmetry". The same logic is applied to the sessions "Strength".

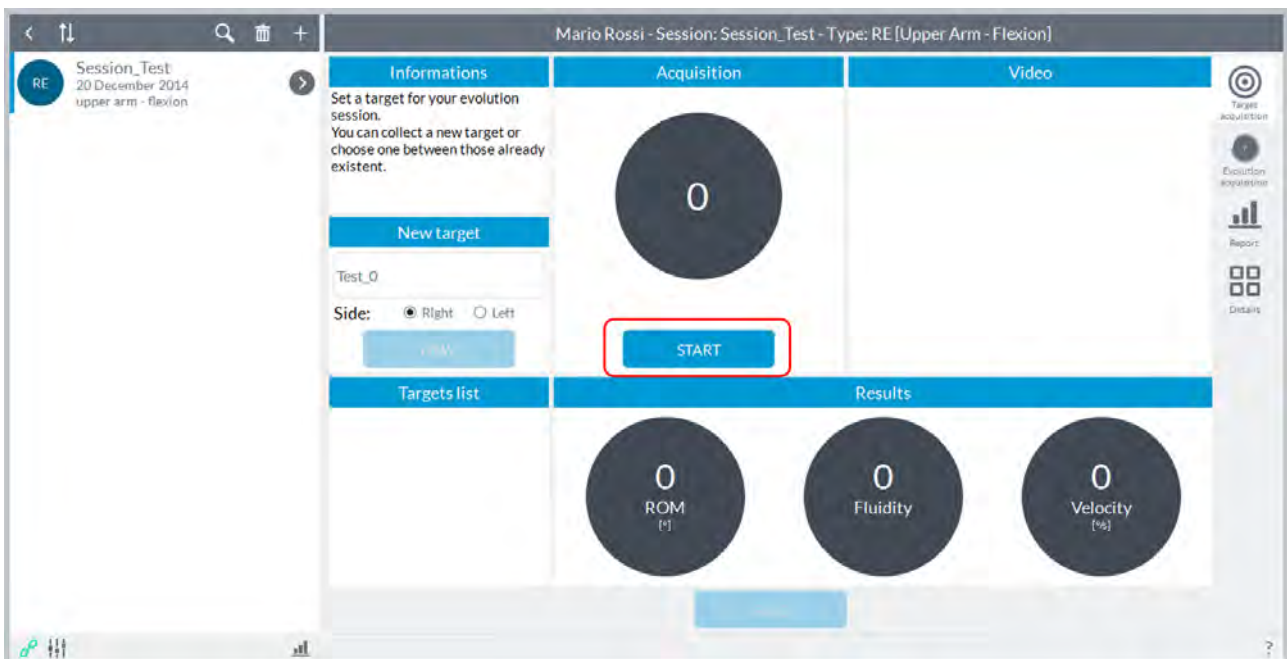
Prior to testing, position the unit within its hardware support (elastic band) and secure the stand on the applicable segment according to the articulation you want to evaluate.

Refer to [Appendix A](#) to have a reference to where to place the device and how to perform the movements as a function of the degrees of freedom which will be analyzed for a given articulation.

Once the subject is ready, before starting the acquisition ensure that the body segment on which the device has been placed is stationary. At this point you have to select which limb you are referring to the acquisition by choosing between "Right" or "Left" at the top:

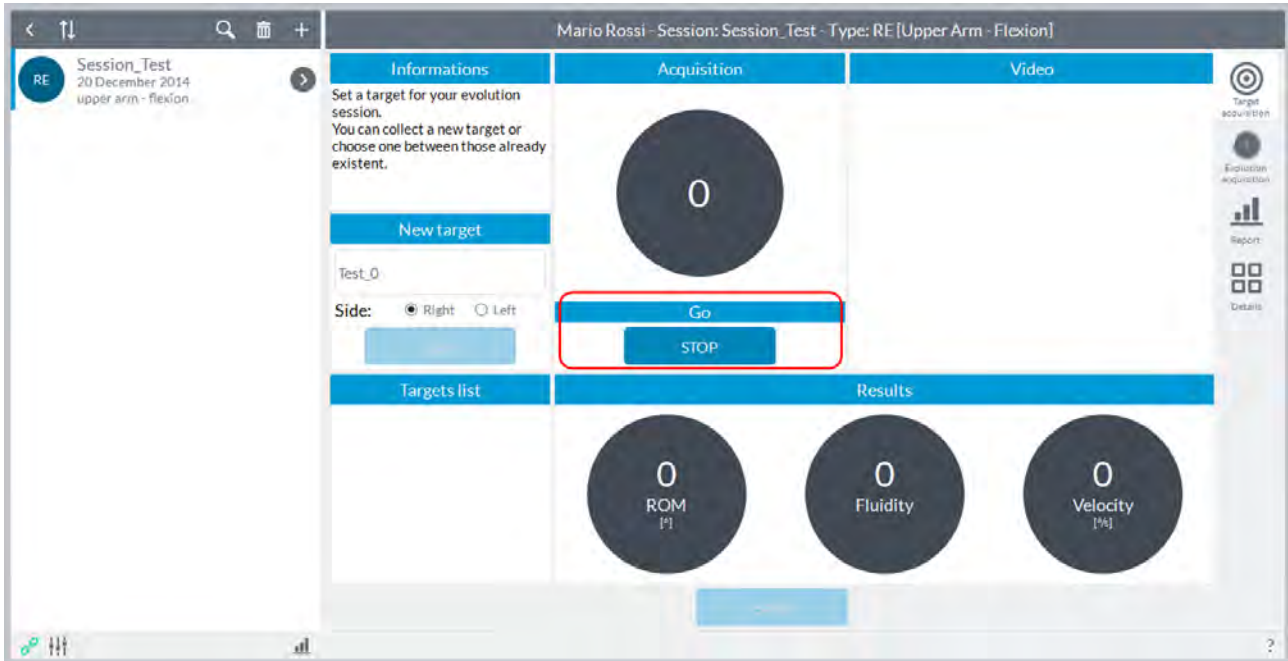


Now the user pressing the start acquisition "**Start**" can begin the subject that can perform the predetermined movement as soon as the software will give an acoustic signal ("Beep"), at the same time will show an indication "**Go**" above the button "**Start**":

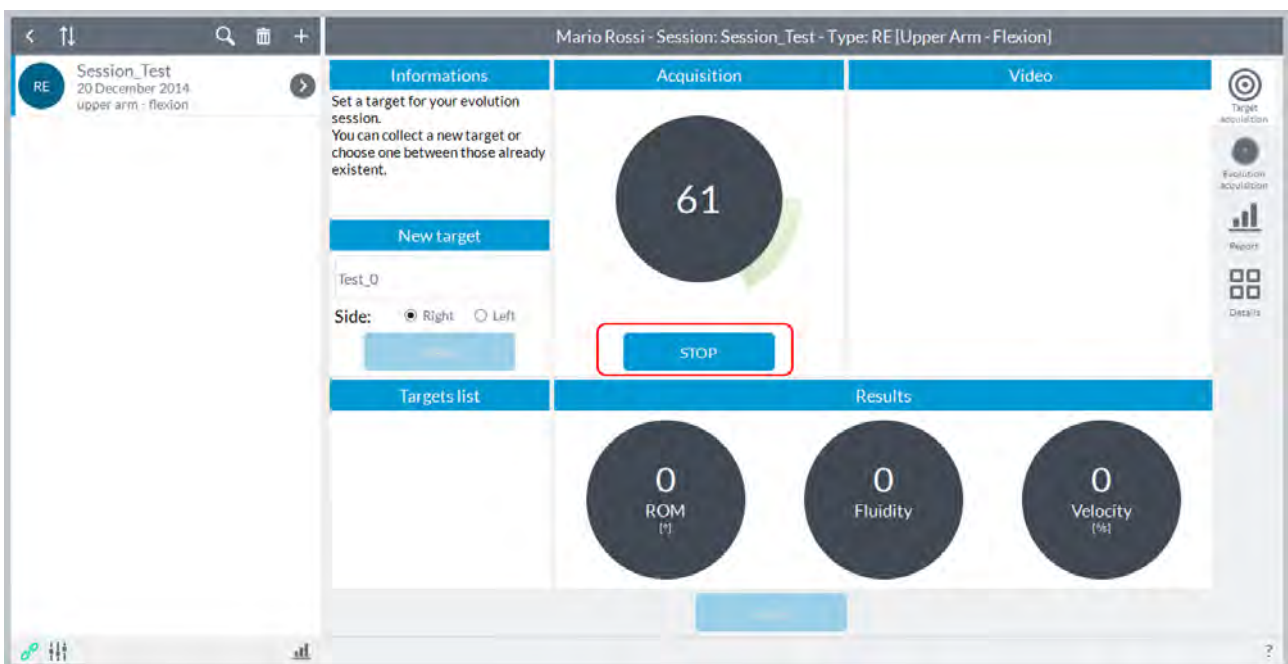


**NOTE:** the acoustic signal will be generated only if the software identifies a initial static phase, that is, if the subject keeps holding the segment on which the device is placed before starting to perform the movement. If the "**Start**" button is pressed while the subject is even slightly moving the segment, the software will wait until the segment is completely stopped before giving the acoustic signal.

At the acoustic signal the "**Start**" button will change its state automatically to "**Stop**":

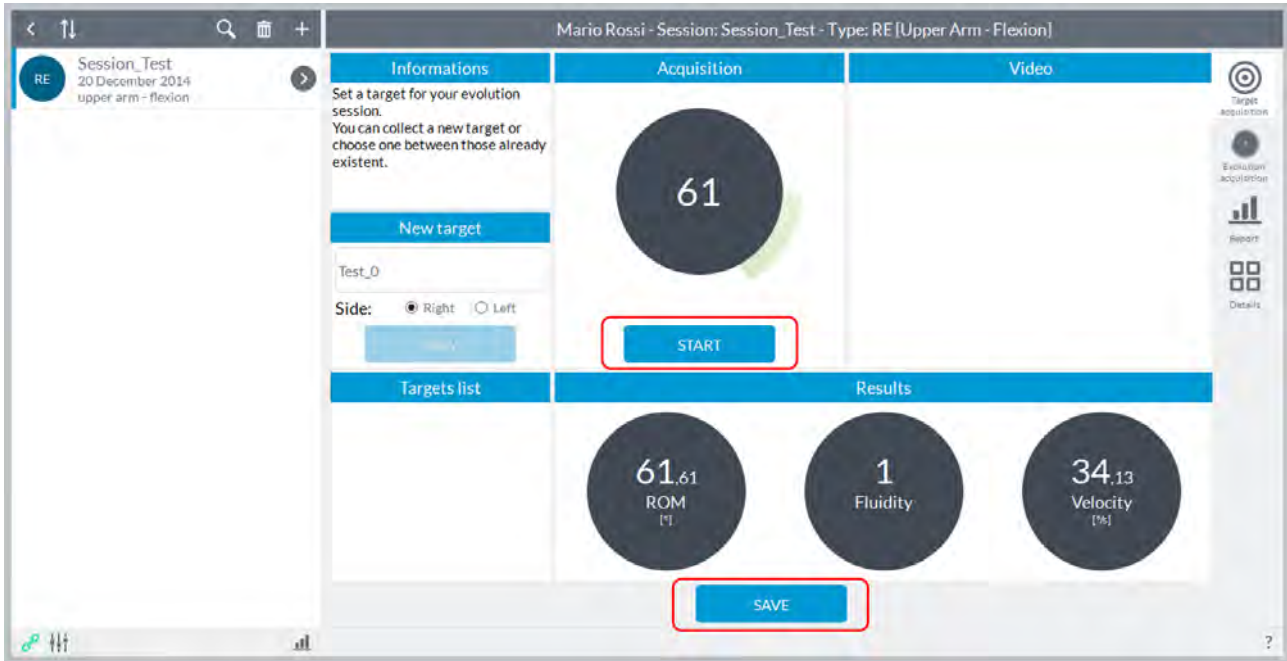


In the box will be shown in real time the ROM (in degrees). When the subject has finished moving, the user must press the button "**Stop**" which is activated after starting the acquisition:

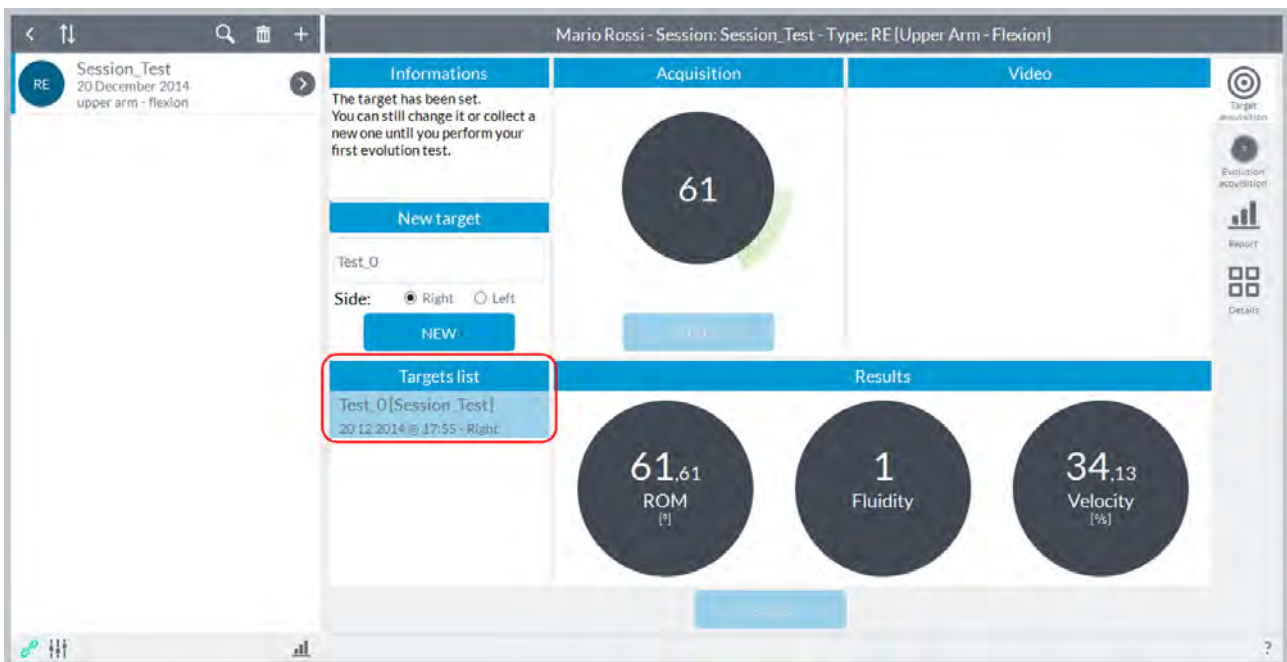


The results will be represented in terms of angular excursion, fluidity of movement and speed of execution. After completing the acquisition, the software automatically re-enable the "**Start**" button in case you want to repeat the acquisition of joint motion just turning and the "**Save**" button to record the target:





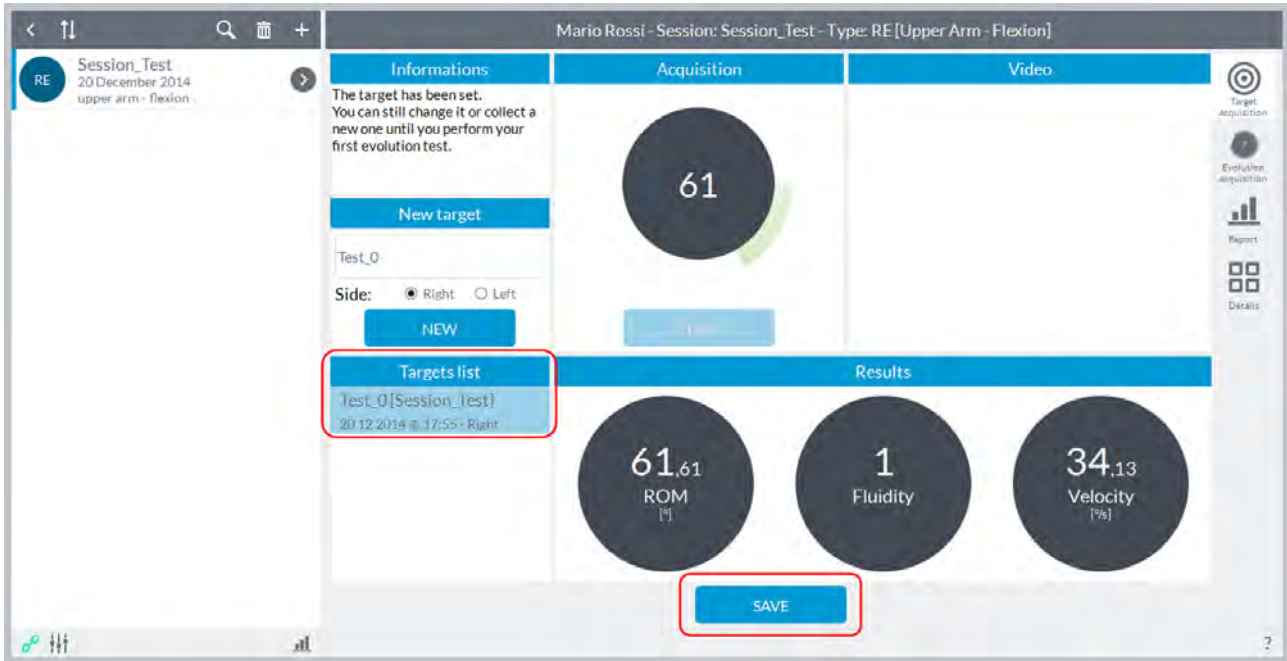
Pressing on "**Save**" the test will be stored and will fill the column "**Targets List**" on the left where they will be given the name of the test, the session in which the target has been performed, the date, time, and the reference of limb "**Right**" or "**Left**":



At the same time it will activate the "**New**" button that will reset the values and allow you to make a new test rehabilitating in turn key "**Start**".

The user can now proceed with the acquisition of new targets by repeating the procedure described above or go to acquire the tests with reference to the target.

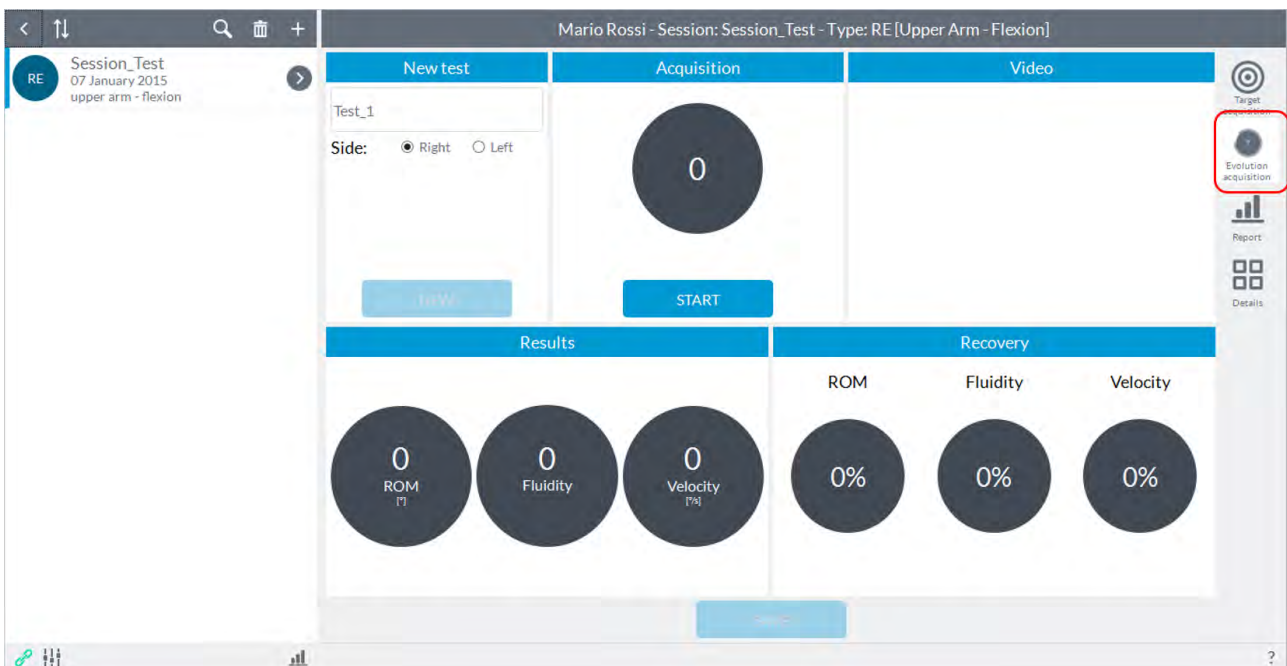
To choose the target, select the test with which you want to compare in the "**Targets List**" by clicking on target and making sure that this is highlighted in blue, at this point also will reactivate the "**Save**" button to record it as a target:



**NOTE:** the software allows you to change the target or acquire new ones even after pressing "Save" till to the moment when you make the first registration in the "Evolution acquisition" described below; in case you were not selected a test as target and had gone directly to the mode "Evolution acquisition" software store as target the last test in chronological order in the "Target List".

**ATTENTION:** you can switch to "Evolution acquisition" only after acquiring at LEAST one target.

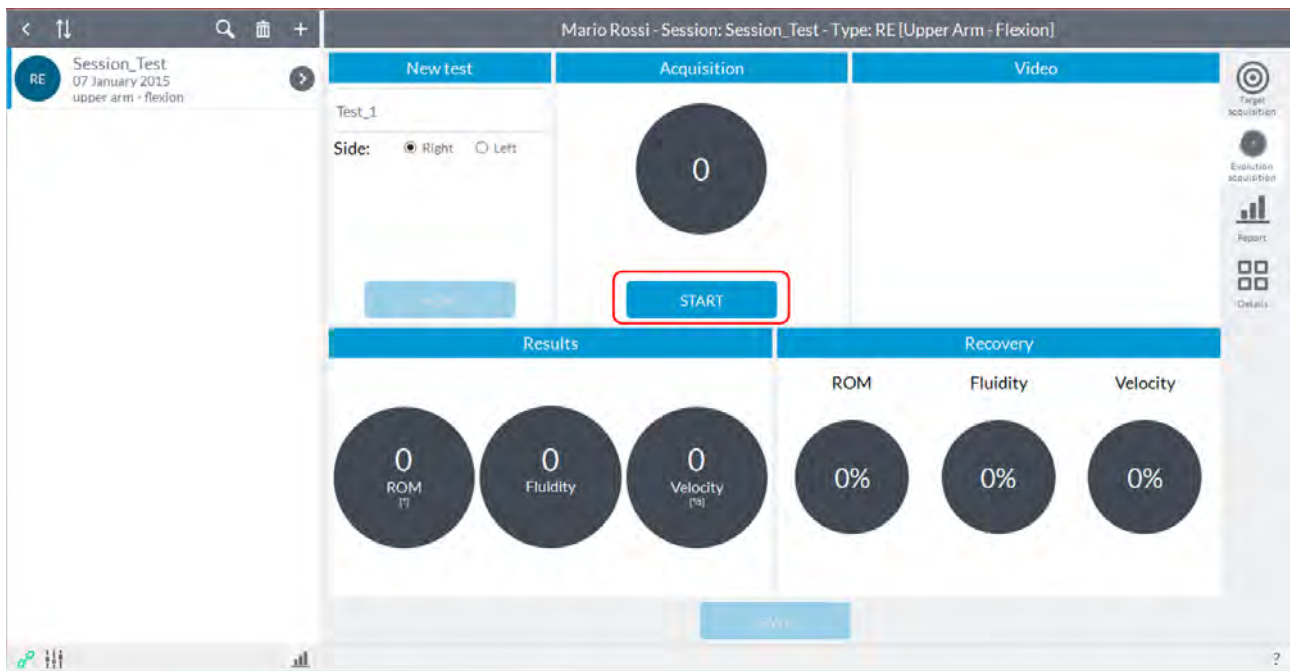
To move to the phase comparison test with the selected target you must click on the second icon (from the top) at the top right and it will open a new window:



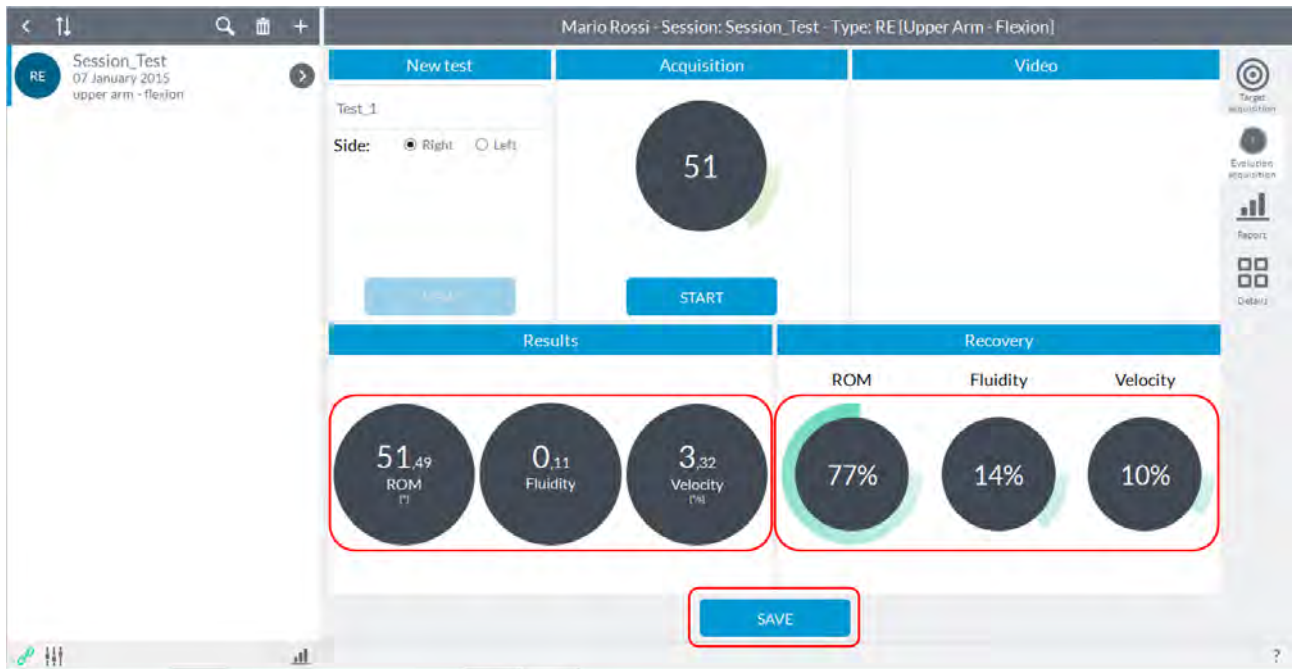
At this point, removing and repositioning the device and selecting the limb between "Right" and "Left", the user can to perform to the subject the exercise with the same limb or with the

contralateral limb according to the type of investigation of interest and then compare the test with the target.

Once the subject is ready, before starting the acquisition ensure that the body segment on which the device has been placed is stationary. At this point the user can press the button to start acquisition "**Start**" located in box of the segment of investigation and give the start to the subject (the user will see an indication of "**Go**" on the "**Start**" button) that can perform the predetermined movement as soon as the software will give an audible signal ("**beep**"):

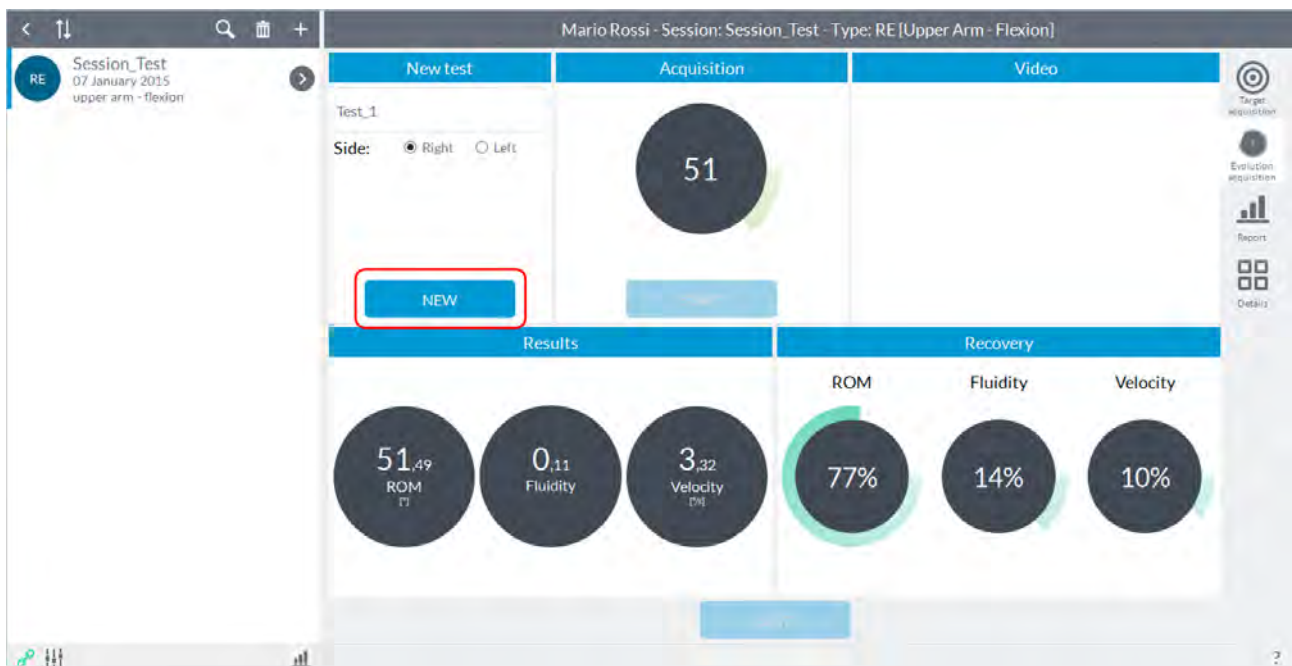


After finishing the execution by the subject and press the button "**Stop**" appeared in place of the "**Start**" after the beep, you will see the results of the exercise in the bottom left and the comparison, in percentage, with the target down to the right; simultaneously will activate the "**Save**" button to store the test:



At this point the user can save the test or repeat it pressing on “Start”.

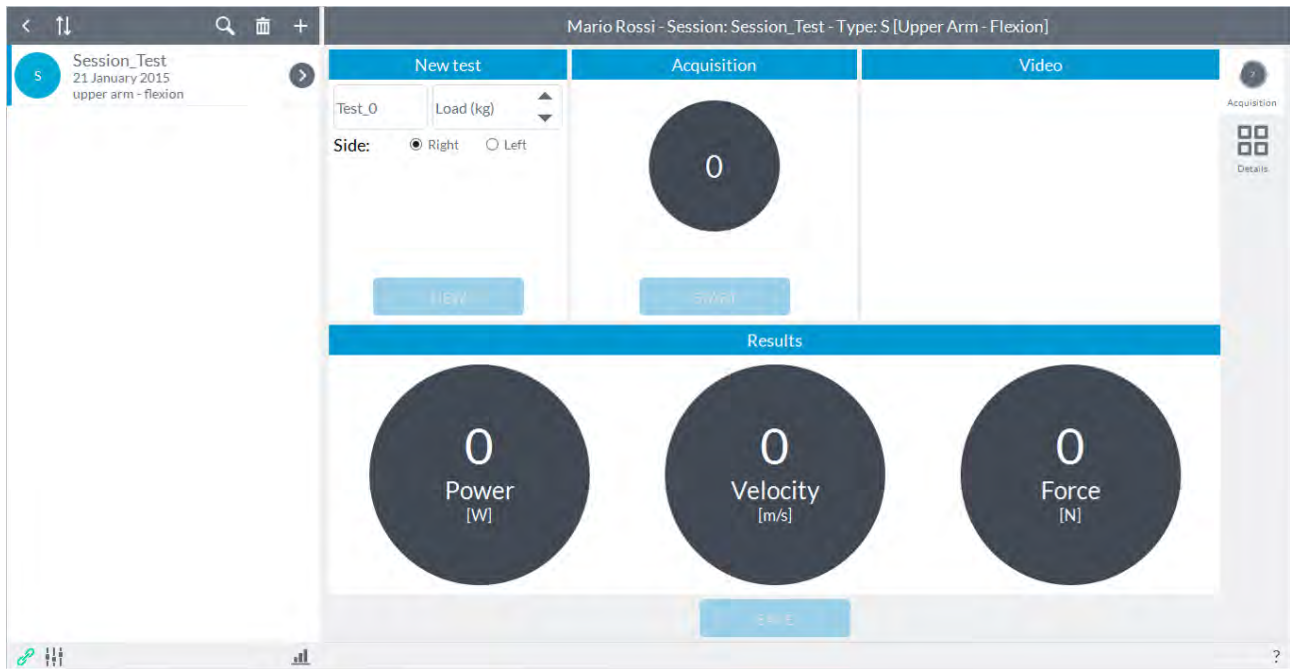
Pushing on “Save” the test will record and the button “New” will be activated:



Pressing on “New” all the values will be reset and the button “Start” will be activated and you can continue with a new acquisition.

### 6.3.7 STRENGTH

Recording a session of "STRENGTH" will see the following screen:



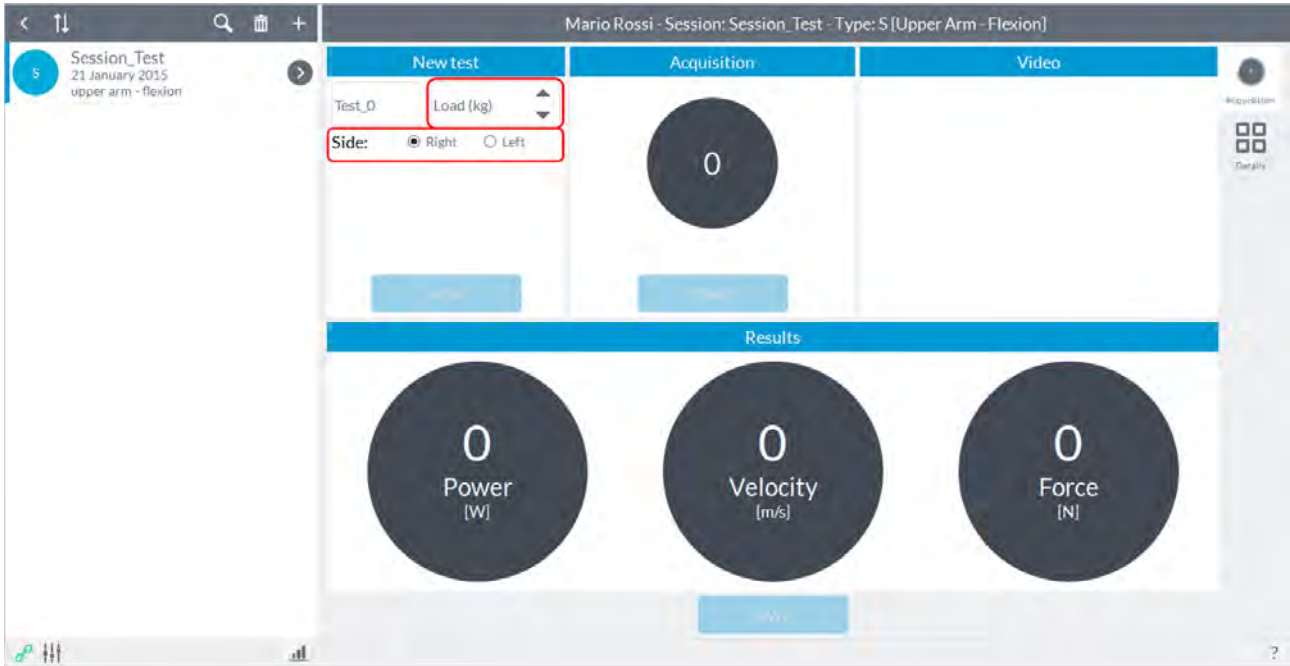
The user can enter notes in the "New Test" in the upper left (this will be shown as a label for the year in view of the results in report mode and details) is set as the default name of the test "Test\_0" with increasing numbering subsequent tests.

The aim of this module is to assess the muscle strength of a limb of the subject in terms of muscle power, velocity of the movement and muscle force. Prior to testing, position the unit within its hardware support (elastic band) and secure the stand on the applicable segment according to the articulation you want to evaluate.

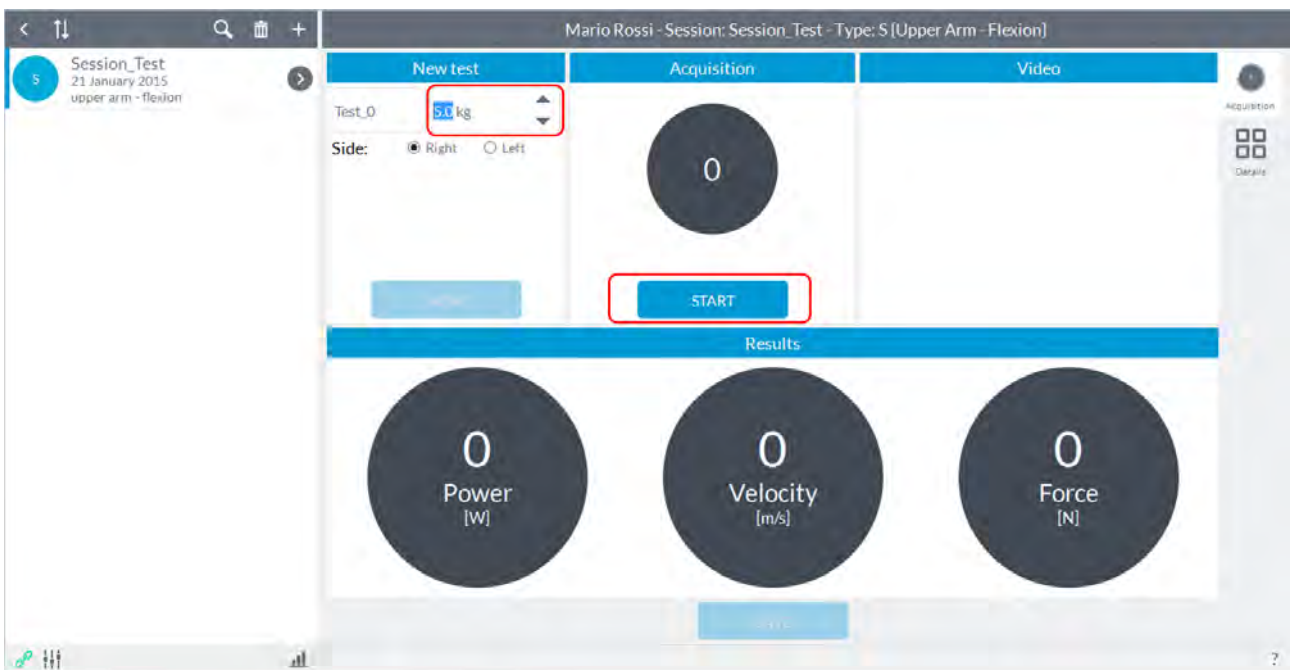
Refer to [Appendix A](#) to have a reference to where to place the device and how to perform the movements as a function of the degrees of freedom which will be analyzed for a given articulation.

Once the subject is ready, before starting the acquisition ensure that the body segment/weight stack on which the device has been placed is stationary.

At this point you need to select the load you are using for the test in the window "Load" at the top using the arrows or by typing the value directly and select the "Side" you are going to evaluate between "Right" and "Left":



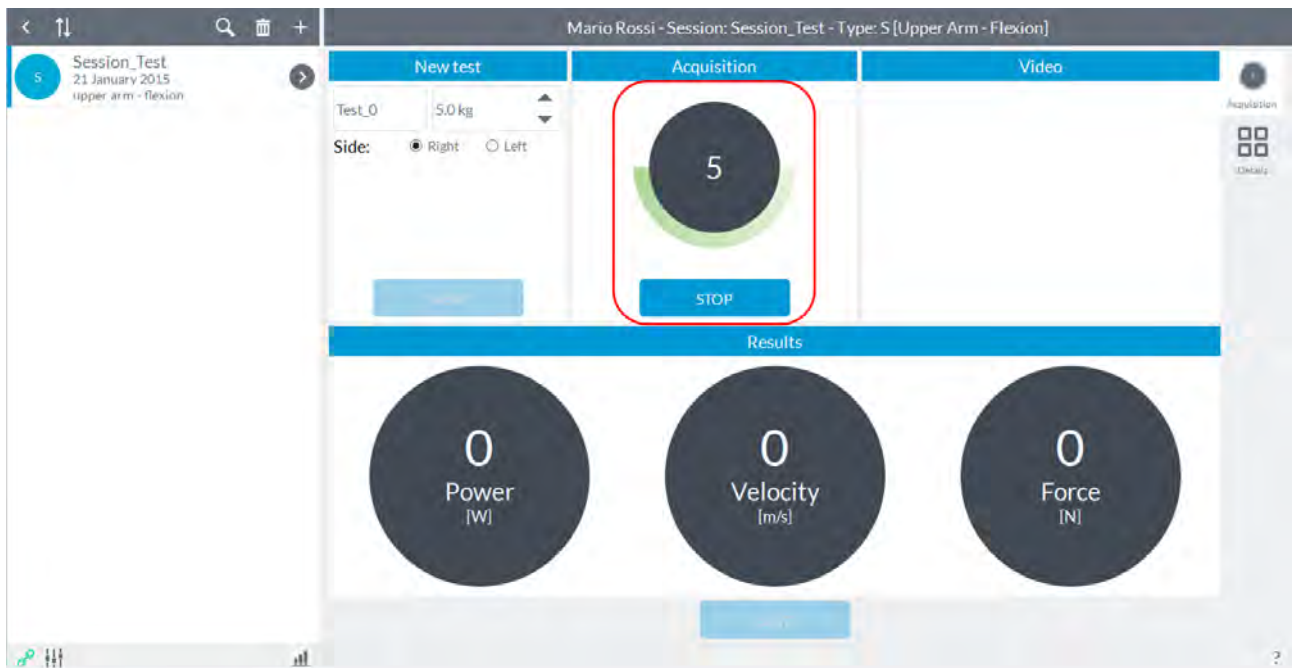
**NOTE:** Only after selecting the load for testing will be activated both keys "Start" to acquire the test.



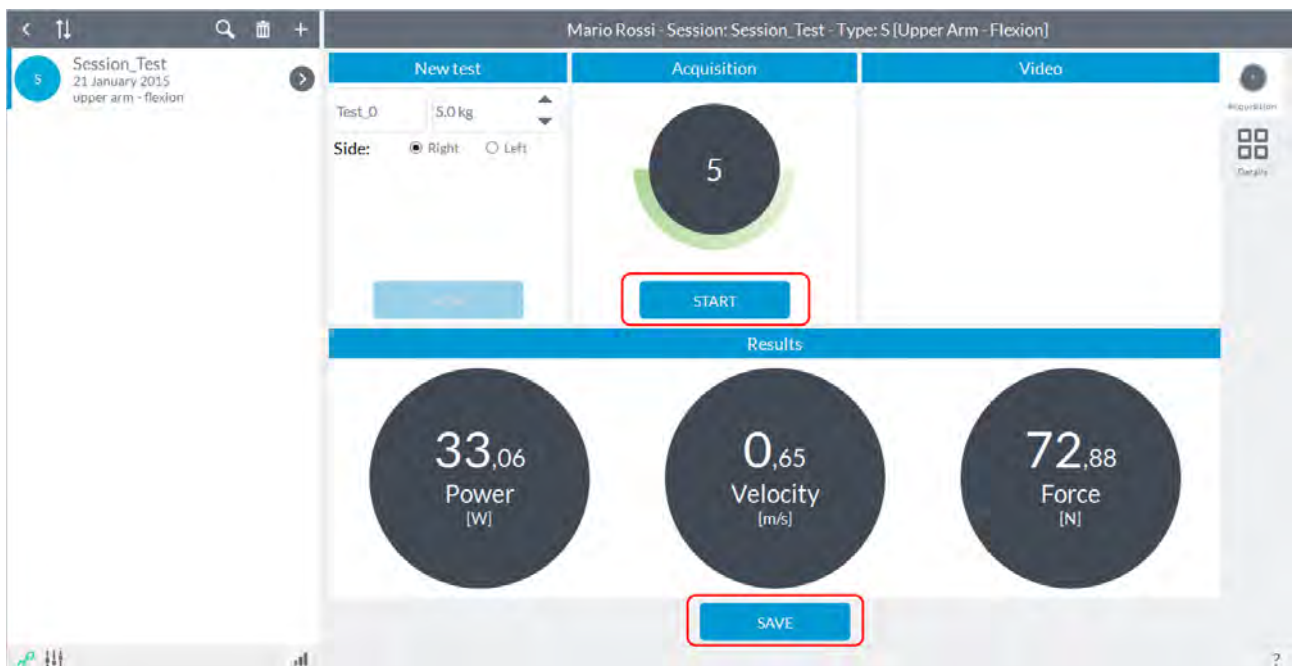
At this point the user can press the button to start acquisition "**Start**" and give the start to the subject (the user will see an indication of "Go" on the "Start" button) that can perform the predetermined movement as soon as the software will give an audible signal ("beep").

**NOTE:** the acoustic signal will be generated only if the software identifies a initial static phase, that is, if the subject keeps holding the segment on which the device is placed before starting to perform the movement. If the "Start" button is pressed while the subject is even slightly moving the segment, the software will wait until the segment is completely stopped before giving the acoustic signal.

In the box will be shown in real time the number of repetitions performed. When the subject has finished running of the movement, the user must press the button "Stop" which is activated after starting the acquisition:

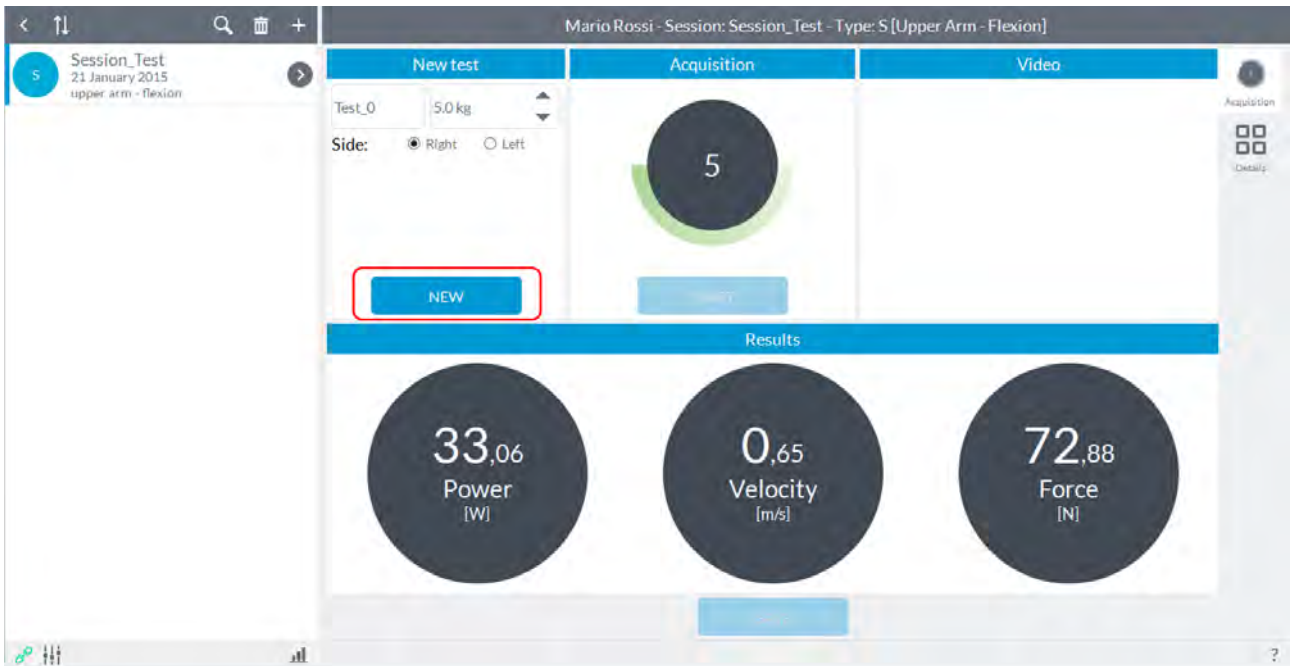


After completing the acquisition, the software simultaneously activate the "Save" button to save the test just ended and re-enable the "Start" button in case you want to repeat the acquisition of joint motion just ended, or switch acquisition on the other limb, in these cases the test data just ended will not saved:



In the box below will be shown the values in terms of muscle power, velocity of the movement and muscle force.

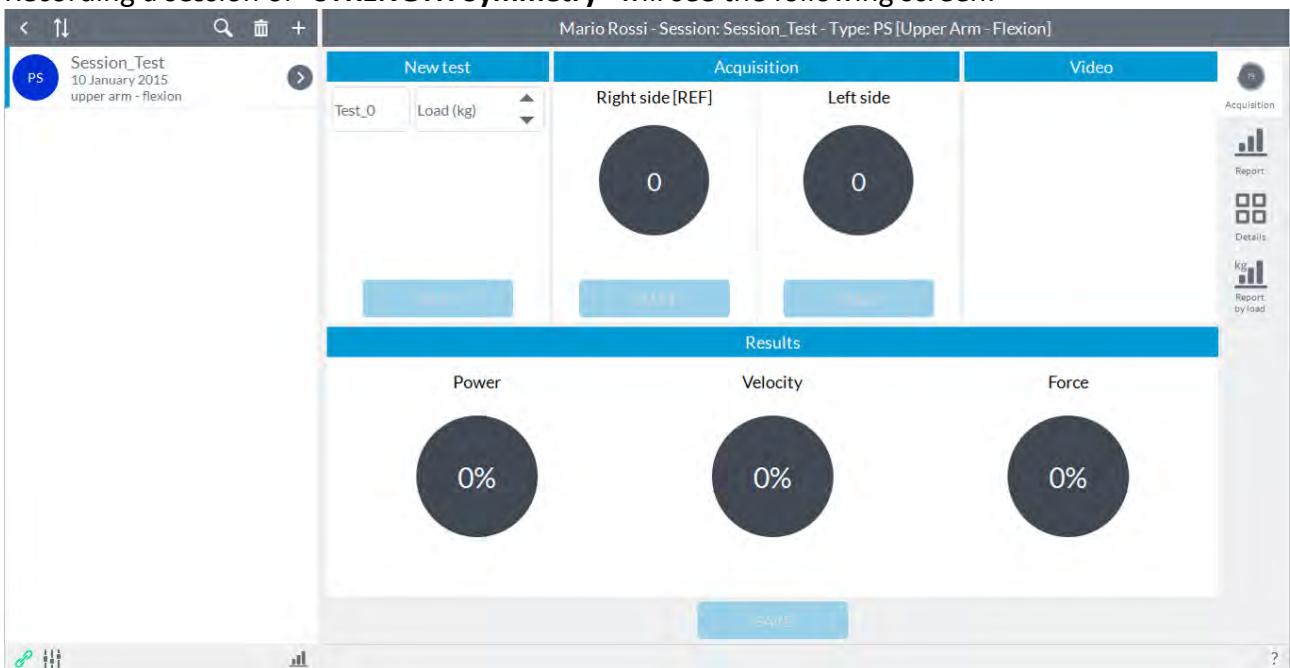
After pressing the "Save" button, the results for the test just made will be saved and will reactivate the "New" button:



Pressing the "New" button will reset the values and will be reactivated the two keys "Start" to proceed with a new acquisition.

### 6.3.8 STRENGTH SYMMETRY

Recording a session of "STRENGTH Symmetry" will see the following screen:





The user can enter notes in the "New Test" in the upper left (this will be shown as a label for the year in view of the results in report mode and details) is set as the default name of the test "Test\_0" with increasing numbering subsequent tests.

The aim of this module is to assess any deficit between right limb and left limb or just make an initial screening of muscle strength of the subject.

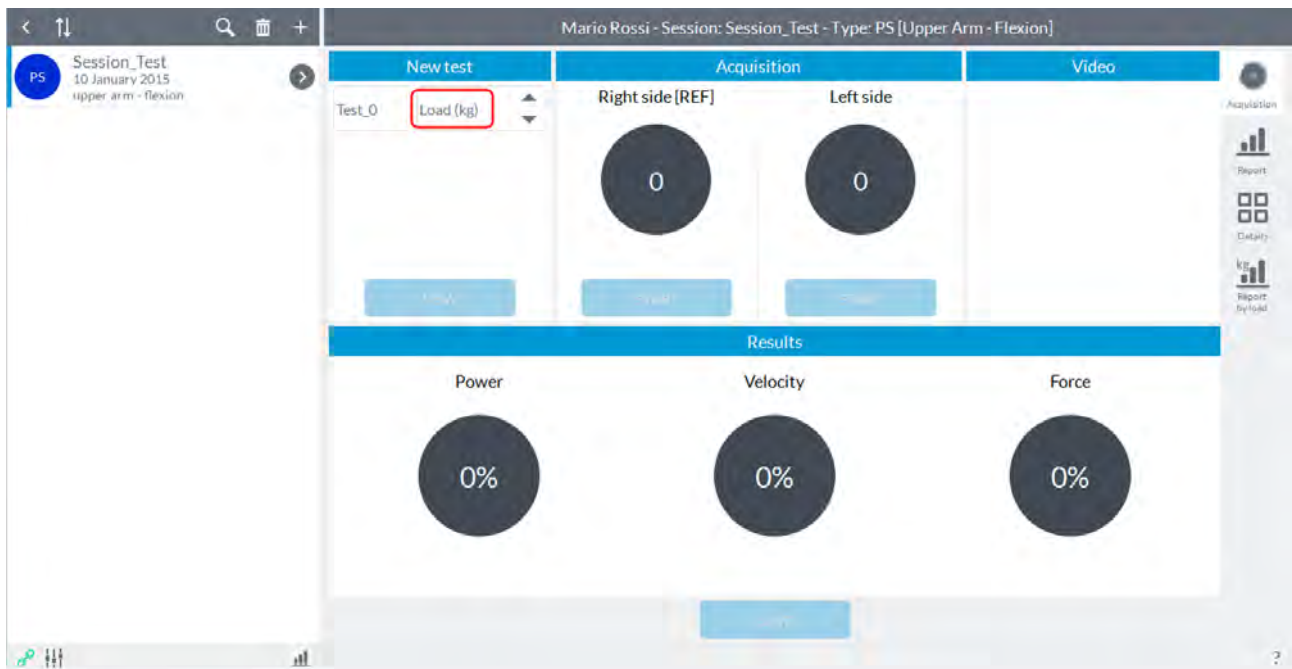
Prior to testing, position the unit within its hardware support (elastic band) and secure the stand on the applicable segment according to the articulation you want to evaluate.

Refer to [Appendix A](#) to have a reference to where to place the device and how to perform the movements as a function of the degrees of freedom which will be analyzed for a given articulation.

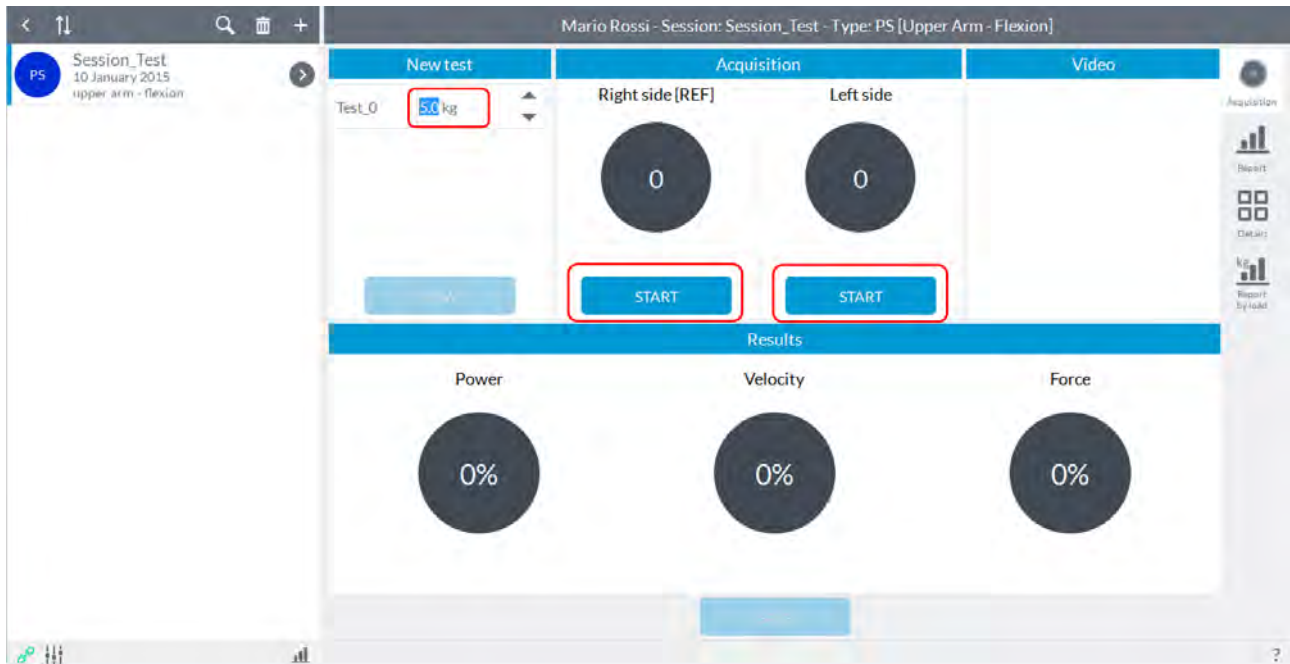
**NOTE:** you can start the acquisition with the right limb or with the left limb.

Once the subject is ready, before starting the acquisition ensure that the body segment/weight stack on which the device has been placed is stationary.

At this point you need to select the load you are using for the test in the window "Load" at the top using the arrows or by typing the value directly:



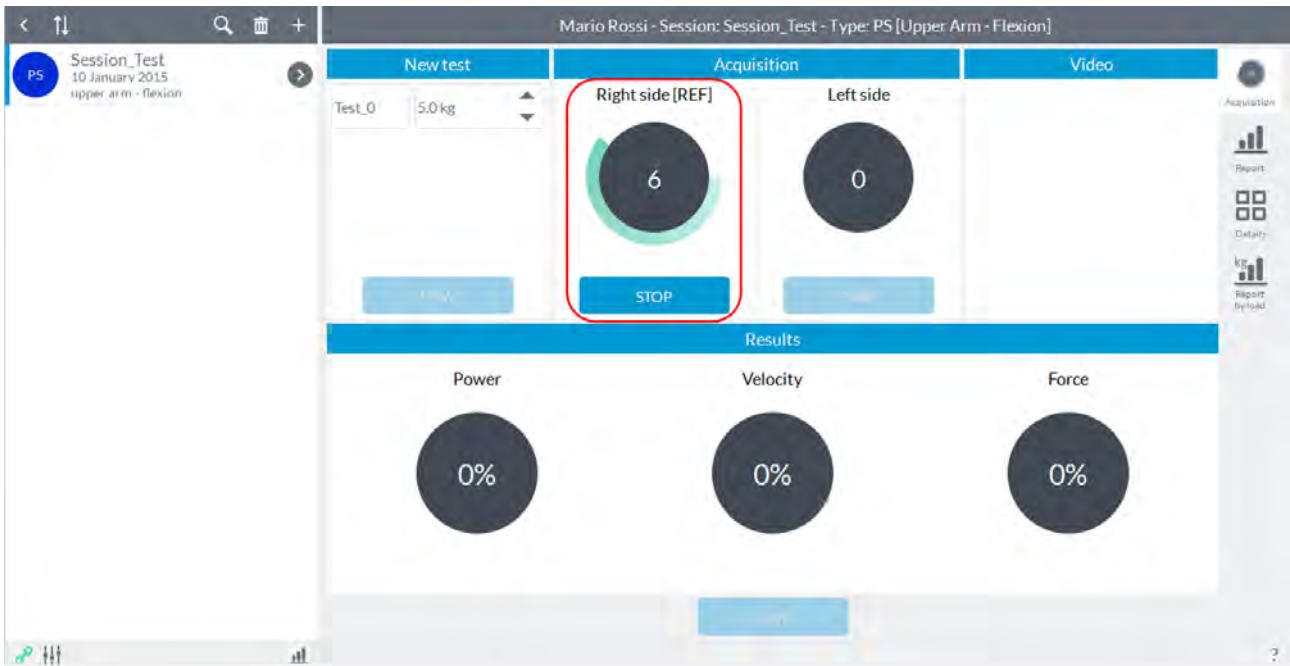
**NOTE:** Only after selecting the load for testing will be activated both keys "Start" to acquire the test.



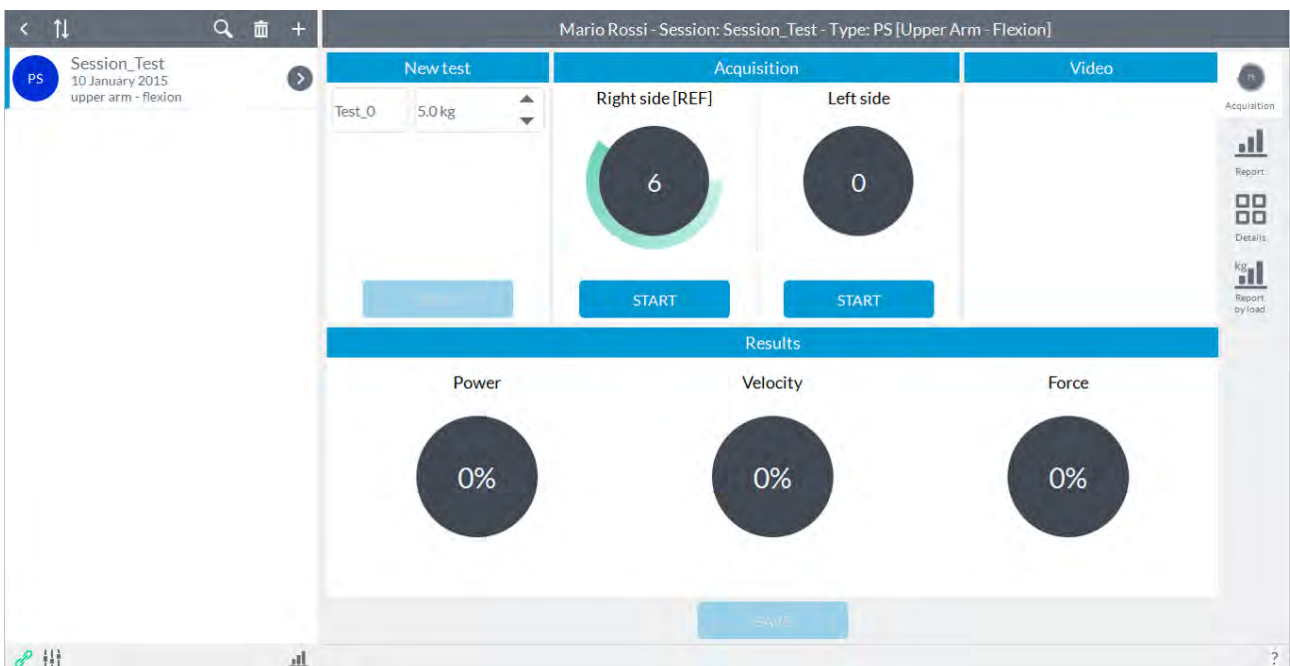
At this point the user can press the button to start acquisition "**Start**" located in box of the segment of investigation and give the start to the subject (the user will see an indication of "**Go**" on the "**Start**" button) that can perform the predetermined movement as soon as the software will give an audible signal ("beep").

**NOTE:** the acoustic signal will be generated only if the software identifies a initial static phase, that is, if the subject keeps holding the segment on which the device is placed before starting to perform the movement. If the "**Start**" button is pressed while the subject is even slightly moving the segment, the software will wait until the segment is completely stopped before giving the acoustic signal.

In the box will be shown in real time the number of repetitions performed. When the subject has finished running of the movement, the user must press the button "**Stop**" which is activated after starting the acquisition:

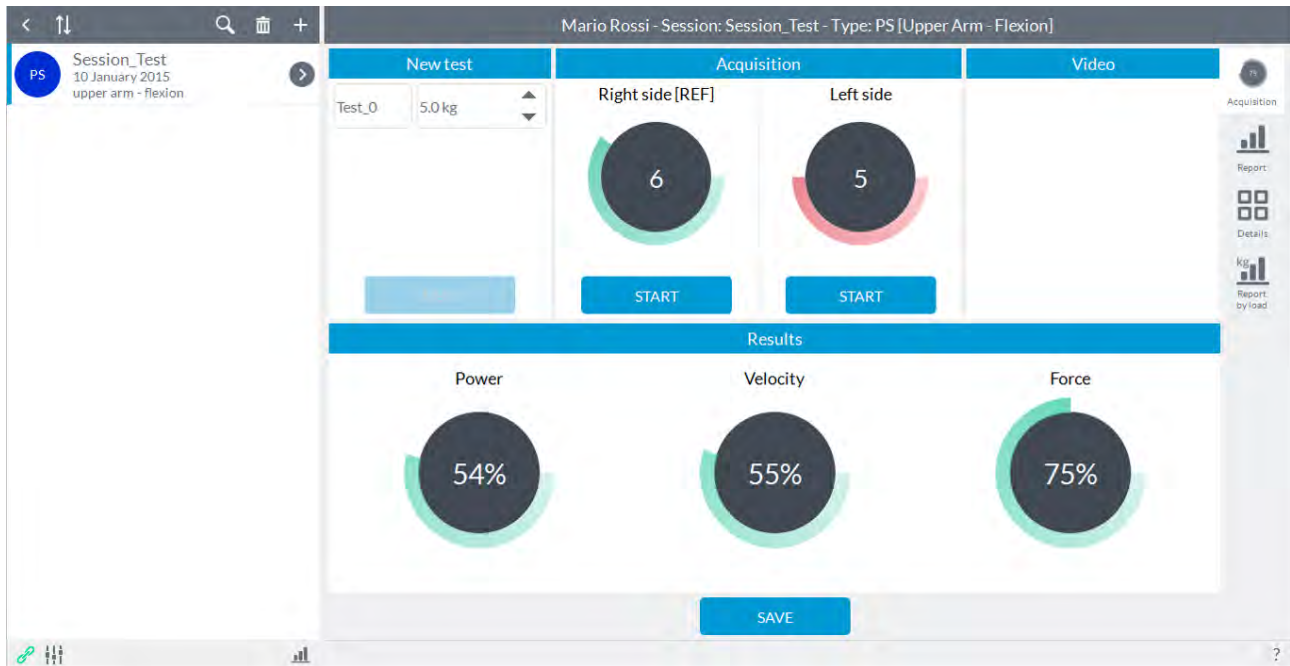


After completing the acquisition, the software automatically re-enable both keys "**Start**" if you want to repeat the acquisition of joint motion just turning or want to go to the acquisition on the other limb:



Now the user must remove the device and fix it on the contralateral (in the example image on the left) and, as described above, start capturing by pressing the start button acquisition in the other box (in this case "**Left Side**").

At the end of the movement of the contralateral, the user must press the button "**Stop**" to end the acquisition. After pressing this button, the software will automatically show a comparison between the two limbs. The comparison will be a percentage of the limb that we have chosen as a reference to the creation of the session (in this case the "**Right**"):



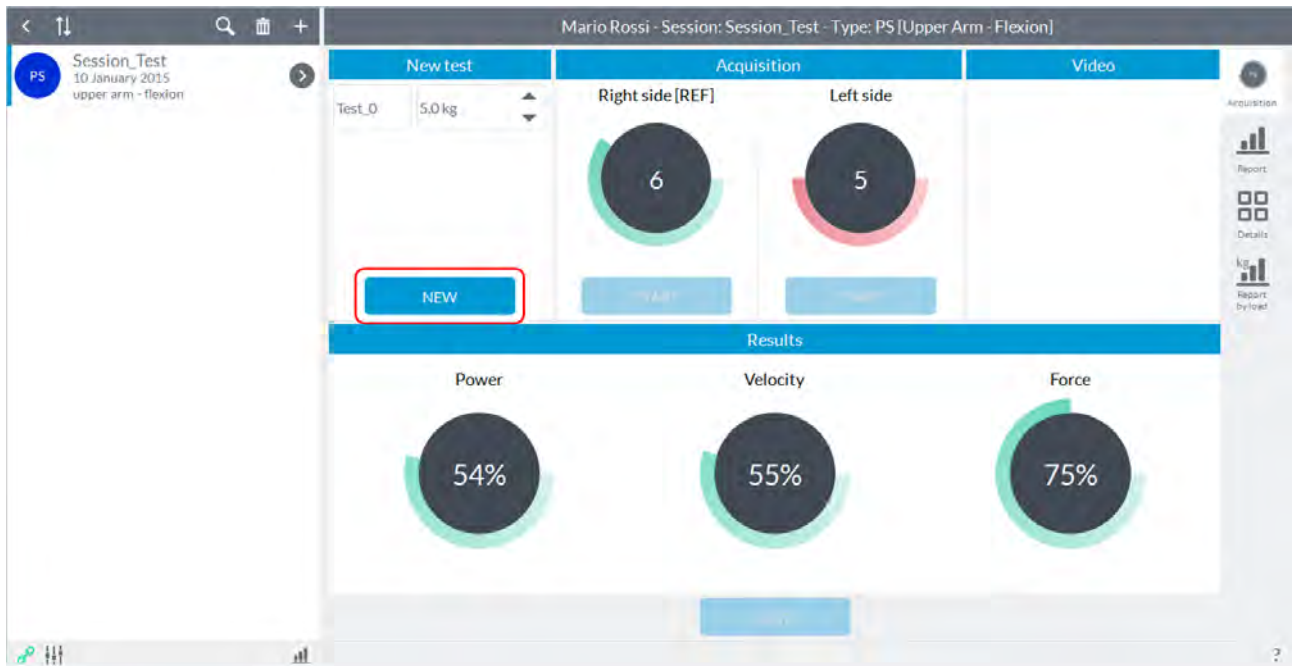
The comparison is represented in terms of muscle power, speed of movement and muscle force. A value of 100% represents the performance obtained from the limb of the reference (in this case the "Right").

**ATTENTION:** Of course you can also obtain values higher than 100% because it is possible that the limb of reference has obtained a performance lower than the contralateral.

In the case where the number of repetitions of a joint is much greater than the joint contralateral, this could result in a greater duration of the motion only in virtue of the fact that the number of repetitions is greater. For this reason, the duration of the movement is compared to the same number of repetitions obtained: for example, if the number of repetitions of the joint left was 5 against 9 of the right side, the duration of the movement of the right is considered up to the number of repetitions obtained from the joint left.

After completing the acquisition of the movement of both limbs, the "Save" button at the bottom center will be activated and the user can record the test or it can repeat the test by pressing one of two buttons to start acquisition "Start".

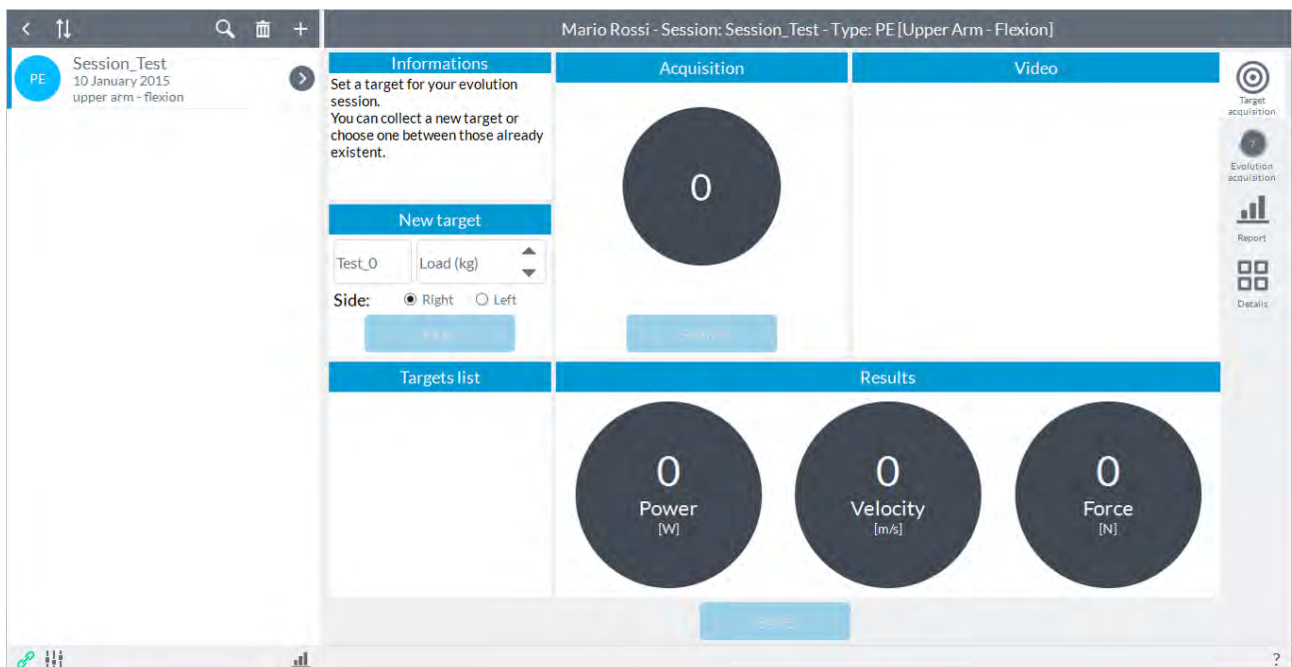
After pressing the "Save" button, the results for the test just made will be saved and will reactivate the "New" button:



Pressing the "New" button will reset the values and will be reactivated the two keys "Start" to proceed with a new acquisition.

### 6.3.9 STRENGTH EVOLUTION

Recording a session of "STRENGTH Evolution" will see the following screen:



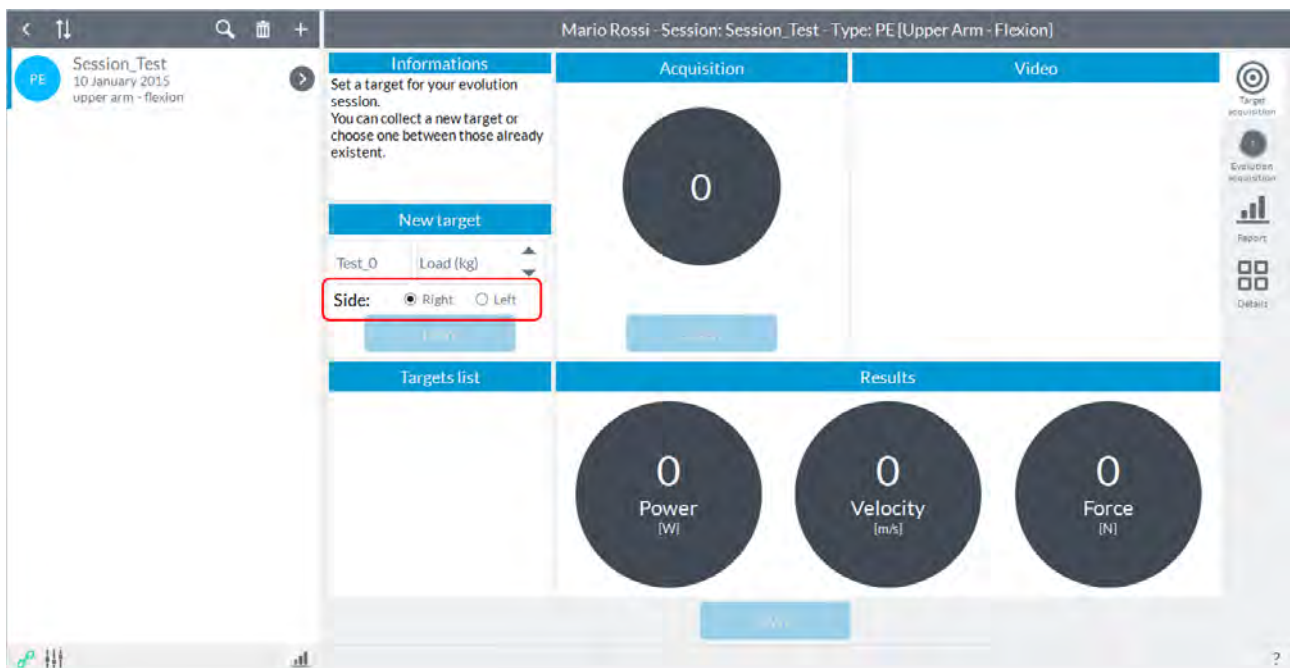
The user can enter notes in the "New Test" in the upper left (this will be shown as a label for the year in view of the results in report mode and details) is set as the default name of the test "Test\_0" with increasing numbering subsequent tests.

The aim of this module is to evaluate deficits of muscle strength compared to a target and monitor, during the time, the evolution of the recovery from the selected target. The target, for example, can be the value of the articulation of the contralateral healthy or can be a test recorded before an accident. The second case is the reason why, creating a session of "**Evolution**" with the same segment and the same movement, the software automatically imports also tests eventually performed previously in a similar session of "**Symmetry**". The same logic is applied to the sessions "**Strength**".

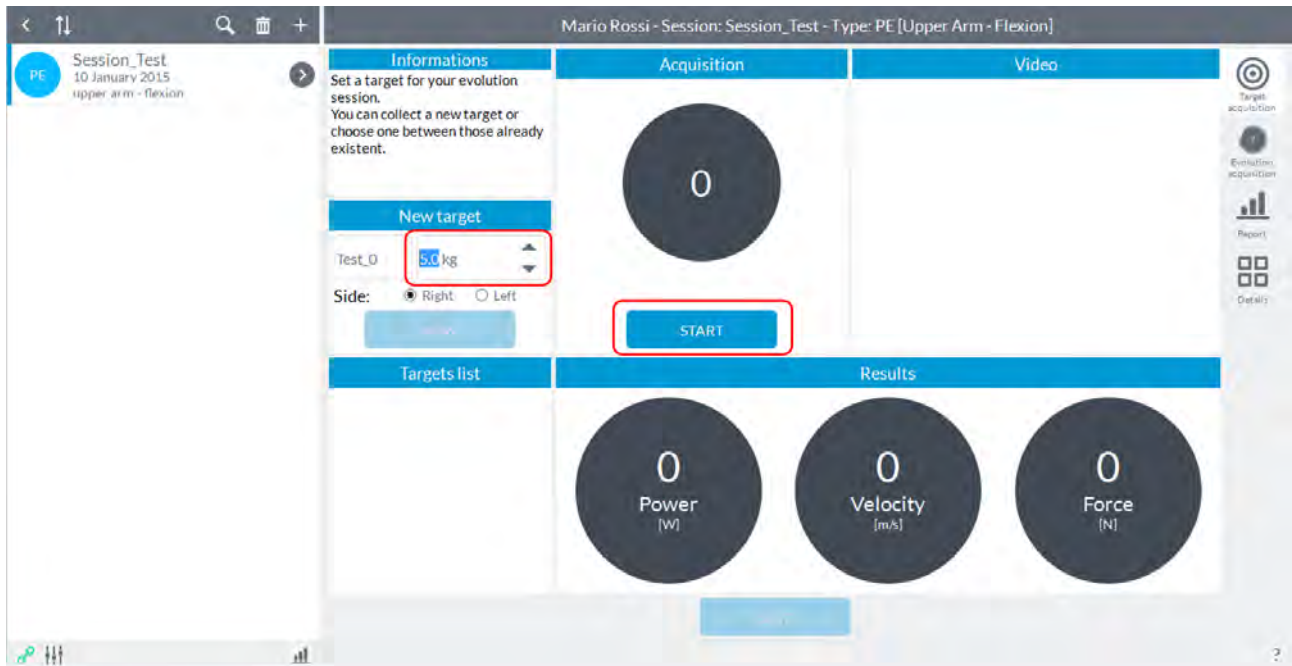
Prior to testing, position the unit within its hardware support (elastic band) and secure the stand on the applicable segment according to the articulation you want to evaluate.

Refer to [Appendix A](#) to have a reference to where to place the device and how to perform the movements as a function of the degrees of freedom which will be analyzed for a given articulation.

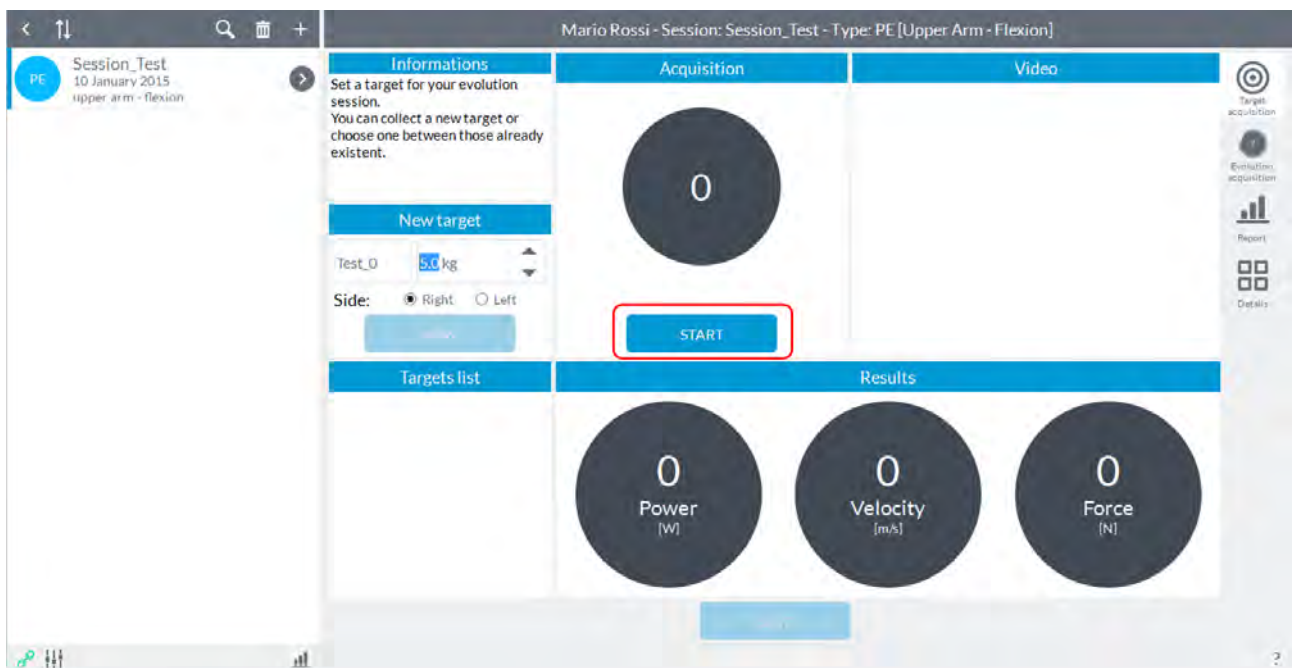
Once the subject is ready, before starting the acquisition ensure that the body segment/weight stack on which the device has been placed is stationary. At this point you have to select which limb you are referring to the acquisition by choosing between "**Right**" or "**Left**" at the top:



To enable the "**Start**" button to start the acquisition is necessary to select the load with which you want to perform the test:

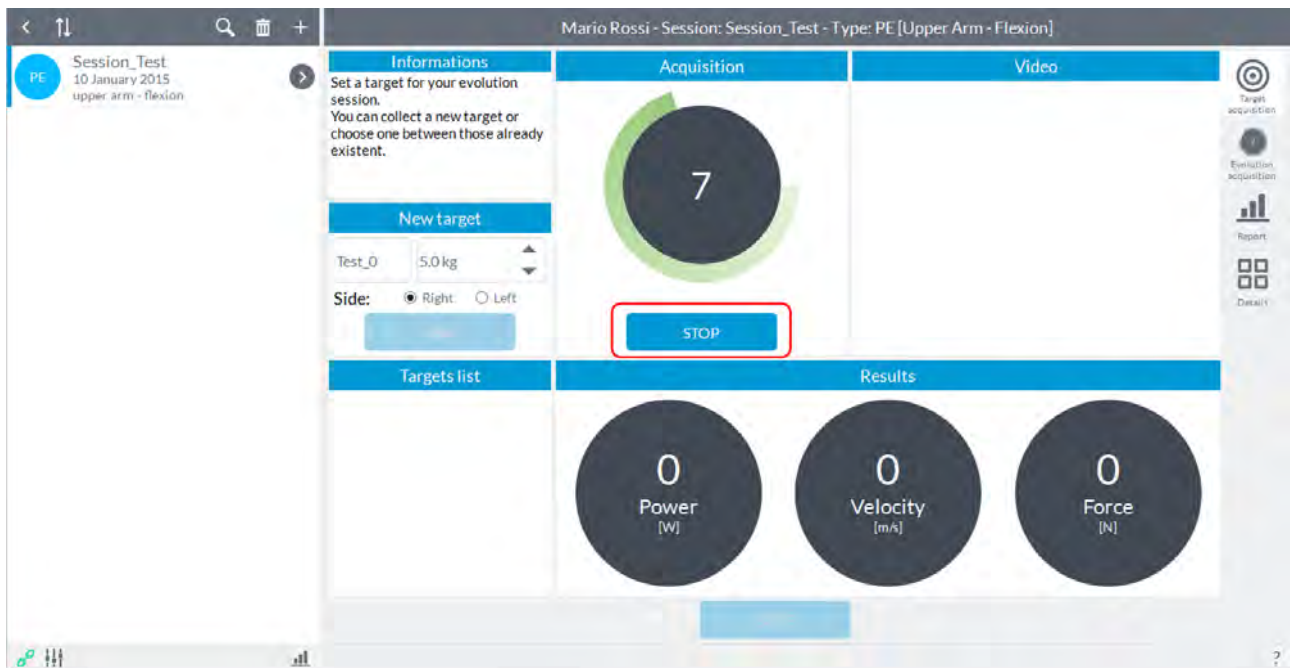


At this point the user can press the button to start acquisition "**Start**" located in box of the segment of investigation and give the start to the subject (the user will see an indication of "**Go**" on the "**Start**" button) that can perform the predetermined movement as soon as the software will give an audible signal ("beep"):

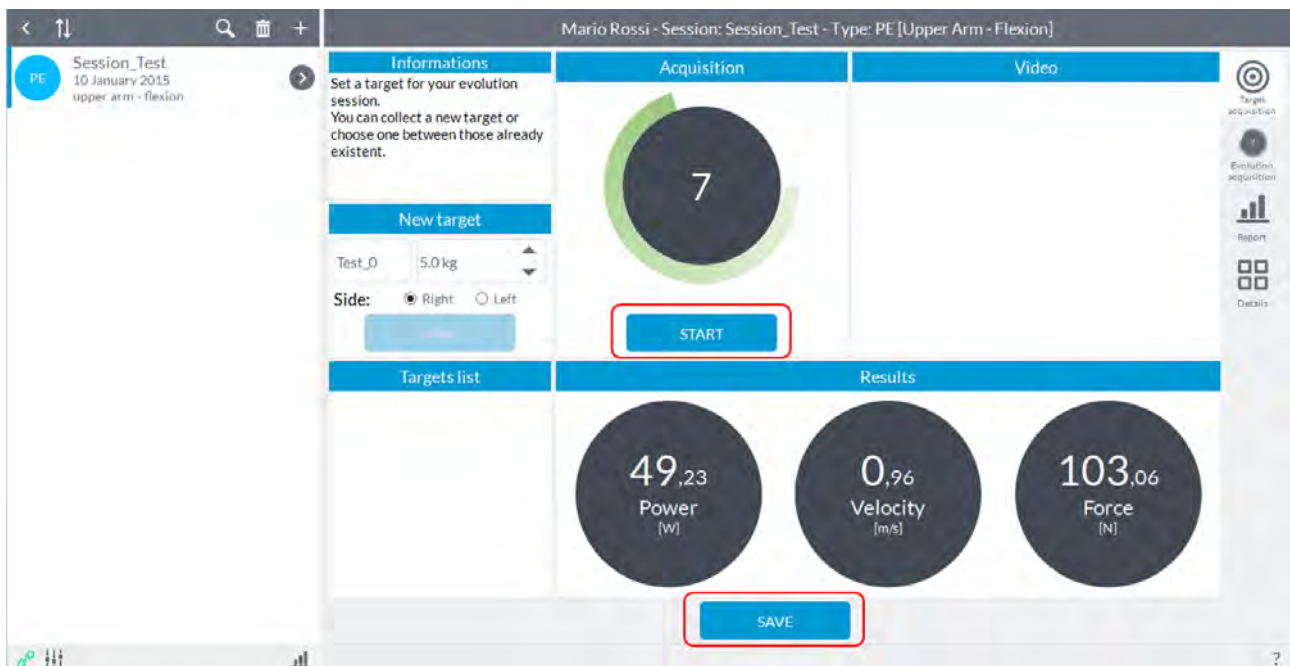


**NOTE:** the acoustic signal will be generated only if the software identifies a initial static phase, that is, if the subject keeps holding the segment on which the device is placed before starting to perform the movement. If the "**Start**" button is pressed while the subject is even slightly moving the segment, the software will wait until the segment is completely stopped before giving the acoustic signal.

In the box will be shown in real time the number of repetitions performed. When the subject has finished running of the movement, the user must press the button "Stop" which is activated after starting the acquisition:

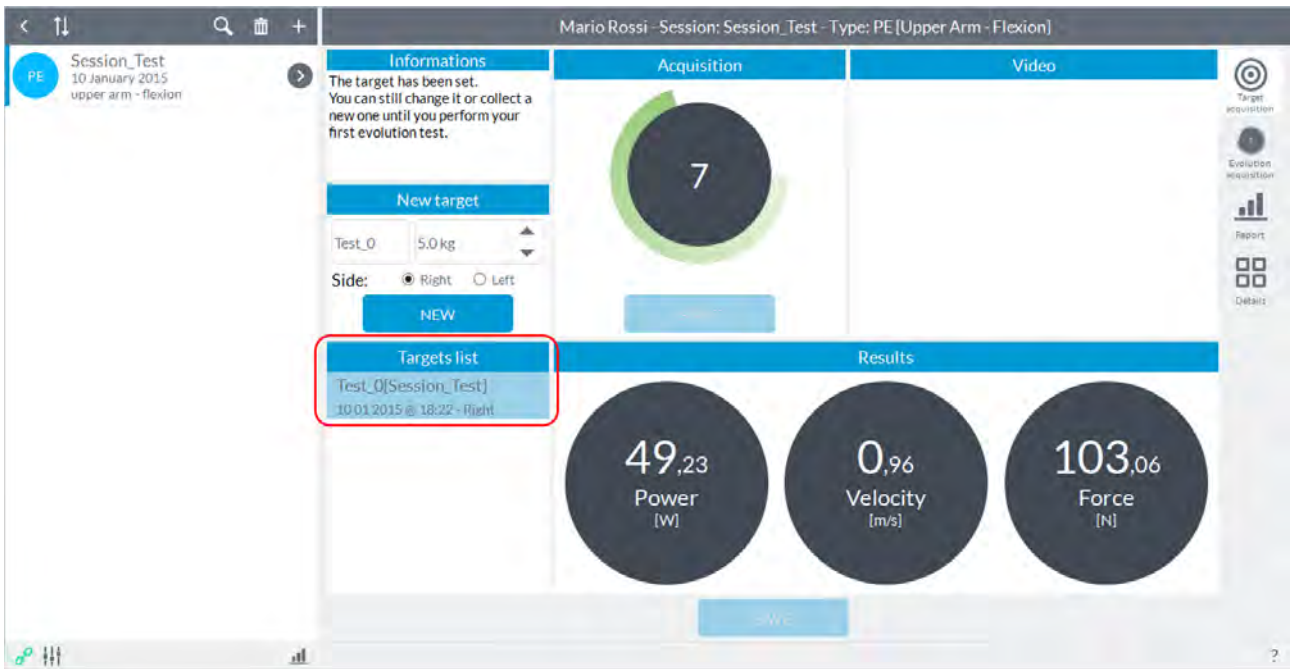


The comparison is represented in terms of muscle power, speed of movement and muscle force. . After completing the acquisition, the software automatically re-enable the "Start" button in case you want to repeat the acquisition of joint motion just turning and the "Save" button to record the target:



Pressing on "Save" the test will be stored and will fill the column "Targets List" on the left where they will be given the name of the test, the session in which the target has been performed, the date, time, and the reference of limb "Right" or "Left":

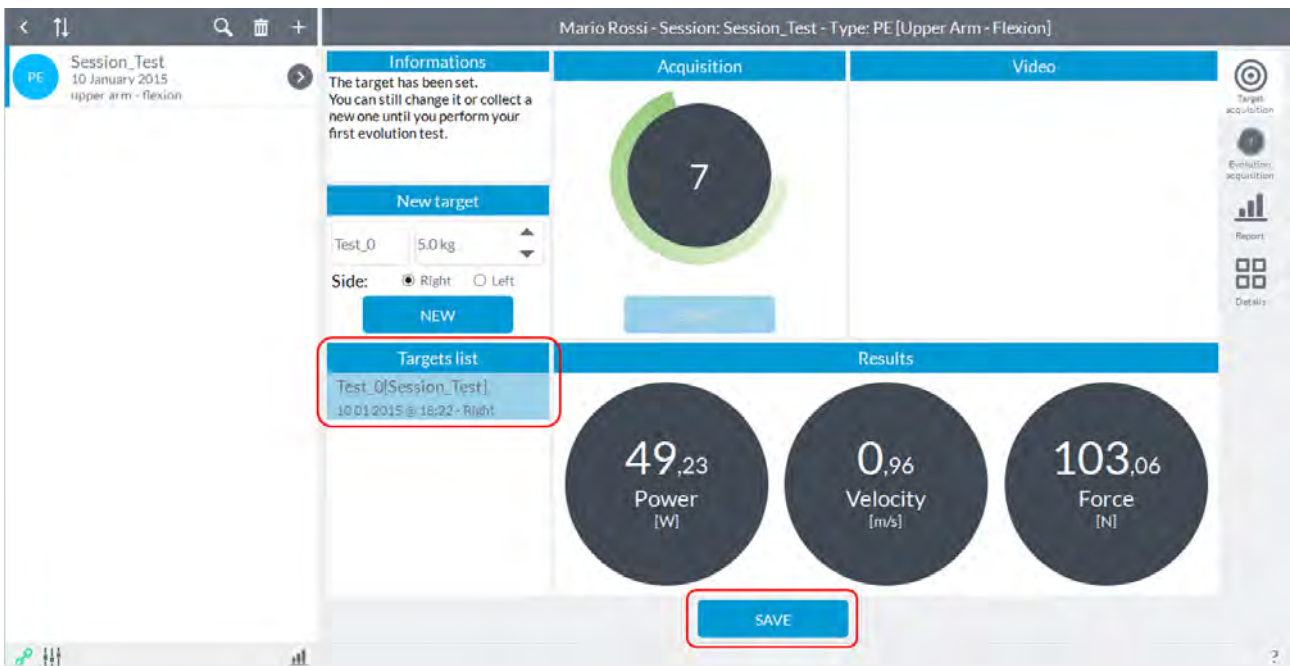




At the same time it will activate the "New" button that will reset the values and allow you to make a new test rehabilitating in turn key "Start".

The user can now proceed with the acquisition of new targets by repeating the procedure described above or go to acquire the tests with reference to the target.

To choose the target, select the test with which you want to compare in the "Targets List" by clicking on target and making sure that this is highlighted in blue, at this point also will reactivate the "Save" button to record it as a target:

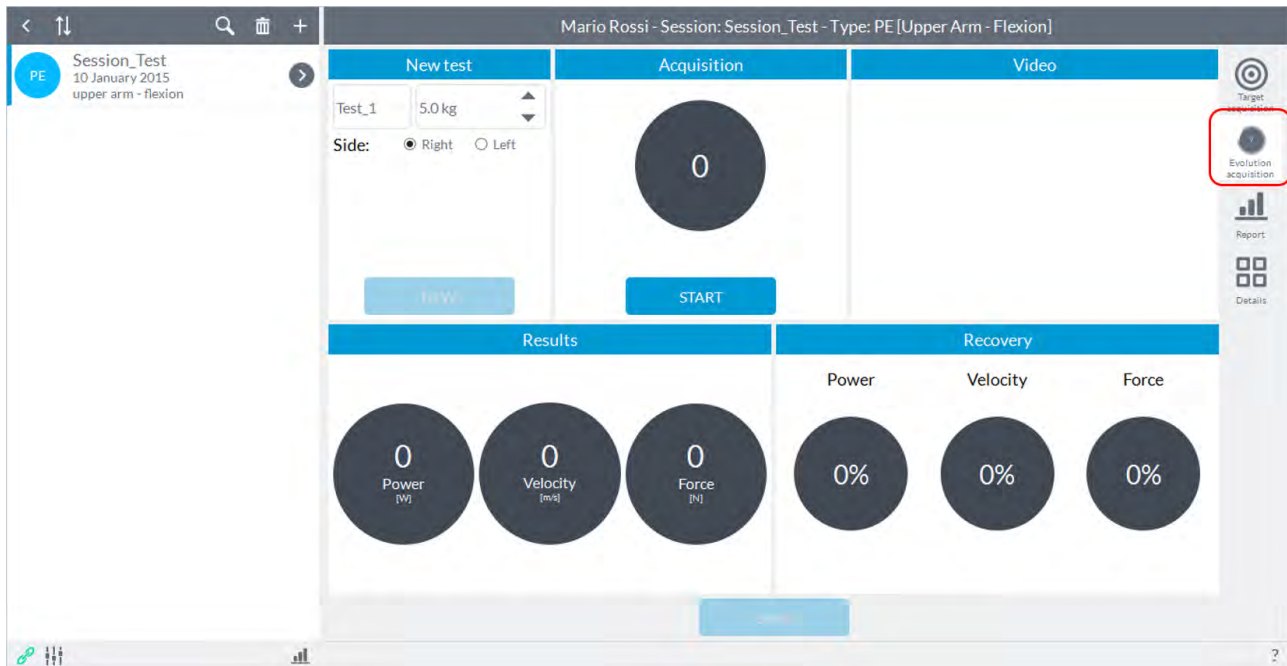


**NOTE:** the software allows you to change the target or acquire new ones even after pressing "Save" till to the moment when you make the first registration in the "Evolution acquisition" described

below; in case you were not selected a test as target and had gone directly to the mode "**Evolution acquisition**" software store as target the last test in chronological order in the "**Target List**".

**ATTENTION:** you can switch to "**Evolution acquisition**" only after acquiring at LEAST one target.

To move to the phase comparison test with the selected target you must click on the second icon (from the top) at the top right and it will open a new window:



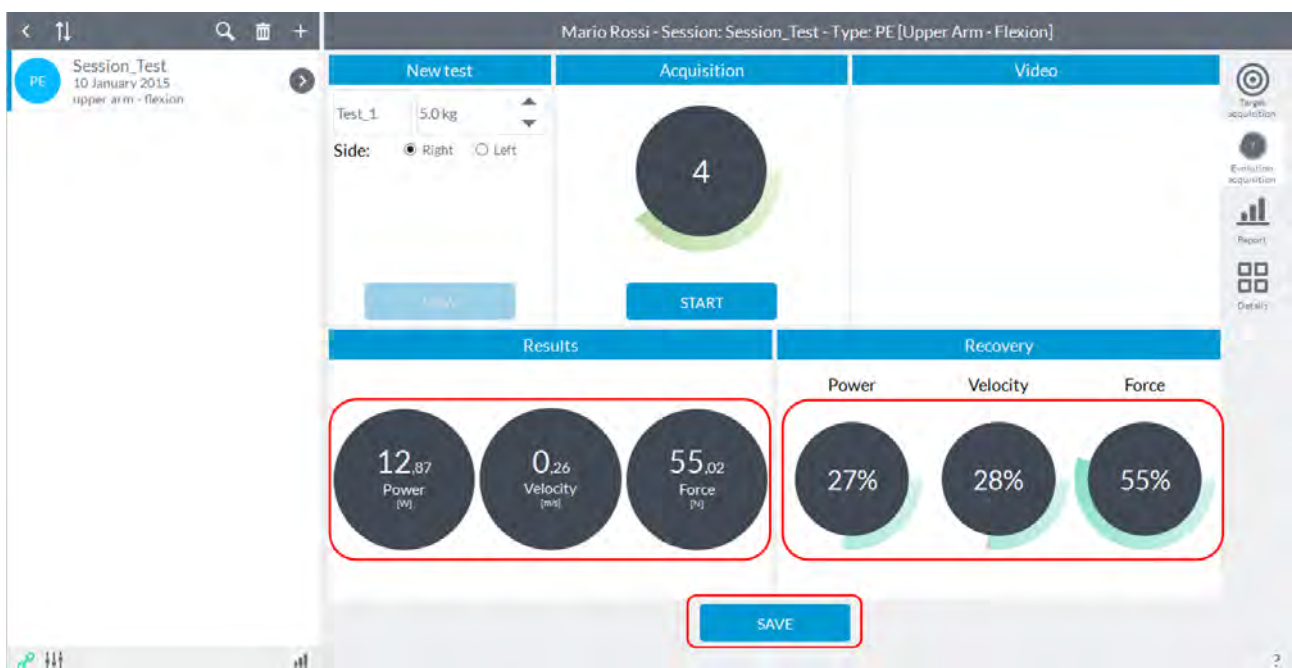
At this point, removing and repositioning the device and selecting the limb between "**Right**" and "**Left**", the user can to perform to the subject the exercise with the same limb or with the contralateral limb according to the type of investigation of interest and then compare the test with the target.

**NOTE:** the load in the "**Acquire evolution**" is automatically set, and is not variable, when you choose the target.

Once the subject is ready, before starting the acquisition ensure that the body segment on which the device has been placed is stationary. At this point the user can press the button to start acquisition "**Start**" located in box of the segment of investigation and give the start to the subject (the user will see an indication of "**Go**" on the "**Start**" button) that can perform the predetermined movement as soon as the software will give an audible signal ("beep"):

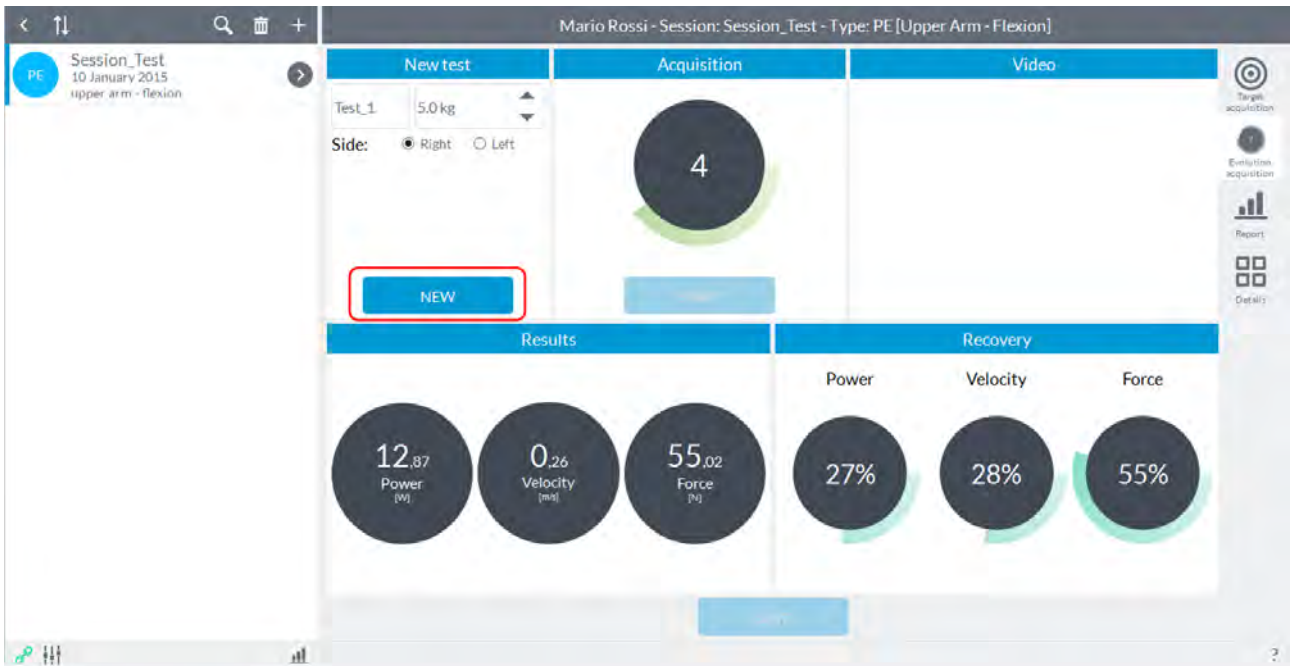


After finishing the execution by the subject and press the button **"Stop"** appeared in place of the **"Start"** after the beep, you will see the results of the exercise in the bottom left and the comparison, in percentage, with the target down to the right; simultaneously will activate the **"Save"** button to store the test:



At this point the user can save the test or repeat it pressing on **"Start"**.

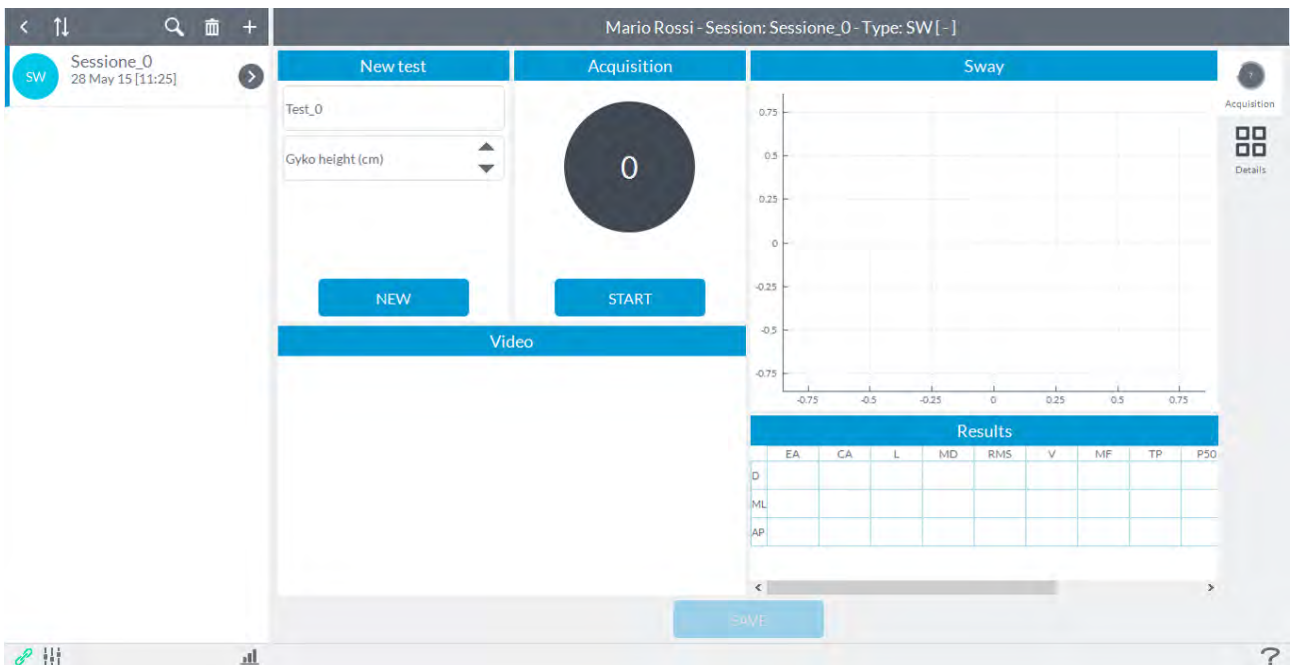
Pushing on **"Save"** the test will record and the button **"New"** will be activated:



Pressing on **“New”** all the values will be reset and the button **“Start”** will be activated and you can continue with a new acquisition.

### 6.3.10 SWAY

Recording a session of **“Sway”** will see the following screen:

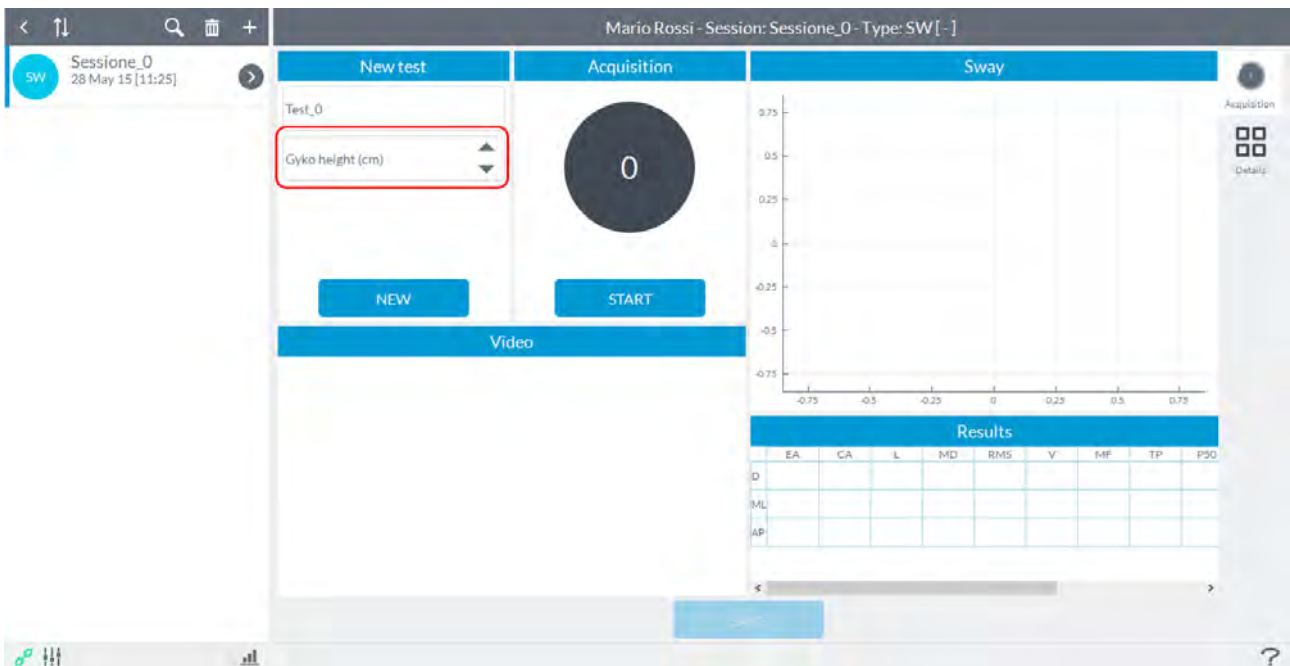


The user can enter notes in the **“New Test”** in the upper left (this will be shown as a label for the year in view of the results in report mode and details) is set as the default name of the test **“Test\_0”** with increasing numbering subsequent tests.

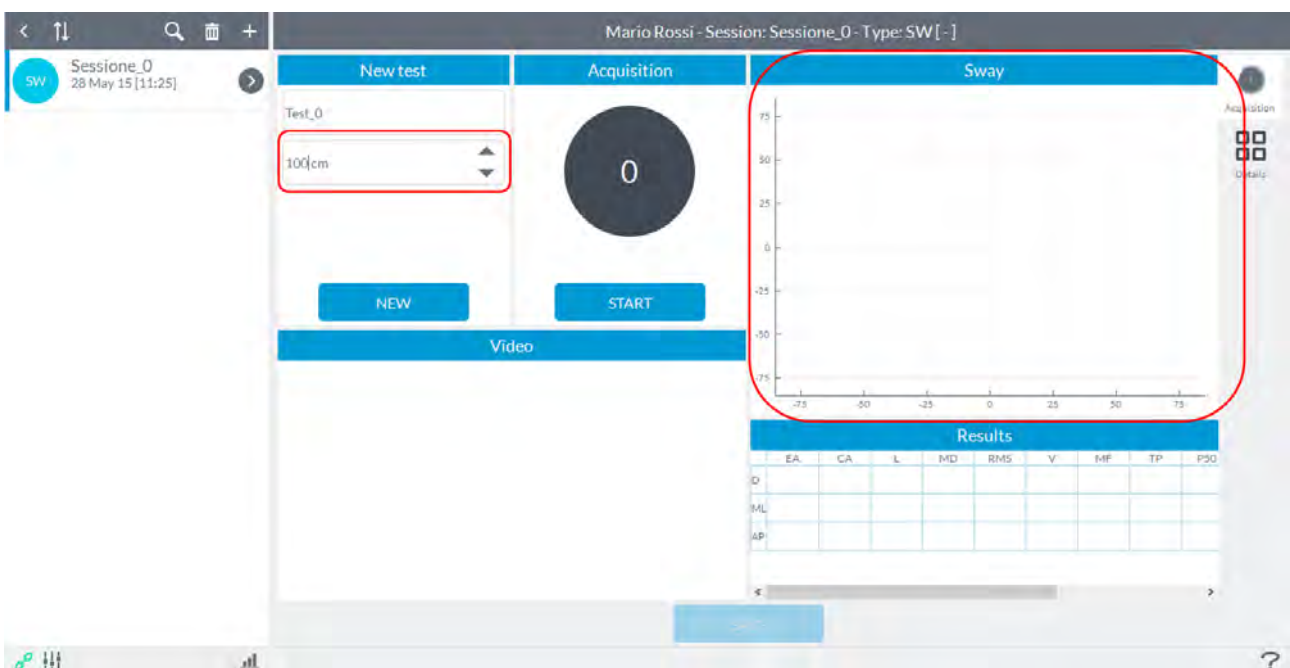
The aim of this module is to evaluate the stability of the subject. Evaluation can be done by asking the subject to take different postures with several motor tasks selected by the operator. Before testing, place the unit in the hardware support (elastic band) and secure it around the subject.

Refer to [Appendix A](#) to have a reference to where to place the device and how to perform the test.

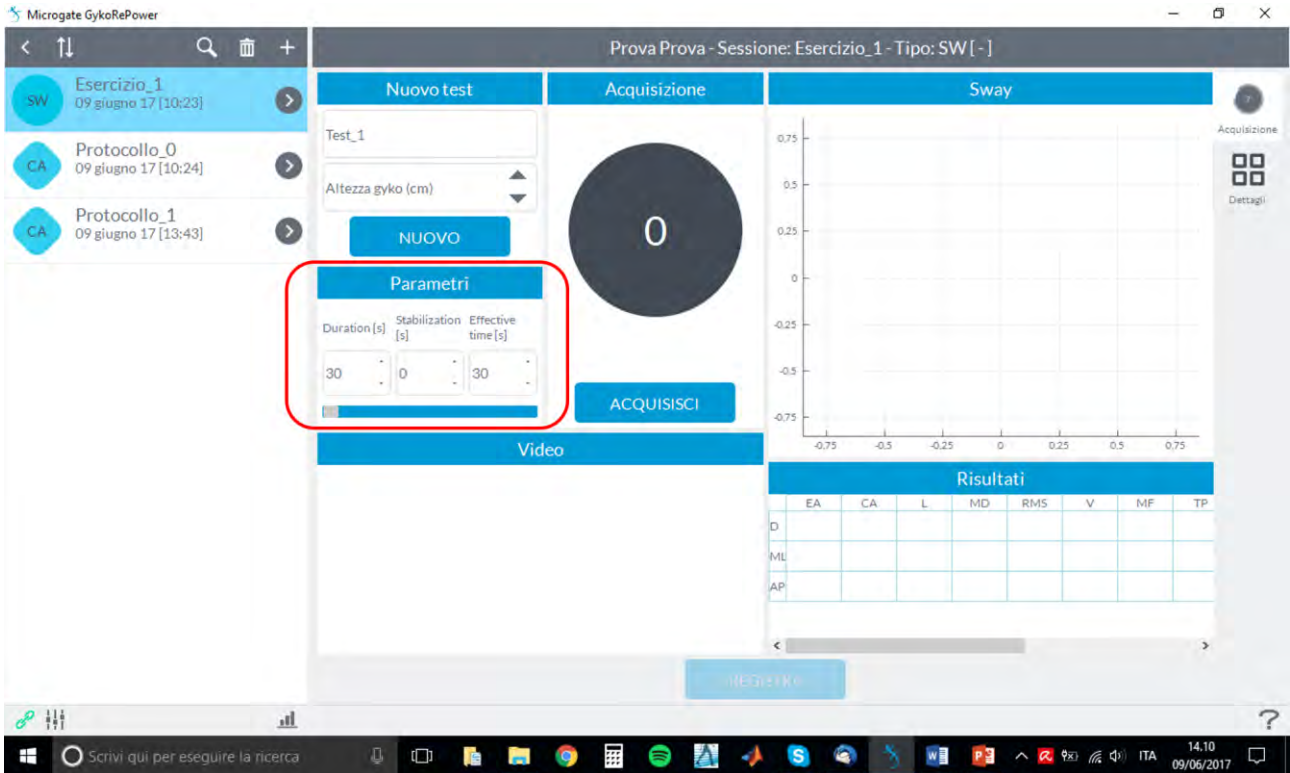
Before starting the acquisition must enter the ride height to which the Gyko is entering the value in cm in the box in the upper left corner:



After inserting the height from the ground at the same time it will change the viewing area of the center of gravity to the right in the window **Sway**:

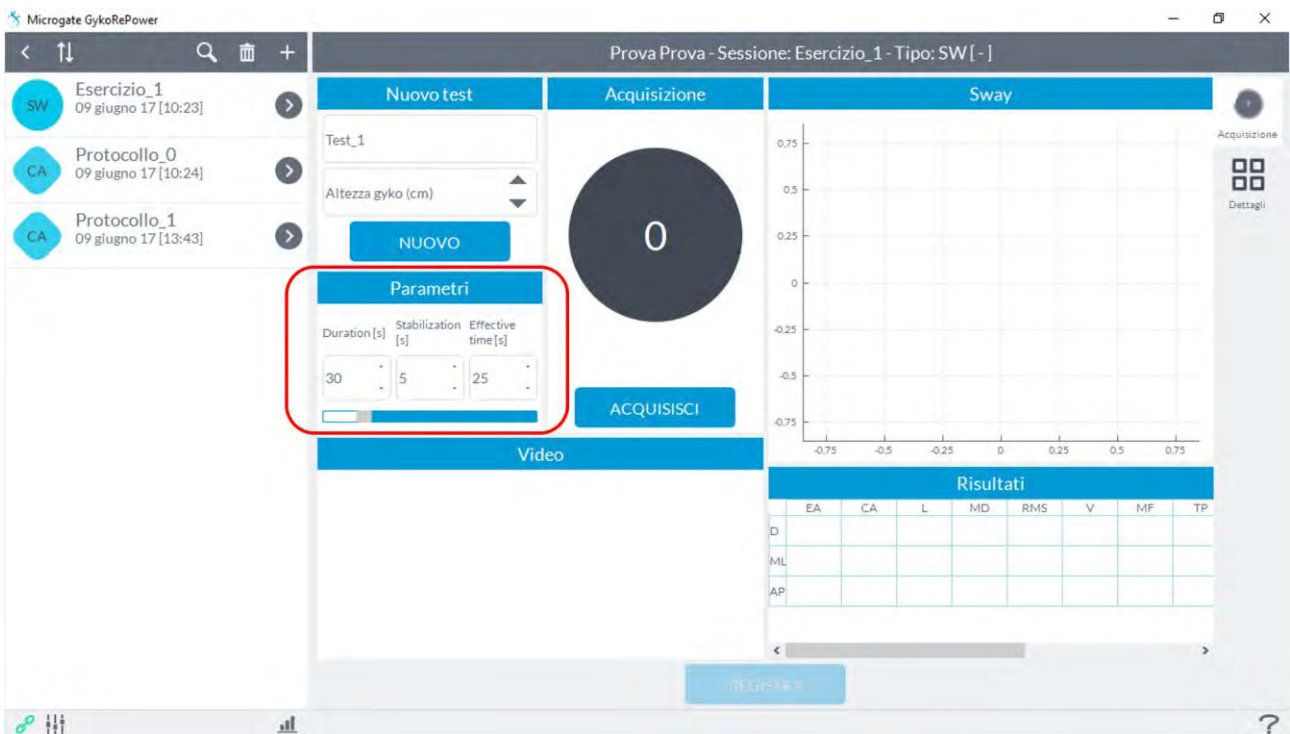


You can change the data acquisition parameters by using the functions in the "**Parameters**" table:



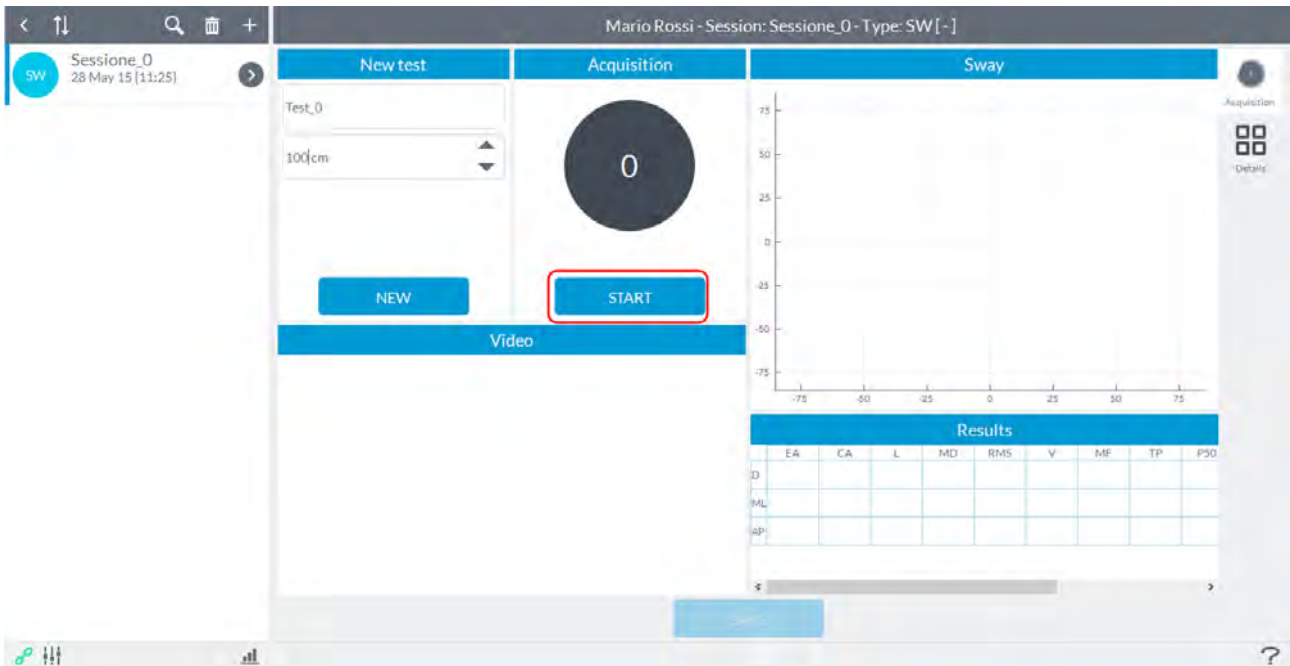
It is possible to set a duration for the acquisition of the test after which it will automatically close by adjusting the parameter "**Duration**" in seconds [s].

Within the duration of the test, such as 30 seconds, it is possible to "*discard*" some initial moments by setting the "**Stabilization**" parameter, for example the first 5 seconds, so that the actual acquisition time becomes relative to the last 25 seconds (parameter "**Effective Time**"):

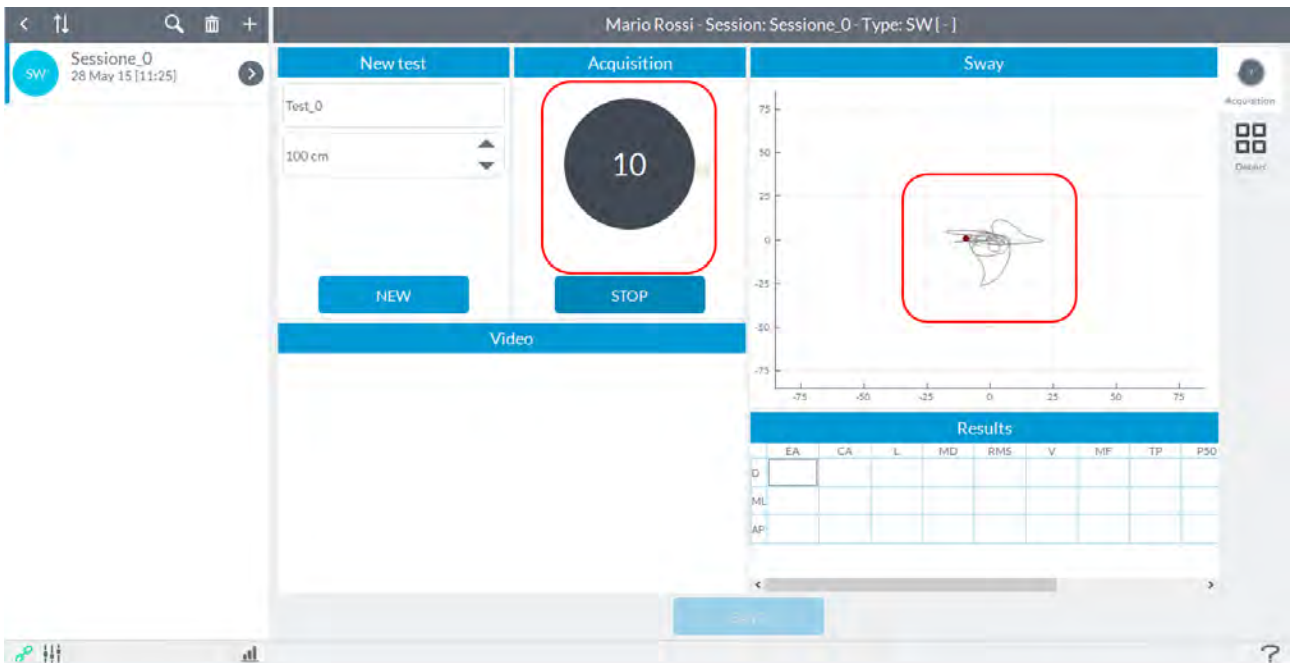


Once the subject is ready, before starting the acquisition make sure that he is stationary.

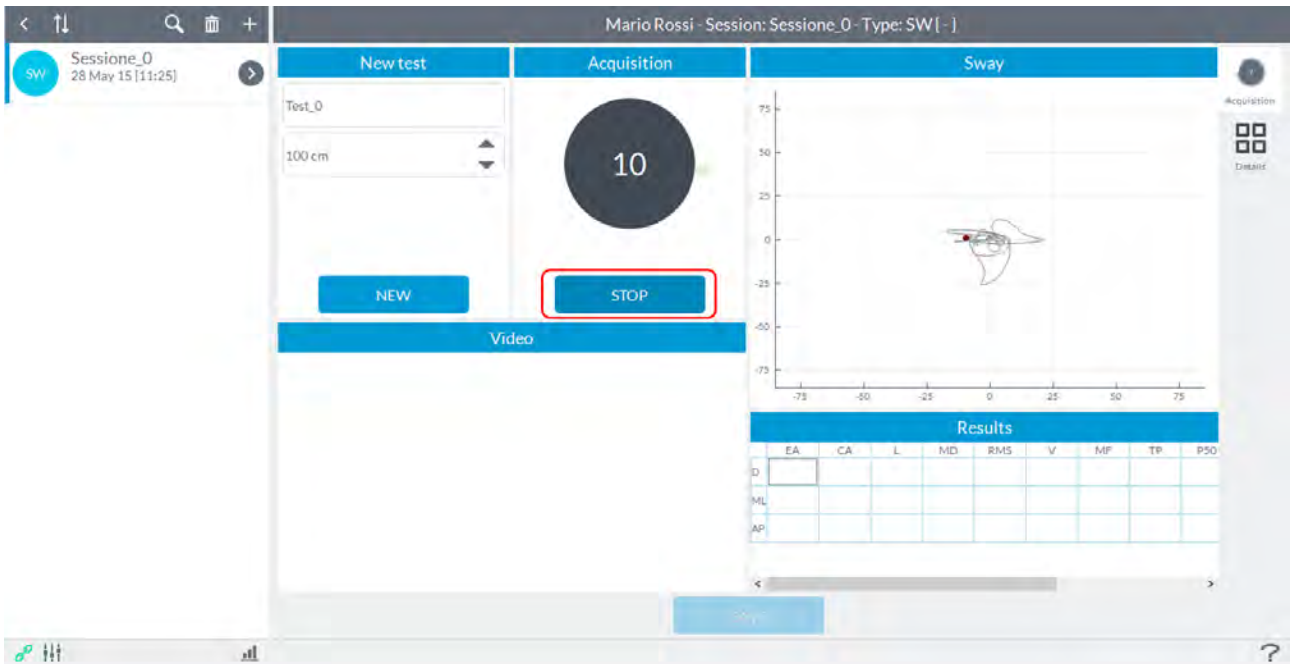
At this point the user can press the button to start acquisition "**Start**" and give the start to the subject (the user will see an indication of "**Go**" on the "**Start**" button) that can perform the predetermined movement as soon as the software will give an audible signal ("beep"):



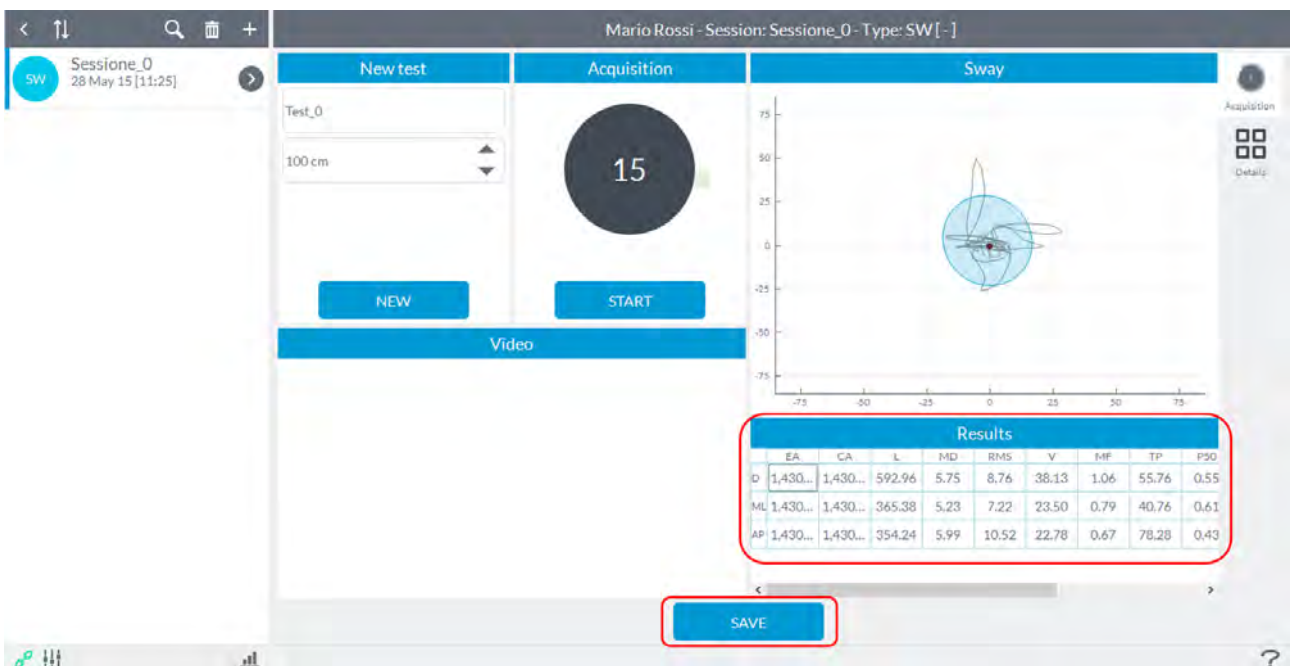
At this point the user will scroll the time (in seconds) in the box and in the box Acquisition **Sway** will be shown in real time the progress of the vertical projection of GyKo on the ground:



To end capturing just press the button "**Stop**":



In the lower right corner will display the results and at the same time will activate the "Save" button to store the data. In case you want to repeat the test simply press the "Start" button:



Once recorded evidence to reactivate the "Start" button and switch to a new test will need to press the button "New".

For a description of the parameters displayed refer to [Appendix C](#) Table 2.

### 6.3.11 CANALI

The "Canali" protocol is aimed at the assessment of different aspects of the subject following the methodology developed by Professor Vincenzo Canali creator of Canali Postural Method.

The protocol has the objective the identification of three different macro aspects of the subject:



- 1) **Weak Side:** The weak side test is structured to show which side rises less flexing the trunk forward holding a rod between the hands. The test is performed by sitting with the lower limbs apart and then standing with legs united. Taking the upper limbs aligned to the head, the trunk flexion puts tension on the front chain, the posterior chain and also the scapular-humeral girdle. The side with the greatest difficulties (which is not necessarily the most load) tends to rise less and to produce a lower upper limb excursion. The rigid rod that is handheld grip on upper limb tilts to the side most in difficulties.
- 2) **Stiff Side:** The stiff side test provides information on what are the musculoskeletal chains with more rigidity between left and right sides and front and rear. It is then provided a comprehensive assessment of the sagittal plane stiffness.
- 3) **Load Side:** The side that sustain more load, or body weight, is identified in a series of components that add up to the support on the lower limbs and the "fall" of the shoulders on the frontal plane. A subject visually more resting on the right side could have more load on the left side and vice versa in the complex. Flexion or abduction of the upper limbs enables us to understand what is actually the load side because the upper limb ipsilateral to the load side will have a greater excursion angle of the scapular-humeral girdle as the final position to upper limbs and high tense will find better support.

You must perform two exercises (identified by Professor Canali) for each of the three macro areas and the average of the results of these two exercises is given an indication if the result exceeds a threshold of alert established by the inventor of the above method.

At the end of the protocol there is a comprehensive assessment that considers the results obtained from the identification of 3 macro aspects.

The tests are designed to be repeated after the application of exercises in order to understand what those exercises shift the support (load side) and difficulty (weak side) of the subject, so as to be effective on the same path.

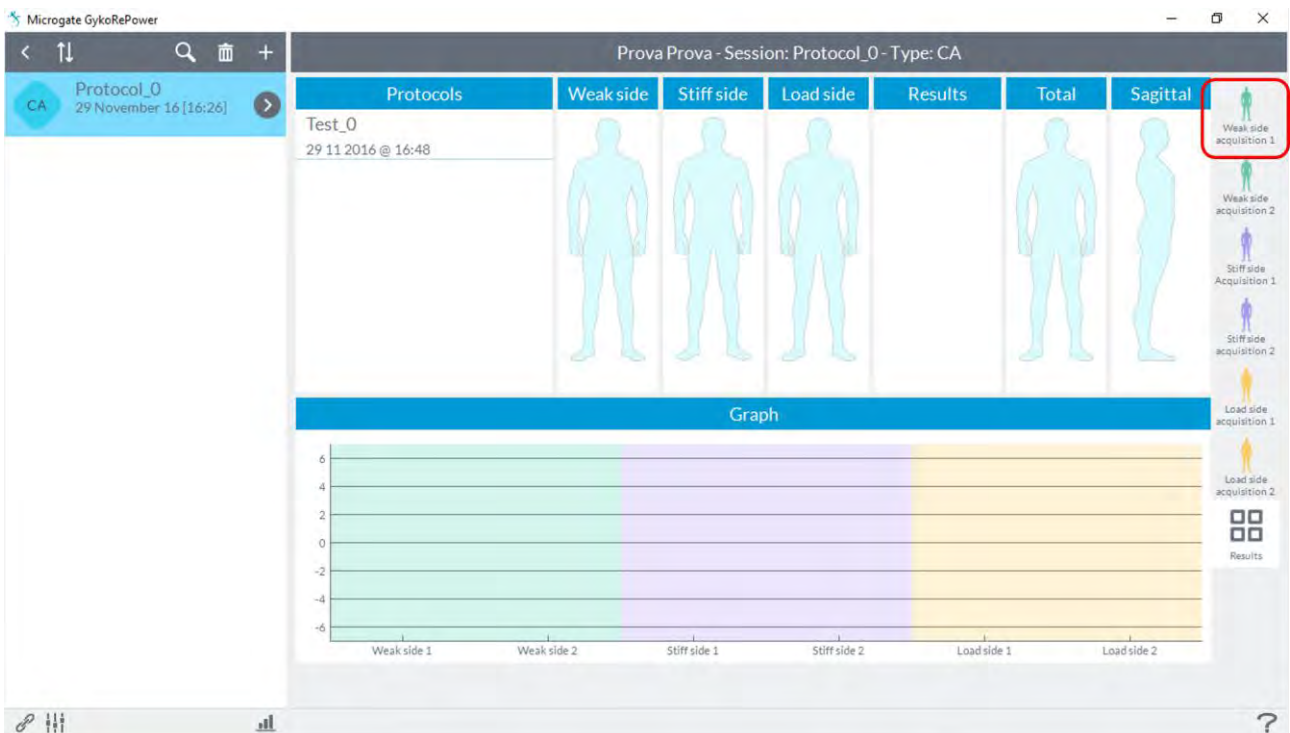
The tests are used to select the most effective actions to the subject.

**NOTE:** For correct use of the protocol is necessary to enter the date of birth of the subject because the final evaluation also depends on the age.

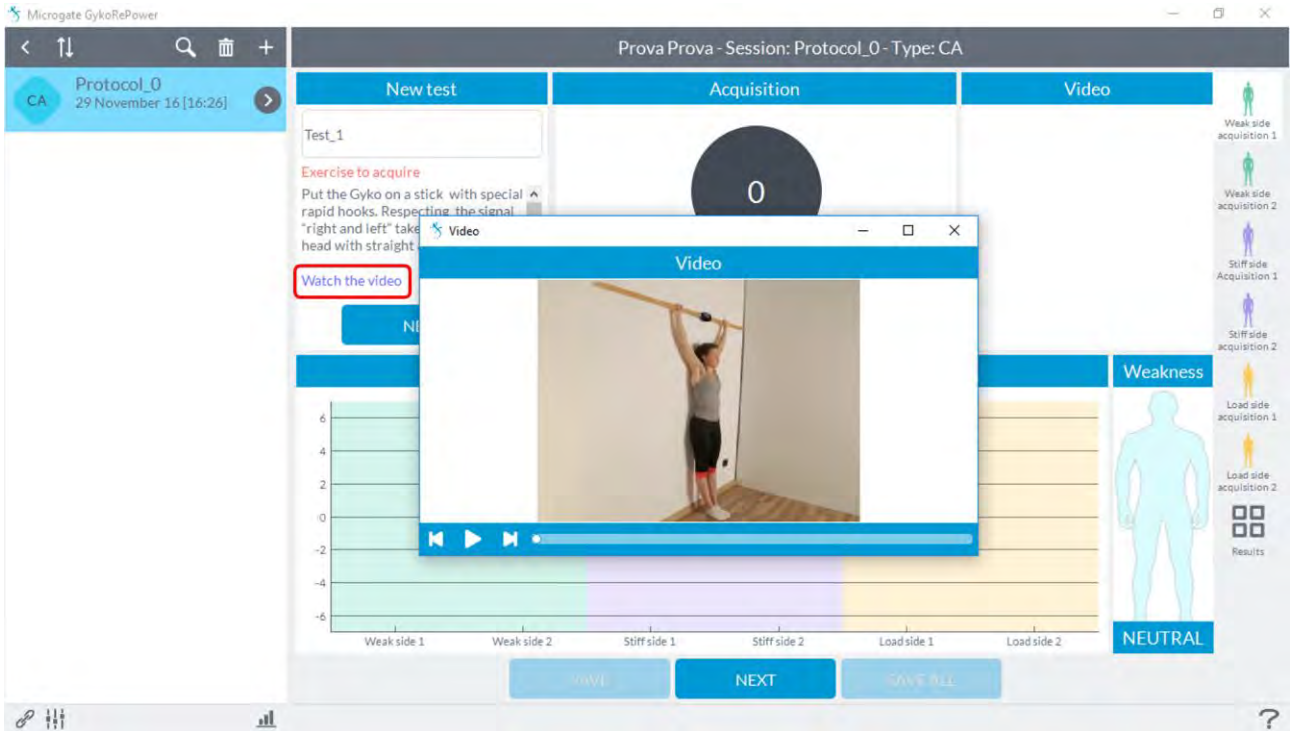
Recording a session of "Canali" will see the following screen:



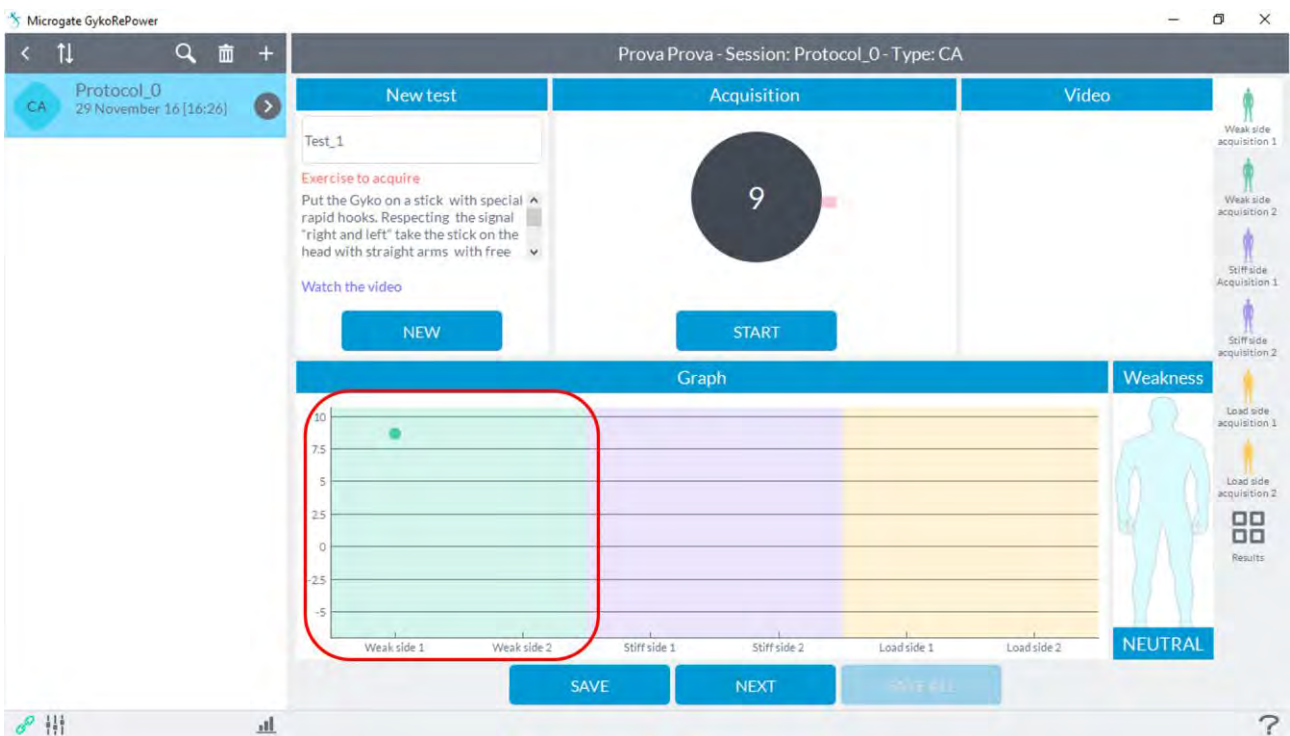
To start the acquisition of the various exercises just click on the first tab in the upper right **"Acquisition weak side 1"** and it will open the following screen:



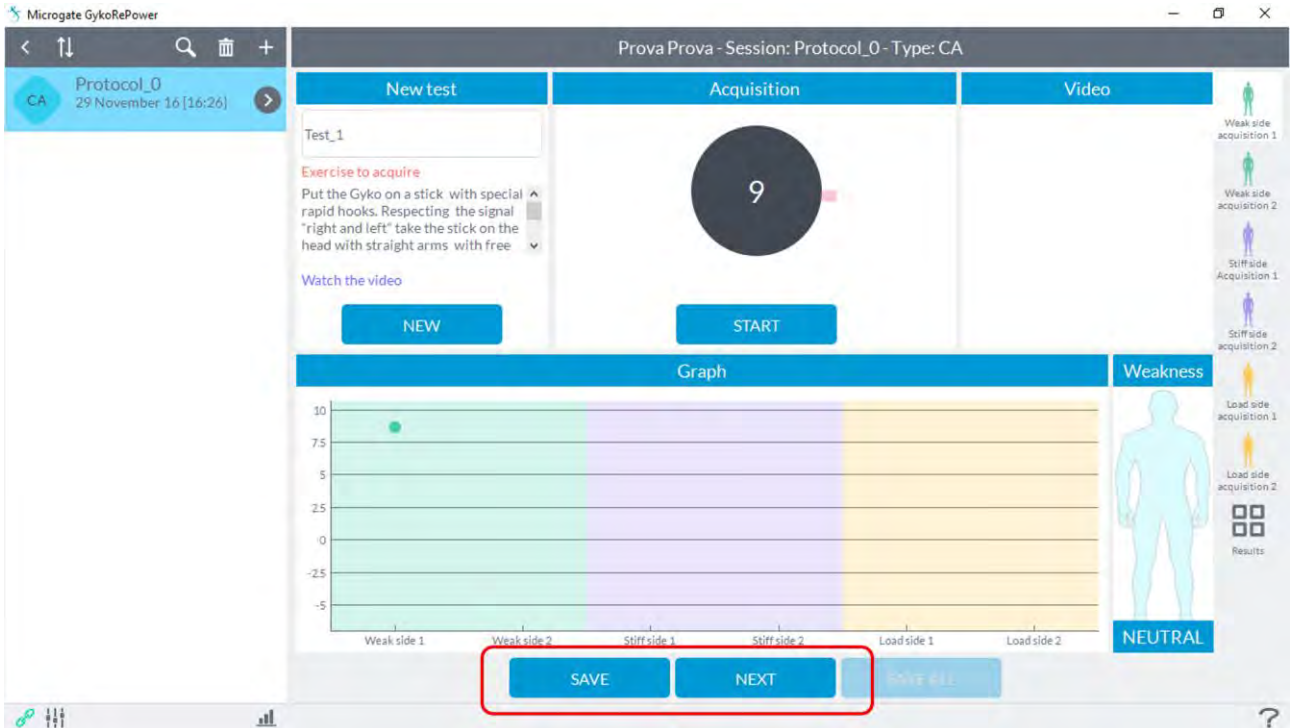
In the **"New Test"** window there is a description of how it should be done the exercise and clicking on **"Watch Video"** it will open a window with a video that shows how to perform the exercise correctly and where to place the GyKo:



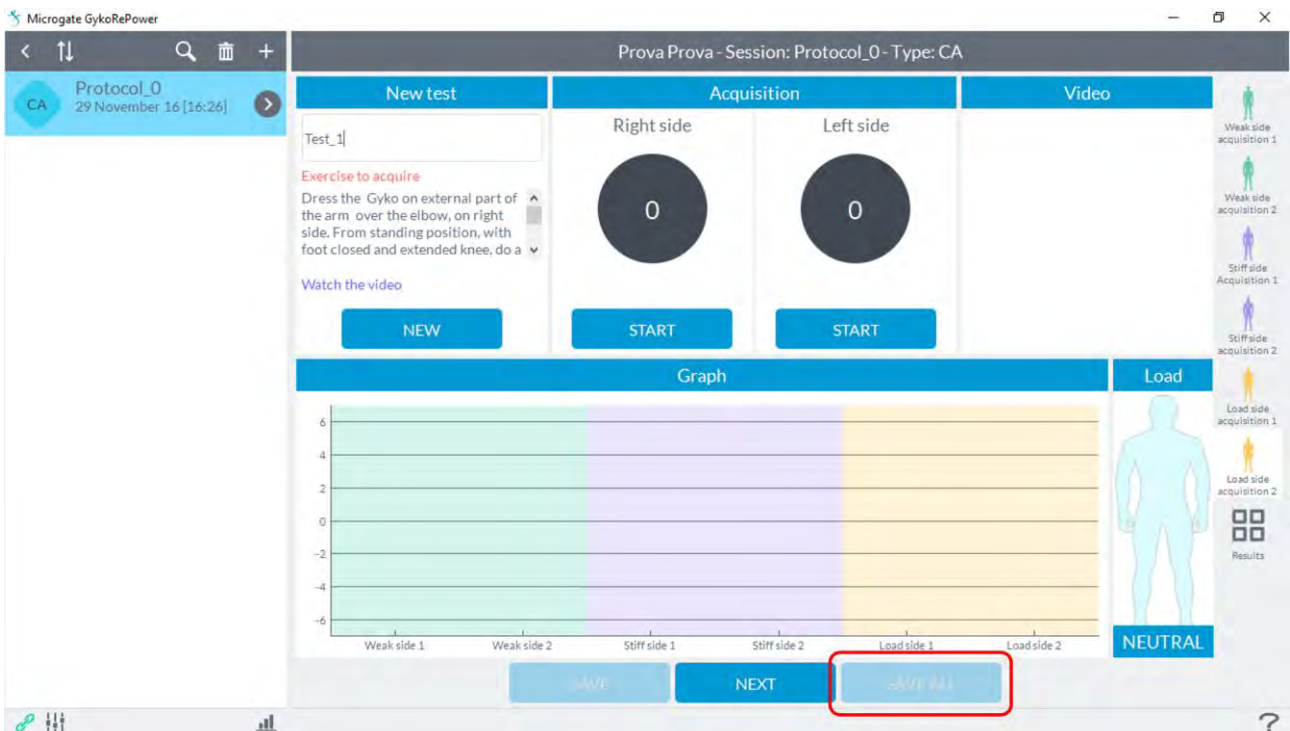
At this point, simply click on the **"Start"** and after **"Go"** and the **"beep"** sound you can perform the movement. At the end of the movement, click the **"Stop"** button and it will appear on the chart below one dot relative to the value just acquired:



If the acquisition was successful, click the **"Save"** button to save the test and clicking **"Next"** you can go to the next test:



Once you finished all the tests using the same procedure you can save the entire protocol by clicking on **"Save All"**:



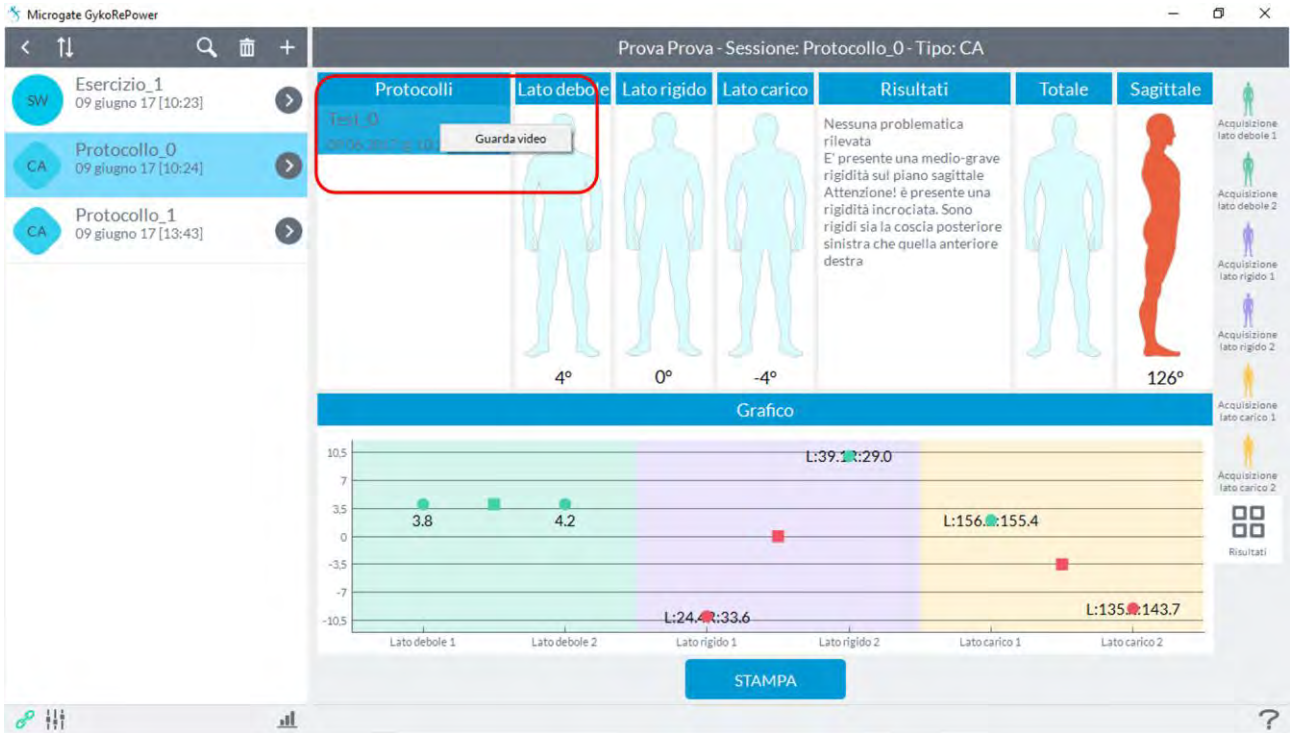
At this point you can view the results obtained with its assessment of the protocol by clicking on the **"Results"** tab at the bottom right:



To proceed with a new protocol simply go back to the first capture tab at the top right "**side debole1 Acquisition**", click on "**New**" and repeat the steps above. The results of the recorded protocols will be present in the "**Protocols**" window on the tab "**Results**".



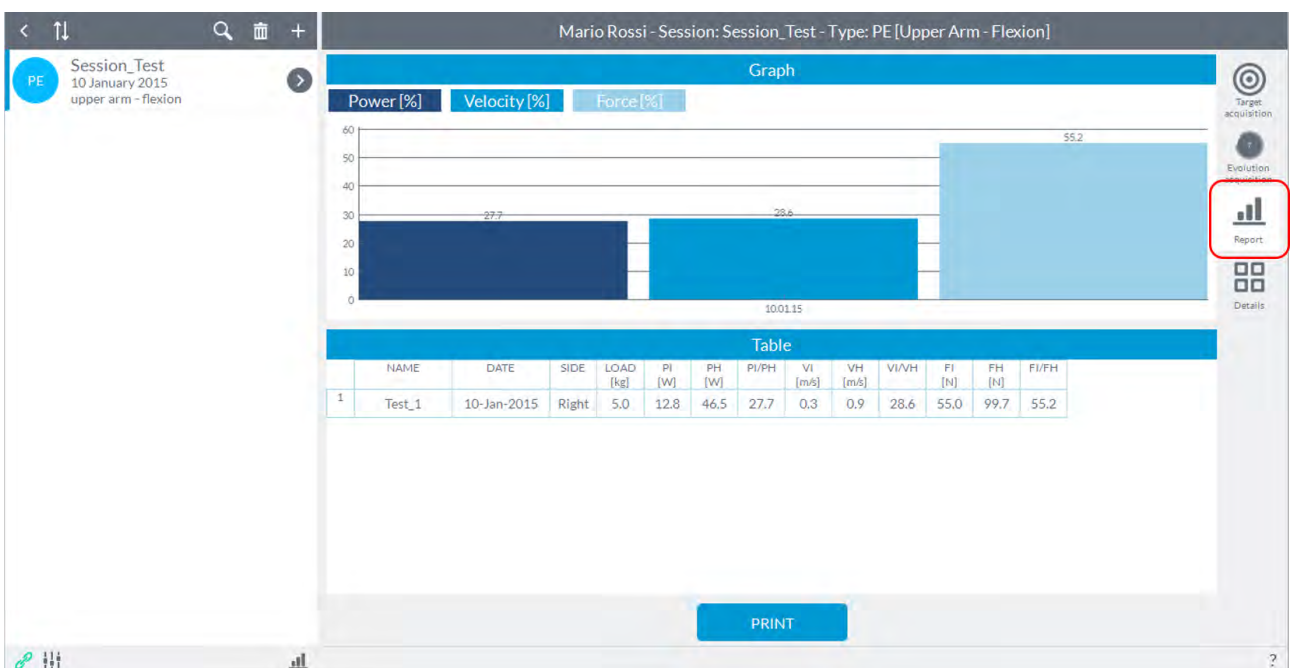
It's possible to review the videos acquired during test by clicking with the right button on the saved test:



## 6.4 VIEW RESULTS

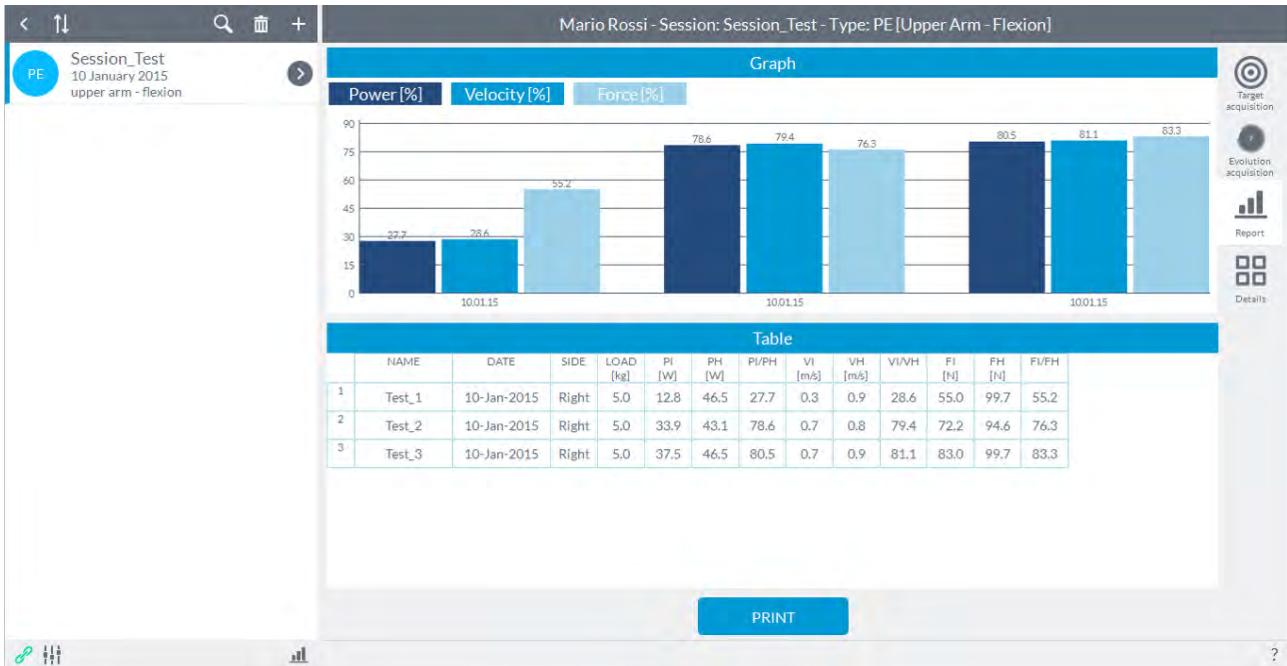
### 6.4.1 REPORT

To switch to reporting of the evaluation session in which the user is located just press the "Report" button located on the right side of the screen.



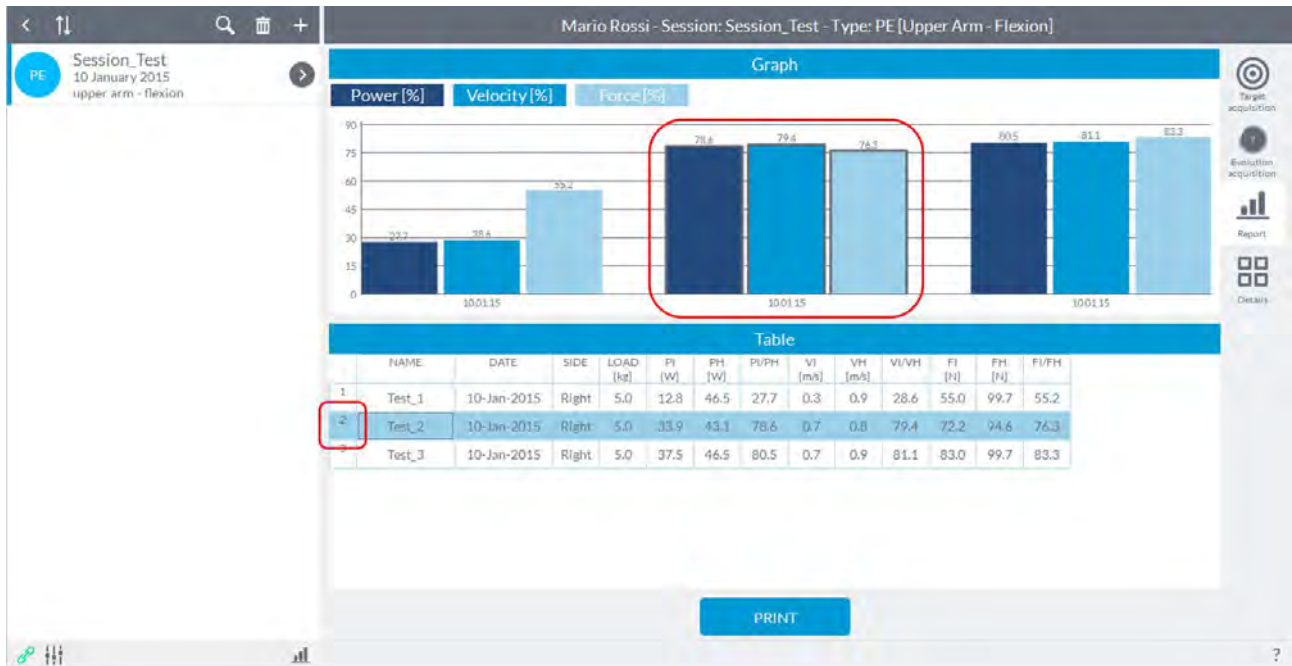
The screen for the reporting differs between sessions "**Symmetry**" and "**Evolution**" only for the parameters listed; ROM, fluidity and speed for sessions "**Symmetry**", power, speed and force for sessions "**Evolution**".

The page shows the results of all tests carried out according to the date on which these were carried out.

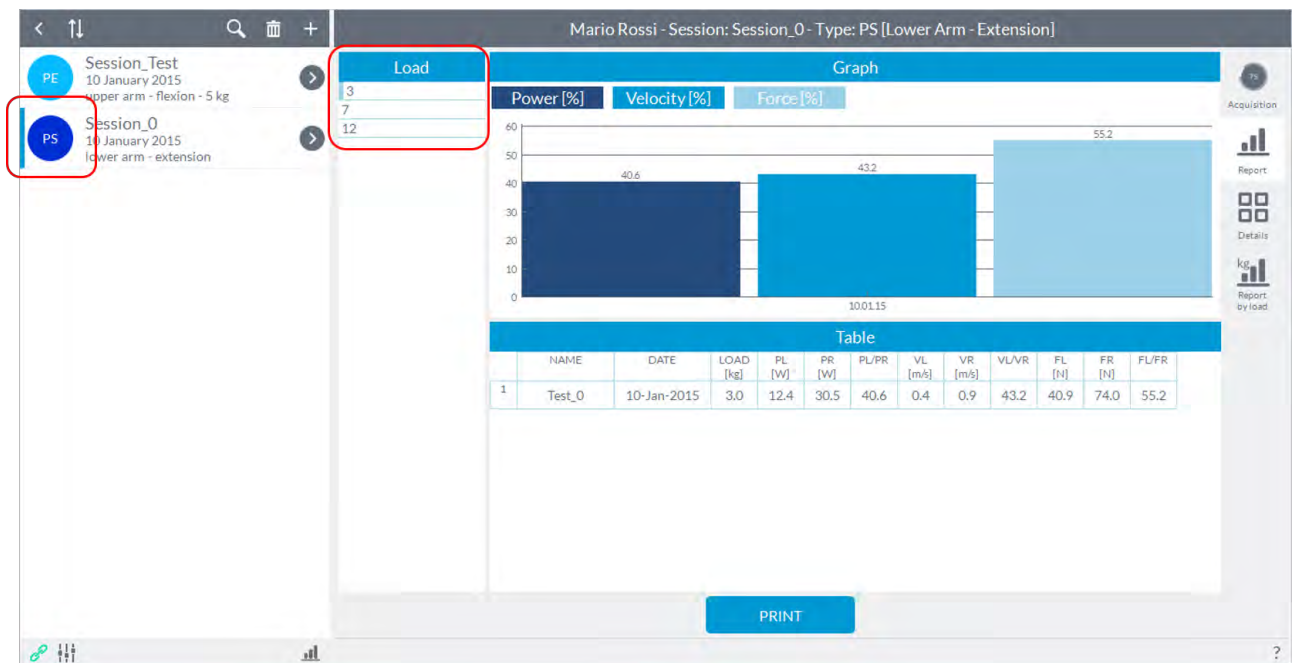


In this way the user will be able to appreciate the desirable improvements in the recovery of the various parameters in that an increase of the percentage values correspond to a respective reduction of the deficit.

If more tests were performed on the same date, most histograms will be shown with the same date. You can also highlight a test clicking on the number of the test to the left of the name. To deselect just click another area of the screen.



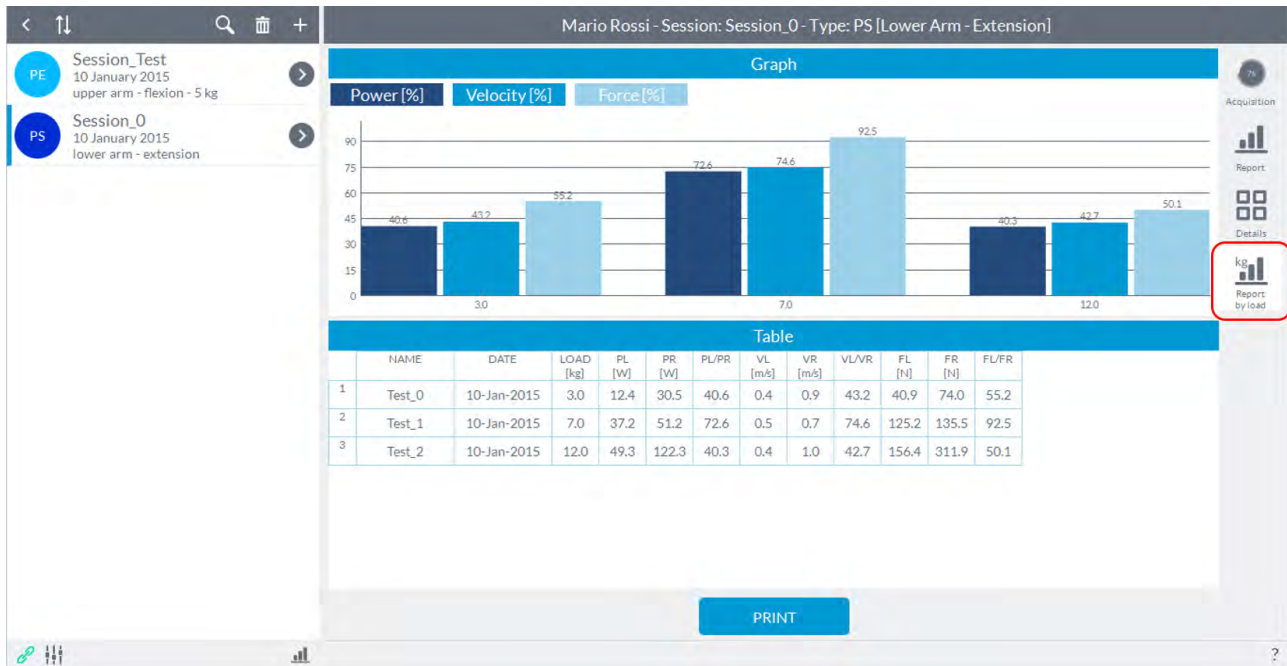
**NOTE:** in the sessions of "Strength Symmetry" are displayed in the upper left the different loads that are possibly used in the evaluation session.



You can select the load of interest for viewing by clicking on the row corresponding to the load at whose side will appear the selector. By default, the screen opens on the first load used in the session.

Also in the session "Strength Symmetry" you can view the results as a function of the loads used by clicking the "Report by load" to the right of the screen.





This report allows to view the recovery as a function of load used, if for example for the subject evaluations are carried out with three different loads, and for each load N tests were carried out, in the graph in correspondence with each load will be displayed the last evaluation corresponding to that load.

#### 6.4.1.1 DELETE A TEST

To delete a test just click with the right mouse button on the number to the left of the name of the test and it will open a small window with "Delete test". You can delete only one test at a time. This feature is also available in the display mode "Details" and "Report by load".

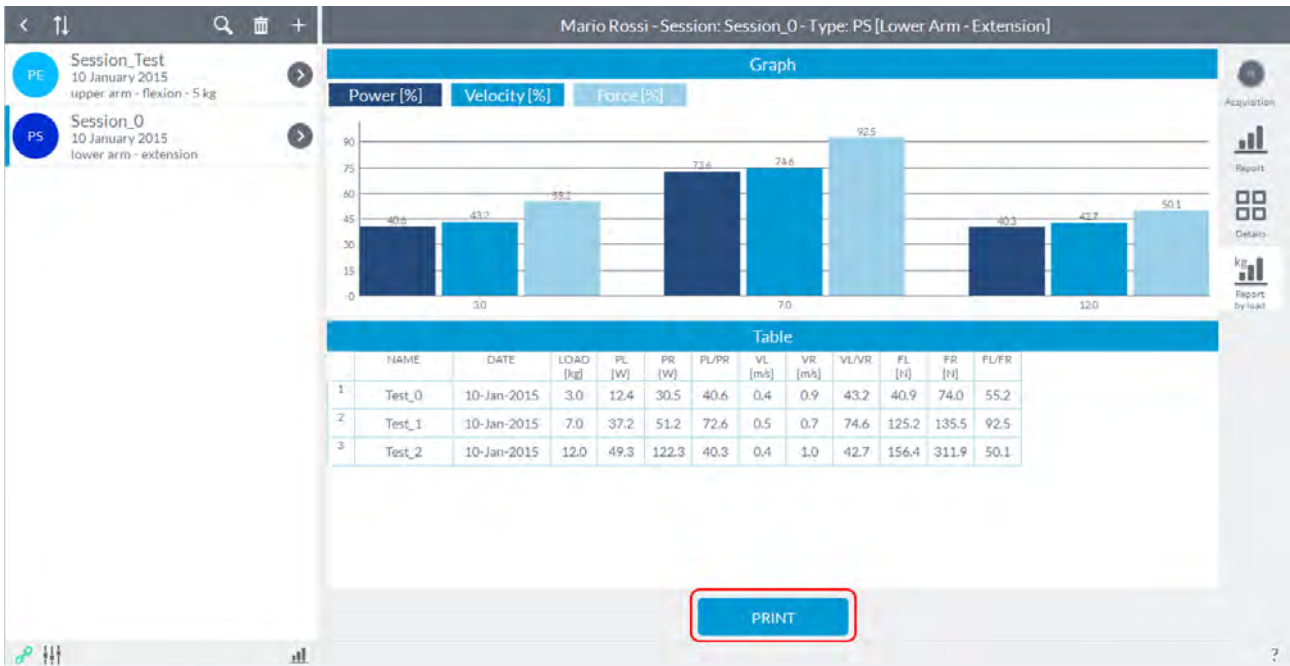
**NOTE:** Once deleted a test in one of the display mode will be deleted in the other.

#### 6.4.1.2 CHANGE SIDE OF THE TEST

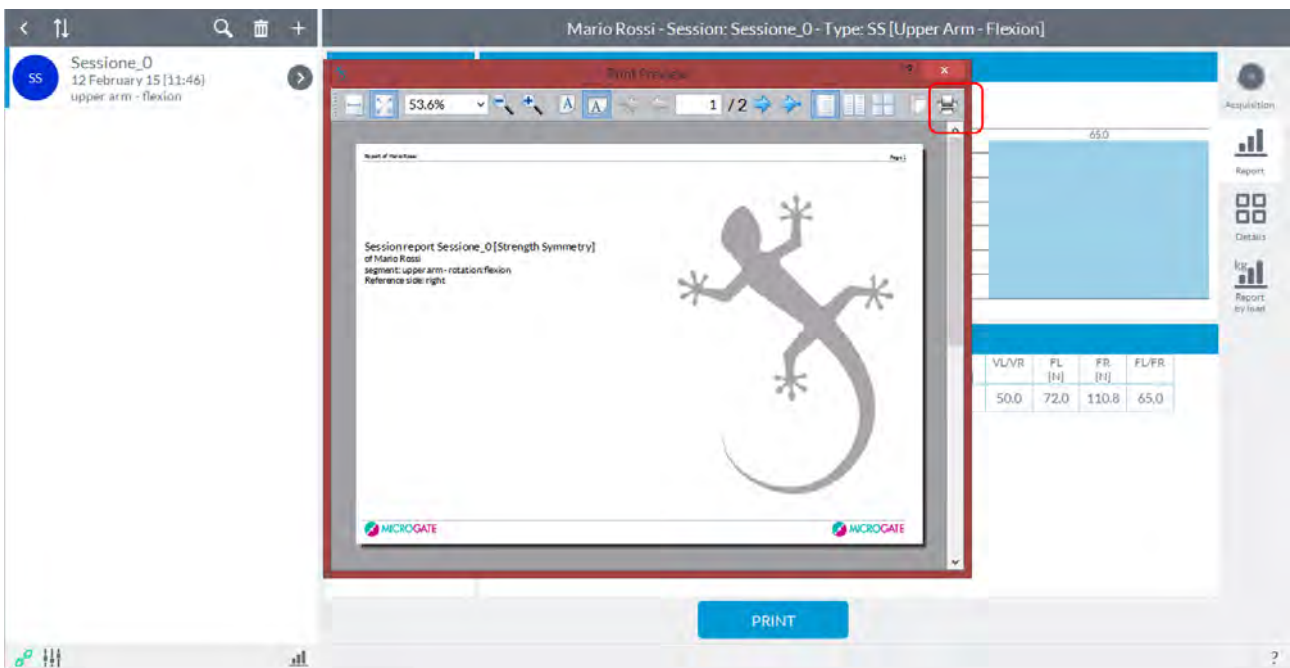
Clicking with the right mouse button on the number to the left of the name of the test you can change the side of that single test from right to left and vice versa if it is made a mistake earlier. This feature is also available in the display mode "Details" and "Report by load".

#### 6.4.1.3 PRINT OF REPORT

To create a pdf file with the content displayed in report mode, simply press the "Print" button at the bottom center of the screen:

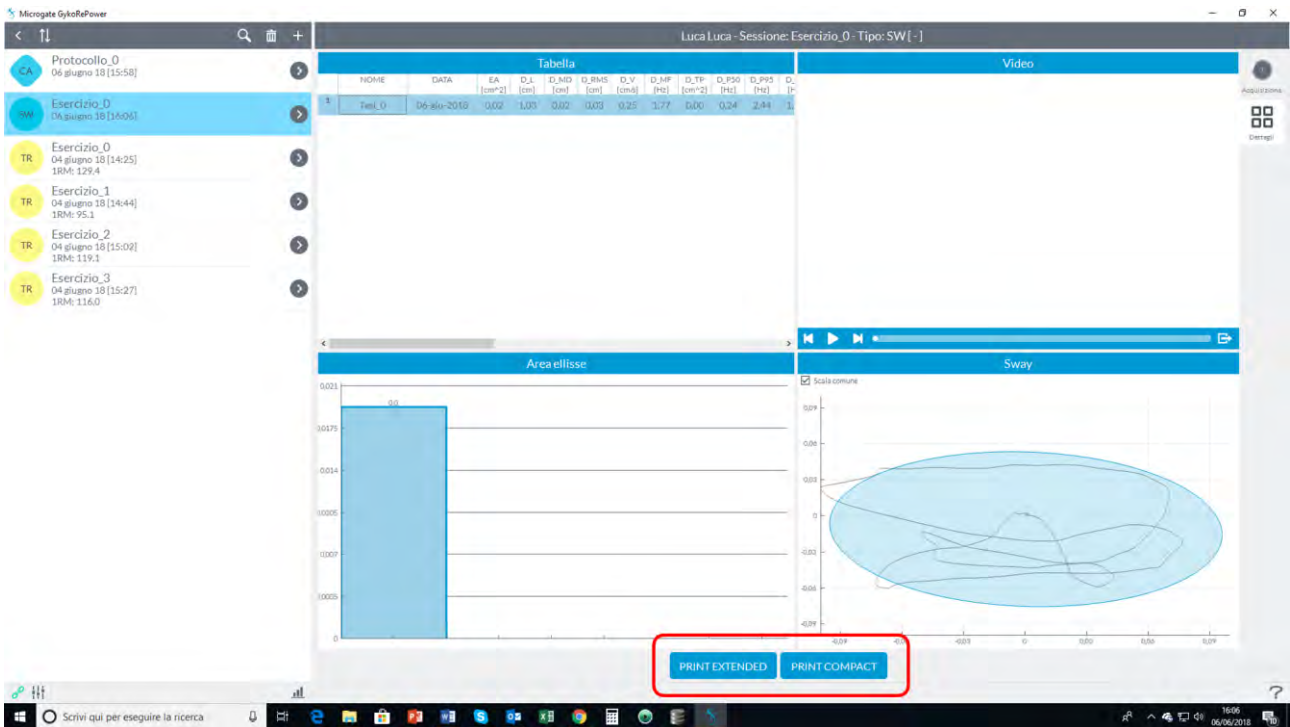


It will open the following window:



At this point, pressing the button highlighted, it will open a new Explorer window where you can specify the destination and the name of the file.

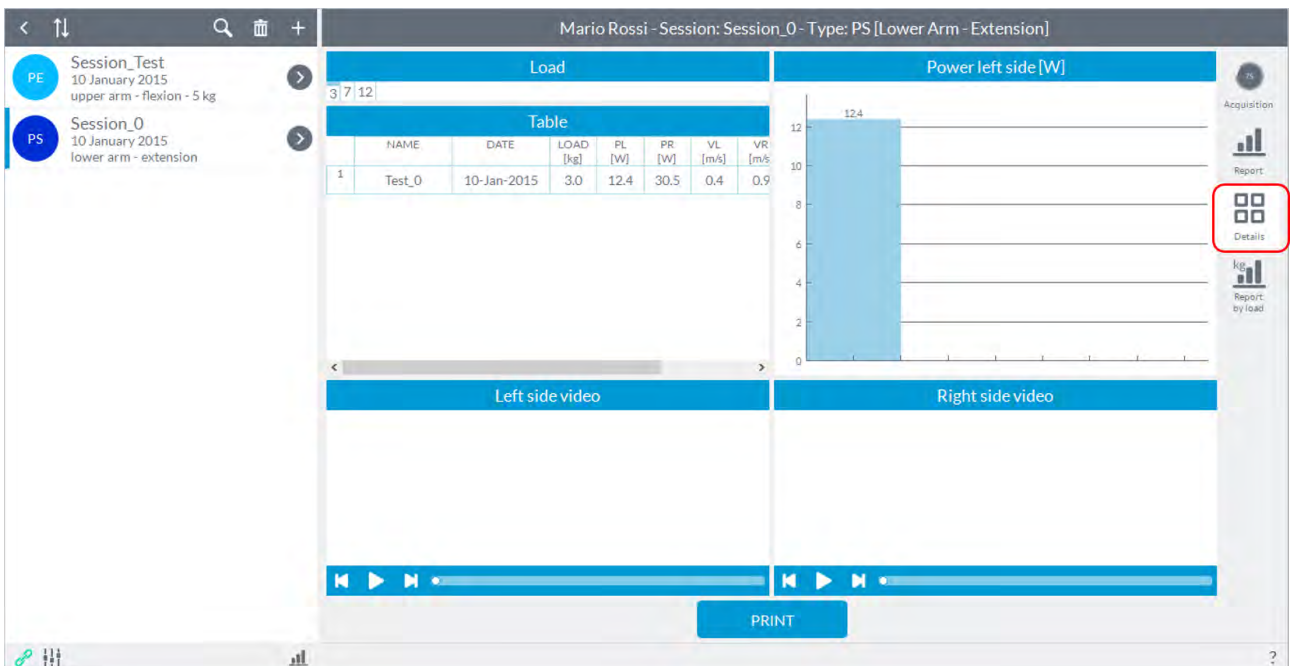
In the Sway test print screen, you can select between two print modes, "EXTEND" or "COMPACT".



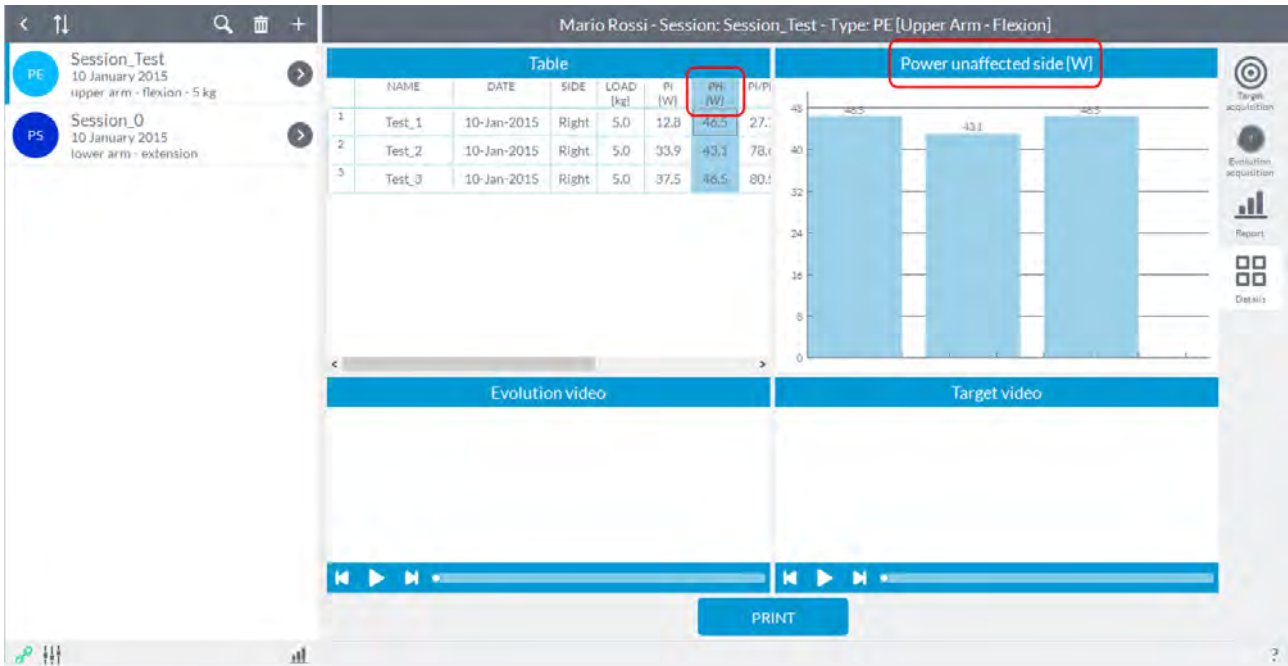
The first will contain all the data of the different parameters of the test while in the "compact" version will contain, in addition to the graphs, the data relative to the area of the confidence ellipse, the length, the displacement on the Antero-posterior and Medio- Lateral, speed and frequency.

## 6.4.2 DETAILS

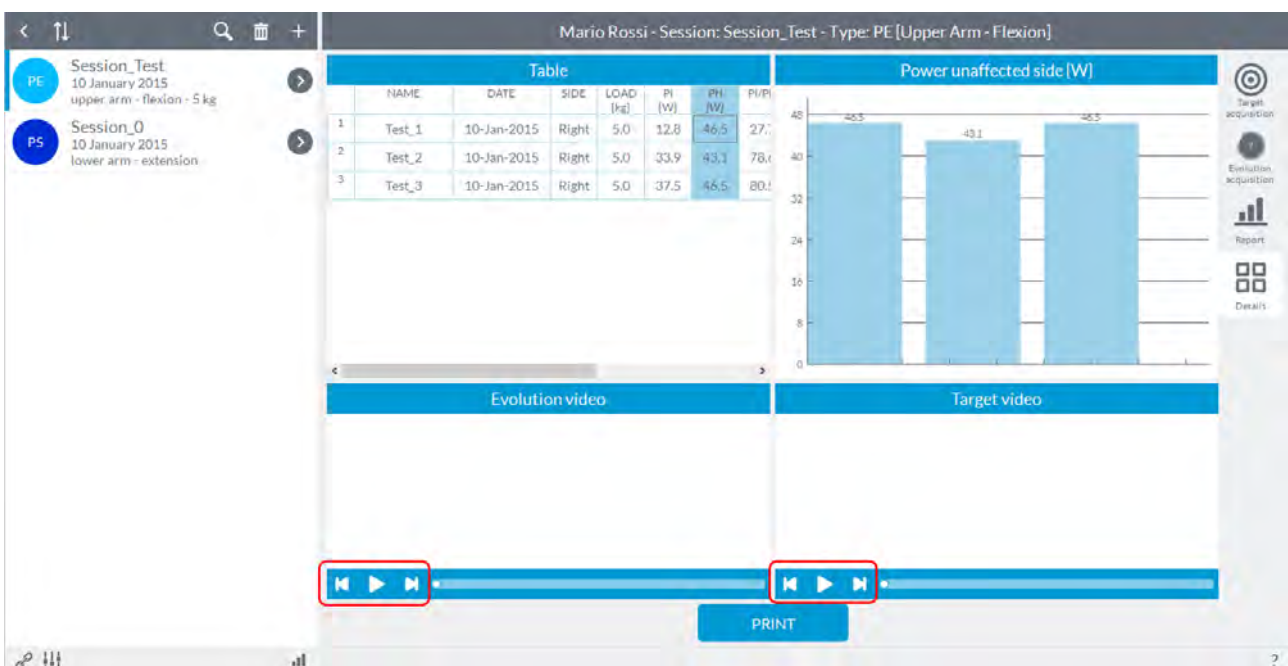
The "Details" mode, selectable by clicking the icon to the right of the screen, allows the visualization of the results in absolute value, as well as in percentage compared with the contralateral limb and/or the target. Furthermore, in this mode, you can review any video recorded during the tests.



By default the screen shows the absolute values of the first parameter in the table on the left of the graph (in the case above, in a session of "**Power Evolution**", are shown muscle power values of the injured limb). To change the parameter to display just select it from the table to the left of the graph by clicking on the index of the parameter name. For example, in the case here proposed, if you wanted to display the value of the healthy limb muscle power, simply click on the index "PH" in the upper left (to see other parameters just move the scroll bar):



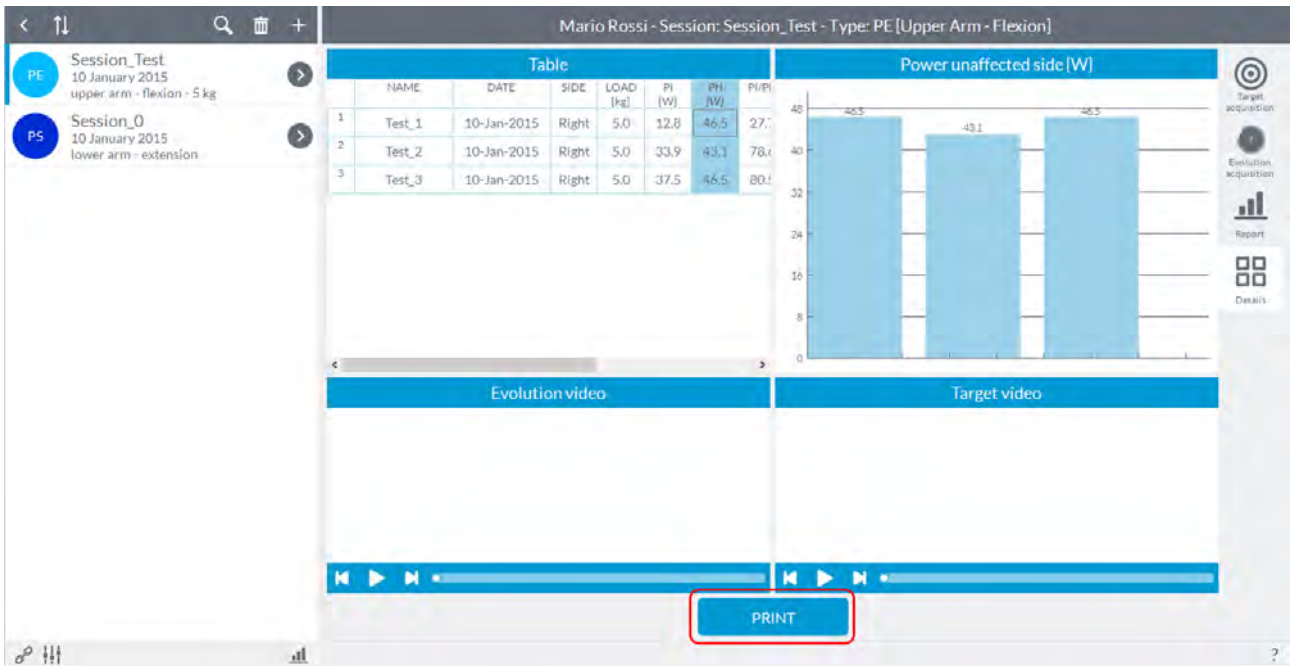
To view the video, simply click on the number to the left of the name of the test in order to highlight the test itself. At this point it will appear the first frame of the two video and clicking on the "**Play**" button will start the execution of the video you want. You can view the video going forward or backward frame by frame using the appropriate buttons on the sides of the button "**Play**".



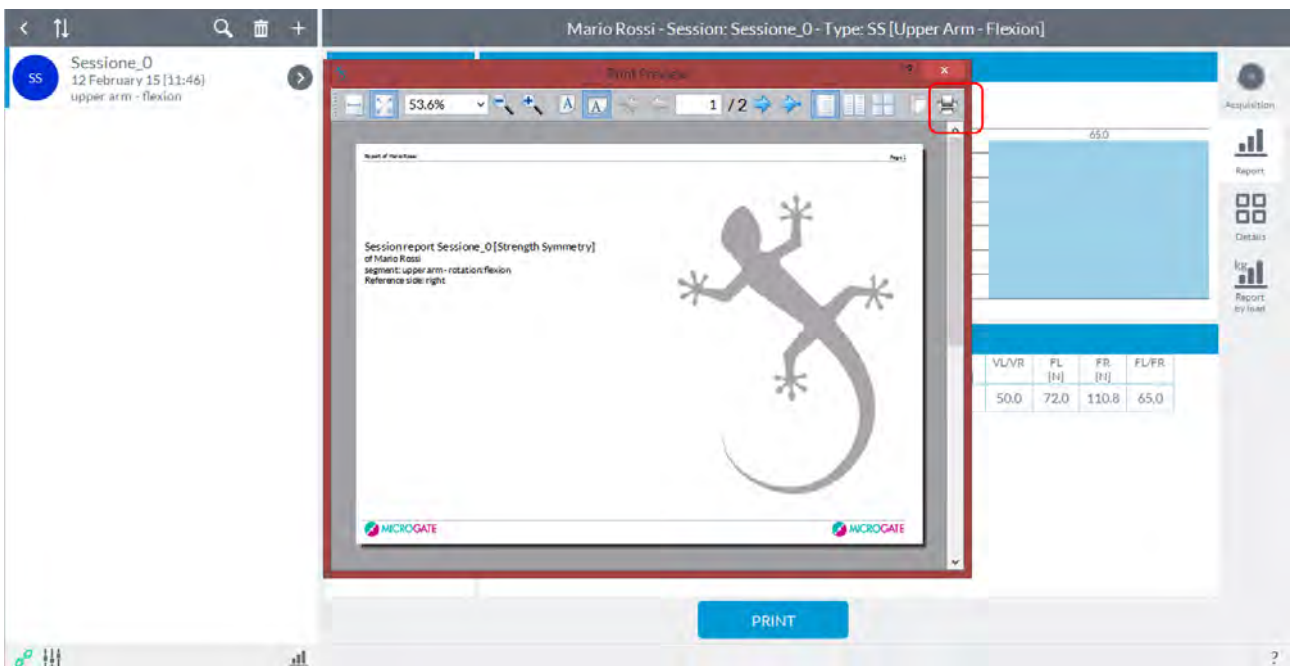
**NOTE:** in the sessions “Symmetry” the videos will nominated “Left Side Video” and “Right Side Video”, while in the sessions “Evolution” will nominated “Evolution Video” and “Target Video”.

### 6.4.2.1 PRINT OF DETAILS

As for mode "Report" for the "Details" you can print a pdf file with the contents displayed in this mode. Simply press the "Print" button at the bottom center.



It will open the following window:



At this point, pressing the button highlighted, it will open a new Explorer window where you can specify the destination and the name of the file.

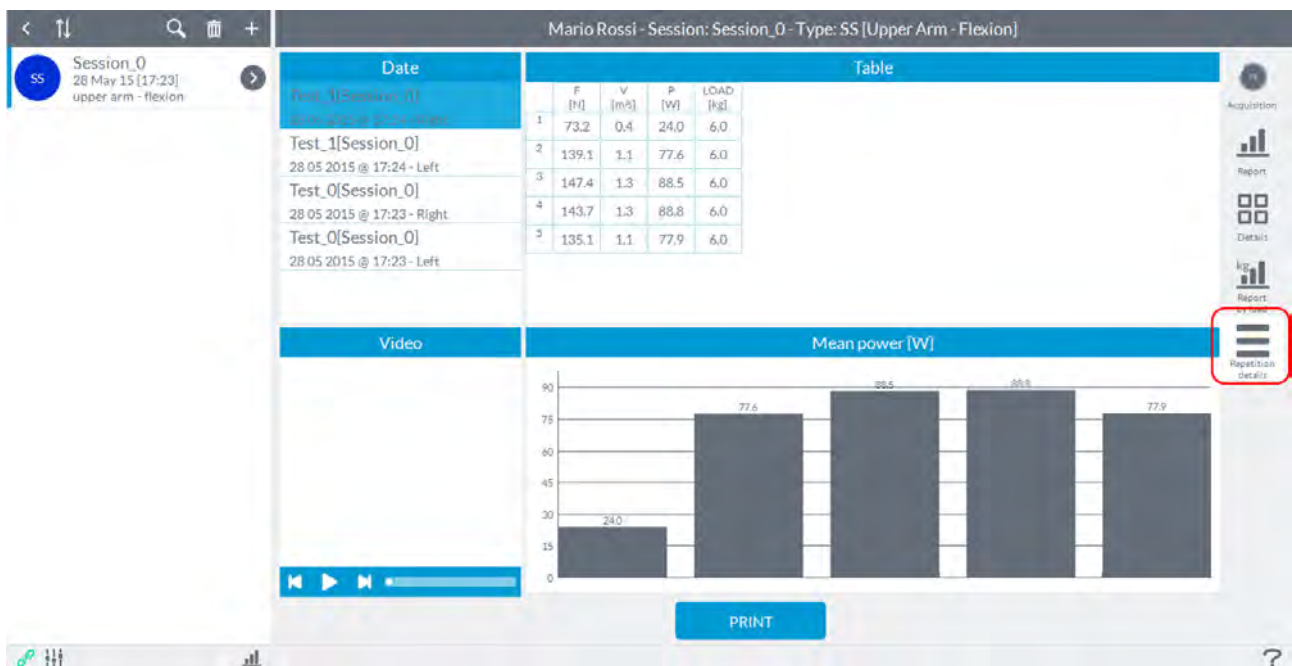
### 6.4.3 CURVES

For sessions **ROM** there is an additional tab that allows the user to view graphs of the performance of the angle and the angular velocities (along the three axes x, y and z) during the test run:



### 6.4.4 REPETITIONS DETAILS

For sessions of **Power** there is an additional tab that allows the user to see in detail the values of strength, power and speed of individual repetitions performed during the test:

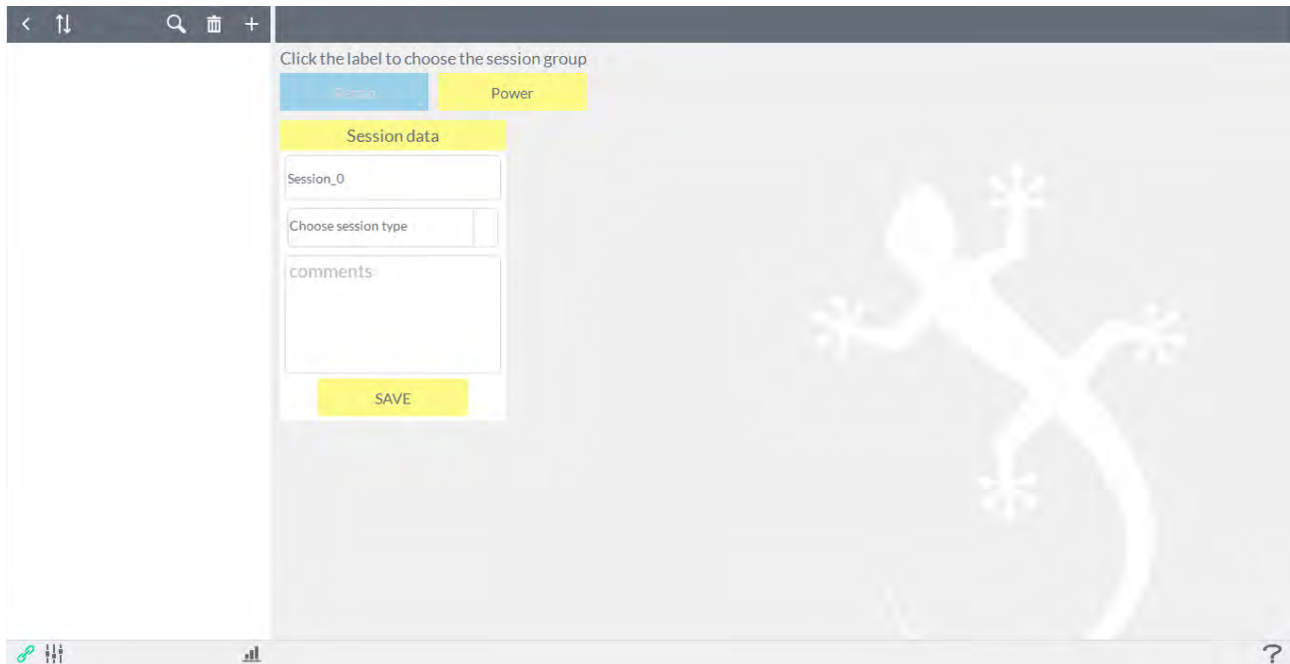


From this window, you can also delete those repetitions that you not consider necessary to assess or which have been performed incorrectly. Is sufficient in this case, click with the right mouse button

on the number of repetition present in the Table button and click "**Hide**", the same can be done by clicking the right mouse button on the histogram in the chart below.

## 6.5 POWER

By clicking on the "**Power**" label opens the following window:

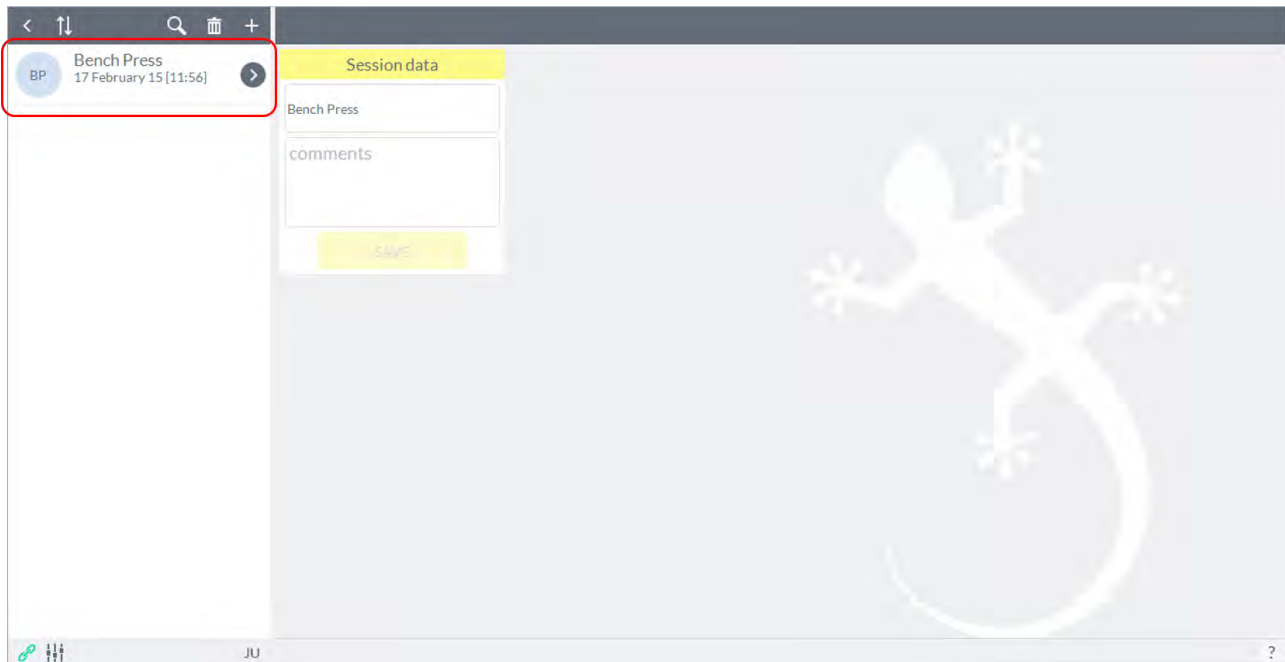


To create an evaluation session must perform the following steps:

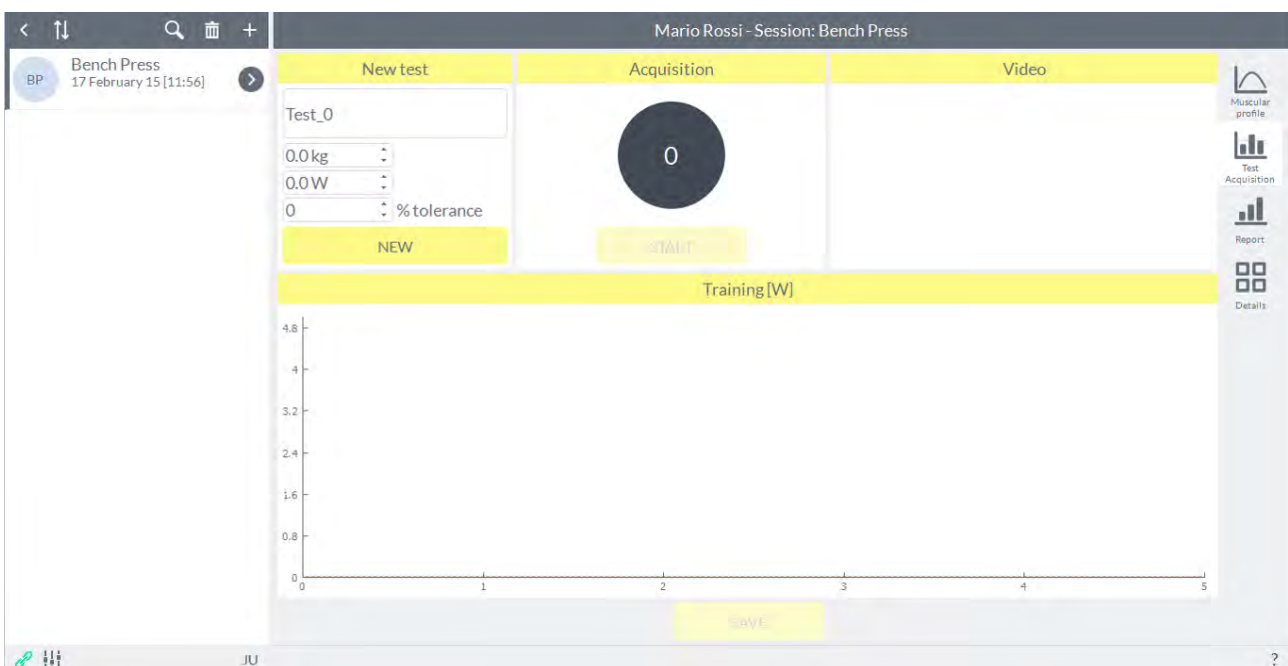
- Enter the name of the test (required), the software set-default for the name is "**Session\_0**" with increasing numbering to follow;
- Choose the type of session from the menu "**Choose the session type**" (required) between:
  - **Training**: performance monitoring during exercise and estimation of 1-RM;
  - **Jump**: tests of jumps;

### 6.5.1 TRAINING MODULE

The user can specify the name for the session: you should create a specific session for a certain type of exercise (depending, for example, the type of machine used or the type of exercise performed, for example, "leg press", "squat ", " lat machine "etc ...). By pressing the "**Save**" session will be recorded in the database and will now be present in the corresponding session list on the left:



To begin testing for the session you just created is necessary to enter in the session by pressing the arrow next to the name of the session. This is the screen that will appear:



At the top right are four tabs that characterize the four functionality of the TRAINING module. By default, the software is opened in "Test Acquisition".

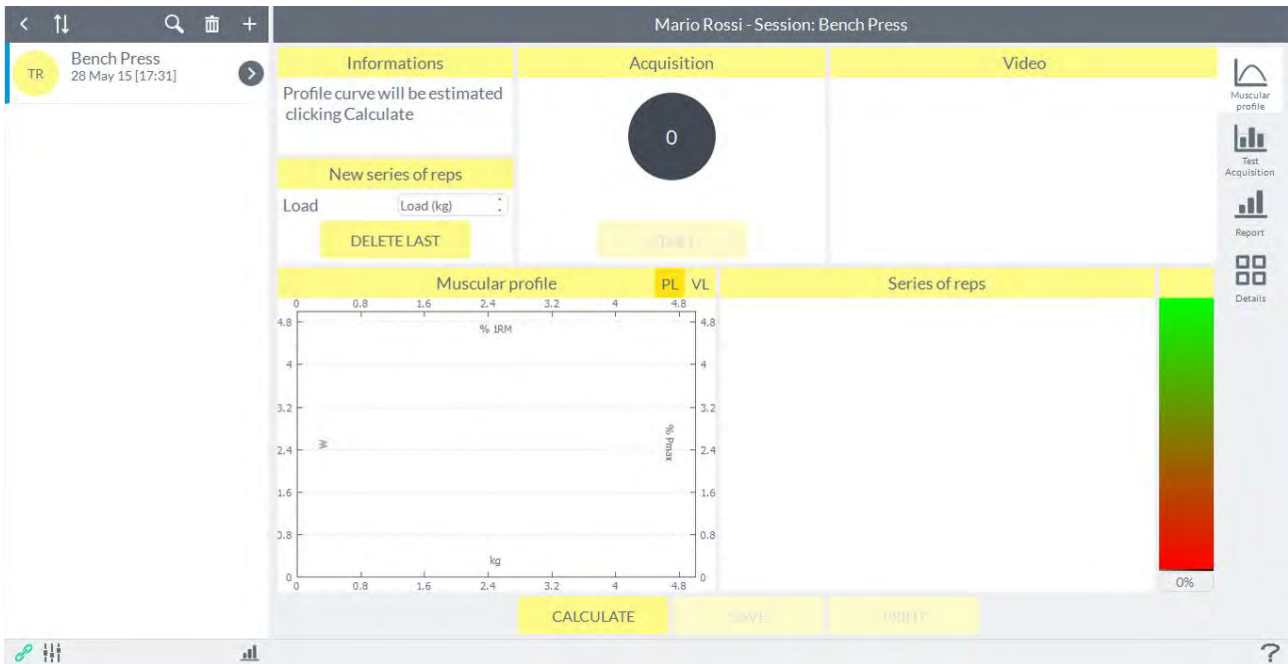
At this point the user can decide whether to create a muscular profile or make a test workout by pressing on the buttons labeled "Muscular profile" or "Test Acquisition".

## 6.5.2 FUNCTIONALITY OF TRAINING MODULE

### 6.5.2.1 MUSCULAR PROFILE

The interface concerning the muscular profile looks like this:

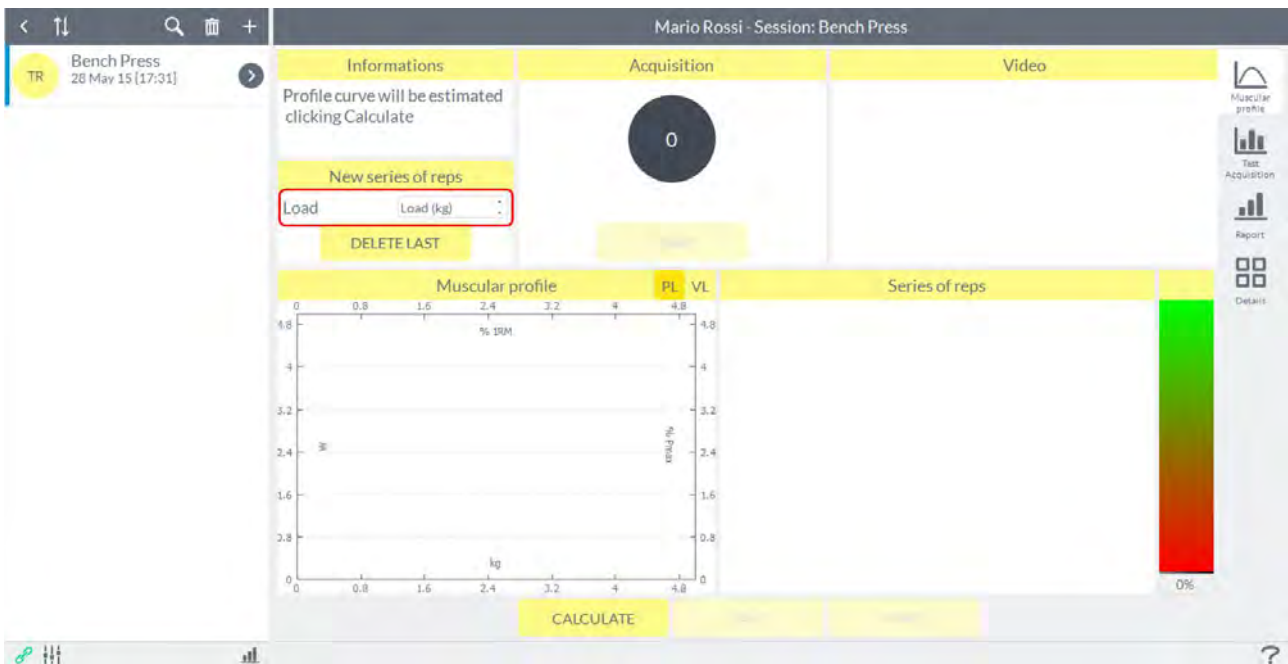




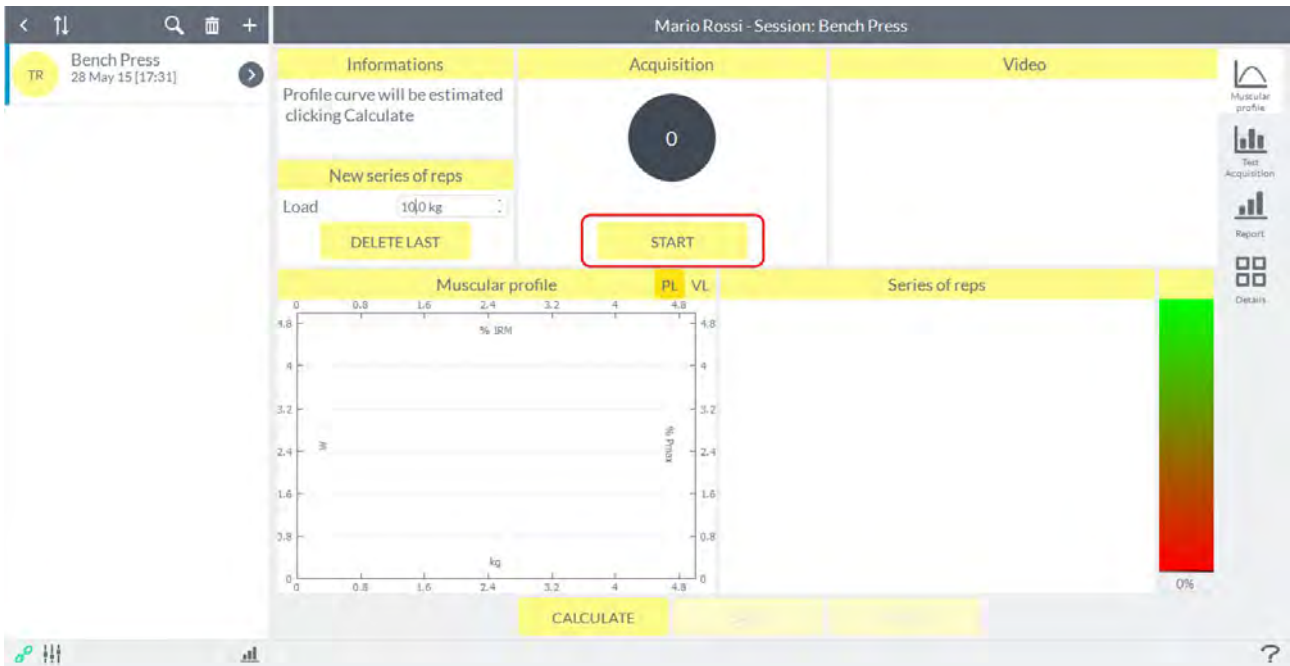
To build a muscular profile should be administered at least three increasing loads; each individual load represents, then, a series of repetitions; the number of repetitions is at your own discretion.

NOTE: during the construction of a muscular profile, the protocol of the test is crucial to obtain an accurate estimate of the theoretical maximum load (1 RM). Refer to paragraph 2 Appendix B and point 6 of the [Troubleshooting](#) section for suggestions about the protocol to follow.

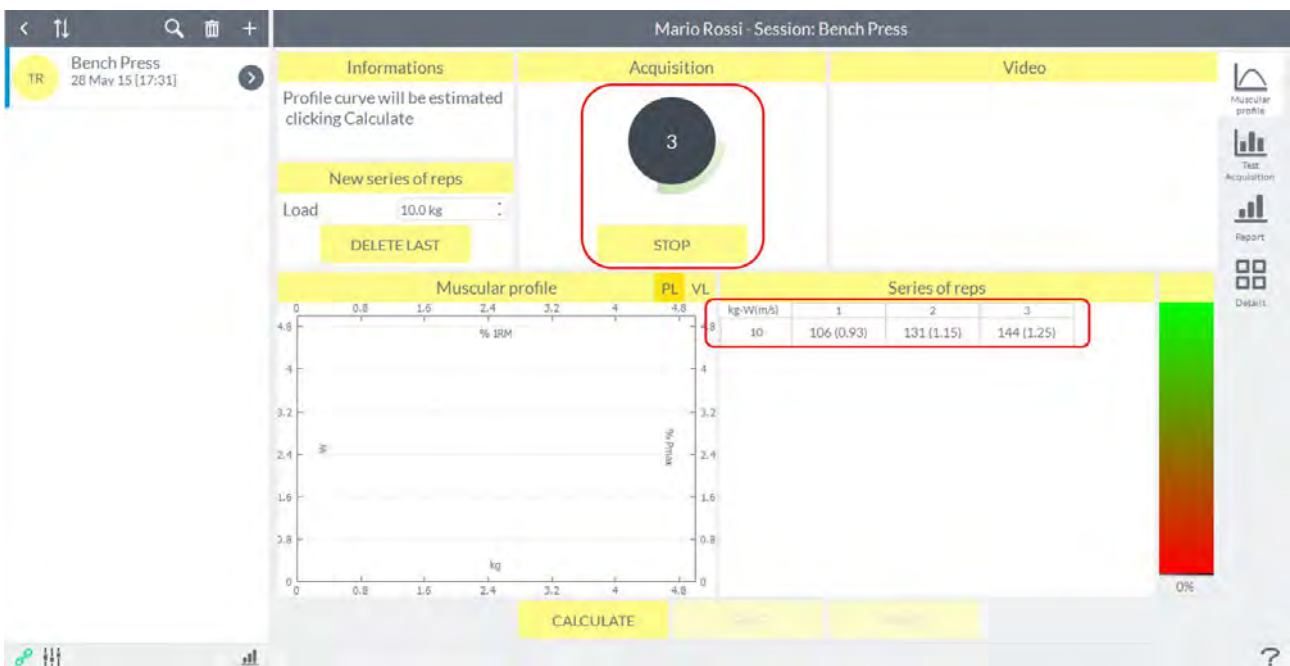
Before pressing the start button acquisition is necessary to enter the load that the user is going to raise in the box shown in Figure otherwise start key will not activate for the acquisition:



At this point you will activate the "**Start**" button to start the acquisition:



Only if the device is in the static phase, the software will generate an acoustic signal and the opportunity to start the test (refer to paragraph 1 Appendix B for more details on the generation of the acoustic signal). The number of repetitions performed and the corresponding power values are shown in real time:



For each repetition performed, the software also will emit an acoustic signal.

To end a series of repetitions the user must press the button "**Stop**" which will return to "**Start**" as soon as it is pressed.

At the end of each series of repetitions the software will notify the series carried out and its load in the lower right corner. At the top left, however, the software will recommend gradually if it will be necessary to conduct further series of repetitions, increasing the load. Refer to paragraph 2

Appendix B for further detail regarding the criteria by which the software suggests whether to make further series of repetitions, increasing the load.

The "Save" button will not be active until the construction of the muscular profile will not be completed.

Completed the first three series, clicking on "Calculate" will be given an indication of the maximum theoretical. The maximum theoretical estimated by the software (1 RM) and the load with which it is expressed the optimum power will be shown in a message on the upper left above the graph of muscular profile as shown in the figure below:



If the construction of the profile is successfully completed, the software will show the following message notification:

*"Muscular Profile correctly estimated"*

If the software was not able to build the profile muscle mathematically (not detected significantly decreasing speed at the three loads that were administered, see section 6 of the [Troubleshooting](#) section), the power-load curve will not be displayed and the software will indicate in the message at the top to still perform a series with a greater load.

If instead the software has been able to build muscle profile mathematically (curve-load power is shown) but believes that the estimated 1 RM can be improved, then the notification message will be as follows:

*"For a better estimate 1RM we recommend a further series to a greater load of X kg"*

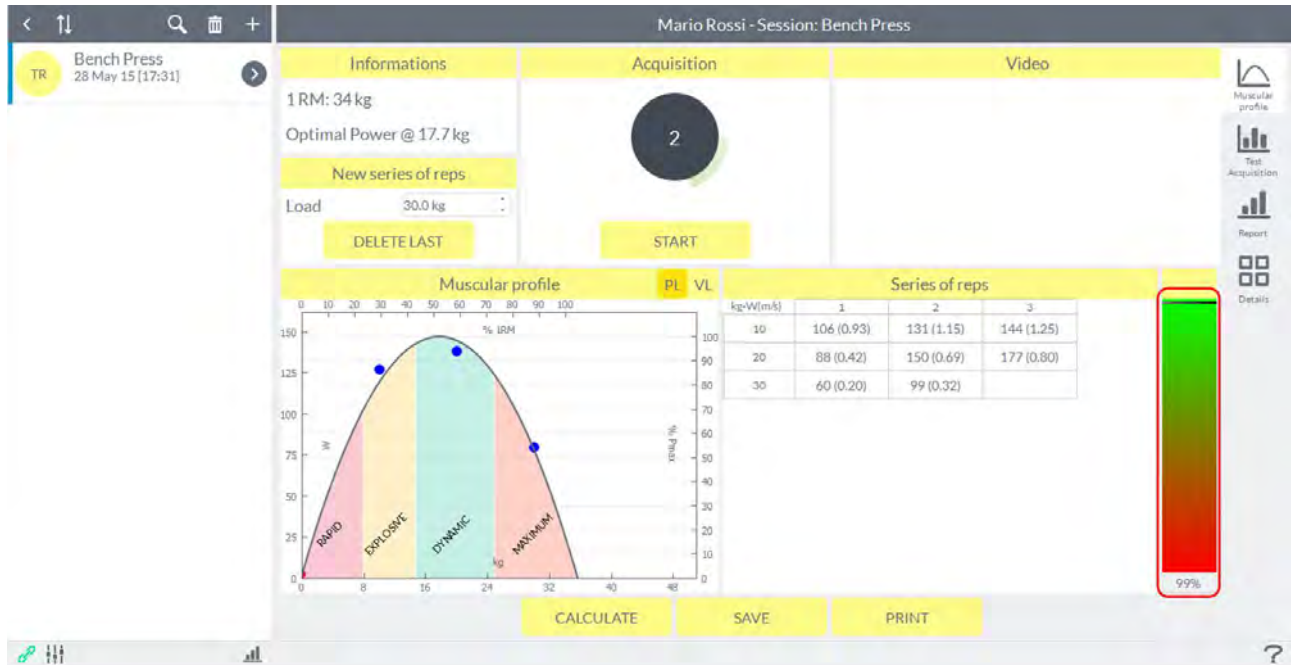
where X is the load used in the latest series of repetitions performed.

This is to further improve the accuracy of the estimated 1 RM. Refer to paragraph 2 [Appendix B](#) for clarification of the criteria by which the software suggests to make an additional series of repetitions, increasing the load.

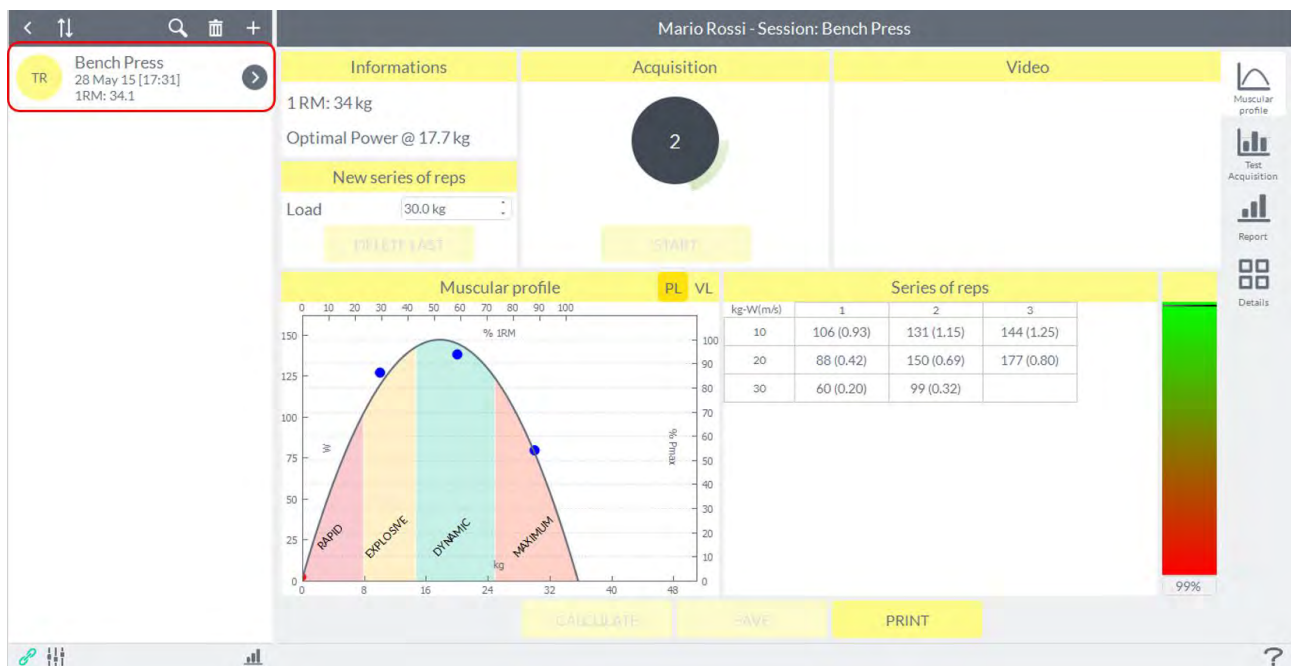
It is therefore advisable that the notification message is of the type:

*"Muscular Profile correctly estimated"*

To further confirm the good estimation of 1-RM there is to the right of the screen, an index of reliability (as a percentage) that denotes the quality of the estimate obtained:

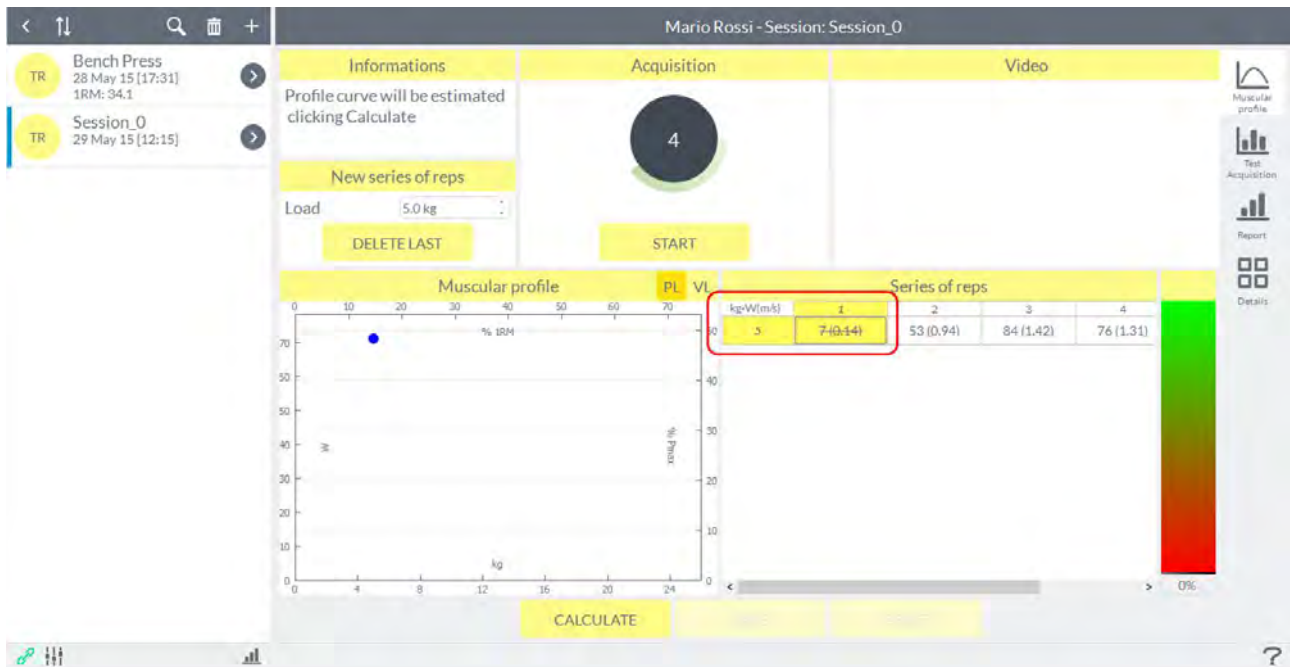


At this point the user can choose to repeat the last set of repetitions performed, or register your profile just built by pressing on the button **"Save"**; in this case the name of the session shown in the left list will be automatically marked with the value of 1 RM estimated to notify the fact that for that particular training session was carried out and completed a muscular profile:



NOTE: During the construction of the muscular profile software applies a set of automatic controls excluding automatically, for each series, any repetitions that turn out to be insignificant.

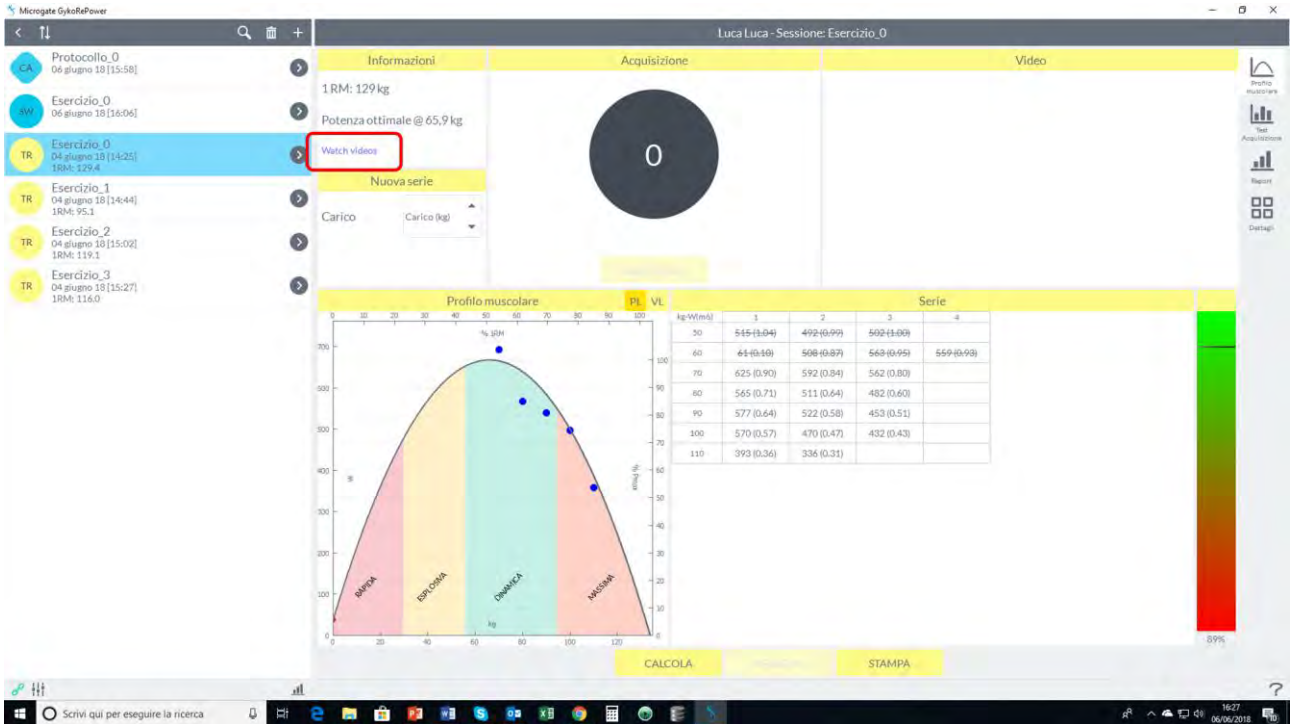
The software also allows the user to intervene in the process of building the muscular profile being able to exclude one or more reps who reputedly not be valid (execution errors etc ...) with a double left mouse click on the cell that you want to exclude from calculation of the muscular profile; the cell, which shows the value of power and speed (the latter in parentheses), be distinguished from a horizontal bar:



To include again the repetition it will be enough to make the same operation.

NOTE: This process of elimination of repetitions is only possible before the registration of the profile, once you press the button "**Save**" will no longer make changes to the profile.

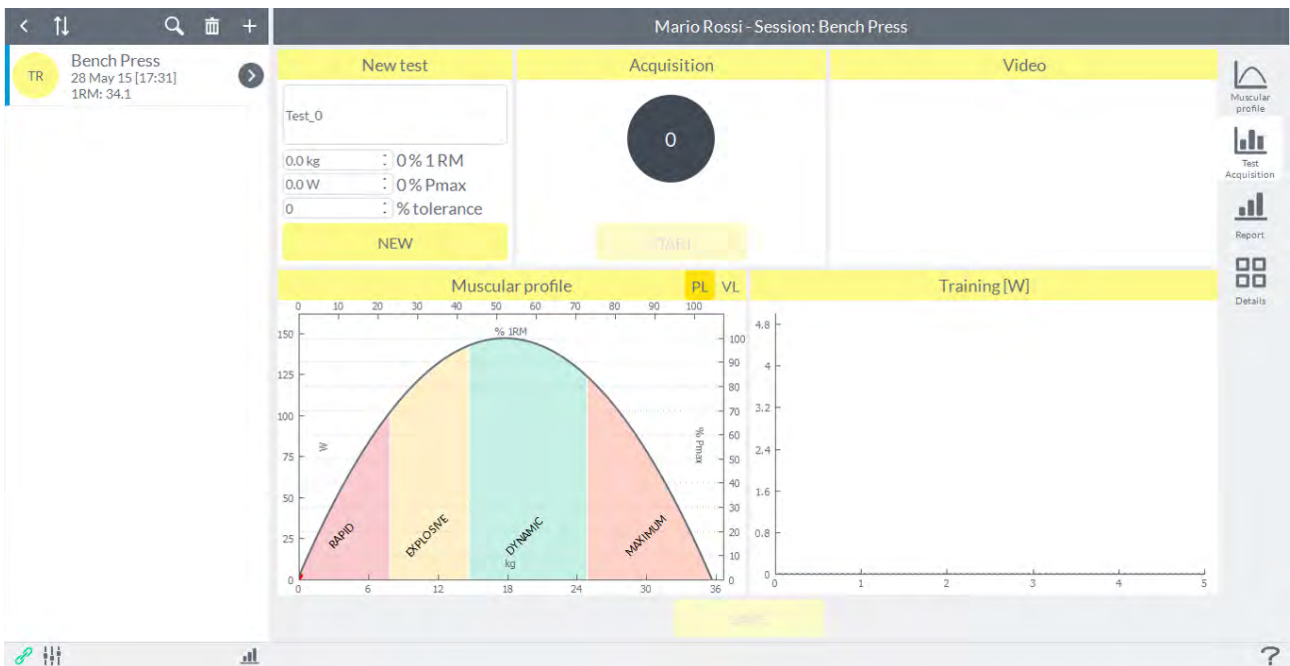
It is possible to record videos during the execution of each series with the different loads and cover them, always after the recording, by clicking on the "**Watch Videos**" button in the box on the top left.



### 6.5.3 TRAINING ON MUSCULAR PROFILE

For training it means the mode with which the user can monitor in real time the powers expressed by the athlete during a series of repetitions. Each exercise, therefore, consists of a series of repetitions.

To access the monitoring mode of training with biofeedback in real time, simply press on the icon "Test Acquisition" between the four icons at the right of the screen. If for that particular assessment session there is a muscular profile, this is the screen that will appear:



At the top there is a field is not mandatory where the user can enter a name for the series that is going to perform. The graph below shows the muscular profile created for the evaluation session from which the user can choose the workout area in which to train their athletes.

Choose the workout area means click with the left mouse button at a given point of the curve depending on the percentage of maximum power or 1 RM that the user has chosen to train your athlete:



In the highlighted box displays some settings related to the exercise you are going to run: the load (in kilograms and as a percentage of 1 RM) to be used and the value of power (in Watts and as a percentage of the maximum power) that athlete must express to stimulate the process of adapting muscle that you are searching for. The "**Tolerance**" (as a percentage) is a percentage of tolerability compared to the criteria previously set to workout and is calculated from the values of power set.

It is also possible to determine these values training also acting directly in the appropriate fields and setting these parameters manually.

To the right of the graph there is a second pane, where they will be displayed in real time histogram that represent, one for each repetition, the powers expressed by the athlete during the lifting of the load. On the graph are two horizontal lines of orange and red color that represent, respectively, the upper and lower limit (tolerance) of the threshold set work:



To start the acquisition just press the button "Start" and wait for the acoustic signal from the software. To end acquisition just press the same button which in the meantime will become "Stop". This is what will be shown to the user during an acquisition:



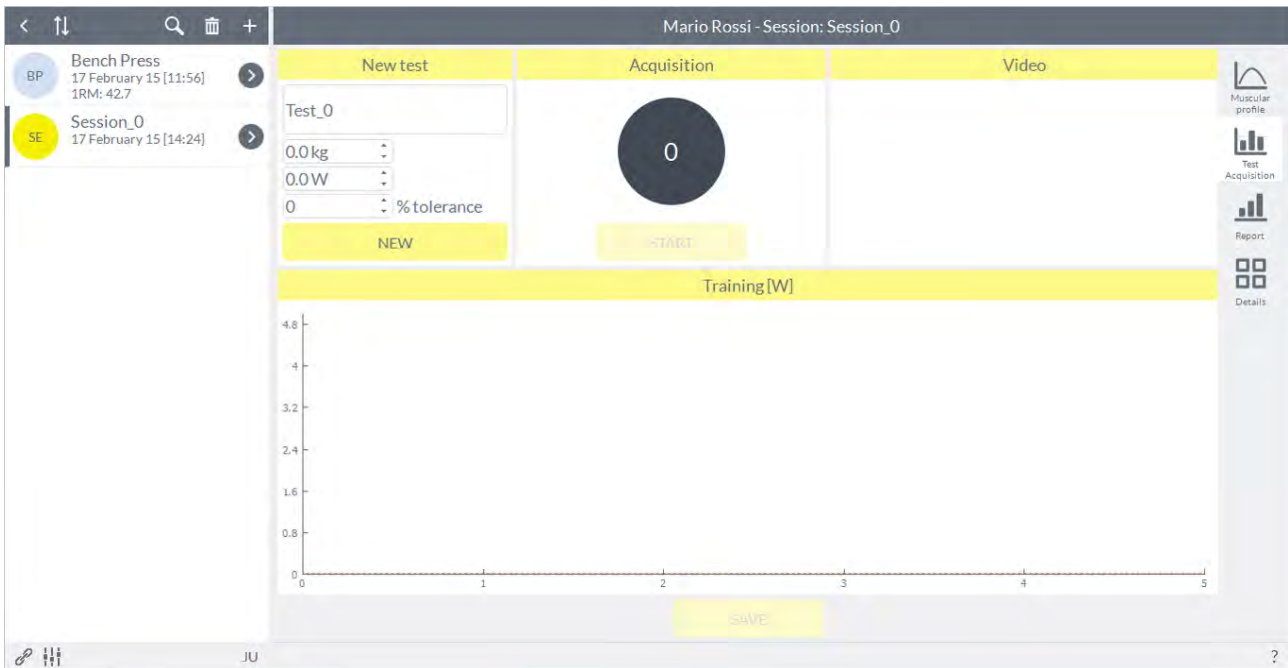
Color code green, red and light blue respectively represent a repetition performed within, below and above the working threshold choice. The user can now decide whether to repeat or record the exercise just made. In the second case, the information relating to the exercise just made may be subsequently accessed by the functionality of the "Report" and "Details" (see paragraphs below).

NOTE: If you leave this page (for example by pressing the arrow in the upper left to return to the home screen of the software) without pressing the "Save" button, the information about the exercise just made will be lost.



### 6.5.3.1 FREE TRAINING

If you are performing a training exercise in an assessment session in which you have not created any muscular profile, this will be the screen that will be presented to the user:



At this point the user must enter the load manually in the appropriate field. All histograms that will be presented during the exercise will be yellow because no power threshold has been inserted:



However the user can add the power threshold manually, for example after he has recorded the powers expressed with a given load during a series of repetitions of "calibration". At this point, the horizontal lines of upper and lower limit threshold of the work will appear similar to an exercise workout based on muscular profile.

### 6.5.3.2 REPORT

In "Report" will be summarized information related to training exercises carried out in that specific evaluation session: the upper graph shows the average and maximum values of power, while the graph below will show the number of repetitions below, within and above threshold:

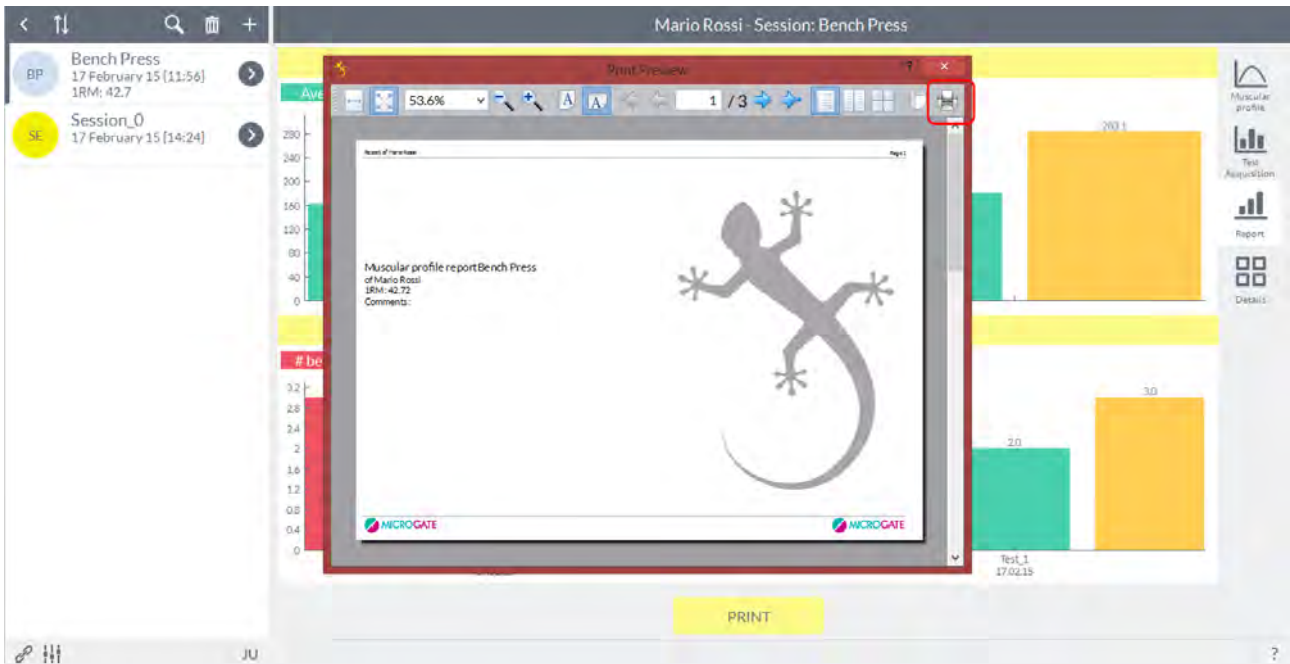


### 6.5.3.3 PRINT REPORT

The print function of the **Report** data is available from the following key:



This will open the following window:



By clicking on the print icon, as shown, will open an Explorer window where you can choose the destination folder for the file and give it a name.

#### 6.5.3.4 DETAILS

In "**Details**" the user can view, by selecting the series from box "**Data**" in the upper left, the powers and speeds of the singles repetitions of each series carried out. The name of each series will be characterized by the load used and the date of registration:



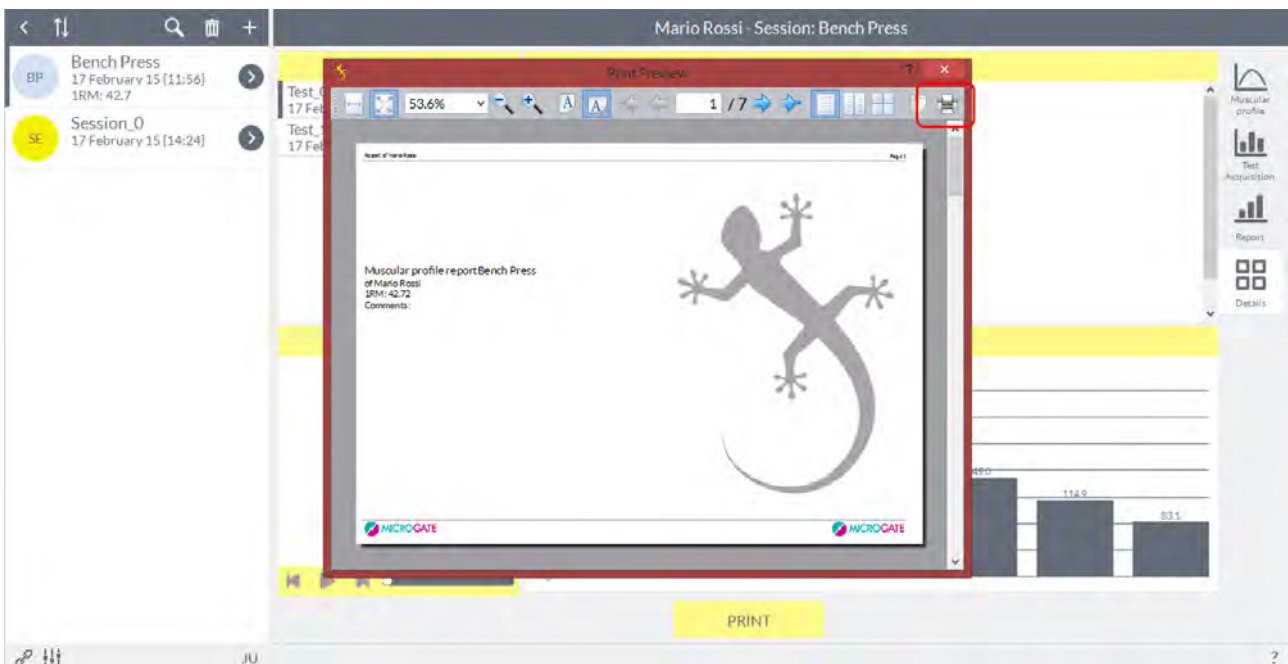
The user can choose which parameter to display on the graph simply by double clicking on the index of the parameter in the table above. Once you select a number from the box "Video" will be able to review the test if it was recorded by a camera.

### 6.5.3.5 PRINT OF DETAILS

The print function of the Report data is available from the following key:



This will open the following window:



By clicking on the print icon, as shown, will open an Explorer window where you can choose the destination folder for the file and give it a name.

### 6.5.3.6 DELETE A TEST

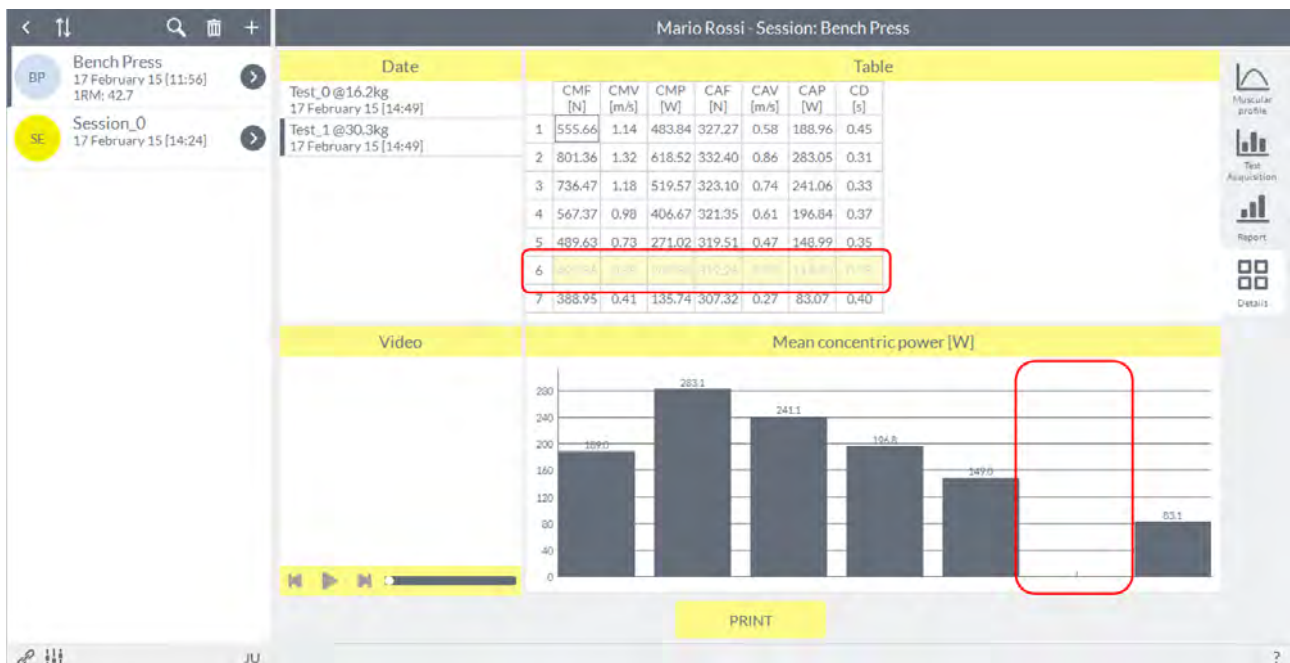
From the window "Details" you can delete the test by clicking with the right mouse button on the selected series in the list at the top left. Indication will appear "Delete" and you can proceed with the elimination of the test.

NOTE: You can delete only one test at a time.

### 6.5.3.7 HIDE A REPETITION

Always on "Details" is possible, selected a test, hide one or more repetitions of the series performed if, for example, the system has detected a repeat "false" or just want to remove from the calculation of the average values of the data that repetition .

You can do this by clicking with the right mouse button on the number of repetition of the box "Table" where an indication "Hide" will appear and, once selected, you will see blurred the line corresponding to the repetition and at the same time will disappear from its histogram graph below. It is also possible to eliminate the repetition directly by clicking on the histogram on the repetition to hide.



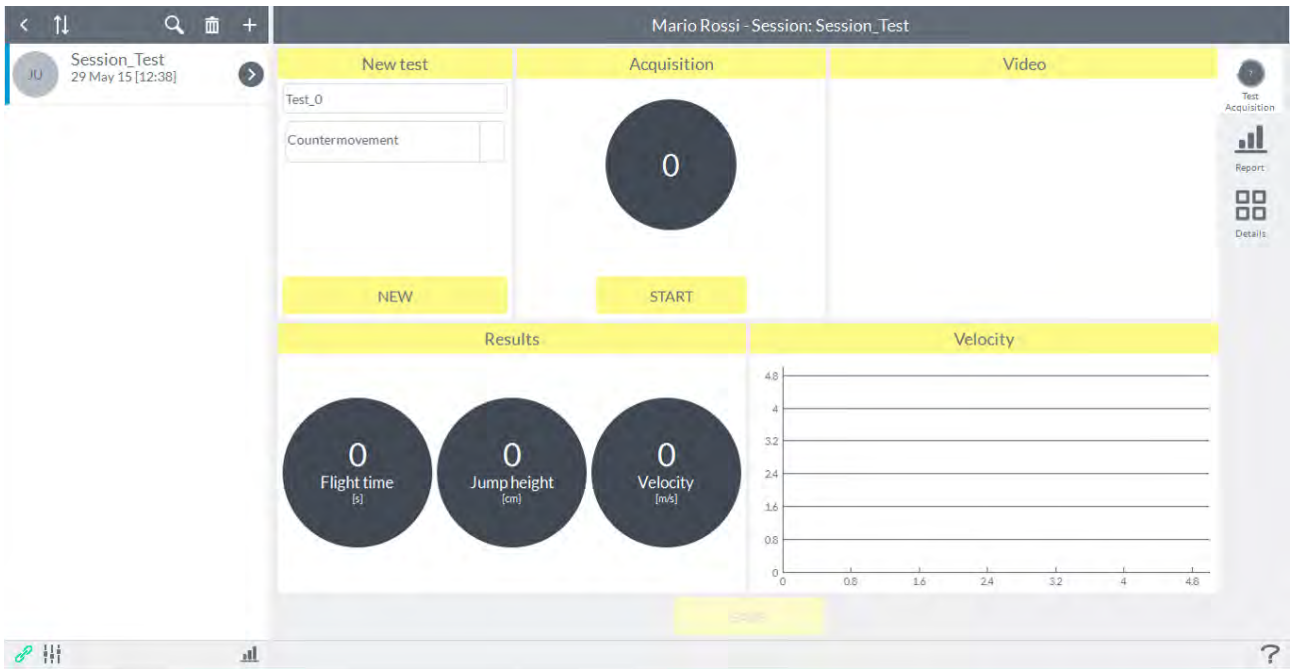
To reinsert the repetition hidden just repeat one of the two transactions described above and to click on "Show".

### 6.5.3.8 EXPORT DATA

The data export function allows the user to export the file type ".csv", subsequently importable into an Excel spreadsheet (see [Appendix D](#)) where you have all information relating to the current assessment session. From the "Details" just click with the right mouse button anywhere on the box "Table" and will appear indication "Export as file", then it will open an Explorer window where you can choose the destination folder and the name for the file.

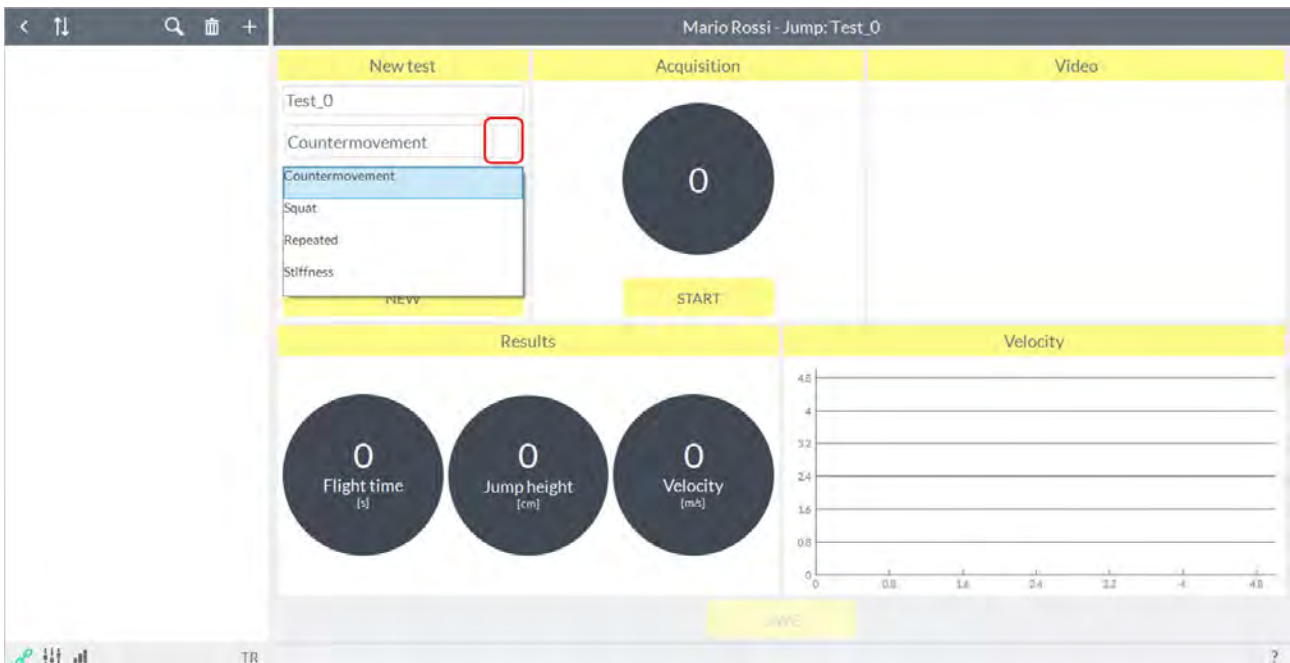
## 6.5.4 JUMP MODULE

The screen for creating a test jump will be as follows:

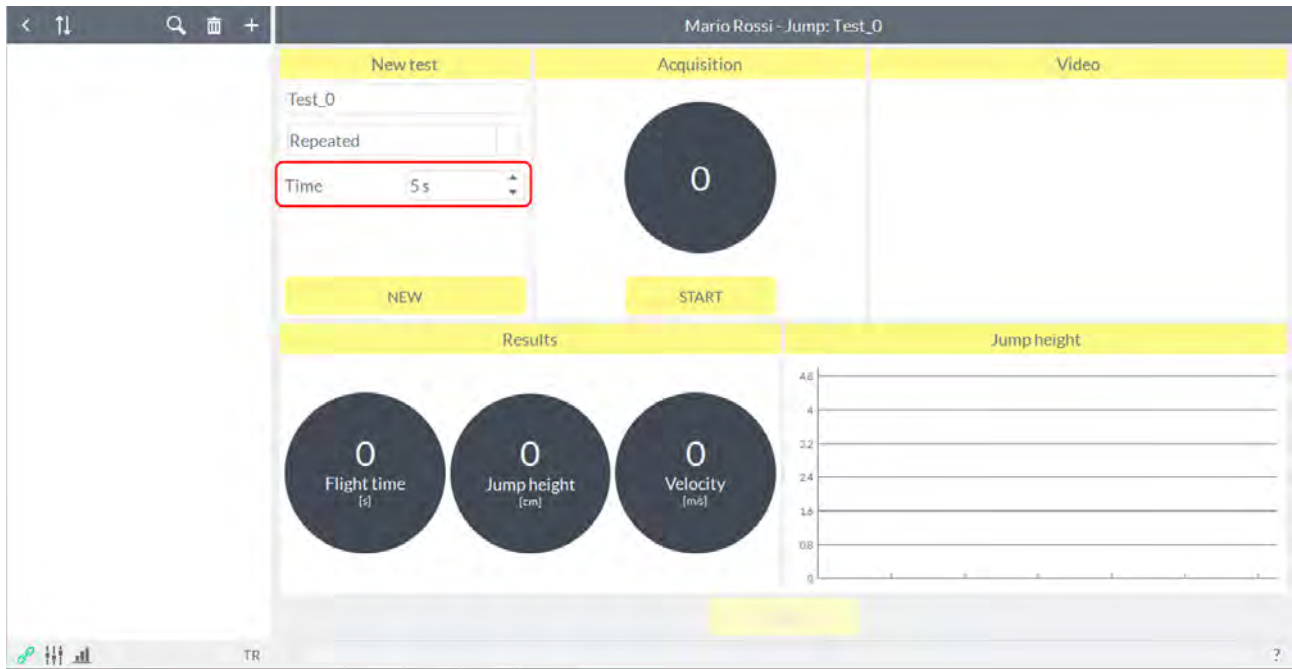


The user can specify the name for the test, or leave by default the name assigned by the software that is "Test\_0" for the first test with an incremental number like "Test\_1", "Test\_2" etc. for subsequent tests (regardless of the type of jump you choose).

The type of jump is selectable via drop-down menu that is activated by pressing the button as shown in the figure below (refer to [Appendix B](#) for the types of jump available):



The test "**Repeated**", when selected, requires user input. This concerns the duration of the test: by default software sets 5 seconds but this is modifiable by the user from 5 to 100 seconds using the appropriate field:



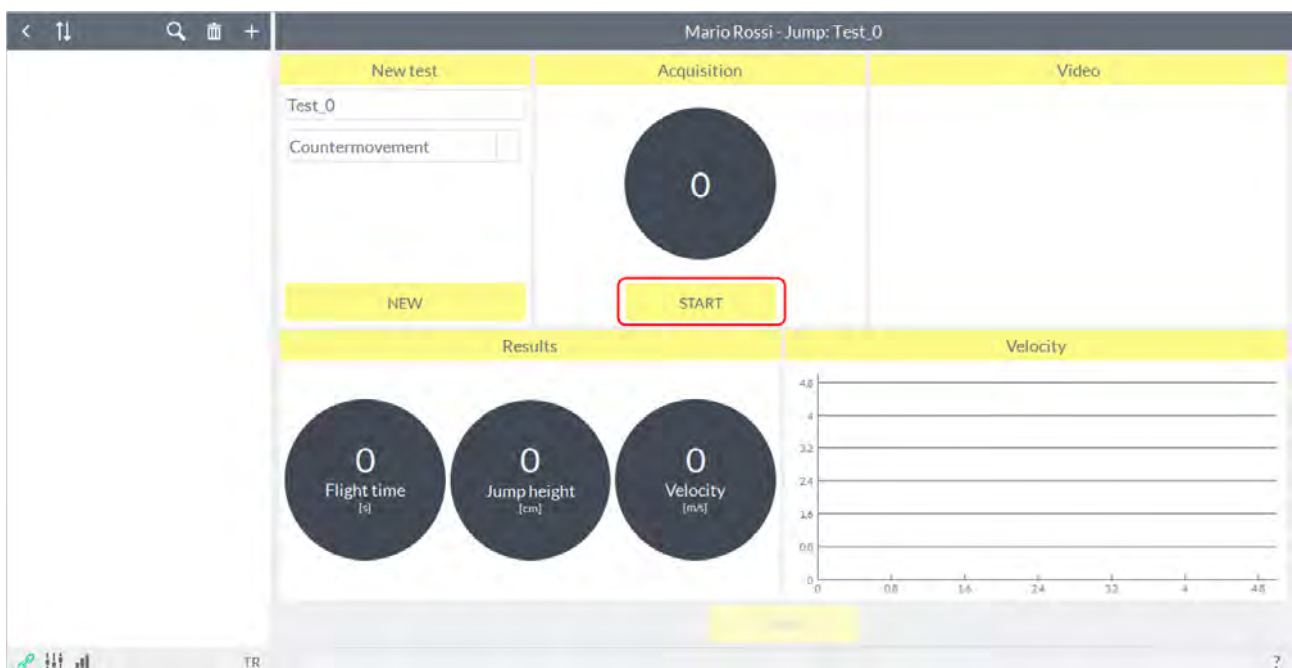
The user can terminate the acquisition of the test before the end of the countdown by asking the athlete to stop in a static position at the end of the predetermined number of jumps awaiting processing by the test software.

To the right there is the box "Video" projecting what is taken from the camera in use if active.

Below there is a preview of the results and to the right a graph showing the trend of speed in the mode jumps "Countermovement" and "Squat" and the elevations of the individual jumps modes "Repeated" and "Stiffness".

### 6.5.5 ACQUIRE A JUMP TEST

After choosing the type of jump to play to the own athlete, simply press the "Start":



NOTE: If the start button is disabled make sure that you connect the software to the device (the connection icon in the bottom left would be gray instead of green); if not, you can do so by pressing the connect button in the lower left.

### 6.5.5.1 HOW START TO ACQUIRE A TESTS

Just press the button "**Start**", the software will proceed to identify a static position. Make sure the athlete maintains a static position, otherwise it will not start the acquisition.

As soon as the software detects that static position, the software will give an acoustic sound after which the athlete can perform the jump. During the acquisition will appear "**Stop**" in place of "**Start**".

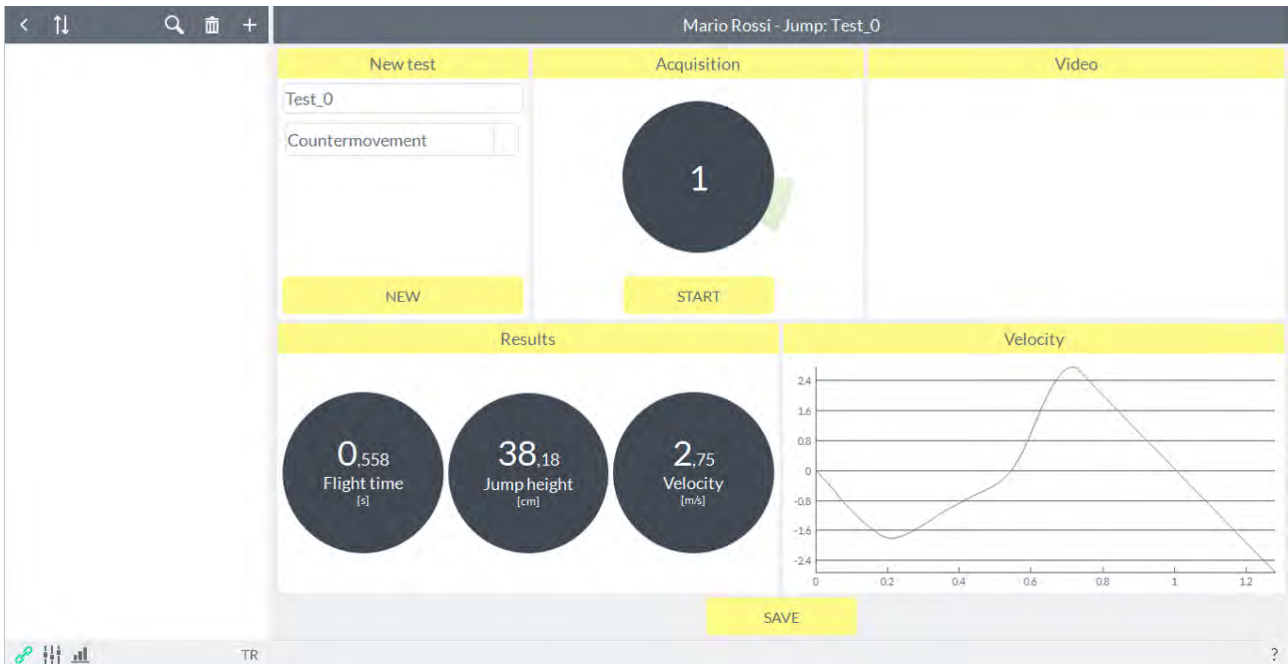


Refer to [Appendix B](#) for how to perform the various tests jump.

### 6.5.5.2 HOW END TO ACQUIRE A TESTS

On landing from the jump, the athlete returns to standstill in the starting position and an additional acoustic signal indicates the automatic closing of the acquisition (excluding the test "**Repeated**", where the acquisition may also be terminated automatically by the software at the end of countdown selected by the user). At this point, what you see is a preview of the results of the test just made:





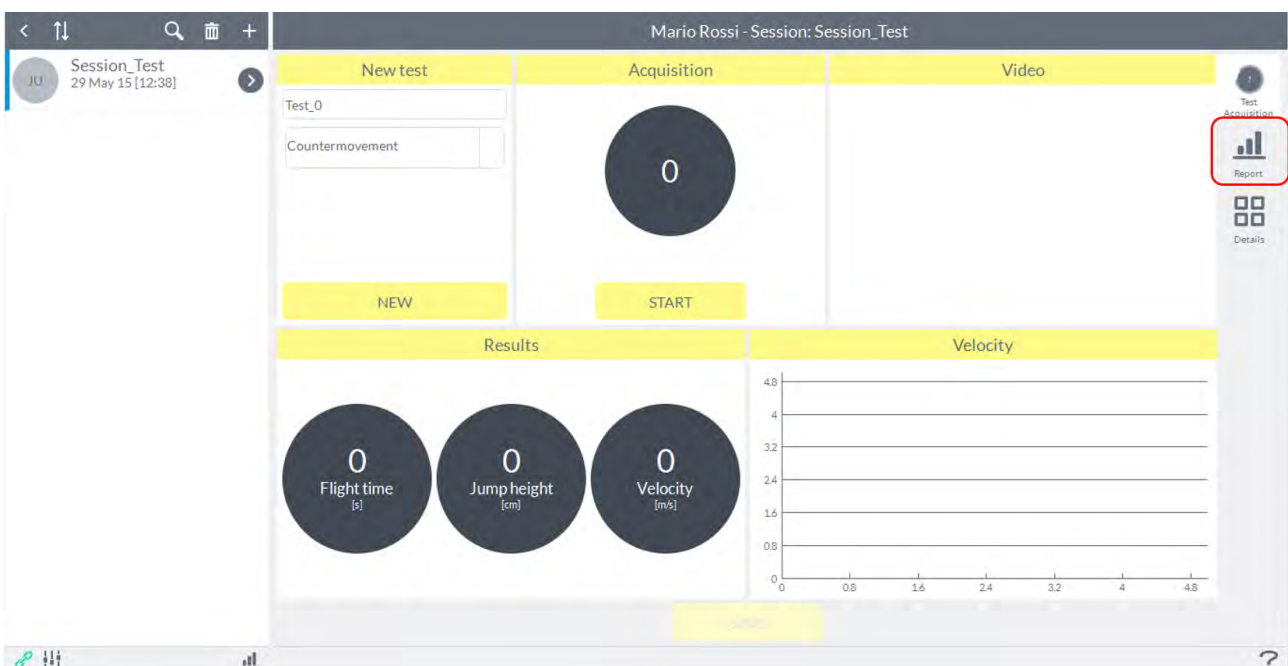
NOTE: there is no manual stop jump tests; if the user presses the button again to start acquisition (which during the acquisition of the jump becomes "Stop"), the jump is terminated and not registered.

### 6.5.5.3 RETENTION OF THE TESTS

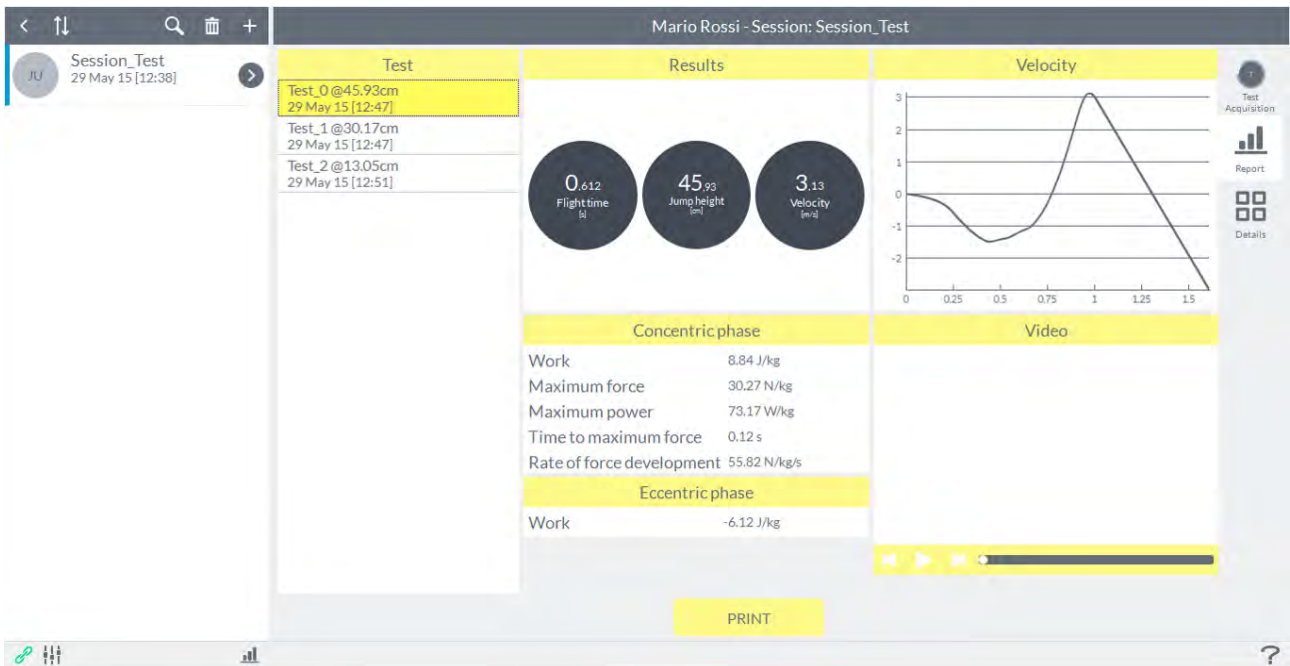
The user can press the "Save" or "New", respectively, in the bottom center and upper left under the type of test, to store or retest respectively. To redo a new test should always press "New" and the "Start" button will become active again to perform additional tests.

### 6.5.6 REPORT

To access the view of test results, simply click on the tab "Report" to the right of the screen:

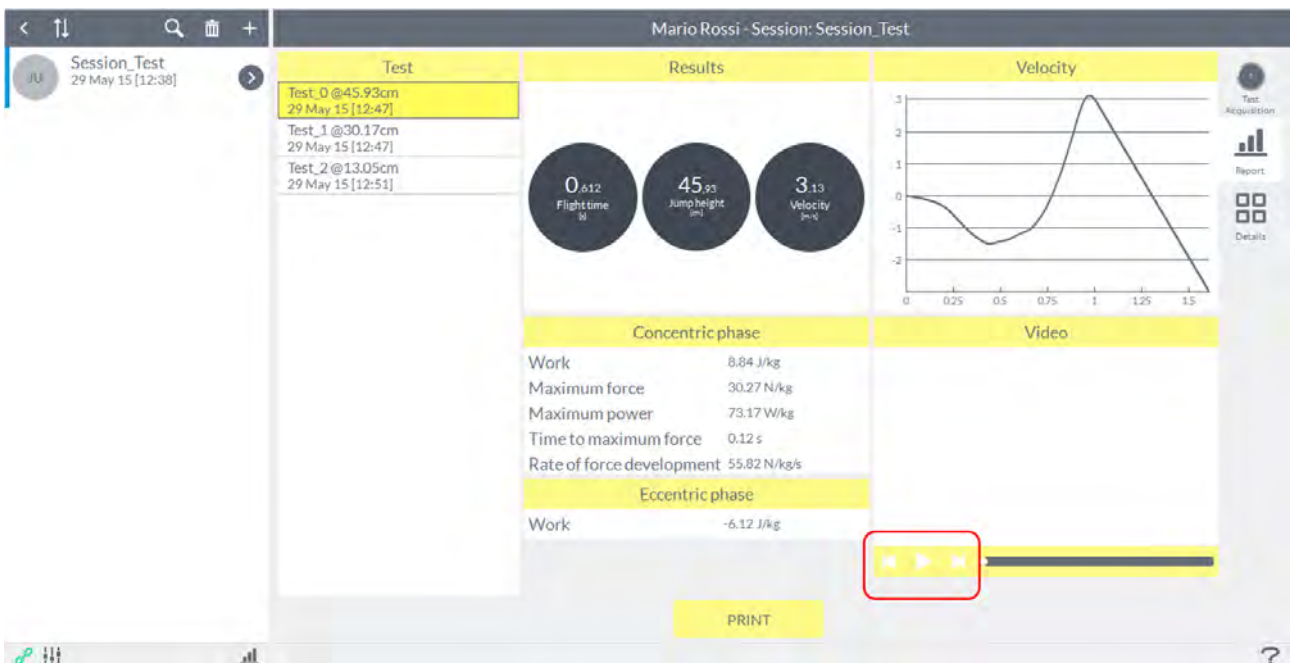


It will open the following screen:



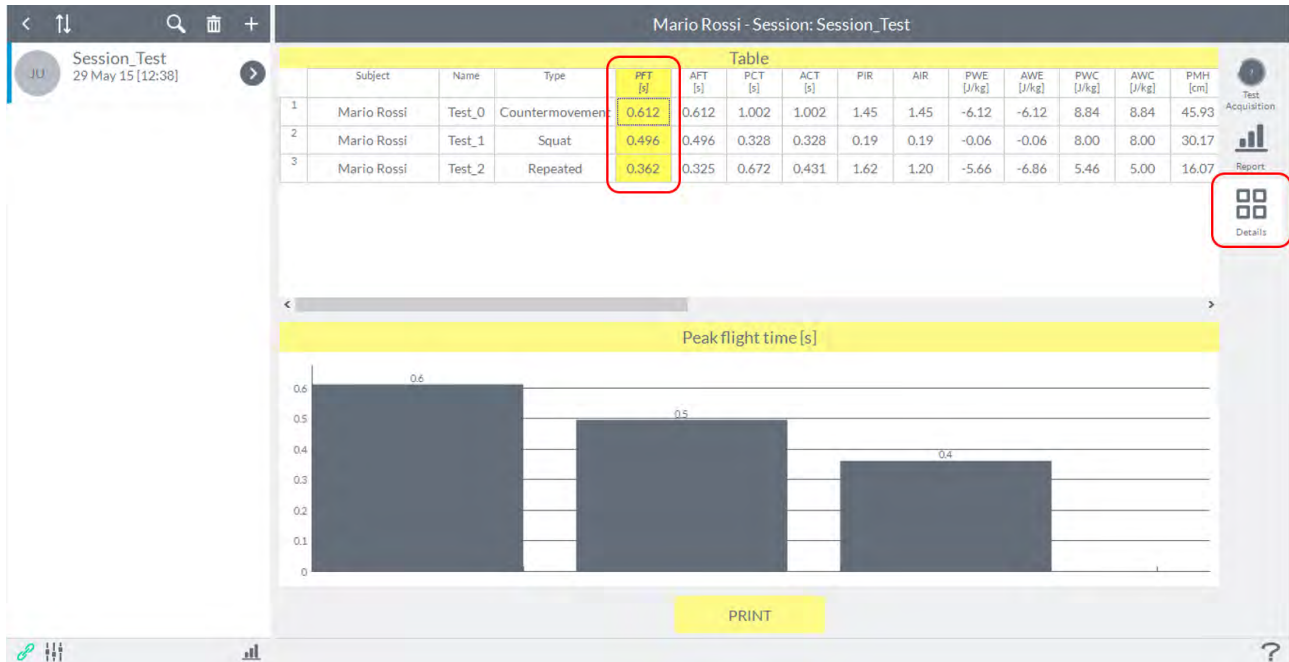
To view the results of a particular jump, simply click on the corresponding line in the list "Test" it will be highlighted in yellow.

In this window, you can review the test by playing the video using the "Play" button. You can view the video going forward or backward frame by frame using the appropriate buttons on the sides of the "Play" button.



## 6.5.7 DETAILS

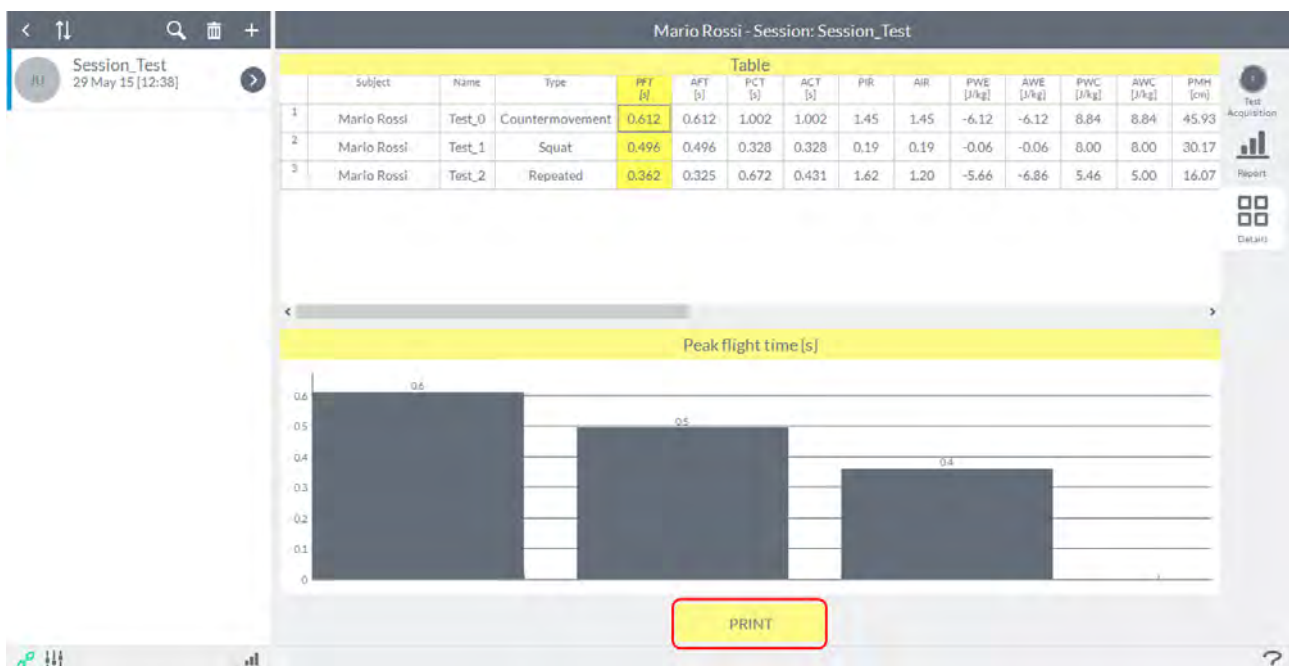
The tab "Details" on the right of the screen allows you to compare different jumps performed by the same person. you can also see in the chart below the values of a parameter of the different jumps by clicking the parameter in the same table:



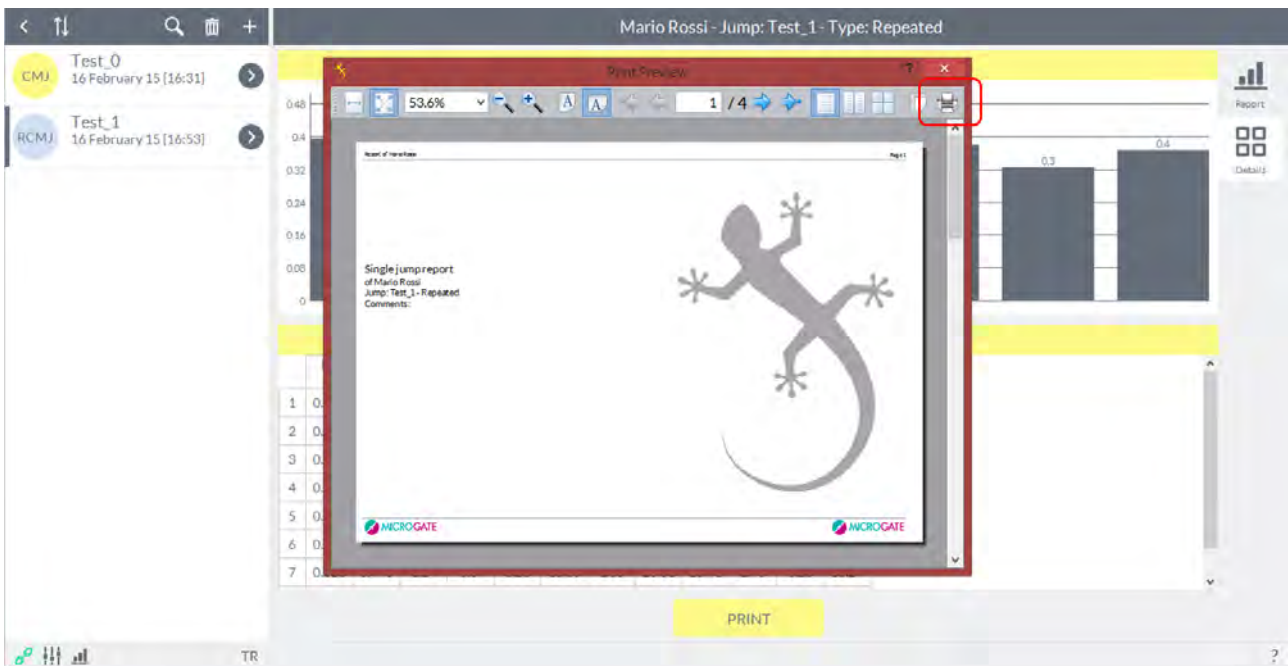
Refer to [Appendix C](#) for details of the variables analyzed.

### 6.5.7.1 PRINT OF REPORT AND DETAILS

You can print in PDF mode the results of the individuals tests recorded via the "Print" button, at the bottom center of the window, both in "Report" that in "Details" (in "Details" will printed the table and all the charts of the individual parameters):



It will open the following window:



By clicking on the print icon, as shown in the image, it will open an Explorer window where you can choose the destination folder for the file and give it a name.

### 6.5.7.2 EXPORT DATA

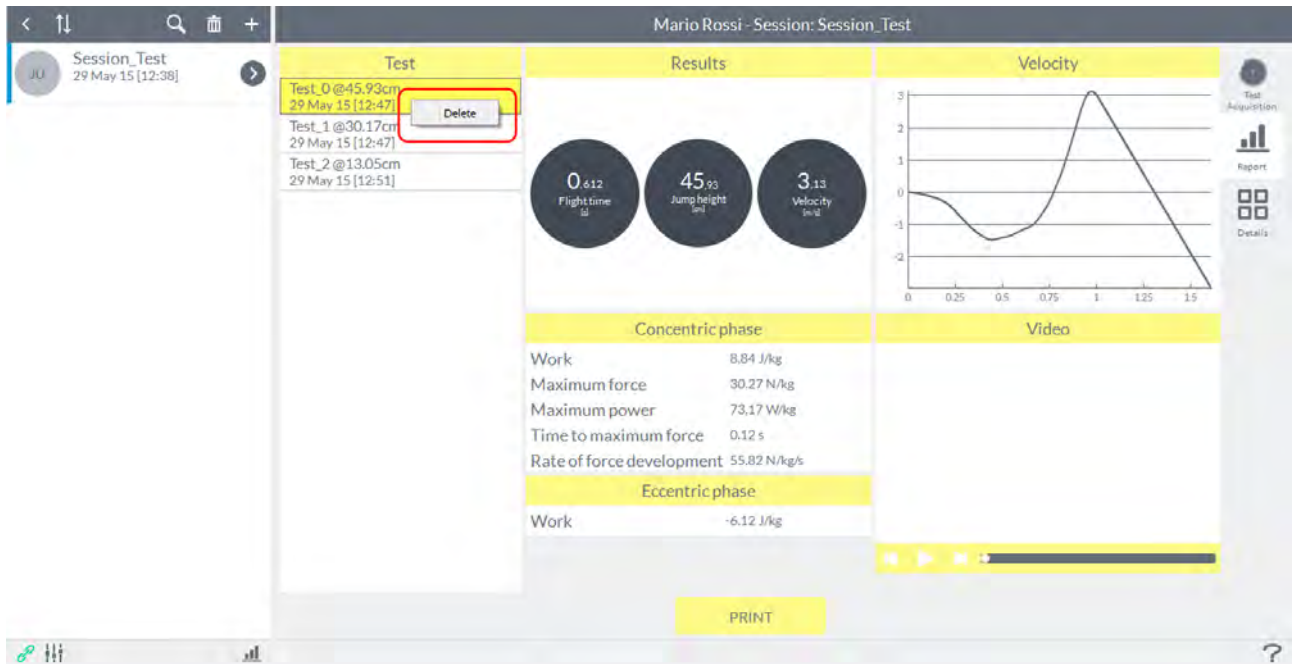
For kinds of jump "**Repeated**" and "**Stiffness**" you can export the numeric values in the format ".csv" importable on Excel.

Refer to [Appendix D](#) for how to import the file into a Microsoft Excel spreadsheet.

To export the results, from the "**Details**" window, just click with the right mouse button anywhere on the table with numerical values and will open an Explorer window where you can choose the destination and the file name.

### 6.5.8 DELETE A TEST

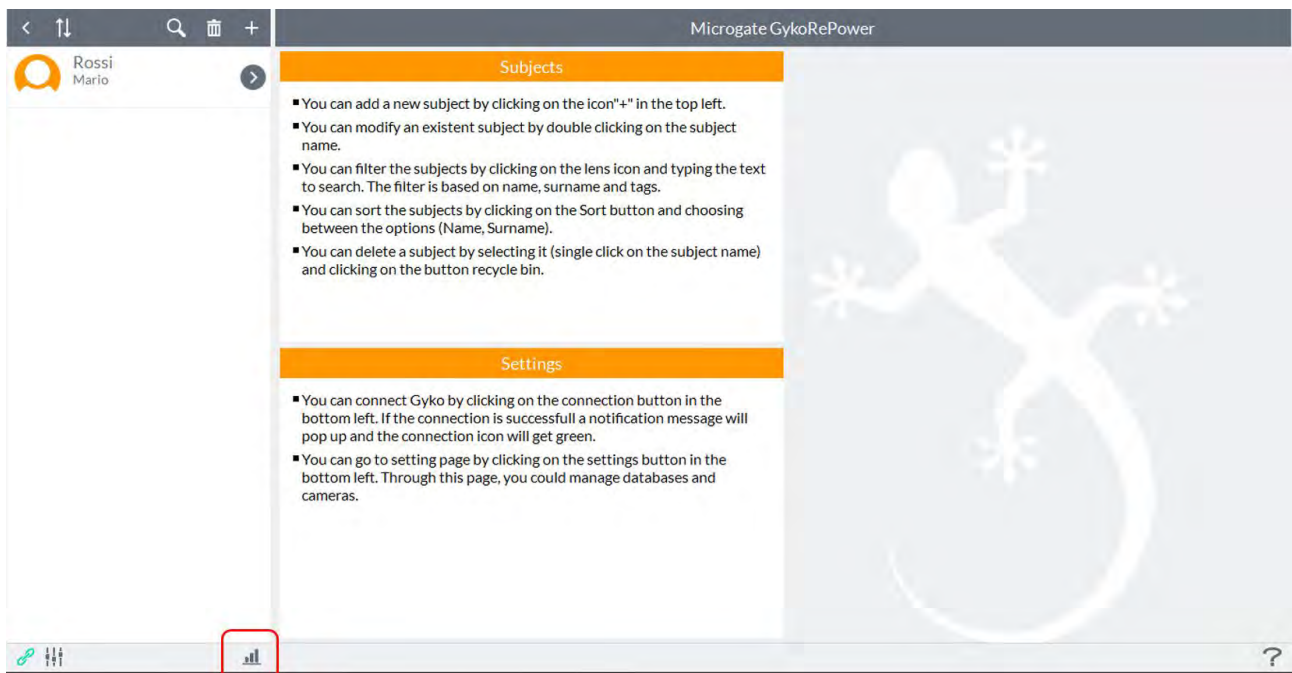
To delete a test jump, you have to select it from the tab "**Report**" with a click of the left mouse button, making sure that it is highlighted in yellow and click with the right mouse button, then it will show "**Delete**":



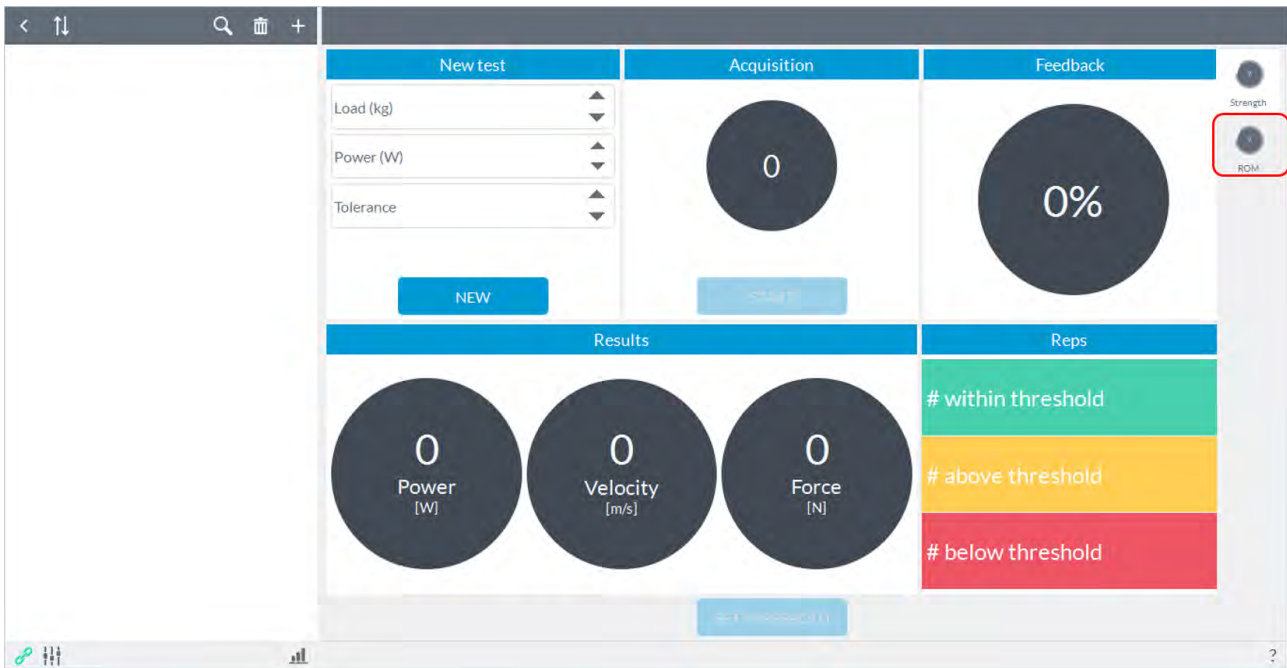
## 6.6 BIOFEEDBACK

This functionality allows the user to monitor the intensity of the exercise that the patient is making with a real time *visual and audio bio-feedback* using a threshold of work set to the user's choice.

The *bio-feedback* mode is not associated with any patient, and can be accessed directly from the home screen of the software by clicking on the icon below:

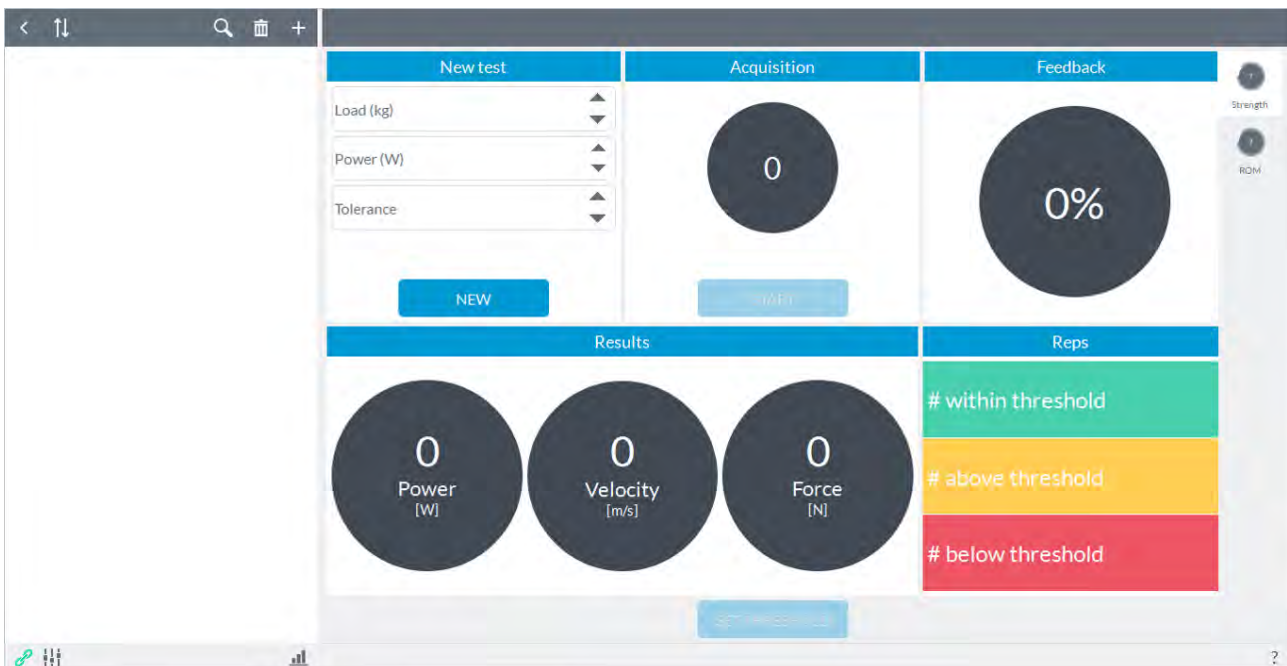


The exercise of *bio-feedback* can be done in either iso-inertial (Strength) that mode of joint mobility (ROM). By default, the software screen will open on the bio-feedback "**Strength**", to switch to "**ROM**" just click on the second icon on the top right:

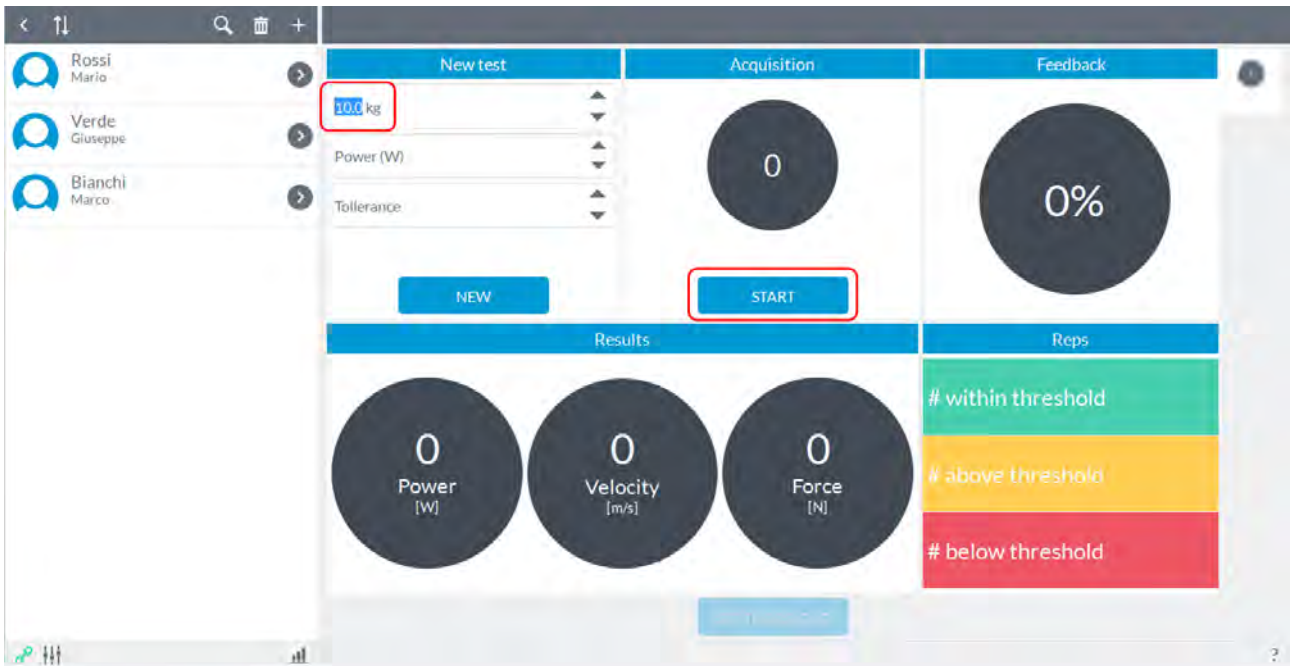


### 6.6.1 BIOFEEDBACK STRENGTH

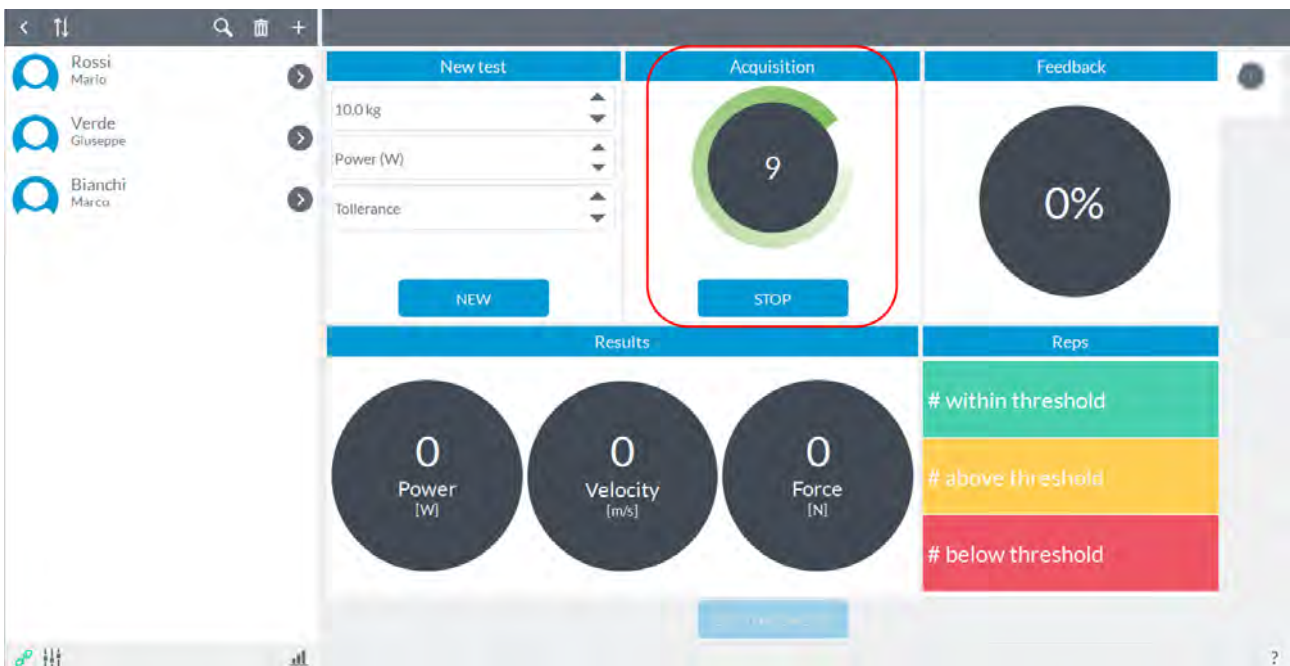
This exercise consists of performing an iso-inertial test in which the user specifies only the load that would like to use (refer to [Appendix A](#) for the preparation of the device and how to perform the test):



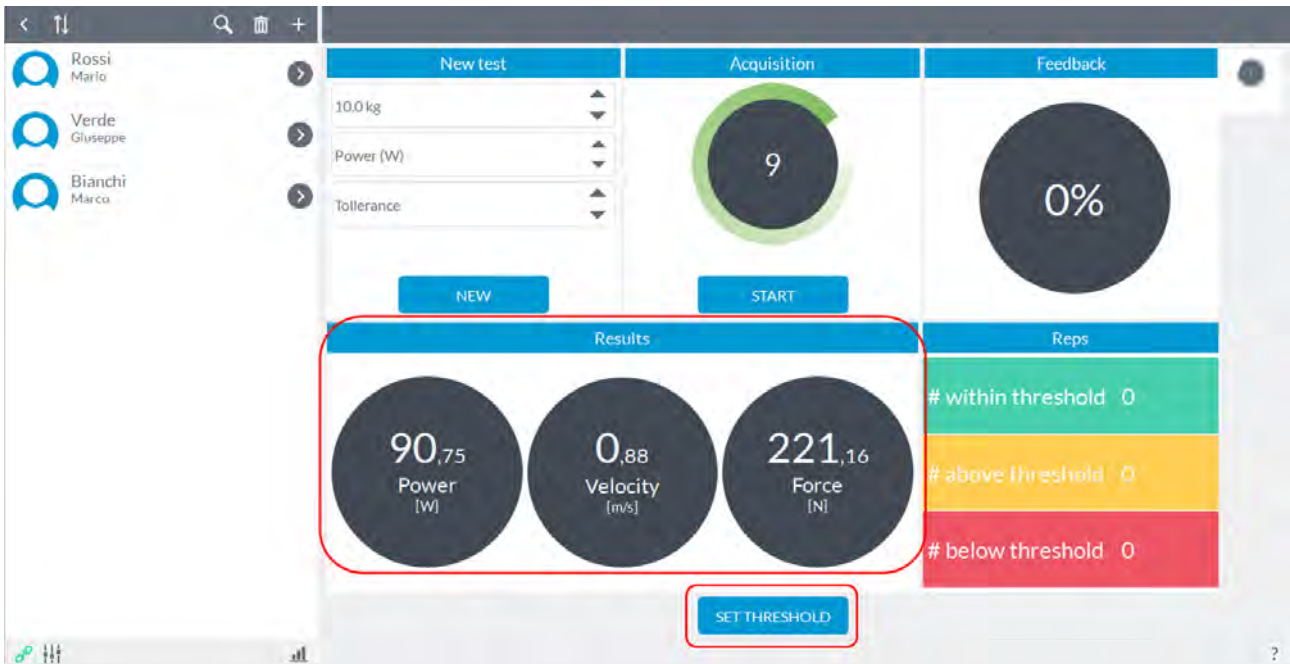
After setting the load in the left box, you begin to acquire by pressing the "**Start**" below the center box.



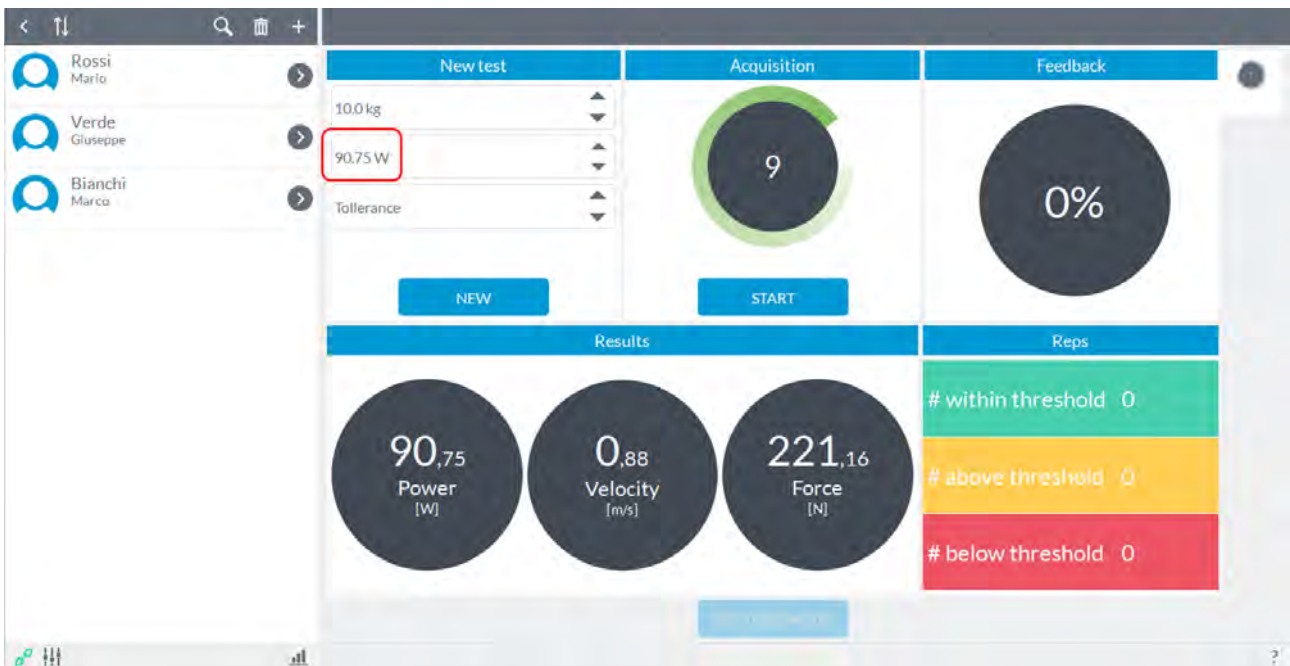
Any feedback is provided (the traffic light at the top right is not active) unless an incremental counter with the number of repetitions performed in its center box:



At the end of exercise you have to press the **"Stop"** button, then the software will show in the box **"Results"** at the bottom of the screen the average values of power, velocity and strength expressed during the series of repetitions performed and simultaneously will activate the button **"Set threshold"**:



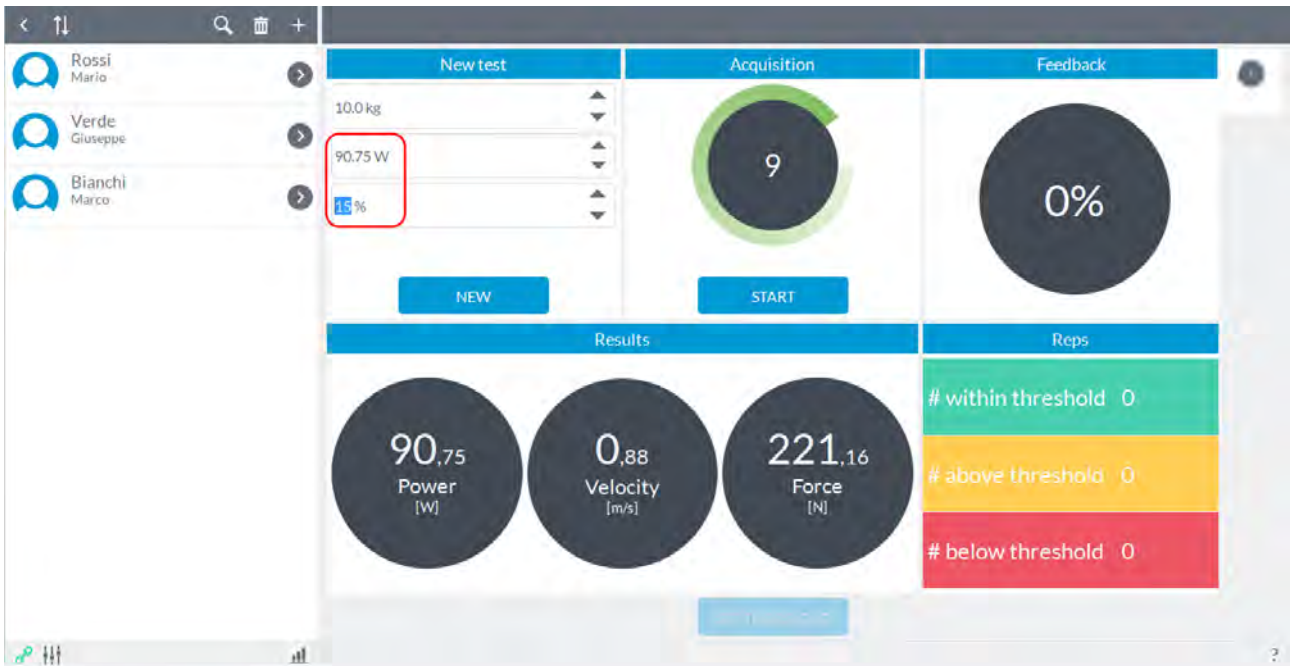
At this point the user will have to set the threshold of work for the following exercise (keeping unchanged the load) and in particular to choose whether to set the threshold based on the value of the average power recorded in the previous exercise. After setting the threshold by pressing the **"Set threshold"** this threshold will be shown at the top:



Using the scroll arrows to the right of the threshold and tolerance, the user can choose the threshold value (increasing or decreasing the value in steps of one unit) that you want to use as a visual feedback and the confidence interval or tolerance. For example:

P is the average power output in the exercise just ended and chosen as the threshold of work. The next exercise will have the load lifted the exercise just ended and a threshold of work that will be chosen from the value recorded in the previous exercise (in this case we choose the same) more or less a confidence interval (in percentage of the threshold value chosen, for example,  $\pm 15\%$  of P):





Set the threshold of work, defined the percentage and confidence, you can now perform an exercise, leaving unchanged the load (otherwise the threshold has no meaning). It will now simply press the "**Start**" button to start acquisition. At this point the exercise we are going to perform will be characterized by an incremental counter of repetitions and a real time traffic light which will be green every time that the power value will be expressed within the power threshold previously specified:



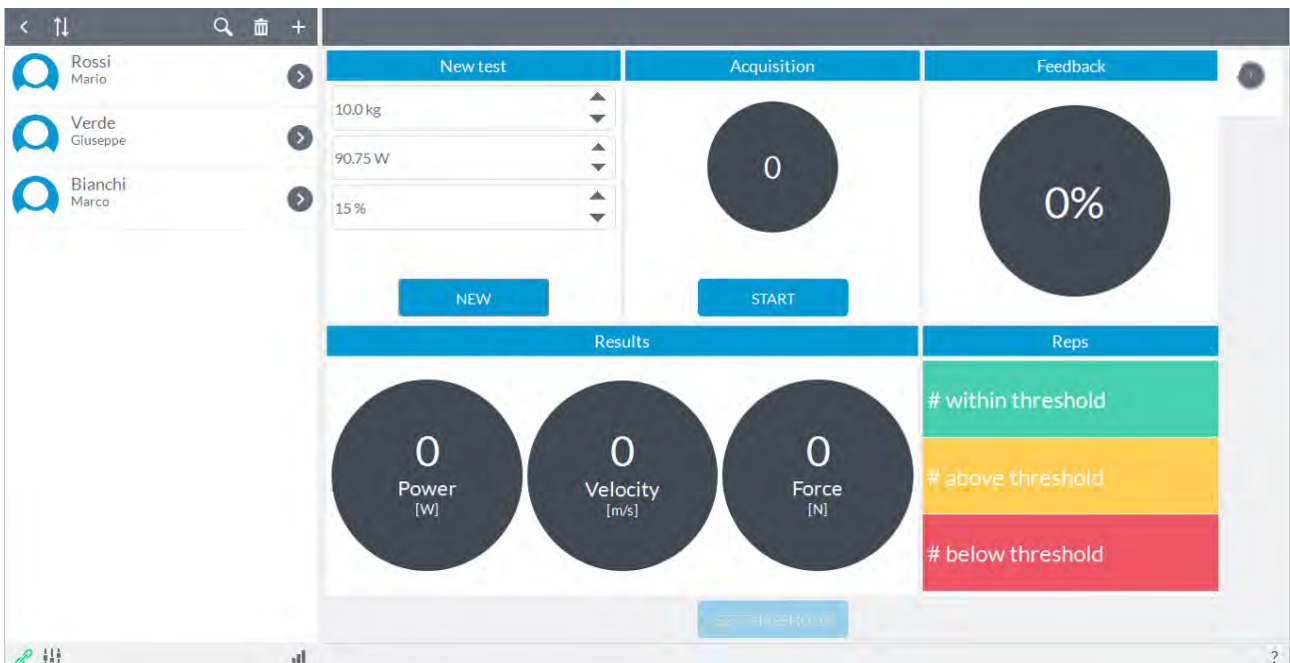
After concluding the acquisition by pressing the "**Stop**", the repetitions above, below and within the set threshold will be counted in the box at bottom right, and the software will update the average values of power, speed and strength to the number of repetitions just ended.



At this point you can perform other exercises while keeping the threshold set at the beginning of work or updating it according to the values of the last operation performed.

If you change the load is obviously advisable to re-set the threshold of work.

Finally, to erase the data displayed on the screen, simply press the "New" button in the top left corner in the "New test" to return the screen to its initial state by saving only the threshold value and tolerance set before:

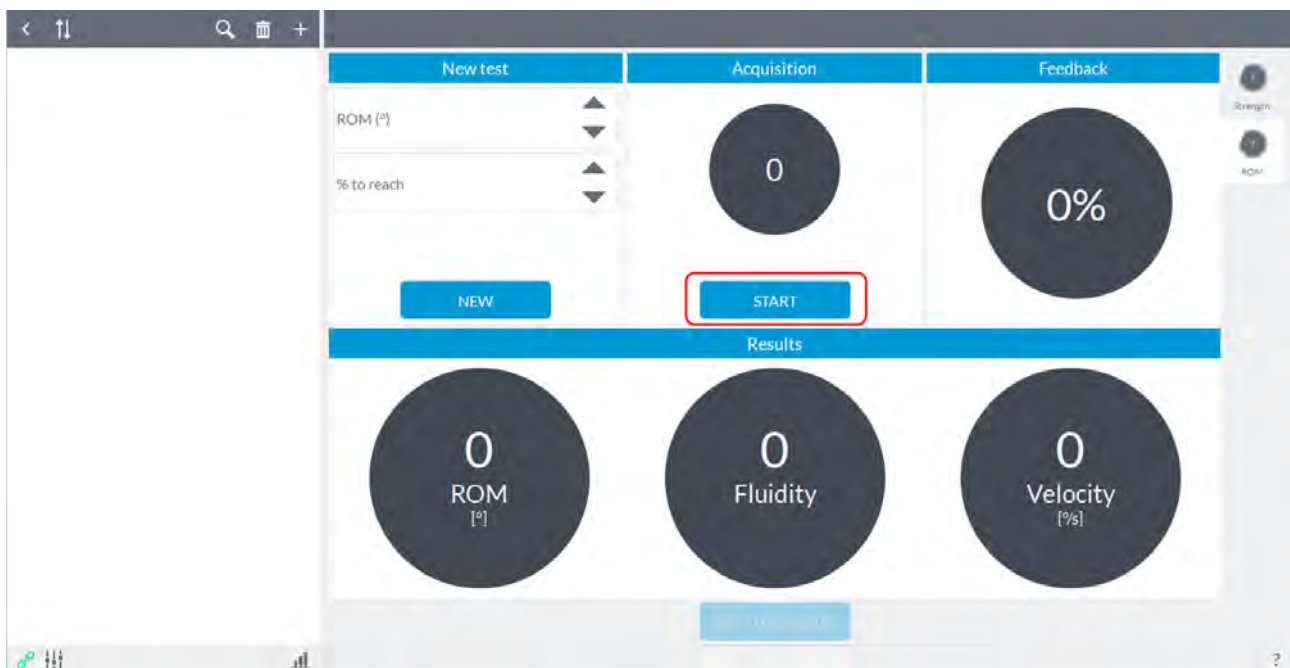


**NOTE:** exercises *bio-feedback* are "disposable" in the sense that no information is maintained in the software.

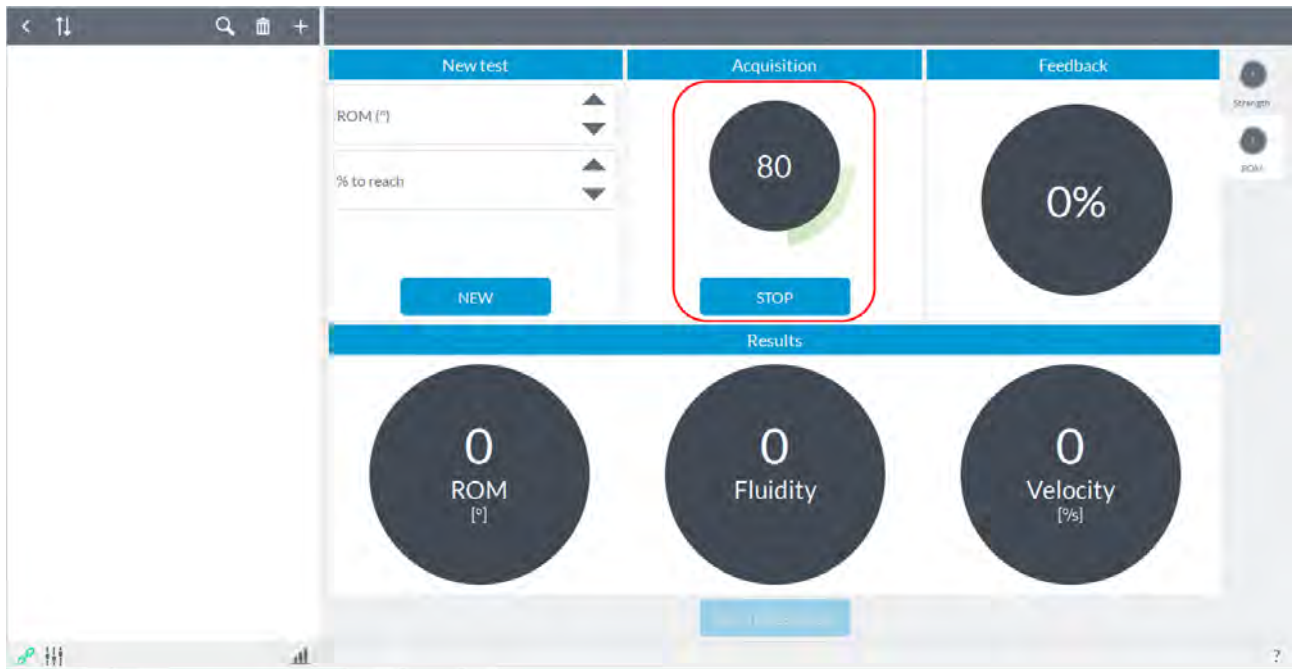
## 6.6.2 BIOFEEDBACK ROM

In this mode, the user can choose to set the threshold of ROM that the subject must reach by recording from a performance by the subject (for example with the contralateral healthy limb) or by directly entering the value to be reached (see [Appendix A](#) for the preparation of the device and method of carrying out the test).

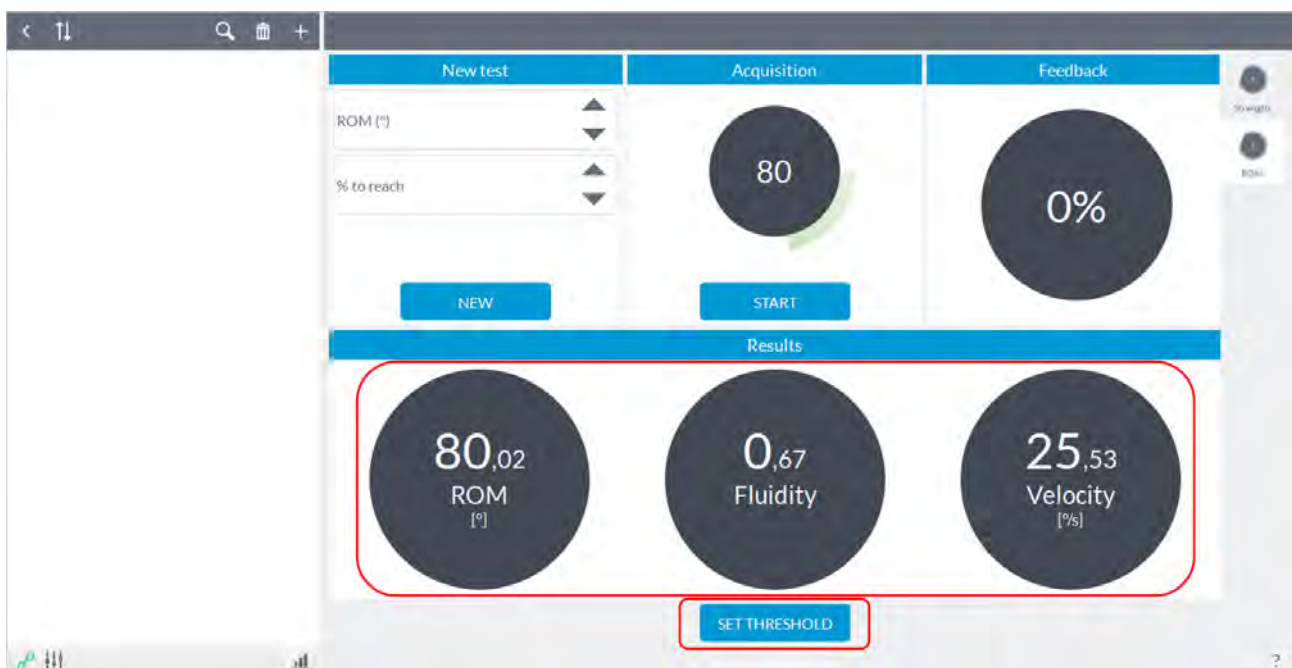
In the first case it is sufficient that the user positions the device with the elastic band on the limb that will provide the reference value (ROM) and, pressing the "**Start**" button, ask the subject to perform the predetermined movement:



At this point the software will provide an acoustic signal that will give a start to the subject to perform the predetermined movement; the user will see an indication of "Go" on the "Start" button and the value ROM in real time achieved by the subject in the "Acquisition" box:

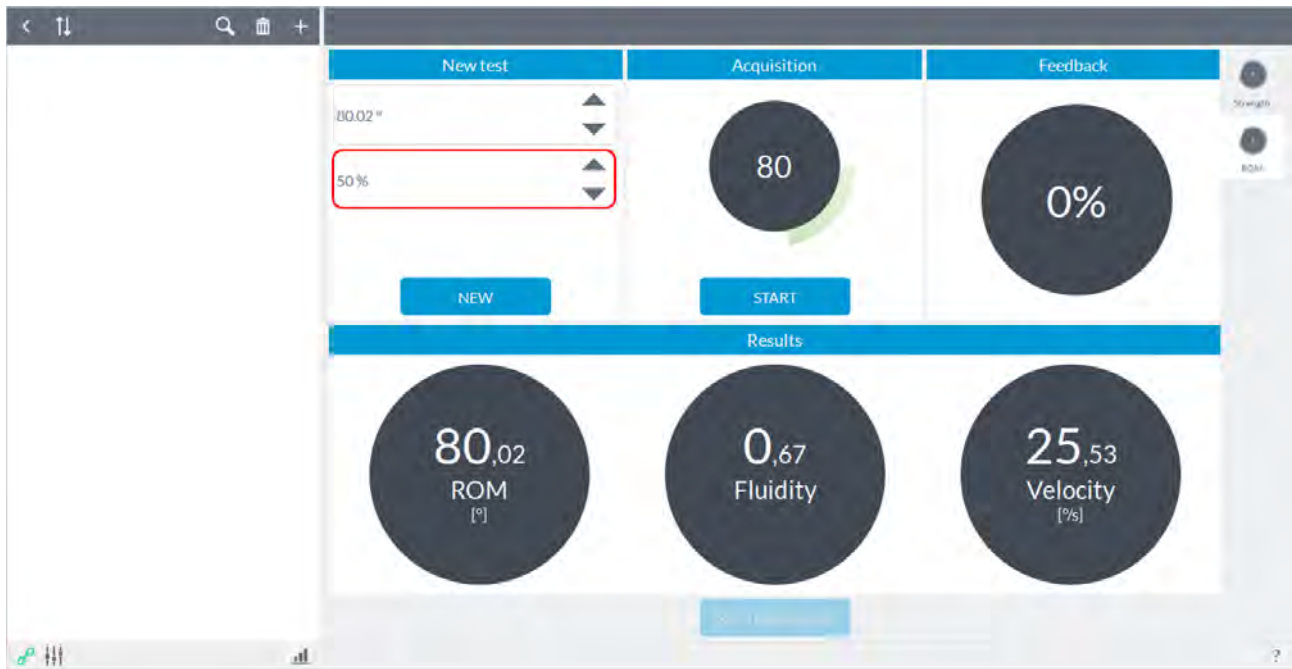


Finished the performance of the subject the user must press the "Stop" button to end acquisition. At this point it will show the results obtained in the lower box and the user can choose whether to set the threshold obtained by pressing the "Set threshold" or repeat the test by clicking again on "Start".

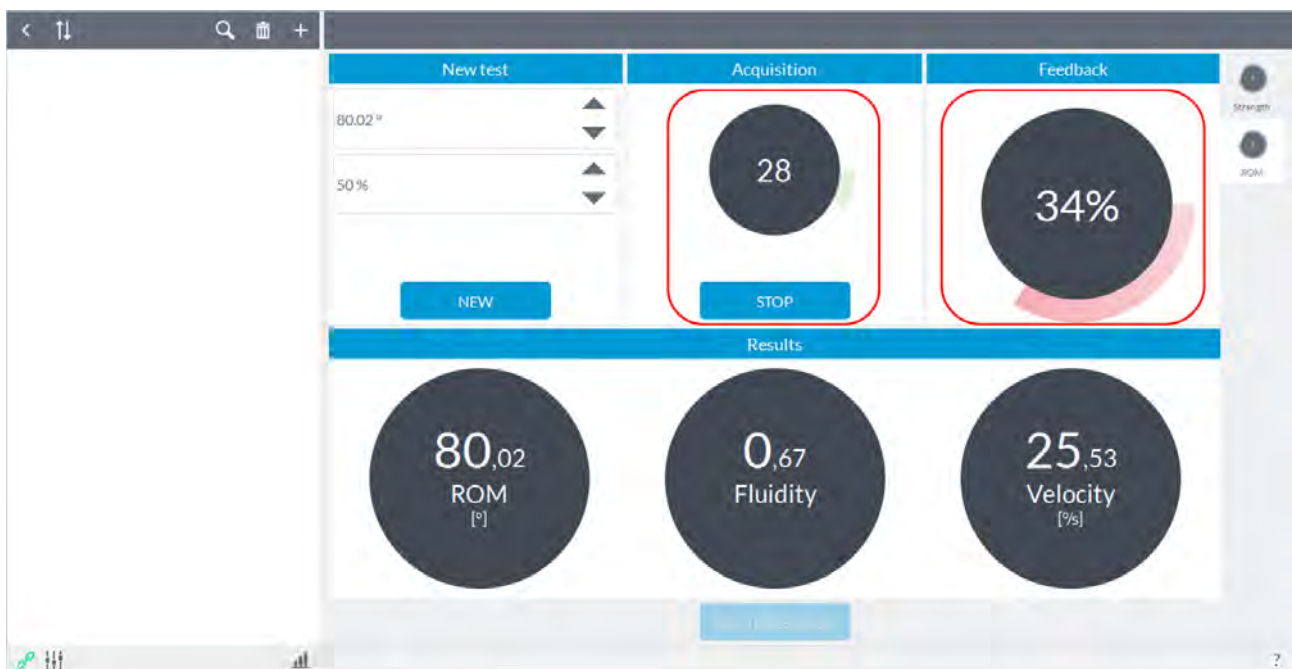


Once you set the threshold value, the user can now select a percentage of the value that the subject will reach with the contralateral limb. In the case reported here, for example, by setting the 50% of the threshold value as a goal to be reached, the subject to complete the exercise will have to perform a movement of at least 40 °.

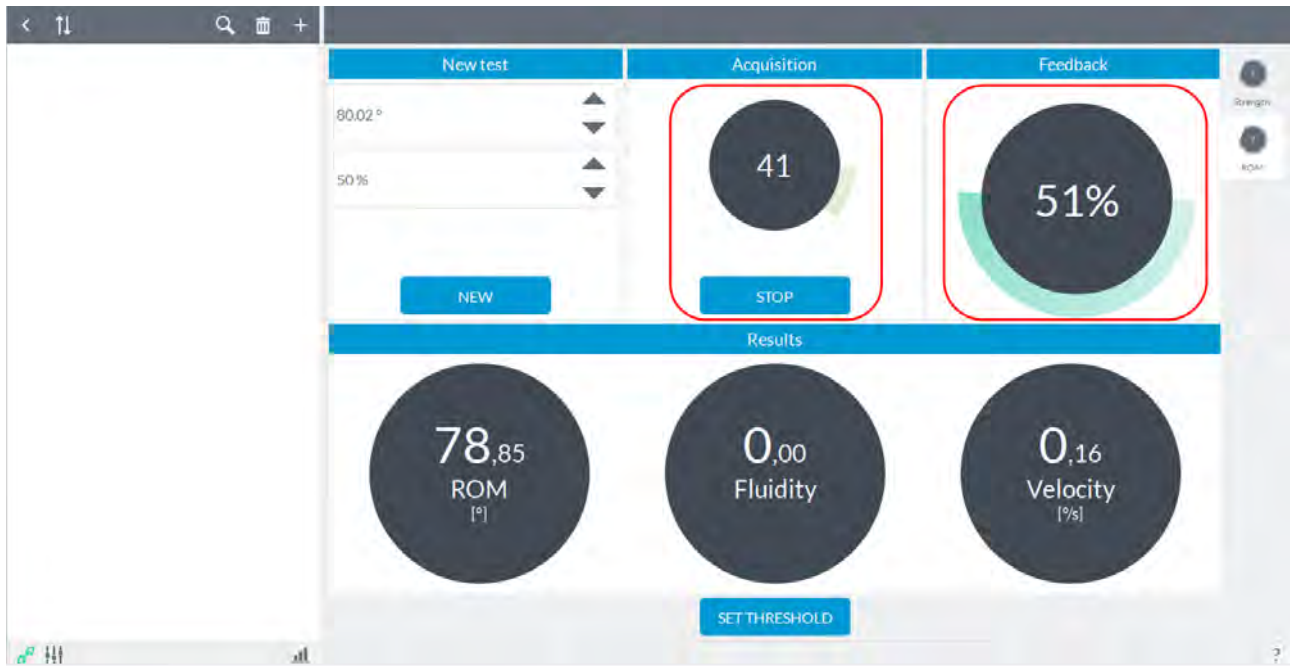
**ATTENTION:** If you do not select any percentage to reach the software will not give any sound for any value reached.



At this point the user can press the button to start acquisition "**Start**" and give the start to the subject (the user will see an indication of "**Go**" on the "**Start**" button) that can perform the predetermined movement as soon as the software will beep ("beep"):



In the middle box will display real-time values of range of motion and in the right pane the corresponding percentage value reached than the threshold. Upon reaching the set percentage software will provide an acoustic signal and the indicator on the right of the screen will turn green:



At this point the user can press **"Stop"** to end acquisition and choose to reset a new threshold or continue with a new acquisition by pressing **"Start"**.

**NOTE:** To directly enter the threshold of ROM simply type the value inside the box in the upper left **"ROM"** and then choose the percentage of that threshold from having to reach in the **"% to reach."**

### 6.6.3 REPORT OF BIOFEEDBACK

This functionality does not provide reporting software.

## 6.7 GRAPHICAL TOOLS

After a certain number of tests present in an evaluation session and depending on the size of the screen of the user's PC, in **"Report"** and/or **"Details"** mode, values normally shown on top of each histogram are hidden automatically by the software avoid overlap:



To view them simply make a **Zoom** on the graph by placing the mouse cursor over the graph and moving the mouse wheel up (Zoom In) or down (Zoom Out):



If you do not have a wheel, the alternative method is to use the touchpad according to the characteristics of your PC. For example for MAC and Lenovo, after placing the cursor on the graph, using the two fingers together going forward to the Zoom In and going back to Zoom Out.

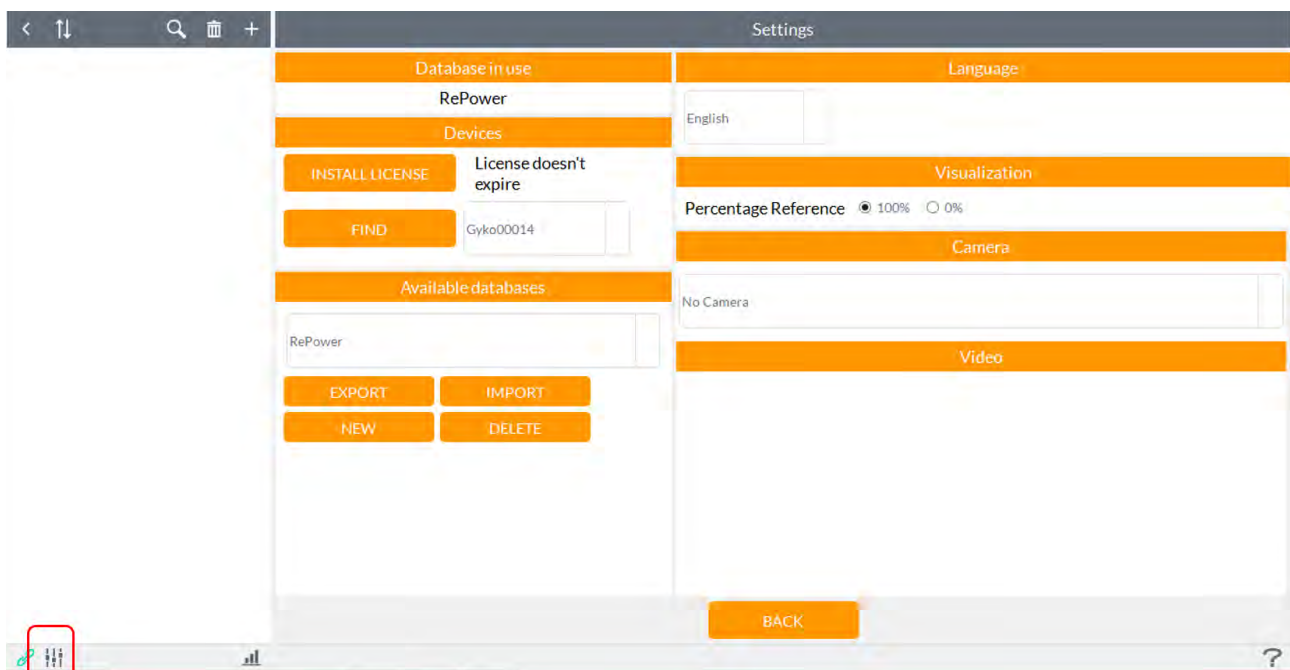
At this point to view the tests that were excluded from the zoom simply place the cursor on the graph and holding the left mouse button, move the cursor over of the graph to the left or right.

To reset any Zooming and moving of the graph and return to the original view, simply double click the left mouse button on the graph.

Finally you can save as an image file (.png, .bmp, etc.) the graphs containing histograms in "**Report**" and "**Details**" mode by clicking on the graph with the right mouse button. This will open a window "**Export as image**" and by clicking on this item, it will open another explorer window where you can name the file and choose the destination on your pc.

## 7 SETTINGS

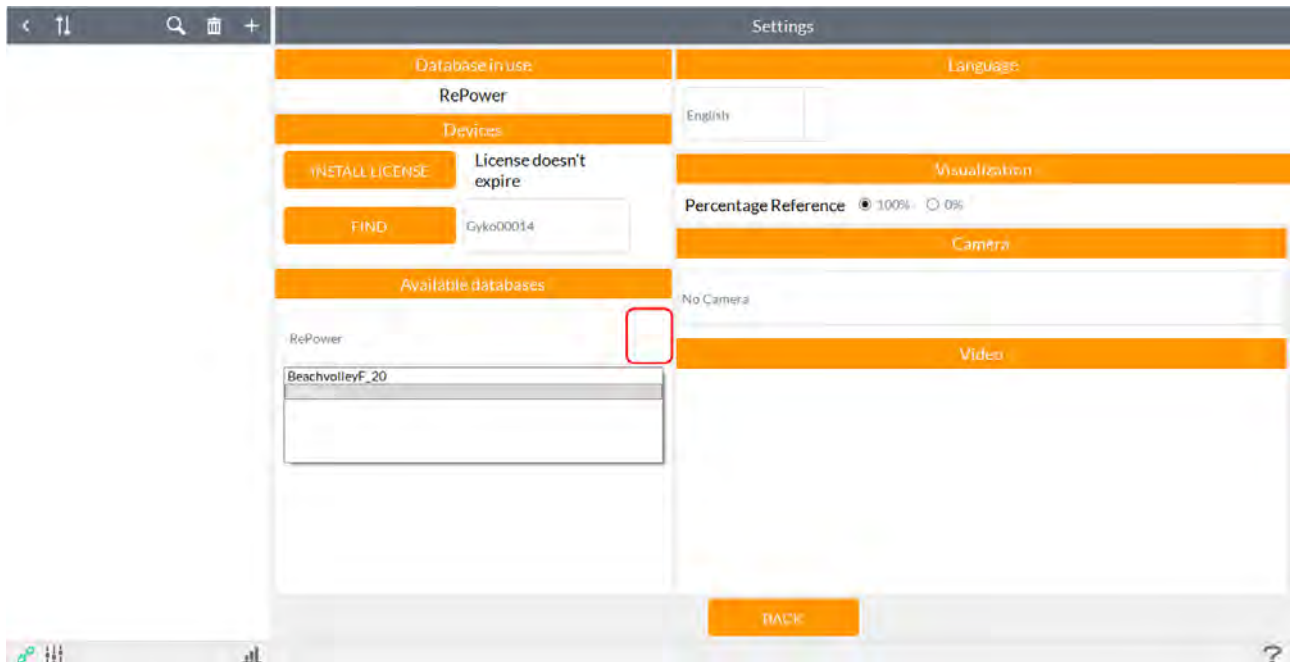
From the home screen of the software, by pressing on the "**Settings**" at the bottom left, you can access the following screen:



### 7.1 DATABASE

The first box from the top shows the database currently in use. By default, the software installs and uses a database named "**Rehab**". If in the software is loaded multiple databases, they will appear in the drop-down menu in the "**Available Databases**". If you want to load one of the database appear in the drop down menu just select it in the list and will be automatically loaded.





### 7.1.1 EXPORTING A DATABASE

To export a database, you must first select it from the drop-down menu in the "**Available Databases**". At this point, just press the button "**Export**": will open a explorer window from which the user must specify the destination on the PC in which you want to save the database and the name for the file.

During export, under the section "**Available Databases**", an icon will appear indicating the progress of the export.

Once complete, the software will notify you with the following message:

"**Database exported**".

### 7.1.2 IMPORTING A DATABASE

You can import into the software, and then use, for example, a database created by a colleague at work, or on another computer.

**NOTE:** you can only import a database that was exported using the function backup software. The database file that you go to import, therefore, will always have an extension ".rcd".

To import a new database, simply press the "**Import**" button and it will open a explorer window where you will search the database of interest. The software will import the new database retaining the name given above.

When finished importing a file named, for example, "xxxx.rcd", the software will notify you with the following message

"Database successfully imported under the name of xxxx".

At this point the user can choose the database that imported from the appropriate menu-down menu in the "**Available Databases**" which will list all databases imported into the software.

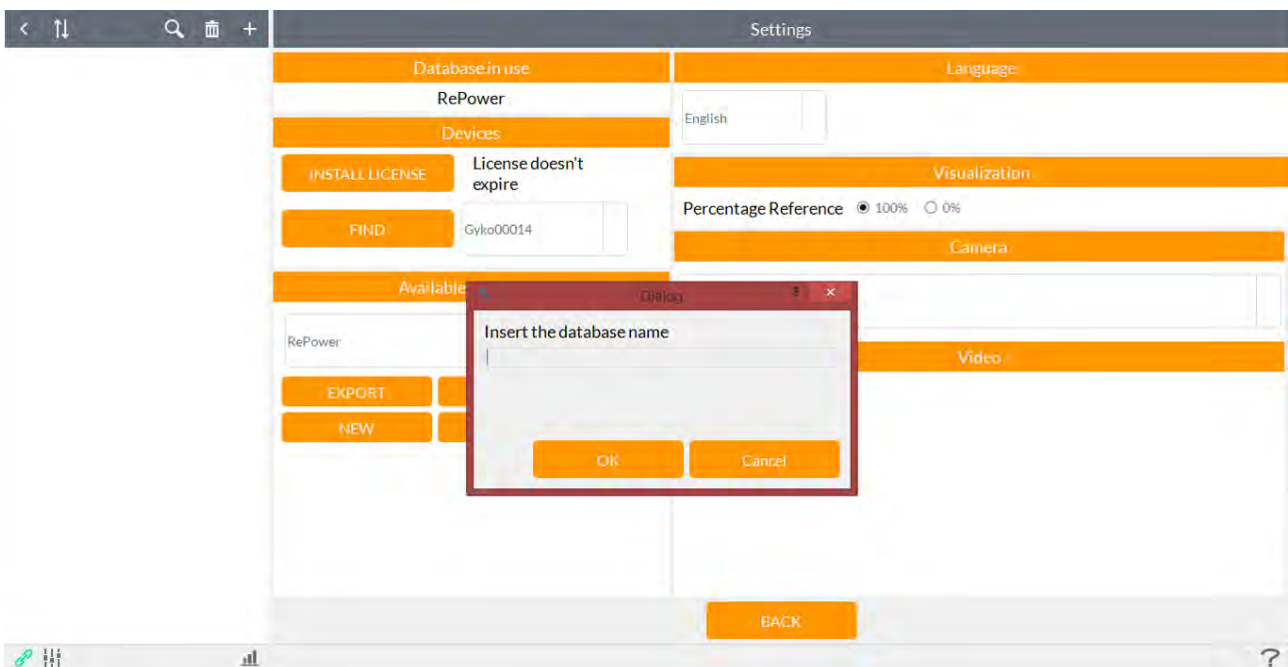
The moment you will select the database you will see subjects appear in the list on the left of the screen.

You can view the database used in the first box from the top "Database in use".

### 7.1.3 CREATION OF A NEW DATABASE

The "**New**" button allows you to create a new database.

Pressing the "**New**" button will open a window where the user must enter the name of the new database being careful not to give it the same name as an existing database (in which case you will see a message "Name already exists in the database").



By pressing the "**Ok**" button the new database will be saved and loaded automatically by the software as you can check the box "**Database in use**".

### 7.1.4 DEVICES

In the box "**Devices**" you can select, from the drop-down menu, the device GyKo be used for testing. If they possessed more than one, you can find devices simply press the button "**Find**".

### 7.1.5 CAMERA

From the box "**Camera**", you can select a camera to record video during the execution of a test. By default it is set the camera of the user's PC if active, otherwise from the drop-down menu you can select a different camera or deactivate the use.

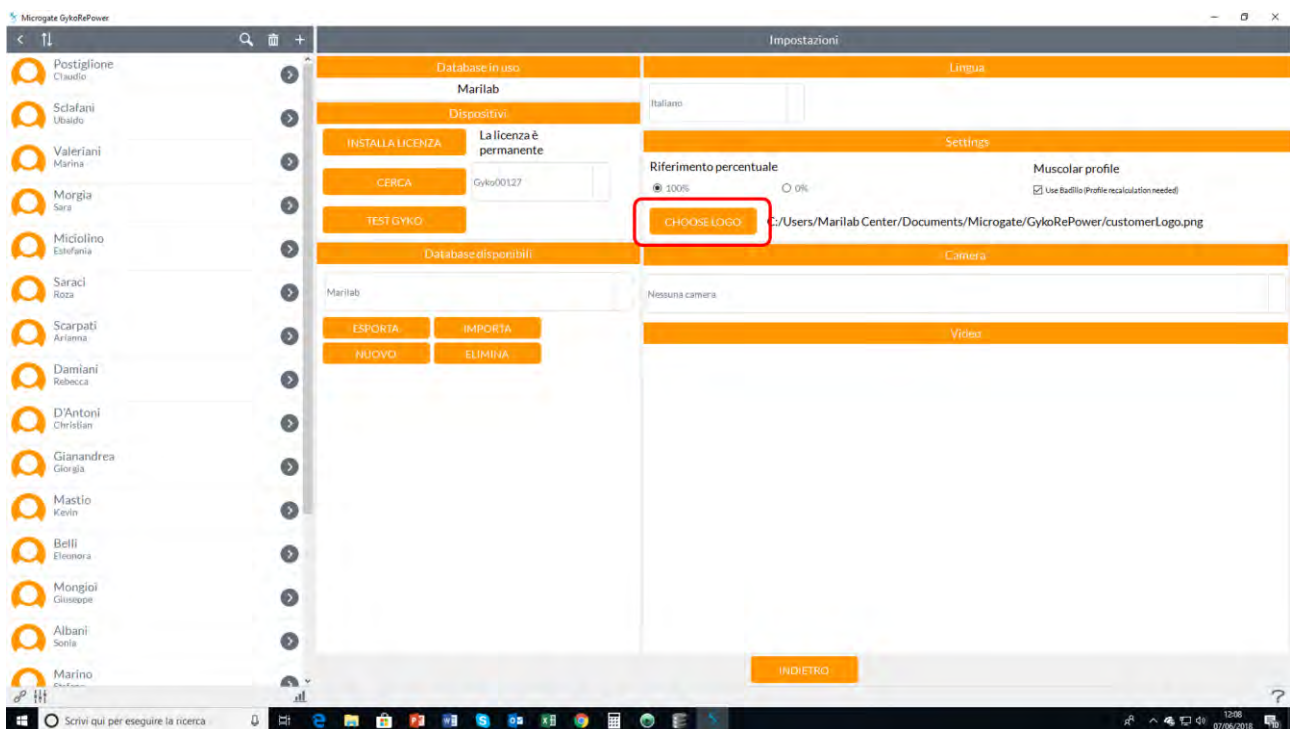
## 7.1.6 LANGUAGE

The box at the top right, "**Language**", allows the user to choose the language of the software interface. Use the dropdown menu to choose the language (Italian/English). After selecting the language from the list you will see a written asking to close the software and restart it to make the change effective.

## 7.1.7 VISUALIZATION

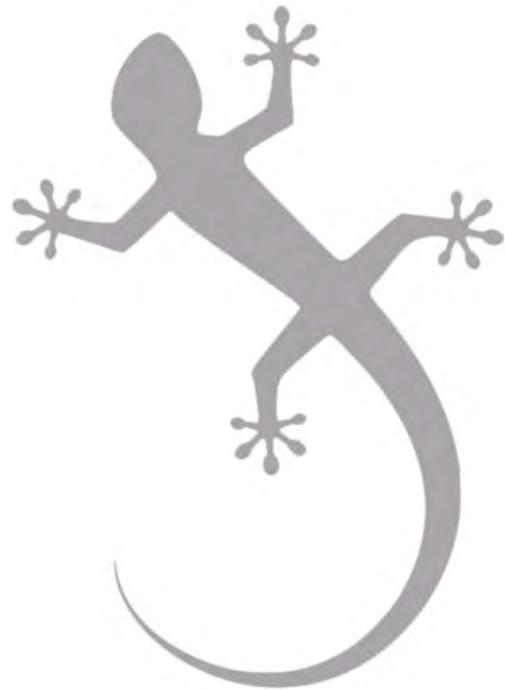
From this setting you can change the display mode of the percentages in the various comparisons of the different sessions. Default is set to the reference at **100%** and then the percentages of the various comparisons will be always positive, even when the reference value is less (there will percentages above 100%). Setting **0%** will be given the percentage difference from the reference value, and then you will also have negative percentage (then indicate what is missing to reach the reference value).

From the "**Visualization**" section it is possible to select a logo to appear in the printout of the reports. Clicking on the "**Choose Logo**" button will open an Explorer window where you can search and select the logo to be attached to the report print:



At this point the logo will appear at the bottom left in all the printouts of the different reports of all the tests.

Report sessione Esercizio\_0 [Sway]  
di [redacted]  
Commenti

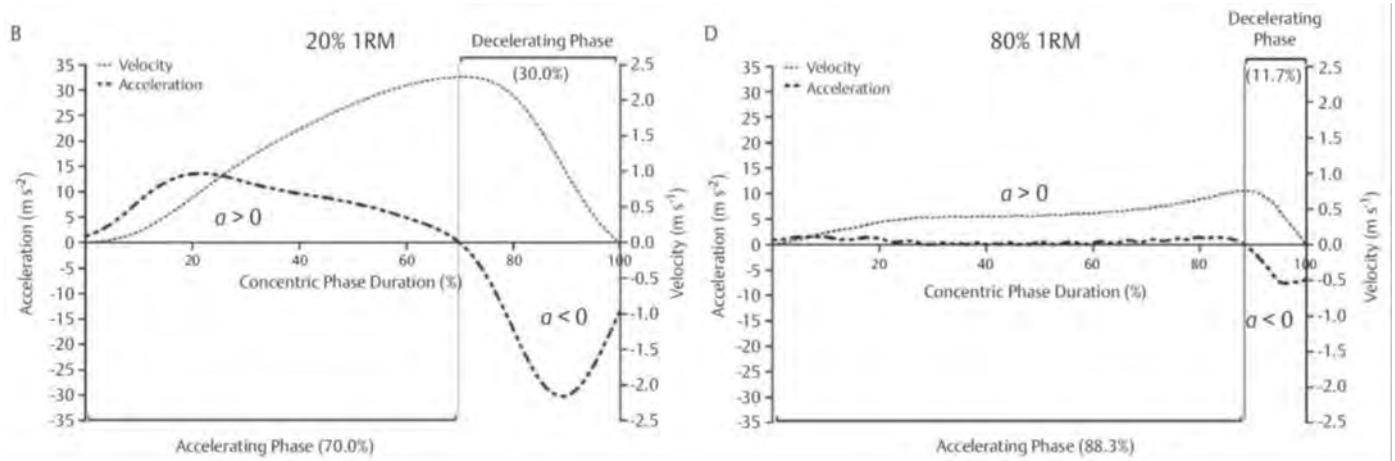


In the "**Visualization**" section it is possible to select a different analysis mode for tests involving the use of loads.

The new **iMPulsive** mode has effects especially as regards the creation of the muscle profile and the consecutive estimation of 1RM improving its accuracy.

The new mode, unlike the previous one, during the execution of a gesture that involves the lifting of a load takes into consideration only the "propulsive" phase of the speed, the part in which it is growing, ie that goes from 0 to its value maximum. In this segment, therefore, only the part in which the acceleration impressed on the load during the movement arc is positive ( $acceleration > 0$ ) is considered. Therefore, the contribution given by the "breaking" phase of the gesture that is present when using loads below 70-80% of the 1RM is excluded.

The following figure shows an acceleration and speed analysis for a bench press run with two loads of 20% and 80% respectively of the 1RM. The dashed line is related to the acceleration which has a negative phase  $a < 0$  (Decelerating Phase) exceeded 70% of the movement (Accelerating Phase). With the **iMPulsive** mode it is excluded, for the analysis of the parameters in output (Power, Strength and Speed), all the contribution given by the "Decelerating Phase".



For a better understanding of the method it is possible to consult the article from which it was inspired for the modification made:

[https://www.researchgate.net/profile/Luis\\_Sanchez-Medina/publication/41896687\\_Importance\\_of\\_the\\_Propulsive\\_Phase\\_in\\_Strength\\_Assessment/links/0912f505b4266a7323000000.pdf](https://www.researchgate.net/profile/Luis_Sanchez-Medina/publication/41896687_Importance_of_the_Propulsive_Phase_in_Strength_Assessment/links/0912f505b4266a7323000000.pdf)

https://www.researchgate.net/profile/Luis\_Sanchez-Medina/publication/41896687\_Importance\_of\_the\_Propulsive\_Phase\_in\_Strength\_Assessment/links/0912f505b4266a7323000000.pdf

## 7.1.8 TEST GYKO

**NOTE:** *This operation must be carried out with the assistance of a qualified Microgate technician.*

By clicking on the "Test GyKo" button, you will start a procedure for calibrating the device in order to optimize the data acquired by the inertial sensor. A window will appear with a video tutorial that will show the movements to be performed with the device after starting the data acquisition. Once the procedure is complete and the capture is closed, the results below will indicate whether or not the device calibration can be optimized.

## 8 APPENDIX A

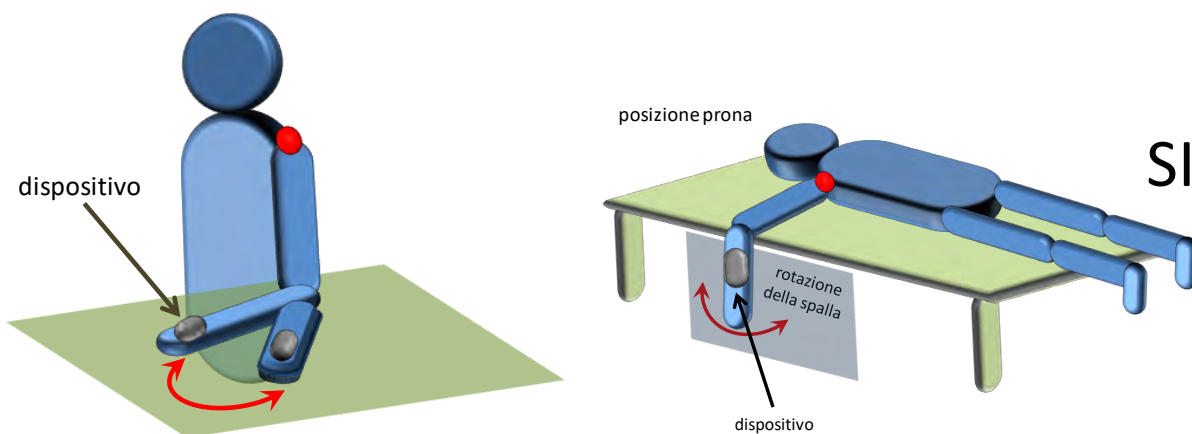
### 8.1 ASSESSMENT OF JOINT MOBILITY AND BIOFEEDBACK ROM

#### 8.1.1 HOW TO PERFORM A TEST

The execution of the test requires a single movement. The results returned by the software will refer to the data acquired from the initial position to the point of maximum excursion. So, if for example, starting from a neutral position, the patient performs an external rotation of the shoulder and back going in internal rotation, the return parameters are related only to the external rotation. So the acquisition of external rotation of the shoulder should be separated from the acquisition of internal rotation. The software analyzes one degree of freedom at a time. For example can not be combined, in the same acquisition, movements such as abduction to 90 ° followed by a shoulder external rotation of the shoulder.

#### 8.1.2 ROTATION

All rotations are allowed. The rotations in which the segment where the device is placed NOT rotates around the vertical axis (therefore on the transversal plane) are preferred to those in which the segment where the device is placed rotates about the vertical axis. For example, if you wanted to measure the internal or external rotation of the shoulder with a device placed on the elbow, it is preferable to adopt the solution shown in the next figure:



#### 8.1.3 DEVICE POSITIONING

The positioning of the device on the selected segment (device orientation, position relative to the proximal end of the segment etc ..) is not a significant aspect (since the orientation of the device is always known to the algorithms of MICROGATE means of the signals from accelerometers and gyroscopes 3D) and then the respective angular measurement is totally operator-independent. The only aspect that should be taken into consideration is to secure the device far away as possible from the center of rotation, i.e. from the joint. To secure the device to measure the limb concerned must use the special elastic band provided in the kit:

### 8.1.4 RECOMMENDED BOOK

Typologies of standardized tests for measuring joint mobility in a robust and reliable manner can be found in:

Title: *Musculoskeletal Assessment: Joint Motion and Muscle Testing*

Author: [Hazel M. Clarkson](#)

Edited by: [Edi. Ermes](#)

## 8.2 STRENGTH ASSESSMENT (ISOINERTIAL EVALUATION) AND BIOFEEDBACK STRENGTH

### 8.2.1 DEVICE POSITIONING

The device should be placed using a special magnetic pocket, on the weight stack of any fitness machine or barbell; the orientation of the device is not relevant since the algorithms of MICROGATE, thanks to 3D accelerometers and gyroscopes, are able to calculate the orientation of the device compensating moment by moment, therefore, the misalignment against the vertical axis with respect to which are expressed magnitudes estimated by the software.

### 8.2.2 HOW TO PERFORM THE TEST

Before you press the "Start" in the window of the software you make sure that the load on which the device is placed is stopped; when you press the "Start" button, you will hear a audible signal; at the acoustic signal, you have to make lifting the load and execute the exercise as determined by the therapist/user. At the end of each lifting the software will display in real time and in a progressive count of repetitions performed. The software will measure only data on the concentric part of the movement.

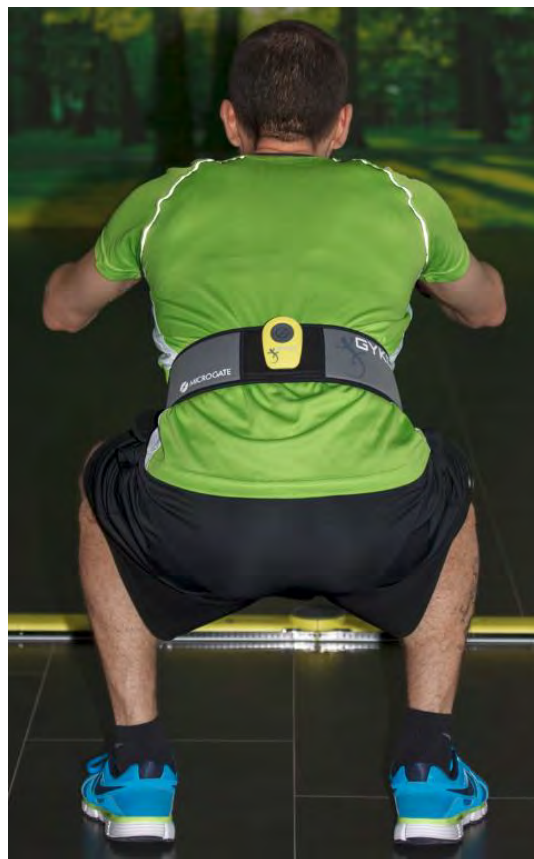
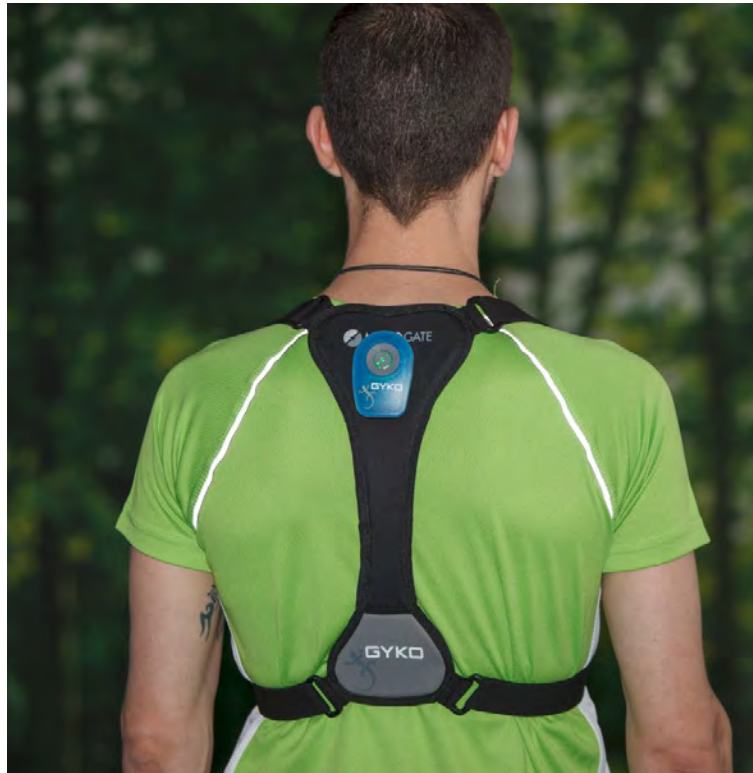
## 8.3 STABILITY ASSESSMENT (SWAY)

The evaluation of the stability (Sway) can be performed according to needs of the user, which may use different motor tasks to provide the person performing the test: standing with eyes open or closed eyes and then on one leg, Fukuda's tests etc. You can use the device with the subject on different surfaces (sand, water, medicine balls, etc.).

Before starting the acquisition, the user must make sure that the subject is as still as possible otherwise we will not provide the startup sound test.

### 8.3.1 DEVICE POSITIONING

The device can be used both using of the elastic waist band or using the special elastic band to the upper part of the trunk:





## 9 APPENDIX B

### 9.1 JUMP MODULE

#### 9.1.1 HOW TO PERFORM A TEST

JUMP module of GyKoRePower allows the assessment of performance relative to the following types of vertical jumps:

- countermovement jump (CMJ)
- squat jump (SJ)
- repeated countermovement jumps (RCMJ)
- stiffness test (STIFF)

**CMJ:** athlete stands still in upright posture; when the user presses the start button, the athlete has to wait for the acoustic signal; if the athlete is not still, the software will not generate any acoustic signal; the acoustic signals tells the athlete he can start to perform the jump.

**SJ:** athlete stands still in upright posture; when the user presses the start button, the athlete has to wait for the acoustic signal; if the athlete is not still, the software will not generate any acoustic signal. At this point if the athlete starts from the standing position must perform the bending of the knees up to the angle predetermined, stop, in order to avoid using the eccentric phase and then jump; in the case of departure from the squat position predetermined the athlete can jump immediately after the acoustic signal.

**RCMJ:** athlete stands still in upright posture; when the user presses the start button, the athlete has to wait for the acoustic signal; if the athlete is not still, the software will not generate any acoustic signal; the acoustic signals tells the athlete he can start to perform the repeated jumps; the athlete can perform:

- a number of jumps within a temporal duration which has been set by the user between 5 and 100 seconds; the software will automatically stop data recording at the end of the countdown, outputting an acoustic signal which will tell the athlete he can stop jumping.
- an arbitrary number of jumps within the selected temporal duration; after the chosen number of jumps to perform (for instance, 6 jumps), the athlete has to stop jumping returning to a standing still posture until the software recognizes the athlete is still and automatically stops data recording before the end of countdown.

**STIFF:** athlete stands still in upright posture; when the user presses the start button, the athlete has to wait for the acoustic signal; if the athlete is not still, the software will not generate any acoustic signal; the acoustic signals tells the athlete he can start to perform the repeated jumps the athlete has to perform at least **7 jumps** and then he has to stop jumping returning to a standing still upright posture until the software recognizes the athlete is still and automatically stops data recording; if the athlete, after having completed at least 7 jumps, before to completely stop himself performs

some small jumps to attenuate shock absorption after landing, these small jumps will be automatically excluded by the software that will take into account only the first 7 jumps. If less than 7 jumps are performed, the software will output results relative to the performed jumps.

## 9.2 TRAINING MODULE

### 9.2.1 HOW TO PERFORM A TEST

When the user presses the start button, it is necessary that the measurement unit be stationary the athlete has to wait for the acoustic signal; if the athlete is not still, the software will not generate any acoustic signal; the acoustic signals tells the athlete he can start to perform the jump

After the user presses the start button, it is necessary that the device is stationary for the software to generate the acoustic signal that tell the athlete he can start to perform the exercise. In exercises such as barbell bench press, it is recommended that the athlete holds the barbell in his hands in the starting position before pressing the start button acquisition. If the load is very high and can not be held for a long time in a static position, then data recording can also be started with the barbell still on its; in this case, it is very likely that the software records as repetition also the movement required to lift the barbell from its placement; it is necessary that the user is aware of this (in the case of a muscular profile test, this repetition can subsequently be excluded by the user).

After pressing the start button, with the device stationary, the software will generate an acoustic signal and the athlete can begin to perform the exercise. The software will identify in real time each repetition performed.

If the software detects two repetitions at a single load lifting please see section 5 of the [Troubleshooting](#) section for details about how to handle such an event.

### 9.2.1 HOW TO BUILD A MUSCULAR PROFILE

Carmel Bosco suggested that, for an optimal determination of the muscular profile, it is necessary to record force, velocity and power in correspondence of 4 loads corresponding to 40%, 55%, 70% and 85% of the theoretical 1 RM of the athlete for that particular exercise. In most cases, the user does not know the 1 RM of its athlete. It is advisable, then, to obtain an approximated estimate of the 1 RM using one of the many regressive methods present in the literature based on the number of repetitions to exhaustion with a submaximal load (for example, the famous Brzycki formula). After obtaining a rough estimate of the 1 RM by regressive methods, it is now possible to have a first guess of the loads to use as suggested by Bosco as a percentage of the 1 RM.

GyKoRePower needs at least three increasing loads to calculate the mathematical relationships between power, force, velocity and loads lifted.

Although the percentages provided by Bosco are a good reference for the determination of the muscular profile, in reality, this procedure must be mediated by the experience of the user and adjusted during the execution of the test. If, for example, it was decided to use 20kg, 40kg and 60kg

but after the second series of repetitions (with 40 kg) the user realizes that the third set with 60kg may be too excessive, then the user can decide to assign 55kg instead of 60kg .

As soon as the software is able to determine the muscular profile, the 1 RM is estimated. Regardless of the number of the performed series of repetitions, if the power values of the last series of repetitions do not go beyond the 70% of the newly estimated 1 RM, the software will notify that the estimate of 1RM could be improved.

### 9.2.2 IMPROVE THE ESTIMATE OF 1RM

If, built a profile (the power-load curve is shown), the software notification:

"For a better estimate 1RM we recommend a further series to a greater load of X kg"

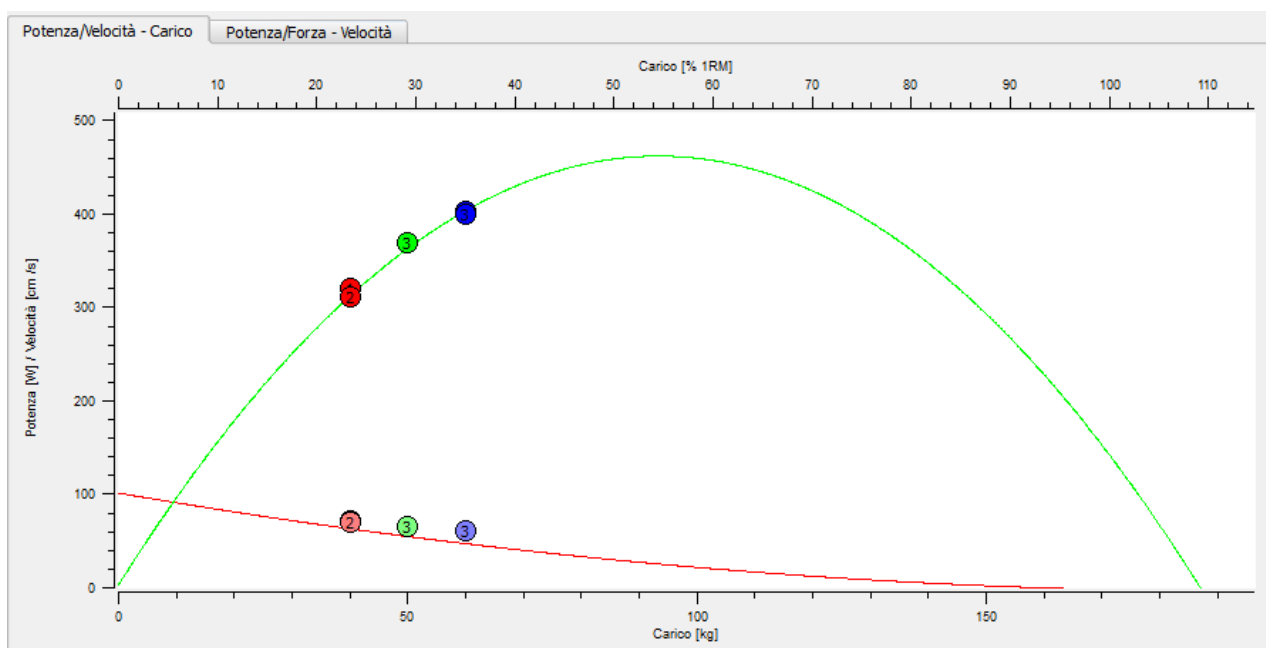
(where "X" is the load given on the last series of repetitions performed)

means that the power observed at the last series is not more than 70% of 1 RM that has been temporarily estimated. The muscular profile is, therefore, improved.

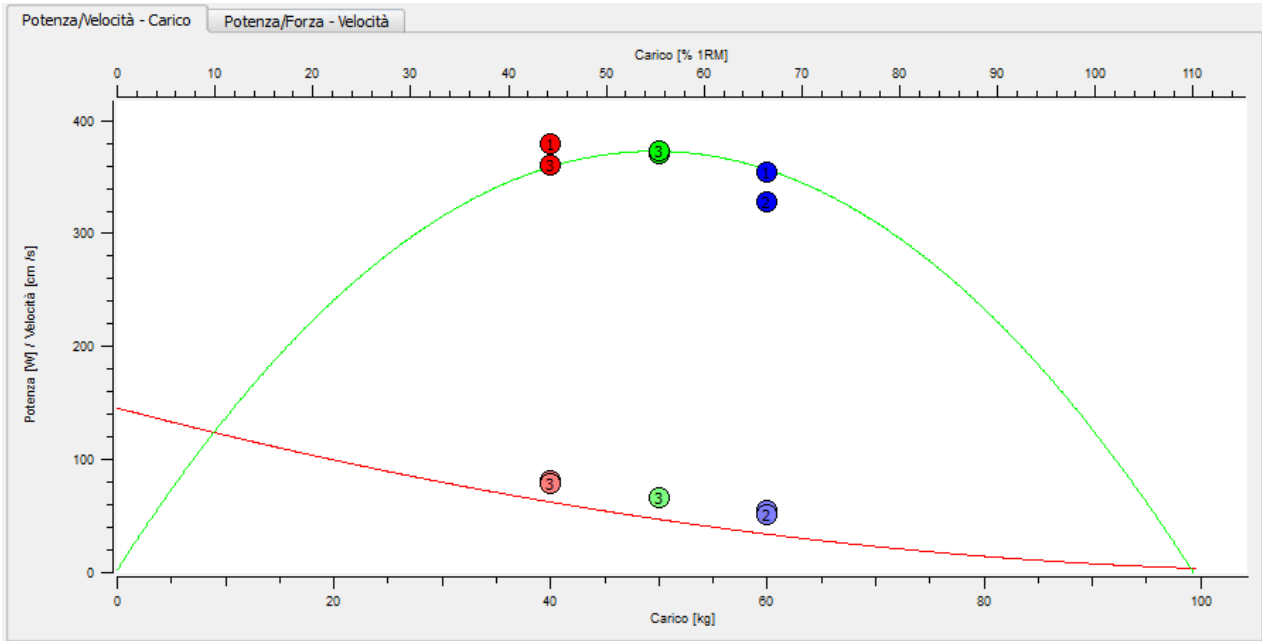
The construction of the muscular profile (i.e., power-load curve) is in fact based on an interpolation of a curve of second degree that is passed to the power values recorded in correspondence with each series of repetitions characterized by a certain load .

Therefore, mathematically speaking, the interpolation is more reliable than the software are data points to the right of the maximum power (peak-load power curve). For GyKoRePower you chose to use 70% of 1RM estimated value as reference threshold.

In the following case is shown by way of example a muscular profile that has been determined as the speed decreases with increasing load, but the power values are always increasing:



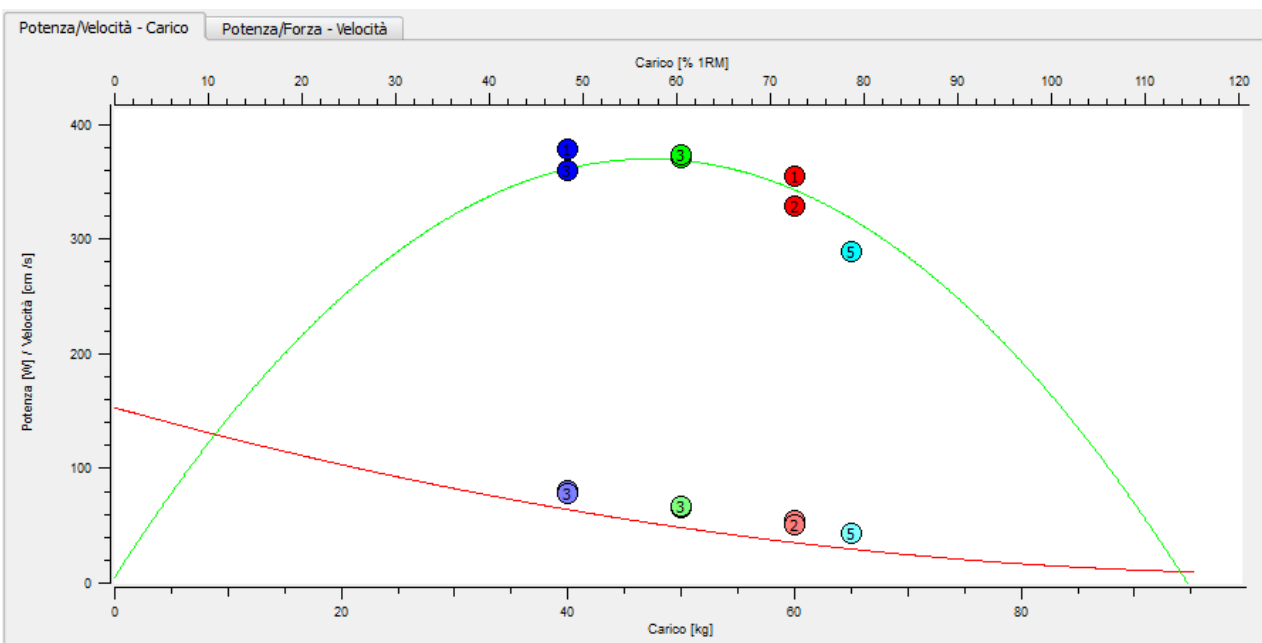
Or they do not go over 70% of 1RM estimated:



The estimate will not be accurate since it would be better to pass the curve to a point (power value) as far right as possible, in order to "close" the curve at best. In this case, the software will notify the central message:

"For a better estimate 1RM we recommend a further series to a greater load of X kg"

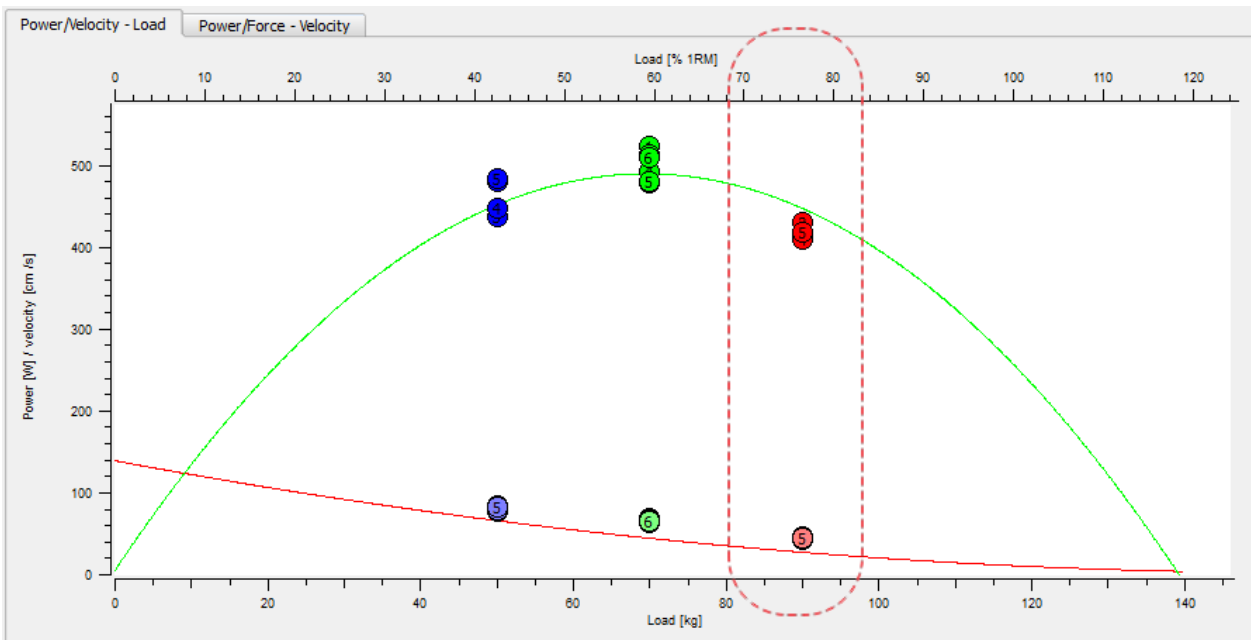
The muscular profile shown in the figure above is then continued by giving a further higher load last used (60kg):



This latest series has served to "close" further power-load curve, adding a point that improves the interpolation.

Regardless of the number of sets performed, if the powers for the last load used should not be more than 70% of 1 RM that was estimated then the software will notify that the estimate of the maximum can be improved.

In the figure below, the powers recorded in correspondence of the last series (@ 90 kg, the lower abscissa) fall between 70% and 80% of 1RM estimated at that time (abscissa higher), then the estimate of 1RM can be considered reliable:



NOTE: This procedure is already automated by GyKoRePower.

## 10 APPENDIX C

### 10.1 ANALIZED VARIABLES

Results are based on the measurement and estimation of various physical quantities that are considered scientifically significant for the assessment of motor performance.

Below, you can find an explanation on how we calculate the various variables that we provide you with.

- **Velocity curve** [m/s] is the linear vertical velocity and is calculated by applying the following numerical integration technique to the vertical acceleration

$$V = 1/6 * [A(i-1) + 4*A(i) + A(i+1)] * dt$$

where **dt** is the time interval between two consecutive sampled instants, **V** is the vertical velocity, **A** is the acceleration.

NOTE: in the jump test the velocity shown in the results and in the Report tab is the maximum speed reached before leaving the ground.

- **Work**[J/kg], indicated as **L**, is calculated as the sum of potential energy (**U**) and kinetic energy (**K**):

$$L = K + U$$

where  $K = 0.5 * V^2$  and  $U = S * g$

- **Power** [W/kg], indicated as **P**, is calculated as

$$P = V * A$$

where **V** is velocity and **A** is acceleration. In the parameters of jumps tests is shown the maximum power which is the maximum value of power.

For RCMJ and stiffness test, muscular power represents the average power exerted during the stance phase and it is computed according to "Bosco et al. in Eur J Appl Physion 1983" using the following formula:

$$P = g^2 * FT * (CT+FT) / 4*CT$$

- **Reactivity index** , indicated as **R**, is calculated as the ratio between flight time and total jump time:

$$R = CT / (FT+CT)$$

where **FT** is flight time [s] and **CT** is contact time [s].

- **Stiffness** [N/m/kg], indicated as **KN**, is calculated according the scientific article of Dalleau et al (2003):

$$KN = \pi * T / [CT^2 * (T/\pi - CT/4)] / 1000$$

- **Time to maximum force** [s] is the time required to reach the maximum force value from the beginning of the concentric phase.
- **Maximum force at landing** [BW] is the peak force at landing and is expressed as bodyweight, 2BW is equivalent to 2 times the body weight.
- **Loading rate** [BW/s] is the ratio between the maximum force at landing and the time to reach it. Similar RFD leaving the ground. It indicates the ability to amortize.
- **The elevation**, indicated by **E**, is calculated by the software from the only flight time (as is typically done by instrumentation that of the jump measure only the flight time) by applying the law of parabolic motion along the vertical axis:

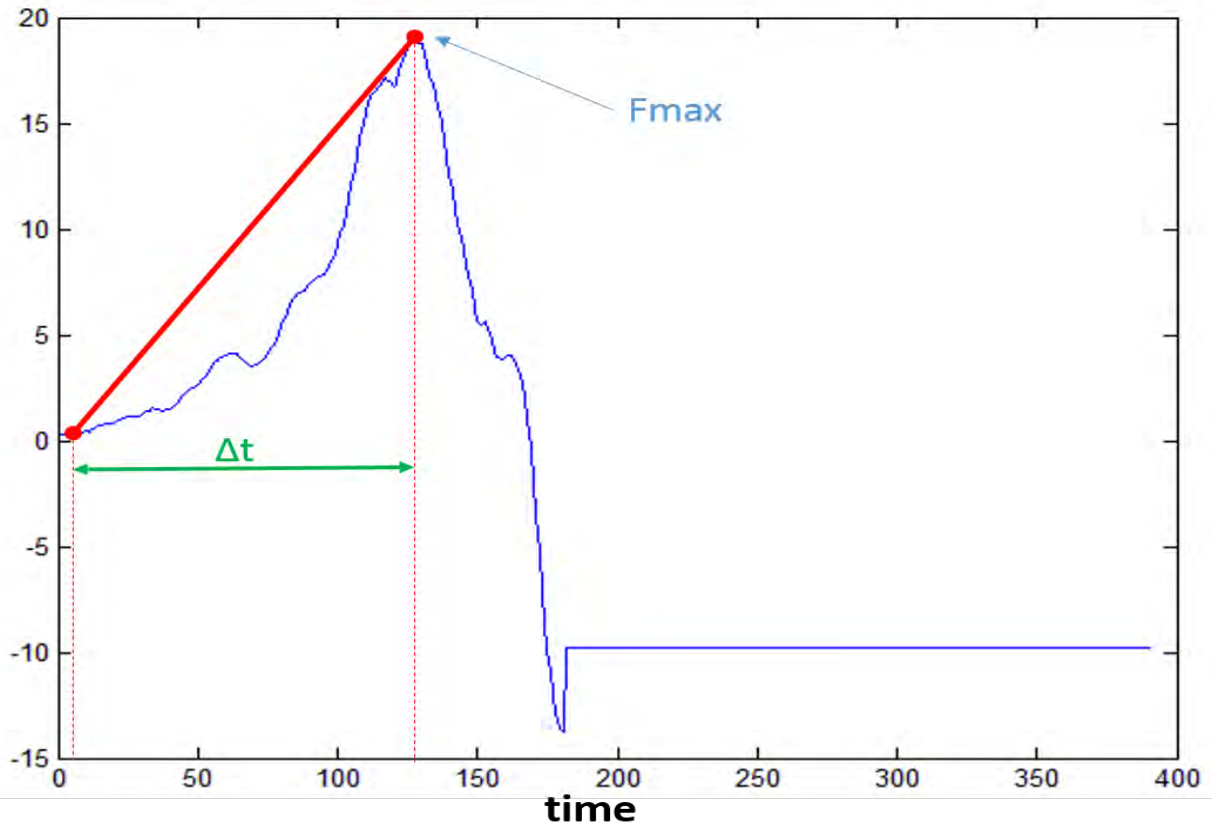
$$E = TV*TV*9.81/8$$

This relation is valid only if the height of the centre of mass at take off and at landing coincides.

- **RSI** assesses the ability to produce force rapidly under high eccentric load.

**RSI = Jump Height/Contact Time (after DROP)**

- **Fatigue Index** is the ratio between the average power and the maximum power reached during the execution of the jumps.
- **Rate of force development (RFD)** is a parameter that describes "how" the athlete comes to the expression of the maximum force in the concentric phase of the jump. From the image (extracted from a squat jump) you can see that this parameter represents the slope of the line that starts at the beginning of the concentric phase (i.e. the instant which the speed is greater than 0 m/s) and reaches up to the peak force. It is therefore dependent by two factors, the value of the maximum force that the athlete reaches and  $\Delta t$  time that it takes to achieve it. For example, a high value of RFD indicates that the athlete has a higher peak force and reaches him in a short time. So it may happen that two athletes exhibit two peaks of different strengths but the same value of RFD, this because the one with a lower peak force developed that strength in less time. From all this it follows that this parameter is very indicative in the squat jump, less in cmj and for next to nothing in the repeated jumps. In fact, with the help of the eccentric phase this parameter loses meaning and in some cases is even zero because the beginning of the concentric phase coincides with the maximum force ( $t=0$ ).



**TABLE OF THE MEASURED PARAMETERS OF THE JUMPS TESTS**

Peak flight time [s]	Maximum value of the flight times measured in the series of jumps
Average flight time [s]	Average value of the flight times measured in the series of jumps
Peak contact time [s]	Maximum value of the contact times measured in the series of jumps
Average contact time [s]	Average value of the contact times measured in the series of jumps
Peak eccentric work [J/kg]	Maximum value of the eccentric work in the series of jumps
Average eccentric work [J/kg]	Average value of the eccentric work in the series of jumps
Peak concentric work [J/kg]	Maximum value of the concentric work in the series of jumps
Average concentric work [J/kg]	Average value of the concentric work in the series of jumps



Peak jump height [cm]	Maximum value of the jump height in the series of jumps
Average jump height [cm]	Average value of the jump height in the series of jumps
Peak maximum velocity [m/s]	Maximum value of the maximum velocity in the series of jumps
Average maximum velocity [m/s]	Average value of the maximum velocity in the series of jumps
Peak maximum power [W/kg]	Maximum value of the maximum power in the series of jumps
Average maximum power [W/kg]	Average value of the maximum power in the series of jumps
Peak maximum force [N/kg]	Maximum value of the maximum force in the series of jumps
Average maximum force [N/kg]	Average value of the maximum force in the series of jumps
Peak rate of force development [N/kg/s]	Maximum value of the rate of force development in the series of jumps
Average rate of force development [N/kg/s]	Average value of the rate of force development in the series of jumps
Peak time to maximum force [s]	Maximum value of the time to maximum force in the series of jumps
Average time to maximum force [s]	Average value of the time to maximum force in the series of jumps
Peak maximum force at landing [BW]	Maximum value of the maximum force at landing in the series of jumps
Average maximum force at landing [BW]	Average value of the maximum force at landing in the series of jumps
Peak time to maximum force at landing [s]	Maximum value of the time to maximum force at landing in the series of jumps
Average time to maximum force at landing [s]	Average value of the flight times measured in the series of jumps
Peak loading rate [BW/s]	Maximum value of the loading rate in the series of jumps

Average loading rate [BW/s]	Average value of the loading rate in the series of jumps
Peak reactivity index	Maximum value of the reactivity index in the series of jumps
Average reactivity index	Average value of the reactivity index in the series of jumps
Peak stiffness index	Maximum value of the stiffness index in the series of jumps
Average stiffness index	Average value of the stiffness index in the series of jumps

**TABLE OF THE MEASURED PARAMETERS OF THE SWAY TEST**

Area [cm <sup>2</sup> ]	The 95% ellipse of confidence is the ellipse that contains approximately 95% of the points of the trajectory.
Area convex hull [cm <sup>2</sup> ]	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.
Length (D)	It is the total length of the trajectory obtained as the sum of the distances from one point to the next.
Mean Distance (D)	This is the mean distance from the midpoint of the trajectory
RMS (D)	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
Velocity (D)	This is the mean travel velocity of the trajectory.
Mean Frequency (D)	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

Total Power (D)	This is the area of the power spectrum in the range 0.15 - 5Hz
Power @ 50% (D)	The frequency below which 50% of the total signal power is contained
Power @ 95% (D)	The frequency below which 95% of the total signal power is contained
Centroidal Frequency (D)	This is the frequency at which the "spectral mass" is concentrated
Frequency dispersion (D)	This is a measurement between 0 and 1 of the content variability in frequency of the power spectrum
Length (ML)	The ML length is the total distance in the anteroposterior direction given as the sum of the absolute distances between two consecutive points in the ML direction
Mean Distance (ML)	This is the mean distance from the midpoint of the medio-lateral trajectory
RMS (ML)	This is the mean distance from the midpoint of the medio-lateral trajectory
Velocity (ML)	This is the mean travel velocity of the trajectory in medio-lateral direction
Mean Frequency (ML)	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
Total Power (ML)	This is the area of the power spectrum in the range 0.15 - 5Hz of the ML trajectory
Power @ 50% (ML)	The frequency below which 50% of the total ML signal power is contained
Power @ 95% (ML)	The frequency below which 95% of the total ML signal power is contained
Centroidal Frequency (ML)	This is the frequency at which the "spectral mass" in the ML direction is concentrated
Frequency dispersion (ML)	This is a measurement between 0 and 1 of the content variability in frequency of the power spectrum in the ML direction
Length (AP)	The AP length is the total distance in the anteroposterior direction given as the sum of

	the absolute distances between two consecutive points in the AP direction
Distanza media (AP)	This is the mean distance from the midpoint of the antero-posterior trajectory
RMS (AP)	This is the mean distance from the midpoint of the antero-posterior trajectory
Velocity (AP)	This is the mean travel velocity of the trajectory in antero-posterior direction
Mean Frequency (AP)	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
Total Power (AP)	This is the area of the power spectrum in the range 0.15 - 5Hz of the AP trajectory
Power @ 50% (AP)	The frequency below which 50% of the total AP signal power is contained
Power @ 95% (AP)	The frequency below which 95% of the total AP signal power is contained
Centroidal Frequency (AP)	This is the frequency at which the "spectral mass" in the AP direction is concentrated
Frequency dispersion (AP)	This is a measurement between 0 and 1 of the content variability in frequency of the power spectrum in the AP direction
GyKo Height	Height of the device from the ground

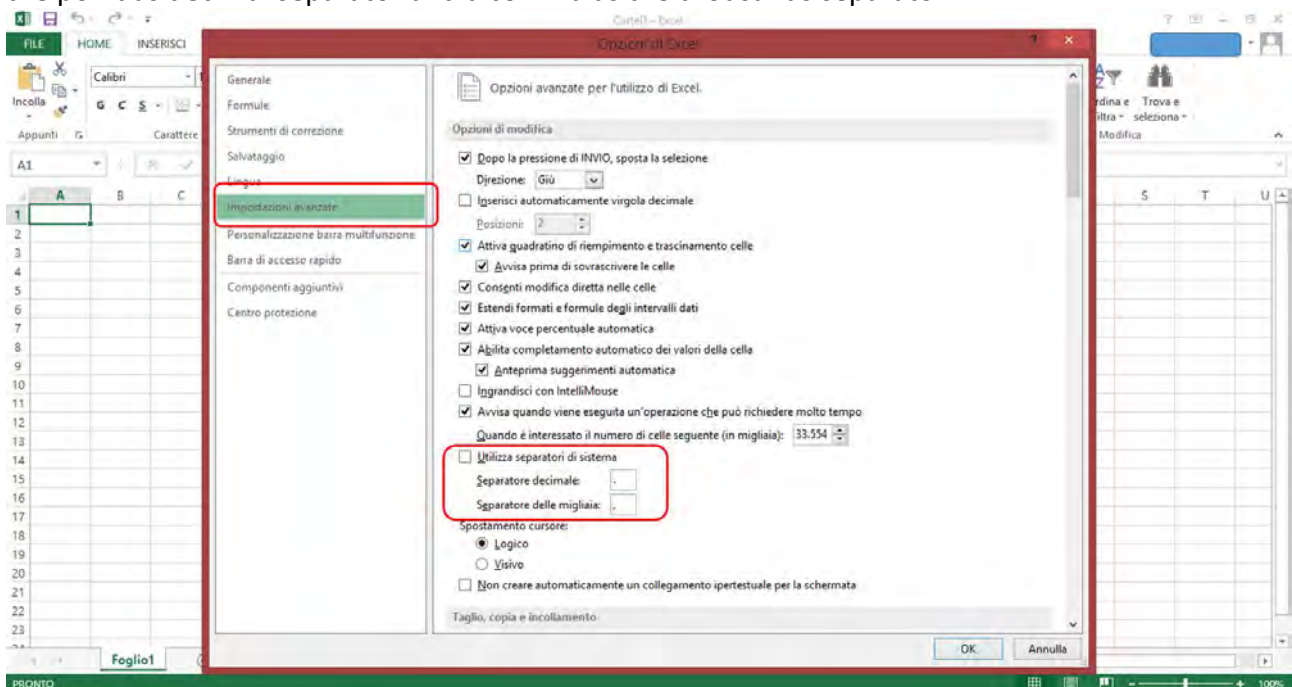
# 11 APPENDIX D

## 11.1 IMPORTING RESULTS IN MICROSOFT EXCEL 2010 AND 2013

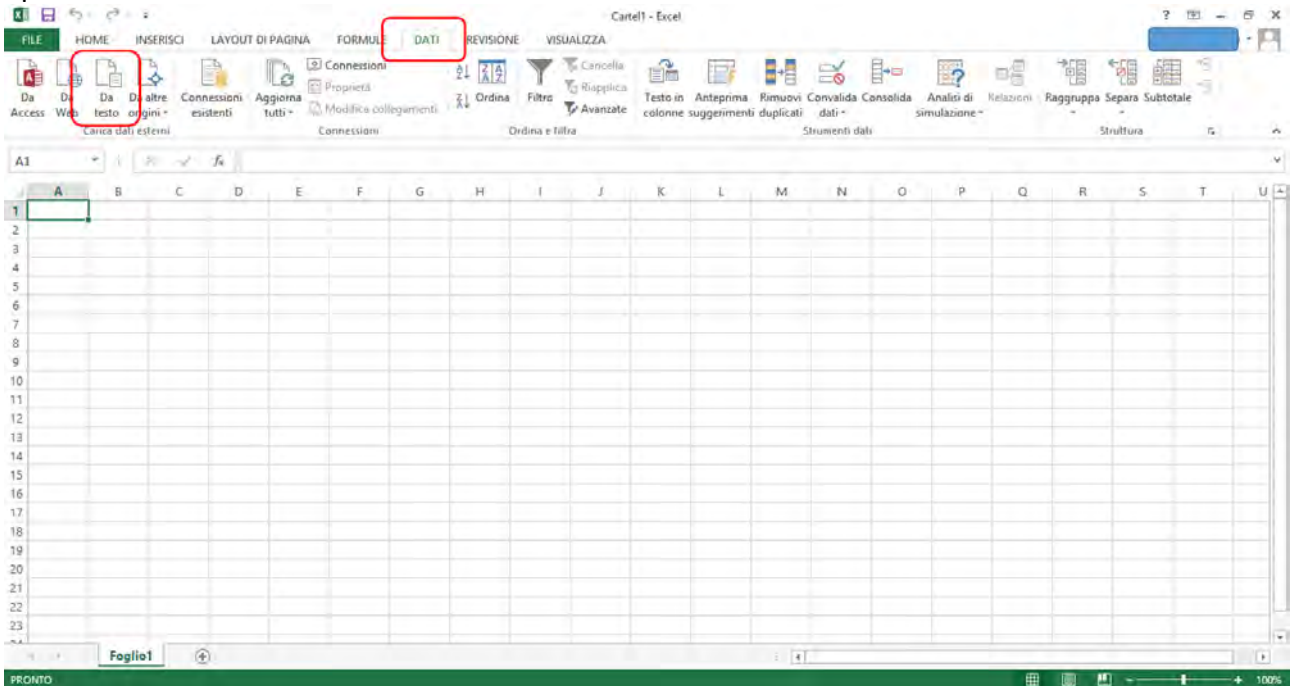
To import in Excel the exported data from GyKoRePower you must first set up it in a way that considers the point as the decimal separator and a comma as the thousands separator (usually is the opposite by default). To do this simply go to "Options" in Excel (which is accessed by pressing the File button):



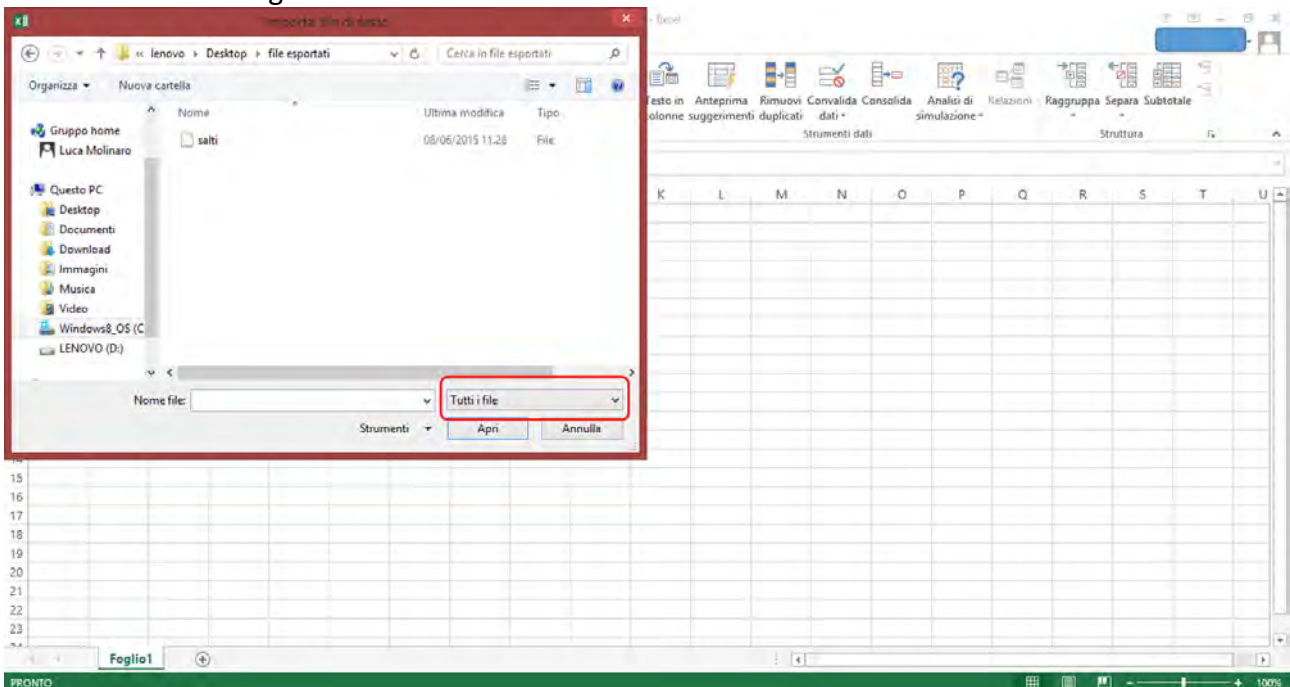
Select the "Advanced Settings" where you can specify, in the fields highlighted in the figure below, the point as decimal separator and a comma as the thousands separator:



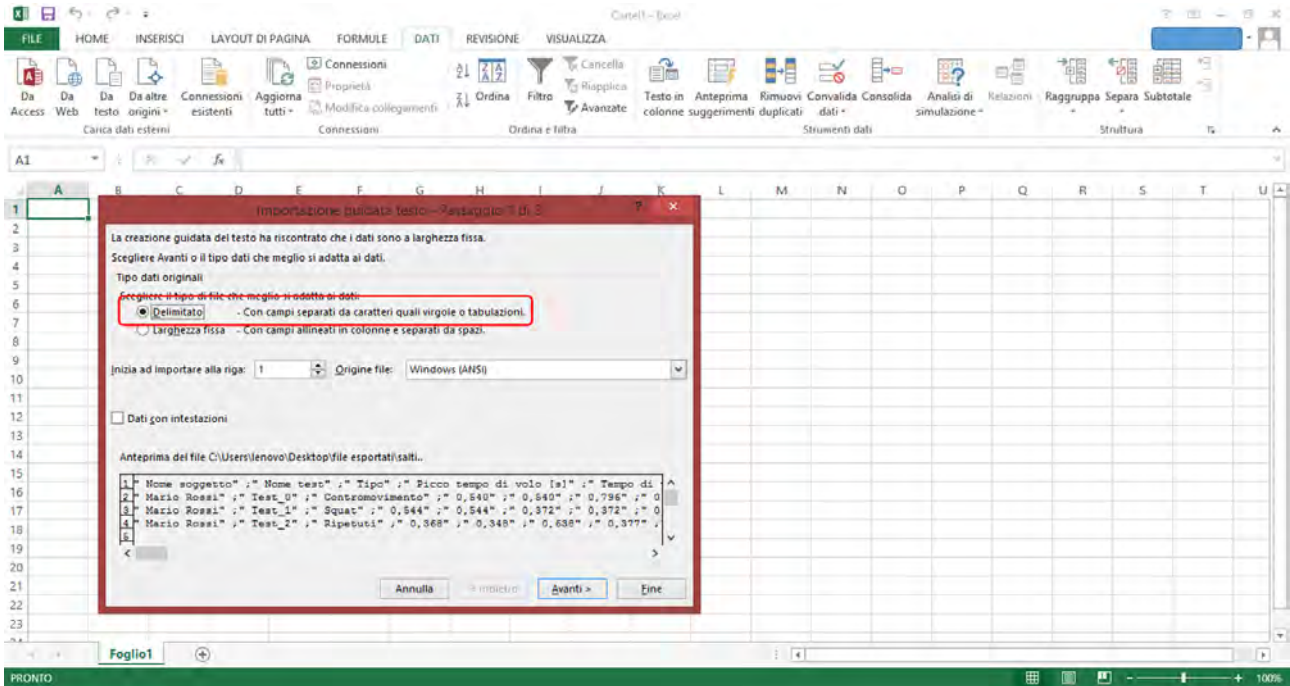
At this point, from the main screen of Excel, you have to press to menù “Data” and select the option “From Text”:



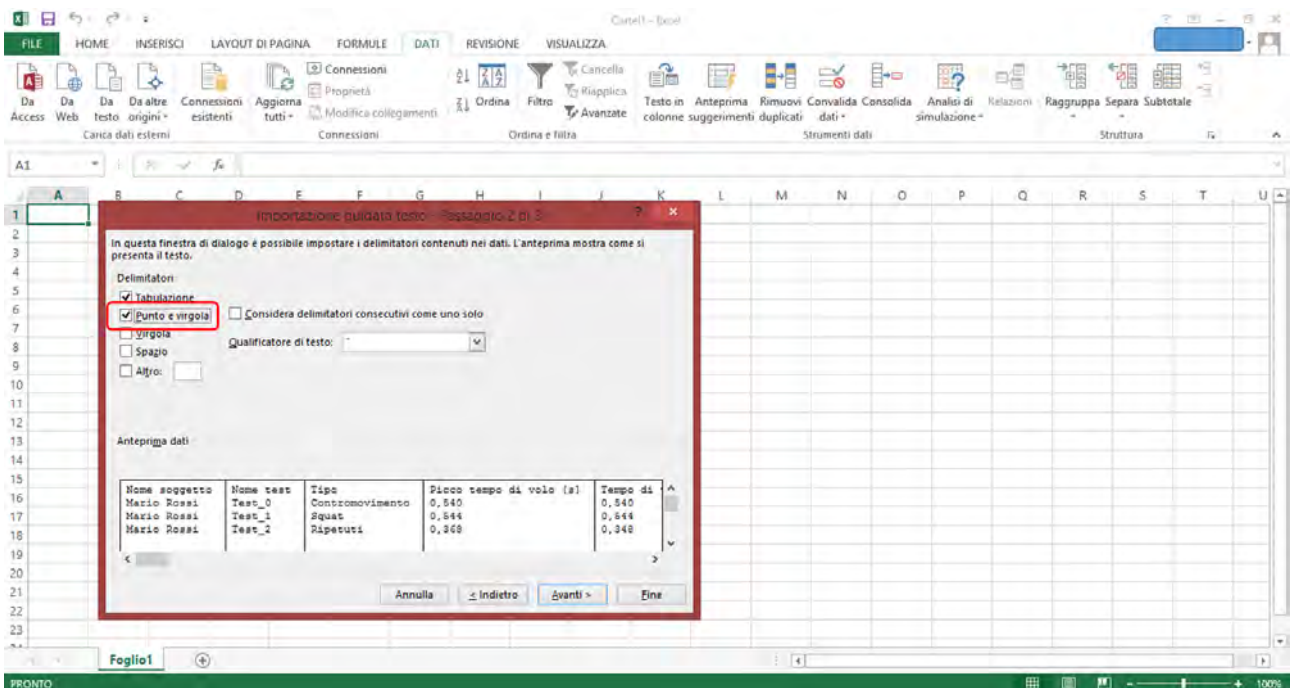
At this point you will open a browser window through which you have to upload the file you want to import. If the file does not show you make sure to select “all the files” from the drop-down menu in the lower right corner:



The following import window that appears you have to specify "Bordered" as option available data:



Pressing "Next" you will have to select the "Point and Comma" as the delimiter:



Pressing the button "Finish" Excel has completed importing the data that will be displayed as well on the spreadsheet.

## 12 TROUBLESHOOTING E TECHNICAL SUPPORT

### ***The “start” button is disabled***

The software has not been connected yet to the device.

### ***The software suddenly stops working***

GykoRePower software has been developed ensuring stability and working robustness.

In case the software suddenly stops working and the user has to force it to terminate its executions, you have to remove and replace the Bluetooth dongle into your PC and wait a few seconds before you can start the software again.

### ***The software displays an unusual and wrong increase of joint range even if the device is stationary***

This is indicative of the fact that the body segment on which the device is placed was not sufficiently still after pressing the start button; in this case, the test has to be repeated.

### ***The software does not detect load lifting***

The GykoRePower measure the accelerations of the weight stack on which the device is placed. During the recording, if load lifting does not produce an increment of the repetitions counter, this is symptomatic of the fact that the software did not detect any acceleration of the weight stack. This may in turn be due to the fact that the average velocity of the weight stack has been constant and therefore no acceleration was produced.

### ***The repetition is counted twice***

The GykoRePower measure the accelerations of the weight stack on which the device is placed. During the recording, if a single repetition is counted twice, this is indicative of the fact that the software has detected a double movement of the weight stack. This is due to a particularly violent impact of weight stack which is read by the software as a further movement of the weight stack. It is advisable to pay attention to this detail.

### ***The muscular profile has not been determined***

Case 1: despite three sets of repetitions performed with increasing load, the muscular profile is not determined and the software keep on to notifying:

“It is recommended to perform 1 series of repetition with a higher load”

Case 2: the muscular profile has been determined but the software notifies that:

“For a better estimate of 1RM it is recommended to perform a further series of repetitions using a load higher than X kg”



When these situations occur it means that the software has not yet been mathematically able to determine the muscular profile (case 1) or has not yet verified the condition that the power measured in correspondence of the last series of repetitions is not beyond the 70% of 1 RM that has been temporarily estimated (see [Appendix B](#)).

The cause of a not determined muscular profile is not estimated is that the software has not detected velocity decreasing at increasing loads (as it should be physiologically normal). This may be due to two factors:

- The athlete has modulated the velocity with lighter loads (ie, he does not raise the load with maximum intensity);
- the athlete, with the increase of the load, reduced the range of motion of the joint involved in the movement (for example, for a squat, if the protocol provides an angle of bending of the knees up to 90 °, the athlete, with higher loads has reduced the angle of knee flexion);

These are the two main reasons why, as the load increases, there might be no significant decreases of lifting velocity.

### ***Interference***

The presence of a large number of devices with active Bluetooth function (other PCs, smartphones, etc. ..) near your place of work could disturb the exchange of data between the hardware and the Bluetooth dongle connected to your PCs. This may affect the normal operation of GykoRePower. It is advisable to pay attention to this detail.

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