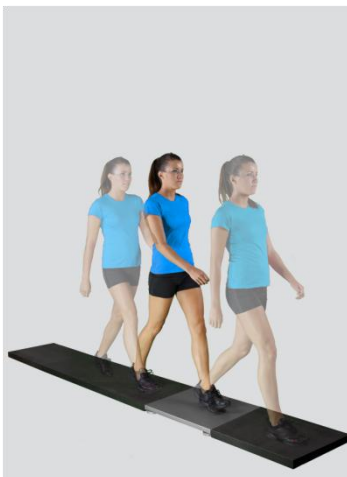


## MODULE: STEP ANALYSIS

### BRIEF DESCRIPTION:

Walking and running are two main gaits in humans. They are forms of bipedal locomotion in which one stride follows another in a continuous pattern. At a certain individually influenced speed a walking person will change to a running pattern of movement, with the lack of a period of double support phase differentiating running from walking. During the stance phase of running/walking a complex three-dimensional dynamic loading of the supporting leg takes place. These loading characteristics differ among individuals, speeds, footwear, etc. For analysing these biomechanical aspects of this floor-leg interaction, ground reaction force measurements are administered most commonly.

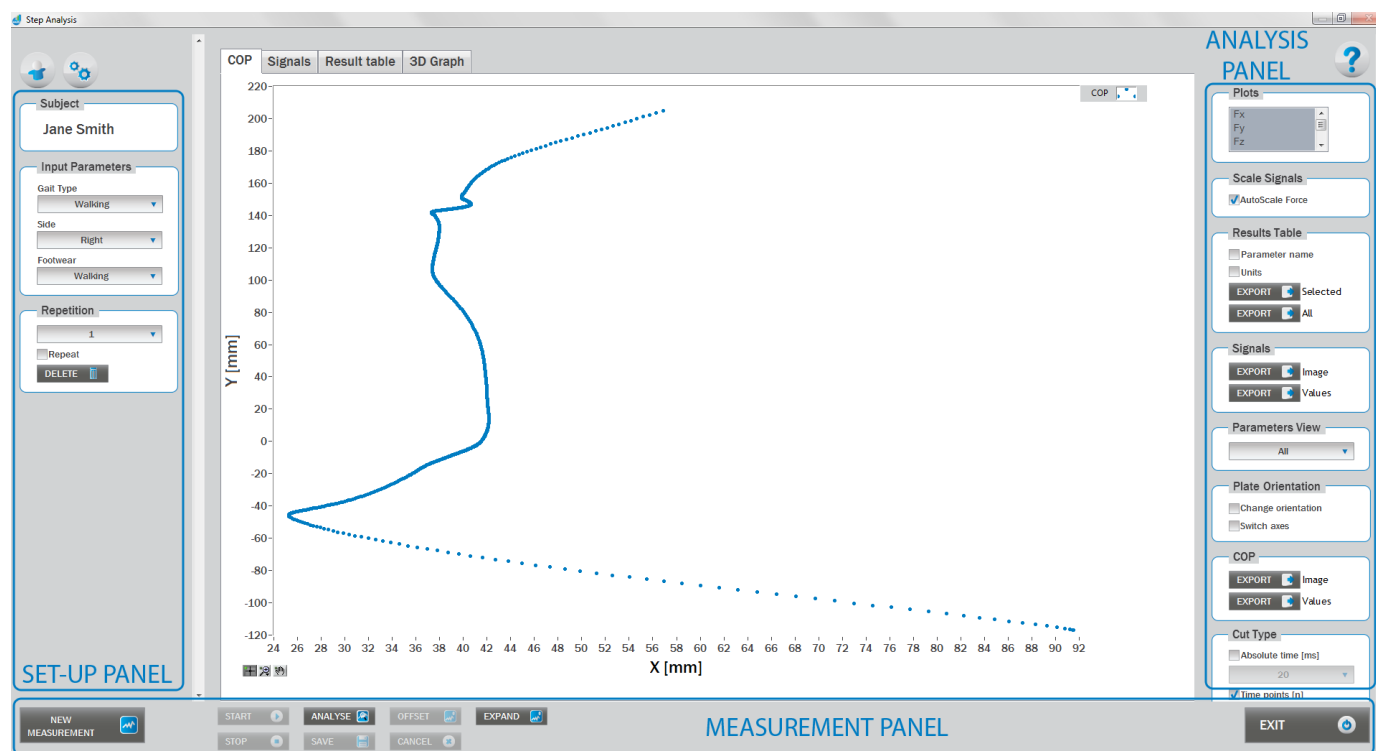
In order to carry out the ground reaction force analysis of the stance phase of the step, we ask a subject to walk/run over the force plate. The foot contact should be done with the entire foot on the plate. The force plate must be installed so that its upper surface is at the same height as the floor on which the subject approaches the force plate and walks/runs away from it. It is important to perform a few preliminary trials so that we assure the appropriate initial positioning of the subject relative to the force plate and to avoid any unwanted adjustments of his/her normal gait pattern.



When the Step Analysis 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, than 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 Step Analysis 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 Step Analysis 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.



---

## 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.

## COP

In the COP 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.

## PLATE ORIENTATION

### Change orientation

Plate orientation is changed for 180°.

### Switch axes

Switches the X and Y axes without moving the force platform.

## CUT TYPE:

In the Cut Type panel, procedure and its parameters for the cut points on the signal are defined.

### Absolute time

The time interval between the adjacent cut points.

### Time points

The number of the cuts points.

## ANIMATE:

### Interval

Speed of the animation defined as time interval (ms) between successive points.

**Start**

Starts the animation.

**Stop**

Stops the animation.

## 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.

**Exit**

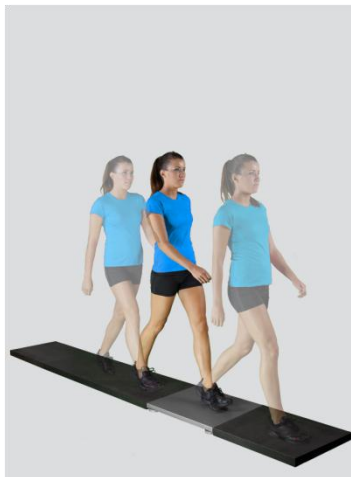
Closes the measurement module.

## SELECTING INPUT PARAMETERS:

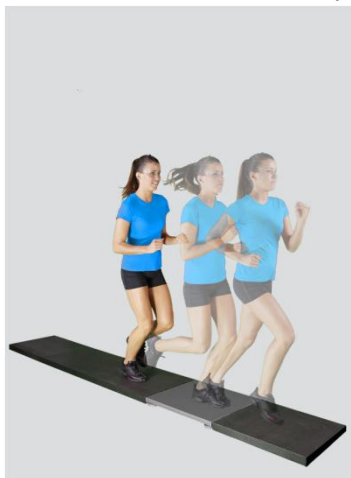
Before the measurement can start, the user has to choose some input parameters with which the measured motor task (walking/running) is specifically defined. These parameters are important for further analysis, comparisons and reporting. The gait`s characteristics are defined by the following parameters:

**GAIT TYPE:****Walking**

The subject walks over the plate so that he performs a single foot contact while walking in the direction of the Y-axis of the force plate.

**Running**

The subject runs over the plate so that he performs a single foot contact while running in the direction of the Y-axis of the force plate.

**Other user defined**

In the Settings panel of the main window of the software the user can define any other type of gait (see Settings Section for details). After doing so, the newly defined input parameter will from then on appear as an optional choice under the Gait Type in the Step Analysis measurement module.



## SIDE:

### Left

The subject performs the single-leg support phase of walking/running over the force plate with his/her left leg.



### Right

The subject performs the single-leg support phase of walking/running over the force plate with his/her right leg.



## FOOTWEAR:

### Barefoot/Running Shoes/Walking Shoes/High Heels

The user selects the type of the shoes that the subject is wearing.



### Other user defined

In the Settings panel of the main window of the software the user can define any other type of footwear (see Settings Section for details). After doing so, the newly defined input parameter will from then on appear as an optional choice under the Footwear in the Step Analysis measurement module.

## MEASUREMENT:

After selecting the input parameters, the subject walks over the plate as described above. It is important that the direction of walking is along the Y-axis of the force plate and that the stance phase of the step which we want to measure is performed about the centre of the plate. When the subject starts to approach the force plate, click Start. After doing so, the software will automatically recognize the moment of the first foot contact and will measure the entire stance phase until the end of it. For details about this automatic acquisition please see Settings Section.

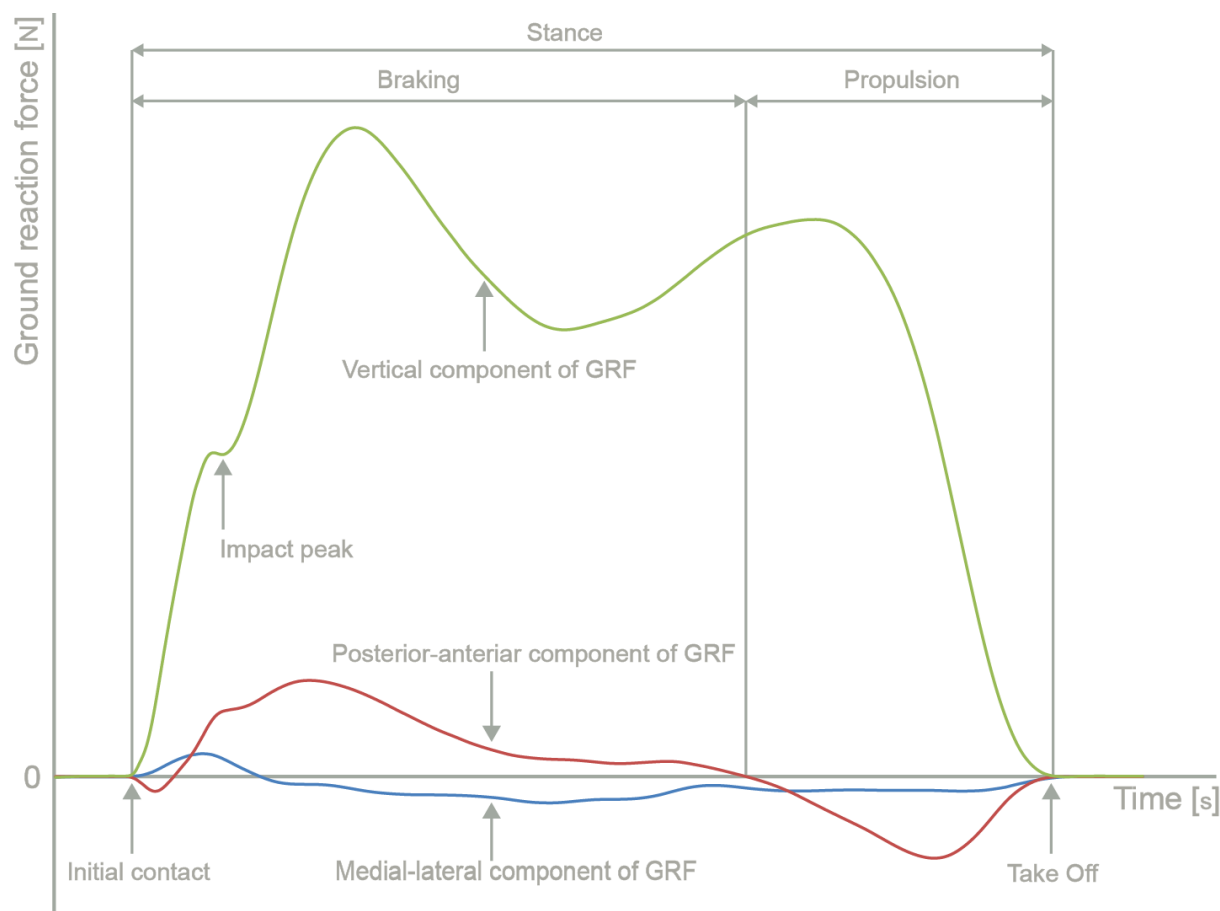
If you want to start a new measurement, click the New Measurement button and repeat the procedure. Before doing so, you can change the Input Parameters; if not, the Input Parameters of the previous measurements will be used. If you want to repeat a certain measurement, click on the drop down menu, select 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 signal of the ground reaction force (GRF) 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 tab you can see all calculated parameters. If you want to confirm the measurement, click Save. 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. Parameters are calculated from the ground reaction force. For more information regarding the parameters click on the references below.



## CALCULATED PARAMETERS:

### TIME PARAMETERS

#### Stance T [s]

The total duration of the entire stance phase of the step observed from the vertical component of the ground reaction force signal.

#### Braking T [s]

The duration of the braking phase of the step observed from the anterior-posterior component of the ground reaction force.

#### Propulsion T [s]

The duration of the propulsion phase of the step observed from the anterior-posterior component of the ground reaction force.

---

## VERTICAL COMPONENT PARAMETERS

### Vertical F of impact peak - abs [N]

The maximum of the vertical component of the ground reaction force calculated on the time interval of the first (i.e. impact) peak and expressed in absolute values. The impact peak is a local maximum of the vertical component which can appear on the initial ascending part of the signal. The impact peak is normally present in case of the rear-foot strike, while absent in case of the mid-foot or fore-foot strike. This parameter is calculated only when the impact peak can be identified on the vertical force signal, otherwise the N.A. value is reported.

### Vertical F of impact peak - rel [%BW]

The maximum of the vertical component of the ground reaction force calculated on the time interval of the first (i.e. impact) peak and expressed in relative values as the percentage of the body weight. The impact peak is a local maximum of the vertical component which can appear on the initial ascending part of the signal. The impact peak is normally present in case of the rear-foot strike, while absent in case of the mid-foot or fore-foot strike. This parameter is calculated only when the impact peak can be identified on the vertical force signal, otherwise the N.A. value is reported.

### T to impact peak [%ST]

The time interval between the initial contact of the foot and the moment at which the impact peak occurs. The parameter is expressed in relative values as the percentage of the total stance time. The impact peak is a local maximum of the vertical component which can appear on the initial ascending part of the signal. The impact peak is normally present in case of the rear-foot strike, while absent in case of the mid-foot or fore-foot strike. This parameter is calculated only when the impact peak can be identified on the vertical force signal, otherwise the N.A. value is reported.

### Vertical F of active peak - abs [N]

The maximum of the vertical component of the ground reaction force calculated on the time interval of the second (i.e. active) peak and expressed in absolute values. The active peak is defined as the global maximum of the vertical component of the ground reaction force.

### Vertical F of active peak - rel [%BW]

The maximum of the vertical component of the ground reaction force calculated on the time interval of the second (i.e. active) peak and expressed in relative values as the percentage of the body weight. The active peak is defined as the global maximum of the vertical component of the ground reaction force.

### T to active peak [%ST]

The time interval between the initial contact of the foot and the moment at which the active peak occurs. The parameter is expressed in relative values as the percentage of the total stance time. The active peak is defined as the global maximum of the vertical component of the ground reaction force.

### Average vertical F during Stance - abs [N]

Average value of the vertical component of the ground reaction force for the entire single-leg stance phase of the step. The parameter is expressed in absolute force values.

### Average vertical F during Stance - rel [%BW]

Average value of the vertical component of the ground reaction force for the entire single-leg stance phase of the step. The parameter is expressed in relative values as the percentage of the body weight.

**Vertical FI during Stance - abs [Ns]**

Force impulse of the vertical component of the ground reaction force for the entire single-leg stance phase of the step. This parameter is represented by the area under the signal of the vertical force component. The parameter is expressed in absolute values as the amount of absolute force in time.

**Vertical FI during Stance - rel [%BWs]**

Force impulse of the vertical component of the ground reaction force for the entire single-leg stance phase of the step. This parameter is represented by the area under the signal of the vertical force component. The parameter is expressed in relative values as the percentage of the body weight in time.

**Change in vertical V [m/s]**

The change in velocity of the subject's body in vertical direction during the stance phase of the step.

**Average vertical F during Braking - abs [N]**

Average value of the vertical component of the ground reaction force for the braking phase of the stance. The parameter is expressed in absolute force values.

**Average vertical F during Braking - rel [%BW]**

Average value of the vertical component of the ground reaction force for the braking phase of the stance. The parameter is expressed in relative values as the percentage of the body weight.

**Vertical FI during Braking - abs [Ns]**

Force impulse of the vertical component of the ground reaction force for the braking phase of the stance. This parameter is represented by the area under the signal of the vertical force component for the time of the braking phase. The parameter is expressed in absolute values as the amount of absolute force in time.

**Vertical FI during Braking - rel [%BWs]**

Force impulse of the vertical component of the ground reaction force for the braking phase of the stance. This parameter is represented by the area under the signal of the vertical force component for the time of the braking phase. The parameter is expressed in relative values as the percentage of the body weight in time.

**Average vertical F during Propulsion - abs [N]**

Average value of the vertical component of the ground reaction force for the propulsion phase of the stance. The parameter is expressed in absolute force values.

**Average vertical F during Propulsion - rel [%BW]**

Average value of the vertical component of the ground reaction force for the propulsion phase of the stance. The parameter is expressed in relative values as the percentage of the body weight.

**Vertical FI during Propulsion - abs [Ns]**

Force impulse of the vertical component of the ground reaction force for the propulsion phase of the stance. This parameter is represented by the area under the signal of the vertical force component for the time of the propulsion phase. The parameter is expressed in absolute values as the amount of absolute force in time.

**Vertical FI during Propulsion - rel [%BWs]**

Force impulse of the vertical component of the ground reaction force for the propulsion phase of the stance. This parameter is represented by the area under the signal of the vertical force component for

the time of the propulsion phase. The parameter is expressed in relative values as the percentage of the body weight in time.

## ANTERIOR-POSTERIOR COMPONENT PARAMETERS

### Peak braking F - abs [N]

The maximum of the repulsion force (the force acting in the opposite direction of the gait; i.e. -Y) calculated from the anterior-posterior component of the ground reaction force. The parameter is expressed in absolute force values.

### Peak braking F - rel [%BW]

The maximum of the repulsion force (the force acting in the opposite direction of the gait; i.e. -Y) calculated from the anterior-posterior component of the ground reaction force. The parameter is expressed in relative values as the percentage of the body weight in time.

### T to peak braking F [%ST]

The time interval between the initial contact of the foot and the moment at which the peak of the repulsion force (the force acting in the opposite direction of the gait; i.e. -Y) occurs. The parameter is expressed in relative values as the percentage of the total stance time.

### Average braking F - abs [N]

Average value of the repulsion force (the force acting in the opposite direction of the gait; i.e. -Y) calculated from the anterior-posterior component of the ground reaction force. The parameter is expressed in absolute force values.

### Average braking F - rel [%BW]

Average value of the repulsion force (the force acting in the opposite direction of the gait; i.e. -Y) calculated from the anterior-posterior component of the ground reaction force. The parameter is expressed in relative values as the percentage of the body weight.

### Braking FI - abs [Ns]

Force impulse of the repulsion force (the force acting in the opposite direction of the gait; i.e. -Y) calculated from the anterior-posterior component of the ground reaction force. The parameter is expressed in absolute values as the amount of absolute force in time.

### Braking FI - rel [%BW<sub>s</sub>]

Force impulse of the repulsion force (the force acting in the opposite direction of the gait; i.e. -Y) calculated from the anterior-posterior component of the ground reaction force. The parameter is expressed in relative values as the percentage of the body weight in time.

### Change in A-P V during braking [m/s]

The change in velocity of the subject's body in anterior-posterior direction during the braking phase of the step.

### Peak propulsion F - abs [N]

The maximum of the propulsion force (the force acting in the same direction as the gait; i.e. +Y) calculated from the anterior-posterior component of the ground reaction force. The parameter is expressed in absolute force values.

**Peak propulsion F - rel [%BW]**

The maximum of the propulsion force (the force acting in the same direction as the gait; i.e. +Y) calculated from the anterior-posterior component of the ground reaction force. The parameter is expressed in relative values as the percentage of the body weight in time.

**T to peak propulsion F [%ST]**

The time interval between the initial contact of the foot and the moment at which the peak of the propulsion force (the force acting in the same direction as the gait; i.e. +Y) occurs. The parameter is expressed in relative values as the percentage of the total stance time.

**Average propulsion F - abs [N]**

Average value of the propulsion force (the force acting in the same direction as the gait; i.e. +Y) calculated from the anterior-posterior component of the ground reaction force. The parameter is expressed in absolute force values.

**Average propulsion F - rel [%BW]**

Average value of the propulsion force (the force acting in the same direction as the gait; i.e. +Y) calculated from the anterior-posterior component of the ground reaction force. The parameter is expressed in relative values as the percentage of the total stance time.

**Propulsion FI - abs [Ns]**

Force impulse of the propulsion force (the force acting in the same direction as the gait; i.e. +Y) calculated from the anterior-posterior component of the ground reaction force. The parameter is expressed in absolute values as the amount of absolute force in time.

**Propulsion FI - rel [%BW<sub>s</sub>]**

Force impulse of the propulsion force (the force acting in the same direction as the gait; i.e. +Y) calculated from the anterior-posterior component of the ground reaction force. The parameter is expressed in relative values as the percentage of the body weight in time.

**Change in A-P V during propulsion [m/s]**

The change in velocity of the subject's body in anterior-posterior direction during the propulsion phase of the step.

**Net A-P FI - abs [Ns]**

Force impulse of the anterior-posterior component of the ground reaction force calculated for the entire single-leg stance phase of the step. The parameter is expressed in absolute values as the amount of absolute force in time.

**Net A-P FI - rel [%BW<sub>s</sub>]**

Force impulse of the anterior-posterior component of the ground reaction force calculated for the entire single-leg stance phase of the step. The parameter is expressed in relative values as the percentage of the body weight in time.

**MEDIAL-LATERAL COMPONENT PARAMETERS****Peak medial F - abs [N]**

The maximum of the medial component of the ground reaction force. The parameter is expressed in absolute force values.

**Peak medial F - rel [%BW]**

The maximum of the medial component of the ground reaction force. The parameter is expressed in relative values as the percentage of the body weight in time.

**Time to peak medial F [%ST]**

The time interval between the initial contact of the foot and the moment at which the maximum of the medial component of the ground reaction force occurs. The parameter is expressed in relative values as the percentage of the total stance time.

**Average medial F - abs [N]**

Average value of the medial component of the ground reaction force. The parameter is expressed in absolute force values.

**Average medial F - rel [%BW]**

Average value of the medial component of the ground reaction force. The parameter is expressed in relative values as the percentage of the body weight.

**Medial FI - abs [Ns]**

Force impulse of the medial component of the ground reaction force. The parameter is expressed in absolute values as the amount of the absolute force in time.

**Medial FI - rel [%BWs]**

Force impulse of the medial component of the ground reaction force. The parameter is expressed in relative values as the percentage of the body weight in time.

**Peak lateral F - abs [N]**

The maximum of the lateral component of the ground reaction force. The parameter is expressed in absolute force values.

**Peak lateral F - rel [%BW]**

The maximum of the lateral component of the ground reaction force. The parameter is expressed in relative values as the percentage of the body weight in time.

**Time to peak lateral F [%ST]**

The time interval between the initial contact of the foot and the moment at which the maximum of the lateral component of the ground reaction force occurs. The parameter is expressed in relative values as the percentage of the total stance time.

**Average lateral F - abs [N]**

Average value of the lateral component of the ground reaction force. The parameter is expressed in absolute force values.

**Average lateral F - rel [%BW]**

Average value of the lateral component of the ground reaction force. The parameter is expressed in relative values as the percentage of the body weight.

**Lateral FI - abs [Ns]**

Force impulse of the lateral component of the ground reaction force. The parameter is expressed in absolute values as the amount of the absolute force in time.

**Lateral FI - rel [%BW<sub>s</sub>]**

Force impulse of the lateral component of the ground reaction force. The parameter is expressed in relative values as the percentage of the body weight in time.

**Net M-L FI - abs [Ns]**

Force impulse of the medial-lateral component of the ground reaction force calculated for the entire single-leg stance phase of the step. The parameter is expressed in absolute values as the amount of absolute force in time.

**Net M-L FI - rel [%BW<sub>s</sub>]**

Force impulse of the medial-lateral component of the ground reaction force calculated for the entire single-leg stance phase of the step. The parameter is expressed in relative values as the percentage of the body weight in time.

**Change in M-L V during stance [m/s]**

The change in velocity of the subject's body in medial-lateral direction during the entire single-leg stance phase of the step.

**COP AND RESULTANT FORCE PARAMETERS****A-P amplitude of COP [mm]**

The maximal amplitude of the centre-of-pressure in anterior-posterior direction during the stance phase of the step.

**M-L amplitude of COP [mm]**

The maximal amplitude of the centre-of-pressure in medial-lateral direction during the stance phase of the step.

**Adapted strike index [% of Foot Length]**

The ratio between the amplitude of the centre-of-pressure in anterior-posterior direction and the length of the foot.

**Absolute peak resultant F [N]**

The maximum of the resultant ground reaction force. The parameter is expressed in absolute force values.

**Relative peak resultant F [%BW]**

The maximum of the resultant ground reaction force. The parameter is expressed in relative values as the percentage of the body weight in time.

**Time to peak resultant F [%ST]**

The time interval between the initial contact of the foot and the moment at which the maximum resultant ground reaction force occurs. The parameter is expressed in relative values as the percentage of the total stance time.

**Average resultant F - abs [N]**

Average value of the resultant ground reaction force. The parameter is expressed in absolute force values.



---

**Average resultant F - rel [%BW]**

Average value of the resultant ground reaction force. The parameter is expressed in relative values as the percentage of the body weight.

**Resultant FI - abs [Ns]**

Force impulse of the resultant of the ground reaction force. The parameter is expressed in absolute values as the amount of the absolute force in time.

**Resultant FI - rel [%BWs]**

Force impulse of the resultant of the ground reaction force. The parameter is expressed in relative values as the percentage of the body weight in time.