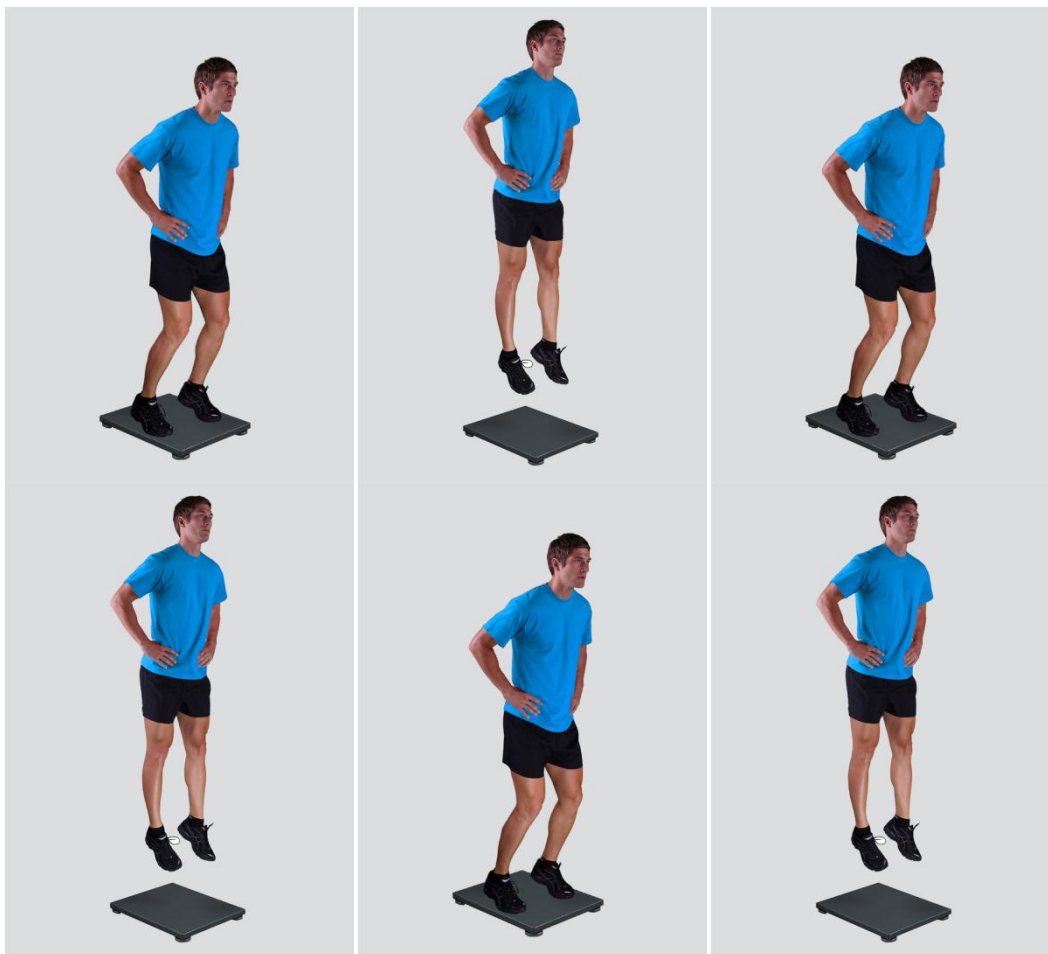


## MODULE: REPETITIVE HOPPING

### BRIEF DESCRIPTION:

Repetitive Hopping is a maximal or submaximal repetitive vertical jumping and is characterized by the large mechanical work of the ankle joint and quite small work of the hip joint. Changes in hops` ground reaction force (GRF) through time carry information about the endurance/fatigue in this aggressive stretch-shortening cycle exercise. The movement task is performed by predominantly activating foot plantar flexors and knee extensors. However, sustained control over the general stiffness of the trunk, pelvic girdle and lower extremities is needed. Based on the parameters derived from the ground reaction force, flight time dynamics and their changing thru repetition can be thoroughly studied. They provide an insight into the ability to sustain storage-and-recoil of elastic energy effective for a certain time period.

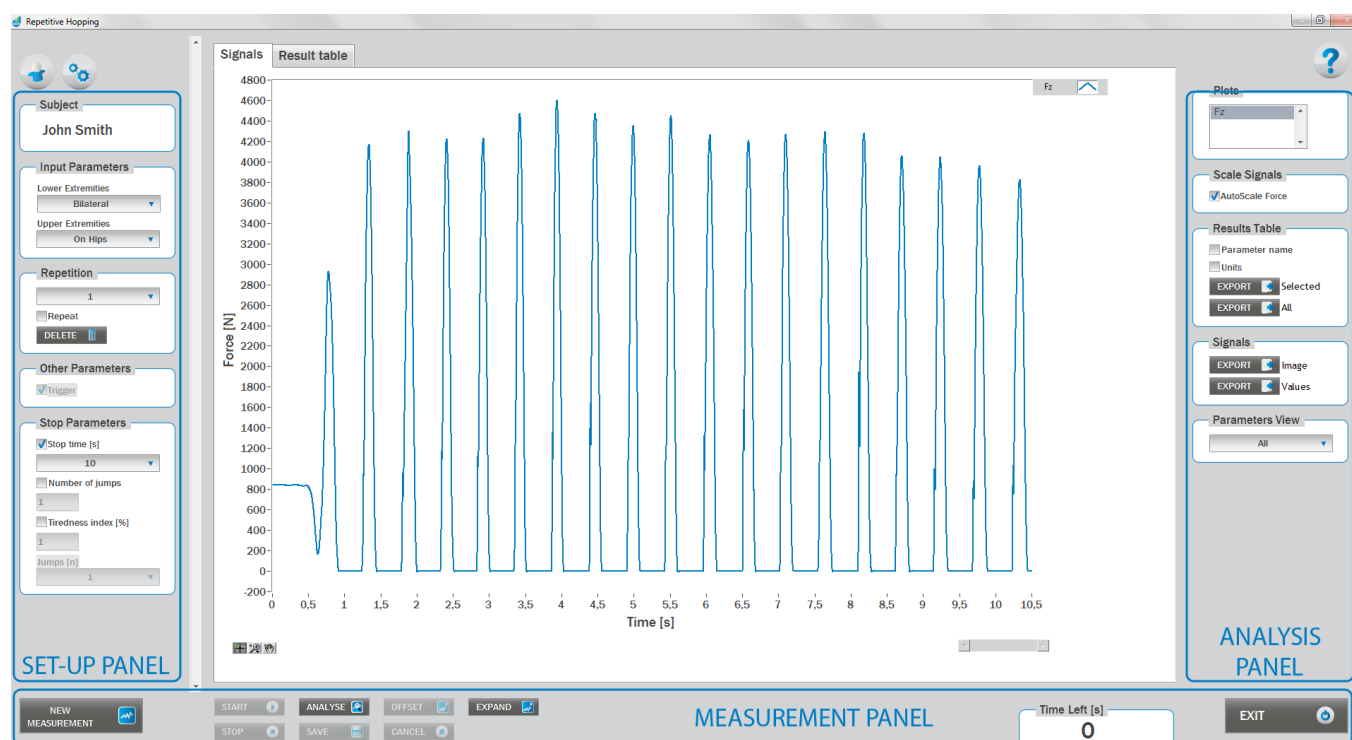
The initial position of the subject is an upright stance. From the starting position the subject begins to perform vertical hops by primarily using plantar flexors. The repetitive hops must be performed as quickly and as explosively as possible in order to perform the highest possible repetitive hops (i.e. highest hops in shortest contact times).



When the Repetitive Hopping module opens, the existing measurements of the selected subject inside the current Visit are displayed and the user can review them (see section Analysis for details). If no measurements have yet been done for this subject, then only the option to start a new measurement is enabled. In order to begin a new measurement, click New Measurement button and select the Input Parameters to exactly define the measurement task.

When the New Measurement button is selected for the first time after entering the Repetitive Hopping module, the force plate is initialized. After the automatic initialization process is finished, the zero offset must be done (follow the instructions on the pop-up message). The plate must be unloaded during the entire initialization and zero offset procedure. This procedure is performed every time you enter the Repetitive Hopping measurement module. Zero offset can be repeated any time manually by pressing the Offset button, otherwise the automatic zero offset is done every 30 minutes.

## BASIC FUNCTIONS:



## SET-UP PANEL:

### SUBJECT

#### Name

The selected subject.

### INPUT PARAMETERS

See Selecting Input Parameters section for details.



## REPETITION

### Repetition

Number of repetitions for the selected Input parameters.

### Repeat

If checked, the selected repetition is replaced when the new measurement is performed.

### Delete

Delete the selected repetition.

## OTHER PARAMETERS:

### Trigger

When trigger option is selected, software will automatically cut the signal before the »first cursor« (duration is defined with Start buffer parameter) and after the »last cursor« (duration is defined with Start buffer parameter). Start buffer and Stop buffer can be set in settings window. For details about setting the parameters refer to Settings Section.

## STOP PARAMETERS:

Three stop conditions are available, from which only one can be selected at once by checking the check box next to it.

After the selected condition is reached measurement will be stopped automatically.

Available stop conditions are:

- 1.) Stop time – measurement will be stopped when the time is exceeded.
- 2.) Number of jumps – measurement will be stopped when desired number of jumps is reached.
- 3.) Tiredness index – measurement will be stopped when the Tiredness index falls under the set threshold. Tiredness index is calculated as average height of the last N jumps divided by the average height of the first N jumps multiplied by 100%. N is the number of jumps.

## ANALYSIS PANEL:

### PLOTS

#### Plots

The list of all channels. The selected channels are shown on the graph.

### SCALE

#### AutoScale Force

If checked, the vertical scale of the graph is adapted to the maximum and minimum value of all force signals.



## RESULTS TABLE

In the Result Table panel, result parameters from Result table tab can be exported into clipboard, CSV or TXT format. Format of the file can be set in settings window under export section. For details about setting the parameters refer to Settings Section.

### Parameter Name

Parameter name will be included.

### Units

Units of the parameters will be included.

### Export Selected

By clicking on Export Selected button only the parameters that are selected in the table will be included.

### Export All

By clicking on Export All button all parameters from the table will be included.

## SIGNALS

In the Signals panel, image or values (row data) of acquired signal can be exported. Image and values can be exported with different parameters, which can be set in Settings window under export section.

For details about setting the parameters refer to Settings Section.

### Export Image

Export the image of signals (as visible on the graph on the Signals tab) into the clipboard. Image can be paste in any image editor.

### Export Values

Export values (raw data) of signals (as visible on the graph on the Signals tab) into CSV or TXT format. Format of the file can be set in settings window under export section. For details about setting the parameters refer to Settings Section.

## PARAMETERS VIEW

In the Parameters View panel, calculated parameters which are displayed in the result table can be set. By default, all and basic view are available. Basic view contains preset parameters and cannot be changed. Custom view can be defined, by clicking »Manage...« button.

To create a new view click on add button and enter the name of the view. Parameters included in the view are selected by checking the checkboxes next to them. To confirm the changes click save.



## MEASUREMENT PANEL

### **New Measurement**

Starts with a new measurement.

### **Start**

Starts the measurement.

### **Stop**

Stops the measurement.

### **Save**

Saves the measurement.

### **Cancel**

Cancel the last measurement.

### **Offset**

Makes zero offset. Note that the force platform must be unloaded during the process.

### **Analyse**

Performs the analysis.

### **Collapse**

Collapses the graph and the side panels are shown.

### **Expand**

Expands the graph and the side panels are hidden.

### **Time left [s]**

Time left to the end of measurement.

### **Number of Jumps [n]**

Number of jumps measurement.

### **Jumps left [n]**

Jumps left to the end of measurement.

### **Exit**

Closes the measurement module.

## SELECTING INPUT PARAMETERS:

Before the measurement can start, the user has to choose some input parameters with which the measured motor task (Repetitive Hopping) is specifically defined. These parameters are important for further analysis, comparisons and reporting. Repetitive Hopping characteristics are defined by the following parameters:

## LOWER EXTREMITIES:

### Bilateral

The subject is standing in the centre of the plate with the feet placed parallel or with toes pointing slightly outward. Feet should be shoulder-width apart.



### Unilateral-Left / Unilateral-Right

The subject is standing on a single leg (dominant or non-dominant) in the centre of the plate.



## UPPER EXTREMITIES:

### On Hips

The subject places his/her hands on his/her hips.



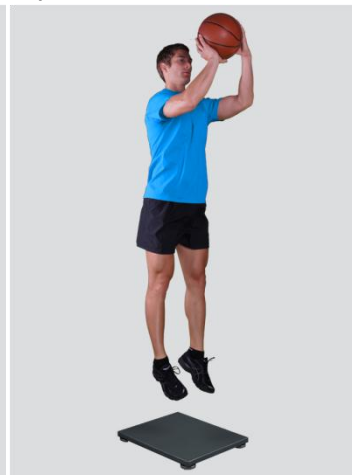
### Free

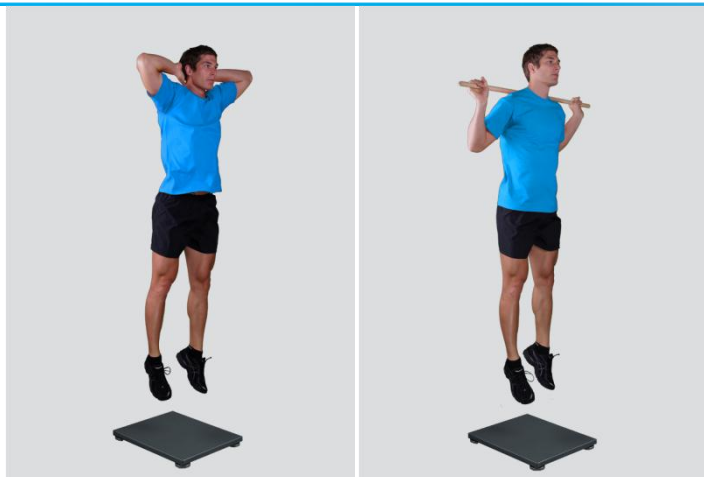
Subjects are free to use their arms as they want. Specifically useful when observing how subjects differ in using arms as a biomechanical advantage.



### Other user defined

In case of any other position of the upper extremities, the user can select this option and can define another function/placement of the upper extremities (see Settings Section for details). After doing so, the newly defined input parameter will from then on appear as an optional choice under the Upper extremities in the Squat Jump measurement module.





## MEASUREMENT:

After selecting input parameters, the subject steps on the plate and acquires the required position. Ensure that the subject is standing in the centre of the plate as described above. When the subject acquires the required position and is ready to start the movement, click Start. At that time, the subject is free to start the task and the software will automatically recognize the beginning and the end of the Repetitive Hopping task. For details about this automatic acquisition please see Settings Section.

If you want to start a new measurement, click the New Measurement button and repeat the procedure. Before doing so, you can change the Input Parameters; if not, the Input Parameters of the previous measurements will be used. If you want to repeat a certain measurement, click on the drop down menu, select the repetition you want to replace and check the box Repeat. Then click Start and a pop-up window will ask you if you really want to repeat the measurement. Click OK if you want to repeat.

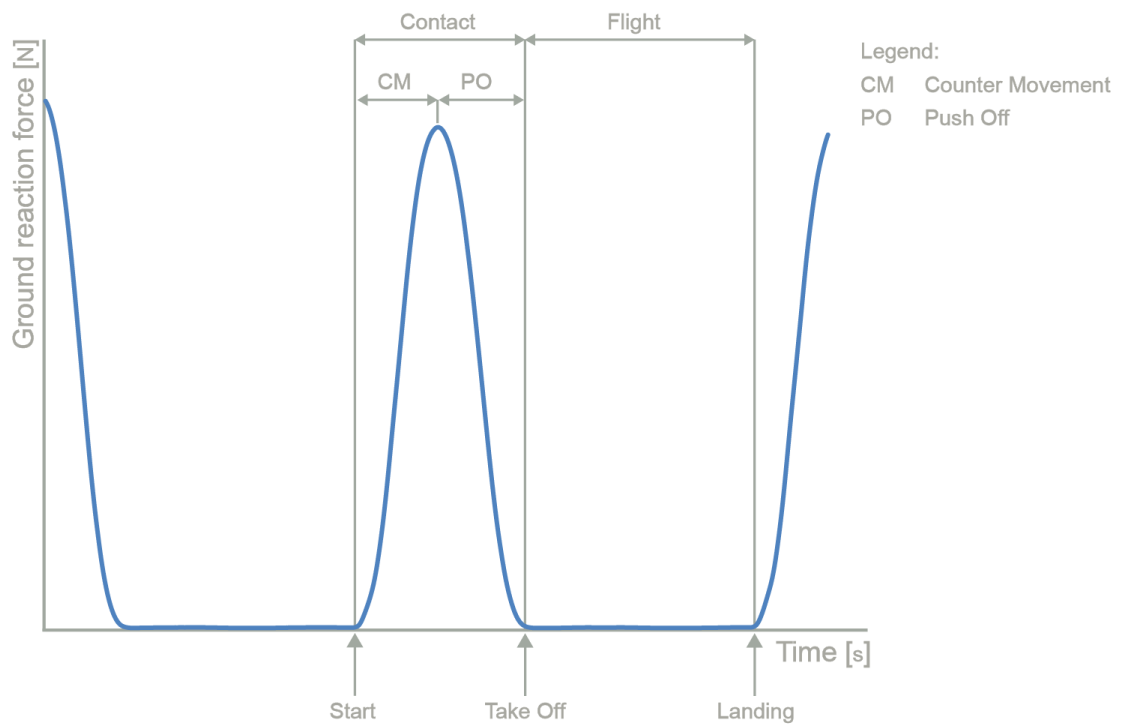
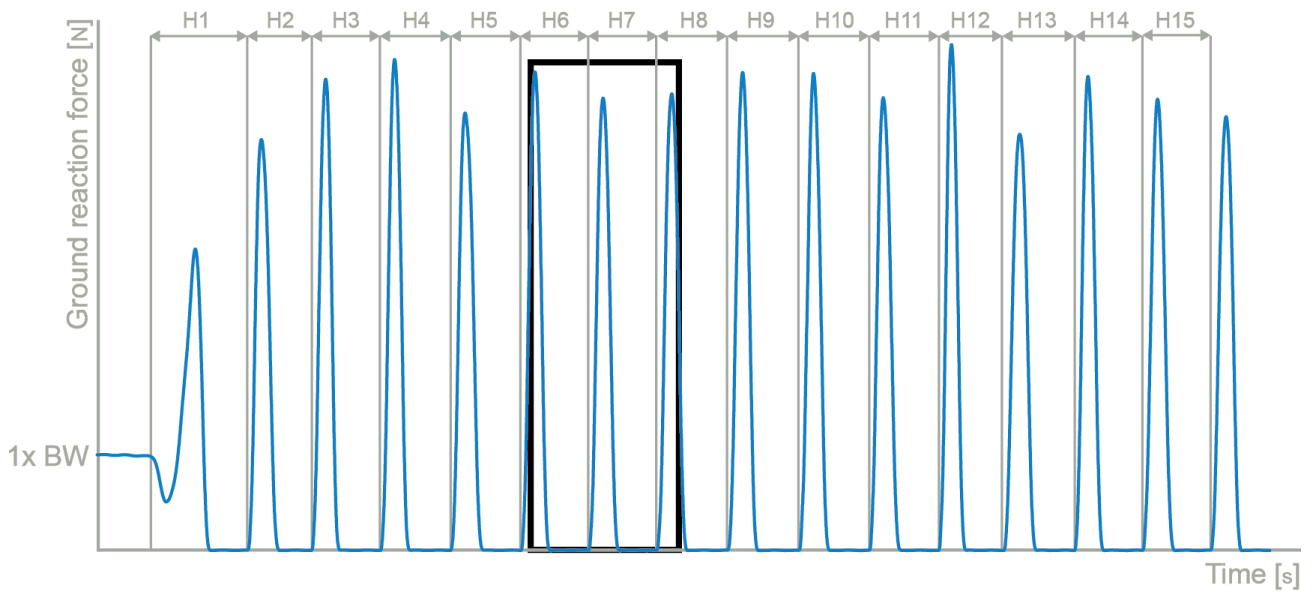
## ANALYSIS:

Analysis enables you to check the vertical signal of the ground reaction force and the calculated parameters. Under the Signal tab you can see the signal and markers which are placed automatically. You can move all markers if they were placed incorrectly. Under the Results Table tab you can see all the calculated parameters numerically, while the visualisation of the results comparisons can be done under the Results Graphs tab. These two tabs enable you to make quick comparisons of the values of the parameters among different repetitions and/or among different sub-versions of the test. If you would like to export the calculated parameters use Export function in Result Table panel.

All the parameters calculated for analysis are commonly used in biomechanics, kinesiology and rehabilitation<sup>1-7</sup>. Parameters are calculated from the ground reaction force, flight time and their changes thru repetition. For more information regarding the parameters click on the references below. Note that the first jump is excluded from the analysis.

For some modules additional analysis routines are available as a separate product. See section About the Product for more information.





## CALCULATED PARAMETERS:

### OVERALL

Note: For all the parameters that are calculated for an individual Hop in a series, the common parameters are observed as listed below. It is important to know that the first jump is not taken into analysis and therefore the algorithm takes as the first jump/hop the one that follows the first Flight.

#### Max

Maximal value.

**Jump No. of max**

Consecutive number of the jump with the maximal value.

**Min**

Minimal value.

**Jump No. of min**

Consecutive number of the jump with the minimal value.

**Average of first n jumps**

Average value of the first n jumps (n is selected in the Setting section and is usually between 3 to 5 jumps).

**Average of middle n jumps**

Average value of n jumps in the middle of series (n is selected in the Setting section and is usually between 3 to 5 jumps).

**Average of last n jumps**

Average value of the last n jumps (n is selected in the Setting section and is usually between 3 to 5 jumps).

**Fatigue index**

Ratio between the Average of the last n jumps and the Average of the first n jumps.

**Endurance index**

Ratio between the Average of the middle n jumps and the Average of the first n jumps.

## CALCULATED PARAMETERS:

### GENERAL

**Jump height from Take Off V [m]**

The height of the jump calculated from the Take Off velocity as calculated from the force impulse.

**Jump height from Flight T [m]**

The height of the jump calculated from the Flight Time.

**Ratio between jump height and Contact T [m/s]**

Ratio between the height of the jump and the time interval between the Start and the Take Off.

**Start interval relative F [%BW]**

Average force in the 1<sup>st</sup> 50 ms of the Push Off (50 ms is a default value and can be changed under the Settings section).

**Start interval relative P [W/kg]**

Average power in the 1<sup>st</sup> 50 ms of the Push Off divided by the body weight (50 ms is a default value and can be changed under the Settings section).

**Start interval A [m/s<sup>2</sup>]**

Average acceleration in the 1<sup>st</sup> 50ms of the Push Off (50 ms is a default value and can be changed under the Settings section).



## Start interval V [m/s]

Average velocity in the 1<sup>st</sup> 50ms of the Push Off (50 ms is a default value and can be changed under the Settings section).

## Relative maximal F [%BW]

Maximal force during the Contact period divided by the body weight.

## Relative maximal F during Counter Movement [%BW]

Maximal force during the Counter Movement divided by the body weight.

## Relative maximal F during Push Off [%BW]

Maximal force during the Push Off divided by the body weight.

## Relative maximal F in the 1<sup>st</sup> half of Push Off [%BW]

Maximal force between the Lowest Position and the half of the Push Off divided by the body weight.

## Relative maximal F in the 2<sup>nd</sup> half of Push Off [%BW]

Maximal force between the half of the Push Off and the Take Off divided by the body weight.

## Relative maximal P [W/kg]

Maximal power during the Contact divided by the body weight.

## Relative E [J/kg]

Energy during the Contact divided by the body weight.

## Counter Movement A [m/s<sup>2</sup>]

Average acceleration during the Counter Movement phase.

## Push Off A [m/s<sup>2</sup>]

Average acceleration during the Push Off phase.

## Vertical Take Off V [m/s]

Velocity of the vertical movement at the Take Off.

## TIME PARAMETERS

### Contact T [s]

Time interval between the First Contact and the Take Off.

### Flight T [s]

Time interval between the Take Off and the Landing.

### Counter Movement T [s]

Duration of the Counter Movement phase from the Start to the Push Off.

### Push Off T [s]

Duration of the Push Off phase.

### Ratio between Counter Movement and Push Off T [%]

Ratio between the duration of the Counter Movement and the duration of the Push Off.

**T to maximal F [s]**

Time interval between the Start and the maximal force.

**T between maximal F and Take Off [s]**

Time interval between the maximal force and the Take Off.

**FORCE IMPULSE PARAMETERS****Total FI [Ns]**

Force impulse (i.e. integral of a force with respect to time) between the Start and the Take Off.

**Push Off FI from Flight T [Ns]**

Force impulse calculated from the Flight Time.

**Counter Movement FI [Ns]**

Force impulse (i.e. integral of a force with respect to time) between the Start and the beginning of the Push Off.

**Push Off FI [Ns]**

Force impulse (i.e. integral of a force with respect to time) between the beginning of the Push Off and the Take Off.

**Ratio between Counter Movement and Push Off FI [%]**

Ratio between the Counter Movement force impulse (i.e. integral of a force with respect to time) and Take Off force impulse.

**FI between First Contact and maximal F [Ns]**

Force impulse (i.e. integral of a force with respect to time) between the Start and the maximal force.

**FI between maximal F and Take Off [Ns]**

Force impulse (i.e. integral of a force with respect to time) between the maximal force and the Take Off.

**Ratio between FI before and after maximal F [%]**

Ratio between the force impulse (i.e. integral of a force with respect to time) between the Start and the maximal force and the force impulse between the maximal force and the Take Off.

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