MARS HELP

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ABOUT MARS

"Kistler MARS" (Measurement, Analysis and Reporting Software) is innovative, comprehensive and user-friendly software for the complete analysis of force plate measurements. It supports routine diagnostics and research work. When you are reporting this MARS product you should refer to the following technical note article that encompasses the development and technical aspects of the MARS:

DEVELOPMENT OF SOFTWARE FOR COMPREHENSIVE ANALYSES OF FORCE PLATE MEASUREMENTS: TECHNICAL NOTE

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Abstract:

This technical note summarizes the development of a software solution aimed at data acquisition and analyses and results reporting on the tests performed on a force plate. In the introduction, the history of force plate development is reviewed, followed by a description of the process of ground reaction force measurement data acquisition and parameterization. The second part is a short description of five groups of the force plate based tests used to evaluate human movement: (i) static balance, (ii) dynamic balance, (iii) locomotion and body transfer, (iv) fast alternating movements, and (v) strength and power tests. This is followed by the main part in which we present a technical solution, describe the software's conceptual structure by test modules, point out the most important functions and graphically present a concise overview of the tests that the software is designed to handle. We conclude with ideas for further development and future directions.

Key words: *biomechanics, assessment, instrumentation, reporting*

Introduction

When uni- or bi-pedal postural or locomotion activities are being performed, the body is acting on the ground under the feet with a dynamic force (i.e. action force) and the ground is reacting on the body with an identical force in the opposite direction (i.e. ground reaction force (GRF) (Winter, 2004). GRF, as the most common force acting on the human body, can be either calculated from kinematical and anthropometrical data or measured directly using a force plate (FP) (Wong, Wong, & Lo, 2007). The first FP was designed and built by a French scientist Étienne-Jules Marey at the end of the 19th century (Novacheck, 1997).

Many types of force sensors (strain gauge, capacitance gauge, piezo electric, piezo resistive, etc.) have been developed over the years and thereafter the availability of these devices on the market has enabled mass production of force plates with sensors embedded in stiff mechanical frameworks (for a review see Lee & Nicholls, 1999). These have become one of the most commonly used measurement tools in biomechanics. Today, there are several FPs on the market with different characteristics (e.g. size, capacity, precision, sensor technology, price, etc.), depending on their intended use (Nardone & Schieppati, 2010).

FP is only a part of a GRF measurement system. The signals generated in the sensors must be amplified and analogue-to-digital converted in order to be ready for acquisition by a computer. This hardware is normally what is offered by the manufacturers on the market. However, for a GRF measurement system to become fully operational and for the user to get the most out of it, computer software is needed. The latter is often a weak point of commercial products, since existing software solutions often have at least one of the following deficiencies: (i) a specialization on a certain group of tests only; (ii) the absence of a thorough parameterization of the GRF signals; (iii) the use of quantification indexes which are not explicitly explained and that possess unknown metric characteristics; and (iv) a dedication to a single FP manufacturer. The latter specifically relates to the fact that the manufacturers offer software that can only be used with their FPs, thus protecting companies' intellectual property.

Many recent advanced scientific developments of routines, tests and new ways of parameterization of FP measurements have not been brought into regular research and professional practice yet. Furthermore, several laboratories do not have their own engineering support which can be an important limitation for conducting some studies. Therefore,

the aim of our technical developmental project was to integrate the existing knowledge in the field of human movement science and to develop an open Measurement, Analysis and Reporting Software (MARS) for use with different FP types.

From science to practice

The development process began with a thorough review of the existing scientific literature and available MARS-like software products on the market. From what we learned from this review, we were able to classify the tests for which an FP has been used for the evaluation of human movement into one of five groups of tests: (i) static balance, (ii) dynamic balance, (iii) locomotion and body transfer, (iv) fast alternating movements, and (v) strength and power. A brief review of the existing commercial FP software testing functions is presented in Table 1.

Static balance is the ability of a human body to maintain a specific posture as still as possible. Most commonly the so-called quiet stance tests are used for its assessment. Because of the dynamic characteristics of the neuromuscular system and the inherently unstable mechanics of the human posture, the human body sways continuously. The specific characteristics of this sway are influenced by several factors such as the size of the support area (Pan, Chiou, Kau, Bhattacharya, & Ammons, 2009), the height of the body's centre of gravity (Rosker, Markovic, & Sarabon, 2011), age (Abrahamova & Hlavacka, 2008), injury (Lysholm, Ledin, Odkvist, & Good, 1998), footwear (Sarabon, Rosker, Loefler, & Kern, 2010), mental attention (Schaefer, Krampe, Lindenberger, & Baltes, 2008), sensory restriction (Kuo, Wang, & Hong, 2010), etc. FP is a commonly used tool for the acquisition of the body sway data which in this case is expressed as the movement of the centre of foot pressure (COP) over time. During the long history of the body sway research, multiple ways of COP analysis and parameterization have been developed. These techniques encompass the following types of analysis: (i) global or standard analysis (Baratto, Morasso, Re, & Spada, 2002), (ii) diffusion plots (Chiari, Cappello, Lenzi, & Della Croce, 2000), (iii) density plots (Jacono, Casadio, Morasso, & Sanguineti, 2004), (iv) recurrence quantification, (v) sample entropy (Borg & Laxaback, 2010; Richman & Moorman, 2000), and (vi) rambling/trembling (Zatsiorsky & Duarte, 1999, 2000). The calculated parameters can be either planar/general or direction-specific.

In addition to sustaining static postures, everyday functional situations often require ***dynamic***

Table 1. Overview of some commercial FP software

Product / module	CMJ	SJ	DJ	RCMJ	RH	LJ	SQ	FL	SS	SA	TU	LOS	BS	FM
Arsalis*														X
All Sport Systems*													X	
MoveTest*									X	X			X	
Biometrics									X				X	
AMTI AccuPower	X	X	X	X	X	X								
AMTI Balance Clinic													X	
AMTI Balance Trainer												X		
AMTI Bioanalysis										X		X	X	X
Bertec BalanceCheck Screener												X	X	
Bertec BalanceCheck Trainer												X	X	
Leonardo Mechanography RES	X	X	X	X	X				X				X	
Kistler Bioware													X	X
Neurocom							X	X	X	X	X	X		
Simi*	X	X	X										X	
Hytek*													X	
Pro-Vec Plus*										X		X	X	
BTS bioengineering*										X			X	
HUR labs*	X	X	X										X	

Legend: CMJ = countermovement jump; SJ = squat jump; DJ = drop jump; RCMJ = repetitive countermovement jumps; RH = repetitive hopping; LJ = long jump; SQ = squat; FL = forward lunge; SS= sit-to-stand; SA = step analysis; TU = turn; LOS = limits of stability; BS = body sway; FM = free measurement.
(Note: * - information gathered from the publically available internet sources).

balance control. It needs to be stressed here that dynamic balance is a component of several other movement activities (e.g. walking, sit-to-stand movements, stair climbing, landing, stopping, etc.) (Bardy, Oullier, Bootsma, & Stoffregen, 2002), but for the purpose of sub-grouping FP tests we intentionally divided these tests on the basis of their predominant characteristics. Many clinical and laboratory tests for dynamic balance assessment have been developed with the aim of improving repeatability and sensitivity of the evaluation (Yelnik & Bonan, 2008). In this respect, laboratory tests with many conceptually different approaches have been reported (for a review see Panjan & Sarabon, 2010). However, tasks in which a subject is voluntarily shifting the centre of body mass (i.e. COP displacement) above a stable support surface are the most common in testing dynamic balance using an FP. Maximal range measures of voluntary body leaning in different directions is used within the limits of stability tests (Cameron & Lord, 2010), while the precision of dynamic control over COP displacement is tested using the so-called active COP tracking tests (Punakallio, 2004). Regarding the latter, the subject attempts to follow different reference COP trajectories with either self-paced (e.g. tracking static lines or shapes) or appointed dynamics (e.g. tracking moving curves), but in both cases with the highest possible precision. This methodological approach has been adopted from the open kinetic chain tasks where it has been used for years (Behm, 2004; Kurillo, Gregoric, Goljar, & Bajd, 2005; Maffiuletti, Bizzini, Schatt, & Munzinger, 2005).

Walking and running are the two main gaits in humans, both being forms of bipedal cyclic locomotion. During the stance phase of running/walking a complex three-dimensional dynamic loading of the supporting leg takes place. These loading characteristics vary across age (Lilley, Dixon, & Stiles, 2011), gait speeds (Chung & Wang, 2010), gender (Chiu & Wang, 2007), footwear (Keenan, Franz, Dicharry, Della Croce, & Kerrigan, 2011), etc. In addition to ***gait, other body transfer activities*** are functionally relevant (e.g. stopping, sit-to-stand and turning) and have been evaluated in science and medical/sports practice. Many of these tests have their origins in daily clinical practice, but they have been advanced by the measurements of the GRF, which enables studies of biomechanical aspects of leg-to-floor interaction. However, when performed at submaximal or maximal intensities, all these movements are also very relevant to sport performance (e.g. agility, running/sprinting and braking).

Fast alternating movements performed by either legs or hands have become a part of everyday sport performance assessment and also a window into some very basic researches in the field of motor control and behaviour (Smits-Engelsman, Swinnen, & Duysens, 2006). Most commonly used are the so called "stamping tests" (i.e. fast cyclic movements with the left and right extremity in anti-phase) and "tapping tests" (i.e. fast cyclic movements with one extremity aimed at two or more different targets) (Baldissera, Rota, & Esposti, 2008). If those tests are performed on an FP, several frequency-, force- and precision-related parameters can be calculated. These parameters can be observed in the context of time which can be applied either to fatigue development or to learning effects. Moreover, stamping tasks could be used to study the effects of gravitational loading on movement frequency (e.g. legs stamping in a seated vs. standing position), while tapping tasks could be used to study contralateral differences or speed/accuracy trade-off (i.e. increased speed of movement reduces its accuracy and *vice versa*) (Kuboyama, Nabetani, Shibuya, Machida, & Ogaki, 2005; Young, Pratt, & Chau, 2009).

The most often used anaerobic ***strength and power*** tests involve multi-joint extensions of the lower extremities (Capelli & di Prampero, 1991; Ziv & Lidor, 2010). This basic movement pattern can be performed either at moderate velocities (e.g. squats) or explosively (e.g. jumps). Jump tests basically differ according to the concentric (e.g. squat jump) or eccentric-concentric (e.g. counter-movement jump) type of muscle action. Functionally, they can also be divided into vertical and horizontal jumps. Additionally, the movement tasks used in the tests can require predominantly hip and knee action (e.g. squat jump and countermovement jump) or a predominant ankle action (e.g. drop jump and hopping) (Baca, 1999). In both cases a test can consist of either a single repetition or multiple consecutive repetitions, the latter being used in the assessment of endurance in explosive power (McCaulley, et al., 2007). Additional loading/unloading can be used in order to observe power:velocity relationships (Kraska, et al., 2009). FP measurements of the previously mentioned strength and power movement tasks enable detailed analyses of the GRF during take-offs and landings. Based on the force:time signal, quantitative analyses can be run in order to calculate numerous time, power, force impulse and COP indexes.

Last but not least, there is a constant need for research laboratories to perform non-standard measurements using their FPs. However, this is often a problem because of the software limitations and restrictions. Therefore, optimal FP software should enable the user to carry out a free acquisition of signals coming out of the FP, perform analysis and export data in different formats. This is namely the way how the development of new evaluation routines emerges and provides a new potential for the translation of science into practice.

Technical solution

The technical solution of MARS is based on the following conceptual structure: (i) central processing unit, (ii) management unit, (iii) test modules, (iv) comparison unit, (v) reporting unit, and (vi) database. The entire software is programmed in LabVIEW 2010 (National Instruments, Austin, Texas, USA). Figure 1 illustrates the data flow and the relations between the main software units. This concept provides MARS with all necessary data structures and functions for the three main tasks: measurement, analysis and reporting. The individual software functions are interrelated in such a way that the end user can carry out the process of measurement, analysis and reporting intuitively and easily. The operation of all MARS functions is well supported with extensive Help information including how-to examples. Moreover, each test is broadly explained in Help including: (i) a brief general description, (ii) performance variations (i.e. input parameters) presented graphically and explained in the text, (iii) test protocols, and (iv) a detailed explanation of the result parameters (descriptions, graphical visualizations and equations).

The MARS central processing unit communicates with all the other units and measurement modules enabling an easy and transparent execution of tests. It is programmed to carry out some basic functions such as weighing the subject, managing test settings, exporting the data (for backup; and all signals and results values in ASCII format) and indicating what measurements were performed.

The management module provides operational functions (add, edit, delete, assigning, searching and filtering) for the main entities: projects, visits and subjects. A project is the topmost entity that defines the conceptual naming of groups of tests to be carried out on a subpopulation (e.g. a football team that is to be tested for strength, power and balance). A project consists of visits and subjects. A visit defines one session of the project for a specified subpopulation (e.g. preseason/postseason) and a subject is a person defined with personal characteristics (name, age, height, profile, etc.). A project could have several visits and subjects. A visit is assigned exactly to one project and could have several subjects, while a subject could be assigned to several projects and several visits.

The test modules shown in Figure 2A, are different motor tests that are used to assess a subject's performance: (i) static balance (body sway), (ii) dynamic balance (shape tracking, curve tracking and limits of stability), (iii) locomotion (step analysis, forward lunge, sit-to-stand and turn), (iv) fast alternating movements (stamping and tapping), and (v) strength and power (squat, squat jump, counter- movement jump, drop jump, jumps with additional weights, long jump, repetitive countermovementjumps and repetitive hopping). A module for free measurements is available for custom tests. In all modules there are functions to export three types of data: raw signal in ASCII format, signals' graphs as an image in BMP format into clipboard (further it can be saved in any other format with an appropriate external application) and results values (with or without names and units) in ASCII format.

MARS test modules provide functions for easy execution of tests, including the definition of the input parameters, the acquisition of signals, real-time signal visualization, user feedback, analysis, visualization of results, and saving the data. Typical execution of the test is presented in Figure 2B. Some tests may have additional steps included. MARS also provides a function for comparing variations

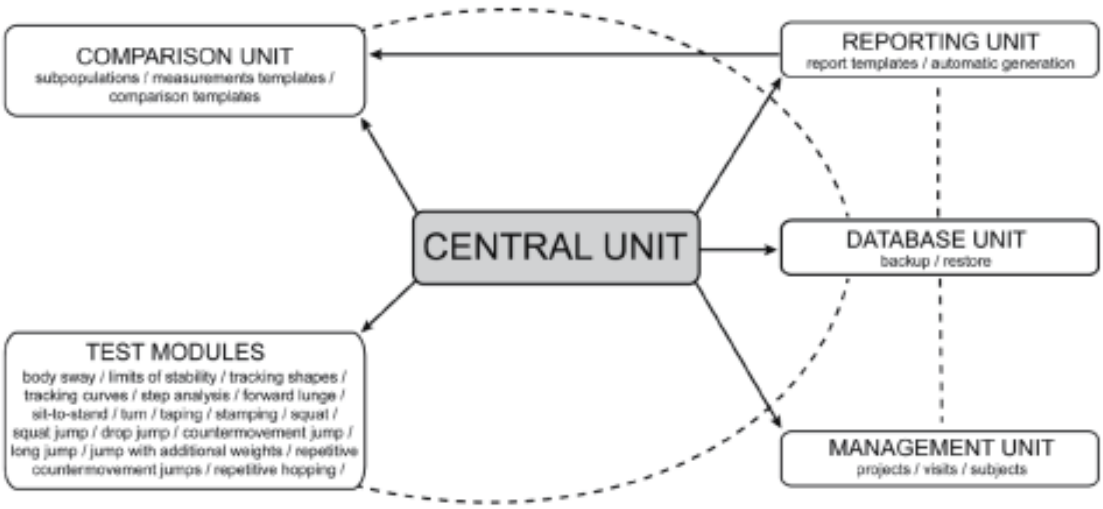

Figure 1. The conceptual structure with data flow and unit relations inside the software.

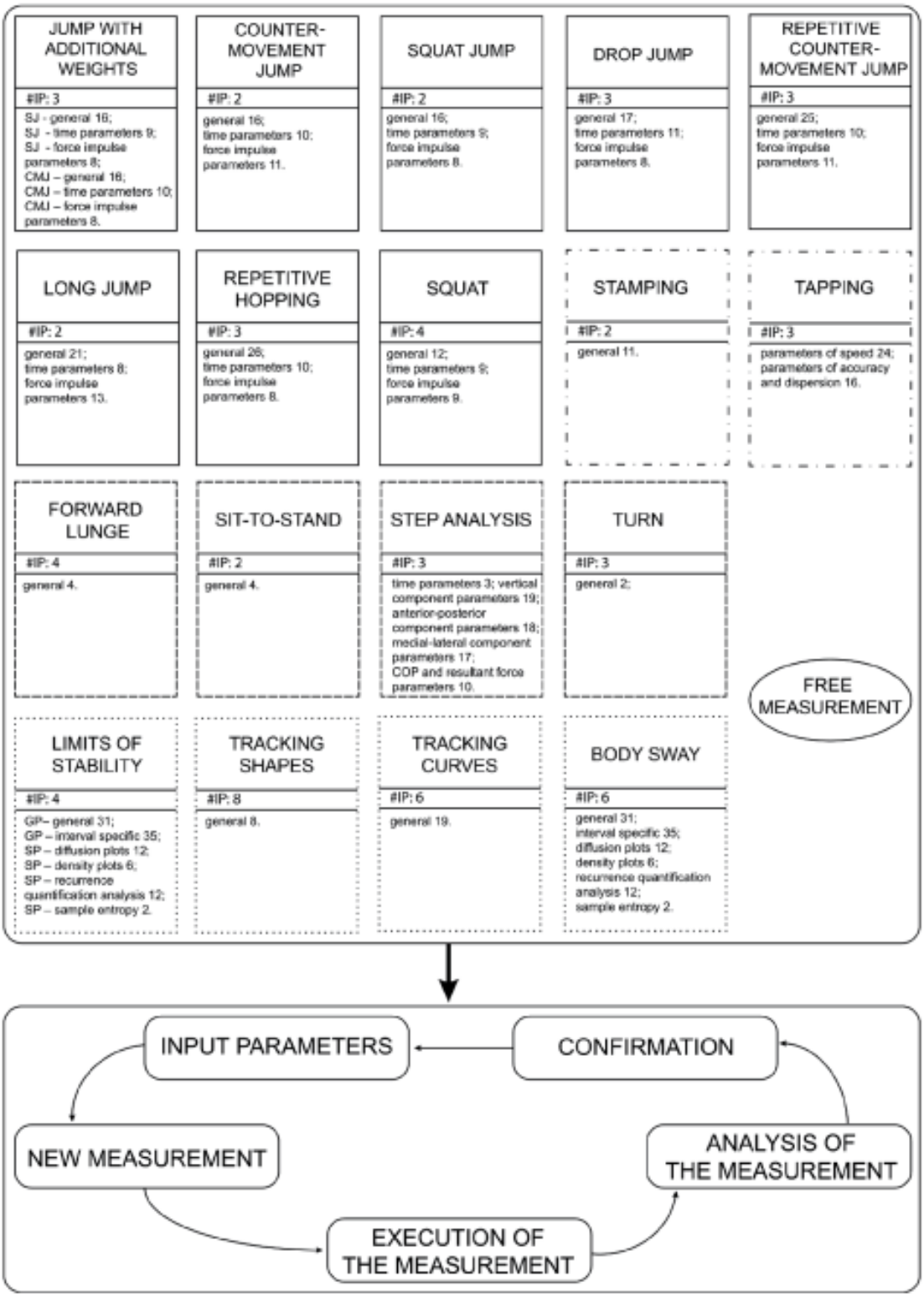

Figure 2. (A) Test units with name, number of input parameters (#IP) and groups of results parameters with the number of parameters. Different frames' lines denotate the groups of tests: solid line – power and strength, dash-dotted line – fast alternating movements, dashed line – locomotion and body transfer, and dotted line – balance. (B) Common execution steps of the test. Legend: SJ – squat jump, CMJ – counter movement jump, GP – global parameters, and SP – structural parameters.

of the test performed with a selected subject, for example, the comparison of performance between the left and the right leg.

The comparison module provides a variety of comparison types; for example, between the subject and subpopulation, between several subpopulations and between visits during a given project. A subpopulation is a group of subjects in a project whose database is used for making a comparison in results' parameters of a certain type of a test or of a group of tests. Four options for defining result parameters (on either a subject or subpopulation level) are available; namely, average, maximal, minimal and manually selected repetition. Comparisons can be expressed in either Z-values or relative values. For relative comparison an additional subpopulation (or a single subject) must be defined. Comparisons with previously described elements could be saved as a template and used in the reporting module for the automatic generation of reports.

The reporting module provides the functions required for the final step of subject evaluation. Its biggest advantage is the option to automatically generate reports for a selected subpopulation. The elements of the report are defined in a user-friendly editor with visual feedback of the specified content. A created template can be saved and used later for another subpopulation. Automatically generated reports can be edited with additional comments/notes or other elements (such as additional tables, images and graphs) and also some elements may be left out when not applicable.

The database module provides the functions for data manipulation and storage. They are automatically executed in the background and the user is not aware of it while working with the application. The database is based on a SQLite software library that implements a self-contained, serverless, zero-configuration, transactional SQL database engine, version 3.7.9. The integrity of the MARS database is assured by an embedded backup function with the ability to restore the database after a disturbance. This crucial requirement is commonly forgotten by users, but the loss of data after days or even months of work is probably one of the most unpleasant experiences for the scientist or practitioner.

In this brief presentation it was not possible to present all the details of the application. Other features have also been built into the concept to provide either further user support to the main functions or to improve user experience.

Conclusion

We believe that MARS can fill the lack of similar comprehensive solutions on the market and advance the field of biomechanics helping researchers and practitioners to exploit the full potential of their FPs. We have set a solid software foundation in which all the crucial functions have already been developed, that is, signal acquisition, storage, processing and quantification, comparisons and reporting. The software enables many different kinds of tests to be run and we see it as a base for future extension, improvement and upgrades. Moreover, further evaluation and validation of the MARS measurement modules shall be carried out at the final stages of the development process.

In the future, we plan to develop MARS in four different ways. First, all the existing test modules will be upgraded for bilateral FP measurements, where each foot is placed on a separate FP. In the majority of bilateral tests (e.g. jump, hop, squat, balance, etc.) this will widen the informational value of the measurements by enabling contralateral comparisons (i.e. asymmetries) to be made. Second, functions for multiple FPs measurements will be added with the aim of enabling the analysis of movements during which the body is predominantly horizontally translated (e.g. sprint start, take-off in ski jumps, track-and-field long jump, etc.). Third, we would like to increase the functional relevance and informational value of the FP tests by developing new sets of additions: (i) a set of visual markers, (ii) a set for simple loading/unloading of the subject, (iii) a set for simultaneous measurements of linear excursions, i.e. functional reach test, star excursion test; and (iv) a set for mechanical perturbations and sensory manipulations. Fourth, we will develop a server-based system with web access for the storage of the measurements. This will enable the storage of measurements from around the world in one central archive. In any case, this upgrade will be offered to the MARS users only as an optional choice. Those users who will decide so, in exchange will have access to a huge amount of data and, consequently, scientists and practitioners will be able to develop reliable normative values. Such an upgrade will also enable large scale research. However, we are well aware of the issues regarding personal data security, which we plan to address accordingly. Moreover, we are also aware of the need to control the quality of the measurements that are going to become a part of such a database. We therefore aim to consider additional control measures (e.g. video recordings of the tests, automatic recognition of outliers, etc.).

To summarize, in the near future we plan to finalize the current stage of the development of MARS for FP-based tests. Besides keeping on with the development, we will commence to attract suitable partners from industry to help us launch the product on the market, and thus, make a real translation from science to practice.

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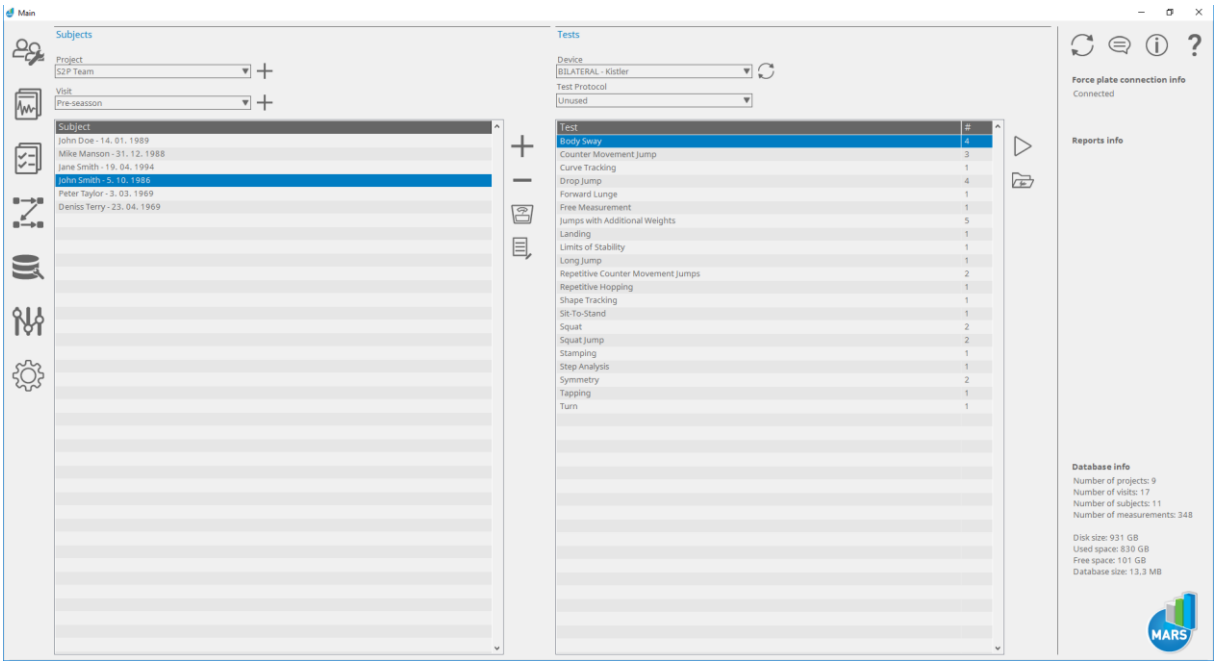
RAZVOJ PROGRAMSKE PODRŠKE ZA SVEOBUHVATNU ANALIZU VARIJABLI DOBIVENIH MJERENJIMA POMOĆU TENZIOMETRIJSKE PLATFORME

Ovaj tehnički rad objašnjava razvoj softverskoga rješenja za prikupljanje i analizu podataka te oblikovanje izvješća o rezultatima testova provedenih na tenziometrijskoj ploči. U uvodu je predstavljen pregled povijesti razvoja tenziometrijskih platforma, nakon čega slijedi opis postupaka za prikupljanje i parametrizaciju rezultata mjerenja sile reakcije podloge. Drugi dio je kratak opis pet skupina testova na tenziometrijskim pločama za procjenu ljudskoga kretanja: (i) testovi statičke ravnoteže, (ii) testovi dinamičke ravnoteže, (iii) testovi lokomocije i aktivnosti transfera tijela, (iv) testovi brzih alternativnih pokreta i (v) testovi snage. Nakon toga slijedi glavni dio u kojemu je predstavljeno tehničko rješenje i koncepcijska modularna struktura softvera. Istaknute su glavne funkcije, a grafički su predstavljeni, u pregledu, svi testovi koje aplikacija podržava. Na kraju su istaknute neke ideje o daljnjemu razvoju i budućoj praktičnoj primjeni ovdje predstavljene programske podrške.

Ključne riječi: *biomehanika, testiranje, instrumentacija, izvještavanje*

MAIN



The Main window is the entry spot into Measurement, Analysis and Reporting Software. From the main window all other functionalities are accessible:

- Entities manager
- Measurement browser
- Measurement
- Test modules
- Reports generator
- Test protocols
- Database manager
- Indirect parameters
- Settings

Main window is divided into three panels:

- Subjects panel is used to select project, visit and subject.
- Tests panel is used to select device, test protocol and test.
- Info panel provides info about the application.

Functionalities

Add project

Add a new project.

Add visit

Add a new visit to the selected project.

Add subject

Add a new subject to the selected visit.

Delete subject

Delete selected subject from the selected visit.

Weight subject

Weigh the selected subject.

Comments

Edit comments for the selected subject in the selected visit.

Refresh (Device)

Checks if the selected device is connected.

Start

Starts a new test for the selected subject and selected test or test protocol.

Open measurements

Opens measurements for the selected subject and selected test or test protocol.

Check for updates

Checks if new updates are available.

Send feedback

Send feedback about MARS.

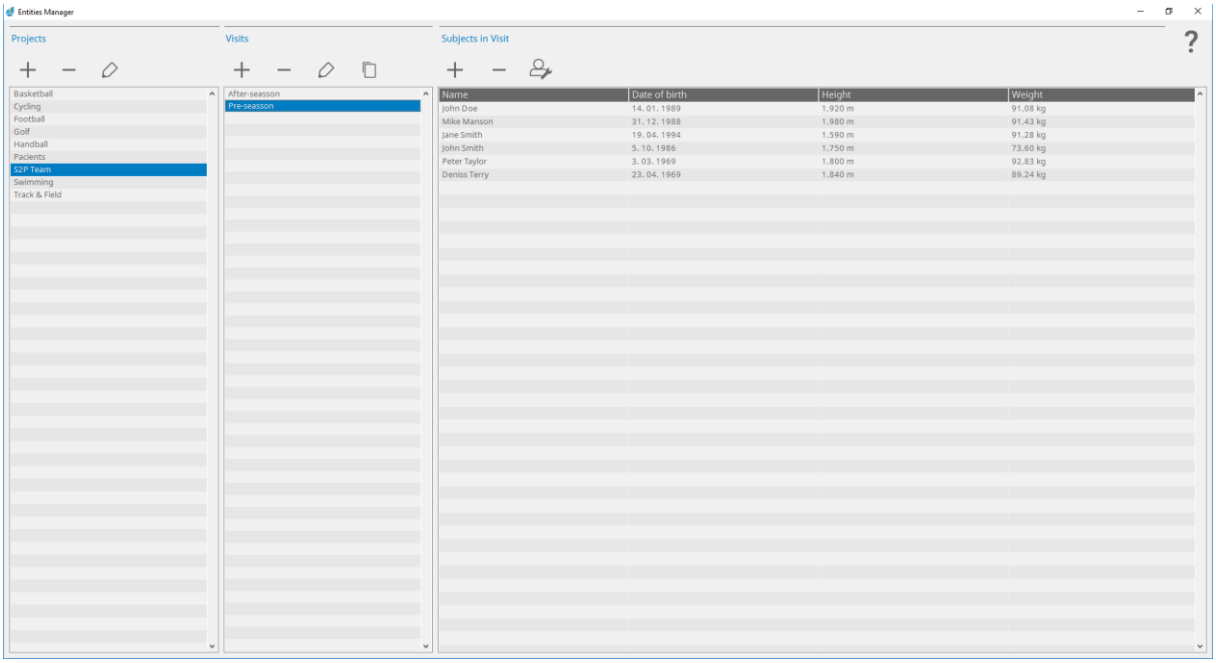
About

Info about MARS.

ENTITIES MANAGER

Entities manager is used to manage projects, visits and subjects. Entities manager window consists of three panels:

- Projects – contains all projects.
- Visits – contains all visits for the selected project.
- Subjects in visit – contains all subjects for the selected visit.



Project functionalities

Add

Add a new project.

Delete

Delete the selected project.

NOTE: When a project is deleted all visits and measurements assigned to the project will be permanently deleted from the database! Subjects assigned to the deleted projects will not be deleted from the database, but measurements of all subjects assigned to the deleted project will be permanently deleted from the database!

Edit

Edit the selected project.

Visit functionalities

Add

Add a new visit.

Delete

Delete the selected visit.

NOTE: When a visit is deleted all measurements assigned to the visit will be permanently deleted from the database! Subjects assigned to the deleted visit will not be deleted from the database, but measurements of all subjects assigned to the deleted visit will be permanently deleted from the database!

Edit

Edit the selected visit.

Duplicate

Duplicate the selected visit.

Subject in visit functionalities

Add

Add a new subject.

Delete

Delete the selected subject.

Manage subjects

Opens Manage subjects window.

MANAGE SUBJECTS

In the Manage subjects, subjects can be added, deleted and edited. Search functionality enables easy search among subjects if there are many subjects. To display selected subjects only, click on Show selected. To show all subjects, click on Show all.

Functionalities

Select / Deselect

Select or deselect all subjects.

Show selected

Shows all selected subjects.

Add

Add a new subjects.

Delete

Delete the selected subjects.

NOTE: When a subject is deleted, all measurements (across all projects and visits) assigned to the subject will be permanently deleted from the database!

Search

Searches for subjects that contains the specified text.

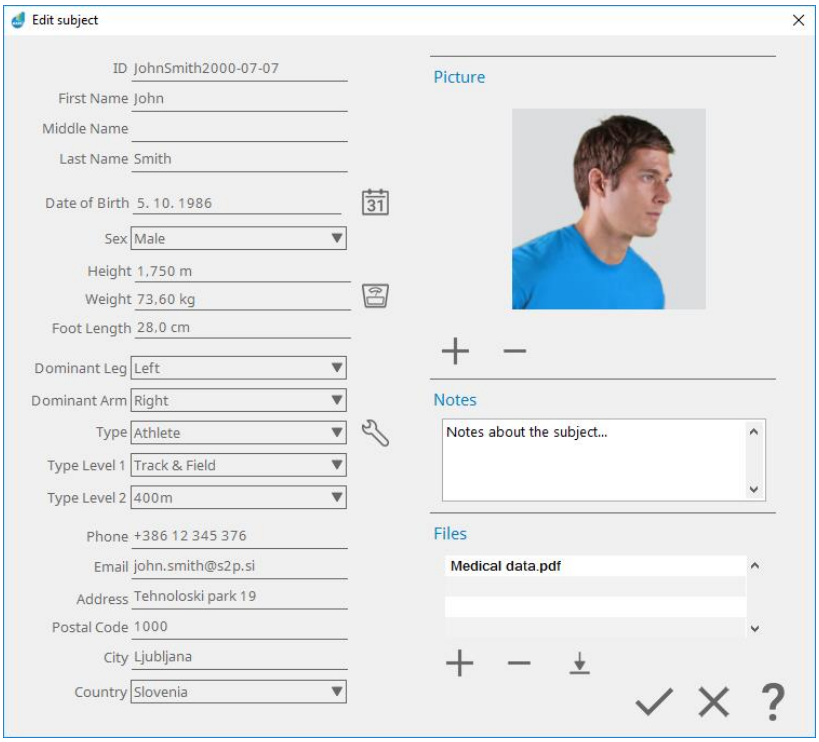
Clear search

Clears the search.

FIND SUBJECT

Find subject is used to find existing subjects with matching ID and/or first name and/or middle name and/or last name. If none of the found subjects is selected, then provided data will be used.

EDIT SUBJECT



The following subject attributes are available to describe every subject:

- ID
- First name
- Middle name
- Last name (*)
- Date of birth (*)
- Sex

- Height
- Weight
- Foot length
- Dominant leg
- Dominant arm
- Type
- Type level 1
- Type level 2
- Phone
- Email
- Address
- Postal code
- City
- Country
- Picture
- Notes
- Files

Attributes marked with * are mandatory. It is recommended to fill also Height, Weight and Foot length as they are required in some modules.

NOTE: If you have not filled in some of the fields of the Subject profile/description this might severely limit some of the comparison, filtering and reporting functions.

Functionalities

Manage subject types

Opens Subject types window.

Add picture

Add a new picture.

Delete picture

Delete the picture.

Add file

Add a new file.

Delete files

Delete the selected files.

Download files

Download the selected files.

SUBJECT TYPES

Subject types are used to describe subjects. Three levels of type can be used.

Type functionalities

Add

Add a new type.

Delete

Delete the selected type.

NOTE: If a type is assigned to any subject in the database, it cannot be deleted. All subjects with the type must be deleted or their types needs to be changed first.

Rename

Rename the selected type.

Type Level 1 functionalities

Add

Add a new type.

Delete

Delete the selected type.

NOTE: If a type is assigned to any subject in the database, it cannot be deleted. All subjects with the type must be deleted or their types needs to be changed first.

Rename

Rename the selected type.

Type Level 2 functionalities

Add

Add a new type.

Delete

Delete the selected type.

NOTE: If a type is assigned to any subject in the database, it cannot be deleted. All subjects with the type must be deleted or their types needs to be changed first.

Rename

Rename the selected type.

MEASUREMENT BROWSER

Measurement browser is used to review measurements for different tests and to apply different operations on them. It can be used to export data in different formats and to start new tests (measurements).

Tests specific help (test protocol, analysis protocol, input parameters and result parameters) is located here.

Measurement browser consists of two panels:

- Left panel – Shows projects/visits/subjects in the tree (hierarchy view) based on the selected hierarchy (Project – Visit – Subject, Project – Visit, Project, All). The tree contains all created projects/visits/subjects, also those without any measurement.

- Right panel – At the top is navigation panel that contains only those entries that have at least one measurement made. Different visualizations (List of measurements, graphs (Signals, COP), Repetitions) can be selected based on selection in the navigation panel.

Left panel functionalities

Export signal

Export signals of all measurements for selection in the tree.

Export result parameters

Export result parameters of all measurements for selection in the tree.

Right panel functionalities

New measurement

Starts a new measurements.

Accept

Accept the selected measurement.

Reject

Reject the selected measurement.

Repeat

Repeat the selected measurement.

LIST OF MEASUREMENTS

Shows all measurements for selection in the navigation panel.

Delete

Delete the selected measurement(s).

Reanalyze

Reanalyze the selected measurement.

Info

Info data for the selected measurement. This info contains also parameters used to analyze the measurement.

Edit input parameters

Change input parameters for the selected measurement.

Export table

Export data currently visible in the table.

COP

Shows COP curve for selection in the navigation panel.

Delete

Delete the selected measurement(s).

Reanalyze

Reanalyze the selected measurement.

Info

Here you can write a notes about this specific repetition.

Notes

Info data for the selected measurement. This info contains also parameters used to analyze the measurement.

Cursor tool

Cursor tool used to move cursors on the graph.

Zoom

Zoom tools.

Hand

Hand tool used to move graph.

Export graph values

Export plots values from currently visible graph.

Export graph image

Export image of currently visible graph.

SIGNALS

Shows signals for selection in the navigation panel.

Delete

Delete the selected measurement(s).

Reanalyze

Reanalyze the selected measurement.

Info

Here you can write a notes about this specific repetition.

Notes

Info data for the selected measurement. This info contains also parameters used to analyze the measurement.

Cursor tool

Cursor tool used to move cursors on the graph.

Zoom

Zoom tools.

Hand

Hand tool used to move graph.

Plot values

Values for each plot on the graph at cursor position.

Statistics

Basic statistics for each plots on the interval between two cursors.

Cut signals

Cut all signals based on the interval between two cursors.

Plots

Select visible plots for the graph.

Cursors

Select visible cursors for the graph.

Export graph values

Export plots values from currently visible graph.

Export graph image

Export image of currently visible graph.

REPETITIONS

Shows repetitions for selection in the navigation panel.

Export table

Export currently visible table.

Coloring options

Set coloring configuration for the repetitions table.

Filter visible parameters

Select subset of parameters for the repetitions table.

MORE

Opens test specific visualizations. Indirect parameters table is accessible via this button.

Plot values

Values for each plot (in rows) on the graph at cursor position. Cursor can be moved manually or by changing the Time value bellow the table.

Value

Value for each plot on the graph at cursor position

@ time [s]

Absolute time point of the Value (cursor position).

Time [s]

Absolute time point of the cursor.

Export table

Export the table.

Statistics

Basic statistics for each plot (in columns) on the interval between two cursors. Cursors can be moved manually or by changing the Start / End values bellow the table.

Time interval [s]

Time interval used for statistics (start time – end time).

Minimum value

Minimum value between the cursors.

Minimum value @ [s]

Absolute time point of the minimum value.

Maximal value

Maximal value between the cursors.

Maximal value @ [s]

Absolute time point of the maximal value.

Range

Range of the values between the cursors (minimum – maximum).

Average

Average of values between the cursors.

Standard deviation (SD)

Standard deviation of values between the cursors.

$$s = \sqrt{\frac{\sum (x_i - \overline{x})^2}{n-1}}$$

Root mean square (RMS)

Root mean square of values between the cursors.

$$RMS = \sqrt{\frac{\sum_{i=0}^{n} a_i^2}{n}}$$

Slope

Derivative of the values between the cursors.

Integral

Integral of the values between the cursors.

Start [s]

Absolute time point of the start of the interval used for statistics.

End [s]

Absolute time point of the end of the interval used for statistics.

Export table

Export currently visible table.

Coloring options

Set coloring configuration for the repetitions table.

PARAMETERS VIEW EDITOR

Two options of coloring paraemters (all parameters or each parameter) are available that can be used separately or both at the same time.

Highlight repetition for all parameters

Select which repetition (MIN or MAX) will be colored for the selected parameter. The column header for which the selected parameter is MIN/MAX will be colored. This condition can be set only for one parameter. If you select Not used, no repetition will be colored.

Highlight repetition for each parameter

Select which repetition (MIN or MAX) will be colored for the selected parameter. The cell containing the parameter value for which the selected parameter is MIN/MAX will be colored. This condition can be set for each parameter separately. If you select Not used, no repetition will be colored. To select the option click on the parameter row.

Filter visible parameters

Select subset of parameters for the repetitions table. You can select from pre-defined filters or create new filter by selecting Manage.

Parameters view manager

Parameters view manager is used to manage parameters view.

Add

Add a new parameters view.

Delete

Delete the selected parameters view.

Edit

Edit the selected parameters view.

Duplicate

Duplicate the selected parameters view.

Rename

Rename the selected parameters view.

Parameters view selection

Parameters view selection is used to selected parameters that will be visible in the repetition table. Select/deselect parameter by clicking on it.

Edit input parameters

This function enables changing Input Parameters after the measurement is completed. To change Input Parameters for the current measurement, click Edit Input Parameters icon and select new Input Parameters from the pop up window. After confirming the selection current measurement will be saved with newly defined Input Parameters.

MEASUREMENT

Measurement is used to acquire measurements for different tests.

Tests specific help (test protocol, analysis protocol, input parameters and result parameters) is located here.

Functionalities

COP

Shows COP curve.

Signals

Shows signals.

Zero offset

Performs zero offset.

Start

Start the measurement.

Stop

Stop the measurement.

Select subject

Select a new subject.

Select test

Select a new test.

Test instructions

Opens help document with test instructions.

Test device

Shows all raw signals for selected device (from all plates). This utility is used to check if all signals are correct.

Set plate range

Set a new plate range.

TEST MODULES

Body Sway

Counter Movement Jump

Curve Tracking

Drop Jump

Forward Lunge

Free Measurement

Jumps With Additional Weights

Landing

Limits of Stability

Long Jump

Repetitive Counter Movement Jumps

Repetitive Hopping

Shape Tracking

Sit-To-Stand

Squat

Squat Jump

Stamping

Step Analysis

Symmetry

Tapping

Turn

BODY SWAY - TEST

This measurement module is a part of MARS Balance & Stability.

Brief Description

Selecting Input Parameters

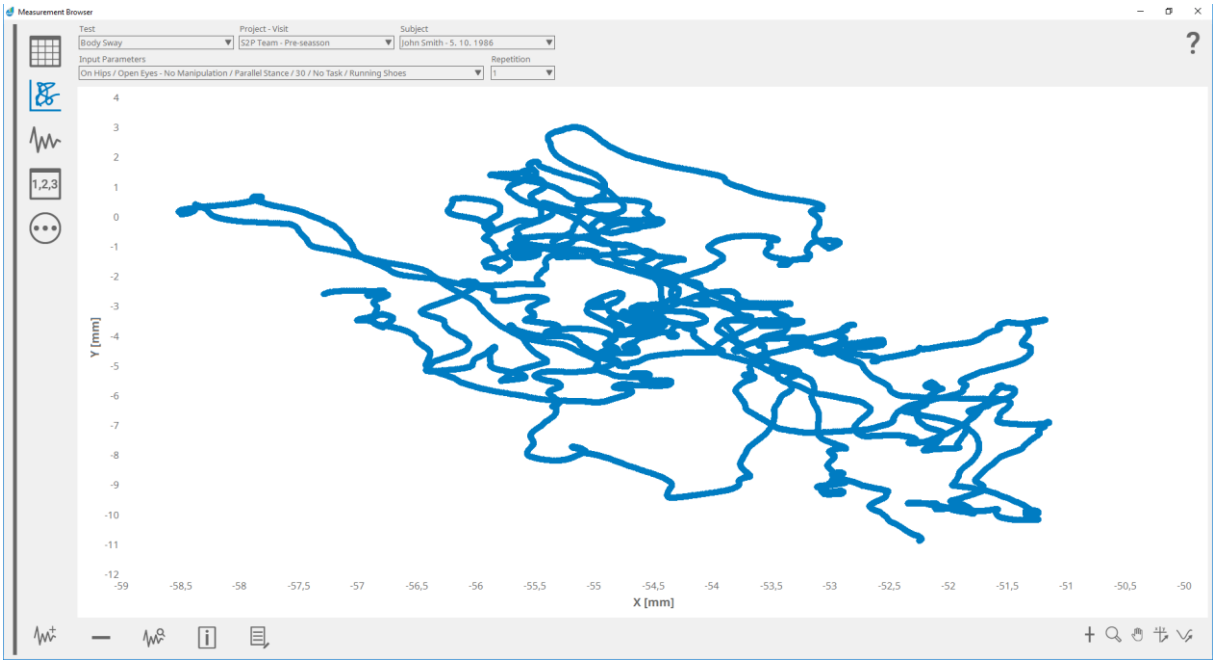
Measurement

Analysis

References

Brief Description

Static balance of the human body is the ability to maintain a specific posture as still as possible. So called quiet stance tasks are most often used for the assessment of static balance. Because of the dynamic characteristics of the neuromuscular system and the inherently unstable mechanics of the human posture, the human body continuously sways. The specific characteristic of the body sway is influenced by several factors such as the size of the support area, the height of the centre of gravity, age, injury, etc. Body sway is traditionally evaluated through measurements of the sway of the centre-of-pressure (COP) below the subject`s feet. At a slow and moderate movement velocity the COP movement mirrors the transversal movement of the centre-of-gravity of the subject. During a long history of the body sway research, multiple analysis approaches and ways of parameterization have been developed by scientists.



The initial position of the subject depends on the difficulty level of the quiet stance task we would like to measure. The subject acquires an active upright stance posture, with the specific posture of the hands and feet as well as potential additional requirements (sensory manipulation or an additional mental task). After the subject has acquired the stance position the measurement starts and lasts for a pre-set period of time. Beware

that the signal you measure is very sensitive to any manipulations and therefore avoid any unwanted small movements (head movements, coughing, etc.) that are not a part of your measurement set up.

Selecting Input Parameters

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

- Upper Extremities
- Sensory Manipulation
- Stance Position
- Duration
- Dual Task
- Footwear

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. In case of the easy quiet stance tasks the hands will normally remain passively hanging. However, in more demanding tasks the free use of the hands can be of great help.

Across the Chest

The subject places his/her hands across his/her chest.

Behind the Neck

The subject places his/her hands behind his/her neck.

Other user defined

In case of any other position of the upper extremities, the user can define new positions under Settings panel - section Input parameters. After doing so, the newly defined input parameter will from then on appear as an optional choice under the Upper Extremities in the Body Sway measurement module.

SENSORY MANIPULATION

Closed Eyes

The subject is restricted to see. This might be done by simply closing the eyes but a better control over this sensory restriction can be by using a non-transparent band or goggles in order to best keep the subjects vision excluded.

Open Eyes – No Manipulation

The subject keeps his/her eyes open. The standard procedure is to ask the subject to keep a focus on a visual marker placed on a wall 1 to 3 meters in front of him/her.

Vestibular Perturbation

Perturbation of the vestibular sensory organ can be done in different ways: head rotation or head circumduction during or before the quiet stance; artificial stimulation of the vestibular system etc. The user should be aware of the potential direct mechanical effects of the vestibular manipulation task.

Other user defined

In case of any other sensory manipulation, the user can define it under Settings panel - section Input parameters. After doing so, the newly defined input parameter will from then on appear as an optional choice under the Sensory Manipulation in the Body Sway measurement module.

STANCE POSITION

Parallel Stance

The subject is standing in the centre of the force plate with the feet placed parallel at the shoulder width. The feet are oriented in anterior-posterior direction (along the Y-axis of the force plate) with the toes pointing anteriorly (+Y). Throughout the measurement the subject sustains his/her normal upright stance position.

Semi-Tandem Stance

The subject is standing in the centre of the force plate with the feet placed close together and shifted longitudinally against each other for one half of the length of the foot (i.e. semi-tandem foot position). The feet are oriented in anterior-posterior direction (along the Y-axis of the force plate) with the toes pointing anteriorly (+Y). Throughout the measurement the subject sustains his/her normal upright stance position. Semi-tandem stance with the dominant leg in front is predominantly used; the opposite foot position is sometimes also referred as “contra semi-tandem”.

Tandem Stance

The subject is standing in the centre of the force plate with the feet placed in-line one behind the other (i.e. heel-to-toe or tandem feet position). The feet are oriented in anterior-posterior direction (along the Y-axis of the force plate) with the toes pointing anteriorly (+Y). Throughout the measurement the subject sustains his/her normal upright stance position. Tandem stance with the dominant leg in front is predominantly used; the opposite foot position is sometimes also referred as “contra tandem”.

Single Leg Stance – Left / Single Leg Stance - Right

The subject is standing on one leg in the centre of the force plate. The foot is oriented in anterior-posterior direction (along the Y-axis of the force plate) with the toes pointing anteriorly (+Y). Throughout the measurement the subject sustains his/her normal upright stance position.

Other user defined

In case of any other type of stance, the user can define it under Settings panel - section Input parameters. After doing so, the newly defined input parameter will from then on appear as an optional choice under the Stance Position in the Body Sway measurement module.

DURATION [s]

10/20/30/40/50/60/70/80/90/100 s

Other user defined

In case of any other duration, the user can define it under Settings panel - section Input parameters. After doing so, the newly defined duration of the quiet stance task will from then on appear as an optional choice under the Duration in the Body Sway measurement module.

DUAL TASK

No Additional Task

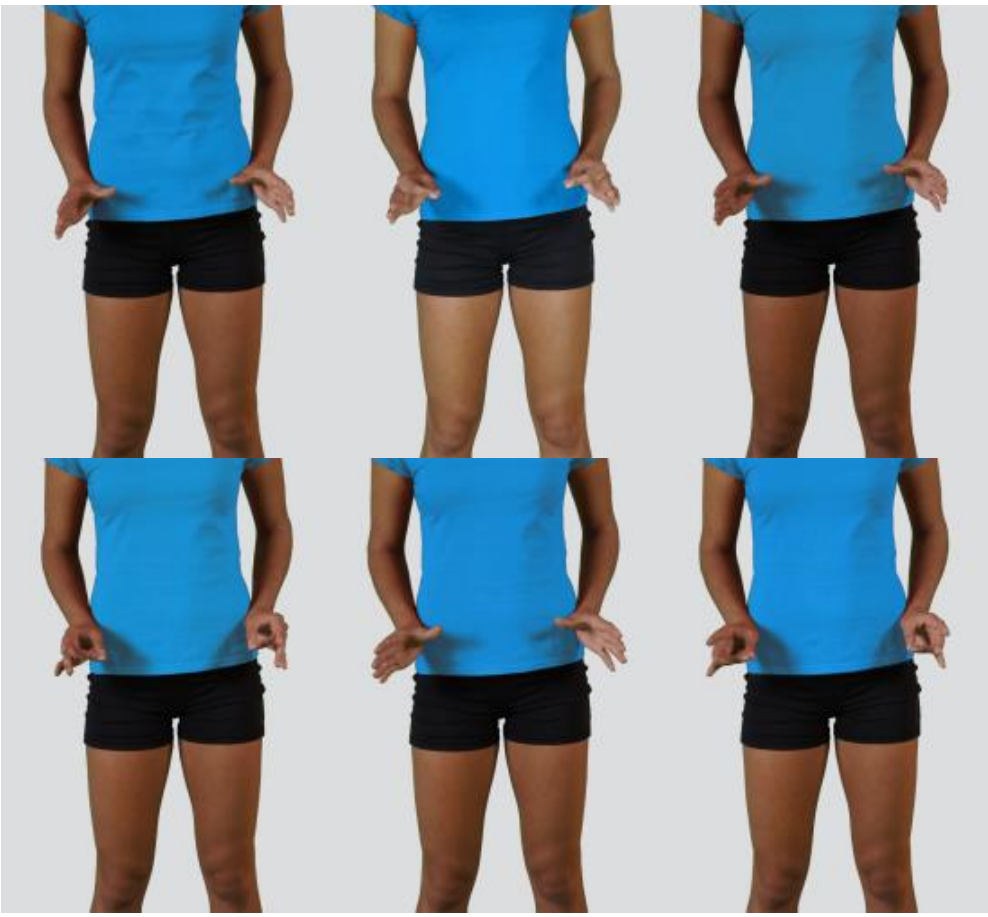
The subject has no additional mental or motor task to do during the time of the measurement.

Additional Mental Task

Together with the quiet stance task the subject has to perform a required mental task. For this purpose different tasks have been used, the most commonly used is counting up/down by three.

Additional Motor Task

Together with the quiet stance task the subject has to perform a required motor task. For this purpose different tasks have been used, the most commonly used is alternative finger tapping task.



Other user defined

In case of any other type of dual task, the user can define it under Settings panel - section Input parameters. After doing so, the newly defined input parameter will from then on appear as an optional choice under the Dual Task in the Body Sway measurement module.

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 case of any other type of footwear, the user can define it under Settings panel - section Input parameters. After doing so, the newly defined input parameter will from then on appear as an optional choice under the Footwear in the Body Sway measurement module.

Measurement

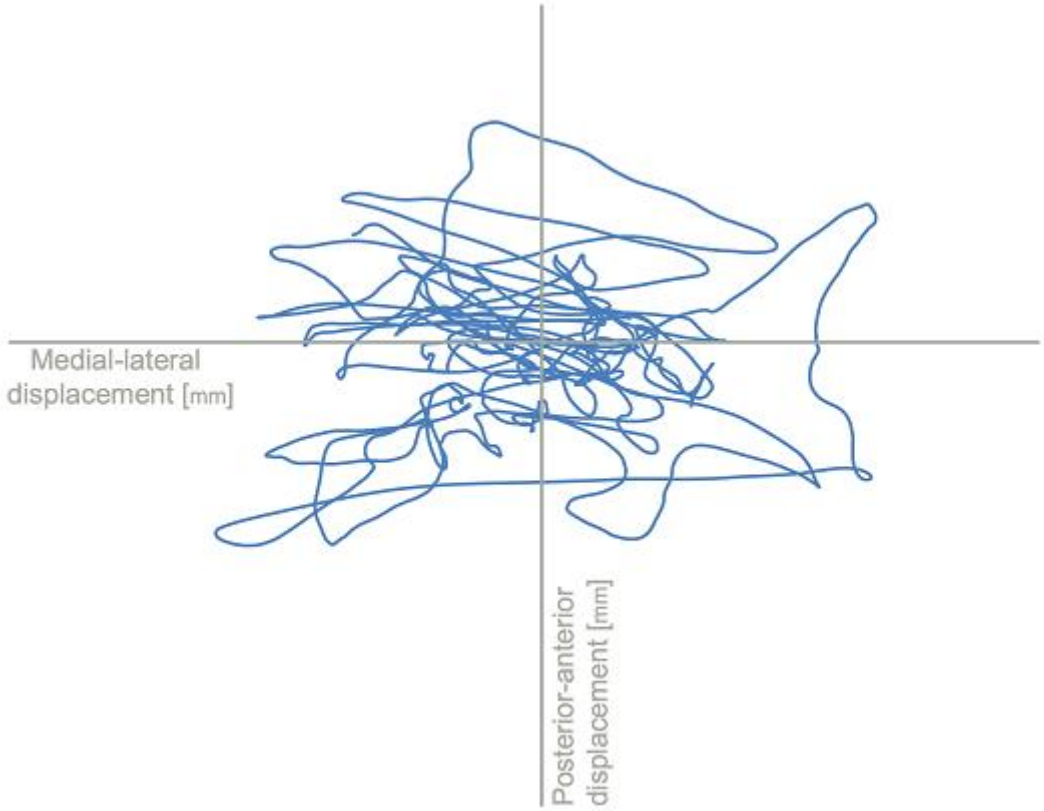
Before starting a test select input parameters (on the left side of Measure window). Then the subject steps on the force plate and gets into the required position in a way that the orientation of the body is consistent with that of the plate (i.e. +Y direction of the plate is the anterior direction). After you are satisfied with the quiet stance of the subject, click Start or press Space. After this the software begins with the signal acquisition and the time left until the end of the test is displayed in the top-right corner of the screen. Data recording will stop automatically after the set time. After the measurement is completed you can chose to Confirm, Reject or Repeat it.

If you want to start a new measurement, click the New Measurement button and repeat the procedure. Before starting a new measurement you can change the Input Parameters; if not, the Input Parameters of the previous measurement will be used.

Analysis

Analysis enables you to check the signal of the ground reaction force and the calculated parameters. Under the COP tab you can see the X:Y signal. Individual components of the ground reaction forces and of the COP movement can be visualized under the Signal tab. Under the Repetitions tab you can see all the calculated parameters.

Specific to the Body Sway measurement module is the extreme profoundness of the analysis which a user can carry out by the software. Altogether ninety-six different COP-related parameters, which are well supported by the literature, are included. For more information regarding the parameters see the References.



Additional analysis routines (e.g. Rambling-Trembling Analysis introduced by Duarte, Zatsiorsky and Latash) are available as separate products. For more information see section About MARS or contact us.

GLOBAL PARAMETERS - GENERAL

Global parameters estimate the overall size of the COP sway. Regarding the direction, parameters can be calculated as two-directional and/or one-directional (i.e. anterior-posterior (A-P) and medio-lateral (M-L)). The following global parameters are calculated:

Sway path – total [mm]

The common length of the trajectory of the COP sway calculated as a sum of the point-to-point Euclidian distances.

Sway path – A-P [mm]

The common length of the trajectory of the COP sway only in the anterior-posterior direction.

Sway path – M-L [mm]

The common length of the trajectory of the COP sway only in the medial-lateral (i.e. left-right) direction.

Sway V– total [mm/s]

The common length of the trajectory of the COP sway calculated as a sum of the point-to-point Euclidian distances divided by the measurement time.

Sway V– A-P [mm/s]

The common length of the trajectory of the COP swayonly in the anterior-posterior direction divided by the measurement time.

Sway V– M-L [mm/s]

The common length of the trajectory of the COP swayonly in the medial-lateral direction divided by the measurement time.

Sway average amplitude – A-P [mm]

The average amount of the COP sway in anterior-posterior direction calculated as the common length of the trajectory of the COP sway only in the anterior-posterior direction divided by the number of changes in this direction (i.e. from moving forward to backward or vice versa).

Sway average amplitude – M-L [mm]

The average amount of the COP sway in medial-lateral (i.e. left-right) direction calculated as the common length of the trajectory of the COP sway only in the medial-lateral direction divided by the number of changes in this direction (i.e. from moving left to right or vice versa).

Sway maximal amplitude – A-P [mm]

The amplitude between the two most distant samples of the COP sway in anterior-posterior direction.

Sway maximal amplitude – M-L [mm]

The amplitude between the two most distant samples of the COP sway in medial-lateral (i.e. left-right) direction.

Sway area – total [mm^2]

Area swayed by the COP trajectory with respect to the central stance point (i.e. mean value of anterior-posterior and medial-lateral components respectively).

Sway area – A-P [mm*s]

The time integral of the anterior-posterior component of the COP with respect to the mean value of anterior-posterior component.Note: don`t be miss led by the name “area” that is commonly used in the literature in this context. This direction-specific area is namely a time integral which results also in the mm*s units and not mm^2.

Sway area – M-L [mm*s]

The time integral of the medial-lateral component of the COP with respect to the mean value of medial-lateral component. Note: don`t be miss led by the name “area” that is commonly used in the literature in this context. This direction-specific area is namely a time integral which results also in the mm*s units and not mm^2.

Sway area per second – total [mm^2/s]

Area swayed by the COP trajectory with respect to the central stance point (i.e. mean value of anterior-posterior and medial-lateral components respectively) divided by the measurement time.

Sway area per second – A-P [mm]

The time integral of the anterior-posterior component of the COP with respect to the mean value of anterior-posterior component divided by the measurement time. Note: don`t be miss led by the name “area” that is commonly used in the literature in this context. This direction-specific area is namely a time integral which results also in the mm*s units and not mm^2.

Sway area per second – M-L [mm]

The time integral of the medial-lateral component of the COP with respect to the mean value of medial-lateral component divided by the measurement time. Note: don`t be miss led by the name “area” that is commonly used in the literature in this context. This direction-specific area is namely a time integral which results also in the mm*s units and not mm^2.

Area of 100% ellipse [mm^2]

The area of the ellipse fitted over the COP trajectory so that it contains 100% of all the data points.

FRE from peaks – A-P [Hz]

The frequency of the oscillations of the COP calculated as the number of peaks in anterior-posterior direction (i.e. changes in direction from forward to backward or vice versa) divided by the measurement time.

FRE from peaks – M-L [Hz]

The frequency of the oscillations of the COP calculated as the number of peaks in medial-lateral direction (i.e. changes in direction from left to right or vice versa) divided by the measurement time.

Mean FRE of total spectrum – A-P [Hz]

The frequency of the oscillations of the COP calculated as the mean frequency of the power spectrum for the anterior-posterior direction.

Mean FRE of total spectrum – M-L [Hz]

The frequency of the oscillations of the COP calculated as the mean frequency of the power spectrum for the medial-lateral (i.e. left to right) direction.

Peak FRE of total spectrum – A-P [Hz]

The frequency of the oscillations of the COP calculated as the peak value on the power spectrum for the anterior-posterior direction.

Peak FRE of total spectrum – M-L [Hz]

The frequency of the oscillations of the COP calculated as the peak value on the power spectrum for the medial-lateral (i.e. left to right) direction.

Mean FRE of 0.1-1 spectrum band – A-P [Hz]

The frequency of the oscillations of the COP calculated as the mean frequency of the power spectrum for the anterior-posterior direction; for the frequency band 0.1 Hz to 1 Hz.

Mean FRE of 0.1-1 spectrum band – M-L [Hz]

The frequency of the oscillations of the COP calculated as the mean frequency of the power spectrum for the medial-lateral direction; for the frequency band 0.1 Hz to 1 Hz.

Mean FRE of 1-2 spectrum band – A-P [Hz]

The frequency of the oscillations of the COP calculated as the mean frequency of the power spectrum for the anterior-posterior direction; for the frequency band 1 Hz to 2 Hz.

Mean FRE of 1-2 spectrum band – M-L [Hz]

The frequency of the oscillations of the COP calculated as the mean frequency of the power spectrum for the medial-lateral direction; for the frequency band 1 Hz to 2 Hz.

Mean FRE of 2-10 spectrum band – A-P [Hz]

The frequency of the oscillations of the COP calculated as the mean frequency of the power spectrum for the anterior-posterior direction; for the frequency band 2 Hz to 10 Hz.

Mean FRE of 2-10 spectrum band – M-L [Hz]

The frequency of the oscillations of the COP calculated as the mean frequency of the power spectrum for the medial-lateral direction; for the frequency band 2 Hz to 10 Hz.

GLOBAL PARAMETERS - INTERVAL SPECIFIC

Global parameters estimate the overall size of the COP sway. Regarding the direction, parameters can be calculated as two-directional and/or one-directional (i.e. anterior-posterior (A-P) and medio-lateral (M-L)). The “Interval Specific” subgroup of the COP global parameters encompasses values for the initial, middle and final sub-interval of the measurement. The default duration of these intervals is 10 s, but the user can change it under the Settings panel - Time Interval. Based on the chosen interval specific global parameters, fatigue/endurance related indexes are further calculated. The following interval specific global COP parameters and related indexes are calculated:

Sway V of the 1st interval – total [mm/s]

The common length of the trajectory of the COP sway calculated as a sum of the point-to-point Euclidian distances in the initial interval (i.e. start + the interval duration) divided by the duration of the initial time interval. The default duration of this interval is 10 s, but it can be changed in the Settings panel - Time Interval.

Sway V of the 2nd interval – total [mm/s]

The common length of the trajectory of the COP sway calculated as a sum of the point-to-point Euclidian distances in the middle time interval (i.e. mid-time ± 1 of the interval duration) divided by the duration of the middle time interval. The default duration of this interval is 10 s, but it can be changed in the Settings panel - Time Interval.

Sway V of the 3rd interval – total [mm/s]

The common length of the trajectory of the COP sway calculated as a sum of the point-to-point Euclidian distances in the final time interval (i.e. end - the interval duration) divided by the duration of the final time interval. The default duration of this interval is 10 s, but it can be changed in the Settings panel - Time Interval.

Sway V endurance index – total [%]

The COP sway total velocity of the middle (2nd) time interval divided by the COP sway total velocity of the initial (1st) time interval. Total velocities are calculated as the common length of the trajectory of the COP sway (i.e. the sum of the point-to-point Euclidian distances) in the time interval divided by the duration of the time interval. The default duration of this interval is 10 s, but it can be changed in the Settings panel - Time Interval.

Sway V fatigue index – total [%]

The COP sway total velocity of the final (3rd) time interval divided by the COP sway total velocity of the initial (1st) time interval. Total velocities are calculated as the common length of the trajectory of the COP sway (i.e. the sum of the point-to-point Euclidian distances) in the time interval divided by the duration of the time interval. The default duration of this interval is 10 s, but it can be changed in the Settings panel - Time Interval.

Sway V of the 1st interval – A-P [mm/s]

The length of the trajectory of the COP sway in anterior-posterior direction in the initial time interval (i.e. start + the interval duration) divided by the duration of the initial time interval. The default duration of this interval is 10 s, but it can be changed in the Settings panel - Time Interval.

Sway V of the 2nd interval – A-P [mm/s]

The length of the trajectory of the COP sway in anterior-posterior direction in the middle time interval (i.e. mid-time ± 1 of the interval duration) divided by the duration of the middle time interval. The default duration of this interval is 10 s, but it can be changed in the Settings panel - Time Interval.

Sway V of the 3rd interval – A-P [mm/s]

The length of the trajectory of the COP sway in anterior-posterior direction in the final time interval (i.e. end - the interval duration) divided by the duration of the final time interval. The default duration of this interval is 10 s, but it can be changed in the Settings panel - Time Interval.

Sway V endurance index – A-P [%]

The COP sway anterior-posterior velocity of the middle (2nd) time interval divided by the COP sway anterior-posterior velocity of the initial (1st) time interval. The anterior-posterior velocities are calculated as the length of the trajectory of the COP sway in anterior-posterior direction in the time interval divided by the duration of the time interval. The default duration of this interval is 10 s, but it can be changed in the Settings panel - Time Interval.

Sway V fatigue index – A-P [%]

The COP sway anterior-posterior velocity of the final (3rd) time interval divided by the COP sway anterior-posterior velocity of the initial (1st) time interval. The anterior-posterior velocities are calculated as the length of the trajectory of the COP sway in anterior-posterior direction in the time interval divided by the duration of the time interval. The default duration of this interval is 10 s, but it can be changed in the Settings panel - Time Interval.

Sway V of the 1st interval – M-L [mm/s]

The length of the trajectory of the COP sway in medial-lateral direction in the initial time interval (i.e. start + the interval duration) divided by the duration of the initial time interval. The default duration of this interval is 10 s, but it can be changed in the Settings panel - Time Interval.

Sway V of the 2nd interval – M-L [mm/s]

The length of the trajectory of the COP sway in medial-lateral direction in the middle time interval (i.e. mid-time ± 1 of the interval duration) divided by the duration of the middle time interval. The default duration of this interval is 10 s, but it can be changed in the Settings panel - Time Interval.

Sway V of the 3rd interval – M-L [mm/s]

The length of the trajectory of the COP sway in medial-lateral direction in the final time interval (i.e. end - the interval duration) divided by the duration of the final time interval. The default duration of this interval is 10 s, but it can be changed in the Settings panel - Time Interval.

Sway V endurance index – M-L [%]

The COP sway medial-lateral velocity of the middle (2nd) time interval divided by the COP sway medial-lateral velocity of the initial (1st) time interval. The medial-lateral velocities are calculated as the length of the trajectory of the COP sway in medial-lateral direction in the time interval divided by the duration of the time interval. The default duration of this interval is 10 s, but it can be changed in the Settings panel - Time Interval.

Sway V fatigue index – M-L [%]

The COP sway medial-lateral velocity of the final (3rd) time interval divided by the COP sway medial-lateral velocity of the initial (1st) time interval. The medial-lateral velocities are calculated as the length of the trajectory of the COP sway in medial-lateral direction in the time interval divided by the duration of the time interval. The default duration of this interval is 10 s, but it can be changed in the Settings panel - Time Interval.

Sway average amplitude of the 1st interval – A-P [mm]

The average amplitude of the COP sway in anterior-posterior direction in the initial time interval (i.e. start + the interval duration).The average amplitude of the COP sway in anterior-posterior direction is calculated as the common length of the trajectory of the COP sway only in the anterior-posterior direction divided by the number of changes in this direction (i.e. from moving forward to backward or vice versa). The default duration of this interval is 10 s, but it can be changed in the Settings panel - Time Interval.

Sway average amplitude of the 2nd interval – A-P [mm]

The average amplitude of the COP sway in anterior-posterior direction in the middle time interval (i.e. mid-time ± 1 of the interval duration). The average amplitude of the COP sway in anterior-posterior direction is calculated as the common length of the trajectory of the COP sway only in the anterior-posterior direction divided by the number of changes in this direction (i.e. from moving forward to backward or vice versa). The default duration of this interval is 10 s, but it can be changed in the Settings panel - Time Interval.

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Sway average amplitude endurance index – A-P [%]

The average amplitude of the COP sway in anterior-posterior direction in the middle (2nd) time interval divided by the average amplitude of the COP sway in anterior-posterior direction in the initial (1st) time interval. The average amplitudes of the COP sway in anterior-posterior direction are calculated as the common length of the trajectory of the COP sway only in the anterior-posterior direction divided by the number of changes in this direction (i.e. from moving forward to backward or vice versa). The default duration of this interval is 10 s, but it can be changed in the Settings panel - Time Interval.

Sway average amplitude fatigue index – A-P [%]

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Sway average amplitude of the 1st interval – M-L [mm]

The average amplitude of the COP sway in medial-lateral direction in the initial time interval (i.e. start + the interval duration). The average amplitude of the COP sway in medial-lateral direction is calculated as the common length of the trajectory of the COP sway only in the medial-lateral direction divided by the number of changes in this direction (i.e. from moving left to right or vice versa). The default duration of this interval is 10 s, but it can be changed in the Settings panel - Time Interval.

Sway average amplitude of the 2nd interval – M-L [mm]

The average amplitude of the COP sway in medial-lateral direction in the middle time interval (i.e. mid-time ± 1 of the interval duration). The average amplitude of the COP sway in medial-lateral direction is calculated as the common length of the trajectory of the COP sway only in the medial-lateral direction divided by the number of changes in

this direction (i.e. from moving left to right or vice versa). The default duration of this interval is 10 s, but it can be changed in the Settings panel - Time Interval.

Sway average amplitude of the 3rd interval – M-L [mm]

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Sway average amplitude endurance index – M-L [%]

The average amplitude of the COP sway in medial-lateral direction in the middle (2nd) time interval divided by the average amplitude of the COP sway in medial-lateral direction in the initial (1st) time interval. The average amplitudes of the COP sway in medial-lateral direction are calculated as the common length of the trajectory of the COP sway only in the medial-lateral direction divided by the number of changes in this direction (i.e. from moving left to right or vice versa). The default duration of this interval is 10 s, but it can be changed in the Settings panel - Time Interval.

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Sway FRE from peaks of the 1st interval – A-P [Hz]

The average frequency of the oscillations of the COP calculated as the number of peaks in anterior-posterior direction (i.e. changes in direction from forward to backward or vice versa) in the initial time interval (i.e. start + the interval duration) divided by the duration of the initial time interval. The default duration of this interval is 10 s, but it can be changed in the Settings panel - Time Interval.

Sway FRE from peaks of the 2nd interval – A-P [Hz]

The average frequency of the oscillations of the COP calculated as the number of peaks in anterior-posterior direction (i.e. changes in direction from forward to backward or vice versa) in the middle time interval (i.e. mid-time ± 1 of the interval duration) divided by the duration of the middle time interval. The default duration of this interval is 10 s, but it can be changed in the Settings panel - Time Interval.

Sway FRE from peaks of the 3rd interval – A-P [Hz]

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Sway FRE from peaks endurance index – A-P [%]

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Sway FRE from peaks of the 1st interval – M-L [Hz]

The average frequency of the oscillations of the COP calculated as the number of peaks in medial-lateral direction (i.e. changes in direction from left to right or vice versa) in the initial time interval (i.e. start + the interval duration) divided by the duration of the initial time interval. The default duration of this interval is 10 s, but it can be changed in the Settings panel - Time Interval.

Sway FRE from peaks of the 2nd interval – M-L [Hz]

The average frequency of the oscillations of the COP calculated as the number of peaks in medial-lateral direction (i.e. changes in direction from left to right or vice versa) in the middle time interval (i.e. mid-time ± 1 of the interval duration) divided by the duration of the middle time interval. The default duration of this interval is 10 s, but it can be changed in the Settings panel - Time Interval.

Sway FRE from peaks of the 3rd interval – M-L [Hz]

The average frequency of the oscillations of the COP calculated as the number of peaks in medial-lateral direction (i.e. changes in direction from left to right or vice versa) in the final time interval (i.e. end - the interval duration) divided by the duration of the final time interval. The default duration of this interval is 10 s, but it can be changed in the Settings panel - Time Interval.

Sway FRE from peaks endurance index – M-L [%]

The average frequency of the COP sway in medial-lateral direction in the middle (2nd) time interval divided by the average frequency of the COP sway in medial-lateral direction in the initial (1st) time interval. The average frequencies of the COP sway in medial-lateral direction are calculated as the number of peaks in medial-lateral direction (i.e. changes in direction from left to right or vice versa) in the time interval divided by the duration of the time interval. The default duration of this interval is 10 s, but it can be changed in the Settings panel - Time Interval.

Sway FRE from peaks fatigue index – M-L [%]

The average frequency of the COP sway in medial-lateral direction in the final (3rd) time interval divided by the average frequency of the COP sway in medial-lateral direction in the initial (1st) time interval. The average frequencies of the COP sway in medial-lateral direction are calculated as the number of peaks in medial-lateral direction (i.e. changes in direction from left to right or vice versa) in the time interval divided by the duration of the time interval. The default duration of this interval is 10 s, but it can be changed in the Settings panel - Time Interval.

STRUCTURAL PARAMETERS – DIFFUSION PLOTS

Different from the global body sway parameters, the structural parameters estimate the elements or smaller parts of the COP sway. The structural parameters are divided on parameters based on the computation of diffusion plots or variograms and on parameters based on the analysis of sway density plots.

Diffusion plots model the stabilograms as fractional Brownian motions and thus decompose the sway patterns into two stochastic processes: (1) a short-term process (interpreted as an open-loop control mechanism) in a logarithmic and linear scale and (2) a long-term process (interpreted as a closed-loop mechanism) in a logarithmic and linear scale.

The following diffusion plots based structural parameters are calculated:

Short-range slope on linear scale – total [mm^2/s]

Long-range slope on linear scale – total [mm^2/s]

Short-range slope on logarithmic scale – total [mm^2/s]

Long-range slope on logarithmic scale – total [mm^2/s]

Short-range slope on linear scale – A-P [mm^2/s]

Long-range slope on linear scale – A-P [mm^2/s]

Short-range slope on logarithmic scale – A-P [mm^2/s]

Long-range slope on logarithmic scale – A-P [mm^2/s]

Short-range slope on linear scale – M-L [mm^2/s]

Long-range slope on linear scale – M-L [mm^2/s]

Short-range slope on logarithmic scale – M-L [mm^2/s]

Long-range slope on logarithmic scale – M-L [mm^2/s]

STRUCTURAL PARAMETERS – DENSITY PLOTS

The analysis of sway density plots is based on idea that the feed-forward control is the prevalent mechanism in the postural stabilization process, thus breaking down the control process into a sequence of anticipatory motor commands. Parameters based on density plots are: (1) mean value of the peaks in the sway density curve and the corresponding variability, (2) mean value of the time interval between successive peaks in the sway density curve and the corresponding variability, and (3) mean value of the distance between successive peaks in the sway density curve and the corresponding variability.

The following density plots based structural parameters are calculated:

Mean value of peaks [s]

Variability of peaks [s]

Mean T interval between successive peaks [s]

Variability of T interval between successive peaks [s]

Mean distance between successive peaks [mm]

Variability of distance between successive peaks [mm]

STRUCTURAL PARAMETERS – RECURRENCE QUANTIFICATION ANALYSIS

Recurrence quantification analysis is a nonlinear and multi-dimensional technique which does not assume data stationary and which provides a characterization of a variety of features of a given time series, including a quantification of deterministic structure and of nonstationarity. All the parameters are calculated for the medial-lateral and anterior-posterior direction.

Parameters of recurrence quantification analysis are:

Recurrence rate– A-P [%]

Recurrence rate– M-L [%]

Average diagonal line length – A-P [%]

Average diagonal line length – M-L [%]

Entropy – A-P [bits]

Entropy – M-L [bits]

Laminarity– A-P [%]

Laminarity – M-L [%]

Trapping time – A-P [%]

Trapping time – M-L [%]

Determinism – A-P [%]

Determinism – M-L [%]

STRUCTURAL PARAMETERS – SAMPLE ENTROPY

Sample entropy provides information about the regularity or predictability of a time-series (COP path) and it is used to analyse complex stochastic systems. Small values of sample entropy are associated with great regularity (high possibility of the same data) while large values of sample entropy reflect great irregularity (low possibility of the same data).

Parameters based on sample entropy are:

Sample entropy in medio-lateral direction [a.u]

Sample entropy in antero-posterior direction [a.u]

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COUNTER MOVEMENT JUMP - TEST

This measurement module is a part of MARS Strength & Power.

Brief Description

Selecting Input Parameters

Measurement

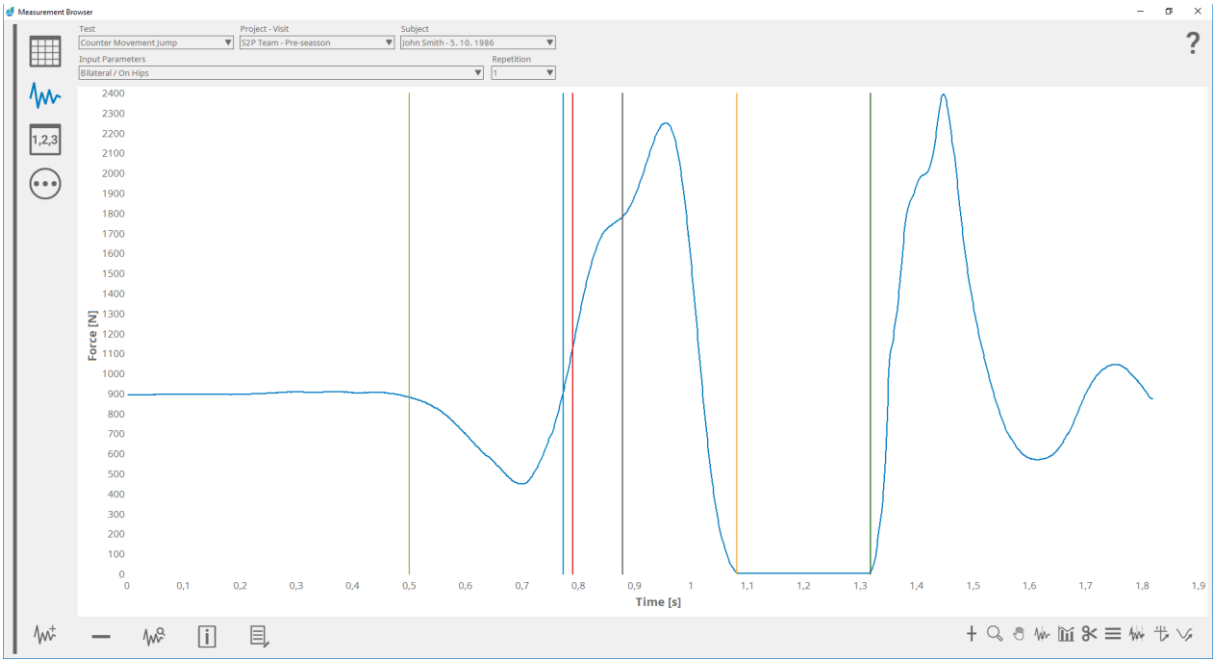
Cursors

Analysis

References

Brief Description

Counter movement jump is a vertical jump and among the most often used tests for maximal anaerobic power output of the lower extremities. It is an eccentric-concentric muscle action which involves coordinated extension of the trunk, hip, knee and ankle. Based on the ground reaction force derived parameters dynamics of this elementary movement pattern can be thoroughly studied. Based on the comparisons of the squat jump and counter movement jump parameters some basic biomechanical and functional characteristics of the neuromuscular system can be analysed (i.e. the use of elastic energy, neuromuscular facilitation under the conditions of eccentric-concentric coupling, etc.).



The initial position of the subject for the counter movement jump is an upright stance. It is important that the subject performs a quickly coupled counter movement – push-off action. While performing this lowest position should be a semi-squat (knee ~90° and trunk/hips in a flexed position) like in the case of the squat jump. The jump must be performed as quickly and explosively as possible in order to make the highest possible

jump in the shortest possible time thereby using the above described neuromuscular action and movement pattern.

Selecting Input Parameters

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

- Lower Extremities
- Upper Extremities

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.

Across the Chest

The subject places his/her hands across his/her chest.

Behind the Neck

The subject places his/her hands behind his/her neck.

Other user defined

In case of any other position of the upper extremities, the user can define new positions under Settings panel - section Input parameters. After doing so, the newly defined input parameter will from then on appear as an optional choice under the Upper extremities in the Counter Movement Jump measurement module.

Measurement

Before starting a test select input parameters (on the left side of Measure window). Then the subject acquires the required position (i.e. upright stance). Ensure that the subject is standing in the centre of the plate as described above. After the subject has acquired the required position and is ready to start the movement, click Start or press Space. At that time, the subject is free to start the jump and the software will automatically recognize the beginning and the end of the jump and will automatically stop the data acquisition. For details about this automatic acquisition please see Settings Panel. After the measurement is completed you can chose to Confirm, Reject or Repeat it.

If you want to start a new measurement, click the New Measurement button and repeat the procedure. Before starting a new measurement you can change the Input Parameters; if not, the Input Parameters of the previous measurement will be used.

Cursors

Start

Indicates the start of the jump (start of the movement).

T1

Indicates the event when force reaches the value of body weight during counter movement.

T/2

Indicates the half of the time between the Start and Take Off event.

Push Off

Indicates the start of the Concentric phase of the jump where negative and positive Force Impulse from start equals.

Take Off

Indicates the start of the flight phase.

Landing

Indicates the start of the landing.

Free Fall

Lowest Force during Eccentric phase of the jump.

Peak Eccentric

Peak Force during Eccentric phase of the jump.

Begin Concentric

Indicates the start of the Concentric phase of the jump.

Peak Concentric

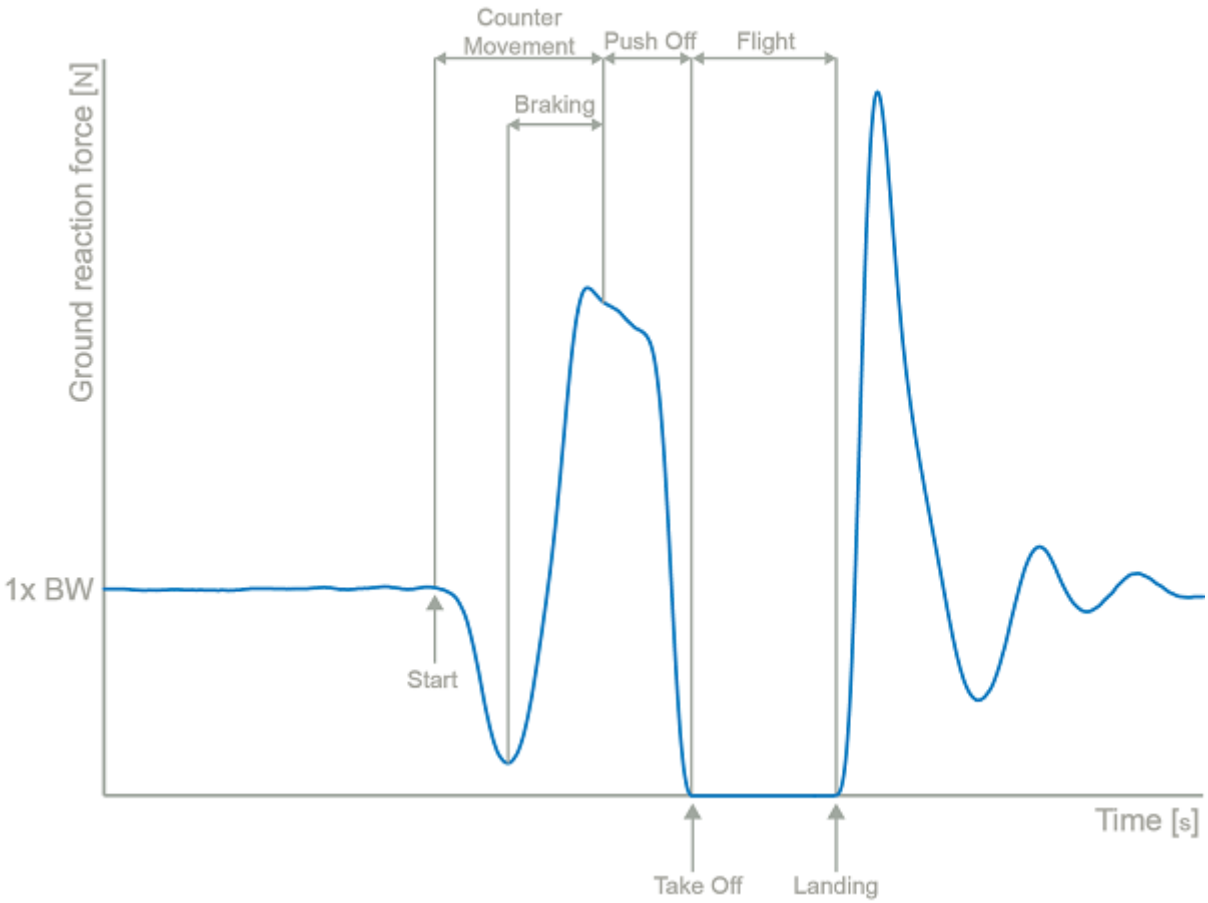
Peak Force during Concentric phase of the jump.

If Peak Eccentric and Begin Concentric cursors are not founded, then they will be placed at the start of the graph (dotted line). In this case cursors have to be positioned manually. When the cursor is moved it became solid. If there are no events where Peak Eccentric and Begin Concentric cursors can be positioned, the parameters related the two cursors are not calculated. If cursors are moved manually, the related parameters are calculated automatically.

Analysis

Analysis enables you to check the signal(s) of the ground reaction force and the calculated parameters. Under the Signals tab you can see the signal(s) and automatically placed markers. You can move certain markers if they were placed incorrectly. Under the Repetitions tab you can see all the calculated parameters.

All the parameters calculated for analysis are commonly used in biomechanics, kinesiology and rehabilitation 1-7. Parameters are calculated from the ground reaction force and flight time. For more information regarding the parameters see the References.



For some modules additional analysis routines are available as separate products. For more information see section About MARS or contact us.

GENERAL PARAMETERS

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 jump calculated from the Flight Time.

Start interval relative F [%BW]

Average force in the 1st 50 ms of the Push Off (50 ms is a default value and can be changed in the Settings Panel - Start Interval).

Start interval relative P [W/kg]

Average power in the 1st 50 ms of the Push Off divided by the body weight (50 ms is a default value and can be changed in the Settings Panel - Start Interval).

Start interval A [m/s^2]

Average acceleration in the 1st 50ms of the Push Off (50 ms is a default value and can be changed in the Settings Panel - Start Interval).

Start interval V [m/s]

Average velocity in the 1st 50ms of the Push Off (50 ms is a default value and can be changed in the Settings Panel - Start Interval).

Relative maximal F [%BW]

Maximal force during the Push Off 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 Fin the 1st 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 2nd half of Push Off [%BW]

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

Relative minimal F [%BW]

Minimal force during the Counter Movement divided by the body weight. At this point, the peak acceleration in downward direction occurs and active deceleration (i.e. braking) begins.

Relative maximal P [W/kg]

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

Relative E [J/kg]

Energy during the Push Off divided by the body weight.

A [m/s^2]

Average acceleration during the jump.

A in the 1st half of Push Off [m/s^2]

Average acceleration between the Lowest Position and the half of the Push Off.

A in the 2nd half of Push Off [m/s^2]

Average acceleration between the half of the Push Off and the Take Off.

Vertical Take Off V [m/s]

Velocity of the vertical movement at the Take Off calculated from Flight T.

TIME PARAMETERS

Jump T [s]

Time interval between the Start and the Take Off.

Counter Movement T [s]

Time interval between the Start and the Lowest Position.

Push Off T [s]

Time interval between the Lowest Position and the Take Off.

Ratio between Counter Movement and Push Off T [%]

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

Flight T [s]

Time interval between the Take Off and the Landing.

Breaking T [s]

Time interval between the minimal force and the Lowest Position.

T to maximal F [s]

Time interval between the Start and the maximal force.

T to minimal F [s]

Time interval between the Start and the minimal force.

FORCE IMPULSE PARAMETERS

Push Off FI [Ns]

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

Push Off FI from Flight T [Ns]

Push Off force impulse calculated from the Flight Time.

Negative FI [Ns]

Force impulse (i.e. integral of a force with respect to time) between the Start and the moment where the ground reaction force equals the body weight again.

Positive FI [Ns]

Force impulse (i.e. integral of a force with respect to time) between the moment where the ground reaction force equals the body weight again and the Take Off.

FI in the 1st half of Push Off [Ns]

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

FI in the 2nd half of Push Off [Ns]

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

Ratio between FI in both halves of Push Off [%]

Ratio of the force impulse (i.e. integral of a force with respect to time) between the Lowest Position and the half of the Push Off and the force impulse between the half of the Push Off and the Take Off.

CONTRALATERAL PARAMETERS

NOTE: Beware that this parameters are calculated only when using bilateral force plates.

Left leg - Start interval relative P [W/kg]

Average power in the 1st 50 ms of the Push Off divided by the body weight (50 ms is a default value and can be changed in the Settings Panel - Start Interval).

Left leg - Relative maximal F [%BW]

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

Left leg - Relative maximal P [W/kg]

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

Left leg - Relative E [J/kg]

Energy during the Push Off divided by the body weight.

Left leg - Push Off FI [Ns]

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

Right leg - Start interval relative P [W/kg]

Average power in the 1st 50 ms of the Push Off divided by the body weight (50 ms is a default value and can be changed in the Settings Panel - Start Interval).

Right leg - Relative maximal F [%BW]

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

Right leg - Relative maximal P [W/kg]

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

Right leg - Relative E [J/kg]

Energy during the Push Off divided by the body weight.

Right leg - Push Off FI [Ns]

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

Left/right leg - Start interval relative P [%]

Average power in the 1st 50 ms of the Push Off divided by the body weight (50 ms is a default value and can be changed in the Settings Panel - Start Interval).

Left/right leg - Relative maximal F [%]

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

Left/right leg - Relative maximal P [%]

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

Left/right leg - Relative E [%]

Energy during the Push Off divided by the body weight.

Left/right leg - Push Off FI [%]

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

P3 PARAMETERS

F at Free Fall [N/kg]

Force per kg of the Body Weight at the Free Fall.

F at Peak Eccentric - Standard [N/kg]

Peak Force per kg of the Body Weight during the Eccentric phase of the jump. Eccentric phase of the jump is between Start and P0.

F at Peak Eccentric – P3 [N/kg]

Peak Force per kg of the Body Weight during the Eccentric phase of the jump. Eccentric phase of the jump is between Free Fall and Begin Concentric.

F at Begin Concentric - Standard [N/kg]

Force per kg of the Body Weight when the Concentric phase starts at the P0.

F at Begin Concentric – P3 [N/kg]

Force per kg of the Body Weight when the Concentric phase starts at the Begin Concentric.

F at Peak Concentric [N/kg]

Peak Force per kg of the Body Weight during the Concentric phase of the jump at the Peak Concentric.

Total FI [Ns/kg]

Force Impulse between the Free Fall and Take Off.

Max RFD [N/s]

Maximum slope of the Force curve between the Free Fall and Peak Concentric.

Max Eccentric RFD – Standard [N/s]

Maximal slope of the Force curve during the Eccentric phase of the jump. Eccentric phase of the jump is between Start and P0.

Max Eccentric RFD – P3 [N/s]

Maximal slope of the Force curve during the Eccentric phase of the jump. Eccentric phase of the jump between the Free Fall and Begin Concentric.

Max Concentric RFD – Standard [N/s]

Maximal slope of the Force curve during the Concentric phase of the jump. Concentric phase of the jump is between P0 and Take Off.

Max Concentric RFD – P3 [N/s]

Maximal slope of the Force curve during the Concentric phase of the jump. Concentric phase of the jump is between Begin Concentric and Peak Concentric.

Total Movement T [s]

Time between the Start and Take Off.

Active Movement T [s]

Time between Free Fall and Take Off.

L/R Ratio Peak Eccentric - Standard [%]

Difference in the Force between left and right force plates at Peak Eccentric. Eccentric phase of the jump is between Start and P0.

L/R Ratio Peak Eccentric – P3 [%]

Difference in the Force between left and right force plates at Peak Eccentric. Eccentric phase of the jump between Free Fall and Begin Concentric.

L/R Ratio Peak Concentric [%]

Difference in the Force between left and right force plates at Peak Concentric.

L/R Ratio Eccentric FI - Standard [%]

Difference in the Force Impulse between left and right force plates during the Eccentric phase of the jump. Eccentric phase of the jump is between Start and P0.

L/R Ratio Eccentric FI – P3 [%]

Difference in the Force Impulse between left and right force plates during the Eccentric phase of the jump. Eccentric phase of the jump is between Free Fall and Begin Concentric.

L/R Ratio Concentric FI - Standard [%]

Difference in the Force Impulse between left and right force plates during the Concentric phase of the jump. Concentric phase of the jump is between P0 and Take Off.

L/R Ratio Concentric FI – P3 [%]

Difference in the Force Impulse between left and right force plates during the Concentric phase of the jump. Concentric phase of the jump is between Begin Concentric and Peak Concentric.

L/R Ratio Total FI

Difference in the Force Impulse between left and right force plates between Free Fall and Take Off.

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CURVE TRACKING - TEST

This measurement module is a part of MARS Balance & Stability.

Brief Description

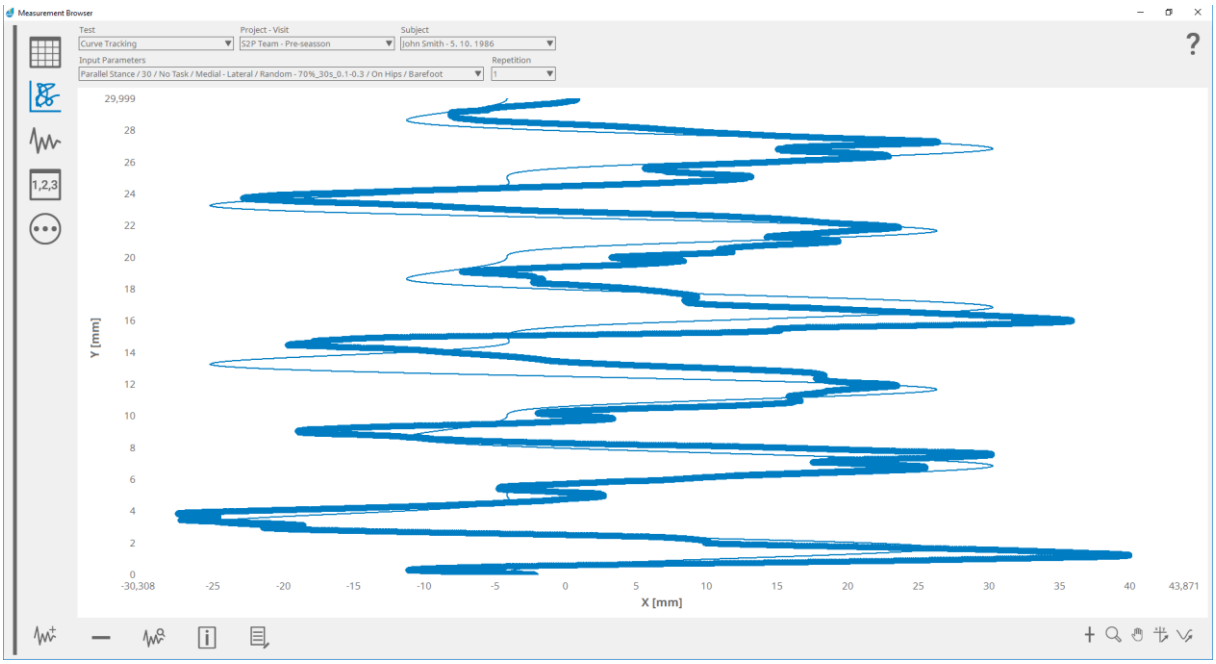
Selecting Input Parameters

Measurement

Analysis

Brief Description

Different from the quiet stance, every day functional situations often require more demanding dynamic balance situations and corresponding balance control. A typical example are those motor tasks in which a subject has to voluntarily shift the body`s centre-of-gravity above the support area. Such leaning of the body in different directions will result in an evident centre-of-pressure (COP) displacement. It can be done with a maximal or submaximal range of COP excursions. Range and precision of voluntary body leaning in different directions can be assessed by measuring the COP displacements. The ability of a subject to finely control the dynamics of the COP excursions can be assessed with visuo-motor integration tasks in which the real COP is displayed in front of the subject and he/she tries to precisely follow the predefined dynamics of the COP shifts.



Evaluation of such visual feed-back based dynamic balance tasks gives us the information about the volitional balance control of the centre-of-gravity and can be quantitatively evaluated using force plate measurements. In case of the Curve Tracking task the subject is instructed to follow the reference curve by voluntarily shifting his/her COP in a pre-defined direction. Such a measurement set-up will enable us to identify direction specific weak points of the subject`s balance and to gather additional

information about the balance dynamic control. These tasks can be also used as a motivation exercise tool.

Selecting Input Parameters

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

- Stance Position
- Duration
- Dual Task
- Curve Direction
- Curve
- Upper Extremities
- Footwear

STANCE POSITION

Parallel Stance

The subject is standing in the centre of the force plate with the feet placed parallel at the shoulder width. The feet are oriented in anterior-posterior direction (along the Y-axis of the force plate) with the toes pointing anteriorly (+Y). Throughout the measurement the subject sustains his/her normal upright stance position.

Semi-Tandem Stance

The subject is standing in the centre of the force plate with the feet placed close together and shifted longitudinally against each other for one half of the length of the foot (i.e. semi-tandem foot position). The feet are oriented in anterior-posterior direction (along the Y-axis of the force plate) with the toes pointing anteriorly (+Y). Throughout the measurement the subject sustains his/her normal upright stance position. Semi-tandem stance with the dominant leg in front is predominantly used; the opposite foot position is sometimes also referred as “contra semi-tandem”.

Tandem Stance

The subject is standing in the centre of the force plate with the feet placed in-line one behind the other (i.e. heel-to-toe or tandem feet position). The feet are oriented in anterior-posterior direction (along the Y-axis of the force plate) with the toes pointing

anteriorly (+Y). Throughout the measurement the subject sustains his/her normal upright stance position. Tandem stance with the dominant leg in front is predominantly used; the opposite foot position is sometimes also referred as “contra tandem”.

Single Leg Stance – Left / Single Leg Stance - Right

The subject is standing on one leg in the centre of the force plate. The foot is oriented in anterior-posterior direction (along the Y-axis of the force plate) with the toes pointing anteriorly (+Y). Throughout the measurement the subject sustains his/her normal upright stance position.

Other user defined

In case of any other type of stance, the user can define it under Settings panel - section Input parameters. After doing so, the newly defined input parameter will from then on appear as an optional choice under the Stance Position in the Curve Tracking measurement module.

DURATION

10/20/30/40/50/60/70/80/90/100 s

Other user defined

In case of any other duration, the user can define it under Settings panel - section Input parameters. After doing so, the newly defined duration of the quiet stance task will from then on appear as an optional choice under the Duration in the Curve Tracking measurement module.

DUAL TASK

No Additional Task

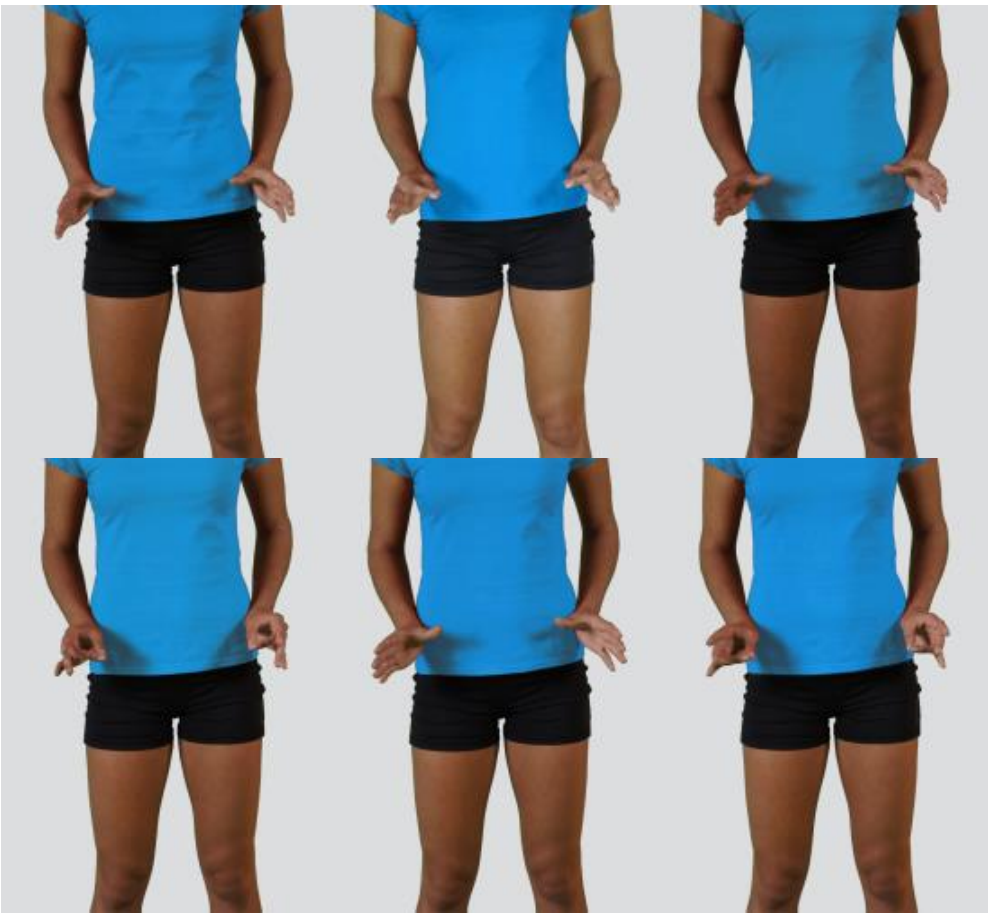
The subject has no additional mental or motor task to do during the time of the measurement.

Additional Mental Task

Together with the quiet stance task the subject has to perform a required mental task. For this purpose different tasks have been used, the most commonly used is counting up/down by three.

Additional Motor Task

Together with the quiet stance task the subject has to perform a required motor task. For this purpose different tasks have been used, the most commonly used is alternative finger tapping task.



Other user defined

In case of any other type of dual task, the user can define it under Settings panel - section Input parameters. After doing so, the newly defined input parameter will from then on appear as an optional choice under the Dual Task in the Curve Tracking measurement module.

CURVE DIRECTION

Medial – Lateral

Subject will track the curve in the Medial-Lateral direction.

Anterior – Posterior

Subject will track the curve in the Anterior-Posterior direction.

CURVE

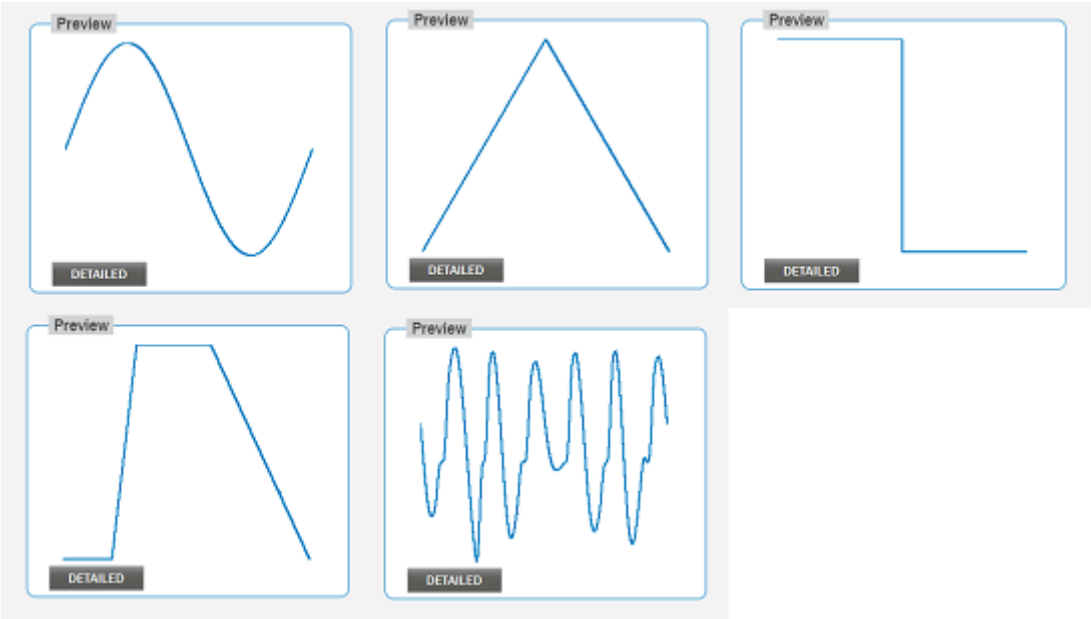
Sinus

Triangle

Square

Ramp

Random



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. In case of the easy quiet stance tasks the hands will normally remain passively hanging. However, in more demanding tasks the free use of the hands can be of great help.

Across the Chest

The subject places his/her hands across his/her chest.

Behind the Neck

The subject places his/her hands behind his/her neck.

Other user defined

In case of any other position of the upper extremities, the user can define new positions under Settings panel - section Input parameters. After doing so, the newly defined input parameter will from then on appear as an optional choice under the Upper Extremities in the Curve Tracking measurement module.

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 case of any other type of footwear, the user can define it under Settings panel - section Input parameters. After doing so, the newly defined input parameter will from then on appear as an optional choice under the Footwear in the Curve Tracking measurement module.

Measurement

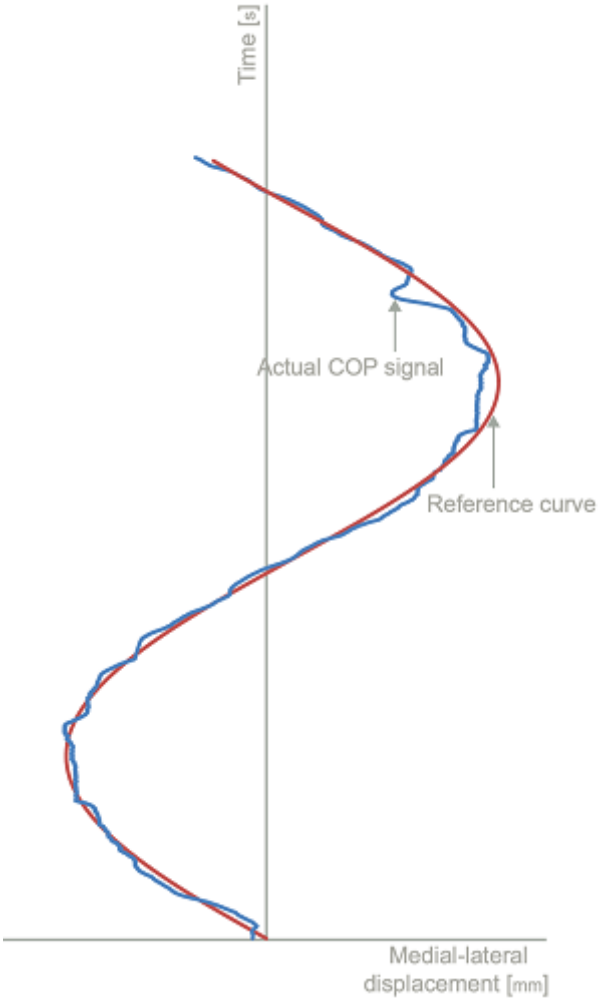
Before starting a test select input parameters (on the left side of Measure window). Then the subject steps on the force plate and gets into the required position in a way that the orientation of the body is consistent with that of the plate (i.e. +Y direction of the plate is the anterior direction). After you are satisfied with the quiet stance of the subject, click Start. While the COP offset is performed, the subject must not move. After this the software begins with the signal acquisition and the time left until the end of the test is displayed in the top-right corner of the screen. Data recording will stop automatically after the set time. After the measurement is completed you can chose to Confirm, Reject or Repeat it.

If you want to start a new measurement, click the New Measurement button and repeat the procedure. Before starting a new measurement you can change the Input Parameters; if not, the Input Parameters of the previous measurement will be used.

Analysis

Analysis enables you to check the signal of the ground reaction force and the calculated parameters. Under the COP tab you can see the X:Y signal. Individual components of the ground reaction forces and of the COP movement can be visualized under the Signals tab. Under the Repetitions tab you can see all the calculated parameters.

General Parameters



For some modules additional analysis routines are available as separate products. For more information see section About MARS or contact us.

GENERAL PARAMETERS

Mean absolute error [mm]

Mean absolute error between the reference curve and the actual COP signal.

SD of absolute error [mm]

Standard deviation calculated from deviations between the reference curve and the actual COP signal.

RMS error [mm]

Root mean squared error between the reference curve and the actual COP signal.

Area [mm*s]

Area between the reference curve and the actual COP signal calculated as the integral of absolute deviations between the two curves.

Normalized error [%]

The error defined as Normalized error= sqrt(((sum(COPa-R)^2)/(Amax)^2)/N)*100, where COPa is the actual COP signal, R is the reference trajectory, Amax is the maximal amplitude of the referenced trajectory and N is the number of samples. For the value 0 the performance was perfect, while for the value 100% the deviation between the referenced trajectory and the actual COP signal was equal to maximal amplitude of the referenced trajectory on average.

Mean FRE [Hz]

Mean frequency of the COP in the tracking direction calculated as mean frequency of the power spectrum.

Median FRE [Hz]

Mean frequency of the COP in the tracking direction calculated as median frequency of the power spectrum.

Peak FRE [Hz]

Mean frequency of the COP in the tracking direction calculated as peak frequency of the power spectrum.

T share on side 1 [%]

The time share spent on the left side of the reference curve in case of a side-to-side task or the time share spent on the anterior side of the reference curve in case of an anterior-posterior tracking task.

T share on side 2 [%]

The time share spent on the right side of the reference curve in case of a side-to-side task or the time share spent on the posterior side of the reference curve in case of an anterior-posterior tracking task.

Cross-correlation [a.u.]

Cross-correlation between the reference curve and the actual COP signal.

Weighted normalized error – common [%]

The error defined as Weighted normalized error=(sum((COPa-R)^2*(R/Asmax)^2))/(sum(R^2*(R/Asmax)^2))*100, where COPa is the actual COP

signal, R is the reference trajectory, Asmax is the maximal amplitude of the referenced trajectory either on the side 1 or the side 2 (if R is on the side 1 then maximal amplitude on the side 1 is used and if R is on the side 2 then maximal amplitude on the side 2 is used). This parameter weights more deviations close to maximal amplitudes on both sides of the reference trajectory and less those close to origin (value of COP when subject stands upright).

Weighted normalized error – outside [%]

The error for those parts of the performance where actual COP signal is on the outside of the referenced trajectory defined as Weighted normalized error=(sum((COPa-R)^2*(R/Asmax)^2))/(sum(R^2*(R/Asmax)^2))*100, where COPa is the actual COP signal, R is the reference trajectory, Asmax is the maximal amplitude of the referenced trajectory either on the side 1 or the side 2 (if R is on the side 1 then maximal amplitude on the side 1 is used and if R is on the side 2 then maximal amplitude on the side 2 is used). This parameter weights more deviations close to maximal amplitudes on both sides of the reference trajectory and less those close to origin (value of COP when subject stands upright).

Weighted normalized error – inside [%]

The error for those parts of the performance where actual COP signal is on the inside of the referenced trajectory defined as Weighted normalized error=(sum((COPa-R)^2*(R/Asmax)^2))/(sum(R^2*(R/Asmax)^2))*100, where COPa is the actual COP signal, R is the reference trajectory, Asmax is the maximal amplitude of the referenced trajectory either on the side 1 or the side 2 (if R is on the side 1 then maximal amplitude on the side 1 is used and if R is on the side 2 then maximal amplitude on the side 2 is used). This parameter weights more deviations close to maximal amplitudes on both sides of the reference trajectory and less those close to origin (value of COP when subject stands upright).

T share on outside [%]

Time while the actual COP signal is on the outside of the referenced trajectory.

T share on inside [%]

Time while the actual COP signal is on the outside of the referenced trajectory.

DROP JUMP - TEST

This measurement module is a part of MARS Strength & Power.

Brief Description

Selecting Input Parameters

Measurement

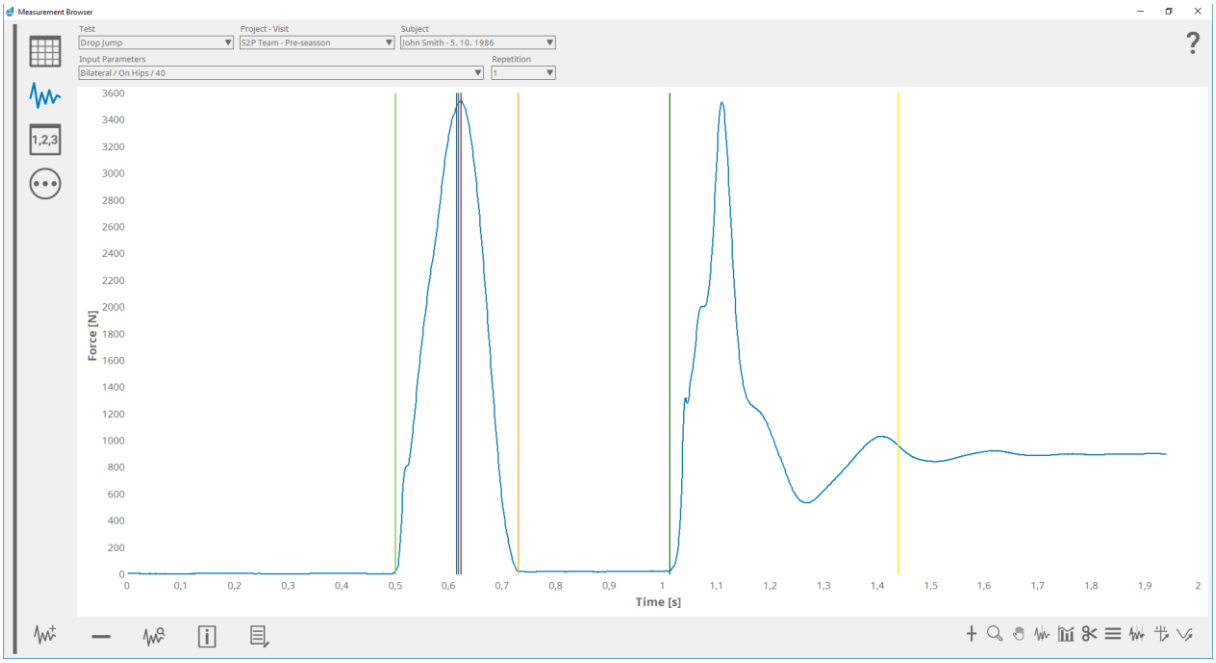
Cursors

Analysis

References

Brief Description

Drop jump is a vertical jump and among the most often used tests for maximal anaerobic power output of the lower extremities. It is an aggressive eccentric-concentric muscle action which involves utilization of stored elastic energy, called stretch-shortening cycle. If only the plantar flexors of the foot and knee extensors play a role of prime movers in this task, the entire body and lower extremities need to be strongly activated to assure general stiffness and optimal technique. Based on the parameters derived from the ground reaction force and flight time dynamics of this elementary movement pattern can be thoroughly studied.



The initial position of the subject is usually in a standing position on the bench (or other surface lifted from the ground) of different heights. The height of the starting point can be adjusted to the specific goals of the measurement. From the starting position the subject performs a drop on a force plate and then a vertical push-off action as quickly and as explosively as possible in order to perform the highest possible jump in the

shortest possible time; thereby using aneccentric-concentric muscle action. It is important that the subject does not strike with heels against the ground.

Selecting Input Parameters

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

- Lower Extremities
- Upper Extremities
- Drop Height [cm]

LOWER EXTREMITIES

Bilateral

The subject is standing on the bench with the feet placed parallel or with toes pointing slightly outward. Feet should be shoulder-width apart. The subject needs to land and perform a push off with the same feet position.

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.

Across the Chest

The subject places his/her hands across his/her chest.

Behind the Neck

The subject places his/her hands behind his/her neck.

Other user defined

In case of any other position of the upper extremities, the user can define new positions under Settings panel - section Input parameters. After doing so, the newly defined input parameter will from then on appear as an optional choice under the Upper extremities in the Counter Movement Jump measurement module.

DROP HEIGHT [cm]

10/20/30/40/50/60/70/80/90/100 cm

Select the start height above the force plate

Other user defined

In case of any other starting point height, the user can define new height under Settings panel - section Input parameters. After doing so, the newly defined input parameter will from then on appear as an optional choice under the Starting point height in the Drop Jump measurement module.

Measurement

Before starting a test select input parameters (on the left side of Measure window). Then the subject steps on a bench next to the force plate and acquires in a required position (i.e. upright stance). After the subject has acquired the required position and is ready to start the movement, click Start or press Space. At that time, the subject is free to start the jump and the software will automatically recognize the beginning and the

end of the jump and will automatically stop the data acquisition. For details about this automatic acquisition please see Settings Panel. After the measurement is completed you can chose to Confirm, Reject or Repeat it.

If you want to start a new measurement, click the New Measurement button and repeat the procedure. Before starting a new measurement you can change the Input Parameters; if not, the Input Parameters of the previous measurement will be used.

Cursors

Start
Indicates the start of the jump (start of the movement).

T/2
Indicates the half of the time between the Start and Take Off event.

G/2
Indicates the start of the push off.

Fmax
Indicates the maximum force between the Start and Take Off event.

Take Off
Indicates the start of the flight phase.

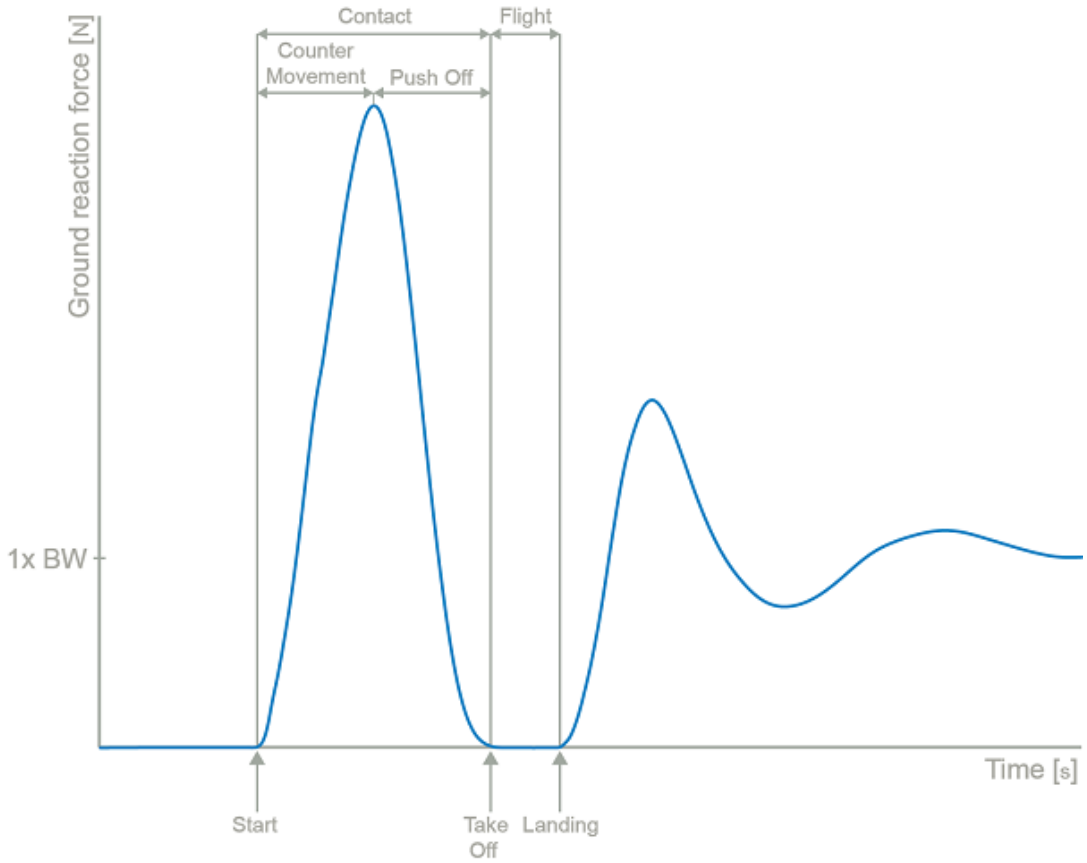
Landing
Indicates the start of the landing.

Steady
Indicates the event when force becomes steady after the landing.

Analysis

Analysis enables you to check the signal(s) of the ground reaction force and the calculated parameters. Under the Signals tab you can see the signal(s) and automatically placed markers. You can move certain markers if they were placed incorrectly. Under the Repetitions tab you can see all the calculated parameters.

All the parameters calculated for analysis are commonly used in biomechanics, kinesiology and rehabilitation 1-5. Parameters are calculated from the ground reaction force and flight time. For more information regarding the parameters see the References.



For some modules additional analysis routines are available as a separate product. For more information see section About MARS or contact us.

GENERAL PARAMETERS

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 1st 50 ms of the Push Off (50 ms is a default value and can be changed in the Settings Panel - Start Interval).

Start interval relative P [W/kg]

Average power in the 1st 50 ms of the Push Off divided by the body weight (50 ms is a default value and can be changed in the Settings Panel - Start Interval).

Start interval A [m/s^2]

Average acceleration in the 1st 50ms of the Push Off (50 ms is a default value and can be changed in the Settings Panel - Start Interval).

Start interval V [m/s]

Average velocity in the 1st 50ms of the Push Off (50 ms is a default value and can be changed in the Settings Panel - Start Interval).

Relative maximal F [%BW]

Maximal force during the Contact 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 1st 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 2nd 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^2]

Average acceleration during the Counter Movement phase.

Push Off A [m/s^2]

Average acceleration during the Push Off phase.

Vertical Take Off V [m/s]

Velocity of the vertical movement at the Take Off calculated from Flight T.

Drop Jump / Squat Jump height ratio [%]

Ratio between the Drop Jump height and the Squat Jump height. This parameter is calculated only if the data from the Squat Jump module exists for the same person.

TIME PARAMETERS

Contact Time duration [s]

Time interval between the First Contact and the Take Off.

Time to half of the Contact Time [s]

Time interval between the First Contact and the half of the Contact Time.

Flight Time [s]

Time interval between the Take Off and the Landing.

Duration of the 1st half of the FI [s]

Time interval between the First Contact and the half of the total force impulse (FI).

Duration of the 2nd half of the FI [s]

Time interval between the half of the total force impulse (FI) and the Take Off.

Time to Fmax [s]

Time interval between the First Contact and the maximal force (Fmax).

Time between the Fmax and the Take Off [s]

Time interval between the maximal force (Fmax) and the Take Off.

Time from Pmax to half of the FI [s]

Time interval between the maximal power (Pmax) and the half of the total force impulse (FI).

FORCE IMPULSE PARAMETERS

Total FI [Ns]

Force impulse (FI) between the First Contact and the Take Off.

Total FI from the Flight Time [Ns]

Force impulse (FI) computed from the Flight Time.

FI in the 1st half of the Contact Time [Ns]

Force impulse (FI) between the First Contact and the half of the Contact Time.

FI in the 2nd half of the Contact Time [Ns]

Force impulse (FI) between the half of the Contact Time and the Take Off.

Ratio between the FI in both halves of the Contact Time [%]

Ratio between the force impulse (FI) between the First Contact and the half of the Contact Time and the force impulse (FI) between the half of the Contact Time and the Take Off.

FI between the First Contact and the Fmax [Ns]

Force impulse (FI) between the First Contact and the maximal force (Fmax).

FI between the Fmax and the Take Off [Ns]

Force impulse (FI) between the maximal force (Fmax) and the Take Off.

Ratio between the FI before and after the Fmax [%]

Ratio between the force impulse (FI) between the First Contact and the maximal force (Fmax) and the force impulse (FI) between the maximal force (Fmax) and the Take Off.

CONTRALATERAL PARAMETERS

NOTE: Beware that this parameters are calculated only when using bilateral force plates.

Left leg - Start interval relative P [W/kg]

Average power in the 1st 50 ms of the Push Off divided by the body weight (50 ms is a default value and can be changed in the Settings Panel - Start Interval).

Left leg - Relative maximal F [%BW]

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

Left leg - Relative maximal P [W/kg]

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

Left leg - Relative E [J/kg]

Energy during the Push Off divided by the body weight.

Left leg - Push Off FI [Ns]

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

Right leg - Start interval relative P [W/kg]

Average power in the 1st 50 ms of the Push Off divided by the body weight (50 ms is a default value and can be changed in the Settings Panel - Start Interval).

Right leg - Relative maximal F [%BW]

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

Right leg - Relative maximal P [W/kg]

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

Right leg - Relative E [J/kg]

Energy during the Push Off divided by the body weight.

Right leg - Push Off FI [Ns]

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

Left/right leg - Start interval relative P [%]

Average power in the 1st 50 ms of the Push Off divided by the body weight (50 ms is a default value and can be changed in the Settings Panel - Start Interval).

Left/right leg - Relative maximal F [%]

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

Left/right leg - Relative maximal P [%]

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

Left/right leg - Relative E [%]

Energy during the Push Off divided by the body weight.

Left/right leg - Push Off FI [%]

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

References

Baca, A. A comparison of methods for analyzing drop jump performance. Med Sci Sports Exerc 31, 437-442 (1999).

Pietraszewski, B. & Rutkowska-Kucharska, A. Relative power of the lower limbs in drop jump. Acta Bioeng Biomech 13, 13-18 (2011).

McLellan, C.P., Lovell, D.I. & Gass, G.C. The role of rate of force development on vertical jump performance. J Strength Cond Res 25, 379-385 (2011).

Vanezis, A. & Lees, A. A biomechanical analysis of good and poor performers of the vertical jump. Ergonomics 48, 1594-1603 (2005).

Walsh, M.S., Ford, K.R., Bangen, K.J., Myer, G.D. & Hewett, T.E. The validation of a portable force plate for measuring force-time data during jumping and landing tasks. J Strength Cond Res 20, 730-734 (2006).

FORWARD LUNGE - TEST

This measurement module is a part of MARS Balance & Stability.

Brief Description

Selecting Input Parameters

Measurement

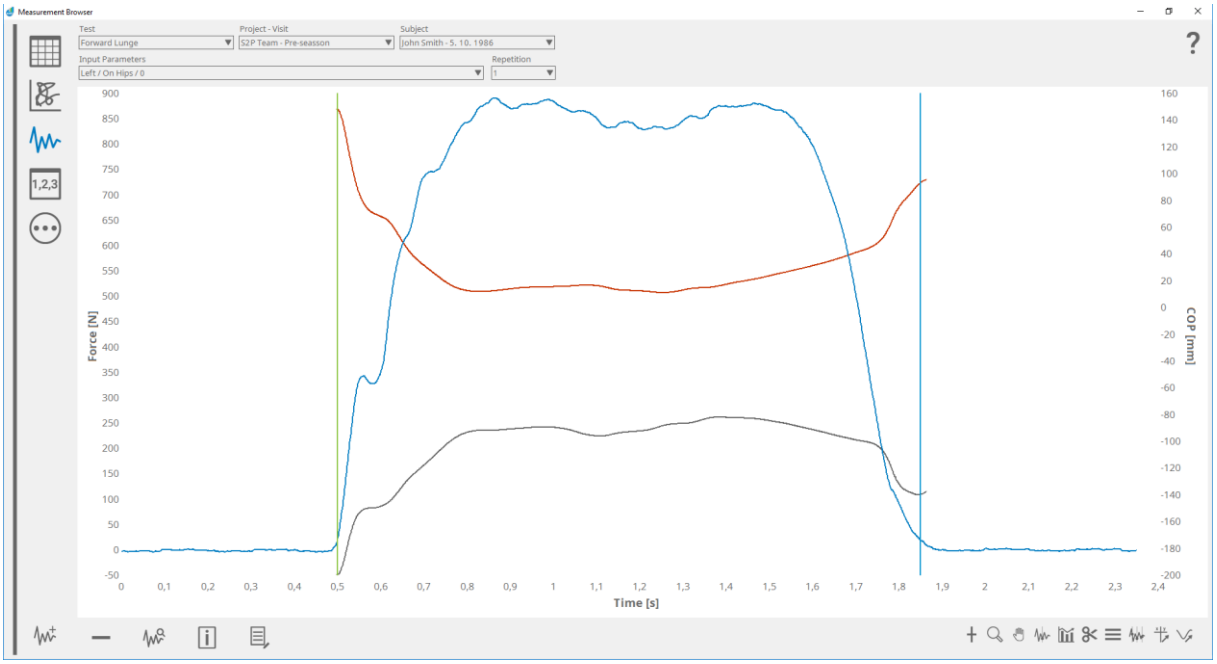
Cursors

Analysis

References

Brief Description

Forward Lunge is a movement task, where the subject lunges/steps forward onto one leg, and then pushes back with that leg to return to a start stance position. The goal is to step as far as possible, however sustaining control over the posture, and to push back as fast as possible.For the optimal performance of the forward lunge it is required to have enough strength, good range of motion, balance and coordination. Based on the ground reaction force the software quantifies distance of the lunge, contact time, impact force, and force impulse.



The initial position of the subject is usually an uprightstance position. From this position a person steps forward into a lunge (front knee ~90° and trunk vertical). From the lowest position the subject than pushes back into the initial position.

Selecting Input Parameters

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

- Side
- Upper Extremities
- Additional Weights [kg]

SIDE

Left leg

The subject performs a step/lunge on a plate with his/her left leg.

Right leg

The subject performs a step/lunge on a plate with his/her right leg.

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.

Across the Chest

The subject places his/her hands across his/her chest.

Behind the Neck

The subject places his/her hands behind his/her neck.

Other user defined

In case of any other position of the upper extremities, the user can define new positions under Settings panel - section Input parameters. After doing so, the newly defined input parameter will from then on appear as an optional choice under the Upper extremities in the Forward Lunge measurement module.

ADDITIONAL WEIGHTS [kg]

0/5/10/15/20/25/30/35/40/45/50/55/60/65/70/75/80/85/90/95/100 kg

Other user defined

In case of different amount of additional weights, the user can define new values under Settings panel - section Input parameters. After doing so, the newly defined input parameter will from then on appear as an optional choice under the Additional Weights in the Forward Lunge measurement module.

Measurement

Before starting a test select input parameters (on the left side of Measure window). Then the subject steps in front of the plate and goes in a required position. When the subject acquires the required position and is ready to start the movement, click Start or press Space. At that time, the subject is free to start the lunge and the software will automatically recognize the beginning and the end of the lunge and will automatically

stop the data acquisition. After the measurement is completed you can chose to Confirm, Reject or Repeat it.

If you want to start a new measurement, click the New Measurement button and repeat the procedure. Before starting a new measurement you can change the Input Parameters; if not, the Input Parameters of the previous measurement will be used.

Cursors

Start
Indicates the start of the lunge.

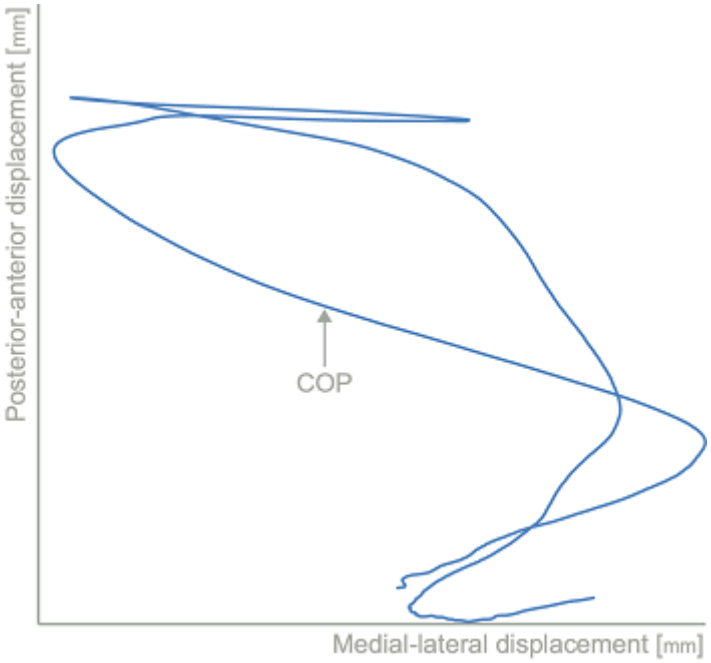
End
Indicates the end of the lunge.

Analysis

Analysis enables you to check the signal of the ground reaction force and the calculated parameters. Under the COP tab you can see the X:Y signal. Individual components of the ground reaction forces and of the COP movement can be visualized under the Signals tab. Under the Repetitions tab you can see all the calculated parameters.

All the parameters calculated for analysis are commonly used in biomechanics, kinesiology and rehabilitation1-4. Parameters are calculated from the ground reaction force. For more information regarding the parameters click on the References.

General Parameters



For some modules additional analysis routines are available as a separate product. For more information see section About MARS or contact us.

GENERAL PARAMETERS

Relative impact F [%BW]

Maximum vertical force exerted by the lunge/step leg onto the surface during the landing, expressed as percentage of body weight.

Contact T [s]

Duration in seconds of surface contact with the lunging leg in the forward direction.

Total FI [%BWs]

Measure of the total work performed by the lunging leg during the landing and thrust phases of the movement. Force impulse is expressed as a percentage of body weight (force) multiplied by the time the force is exerted in seconds.

References

Escamilla, R.F. et al. Cruciate ligament forces between short-step and long-step forward lunge. Medicine & Science in Sports & Exercise 42, 1932-1942 (2010).

Mattacola, C.G., Jacobs, C.A., Rund, M.A. & Johnson, D.L. Functional assessment using the step-up-and-over test and forward lunge following ACL reconstruction. Orthopedics 27, 602-608 (2004).

Yiou, E. & Do, M.C. In a complex sequential movement, what component of the motor program is improved with intensive practice, sequence timing or ensemble motor learning? Exp Brain Res 137, 197-204 (2001).

Escamilla, R.F. et al. Patellofemoral joint force and stress between a short- and long-step forward lunge. J Orthop Sports Phys Ther 38, 681-690 (2008).

FREE MEASUREMENT - TEST

This measurement module is a part of MARS Strength & Power and MARS Balance & Power.

Brief Description

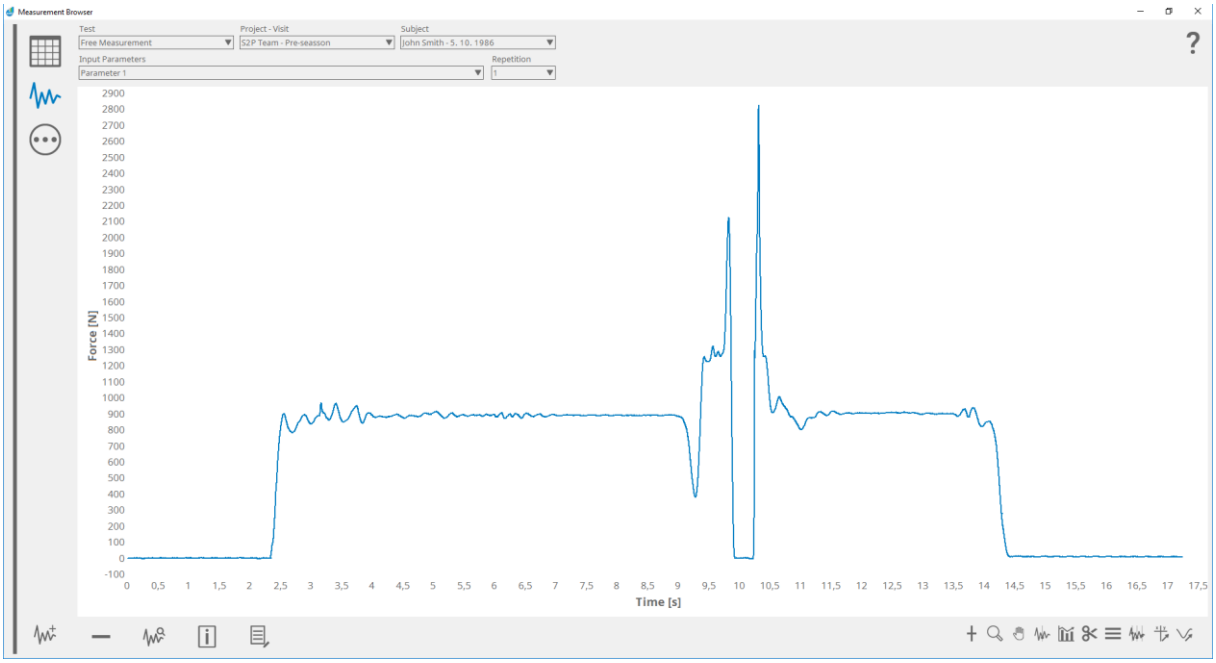
Selecting Input Parameters

Measurement

Analysis

Brief Description

Scientific research often requires very specific analyses which differ among different studies. For that need automatic calculations of the parameters are inappropriate and more detailed analyses are usually necessary. With the Free Measurement module signals are acquired for all three force components (Fy, Fy and Fx) for unlimited time period.



Selecting Input Parameters

Before the measurement can start, the user can choose the input parametere with which the measured motor task is specifically defined. This parameter is important for further analysis, comparisons and reporting.

PARAMETER

Other User defined

The user can define the input parameter under Settings panel - section Input parameters. After doing so, the newly defined input parameter will from then on appear as an optional choice in the Free Measurement module.

Measurement

Before starting a test select input parameters (on the left side of Measure window). After the subject has acquired the required position and is ready to start the movement, click Start or press Space. After this the software begins with the signal acquisition and the acquisition time is displayed in the top-right corner of the screen. To stop data recording click Stop. After the measurement is completed you can chose to Confirm, Reject or Repeat it.

If you want to start a new measurement, click the New Measurement button and repeat the procedure. Before starting a new measurement you can change the Input Parameters; if not, the Input Parameters of the previous measurement will be used.

Analysis

Analysis enables you to check the signal(s) of the ground reaction force under the Signals tab.

For some modules additional analysis routines are available as separate products. For more information see section About MARS or contact us.

JUMPS WITH ADDITIONAL WEIGHTS - TEST

This measurement module is a part of MARS Strength & Power.

Brief Description

Selecting Input Parameters

Measurement

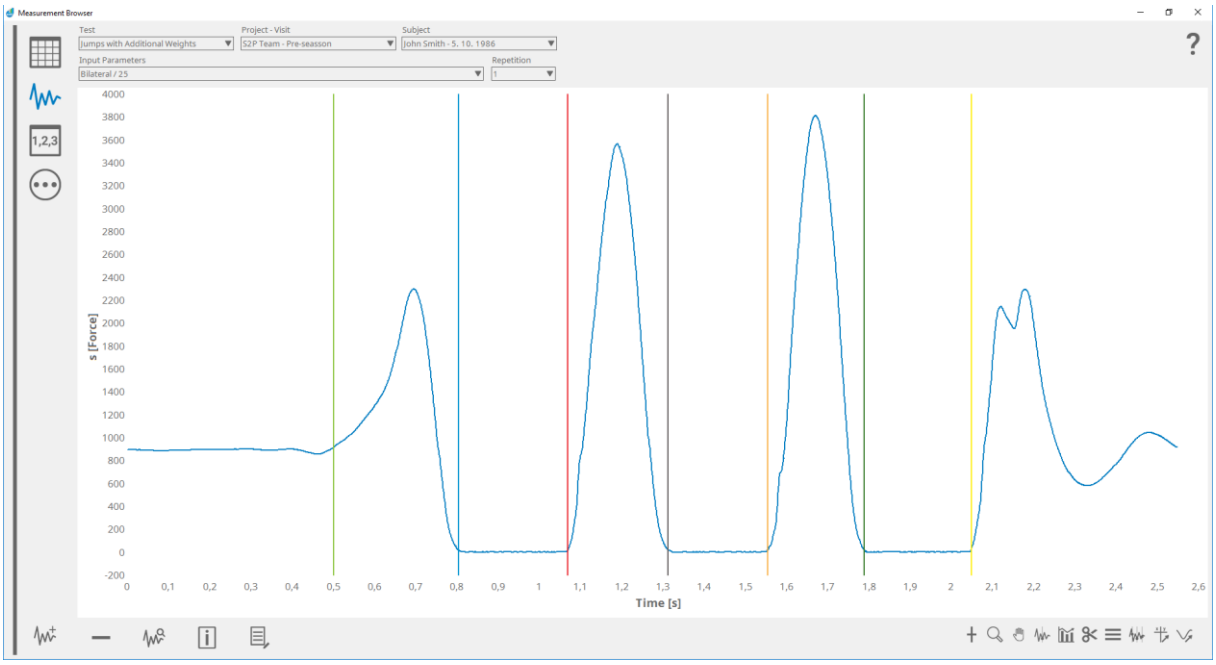
Cursors

Analysis

References

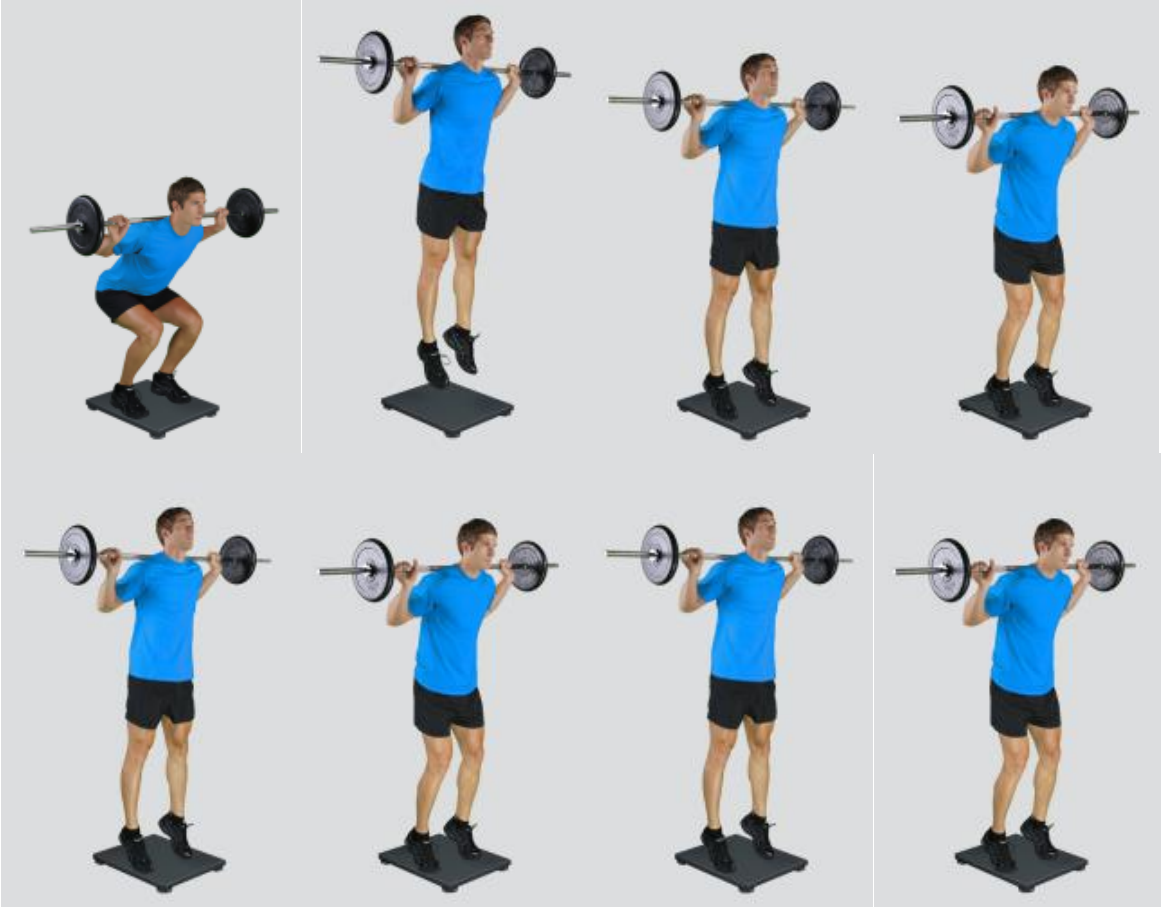
Brief Description

Vertical jumps with additional weights are used in order to study the load:velocity relationship in this multi-segment coordinated movement that involves lower extremities` and trunk`s muscle groups. Many different test protocols can be used and MARS anticipates the test to be performed as a combination of three consecutive vertical jumps (first one squat jump plus two hops). The required movement task is repeated by an athlete thereby using different (i.e. progressive) load during every trial. These kinds of jumps are among the most often used tests for maximal anaerobic power output of the lower extremities. Squat jump represents the concentric and both hops represent an eccentric-concentric muscle action. Based on the parameters derived from the ground reaction force and flight time dynamics of this elementary movement patterns can be thoroughly studied.



The initial position of the subject is usually a semi-squat (knee ~90° and trunk/hips in a flexed position). However, this position can sometimes be adjusted to the specific goals of the measurement. From the starting position the subject performs a vertical push off

action (same as squat jump) and then immediately after landing two consecutive hops. All jumps should be performed as quickly and as explosively as possible with a goal to jump as high as possible.



Selecting Input Parameters

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

- Lower Extremities
- Additional Weights [kg]

LOWER EXTREMITIES:

Bilateral

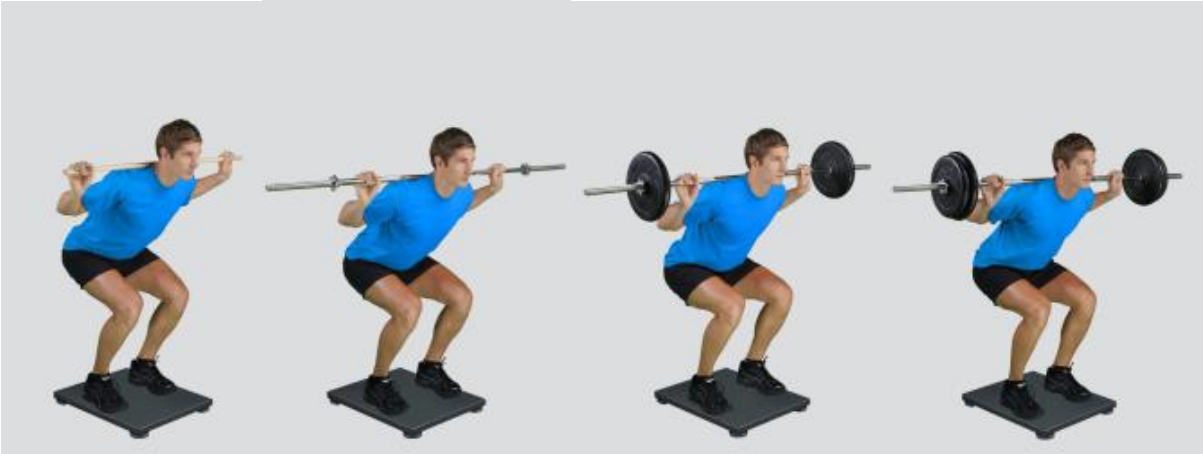
The subject is standing in the centre of the plate with the feet placed parallel or with toes pointing slightly outward. Feet should be shoulder-width apart.

Unilateral-Left / Unilateral-Right

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

ADDITIONAL WEIGHTS [kg]

0/5/10/15/20/25/30/35/40/45/50/55/60/65/70/75/80/85/90/95/100 kg



Other user defined

In case of different amount of additional weights, the user can define new values under Settings panel - section Input parameters. After doing so, the newly defined input

parameter will from then on appear as an optional choice under the Additional Weights in the Jumps with Additional Weights measurement module.

Measurement

Before starting a test select input parameters (on the left side of Measure window). Then the subject acquires the required position (i.e. upright stance). Ensure that the subject is standing in the centre of the plate as described above. After the subject has acquired the required position and is ready to start the movement, click Start or press Space. At that time, the subject is free to start the jump and the software will automatically recognize the beginning and the end of the jump and will automatically stop the data acquisition. For details about this automatic acquisition please see Settings Panel. After the measurement is completed you can chose to Confirm, Reject or Repeat it.

If you want to start a new measurement, click the New Measurement button and repeat the procedure. Before starting a new measurement you can change the Input Parameters; if not, the Input Parameters of the previous measurement will be used.

Cursors

Start-SJ
Indicates the start of the squat jump.

End-SJ
Indicates the take off of the squat jump.

Start-HOP1
Indicates the start of the first hop.

End-HOP1
Indicates the take off of the first hop.

Start-HOP2
Indicates the start of the second hop.

End-HOP2
Indicates the take off of the second hop.

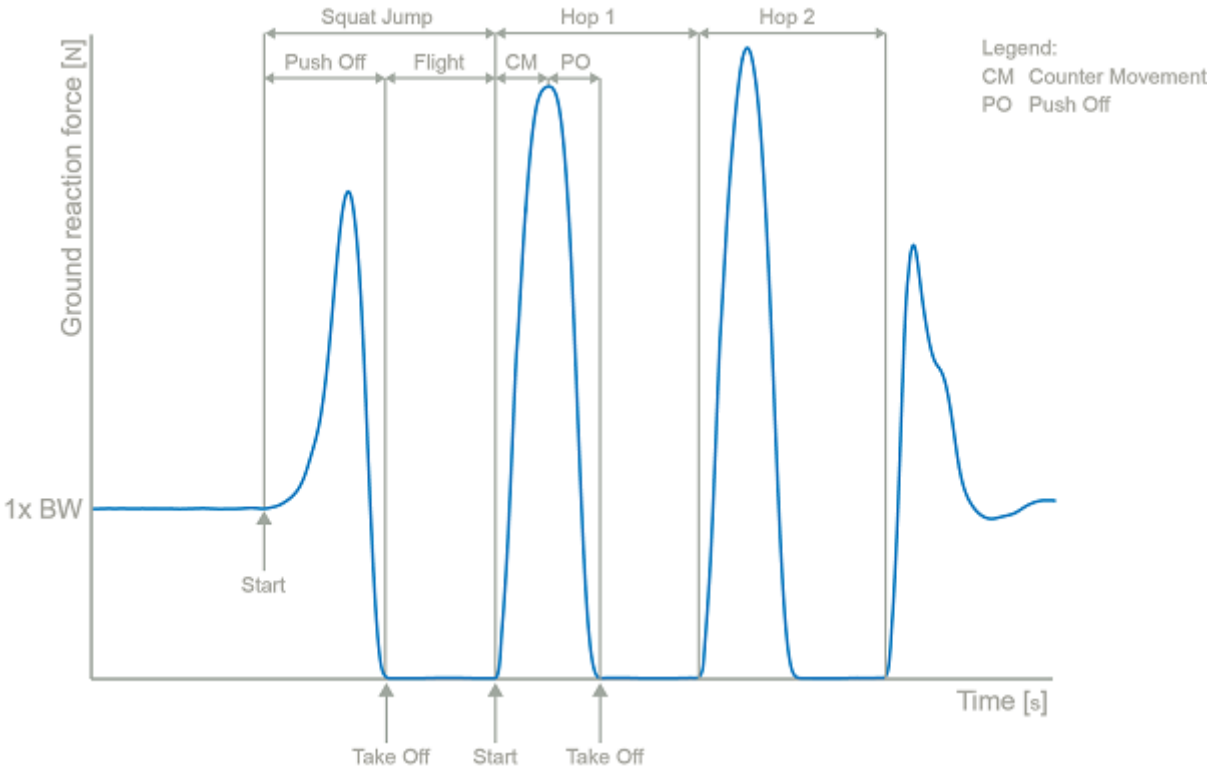
Landing
Indicates the landing of the second hop.

Analysis

Analysis enables you to check the signal(s) of the ground reaction force and the calculated parameters. Under the Signals tab you can see the signal(s) and automatically placed markers. You can move certain markers if they were placed incorrectly. Under the Repetitions tab you can see all the calculated parameters.

All the parameters calculated for analysis are commonly used in biomechanics, kinesiology and rehabilitation1-5. Parameters are calculated from the ground reaction

force and flight time. For more information regarding the parameters see the References.



For some modules additional analysis software routines can be developed as separate products according to the wishes of the customer. For more information see section About MARS or contact us.

CALCULATED PARAMETERS SQUAT JUMP

General Parameters

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.

Start interval relative F [%BW]

Average force in the 1st 50 ms of the Push Off divided by the body weight (50 ms is a default value and can be changed in the Settings Panel - Start Interval).

Start interval relative P [W/kg]

Average power in the 1st 50 ms of the Push Off divided by the body weight (50 ms is a default value and can be changed in the Settings Panel - Start Interval).

Start interval A [m/s^2]

Average acceleration in the 1st 50ms of the Push Off (50 ms is a default value and can be changed in the Settings Panel - Start Interval).

Start Interval V [m/s]

Average velocity in the 1st 50ms of the Push Off (50 ms is a default value and can be changed in the Settings Panel - Start Interval).

Relative maximal F [%BW]

Maximal force during the jump (i.e. Push Off) divided by the body weight.

Relative maximal Fin the 1st half of Push Off [%BW]

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

Relative maximal Fin the 2nd 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 Push Off divided by the body weight.

Relative E [J/kg]

Energy during the Push Off divided by the body weight.

A [m/s^2]

Average acceleration during the jump.

A in the 1st half of Push Off [m/s^2]

Average acceleration between the Start and the half of the Push Off.

A in the 2nd half of Push Off [m/s^2]

Average acceleration between the half of the Push Off and the Take Off.

Vertical Take Off V [m/s]

Velocity of the vertical movement at the Take Off calculated from Flight T.

Time Parameters

Push Off T [s]

Time interval between the Start and the Take Off.

Flight T [s]

Time interval between the Take Off and the Start of the first hop that follows.

T of the 1st half of FI [s]

Time interval between the Start and the half of the total force impulse.

T of the 2nd half of FI [s]

Time interval between the half of the total force impulse and the Take Off.

T to maximal F [s]

Time interval between the Start and the maximal force.

T from maximal F to 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.

Total FI from Flight T [Ns]

Total force impulse calculated from the Flight Time.

FI in the 1st half of Push Off [Ns]

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

FI in the 2nd half of Push Off [Ns]

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

Ratio between FI in both halves of Push Off [%]

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

FI between Start 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 of 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.

Contralateral Parameters

NOTE: Beware that this parameters are calculated only when using bilateral force plates.

Left leg - Start interval relative P [W/kg]

Average power in the 1st 50 ms of the Push Off divided by the body weight (50 ms is a default value and can be changed in the Settings Panel - Start Interval).

Left leg - Relative maximal F [%BW]

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

Left leg - Relative maximal P [W/kg]

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

Left leg - Relative E [J/kg]

Energy during the Push Off divided by the body weight.

Left leg - Push Off FI [Ns]

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

Right leg - Start interval relative P [W/kg]

Average power in the 1st 50 ms of the Push Off divided by the body weight (50 ms is a default value and can be changed in the Settings Panel - Start Interval).

Right leg - Relative maximal F [%BW]

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

Right leg - Relative maximal P [W/kg]

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

Right leg - Relative E [J/kg]

Energy during the Push Off divided by the body weight.

Right leg - Push Off FI [Ns]

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

Left/right leg - Start interval relative P [%]

Average power in the 1st 50 ms of the Push Off divided by the body weight (50 ms is a default value and can be changed in the Settings Panel - Start Interval).

Left/right leg - Relative maximal F [%]

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

Left/right leg - Relative maximal P [%]

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

Left/right leg - Relative E [%]

Energy during the Push Off divided by the body weight.

Left/right leg - Push Off FI [%]

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

CALCULATED PARAMETERS HOP

General Parameters

NOTE: The Hop related parameters are calculated from the higher of the two hops being performed.

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 jump computed 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 1st 50ms of the Push Off divided by body weight (50 ms is a default value and can be changed in the Settings Panel - Start Interval).

Start interval relative P [W/kg]

Average power in the 1st 50ms of the Push Off divided by the body weight (50 ms is a default value and can be changed in the Settings Panel - Start Interval).

Start interval A [m/s^2]

Average acceleration in the 1st 50ms of the Push Off (50 ms is a default value and can be changed in the Settings Panel - Start Interval).

Start interval V [m/s]

Average velocity in the 1st 50 ms of the Push Off (50 ms is a default value and can be changed in the Settings Panel - Start Interval).

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 1st 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 2nd 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^2]

Average acceleration during counter Movement phase.

Push Off A [m/s^2]

Average acceleration during Push Off.

Vertical Take Off V [m/s]

Velocity of the vertical movement at the Take Off calculated from Flight T.

Hop / Squat Jump height ratio [%]

Ratio between the Hop height and the Squat Jump height – for the same repetition, i.e. additional weight condition.

Time Parameters

Contact T [s]

Time interval between the Start 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 form the Start to the Push Off.

Push Off T [s]

Duration of the Push Off phase, from Counter Movement end to Take Off.

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 begin 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 Take Off.

Ratio between Counter Movement and Push Off FI [%]

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

FI between Start 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.

Contralateral Parameters

NOTE: Beware that this parameters are calculated only when using bilateral force plates.

Left leg - Start interval relative P [W/kg]

Average power in the 1st 50 ms of the Push Off divided by the body weight (50 ms is a default value and can be changed in the Settings Panel - Start Interval).

Left leg - Relative maximal F [%BW]

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

Left leg - Relative maximal P [W/kg]

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

Left leg - Relative E [J/kg]

Energy during the Push Off divided by the body weight.

Left leg - Push Off FI [Ns]

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

Right leg - Start interval relative P [W/kg]

Average power in the 1st 50 ms of the Push Off divided by the body weight (50 ms is a default value and can be changed in the Settings Panel - Start Interval).

Right leg - Relative maximal F [%BW]

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

Right leg - Relative maximal P [W/kg]

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

Right leg - Relative E [J/kg]

Energy during the Push Off divided by the body weight.

Right leg - Push Off FI [Ns]

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

Left/right leg - Start interval relative P [%]

Average power in the 1st 50 ms of the Push Off divided by the body weight (50 ms is a default value and can be changed in the Settings Panel - Start Interval).

Left/right leg - Relative maximal F [%]

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

Left/right leg - Relative maximal P [%]

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

Left/right leg - Relative E [%]

Energy during the Push Off divided by the body weight.

Left/right leg - Push Off FI [%]

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

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LANDING - TEST

This measurement module is a part of MARS Balance & Stability.

Brief Description

Selecting Input Parameters

Measurement

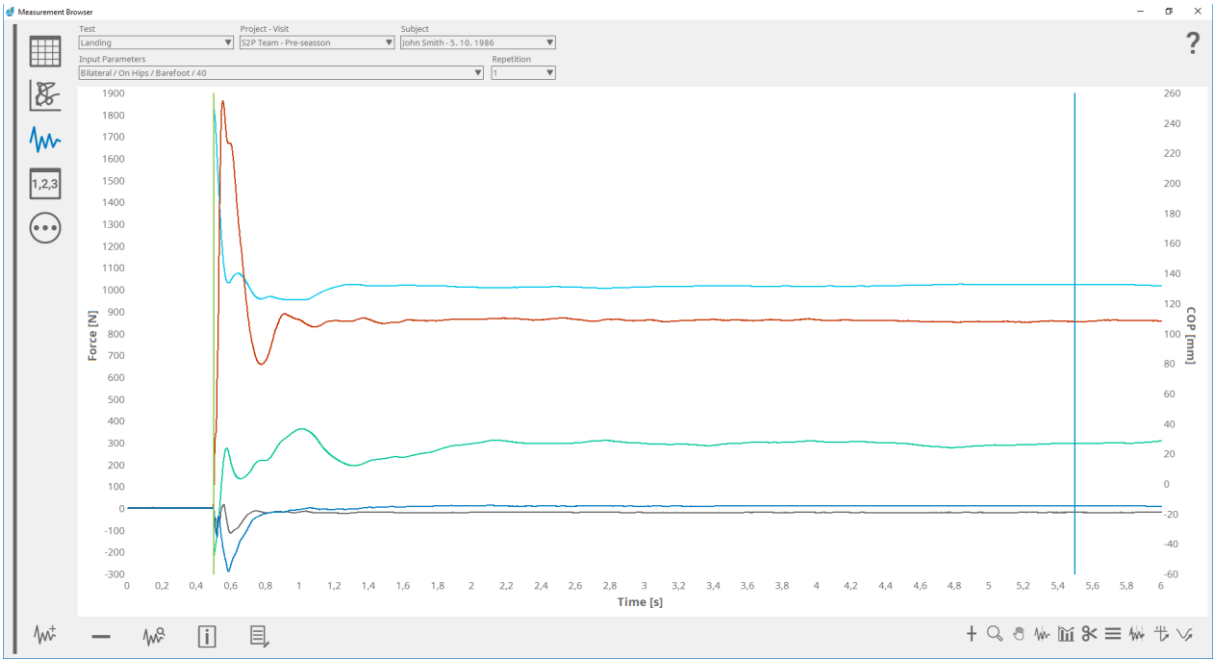
Cursors

Analysis

References

Brief Description

Good dynamic postural stability is important to sport performance as well as to prevention from mechanical overloading. Closed kinetic chain movements, particularly in single-leg support, require complex interplay between stability and mobility of the multi-segmental system (joints of lower extremities, pelvic girdle and trunk). This inter-joint impact has often been studied using kinematics and/or dynamics of landing; transition from flight phase to stable leg support. Ground reaction force measurements offer an insight into the three-planes in which the stability has to be controlled. Through quantitative parameters of centre-of-pressure, single-plane forces and derived stability indexes, we gain valuable information on landing. This functional (sport specific) movement has been more and more used in applied research and sports medicine (Wilkstrom et al., 2005; Colby et al., 1999) as an upgrade from the standard balance tests such as quiet stance, limits-of-stability, star excursion, etc.



The initial position of the subject is usually in a standing position on the bench (or other surface lifted from the ground) of different heights. The height of the starting point can

be adjusted to the specific goals of the measurement. From the starting position the subject performs a landing on the force plate.

Selecting Input Parameters

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

- Lower Extremities
- Upper Extremities
- Footwear
- Drop Height [cm]

LOWER EXTREMITIES

Bilateral

The subject is standing on the bench with the feet placed parallel or with toes pointing slightly outward. Feet should be shoulder-width apart. The subject needs to land and perform a push off with the same feet position.

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.

Across the Chest

The subject places his/her hands across his/her chest.

Behind the Neck

The subject places his/her hands behind his/her neck.

Other user defined

In case of any other position of the upper extremities, the user can define new positions under Settings panel - section Input parameters. After doing so, the newly defined input

parameter will from then on appear as an optional choice under the Upper extremities in the Landing measurement module.

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 case of any other type of footwear, the user can define it under Settings panel - section Input parameters. After doing so, the newly defined input parameter will from then on appear as an optional choice under the Footwear in the Landing measurement module.

DROP HEIGHT [cm]

10 cm: select this if the starting point is 10 cm higher than the force plate

20 cm: select this if the starting point is 20 cm higher than the force plate

30 cm: select this if the starting point is 30 cm higher than the force plate

40 cm: select this if the starting point is 40 cm higher than the force plate

50 cm: select this if the starting point is 50 cm higher than the force plate

60 cm: select this if the starting point is 60 cm higher than the force plate

70 cm: select this if the starting point is 70 cm higher than the force plate

80 cm: select this if the starting point is 80 cm higher than the force plate

90 cm: select this if the starting point is 90 cm higher than the force plate

100 cm: select this if the starting point is 100 cm higher than the force plate

Other user defined

In case of any other starting point height, the user can define new height under Settings panel - section Input parameters. After doing so, the newly defined input parameter will from then on appear as an optional choice under the Starting point height in the Landing measurement module.

Measurement

Before starting a test select input parameters (on the left side of Measure window). Then the subject steps on a bench next to the force plate and acquires in a required position (i.e. upright stance). After the subject has acquired the required position and is ready to start the movement, click Start or press Space. At that time, the subject is free to start the jump and the software will automatically recognize the beginning and the end of the jump and will automatically stop the data acquisition. For details about this automatic acquisition please see Settings Panel. After the measurement is completed you can chose to Confirm, Reject or Repeat it.

If you want to start a new measurement, click the New Measurement button and repeat the procedure. Before starting a new measurement you can change the Input Parameters; if not, the Input Parameters of the previous measurement will be used.

Cursors

Start
Indicates the start of the landing i.e. first contact with the force plate.

End
Indicates the end of the landing i.e. end of the stabilization phase.

Analysis

Analysis enables you to check the signal of the ground reaction force and the calculated parameters. Under the COP tab you can see the X:Y signal. Individual components of the ground reaction forces and of the COP movement can be visualized under the Signals tab. Under the Repetitions tab you can see all the calculated parameters.

All the parameters calculated for analysis are commonly used in biomechanics, kinesiology and rehabilitation1,2. Parameters are calculated from the ground reaction force. For more information regarding the parameters see the References.

For some modules additional analysis routines are available as a separate product. For more information see section About MARS or contact us.

GENERAL PARAMETERS

Sway Maximal Amplitude – A-P [mm]

The amplitude between the two most distant samples of the COP sway in anterior-posterior direction.

Sway Maximal Amplitude – M-L [mm]

The amplitude between the two most distant samples of the COP sway in medial-lateral (i.e. left-right) direction.

Sway Velocity – Total [mm/s]

The common length of the trajectory of the COP sway, calculated as a sum of the point-to-point Euclidian distances, divided by the measurement time. Sway Velocity is calculated on the 0.5 s long interval after the reference interval. Reference interval starts 0.03 s after the initial contact with the force plate. Analysis duration and Reference interval can be changed in the Setting panel.

Sway Velocity – A-P[mm/s]

The common length of the trajectory of the COP sway, calculated as a sum of the point-to-point Euclidian distances only in the anterior-posterior direction, divided by the measurement time. Sway Velocity is calculated on the 0.5 s long interval after the reference interval. Reference interval starts 0.03 s after the initial contact with the force plate. Analysis duration and Reference interval can be changed in the Setting panel.

Sway Velocity – M-L [mm/s]

The common length of the trajectory of the COP sway, calculated as a sum of the point-to-point Euclidian distances only in the medial-lateral direction, divided by the measurement time. Sway Velocity is calculated on the 0.5 s long interval after the reference interval. Reference interval starts 0.03 s after the initial contact with the force plate. Analysis duration and Reference interval can be changed in the Setting panel.

Fmax [N]

Maximal force on the 1 s long interval starts from reference interval. Reference interval starts 0.03 s after the initial contact with the force plate. Reference interval can be changed in the Setting panel.

TIME PARAMETERS

Stabilization T from Vertical F [s]

Time to stabilization calculated from Vertical force. Time interval starts at initial contact with the force plate and ends when the force becomes steady after the landing. End of the interval can be managed with Settings parameters “Criteria Time Interval – Force [s]” and “Force Stabilization Criteria [%BW]” under Settings Panel.

Stabilization T from COP [s]

Time to stabilization calculated from COP. Time interval starts at initial contact with the force plate and ends when the COP becomes steady after the landing. End of the interval can be managed with Settings parameters “Criteria Time Interval – COP [s]” and “COP Stabilization Criteria [mm]” under Settings Panel.

Stabilization T from COP-AP SD [s

Time to stabilization calculated from COP-AP SD. The time interval starts 0.03 s after the initial contact with the force plate and ends when the sequential average of the COP-AP remained within one-quarter standard deviation of the overall. Overall data consists from first 3 s after initial contact with the force plate. If measurement, after initial contact with the force plate, is less than 3 s, parameter won’t be calculated.

Stabilization T from COP-ML SD [s]

Time to stabilization calculated from COP-ML SD. Time interval starts at initial contact with the force plate and ends when the sequential average of the COP-ML remained within one-quarter standard deviation of the overall. Overall data consists from first 3 s after initial contact with the force plate. If measurement, after initial contact with the force plate, is less than 3 s, parameter won’t be calculated.

STABILITY INDICES

Stability Indices (MLSI, APSI and VSI) are calculated as square root of the mean squared deviation of force from the baseline value and divided by the body weight.

MLSI = (√ [Σ (0 – FX)2 / number of data points]) / BW

APSI = (√ [Σ (0 – FY)2 / number of data points]) / BW

MLSI = (√ [Σ (body weight – FZ)2 / number of data points]) / BW

Total Dynamic Stability Index (DSI) is calculated as the composite of the individual stability components, given by:

DPSI = √ (MLSI2 + APSI2 + VSI2)

APSI_F [a.u.]

Stability Index in the anterior-posterior direction calculated for interval between the initial contact with the force plate and the stabilization point. Stabilization point is defined as point where body weight is stabilized in interval BW ± Criteria. The default value for Criteria is 5 %, but it can be changed in the Settings Panel – Criteria.

MLSI_F [a.u.]

Stability Index in the medial-lateral direction calculated for interval between the initial contact with the force plate and the stabilization point. Stabilization point is defined as point where body weight is stabilized in interval BW ± Criteria. The default value for Criteria is 5 %, but it can be changed in the Settings Panel – Criteria.

VSI_F [a.u.]

Vertical Stability Index calculated for interval between the initial contact with the force plate and the stabilization point. Stabilization point is defined as point where body weight is stabilized in interval BW ± Criteria. The default value for Criteria is 5 %, but it can be changed in the Settings Panel – Criteria.

DPSI_F [a.u.]

Dynamic Postural Stability Index calculated for interval between the initial contact with the force plate and the stabilization point. Stabilization point is defined as point where body weight is stabilized in interval BW ± Criteria. The default value for Criteria is 5 %, but it can be changed in the Settings Panel – Criteria.

APSI_COP [a.u.]

Stability Index in the anterior-posterior direction calculated for interval between the initial contact with the force plate and the stabilization point. Stabilization point is defined as point where COP Amplitude is stabilized in interval which is defined with parameter Criteria. The default value for Criteria is 0.005 m, but it can be changed in the Settings Panel – Criteria.

MLSI_COP [a.u.]

Stability Index in the medial-lateral direction calculated for interval between the initial contact with the force plate and the stabilization point. Stabilization point is defined as point where COP Amplitude is stabilized in interval which is defined with parameter Criteria. The default value for Criteria is 0.005 m, but it can be changed in the Settings Panel – Criteria.

VSI_COP [a.u.]

Vertical Stability Index calculated for interval between the initial contact with the force plate and the stabilization point. Stabilization point is defined as point where COP Amplitude is stabilized in interval which is defined with parameter Criteria. The default value for Criteria is 0.005 m, but it can be changed in the Settings Panel – Criteria.

DPSI_COP [a.u.]

Dynamic Postural Stability Index calculated for interval between the initial contact with the force plate and the stabilization point. Stabilization point is defined as point where COP Amplitude is stabilized in interval which is defined with parameter Criteria. The default value for Criteria is 0.005 m, but it can be changed in the Settings Panel – Criteria.

APSI_COP-AP SD [a.u.]

Stability Index in the anterior-posterior direction calculated for interval between the initial contact with the force plate and the stabilization point. Stabilization point is defined as point where sequential average of the COP-AP remained within one-quarter standard deviation.

MLSI_COP-AP SD [a.u.]

Stability Index in the medial-lateral direction calculated for interval between the initial contact with the force plate and the stabilization point. Stabilization point is defined as point where sequential average of the COP-AP remained within one-quarter standard deviation.

VSI_COP-AP SD [a.u.]

Vertical Stability Index calculated for interval between the initial contact with the force plate and the stabilization point. Stabilization point is defined as point where sequential average of the COP-AP remained within one-quarter standard deviation.

DPSI_COP-AP SD [a.u.]

Dynamic Postural Stability Index calculated for interval between the initial contact with the force plate and the stabilization point. Stabilization point is defined as point where sequential average of the COP-AP remained within one-quarter standard deviation.

APSI_COP-ML SD [a.u.]

Stability Index in the anterior-posterior direction calculated for interval between the initial contact with the force plate and the stabilization point. Stabilization point is defined as point where sequential average of the COP-ML remained within one-quarter standard deviation.

MLSI_COP-ML SD [a.u.]

Stability Index in the medial-lateral direction calculated for interval between the initial contact with the force plate and the stabilization point. Stabilization point is defined as point where sequential average of the COP-ML remained within one-quarter standard deviation.

VSI_COP-ML SD [a.u.]

Vertical Stability Index calculated for interval between the initial contact with the force plate and the stabilization point. Stabilization point is defined as point where sequential average of the COP-ML remained within one-quarter standard deviation.

DPSI_COP-ML SD [a.u.]

Dynamic Postural Stability Index calculated for interval between the initial contact with the force plate and the stabilization point. Stabilization point is defined as point where sequential average of the COP-ML remained within one-quarter standard deviation.

APSI_3 [a.u.]

Stability Index in the anterior-posterior direction calculated for interval between the initial contact with the force plate and 3 s after the initial contact with the force plate.

MLSI_3 [a.u.]

Stability Index in the medial-lateral direction calculated for interval between the initial contact with the force plate and 3 s after the initial contact with the force plate.

VSI_3 [a.u.]

Vertical Stability Index calculated for interval between the initial contact with the force plate and 3 s after the initial contact with the force plate.

DPSI_3 [a.u.]

Dynamic Postural Stability Index calculated for interval between the initial contact with the force plate and 3 s after the initial contact with the force plate.

APSI_5 [a.u.]

Stability Index in the anterior-posterior direction calculated for interval between the initial contact with the force plate and 5 s after the initial contact with the force plate.

MLSI_5 [a.u.]

Stability Index in the medial-lateral direction calculated for interval between the initial contact with the force plate and 5 s after the initial contact with the force plate.

VSI_5 [a.u.]

Vertical Stability Index calculated for interval between the initial contact with the force plate and 5 s after the initial contact with the force plate.

DPSI_5 [a.u.]

Dynamic Postural Stability Index calculated for interval between the initial contact with the force plate and 5 s after the initial contact with the force plate.

APSI_10 [a.u.]

Stability Index in the anterior-posterior direction calculated for interval between the initial contact with the force plate and 10 s after the initial contact with the force plate.

MLSI_10 [a.u.]

Stability Index in the medial-lateral direction calculated for interval between the initial contact with the force plate and 10 s after the initial contact with the force plate.

VSI_10 [a.u.]

Vertical Stability Index calculated for interval between the initial contact with the force plate and 10 s after the initial contact with the force plate.

DPSI_10 [a.u.]

Dynamic Postural Stability Index calculated for interval between the initial contact with the force plate and 10 s after the initial contact with the force plate.

References

Erik A.W., Mark D.T., Andrew N.S., Paul A.B. A new force-plate technology measure of dynamic postural stability: The Dynamic Postural Stability Index. J Athl Training, 40, 305–309 (2005)

Scott M. C., Robert A.H., Michael R. T., Richard S. Lower limb stability with ACL impairment. J Orthop Sport Phys 29, 444-454 (1999).

LIMITS OF STABILITY - TEST

This measurement module is a part of MARS Balance & Stability.

Brief Description

Selecting Input Parameters

Measurement

Analysis

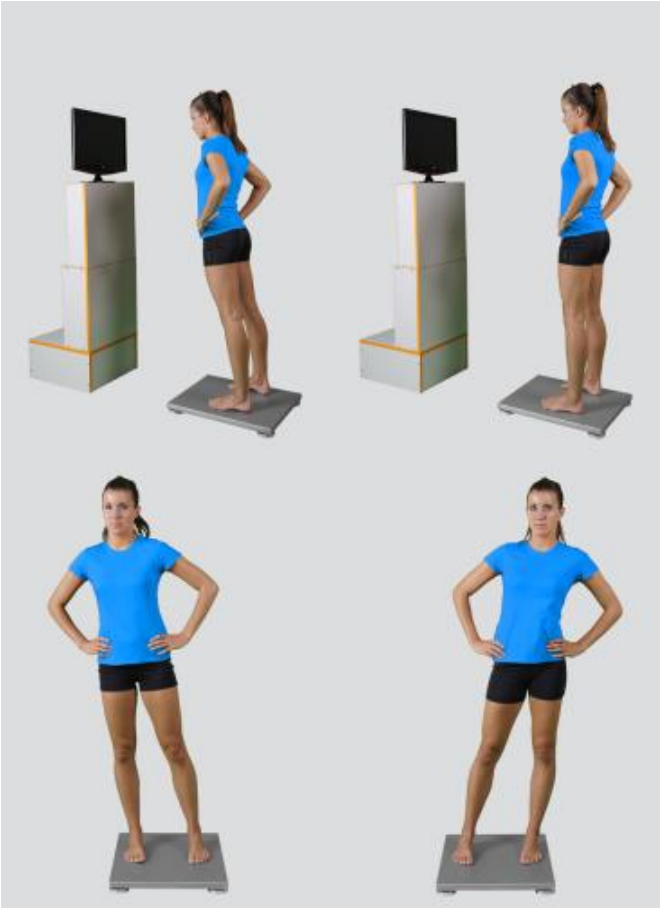
References

Brief Description

Different from the quiet stance, every day functional situations often require more demanding dynamic balance situations and corresponding balance control. A typical example are those motor tasks in which a subject has to voluntarily shift the body`s centre-of-gravity above the support area. Such leaning of the body in different directions will result in an evident centre-of-pressure (COP) displacement. Maximal range of voluntary body leaning in different directions can be assessed by measuring the COP displacements. Stability limits can be defined as the extent to which an individual is willing to lean his/her body in a certain direction. One commonly used clinical measure of stability limits is the functional reach test. However, it has been shown that the results of this test and those of the maximal COP displacement test do not correlate as expected. We can say that the COP based limits of stability is proposed as the current golden standard for the evaluation of this specific type of voluntary dynamic balance control.

Evaluation of limits of stability gives us the information about the volitional balance control of the centre-of-gravity and can be quantitatively evaluated using force plate measurements. We can ask a subject to perform voluntary body leaning task in

different directions thereby initiating the movement as quickly as possible following the visual start signal. Such a measurement set-up will enable us to identify direction specific weak points of the subject`s balance and to gather additional information about the other functionally specific abilities regarding balance. The latter encompass situational reaction times in the context of standing posture, start velocity of the voluntary COP shift, etc.



Selecting Input Parameters

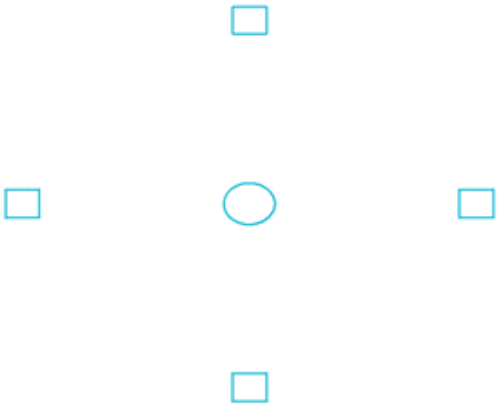
Before the measurement can start, the user has to choose some input parameters with which the measured motor task (i.e. quiet stance task) is specifically defined. These parameters are important for further analysis, comparisons and reporting. The characteristics of the voluntary body leaning task are defined by the following parameters:

- Number of Directions
- Upper Extremities
- Stance Position
- Footwear

NUMBER OF DIRECTIONS

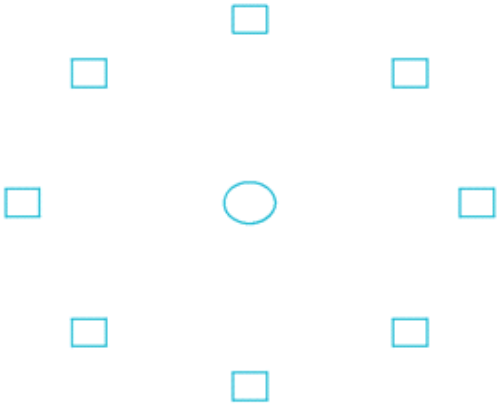
4D

Four Directions - forward, backward, right, left.



8D

Eight Directions - forward, backward, right, left, forward-right, backward-left, backward-right, forward-left.



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. In case of the easy quiet stance tasks the hands will normally remain passively hanging. However, in more demanding tasks the free use of the hands can be of great help.

Across the Chest

The subject places his/her hands across his/her chest.

Behind the Neck

The subject places his/her hands behind his/her neck.

Other user defined

In case of any other position of the upper extremities, the user can define new positions under Settings panel - section Input parameters. After doing so, the newly defined input parameter will from then on appear as an optional choice under the Upper Extremities in the Limits Of Stability measurement module.

STANCE POSITION

Parallel Stance

The subject is standing in the centre of the force plate with the feet placed parallel at the shoulder width. The feet are oriented in anterior-posterior direction (along the Y-axis of the force plate) with the toes pointing anteriorly (+Y). Throughout the measurement the subject sustains his/her normal upright stance position.

Semi-Tandem Stance

The subject is standing in the centre of the force plate with the feet placed close together and shifted longitudinally against each other for one half of the length of the foot (i.e. semi-tandem foot position). The feet are oriented in anterior-posterior direction (along the Y-axis of the force plate) with the toes pointing anteriorly (+Y). Throughout the measurement the subject sustains his/her normal upright stance position. Semi-tandem stance with the dominant leg in front is predominantly used; the opposite foot position is sometimes also referred as “contra semi-tandem”.

Tandem Stance

The subject is standing in the centre of the force plate with the feet placed in-line one behind the other (i.e. heel-to-toe or tandem feet position). The feet are oriented in anterior-posterior direction (along the Y-axis of the force plate) with the toes pointing anteriorly (+Y). Throughout the measurement the subject sustains his/her normal upright stance position. Tandem stance with the dominant leg in front is predominantly used; the opposite foot position is sometimes also referred as “contra tandem”.

Single Leg Stance – Left / Single Leg Stance - Right

The subject is standing on one leg in the centre of the force plate. The foot is oriented in anterior-posterior direction (along the Y-axis of the force plate) with the toes pointing anteriorly (+Y). Throughout the measurement the subject sustains his/her normal upright stance position.

Other user defined

In case of any other type of stance, the user can define it under Settings panel - section Input parameters. After doing so, the newly defined input parameter will from then on appear as an optional choice under the Stance Position in the Limits of Stability measurement module.

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 case of any other type of footwear, the user can define it under Settings panel - section Input parameters. After doing so, the newly defined input parameter will from then on appear as an optional choice under the Footwear in the Limits Of Stability measurement module.

Measurement

After selecting the input parameters, the subject steps on the force plate and gets into the required position in a way that the orientation of the body is consistent with that of the plate (i.e. +Y direction of the plate is the anterior direction). After you are satisfied with the quiet stance of the subject, click Start. While the COP offset is performed, the subject must not move. After this the software begins with the signal acquisition and the time left until the end of the test is displayed in the top-right corner of the screen. Data recording will stop automatically after the the test is finished.

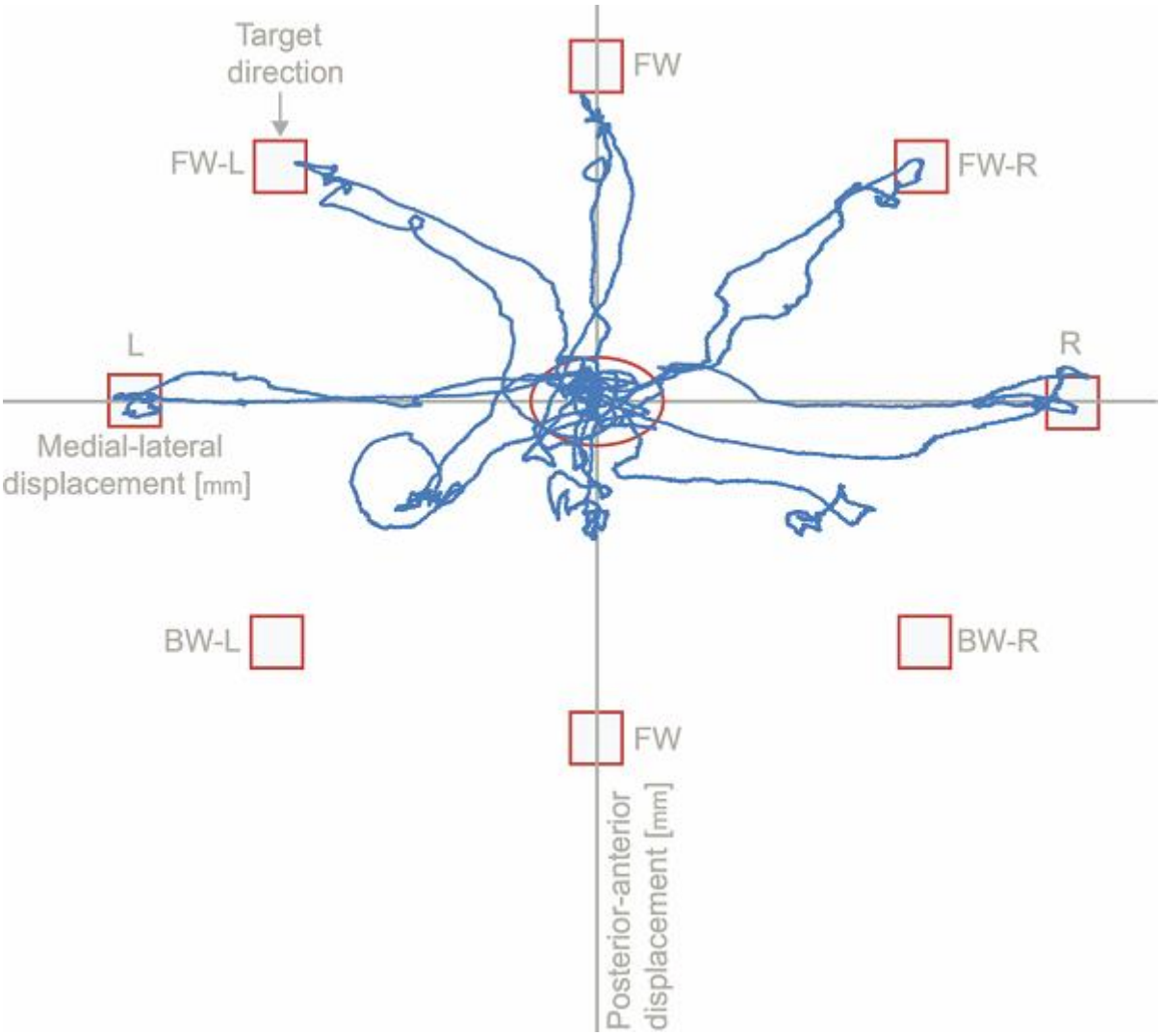
Before starting a test select input parameters (on the left side of Measure window). Then the subject steps on the force plate and gets into the required position in a way that the orientation of the body is consistent with that of the plate (i.e. +Y direction of the plate is the anterior direction). After you are satisfied with the quiet stance of the subject, click Start or press Space. While the COP offset is performed, the subject must not move. After this the software begins with the signal acquisition and the time left until the end of the test is displayed in the top-right corner of the screen. Data recording will stop automatically after the test is finished. After the measurement is completed you can chose to Confirm, Reject or Repeat it.

If you want to start a new measurement, click the New Measurement button and repeat the procedure. Before starting a new measurement you can change the Input Parameters; if not, the Input Parameters of the previous measurement will be used.

Analysis

Analysis enables you to check the signal of the ground reaction force and the calculated parameters. Under the COP tab you can see the X:Y signal. Individual components of the ground reaction forces and of the COP movement can be visualized under the Signals tab. Under the Repetitions tab you can see all the calculated parameters.

For more information regarding the parameters see the References.



For some modules additional analysis routines are available as separate products. For more information see section About MARS or contact us.

GENERAL PARAMETERS

NOTE: All parameters are calculated in the following directions:

- Forward
- Backward
- Right
- Left
- Forward – Right
- Backward – Left
- Forward – Left

- Backward - Right

Reaction T [s]

Is the time in seconds between the command to move and the patient's first movement.

Movement V [mm/s]

Is the average velocity of the COP movement in millimeters per second.

Maximum Excursion [mm]

Is the maximum distance achieved during the trial.

Direction Control [°]

Is a comparison of the amount of movement in the intended direction (towards the target) to the amount of movement in the non-intended direction (away from the target).

Maximal body lean [°]

It is a maximal incline of the body in relation to the starting position expressed in degrees.

References

Baratto, L., Morasso, P. G., Re, C., & Spada, G. (2002). A new look at posturographic analysis in the clinical context: sway-density versus other parameterization techniques. Motor Control, 6(3), 246-270.

Belaire-Franch, J., Contreras, D., & Tordera-Lledo, L. (2002). Assessing nonlinear structures in real exchange rates using recurrence plot strategies. Physica D: Nonlinear Phenomena, 171(4), 249-264.

Borg, F. G., & Laxaback, G. (2010). Entropy of balance–some recent results. Journal of Neuroengineering and Rehabilitation, 7, 38.

Collins, J. J., & De Luca, C. J. (1993). Open-loop and closed-loop control of posture: a random-walk analysis of center-of-pressure trajectories. Experimental Brain Research. Experimentelle Hirnforschung. Expérimentation Cérébrale, 95(2), 308-318.

Collins, J. J., & De Luca, C. J. (1995). The effects of visual input on open-loop and closed-loop postural control mechanisms. Experimental Brain Research. Experimentelle Hirnforschung. Expérimentation Cérébrale, 103(1), 151-163.

Collins, J. J., De Luca, C. J., Burrows, A., & Lipsitz, L. A. (1995). Age-related changes in open-loop and closed-loop postural control mechanisms. Experimental Brain Research. Experimentelle Hirnforschung. Expérimentation Cérébrale, 104(3), 480-492.

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Morasso, P. G., & Schieppati, M. (1999). Can muscle stiffness alone stabilize upright standing? Journal of neurophysiology, 82(3), 1622.

Richman, J. S., & Moorman, J. R. (2000). Physiological time-series analysis using approximate entropy and sample entropy. American Journal of Physiology. Heart and Circulatory Physiology, 278(6), H2039-2049.

Riley, M. A., Balasubramaniam, R., & Turvey, M. T. (1999). Recurrence quantification analysis of postural fluctuations. Gait & Posture, 9(1), 65-78.

Webber, C. L., & Zbilut, J. P. (1994). Dynamical assessment of physiological systems and states using recurrence plot strategies. Journal of Applied Physiology (Bethesda, Md.: 1985), 76(2), 965-973.

LONG JUMP - TEST

This measurement module is a part of MARS Strength & Power.

Brief Description

Selecting Input Parameters

Measurement

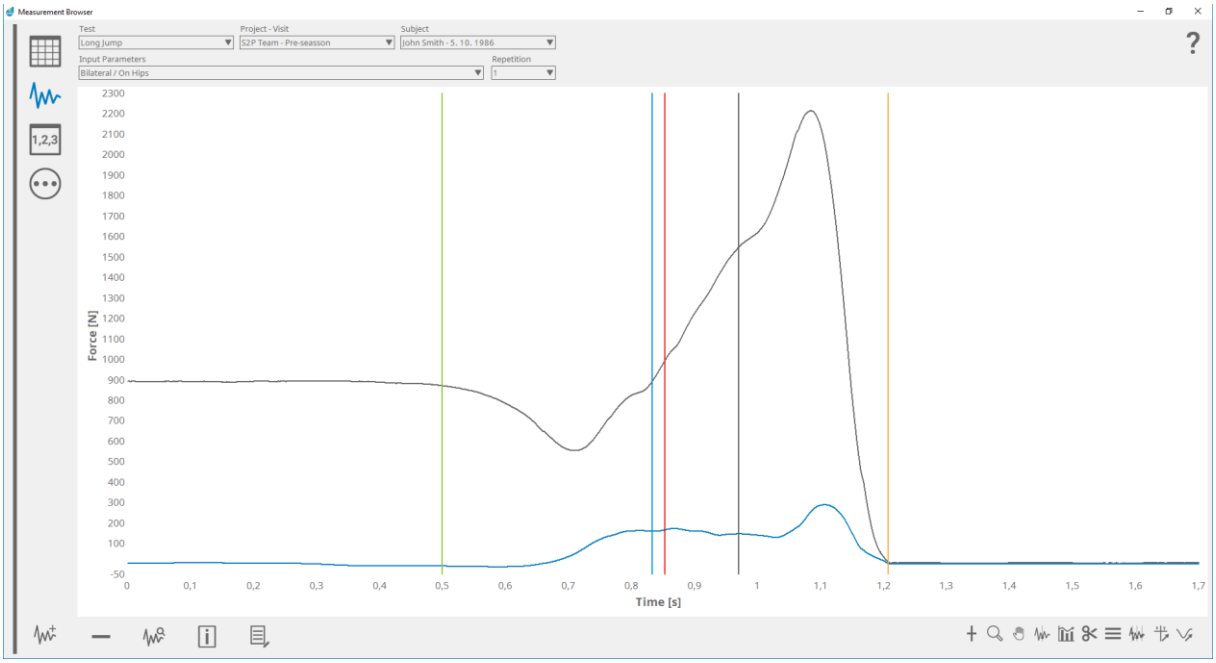
Cursors

Analysis

References

Brief Description

Long jump is a jump where a subject's task is to jump as long as possible. Long jump is one of the most often used tests for maximal anaerobic power output of the lower extremities. It is aneccentric-concentric muscle action which involves coordinated extension of the trunk, hips, knees and ankles all aimed to produce an optimal angle of the propulsion force vector. Based on the parameters derived from the ground reaction force ,dynamics of this elementary movement pattern can be thoroughly studied. Somehow different from the vertical jumps, the horizontal distance of the long jump strongly depends also on the coordinated movements in the flight and landing phase of the jump.



The initial position of the subject is usually a standing position and then a counter movement into a semi-squat (knee ~90° and trunk/hips in a flexed position) follows. However, this position can sometimes be adjusted to the specific goals of the measurement. From the starting position the subject performs a counter movement and

then a push-off action at the angle approximately at the 45 degrees forward as quickly and as explosively as possible in order to perform the longest possible jump.

Selecting Input Parameters

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

- Lower Extremities
- Upper Extremities

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.

Across the Chest

The subject places his/her hands across his/her chest.

Behind the Neck

The subject places his/her hands behind his/her neck.

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 Long Jump measurement module.

Measurement

Before starting a test select input parameters (on the left side of Measure window). Then the subject acquires the required position (i.e. upright stance). Ensure that the subject is standing in the centre of the plate as described above. After the subject has acquired the required position and is ready to start the movement, click Start or press Space. At that time, the subject is free to start the jump. It is important that the direction of jump is along the Y-axis (negative). Software will automatically recognize the beginning and the end of the jump and will automatically stop the data acquisition. For details about this automatic acquisition please see Settings Panel. After the measurement is completed you can chose to Confirm, Reject or Repeat it.

If you want to start a new measurement, click the New Measurement button and repeat the procedure. Before starting a new measurement you can change the Input Parameters; if not, the Input Parameters of the previous measurement will be used.

Cursors

Start
Indicates the start of the jump (start of the movement).

T1

Indicates the event when force reaches the value of body weight during counter movement.

T/2
Indicates the half of the time between the Start and Take Off event.

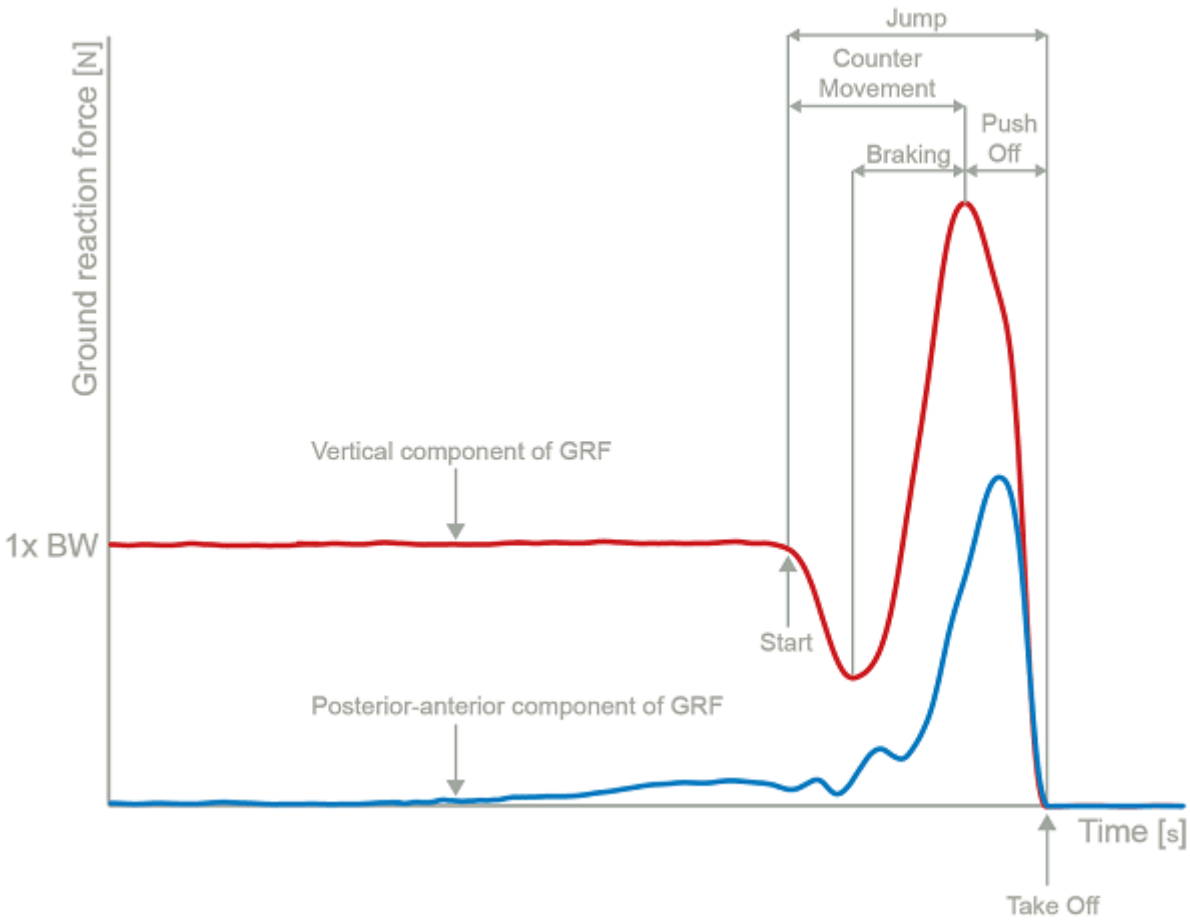
Push Off
Indicates the start of the push off.

Take Off
Indicates the start of the flight phase.

Analysis

Analysis enables you to check the signal(s) of the ground reaction force and the calculated parameters. Under the Signals tab you can see the signal(s) and automatically placed markers. You can move certain markers if they were placed incorrectly. Under the Repetitions tab you can see all the calculated parameters.

All the parameters calculated for analysis are commonly used in biomechanics, kinesiology and rehabilitation 1-4. Parameters are calculated from the ground reaction force and flight time. For more information regarding the parameters see the References.



For some modules additional analysis routines are available as separate products. For more information see section About MARS or contact us.

GENERAL PARAMETERS

Calculated horizontal COG distance [m]

Predicted horizontal displacement of the centre of gravity (COG) of the subject calculated from the Take Off velocity vector.

Jump Height from Take Off V [m]

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

Height/distance ratio [%]

Ratio between the height and the distance of the jump.

Start interval relative F [%BW]

Average resultant force in the 1st 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 relative P [W/kg]

Average resultant power in the 1st 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^2]

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

Relative maximal F [%BW]

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

Relative horizontal maximal F [%BW]

Maximal horizontal force during the jump divided by the body weight.

Relative vertical maximal F [%BW]

Maximal vertical force during the jump divided by the body weight.

Relative maximal F during Counter Movement [%BW]

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

Relative maximal F during Push Off [%BW]

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

Relative maximal F in the 1st half of Push Off [%BW]

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

Relative maximal F in the 2nd half of Push Off [%BW]

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

Relative minimal F [%BW]

Minimal resultant force during the Counter Movement divided by the body weight. At this point, the peak acceleration in downward direction occurs and the deceleration begins.

Relative maximal P [W/kg]

Maximal resultant power during the Push Off divided by the body weight.

Relative horizontal maximal P [W/kg]

Maximal power during the Jump in horizontal direction divided by the body weight.

Relative vertical maximal P [W/kg]

Maximal power during the Jump in vertical direction divided by the body weight.

Relative E [J/kg]

Energy,calculated from the resultant force, during the Push Off divided by the body weight.

A [m/s^2]

Average resultant acceleration during the jump.

A in the 1st half of the Push Off [m/s^2]

Average resultant acceleration between the Lowest Position and the half of the Push Off.

A in the 2nd half of the Push Off [m/s^2]

Average resultant acceleration between the half of the Push Off and the Take Off.

Vertical Take Off V [m/s]

Velocity of the vertical movement at the Take Off calculated from Flight T.

Horizontal Take Off V [m/s]

Velocity of the horizontal movement at the Take Off.

Take Off V [m/s]

Velocity at the Take Off

TIME PARAMETERS

Jump T [s]

Time interval between the Start and the Take Off.

Counter Movement T [s]

Time interval between the Start and the Lowest Position.

Push Off T [s]

Time interval between the Lowest Position and the Take Off.

Ratio between Counter Movement and Push Off T [%]

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

Braking T [s]

Time interval between the minimal force and the Lowest Position.

T to maximal F [s]

Time interval between the Start and the maximal force.

T to minimal F [s]

Time interval between the Start and the minimal force.

FORCE IMPULSE PARAMETERS

Push Off FI [Ns]

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

Horizontal FI [Ns]

Force impulse in horizontal direction (i.e. integral of a horizontal force with respect to time).

Vertical FI [Ns]

Force impulse in vertical direction (i.e. integral of a vertical force with respect to time).

Negative FI [Ns]

Force Impulse (i.e. integral of a vertical force with respect to time) between the Start and the moment where the ground reaction force equals the body weight again.

Positive FI [Ns]

Force Impulse (i.e. integral of a vertical force with respect to time) between the moment where the ground reaction force equals the body weight again and the Take Off.

FI in the 1st half of Push Off [Ns]

Resultant force impulse (i.e. integral of a resultant force with respect to time) between the Lowest Position and the half of the Push Off.

FI in the 2nd half of Push Off [Ns]

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

Ratio between FI in both halves of Push Off [%]

Ratio of the force impulse (i.e. integral of a resultant force with respect to time) between the Lowest Position and the half of the Push Off and the force impulse between the half of the Push Off and the Take Off.

CONTRALATERAL PARAMETERS

NOTE: Beware that this parameters are calculated only when using bilateral force plates.

Left leg - Start interval relative P [W/kg]

Average power in the 1st 50 ms of the Push Off divided by the body weight (50 ms is a default value and can be changed in the Settings Panel - Start Interval).

Left leg - Relative maximal F [%BW]

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

Left leg - Relative maximal P [W/kg]

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

Left leg - Relative E [J/kg]

Energy during the Push Off divided by the body weight.

Left leg - Push Off FI [Ns]

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

Right leg - Start interval relative P [W/kg]

Average power in the 1st 50 ms of the Push Off divided by the body weight (50 ms is a default value and can be changed in the Settings Panel - Start Interval).

Right leg - Relative maximal F [%BW]

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

Right leg - Relative maximal P [W/kg]

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

Right leg - Relative E [J/kg]

Energy during the Push Off divided by the body weight.

Right leg - Push Off FI [Ns]

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

Left/right leg - Start interval relative P [%]

Average power in the 1st 50 ms of the Push Off divided by the body weight (50 ms is a default value and can be changed in the Settings Panel - Start Interval).

Left/right leg - Relative maximal F [%]

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

Left/right leg - Relative maximal P [%]

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

Left/right leg - Relative E [%]

Energy during the Push Off divided by the body weight.

Left/right leg - Push Off FI [%]

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

References

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Luhtanen, P. & Komi, P.V. Force-, power-, and elasticity-velocity relationships in walking, running, and jumping. Eur J Appl Physiol Occup Physiol 44, 279-289 (1980).

Muraki, Y., Ae, M., Yokozawa, T. & Koyama, H. Mechanical properties of the take-off leg as a support mechanism in the long jump. Sports Biomech 4, 1-15 (2005).

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REPETITIVE COUNTER MOVEMENT JUMPS - TEST

This measurement module is a part of MARS Strength & Power.

Brief Description

Selecting Input Parameters

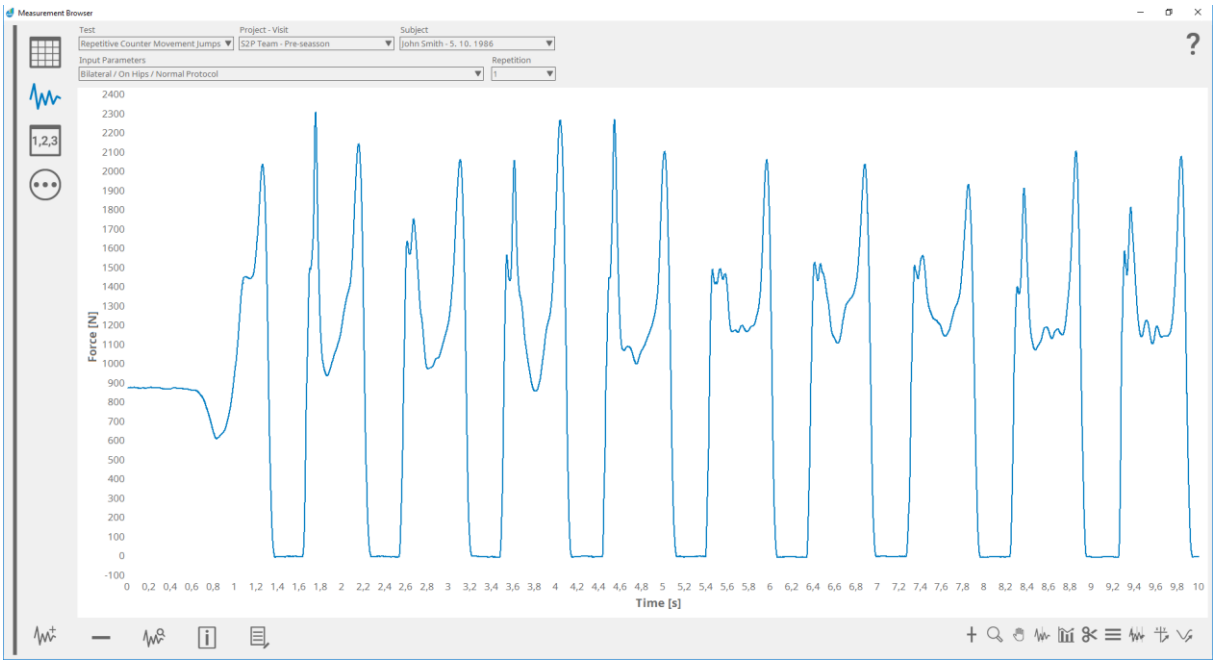
Measurement

Analysis

References

Brief Description

Repetitive Counter Movement Jumps is a repetitive vertical jumping that involves cyclic eccentric-concentric muscle action primarily including muscle actions of the trunk, hip, knee and ankle extensors. Based on the parameters` change through the repetitions,we can analyse some basic biomechanical and functional characteristics of the neuromuscular system (i.e. endurance, fatigue, elastic energy utilization, potentiation, etc.).



The initial position of the subject is an upright stance. It is important that the subject performs a coupled amortisation-push-off action using a coordinated multi-joint action of the lower extremities and the trunk; the lowest position being the semi-squat (knee ~90° and trunk/hips in a flexed position). The Repetitive Counter Movement Jumps has to be performed fluently, by directly linking successive counter movement jumps, each one being performed as explosively as possible in order to make the highest possible jumps thereby using the above described neuromuscular action and movement pattern.

Selecting Input Parameters

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

- Lower Extremities
- Upper Extremities
- Jumps Type

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.

Across the Chest

The subject places his/her hands across his/her chest.

Behind the Neck

The subject places his/her hands behind his/her neck.

Other user defined

In case of any other position of the upper extremities, the user can define new positions under Settings panel - section Input parameters. After doing so, the newly defined input parameter will from then on appear as an optional choice under the Upper extremities in the Repetitive Counter Movement Jumps measurement module.

JUMPS TYPE

Normal Protocol

Normal Repetitive Counter Movement Jumps.

Reference Jumps

A series of 5 Repetitive Counter Movement Jumps used as reference for the calculation of some parameters in Repetitive Counter Movement Jumps (Speed Endurance Index and Voluntary Effort Index) and Repetitive Hopping (Leg Equilibrium Index).

Measurement

Before starting a test select input parameters (on the left side of Measure window). Then the subject acquires the required position (i.e. upright stance). Ensure that the subject is standing in the centre of the plate as described above. After the subject has acquired the required position and is ready to start the movement, click Start or press Space. At that time, the subject is free to start the jump and the software will automatically recognize the beginning and the end of the jump and will automatically stop the data acquisition. For details about this automatic acquisition please see Settings Panel. After the measurement is completed you can chose to Confirm, Reject or Repeat it.

If you want to start a new measurement, click the New Measurement button and repeat the procedure. Before starting a new measurement you can change the Input Parameters; if not, the Input Parameters of the previous measurement will be used.

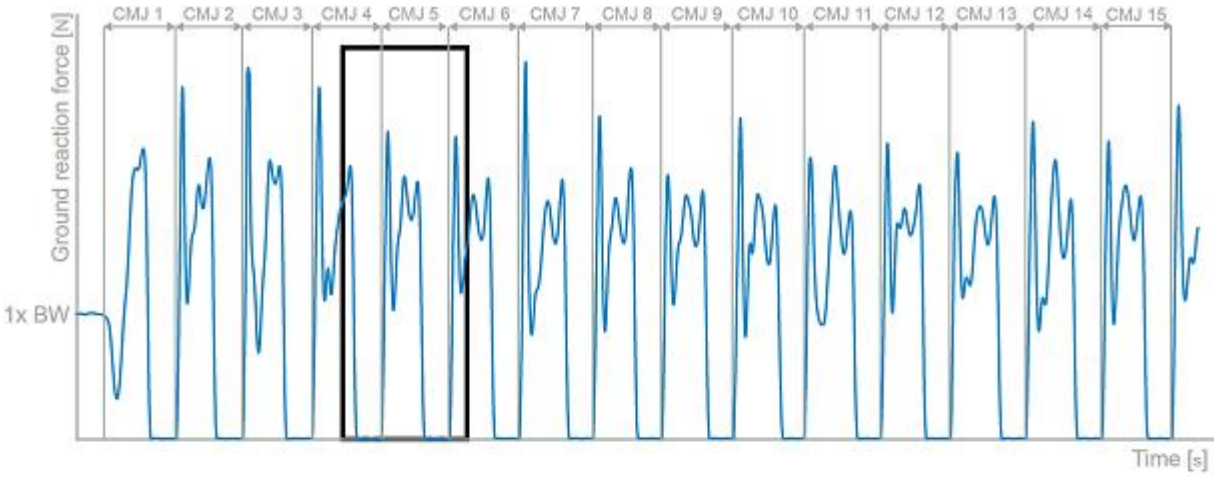
Analysis

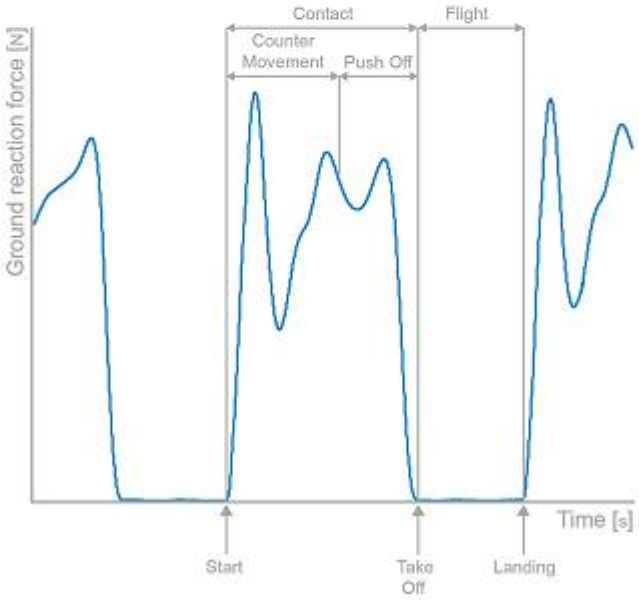
Analysis enables you to check the signal(s) of the ground reaction force and the calculated parameters. Under the Signals tab you can see the signal(s). Under the

Repetitions tab you can see all the calculated parameters. Under More – Repetitive Jumps Viewer you can analyse each jump separately.

All the parameters calculated for analysis are commonly used in biomechanics, kinesiology and rehabilitation 1-9. Parameters are calculated from the ground reaction force, flight time and their changes through the repetition. For more information regarding the parameters see the References.

NOTE: The first jump is excluded from the analysis.





For some modules additional analysis routines are available as a separate product. For more information see section About MARS or contact us.

REPETITIVE JUMPS VIEWER

Calculated parameters for each jump separately are shown in the table. Number in the column headers represents the sequence number of the jump in the group. You can exclude/include separate jump from final analysis by right mouse click on column header.

By left mouse click on the column header you can see each jump separately in the right-bottom graph where cursors represents the start-end interval of the jump/analysis.

With left mouse click on the parameter name in the table you can select up to 5 parameters for graphical representation in the graph left-bottom.

Export table

Export data currently visible in the table.

Zoom

Zoom tools.

Hand

Hand tool used to move graph.

Plot values

Values for each plot on the graph at cursor position.

Statistics

Basic statistics for each plots on the interval between two cursors.

Export graph values

Export plots values from currently visible graph.

Export graph image

Export image of currently visible graph.

OVERALL

NOTE: For all the parameters that are calculated for an individual Counter Movement Jump 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 usually between 3 to 5 jumps and can be selected in the Setting Panel - Number of Jumps).

Average of middle n jumps

Average value of n jumps in the middle of series (n is usually between 3 to 5 jumps and can be selected in the Setting Panel - Number of Jumps).

Average of last n jumps

Average value of the last n jumps (n is usually between 3 to 5 jumps and can be selected in the Setting Panel - Number of 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.

Speed Endurance Index

Capacity to develop high power output in function of the time. The measurement must be at least 15 sec long to calculate this parameter.

Voluntary Effort Index

Relation of how high a subject jumps if it has only 5 jumps to do or if it starts doing a long series of jumps.

GENERAL PARAMETERS

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 1st 50ms of the Push Off (50 ms is a default value and can be changed in the Settings Panel - Start Interval).

Start interval relative P [W/kg]

Average power in the 1st 50ms of the Push Off divided by the body weight (50 ms is a default value and can be changed in the Settings Panel - Start Interval).

Start interval A [m/s^2]

Average acceleration in the 1st 50ms of the Push Off (50 ms is a default value and can be changed in the Settings Panel - Start Interval).

Start interval V [m/s]

Average velocity in the 1st 50ms of the Push Off (50 ms is a default value and can be changed in the Settings Panel - Start Interval).

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 1st 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 2nd 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^2]

Average acceleration during the Counter Movement phase.

Push Off A [m/s^2]

Average acceleration during the Push Off phase.

Vertical Take Off V [m/s]

Velocity of the vertical movement at the Take Off calculated from Flight T.

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]v

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.

CONTRALATERAL PARAMETERS

NOTE: Beware that this parameters are calculated only when using bilateral force plates.

Left leg - Start interval relative P [W/kg]

Average power in the 1st 50 ms of the Push Off divided by the body weight (50 ms is a default value and can be changed in the Settings Panel - Start Interval).

Left leg - Relative maximal F [%BW]

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

Left leg - Relative maximal P [W/kg]

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

Left leg - Relative E [J/kg]

Energy during the Push Off divided by the body weight.

Left leg - Push Off FI [Ns]

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

Right leg - Start interval relative P [W/kg]

Average power in the 1st 50 ms of the Push Off divided by the body weight (50 ms is a default value and can be changed in the Settings Panel - Start Interval).

Right leg - Relative maximal F [%BW]

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

Right leg - Relative maximal P [W/kg]

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

Right leg - Relative E [J/kg]

Energy during the Push Off divided by the body weight.

Right leg - Push Off FI [Ns]

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

Left/right leg - Start interval relative P [%]

Average power in the 1st 50 ms of the Push Off divided by the body weight (50 ms is a default value and can be changed in the Settings Panel - Start Interval).

Left/right leg - Relative maximal F [%]

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

Left/right leg - Relative maximal P [%]

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

Left/right leg - Relative E [%]

Energy during the Push Off divided by the body weight.

Left/right leg - Push Off FI [%]

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

References

Bosco, C., Luhtanen, P. & Komi, P.V. A simple method for measurement of mechanical power in jumping. Eur J Appl Physiol Occup Physiol 50, 273-282 (1983).

Finni, T., Komi, P.V. & Lepola, V. In vivo human triceps surae and quadriceps femoris muscle function in a squat jump and counter movement jump. Eur. J. Appl. Physiol 83, 416-426 (2000).

Finni, T., Komi, P.V. & Lepola, V. In vivo muscle mechanics during locomotion depend on movement amplitude and contraction intensity. Eur. J. Appl. Physiol 85, 170-176 (2001).

McBride, J.M., McCaulley, G.O. & Cormie, P. Influence of preactivity and eccentric muscle activity on concentric performance during vertical jumping. J Strength Cond Res 22, 750-757 (2008).

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McCaulley, G.O. et al. Mechanical efficiency during repetitive vertical jumping. Eur. J. Appl. Physiol 101, 115-123 (2007).

Anderson, F.C. & Pandy, M.G. Storage and utilization of elastic strain energy during jumping. J Biomech 26, 1413-1427 (1993).

Bosco, C., Tihanyi, J., Komi, P.V., Fekete, G. & Apor, P. Store and recoil of elastic energy in slow and fast types of human skeletal muscles. Acta Physiol. Scand 116, 343-349 (1982).

Bosco, C. et al. The effect of fatigue on store and re-use of elastic energy in slow and fast types of human skeletal muscle. Acta Physiol. Scand 128, 109-117 (1986).

REPETITIVE HOPPING - TEST

This measurement module is a part of MARS Strength & Power.

Brief Description

Selecting Input Parameters

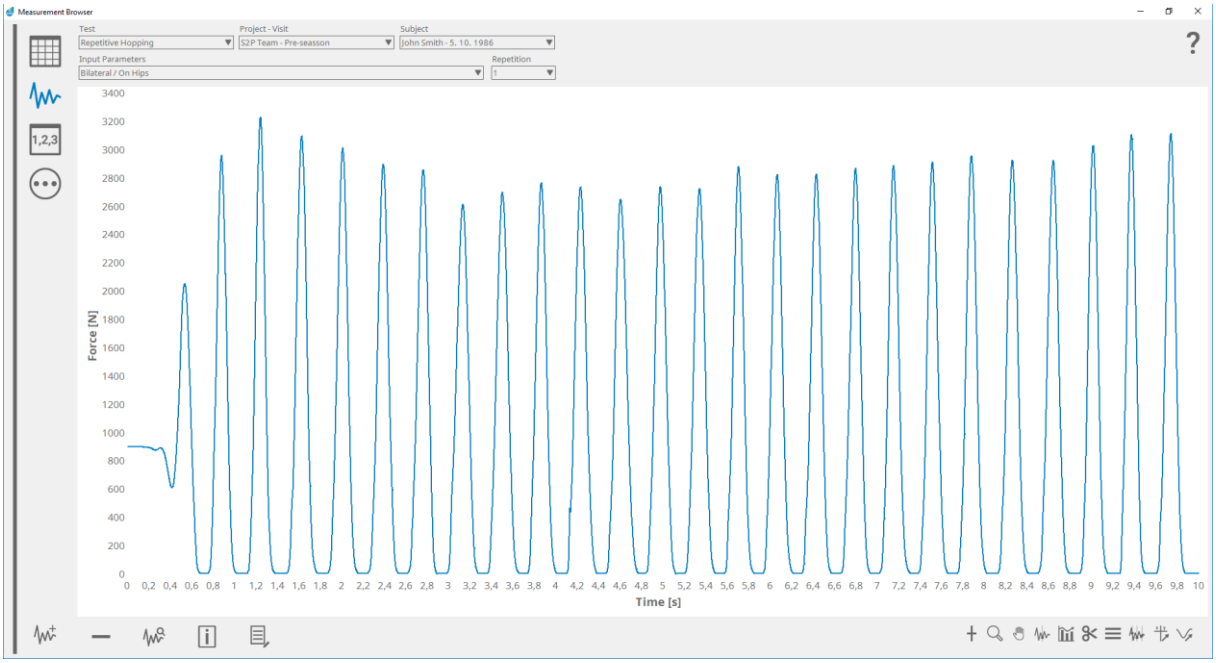
Measurement

Analysis

References

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 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).

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
- Upper Extremities

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.

Across the Chest

The subject places his/her hands across his/her chest.

Behind the Neck

The subject places his/her hands behind his/her neck.

Other user defined

In case of any other position of the upper extremities, the user can define new positions under Settings panel - section Input parameters. After doing so, the newly defined input parameter will from then on appear as an optional choice under the Upper extremities in the Repetitive Hopping measurement module.

Measurement

Before starting a test select input parameters (on the left side of Measure window). Then the subject acquires the required position (i.e. upright stance). Ensure that the subject is standing in the centre of the plate as described above. After the subject has acquired the required position and is ready to start the movement, click Start or press Space. At that time, the subject is free to start the jump and the software will automatically recognize the beginning and the end of the jump and will automatically stop the data acquisition. For details about this automatic acquisition please see Settings Panel. After the measurement is completed you can chose to Confirm, Reject or Repeat it.

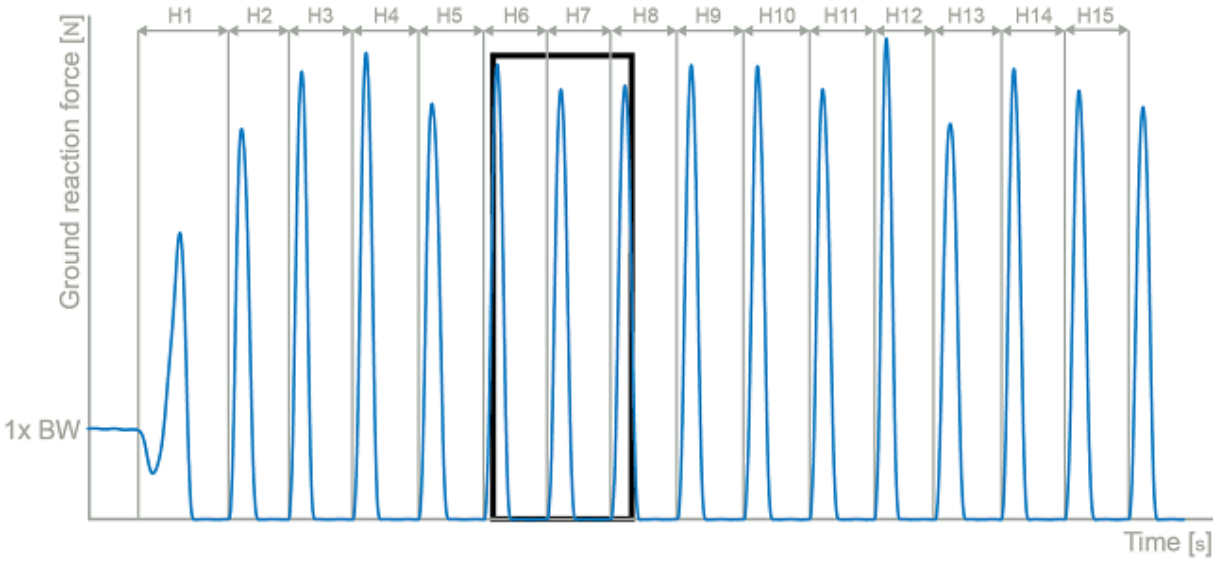
If you want to start a new measurement, click the New Measurement button and repeat the procedure. Before starting a new measurement you can change the Input Parameters; if not, the Input Parameters of the previous measurement will be used.

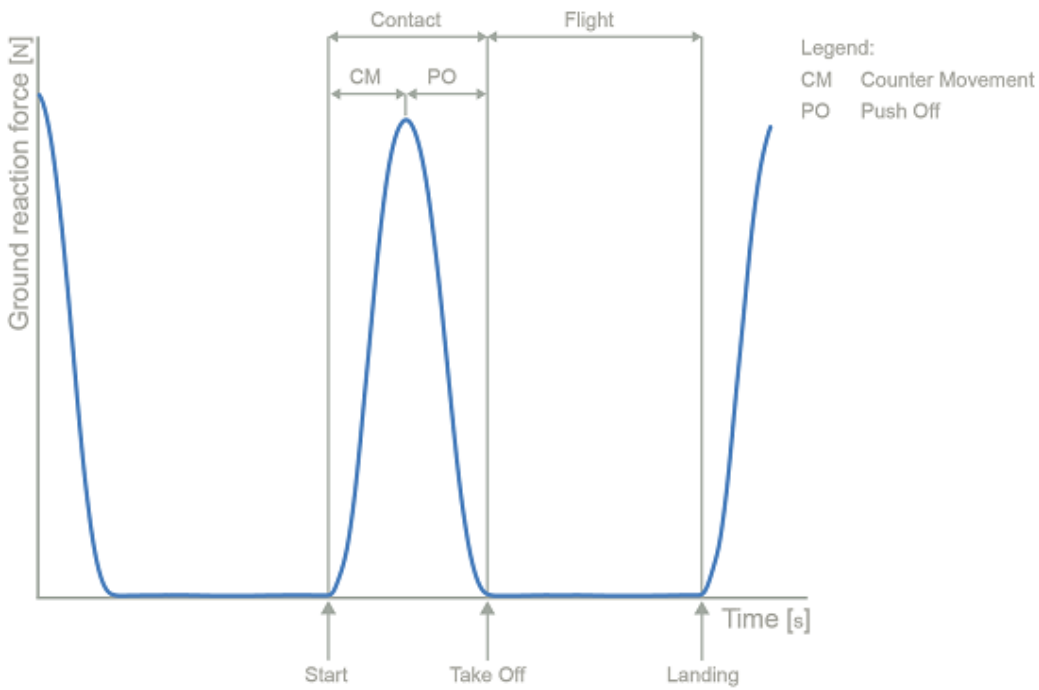
Analysis

Analysis enables you to check the signal(s) of the ground reaction force and the calculated parameters. Under the Signals tab you can see the signal(s). Under the Repetitions tab you can see all the calculated parameters.). Under the Repetitions tab you can see all the calculated parameters. Under More – Repetitive Jumps Viewer you can analyse each jump separately.

All the parameters calculated for analysis are commonly used in biomechanics, kinesiology and rehabilitation1-7. 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.

NOTE: The first jump is excluded from the analysis.





For some modules additional analysis routines are available as a separate product. For more information see section About MARS or contact us.

REPETITIVE JUMPS VIEWER

Calculated parameters for each jump separately are shown in the table. Number in the column headers represents the sequence number of the jump in the group. You can exclude/include separate jump from final analysis by right mouse click on column header.

By left mouse click on the column header you can see each jump separately in the right-bottom graph where cursors represents the start-end interval of the jump/analysis.

With left mouse click on the parameter name in the table you can select up to 5 parameters for graphical representation in the graph left-bottom.

Export table

Export data currently visible in the table.

Zoom

Zoom tools.

Hand

Hand tool used to move graph.

Plot values

Values for each plot on the graph at cursor position.

Statistics

Basic statistics for each plots on the interval between two cursors.

Export graph values

Export plots values from currently visible graph.

Export graph image

Export image of currently visible graph.

OVERALL

NOTE: For all the parameters that are calculated for an individual Hoping 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 usually between 3 to 5 jumps and can be selected in the Setting Panel - Number of Jumps).

Average of middle n jumps

Average value of n jumps in the middle of series (n is usually between 3 to 5 jumps and can be selected in the Setting Panel - Number of Jumps).

Average of last n jumps

Average value of the last n jumps (n is usually between 3 to 5 jumps and can be selected in the Setting Panel - Number of 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.

Leg Equilibrium Index

Equilibrium of the functional structure of the leg including three joints (hip, knee, ankle) and the upper and lower leg (thigh, calf).

Value » 2.3 -> the neuromuscular function of the total leg (upper and lower is in balance.

Value < 2 -> the neuromuscular function of the knee, ankle and lower limb are weaker than the hip and thigh.

GENERAL PARAMETERS

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 1st 50ms of the Push Off (50 ms is a default value and can be changed in the Settings Panel - Start Interval).

Start interval relative P [W/kg]

Average power in the 1st 50ms of the Push Off divided by the body weight (50 ms is a default value and can be changed in the Settings Panel - Start Interval).

Start interval A [m/s^2]

Average acceleration in the 1st 50ms of the Push Off (50 ms is a default value and can be changed in the Settings Panel - Start Interval).

Start interval V [m/s]

Average velocity in the 1st 50ms of the Push Off (50 ms is a default value and can be changed in the Settings Panel - Start Interval).

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 1st 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 2nd 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^2]

Average acceleration during the Counter Movement phase.

Push Off A [m/s^2]

Average acceleration during the Push Off phase.

Vertical Take Off V [m/s]

Velocity of the vertical movement at the Take Off calculated from Flight T.

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.

CONTRALATERAL PARAMETERS

NOTE: Beware that this parameters are calculated only when using bilateral force plates.

Left leg - Start interval relative P [W/kg]

Average power in the 1st 50 ms of the Push Off divided by the body weight (50 ms is a default value and can be changed in the Settings Panel - Start Interval).

Left leg - Relative maximal F [%BW]

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

Left leg - Relative maximal P [W/kg]

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

Left leg - Relative E [J/kg]

Energy during the Push Off divided by the body weight.

Left leg - Push Off FI [Ns]

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

Right leg - Start interval relative P [W/kg]

Average power in the 1st 50 ms of the Push Off divided by the body weight (50 ms is a default value and can be changed in the Settings Panel - Start Interval).

Right leg - Relative maximal F [%BW]

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

Right leg - Relative maximal P [W/kg]

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

Right leg - Relative E [J/kg]

Energy during the Push Off divided by the body weight.

Right leg - Push Off FI [Ns]

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

Left/right leg - Start interval relative P [%]

Average power in the 1st 50 ms of the Push Off divided by the body weight (50 ms is a default value and can be changed in the Settings Panel - Start Interval).

Left/right leg - Relative maximal F [%]

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

Left/right leg - Relative maximal P [%]

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

Left/right leg - Relative E [%]

Energy during the Push Off divided by the body weight.

Left/right leg - Push Off FI [%]

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

References

Finni T, Komi PV, Lepola V. In vivo muscle mechanics during locomotion depend on movement amplitude and contraction intensity. Eur. J. Appl. Physiol. 2001;85(1-2):170-176.

Belli A, Bosco C. Influence of stretch-shortening cycle on mechanical behaviour of triceps surae during hopping. Acta Physiol. Scand. 1992;144(4):401-408.

Fukashiro S, Komi PV. Joint moment and mechanical power flow of the lower limb during vertical jump. Int J Sports Med. 1987;8 Suppl 1:15-21.

McCaulley GO, Cormie P, Cavill MJ, et al. Mechanical efficiency during repetitive vertical jumping. Eur. J. Appl. Physiol. 2007;101(1):115-123.

Bosco C, Ito A, Komi PV, et al. Neuromuscular function and mechanical efficiency of human leg extensor muscles during jumping exercises. Acta Physiol. Scand. 1982;114(4):543-550.

Bosco C, Tihanyi J, Komi PV, Fekete G, Apor P. Store and recoil of elastic energy in slow and fast types of human skeletal muscles. Acta Physiol. Scand. 1982;116(4):343-349.

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SHAPE TRACKING - TEST

This measurement module is a part of MARS Balance & Stability.

Brief Description

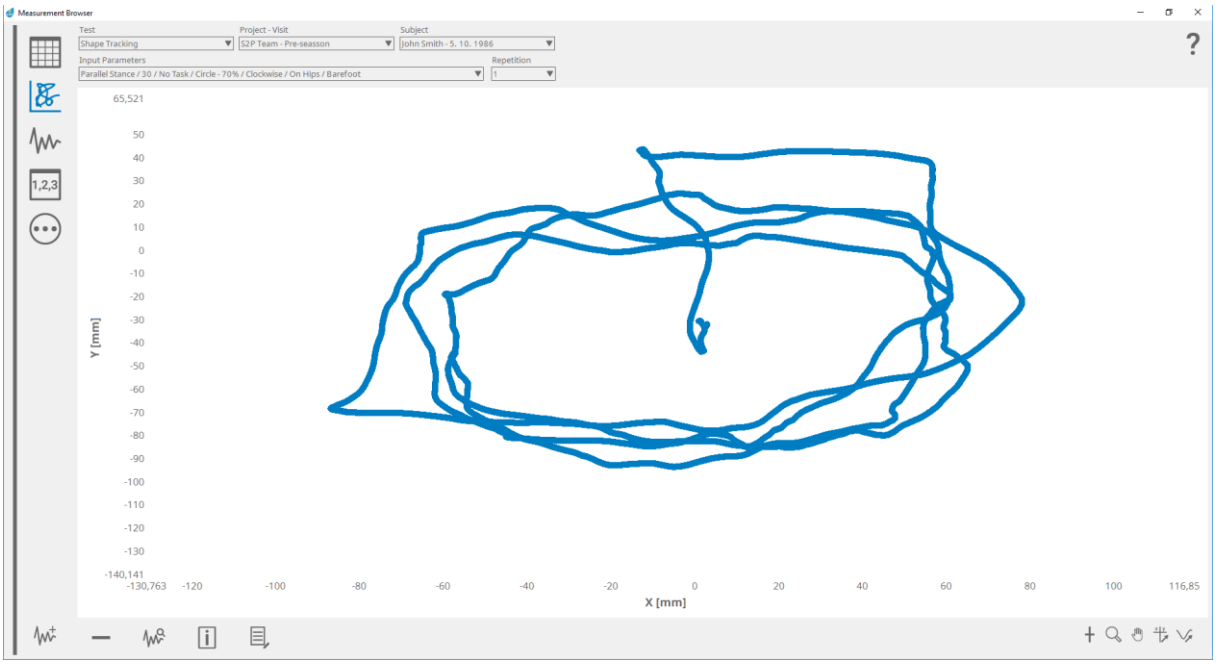
Selecting Input Parameters

Measurement

Analysis

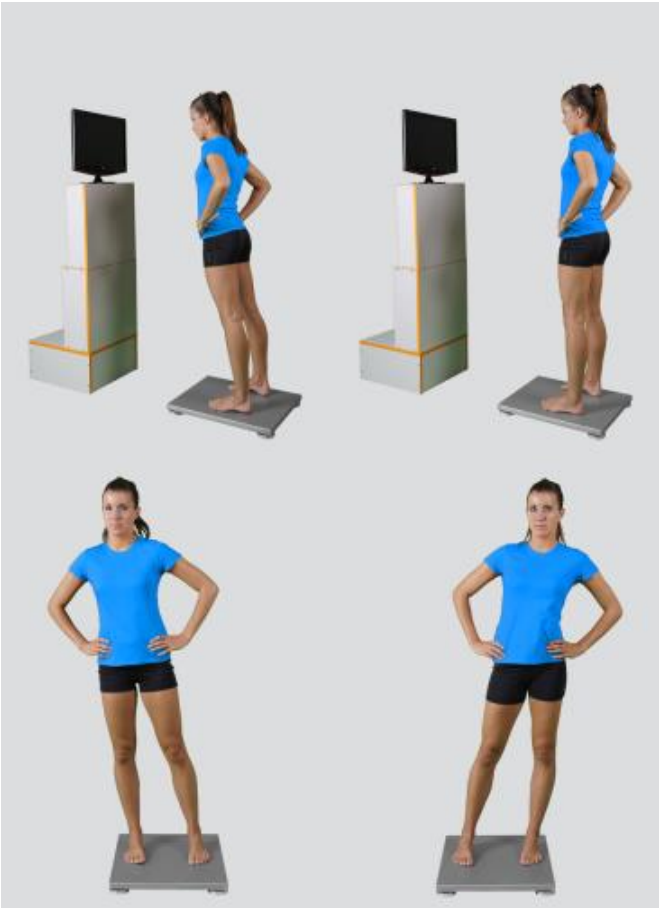
Brief Description

Different from the quiet stance, every day functional situations often require more demanding dynamic balance situations and corresponding balance control. A typical example are those motor tasks in which a subject has to voluntarily shift the body`s centre-of-gravity above the support area. Such leaning of the body in different directions will result in an evident centre-of-pressure (COP) displacement. It can be done with a maximal or submaximal range of COP excursions. Range and precision of voluntary body leaning in different directions can be assessed by measuring the COP displacements. The ability of a subject to finely control the dynamics of the COP excursions can be assessed with visuo-motor integration tasks in which the real COP is displayed in front of the subject and he/she tries to precisely follow the predefined dynamics of the COP shifts.



Evaluation of such visual feed-back based dynamic balance tasks gives us the information about the volitional balance control of the centre-of-gravity and can be quantitatively evaluated using force plate measurements. In case of the Shape Tracking task the subject is instructed to follow the reference curve by voluntarily shifting his/her COP in a pre-defined direction. Such a measurement set-up will enable us to identify direction specific weak points of the subject`s balance and to gather additional

information about the dynamic balance control. These tasks can also be used as a motivation exercise tool.



Selecting Input Parameters

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

- Stance Position
- Duration [s]
- Dual Task
- Shape
- Tracking Direction
- Upper Extremities
- Footwear

STANCE POSITION

Parallel Stance

The subject is standing in the centre of the force plate with the feet placed parallel at the shoulder width. The feet are oriented in anterior-posterior direction (along the Y-axis of the force plate) with the toes pointing anteriorly (+Y). Throughout the measurement the subject sustains his/her normal upright stance position.

Semi-Tandem Stance

The subject is standing in the centre of the force plate with the feet placed close together and shifted longitudinally against each other for one half of the length of the foot (i.e. semi-tandem foot position). The feet are oriented in anterior-posterior direction (along the Y-axis of the force plate) with the toes pointing anteriorly (+Y). Throughout the measurement the subject sustains his/her normal upright stance position. Semi-tandem stance with the dominant leg in front is predominantly used; the opposite foot position is sometimes also referred as “contra semi-tandem”.

Tandem Stance

The subject is standing in the centre of the force plate with the feet placed in-line one behind the other (i.e. heel-to-toe or tandem feet position). The feet are oriented in anterior-posterior direction (along the Y-axis of the force plate) with the toes pointing anteriorly (+Y). Throughout the measurement the subject sustains his/her normal upright stance position. Tandem stance with the dominant leg in front is predominantly used; the opposite foot position is sometimes also referred as “contra tandem”.

Single Leg Stance – Left / Single Leg Stance - Right

The subject is standing on one leg in the centre of the force plate. The foot is oriented in anterior-posterior direction (along the Y-axis of the force plate) with the toes pointing anteriorly (+Y). Throughout the measurement the subject sustains his/her normal upright stance position.

Other user defined

In case of any other type of stance, the user can define it under Settings panel - section Input parameters. After doing so, the newly defined input parameter will from then on appear as an optional choice under the Stance Position in the Shape Tracking measurement module.

DURATION [s]

10/20/30/40/50/60/70/80/90/100 s

Other user defined

In case of any other duration, the user can define it under Settings panel - section Input parameters. After doing so, the newly defined duration of the quiet stance task will from then on appear as an optional choice under the Duration in the Shape Tracking measurement module.

DUAL TASK

No Additional Task

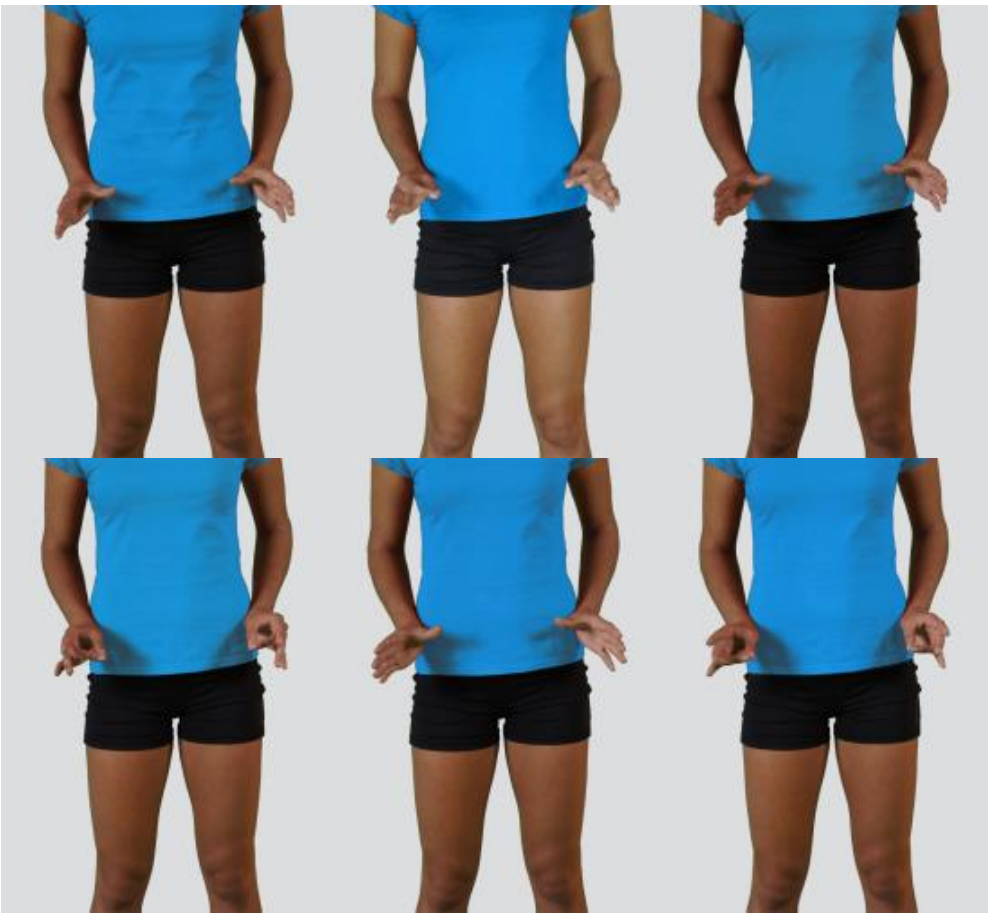
The subject has no additional mental or motor task to do during the time of the measurement.

Additional Mental Task

Together with the quiet stance task the subject has to perform a required mental task. For this purpose different tasks have been used, the most commonly used is counting up/down by three.

Additional Motor Task

Together with the quiet stance task the subject has to perform a required motor task. For this purpose different tasks have been used, the most commonly used is alternative finger tapping task.



Other user defined

In case of any other type of dual task, the user can define it under Settings panel - section Input parameters. After doing so, the newly defined input parameter will from then on appear as an optional choice under the Dual Task in the Shape Tracking measurement module.

SHAPE

Front horizontal line

Back horizontal line

Middle horizontal line

Left vertical line

Right vertical line

Middle vertical line

Diagonal line 1

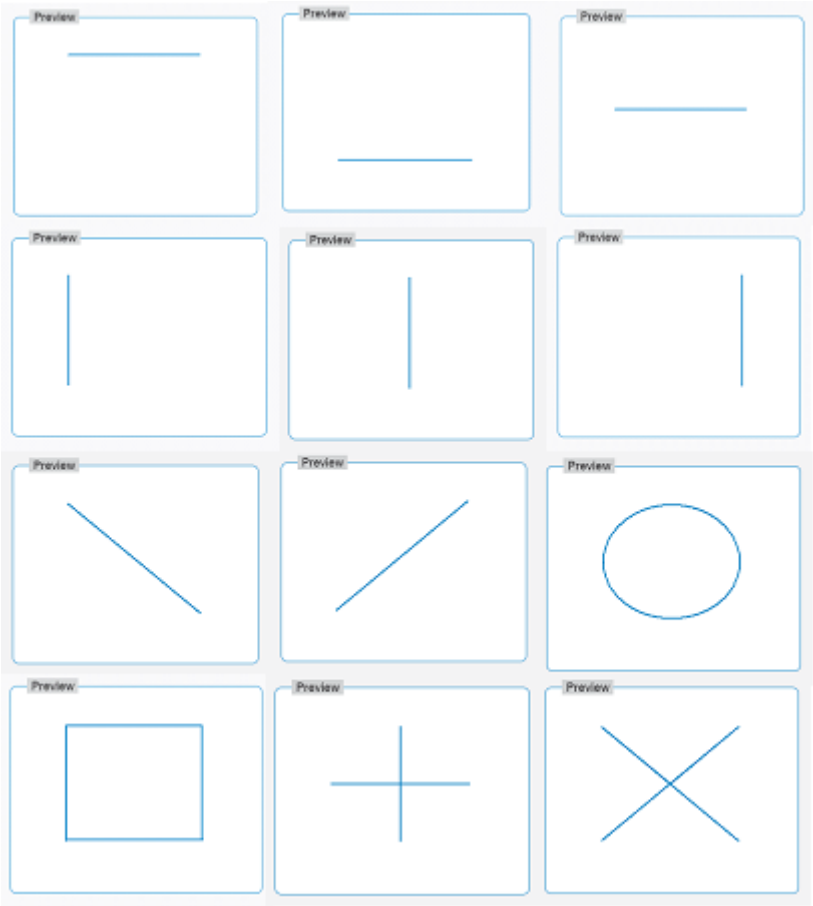
Diagonal line 2

Circle

Rectangle

Front cross

Diagonal cross



TRACKING DIRECTION

Clockwise

The subject has to track the shape in the clockwise direction.

Counter-clockwise

The subject has to track the shape in the counter-clockwise direction.

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. In case of the easy quiet stance tasks the hands will normally remain passively hanging. However, in more demanding tasks the free use of the hands can be of great help.

Across the Chest

The subject places his/her hands across his/her chest.

Behind the Neck

The subject places his/her hands behind his/her neck.

Other user defined

In case of any other position of the upper extremities, the user can define new positions under Settings panel - section Input parameters. After doing so, the newly defined input parameter will from then on appear as an optional choice under the Upper Extremities in the Shape Tracking measurement module.

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 case of any other type of footwear, the user can define it under Settings panel - section Input parameters. After doing so, the newly defined input parameter will from then on appear as an optional choice under the Footwear in the Shape Tracking measurement module.

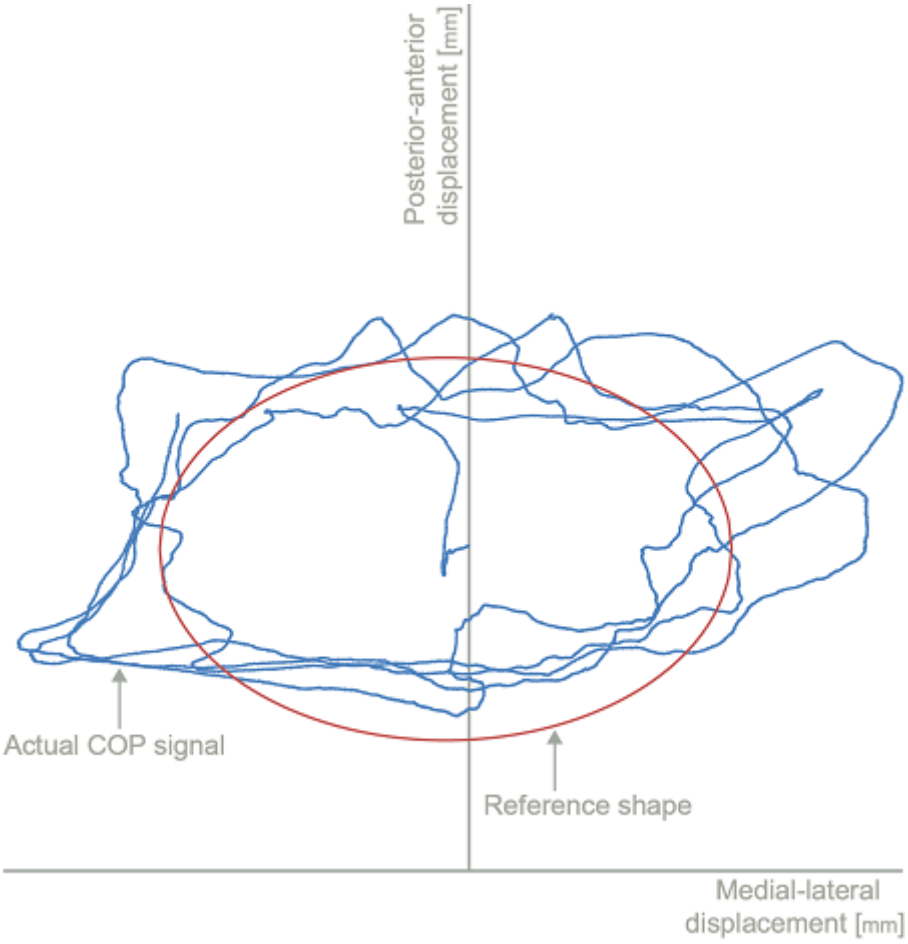
Measurement

Before starting a test select input parameters (on the left side of Measure window). Then the subject steps on the force plate and gets into the required position in a way that the orientation of the body is consistent with that of the plate (i.e. +Y direction of the plate is the anterior direction). After you are satisfied with the quiet stance of the subject, click Start or press Space. While the COP offset is performed, the subject must not move. After this the software begins with the signal acquisition and the time left until the end of the test is displayed in the top-right corner of the screen. Data recording will stop automatically after the set time. After the measurement is completed you can chose to Confirm, Reject or Repeat it.

If you want to start a new measurement, click the New Measurement button and repeat the procedure. Before starting a new measurement you can change the Input Parameters; if not, the Input Parameters of the previous measurement will be used.

Analysis

Analysis enables you to check the signal of the ground reaction force and the calculated parameters. Under the COP tab you can see the X:Y signal. Individual components of the ground reaction forces and of the COP movement can be visualized under the Signals tab. Under the Repetitions tab you can see all the calculated parameters.



For some modules additional analysis routines are available as separate products. For more information see section About MARS or contact us.

GENERAL PARAMETERS

Number changes [n]

Number of changes in direction.

Mean absolute error [mm]

Mean absolute error between the Reference Curve and the Actual COP Signal.

Mean absolute error fatigue index [%]

Mean absolute error fatigue index.

Mean absolute error endurance index [%]

Mean absolute error endurance index.

Maximal Amplitude [mm]

Maximal amplitude.

Amplitude fatigue index [%]

Fatigue index of amplitude.

Amplitude endurance index [%]

Endurance index of amplitude.

SIT-TO-STAND - TEST

This measurement module is a part of MARS Balance & Stability.

Brief Description

Selecting Input Parameters

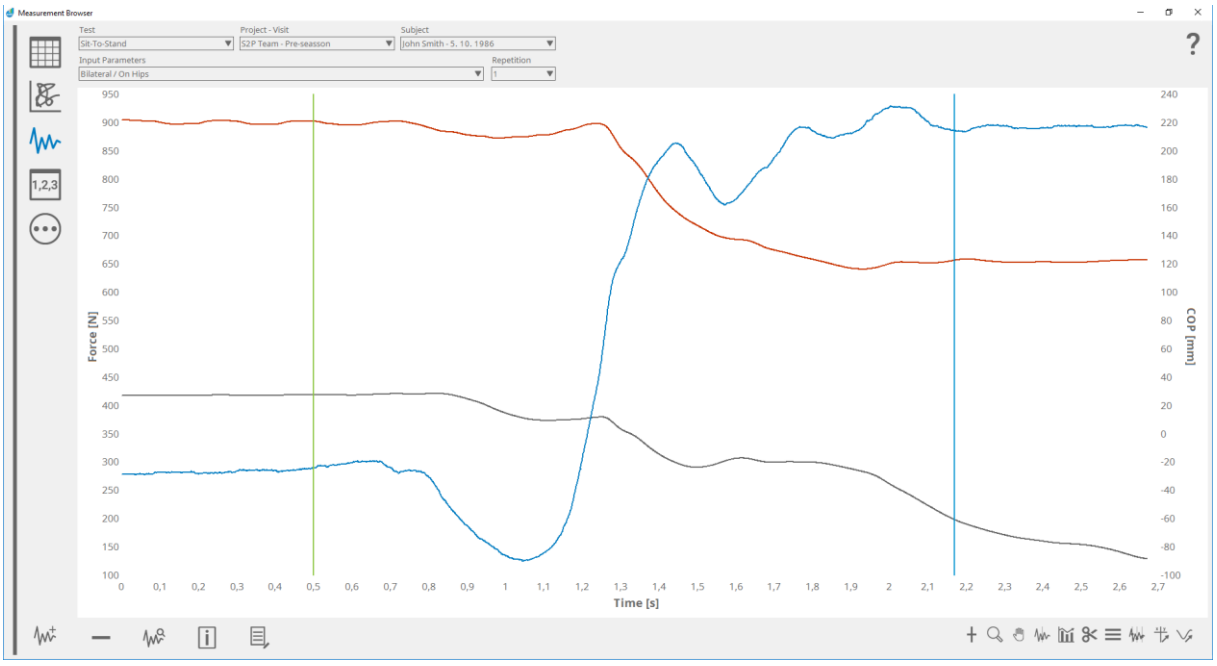
Measurement

Cursors

Analysis

Brief Description

Sit-To-Stand is a clinical test where the subject needs to rise from a seated to a standing position. This is associated with the ability to perform lifestyle tasks such as climbing stairs, getting in and out of a vehicle or bath. The test is specifically useful for elderly population or movement impaired people. All the parameters are calculated based on the ground reaction force.



The initial position of the subject is a sitting position on a chair with feet placed on a force plate. The chair is placed next to the force plate and not on it. From this position the subject performs a vertical upward movement into a standing position without moving the feet.The test is finished when the subject stands still on a force plate. The subject is not allowed to use hands as a support.

Selecting Input Parameters

Before the measurement can start, the user has to choose some input parameters with which the measured motor task (i.e. quiet stance task) is specifically defined. These

parameters are important for further analysis, comparisons and reporting. The characteristics of the quiet stance task are defined by the following parameters:

- Lower Extremities
- Upper Extremities

LOWER EXTREMITIES

Bilateral

The subject is sitting on a chair with the feet placed parallel in the centre of the plate. Feet should be shoulder-width apart.

Unilateral-Left / Unilateral-Right

The subject is sitting on a chair with the foot (left or right)in the centre of the plate.

UPPER EXTREMITIES

On Hips

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

Free

The subject is free to use his/her arms as he/she wants. Specifically useful when observing how subjects differ in using arms as a biomechanical advantage. The subject is not allowed to use hands as a support.

Across the Chest

The subject places his/her hands across his/her chest.

Behind the Neck

The subject places his/her hands behind his/her neck.

Other user defined

In case of any other position of the upper extremities, the user can define new positions under Settings panel - section Input parameters. After doing so, the newly defined input parameter will from then on appear as an optional choice under the Upper extremities in the Sit-To-Stand measurement module.

Measurement

After selecting input parameters, the subject sits on a chair and places his/her feet on a plate. Ensure that the subject has placed the feet 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. While the COP offset is performed, the subject must not move.

After that, the subject is free to start the upward movement and the software will automatically recognize the beginning and the end of the test. For details about this automatic acquisition please see Settings Panel.

Before starting a test select input parameters (on the left side of Measure window). Then the subject sits on a chair and places his/her feet on a plate. Ensure that the subject has placed the feet 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 or press Space. While the COP offset is performed, the subject must not move. After that, the subject is free to start the upward movement and the software will automatically recognize the beginning and the end of the test. For details about this automatic acquisition please see Settings Panel. After the measurement is completed you can chose to Confirm, Reject or Repeat it.

If you want to start a new measurement, click the New Measurement button and repeat the procedure. Before starting a new measurement you can change the Input Parameters; if not, the Input Parameters of the previous measurement will be used.

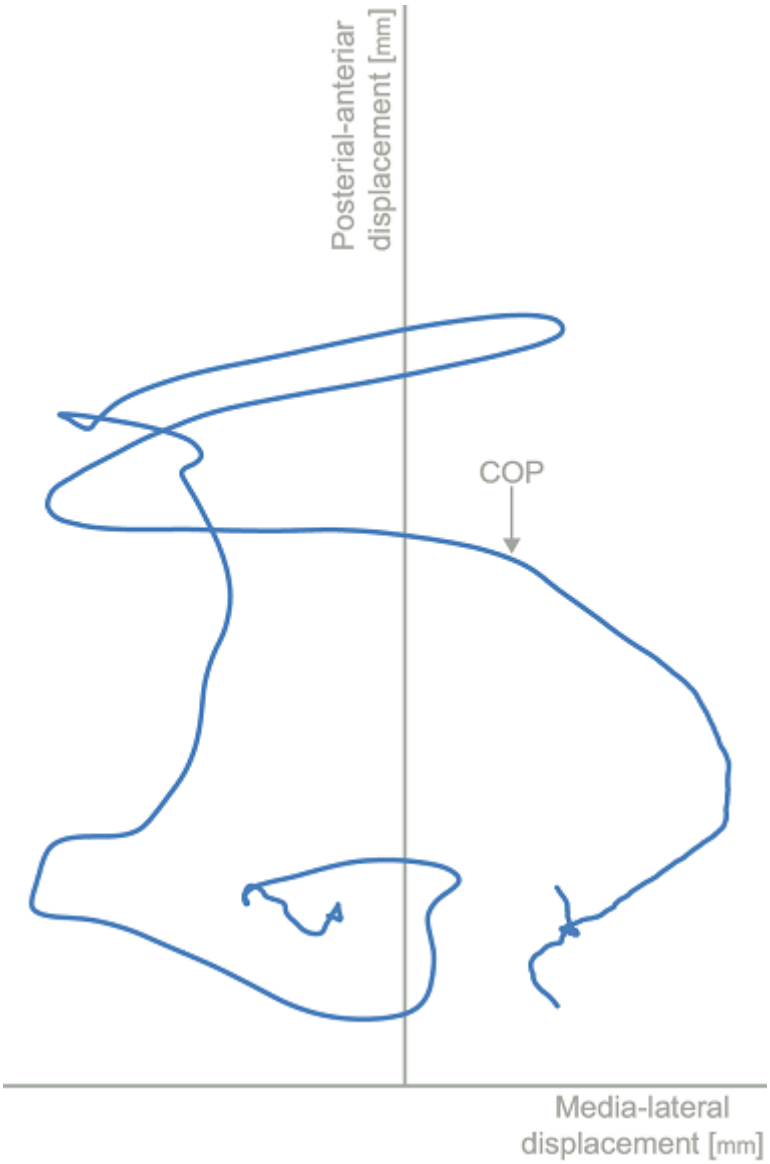
Cursors

Start
Indicates the start of the standing.

End
Indicates the end of the standing.

Analysis

Analysis enables you to check the signal of the ground reaction force and the calculated parameters. Under the COP tab you can see the X:Y signal. Individual components of the ground reaction forces and of the COP movement can be visualized under the Signals tab. Under the Repetitions tab you can see all the calculated parameters.



For some modules additional analysis routines are available as separate products. For more information see section About MARS or contact us.

GENERAL PARAMETERS

Weight Transfer T [s]

Weight Transfer is the time in seconds required to voluntarily shift COG forward beginning in the seated position and ending with full weight bearing on the feet.

Rising Index [%BW]

Rising Index is the amount of force exerted by the legs during the rising phase. The force is expressed as a percentage of the patient's body weight.

COP Sway V [mm/s]

Average COP Sway Velocity over the base of support during the rising phase.

SQUAT - TEST

This measurement module is a part of MARS Strength & Power.

Brief Description

Selecting Input Parameters

Measurement

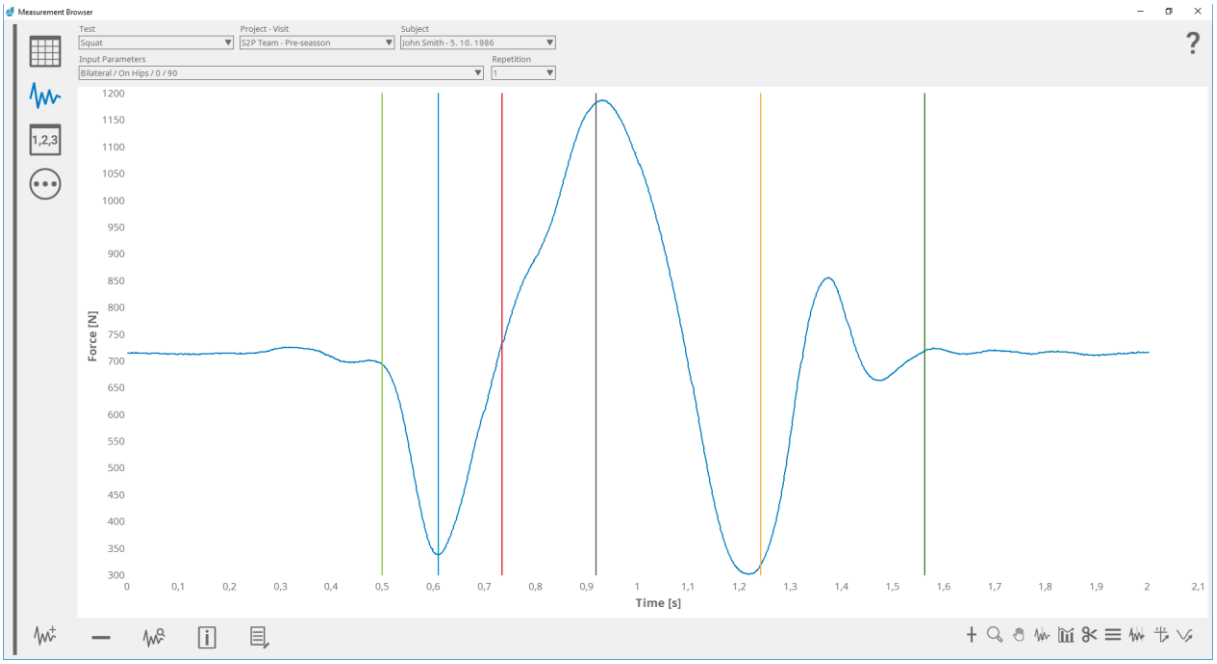
Cursors

Analysis

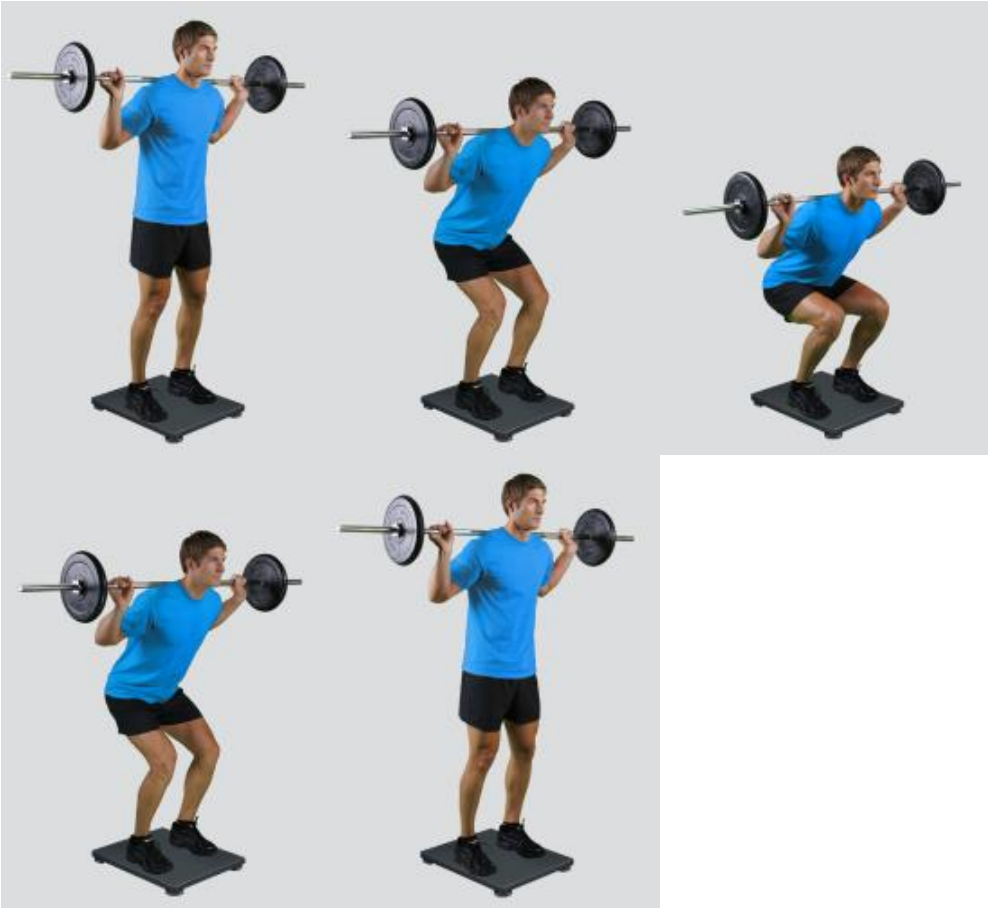
References

Brief Description

Squat is a vertical down-and-up movement which is among the most often used strength exercise for maximal anaerobic power output, strength endurance and injury prevention of the lower extremities. It is a concentric or eccentric/concentric muscle action which involves coordinated movement in the trunk, hips and knees. However, squat is not only used for exercising, but also as a clinical test. Based on the parameters derived from the ground reaction force dynamics of this elementary movement pattern can be thoroughly studied.



The initial position of the subject is usually a standing position. From this position a person performs a vertical downward movement into a semi-squat (knee ~90° and trunk/hips in a flexed position). However, this position can sometimes be adjusted to the specific goals of the measurement (e.g. half-squat). The subject than needs to perform vertical upward movement. In this phase, the majority of parameters are calculated.



Selecting Input Parameters

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

- Lower Extremities
- Upper Extremities
- Additional Weights [kg]
- Angle [°]

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

Subject is free to use his/her arms as he/she want. Specifically useful when observing how subjects differ in using arms as a biomechanical advantage.

Across the Chest

The subject places his/her hands across his/her chest.

Behind the Neck

The subject places his/her hands behind his/her neck.

Other user defined

In case of any other position of the upper extremities, the user can define new positions under Settings panel - section Input parameters. After doing so, the newly defined input parameter will from then on appear as an optional choice under the Upper extremities in the Squat measurement module.

ADDITIONAL WEIGHTS

0/5/10/15/20/25/30/35/40/45/50/55/60/65/70/75/80/85/90/95/100 kg

Other user defined

In case of different amount of additional weights, the user can define new values under Settings panel - section Input parameters. After doing so, the newly defined input parameter will from then on appear as an optional choice under the Additional Weights in the Squat measurement module.

ANGLE [°]

90/60/30 °

The subject performs a squat to the position where the knee angle is 90/60/30 degrees.

Other user defined

In case of different angle, the user can define new values under Settings panel - section Input parameters. After doing so, the newly defined input parameter will from then on appear as an optional choice under the Angle in the Squat measurement module.

Measurement

Before starting a test select input parameters (on the left side of Measure window). Then 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 or press Space. At that time, the subject is free to start the squat and the software will automatically recognize the start and the end of the squat and will automatically stop the data acquisition. For details about this automatic acquisition please see Settings Panel. After the measurement is completed you can chose to Confirm, Reject or Repeat it.

If you want to start a new measurement, click the New Measurement button and repeat the procedure. Before starting a new measurement you can change the Input Parameters; if not, the Input Parameters of the previous measurement will be used.

Cursors

Start
Indicates the start of the squat (start of the movement).

Fmin
Indicates the minimum force during the counter movement.

T1
Indicates the event when force reaches the value of body weight during counter movement.

Push Off
Indicates the start of the push off.

T/2

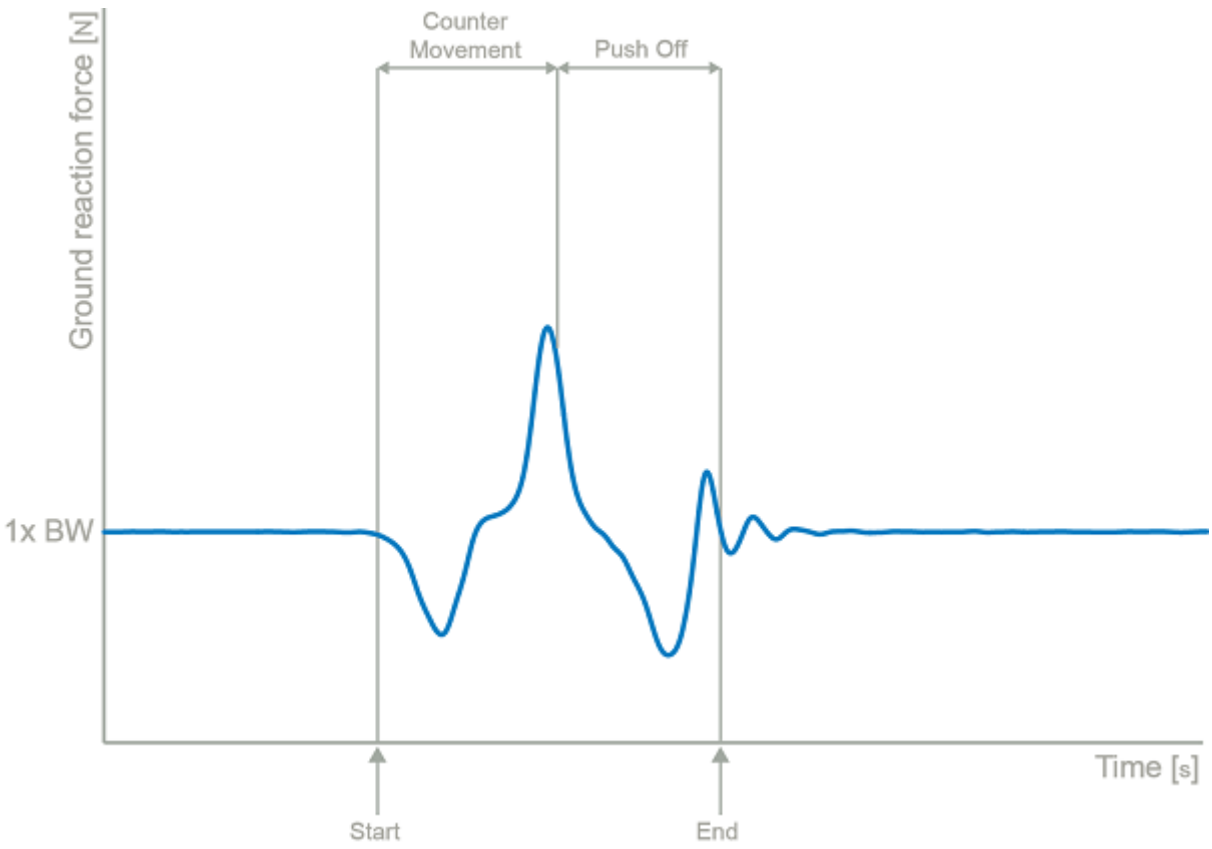
Indicates the half of the time between the Start and End event.

End
Indicates the end of the squat.

Analysis

Analysis enables you to check the signal(s) of the ground reaction force and the calculated parameters. Under the Signals tab you can see the signal(s) and automatically placed markers. You can move certain markers if they were placed incorrectly. Under the Repetitions tab you can see all the calculated.

All the parameters calculated for analysis are commonly used in biomechanics, kinesiology and rehabilitation1-5. Parameters are calculated from the ground reaction force. For more information regarding the parameters see the References.



For some modules additional analysis routines are available as separate products. For more information see section About MARS or contact us.

GENERAL PARAMETERS

Start interval relative F [%BW]

Average force in the 1st 50ms after the lowest position divided by the body weight (50 ms is a default value and can be changed in the Settings Panel - Start Interval).

Start interval relative P [W/kg]

Average power in the 1st 50ms after the lowest position divided by the body weight (50 ms is a default value and can be changed in the Settings Panel - Start Interval).

Start interval A [m/s^2]

Average acceleration in the 1st 50ms after the lowest position (50 ms is a default value and can be changed in the Settings Panel - Start Interval).

Start interval V [m/s]

Average velocity in the 1st 50ms after the lowest position (50 ms is a default value and can be changed in the Settings Panel - Start Interval).

Relative maximal F [%BW]

Maximal force during the squat 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 1st 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 2nd half of the Push Off [%BW]

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

Relative minimal F [%BW]

Minimal force during the Counter Movement divided by the body weight. At this point, the peak acceleration in downward direction occurs and the deceleration begins.

Relative maximal P [W/kg]

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

Relative E [J/kg]

Energy during the Push Off divided by the body weight.

A in the 1st half of Push Off [m/s^2]

Average acceleration between the lowest position and the half of the Push Off.

A in the 2nd half of Push Off [m/s^2]

Average acceleration between the half of the Push Off and the End.

TIME PARAMETERS

Squat T [s]

Time interval between the Start and the End.

Counter Movement T [s]

Time interval between the Start and the lowest position.

Push off T [s]

Time interval between the lowest position and the End.

Braking T [s]

Time interval between the minimal force and the lowest position.

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 to minimal F [s]

Time interval between the Start and the minimal force.

FORCE IMPULSE PARAMETERS

Negative FI [Ns]

Force Impulse of the parts where the ground reaction force is below the body weight.

Positive FI [Ns]

Force Impulse of the parts where the ground reaction force is above the body weight.

FI in the 1st half of Push Off [Ns]

Force impulse between the lowest position and the half of the Push Off.

FI in the 2nd half of Push Off [Ns]

Force impulse between the half of the Push Off and the End.

Ratio between FI in both halves of Push Off [%]

Ratio of the force impulse between the Lowest Position and the half of the Upward Movement and the force impulse between the half of the Upward Movement and the End.

CONTRALATERAL PARAMETERS

NOTE: Beware that this parameters are calculated only when using bilateral force plates.

Left leg - Start interval relative P [W/kg]

Average power in the 1st 50 ms of the Push Off divided by the body weight (50 ms is a default value and can be changed in the Settings Panel - Start Interval).

Left leg - Relative maximal F [%BW]

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

Left leg - Relative maximal P [W/kg]

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

Left leg - Relative E [J/kg]

Energy during the Push Off divided by the body weight.

Left leg - Push Off FI [Ns]

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

Right leg - Start interval relative P [W/kg]

Average power in the 1st 50 ms of the Push Off divided by the body weight (50 ms is a default value and can be changed in the Settings Panel - Start Interval).

Right leg - Relative maximal F [%BW]

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

Right leg - Relative maximal P [W/kg]

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

Right leg - Relative E [J/kg]

Energy during the Push Off divided by the body weight.

Right leg - Push Off FI [Ns]

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

Left/right leg - Start interval relative P [%]

Average power in the 1st 50 ms of the Push Off divided by the body weight (50 ms is a default value and can be changed in the Settings Panel - Start Interval).

Left/right leg - Relative maximal F [%]

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

Left/right leg - Relative maximal P [%]

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

Left/right leg - Relative E [%]

Energy during the Push Off divided by the body weight.

Left/right leg - Push Off FI [%]

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

References

Hori, N. et al. Comparison of four different methods to measure power output during the hang power clean and the weighted jump squat. The Journal of Strength & Conditioning Research 21, 314 (2007).

Bentley, J.R., Amonette, W.E., De Witt, J.K. & Hagan, R.D. Effects of different lifting cadences on ground reaction forces during the squat exercise. J Strength Cond Res 24, 1414-1420 (2010).

Kellis, E., Arambatzi, F. & Papadopoulos, C. Effects of load on ground reaction force and lower limb kinematics during concentric squats. Journal of Sports Sciences 23, 1045-1055 (2005).

Rahmani, A., Viale, F., Dalleau, G. & Lacour, J.-R. Force/velocity and power/velocity relationships in squat exercise. Eur J Appl Physiol 84, 227-232 (2001).

Zink, A.J., Perry, A.C., Robertson, B.L., Roach, K.E. & Signorile, J.F. Peak power, ground reaction forces, and velocity during the squat exercise performed at different loads. The Journal of Strength & Conditioning Research 20, 658 (2006).

SQUAT JUMP - TEST

This measurement module is a part of MARS Strength & Power.

Brief Description

Selecting Input Parameters

Measurement

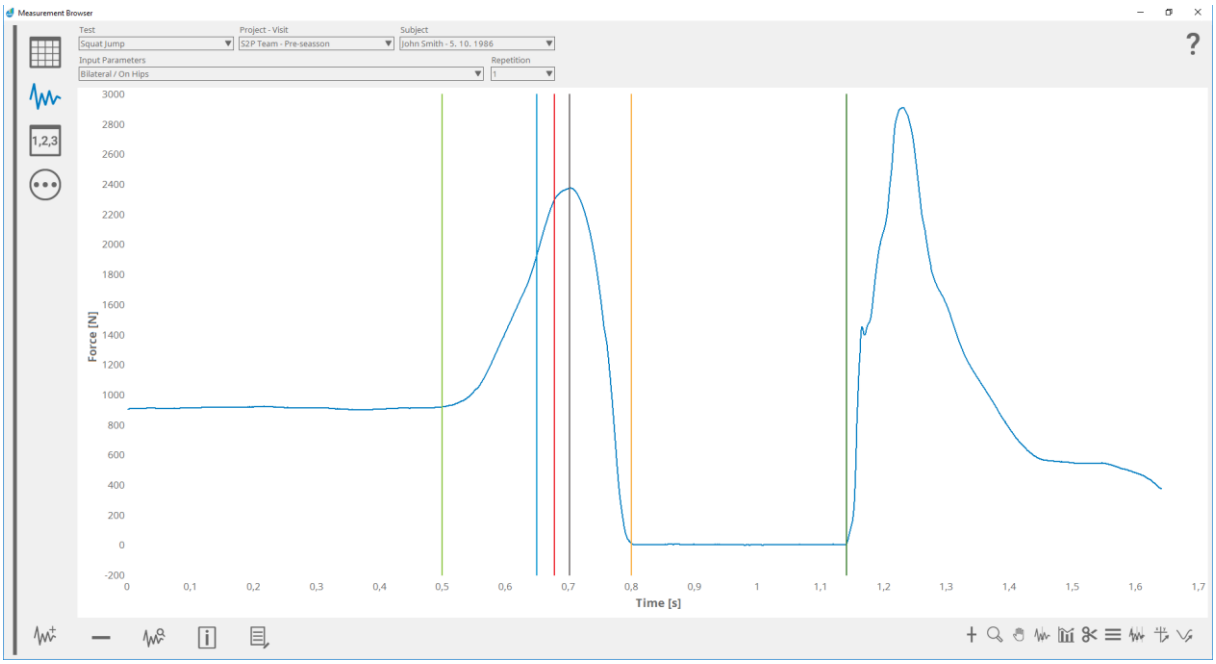
Cursors

Analysis

References

Brief Description

Squat jump is a vertical jump and among the most often used tests for maximal anaerobic power output of the lower extremities. It is a concentric muscle action which involves coordinated extension of the trunk, hip, knee and ankle. Based on the parameters derived from the ground reaction force and flight time dynamics of this elementary movement pattern can be thoroughly studied.



The initial position of the subject is usually a semi-squat (knee ~90° and trunk/hips in a flexed position). However, this position can sometimes be adjusted to the specific goals of the measurement. From the starting position the subject performs a vertical push off action as quickly and as explosively as possible in order to perform the highest possible jump in the shortest possible time; thereby using a concentric movement only. It is important to ensure that the subject does not perform any counter movement before the push off.

Selecting Input Parameters

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

- Lower Extremities
- Upper Extremities

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.

Across the Chest

The subject places his/her hands across his/her chest.

Behind the Neck

The subject places his/her hands behind his/her neck.

Other user defined

In case of any other position of the upper extremities, the user can define new positions under Settings panel - section Input parameters. 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

Before starting a test select input parameters (on the left side of Measure window). Then the subject acquires the required position (i.e. upright stance). Ensure that the subject is standing in the centre of the plate as described above. After the subject has acquired the required position and is ready to start the movement, click Start or press Space. At that time, the subject is free to start the jump and the software will automatically recognize the beginning and the end of the jump and will automatically stop the data acquisition. For details about this automatic acquisition please see Settings Panel. After the measurement is completed you can chose to Confirm, Reject or Repeat it.

If you want to start a new measurement, click the New Measurement button and repeat the procedure. Before starting a new measurement you can change the Input Parameters; if not, the Input Parameters of the previous measurement will be used.

Cursors

Start
Indicates the start of the jump (start of the movement).

T/2
Indicates the half of the time between the Start and Take Off event.

G/2
Indicates the time where half of the force impulse is reached. Force impulse is calculated between the Start and Take Off event.

Fmax
Indicates the maximum force between the Start and Take Off event.

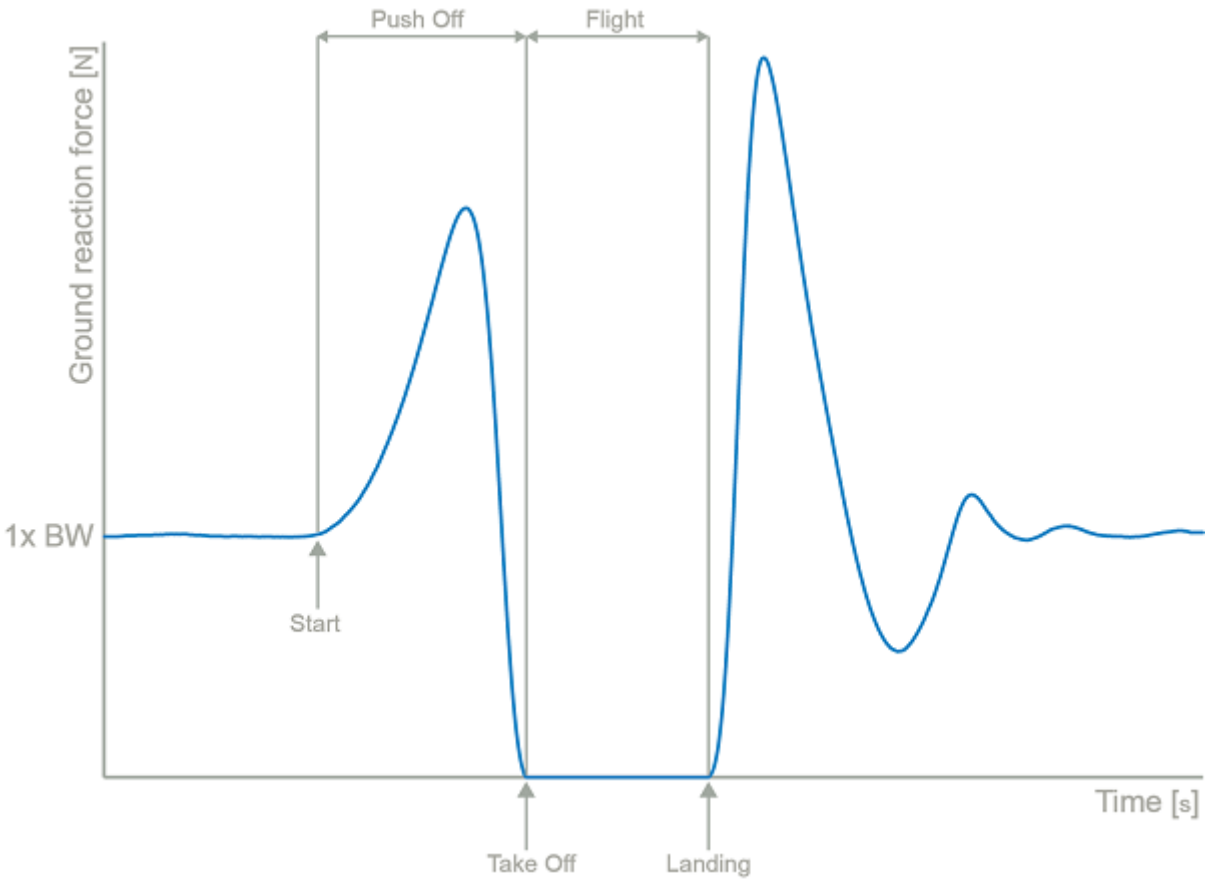
Take Off
Indicates the start of the flight phase.

Landing
Indicates the start of the landing.

Analysis

Analysis enables you to check the signal(s) of the ground reaction force and the calculated parameters. Under the Signals tab you can see the signal(s) and automatically placed markers. You can move certain markers if they were placed incorrectly. Under the Repetitions tab you can see all the calculated.

All the parameters calculated for analysis are commonly used in biomechanics, kinesiology and rehabilitation1-4. Parameters are calculated from the ground reaction force and flight time. For more information regarding the parameters see the References.



For some modules additional analysis routines are available as separate products. For more information see section About MARS or contact us.

GENERAL PARAMETERS

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.

Start interval relative F [%BW]

Average force in the 1st 50ms of the Push Off divided by the body weight (50 ms is a default value and can be changed in the Settings Panel - Start Interval).

Start interval relative P [W/kg]

Average power in the 1st 50ms of the Push Off divided by the body weight (50 ms is a default value and can be changed in the Settings Panel - Start Interval).

Start interval A [m/s^2]

Average acceleration in the 1st 50ms of the Push Off (50 ms is a default value and can be changed in the Settings Panel - Start Interval).

Start interval V [m/s]

Average velocity in the 1st 50ms of the Push Off (50 ms is a default value and can be changed in the Settings Panel - Start Interval).

Relative maximal F [%BW]

Maximal force during the jump (i.e. Push Off) divided by the body weight.

Relative maximal F in the 1st half of Push Off [%BW]

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

Relative maximal F in the 2nd 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 Push Off divided by the body weight.

Relative E [J/kg]

Energy during the Push Off divided by the body weight.

A [m/s^2]

Average acceleration during the jump.

A in the 1st half of Push Off [m/s^2]

Average acceleration between the Start and the half of the Push Off.

A in the 2nd half of Push Off [m/s^2]

Average acceleration between the half of the Push Off and the Take Off.

Vertical Take Off V [m/s]

Velocity of the vertical movement at the Take Off calculated from Flight T.

TIME PARAMETERS

Push Off T [s]

Time interval between the Start and the Take Off.

Flight T [s]

Time interval between the Take Off and the Landing.

T of the 1st half of FI [s]

Time interval between the Start and the half of the total force impulse.

T of the 2nd half of FI [s]

Time interval between the half of the total force impulse and the Take Off.

T to maximal F [s]

Time interval between the Start and the maximal force.

T from maximal F to 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.

Total FI from Flight T [Ns]

Total force impulse calculated from the Flight Time.

FI in the 1st half of Push Off [Ns]

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

FI in the 2nd half of Push Off [Ns]

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

Ratio between FI in both halves of Push Off [%]

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

FI between Start 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 of 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.

CONTRALATERAL PARAMETERS

NOTE: Beware that this parameters are calculated only when using bilateral force plates.

Left leg - Start interval relative P [W/kg]

Average power in the 1st 50 ms of the Push Off divided by the body weight (50 ms is a default value and can be changed in the Settings Panel - Start Interval).

Left leg - Relative maximal F [%BW]

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

Left leg - Relative maximal P [W/kg]

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

Left leg - Relative E [J/kg]

Energy during the Push Off divided by the body weight.

Left leg - Push Off FI [Ns]

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

Right leg - Start interval relative P [W/kg]

Average power in the 1st 50 ms of the Push Off divided by the body weight (50 ms is a default value and can be changed in the Settings Panel - Start Interval).

Right leg - Relative maximal F [%BW]

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

Right leg - Relative maximal P [W/kg]

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

Right leg - Relative E [J/kg]

Energy during the Push Off divided by the body weight.

Right leg - Push Off FI [Ns]

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

Left/right leg - Start interval relative P [%]

Average power in the 1st 50 ms of the Push Off divided by the body weight (50 ms is a default value and can be changed in the Settings Panel - Start Interval).

Left/right leg - Relative maximal F [%]

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

Left/right leg - Relative maximal P [%]

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

Left/right leg - Relative E [%]

Energy during the Push Off divided by the body weight.

Left/right leg - Push Off FI [%]

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

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STAMPING - TEST

This measurement module is a part of MARS Strength & Power.

Brief Description

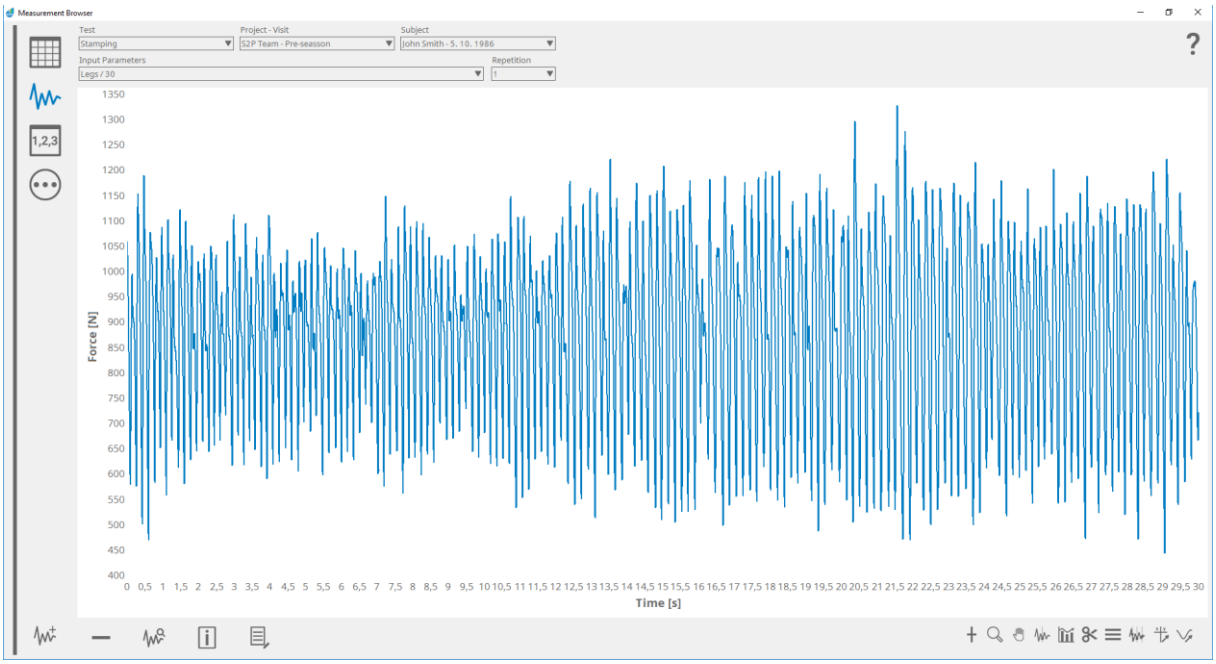
Selecting Input Parameters

Measurement

Analysis

Brief Description

Fast alternating leg movements are essential to the locomotion in agile sports such as fast acceleration, quick stops, turns or direction changes. Maximal or near maximal locomotion speeds pose a challenge or the central nervous system, to preserve proper limb coordination in accordance with the task demands. Control over the rapid alternating muscle relaxations and contractions turns out to be an important limiting factor affecting frequency, smoothness and effectiveness of locomotion. Fatigue resistance presents another important aspect of alternating high speed leg movement. Accumulation of metabolites formed during intense muscle contraction can affect nerve signal transmission as well as central movement processing. Athletes that are able to cope with the fatigue better have an advantage in sports where prolonged high speed and power activities are needed.



In order to measure the speed and coordination of alternating leg movements, ground stamping test is performed. The subject is asked to adopt a sport specific position like for example a defensive stance in basketball. Before the start of the measurement, both feet are positioned on the force plate. The subject starts to stamp as fast as possible, not stepping outside the force plate. By performing the test for a longer period of time, specific endurance can be assessed. Additionally, other test modalities can be used according to the specific needs (for example hands stamping, etc.).

Selecting Input Parameters

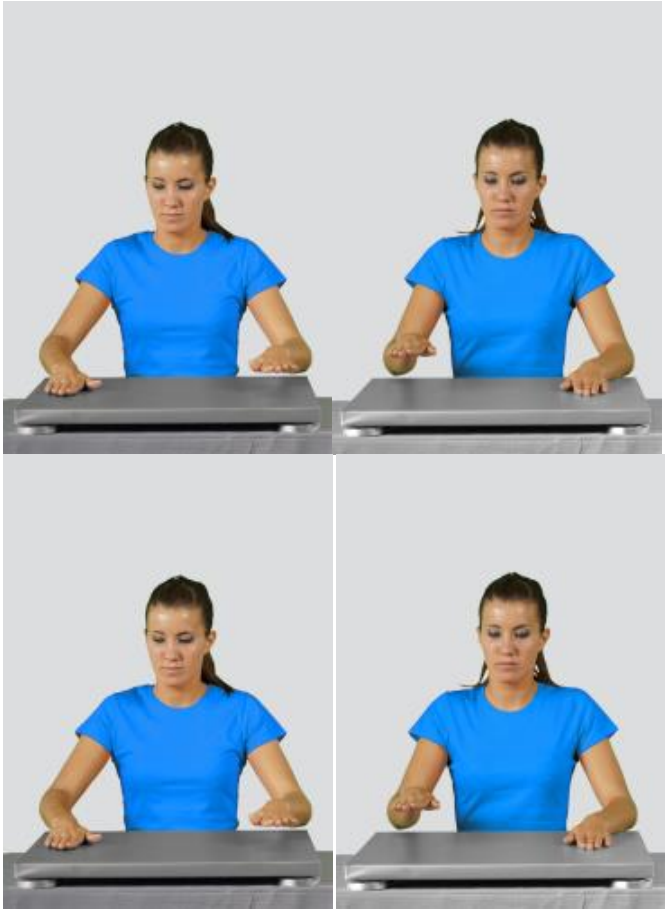
Before the measurement can start, the user has to choose some input parameters with which the measured motor task (stamping) is specifically defined. These parameters are important for further analysis, comparisons and reporting. The stamping characteristics are defined by the following parameters:

- Type of Stamping
- Duration [s]

TYPE OF STAMPING

Arms

The subject performs the stamping task so that he/she is alternatively tapping one and the other hand against the surface of the force plate, thereby using the highest possible frequency – just like drumming.



Legs

The subject performs the stamping taskso that he/she is alternatively loading one and the other foot with the highest possible frequency. This task should be performed with the “active feet” which means that the heels are lifted and the foot pressure is on the front parts of the feet.

Other user defined

In case of any other type of a stamping-like movement/task, the user can define it under Settings panel - section Input parameters. After doing so, the newly defined input parameter will from then on appear as an optional choice under the Type of Stamping in the Stamping measurement module.

DURATION

10/20/30/40/50/60/70/80/90/100 s

Other user defined

In case of any other duration, the user can define it under Settings panel - section Input parameters. After doing so, the newly defined duration of the quiet stance task will from then on appear as an optional choice under the Duration in the Stamping measurement module.

Measurement

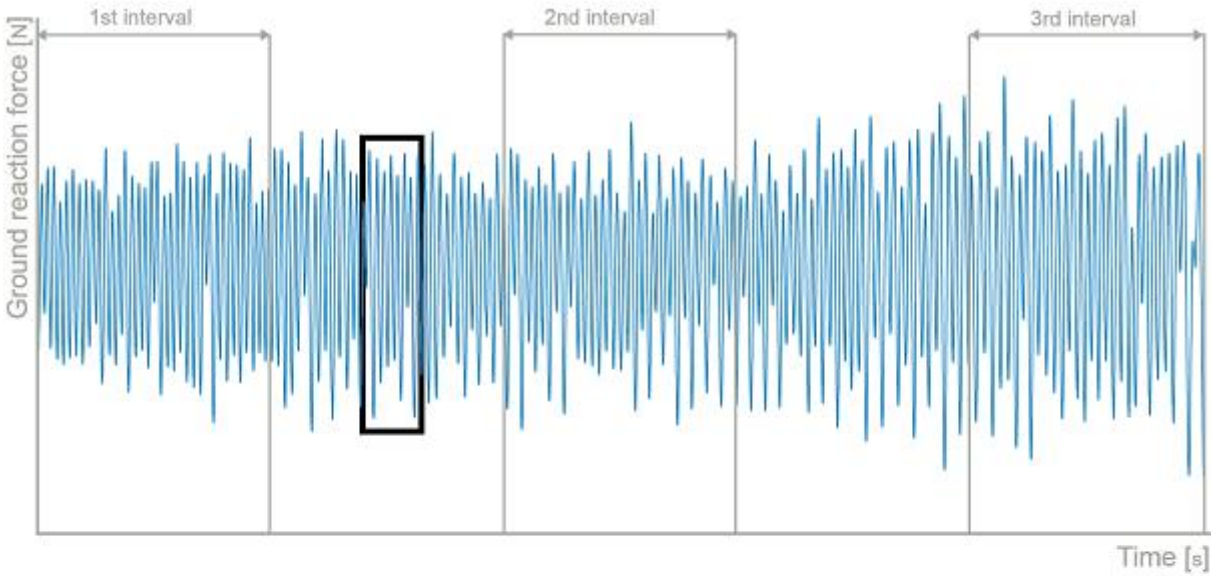
After selecting the input parameters, the subject acquires the initial position for the test: (1) for the Legs-Stamping he steps on the force plate and acquires the required initial active position or (2) for the Hands-Stamping he places the hands on the force plate while sitting in front of it. After you are satisfied with the initial position, you give the verbal start signal to the subject to begin with the stamping task. Right after the subject begins with the task, click Start. After this, the software begins with the signal acquisition and the time left until the end of the test is displayed in the bottom-right corner of the screen.

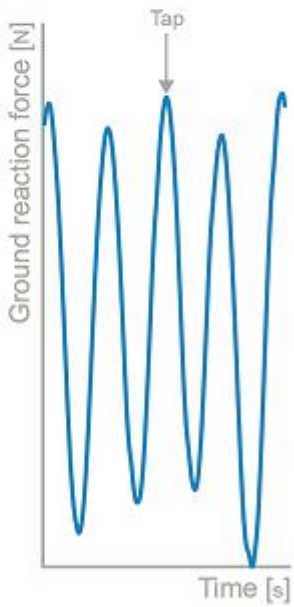
Before starting a test select input parameters (on the left side of Measure window). Then the subject acquires the initial position for the test: (1) for the Legs-Stamping he steps on the force plate and acquires the required initial active position or (2) for the Hands-Stamping he places the hands on the force plate while sitting in front of it. After you are satisfied with the initial position, you give the verbal start signal to the subject to begin with the stamping task. Right after the subject begins with the task, click Start or press Space. After this, the software begins with the signal acquisition and the time left until the end of the test is displayed in the top-right corner of the screen. After the measurement is completed you can chose to Confirm, Reject or Repeat it.

If you want to start a new measurement, click the New Measurement button and repeat the procedure. Before starting a new measurement you can change the Input Parameters; if not, the Input Parameters of the previous measurement will be used.

Analysis

Analysis enables you to check the signal(s) of the ground reaction force and the calculated parameters. Under the Signals tab you can see the signal(s). Under the Repetitions tab you can see all the calculated parameters.





For some modules additional analysis routines are available as separate products. For more information see section About MARS or contact us.

GENERAL PARAMETERS

Mean FRE from peaks [Hz]

The frequency of stamping calculated as the number of vertical force peaks divided by the measurement time.

Mean FRE from peaks – 1st interval [Hz]

The frequency of stamping calculated as the number of vertical force peaks in the initial time interval (i.e. start + the interval duration) divided by the duration of the initial time interval. The default duration of this interval is 3 s, but it can be changed in the Settings panel - Time Interval.

Mean FRE from peaks – 2nd interval [Hz]

The frequency of stamping calculated as the number of vertical force peaks in the middle time interval (i.e. mid-time ± 1 of the interval duration) divided by the duration of the middle time interval. The default duration of this interval is 3 s, but it can be changed in the Settings panel - Time Interval.

Mean FRE from peaks – 3rd interval [Hz]

The frequency of stamping calculated as the number of vertical force peaks in the final time interval (i.e. end - the interval duration) divided by the duration of the final time interval. The default duration of this interval is 3 s, but it can be changed in the Settings panel - Time Interval.

Endurance index [%]

The mean frequency of stamping in the middle (2nd) time interval divided by the mean frequency of stamping in the initial (1st) time interval. The mean frequencies are calculated as the number of vertical force peaks in the time interval divided by the duration of the time interval.

Fatigue index [%]

The mean frequency of stamping in the final (3rd) time interval divided by the mean frequency of stamping in the initial (1st) time interval. The mean frequencies are calculated as the number of vertical force peaks in the time interval divided by the duration of the time interval.

Minimum FRE from peaks [Hz]

The minimal frequency of stamping calculated as the number of vertical force peaks divided by the duration of the time interval. The running time interval for which the frequency values (and then the minimum among them) are calculated is by default set to 3 s, but can be changed in the Settings panel - Time Interval.

Maximum FRE from peaks [Hz]

The maximal frequency of stamping calculated as the number of vertical force peaks divided by the duration of the time interval. The running time interval for which the frequency values (and then the minimum among them) are calculated is by default set to 3 s, but can be changed in the Settings panel - Time Interval.

Min/Max ratio – FRE from peaks [%]

The ratio between the minimum frequency and maximum frequency of stamping calculated as the number of vertical force peaks divided by the duration of the time interval. The time interval for which the frequency values are calculated is by default set to 3 s, but can be changed in the Settings panel - Time Interval.

Mean F of the peaks – abs [N]

The mean value of the peaks in vertical force during the foot/hand taps. The parameter is expressed in absolute force values.

Mean F of the peaks – rel [%BW]

The mean value of the peaks in vertical force during the foot/hand taps. The parameter is expressed in relative values as the percentage of the body weight.

STEP ANALYSIS - TEST

This measurement module is a part of MARS Balance & Stability.

Brief Description

Selecting Input Parameters

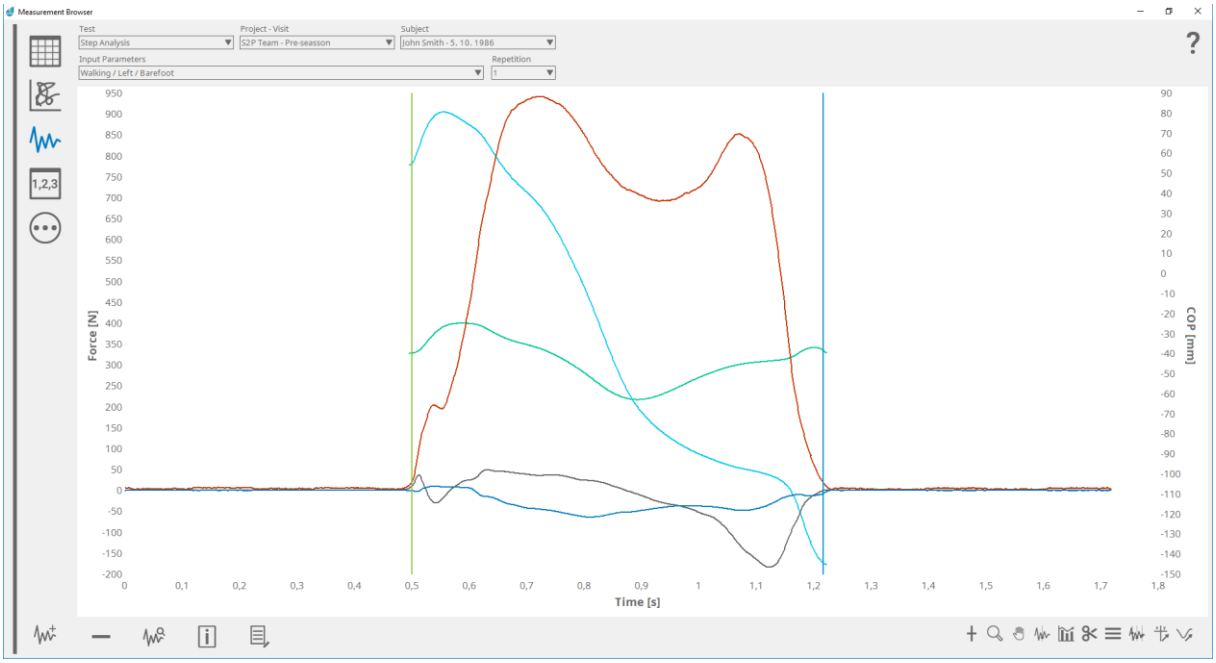
Measurement

Cursors

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.

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
- Side
- Footwear

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 windowof 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 acquires the required start position and walks over the plate. It is important that the direction of walking is along the Y-axis (positive) 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, will measure the entire stance phase until the end of it and will automatically stop the data acquisition. Note that the subject must step on one plate (in case of two plate setup) with one foot. For details about this automatic acquisition please see Settings Section.

Before starting a test select input parameters (on the left side of Measure window). Then the subject acquires the required start position and walks over the plate. It is important that the direction of walking is along the Y-axis (positive) 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 or press Space. After doing so, the software will automatically recognize the moment of the first foot contact, will measure the entire stance phase until the end of it and will automatically stop the data acquisition. Note that the subject must step on one plate (in case of two plate setup) with one foot. For details about this automatic acquisition please see Settings Section. After the measurement is completed you can chose to Confirm, Reject or Repeat it.

If you want to start a new measurement, click the New Measurement button and repeat the procedure. Before starting a new measurement you can change the Input Parameters; if not, the Input Parameters of the previous measurement will be used.

Cursors

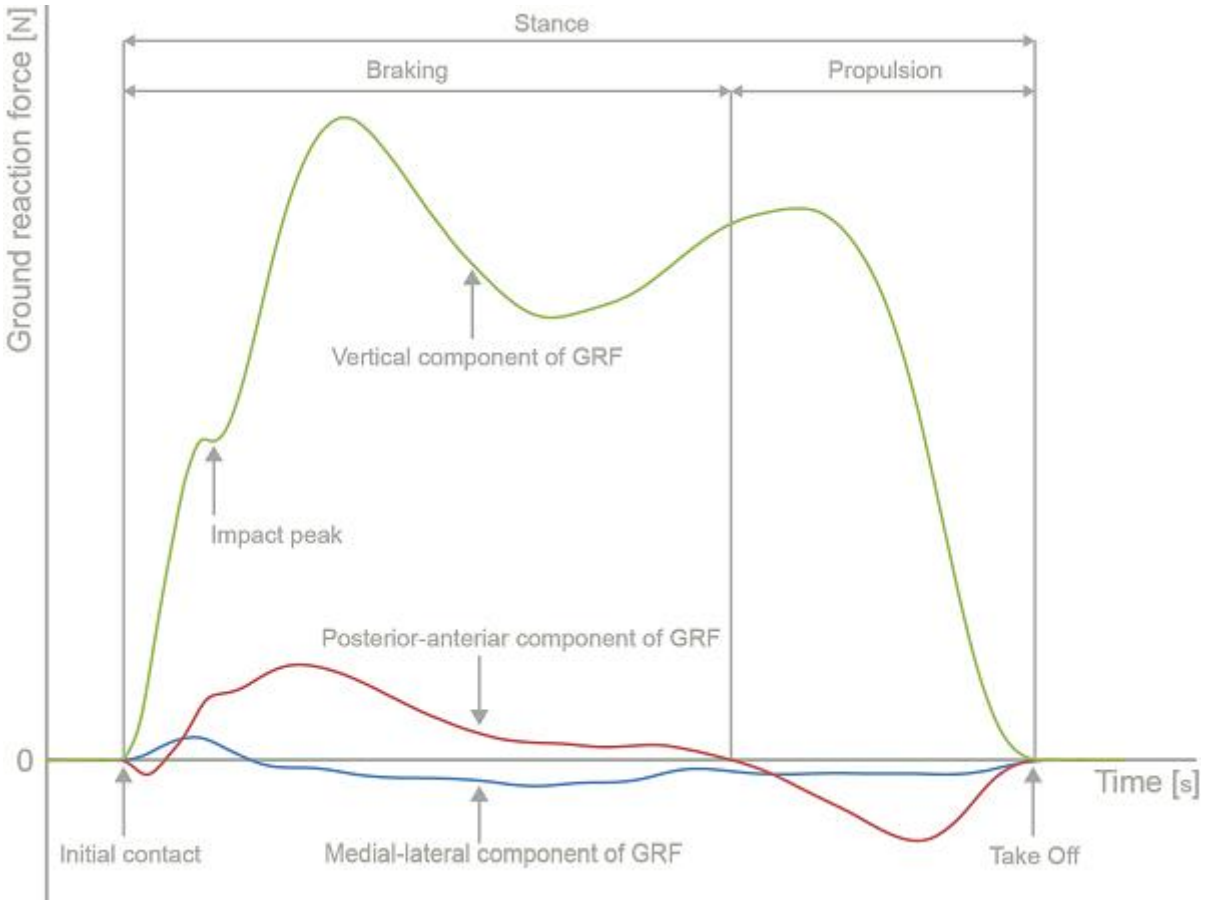
Start
Indicates the start of the step i.e. first contact with the force plate.

End
Indicates the end of the standing.

Analysis

Analysis enables you to check the signal of the ground reaction force and the calculated parameters. Under the COP tab you can see the X:Y signal. Individual components of the ground reaction forces and of the COP movement can be visualized under the Signals tab. Under the Repetitions tab you can see all the calculated parameters. Under More - 3D step animation vectors of resultant force applied to the ground during the step phase are shown.

All the parameters calculated for analysis are commonly used in biomechanics, kinesiology and rehabilitation. Parameters are calculated from the ground reaction force.



For some modules additional analysis routines are available as separate products. For more information see section About MARS or contact us.

3D STEP ANIMATION

The 3D step animation shows vectors of resultant force applied to the ground during the step phase. Vectors are shown at specific time point as set in the settings.

Time interval [ms]

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

Start animation

Start the animation of the step.

Stop animation

Stop the animation of the step.

Absolute time [s]

The time interval between the adjacent cut points.

Time points

The number of the cut points.

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 vertica l 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 [%BWs]

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 [%BWs]

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 [%BWs]

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 [%BWs]

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 [%BWs]

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.

SYMMETRY - TEST

This measurement module is a part of MARS Balance & Stability.

Brief Description

Selecting Input Parameters

Measurement

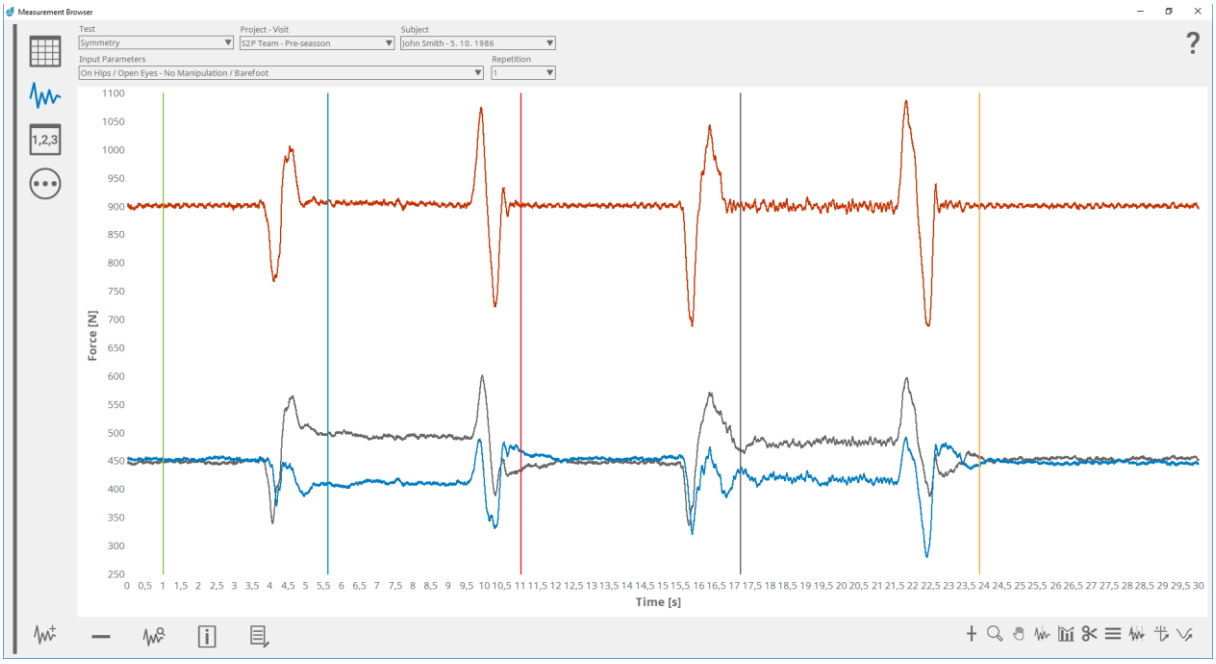
Cursors

Analysis

References

Brief Description

Side-to-side differences (i.e. (a)symmetries) are commonly tested in sports science and medicine and interpreted in the context of prevention and rehabilitation of musculoskeletal injuries. Differences between loading the left and right leg during bilateral weight bearing activities (stance, chair rising, squat, etc.) has been a common way of testing body postural/movement symmetries. By definition, a symmetrical movement act should express the highest possible level of equivalence between side involvements. Deviations from this optimum (i.e. weight bearing asymmetries) have been reported in patients after injuries of lower extremities – a compensatory mechanism (Ross et al., 2014; Webster et al., 2014). Moreover, anthropometrical asymmetries (expl. differences in leg lengths or scoliosis), neurological deficits and contralateral legs strength differences have been reported to result in significant weight bearing asymmetries (White et al., 2004; Chockalingam et al., 2004).



The initial position of the subject is an upright stance. This is followed by transition to semi-squat, back to upright stance, down to full squat and at the end back to upright

stance again. Transitions between the postures has to be smooth and in each posture the subject should remain as still as possible for several seconds.

Selecting Input Parameters

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

- Uper Extremities
- Sensory Manipulation
- Footwear

UPPER EXTREMITIES

On Hips

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

Free

Subject is free to use his/her arms as he/she want. Specifically useful when observing how subjects differ in using arms as a biomechanical advantage.

Across the Chest

The subject places his/her hands across his/her chest.

Behind the Neck

The subject places his/her hands behind his/her neck.

Other user defined

In case of any other position of the upper extremities, the user can define new positions under Settings panel - section Input parameters. After doing so, the newly defined input parameter will from then on appear as an optional choice under the Upper extremities in the Symmetry measurement module.

SENSORY MANIPULATION

Closed Eyes

The subject is restricted to see. This might be done by simply closing the eyes but a better control over this sensory restriction can be by using a non-transparent band or goggles in order to best keep the subjects vision excluded.

Open Eyes – No Manipulation

The subject keeps his/her eyes open. The standard procedure is to ask the subject to keep a focus on a visual marker placed on a wall 1 to 3 meters in front of him/her.

Vestibular Perturbation

Perturbation of the vestibular sensory organ can be done in different ways: head rotation or head circumduction during or before the quiet stance; artificial stimulation of the vestibular system etc. The user should be aware of the potential direct mechanical effects of the vestibular manipulation task.

Other user defined

In case of any other sensory manipulation, the user can define it under Settings panel - section Input parameters. After doing so, the newly defined input parameter will from then on appear as an optional choice under the Sensory Manipulation in the Symmetry measurement module.

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 case of any other type of footwear, the user can define it under Settings panel - section Input parameters. After doing so, the newly defined input parameter will from then on appear as an optional choice under the Footwear in the Symmetry measurement module.

Measurement

This measurement module requires two force plates setup.

Before starting a test select input parameters (on the left side of Measure window). Then the subject steps on the plate and acquires the required position (upright stance with parallel feet at hips width). 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 or press Space. The subject is instructed to transit between the following postures: upright stance, semi-squat, upright stance, full-squat and upright stance again. The transitions should be performed with a moderate velocity (<1 s per transition) and the subject should try to remain as still as possible in each of the newly gained positions; until the next transition is required. The instructions for transitions are given by the measurer verbally with the timing that follows the commands displayed at top-right of the screen during the course of the measurement. After the measurement is completed you can chose to Confirm, Reject or Repeat it.

If you want to start a new measurement, click the New Measurement button and repeat the procedure. Before starting a new measurement you can change the Input Parameters; if not, the Input Parameters of the previous measurement will be used.

Cursors

Start Standing 1
Indicates the start of the first standing phase.

Start Semi - Squat
Indicates the start of the semi-squat phase.

Start Standing 2
Indicates the start of the second standing phase.

Start Squat
Indicates the start of the squat phase.

Start Standing 3
Indicates the start of the third standing phase.

Analysis

Analysis enables you to check the signal(s) of the ground reaction force and the calculated parameters. Under the Signals tab you can see the signal(s) and automatically placed markers. You can move certain markers if they were placed incorrectly. Under the Repetitions tab you can see all the calculated parameters.

All the parameters calculated for analysis are commonly used in biomechanics, kinesiology and rehabilitation1-4. Parameters are calculated from the ground reaction force. For more information regarding the parameters see the References.

For some modules additional analysis routines are available as separate products. For more information see section About MARS or contact us.

GENERAL PARAMETERS

Standing Symmetry Index

Relative difference in weight bearing between legs expressed as a percentage of common vertical force during upright stance phase.

Semi-Squat Symmetry Index

Relative difference in weight bearing between legs expressed as a percentage of common vertical force during semi-squat phase.

Squat Symmetry Index

Relative difference in weight bearing between legs expressed as a percentage of common vertical force during squat phase.

Weight - Standing – Left

Percentage of the body weight on the left force plate during upright stance phase.

Weight - Standing – Right

Percentage of the body weight on the right force plate during upright stance phase.

Weight - Semi-Squat – Left

Percentage of the body weight on the left force plate during semi-squat phase.

Weight - Semi-Squat – Right

Percentage of the body weight on the right force plate during semi-squat phase.

Weight - Squat – Left

Percentage of the body weight on the left force plate during squat phase.

Weight - Squat – Right

Percentage of the body weight on the right force plate during squat phase.

References

Clark R.A., Howells B., Pua Y.H., Feller J., Whitehead T., Webster K.E. Assessment of standing balance deficits in people who have undergone anterior cruciate ligament reconstruction using traditional and modern analysis methods. J Biomech 47, 1134-7 (2014).

Webster K.E., Austin D.C., Feller J.A., Clark R.A., McClelland J.A. Symmetry of squatting and the effect of fatigue following anterior cruciate ligament reconstruction. Knee Surg Sports Traumatol Arthrosc. [PubMed - as supplied by publisher], [Epub ahead of print], (2014).

Chockalingam N., Dangerfield P.H., Rahmatalla A., Ahmed el-N., Cochrane T. Assessment of ground reaction force during scoliotic gait. Eur Spine J 13, 750-4 (2004).

White S.C., Gilchrist L.A., Wilk B.E. Asymmetric limb loading with true or simulated leg-length differences. Clin Orthop Relat Res. 421, 287-92 (2004).

TAPPING - TEST

This measurement module is a part of MARS Balance & Stability.

Brief Description

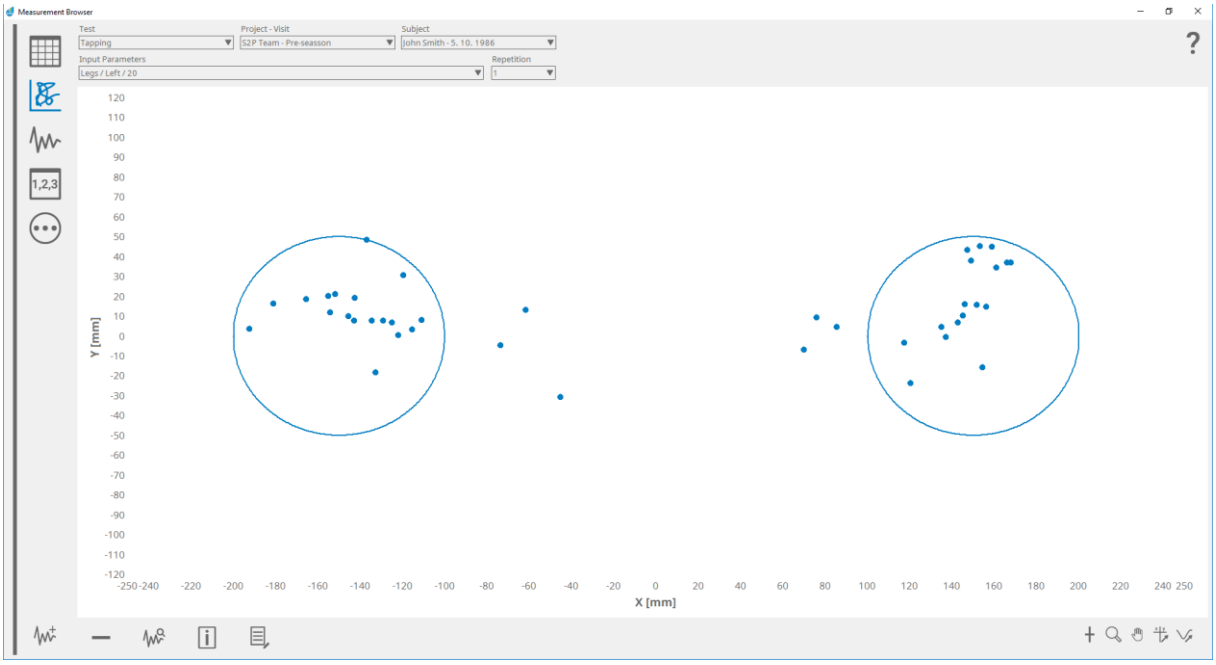
Selecting Input Parameters

Measurement

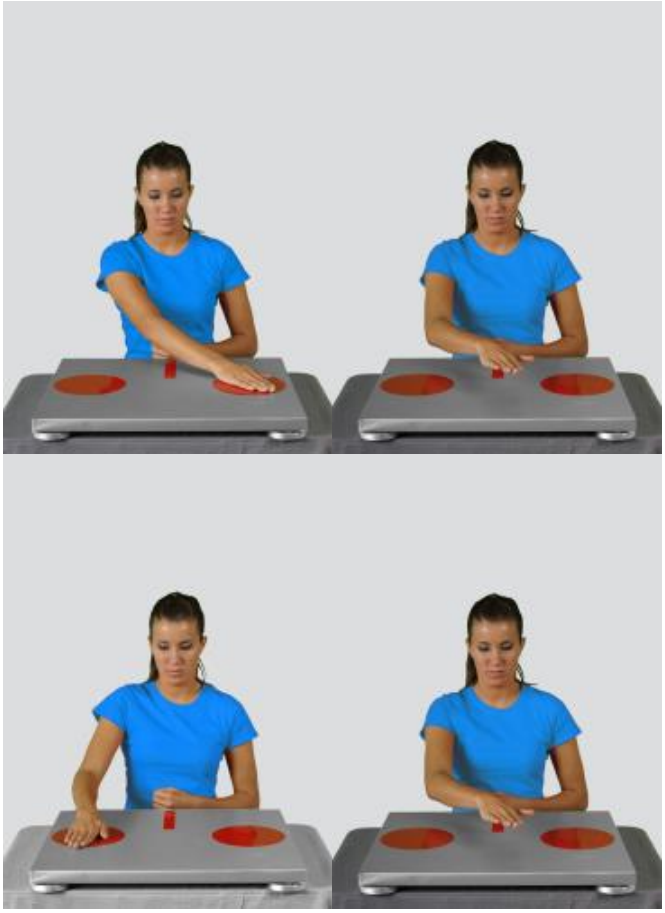
Analysis

Brief Description

Speed/accuracy trade-off regards any movement where accurate termination or change of movement direction is of importance. It describes the reciprocal relation where increased speed of movement reduces its accuracy and vice versa. Moreover, reducing the size of the target area, where movement direction changes or terminates, causes decline in speed in order to maintain accuracy. On the other hand, if there is no special requirement for precision, the same task can be used to measure the maximal frequencies of the cyclic movements done by the same extremity. This basic principle implies directly to sports and every day movements such as basketball throwing, passing, precise leg positioning during locomotion etc.



The ability to produce fast and accurate movements is readily measured by a simple tapping test. Alternating or discrete arm or leg movements can be used depending on the focus of interest. The subject is seated on a chair in front of the force plate; the latter installed at the table level or on the floor. In the initial position the non-dominant limb is positioned in the middle position in front of the force plate and the measured limb is positioned into a target space on the contralateral side. Subject`s goal is to tap opposing target spaces (i.e. left-right-left-right-etc.) with the chosen extremity as fast and as accurate as possible. The difficulty of the test can be increased by decreasing the size of the target space.



Selecting Input Parameters

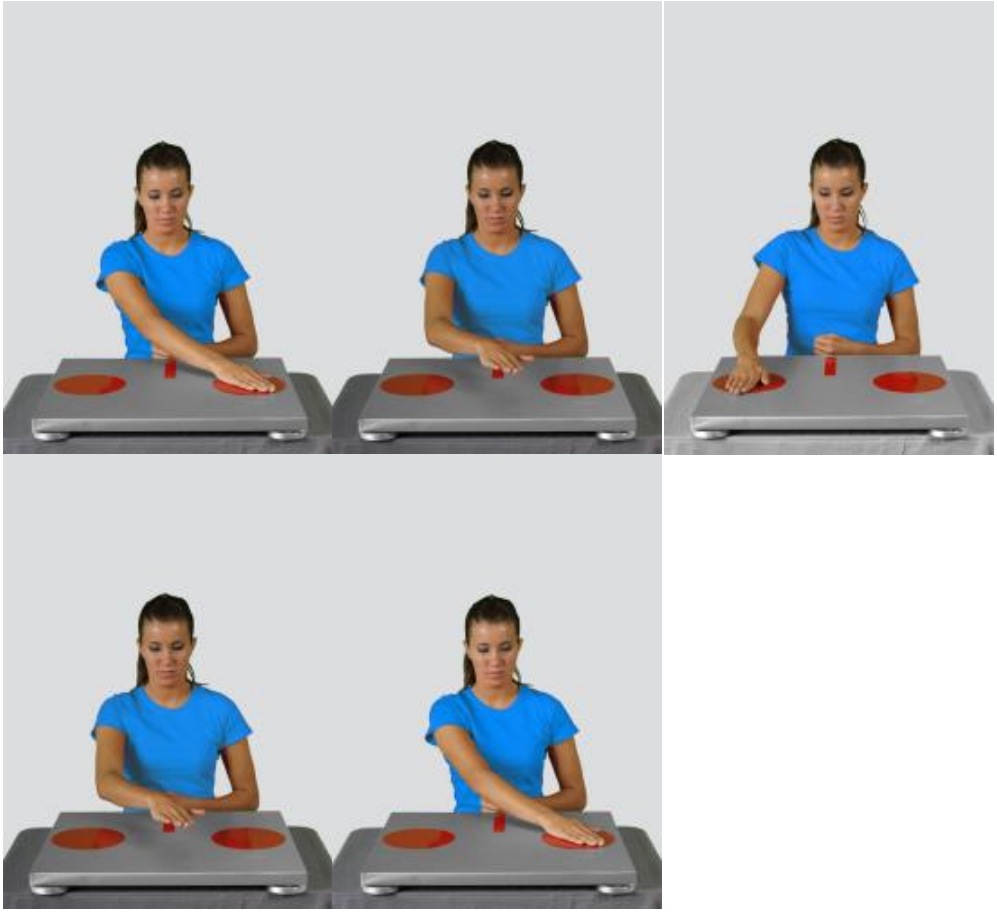
Before the measurement can start, the user has to choose some input parameters with which the measured motor task (tapping) is specifically defined. These parameters are important for further analysis, comparisons and reporting. The tapping characteristics are defined by the following parameters:

- Type of Tapping
- Side
- Duration [s]

TYPE OF TAPPING

Arms

The subject performs the tapping task so that he/she is alternatively touching the left and the right marked area on the force plate with the same hand. The subject performs this cyclic arm movement with the highest possible speed and accuracy.



Legs

The subject performs the tapping task so that he/she is alternatively touching the left and the right marked area on the force plate with the same foot. The subject performs this cyclic leg movement with the highest possible speed and accuracy.

Other user defined

In case of any other type of a tapping, the user can define it under Settings panel - section Input parameters. After doing so, the newly defined input parameter will from then on appear as an optional choice under the Type of Tapping in the Tapping measurement module.

SIDE

Left

The subject performs the tapping test with his/her left leg/hand.

Right

The subject performs the tapping test with his/her right leg/hand.

DURATION [s]

10/20/30/40/50/60/70/80/90/100 s

Other user defined

In case of any other duration, the user can define it under Settings panel - section Input parameters. After doing so, the newly defined duration of the quiet stance task will from then on appear as an optional choice the Duration in the Tapping measurement module.

Measurement

Before starting a test select input parameters (on the left side of Measure window). Then the subject acquires the initial position for the test – sitting in front of the force plate. After that, you give the verbal start signal to the subject to begin with the tapping task. Right after the subject begins with the task, click Start or press Space. After this,

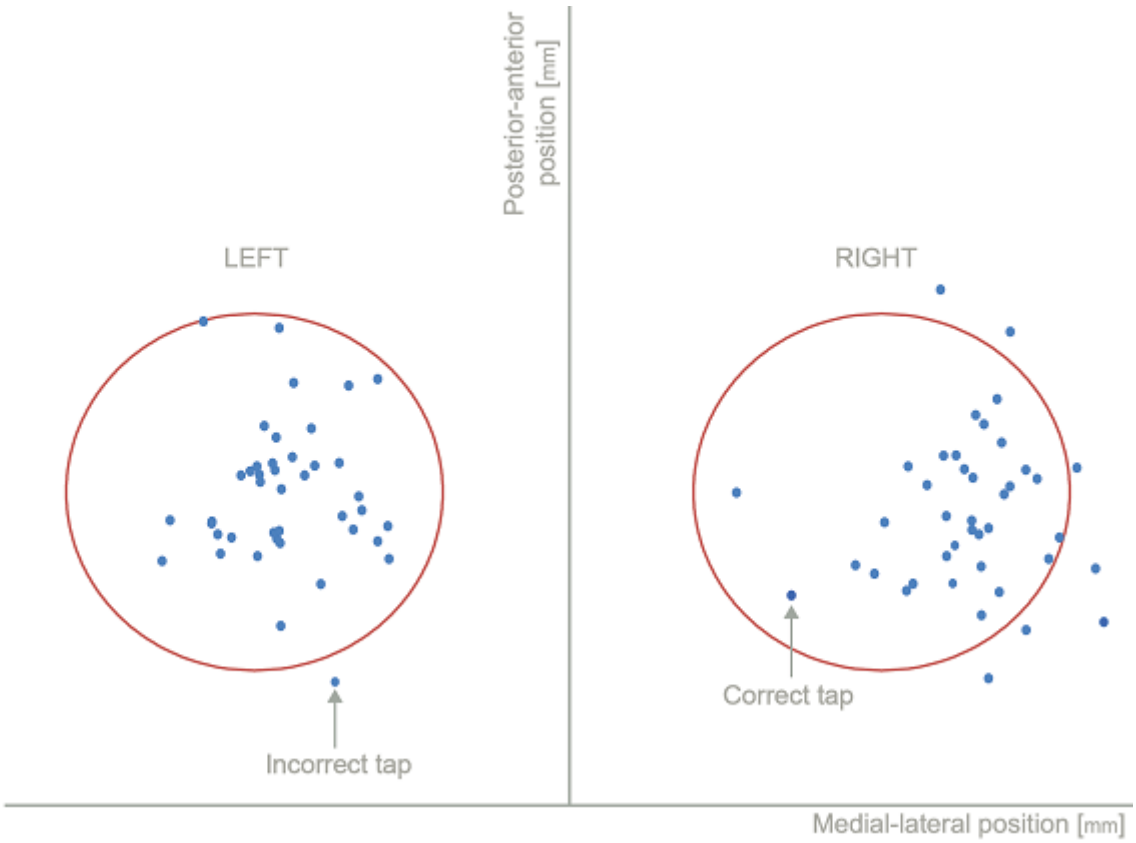
the software begins with the signal acquisition and the time left until the end of the test is displayed in the top-right corner of the screen. After the measurement is completed you can chose to Confirm, Reject or Repeat it.

If you want to start a new measurement, click the New Measurement button and repeat the procedure. Before starting a new measurement you can change the Input Parameters; if not, the Input Parameters of the previous measurement will be used.

Analysis

Analysis enables you to check the signal of the ground reaction force and the calculated parameters. Under the COP tab you can see the X:Y signal. Individual components of the ground reaction forces and of the COP movement can be visualized under the Signals tab. Under the Repetitions tab you can see all the calculated parameters.

The number of taps performed in a given time interval is the measure of success. Additionally the COP plots give information on the accuracy and dispersion of the contact points.



For some modules additional analysis routines are available as separate products. For more information see section About MARS or contact us.

PARAMETERS OF SPEED

Number of all taps – total [n]

The total number of the taps on the left and the right side of the force plate (their sum), regardless of their precision (i.e. no matter if the taps are inside or outside the target tap area).

Number of correct taps – total [n]

The total number of those taps on the left and the right side of the force plate (their sum) that were performed inside the target tap area.

Number of incorrect taps – total [n]

The total number of those taps on the left and the right side of the force plate (their sum) that were performed outside the target tap area.

Number of all taps – left [n]

The total number of the taps on the left side of the force plate, regardless of their precision (i.e. no matter if the taps are inside or outside the target tap area).

Number of correct taps – left [n]

The total number of those taps on the left side of the force plate that were performed inside the target tap area.

Number of incorrect taps – left [n]

The total number of those taps on the left side of the force plate that were performed outside the target tap area.

Number of all taps – right [n]

The total number of the taps on the right side of the force plate, regardless of their precision (i.e. no matter if the taps are inside or outside the target tap area).

Number of correct taps – right [n]

The total number of those taps on the right side of the force plate that were performed inside the target tap area.

Number of incorrect taps – right [n]

The total number of those taps on the right side of the force plate that were performed outside the target tap area.

Mean FRE from all paired taps [Hz]

The frequency of tapping calculated as the number of all (i.e. no matter if the taps are inside or outside the target tap area) paired taps (left-side tap followed by the right-side tap or vice versa) divided by the measurement time.

Mean FRE from correct paired taps [Hz]

The frequency of tapping calculated as the number of correct (i.e. the taps performed inside the target tap area) paired taps (left-side tap followed by the right-side tap or vice versa) divided by the measurement time.

Mean FRE from all paired taps – 1st interval [Hz]

The frequency of tapping calculated as the number of all (i.e. no matter if the taps are inside or outside the target tap area) paired taps (left-side tap followed by the right-side tap or vice versa) in the initial time interval (i.e. start + the interval duration) divided by the duration of the initial time interval. The default duration of this interval is 3 s, but it can be changed in the Settings panel.

Mean FRE from all paired taps – 2nd interval [Hz]

The frequency of tapping calculated as the number of all (i.e. no matter if the taps are inside or outside the target tap area) paired taps (left-side tap followed by the right-side tap or vice versa) in the middle time interval (i.e. mid-time ± 1 of the interval duration) divided by the duration of the middle time interval. The default duration of this interval is 3 s, but it can be changed in the Settings panel - Time Interval.

Mean FRE from all paired taps – 3rd interval [Hz]

The frequency of tapping calculated as the number of all (i.e. no matter if the taps are inside or outside the target tap area) paired taps (left-side tap followed by the right-side tap or vice versa) in the final time interval (i.e. end - the interval duration) divided by the duration of the final time interval. The default duration of this interval is 3 s, but it can be changed in the Settings panel - Time Interval.

FRE endurance index – all paired taps [%]

The mean frequency of tapping in the middle (2nd) time interval divided by the mean frequency of tapping in the initial (1st) time interval. The mean frequencies are calculated as the number of all (i.e. no matter if the taps are inside or outside the target tap area) paired taps (left-side tap followed by the right-side tap or vice versa) in the time interval divided by the duration of the time interval. The default duration of the time intervals is 3 s, but it can be changed in the Settings panel - Time Interval.

FRE fatigue index – all paired taps [%]

The mean frequency of tapping in the final (3rd) time interval divided by the mean frequency of tapping in the initial (1st) time interval. The mean frequencies are calculated as the number of all (i.e. no matter if the taps are inside or outside the target tap area) paired taps (left-side tap followed by the right-side tap or vice versa) in the time interval divided by the duration of the time interval. The default duration of the time intervals is 3 s, but it can be changed in the Settings panel - Time Interval.

Mean FRE from correct paired taps – 1st interval [Hz]

The frequency of tapping calculated as the number of correct (i.e. the taps performed inside the target tap area) paired taps (left-side tap followed by the right-side tap or vice versa) in the initial time interval (i.e. start + the interval duration) divided by the duration of the initial time interval. The default duration of this interval is 3 s, but it can be changed in the Settings panel - Time Interval.

Mean FRE from correct paired taps – 2nd interval [Hz]

The frequency of tapping calculated as the number of correct (i.e. the taps performed inside the target tap area) paired taps (left-side tap followed by the right-side tap or vice versa) in the middle time interval (i.e. mid-time ± 1/2 of the interval duration) divided by the duration of the middle time interval. The default duration of this interval is 3 s, but it can be changed in the Settings panel - Time Interval.

Mean FRE from correct paired taps – 3rd interval [Hz]

The frequency of tapping calculated as the number of correct (i.e. the taps performed inside the target tap area) paired taps (left-side tap followed by the right-side tap or vice versa) in the final time interval (i.e. end - the interval duration) divided by the duration of the final time interval. The default duration of this interval is 3 s, but it can be changed in the Settings panel - Time Interval.

FRE endurance index – correct paired taps [%]

The mean frequency of tapping in the middle (2nd) time interval divided by the mean frequency of tapping in the initial (1st) time interval. The mean frequencies are calculated as the number of the correct (i.e. the taps performed inside the target tap area) paired taps (left-side tap followed by the right-side tap or vice versa) in the time interval divided by the duration of the time interval. The default duration of the time intervals is 3 s, but it can be changed in the Settings panel - Time Interval.

FRE fatigue index – correct paired taps [%]

The mean frequency of tapping in the final (3rd) time interval divided by the mean frequency of tapping in the initial (1st) time interval. The mean frequencies are calculated as the number of the correct (i.e. the taps performed inside the target tap area) paired taps (left-side tap followed by the right-side tap or vice versa) in the time interval divided by the duration of the time interval. The default duration of the time intervals is 3 s, but it can be changed in the Settings panel - Time Interval.

Minimum FRE– all paired taps [Hz]

The frequency of tapping is calculated on the tap-to-tap basis for all (i.e. no matter if the taps are inside or outside the target tap area) paired taps (left-side tap followed by the right-side tap or vice versa) based on the inter-tap time intervals. The minimum among the values is taken.

Maximum FRE– all paired taps [Hz]

The frequency of tapping is calculated on the tap-to-tap basis for all (i.e. no matter if the taps are inside or outside the target tap area) paired taps (left-side tap followed by the right-side tap or vice versa) based on the inter-tap time intervals. The maximum among the values is taken.

Min/Max ratio – FRE from all paired taps [%]

The ratio between the minimum frequency and maximum frequency defined from the analysis of all (i.e. no matter if the taps are inside or outside the target tap area) paired taps (left-side tap followed by the right-side tap or vice versa).

PARAMETERS OF ACCURACY AND DISPERSION

Dispersion of taps – total [mm]

Standard deviation of the taps` distances from the central point of taps on the same side of the force plate calculated for the left and the right side together. The central point of all taps is calculated as the average COP position of all taps on the same side of the force plate.

Dispersion of taps – left [mm]

Standard deviation of the taps` distances from the central point of taps on the same side of the force plate calculated only for the left side. The central point of all taps is calculated as the average COP position of all taps on the left side of the force plate.

Dispersion of taps – right [mm]

Standard deviation of the taps` distances from the central point of taps on the same side of the force plate calculated only for the right side. The central point of all taps is calculated as the average COP position of all taps on the right side of the force plate.

Dispersion of taps – 1st interval [mm]

Standard deviation of the taps` distances from the central point of taps on the same side of the force plate calculated the initial time interval (i.e. start + the interval duration). The default duration of this interval is 3 s, but it can be changed in the Settings panel - Time Interval.

Dispersion of taps – 2nd interval [mm]

Standard deviation of the taps` distances from the central point of taps on the same side of the force plate calculated the middle time interval (i.e. mid-time ± 1/2 of the interval duration). The default duration of this interval is 3 s, but it can be changed in the Settings panel - Time Interval.

Dispersion of taps – 3rd interval [mm]

Standard deviation of the taps` distances from the central point of taps on the same side of the force plate calculated the final time interval (i.e. end - the interval duration). The default duration of this interval is 3 s, but it can be changed in the Settings panel - Time Interval.

Dispersion endurance index – all taps [%]

Standard deviation of tapping positions in the middle (2nd) time interval divided by the standard deviation of tapping positions in the initial (1st) time interval. The default duration of this interval is 3 s, but it can be changed in the Settings panel - Time Interval.

Dispersion fatigue index – all taps [%]

Standard deviation of tapping positions in the final (3rd) time interval divided by the standard deviation of tapping positions in the initial (1st) time interval. The default duration of this interval is 3 s, but it can be changed in the Settings panel - Time Interval.

Accuracy of taps – total [mm]

The average distance of taps from the central point of the target area. The parameter is calculated for the taps on both sides of the force plate together.

Accuracy of taps – left [mm]

The average distance of taps from the central point of the target area. The parameter is calculated only for the taps on the left side of the force plate.

Accuracy of taps – right [mm]

The average distance of taps from the central point of the target area. The parameter is calculated only for the taps on the right side of the force plate.

Accuracy of taps – 1st interval [mm]

The average distance of taps from the central point of the target areas in the initial time interval (i.e. start + the interval duration). The default duration of this interval is 3 s, but it can be changed in the Settings panel - Time Interval.

Accuracy of taps – 2nd interval [mm]

The average distance of taps from the central point of the target areas in the middle time interval (i.e. mid-time ± 1/2 of the interval duration). The default duration of this interval is 3 s, but it can be changed in the Settings panel - Time Interval.

Accuracy of taps – 3rd interval [mm]

The average distance of taps from the central point of the target areas in the final time interval (i.e. end - the interval duration). The default duration of this interval is 3 s, but it can be changed in the Settings panel - Time Interval.

Accuracy endurance index – all taps [%]

The average distance of taps from the central point of the target in the middle (2nd) time interval divided by the average distance of taps from the central point of the target in the initial (1st) time interval. The default duration of this interval is 3 s, but it can be changed in the Settings panel - Time Interval.

Accuracy fatigue index – all taps [%]

The average distance of taps from the central point of the target in the final (3rd) time interval divided by the average distance of taps from the central point of the target in the initial (1st) time interval. The default duration of this interval is 3 s, but it can be changed in the Settings panel - Time Interval.

TURN - TEST

This measurement module is a part of MARS Balance & Stability.

Brief Description

Selecting Input Parameters

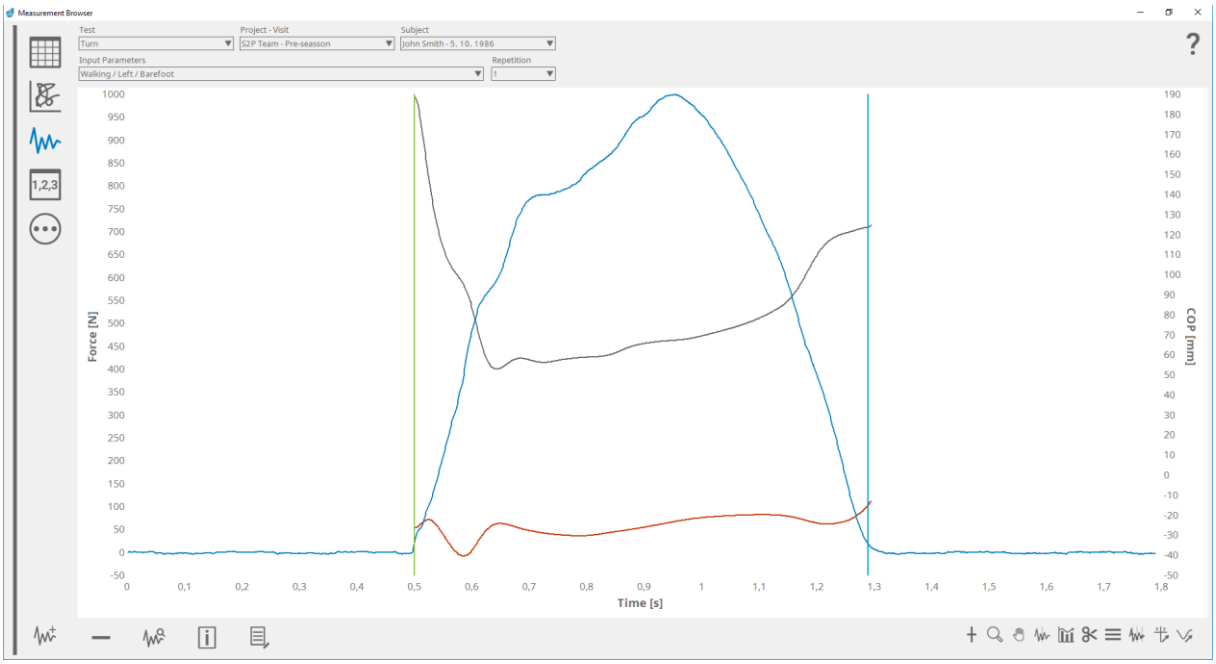
Measurement

Cursors

Analysis

Brief Description

Changing locomotion direction through different kinds of turns is a part of everyday life. In its extreme this movement act is very common in many sports (sport games) which are based on quickness and agility. Turn is a clinical test, where the subject has to make at least two forward steps and then quickly turn for 180°. After the turn, the subject walks/runs back to the start point. Based on the ground reaction force the software calculates the time needed to execute the turn and the sway velocity during the turn.



The initial position of the subject is usually a standing position approximately two steps behind the force plate. The subject than approaches to the force plate and executes the turn on a force plate. The test is finished when the subject walks back to the starting point. Although only the turn is quantified based on a ground reaction force, it is important to make at least two steps before and two steps after the turn to make the test as natural as possible.

Selecting Input Parameters

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

- Gait Type
- Side
- Footwear

GAIT TYPE

Walking

The subject performs the turn while walking.

Running

The subject performs the turn while running.

Other user defined

In case of any other type of gait, the user can define it under Settings panel - section Input parameters. After doing so, the newly defined input parameter will from then on appear as an optional choice under the Gait Type in the Turn measurement module.

SIDE

Left

The subject performs the support phase of the turn over the force plate with his left leg.

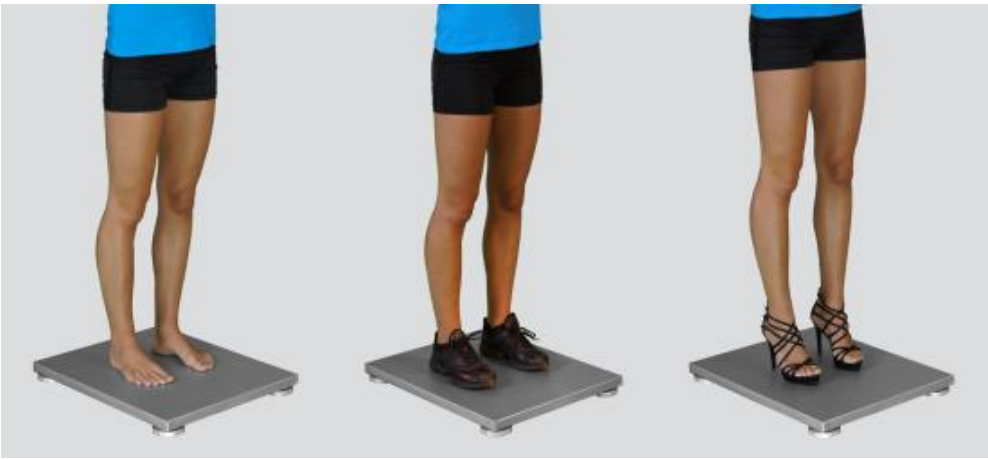
Right

The subject performs the support phase of the turn over the force plate with his 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 case of any other type of footwear, the user can define it under Settings panel - section Input parameters. After doing so, the newly defined input parameter will from then on appear as an optional choice under the Footwear in the Turn measurement module.

Measurement

Before starting a test select input parameters (on the left side of Measure window). Then the subject acquires the required position facing the force plate from a certain distance. When asked, he/she starts approaching the plate in order to make a turn by stepping on it. When the subject is approaching the force plate, click Start or press Space. The software will automatically recognize the beginning and the end of the turn and will automatically stop the data acquisition. For details about this automatic acquisition please see Settings Panel. After the measurement is completed you can chose to Confirm, Reject or Repeat it.

If you want to start a new measurement, click the New Measurement button and repeat the procedure. Before starting a new measurement you can change the Input Parameters; if not, the Input Parameters of the previous measurement will be used.

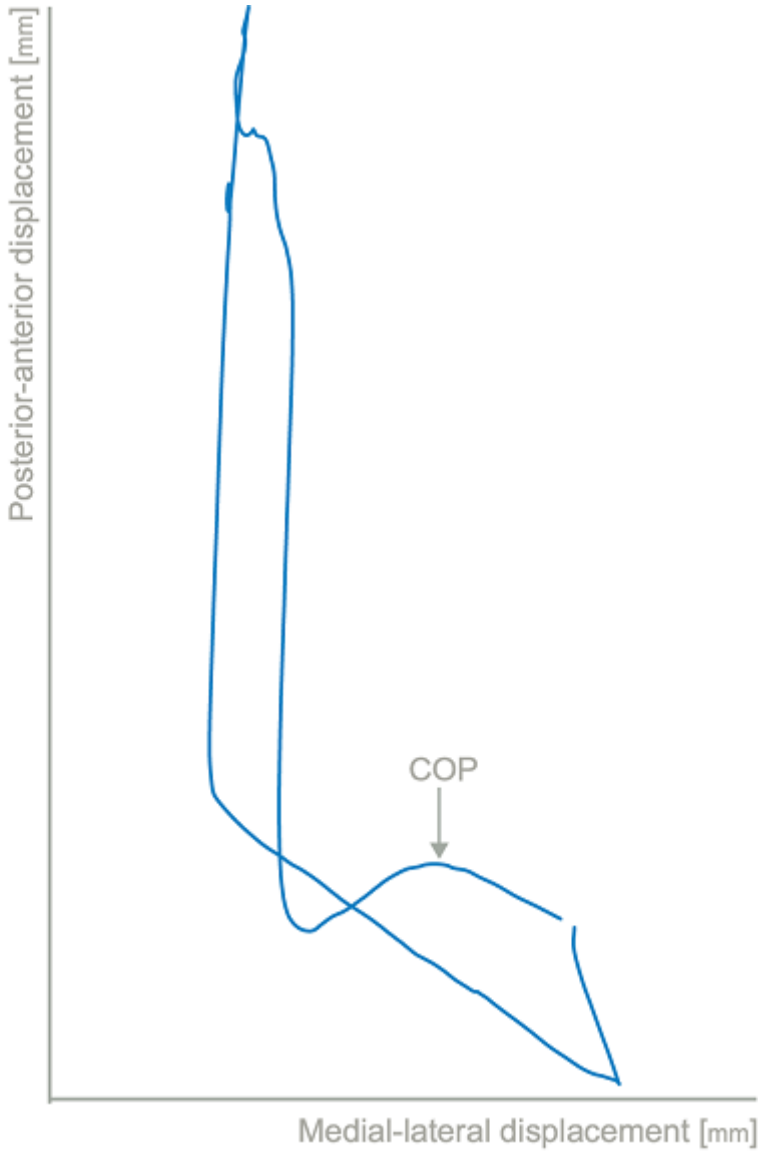
Cursors

Start
Indicates the start of the turn.

End
Indicates the end of the turn.

Analysis

Analysis enables you to check the signal of the ground reaction force and the calculated parameters. Under the COP tab you can see the X:Y signal. Individual components of the ground reaction forces and of the COP movement can be visualized under the Signals tab. Under the Repetitions tab you can see all the calculated parameters.



For some modules additional analysis routines are available as separate products. For more information see section About MARS or contact us.

GENERAL PARAMETERS

Turn T [s]

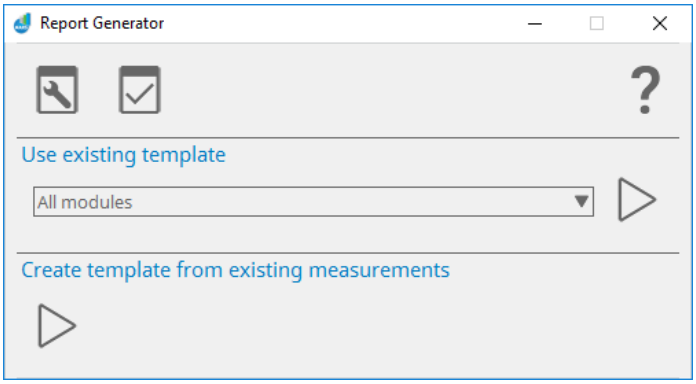
The time needed to execute the 180-degree in-place turn. This time begins when forward progression is arrested and ends when forward progression in the opposite direction is initiated.

Turn Sway [mm/s]

The average COP velocity during the turn time.It quantifies the postural stability of the individual during the turn time. Turn sway is expressed in millimeters per second.

REPORTS GENERATOR

Reports generator is used to automatically create reports in PDF format for subject or team based on prepared templates or based on existing measurements.



FUNCTIONALITIES

Template manager

Open template manager.

Review made reports

Review reports that were not reviewed yet.

Use existing template

Use existing template to create reports.

Create template from existing measurements

Create template from existing measurements and create reports based on this template.

TEMPLATE MANAGER

Template manager is used to manage templates for reports.

Functionalities

Add

Add a new template.

Delete

Delete the selected template.

Edit

Edit the selected template.

Duplicate

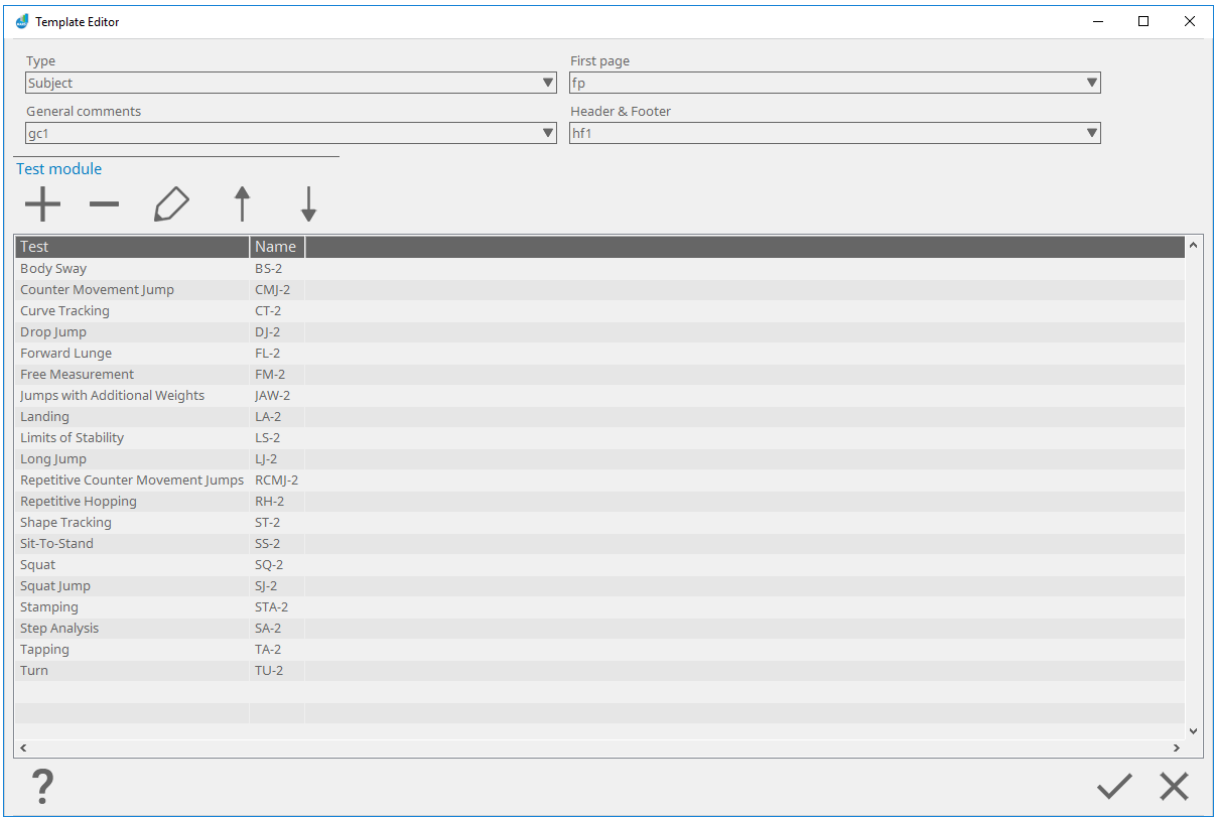
Duplicate the selected template.

Rename

Rename the selected template.

TEMPLATE EDITOR

Template editor is used to edit templates for reports. Type of the report, first page, general comments, header/footer and test modules templates for the template can be defined.



Functionalities

Type

Select the type of report (Subject or Team). Subject type is used for subject specific report. Team type is used for team specific report.

Add

Add a new test module.

Delete

Delete the selected test module.

Edit

Edit the selected test module.

Move up

Move up the selected test module.

Move down

Move down the selected test module.

FIRST PAGE MANAGER

First page manager is used to manage first pages templates.

Functionalities

Add

Add a new first page template.

Delete

Delete the selected first page template.

Edit

Edit the selected first page template.

Duplicate

Duplicate the selected first page template.

Rename

Rename the selected first page template.

EDIT FIRST PAGE

Tittle

Text for the title.

Subtittle

Text for the subtitle.

Name / Data of Birth / Addres / Height / Weight / Picture / Date

If checked, the property will be included on the first page.

Prepared by

Name of the person who prepared the report.

Contact info

Contact info (e.g. e-mail, phone number, etc.).

GENERAL COMMENTS MANAGER

General comments manager is used to manage general comments templates.

Functionalities

Add

Add a new general comments template.

Delete

Delete the selected general comments template.

Edit

Edit the selected general comments template.

Duplicate

Duplicate the selected general comments template.

Rename

Rename the selected general comments template.

HEADER & FOOTER MANAGER

Header & footer manager is used to manage header & footer templates.

Functionalities

Add

Add a new header & footer template.

Delete

Delete the selected header & footer template.

Edit

Edit the selected header & footer template.

Duplicate

Duplicate the selected header & footer template.

Rename

Rename the selected header & footer template.

EDIT HEADER FOOTER

Logo

Path to the image file. Logo will be shown on the right side of the page header.

Text

Text that will be shown on the left side of the page header.

Date

If checked, the date will be shown on the left side of the page footer.

Page number

If checked, the page number will be shown on the right side of the page footer.

TEST TEMPLATE MANAGER

Test template manager is used to manage test templates.

Functionalities

Add

Add a new test templates for the selected test.

Delete

Delete the selected test templates.

Edit

Edit the selected test templates.

Duplicate

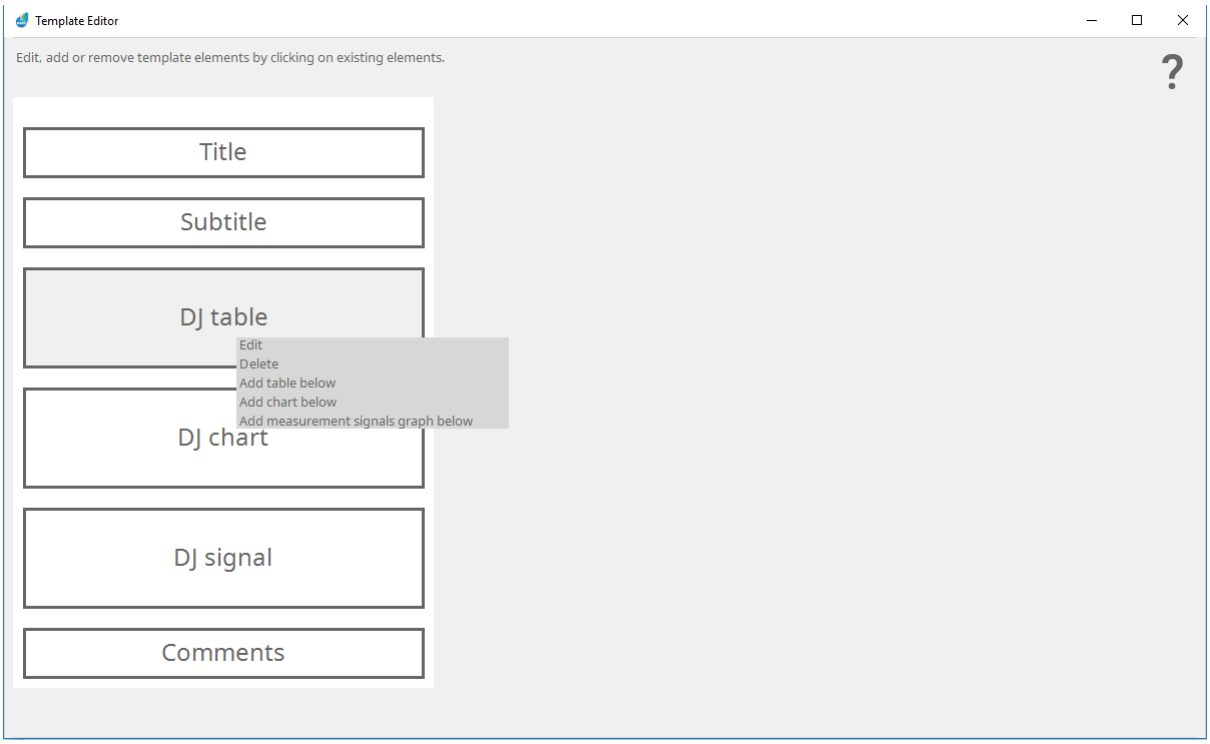
Duplicate the selected test templates.

Rename

Rename the selected test templates.

TEST TEMPLATE EDITOR

Test template editor is used to edit test templates. The layout is visualized in the graphics. Valid options are displayed by clicking on an element in the graphics.



Functionalities

Edit

Edit the selected element.

Delete

Delete the selected element.

Add table below

Add a new table below the selected element.

Add chart below

Add a new chart below the selected element.

Add measurement signals graph below

Add a new measurement signals graph below the selected element.

Add indirect parameters table below

Add a new indirect parameters table below the selected element.

TABLE EDITOR

Table editor is used to define table content.

Options

Table type

Defines what data is in the table.

Select input parameters

Define input parameters for the table.

Select result parameters

Define result parameters for the table.

Caption

Defines text below the table.

Reference values

Defines reference values that are put into the table. Subpopulation is defined during data selection for reports. Normative values can be managed by clicking Manage normative values.

Threshold

Threshold in standard deviations (SD) used to calculate the range on normative values.

Color values outside of threshold

If true, the values that are outside the range of normative values will be colored.

INDIRECT PARAMETERS TABLE EDITOR

Indirect parameters table editor is used to define table content.

Options

Table type

Defines what data is in the table.

Select indirect parameters

Define indirect parameters for the table.

Caption

Defines text below the table.

Reference values

Defines reference values that are put into the table. Subpopulation is defined during data selection for reports.

Threshold

Threshold in standard deviations (SD) used to calculate the range on normative values.

Color values outside of threshold

If true, the values that are outside the range of normative values will be colored.

CHART EDITOR

Chart editor is used to define chart content.

Options

Chart type

Defines what data is in the chart.

Select input parameters

Define input parameters for the chart.

Select result parameters

Define result parameters for the chart.

Caption

Defines text below the chart.

GRAPH OF SIGNALS EDITOR

Graph of signals editor is used to define graph of signals content.

Options

Graph of signals type

Defines what data is in the graph of signals.

SUBPOPULATION EDITOR

Subpopulation editor is used to define subpopulation.

Options

Project

Defines which project will be used for the subpopulation.

Visit

Defines which visit will be used for the subpopulation.

Subjects

Defines which subjects will be used for the subpopulation.

VISITS EDITOR

Visit editor is used to select visits.

Options

Project

Defines which project will be used.

Visits

Defines which visits will be used.

INPUT PARAMETERS EDITOR

Input parameters editor is used to select combinations of input parameters.

Functionalities

Add

Add a new combination of input parameters.

Delete

Delete the selected combination of input parameters.

Rename

Rename the selected combination of input parameters (Short name).

RESULT PARAMETERS EDITOR

Result parameters editor is used to select subset of result parameters. Result parameters are calculated (across repetitions) either as:

- AVG across all repetitions for each parameter separately
- MIN of all repetitions for each parameter separately
- MAX of all repetitions for each parameter separately
- Repetition with MIN value for the se selected parameter
- Repetition with MAX value for the se selected parameter

NORMATIVE VALUES

Normative values are used to define reference values for result parameters for a test. Normative values are specified for profiles. Profile is defined with test module, input parameters, subject age, subject sex and subject type.

Normative values manager

Normative values manager is used to manage normative values.

Add

Add a new normative values template.

Delete

Delete the selected normative values template.

Edit

Edit the selected normative values template.

Rename

Rename the selected normative values template.

Normative values profiles manager

Add

Add a new normative values profile.

Delete

Delete the selected normative values profile.

Edit

Edit the selected normative values profile.

Get profiles from the database

Retrive normative values profiles for the selected test from the database.

Normative values profiles editor

Test module

Test module for the normative value profile.

Age group

Age group for the normative value profile.

Sex

Sex for the normative value profile.

Subject type

Subject type for the normative value profile.

Number of measurements

Number of measurements used to calculate normative values.

Input parameters

Input parameters for the normative value profile.

Get values from the database

Retrieve mean value and standard deviation for each result parameter for the specified profile from the database.

REPORTS FOR REVIEW

Reports for review is used to select reports that needs to be reviewed.

REVIEW REPORTS

Review reports is used to review reports for each subject and test.

Functionalities

Edit comments

Edit comments for the selected subject and test.

CREATE TEMPLATE FROM EXISTING MEASUREMENTS

Create template from existing measurements and create reports based on this template.

SUBPOPULATION EDITOR

Subpopulation editor is used to define subpopulation.

Options

Project

Defines which project will be used for the subpopulation.

Visit

Defines which visit will be used for the subpopulation.

Subjects

Defines which subjects will be used for the subpopulation.

TEST MODULE EDITOR

Test module editor is used to select test modules for reports. You can select/deselect all test modules at once or select them manually by clicking on test module name.

TEST MODULE TEMPLATE

Select a template for the test module.

Add

Add a new test module template.

Edit

Edit the selected test module template.

Duplicate

Duplicate the selected test module template.

Rename

Rename the selected test module template.

TEST PROTOCOLS

Test protocols are used for guided execution of tests in defined order. Starting a new test with test protocol (in Main window) will automatically guide you through the specified protocol of the test protocol for all subjects in the selected visit. Subject and/or test can be switched (in Measurement window) during the guided procedure.

TEST PROTOCOLS MANAGER

Test protocols manager is used to manage test protocols.

Functionalities

Add

Add a new test protocol.

Delete

Delete the selected test protocol.

Edit

Edit the selected test protocol.

Duplicate

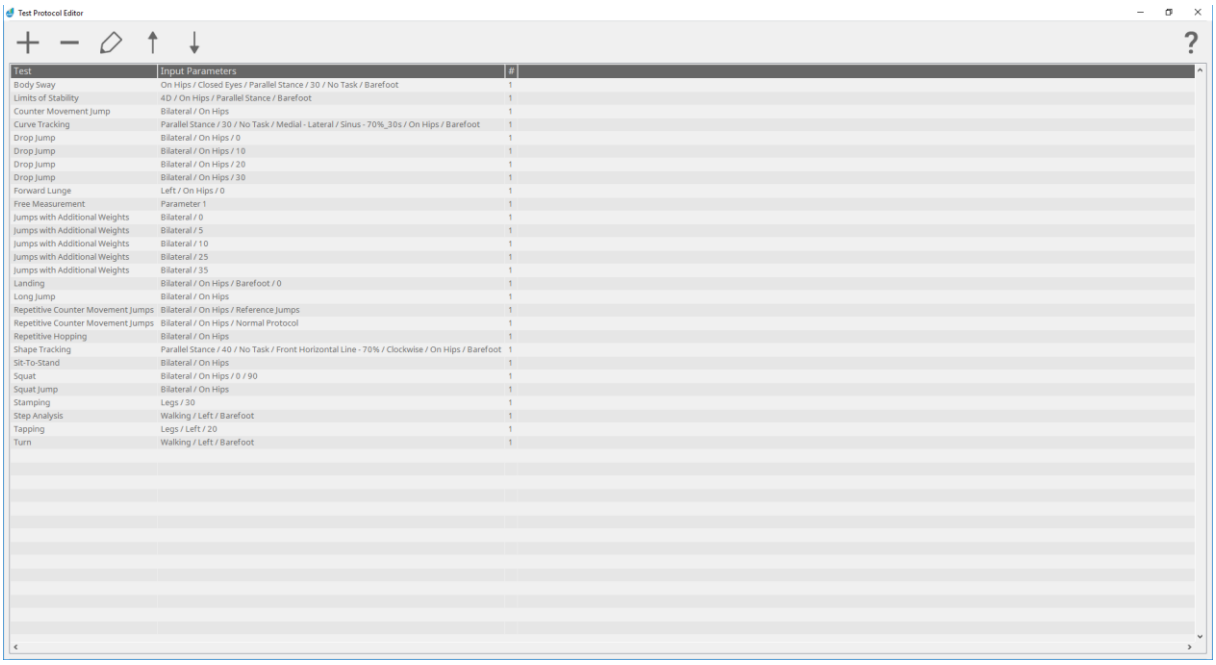
Duplicate the selected test protocol.

Rename

Rename the selected test protocol.

TEST PROTOCOL EDITOR

Test protocol editor is used to define test protocol.



Test	Input Parameters	#
Body Sway	On Hips / Closed Eyes / Parallel Stance / 30 / No Task / Barefoot	1
Limits of Stability	4D / On Hips / Parallel Stance / Barefoot	1
Counter Movement Jump	Bilateral / On Hips	1
Curve Tracking	Parallel Stance / 30 / No Task / Medial - Lateral / Sinus - 70%_30s / On Hips / Barefoot	1
Drop Jump	Bilateral / On Hips / 0	1
Drop Jump	Bilateral / On Hips / 10	1
Drop Jump	Bilateral / On Hips / 20	1
Drop Jump	Bilateral / On Hips / 30	1
Forward Lunge	Left / On Hips / 0	1
Free Measurement	Parameter 1	1
Jumps with Additional Weights	Bilateral / 0	1
Jumps with Additional Weights	Bilateral / 5	1
Jumps with Additional Weights	Bilateral / 10	1
Jumps with Additional Weights	Bilateral / 25	1
Jumps with Additional Weights	Bilateral / 35	1
Landing	Bilateral / On Hips / Barefoot / 0	1
Long Jump	Bilateral / On Hips	1
Repetitive Counter Movement Jumps	Bilateral / On Hips / Reference Jumps	1
Repetitive Counter Movement Jumps	Bilateral / On Hips / Normal Protocol	1
Repetitive Hopping	Bilateral / On Hips	1
Shape Tracking	Parallel Stance / 40 / No Task / Front Horizontal Line - 70% / Clockwise / On Hips / Barefoot	1
Sit-To-Stand	Bilateral / On Hips	1
Squat	Bilateral / On Hips / 0 / 90	1
Squat Jump	Bilateral / On Hips	1
Stamping	Legs / 30	1
Step Analysis	Walking / Left / Barefoot	1
Tapping	Legs / Left / 20	1
Turn	Walking / Left / Barefoot	1

Functionalities

Add

Add a new protocol step.

Delete

Delete the selected protocol step.

Edit

Edit the selected protocol step.

Move up

Move up the selected protocol step.

Move down

Move down the selected protocol step.

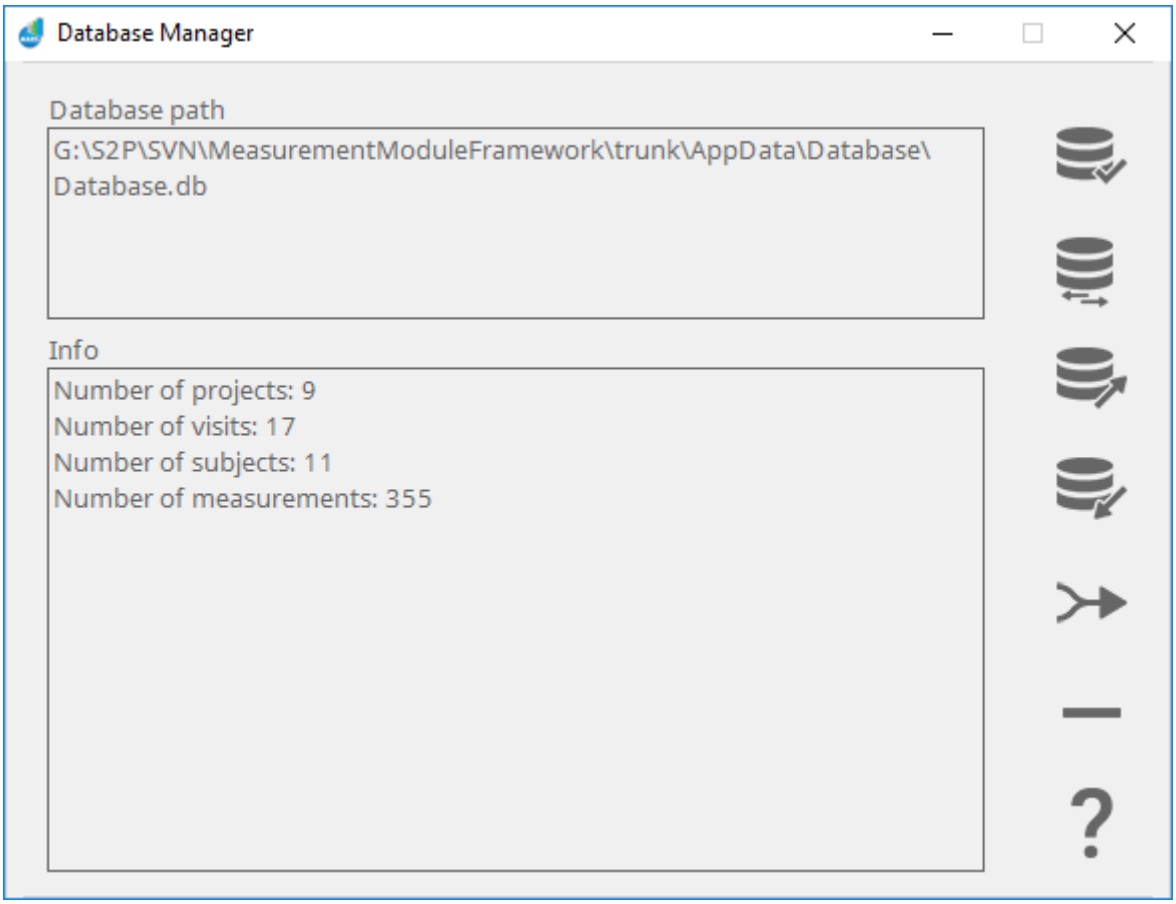
TEST PROTOCOL TEST CONFIGURATION

Test protocol test configuration is used to define single protocol step of the test protocol.

Each protocol step consists of Test module, Input parameters and Number of repetitions.

DATABASE MANAGER

Database manager is used to manage database(s) of the MARS. At once only one database can be selected. To use another database use Select database functionality.



Functionalities

Select database

Used to select working database. Currently selected database is displayed in the Database path.

Move database

Used to move current database to another location.

Backup from database

Used to backup data from the current database.

Restore to database

Used to restore data to the current database.

NOTE: Data in the current data will be permanently deleted!

Import database (merge)

Used to import data to the current database from another database.

Delete from database

Used to delete data from the current database.

BACKUP FROM DATABASE

Backup from database is used to define data set that will be saved in another database; however, data set will be also preserved in the current database.

Functionalities

Backup all data

All data from the database will be used.

Backup filtered data

Specified data (Projects, Visits, Subjects and Test) subset from the database will be used.

Destination folder

Destination of the backed up data.

RESTORE TO DATABASE

Restore to database is used to define the database that will replace the current database.

NOTE: Restore will erase all data in the current database.

Functionalities

Database file

Database file of the database that will replace the current database.

DELETE FROM DATABASE

Delete from database is used to define data set that will be deleted from the current database.

Functionalities

Delete all data

All data from the database will be deleted.

Delete filtered data

Specified data (Projects, Visits, Subjects and Test) subset from the database will be deleted.

IMPORT DATABASE

Import database is used to import (merge) data set to the current database.

Import configuration process is performed in three steps:

- Select projects
- Select visits
- Select subjects

Functionalities

Add

Project/visit/subject will be added to the database.

Merge

Project/visit/subject will be merged with the existing (selected) project/visit/subject in the database.

Previous

Go to the previous step.

Next

Go to the next step and confirm changes.

INDIRECT PARAMETERS

Indirect parameters are calculated from existing result parameters of each test for specified input parameter combination. An indirect parameter is defined with equation that contains result parameters of tests as variables. Each variable is defined as the result parameter for the specified input parameters of the specified test. Indirect parameters of each test are accessible via More button in the Measurement browser.

INDIRECT PARAMETERS MANAGER

Indirect parameters manager is used to manage indirect parameters.

Functionalities

Add

Add a new indirect parameter.

Delete

Delete the selected indirect parameter.

Edit

Edit the selected indirect parameter.

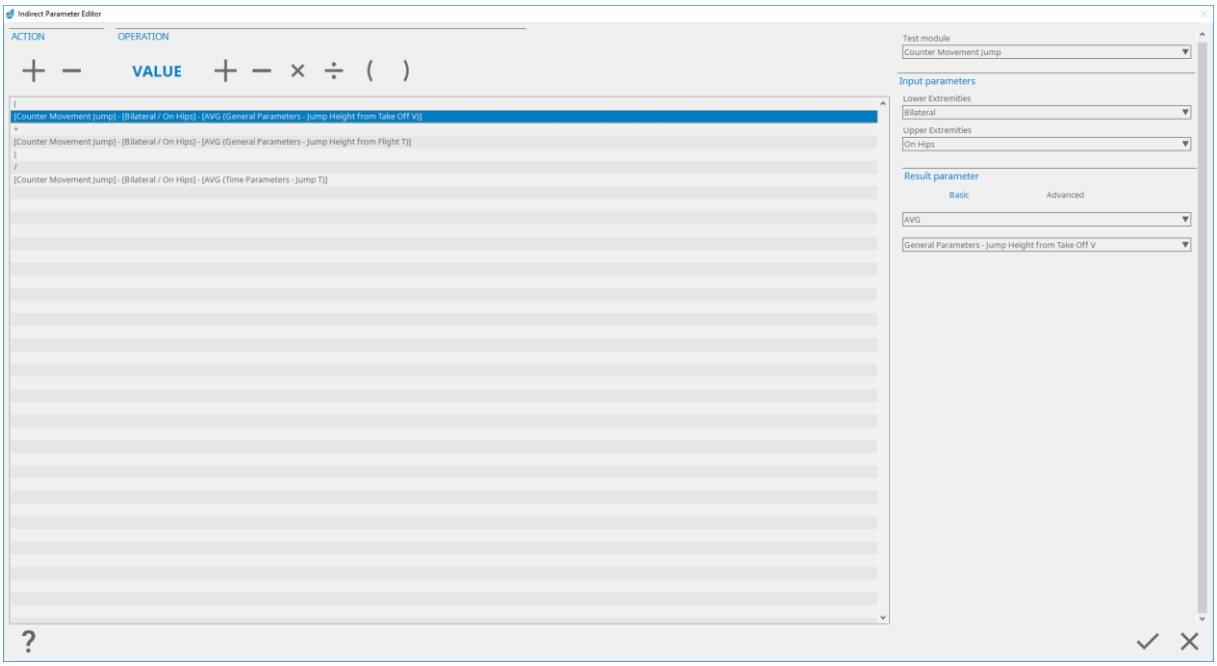
Duplicate

Duplicate the selected indirect parameter.

Rename

Rename the selected indirect parameter.

INDIRECT PARAMETER EDITOR



Indirect parameter editor is used to define indirect parameter equation.

Action is used to add or remove an operation. Operation is used to select the desired operation for selected operation (element) in the equation table. Value (variable) is defined with data on the right side of the window.

Action functionalities

Add

Add a new operation.

Delete

Delete selected operation.

Operation functionalities

VALUE

Variable defined with data on the right side of the window.

Add

Add operator.

Subtract

Subtract operator.

Multiply

Multiply operator.

Divide

Divide operator.

Opening parenthesis

Opening parenthesis operator.

Closing parenthesis

Closing parenthesis operator.

INDIRECT PARAMETERS VIEWER

Parameter

Name of the indirect parameter.

Value

Calculated value of the indirect parameter.

Export table

Export data in the table.

SETTINGS

The Settings panel window consists of 5 different panels, which are listed on the left side of the panel:

- Under the "General" panel, basic functions can be set up.
- Under the “Acquisition” panel, settings regarding the acquisition from the force plate can be set up.
- Under the “Processing & Procedure” panel, settings regarding the calculation of the parameters can be set up.
- Under the “Input parameters” panel, new input parameters can be added.
- Under the “Hardware” panel, configuration of the force plate and data acquisition system can be done.

General

Acquisition

Processing & Procedure

Input Parameters

Hardware

GENERAL - SETTINGS

Common Settings

g [m/(s^2)]

Gravitational constant.

Automatic export of measurements into JSON files

Enable

Enables automatic export of measurements into the JSON files.

Location

Folder path for exported JSON file(s).

Units

Select either SI units (metrics) or Imperial units.

Language

Language of the application.

ACQUISITION - SETTINGS

Channel Settings

Here you can select which channels you want to acquire. You can select a channel to acquire from by checking the checkbox next to the channel.

Acquisition Initialization

Here you can set frequency of the data acquisition from the force plate.

PROCESSING & PROCEDURE - SETTINGS

Under the Processing & Procedure panel the settings for the analyses can be set up for each module separately.

In general, Processing & Procedure are divided into four groups:

1. **General Settings** – Here you can set parameters that are specified for each test module.
2. **Filter Settings** – Here you can set filter options for the Signals Tab.
3. **COP Filter Settings** – Here you can set COP filter options for the COP Tab.

Body Sway - Settings

PROCEDURE - GENERAL

Graph Length [s]

Interval used for the time axis.

Graph Update Interval [s]

Time interval used to update the graph.

DATA PROCESSING

SELECT QUANTIFICATION METHOD

Select method for analysis the measurement.

GLOBAL SETTINGS

Time Interval [s]

Interval used to calculate fatigue and endurance.

Peak Width [s]

Minimal allowed width between peaks of the vertical force.

Contact Threshold [N]

Minimal allowed load at force plate to enable the onset of the signal acquisition.

DIFFUSION PLOTS SETTINGS

Max Time Window Portion [s]

Maximal window length used in the analysis.

DENSITY PLOTS SETTINGS

Radius [mm]

Radius (millimeters) that defines neighbor samples on the COP sway.

Lowerpass Filter Cutoff Frequency [Hz]

Cutoff frequency for the Butterworth lowpass filter used to filter density graph.

RECURRENCE QUANTIFICATION ANALYSIS SETTINGS

Embedding Dimension [n]

How many data points are used for the reconstruction of the space.

Epsilon [%]

% of the mean distance between data points in the reconstructed space.

Diagonal Line Min Length [n]

Minimum length of diagonal line.

Vertical Line Min Length [n]

Minimum length of vertical line.

Trend [%]

Percent of lines included.

Downsample Factor [a.u.]

Downsample factor for the original signal.

SAMPLE ENTROPY SETTINGS

m [a.u.]

Maximum epoch length used in the algorithm.

r [a.u.]

Tolerance used in the algorithm.

FILTER SETTINGS

Filter settings for signals.

Filter

When checkbox Filter is checked then the selected filter is active.

Filter Type

Specifies the passband of the filter.

High Cutoff Frequency [Hz]

Is the high cut-off frequency in Hz. When filter type is passband or bandstop, high cut-off frequency must be greater than low cut-off frequency and the Nyquist criterion has to be respected.

Low Cutoff Frequency [Hz]

Is the low cut-off frequency in Hz and must observe the Nyquist criterion. When filter type is passband or bandstop, low cut-off frequency must be less than high cut-off frequency.

Order

Specifies the filter order and must be greater than 0.

Smoothing Filter - Window Size [s]

Window size in seconds that is used for the smoothing filter of the acquired signal.

COP FILTER SETTINGS

Filter settings for COP curve (X and Y directions).

Filter

When checkbox Filter is checked then the selected filter is active.

Filter Type

Specifies the passband of the filter.

High Cutoff Frequency [Hz]

Is the high cut-off frequency in Hz. When filter type is passband or bandstop, high cut-off frequency must be greater than low cut-off frequency and the Nyquist criterion has to be respected.

Low Cutoff Frequency [Hz]

Is the low cut-off frequency in Hz and must observe the Nyquist criterion. When filter type is passband or bandstop, low cut-off frequency must be less than high cut-off frequency.

Order

Specifies the filter order and must be greater than 0.

Counter Movement Jump - Settings

PROCEDURE - GENERAL

Graph Length [s]

Interval used for the time axis.

Graph Update Interval [s]

Time interval used to update the graph.

Enable Buffers

Enables Pre/Post buffer.

Pre-buffer [s]

Maximal time inteval before the start event.

Post-buffer [s]

Maximal time inteval after the end event.

PROCEDURE – AUTOMATIC CURSORS POSITIONING

Start of Increasing [N]

The threshold used to detect the event when force reaches the value of body weight during counter movement.

Start of Falling [N]

Threshold below the body weight that specifies the start event.

Fly Limit [N]

Threshold used to detect take-off and landing event.

Take Off Delay [s]

Time interval after take-off event when small oscillations of the vertical force can occur – that defines minimal flight time of correctly processed jump Start Power.

DATA PROCESSING

Start Interval [s]

Interval after the start event used to calculate start power.

Show P3 cursors.

Show cursors that are used for P3 releated analysis.

FILTER SETTINGS

Filter settings for signals.

Filter

When checkbox Filter is checked then the selected filter is active.

Filter Type

Specifies the passband of the filter.

High Cutoff Frequency [Hz]

Is the high cut-off frequency in Hz. When filter type is passband or bandstop, high cut-off frequency must be greater than low cut-off frequency and the Nyquist criterion has to be respected.

Low Cutoff Frequency [Hz]

Is the low cut-off frequency in Hz and must observe the Nyquist criterion. When filter type is passband or bandstop, low cut-off frequency must be less than high cut-off frequency.

Order

Specifies the filter order and must be greater than 0.

Smoothing Filter - Window Size [s]

Window size in seconds that is used for the smoothing filter of the acquired signal.

Curve Tracking - Settings

PROCEDURE - GENERAL

Graph Length [s]

Interval used for the time axis.

Graph Update Interval [s]

Time interval used to update the graph.

DATA PROCESSING

Contact Threshold [N]

Minimal allowed load at force plate to enable the onset of the signal acquisition.

Time Interval [s]

Interval used to calculate fatigue and endurance.

FILTER SETTINGS

Filter settings for signals.

Filter

When checkbox Filter is checked then the selected filter is active.

Filter Type

Specifies the passband of the filter.

High Cutoff Frequency [Hz]

Is the high cut-off frequency in Hz. When filter type is passband or bandstop, high cut-off frequency must be greater than low cut-off frequency and the Nyquist criterion has to be respected.

Low Cutoff Frequency [Hz]

Is the low cut-off frequency in Hz and must observe the Nyquist criterion. When filter type is passband or bandstop, low cut-off frequency must be less than high cut-off frequency.

Order

Specifies the filter order and must be greater than 0.

Smoothing Filter - Window Size [s]

Window size in seconds that is used for the smoothing filter of the acquired signal.

COP FILTER SETTINGS

Filter settings for COP curve (X and Y directions).

Filter

When checkbox Filter is checked then the selected filter is active.

Filter Type

Specifies the passband of the filter.

High Cutoff Frequency [Hz]

Is the high cut-off frequency in Hz. When filter type is passband or bandstop, high cut-off frequency must be greater than low cut-off frequency and the Nyquist criterion has to be respected.

Low Cutoff Frequency [Hz]

Is the low cut-off frequency in Hz and must observe the Nyquist criterion. When filter type is passband or bandstop, low cut-off frequency must be less than high cut-off frequency.

Order

Specifies the filter order and must be greater than 0.

Drop Jump - Settings

PROCEDURE - GENERAL

Graph Length [s]

Interval used for the time axis.

Graph Update Interval [s]

Time interval used to update the graph.

Enable Buffers

Enables Pre/Post buffer.

Pre-buffer [s]

Maximal time inteval before the start event.

Post-buffer [s]

Maximal time inteval after the end event.

Maximal Measurement Time [s]

Maximal measurement time allowed.

PROCEDURE – AUTOMATIC CURSORS POSITIONING

Fly Limit [N]

Threshold used to detect take-off and landing event.

Force Stabilization Criteria [%BW]

Percentage deviation from body weight, used for steady phase.

Criteria Time Interval [s]

Steady phase time interval.

Take Off Delay [s]

Time interval after take-off event when small oscillations of the vertical force can occur – that defines minimal flight time of correctly processed jump Start Power.

DATA PROCESSING

Start Interval [s]

Interval after the start event used to calculate start power.

Contact Time Criteria [s]

Maximal contact time allowed.

FILTER SETTINGS

Filter settings for signals.

Filter

When checkbox Filter is checked then the selected filter is active.

Filter Type

Specifies the passband of the filter.

High Cutoff Frequency [Hz]

Is the high cut-off frequency in Hz. When filter type is passband or bandstop, high cut-off frequency must be greater than low cut-off frequency and the Nyquist criterion has to be respected.

Low Cutoff Frequency [Hz]

Is the low cut-off frequency in Hz and must observe the Nyquist criterion. When filter type is passband or bandstop, low cut-off frequency must be less than high cut-off frequency.

Order

Specifies the filter order and must be greater than 0.

Smoothing Filter - Window Size [s]

Window size in seconds that is used for the smoothing filter of the acquired signal.

Forward Lunge - Settings

PROCEDURE - GENERAL

Graph Length [s]

Interval used for the time axis.

Graph Update Interval [s]

Time interval used to update the graph.

Enable Buffers

Enables Pre/Post buffer.

Pre-buffer [s]

Maximal time inteval before the start event.

Post-buffer [s]

Maximal time inteval after the end event.

DATA PROCESSING

Contact Threshold [N]

Minimal allowed load at force plate to enable the onset of the signal acquisition.

After Event Delay [s]

The threshold used to calculate the parameters labelled under.

FILTER SETTINGS

Filter settings for signals.

Filter

When checkbox Filter is checked then the selected filter is active.

Filter Type

Specifies the passband of the filter.

High Cutoff Frequency [Hz]

Is the high cut-off frequency in Hz. When filter type is passband or bandstop, high cut-off frequency must be greater than low cut-off frequency and the Nyquist criterion has to be respected.

Low Cutoff Frequency [Hz]

Is the low cut-off frequency in Hz and must observe the Nyquist criterion. When filter type is passband or bandstop, low cut-off frequency must be less than high cut-off frequency.

Order

Specifies the filter order and must be greater than 0.

Smoothing Filter - Window Size [s]

Window size in seconds that is used for the smoothing filter of the acquired signal.

COP FILTER SETTINGS

Filter settings for COP curve (X and Y directions).

Filter

When checkbox Filter is checked then the selected filter is active.

Filter Type

Specifies the passband of the filter.

High Cutoff Frequency [Hz]

Is the high cut-off frequency in Hz. When filter type is passband or bandstop, high cut-off frequency must be greater than low cut-off frequency and the Nyquist criterion has to be respected.

Low Cutoff Frequency [Hz]

Is the low cut-off frequency in Hz and must observe the Nyquist criterion. When filter type is passband or bandstop, low cut-off frequency must be less than high cut-off frequency.

Order

Specifies the filter order and must be greater than 0.

Free Measurement - Settings

PROCEDURE - GENERAL

Graph Length [s]

Interval used for the time axis.

Graph Update Interval [s]

Time interval used to update the graph.

FILTER SETTINGS

Filter settings for signals.

Filter

When checkbox Filter is checked then the selected filter is active.

Filter Type

Specifies the passband of the filter.

High Cutoff Frequency [Hz]

Is the high cut-off frequency in Hz. When filter type is passband or bandstop, high cut-off frequency must be greater than low cut-off frequency and the Nyquist criterion has to be respected.

Low Cutoff Frequency [Hz]

Is the low cut-off frequency in Hz and must observe the Nyquist criterion. When filter type is passband or bandstop, low cut-off frequency must be less than high cut-off frequency.

Order

Specifies the filter order and must be greater than 0.

Smoothing Filter - Window Size [s]

Window size in seconds that is used for the smoothing filter of the acquired signal.

Jumps with Additional Weights - Settings

PROCEDURE - GENERAL

Graph Length [s]

Interval used for the time axis.

Graph Update Interval [s]

Time interval used to update the graph.

Enable Buffers

Enables Pre/Post buffer.

Pre-buffer [s]

Maximal time inteval before the start event.

Post-buffer [s]

Maximal time inteval after the end event.

PROCEDURE – AUTOMATIC CURSORS POSITIONING

Start of Increasing [N]

The threshold above the body weight that specifies the start event.

Fly Limit [N]

Threshold used to detect take-off and landing event.

Take Off Delay [s]

Time interval after take-off event when small oscillations of the vertical force can occur – that defines minimal flight time of correctly processed jump Start Power.

Criteria [%]

Percentage of the body weight used to detect false movement at start (concentric movement).

DATA PROCESSING

Start Interval [s]

Interval after the start event used to calculate start power.

FILTER SETTINGS

Filter settings for signals.

Filter

When checkbox Filter is checked then the selected filter is active.

Filter Type

Specifies the passband of the filter.

High Cutoff Frequency [Hz]

Is the high cut-off frequency in Hz. When filter type is passband or bandstop, high cut-off frequency must be greater than low cut-off frequency and the Nyquist criterion has to be respected.

Low Cutoff Frequency [Hz]

Is the low cut-off frequency in Hz and must observe the Nyquist criterion. When filter type is passband or bandstop, low cut-off frequency must be less than high cut-off frequency.

Order

Specifies the filter order and must be greater than 0.

Smoothing Filter - Window Size [s]

Window size in seconds that is used for the smoothing filter of the acquired signal.

Landing - Settings

PROCEDURE - GENERAL

Graph Length [s]

Interval used for the time axis.

Graph Update Interval [s]

Time interval used to update the graph.

Enable Buffers

Enables Pre/Post buffer.

Pre-buffer [s]

Maximal time inteval before the start event.

Post-buffer [s]

Maximal time inteval after the end event.

Maximal Measurement Time [s]

Maximal time allowed for finishing the measurement. Time starts to count from initial contact with the force plate.

PROCEDURE – STOP PARAMETER

Five 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:

3 s

Measurement will be stoped 3 s after the inital contact with the force plate.

5 s

Measurement will be stoped 5 s after the inital contact with the force plate.

10 s

Measurement will be stoped 10 s after the inital contact with the force plate.

Fz Stabilization

Measurement will be stoped when the force becomes steady after the landing. End of the interval can be managed with Settings parameters “Criteria Time Interval – Force [s]” and “Force Stabilization Criteria [%BW]” under Settings Panel.

COP Stabilization

Measurement will be stoped when the COP becomes steady after the landing. End of the interval can be managed with Settings parameters “Criteria Time Interval – COP [s]” and “COP Stabilization Criteria [mm]” under Settings Panel.

DATA PROCESSING

Reference Interval Start [s]

Time interval after initial contact with the force plate.

Analysis Duration [s]

Duration of the analysis.

Criteria Time Interval – Force [s]

Steady phase time interval for force.

Criteria Time Interval – COP [s]

Steady phase time interval for COP.

Contact Threshold [N]

Minimal allowed load at force plate to enable the onset of the signal acquisition.

Fly Limit [N]

Threshold used to detect landing event.

Force Stabilization Criteria [%BW]

Percentage deviation from body weight, used for steady phase.

COP Stabilization Criteria [mm]

Distance deviation from COP, used for steady phase.

FILTER SETTINGS

Filter settings for signals.

Filter

When checkbox Filter is checked then the selected filter is active.

Filter Type

Specifies the passband of the filter.

High Cutoff Frequency [Hz]

Is the high cut-off frequency in Hz. When filter type is passband or bandstop, high cut-off frequency must be greater than low cut-off frequency and the Nyquist criterion has to be respected.

Low Cutoff Frequency [Hz]

Is the low cut-off frequency in Hz and must observe the Nyquist criterion. When filter type is passband or bandstop, low cut-off frequency must be less than high cut-off frequency.

Order

Specifies the filter order and must be greater than 0.

Smoothing Filter - Window Size [s]

Window size in seconds that is used for the smoothing filter of the acquired signal.

COP FILTER SETTINGS

Filter settings for COP curve (X and Y directions).

Filter

When checkbox Filter is checked then the selected filter is active.

Filter Type

Specifies the passband of the filter.

High Cutoff Frequency [Hz]

Is the high cut-off frequency in Hz. When filter type is passband or bandstop, high cut-off frequency must be greater than low cut-off frequency and the Nyquist criterion has to be respected.

Low Cutoff Frequency [Hz]

Is the low cut-off frequency in Hz and must observe the Nyquist criterion. When filter type is passband or bandstop, low cut-off frequency must be less than high cut-off frequency.

Order

Specifies the filter order and must be greater than 0.

Limits of Stability - Settings

PROCEDURE - GENERAL

Graph Length [s]

Interval used for the time axis.

Graph Update Interval [s]

Time interval used to update the graph.

Time – Center [s]

Time needed from rectangle to circle (foot offset).

Time – Leaning [s]

Time needed from circle (foot offset) to rectangle.

DATA PROCESSING

Time Interval [s]

Interval needed for calculating result parameters Movement Velocity and Reaction Time.

Percent from Offset [%]

Percentage of length from Foot Offset to Maximum Excursion for start point of calculating result parameters Movement Velocity and Reaction Time. This point is start point of Time Interval.

Size for Directional Control [n]

Size of vector needed for calculating result parameter Directional Control.

Contact Threshold [N]

Minimal allowed load at force plate to enable the onset of the signal acquisition.

COP Range [mm]

Distance between two opposites direction shapes.

Shape Size [mm]

Length side of direction squares.

Foot Offset Radius [mm]

Radius of circle which is drawn around active foot offset.

FILTER SETTINGS

Filter settings for signals.

Filter

When checkbox Filter is checked then the selected filter is active.

Filter Type

Specifies the passband of the filter.

High Cutoff Frequency [Hz]

Is the high cut-off frequency in Hz. When filter type is passband or bandstop, high cut-off frequency must be greater than low cut-off frequency and the Nyquist criterion has to be respected.

Low Cutoff Frequency [Hz]

Is the low cut-off frequency in Hz and must observe the Nyquist criterion. When filter type is passband or bandstop, low cut-off frequency must be less than high cut-off frequency.

Order

Specifies the filter order and must be greater than 0.

Smoothing Filter - Window Size [s]

Window size in seconds that is used for the smoothing filter of the acquired signal.

COP FILTER SETTINGS

Filter settings for COP curve (X and Y directions).

Filter

When checkbox Filter is checked then the selected filter is active.

Filter Type

Specifies the passband of the filter.

High Cutoff Frequency [Hz]

Is the high cut-off frequency in Hz. When filter type is passband or bandstop, high cut-off frequency must be greater than low cut-off frequency and the Nyquist criterion has to be respected.

Low Cutoff Frequency [Hz]

Is the low cut-off frequency in Hz and must observe the Nyquist criterion. When filter type is passband or bandstop, low cut-off frequency must be less than high cut-off frequency.

Order

Specifies the filter order and must be greater than 0.

Long Jump - Settings

PROCEDURE - GENERAL

Graph Length [s]

Interval used for the time axis.

Graph Update Interval [s]

Time interval used to update the graph.

Enable Buffers

Enables Pre/Post buffer.

Pre-buffer [s]

Maximal time inteval before the start event.

Post-buffer [s]

Maximal time inteval after the end event.

PROCEDURE – AUTOMATIC CURSORS POSITIONING

Start of Increasing [N]

The threshold used to detect the event when force reaches the value of body weight during counter movement.

Start of Falling [N]

Threshold below the body weight that specifies the start event.

Fly Limit [N]

Threshold used to detect take-off and landing event.

Take Off Delay [s]

Time interval after take-off event when small oscillations of the vertical force can occur – that defines minimal flight time of correctly processed jump Start Power.

DATA PROCESSING

Start Interval [s]

Interval after the start event used to calculate start power.

FILTER SETTINGS

Filter settings for signals.

Filter

When checkbox Filter is checked then the selected filter is active.

Filter Type

Specifies the passband of the filter.

High Cutoff Frequency [Hz]

Is the high cut-off frequency in Hz. When filter type is passband or bandstop, high cut-off frequency must be greater than low cut-off frequency and the Nyquist criterion has to be respected.

Low Cutoff Frequency [Hz]

Is the low cut-off frequency in Hz and must observe the Nyquist criterion. When filter type is passband or bandstop, low cut-off frequency must be less than high cut-off frequency.

Order

Specifies the filter order and must be greater than 0.

Smoothing Filter - Window Size [s]

Window size in seconds that is used for the smoothing filter of the acquired signal.

Repetitive Counter Movement Jumps - Settings

PROCEDURE - GENERAL

Graph Length [s]

Interval used for the time axis.

Graph Update Interval [s]

Time interval used to update the graph.

Enable Buffers

Enables Pre/Post buffer.

Pre-buffer [s]

Maximal time inteval before the start event.

Post-buffer [s]

Maximal time inteval after the end event.

PROCEDURE – 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.

Stop time

Measurement will be stopped when the time is exceeded.

Number of jumps

Measurement will be stopped when desired number of jumps is reached.

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.

PROCEDURE – AUTOMATIC CURSORS POSITIONING

Start of Increasing [N]

The threshold used to detect the event when force reaches the value of body weight during counter movement.

Start of Falling [N]

Threshold below the body weight that specifies the start event.

Fly Limit [N]

Threshold used to detect take-off and landing event.

Take Off Delay [s]

Time interval after take-off event when small oscillations of the vertical force can occur – that defines minimal flight time of correctly processed jump Start Power.

DATA PROCESSING

Start Interval [s]

Interval after the start event used to calculate start power.

Number of Jumps [n]

Number of jumps taken from repetitive jumps for analyse.

FILTER SETTINGS

Filter settings for signals.

Filter

When checkbox Filter is checked then the selected filter is active.

Filter Type

Specifies the passband of the filter.

High Cutoff Frequency [Hz]

Is the high cut-off frequency in Hz. When filter type is passband or bandstop, high cut-off frequency must be greater than low cut-off frequency and the Nyquist criterion has to be respected.

Low Cutoff Frequency [Hz]

Is the low cut-off frequency in Hz and must observe the Nyquist criterion. When filter type is passband or bandstop, low cut-off frequency must be less than high cut-off frequency.

Order

Specifies the filter order and must be greater than 0.

Smoothing Filter - Window Size [s]

Window size in seconds that is used for the smoothing filter of the acquired signal.

Repetitive Hopping - Settings

PROCEDURE - GENERAL

Graph Length [s]

Interval used for the time axis.

Graph Update Interval [s]

Time interval used to update the graph.

Enable Buffers

Enables Pre/Post buffer.

Pre-buffer [s]

Maximal time inteval before the start event.

Post-buffer [s]

Maximal time inteval after the end event.

PROCEDURE – 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.

Stop time

Measurement will be stopped when the time is exceeded.

Number of jumps

Measurement will be stopped when desired number of jumps is reached.

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.

PROCEDURE – AUTOMATIC CURSORS POSITIONING

Start of Increasing [N]

The threshold used to detect the event when force reaches the value of body weight during counter movement.

Start of Falling [N]

Threshold below the body weight that specifies the start event.

Fly Limit [N]

Threshold used to detect take-off and landing event.

Take Off Delay [s]

Time interval after take-off event when small oscillations of the vertical force can occur – that defines minimal flight time of correctly processed jump Start Power.

DATA PROCESSING

Start Interval [s]

Interval after the start event used to calculate start power.

Number of Jumps [n]

Number of jumps taken from repetitive jumps for analyse.

FILTER SETTINGS

Filter settings for signals.

Filter

When checkbox Filter is checked then the selected filter is active.

Filter Type

Specifies the passband of the filter.

High Cutoff Frequency [Hz]

Is the high cut-off frequency in Hz. When filter type is passband or bandstop, high cut-off frequency must be greater than low cut-off frequency and the Nyquist criterion has to be respected.

Low Cutoff Frequency [Hz]

Is the low cut-off frequency in Hz and must observe the Nyquist criterion. When filter type is passband or bandstop, low cut-off frequency must be less than high cut-off frequency.

Order

Specifies the filter order and must be greater than 0.

Smoothing Filter - Window Size [s]

Window size in seconds that is used for the smoothing filter of the acquired signal.

Shape Tracking - Settings

PROCEDURE - GENERAL

Graph Length [s]

Interval used for the time axis.

Graph Update Interval [s]

Time interval used to update the graph.

DATA PROCESSING

Contact Threshold [N]

Minimal allowed load at force plate to enable the onset of the signal acquisition.

Time Interval [s]

Interval used to calculate fatigue and endurance.

FILTER SETTINGS

Filter settings for signals.

Filter

When checkbox Filter is checked then the selected filter is active.

Filter Type

Specifies the passband of the filter.

High Cutoff Frequency [Hz]

Is the high cut-off frequency in Hz. When filter type is passband or bandstop, high cut-off frequency must be greater than low cut-off frequency and the Nyquist criterion has to be respected.

Low Cutoff Frequency [Hz]

Is the low cut-off frequency in Hz and must observe the Nyquist criterion. When filter type is passband or bandstop, low cut-off frequency must be less than high cut-off frequency.

Order

Specifies the filter order and must be greater than 0.

Smoothing Filter - Window Size [s]

Window size in seconds that is used for the smoothing filter of the acquired signal.

COP FILTER SETTINGS

Filter settings for COP curve (X and Y directions).

Filter

When checkbox Filter is checked then the selected filter is active.

Filter Type

Specifies the passband of the filter.

High Cutoff Frequency [Hz]

Is the high cut-off frequency in Hz. When filter type is passband or bandstop, high cut-off frequency must be greater than low cut-off frequency and the Nyquist criterion has to be respected.

Low Cutoff Frequency [Hz]

Is the low cut-off frequency in Hz and must observe the Nyquist criterion. When filter type is passband or bandstop, low cut-off frequency must be less than high cut-off frequency.

Order

Specifies the filter order and must be greater than 0.

Sit-To-Stand - Settings

PROCEDURE - GENERAL

Graph Length [s]

Interval used for the time axis.

Graph Update Interval [s]

Time interval used to update the graph.

Enable Buffers

Enables Pre/Post buffer.

Pre-buffer [s]

Maximal time inteval before the start event.

Post-buffer [s]

Maximal time inteval after the end event.

Maximal Measurement Time [s]

Maximal measurement time allowed.

DATA PROCESSING

Contact Threshold [N]

Minimal allowed load at force plate to enable the onset of the signal acquisition.

Start of Increasing [N]

The threshold above the body weight that specifies the start event.

Start of Falling [N]

Threshold below the body weight that specifies the start event.

Criteria Time Interval [s]

Steady phase time interval.

Force Stabilization Criteria [%BW]

Percentage deviation from body weight, used for steady phase.

FILTER SETTINGS

Filter settings for signals.

Filter

When checkbox Filter is checked then the selected filter is active.

Filter Type

Specifies the passband of the filter.

High Cutoff Frequency [Hz]

Is the high cut-off frequency in Hz. When filter type is passband or bandstop, high cut-off frequency must be greater than low cut-off frequency and the Nyquist criterion has to be respected.

Low Cutoff Frequency [Hz]

Is the low cut-off frequency in Hz and must observe the Nyquist criterion. When filter type is passband or bandstop, low cut-off frequency must be less than high cut-off frequency.

Order

Specifies the filter order and must be greater than 0.

Smoothing Filter - Window Size [s]

Window size in seconds that is used for the smoothing filter of the acquired signal.

COP FILTER SETTINGS

Filter settings for COP curve (X and Y directions).

Filter

When checkbox Filter is checked then the selected filter is active.

Filter Type

Specifies the passband of the filter.

High Cutoff Frequency [Hz]

Is the high cut-off frequency in Hz. When filter type is passband or bandstop, high cut-off frequency must be greater than low cut-off frequency and the Nyquist criterion has to be respected.

Low Cutoff Frequency [Hz]

Is the low cut-off frequency in Hz and must observe the Nyquist criterion. When filter type is passband or bandstop, low cut-off frequency must be less than high cut-off frequency.

Order

Specifies the filter order and must be greater than 0.

Squat - Settings

PROCEDURE - GENERAL

Graph Length [s]

Interval used for the time axis.

Graph Update Interval [s]

Time interval used to update the graph.

Enable Buffers

Enables Pre/Post buffer.

Pre-buffer [s]

Maximal time inteval before the start event.

Post-buffer [s]

Maximal time inteval after the end event.

Maximal Measurement Time [s]

Maximal measurement time allowed.

PROCEDURE – AUTOMATIC CURSORS POSITIONING

Start of Increasing [N]

The threshold used to detect the event when force reaches the value of body weight during counter movement.

Start of Falling [N]

Threshold below the body weight that specifies the start event.

Criteria Time Interval [s]

Steady phase time interval.

Force Stabilization Criteria [%BW]

Percentage deviation from body weight, used for steady phase.

DATA PROCESSING

Start Interval [s]

Interval after the start event used to calculate start power.

FILTER SETTINGS

Filter settings for signals.

Filter

When checkbox Filter is checked then the selected filter is active.

Filter Type

Specifies the passband of the filter.

High Cutoff Frequency [Hz]

Is the high cut-off frequency in Hz. When filter type is passband or bandstop, high cut-off frequency must be greater than low cut-off frequency and the Nyquist criterion has to be respected.

Low Cutoff Frequency [Hz]

Is the low cut-off frequency in Hz and must observe the Nyquist criterion. When filter type is passband or bandstop, low cut-off frequency must be less than high cut-off frequency.

Order

Specifies the filter order and must be greater than 0.

Smoothing Filter - Window Size [s]

Window size in seconds that is used for the smoothing filter of the acquired signal.

Squat Jump - Settings

PROCEDURE - GENERAL

Graph Length [s]

Interval used for the time axis.

Graph Update Interval [s]

Time interval used to update the graph.

Enable Buffers

Enables Pre/Post buffer.

Pre-buffer [s]

Maximal time inteval before the start event.

Post-buffer [s]

Maximal time inteval after the end event.

PROCEDURE – AUTOMATIC CURSORS POSITIONING

Start of Increasing [N]

Force threshold above body weight that specifies the start event.

Fly Limit [N]

Force threshold used to detect the take-off and landing events.

Take Off Delay [s]

Time interval after the take-off event when small oscillations of the vertical force can occur – that defines minimal flight time of correctly processed jump.

Criteria [%]

Percentage of the body weight used to detect false movement at the start (eccentric movement).

DATA PROCESSING

Start Interval [s]

Interval after the start event used to calculate start interval related parameters.

FILTER SETTINGS

Filter settings for signals.

Filter

When checkbox Filter is checked then the selected filter is active.

Filter Type

Specifies the passband of the filter.

High Cutoff Frequency [Hz]

Is the high cut-off frequency in Hz. When filter type is passband or bandstop, high cut-off frequency must be greater than low cut-off frequency and the Nyquist criterion has to be respected.

Low Cutoff Frequency [Hz]

Is the low cut-off frequency in Hz and must observe the Nyquist criterion. When filter type is passband or bandstop, low cut-off frequency must be less than high cut-off frequency.

Order

Specifies the filter order and must be greater than 0.

Smoothing Filter - Window Size [s]

Window size in seconds that is used for the smoothing filter of the acquired signal.

Stamping - Settings

PROCEDURE - GENERAL

Graph Length [s]

Interval used for the time axis.

Graph Update Interval [s]

Time interval used to update the graph.

DATA PROCESSING

Peak Threshold [N]

Threshold of minimal used value.

Time Interval [s]

Interval used to calculate fatigue and endurance.

Time Interval Fmin/Fmax [s]

Time interval within calculate of ratio Fmin/Fmax performs. Interval step through acquired signal is 1s.

Peak Width [s]

Minimal allowed width between peaks of the vertical force.

FILTER SETTINGS

Filter settings for signals.

Filter

When checkbox Filter is checked then the selected filter is active.

Filter Type

Specifies the passband of the filter.

High Cutoff Frequency [Hz]

Is the high cut-off frequency in Hz. When filter type is passband or bandstop, high cut-off frequency must be greater than low cut-off frequency and the Nyquist criterion has to be respected.

Low Cutoff Frequency [Hz]

Is the low cut-off frequency in Hz and must observe the Nyquist criterion. When filter type is passband or bandstop, low cut-off frequency must be less than high cut-off frequency.

Order

Specifies the filter order and must be greater than 0.

Smoothing Filter - Window Size [s]

Window size in seconds that is used for the smoothing filter of the acquired signal.

Step Analysis - Settings

PROCEDURE - GENERAL

Graph Length [s]

Interval used for the time axis.

Graph Update Interval [s]

Time interval used to update the graph.

Enable Buffers

Enables Pre/Post buffer.

Pre-buffer [s]

Maximal time inteval before the start event.

Post-buffer [s]

Maximal time inteval after the end event.

DATA PROCESSING

Contact Threshold [N]

Minimal allowed load at force plate to enable the onset of the signal acquisition.

After Event Delay [s]

The threshold used to calculate the parameters labelled under.

FILTER SETTINGS

Filter settings for signals.

Filter

When checkbox Filter is checked then the selected filter is active.

Filter Type

Specifies the passband of the filter.

High Cutoff Frequency [Hz]

Is the high cut-off frequency in Hz. When filter type is passband or bandstop, high cut-off frequency must be greater than low cut-off frequency and the Nyquist criterion has to be respected.

Low Cutoff Frequency [Hz]

Is the low cut-off frequency in Hz and must observe the Nyquist criterion. When filter type is passband or bandstop, low cut-off frequency must be less than high cut-off frequency.

Order

Specifies the filter order and must be greater than 0.

Smoothing Filter - Window Size [s]

Window size in seconds that is used for the smoothing filter of the acquired signal.

COP FILTER SETTINGS

Filter settings for COP curve (X and Y directions).

Filter

When checkbox Filter is checked then the selected filter is active.

Filter Type

Specifies the passband of the filter.

High Cutoff Frequency [Hz]

Is the high cut-off frequency in Hz. When filter type is passband or bandstop, high cut-off frequency must be greater than low cut-off frequency and the Nyquist criterion has to be respected.

Low Cutoff Frequency [Hz]

Is the low cut-off frequency in Hz and must observe the Nyquist criterion. When filter type is passband or bandstop, low cut-off frequency must be less than high cut-off frequency.

Order

Specifies the filter order and must be greater than 0.

Symmetry - Settings

PROCEDURE - GENERAL

Graph Length [s]

Interval used for the time axis.

Graph Update Interval [s]

Time interval used to update the graph.

Standing Time [s]

Time interval for standing phases.

Squatting Time [s]

Time interval for standing phases.

GENERAL SETTINGS

Offset Interval [s]

Interval after the start used for start of the analysis.

Analysis Time Window [s]

Analysis duration.

FILTER SETTINGS

Filter settings for signals.

Filter

When checkbox Filter is checked then the selected filter is active.

Filter Type

Specifies the passband of the filter.

High Cutoff Frequency [Hz]

Is the high cut-off frequency in Hz. When filter type is passband or bandstop, high cut-off frequency must be greater than low cut-off frequency and the Nyquist criterion has to be respected.

Low Cutoff Frequency [Hz]

Is the low cut-off frequency in Hz and must observe the Nyquist criterion. When filter type is passband or bandstop, low cut-off frequency must be less than high cut-off frequency.

Order

Specifies the filter order and must be greater than 0.

Smoothing Filter - Window Size [s]

Window size in seconds that is used for the smoothing filter of the acquired signal.

Tapping - Settings

PROCEDURE - GENERAL

Graph Length [s]

Interval used for the time axis.

Graph Update Interval [s]

Time interval used to update the graph.

DATA PROCESSING

Contact Threshold [N]

Minimal allowed load at force plate to enable the onset of the signal acquisition.

Peak Width [s]

Minimal allowed width between peaks of the vertical force.

Time Interval [s]

Interval used to calculate fatigue and endurance.

FILTER SETTINGS

Filter settings for signals.

Filter

When checkbox Filter is checked then the selected filter is active.

Filter Type

Specifies the passband of the filter.

High Cutoff Frequency [Hz]

Is the high cut-off frequency in Hz. When filter type is passband or bandstop, high cut-off frequency must be greater than low cut-off frequency and the Nyquist criterion has to be respected.

Low Cutoff Frequency [Hz]

Is the low cut-off frequency in Hz and must observe the Nyquist criterion. When filter type is passband or bandstop, low cut-off frequency must be less than high cut-off frequency.

Order

Specifies the filter order and must be greater than 0.

Smoothing Filter - Window Size [s]

Window size in seconds that is used for the smoothing filter of the acquired signal.

COP FILTER SETTINGS

Filter settings for COP curve (X and Y directions).

Filter

When checkbox Filter is checked then the selected filter is active.

Filter Type

Specifies the passband of the filter.

High Cutoff Frequency [Hz]

Is the high cut-off frequency in Hz. When filter type is passband or bandstop, high cut-off frequency must be greater than low cut-off frequency and the Nyquist criterion has to be respected.

Low Cutoff Frequency [Hz]

Is the low cut-off frequency in Hz and must observe the Nyquist criterion. When filter type is passband or bandstop, low cut-off frequency must be less than high cut-off frequency.

Order

Specifies the filter order and must be greater than 0.

Turn - Settings

PROCEDURE - GENERAL

Graph Length [s]

Interval used for the time axis.

Graph Update Interval [s]

Time interval used to update the graph.

Enable Buffers

Enables Pre/Post buffer.

Pre-buffer [s]

Maximal time inteval before the start event.

Post-buffer [s]

Maximal time inteval after the end event.

DATA PROCESSING

Contact Threshold [N]

Minimal allowed load at force plate to enable the onset of the signal acquisition.

After Event Delay [s]

The threshold used to calculate the parameters labelled under.

FILTER SETTINGS

Filter settings for signals.

Filter

When checkbox Filter is checked then the selected filter is active.

Filter Type

Specifies the passband of the filter.

High Cutoff Frequency [Hz]

Is the high cut-off frequency in Hz. When filter type is passband or bandstop, high cut-off frequency must be greater than low cut-off frequency and the Nyquist criterion has to be respected.

Low Cutoff Frequency [Hz]

Is the low cut-off frequency in Hz and must observe the Nyquist criterion. When filter type is passband or bandstop, low cut-off frequency must be less than high cut-off frequency.

Order

Specifies the filter order and must be greater than 0.

Smoothing Filter - Window Size [s]

Window size in seconds that is used for the smoothing filter of the acquired signal.

COP FILTER SETTINGS

Filter settings for COP curve (X and Y directions).

Filter

When checkbox Filter is checked then the selected filter is active.

Filter Type

Specifies the passband of the filter.

High Cutoff Frequency [Hz]

Is the high cut-off frequency in Hz. When filter type is passband or bandstop, high cut-off frequency must be greater than low cut-off frequency and the Nyquist criterion has to be respected.

Low Cutoff Frequency [Hz]

Is the low cut-off frequency in Hz and must observe the Nyquist criterion. When filter type is passband or bandstop, low cut-off frequency must be less than high cut-off frequency.

Order

Specifies the filter order and must be greater than 0.

INPUT PARAMETERS - SETTINGS

In this section you can add, delete or rename existing Input Parameter. Delete and rename function is available only for Input Parameter added by the user. Default Input Parameter can not be deleted or renamed.

Add

Add new input parameter value.

Rename

Rename input parameter value.

Delete

Delete input parameter value from database.

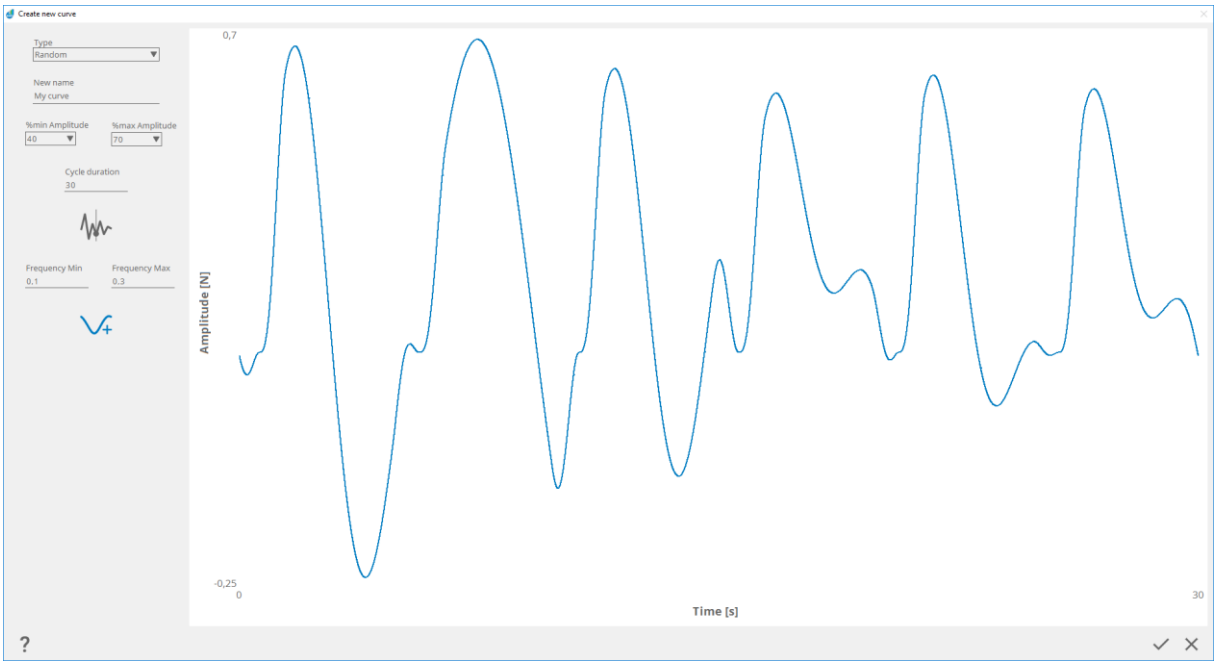
Manage Input Parameters

Procedure for editing Input Parameters values are the same for all Input Parameters. An exception is only for editing Input Parameter Curve (test Curve Tracking) and Shape (test Shape Tracking). The procedure for these exceptions is described below.

CURVE TRACKING

All Curves are defined with Type of curve, name, per cent of maximal and minimal amplitude and cycle duration.

Ramp has additional settings for defining per cents of line, where the sum of per cents must be 100. Random curve has additional settings for minimal and maximal frequency, which means that frequency of new the random signal will be somewhere between minimal and maximal frequency.



Type

Type of curve.

New name

Defines the name of the curve.

% min

Minimum % of amplitude from generated signal.

% max

Maximum % of amplitude from generated signal.

Cycle duration [s]

Cycle duration of generated signal.

Random start point

Generates the same curve with new start point.

Frequency min [Hz]

This parameter is enabled only for Random type of the curve.

Frequency max [Hz]

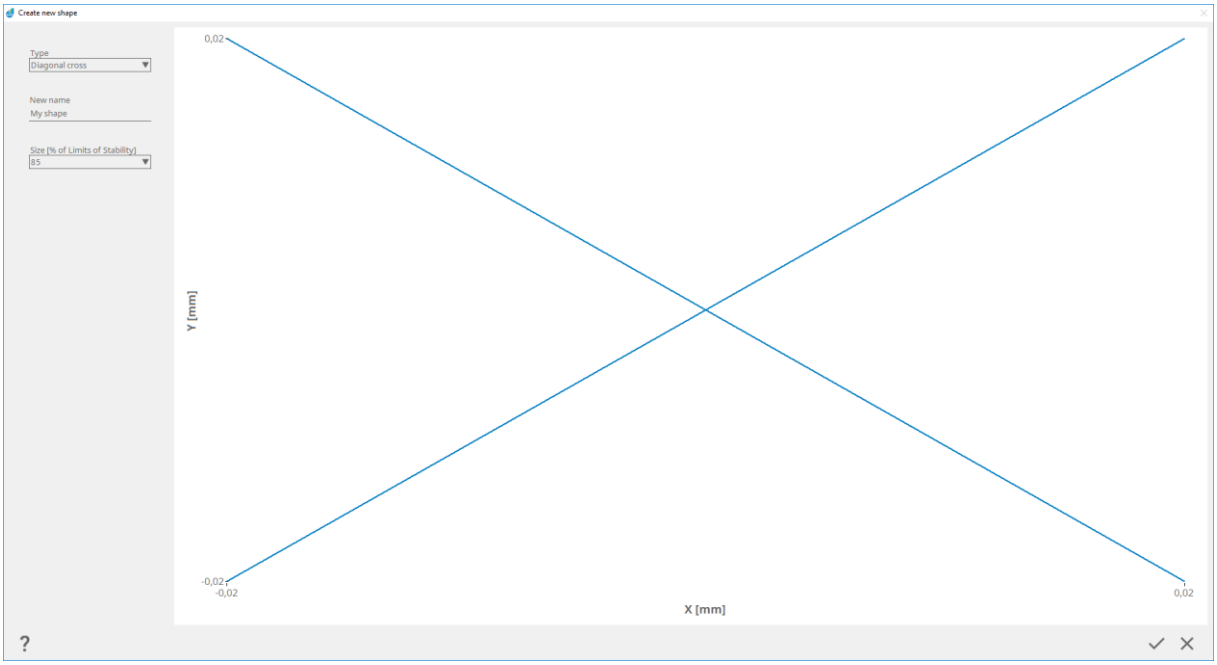
This parameter is enabled only for Random type of the curve.

New random curve

Generates the new random curve with selected parameters.

SHAPE TRACKING

Shape is defined with name, type and size with percentages of Limits of Stability.



New name

Defines the name of the shape.

Type

Type of shape.

Size [%]

Size of the shape expressed in the % of Limits of stability.

HARDWARE - SETTINGS

Under Hardware setup panel, you can set parameters for device.

Functionalities

Add

Add a new device.

Delete

Delete the selected device.

NOTE: Deleting device will permanently remove the device from the database.

Edit

Edit the selected device.

Test device

Shows all raw signals for selected device (from all plates). This utility is used to check if all signals are correct.

DEVICE CONFIGURATION

Select device type from the list, enter a name for the device and select plates configuration (one plate or two plates).

Name helps you identify the device easily in case you use more than one device.

PLATE CONFIGURATION

Select force plate type from the list, enter the plate serial number and name. Name helps you identifying the force plate easily, in case yoou use more than one plate.

Plate Type

Type of the force plate.

Selecting the plate type provides default settings for futher steps of plate configuration. These are the default values and may not need editing. Compare these values with the values shipped with your force plate, and change them if necessary.

Name

Name of the force plate.

Serial Number

Serial number of the force plate.

PLATE DIMENSIONS

The plate dimensions are shown in millimeters and once entered correctly they should not change.

Width (x) [mm]

The width of the force plate.

Length (y) [mm]

The length of the force plate.

a (x - offset) [mm]

Distance of sensor from y-axis.

b (y - offset) [mm]

Distance of sensor from x-axis.

Az (depth) [mm]

Distance of plate surface from x-y sensor plane.

PLATE SENSITIVITIES AND RANGE

SENSITIVITIES

Values for sensitivities must be taken from the force plate calibration sheet that comes with the force plate. Default values for the selected force plate are used by default. It is strongly recommended that the default values are replaced with the values from the calibration sheet; otherwise, the measured forces may be incorrect.

The calibration sheet contains sensitivities values for the three dimensions Fx, Fy and Fz:

- Fx values for **x1-2** and **x3-4,**
- Fy value for **y1-4** and **y2-3,**
- Fz value for **z1, z2, z3** and **z4**.

Enter the sensitivities in mV/N for plates with integrated amplifiers. These settings should not need editing once they are correctly entered. These sensitivities are a combination of the load cell sensitivity and amplifier range. These values should come from the calibration sheet that came with your force plate.

RANGE

The user should select the initial force range per channel for both the shear and vertical directions. These ranges are calculated from the force plate sensitivities and amplifier ranges and Full Scale Output (FSO). A good rule of thumb is to choose the lowest range that will not be exceeded during the intended trials (peak force). This range selection can be changed as needed to handle a wide variety of applications, so it is not critical to know exactly which range to enter at this time.

X,Y (Shear)

Shear direction.

Z (Vertical)

Vertical direction.

Select the desired vertical and shear ranges from the drop boxes. The range values are automatically calculated from the sensitivities of the plate and the amplifier full scale output.

The range represents the maximum force that can be measured per sensor. Thus, a vertical force range of 1000 N can measure up to 4000 N if the force is applied exactly in the center of the plate and is evenly distributed across the four load cells. The force distribution is dependant on the measurement conditions and is an unknown variable. Generally, you can safely measure up to twice the vertical range without overloading the system.

PLATE COP IMPROVEMENT

Some eight-channel plates have Center of Pressure enhancement variables that, when activated, implement an algorithm based on these variables to more accurately calculate the center of pressure of the force plate.

PLATE CHANNELS

Channels on the DAQ System to which the force plate is connected. Kistler force plates normally use eight channels.

Start

Start channel number.

End

End channel number.

NOTE: Next step depends on the plate setup that you selected under the Device Configuration. In case of the One plate setup you will be promped to select DAQ System; otherwise, you will have to select plate properties for second plate before selecting the DAQ System.

DAQ SYSTEM

Board Type

Type of the DAQ System.

Board Number

Board number that is assigned in the Instacal software.

NOTE: The board type and the board number configured in Instacal must match.

PLATE ORIENTATION

Follow the instructions on the screen and step on the front left side of the plate. In case of the two plates setup you have to perform this procedure for both plates.

PLATE PROPERTIES

Plate Name

Name of the force plate.

Orientation

Orientation of the force plate with respect to the global coordinate system (bottom-left).

Channels

Channels on the DAQ System to which the force plate is connected.

Side

Side (left or right) for which the force plate is used.

Orientation [°]

Orientation of the force plate(s) regarding to the global coordinate system (bottom-left).

NOTE: Orienttion of the force plate can be recognized automatically if the device is connected to the computer.

X offset [mm]

Distance between the plates in the x direction of the global coordinate system (bottom-left).

Y offset [mm]

Distance between the plates in the y direction of the global coordinate system (bottom-left).

NOTE: Side, X and Y offset are avaliable only for two plate setup.

SEND FEEDBACK

Send feed back is used to send your feedback directly to the development team. Two types of feedback are available: enhancement and bug (you found in the application).

Feedback type

Select the type of your feedback from the list.

Your email

Write the email for further contact.

Subject

Subject of the feedback.

Text

Describe the enhancement/bug in details. In case of the bug, try to describe the procedure (last steps) that lead to the bug.

Attachments

Attach the file(s) for the reported enhancement/bug.