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# **Misura Documentation**

***Release 4.4***

**TA Instruments / Waters LLC**

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Misura™ is the data acquisition and analysis software platform for non-contact high temperature measurement instruments.

Please always refer to the updated version of this document which can be found online here:

<http://misura.readthedocs.io>

This document describes the installation and quick start of Misura™4 software.

### 1.1 Prerequisites

- 2GB of free hard disk storage
- At least 500MB of free RAM at runtime (see below)
- 2Ghz, dual core processor
- Maximum screen resolution: 96dpi.

For windows: - Windows 10 64bit - 4GB RAM for ODP users - 8GB RAM for Flash users

For linux: - Ubuntu 16.04 - 2GB RAM for general users - 8GB for Flash users

Dependencies:

- The latest Windows Visual C++ 2008 Redistributable package, x86 version (independently on your OS being 64 or 32 bits): [vc redistrib.](#)
- You will need [Xvid](#) MPEG4 video compression filter in order to export compressed videos of recorded frames.

Known incompatibilities:

- High DPI screens might not be supported and cause Misura to crash. Please

rescale to 96 DPI.

### 1.2 Microsoft Windows™ 10 64bit

Misura™4 for Microsoft Windows™ 1064bit can be obtained as a *standard installer* (.exe).

Installation initiates by double clicking on the installer package proceeding through the pages. Any previous installation will be deleted, but local Misura data and configuration will not be affected.

The installer will ask which components to install. Misura Flash users can skip the installation of Acquisition and Graphics components.

### 1.2.1 Upgrading

The *Misura™ Browser* menu action *Help → Check client updates* will check if any newer client version is available, download the installer and start the installation procedure.

The *Live Acquisition* window also offers *Help → Check server updates* when connected to an instrument. This action upgrades the instrument's firmware, closes the client and restarts the server.

## 1.3 Canonical Ubuntu™ GNU/Linux

Misura™4 for Ubuntu™ 14.04 LTS GNU/Linux operative system should be installed along with the full development environment.

Follow instructions contained in the [README](#).

Both client and server upgrades are available as explained above, *Upgrading*.

## 1.4 Bug reports and support

For assistance you can contact Daniele Paganelli, [d.paganelli@tainstruments.com](mailto:d.paganelli@tainstruments.com).

The **Help** menu of *Misura™ Browser* and *Live Acquisition* contains a **Bug report** action which will create a zip archive containing useful information for debugging, *Help → Bug report*. It is recommended to attach this archive to any support request.

- If the issue involves running a test or controlling an instrument, the bug report should be created from *Live Acquisition* while connected to the machine. In this way also instrument logs will be included.
- If the issue involves only data processing and visualization, the bug report can be created from the *Misura™ Browser*.
- If doubts about measurements are implied, please send also relevant test files.

It is advisable to set the client bug level filter to 0, so all user interface messages will be logged (Logging level option in *Preferences*).

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### The Measurement Platform

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This section describes software components that are shared across all or many Misura applications. They are presented in a general way which is applicable to any measurement task.

## 2.1 Live Acquisition

The Live Acquisition software allows to carry on any kind of measurement available on a Misura platform.

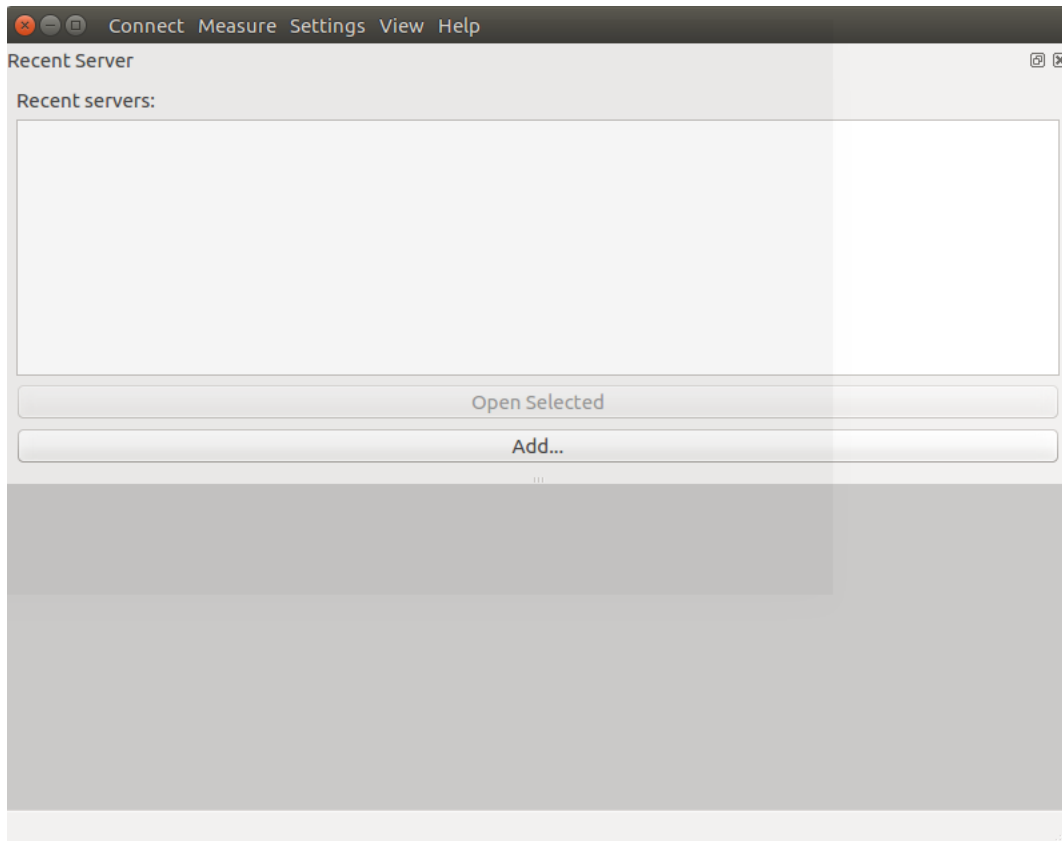
This section describes basic concepts, functionalities and procedures which are general enough to be applicable to any measurement.

More specific instructions can be found in *Measurement Apps* sections dedicated to each instrument.

### 2.1.1 Connecting

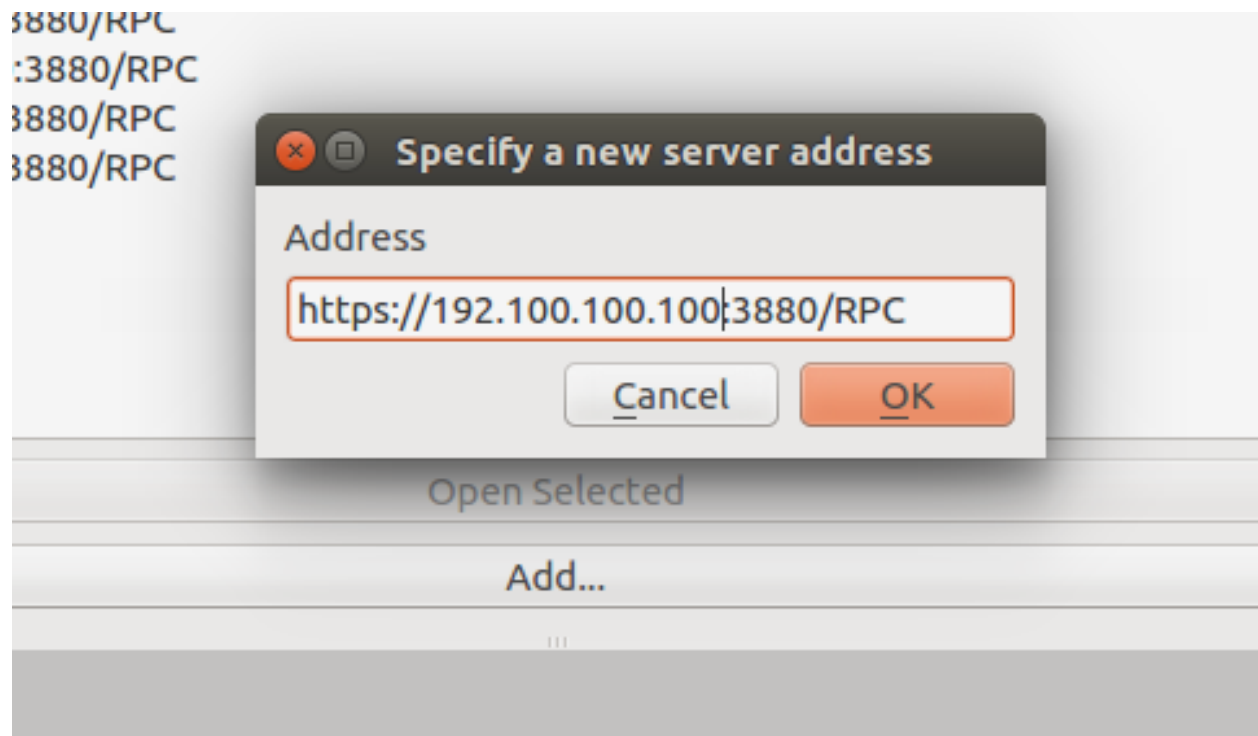
When you first launch Acquisition software, you have to select a server to connect to.

Select the *Connect* → *Server* → *Open* action. Alternatively, from the *Recent Servers* area, click the *Add* button:

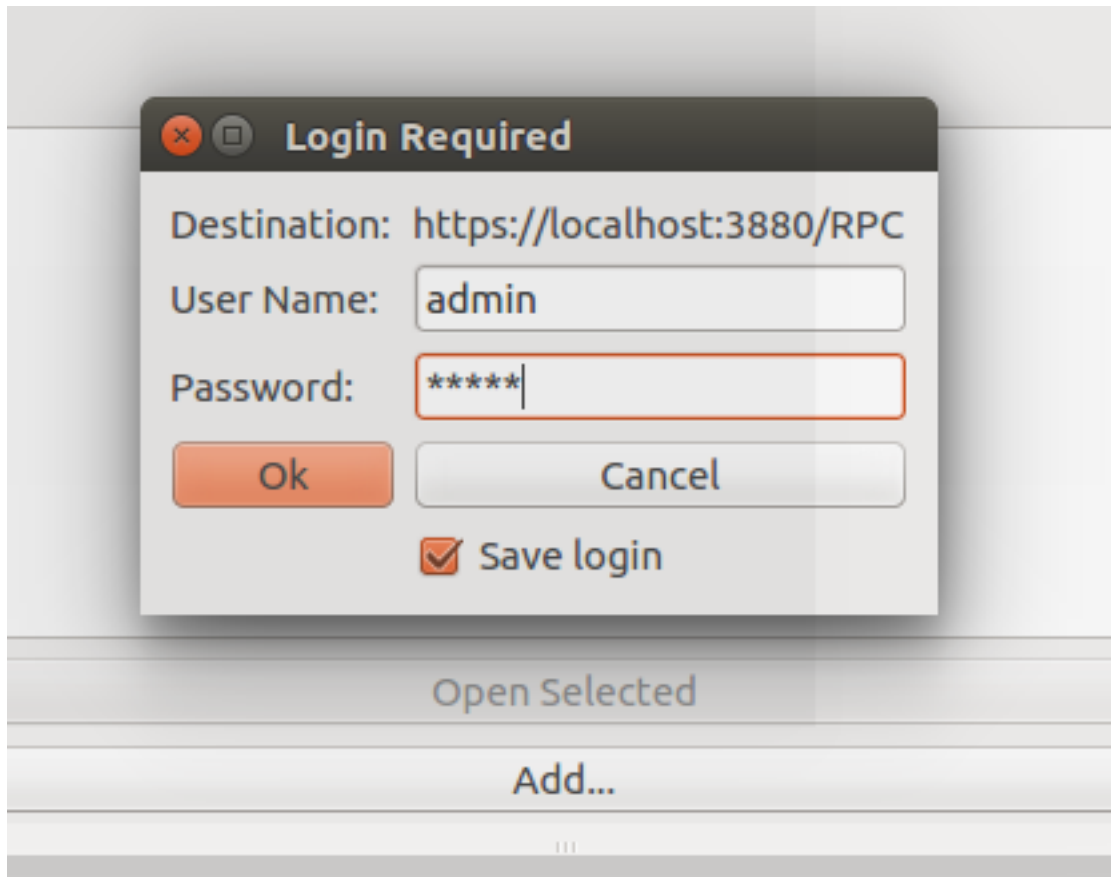


An input dialog will let you specify the server protocol, IP, port and path. In a normal environment, the server address will be:

`https://192.100.100.100:3880/RPC`



A username and a password will be prompted, and saved for any future connection to that machine.



Saved connections will be displayed both as items in the *Recent servers* box on the welcome page of Live Acquisition, and as *Connect* → *Server* menu items.

### Client network configuration

You should connect to the instrument through a crossover cable or a private hub just between the client PC and the instrument network interface.

As the instrument provides no network auto-configuration, you will be required to manually set-up your network interface in order to be able to reach that IP.

Factory-installed clients usually have this configuration:

- IP: 192.100.100.2
- Netmask: 255.255.255.0
- Gateway and DNS: None

Follow this [official guide for Windows](#) to disable DHCP and manually set a fixed address.

### Time synchronization

The time between instrument and client computer is kept synchronized. The user may periodically see a warning message upon connection, asking to re-synchronize times. If replied positively, the instrument will restart for synchronization.

It's up to the user keep the client's computer time up-to-date, manually or by using exact time services.

When connecting from multiple clients, you should keep all client synchronized at the same time, to avoid multiple re-sync.

## 2.1.2 Initializing the Measurement App

After a successful connection you will be shown a list with available *Measurement Apps*, a button for each instrument. Click the corresponding button to select your desired instrument.

Once the instrument is selected, the machine will start its setup, also called *measurement morphing*. A "Pending Tasks" dialog will appear in the left panel, showing some details about what is happening. The internal positions of measuring components will change in order to reach the configuration required to perform the requested instrument, as displayed in [this video](#).

This operation can take up to a couple of minutes, depending on the instrument. Any interaction with the application is discouraged until when the dialog disappears.

Once the initialization is complete, the application will display all relevant controls needed to configure, start and follow the execution of the test.

**The menu bar contains:**

- **Connect:** to connect to a different machine or to change measurement app.
- **Measure:** allows to re-initialize the instrument from zero, set a delayed start, hide/show user interface components (Test Configuration, Storyboard, Data Plot, Data Table, Log Window), Reload Data from the instrument, Quit client.
- **Settings:** gives access to advanced configuration panels for the **Instrument** itself, its individual **Devices**, or the full **Global** configuration.
- **View:** Hide/show user interface components, like plot window, storyboard, etc.
- **Help:** client configuration, documentation link opening the documentation you are reading, the *Pending Tasks* dialog, the software information dialog.

**On the right side of the window you find a tabbed Test Configuration area, showing:**

- **Status** tab: contains short summary of the current test condition. The first two options shows if a test is running (data recording) and if the thermal control is active. They are underlined in green when not active, in red when running. Then follows information on test name and test duration (if running); the furnace position if motorized; temperatures, setpoint and power output. More sample-dependent option can be shown based on the active measurement app.
- **Measure** tab: generic test configurations can be made (starting and stopping conditions) and metadata can be viewed (eg: maximum temperature reached)
- **Thermal Cycle** tab: allows to define the thermal cycle and preview it
- **Sample<N>** tabs: one tab for each sample defined in the analysis.
- **Results** tab: empty until the start of the test. Will be populated with tools for *Interacting with a running test*.

**On the bottom, a bar showing:**

- **Focus** slider and spin-box, to adjust the focus distance.
- **Furnace:** option to view and control furnace position (Opened/Closed). Only available if furnace is motorized.

### 2.1.3 Configuring the test

The following paragraphs explain common procedures or concepts needed to carry out any test with Misura™.

#### Moving the furnace

The first step of test configuration is placing the sample in the right position. If the furnace is motorized, you should always open it by using the option **Is the furnace closed?** in the Status tab, or the **Furnace:** box in the bottom bar. That option should be changed to the desired position: *Closed* or *Opened*.

Once the sample is positioned and correctly framed, it is advisable to close the furnace using the same option, and proceed with test configuration.

#### Measure and Sample names

The test name can be directly set in the Status panel, or in the *Measure* tab.

This is the name of your measurement, but the sample (and each sample) can have a different name. Sample names can be set in their Sample<N> tab, in *Name* option (see *Samples*).

The test name should identify the kind of measurement, while the sample name should identify the material the measurement method is applied to. You will be able to recall the both test name and sample name from the *Database Indexes*.

For simplicity you can just set the test name to a string identifying both the kind of test and the sample name, and leave the sample name field to the default value (*Sample N. 0*).

The test name will also be used as the output file name. If a file with the same name already exists, it will be postfixed with *\_<N>*, where *<N>* will be increased until an unique name exists (*measure*, *measure\_1*, *measure\_2*, etc).

#### Thermal cycle

The **Thermal Cycle** tab in the Test Configuration area allows to load a thermal cycle preset or to design a new one. Refer to *Thermal Cycle Designer* for a detailed explanation.

Additional test termination options can be configured in the Measure and Sample sections, depending on the *Measurement Apps* you are using.

### 2.1.4 Measure

This tab contains:

- *Configuration preset*: a combo that allows you to load a previously saved configuration. *Save* and *Del* buttons respectively save and delete currently selected preset.
- *Name*: the name to give to the test.
- *Maximum test duration*: defines the amount of passed time that will cause the end of the test, even if the thermal cycle is not completed (-1 removes this timeout)
- *Stop after thermal cycle*: when set, the acquisition will stop when the thermal cycle is over. If not set, the acquisition will go on until the operator won't stop it manually.
- *Operator*: the operator running the test
- *Type*: the type of test. Only *Standard* is supported to date

- *Start at*: date and time when the test was started
- *Number of samples*: sets the number of samples to analyze (can be from 1 to 8)
- *Kiln position before acquisition*: the position where the kiln will be placed right before the start of the acquisition
- *Kiln position after acquisition*: the position where the kiln will be placed after the end of the acquisition
- *End status*: displays the reason of the acquisition's termination

## 2.1.5 Samples

Every sample has its own tab, named Sample0, Sample1, ...

Each tab contains the details of its sample:

- *Configuration preset* is the currently loaded preset. You can change it, save it if you make any change, and delete it.
- *Name* is the name of the sample
- *Temperature* is the current sample temperature
- *Initial sample dimension* is the size of the specimen, before the start of the test
- *Record frames* defines whether the raw frame of the sample should be saved or not
- *Record profiles* defines whether the sample profiles have to be saved or not
- *Border angle* is the angle of currently detected border
- *Total displacement* is the current displacement from initial position

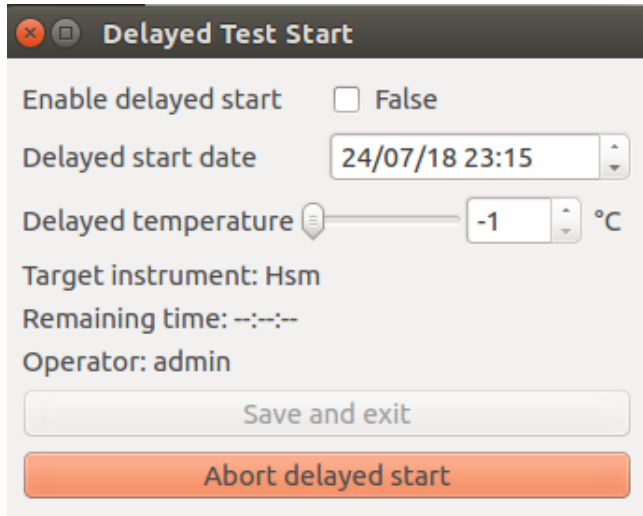
## 2.1.6 Starting/stopping the test

Once the test is completely configured, the sample positioned and the furnace moved to its intended initial position, you can start it by clicking on **Start** button in the upper-left toolbar. A confirmation dialog will ask you to review the test name, the initial dimension if any, and the system status. By confirming, the test will start.

The button bar in the upper side of the main window has two more buttons, **Stop** and **Cool**, as explained in [Ending the test](#).

### Delayed start

To schedule a test to start at a specified date in the future, you can use the **Delayed start** feature, available from the **Measure** menu.



The Delayed Test Start dialog will appear with the options needed to control its behaviour.

- **Enable delayed start:** click on the checkbox to engage the delayed start. When the configured time and temperature are reached, the test will automatically start.
- **Delayed start date:** Set date and time when the test will start.
- **Delayed temperature:** Set a required minimum temperature for the start of the test. If set to -1, no temperature will be required and only the time delay will be considered.

Then 3 fields allows to understand how and when the test will be started.

- **Target instrument:** the current instrument app name. It will not be possible to change instrument a delayed start is already configured.
- **Remaining time:** a countdown showing remaining time to test start
- **Operator:** the user name of the operator who set the delayed start

Finally, 2 buttons:

- **Save and exit:** close the client application. The delayed start will remain active and the test will be started at the configured time, even if no client is connected to the instrument.
- **Abort delayed start:** cancel delayed start and dismiss the dialog.

The dialog will remain active until the test starts. If you close the client application or click **Save and exit**, the delayed start will remain effective. If you later reconnect to the instrument, the delayed start dialog will pop up again, until test starts or delayed start is aborted.

Dismissing the dialog equals aborting the delayed start.

## 2.1.7 Interacting with a running test

While the test is running it is possible to perform most of the data visualization and processing operations which are available when accessing to a finished test output file.

- The *Status panel* tab will update showing relevant options and output values
- By clicking on menu *Measure* → *Data Plot*, you can view a realtime graph of output values which will open in a *Data Plot* subwindow. You can interact with the plot under the Results tab (adding a curve, changing visualization options, etc).

- By clicking on menu *Measure* → *Data Table*, you can inspect all active datasets in a tabular view, which will open in a *Data Table* subwindow.
- If the instruments records images or sample profiles, the *Storyboard* will be visible.

## Status panel

The Status panel will update showing relevant status, configuration options and real-time output values.

It always contains information about:

- **Acquisition status:** is there a running test? This coloured checkbox will be False over green background when there is no running test; True over red background while a test is running.
- **Thermal control status:** is there any running thermal cycle? This coloured checkbox will be False over green background when there is no active thermal control (no thermal cycle); True over red background if the temperature is currently under control by a thermal cycle.
- **Test name.** This text box is synchronized with the one contained in the **Measure** tab.
- **Elapsed time:** Seconds passed since the start of the test.

Thermal control status cannot be True if the acquisition status is False. In other words, temperature cannot be controlled by a thermal cycle outside of a running test.

On the opposite it is possible that the thermal control is turned off during a running test. This happens if the test was set to do not end with the thermal cycle and its target duration was longer than the duration of the thermal cycle. The operator can also manually interrupt the thermal control anytime by pressing the `Cool` button - without stopping the acquisition (see below *Ending the test*).

The Status panel also contains real-time thermal control parameters, as:

- **Sample temperature:** Temperature measured as near as possible the sample, on the sample holder.
- **Furnace temperature:** Also measured quite near the sample, but attached to the furnace chamber. Thus, if the furnace opens, this thermocouple signal will record the inside of the empty furnace, while the Sample temperature above will record the environment temperature outside of the furnace, nearby to the sample.
- **Setpoint:** The target temperature of the thermal cycle.
- **Power:** The percentage of power emitted in order for the control temperature to reach the setpoint temperature.
- **Control temperature:** The reference temperature used for power emission in order to reach the setpoint. This is usually equal to the Sample temperature while the furnace is closed; to the furnace temperature while it is open; or to a custom combination of both.

Additionally, the Status panel contains realtime values depending on the current Measurement App:

- Initial sample dimension
- Displacement (expansion/contraction/flexion)
- Volume
- Height
- ...

## Data Plot

The Data Plot is accessible by clicking on menu *Measure* → *Data Plot*. It is initialized at the start of the test with a default plot showing the most relevant measured property against time.

The plot can be edited and customized exactly as you would offline using the *Misura™ Browser* or the *Plotting*. See *Data Plot* for more help.

**Warning:** It is advisable not to build complex plots during live acquisition, as you will lose all your careful work when the test ends. Moreover, complex data operations might slow down the user interface and lead it to a complete freeze, as they are entirely re-computed each time a new data point is received. If this happens, close the Live Acquisition window and reconnect to the running machine. Plotting data has no effect on test execution, measurement, and data collection.

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**Hint:** The data you see during live acquisition is not exactly the same you will find on the output file. This is because the data plot will display raw values as they arrive each couple of seconds. Instead, when you open the output file after the test ended, you will plot slightly smoothed data considering tens of points per second.

---

## Results

The *Results* tab contains another series of tabs, which are:

- *Data Tab*: a tree that contains all plottable data to allow you to perform operations over it.
- *Properties* and *Formatting*: are the equivalent of Properties and Formatting on the right click menu of the *Data Plot*. Operations are applied on the object selected in the Objects tab or on the plot.
- *Objects* is a 1 to 1 representation of the plot; it allows to select objects to perform operations in other contexts.
- *Console* is the Veusz output console.

## Data Table

The Data table is accessible by clicking on menu *Measure* → *Data Table*. It displays one column for each *Loaded Dataset*.

New data points are dynamically added at the end of the table. The table can be exported to \*.csv file format anytime by right-clicking on the header.

## Storyboard

The storyboard displays a list of recorded frames or profiles of a sample. The target sample can be changed with the upper-left combo box.

The storyboard is available only when images or profiles are saved in the output file. Frame and profile recording can be configured, before test start, in the **Sample <N>** tabs in Test Configuration panel.

It is always visible in the Microscope app. If not, it can be accessed by clicking on menu *Measure* → *Storyboard*.

A label below each image reports the temperature value at which the image was recorded (eg: T: 321). More measured values can be displayed by dragging and dropping nodes from the **Results** tab.

The number of images is fixed (usually five on an horizontal row).

The user can navigate forward and backward by using the upper slide bar, which will cause the images to update to the recorded data in the position indicated by the slider, relative to total test duration.

Navigating through the images will cause a vertical red line to move back and forth in the *Data Plot*, if visible. The operator can thus view measured values associated with displayed images.

It is possible to navigate through the images also by dragging and dropping the red bar on the *Data Plot* to different X-axis values.

### 2.1.8 Ending the test

The test will naturally end when a termination option is triggered (end of thermal cycle, test duration elapsed, etc). At the end of the test, the output file will be downloaded to the client PC - if the client is connected - or scheduled for download with the *Storage synchronization* mechanism.

To forcefully stop the test, click **Stop** button in upper-left toolbar. You will be asked to confirm your decision, and if you want to save the partial output file or immediately delete it.

In certain conditions it is useful to stop the thermal control without stopping the test. Click the **Cool** button in the upper-left toolbar and confirm your decision. The confirmation dialog will warn you that, in order to stop the thermal cycle without stopping the test, the option *Stop after thermal cycle* was implicitly disabled. If you did not provide a maximum duration for your test, or other special termination option, it is possible that your test will never end.

**Never ending tests** are possible by disabling the *Stop after thermal cycle* option and setting a zero or negative *Maximum test duration*. It's up to you to manually stop these tests.

Changing termination options has immediate effect on the running test. For example, if the thermal control ended and enable the *Stop after thermal cycle* option, the test will instantly stop. Or, if you set a maximum test duration greater than zero but smaller than current elapsed time.

## 2.2 Components and options

The configuration of a test involves many different components of the system: the measurement definition, one or more samples, the thermal cycle.

Under the hood, many other components are configured automatically or based on the user's input: real physical devices (cameras, motors, power controllers, etc) and virtual components like sub-samples (Left/Right/Center, Base/Height), feedback regulators, the instrument itself, etc.

All these configurations are defined and saved in a consistent hierarchy of components both in the live instrument and in the output file.

Each component defines several options: all summed up, they represent the **component's configuration**. Component configurations can be saved as **Configuration presets**, and recalled by their name to quickly get the component back in the desired configuration.

The user interface displays a component configuration as a **Configuration panel**: a structured list containing all available options (according to the user's *Access Management*).

Components are organized in a hierarchical way, in order to make easier to search for them and to automate some actions on group of related components.

### 2.2.1 Configuration panel

A configuration panel lists all options related to a single component. For example, left-side panel in *Configuring the test*, is a configuration panel.

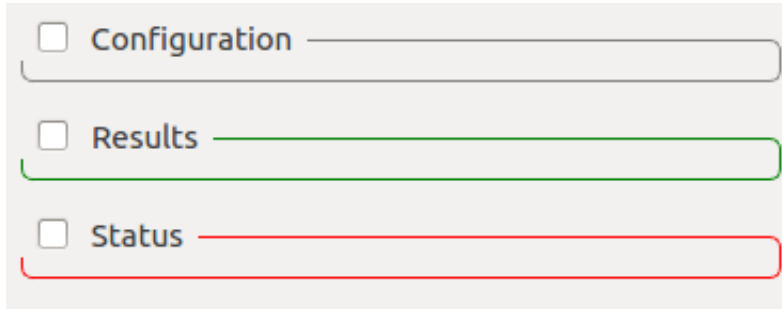
It can contain tabs, one for each major configuration section. For example, shape identification standards, listed as tabs in microscope *Standards for Characteristic shapes identification*, are configuration sections.

The options listing can be divided up to 3 boxes, one for each option role:

- **Configuration:** options which can be edited by the user.

- **Status:** options which are generally changed server-side to reflect internal status. The user can interact with some of them.
- **Results:** options which represent the output of a server process - usually read-only.

Box visibility can be toggled by clicking on the checkbox near the header.



## 2.2.2 Configuration options

Misura™4 offers a unified experience to visualize and edit any variable, generically called **Option**.

Options can represent proper **Configuration** variables, which the user can change to obtain an effect, but also the **Status** of some server-side variable, or a read-only **Result** from an analysis.

This distinction is well visible in any configuration panel, where options are grouped in 3 boxes - one for each role.

Options have types (String, Integer, Float, etc) which determine their appearance in the user interface.

All options share a common representation pattern: a label, containing the option's name, and the option value. The option value can be represented as an input box (for text), a spinbox (for numbers), a slider and a spinbox (for number with boundaries), a combo-box (for selections), a checkbox (for booleans), etc.

**Read-only** options usually appear as simple text labels, without any control associated with editing. Some read-only option types, like tables, have no visual distinction: editing interactions are simply disabled.

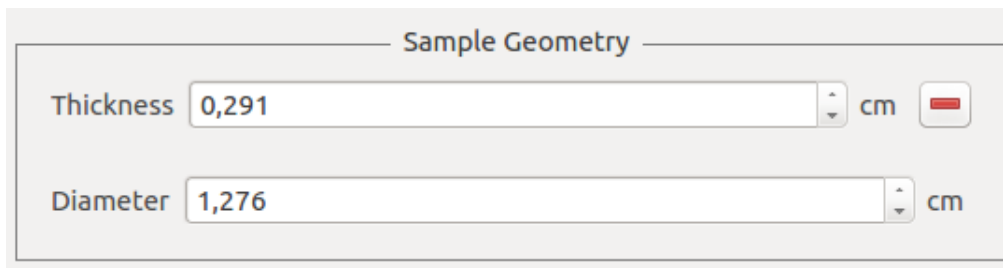
If a numerical option has an associated measurement unit, it will be displayed between the label and the value.

### Sub-options and groups

An option can have sub-options, which are hidden by default. Sub-options usually represent fine-tuning aspects of the parent option.

The presence of sub-options is indicated by a + symbol on the right of the option itself. When clicked, subordered options will become visible below the main option, and the symbol will turn to – and produce the opposite effect (hiding sub-options).

Options might be grouped together in a titled box.



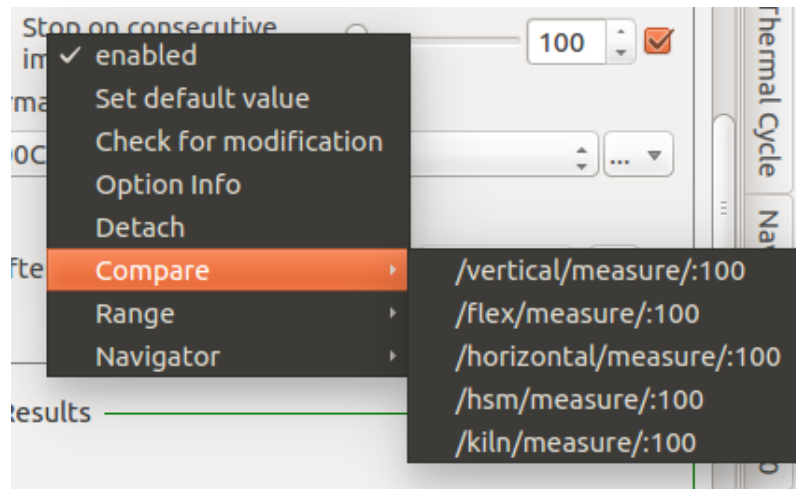
## Option's context menu

The options's context menu can be visualized by right-clicking on the option's label. Actions marked with (\*) are available only when connected to a live instrument.

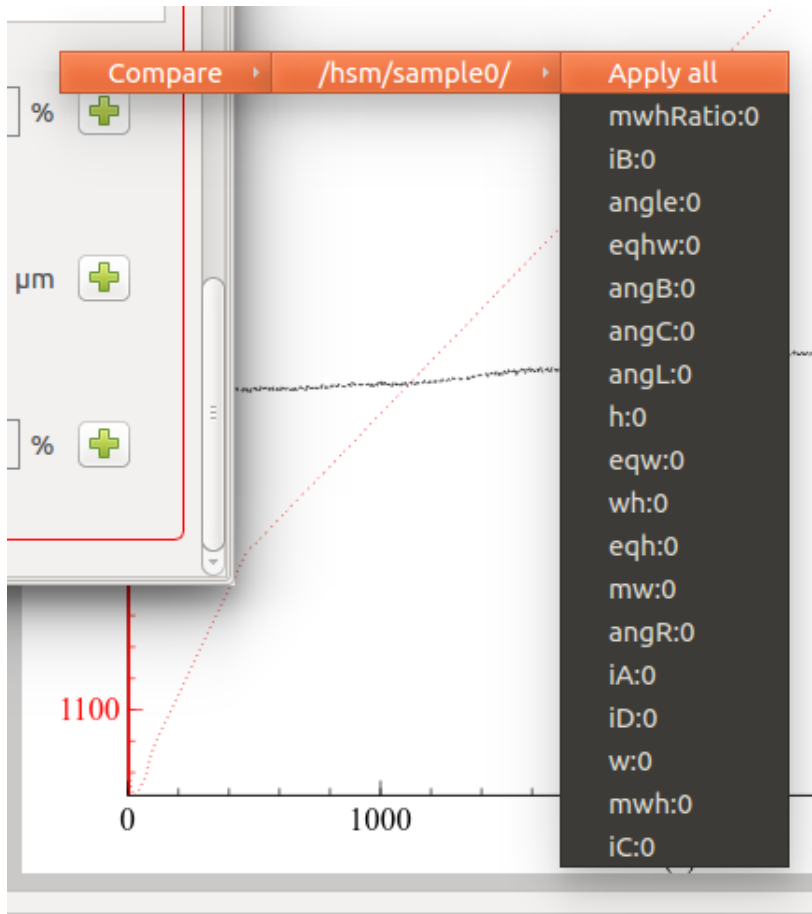
- **enabled:** some options might support an enabled/disabled state.
- **Units:** Change measurement unit. Only for numerical options defining a number.
- **Set default value:** resets to factory default.
- **Check for modifications:** (\*) force to read the current value on the instrument's side and refresh. It has the same effect as passing the mouse over the option.
- **Option info:** opens a dialog where all option's attributes are listed.
- **Detach:** opens a separate window containing the option label and value alone. This can be useful to view more clearly complex options, like tables.
- **Aggregation:** only visible if the option is an aggregate, see [Aggregates](#).
- **Presets:** (\*) lists all values in any saved configuration preset for this component. By clicking on a submenu action, the related value will be applied.

## Compare menu

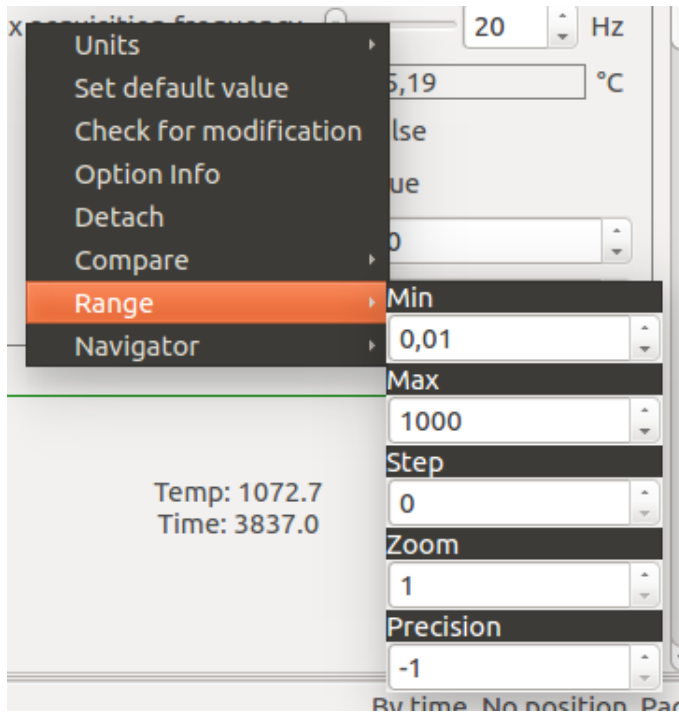
**Compare** lists all values for options with the same name in any other component on the server or in the test. By clicking on a submenu action, the related value will be applied.



When an option has some sub-options, a *Compare* menu is also accessible from the +/- symbols used for exploding or collapsing the option group. This menu contains an intermediate level, listing all components containing *all the options grouped together*. For there, another submenu lists the option values one by one. By clicking on an option:value couple you can apply that value to the option in the current group. By clicking on **Apply all**, all the values from the referred group will be imported and applied to the current group's options.



## Range menu



Numerical options also show a **Range** submenu, containing settings for:

- **Min:** the minimum value the option can have
- **Max:** the maximum value the option can have
- **Step:** step used for user-interface interactions (spinbox, slider)
- **Zoom:** The control slider will be zoomed into a region of valid values and be colored in red. This can be activated on options having a min/max and showing a slider. Zooming can be used in *Motion Control*.
- **Precision:** how many digits to show. They will be shown only if needed (eg: 1.20001 will be just 1.2 if precision is set to 4 or less). A less than 0 value means digits are unmanaged.

## Tables

Tabular options have more complex editing interactions and they offer 3 context menus accessible with right-clicks.

### Cell context menu

Also callable from the empty space:

- **Add row after or before**
- **Delete row** - currently selected or first
- **Update** values from remote
- **Copy** selected contents to clipboard, in a text format which is suitable for pasting in third-party applications.
- **Export** to csv file, which can be imported in third-party applications.

- **Rotate**: exchange rows with columns. Will not affect underlining data structure nor csv export. Data copied to clipboard will be rotated.
- **Zoom**: graphically zoom in/out of the table, enlarging or shrinking all fonts and graphical elements
- **Visible units**: toggle visibility of column header units
- **More columns**: view previously hidden columns.
- **More rows**: view previously hidden rows.

### Column and row header context menus

- **Visible** checkbox: uncheck to hide the column.
- **More columns**: view previously hidden columns again.
- **Units**: contains sub-actions related to measurement units management.
  - **Visible** unit in the header.
  - Select the current measurement unit.
- **Use as header**: will activate row header using this column.
- **Export** and **Rotate** as above
- **Add row** at the end of the table.

A **Row header** context menu is also available, containing the same options as the column header. Visibility refers to the clicked row, and **More rows** allows to recall hidden rows.

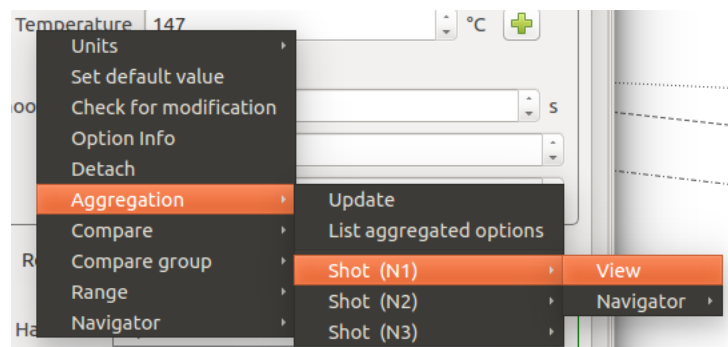
### Aggregates

The value of an option might be dynamically calculated according to options contained in other components. In this case, the option is referred as an **aggregate**.

For example, an option might be defined as the mean, a sum, a product or a tabular representation of numerous other options. Involved options typically come from sub components. For example, if component A has 3 sub components A/B, A/C, A/D and each of them defines a **Temperature** option, component A might define an aggregated **Temperature** option which is defined by the mean of all its subcomponent's temperatures:

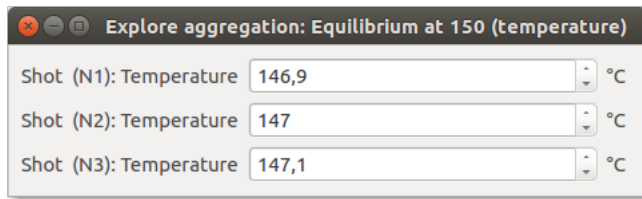
$$A.Temperature = (A/B.Temperature + A/C.Temperature + A/D.Temperature) / 3$$

Aggregated options can be recognized because they offer an additional context-menu submenu: **Aggregation** (see *Option's context menu*), containing these options:

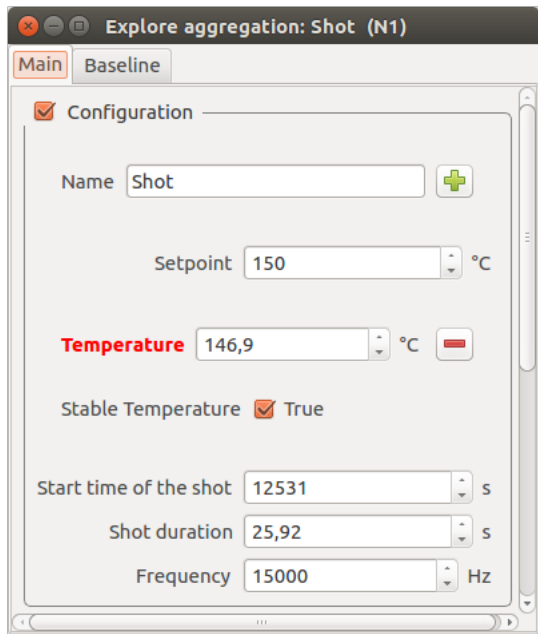


- **Update**: re-calculate the value of the aggregation.

- **List aggregated options:** opens a new window showing the values of options involved in the aggregation.



After a separator, all components involved in the aggregation are listed. Each component opens a sub-menu, with a **View** action, which will open a *Configuration panel* for the aggregated component where the involved option is highlighted in red.



A **Navigator** action is also available, giving access to the same actions which could be performed on the component's node if selected in the *Misura™ Navigator*.

A special tabular aggregation produces a table, where each cell value derives from an option pertaining to another component. An additional sub-menu is appended to the *Cell context menu*, with the same functionality as the **View** action above.

Tables can also be *merged* together, following the same criteria.

## 2.3 Pending Tasks

Misura™ is an heavily multi-threaded and multi-processing application, usually distributed between two computers (the client and the instrument itself).

It is important to have a clear visualization of what is happening and have a feedback about long-running tasks. When it is possible, the user should also have the choice to interrupt a task.

The **Pending Tasks** component is divided in three *tasks tabs*, each visualizing the ongoing operations on the **Remote** machine (the instrument), on the **Local** computer (the client) or data transfers involved in **Storage synchronization**.

A task is represented as a label containing the task name and a progress bar showing its current status.

Tasks can involve sub-tasks, which are displayed as rows below the main task.

The Pending Tasks component is usually hidden, and can be showed only from the **Help** menu. When a Remote, Local or Storage task is started, it pops up either in the form of a dialog or integrated into the *Live Acquisition* window. When no more tasks are running anymore, the Pending Tasks component usually hides itself.

### 2.3.1 Remote operations

Remote operations, or tasks, run on the instrument hardware and involve electronics configuration, motor positioning, multi-processing initialization or termination, output file creation or closure, calibration procedures and much more.

The unique feature of *Head Morphing*, which allows to change the observing system as a function of the kind of measurement you want to make, implies a reconfiguration step which can take few minutes and involve many moving parts. All concurrent remote operations involved in this *transformation* are showed each time you connect for the first time to a *Measurement App* or each time you select a different Measurement App.

Starting and stopping a test involve the coordination of multiple processes, the creation of complex data structures and the writing of big chunks of data on disk. These remote operations appear when a new test starts and even more when it finishes.

The **Remote** tasks tab is empty when no remote tasks are running. It populates with a list of ongoing tasks when as the server performs them.

**Remote tasks cannot be interrupted. You should not interact with the software in any way while remote tasks are running.** If remote operations are forcefully interrupted or the user unintentionally interacts with the system while performing remote tasks, it is advisable to *Soft-Restart* the server.

---

**Hint:** It is safe to interrupt the test initialization for security reasons by clicking the **Stop** button in the *Live Acquisition* window. After that, anyway, it is advisable to run a new instrument initialization by clicking *Initialize new test* under the *Measure* menu.

---

### 2.3.2 Local operations

Tasks ran by the client application are listed in the *Local* tab. For example:

- Connecting to an instrument or opening an output file
- Drawing the user interface for the various components (cameras, thermal cycle, graphs, etc)
- Accessing to datasets

Local operations are generated both when connected to a remote server and when accessing to local output data files.

### 2.3.3 Storage synchronization

The default user's *Database Indexes* is always kept synchronized with each instrument the client connects to. This allows to build an unified archive of all tests, independently from where they are carried out.

The position of the database on the client machine can be configured in the *Preferences* dialog, under **Default database** option. If you change this path without actually moving the database folder from the old location to the new one, the storage synch mechanism will re-download any available output file on the remote machine. You might loose old tests.

If the client is connected to the instrument when the a test finishes, the test is automatically downloaded to the local database. If the client was not connected, or other errors occurred, the next time you connect to the machine you will be warned about output files which were not downloaded.

The warning appears in the *Pending Tasks* dialog, under the **Storage** tab. The Storage widget allows manual management of storage synchronization. It is composed by four sub-tabs containing tables, each table listing metadata about tests which can either be downloaded or ignored.

The workflow of a test which was not automatically downloaded is the following:

1. It appears as row in **Waiting approval** table. You should right-click on the table and select *Download* from the context menu.
2. This will move the row to the **Download Queue** table. After a while the download will start.
3. Before the download starts you can still choose to *Ignore* the file by right-clicking on its row in the table and selecting *Ignore*. This will move the file to the **Ignored** table. Suppose you do not choose to *Ignore* it.
4. The file download will cause a progress bar to appear in the *Local operations*, until downloads finishes.
5. If an error occurs, the row will be moved from **Download Queue** to the **Errors** table.
6. From the **Errors** table you can right-click again on the row representing the remote file and ask for a *Retry*.
7. If you are unable to download a file, you can copy the full error log from the **Errors** table and send to the developers for debug.
8. Once the file is correctly downloaded, its associated metadata row will disappear from the tables. A new entry will be added to the local *Database Indexes*.

### Waiting approval

This table lists tests which are available on the machine but not on the local database.

By right clicking on one or more rows you can either:

- *Download*: Try to download the test by moving it to the **Download Queue**.
- *Ignore*: Discard the test by moving it to the **Ignored** table.

### Download Queue

This table lists tests which are waiting to be downloaded.

By right-clicking on one or more rows you can *Ignore* the file by removing it from the queue and adding to the **Ignored** table.

### Ignored

This table lists tests for which a download will not be tried again and for which the user will never be warned about.

By right-clicking on one or more rows you can *Download* the file again by moving its entry to the **Download Queue**.

### Errors

This table lists tests which were not possible to download due to errors, along with a log message about the error which occurred. By right-clicking on one or more rows you can either:

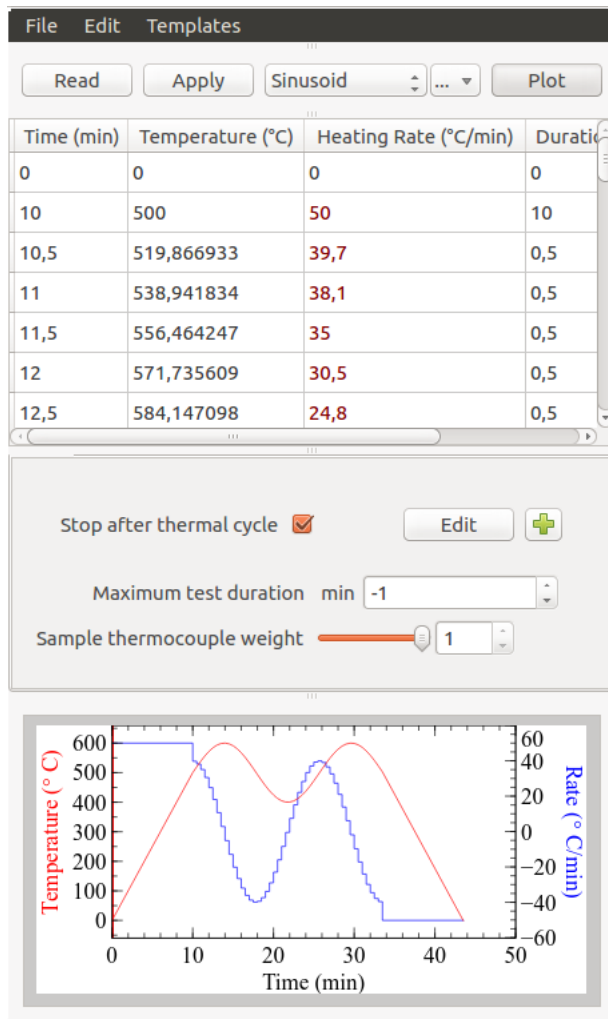
- *Retry* the download it by sending back to the **Download Queue**.
- *Ignore* it by moving to the **Ignored** table.

## 2.4 Thermal Cycle Designer

The Thermal Cycle Designer contains the controls to setup the desired thermal cycle.

It is divided in three parts:

1. The upper area contains a table where you can define the thermal cycle.
2. The middle area shows general control options and furnace positions before the start or after the end of the test (if the furnace is motorized).
3. The lower area is usually hidden and can be toggled via **Plot** button above the table. Displays a plot of temperature (red) and heating rate (blue) against forecasted time.



### 2.4.1 Editing the thermal cycle table

To set a thermal cycle, fill the upper table with rows. Each row of this table represents a target status to be reached by the furnace as the test execution proceeds, and how that status should be reached by the temperature controller.

Each row will be executed in sequence. When there are no more rows left, the thermal cycle ends, which can cause also the end of the tests depending on how control options are configured.

You can load a predefined thermal cycle from the upper-right combo box, showing all saved cycles.

The table has four columns:

1. **Time**: the expected end time of the row, relative to the start of the test (zero).
2. **Temperature**: the target setpoint of the row, which the furnace controller will try to reach by modulating power emission.
3. **Heating Rate**: the rate by which the temperature is changed from the previous row up (or down to) to the target setpoint.
4. **Duration**: the expected duration needed to finish the row.

To insert or delete rows you can use the **Edit** menu or the context menu appearing by right-clicking on the table. On insert, a new row will be added after the currently selected row. On **Remove current line**, the current row will be removed from the table. On insert/delete/edit of a row, all subsequent rows might get automatically updated to reflect the changes (eg: in Time column).

The **File** menu allows to import/export from CSV (comma separated values) text files and to completely clear the table.

The **Templates** menu lists some shortcuts to easily create predefined thermal cycle based on few parameters.

Each time a row is edited or a cycle is loaded, its value is validated against temperature and heating rate limits, and the whole table is updated with valid data.

---

**Hint:** The time-temperature curve obtained by filling this table is not the real temperature profile that you will get at the end of the test. This is due to thermal inertia of the furnace, power emission limits, automatic control adjustments and variable length events.

---

## Security limits

Thermal cycle designer will forbid the creation of temperature ramps which are considered dangerous for the equipment. In particular, both heating rate and temperature columns are limited to maximum values determined in the factory.

### 2.4.2 Managing your thermal cycle definitions

Thermal cycle definitions can be saved on the instrument and easily recalled from a list. Before proceeding in describing how this works, we should understand that in any given moment 3 thermal cycle definitions exists.

1. The **active** thermal cycle definition will be actually executed by the instrument.
2. Multiple definitions can be **saved** with names. A definition can then be loaded from the selected name. Once loaded, it will also be the active definition.
3. That same definition is also **displayed** in the table. The user can then edit it. While he is editing, the displayed definition can diverge from the preset from which it was loaded. The user can then **apply** the displayed configuration - making it also active, and/or **save** it with a name.

These distinctions allows the maximum freedom of editing without compromising saved values or without undergoing automatic consistency and security checks from the instrument. Misura™4 will warn the user if there is any unsaved or non-applied change, by coloring related controls in red.

- **Read**: Read the thermal cycle currently active on the instrument. If the thermal cycle on the instrument is different than what contained in the table, this button's text would be red.
- **Apply**: Transmit the thermal cycle defined in the table to the instrument. If the remote cycle is different than the displayed one, this button will be red.

- Preset chooser: This combobox lists the definitions which were previously saved on the instrument. Select any entry to load the associated cycle on the instrument and in the table. It is colored red if the displayed/applied cycle differs from the visible preset name.
- Preset menu: This dropdown menu contains actions for managing saved definitions.
- **Plot**: Hide/show the thermal cycle plot.

At the end of the preset chooser listing there is a special entry, **+Add**, which allows to save the currently edited cycle with a different name. An input dialog will appear where you can set your cycle name.

The preset menu contains the following options:

- **Save**: Save the definition displayed on the table onto the remote instrument, with the name displayed in the preset chooser. If no name is displayed, a dialog will ask for a new name.
- **Save as**: Save the table's definition onto a remote definition with a new name.
- **Rename**: Rename currently viewed definition name with a new definition.
- **Delete**: Delete currently viewed definition.

### 2.4.3 Inserting a Temperature Ramp (Point)

A temperature ramp is defined by a setpoint temperature and a time by which that temperature must be reached by the furnace (a time, temperature point). Before you input the target temperature, you should input either the end time of the ramp (**Time** column), or the desired **Heating Rate**, or the **Duration** of the ramp.

After having defined one of the three columns, you can input the **Temperature** target for that row. The remaining columns will be filled accordingly.

The default way of defining the ramp is by setting the **Heating Rate** column (°C per minute). The row **Time** and **Duration** will be auto-filled.

Filling the **Duration** column is mostly useful to express dwell ramps, where the heating rate is zero and the temperature must be kept fixed for a certain duration.

#### To add a temperature ramp to the table:

1. Right click on the row before the position where you want the new row to appear and select *Insert point*.
2. Once the row appears, double-click either on the Heating Rate, Duration or Time cell and set the correct value.
3. Double-click on the Temperature cell and insert the target setpoint.
4. Other cells will be automatically calculated.
5. Subsequent rows in the table will be re-calculated as needed.

---

**Hint:** Use negative values to express controlled cooling.

---

### 2.4.4 Inserting a Checkpoint

When a checkpoint row is reached, the setpoint will be kept constant until the real furnace temperature reaches it within a tolerance, or a timeout expires.

As the real temperature reached by the furnace is never exactly equal to the setpoint temperature, the checkpoint event allows to wait until the setpoint is actually reached before proceeding with the next row.

This is useful, for example, to start the controlled cooling always from the same temperature.

The setpoint will be the last available in the thermal cycle - usually the previous row in the table.

The typical temperature profile will be the same as a dwell row.

To add a checkpoint, right click and select *Insert checkpoint*. A dialog will show up, where you'll be able insert the desired temperature and timeout.

The plot displays checkpoints as dwell segments with few minutes duration, but their real duration cannot be forecasted because it depends from tolerance, timeout and furnace inertia.

---

**Tip:** A checkpoint with tolerance 3°C and timeout 60min is added after a row with setpoint temperature at 1000°C.

When the execution reaches the checkpoint event, suppose the real temperature is 980°C. The checkpoint will cause the controller to keep the setpoint fixed at 1000°C, until the temperature raises above 997°C (1000°C - 3°C tolerance). If this condition is not satisfied in 60min timeout, the control will anyway pass to the next row.

---

### 2.4.5 Inserting a Furnace Movement

Furnace movement events are available only if your instrument has a motorized furnace.

Movement events will cause the furnace to reach the configured position when executed. After movement execution, the control will pass to the next row.

During *Open* movements the thermal control will suspend and power emission will be zero until the movement ends.

During *Close* event, if the furnace thermocouple is controlling the temperature, the controller will try to keep any previously configured setpoint until the movement ends.

Furnace movement can be used to obtain flash heating / flash cooling temperature profiles.

To add a movement, right click on the previous row and select *Insert movement*. A dialog will show up, and you'll be able to select a *Open* or *Close* furnace movement.

---

**Hint:** If the furnace is already in the position configured in the event, nothing will happen.

---

### 2.4.6 Inserting a Natural Cooling

During natural cooling events the thermal control is suspended and power emission is set to zero. The event will end, and pass control to the next row, when a target temperature is reached or a timeout occurs.

The resulting temperature profile is a double exponential decay.

To add a natural cooling, right click on the previous row and select *Insert natural cooling*. A dialog will show up, where you can set target temperature and timeout.

---

**Hint:** Set timeout to a negative value to avoid a timeout to occur. This might lead to unlimited acquisition whenever the room temperature is above the target temperature of the event. The suggested minimum target temperature is 40°C.

---

## 2.4.7 Inserting a Thermocouple Control Transition

Thermocouple transition events can switch the control temperature between two thermocouples.

The control temperature is usually equal to the sample temperature for the whole duration of the test. This means that the controller will try to obtain equality between sample temperature and setpoint temperature.

Under some circumstances it is preferable to control the furnace temperature instead, meaning that the controller will emit power to obtain equality between furnace temperature and setpoint.

A typical usage is to pre-heat a motorized furnace while it is opened, in order to obtain a flash heating temperature profile.

To add a control transition, right click and select *Insert control transition*. A dialog will show up, and you'll be able to select to which of the thermocouples move the control and how fast.

---

**Tip:** We want to pre-heat the furnace to 1000°C while it is opened, then close it over the sample to flash-heat it. Then, we need to continue the thermal cycle up to 1400°C.

**We should:**

1. Set the “Kiln position before start” in execution options to “Opened”.
  2. Insert a thermocouple control transition as the first line of the cycle. We need to pass the control to the furnace in order to pre-heat it.
  3. Insert the pre-heating ramp to 1000°C as usual.
  4. Insert a furnace movement event to close it.
  5. Insert a thermocouple control transition to transfer the control back to the sample thermocouple. This transition should not be instantaneous, because after the movement there will still be turbulence due to thermal inertia. Give the transition a 5°C/min speed.
  6. Insert the last ramp up to 1400°C as usual. This ramp will be executed while the sample thermocouple is controlling.
- 

---

**Hint:** This event is meaningful only when your instrument supports more than one thermocouple (samples and/or furnace).

---

## 2.4.8 Parametric Templates

The **Templates** menu in the thermal cycle gives access to thermal cycle templates. A template is a shortcut to create a complex thermal cycle based on few parameters: for that reason they are also called parametric templates.

### Single ramp

Create single-point ramp from current temperature up to end temperature, with specified heating rate.

Parameters:

1. Ramp end temperature
2. Heating rate

Example: up to 1000°C, at 10°C/min

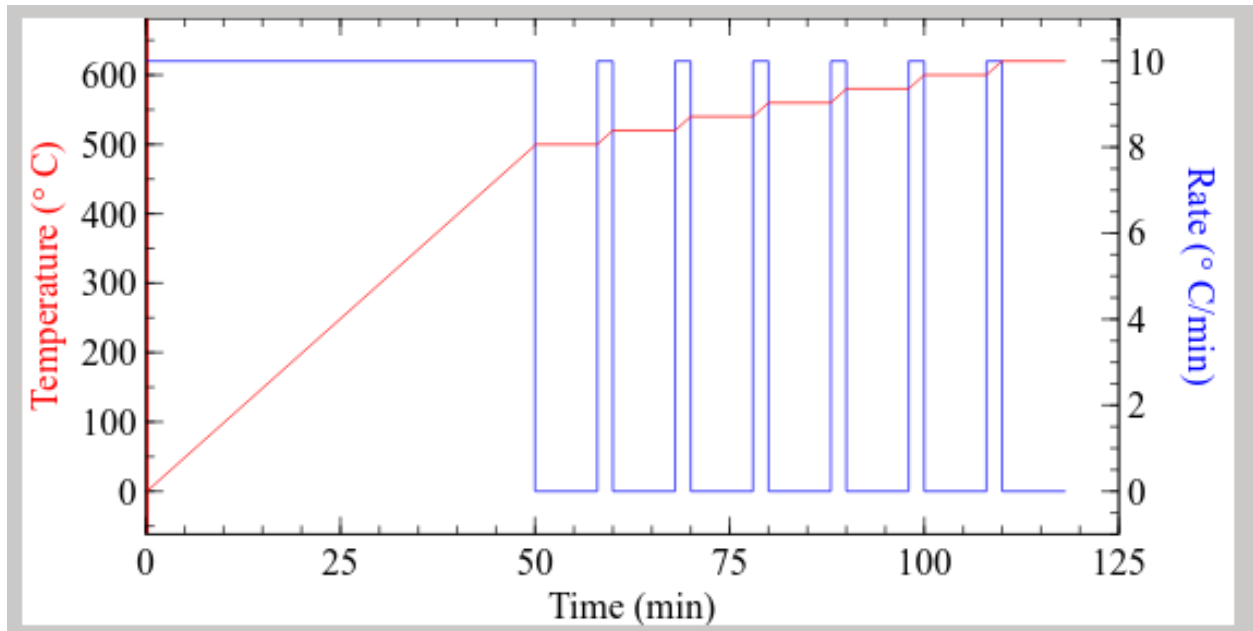
## Steps

Reach a start temperature with requested heating rate. Then, create a variable number of heat-wait segments.

Parameters:

1. Heating Rate: used to reach the first step temperature and for subsequent increases.
2. First step temperature: temperature at which stepping starts.
3. Stasis duration: wait this time between heating steps.
4. Number of steps
5. Steps delta T: temperature increase for each heating step.

Example: up to 500°C, at 10°C/min. Then increase 20°C at 5°C/min and wait 8 minutes, for 7 times.



## Maximize speed

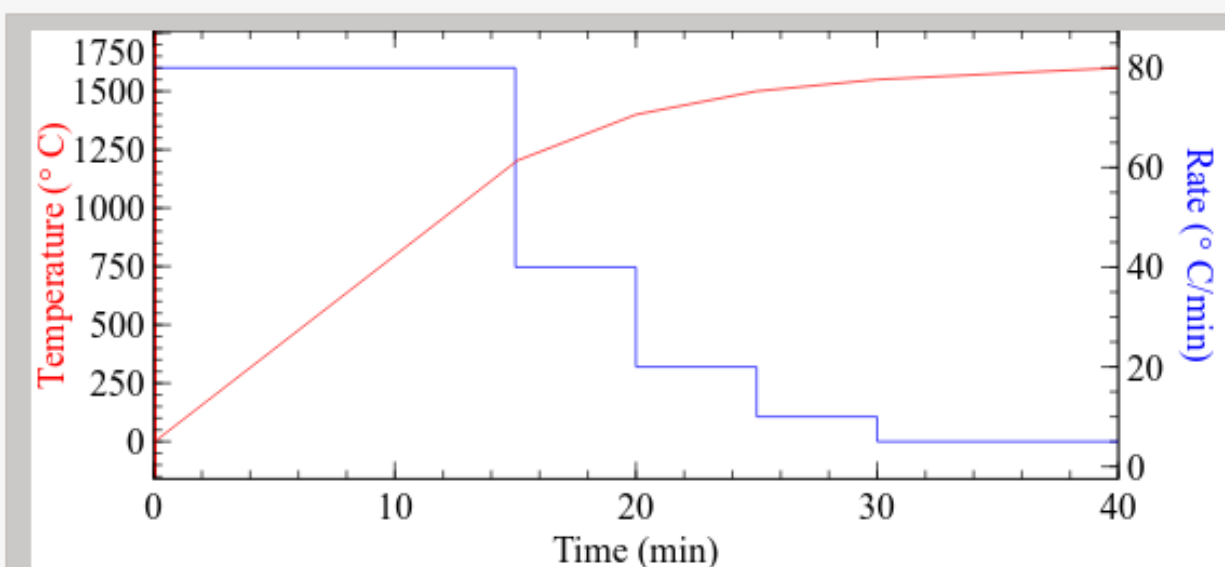
Heat at the maximum supported heating rate up to the target temperature.

Parameters:

1. Target temperature

Example: target temperature = 1600°C produces:

Time (min)	Temperature (°C)	Heating Rate (°C/min)	Duration (min)
0	0	0	0
15	1200	80	15
20	1400	40	5
25	1500	20	5
30	1550	10	5
40	1600	5	10



## 2.4.9 Additional Control Options

Additional control options are displayed under the thermal cycle table. These can influence how the heating cycle and the test are stopped, plus initial and final furnace positions.

### Stop after thermal cycle

The *Stop after thermal cycle* flag defines whether the acquisition should stop or not, when the thermal cycle reaches its end. If not, the acquisition will have to be stopped manually.

By clicking on the + button, two more sub-options are available. These are active only if the *Stop after thermal cycle* flag is checked, and are used to protract the acquisition further after thermal cycle end.

- **Wait T smaller than:** After the cycle is stopped, the test will be stopped as well only when the temperature is smaller than the configured value. Leave zero to disable this behaviour.
- **Wait minutes:** After the cycle is stopped, the test will be stopped as well after a certain amount of additional minutes. Leave zero to disable this behaviour.

### Maximum test duration

This option will interrupt the test when the total duration reaches the configured valued. The thermal cycle will be implicitly interrupted.

This option will not *force* the test to have this duration: the test can end before this target duration if any other termination condition is met (end of thermal cycle, error condition, analytical condition).

Leave zero to disable.

### Kiln position before start/after end

These two options allow to set a position of the furnace before and after the test. These options can be set either on *Closed*, *Opened* or *Unchanged*.

The movement needed to comply with this position will not be recorded in the test result.

The position before start is usually *Closed*, to avoid forgetting the furnace open. It can be set to *Opened* in case we need to pre-heat the furnace and then close on the sample. It should be avoided to set on *Unchanged*.

The position after end is usually *Unchanged* or *Closed*, to reduce thermal shock on the heating elements. It can be *Opened* to minimize the risk of sample flowing on the furnace or to quickly cool it for the next test.

---

**Hint:** Available only for instruments with motorized furnaces.

---

## 2.5 Data Plot

The data plot is a simplified plotting sub-window displayed in *Live Acquisition* and *Misura™ Browser*.

To access the visualization's tweaks, you can right click on an element of the plot to get its options menu:

- *Axis* allows you to change what axis measures are plotted towards. You can join axes together in order to synchronize their scales.
- *Curves* allows you to select which curves to plot.
- *View* allows you to select if you want data to be plotted by *temperature* or by *time*.
- *Reset* rebuilds the data plot
- *Update* forces a reload of data.
- *Properties* allows you to set behavioural features of the clicked element
- *Formatting* allows you to set appearance features of the clicked element
- *Zoom* changes the zoom level
- *Previous / Next Page* changes the currently visualized page.
- *Full Screen* toggles fullscreen mode.
- *Updates* allows you to change the update frequency of the page.
- *Antialias* toggles antialias
- *Export* allows you to export the current page to a pdf

Other visualization, plotting and elaboration options are accessible via the *Misura™ Navigator*.

## 2.6 Camera controller

The camera controller is showed by any *Live Acquisition* App for controlling an instrument which is using cameras. When initially started, it appears as a live acquisition sub-window containing a dark gray rectangle over a light gray area, the former representing the camera resolution or *CCD*.

The principal mode of interaction with the camera is by right-clicking anywhere. The **camera menu** appears showing all possible controls.

If X or Y motors are defined for the camera, motion control sliders are shown near the sides of the window.

---

### Hint:

- *Heating Microscope HSM* has 1 or 2 cameras
  - *Vertical Optical Dilatometer* and *Horizontal Optical Dilatometer* have 2 cameras
  - *Relative Fleximeter* has 1 camera
  - *Absolute Fleximeter* has 3 cameras
  - `furnace_instrument` has no camera
- 

### 2.6.1 Streaming

Streaming can be started/stopped from the camera menu by setting the **Streaming** flag (first menu entry). Streaming means the user interface is continuously receiving and showing images. After a few seconds from when it is started, frames will be displayed in the gray area. If the streaming is subsequently stopped, the last frame will remain visible.

Streaming images will not interfere with a running test. It can be started, stopped and resumed without any effect on actual image analysis and acquired data.

The image viewed in the controller can be quickly **zoomed** in/out by using the mouse wheel. The **Fit view** action, accessible from the context menu, will resize back the image so it fits the window.

### Saving the current frame

The current frame can be saved with **Save frame** camera menu entry. The first frame you save you will be asked a destination directory where to save current and all future frames.

That directory will be remembered for each time you click on **Save frame** and frames will be saved there with increasing sequence numbers.

All samples contained in the frame will be saved in separate images having the same sequence numbers.

File names will have the format `<name>_smp<N>_<seq>.jpg` where `<seq>` is the sequence number increased each time you save, `<N>` is the sample number, `<name>` is the camera name. For example: `Left_smp0_12`.

### Simulation

The **Analysis** flag activates image analysis on the received frames. This flag can be changed only when no test is running.

Simulation can be used before starting a real test, in order to validate the image quality. For example, to check that sample borders and limits are correctly detected, or that motors react in the right way to sample movements.

## 2.6.2 Imaging

Most important digital imaging options are displayed in the camera menu, submenu **Imaging**, as a slider with an associated spinbox. You can either control the slider position or write the desired number in the spinbox and press Enter.

Available imaging options:

- Exposure (should be in range 1-1000)
- Contrast
- Brightness
- Gamma (should be minimum possible)
- Saturation (should be minimum)
- Hue (should be minimum)

---

**Hint:** On most models it is advisable to use the spin-box to control the exposure. High values (>1000) might freeze the camera.

---

## 2.6.3 Motion Control

Camera position can be controlled by up to four motors roles, depending on your instrument's hardware:

- **X**, lateral
- **Y**, vertical
- **Angle**, angular
- **Focus**, focus distance, usually shared by (and affecting) all cameras

If those motors are available, their movement can be set from the camera menu, submenu **Motion**.

Each motor role shows an additional submenu called after its name, with those entries:

- A slider, to control the position.
- A *Zoom* checkbox, allowing to zoom in or out from the motion range for fine movements.
- An **Is moving?** flag: can be unset to block the motor (but cannot be set).
- A **Set zero position** action: define any current motor position as the new zero.
- A **Configure motor** action: opens the extended configuration panel for the motor.
- A **Configure encoder** action: opens the motion-to-image *optical encoder* configuration panel.

Moreover, **X** and **Y** motors are represented directly in the camera controller as a bottom slider (**X**) and a lateral slider on the left (**Y**). A right click on these sliders opens a context menu showing the current position and offering a **Configure** action to open motor configuration panel.

The motion sliders allow to *focus-in* by double-clicking anywhere on them.

There is a third way to interact with camera positioning: the **motion handle**. It is displayed as a red square in the top-left corner of the image. Dragging and dropping it around the image will cause a motion such that the new position of the top-left corner of the image will correspond to the position where you dropped the square.

## Finding the sample on camera

Upon instrument initialization cameras should automatically be positioned very near to the sample. As Misura instrument allow *Free Sample Positioning*, motion control must then be used to exactly find the sample or the part of it which should be analyzed (eg: the border).

This positioning can usually be carried out with provided X, Y motion controls (were present) or with manual micro-metrical axis tables.

## Adjusting the focus

All Misura *ODP* instruments allow *Free Sample Positioning*. Before starting a test, the user must manually adjust the focus distance with the provided focus motion controller.

As the focus motor is only one and affects all cameras in the instrument, its motion control is usually showed in a privileged position as a slider on the bottom of the acquisition window.

In case multiple cameras are used (horizontal dilatometer or fleximeter), care must be taken at positioning the sample perpendicularly to the alumina holding rods, in order to have the same focus distance for all of the cameras.

Focusing the sample is an iterative procedure, where the focus slider is moved back and forth until the optimal focus distance is found.

## 2.6.4 Morphometrics

The **Morphometrics** submenu allows to visualize some of the results obtained from image analysis. The results will be displayed as lines overlaid on the original frames.

The most useful analysis overlay is the *Region of Interest*, which can be activated by the **View Regions** action. Each sample defined for the camera will be surrounded by a colored rectangle, representing the area of analysis. This rectangle can be resized by dragging and dropping two hook points on the top-left and bottom-right corners.

Restricting the region of interest allows to individually select samples when more than one is viewed by the same camera. It is also useful to filter out imperfections, like dirt on holding plate or camera CCD.

The **Reset Regions** action will restore the default region sizes.

Then we have ovalays, which are realtime visualization of some aspects of the analysis being performed.

Generic overlays:

- **Grids:** this overlay will draw a grid over each sample.
- **Profile:** the border detected as the sample will be overlaid by a blue line, and the area of the sample with a faded blue.
- **Values Label:** a movable label is added. The label will contain lines in the form `name : value`, where name stays for any sample option and value shows the current value for that option (e.g.: height).
- **Pixel Calibration:** the *Pixel calibration* tool discussed below.

*Heating Microscope HSM* overlays:

- **Points:** relevant profile point are highlighted with circles.
- **Base and Height:** (only for *Heating Microscope HSM*) two perpendicular segments starting from the bottom-left starting point of the sample, representing base and height.
- **Circle Fitting:** (only for *Heating Microscope HSM*) a circle representing the best circular fitting to the profile.

*Horizontal Optical Dilatometer, Vertical Optical Dilatometer, Absolute Optical Fleximeter* overlays:

- **Reference line:** position of the sample border at the beginning of the test.
- **Regression line:** actual detected position of the sample border.
- **Filtered profile:** profile fragments which were actually included in the calculation of the regression line, after noise filtering.

## Samples

The concept of **sample** is fundamental to understand the camera controller, the management of *ROI* and the image analysis. From the point of view of the camera, a sample is a portion of image, delimited by a *ROI*, which can be analyzed in some way to extract results. This not always correspond to the concept of **physical sample** known to the instrument's operator.

For example, a sample is a cylinder of pressed powder used for *Heating Microscope HSM* analysis. In this case, the sample known to the camera is the same physical sample intended by the operator.

The situation is less intuitive in the case of dilatometers or fleximeters. In this case, the operator places one physical sample, but two (or more) cameras view just one side of it. Each side is viewed as a separate **sub-sample**, one assigned to each camera.

The samples are defined in the active instrument. The camera just points to them, and use them to analyze images and associate output results.

A camera can view one or more samples at the same time. The number of defined samples is available under the **Number of samples** option in the camera configuration panel. The camera defines an equivalent number of sub-options, accessible by clicking on the right + button, each pointing to the sample which should be used for the corresponding sample number.

Each sample defines its own image analyzer configuration. The advanced user can thus fine-tune image analysis parameters for each sample in the image, separately, making simultaneous multi-standard analysis straight-forward.

Active samples are shown in the camera menu, as **Sample <N>** menu items where <N> is the sample index from 0 (first sample) to the number of samples minus one.

Each sub-menu contains these items:

- **Configure:** opens the sample configuration panel, where image analysis results are stored. From the object tree on the left, it is possible to access to the image analysis option. Some true/false flags are repeated as menu items.
- **Black/white levelling:** convert the grayscale image to black/white. Color levels are accessible from the image analysis configuration panel.
- **Adaptive threshold:** convert grayscale image to black/white. Color levels are adaptively calculated point-by-point as a function of neighborhood intensities.
- **Dynamic regions:** activate *ROI* auto-follow.

### 2.6.5 Advanced configurations

The complete camera configuration panel is reserved for service purposes.

#### Pixel calibration

A visual tool to calibrate the translation between *CCD* pixels and real sample's microns. Reserved for service purposes.

## Troubleshooting

To forcefully restart a camera which is no longer working correctly follow these steps:

1. Open a camera controller, either from an instrument using it or from the global configuration panel.
2. Right click on the camera frame. Select **Configure** action.
3. Locate the **Running acquisition** option and set its value to **Stopped**.
4. Back to the controller. Ensure the camera is **Streaming** by activating the corresponding context menu option.
5. The camera will try to restart itself. On repeated failures, *Soft-Restart* the server. On continued failure, *Rebooting* the embedded controller.

## 2.7 Misura™ Navigator

Misura™ Navigator is a tree view, located on the right of the application by default.

It contains all the currently loaded datasets, and it's an entry point for data manipulation. When you right click on a curve or group of curves, you get a menu that lists all the possible operations you can perform on that curve.

## 2.8 Metadata and Scripts

Misura™ identifies and records characteristic points during the analysis into `Metadata` options, containing the values of time and temperature at which the point was recognized.

Example of metadata are:

- Microscope Samples characteristic shapes, like Sintering, Softening, Sphere, HalfSphere, Melting.
- General Measurement points of interest, like where the maximum temperature is reached, the maximum heating or cooling rate, when did the cooling phase started, etc

The identification logic is expressed by means of `Script` options, containing small portion of source code. The editing of Scripts is currently reserved for service purposes.

## 2.9 Preferences

From preferences dialog you can tweak Misura™ user interface (or client-side) configuration. They are related to the computer running a Misura™ client and will not be saved on any instrument.

The first entry, `ConfigurationFile`, is the location where Misura™ stores its configuration's details.

Everytime you change something, you should press `Save` to ensure that all changes have been saved.

The `Reload` button allows you to reload the configuration if, for example, something went wrong after a change.

`Open` button shows a dialog to locate and load another existing configuration.

Configuration File:

**Main** Flash Data import Dataset Rules

Client Language

Remote Server Refresh Rate (ms)  2000

Default Database

Recent Servers  5

Save User/Password by Default ☒ True

Auto-connect to last server used ☐ False

Authorization level when opening test files

Recent Database Files  10

Recent Test Files  15

Recent Misura3  10

Log files directory

Logging Level  0

Popup notification level  40

Size of each log file  KB

Max number of logfiles to be kept

Templates directory

Measurement units

Dimension	Unit
tension	volt
weight	gram

### 2.9.1 Main Tab

The Main tab contains general configuration options.

- Client Language allows to select the interface language
- Remote Server Refresh Rate (ms) lets you change the frequency, in milliseconds, of data update from server, if you are connected to a server (in an offline environment, you can ignore this option)
- Default Database is the location of the default tests database (see [Database Indexes](#))
- Auto-download finished tests: when connected to a server, this option defines if a test should be downloaded locally or not when it finishes.

- `Recent Servers` is the number of recent servers to be remembered
- `Save User/Password bu Default` defines if, when connecting to a server, the password should be saved or not
- `Recent Database Files`: the number of databases to remember in the list of last used databases
- `Recent Test Files`: the number of tests to remember in the list of last opened tests
- `Recent Misura3 Databases`: the number of Misura™ 3 databases to remember in the list of last opened Misura™ 3 databases
- `Log files directory`: the location to place log files
- `Logging level`: from 0 to 50, defines the amount of logging (0 -> nothing, 50 -> everything)
- `Size of each log file`: the size of a log file, after which, the log file is archived
- `Max number og logfiles to be kept`: when the number of log files exceeds this number, the oldest log file is deleted
- `Measurement units`: a table that defines, for every Misura™ dataset, its unit

### 2.9.2 Misura 3 Tab

This tab contains only the `Enable Misura 3 database interface flag`, that enables/disables Misura™ capabilities to import Misura™ 3 databases.

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### Measurement Apps

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Misura™ software can run different measurement functions, depending on its version and on your hardware capabilities. Each measurement is controlled by a specific **App** which allows the user to access relevant configuration options, frame the samples on cameras, start/stop the test and follow the analysis real-time.

Measurement Apps are accessible through the *Live Acquisition* executable.

Use this index to navigate to the desired measurement function.

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**Hint:** Availability of measurement functions depends on your hardware and software version.

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### 3.1 Heating Microscope HSM

The Misura Heating Microscope allows to study the change in shape of a small sample of material as a function of the furnace temperature. Through Misura Morphometrics analysis, it is possible to fully characterize the behavior of the material, automatically detecting characteristic shapes according to improved mathematical models and traditional international standards as well.

The following sections contain instruction about how to start a test, prepare a sample and analyze test results.

#### 3.1.1 Quick Start: Running an Heating Microscope Test

While the general *Live Acquisition* instructions apply also for the Heating Microscope, this section describes specific topics which should be considered to carry out microscopy tests.

##### Microscope Acquisition Window

The Microscope *Live Acquisition* window additionally comprises:

- One/two high-resolution *Camera controller* windows with height motion controller.

- *Global Focus* motion controller.
- Samples height information displayed on the *Status panel* panel, updated realtime during the analysis.
- One to eight *Samples* tabs in the left Test Configuration area.
- The *Storyboard* bottom area.

The workflow for a microscope test follows the general rules described in section *Live Acquisition*.

## Adjusting the camera position

*ODP* cameras are mounted on two motorized axes: the height and the focus. Older/simpler models might still have manual positioning with micrometric translation stages.

The initial position of the camera should be automatically reached during instrument initialization, as described in *Motion Control*.

Use the height motion control to ensure the holding plate is always visible.

Once the position of the camera has been established you have to put the sample in focus. This should be carried out before every test. Note that the typical cylindrical shape of the sample means that when the centre of the sample is in focus the sides are not. This is absolutely normal and does not affect the reliability of the analysis which will get the best results anyway.

The *Region Of Interest* should then be reduced so that the height of the sample occupies just 3/4 of the active region, and the width is 1/2. If multi-sampling, each region should manually be placed around each sample. The excess of the region dimensions with respect to the sample depend on the limiting sample behaviours. If the melting should be observed, enough region width should be provided for the molten sample to be still framed. If the sample undergoes a huge expansion, the region height should exceed the initial sample width by appropriate amount.

## Recording Frames and Profiles

Misura™ records can record raw frames, as they are received from the camera, and/or analyzed (x,y) profiles produced by the morphometric analysis.

The default behaviour is to record profiles and discard frames, to save space.

This option can be set in *Samples* sections independently for each sample.

## Standards for Characteristic shapes identification

Characteristic shapes are displayed in the *Samples* tab in **Test Configuration** side area, as a Time/Temperature *Meta-data and Scripts* label.

Basic shape recognition parameters can be affected by expanding sub-options ([+] button on the right) and adjusting the sliders to the desired values.

Misura™ always calculate shapes according to its advanced morphometric logic, making use of 3D extrapolations and

## Stopping the test when a shape is recognized

A Microscope test can be automatically interrupted when a characteristic shape is recognized. To activate this termination option:

- Select the *Measure* tab in **Test Configuration** side area and scroll to the bottom of the page.
- Locate the *After recognized shape* option and click on the checkbox on the right to enable it.

- The the test will end when the `Melting` shape is recognized.

To fine-tune the test termination, expand sub-options by clicking on the “+” sign on the right of the `Edit` button.

- `Stop after temperature changed by` will cause the test to interrupt after the temperature changed by the configured number of degrees from the instant when the shape was recognized. The default value is 10°C. This means that if the melting is recognized at 600°C, the test will be interrupted at 610°C, or 590°C in the unlikely event the furnace was cooling down.
- `Stop after time passed` will wait the configured amount of seconds before interrupting the test. The default value is zero, meaning as soon as the condition is met.
- The test will end when both termination options are met (after temperature changed enough and after the minimum amount of time has passed).
- `Require all samples`: in case of multi-sample tests, the default behaviour is to interrupt the test as soon as any sample meets the conditions (as soon as any sample melts). If this option is activated, all samples are required to meet the termination conditions for the test to be stopped (all samples must melt).

### 3.1.2 Sample preparation for the Heating Microscope

The shape of the sample and the change in outline are very important for recognizing the fundamental points. The sample should be made with the correct tools and be of the correct dimensions. You should also avoid carrying out tests on samples with particular imperfections, such as those described and illustrated below.

The preparation of a test consists of a series of manual procedures by which you make a test sample, put it in the kiln, focus the image and make the initial observation of the silhouette (to avoid acquiring unreliable data).

The rectangular base and the pressing tool are designed for preparing a sample of the correct dimensions, where the diameter of the base of the cylinder is 2/3 of the height. Keeping these proportions is very important as the analysis of the images works on the basis of this relationship. The best dimension is 2mm in diameter by 3mm in height. To make a sample you should put a small amount of body on the metal part of the base, beside the holes.

1. The powder should be dampened with water (distilled if possible), to form a composite which is cohesive enough to ensure compactness, without sticking. The material should be dampened just enough for it to hold its shape. If it is too dry it will break when it is being transferred to the plate. If it is too wet it could mist the quartz filter at the edge of the kiln at temperatures between 70 - 120°C.
2. Using this compound fill one of the holes up to the edge and press down using the pressing tool.
3. Add more compound little by little pressing it down between each addition so that you get a compact cylinder.
4. Put a small amount of dry powder on the surface of the sample so that it does not become stuck to the pressing tool when you transfer it to the plate.
5. When you have made the cylinder you need to “slide” the base open a little so that the sample is free to be pushed onto the plate, which you should place underneath the hole.
6. Gently push the sample with the pressing tool until it the sample comes out and stands upright on the plate. It may help to turn the pressing tool slightly while doing this.
7. Repeat the procedure on the same plate if you want to do a double test.

If the sample has been correctly prepared and placed, besides obtaining error free analyses, you can also better recognise the characteristic points of the test. Above all, to record the point of fusion, it is essential that the sample is made correctly.

### How a good sample looks like

The correct preparation of the sample is essential to a good analysis. Based on our experience, we found that the best shape for ceramic materials the diameter of the base of the sample should be  $\frac{2}{3}$  of the height. This relationship is the standard for this type of study. Variations from this standard may cause erroneous results.

1. The base should appear as a single line. You should not be able to see the rear part of the base.
2. There should be no light between the base of the sample and the plate. This is essential for an accurate calculation of the angle of contact and the outline of the sample.
3. Both the sides and the top of the sample should have the natural roughness which results from making the sample without compressing it or dampening too much. If the sample is too damp you might get unreliable results because the consistency of the sample is not correct.
4. The sample should touch the plate all round without leaving any spaces or excess deposits around the edges. It should be at an angle of  $90^\circ$  to the plate.
5. Make sure the plate is perfectly clean and that there are no residues or build up of body on it.
6. In general it is best to place the samples in the centre of the plate, slightly towards the thermocouple.



Multi-samples should be separated sufficiently so that they will not stick together or melt over the edge of the plate damaging the thermocouple. For safety you can put another plate underneath. They should be positioned so that they do not melt together and confuse the analysis of the image but not so far apart that they could melt over the edge or not be picked up properly by the camera.

### How a bad sample looks like

A gallery of bad sample positioning. The advanced image analysis and morphometrics algorithm of Misura will do their best at getting reasonable numbers out of these images. But, if the user chooses to carry out the analysis under International Standard metrics, the results will be misleading or completely wrong.

### **Inclined sample**

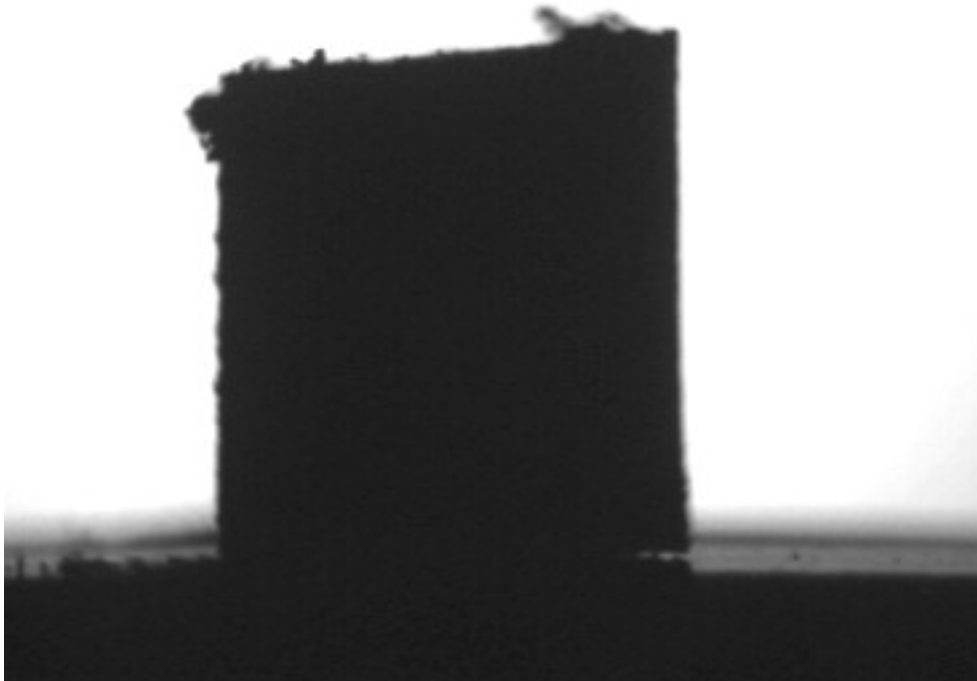
A sample of this kind may cause a wrong measurement of the height. In this case, the measurements are taken more on the diagonal of the sample than on the actual height even so the analysis indicates accurately little and predictable slopes on the top of the sample. In addition to this the sample has a beginning slope which increases during the heating, you could even have an apparent increase in height.

This image also show wrong base focus.



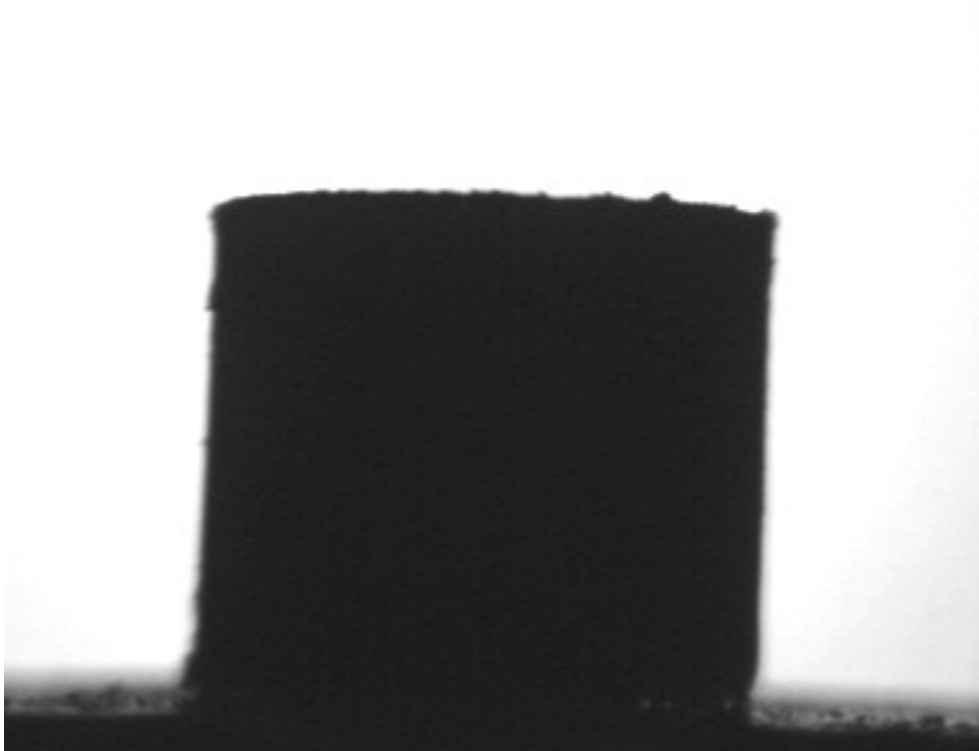
### **Irregular sample top**

As described in the previous situation, a sample that shows an unusual bulge on the top, as in the figure, can modify the measurement of the height. Moreover it can influence all the development of the analysis, if it melts so as to modify the profile of the fundamental shapes.



### Out of proportions

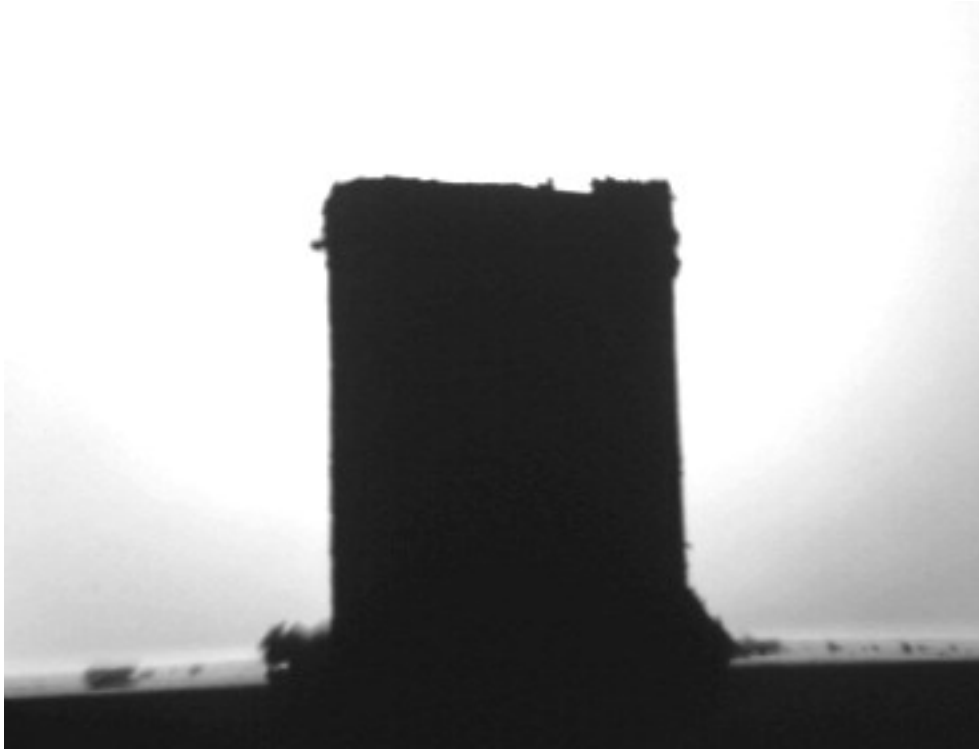
The sample prepared with the proper accessory is correctly proportioned to have the fundamental shapes during the firing cycle. If you do not pay attention to the proportion between height and width, already standard for these kind of instrumental measurements, the analysis will not be reliable. For a square sample, as it is shown in the upper figure, it will be difficult to recognize the right shapes at the right moment, in particular you can have problems with the sphere.



### Dirty base

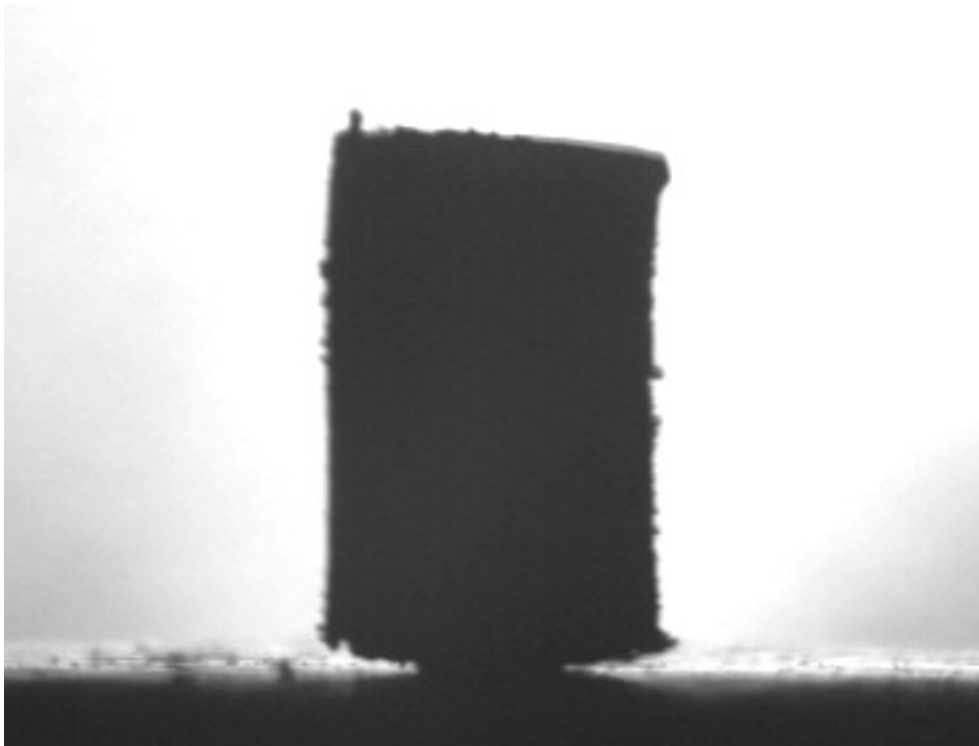
You need to carry out a test with the base well cleaned around the sample, and you have to check it either before putting the sample in the kiln or by observing with the camera. The little quantities of material or in general the dirt on the base do not allow the measurement of the contact angle, whose measurement is only possible on a smooth and well cleaned base.

This images also shows a base with wrong focus and inclination.



### The “flying” sample

You should avoid carrying out tests with samples which, like that in the figure, do not lay uniformly on the base. The contact between sample and base should not have “light”; in this case you will have unreliable contact angles.



### 3.1.3 Quick Start: Browsing a Microscope file

This Demo will guide you through the data analysis of Heating Microscope (hsm) output files.

In order to follow the tutorial you should:

- Download and Install Misura™ (see [Installation](#)).
- Get the sample file [Microscope Sample File 1.h5](#) and save it to a known location (eg: your Desktop)

#### Opening the output file

1. Run `browser.exe` application from the folder where you extracted Misura™, or run the link you created on your desktop.
2. In the **Recent data sources** window, under the first column **Recent files**, click on **Add** button.
3. Browse to the location where you downloaded [Microscope Sample File 1.h5](#), select and open it.
4. The loading process will start. If the file is considerably big (several GB) or located on network or slow storage drive, it may take several seconds to open.
5. The file is displayed on a new tab, on the right of the **Databases** tab.

The test file tab is divided in three areas:

- A menu bar in the upper part of the window
- A right area called **Test Configuration**. It is divided in at least 4 vertical tabs: **Measure**, **Thermal Cycle**, **Sample0** and **Results**.
- A central area displaying movable and resizable sub-windows, where you see the **Data Plot** window.

#### Test Configuration and Data

The most relevant configuration options used for the test run and output results are displayed in the right **Test Configuration** area.

#### Measure overview

The first **Measure** tab contains the list of options regarding the test run.

Detect the following:

- **Name**: Name of the test run, set by the operator anytime before the end of the test.
- **Operator**: the login name used by the operator who started the test.
- **Elapsed time**: the total duration of the test.

#### Measurement Units

Elapsed time is expressed, by default, in *seconds* unit. This might be difficult to read. You can change the measurement unit of any value listed in Misura™ options panels by following this steps:

1. Right click on the **Elapsed time** text label. A menu will popup.
2. Select the **Units** sub-menu.

3. Change to your preferred unit. E.g.: *minute*.
4. You can roll-back to *second* by repeating the procedure.

---

**Hint:** If the Units sub-menu is not shown, it means the option does not have a specific measurement unit set, so it cannot be converted.

---

## Metadata

The following values (after **Elapsed time**) are called **Metadata** or, more specifically, characteristic points. For example:

- **End of the test:** it contains time and temperature values recorded when the test ended.
- **Maximum temperature:** time and temperature of the point when maximum temperature was reached.
- **Maximum Heating Rate:** time and temperature of the point when the maximum punctual heating rate was reached in the measured temperature profile.

By clicking on the last one, a new window will open displaying again time and temperature, plus a **Value** number. In the case of Maximum Heating Rate, this number is the actual heating rate (°C/s) measured in that point.

---

**Hint:** At the end of each Metadata row there is a + sign button. It means there are nested options under the visible one. By clicking on it, access to another option, viewed as a **Edit** button. By clicking on it, you open an editor where you can read the logic used to calculate the parent Metadata point.

General measurement Metadata are usually short and simple to understand.

---

## Thermal cycle

This tab contains a table with points defining the thermal cycle and a graph with a cartesian representation.

The graph displays two curves: the red line is the setpoint temperature; the blue line is the heating rate.

If you cannot see the axes and their labels, enlarge the application window and the Test Configuration area.

## Sample data

Most relevant data in the Sample0 tab are:

- **Name:** if set, the name the operator gave to this specific sample. It is mainly useful for multi-sample measurement.
- **Initial sample dimension:** the operator can optionally set this value if he measured the initial sample height with other instruments (eg: a digital micrometer).
- **Record frames/profiles:** did the operator required full frames and (x,y) sample profiles to be recorded onto the output file? In the case of [Microscope Sample File 1.h5](#), only profiles were required, in order to keep the file smaller.

You can ignore **Height**, **Perimeter**, **Volume** options and all their nested options, as they are only useful during live acquisition.

Of paramount importance are the five **Characteristic Points**, expressed as **Metadata** options. They are defined and identified according to the highly reliable Misura™ standard.

- **Sintering**
- **Softening**
- **Sphere**
- **HalfSphere**
- **Melting**

## Re-evaluating Standards

As the logic by which characteristic points are identified is accessible from the Misura™ Browser, you can also change it and see the effect on the identified points. This process is called *Standard Re-Evaluation*, as this logic is usually codified in an international standard depending on your material.

As an example, we will affect the **Sintering** point.

1. Take note of the current value of Temp:/Time: label (611.0, 1805.0).
2. Click on the [+] button right to the Temp:/Time: label.
3. Change the **Height shrinking for Sintering** from 95 to 90.
4. Locate the **Measure** menu on the upper-left menu bar. Click on the **Re-evaluate standards** action.
5. Move your mouse on the Sintering label. It will update to a different Temp:/Time: point (621.0, 1836.3).

You required a higher shrinking in order to detect the Sintering point, so the point is now identified 10°C above its original value.

## Results

The Results tab displays the *Misura™ Navigator* tree component. It is the tree of recorded datasets (curves), organized by groups. Each group represents a part of the instrument or of the measurement.

For example:

- **hsm** represents the Microscope instruments itself. It generates no datasets, but contains one sample (**sample0**). If we have a multi-sample test, it will contain one sub group for each sample.
- **kiln** represents the furnace, and contains datasets regarding temperature control (T, temperature; S, setpoint; P, power; etc).

We will see it in detail in next sections, as it is the most powerful and versatile component of the interface.

## Visual shape assessment

To understand the behaviour of your material with time and temperature change, you will use three main tools:

- a. The **Story Board**, where you can see the shape of your sample at the desired time in the test.
- b. The Navigator tree in **Results** tab contained in the Test Configuration area, where you can see the exact value of each calculated output.
- c. The **Data Plot**, where you can evaluate the behaviour and rate of change of each plotted datasets.

These tools are all *synchronized* at the same time in the test. When you move the horizontal slider in the Snapshot area, the images are updated to reflect the state of the sample at the selected point. At the same time, a vertical red bar updates its position on the Data Plot, and Navigator tree changes in order to display the current values at that point.

The point selection can happen either:

- by moving the Snapshot horizontal slider
- by clicking on the red bar in Data Plot and dragging in a new position
- by dragging the label showing the characteristic point value (eg: *Sintering*) and dropping it on the Story Board. The Story Board and the plot will sync to the requested time.

The Story Board area also displays the temperature value associated to each image. You can add more values by dragging them from the Navigator tree and dropping them in the Story Board area. To remove unnecessary values, right click on them and de-select from the Labels popup sub-menu.

The length, number of rows and stepping of the storyboard can be changed from the context menu that can be called by right-clicking on the horizontal scroll bar or by clicking on the (...) button on the right of the current sample name.

### Characteristic points on the Data Plot

Characteristics points are connected to the behaviour of dimensional shape measurements as a function of temperature and time. It is thus interesting to evaluate their position on the plot.

The command to add characteristic points is located in the Navigator tree context menu, accessible by right clicking on tree elements.

As Navigator tree elements represent different parts of the measurement instrument (datasets, samples, instruments, devices, etc), the menu which pops-up depends on the kind of element.

1. Click on a blank area inside x,y ranges of Data Plot graph. A blue dashed line will appear over the plot area, meaning you correctly selected the graph on which to draw.
2. Go to the Results tab and look at the Navigator tree.
3. Find the `sample0` group, under `hsm` group (path is `/hsm/sample0`).
4. Select and right click on `/hsm/sample0` group.
5. From the context menu, select **Show characteristic points**.
6. A new dialog will open. Click **Apply**.
7. If a new dialog opens with “You should run this tool on a graph”, check that you properly selected the graph area in point 1.

The five characteristic points labels will appear on the Volume curve (blue), near their intersection points. You can select the labels with a click and move them in order to increase readability.

### Changing a characteristic shape

To modify the value of the automatically calculated shape:

1. Evaluate the frames on the Story Board and locate the frame which you wish to assign to a specific point.
2. Click on the frame image and keep pressed to start a *drag* gesture.
3. Drag & drop the frame image onto the target point's label.

In the following example, the Sphere point was changed from 908°C to 888°C:

## Interacting with the Data Plot

As you have seen for Characteristic Points, the Navigator tree is the gate to the most important actions you can perform on the data plot.

In order to plot one more dataset (for example the height):

1. Right-click on the dataset you wish to plot on the Navigator tree (`/hsm/sample0/h`).
2. Select the **Plot** action from the context menu.

The same apply for removing a dataset and all its related objects from the plot. The Plot action will be checked if the curve is visible, unchecked if not visibile.

## Mathematical manipulations: Smoothing

A frequently used feature is the Smoothing of a dataset. In order to smooth the volume, for example:

1. Locate the Vol (`/hsm/sample0/Vol`) element in the Navigator tree under Results tab.
2. Right-click and select **Smoothing**.
3. A dialog will appear. Click **Apply**.
4. A new temporary label in the dialog confirms the dataset was created. Click **Close**.
5. The Navigator tree is updated. The Vol element now has a child: *Smooth(48,Vol)*. This is the smoothed Vol dataset.
6. Plot the smoothed dataset using its context menu.

The new dataset will be plotted over the old one, with the same color and just slight differences (mostly visible in the first 200s or 50°C). You can either un-plot the old one, or change the color of one of the two.

To change the color of the curve:

1. Click on the curve on the Data Plot.
2. Right-click again on the same spot. A context menu opens. Choose **Formatting**.
3. Select the second tab, with a *Line* symbol.
4. Change the color to something distinguishable (eg: red).

## Creating a Report

Sample reports summarize the most meaningful data about a test run and a single sample behaviour in a printable page.

1. Identify the Navigator tree element for the sample you are about to create a report for. E.g.: `/hsm/sample0`.
2. Right-click on the element and select **Report**. A new dialog opens: click **Apply**.
3. A temporary label *Done* appears. Click **Close**.
4. **Reports are rendered as new pages in the Data Plot. Right-click anywhere in the Data Plot and select Next page.**  
Wait some secons for the rendering of the report to complete.
5. The Data Plot displays the report.
6. Right-click anywhere in the Data Plot and select the **Export** action.
7. Select the location of the output **PDF file**.

The exported report is vector quality. Compare your result with [Microscope Sample Report 1.pdf](#).

### Creating a report listing all images

Listing all images, according to temperature and time steps, can be accomplished by the *Export images* action. It can be reached either:

- By right-clicking on the `sample0` vertical tab title in the *Test Configuration* panel on the right.
- From the context-menu of `sample0` node in the Navigator (right-click on the node).
- **From the *Storyboard*, by right-clicking the slider or clicking on the ... button on the extreme right.** In this case, time/temperature stepping will be inherited from the current storyboard settings.

This action will output an HTML document listing all images, according to the selected starting/ending temperature and temperature/time stepping.

Compare your result with [Microscope Sample Images 1.html](#).

### Exporting to a Video

1. Identify the Navigator tree element for the sample you are about to create a report for. E.g.: `/hsm/sample0`.
2. Right-click on the element and select `Render video`.
3. On Microsoft Windows™, a native dialog will open asking the desired output video encoding. Choose according to your supported formats.
4. You can click **Cancel** anytime without losing the partially rendered video.

Compare your result with [Microscope Sample Video 1.avi](#).

---

**Hint:** Install [Xvid](#) MPEG4 video compression filter in order to get smaller video outputs.

---

## 3.1.4 Viscosity

The determination of the viscosity curve of glasses is performed using data supplied by the heating microscope and by a dilatometer. This method is based on the Vogel-Fulcher-Tammann (VFT) equation.

$$\log \eta = A + \frac{B}{T - T_0}$$

The determination of the parameters A, B and T<sub>0</sub> is done using three pairs of known temperature-viscosity ( $\eta$ , T) values.

According to Scholze (1962) and Ferrari, Magrini and Brunetti (1980), in correspondence of some characteristic points of glasses, it has been established that the viscosity values are fairly constant:

- Glass transition temperature:  $\log \eta = 13$  Poises
- Softening point (calculated with a mechanical dilatometer):  $\log \eta = 10,25$  Poises
- Sintering beginning:  $\log \eta = 10$  Poises
- Softening point (calculated with an optical dilatometer):  $\log \eta = 8,2$  Poises
- Sphere temperature:  $\log \eta = 6,1$  Poises
- Half sphere temperature:  $\log \eta = 4,5$  Poises

(1 Poise= 0.1 Pa \* s)

These data allow to solve the equations system to determine A, B and T0. Applying the VFT equation, the viscosity trend can be completely reconstructed, right across the temperature range. This operation is completely automatic, once inserted in the software three of the six temperatures mentioned above.

## Calling the viscosity plugin

It is necessary to open the softening test of the material you are interested in the *Misura™ Browser*. Then:

1. On the *Misura™ Navigator*, locate the sample<N> node corresponding to your sample (sample0 in single tests).
2. Right-click on the node to access the context menu. Select viscosity entry.

The viscosity parameters window will open:

The **Temperature dataset** field refers to the temperature values which will be used to calculate the viscosity. It is pre-compiled and should not be modified.

Three temperature-known viscosity pairs are then listed. Each pair consists of a temperature, which should be manually added by the user, and a known viscosity point, which should be selected from the drop-down menu. Each known viscosity value should be unique in this window.

The user can also insert a viscosity number, if none of listed viscosities is considered satisfactory for the analyzed material.

The order of viscosity points does not matter.

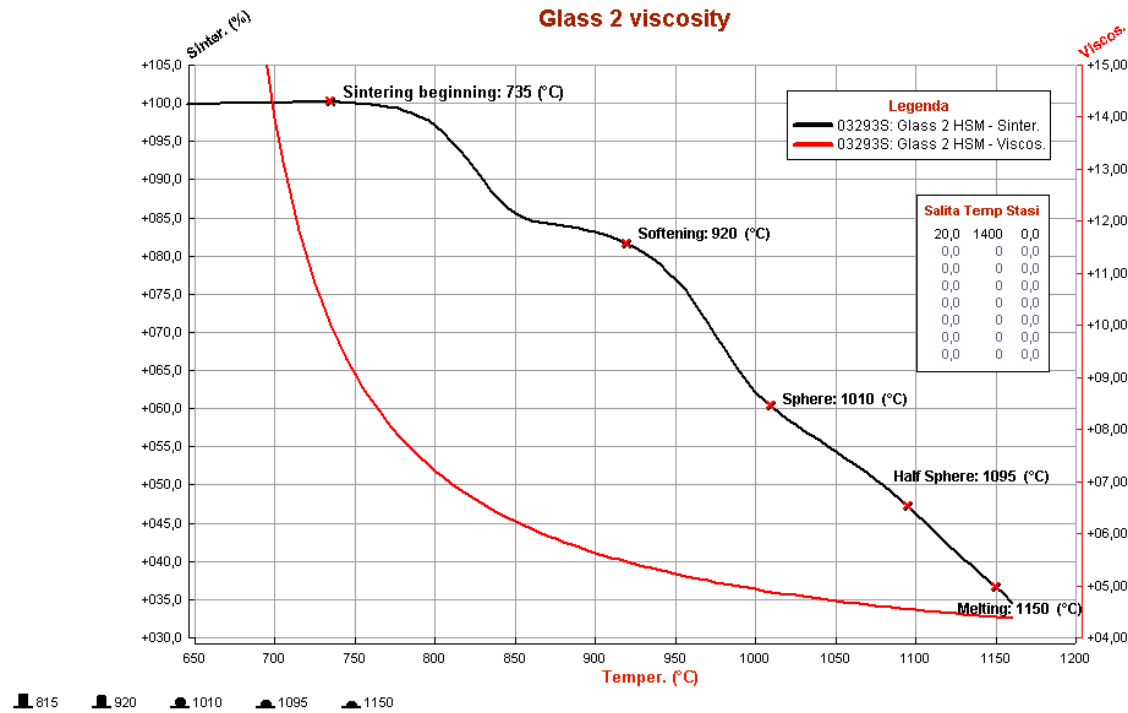
The **Output dataset name** comes precompiled and shows the name of the dataset where the viscosity data will be stored. It is possible to run multiple viscosity calculations, with different known point combinations, by giving them different output names (like viscosity\_1, \_2, etc).

After clicking on **Apply** button, a new viscosity dataset will be created as a sub-node of sample temperature. It can then be plotted and managed the usual way.

The viscosity parameters and outputs will be saved with the current plot.

The viscosity data are expressed as viscosity logarithm ( $\log \eta$ ), in Poises.

An example of viscosity curve obtained for a glass is provided below:



## Choosing the known temperature points

As mentioned above, Scholze proposed six values in correspondence of which the viscosity values can be considered fairly constant.

But if the three values chosen to calculate viscosity are too close each other, the viscosity curve cannot be calculated correctly. For this reason, it is necessary to follow the procedures described below, and not to choose three random values among the six.

The choice of the three temperatures is fundamental in order to perform the viscosity calculation in a correct way.

Now it is necessary to distinguish two cases:

1. your laboratory is equipped with Misura™4 Heating Microscope and Horizontal or Vertical Optical Dilatometer;
2. your laboratory is equipped with Misura™4 Heating Microscope and a traditional mechanical dilatometer.

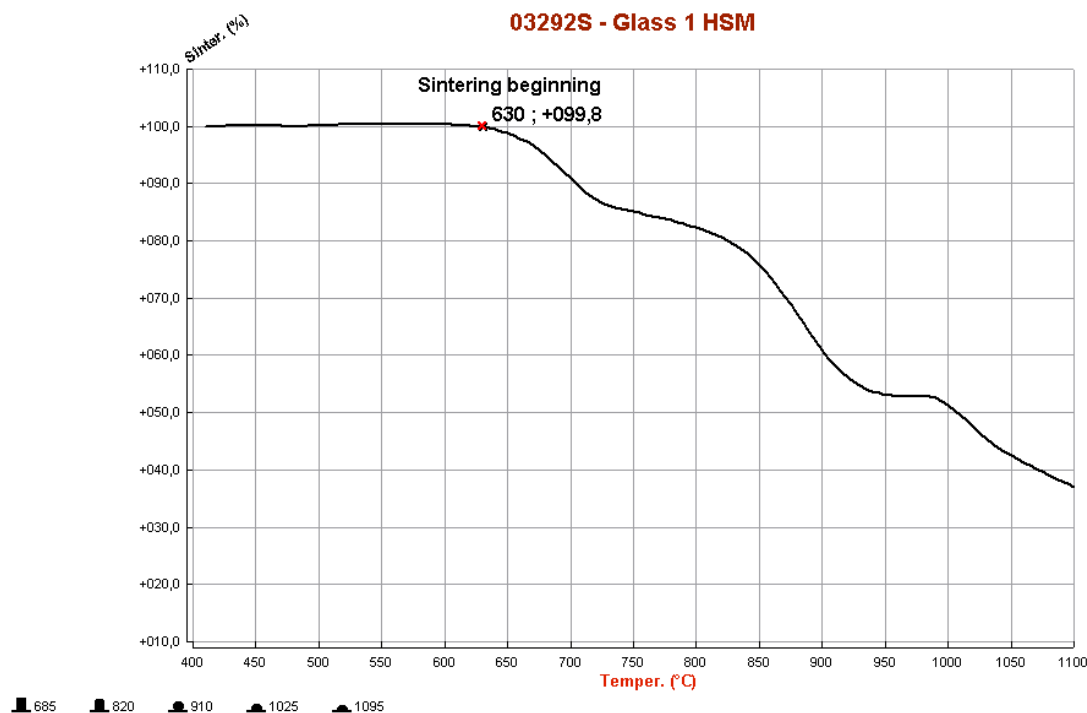
## Microscope and Optical Dilatometer

In this case, the viscosity calculation is performed using data provided by the horizontal optical dilatometer and by the heating microscope. The values employed correspond to the temperatures of glass transition (optical dilatometer), sintering beginning and half sphere (heating microscope).

A preliminary thermal expansion tests is performed with the optical non-contact dilatometer, in order to obtain the expansion curve of the sample analyzed, identifying its glass transition temperature (the heating rate can be 20°C/min).

The second step consists of a softening test with the Misura™4 Heating Microscope, in order to determine the two temperatures of “sintering beginning” and “half sphere”.

We identify manually the sintering beginning point in correspondence of the shrinkage onset, as shown in the following graph. The half sphere temperature is automatically identified by the software.



Then, you should insert the values of glass transition (“Glass transition DIL”) obtained from the dilatometric test performed with MISURA ODLT, sintering beginning (“Sintering beginning HSM”) and half sphere (“Half sphere HSM”), obtained with the heating microscope.

### Microscope and Mechanical Dilatometer

You can measure viscosity using the data provided by a mechanical dilatometer. In fact, you can use the temperatures of glass transition and dilatometric softening (from a mechanical dilatometer) and half sphere (from heating microscope).

You should insert the two values of glass transition (“Glass transition DIL”) and dilatometric softening (“Softening point DIL MEC”), obtained from the dilatometric test performed with a mechanical dilatometer. The third value is the “half sphere” temperature, obtained with the heating microscope.

## 3.1.5 Surface Tension with the Sessile Drop method

Misura™4 MorphometriX can extrapolate the surface tension of the sample from its shape and some additional parameters about the material and the atmosphere.

The method relies on the numerical solution of the Young-Laplace equation for the surface tension of a sessile drop:

$$p_1 - p_2 = \gamma \left( \frac{1}{R_1} + \frac{1}{R_2} \right)$$

Where: \*  $p_1$  is the pressure on the internal wall of the drop (material against atmosphere) \*  $p_2$  is the pressure on the external wall of the drop (atmosphere against material) \*  $\gamma$  is the surface tension \*  $R_1$  is the first curvature radius describing the upper-half of the drop \*  $R_2$  is the second curvature radius describing the upper-half of the drop

The analysis is split in two phases:

1. During a normal *Heating Microscope HSM* test, adimensional shape parameters are calculated by solving the Young-Laplace equation for the sessile drop.

2. Once the test is finished, it can be loaded in the *Misura™ Browser* to calculate the surface tension from the adimensional parameters. In this phase the user should provide additional material's and environmental properties like density, thermal expansion, atmosphere etc.

This design allows the user to change/correct any material property without the need to re-run the entire analysis.

### Activating the Sessile Drop

Sessile drop analysis can be activated in each sample's Analyzer configuration panel, by setting to *True* the **Enable sessile drop analysis** (default='False') option. Alternatively, from the *Samples* submenu in *Camera controller* windows, you can directly turn this option on or off.

This option can be turned on/off also while the test is already running, and will take immediate effect, starting/stopping/resuming the analysis.

As the analysis is quite computationally expensive, the algorithm will be activated when the sample assumes a *likely* shape.

The activation is controlled by the sub-option **Contact angle limit for sessile capillarity (0=no)** (default='100°'). The Young-Laplace solution will not be attempted unless the contact angle between the base and the sample reaches this angle.

Another sub-option allows to tune the **Runge-Kutta integration step** used by the numerical solver.

During this phase, Misura will create two adimensional sample datasets which contain the solution to the Young-Laplace equation:

- **Capillary factor** *beta*
- **Scaling factor** *r0*

### The Surface Tension plugin

If the sessile drop analysis was enabled during the test execution, the Surface Tension plugin can be called from the `sample<N>` node corresponding to the analyzed sample, in the *Misura™ Navigator*.

The surface tension plugin will ask to the user all remaining physical sample properties in order to calculate a proper surface tension from the adimensional parameters calculated by the image analysis.

**Misura: Surface Tension**

Calculate surface tension from capillary shape parameters, scaling factor, temperature, sample expansion curve, media expansion curve.

**Options**

Capillarity factor dataset	<input type="text"/> ..
Scaling factor dataset	<input type="text"/> ..
Sample temperature (°C)	<input type="text"/> ..
Reference sample density (kg/m <sup>3</sup> )	<input type="text" value="1000"/>
Reference sample temperature (°C)	<input type="text" value="25"/>
Sample expansion [blank=fixed] (%)	<input type="text"/> ..
Sample expansion temperature [blank=as beta] (°C)	<input type="text"/> ..
Extrapolate below temperature [0=no] (°C)	<input type="text" value="0"/>
Extrapolate above temperature [0=no] (°C)	<input type="text" value="0"/>
Sample expansion dimension	<input type="text" value="Linear"/>
Reference gas density (kg/m <sup>3</sup> )	<input type="text" value="1,1871110860799"/>
Reference gas temperature (°C)	<input type="text" value="25"/>
Gas expansion [blank=air] (%)	<input type="text"/> ..
Gas expansion temperature [blank=air] (°C)	<input type="text"/> ..
Gas expansion dimension	<input type="text" value="Volumetric"/>
Output dataset name	<input type="text"/> ..

## Pre-compiled fields

- **Capillarity factor dataset:** this pre-compiled field contains the reference to the adimensional *beta* dataset obtained by the sessile drop analysis.
- **Scaling factor dataset:** referring to the adimensional *r0* dataset.
- **Sample temperature:** referring to the sample's temperature dataset.
- **Output dataset name:** the name where to save the calculated surface tension. It is possible to save multiple datasets corresponding to different configurations.

## Sample density

- **Reference sample density:** density of the sample at the reference temperature.
- **Reference sample temperature:** reference temperature at which the reference sample density is measured.

Sample thermal expansion, which Will be used to correct sample density by temperature:

- **Sample expansion:** if left blank, assume no expansion (and no density change). Else, point to an expansion % dataset for the material (height, volume or the expansion curve coming from a dilatometer).
- **Sample expansion temperature:** if the sample expansion datasets comes from a different test (a dilatometer) this field should point to the sample's temperature of that test.

- **Extrapolate below temperature:** do not trust expansion values below this temperature. Use linear extrapolation instead.
- **Extrapolate above temperature:** do not trust expansion values above this temperature. Use linear extrapolation instead.
- **Sample expansion dimension:** specify if the Sample expansion dataset is linear or volumetric.

### Atmosphere density

- **Reference gas density:** Gas density at the reference temperature.
- **Reference gas temperature:** Reference density at which the reference gas density is measured.

Gas thermal expansion, which will be used to correct gas density by temperature:

- **Gas expansion:** if left blank, assume reference air expansion. Else, point to an expansion % dataset for the gas.
- **Gas expansion temperature:** temperature dataset used for the gas expansion values.
- **Gas expansion dimension:** specify if the Gas expansion dataset is linear or volumetric.

## 3.2 Horizontal Optical Dilatometer

Misura™ Horizontal Optical Dilatometer measures the dimensional changes of materials through patented True Differential, double-beam technology.

The following sections contain instruction about how to start a test, prepare a sample and analyze test results.

### 3.2.1 Quick Start: Running an Horizontal Dilatometer Test

This section documents specific dilatometric functions. Read [Live Acquisition](#) for a general description of the acquisition window.

#### Horizontal Dilatometer Acquisition Window

The Horizontal Dilatometer [Live Acquisition](#) window additionally comprises:

- Two [Camera controller](#) windows with X, Y motion controllers.
- [Global Focus](#) motion controllers.
- Sample Total displacement information displayed on the [Status panel](#) panel, updated realtime during the analysis.
- One [Samples](#) tab in the left Test Configuration area.

The workflow for an horizontal dilatometer test follows the general rules described in section [Live Acquisition](#).

#### Adjusting cameras position

The initial position of the camera should be automatically reached during instrument initialization, as described in [Motion Control](#).

Use the X motion control under each camera to find the border of the sample, which should appear as a vertical division line between a white and a black area, where the black represents the sample.

In case of indented sample borders, use the Y motion control to frame the most planar section of the surface.

Once the position of the camera has been established you have to find the right focal distance, by moving the focus slider on the bottom of the Acquisition window.

It is advisable to close the furnace before starting a new tests. Vibrations produced during furnace movements can slightly change the sample position.

### Setting initial sample dimension

The Horizontal Optical Dilatometer measures changes in length, but cannot measure the initial length of the sample.

The operator must measure it before starting a test, by using a high precision caliper.

### Stopping the test on excess deformation

In thermal cycle tab, under *Additional Control Options* section, the Horizontal Optical Dilatometers offers a security option to stop the test whenever deformation exceeds a configurable threshold, **Stop on deformation excess**.

The security limits are +10 and -10 and are active by default.

This option helps preventing sample melting in the furnace. In many cases melting will raise image analysis errors which will stop the acquisition anyway. Nevertheless, under some circumstances there is no way to detect melting from the border image.

We advise to enable this option and set reasonable limits for the specific material analysed.

## 3.2.2 Sample preparation for the Horizontal Optical Dilatometer

The optical dilatometer frames two opposite sides of the sample with two independent optics.

In order to achieve the best focus the sample should be:

- machined to a trapezoidal shape, in such a way that the lengths of the faces parallel to the optical path are minimized
- placed on an alumina holding plate, in order to avoid elastic friction with holding rods
- aligned to the end of the holding rods, in such a way that the border distances from the optics are equal and the focus distance is the same
- placed in the middle of the furnace, so that the maximum expansion excursion is available both towards the left optic and towards the right optic

## 3.2.3 Quick Start: Browsing an Horizontal Dilatometer file

This Demo will guide you through the data analysis of Horizontal Dilatometer (`horizontal`) output files.

In order to follow the tutorial you should:

- Download and Install Misura™ (see *Installation*).
- Get the sample file `Horizontal Dilatometer Sample File 1.h5` and save it to a known location (eg: your Desktop)

## Opening the output file

1. Run `browser.exe` application from the folder where you extracted Misura™, or run the link you created on your desktop.
2. In the **Recent data sources** window, under the first column **Recent files**, click on **Add** button.
3. Browse to the location where you downloaded `Horizontal Dilatometer Sample File 1.h5`, select and open it.
4. The loading process will start. If the file is considerably big (several GB) or located on network or slow storage drive, it may take several seconds to open.
5. The file is displayed on a new tab, on the right of the **Databases** tab.

The test file tab is divided in three areas:

- A menu bar in the upper part of the window
- A right area called **Test Configuration**. It is divided in at least 4 vertical tabs: **Measure**, **Thermal Cycle**, **Sample0** and **Results**.
- A central area displaying movable and resizable sub-windows, where you see the **Data Plot** window.

## Test Configuration and Data

The most relevant configuration options used for the test run and output results are displayed in the right **Test Configuration** area.

### Measure overview

The first **Measure** tab contains the list of options regarding the test run.

Detect the following:

- **Name**: Name of the test run, set by the operator anytime before the end of the test.
- **Operator**: the login name used by the operator who started the test.
- **Type**: The type of the test (usually `Standard` or `Calibration`).
- **Elapsed time**: the total duration of the test.

### Thermal cycle

This tab contains a table with points defining the thermal cycle and a graph with a cartesian representation.

The graph displays two curves: the red line is the setpoint temperature; the blue line is the heating rate.

If you cannot see the axes and their labels, enlarge the application window and the Test Configuration area.

### Sample data

Most relevant data in the `Sample0` tab are:

- **Name**: if set, the name the operator gave to this specific sample. It is mainly useful for multi-sample measurement.

- **Initial sample dimension:** the operator must set this value to the initial sample length, measured with another instrument (eg: a digital micrometer).
- **Record frames/profiles:** did the operator required full frames and (x,y) sample profiles to be recorded onto the output file? They are usually turned off.

You can ignore *Border angle*, *Motion start*, *Total displacement*, *Cumulative error* options and all their nested options, as they are only useful during live acquisition.

## Results

The Results tab displays the Navigator tree component. It is the tree of recorded datasets (curves), organized by groups. Each group represents a part of the instrument or of the measurement.

For example:

- `/horizontal` element represents the Horizontal Dilatometer instrument itself. It generates no datasets, but contains one sample (**sample0**).
- `/kiln` element represents the furnace, and contains datasets regarding temperature control (T, temperature; S, setpoint; P, power; etc).

We will see it in detail in next sections, as it is the most powerful and versatile component of the interface.

## Interacting with the Data Plot

The *Misura™ Navigator* tree is the gate to the most important actions you can perform on the data plot.

In order to plot one more dataset (for example the temperature setpoint):

1. Right-click on the dataset you wish to plot on the Navigator tree (`/kiln/S`).
2. Select the **Plot** action from the context menu.

The same apply for removing a dataset and all its related objects from the plot. The Plot action will be checked if the curve is visible, unchecked if not visible.

The setpoint curve plot is now referred to its own axis labelled  $S (^{\circ}C)$ . To better compare temperature and setpoint, it is useful to refer the setpoint plot to the temperature axis:

1. Right-click on the setpoint curve on the Data Plot window. Select **Properties** from the context menu.
2. A new dialog window opens, listing all the properties of the plotted curve. Search for the bold **Y axis** entry.
3. Change **Y axis** from **ax:S** to **ax:T**. The curve will be immediately referred to the  $T (^{\circ}C)$  axis.

The  $S (^{\circ}C)$  axis loses its scale (it's now from 0 to 1). It's no longer useful, so you can hide it:

1. Right-click on the  $S (^{\circ}C)$  axis, select **Properties**.
2. The first entry is **Hide**. Check the checkbox. The axis disappears.

You can freely move any axis by clicking on it and dragging.

## Viewing dilatation as Percentile

The `/horizontal/sample0/d` dataset represents dilatation. It is recorded in microns, but is frequently useful to analyze it as a percentile of the total initial length of the sample. The initial length was measured with a manual digital micrometer, and set before starting the test.

Follow these steps to convert the curve to percentile:

1. Locate the `d (/horizontal/sample0/d)` element in the Navigator tree under Results tab.
2. Right-click and select **Percentile**.
3. A dialog will appear. Click **Apply**.
4. A new temporary label in the dialog confirms the dataset was created (Done). Click **Close**.
5. If the curve is currently plotted, you immediately view the effect in the graph.

It may happen that the operator forget to measure the sample, or inserts a wrong initial dimension. If the thermal treatment modify the structure of your material, the test must be repeated. In case you are able to recover the correct initial dimension, or you are confident that you can measure it after the test run, you can change its value.

1. Locate the `d` element in the Navigator tree.
2. Right-click and select **Set Initial Dimension**.
3. Insert the correct value in **Initial dimension value**.
4. De-select *OR, automatic calculation based on first points* checkbox.
5. Click **Apply** then **Close**.

If the curve is currently plotted in percentile, you will see the axis scale changing accordingly to the new initial dimension set.

## Evaluating the Coefficient of Expansion

The coefficient of expansion is calculated from the `d` dataset, the initial dimension and the temperature. To create the coefficient curve:

1. Locate the `d` element in the Navigator tree.
2. Right-click and select **Linear Coefficient**.
3. Click **Apply** and **Close**.
4. The Navigator tree is updated. The `d` element now has a child: *Coefficient(T,d)*. This is the coefficient of expansion.
5. Plot the coefficient dataset using its context menu.

The curve will be referred to a new axis *Coeff(50)*. The number 50 in the label means the coefficient was calculated starting from 50°C. The scale of the axis will be around  $10^{-6}$  -  $10^{-5}$ . You can rescale the axis to a more comfortable multiplier:

1. Right-click on the *Coeff(50)* axis. Select **Properties** action.
2. Locate the **Scale** entry and set it to  $1e6$ .

Now the scale of the axis should go from 2.5 to 12.5, where the multiplier is  $10^{-6}$ .

## Calibrating with a known standard

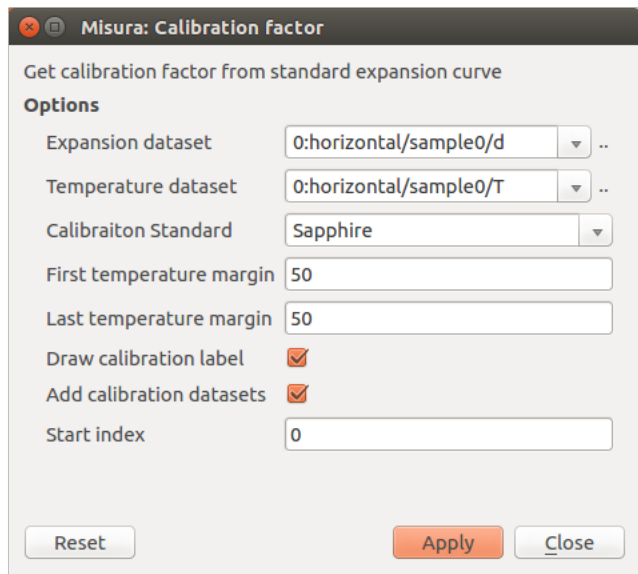
By comparing the measured expansion curve of a standard material with theoretical values, it is possible to calculate a **calibration factor** which can then be applied directly during the measurement. The calibration factor will be multiplied by the observed expansion, acting as a slope correction on the whole expansion curve.

If the factor is less than one, it means the measured curve of the standard material was higher than the theoretical, so all measurements will be reduced by that number. In case the factor is greater than one, it means the measurement was lower: all subsequent measurements will be increased accordingly.

To execute the calibration tool, open the test in the Browser or Graphics, then:

1. Locate the `d` element in the Navigator tree.
2. Right-click and select **Calibration**.
3. Select the **Calibration standard**, start/end temperature and display options.
4. Click **Apply** and **Close**.

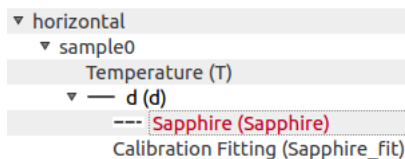
When launched through this sequence, the calibration plugin dialog will show pre-filled fields for *Expansion dataset* and *Temperature dataset*:



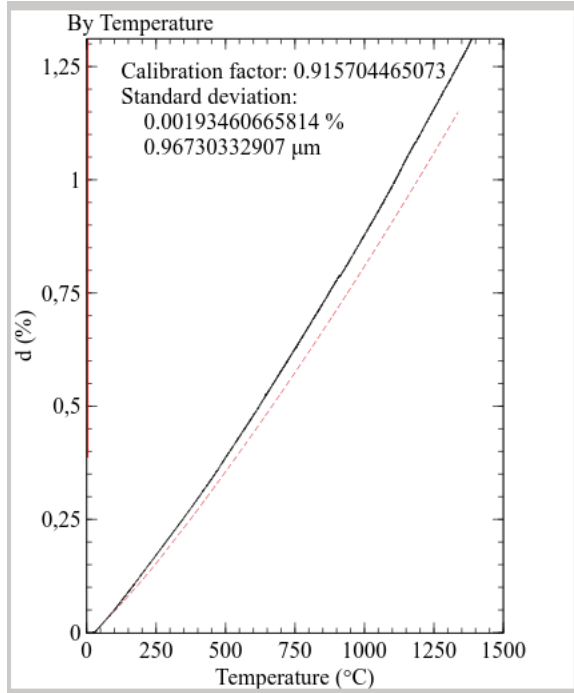
Other options include:

- **Calibration Standard** chooser contains a list of materials having certified expansion curves.
- **First temperature margin** determines the temperature interval to discard from the start of the test. When the test starts, thermal control might induce imperfections in the heating rate, due to furnace inertia. This options allows to ignore the initial part of the curve.
- **Last temperature margin** allows to discard a temperature interval at the end of the test.
- **Draw calibration label** will create a text label on the currently selected plot page, and output the calibration factor and standard deviation.
- **Add calibration datasets** will add the theoretical expansion values and a polynomial fit of the measured values to two child datasets. Those curves can later be plotted.
- **Start index** allows to skip initial points by index (second) - alternative to *First temperature margin*

Example navigator tree after the creation of calibration datasets:



Example calibration plot with calibration label and plotted standard:



The calibration factor can then be copied from the label and configured in the *Settings* → *Instrument panel* under *ref:live\_acquisition*.

This procedure works both on native Misura™ tests and on imported Misura3 tests.

### 3.3 Vertical Optical Dilatometer

Misura™ Vertical Optical Dilatometer measures the dimensional changes of materials through patented True Differential, double-beam technology.

#### 3.3.1 Quick Start: Running a Vertical Dilatometer test

This section documents specific dilatometric functions. Read *Live Acquisition* for a general description of the acquisition window.

##### Vertical Dilatometer Acquisition Window

The Vertical Dilatometer *Live Acquisition* window additionally comprises:

- Two *Camera controller* windows with X, Y motion controllers.
- *Global Focus* motion controllers.
- Sample Total displacement information displayed on the *Status panel* panel, updated realtime during the analysis.
- One *Samples* tab in the left Test Configuration area.

The workflow for an vertical dilatometer test follows the general rules described in section *Live Acquisition*.

### Adjusting cameras position

The initial position of the camera should be automatically reached during instrument initialization, as described in *Motion Control*.

Use the Y motion control on the left side of each camera to find the border of the sample and of the holding plate. They both appear as an horizontal division line between a white and a black area, where the black represents the sample for the Height camera and the holding plate for the Base camera.

In case of indented sample borders, use the X motion control to frame the most planar section of the surface.

Once the position of the camera has been established you have to find the right focal distance, by moving the focus slider on the bottom of the Acquisition window.

It is advisable to close the furnace before starting a new tests. Vibrations produced during furnace movements can slightly change the sample position.

### Setting initial sample dimension

The Vertical Optical Dilatometer measures changes in length, but cannot measure the initial length of the sample.

The operator must measure it before starting a test, by using a high precision caliper.

### Stopping the test on excess deformation

The vertical dilatometer is designed to follow the sample until complete melting. Nevertheless, this might pose the risk of sample flowing below the sample holder if its viscosity drops down enough.

In thermal cycle tab, under *Additional Control Options* section, the Horizontal Optical Dilatometers offers a security option to stop the test whenever deformation exceeds a configurable threshold, **Stop on deformation excess**.

The security limits are +25 and -50 and are active by default.

This option helps preventing sample flowing in the furnace.

We advise to enable this option and set reasonable limits for the specific material analysed.

## 3.3.2 Sample preparation for the Vertical Optical Dilatometer

The optical dilatometer frames two opposite sides of the sample with two independent optics.

In order to achieve the best focus the sample should be:

- machined with a triangular tip, in such a way that the length of the upper face parallel to the optical path is minimized
- the long side of the sample should face the optics and be aligned with the holding plate

### 3.3.3 Quick Start: Browsing a Vertical Dilatometer file

This Demo will guide you through the data analysis of Vertical Dilatometer (vertical) output files.

In order to follow the tutorial you should:

- Download and Install Misura™ (see *Installation*).
- Get the sample file `Vertical Dilatometer Sample File 1.h5` and save it to a known location (eg: your Desktop)

## Opening the output file

1. Run `browser.exe` application from the folder where you extracted Misura™, or run the link you created on your desktop.
2. In the **Recent data sources** window, under the first column **Recent files**, click on **Add** button.
3. Browse to the location where you downloaded `Vertical Dilatometer Sample File 1.h5`, select and open it.
4. The loading process will start. If the file is considerably big (several GB) or located on network or slow storage drive, it may take several seconds to open.
5. The file is displayed on a new tab, on the right of the **Databases** tab.

The test file tab is divided in three areas:

- A menu bar in the upper part of the window
- A right area called **Test Configuration**. It is divided in at least 4 vertical tabs: **Measure**, **Thermal Cycle**, **Sample0** and **Results**.
- A central area displaying movable and resizable sub-windows, where you see the **Data Plot** window.

## Test Configuration and Data

The most relevant configuration options used for the test run and output results are displayed in the right **Test Configuration** area.

### Measure overview

The first **Measure** tab contains the list of options regarding the test run.

Detect the following:

- **Name**: Name of the test run, set by the operator anytime before the end of the test.
- **Operator**: the login name used by the operator who started the test.
- **Type**: The type of the test (usually `Standard` or `Calibration`).
- **Elapsed time**: the total duration of the test.

### Thermal cycle

This tab contains a table with points defining the thermal cycle and a graph with a cartesian representation.

The graph displays two curves: the red line is the setpoint temperature; the blue line is the heating rate.

If you cannot see the axes and their labels, enlarge the application window and the Test Configuration area.

### Sample data

Most relevant data in the `Sample0` tab are:

- **Name**: if set, the name the operator gave to this specific sample. It is mainly useful for multi-sample measurement.

- **Initial sample dimension:** the operator must set this value to the initial sample length, measured with another instrument (eg: a digital micrometer).
- **Record frames/profiles:** did the operator required full frames and (x,y) sample profiles to be recorded onto the output file? They are usually turned off.

You can ignore *Border angle*, *Motion start*, *Total displacement*, *Cumulative error* options and all their nested options, as they are only useful during live acquisition.

## Results

The Results tab displays the Navigator tree component. It is the tree of recorded datasets (curves), organized by groups. Each group represents a part of the instrument or of the measurement.

For example:

- /vertical element represents the Vertical Dilatometer instrument itself. It generates no datasets, but contains one sample (**sample0**).
- /kiln element represents the furnace, and contains datasets regarding temperature control (T, temperature; S, setpoint; P, power; etc).

We will see it in detail in next sections, as it is the most powerful and versatile component of the interface.

## Interacting with the Data Plot

The *Misura™ Navigator* tree is the gate to the most important actions you can perform on the data plot.

In order to plot one more dataset (for example the temperature setpoint):

1. Right-click on the dataset you wish to plot on the Navigator tree (/kiln/S).
2. Select the **Plot** action from the context menu.

The same apply for removing a dataset and all its related objects from the plot. The Plot action will be checked if the curve is visible, unchecked if not visible.

The setpoint curve plot is now referred to its own axis labelled  $S (^{\circ}C)$ . To better compare temperature and setpoint, it is useful to refer the setpoint plot to the temperature axis:

1. Right-click on the setpoint curve on the Data Plot window. Select **Properties** from the context menu.
2. A new dialog window opens, listing all the properties of the plotted curve. Search for the bold **Y axis** entry.
3. Change **Y axis** from **ax:S** to **ax:T**. The curve will be immediately referred to the  $T (^{\circ}C)$  axis.

The  $S (^{\circ}C)$  axis loses its scale (it's now from 0 to 1). It's no longer useful, so you can hide it:

1. Right-click on the  $S (^{\circ}C)$  axis, select **Properties**.
2. The first entry is **Hide**. Check the checkbox. The axis disappears.

You can freely move any axis by clicking on it and dragging.

## Viewing dilatation as Percentile

The /vertical/sample0/d dataset represents dilatation. It is recorded in microns, but is frequently useful to analyze it as a percentile of the total initial length of the sample. The initial length was measured with a manual digital micrometer, and set before starting the test.

Follow these steps to convert the curve to percentile:

1. Locate the `d (/vertical/sample0/d)` element in the Navigator tree under Results tab.
2. Right-click and select **Percentile**.
3. A dialog will appear. Click **Apply**.
4. A new temporary label in the dialog confirms the dataset was created (Done). Click **Close**.
5. If the curve is currently plotted, you immediately view the effect in the graph.

It may happen that the operator forget to measure the sample, or inserts a wrong initial dimension. If the thermal treatment modify the structure of your material, the test must be repeated. In case you are able to recover the correct initial dimension, or you are confident that you can measure it after the test run, you can change its value.

1. Locate the `d` element in the Navigator tree.
2. Right-click and select **Set Initial Dimension**.
3. Insert the correct value in **Initial dimension value**.
4. De-select *OR, automatic calculation based on first points* checkbox.
5. Click **Apply** then **Close**.

If the curve is currently plotted in percentile, you will see the axis scale changing accordingly to the new initial dimension set.

### Evaluating the Coefficient of Expansion

The coefficient of expansion is calculated from the `d` dataset, the initial dimension and the temperature. To create the coefficient curve:

1. Locate the `d` element in the Navigator tree.
2. Right-click and select **Linear Coefficient**.
3. Click **Apply** and **Close**.
4. The Navigator tree is updated. The `d` element now has a child: *Coefficient(T,d)*. This is the coefficient of expansion.
5. Plot the coefficient dataset using its context menu.

The curve will be referred to a new axis *Coeff(50)*. The number 50 in the label means the coefficient was calculated starting from 50°C. The scale of the axis will be around  $10^{-6}$  -  $10^{-5}$ . You can rescale the axis to a more comfortable multiplier:

1. Right-click on the *Coeff(50)* axis. Select **Properties** action.
2. Locate the **Scale** entry and set it to  $1e6$ .

Now the scale of the axis should go from 2.5 to 12.5, where the multiplier is  $10^{-6}$ .

## 3.4 Absolute Optical Fleximeter

Misura™ Absolute Optical Fleximeter measures the dimensional changes of materials through patent-pending True Differential, triple-beam technology.

The relative fleximeter only uses one camera and needs a calibration curve to be subtracted from the measurement.

The following sections contain instruction about how to start a test, prepare a sample and analyze test results.

### 3.4.1 Quick Start: Running an Absolute Optical Fleximeter Test

This section documents specific dilatometric functions. Read *Live Acquisition* for a general description of the acquisition window.

#### Fleximeter Acquisition Window

The Absolute Fleximeter *Live Acquisition* window additionally comprises:

- Three *Camera controller* windows. Two lateral (right/left) cameras with X, Y motion controllers and one center camera with Y motion controller.
- *Global Focus* motion controllers.
- Sample Total displacement information displayed on the *Status panel* panel, updated realtime during the analysis.
- One *Samples* tab in the left Test Configuration area.

The workflow for an Absolute Fleximeter test follows the general rules described in section *Live Acquisition*.

#### Adjusting cameras position

The initial position of the camera should be automatically reached during instrument initialization, as described in *Motion Control*.

Use the Y motion control on the left side of each camera window to find the border of the sample, which should appear as an horizontal division line between a white and a black area, where the black represents the sample.

X motion controllers should not be changed, unless default positions make it impossible to carry out the test.

Once the position of the camera has been established you have to find the right focal distance, by moving the focus slider on the bottom of the Acquisition window.

It is advisable to close the furnace before starting a new tests. Vibrations produced during furnace movements can slightly change the sample position.

### 3.4.2 Sample preparation for the Absolute Optical Fleximeter

The absolute fleximeter frames three points on the bottom side of the sample with three independent optics.

In order to achieve the best focus the sample should be:

- aligned to the end of the middle holding rods, in such a way that the border distances from the optics are equal and the focus distance is the same

### 3.4.3 Quick Start: Browsing an Absolute Fleximeter file

This Demo will guide you through the data analysis of Absolute Fleximeter (`flex`) output files.

In order to follow the tutorial you should:

- Download and Install Misura™ (see *Installation*).
- Get the sample file `Absolute Fleximeter Sample File 1.h5` and save it to a known location (eg: your Desktop)

## Opening the output file

1. Run `browser.exe` application from the folder where you extracted Misura™, or run the link you created on your desktop.
2. In the **Recent data sources** window, under the first column **Recent files**, click on **Add** button.
3. Browse to the location where you downloaded `Absolute Fleximeter Sample File 1.h5`, select and open it.
4. The loading process will start. If the file is considerably big (several GB) or located on network or slow storage drive, it may take several seconds to open.
5. The file is displayed on a new tab, on the right of the **Databases** tab.

The test file tab is divided in three areas:

- A menu bar in the upper part of the window
- A right area called **Test Configuration**. It is divided in at least 4 vertical tabs: **Measure**, **Thermal Cycle**, **Sample0** and **Results**.
- A central area displaying movable and resizable sub-windows, where you see the **Data Plot** window.

## Test Configuration and Data

The most relevant configuration options used for the test run and output results are displayed in the right **Test Configuration** area.

### Measure overview

The first **Measure** tab contains the list of options regarding the test run.

Detect the following:

- **Name**: Name of the test run, set by the operator anytime before the end of the test.
- **Operator**: the login name used by the operator who started the test.
- **Type**: The type of the test (usually `Standard` or `Calibration`).
- **Elapsed time**: the total duration of the test.

### Thermal cycle

This tab contains a table with points defining the thermal cycle and a graph with a cartesian representation.

The graph displays two curves: the red line is the setpoint temperature; the blue line is the heating rate.

If you cannot see the axes and their labels, enlarge the application window and the Test Configuration area.

### Sample data

Most relevant data in the `Sample0` tab are:

- **Name**: if set, the name the operator gave to this specific sample. It is mainly useful for multi-sample measurement.

- **Initial sample dimension:** the operator must set this value to the initial sample length, measured with another instrument (eg: a digital micrometer).
- **Record frames/profiles:** did the operator required full frames and (x,y) sample profiles to be recorded onto the output file? They are usually turned off.

You can ignore *Border angle*, *Motion start*, *Total displacement*, *Cumulative error* options and all their nested options, as they are only useful during live acquisition.

## Results

The Results tab displays the Navigator tree component. It is the tree of recorded datasets (curves), organized by groups. Each group represents a part of the instrument or of the measurement.

For example:

- `/flex` element represents the Absolute Fleximeter instrument itself. It generates no datasets, but contains one sample (**sample0**).
- `/kiln` element represents the furnace, and contains datasets regarding temperature control (T, temperature; S, setpoint; P, power; etc).

We will see it in detail in next sections, as it is the most powerful and versatile component of the interface.

## Interacting with the Data Plot

The *Misura™ Navigator* tree is the gate to the most important actions you can perform on the data plot.

In order to plot one more dataset (for example the temperature setpoint):

1. Right-click on the dataset you wish to plot on the Navigator tree (`/kiln/S`).
2. Select the **Plot** action from the context menu.

The same apply for removing a dataset and all its related objects from the plot. The Plot action will be checked if the curve is visible, unchecked if not visible.

The setpoint curve plot is now referred to its own axis labelled  $S (^{\circ}C)$ . To better compare temperature and setpoint, it is useful to refer the setpoint plot to the temperature axis:

1. Right-click on the setpoint curve on the Data Plot window. Select **Properties** from the context menu.
2. A new dialog window opens, listing all the properties of the plotted curve. Search for the bold **Y axis** entry.
3. Change **Y axis** from **ax:S** to **ax:T**. The curve will be immediately referred to the  $T (^{\circ}C)$  axis.

The  $S (^{\circ}C)$  axis loses its scale (it's now from 0 to 1). It's no longer useful, so you can hide it:

1. Right-click on the  $S (^{\circ}C)$  axis, select **Properties**.
2. The first entry is **Hide**. Check the checkbox. The axis disappears.

You can freely move any axis by clicking on it and dragging.

## Viewing flexion in micron unit

The `/flex/sample0/d` dataset represents flexion. It is recorded in microns and automatically converted to percentile on dataset loading, but is frequently useful to analyze it as an absolute value in microns. The percentile is calculated towards the distance between the flex rods, set before starting the test.

Follow these steps to convert the curve back to microns:

1. Locate the `d (/flex/sample0/d)` element in the Navigator. #. Right-click and select the flagged action **Percentile**.
2. A dialog will appear. Click **Apply**.
3. A new temporary label in the dialog confirms the dataset was created (Done). Click **Close**.
4. If the curve is currently plotted, you immediately view the effect in the graph.
5. By right-clicking again on the dataset node the **Percentile** action is now unflagged.

Misura™ Browser allows to evaluate the results of a test run and to access to the full measurement instrument configuration.

The browser has a tab interface, where the first tab is reserved to Databases, and any additional tab represents a test file.

Each test is saved into a single test file in standard *HDF5* file format. Test files and can be indexed into one or more databases to ease up search and organization.

### 4.1 Data Sources

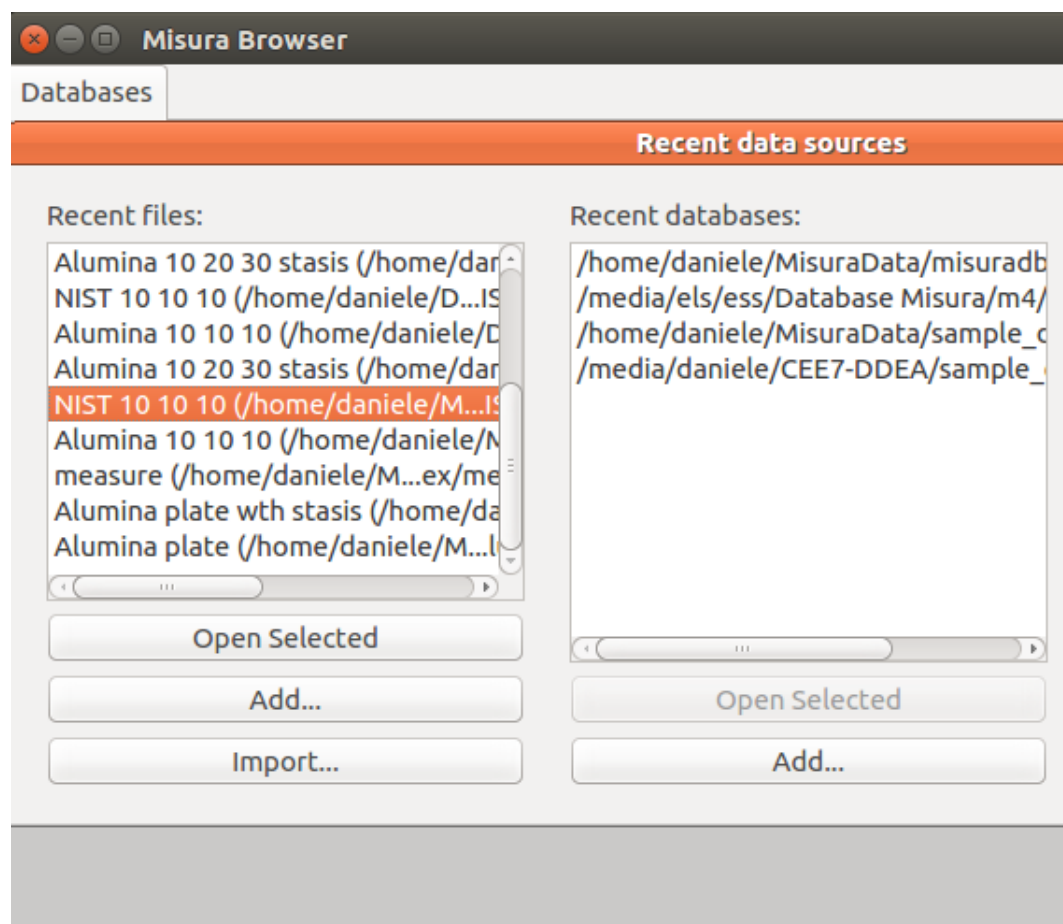
Data Sources is always the first Browser's tab, and is not possible to close it. The tab is mostly empty, displaying the gray background.

Any *HDF5* Misura file can be dragged from your file system browser and dropped into this gray area. The file will be immediately opened in a new tab.

The only visible sub-window on startup is *Recent Data Sources*, displaying two columns: one for recently opened files; one for recently accessed databases. More columns might be displayed by plugins.

The recently opened tests listing is a quick way to directly re-open any recent file, no matter if it is indexed in a database. To open a file from the recent files column, either:

- Double-click on the file
- Select the file, then click on the *Open selected* button
- Click on the *Add* button then select the file anywhere from the file-system.
- If any data import plugin is enabled, an *Import* button is also visible, which allows to select a foreign data format and convert it to a compatible *HDF5*. The converted file will be opened.



If a recent file is double-clicked from the list, or selected from the file system using the [File -> Open](#) menu action, it is opened in a new Test Window, in a new tab. The more recently accessed file is placed at the top of the list.

The more convenient way to open a test file is to query the database index.

### 4.1.1 Database Indexes

Misura™ databases are a way to organize and search large amounts of tests, and for finding or establishing relations between them.

They are advanced indexes, collecting all important information about each test (metadata) but not storing any raw dataset.

They are ephemeral, in the sense that they can be safely removed and recreated identical from the same set of files. They do not hold any unique information about your test. All information is actually saved only into the test files or into the plotting files.

There should always be a default database defined at the top of the list. This is the database where finished tests are automatically saved and indexed, configured in [Preferences](#) under **Default database** option.

If you would like to open a database which is not listed in the Recent databases column, you can Add it from the below button, or click on *File -> Open database* menu action in the main Browser window.

You can **create a database index** out of any structure of folders containing some Misura tests (and any other file type, which will be skipped). To create a new database, select the *File -> New database* menu action. It will ask the name and location of the database index. The database index must be placed on the topmost folder in your folder

structure. After confirmation, the folder where the database index is being created will be scanned as well as any sub-folder, recursively.

Databases can be located on a network share, to enable multi-user collaboration. Every client which needs to access the output files or the machine can configure it as its **Default database** in *Preferences*, so finished tests are automatically added to that location only once.

This is an easy way to collaborate on data post-processing. It is advisable to save also the plots in the same, shared folder, so any user participating in the network will be able to open them.

**Warning:** You might experience problems if a Linux client is accessing a database on a windows share through Samba. You will probably need to disable byte range locks by setting the `nobrl` flag when mounting the CIFS filesystem. Example `/etc/fstab` entry: `//192.168.0.1/database /media/database cifs rw, users, nobrl, user=misura, pass=xxxx, exec 0 0`

### 4.1.2 Database Dialog

The interface towards a database is the Database Dialog. A new database dialog sub-window will be added to the Data Sources every time a database index is opened.

It shows a listing with all indexed tests, plus a query line with some filtering options to filter the list.

The toolbar holds two buttons: Refresh, Rebuild.

- **Refresh** will search for indexed files that no longer exist and for new files that are still not indexed.
- **Rebuild** will clear the current listing and rebuild entirely from the files found in the same folder or below the folder where the database file is located.

The query line allows to match the input line against one database column at a time. Select the column name, insert the text to be searched and press enter. A special **All** filter will match simple text against all text column (name, file name, id, instrument type, etc).

Every line listed in the table represents one test. By double-clicking on a line, the test is opened in a new browser's tab. By right-clicking on a line, a context menu displays some actions relative to the selected test:

- **Open selected tests:** open the currently selected test (as double-click). Multiple lines can be selected by pressing **Ctrl** key while clicking. In case multiple lines were selected, all tests will be opened in new tabs.
- **Add to:** This action displays a sub-menu, listing all currently opened tabs (tests). By clicking on a tab name, the selected test will be **added** to the already opened tab. In this way, it is possible to compare multiple tests in the same browser window.
- **View folder:** Open the file system folder containing the test file.
- **Delete:** Delete selected file/s. Will ask a confirmation.

While cells **Name** or **Column** are selected, it is possible to press the **F2** key to rename the test or edit the comment.

The database dialog can be created also from *Plotting* menu, *Misura* → *Recent databases*. In this case, double-clicking on a test will add its datasets to the active document, and default plots to be created and overlaid to any existing plot.

## 4.2 Test Window

The Misura™ Test Window opens in Browser's tabs once a test has been selected.

Its appearance is very similar to the *Live Acquisition* window, with a central area displaying a plot and a lateral area showing test configurations and data Navigator.

The values contained in the configuration tabs (Measure, Sample 0...n, Thermal Cycle) are the ones recorded at the end of the test.

### 4.2.1 Basic Plotting and Embedding

At the opening of the test, a standard plot is displayed. In order to interact with this plot, switch to `Results` tab in the left panel.

You can operate on the plot with the usual Navigator functions (un/plotting a curve, smoothing, deriving, etc). You can also create a test report on a new plot page.

Once you are satisfied by your plot, you can permanently save into the test file.

- From `Measure` menu, click on `Plots` submenu.
- Select `Save new plot`. Give a name to your plot.
- Your new plot will appear in the `Plots` submenu.

Saved plots can be recalled, overwriting any current plot.

### 4.2.2 Re-calculate metadata

The logic by which characteristic or important points are identified during the test is saved onto the test file. Through the Browser it is possible to change and replay this logic, for research purposes.

The replay is accessible from the `Measure` menu, at the `Re-calculate metadata` action. All affected values will be recalculated. If the target value is unchanged, refresh it by hovering with the mouse.

### 4.2.3 Versioning

The original data cannot be modified or removed from a test file.

A versioning mechanism allows to change any configuration option and any metadata and save everything in a new test `version`. Multiple versions can be saved in each test file.

Multiple plots can also be saved under the version that generated them and recalled.

Versioning allows, for example, to correct the test name, or add a comment, or manually edit characteristic shapes. To save a new version, starting from a file containing only the original data:

1. Do your changes to any configuration option
2. Click on menu *Measure* → *Version* → *New version and plot*
3. A dialog box will ask the label of the new version.

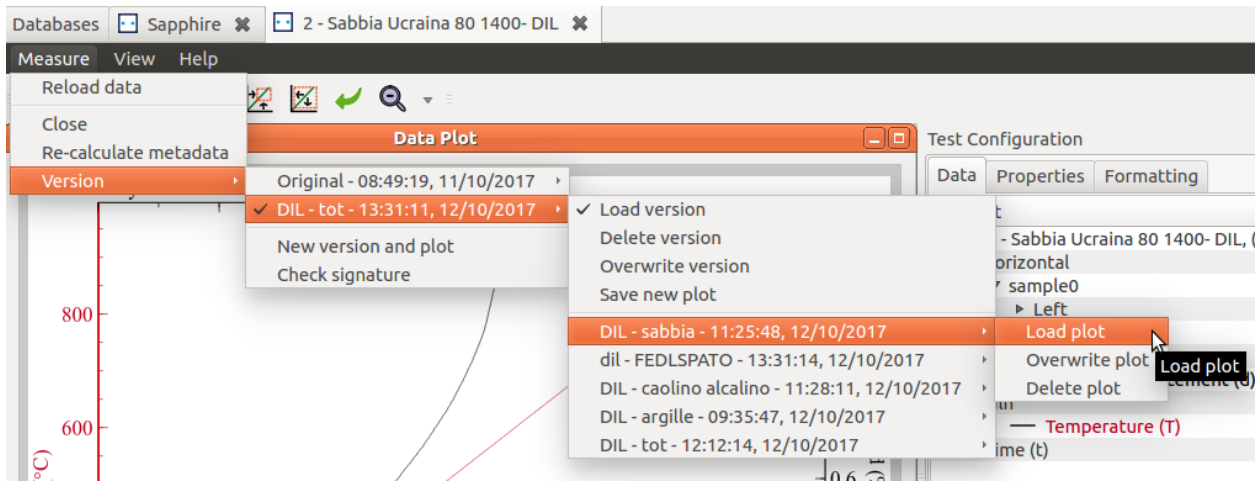
After a new version is created, the `Version` menu will show an additional, checked sub-menu below the `Original` one. The version submenu allows to:

- `Load version`: reload the configuration options from the parent version. This menu action is checked in the current version.
- `Delete version`: remove the parent version and any associated plot.
- `Overwrite version`: overwrite saved configuration.
- `Save new plot`: save current plot as a new plot associated to the current version, with a new name.

The Original version cannot be overwritten nor deleted, and only displays the Load version action.

Below these version-submenu actions, all associated plots are listed as sub-menu. Each plot-submenu has three entries:

- **Load plot:** loads the selected plot. If the plot pertain to a version which is not current, the parent version will be loaded. The current plot will be deleted and replaced with the loaded one. By hovering the mouse over the load action, a preview of the plot will pop-up.
- Overwrite plot: overwrite that plot.
- Delete plot: delete that plot.



Misura™ is built upon [Veusz](#), an advanced scientific plotting package.

[Veusz](#)'s website contains the basic documentation needed to start using its plotting features ([this introductory video](#) can be a good starting point).

Once you know the basics of [Veusz](#), you can start using proficiently Misura™ plugins.

## 5.1 Misura™ Menu

Misura™ Menu is composed of the following entries:

- Recent Files - shows the most recent N opened file. N can be modified in Preferences (default value is 15)
- Recent Databases - shows the most recent N databases. N can be modified in Preferences (default value is 10)
- Open File - opens a dialog boxes to locate and load a new test file.
- Opened Tests Navigator - shows/hide the Misura™ *Misura™ Navigator* panel
- Preferences - opens *Preferences*.

## 5.2 Tools

Useful plotting tools, specifically created for Misura™ and not documented in [Veusz](#), are listed in the following chapters.

### 5.2.1 DataPoint

A DataPoint represents an highlighted point on a plotted curve. It is subordered to that curve and strictly bound to its fate. If the curve is deleted, the DataPoint gets deleted also. If some aspect of the curve change, like the x or y dataset or axis, the DataPoint is adjusted accordingly.

## Creating a DataPoint

There are two methods of placing a new DataPoint on a curve:

1. Activate the *picker* tool and click on a curve. A new DataPoint will be created, associated to the curve you clicked onto, and as near as possible to the coordinates where your click happened.
2. Select the curve in the *Misura™ Navigator*, then right click on its node and select the *Intercept* action. A plugin window will allow to customize the location where the DataPoint will appear and some additional settings.

## Positioning

Once created, a DataPoint can be positioned by dragging and dropping it along its curve (it will never *jump* to another curve).

Its exact positioning, once dropped, can follow different algorithms, which makes it a powerful analytical tools. For example, a DataPoint can search for the nearest maximum, minimum or inflection point in the target curve.

Placement options can be configured before creating a datapoint according to method (2) above (*Intercept* from *Misura™ Navigator*) by setting the *Place nearest* field. Once the DataPoint has been created with either method, placement algorithm can be modified from the *Place nearest* setting found in the *Properties* panel.

1. *Nearest (fixed X)*: the default method will consider the X coordinate of your click, and place the DataPoint the nearest possible to that value, without considering the Y coordinate.
2. *Nearest*: as above, but will consider also the Y coordinate. Use this method when there is a non-univocal curve (multiple Y for the same X).
3. *Maximum*: search the nearest maximum value
4. *Minimum*: as above, looking for the minimum
5. *Inflection*: search the nearest point where the second derivative is zero
6. *Stationary*: as above, but use the first derivative

Inflection and Stationary methods will need an additional X dataset in order to calculate the derivatives. The DataPoint is initialized with the same X dataset of the parent curve, but that can be changed in the *Critical search X dataset* setting.

The surrounding portion of the curve, in which the automatic positioning will occur, is defined by *Critical search range* option. It is expressed as the number of points around the current position of the DataPoint where to search according to the selected method. This allows a precise *local* search of the desired morphological feature of the curve.

## Labels

DataPoint creates a subordered label listing the Y value, temperature and time of the point. The label can be deleted by setting *Show label* to `False` under the *Formatting* panel of the DataPoint.

The label can be customized in *Output label text* following Python replacement rules. Available substitutions are:

- `y`: y value (`%(y) .1f` will output `1.2` if y is 1.234)
- `x`: x value, as above
- `ylabel`: the label of the y axis, use the string formatter: `%(ylabel) s`
- `xlabel`: x axis label, as above
- `t`: time value
- `T`: temperature value

For example:

```
Intercept\\% (ylabel) s=% (y) .1E\\T=% (T) .1f\\t=% (t) i
```

Will render as:

Intercept

Vol (%)=5.1E

T=840.1

t=2800

## Lines

The *Formatting* panel offers three kinds of subordered lines:

1. *Show tangent line*: a line tangent to the curve will be added
2. *Show perpendicular line*: a line perpendicular to the curve will be added
3. *Second Data Point*: specify a second DataPoint: a line will be drawn which passes through both the current DataPoint and that second DataPoint.

After one of these option is activated, it might be necessary to move the DataPoint on the plot for the related lines to show up. Alternatively, you can click the *Update Data Point* button a few times.

## Remove Gaps

A DataPoint can also be placed on curve *defects*, like sudden jumps, in order to remove them by clicking on the *Remove Gaps* button. The curve will be *smoothed* around the datapoint, removing sudden jumps. You can use the *Undo* button to revert its operation.

Gaps removal algorithm reads two DataPoint settings which can be properly configured to obtain the desired output:

1. *Remove gaps range*: Number of points surrounding the DataPoint that will be scanned for jump removal.
2. *Remove gaps threshold*: A limit above which the distance between two points is considered a jump that should be removed.

The threshold is automatically configured according to the range and the selected surrounding, so that any point above the mean scattering should be *flattened* out.

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### Misura™3 Data Import

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Misura™4 can access data acquired from measurement instruments operated by previous Misura™3 software. By enabling the Misura™3 data import function, you can open any Misura™3 database, navigate through stored tests and get a preview of images, then convert the requested tests to the latest Misura™ file format.

Once the test data has been converted and stored into the newer format, it can be opened and used exactly as any other Misura™ file, taking advantage of nice vector plotting, flexible data storage, reporting, and advanced math operations.

#### 6.1 Limitations

- The Misura™3 data import function works only on Microsoft Windows™ OS.
- Misura™3 tests does not contain all the metadata generated by a newer instrument. Part of the metadata needed for correct interoperability is guessed or simply filled with a default.
- For the above reason, Misura™3 data import should be considered experimental and might lead to unexpected or wrong results.

#### 6.2 Enabling the Misura™3 import function

The import function can be configured in the *Preferences* panel. This panel is accessible from the Help menu in Browser and from the Misura menu in Graphics.

You find a specific **Data Import** tab where you can enable or disable compatibility mode. After enabling it, click **Save** button (upper-right), then exit from any opened Misura™ window.

#### 6.3 Opening Misura™3 databases

The import function is available both in the Browser and in the Graphics applications.

### 6.3.1 From Browser

1. Open the Browser app. Amongst recent items, you will notice a new empty column named **Recent Misura 3 databases**.
2. If no recent database is listed, open a new one using the **Add** button.
3. You can select a previously opened database from the list of recent paths by double-click or by clicking on **Open Selected** button at the bottom of the list.

When a database is selected either ways, a Database Dialog opens. Multiple database dialogs can be opened at the same time, remaining active in the Browser's Database tab.

By double clicking on a test row, the test is converted to the latest Misura™ format and immediately opened in a new Browser tab.

Now all advanced Browser operations and functionalities are available.

### 6.3.2 From Graphics

1. In the Graphics app a new **Misura3** menu appears on the right of standard **Misura** menu, in the top menubar (File, Edit, etc).
2. **Recent Misura3 databases** submenu lists recently opened databases and lets you open a new one via **Open..** menu action.
3. When a database is selected, a Database Dialog opens.

By double clicking on a test row, the test is converted to the latest Misura™ format and immediately added to the current graph.

It is now possible to create beautiful and complex plots out of Misura™3 data.

### 6.3.3 The Database Dialog

The Database Dialog lists all tests contained in the database, in reverse chronological order.

Simple searches against test name can be performed via the text input on the bottom of the list, followed by a click on "Query" button. The listing can also be restricted by test type, using the chooser menu.

If a selected test contains images, they will be previewed on the bottom of the dialog.

Below the query input line there are controls about how the format conversion should happen. Using these controls it is possible to force/avoid the overwriting of any previously converted file.

## 6.4 Quick Start: Correcting a Flex test from Misura™3 database

A common task to be performed with Misura™3 data is to correct a Flex test with its corresponding calibration test. The following Quick Start explains how to achieve this result in a reversible way.

### 6.4.1 Getting a Misura™3 example database

Please download the [example Misura3 database](#) for a pre-populated database you can use to follow this Quick Start. Extract the folder wherever and point to the `misura3_sample.mdb` file herein contained when asked to open a Misura™3 database.

## 6.5 Opening the output file in Graphics app

1. Run `graphics.exe` application from the folder where you extracted Misura™, or run the link you created on your desktop.
2. Select **Misura3** menu, **Recent Misura3 databases** submenu, and click on **Open** button.
3. Browse to the location of your Misura™3 database, select and open it.
4. From the Database Dialog, search for a fleximeter test and its calibration test. Double click on each row in the listing in order to open both.
5. Each file will be converted and loaded into Graphics, then displayed as a tree of datasets in **Misura Navigator** right window area. Both datasets `d` (displacement) are already plotted in with two different line styles.
6. If the **Misura Navigator** area is not visible, you can show/hide it by clicking on menu *Misura* → *Opened Tests Navigator*.

Misura *Misura™ Navigator* is the tree of recorded datasets organized by groups. Each group represents a part of the instrument or of the measurement.

For example:

- `/|instr|` element represents the Fleximeter instrument itself. It has datasets, but contains one sample (**sample0**).
- `/kiln` element represents the furnace, and contains datasets regarding temperature control (T, temperature; S, setpoint; P, power; etc).

## 6.6 Interacting with the Data Plot

The *Misura™ Navigator* tree is the gate to the most important actions you can perform on the data plot.

In order to plot one more dataset (for example the temperature setpoint):

1. Right-click on the dataset you wish to plot on the Navigator tree (`/kiln/S`).
2. Select the **Plot** action from the context menu.

The same apply for removing a dataset and all its related objects from the plot. The Plot action will be checked if the curve is visible, unchecked if not visibile.

The setpoint curve plot is now referred to its own axis labelled  $S$  (°C). To better compare temperature and setpoint, it is useful to refer the setpoint plot to the temperature axis:

1. Click on the setpoint curve on the plot area window. Visualize the **Properties** area. If it is not visible, click on menu *View* → *Windows* → *Properties window*.
2. The Properties area lists all the properties of the plotted curve. Search for the bold **Y axis** entry.
3. Change **Y axis** from **ax:S** to **ax:T**. The curve will be immediately referred to the  $T$  (°C) axis.

The  $S$  (°C) axis loses its scale (it's now from 0 to 1). It's no longer useful, so you can hide it:

1. Click on the setpoint curve on the plot area window, view **Properties** area.
2. The first entry is **Hide**. Check the checkbox. The axis disappears.

You can freely move any axis by clicking on it and dragging.

### 6.6.1 Viewing flexion in micron unit

The `/flex/sample0/d` dataset represents flexion. It is recorded in microns and automatically converted to percentile on dataset loading, but is frequently useful to analyze it as an absolute value in microns. The percentile is calculated towards the distance between the flex rods, set before starting the test.

Follow these steps to convert the curve back to microns:

1. Locate the `d (/flex/sample0/d)` element in the Navigator.
2. Right-click and select the flagged action **Percentile**.
3. A dialog will appear. Click **Apply**.
4. A new temporary label in the dialog confirms the dataset was created (Done). Click **Close**.
5. If the curve is currently plotted, you immediately view the effect in the graph.
6. By right-clicking again on the dataset node the **Percentile** action is now unflagged.

It may happen that the operator forgot to measure the sample, or inserted a wrong initial dimension. If the thermal treatment modify the structure of your material, the test must be repeated. In case you are able to recover the correct initial dimension, or you are confident that you can measure it after the test run, you can change this value on the output file.

1. Locate the `d` element in the Navigator tree.
2. Right-click and select **Set Initial Dimension**.
3. Insert the correct value in **Initial dimension value**.
4. De-select *OR, automatic calculation based on first points* checkbox.
5. Click **Apply** then **Close**.

If the curve is currently plotted in percentile, you will see the axis scale changing accordingly to the new initial dimension set.

### 6.6.2 Correcting sample flexion with a calibration curve

Once both sample test and calibration test are loaded, it is possible to subtract the calibration curve to the test curve.

---

**Hint:** Although Misura™ allows to perform operation between curves with unrelated heating cycles, in order for the correction to be meaningful, you should always compare curves obtained with exactly the same heating cycle and starting from approximately the same temperature.

---

In order to do operations, you should select two datasets at the same time by keeping the Control key pressed while you click on their nodes in the Navigator tree.

1. Select the `/flex/sample0/d` node from the sample test tree you wish to correct.
2. Keeping the Ctrl (control) key pressed, select the corresponding `/flex/sample0/d` node from the calibration test tree.
3. Having both `d` nodes selected, right-click on one of the two and select **Correct**.
4. A new dialog will open, **Compute: Curve Operation**. Select a new name for the output dataset (eg: correction) in the **Output dataset name** field.
5. Click **Apply** button.

6. The Navigator will update showing the new curve as `CurveOperation(...)`. If not, right click in the blank space and select **Update view** action.

You can plot the corrected dataset as usual by right-click, and compare with the previous, not corrected curve.

---

**Hint:** The correction dataset node will appear many times in the Navigator tree. It is shown as child of each dataset upon which it depends for its calculation (both `/flex/sample0/d` datasets and both `/kiln/T`). Be careful to execute operation on the node stemming from the sample test root, otherwise it might be performed using wrong temperature or time references.

---

## 6.7 Additional Test Configurations

The most relevant configuration options used for the test run and Misura<sup>TM</sup>3 conversion can be displayed following these steps:

1. From the **Misura Navigator**, locate the root of the tree corresponding to the test you wish like to view. The root node shows the name of the test and a (N:) notation, where N is a number  $\geq 0$ .
2. Right click on the root node and select **View** from the context menu.

A Test Window will be opened showing an embedded plot and a **Test Configuration** area. The Test Window is divided in three areas:

- A menu bar in the upper part of the window
- A right area called **Test Configuration**. It is divided in 4 vertical tabs: **Measure**, **Thermal Cycle**, **Sample0** and **Results**.
- A central area displaying movable and resizable sub-windows, where you see the **Data Plot** window.

### 6.7.1 Measure overview

The first **Measure** tab contains the list of options regarding the test run.

Detect the following:

- **Name:** Name of the test run, the same the test had in Misura<sup>TM</sup>3 database.
- **Comment:** Note about the test, imported from the database.
- **id:** Path of the Misura<sup>TM</sup>3 database, followed by a vertical bar and the test id (eg: `C:essmisura.mdb|00137F`)
- **uid:** Unique id generated during conversion.
- **Test date:** Date when the test started.
- **Test duration:** Total test duration in seconds.

### 6.7.2 Thermal cycle

This tab contains a table with points defining the thermal cycle and a graph with a cartesian representation.

The graph displays two curves: the red line is the setpoint temperature; the blue line is the heating rate.

If you cannot see the axes and their labels, enlarge the application window and the Test Configuration area.

### 6.7.3 Sample data

Most relevant data in the Sample0 tab are:

- **Name:** The same as Measure name.
- **Comment:** empty label.
- **Initial dimension:** initial dimension set by the operator.
- **Initial width:** only applicable to Microscope tests.

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## Misura™ Flash documentation

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Misura™ Flash is a post-analysis tool for reading, organizing and processing data obtained from FlashLine instrument control software running on TA Instrument's flash products.

Misura™ Flash extends the functionality of Misura™4 software: it is build upon the common platform explained in the general documentation.

It currently supports the calculation of thermal diffusivity from flash thermograms, according to advanced curve fitting models as:

- *Gembarovic Two Dimensional Model*
- *In-Plane Model*
- *MultiLayer Model* (two and three layers)

After a new Misura™ installation, the Flash functionality is deactivated by default. To activate it:

1. open the *Misura™ Browser*
2. from the menubar select *Help* → *Client configuration*
3. Navigate to the *Data import*
4. Write the word `thegram` in the *Import plugins by name* option
5. Click upper-right *Save* button
6. Close and reopen the *Misura™ Browser*

### 7.1 Quickstart

This step-by-step guide will explain all actions required to:

1. import a FlashLine data folder into Misura™,
2. review and plot the results,
3. configure and run a curve-fitting model.

### 7.1.1 From FlashLine to Misura™ Flash

Misura™ Flash needs to convert and compress a FlashLine test folder into a single *HDF5* file in order to elaborate it.

1. Open the *Misura™ Browser* by double-click on **browser.exe**.
2. Locate the *Data Sources* sub-window, under the first *Databases* tab.
3. Click on the *Import* button under the *Recent files* column.
4. Navigate to the `TestInformation.xml` file, located in the root of your FlashLine test folder, and click *Open*.
5. The import process will require some minutes, depending on the speed of your computer, disk and network connection if the file is remote. The progress will be indicated by a dialog window containing a progress bar.
6. After the import finishes, the file will be opened in a new tab, named after the title of the test.
7. The default *Summary Plots* is shown.

More details on these steps, and alternative ways of importing files, can be found in the *Importing FlashLine data* section.

#### Test properties

Most FlashLine properties are mapped into Misura™ components, accessible through interface elements.

1. Locate the *Test Configuration* right-area.
2. Identify lateral vertical sub-tabs on the right and activate the *Measure* tab.
3. Observe as the *Test title* and *Test ID* corresponds to your original FlashLine test.
4. Activate the *Sample 1* tab and check that *Sample title* and *Sample ID* are correctly reported from the FlashLine test.

For more details and a mapping between FlashLine and Misura™ fields, please read *Navigating configurations*.

#### FlashLine results

1. Activate the *Measure* vertical sub-tab on the right of *Test Configuration*.
2. The last entry is *Summary*. This is the grand-summary of all diffusivities contained in the test. It is thus quite complex to navigate.
3. Right-click on *Summary* and select the *Detach* action.
4. The same table will open in a new, enlargeable table. Column headers contain the sample name and the diffusivity type.
5. Right-click on the header and select *Rotate* for a more comfortable view.
6. Read *Tables* for more controls.

Numerous partial tables are contained in *Sample <N>* tabs.

1. Activate *Sample 1* tab. Deactivate the *Configuration* section checkbox. The *Results* section will remain active.
2. Locate the *Half Time* table by scrolling through the panel.
3. Right-click on the second cell (*Half Time (s)*) of the first row.
4. From the context-menu, select *Equilibrium at <X> (T<X>)* (where <X> is the temperature of the segment).

5. Select menu action *List aggregated options*.
6. Review diffusivity from each single shot at the selected temperature. Each shot contributes to the mean value displayed in the column cell from which the context menu popped out.

The component's tree can be reached anytime also by right-click on vertical tabs labels' of the *Test Configuration* area.

1. Right-click on *Sample 1* tab label.
2. Select *Configure*.
3. A new window will open, displaying the configuration tree spawning from *Sample 1* component.
4. Expand any *T<X>* node on the left tree (where *<X>* stands for the temperature of the segment).
5. Double-click on a *N<Y>* leaf node (where *<Y>* is the shot number).
6. Individual shot information will appear in the right area.

Important shot information, contained in the *Configuration* section, are:

Object	Description
▼ server	sample2
▼ T100	
N1	
N3	
N2	
▶ T150	
▶ T200	
▶ T250	
▶ T300	
▶ T350	

/flash/sample2/T100/N1/ ✕

Main
Baseline

☒ **Configuration**

Name  +

Setpoint  °C

Temperature  °C -

Stable Temperature ☒ True

Start time of the shot  s

Shot duration  s

Frequency  Hz

☒ **Results**

Half Time	<input type="text" value="0,01660"/>	s
Clark&Taylor	<input type="text" value="0,47596"/>	cm <sup>2</sup> s <sup>-1</sup>
Degiovanni	<input type="text" value="0,48589"/>	cm <sup>2</sup> s <sup>-1</sup>
Parker	<input type="text" value="0,50334"/>	cm <sup>2</sup> s <sup>-1</sup>
Koski	<input type="text" value="0,50066"/>	cm <sup>2</sup> s <sup>-1</sup>
Heckman	<input type="text" value="0,51320"/>	cm <sup>2</sup> s <sup>-1</sup>
Cowan (5)	<input type="text" value="0,47034"/>	cm <sup>2</sup> s <sup>-1</sup>
Cowan (10)	<input type="text" value="0,49580"/>	cm <sup>2</sup> s <sup>-1</sup>
Clark&Taylor (1)	<input type="text" value="0,47039"/>	cm <sup>2</sup> s <sup>-1</sup>
Clark&Taylor (2)	<input type="text" value="0,45621"/>	cm <sup>2</sup> s <sup>-1</sup>
Clark&Taylor (3)	<input type="text" value="0,47613"/>	cm <sup>2</sup> s <sup>-1</sup>

- *Setpoint*, the target temperature of the segment
- *Temperature*, the actual temperature recorded at the beginning of the shot.
  - *Stable temperature* sub-option can be activated by clicking on the + button. Tells if temperature value was stable enough.

- *Shot duration and Frequency*

The *Results* section contains all diffusivity results.

Shots contain also a *Baseline* tab containing baseline information.

- *Pulse start time* calculated at the onset of laser pulse
- *Pulse center of gravity* calculated in the center of gravity of laser pulse (*Use Center of Gravity to detect initial time*)
- *Slope* and *Intercept* determine detected baseline linear regression
- *Fitted exponential pulse* checkbox indicate if the laser pulse could be successfully fitted with an exponential function

## Plotting

The navigator is the most explicit way of performing plotting operations.

1. Activate the *Misura™ Navigator* vertical tab in *Test Configuration* area.
2. It is divided into *Data*, *Properties*, *Formatting* and optionally more horizontal tabs. Ensure the *Data* tab is active.
3. Right-click on *sample1* node of the tree. Tree nodes can also be addressed by their full path: `/flash/sample1`.
4. Select *Sample Plot* context-menu action.
5. A *Sample Plot* is created and displayed.



Default plots can be generated also by directly interacting with currently plotted curves.

1. Right-click on a point-cloud representing the individual shot values for a temperature.
2. Select the *Node* submenu. Notice as this shows exactly the same actions as if you clicked on the corresponding *T<X>* node on the navigator.
3. Select the *Segment plot* action, which will generate a thermogram overlap plot for the selected temperature segment (*Segment Plot*).

4. Now right-click on any thermogram, select again *Node* → *Shot plot*.
5. This will display the shot plot alone.

## Zooming


Most common task on a shot plot is zooming in and out. There are several ways.

1. Click on the  toolbar button.
2. If you now hover on the plot, mouse icon will be a sort of cross.
3. Click on any point of the plot, then keep the left mouse button clicked and draw the rectangle you would like to zoom into.
4. When you release the mouse, axes ranges will adjust in order to visualize only the selected rectangle.
5. Click on the left-most white arrow to exit from the zooming tool.
6. Click on  toolbar button to reset all axes ranges to automatic.

Another method is by selecting an axis, then use the internal black square handles to move the ax range wherever you like. Instead, if you need to precisely set axes ranges:

1. Select the axis.
2. Activate *Navigator* vertical tab in *Test Configuration*, then *Properties* horizontal tab.
3. Set *Min* and *Max* according to your needs.

## Browsing plots

Generated plots can be considered as *pages* of a larger document. Each time a plot is generated, a new page is added to the document. To browse document's pages, you can click on  arrows on the toolbar.

After many plots are created, it might become cumbersome to navigate through them.

The *Plots board* area keeps an organized view of all plots generated in the current document.

1. Generate all sample plots, by double-click on all sample nodes in the navigator tree.
2. The board still shows only a screenshot of the initial overview plot, because it is showing the root level of the hierarchy.
3. Click on the down arrow in the right area of the board. The board fills with all the sample plots generated before.
4. Click on a sample plot screenshot. The corresponding plot will be loaded in the main plot area.
5. Now generate some shot plots by double clicking on shot nodes in the navigator.
6. Navigate one level down with the plots board's down arrow.
7. All generated shot plots are listed.
8. Now click the up arrow to navigate in the upper level of the hierarchy.
9. Click the home button to go straight to the root level.

Learn more in the [Plots Board](#) section.

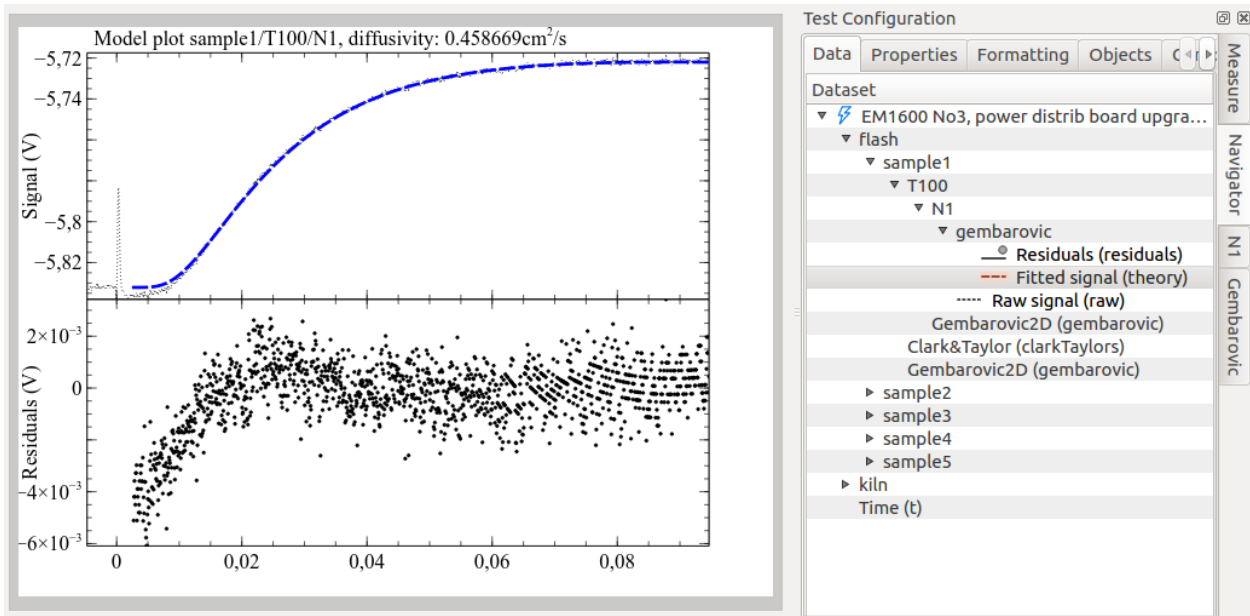
## 7.1.2 Calling a curve-fitting model

1. Right-click on a shot node on the navigator.
2. Select the curve-fitting model you would like to run (eg: *Gembarovic 2D*). The model runner dialog will pop up in a new window.
3. Configure the *Flash Geometry* and *Start Values*.
4. Click *Ok*.
5. Models can take minutes to run. A progress bar dialog will keep you informed about the approximative progress.
6. When the execution ends, a **new node** will appear in the navigator, as a leaf of the shot node starting the calculation.
7. The node is named after the model, eg: *gembarovic*.

Learn more in [Flash Models](#).

### Model plot

1. Locate the output node generated by the model run and right-click on it.
2. Select *Model plot* action.
3. The model plot will appear in a new document page.



Learn more in [Model Plot](#).

### Viewing the results

Model run results are always repeated in two components (or navigator nodes): the model's output and the shot. These are visible as *Test Configuration* vertical tabs when the [Model Plot](#) is visible.

Both node and shot configuration panels display an additional horizontal tab titled after the model (eg: *Gembarovic2D*), after the *Main* tab.

The *Main* tab of the shot panel shows an additional field named after the model's diffusivity output.

New model's diffusivity tables are added to the parent segment and to the sample, collecting the only one diffusivity point we calculated.

Learn more in [Analyzing results](#).

## 7.2 Importing FlashLine data

Flash functionalities have been implemented in the *Misura™ Browser*.

FlashLine saves each data item in a separate file. This large number of files is then organized in a hierarchy of directories. FlashLine data structure cannot be directly opened by Misura™ Flash: a conversion procedure will be needed in order to compress every data file into a single test file.

Data import functionalities are available from the *Data Sources* base tab in the Browser.

The import procedure will start when the **TestInformation.xml** file either dragged and dropped onto the gray area in the *Databases* tab, or selected from the filesystem after clicking the `Import...` button. Other files which will trigger the import procedure are the shot files with **.fw0** or **.fw1** extensions (like `00101001.fw0`).

Opening any other file will abort the procedure.

When the import starts, a progress bar will appear in a popup-up window. A `Log` button allows to follow the conversion of each file and each shot.

Upon successful completion, the resulting file is directly opened in a new browser tab.

### 7.2.1 Double import

**In the case the user attempts to import a file which was already converted in the past**, and still existing on the file system, a dialog will prompt the user to choose what to do.

- `Open`, will just open the already converted file, without converting it again
- `Rename`, will import the file again, and save it with a different name
- `Overwrite`, will delete the old file and import all the data again
- `Cancel`, abort any action and just exit the dialog (same effect as clicking X button)

Most of the times it is advisable to just `Open` the old file and save the long import procedure.

### 7.2.2 Locating the converted file

The converted file will be added to the default database index, so that the user will be able to query all previously converted tests. Available database indexes are visible in the second column of the *Data Sources* subwindow. If the user has not configured additional indexes, only the default one is visible.

During the conversion, data is copied from the original location into a compressed and optimized *HDF5* file. By default, the file is in the user folder on the local computer, under a `flash` subfolder in the default database directory.

The location of the default database is `MisuraData` under the **user** home folder. On most modern windows systems, it will be something like `C:\Users\<username>\MisuraData`.

The default database name and location is visible under `Default Database preference`.

## 7.3 Wizard Tutorial

This step-by-step guide will explain how to:

1. Open and use the wizard built into Misura™ Flash,
2. Navigate through the wizard's different functionalities,
3. Run model analysis on shots, segments, and samples.

### 7.3.1 From FlashLine to Misura™ Flash

Misura™ Flash needs to convert and compress a FlashLine test folder into a single *HDF5* file in order to elaborate it.

1. Open the *Misura™ Browser* by double-click on **browser.exe**.
2. Locate the *Data Sources* sub-window, under the first *Databases* tab.
3. Click on the *Import* button under the *Recent files:* column.
4. Navigate to the `TestInformation.xml` file, located in the root of your FlashLine test folder, and click *Open*.
5. The import process will require some minutes, depending on the speed of your computer, disk and network connection if the file is remote. The progress will be indicated by a dialog window containing a progress bar.
6. After the import finishes, a pop-up dialog will ask to *Start the Wizard* or open the *Default Plot*. Select *Start the Wizard* for now.

#### Wizard: General Options

The Misura™ wizard will open to the General Options page, where different parameters for file can be set, such as:

1. Click the drop-down menu next to *Preferred Curve-Fitting Model* and select the desired model for analysis of the test. Note: This is the only selection that is mandatory to set to move to the next step in the wizard.
2. To set a *Diffusivity Reference* for the whole test, select the an option from the second drop down menu. This is step is optional. Note: Set individual reference values for each sample by clicking on the check box to expand the sample options, and then select a *Diffusivity Reference*.
3. To set a *System Geometry* for the whole test, select an option from the third drop-down menu. This step is optional. Note: In some cases, **lfi** will automatically determine the system geometry and import it into Misura™. If that is the case, this option may be selected already, you can override value. Also, like *Diffusivity Reference*, you can set a differnt *System Geometry* for each sample.

At the bottom of the Wizard view are the controls for navigating through the Wizard. At this point, click *Select Shot* to move to the next section.

#### Wizard: Shot Selection

The orange arrows highlight the flow in selecting a shot to model:

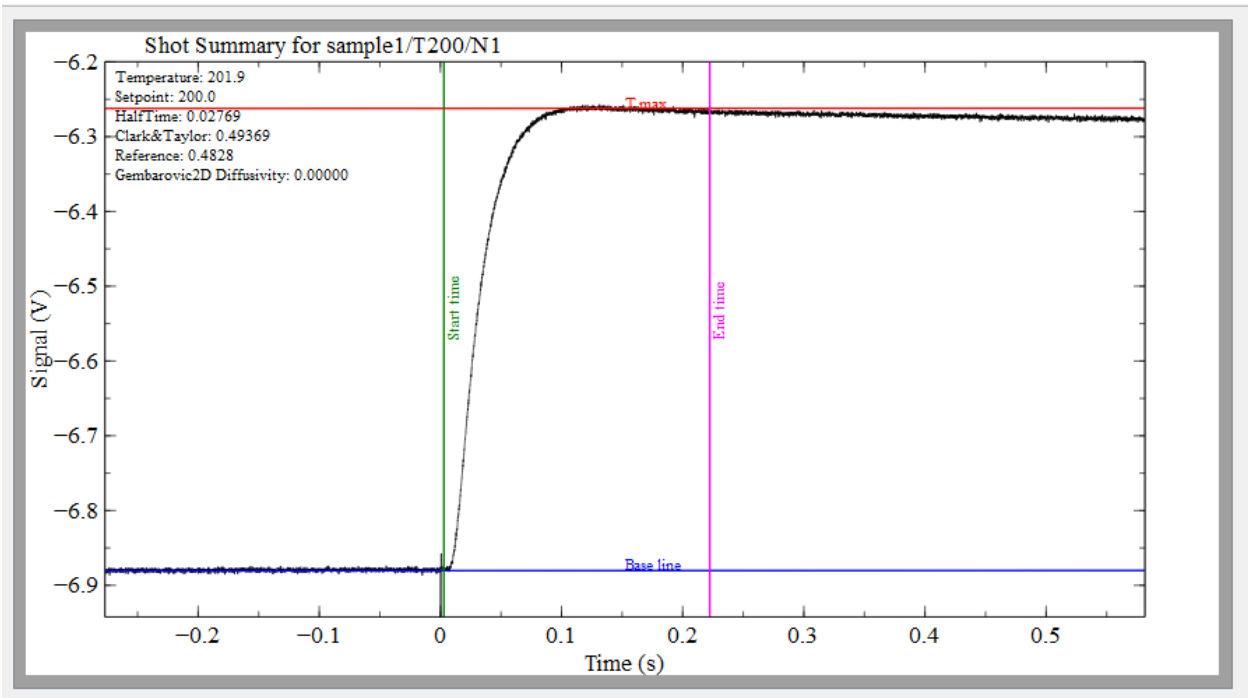
1. Select a sample from the rightmost box.
2. Once the segment values appear in the middle box, select a temperature value.
3. Select a shot from the final box.
4. A preview of the shot will be shown in the middle window.

Click *Modeling* to move to the next section.

## Wizard: Modeling

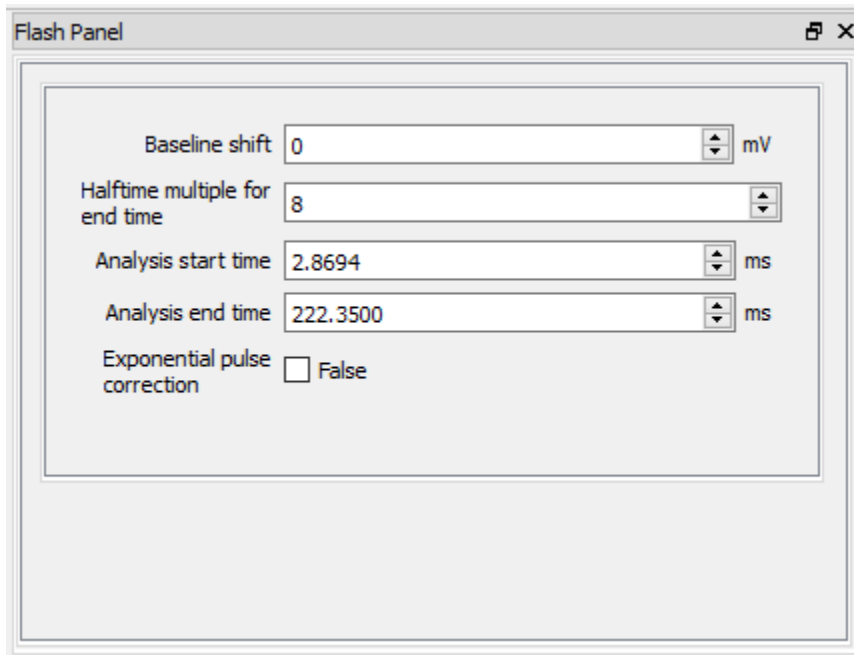
This section of the Wizard is for prototyping parameter values for the analysis of a shot. Below is a description of the three main components of this page of the Wizard:

1. The shot on display:

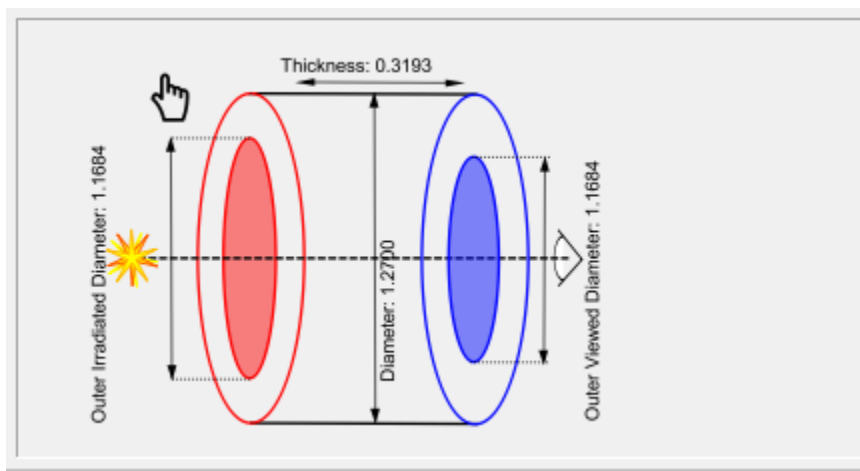


This is a normal shot plot with 4 colored lines on it, each representing different model parameters: - **Start Time** represents the *Analysis start time* parameter. - **End Time** represents the *Analysis end time* parameter. - **Tmax** represents the *Tmax* parameter. - **Base line** represents the *Baseline level* parameter. You can click and drag each line to test different values.

2. The parameter window:



- This parameter window will initially show parameters that a user may commonly alter and test.
  - The values in this window change a line in the shot plot gets clicked and dragged.
  - If a value is changed in this window, the corresponding line in the shot plot will move to match the parameter value.
  - To access all of the model parameters that a user can alter, click on the plot.
3. The geometry diagram:



- This diagram is a representation of the sample and geometry.
- The labeled numbers match the values set in the sample geometry section of the parameter window.
- To view the **Sample Geometry** and **Flash Geometry** parameters in the parameter window, click on the diagram.

Before running a model, test out some of this functionality: #. In the parameter window, click the up-arrow on the value of *Halftime multiple for endtime* a couple times. #. Notice the line for **End time** move a short distance to the right. #. Now, select the **End time** line by clicking on it. #. Click and drag the line back left, roughly to where it began. #. The value for *Halftime multiple for endtime* will decrease to match the **End time** line. #. The same behavior

will be observed for each line on the shot plot. #. Now click the geometry diagram. #. Notice that the parameter window now has the parameters for **Sample Geometry** and *Flash Geometry\**. #. Also, notice how the values for each parameter match up with the labeled values in the diagram. #. Now click on an area of open space in the graph. #. Notice that the parameter window now contains all changeable parameters relevant to the model.

Once happy with the values for the model, click *Run: Shot >* to run the analysis.

### Wizard: Shot Analysis

Once the model has finished running, it is time to analyze the results:

1. The model plot is displayed in the wizard. The top half of the plot is the curve fit, and the bottom half is for the residuals.
2. In the top left of the plot is the calculated diffusivity value for the model. Note: if a reference was set, then it will appear underneath the calculated diffusivity along with the percent difference between the two.
3. At the top of the parameter window, there is a tab for results, if the user would like to see more information from the analysis.
4. If the results are unfavorable, you can alter parameter values the same way as in the above section for **Wizard: Modeling**. Click *Run: Shot >* to run the model again.
5. If happy with the results, you can run a recursion.
6. To run a segment recursion, click *Segment >*.
7. The pop-up provides a list of all the parameter values set for the model incase you want to review them. Also, you can opt to skip running shots that were already analyzed.
8. Click *Ok* in the pop-up to run the segment.

Once the segment completes, the wizard will display the segment summary plot.

### Wizard: Segment Analysis

1. The segment plot is on display.
2. In the top left corner of the plot is the table summary of the results.
3. There is a red vertical line on the plot which can be dragged to any X coordinate to align the shots at that coordinate.
4. Next, you can run a sample recursion by clicking *Sample >*, but before you do, check out the hints below.

Hint 1: To view a specific shot, right click on the button *< Select shot* and then left click on one of the drop down options. Hint 2: To run the segment again, you may alter parameters to how you want, then click *Segment >*.

### Wizard: Sample Analysis

Once the sample recursion completes, the wizard will display the summary sample plot.

1. View the sample plot.
2. At the bottom left corner of the plot is the table summary of the results.
3. Next, you can run a recursion on the whole test by clicking *Test >*, but before you do, check out the hints below.

Hint 1: To view a specific shot plot or segment plot, right click on the button *< Select shot* or *< Segment* and then left click on one of the drop down options. Hint 2: To run the sample again, you may alter parameters to how you want, then click *Segment >*.

Warning: Test recursion may take a while.

### Wizard: Test Analysis

Once the test recursion completes, a sample test plot will be displayed.

Click the *Save* button to save your analysis progress to another version of the test file.

Click the *Close Wizard* button to exit the wizard view and operate misura from the default view.

## 7.4 Data Interface

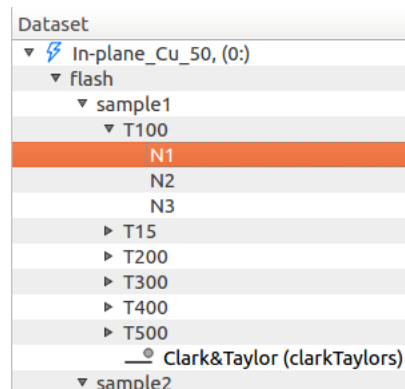
This chapter offers additional information tailored at Misura™ Flash users, which might not be sufficiently covered in the general Misura™ documentation.

Flash data is organized in a highly hierarchical interface, designed to allow to both have a quick overview and dig deeper into every detail.

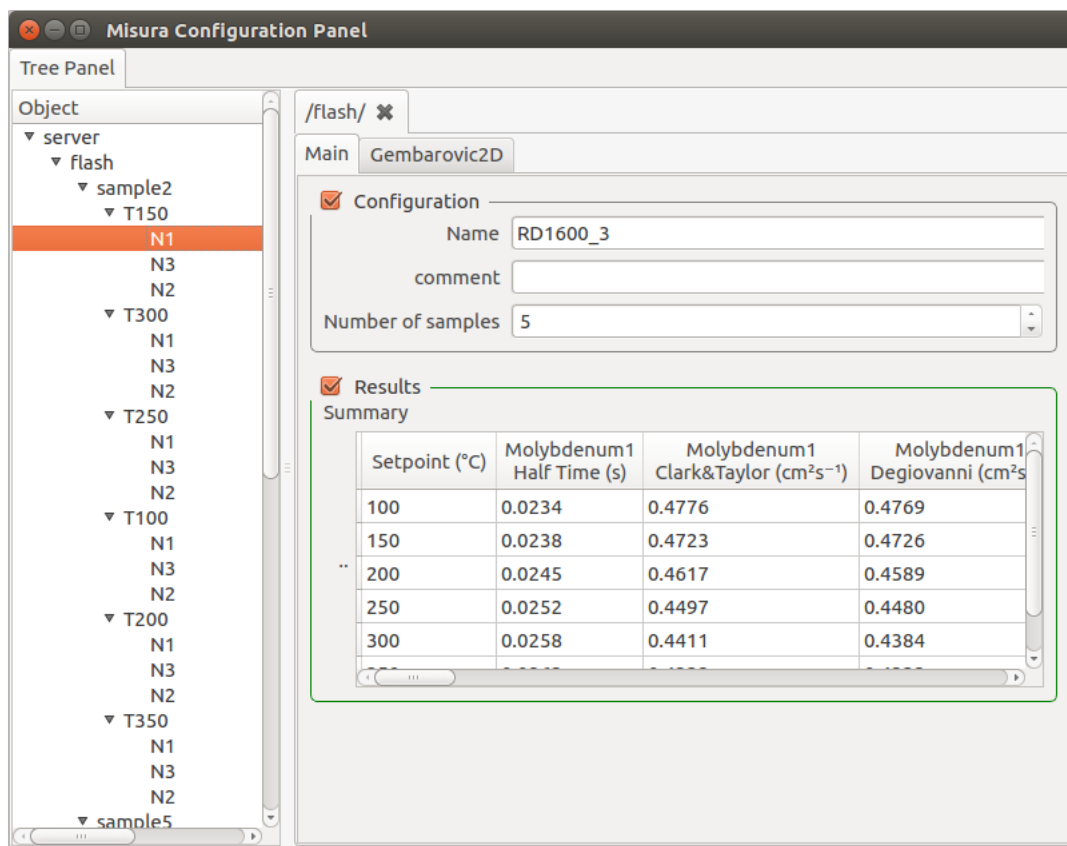
- For each Sample (S), we have multiple segments or equilibrium temperatures (T):
- For each Equilibrium Temperature (T) we have multiple shots
- For each shot (N), we have:
  - raw thermogram,
  - laser pulse
  - corrected thermogram
  - one or more curve-fitting results
- Each shot can be fitted against one or more models (M), with different model parameters each time
- For each set of model parameters we have:
  - Fitting Results
  - Fitting Errors

So the hierarchy is: S / T / N / M, or sample, temperature, shot, model.

This structure is represented in the *Misura™ Navigator* tree:



And in the global component's panel, from *Settings* → *Global*:



Each entry in those trees represents a component of the above hierarchy, and each component has several options representing either results or configurations.

### 7.4.1 Navigating configurations

Misura™ Flash tries to read most of the test information contained in the original test FlashLine structure, except few debug outputs.

The FlashLine configuration dialog is reported here to better understand field mapping:

Test Information

Test Title:  Use Information From Previous Test

Test ID:  Sequence Number:

Operator:  Date:

Common Specimen ID:  Common Specimen Title:  Common Thickness (cm):  Use Expansion:

Position	Specimen ID	Specimen Title	Thickness (c...	Diameter (c...	Weight ...
1	Sample11	Sample Title 1	0.3170	1.270	0.0000
2	Sample12	Sample Title 2	0.3170	1.270	0.0000
3	Sample13	Sample Title 3	0.3170	1.270	0.0000
4	Sample14	Sample Title 4	0.3170	1.270	0.0000

Test Segment	Temperature (°C)	Ramp (°C/Min.)	Repeat Points	Power Level	Point 1 Level	Point 2 Level	Point 3 Level	Point 4 Level
1	25	20.0	3	1000	1000	1000	1000	1000
2	200	20.0	3	1000	1000	1000	1000	1000
3	400	20.0	3	1000	1000	1000	1000	1000
4	600	20.0	3	1000	1000	1000	1000	1000
5	800	20.0	3	1000	1000	1000	1000	1000
6	1000	20.0	3	1000	1000	1000	1000	1000
7	1300	20.0	3	1000	1000	1000	1000	1000

Uniform:


Clear Program  Add Segment  Delete Segment  Insert Segment  List Programs  Save Program  Safety Temperature (C)

☐ Specific Heat/Conductivity ☐ In Plane ☐ Show Acquisition Params

This information is organized across Misura™ user interface elements. This paragraph helps locating most important metadata.

Most information is shown in the *Test Configuration* area.

Test Configuration

Test title  

nSamples

Test ID

uid

Test date

Acquisition starting time

Test duration  s

Operator

Preferred FlashLine Model

Preferred Curve-Fitting Model

Summary

Setpoint (°C)	Molybdenum1 Half Time (s)	Molybdenum1 Clark&Taylor (cm <sup>2</sup> s <sup>-1</sup> )	Molybdenum1 Degree
100	0.0234	0.4776	0.476
150	0.0238	0.4723	0.472
200	0.0245	0.4617	0.458
250	0.0252	0.4497	0.448
300	0.0258	0.4411	0.438

Measure Navigator Sample 1 Sample 2 Sample 3 Sample 4 Samples

This area is divided into several tabs:

1. *Measure* tab contains global test information - eg, not specific to a single file.
2. *Navigator* tab contains *Misura™ Navigator* controls.
3. *Sample<N>* tabs, one for each <N> samples, contain data which is specific and potentially different for each single sample.

### Measure tab

Relevant *Measure* entries are explained below:

Table 1: Measure tab mapping to FlashLine

Misura™	FlashLine	Notes
<i>Test title</i>	Same	
<i>Test ID</i>	Same	
<i>uid</i>	None	Automatically generated by Misura™ to uniquely identify the test
<i>Test date</i>	<i>Date</i>	
<i>Test duration</i>	None	Total time elapsed from the start
<i>Operator</i>	Same	
<i>Preferred FlashLine Model</i>	None	The preferred diffusivity value to be displayed in plots.
<i>Preferred curve-fitting model</i>	None	The default curve-fitting model
<i>Summary table</i>	None	A table listing all diffusivities, for all temperatures and all samples

## Sample tabs

The sample tab is divided into two subsections:

1. *Configuration* contains sample properties as entered by the user.
2. *Results*. contains diffusivity results.

FlashLine displays sample properties in a table under the general test information. FlashLine table columns are mapped here:

Table 2: Sample tab mapping to FlashLine

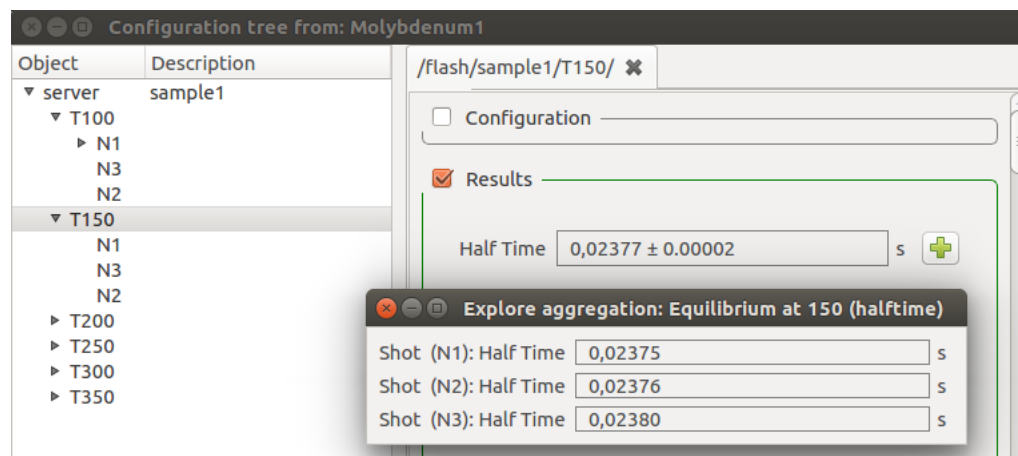
Misura™	FlashLine column	Notes
<i>Sample title</i>	Third, namesake column	
<i>Position</i>	First, namesake column	Carousel position
<i>Thickness</i>	Fourth, namesake column	
<i>Diameter</i>	Fifth, namesake column	
<i>Weight</i>	Last, namesake column	
<i>Test type</i>	<i>Specific Heat/Conductivity</i> global checkbox (bottom dialog).	Not all test types can be directly mapped to a FlashLine interface element. Some of them are global (eg: equal for all samples).
<i>Sample ID</i>	Second, namesake column	
<i>Expansion type</i>	<i>Use Expansion</i> dialog	Type of expansion fitting function
<i>Expansion reference</i>	<i>Use Expansion</i> dialog	Expansion reference data
<i>Diffusivity Reference</i>	None	See <a href="#">Loading reference data</a>
<i>Specific Heat Reference</i>	None	
<i>Density Reference</i>	None	

## 7.4.2 Navigating results

Configuration panels, tabs, sections, groups and options are introduced in the general Misura™ documentation about *Components and options*.

A prominent role is played by **aggregates**. Diffusivities and associated errors are calculated for each shot and for each model run, in the (N) and (M) nodes above. Parent nodes are informed of these results with a mechanism called *option aggregation*, explained in *Aggregates*.

In this way, each segment node (T100) can calculate and display the mean value across diffusivities of its shots (N1, N2, N3...):



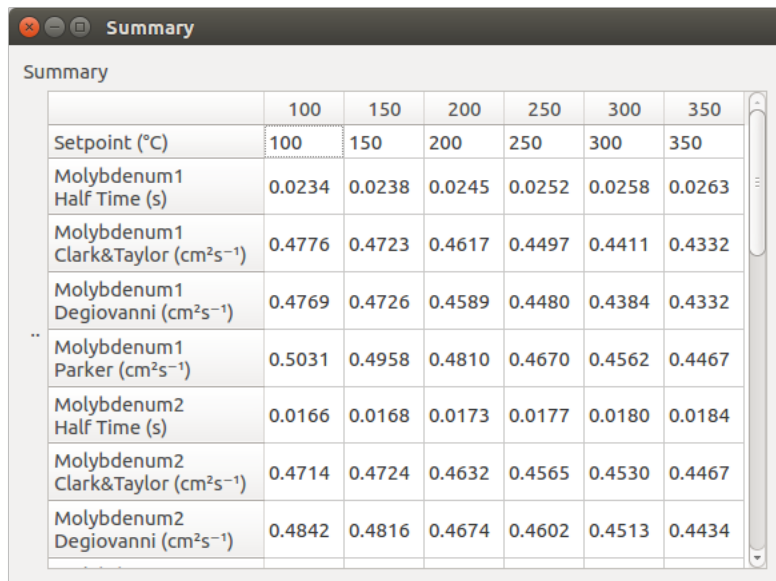
And a tabular representation, by shot temperature:

Half Time	
Temperature (°C)	Half Time (s)
145.8	0.0237
146.2	0.0238
146.4	0.0238

A sample (S1) can build a table with temperature-diffusivity mean from all its temperature segments (T50, T100, T150...):

Half Time		
Temperature (°C)	Half Time (s)	Half Time Error (s)
99	0.0234	0
146.1	0.0238	0
197.3	0.0245	0
246.3	0.0252	0
295.5	0.0258	0
345	0.0263	0

And the whole test can display a global summary table containing all values, from all samples (S1, S2, S3...).



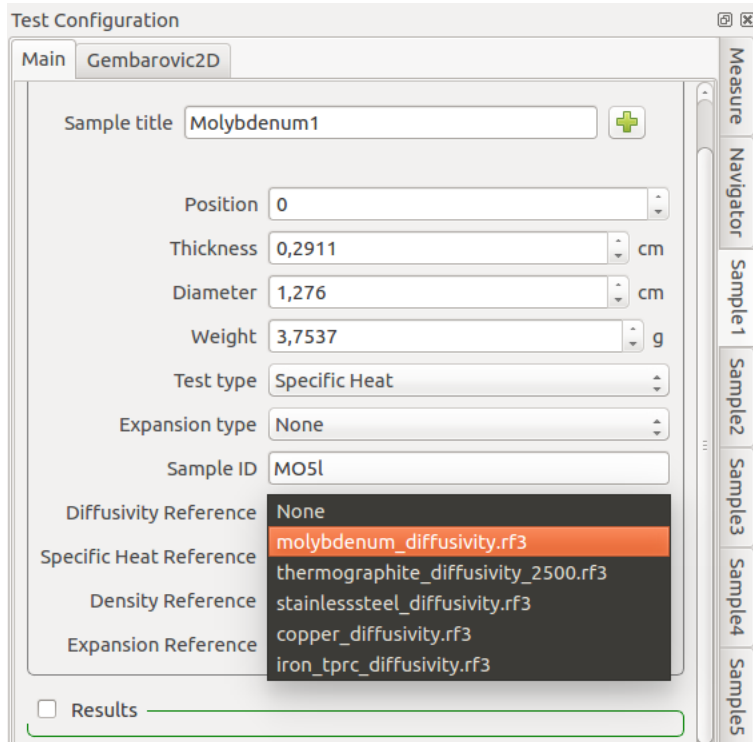
Summary

	100	150	200	250	300	350
Setpoint (°C)	100	150	200	250	300	350
Molybdenum1 Half Time (s)	0.0234	0.0238	0.0245	0.0252	0.0258	0.0263
Molybdenum1 Clark&Taylor (cm²s⁻¹)	0.4776	0.4723	0.4617	0.4497	0.4411	0.4332
Molybdenum1 Degiovanni (cm²s⁻¹)	0.4769	0.4726	0.4589	0.4480	0.4384	0.4332
Molybdenum1 Parker (cm²s⁻¹)	0.5031	0.4958	0.4810	0.4670	0.4562	0.4467
Molybdenum2 Half Time (s)	0.0166	0.0168	0.0173	0.0177	0.0180	0.0184
Molybdenum2 Clark&Taylor (cm²s⁻¹)	0.4714	0.4724	0.4632	0.4565	0.4530	0.4467
Molybdenum2 Degiovanni (cm²s⁻¹)	0.4842	0.4816	0.4674	0.4602	0.4513	0.4434

## Loading reference data

Standard reference materials can be defined for each sample, in the **Sample N** right panel.

If all samples have the same reference, it can be defined just on time.



Test Configuration

Main Gembarovic2D

Sample title: Molybdenum1

Position: 0

Thickness: 0,2911 cm

Diameter: 1,276 cm

Weight: 3,7537 g

Test type: Specific Heat

Expansion type: None

Sample ID: MOSI

Diffusivity Reference: **molybdenum\_diffusivity.rf3**

Specific Heat Reference: thermographite\_diffusivity\_2500.rf3

Density Reference: stainlesssteel\_diffusivity.rf3

Expansion Reference: copper\_diffusivity.rf3, iron\_tprc\_diffusivity.rf3

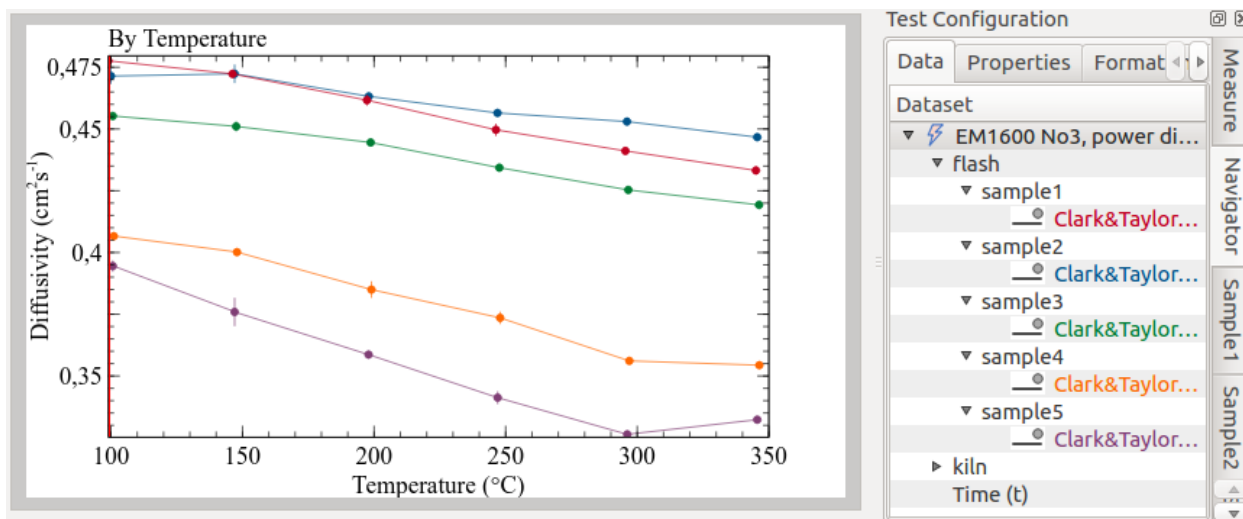
☐ Results

After a selection is made, new output tables and values will be generated in each sample, segment and shot, containing reference data.

New reference datasets will also appear in the *Misura™ Navigator* under the sample and segment nodes, so they can be plotted by double-clicking or right-click then **Plot**.

### 7.4.3 Summary Plots

When a test is opened, a *summary* plot will display Clark&Taylor diffusivities with temperature, for all samples. The diffusivity method can be changed by setting *Preferred FlashLine Model* to any supported technique.



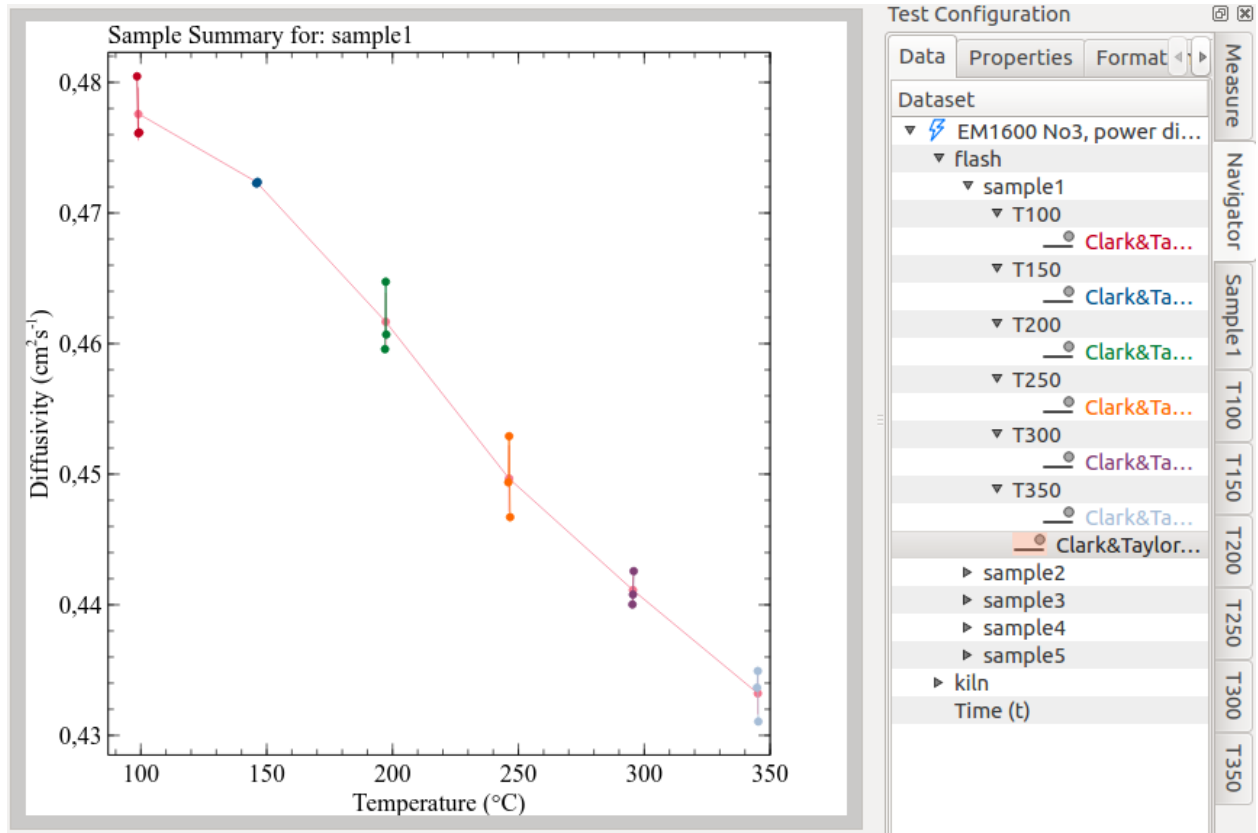
Other summary plots can be created from the navigator, by double-clicking on supported nodes, or right-click and selecting the associated plot action.

The following animation illustrate the process of creating the default plots as hereafter explained:

#### Sample Plot

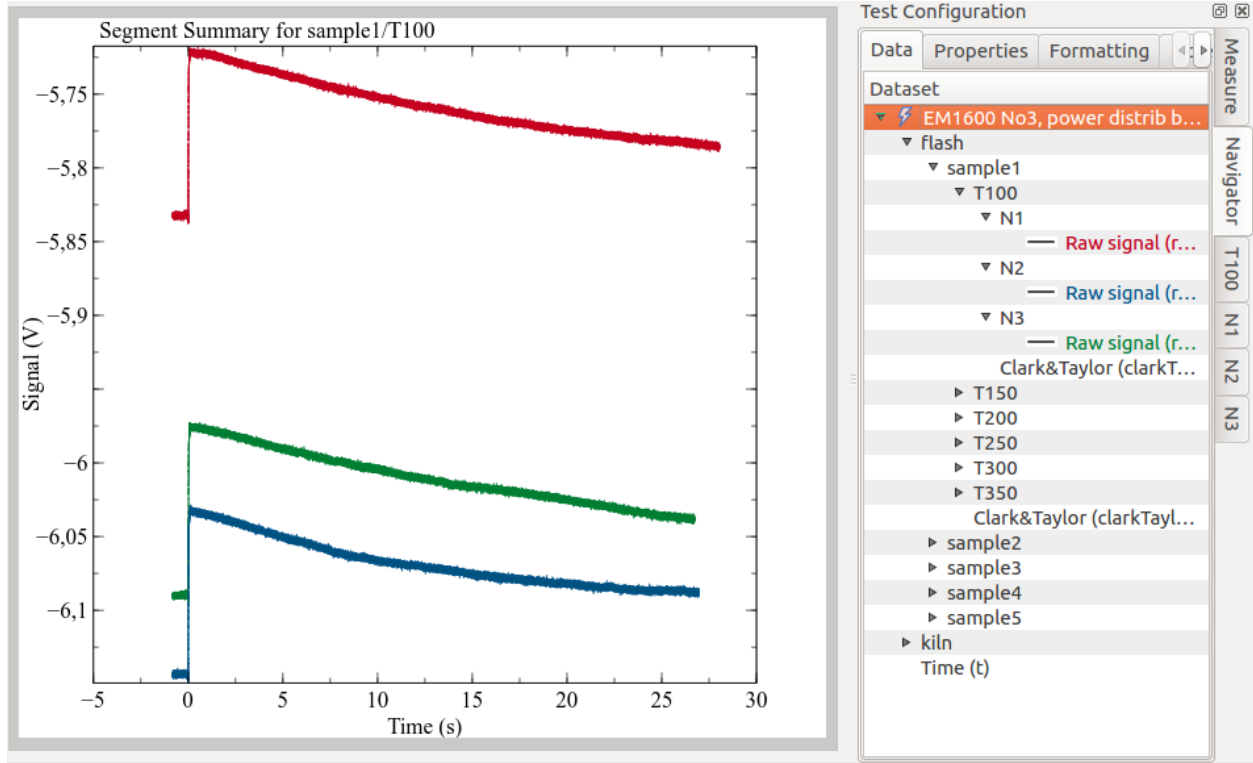
By selecting **Sample Plot** or double-clicking on a sample node, a new plot will be created with diffusivities by temperatures of the selected sample.

It will additionally display point clouds around each mean diffusivity value, representing the diffusivity obtained from each shot.



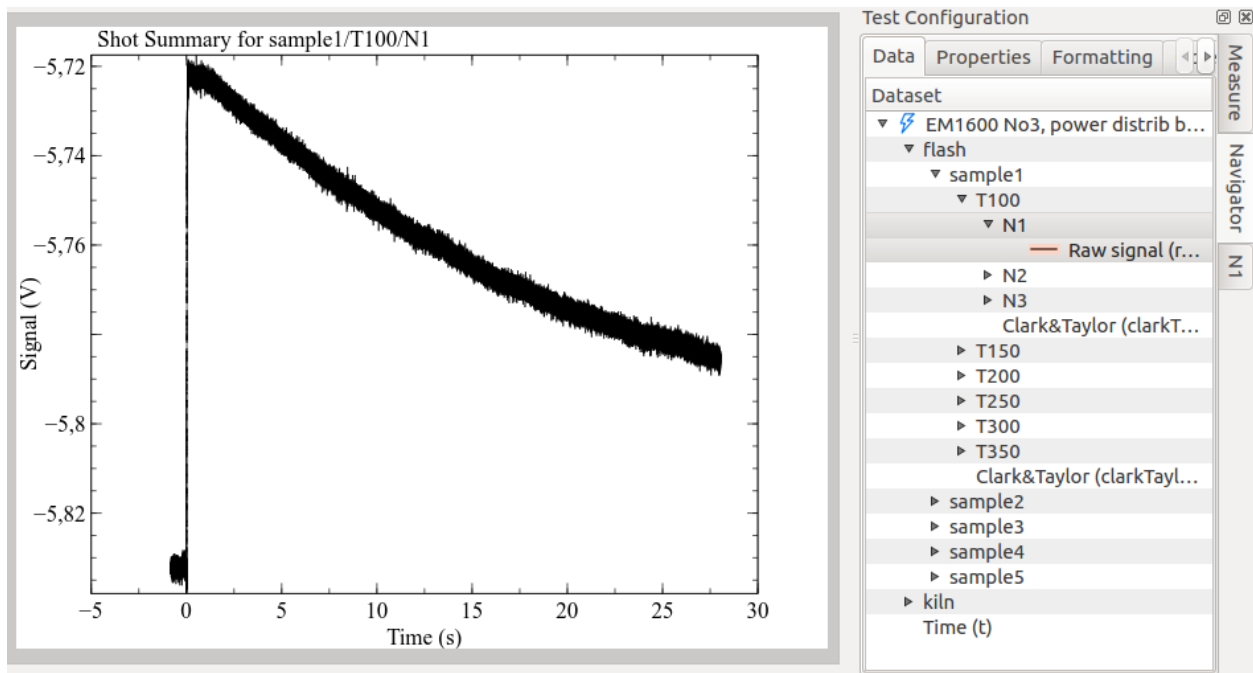
## Segment Plot

A **Segment Plot** will overlap thermograms from all shots contained in a segment.



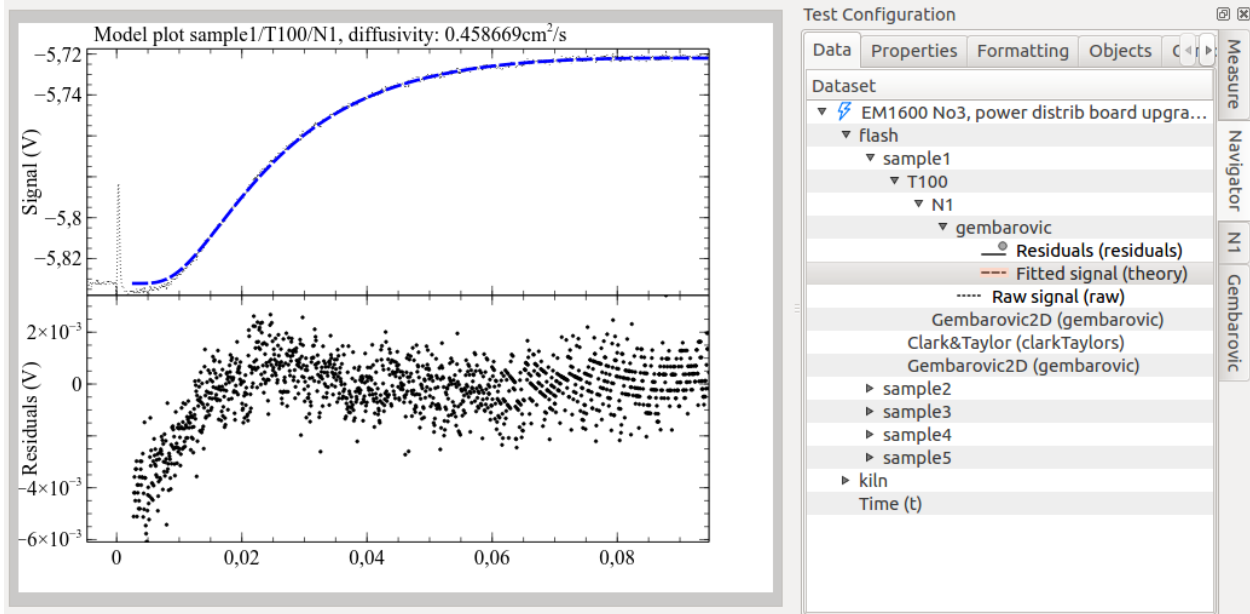
## Shot Plot

The **Shot Plot** simply displays the thermogram.



## Model Plot

Any curve-fitting model can create a **Model Plot**. The page is splitted in two sub-plots: the upper part shows the thermogram and model output; the lower part shows the residuals.



In case of model re-run, this model will only partially update. It is preferable to re-create it from zero, from the *Model Plot* action in the navigator.

### 7.4.4 Dynamic Test Configuration tabs

As the current plot changes to display data from different samples, segments and shots, the vertical tabs in the *Test Configuration* load relevant component's information.

The default *Summary Plots*, for example, displays diffusivity curves for all samples. The *Test Configuration* accordingly lists one configuration tab for each sample.

A *Sample Plot*, plotting data from one sample and multiple segments, will show both relevant sample's tab, and one tab for each segment.

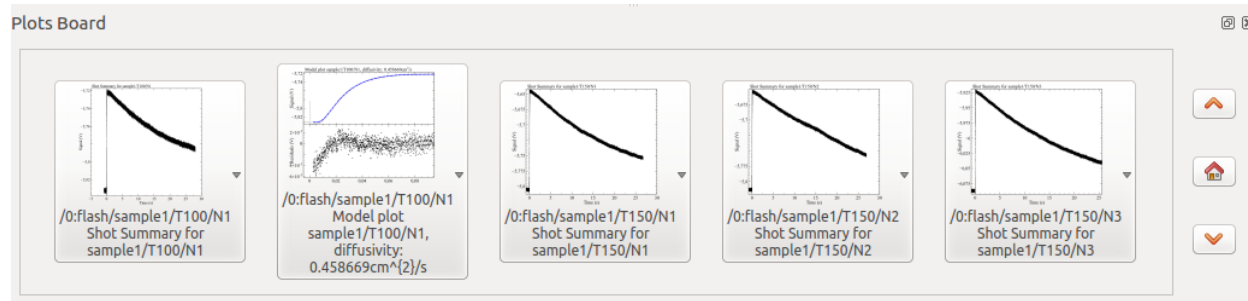
With the same logic, *Segment Plot* offers the loaded segment tab plus one tab for each shot, and the *Model Plot* both the shot tab and the model output tab where model configuration and results are saved (for example, *gembarovic*).

### 7.4.5 Plots Board

Plots are organized as pages of a document. Pages can be browsed with the blue left/right arrows on the upper plot bar.

When many plots are created, navigation can become quite confusing. The *Plots Board* and the breadcrumbs navigator allow to view and manage plot pages in a hierarchical way.

The plots board displays pages screenshots side-by-side, as a plain list. But not all pages are displayed at once: only those sharing the same hierarchical level.



All sample plots will be listed together, as well as segment plots or shot plots, but they will never mix. The example shows numerous shot plots, and a model plot (classified at the same hierarchical level as shots).

By left-clicking on a plot screenshot, it will appear in the main plot window.

If the left mouse button is kept pressed, or with a right-click, a context menu will appear, allowing to:

- Explicitly **Show** (the same as single click)
- **List all children**: will show only plots containing curves which are dependent from those contained in this plot. For example, if only children of a sample are selected, only plots from that sample's shots will be listed.
- **Delete** the plot page
- **Export** the page to pdf

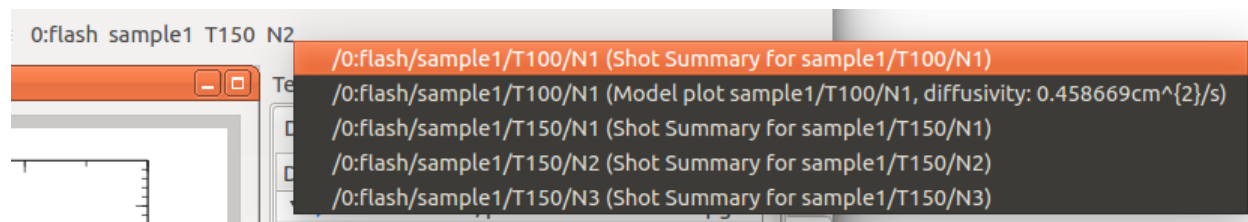
The board also shows three buttons:

- **up** and **down** arrow, to navigate in the hierarchy levels
- *home*, to reset all selections and display the level corresponding to the current plot page

The following animation illustrates the plots board in action. Notice also as the *Breadcrumbs* updates accordingly.

## 7.4.6 Breadcrumbs

It appears as a simple sequence of labels, representing the current hierarchical level. Each label can be clicked and gives access to any other plot page in that hierarchical level.



The principle of the breadcrumbs is similar to the plots board, except that it does not include screenshots and can only switch to the selected page, with no additional actions like delete etc.

## 7.5 Flash Models

### 7.5.1 Fitting models from the Navigator

Flash post-processing actions are currently accessible from the *Misura™ Navigator*. The Navigator represents all the data contained in one or more test runs as a hierarchy of *nodes*. Usually the tree has only one root node, corresponding to the opened test.

Right clicking on a node gives access to specific actions, including those related to Flash models.

Child nodes might represent:

- A *component*. Samples, segments, shots are componets. The component configuration can be accessed via right-click and *Configure* action.
- A dataset, which can be plotted, manipulated and edited.

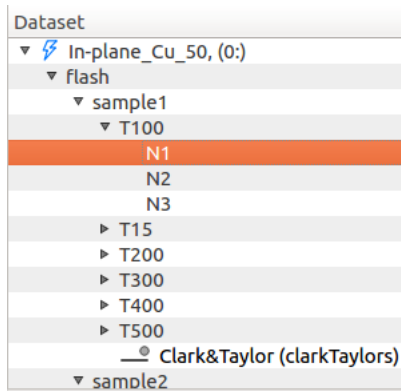
The root node always has a *kiln* sub-node, containing information and sub-nodes related to thermal control, and a *flash* sub-node. The *flash* sub-node always contains *measure* sub-node, with general test configurations (name, number of samples, instrument serial number, etc) and *Aggregates* summarizing all diffusivity results. The *measure* node *Configuration panel* is usually displayed in the right interface area (*Test Configuration*).

The *flash* node also presents one *sample<N>* node for each sample in the test (eg: *sample1*, *sample2*, *sample3*...).

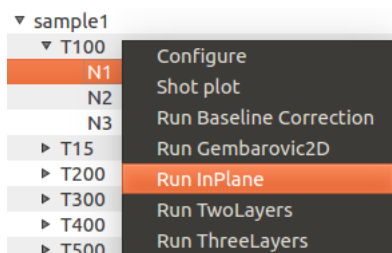
Samples have one *segment* sub-node for each equilibrium temperature.

The general procedure to execute models or related calculations is:

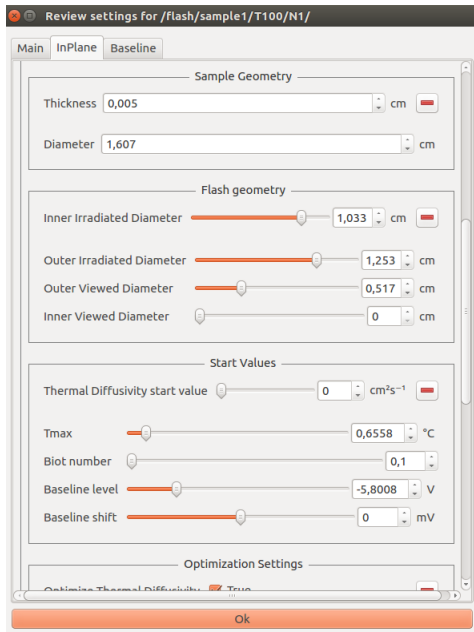
- Select the navigator node which will be subject to the desired action.



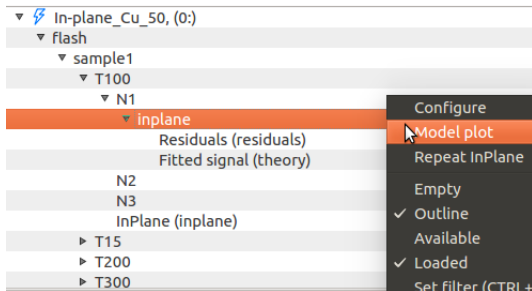
- Right-click on the node. The node context menu will appear.
- Select the model to run (*Run ...*).



- If the model has options, a dialog box will allow the user to inspect and modify default model parameters through a *Configuration panel*.



- As the model parameters are confirmed by Enter keystroke or by clicking the Ok button on the bottom of the dialog, computation starts.
- The output of the calculation will be shown in the navigator in the form of additional sub-nodes, containing results.
- Additional actions can be performed on the model output node (plotting according to a template, re-running the model, etc).

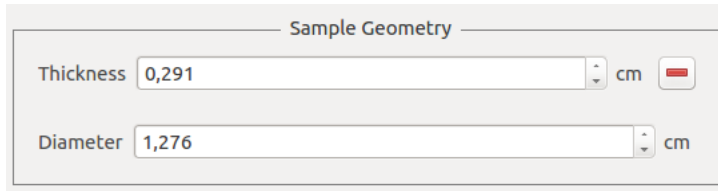


When the clicked node represents a single shot, the model is fitted against that shot thermogram. If parent nodes are clicked, for example a segment node or a sample node, a recursive execution will be performed.

Model dialogs contain some common groups of options, which are generally explained in the following sections. Presets or equivalent values from other nodes of the test can be loaded with the mechanism explained in [Sub-options and groups](#). More details are included in each model's section.

The following animation illustrates the process of executing *Gembarovic Two Dimensional Model* on a single shot:

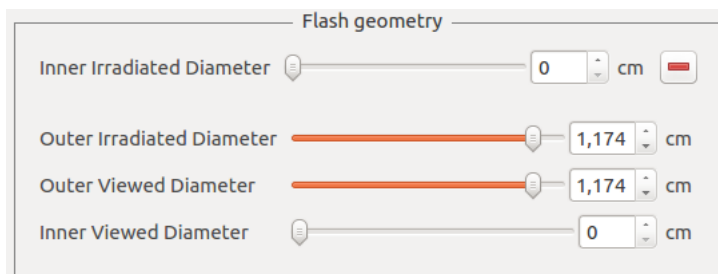
## Sample Geometry



A dialog box titled "Sample Geometry" with two input fields. The first field is labeled "Thickness" and contains the value "0,291" with a unit of "cm". The second field is labeled "Diameter" and contains the value "1,276" with a unit of "cm". Both fields have a small red square icon to their right.

This section contains basic geometric information pertaining the sample itself and, for multi-layer tests, the sample holder. They are pre-filled with values obtained from the sample description before starting the test, and are equal for each shot in the test. The user can anyway experiment an change them.

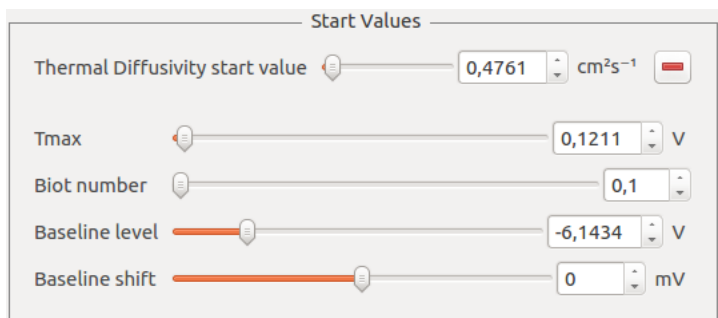
## Flash Geometry



A dialog box titled "Flash geometry" with four input fields. The first field is labeled "Inner Irradiated Diameter" and contains the value "0" with a unit of "cm". The second field is labeled "Outer Irradiated Diameter" and contains the value "1,174" with a unit of "cm". The third field is labeled "Outer Viewed Diameter" and contains the value "1,174" with a unit of "cm". The fourth field is labeled "Inner Viewed Diameter" and contains the value "0" with a unit of "cm". Each field has a small red square icon to its right.

These options are related to the optics of the flash apparatus. They should be configured according to the hardware calibration, but they can also be used as an initial guess to be optimized.

## Start Values



A dialog box titled "Start Values" with five input fields. The first field is labeled "Thermal Diffusivity start value" and contains the value "0,4761" with a unit of "cm<sup>2</sup>s<sup>-1</sup>". The second field is labeled "Tmax" and contains the value "0,1211" with a unit of "V". The third field is labeled "Biot number" and contains the value "0,1". The fourth field is labeled "Baseline level" and contains the value "-6,1434" with a unit of "V". The fifth field is labeled "Baseline shift" and contains the value "0" with a unit of "mV". Each field has a small red square icon to its right.

Fundamental model parameters. They must be as close as possible to the *real* solution. Misura™ Flash will guess optimal values based on legacy diffusivity models and gross properties of the shot.

## Optimization Settings

Optimization Settings

Optimize Thermal Diffusivity ☒ True

Optimize Baseline ☐ False

Optimize Tmax ☒ True

Optimize Biot number ☒ True

Optimize Outer Irradiated ☐ False

Optimize Outer Viewed ☐ False

Optimize Inner Irradiated ☐ False

Optimize Inner Viewed ☐ False

Halftime multiple for end time 4

Analysis start time 2,7320 ms

Analysis end time 95,4967 ms

Max number of points for analysis 5000

Exponential pulse correction ☐ False

Enable global minimum search ☐ False

Maximum starting points iterations 100

Minimum successful iterations 5

Maximum duration 5 min

This section allows to enable or disable the optimization of each individual parameter, through a series of **Optimize <name>** boolean options.

Moreover it allows to finely tune which region of the shot will be used as the target for the curve-fitting:

- **Analysis start time** and **Analysis end time** allow to define the analysis temporal window in milliseconds. The start time might be useful to cut interferences due to the energy burst. The end time allows to discard excessive amount of data, which is useless and sometimes even detrimental.
- **Halftime multiple for end time:** This option allows to define the end time relative to the halftime of the shot. This is the preferred way to set the end time. The default is configured in *HalfTimes for analysis duration*.
- **Max number of points for analysis defines the maximum number of points which will be used to perform the curve-fitting**  
If the selected shot range includes more points, an even selection of them will be dropped until this condition is satisfied.

Each model might include additional, specific optimization options.

## Optimization constraints

During the curve-fitting procedure, model parameters are being varied according to mathematical criteria in order to minimize the error between the model and the thermogram.

As models are quite complex equations, they will always offer many solutions. Most of them might have no physical meaning, while some are impossible given additional knowledge about the material generating the thermogram.

It is thus advisable not only to set the *Start Values* and *Flash Geometry* to reasonable values, but also check that parameter's ranges are plausible given other material's property.

Ranges are accessible by right-click on the option's label, then enter the *Range menu*, and edit minimum/maximum values.

## Minimization algorithm

The optimal parameters which best approximate any model to real data will be searched via an error minimization algorithm.

This kind of search is highly dependent on initial conditions: if they are a good approximation of the *best* solution, the search will be fast and successful. Otherwise it will take longer time and the risk of finding a local minimum with little or no physical sense increases.

Misura™ Flash offers some help in this area:

- An initial guess will be attempted from legacy diffusivity models (Clark&Taylor) and from gross mathematical properties of the shot. It's up to the user to review and refine this guess.
- As seen above in *Optimization Settings*, the user can restrict the search only to relevant, unknown parameters.
- Parameters being optimized should define *Optimization constraints*. The algorithm will not be allowed to wander off this range.

The default optimization algorithm is *ODRPACK*, orthogonal distance regression. It will work most of the times and give a good result but, because of its *local* nature, it will usually require that the initial guess is not too far from the solution.

When the initial guess is still giving unreasonable results, a global search can be attempted using a modified *Basin Hopping* algorithm. It creates multi-dimensional grid of starting values and attempt an ODR local search from a random selection of points. It will try until a good fit is found, the grid is completed or the search times out.

Basin Hopping options are:

- **Enable global minimum search:** activate Basin Hopping.
- **Maximum starting points iterations:** maximum number of iterations from the initial starting grid
- **Minimum successful iterations:** iterations needed to decide if a local minimum can be considered global and the search ended
- **Maximum duration:** after this timeout expired, the search will be ended and the best result selected

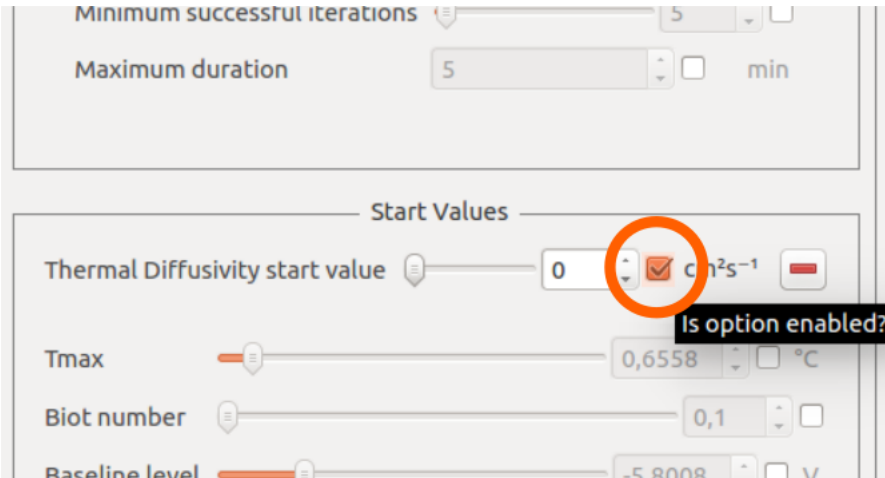
## 7.5.2 Recursive Model Run

Recursive model run can start from a segment, sample or test (root) node. It will fit all thermograms contained underneath the starting node with the selected model.

Before starting the recursion, a dialog box allows the user to specify model parameters and decide if they should be forced to some fixed value or calculated for each thermogram.

At each thermogram the algorithm will use the default sample geometry and optimization settings. It will also try to guess the starting values for the fitting procedure, as well as the time frame for the analysis (based on the *half times option*).

This behavior can be overridden by forcing any option into a fixed value in the model configuration dialog, via the *enabled* checkbox.



When a configuration option is enabled before a recursion, it means its value will be fixed for all shots encountered during the recursion. When disabled, it means a default value will be used if available, or a custom value will be calculated based on thermogram features (for example: Tmax).

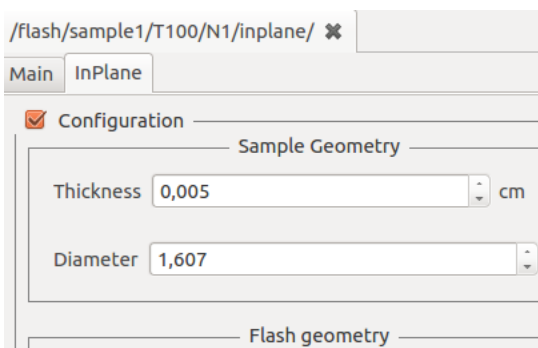
### 7.5.3 Analyzing results

Results are mainly stored into dedicated *output nodes* in the *Misura™ Navigator*. Each output node descends from the shot containing the thermogram which was used to generate it.

By right-clicking on an output node, it is possible to:

- *Configure*: Access configurations and results by opening a new *Configuration panel*.
- *Model Plot*: Create a default plot out of the model results (*Model Plot*)
- *Repeat* the model execution. This action will not display the model dialog and will proceed silently

The output node configuration contains a copy of the starting parameters which were used to perform the model fitting. The panel is divided in two tabs: *Main*, containing just node and model name, and a section with the same name of the model (eg: InPlane), containing all model parameters *and* fitting results.



After running an analysis, output results are automatically *aggregated in result tables*.

### 7.5.4 Repeating a model fitting

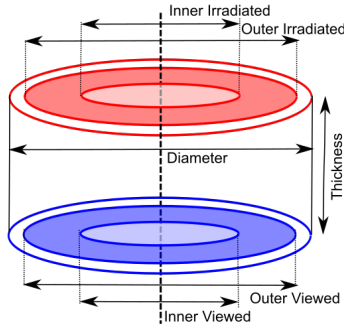
Fitting real data against complex theoretical models sometimes requires trial and error. It is advisable to always try curve-fitting on few shots, then use the same parameters for few segments, and finally extend to the entire sample or the whole test.

Misura™ offers different ways to repeat an optimization.

1. A navigator context-menu action *Repeat*, available from the model node, allows to silently repeat the fitting.
2. The optimization configuration dialog can be recalled from the shot node, using the corresponding *Run model*  $\langle M \rangle$ .

### 7.5.5 Gembarovic Two Dimensional Model

The Two Dimensional model, named after Jozef Gembarovic, takes into account optical details - like viewed and irradiated diameters, heat diffusion through the sample area and the exponential shape of the pulse.



Additional parameters include, under **Flash Geometry**:

- **Outer irradiated diameter:** the diameter illuminated by the energy source
- **Inner irradiated diameter:** an optional *blind spot* in the middle of the energy source
- **Outer viewed diameter:** the diameter viewed by the detector
- **Inner viewed diameter:** an optional **blind spot** which is not detected, in the center of the viewed circumference

These parameters can be individually enabled for optimization in the *Optimization Settings* group.

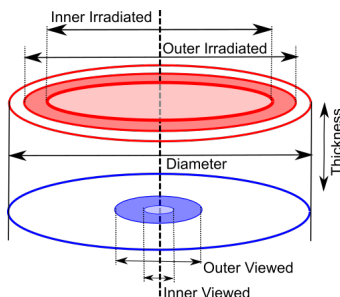
This model additionally supports **Exponential pulse correction**, if enabled and correctly fitted on the laser pulse.

### 7.5.6 In-Plane Model

The In-Plane model takes similar parameters as the Gembarovic Two Dimensional model, but with a different meaning.

Here we assume the sample is so thin, or heat diffusion is so fast, that through-thickness transmission is negligible.

Irradiated diameters are configured to create an outer doughnut, containing the viewed area after a circular section which is neither irradiated nor viewed. In other words, the outer viewed diameter **must** be smaller than the inner irradiated diameter by some margin, as this margin is used to calculate the diffusivity.



The thermogram is thus the result of diffusion through this blind area of the sample.

This model does not support exponential pulse correction.

## 7.5.7 MultiLayer Model

This method is divided in two actual models, for **two** and **three** layers.

Additional options:

- **Sample Geometry** group shows two or three **Thickness** values (Thickness (1), Thickness (2) and for three layers also Thickness (3)).
- **Start Values** group lists additional entries for each layer (n) **Density (n)**, **Specific Heat (n)**, **Heat Loss (n)**.
- For two layers only, **Start Values** also allows to configure the **Thermal contact resistance** between the first and the second layer.
- Each option listed in **Start Values** is also listed in *Optimization Settings*, so it can be optimized during the curve-fitting procedure.

## 7.6 Global configuration preferences

Misura™ Flash offers few configuration options which will determine default plotting appearance, parameters population, and data import aspects.

Options are contained into the general *Preferences*, under the **Flash** tab:

Import FlashLine to default database ☒ True

Preferred FlashLine Model Clark & Taylor

Preferred Curve-Fitting Model Gembarovic 2D

HalfTimes for analysis duration 4

Use Center of Gravity to detect initial time ☒ True

Flash Test plot rule flash/sample[0-9]+/XmodelXs\$

Advanced options, related to default plots, are also listed.

### 7.6.1 Import FlashLine to default database

Default: True

FlashLine data will be compressed into an Misura™ file into default database location (usually MisuraData under user's home folder). If this option is false, the Misura™ file will be created into the same folder containing the FlashLine data - even if remote.

### 7.6.2 Preferred FlashLine Model

Default: Clark & Taylor

This option determines which model will be loaded to create default plots.

### 7.6.3 Preferred Curve-Fitting Model

Default: Gembarovic 2D

The default curve-fitting model which Misura™ will attempt to plot when loading a test for the first time.

### 7.6.4 HalfTimes for analysis duration

Default: 4

The halftime will be multiplied for this value in order to obtain the required thermogram time frame to perform a model fitting.

### 7.6.5 Use Center of Gravity to detect initial time

Default: True

While importing FlashLine data, the center of gravity of the laser pulse is always calculated and saved. By enabling this option, any subsequent computation will use the center of gravity as the initial time of the test. By disabling it, the onset of laser pulse will be used instead.

### 7.6.6 Show HalfTime multiple on thermograms

Default: 20

Each thermogram (“shot”) is usually longer than needed. This options determines the maximum number of halftime multiples to plot on *Model Plot* and *Segment Plot*.

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### Access Management

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Communication between *Misura Server* and *Misura Client* happens over an SSL-encrypted channel and is password-protected.

Server-side it is possible to define users, associate passwords and assign read and write permission levels. Users can be managed from the General configuration panel, under the `users` node.

The `Users` section exposes the `Users List` option table, with 4 columns which can be directly edited by double-clicking:

- `Name`: The user name asked at login time
- `Read level`: The permission level for reading. Only options having a read level equal or lower than the user's one will be visible to the user.
- `Write level`: The permission level for writing. Only options having a write level equal or lower than the user's one will be editable by the user.
- `Hash`: The password, currently in plain text

The `users` object is currently reserved for service purposes.

Misura Server is the software component embedded in the measurement instrument. It is responsible for the control of all of the instrument's hardware and for data recording.

### 9.1 Web Interface

A very basic web interface is available to retrieve test files, logs and configurations.

- Test files: <https://172.16.8.68:3880/data>
- Log files: <https://172.16.8.68:3880/data/log>
- Configuration files: <https://172.16.8.68:3880/conf>
- Status: <https://172.16.8.68:3880/stream>

### 9.2 Process Management

#### 9.2.1 Soft-Restart

Most of the software problems will go away after a server restart, which means you just close and reopen the server application.

In order to restart the server:

1. Open the Acquisition application. Connect to the instrument you want to restart.
2. From the **Connect** menu (top-left), select **Restart**
3. Wait few seconds, then reconnect to the instrument.

## 9.2.2 Rebooting

Rare but serious operative system issues are usually solved by an embedded computer restart. Only the controller will restart: you shall not turn off the main power.

To reboot the controller:

1. Open the Acquisition application. Connect to the instrument you want to reboot.
2. From the **Settings** menu, select **Global** action.
3. Double-click on **support** entry from the tree on the left. The support configuration panel is displayed as first tab on the right.
4. Locate the **Reboot machine OS** option and click on the button on the left.
5. The reboot will immediately start. At this point you can close the Acquisition application.
6. After 5 minutes you can reconnect to your instrument.

## 9.2.3 Shutting down

The shutdown command from the **Connect** menu will cause the onboard computer controlling the instrument to shutdown.

1. Open the Acquisition application. Connect to the instrument you want to shutdown.
2. From the **Connect** menu, select **Shutdown**.
3. A confirmation message box will be shown.
4. Acquisition app can be closed.

The onboard computer should start up automatically after next connection tentative from Acquisition application.

## 9.3 Upgrading

Server upgrade package might be provided as tarballs (.tar) or zipped (.zip) archives. An upgrade archive needs to be transferred onto the instrument while it is active, and then the server process should be restarted.

Follow these steps:

1. *Connect* to the server with *admin* rights.
2. From main window menu: *Settings > Send update package*.
3. Navigate to the update package (*misura\_pkg\_<version>.tar*) and send.
4. The server will reboot and the client will shortly close itself.
5. When you reconnect to the server, it will be at the selected version.

You can check package name and last update date in the sub-options **Last applied package name** and **date** in the **Support** configuration node (*Settings > Global* menu action).

### 9.3.1 Downgrading

Each upgrade package which is sent to the server remains saved locally, so that it is possible to rollback any previous release. Since this operation is much less usual, the procedure is less straightforward than upgrading.

1. Open Acquisition and connect to the instrument.
2. From **Settings** menu, select **Global** action.
3. From the objects tree on the left of the new window, double-click on **Support** node.
4. Activate the **Status** configuration section by clicking the checkbox.
5. Locate the **Available software versions** option and select the version you want to revert to.
6. Expand sub-options by clicking on the [ + ] leftmost button.
7. Click on **Apply selected software version**.
8. A confirmation dialog appears. Acknowledge it and close the global configuration window.
9. Return to Acquisition application and command a *Soft-Restart* to make the changes effective.

**ODP** Optical Dilatometry Platform, the most complete hardware controlled by Misura software.

**CCD** The Charge-Coupled Device responsible for digital image acquisition. The term is usually referred to mean the active camera resolution, from which one or multiple regions of interests can be selected.

### **ROI**

**Region of Interest** A rectangle representing a selection of the total camera resolution.

**Optical Encoder** The entity defining, forecasting and applying the conversion factor between one motor step and the number of pixels it produces on the image.

**Misura Platform** The measurement instrument as a whole, comprising both software and hardware components.

**Misura Server** The embedded software component controlling the instrument's hardware and actually performing measurements.

**Misura Client** The user interface which allows to connect to a platform, carry out analysis, get the results, visualize, organize and post-process them.

**Instrument App** The software component used to carry out one kind of measurement technique (microscopy, dilatometry, fleximetry, etc). The Instrument App determines the user interface appearance, and is actually the category under which Measurement Apps are furtherer specified. The user never directly starts an Instrument App.

**Measurement App** The specific configuration used to carry out a measurement. For example, the same measurement technique might be applied to very small or very big samples, requiring different Measurement Apps which configure hardware and software in order to meet different measurement requirements. The user always starts a Measurement App.

**Analysis App** A software component extending an Instrument App in order to add advanced functionalities. An Analysis App might add an experimental image analysis method or an innovative thermal control feature.

### **Head Morphing**

#### **Measurement Head Morphing**

**Instrument Initialization** The process of configuring the measuring instrument to make a specific kind of measurement. This involves many software controllers setup and moving parts.

## Loaded

### Loaded Dataset

**Loaded Datasets** A loaded dataset is currently loaded into the application memory. It can be plotted and used as the input for any data processing step. Opposite of *Available Dataset*.

## Available

### Available Dataset

**Available Datasets** An available dataset is not loaded into the application memory, but exists on the output file containing test data (it is *available for loading*). They are usually filtered out from the *Misura™ Navigator* and are not visible in data processing steps. An available dataset can be easily loaded through the use of *Misura™ Navigator*.

**Free Sample Positioning** A characteristic of all *ODP* instrument is that samples are placed by hand with no physical constraints and very ample limiting geometries.

**Metadata** Test metadata summarizes high-level aspects about test execution, expressed as a value, a time and a temperature. Test data contains time series of recorded values: eg how the length of the sample changes with time. A metadata is, for example, the maximum rate of change of the length: its value, the time at which it happened and the sample temperature at that time. Metadata is usually calculated runtime during the test execution, and can be replayed offline from the *Misura™ Browser*.

## Scripts

**Script** Small portions of source code which is executed by *Misura Server* during a test. Scripts are exposed to the client and can be customized by the user to meet specific control procedures or experimental morphometrics standards.

**Global Focus** The focus distance can be adjusted for all cameras at the same time by means of a motorized translation stage. It is not possible to independently adjust the focus of each single camera. This is actually intentional as a discrepancy in focus distances usually suggests a sub-optimal sample orientation.

**HDF5** The *Hierarchical Dataset Format v5* file format used to store test data. Has *.h5* extension.

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