Anton Paar

Measure
what is measurable
and make measurable
that which is not.

Galileo Galilei (1564-1642)

Reference Guide

Step X00 - UNHT^3

Ultra Nanoindentation Tester

From Indentation Software Version 9
for Windows® 7 64 bits and Windows® 10

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Published and printed by Anton Paar TriTec SA, Switzerland

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Date: Jan 2020

Document number: G70IB003EN-A

Reference Guide

Step X00 - UNHT^3

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Contents

1 ABOUT THIS DOCUMENT

This document explains how to carry out an indentation measurement using the Anton Paar Step - UNHT^3 instrument.

For further explanations concerning the platform, refer to the ***Step X00 Instruction manual and safety information (IMSI)***; this document is common for every Step X00 measuring/imaging head and mentions important information (safety, acquisition system configuration, setup, maintenance/warranty…).

For further information concerning the Anton Paar software, refer to the following documents:

- ***Common Scratch & Indentation software reference guide***
- ***Indentation software reference guide***
- ***Video software reference guide***

For further explanations concerning the available Anton Paar sample holder, refer to the ***Sample holders user manual***. The universal sample holder is used as an example in this document.

In this document

- The images may differ from the actual product:
  - Some print screens are coming from a previous software version but they are similar/applicable for V9.0.x version.
  - Some pictures show previous UNHT^3 measuring head design but it doesn't change the way to use it.
  - etc.
- Sometimes several ways to access a software window are possible but only the main one(s) is used in this document. However they are all described in the software reference guides (like keyboard shortcuts…).
- The units can be different from a print screen to another (e.g. µN, mN or N and µm or mm), to change the units, refer to ***Common Scratch & Indentation software reference guide*** in section ***Customizing options / Preferences tab (units)***.
- There are some references with a letter and a number '(Z.#)' which are described in section 3.3 (Indenter and reference details for handling).
- If not specified, 'Step X00', 'Step' or 'platform' means Step 700 and 700 Noise-Control if not specified.
- If not specified 'head' means measuring head (UNHT^3), as it could be video microscope (VID) imaging head or other measuring/imaging head(s).
- 'key(s)' means keyboard key(s).

Abbreviations & symbols

Physical quantity symbols are according to the ISO 14577 standard.

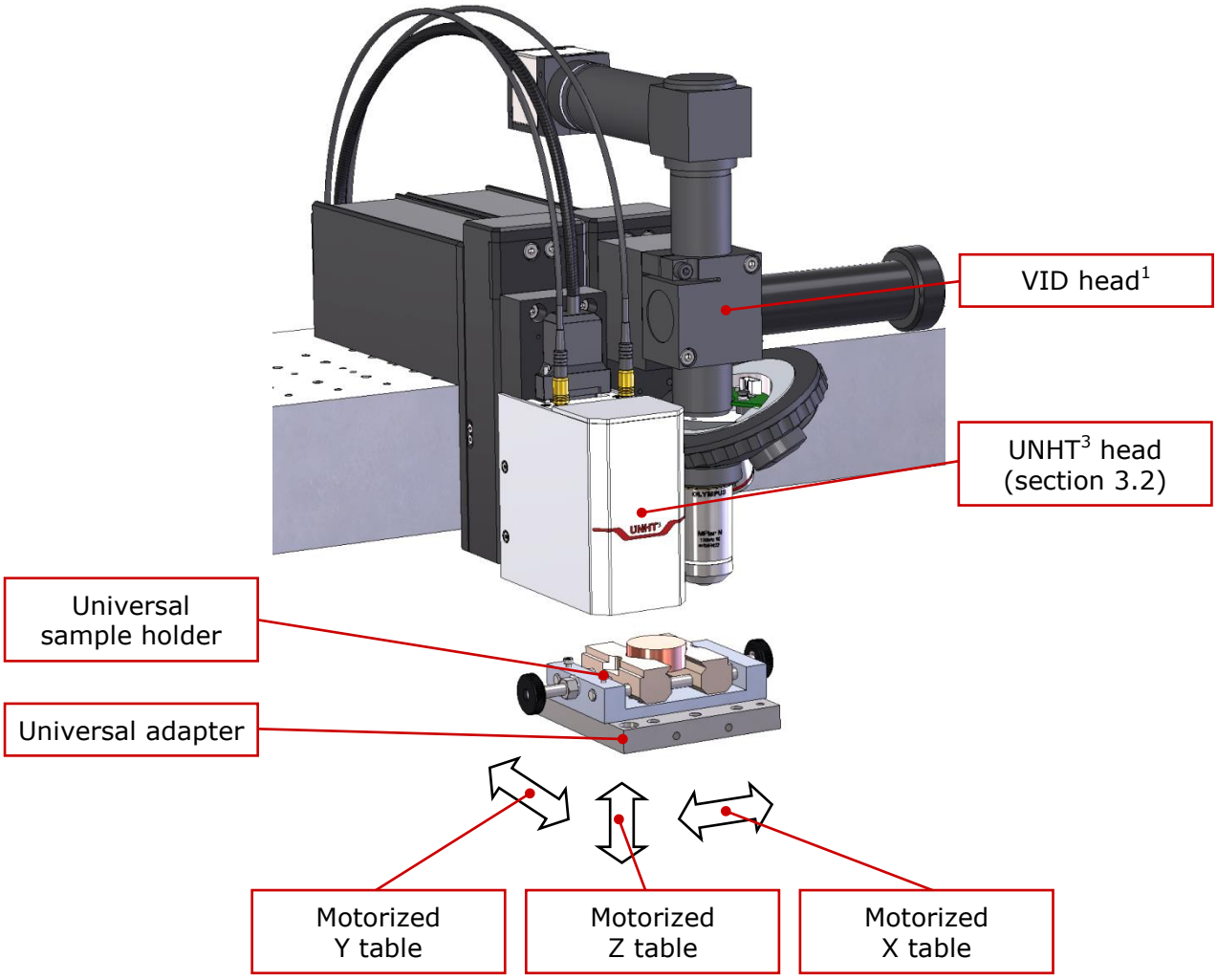
Abbreviations Symbols	Designations	Units
ADO	adjust depth offset	
AFM	Atomic Force Microscope (imaging head)	
A_p	projected contact area	m^2
E*	plane strain modulus	Pa
E_{IT}	indentation modulus	Pa
F	test force	N
h	indentation depth under applied test force	m
h_c	contact depth of the indenter with the sample at F_{max}	m
h_{max}	maximum indentation depth	m
h_p	permanent indentation depth	m
ν (Nu)	Poisson's ratio	
sec	seconds	
Step 700	Surface testing platform with up to 3 measuring heads: - with optical video microscope imaging head - with acoustic enclosure - with anti-vibration air table	
Step 700 Noise-Control	Similar as Step 700, **exception:** With anti-vibration (electronic) active table	
$UNHT^3$	Ultra Nanoindentation Tester (measuring head)	
VID	optical video microscope (imaging head)	

2 SAFETY INSTRUCTIONS

Refer to the ***Step X00 Instruction manual and safety information (IMSI)*** in section ***Safety instructions***.

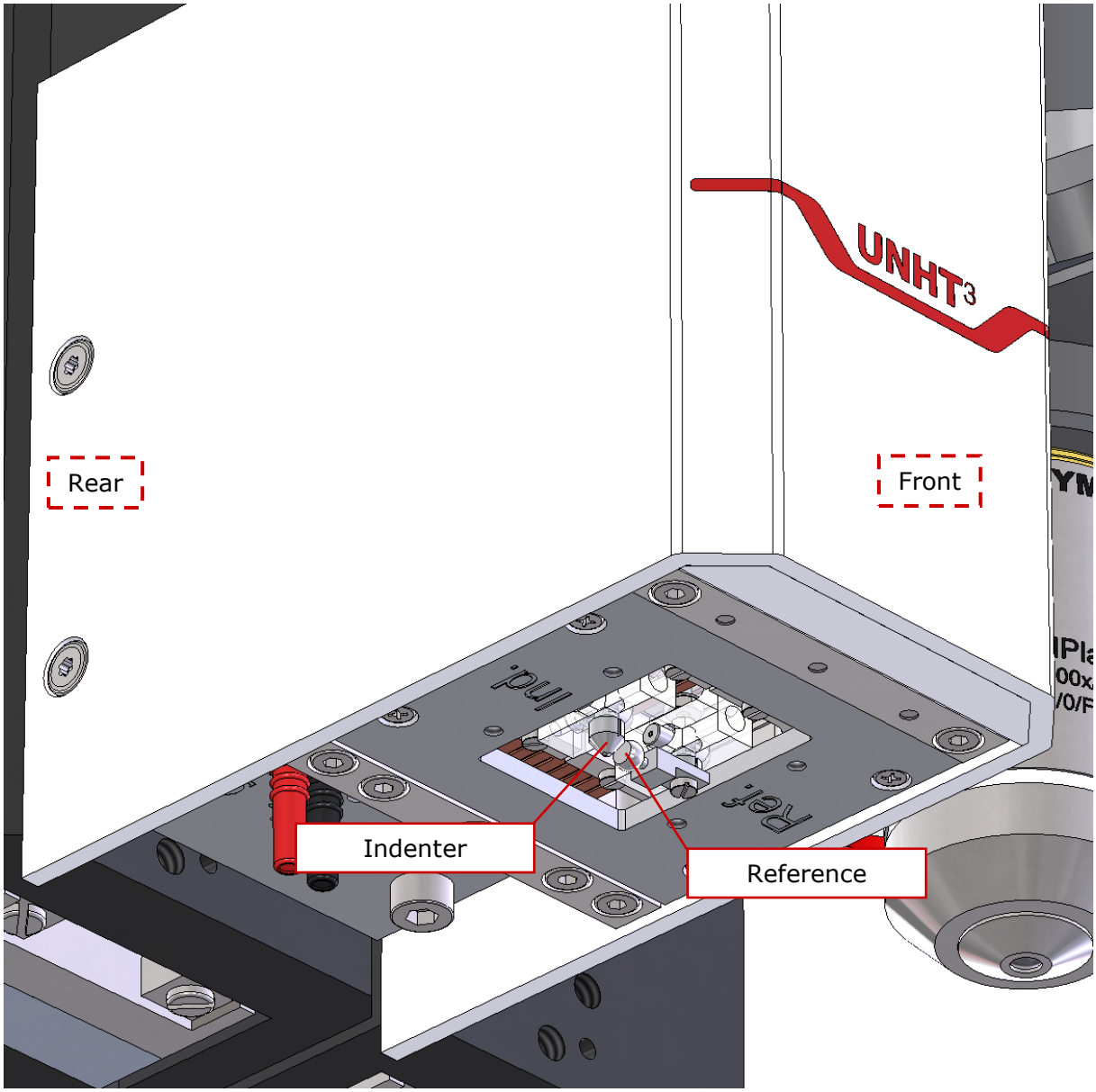
3 INSTRUMENT VIEWS

3.1 GENERAL



1 Refer to the **Step X00 Instruction manual and safety instruction** *in section* **Instrument overview / General views / VID head**.

3.2 HEAD DETAILS



3.3 INDENTER & REFERENCE DETAILS FOR HANDLING

Observe the UNHT^3 head.

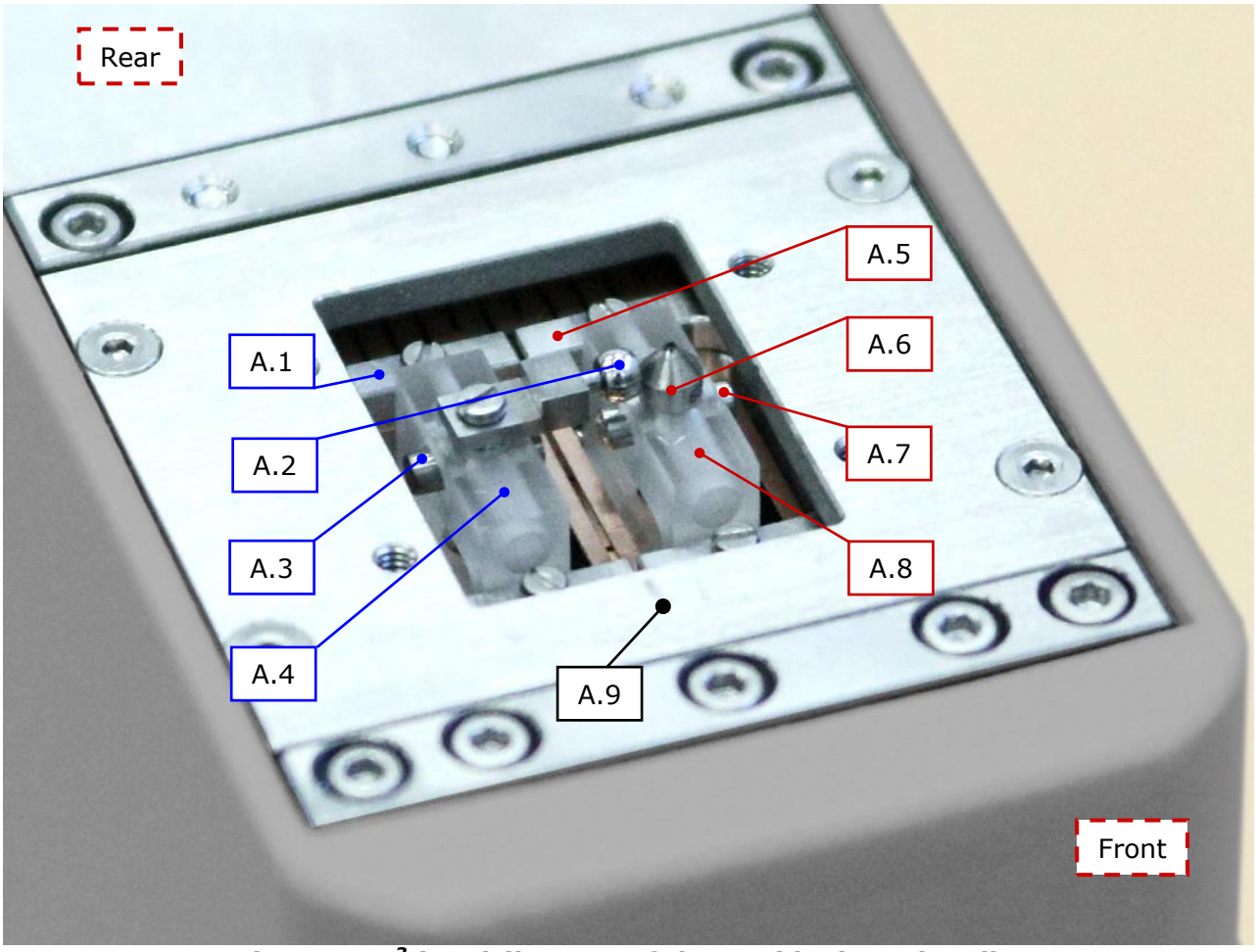


Fig.1 UNHT^3 head (bottom of the upside down head)

A.1 Reference bar
A.2 Reference
A.3 Reference Dumbbell
A.4 Reference glass block support
A.5 Indenter bar
A.6 Indenter
A.7 Indenter Dumbbell
A.8 Indenter glass block support
A.9 Steel base

When dumbbell (A.3 or A.7) is compressed by the special exchange tool (B.1), this releases the corresponding reference or indenter spring (located inside the corresponding glass block A.4 or A.8) and allows inserting or removing the reference (A.2) or the indenter (A.6).

Carefully observe the tools which should be used.

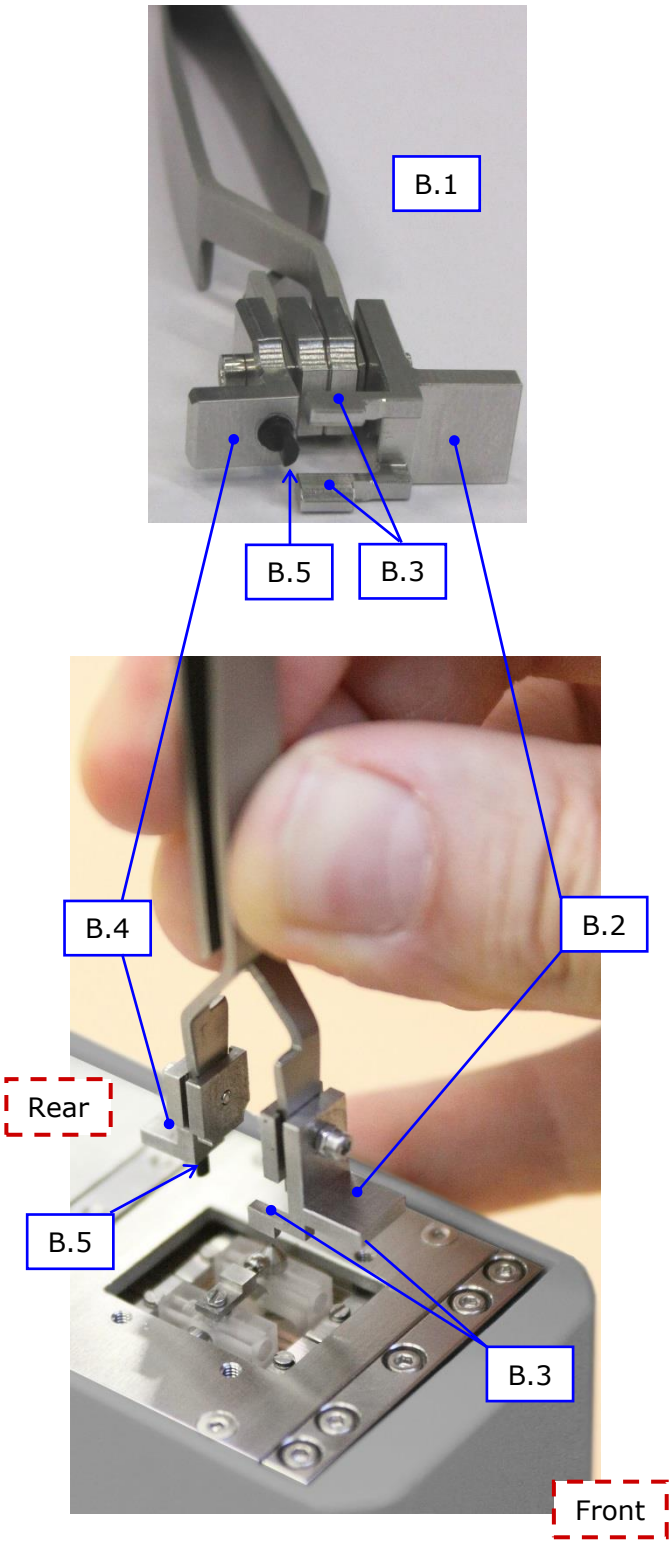


Fig.2 Special exchange tool V2 orientation relative to head orientation (bottom of the upside down head)

B.1 Special (self-closing) indenter/reference exchange tool V2 (version 2)
has a specific design which needs to be understood before proceeding with an indenter or reference change. This tool is not symmetrical, it has a locating tab on either side:

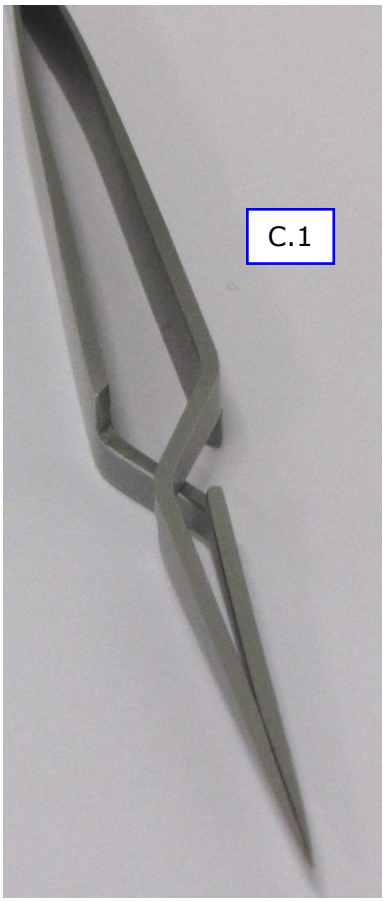
- 1 large (B.2) which includes 2 legs (B.3)

AND

- 1 small (B.4) which contains a pin of half-moon section (B.5)

B.2 Larger locating tab with
B.3 Legs x2

B.4 Smaller locating tab with
B.5 Pin of half-moon section



C.1 (standard) self-closing tweezers

3.4 INDENTER-REFERENCE SPACING DISTANCE

The spacing distance between the standard indenter and reference is:

2.7 ±0.1 mm (Fig.3).

The spacing distance between long shaft indenter and reference used with optional liquid cell is:

9.3 ±0.1 mm (4).

However, the longest spacing distance: 9.3 ±0.1 mm (Fig.4) could have been ordered with standard (short shafts) indenter and reference.

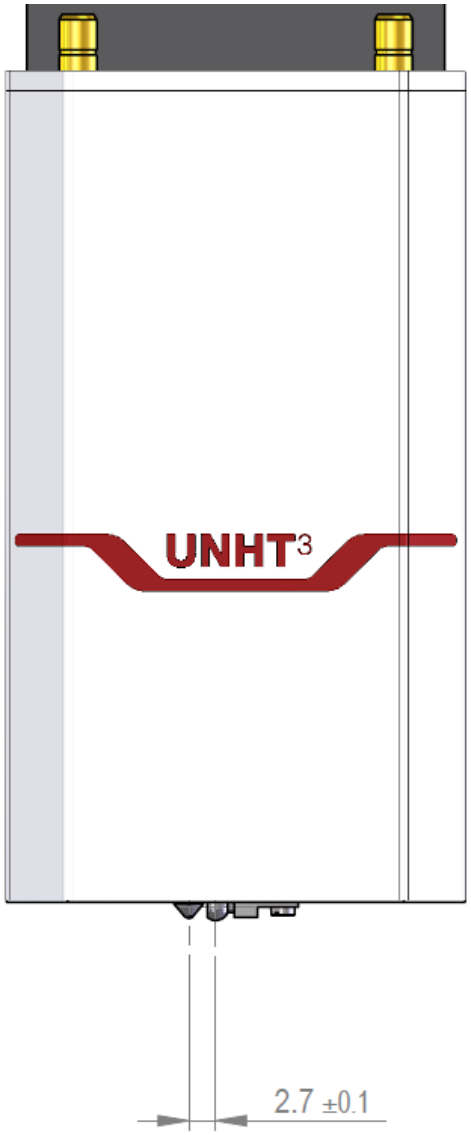


Fig.3 Standard indenter/ reference distance

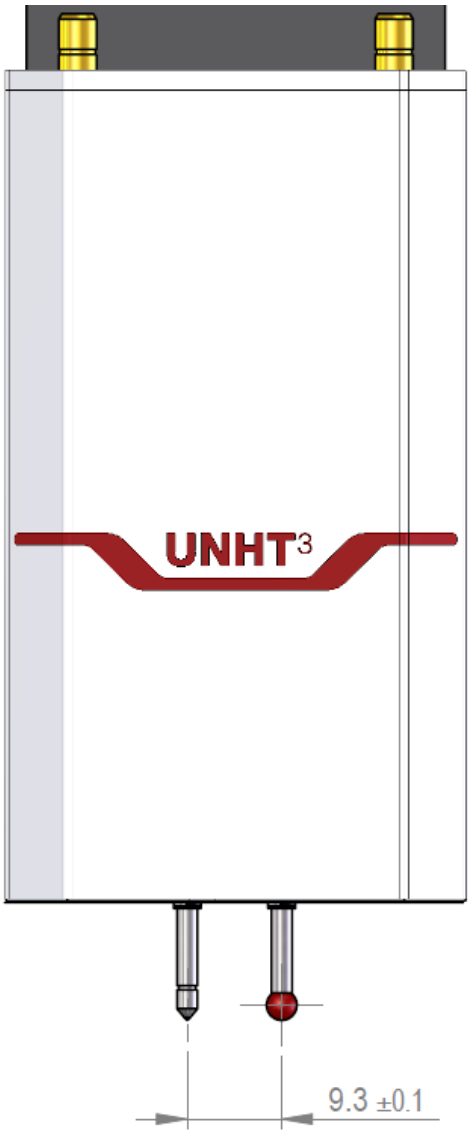


Fig.4 Long shaft indenter/ reference distance

4 PATENT

The Anton Paar Ultra Nanoindenation Tester (UNHT^3) design includes active top referencing and 3 sensors and is patented under the following number:

US Patent 7,685,868 B2: Measuring head for nanoindentation instruments and measuring method

5 INSTRUMENT & MEASUREMENT PREPARATION

5.1 WARNING: REMOVE HEAD BOTTOM PROTECTION COVER

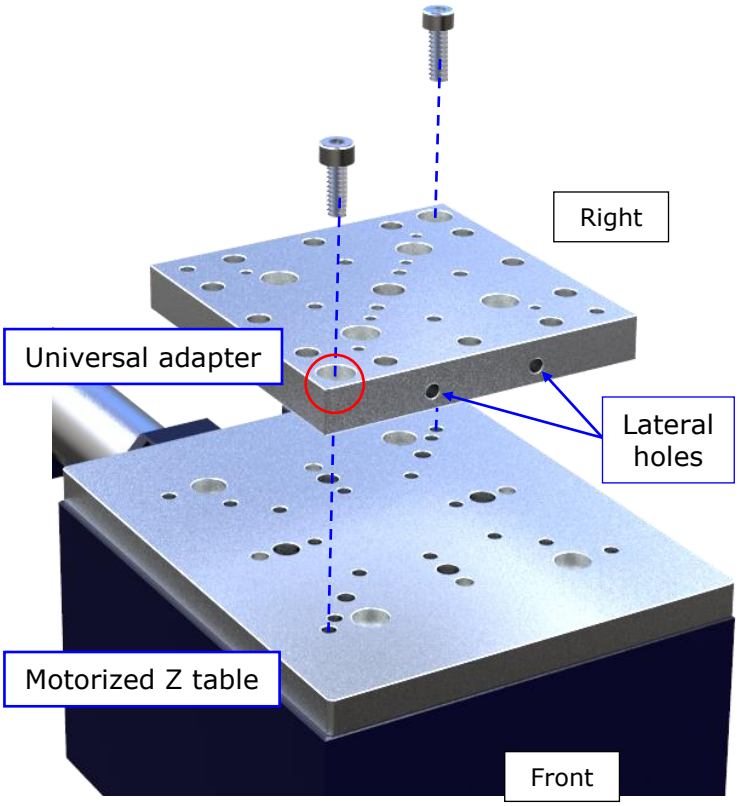
Fig.5 Head bottom with protection cover

Before operating the instrument, remove the head bottom protection cover, ⚠ **avoid** any collision with the indenter/ reference:

Holding/retaining the cover, unscrew its 2 hand screws and then ⚠ doing **only vertical movement**, pull down and remove the cover.

(to remount the cover, section 9)

5.2 UNIVERSAL ADAPTER MOUNTING/DISMOUNTING



The universal adapter 2 lateral holes should be placed in front or at the rear.

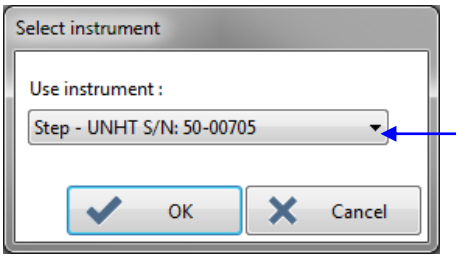
Mounting

The universal adapter **should** be mounted on the motorized Z table with a large hole located at the front left side:

Insert into the large left front and right rear holes and tighten the 2 screws with an Allen key (3 mm) to lock the adapter on Z table.

5.3 SWITCHING ON THE INSTRUMENT

Switch on the instrument; refer to the ***Step X00 Instruction manual and safety information*** in section ***Operating the instrument / Switching ON/OFF***.
Then start the Anton Paar *Indentation Software* by double clicking  on the acquisition system desktop.



If the platform is equipped with 2 indentation heads, select
"Use instrument : > Step - UNHT S/N: #" (UNHT[3]) from drop-down menu.

5.4 POSITION CALIBRATION OF EACH OBJECTIVE

The position of each available objective[1] is calibrated before leaving the factory. However, to perform a new calibration, refer to the ***Common Scratch & Indentation software reference guide*** in section ***Managing the instrument / Hardware configuration / Control unit & modules tab / I/O card***.

5.5 VIDEO SCALE CALIBRATION OF EACH OBJECTIVE

The video scale of each available objective[1] is calibrated before leaving the factory. However to perform a new calibration, refer to the ***Video software reference guide*** in section ***Using the Video software / Toolboxes / Objective / Video scale calibration***.

[1] *Each objective is mounted on the video microscope turret.*

5.6 INDENTERS/REFERENCES

If the indenter/reference is not yet mounted or needs to be changed, read the following sections.

Each time the indenter is changed on the head:

- The corresponding indenter in use **should** be created and/or selected in the software (section 5.6.2).
- The calibration of the distance between the indenter and the video microscope **should** be performed (section 5.10).
- An ADO **should** be successfully (ADO) performed (section 5.11).

Be sure that each indenter in use:

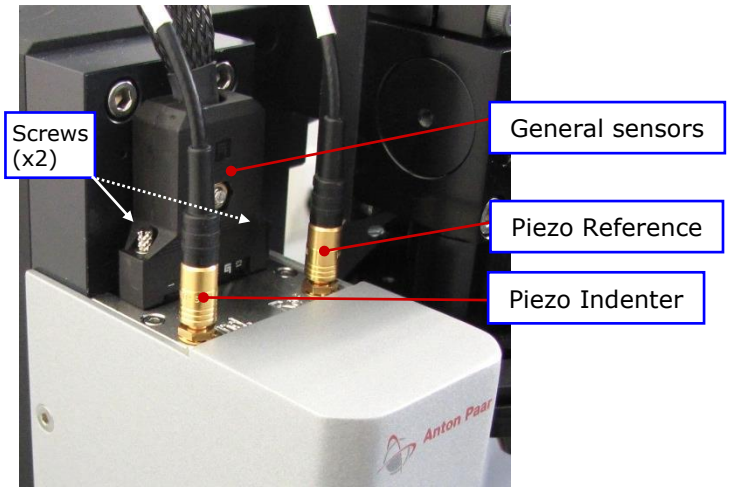
- Is **not** too worn out or damaged for the application; periodically verify the indenter wear by performing a calibration (section 5.13).
- Is **not** dirty; periodically or if necessary, clean the indenter extremity (sections 5.6.1.3 and 0).

5.6.1 DISMOUNTING/MOUNTING

It is advised to **read** all following sections in chronological order before manipulating the head.

5.6.1.1 Removing the head

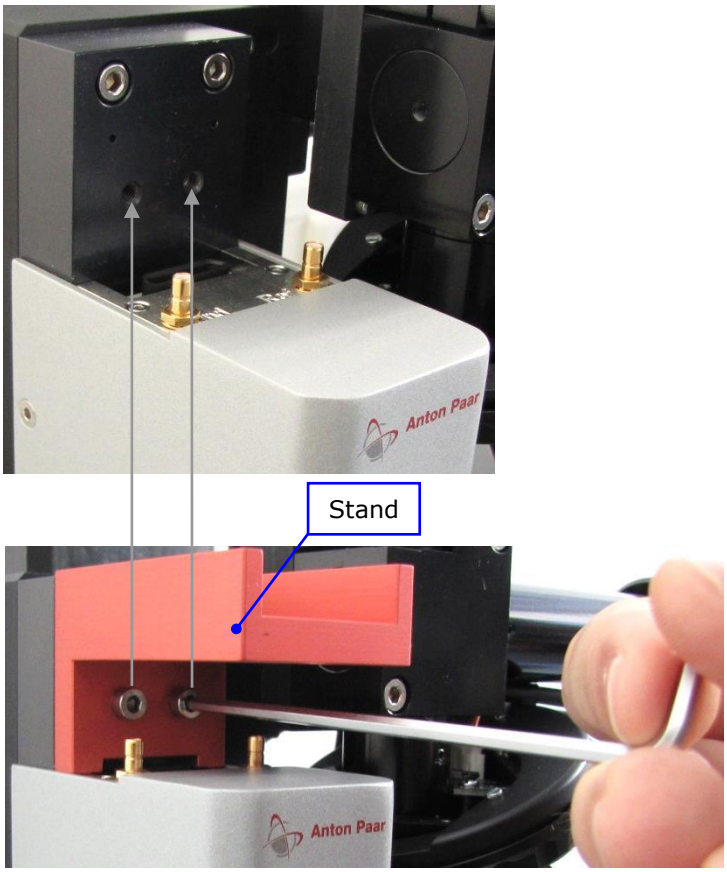
Before unplugging the head connectors, **close** the *Indentation Software*, **shut down** the acquisition system by software (Windows®) and then **switch off** the instrument using the main power switch; refer to the ***Step X00 Instruction manual and safety information*** in section ***Operating the instrument / Switching ON/OFF***.



First unscrew (with a small flat screw driver) the 2 screws of the general sensors connector to release it.

Then unplug (pull out/up) the 3 connectors from the head;

do **not** pull on cable, only on connector.

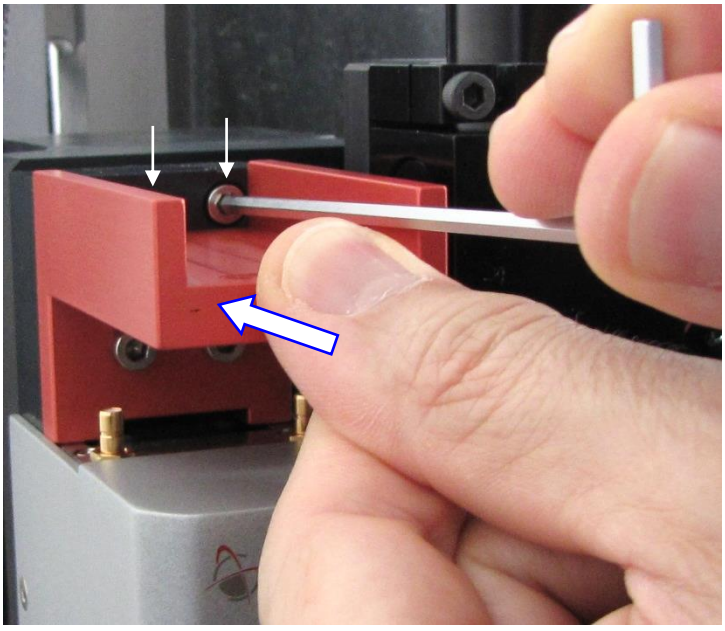


Hold the stand (not shown on images) until it is screwed on the head as follows.

Place the head (red) stand by inserting its 2 captive screws into the head holes with an Allen key long part (3 mm) and tighten these 2 screws, in order to lock the stand to the head.

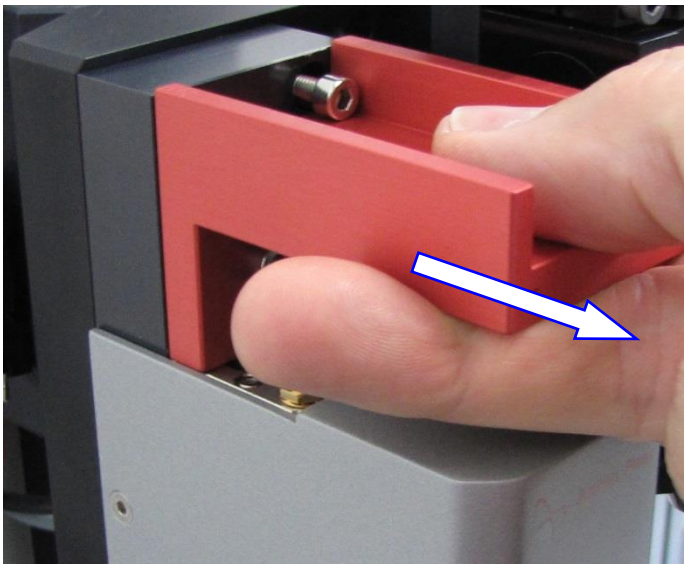
Risk of damage

The head is equipped with 2 rear pins of a few millimeter inserted into the measurement assembly frame. Therefore **carefully follow** the operations below to avoid that the head fall down and be damaged during its removal.

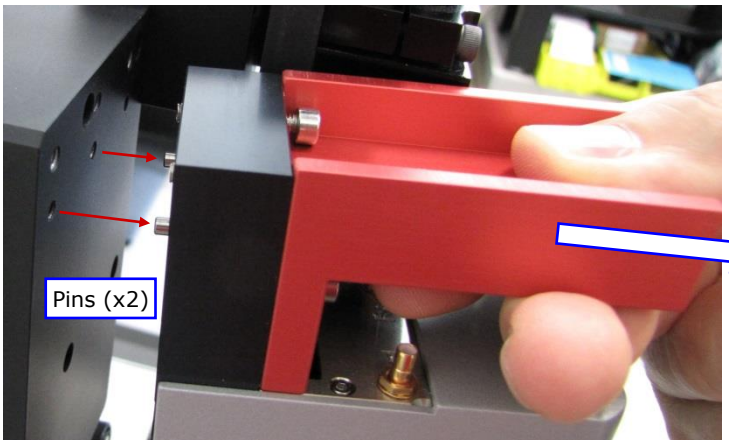


Push on the stand with one hand during the following operations.

Unscrew the 2 head **upper** captive screws with the Allen key long part to release the head - the head is still maintained (pushed) with its 2 rear pins inserted into the frame.

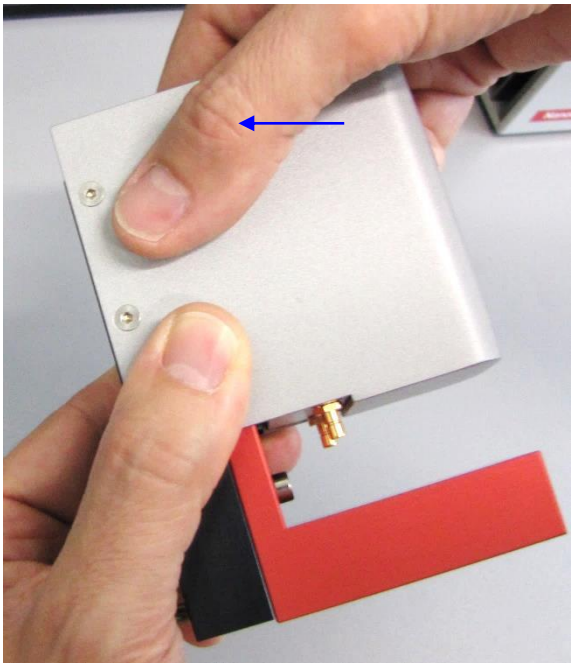


From pushing the stand, grab it and carefully pull out the stand, holding it vertically: **end of pins**, until the head is removed from the frame.



Carefully bring the head **over** a **stable** table - **avoid** any collision with the bottom of the head where the indenter and references are located - and follow the next steps.

Return upside down the head by its stand and with other hand also hold the head by its rear side, near the stand (on head frame cover).



Keeping the hand holding by the rear side, move the other hand over the bottom of the head (on head frame cover) **without** touching the indenter and reference.

With the hand holding the head bottom (by frame cover), **carefully place** the head upside down **on its stand** and on the **stable** desk.

The head is ready to mount or change its indenter/reference.

5.6.1.2 Removing the indenter/reference

Carefully read section 3.3 (indenter & reference details for handling) before manipulating the head assembly.

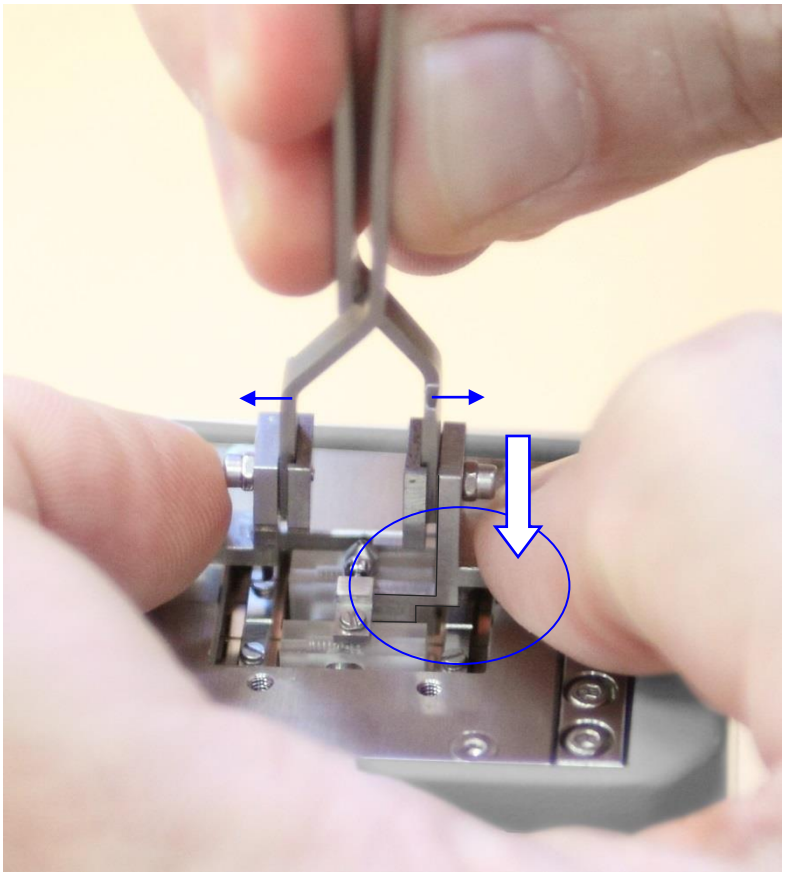
On a **stable** desk, with the head is placed upside down **on its stand**; see the previous section 5.6.1.1

Perform all the following manipulations **extremely carefully**, as there is a risk of damaging the UNHT^3. **Avoid** shaking, vibrating the head assembly and **avoid** any collision with it.

Avoid any collision with the indenter/reference and **avoid** touching the indenter/reference extremity during the following operations.

Have special exchange tool V2 (B.1) and (standard) self-closing tweezers (C.1) at hand.

Place your forearms/elbow on the desk to provide greater stability during delicate manipulations.



Lean your fingers lightly on the head casing for better stability.

Open (press) widely the special exchange tool V2.

Carefully approach with the special exchange tool V2 opened and insert its 2 legs (B.3) around and along the indenter glass block (A.8).

Be careful **not** to press on the indenter glass block support.

First place the larger locating tab (B.2) on the steel base (A.9) and press lightly on it with the thumb (shown by larger arrow). Keep holding for the following steps.

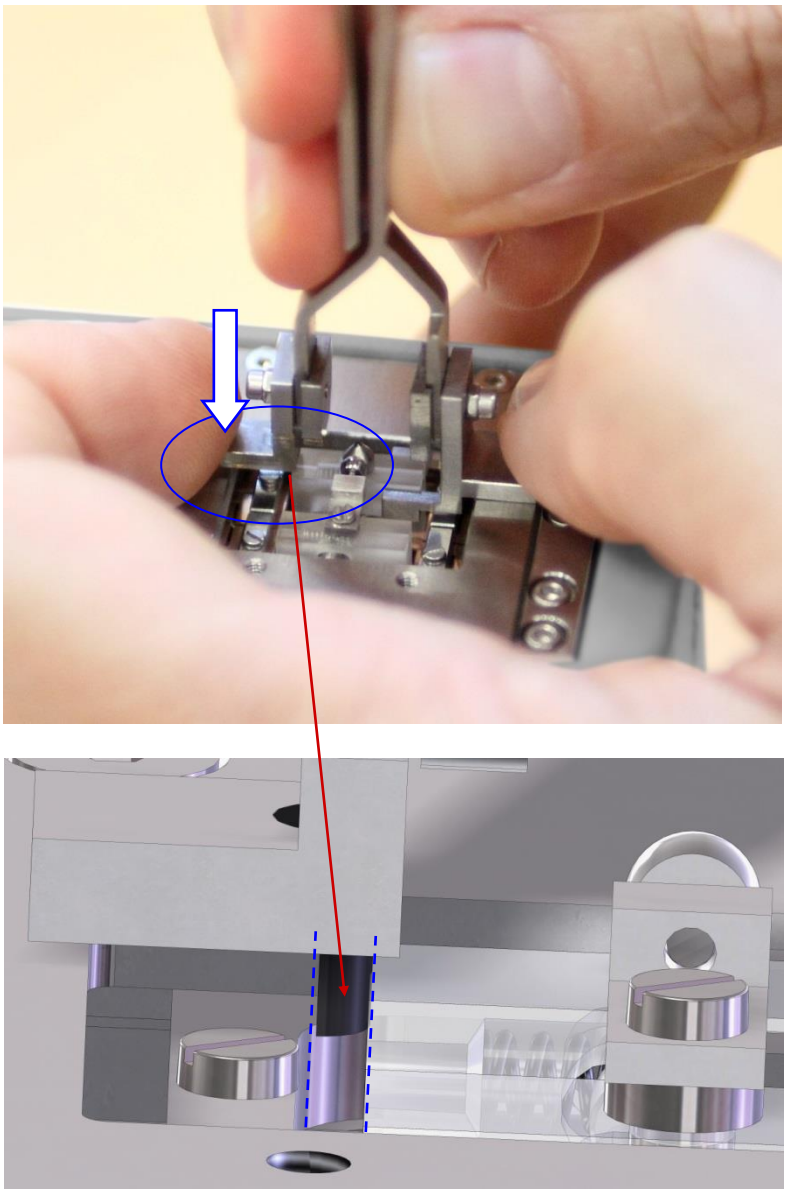
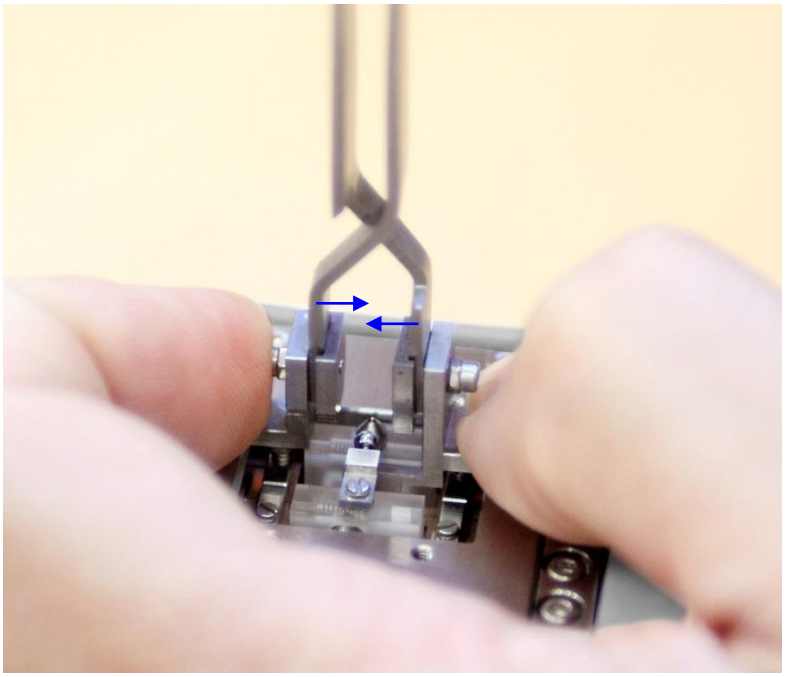


Fig.6 pin of half-moon section insertion zoom

⚠ Then **Carefully** insert the pin of half-moon section (B.5) between the indenter glass block side and the side of indenter bar (A.5) as shown on Fig.6,

and place the smaller locating tab (B.4) on the steel base in front of the glass block. Press lightly on the smaller locating tab (shown by arrow) and keep holding for the following steps.

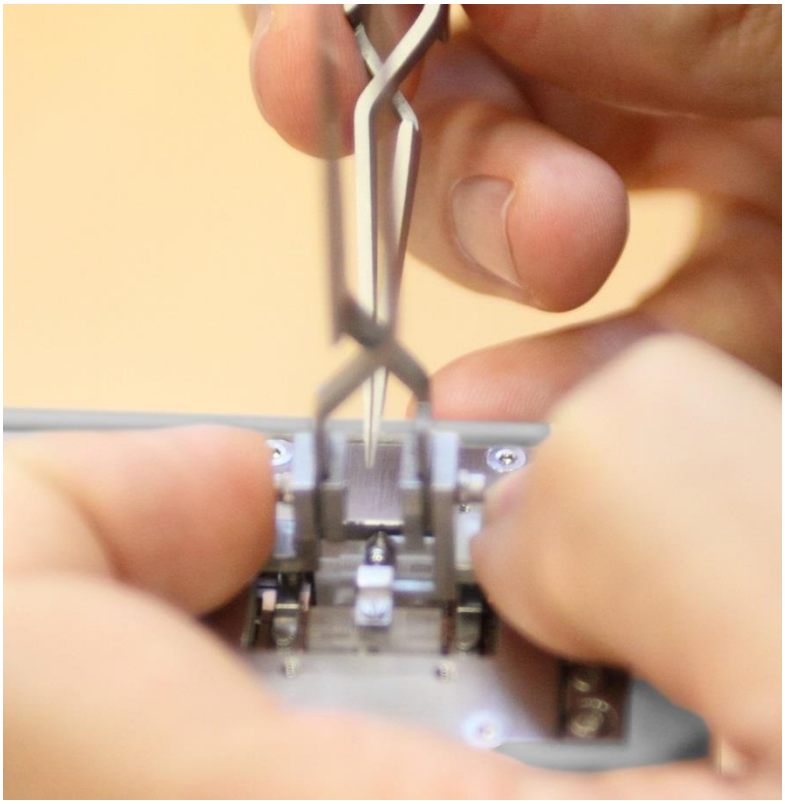


Slowly release the special exchange tool V2.

This releases the spring in the glass block and allows the extraction/insertion of the indenter.

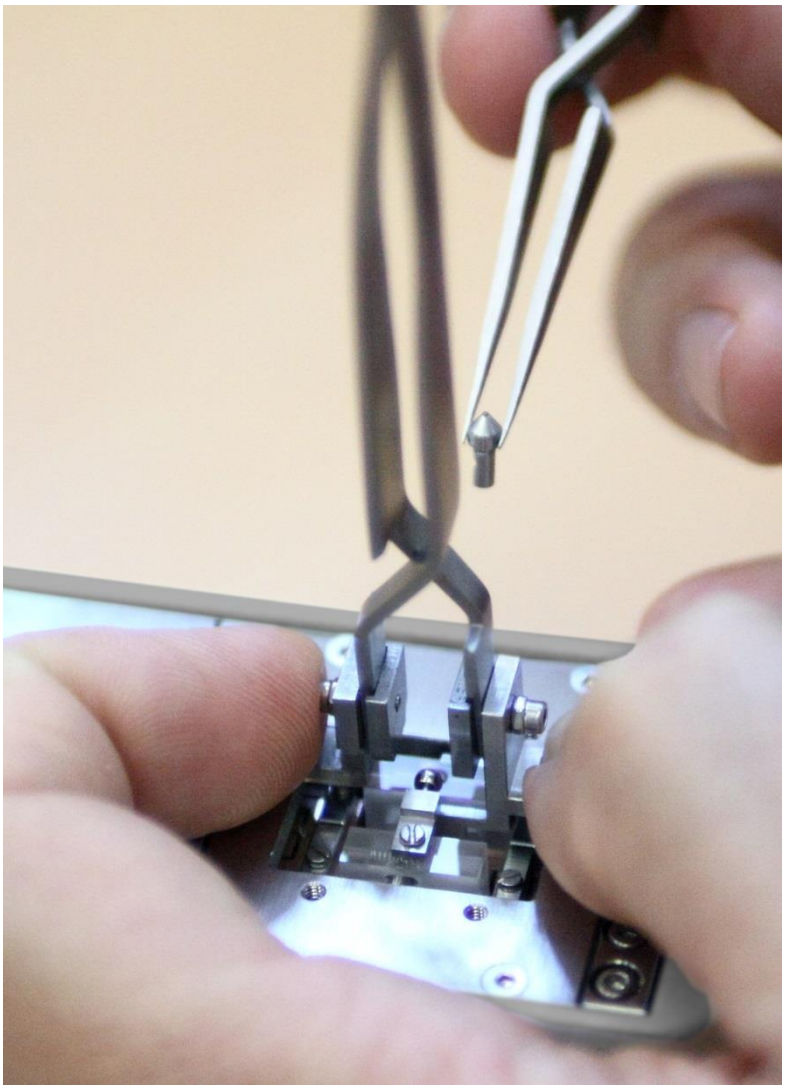
Do **not** move the UNHT^3 head with the special exchange tool V2 in place.

End of special exchange tool V2 installation.



Still press lightly on both larger and smaller locating tabs and keep holding.

With the other hand take the (standard) tweezers.



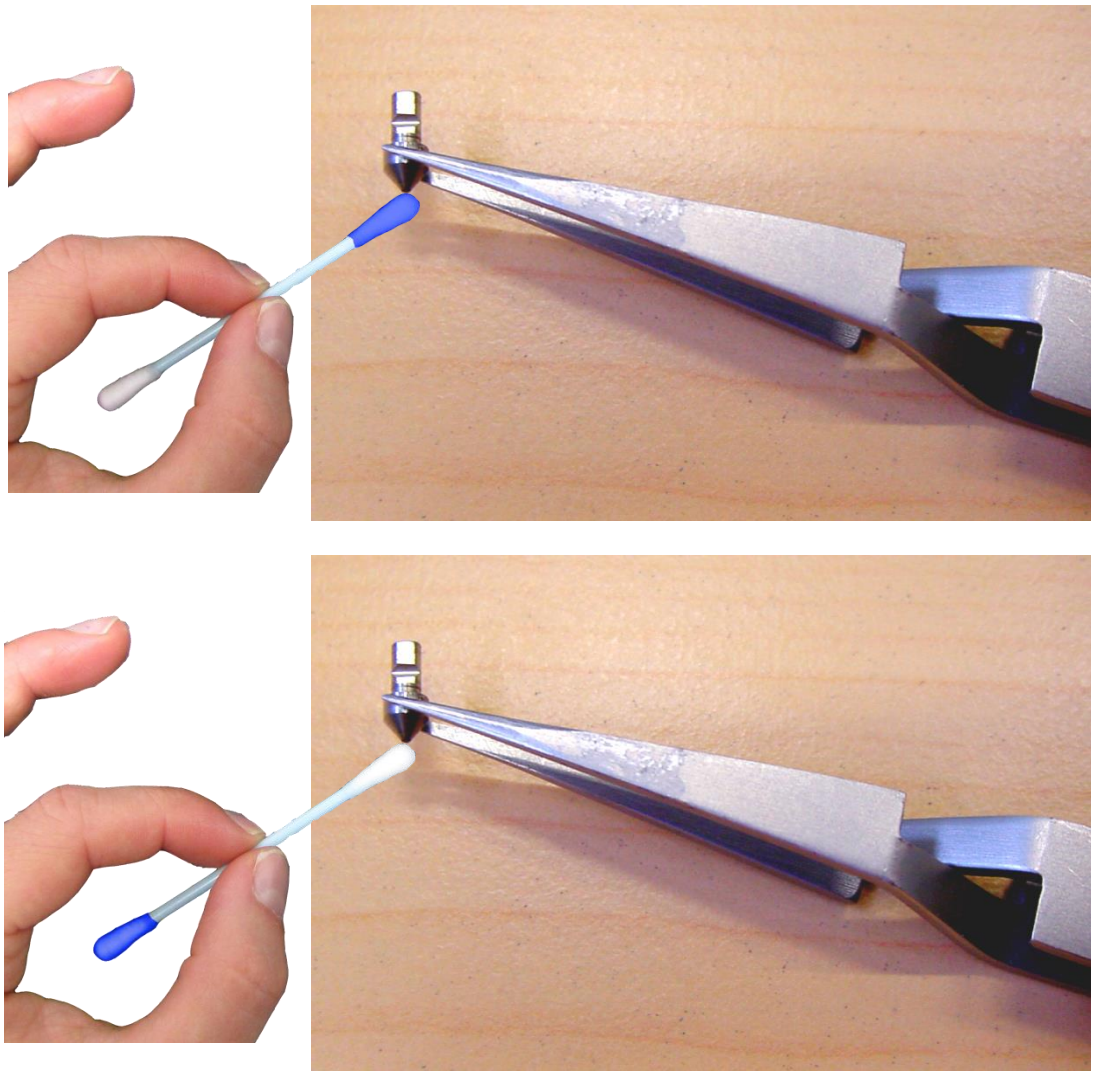
Slowly pull the indenter **vertically** up and release it; it should smoothly slide out from the glass block.

Being careful to **not** touch any part of the indenter and reference axes, **gently** open and remove the special exchange tool V2.

5.6.1.3 Cleaning the indenter with isopropanol

⚠ It is recommended to clean the indenter when it is **not** mounted on the head.

Hold the indenter by its shaft using the self-closing tweezers.



For the cleaning details, refer to the ***Step X00 Instruction manual and safety information*** in section ***Upkeep and cleaning / Cleaning the indenters***.

5.6.1.4 Installing the indenter/reference

Choose a suitable and cleaned indenter (section 5.6.1.3) for the indentation measurement.

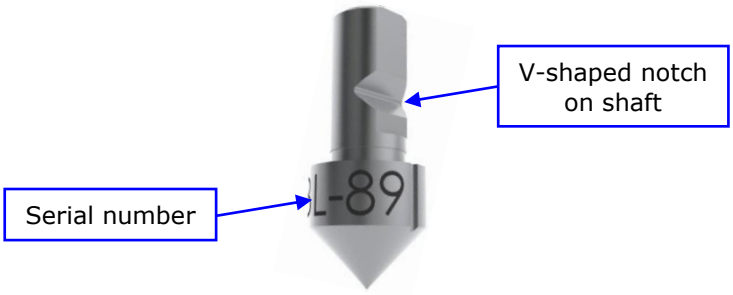
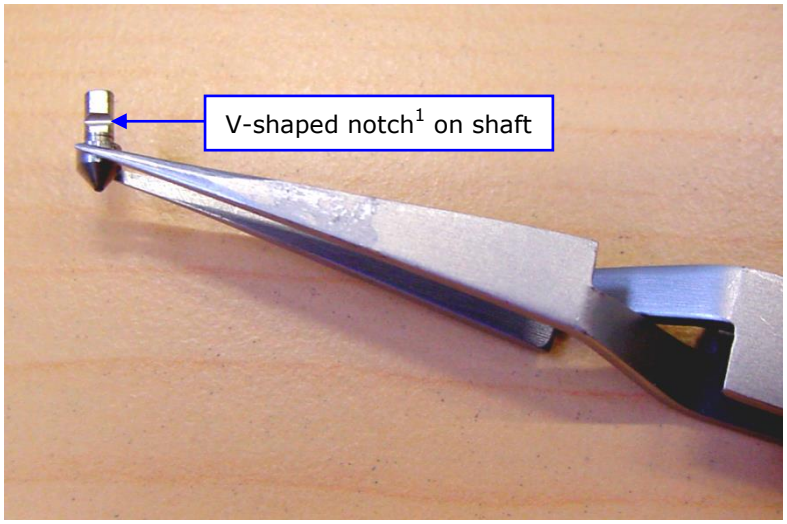


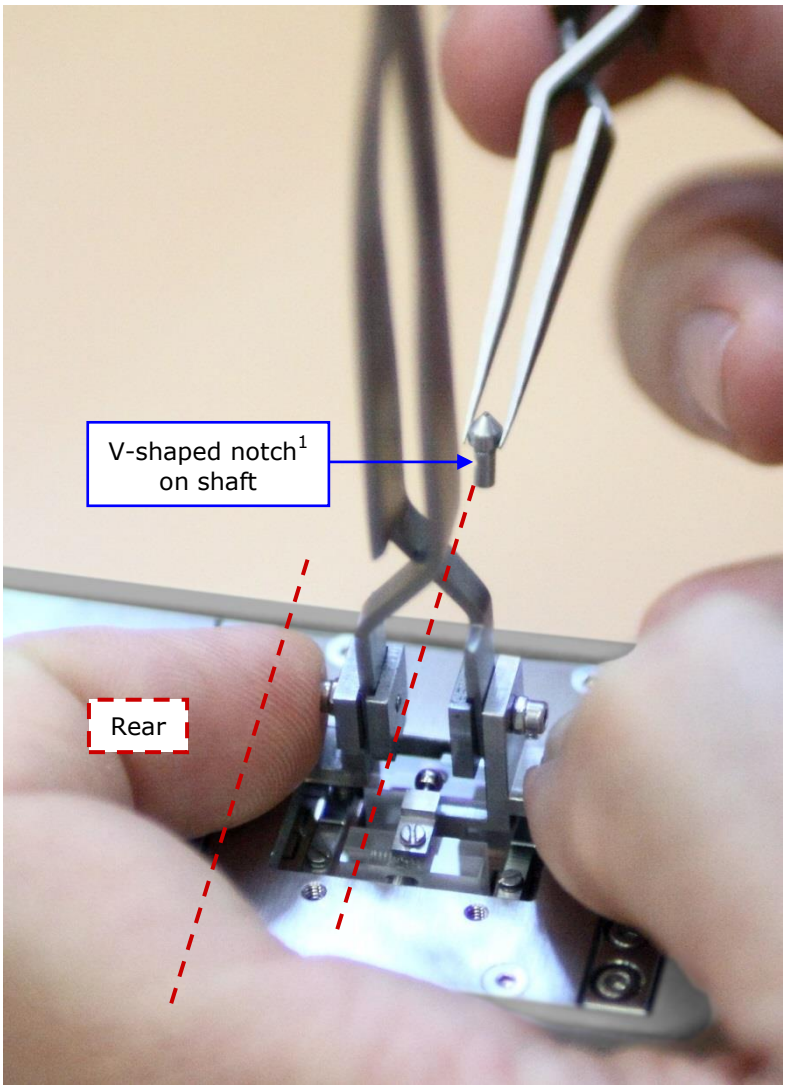
Fig.7 Berkovich indenter

E.g. a **Berkovich** indenter is chosen; the image shows a serial number **B**-L 89 but in this manual, the **B**-Q 03 will be used.

⚠ Go to section 5.6.1.2 to carefully read all warnings and instructions until **End of special exchange tool V2 installation**. Then come back here and continue to read the following steps.



Carefully take the indenter by its head (wider part ending with the indenter diamond extremity) in the (standard) self-closing tweezers.



Still press lightly on both larger and smaller locating tabs and keep holding.

Make sure that the V-shaped notch[1] on indenter shaft faces the head rear and is perpendicular to the glass block length.

With the (standard) self-closing tweezers, insert the indenter into the dedicated indenter glass block opening; it should smoothly slide into.

⚠ Being careful **not** to touch any part of the indenter and reference axes, **gently** open and remove the special exchange tool V2.

The indenter is locked as the released spring pushes the dumbbell into the V-shaped notch (inside the glass block).

[1] ⚠ *On the other side of the indenter shaft, there is **no** notch - only a flat (dedicated for another measuring head), do **not** orient this flat facing the head rear. Otherwise the indenter will **not** be locked.*

5.6.1.5 (Re)installing the head

Perform the manipulations described in section 5.6.1.1 (removing the head) in the **reverse order** to (re)mount the head (together with the mounted indenter and reference), **being careful** of the following steps:

- Push on the stand while tightening the 2 head locking screws.
- Hold/retain the stand while unscrewing and removing its 2 locking screws to avoid that the stand fall down and damage the head/instrument.
- Only after the reconnection of the connectors, switch on the instrument and then restart the software.

5.6.1.6 Cleaning the indenter by indentation

The indenter cleaning has been previously done before installing the indenter on the head (section 5.6.1.3). However, an indentation at 50 mN in copper can be performed to remove any remaining dirt.

5.6.2 MANAGEMENT

Create and/or select the indenter which is mounted on the head (**"Indenter in use"** drop-down menu) as follows.

Select **"Instrument > Indenters..."** from menu bar to open the following *Edit indenters* window (Fig.8).

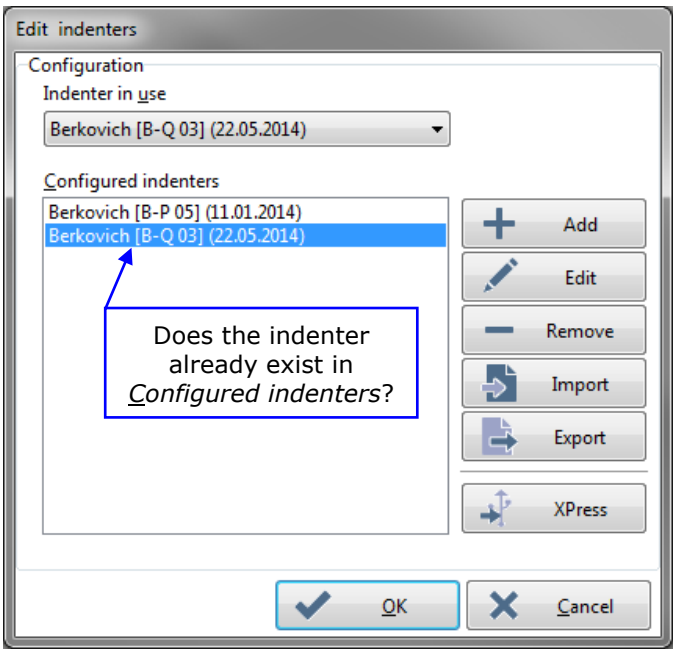


Fig.8 Indenter(s) creation and/or selection

If the indenter already exists in *Configured indenters* and a new calibration is **not** necessary, select the indenter in use, p. 35 and later **skip** section 5.13 (calibration).

OR

If the indenter already exists in *Configured indenters* and a new calibration is necessary, it is advised to create a new indenter below.

OR

If the indenter does not exist in *Configured indenters*,

create a new indenter

by clicking <Add> button.

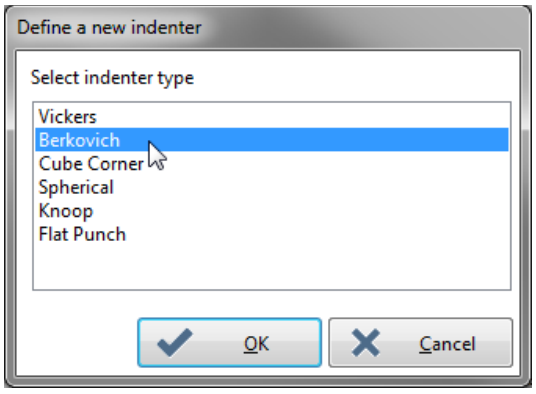


Fig.9 Berkovich type is selected

This *Define a new indenter* window appears.

Double click on the new indenter type.

The following *Indenter properties* window appears (Fig.10).

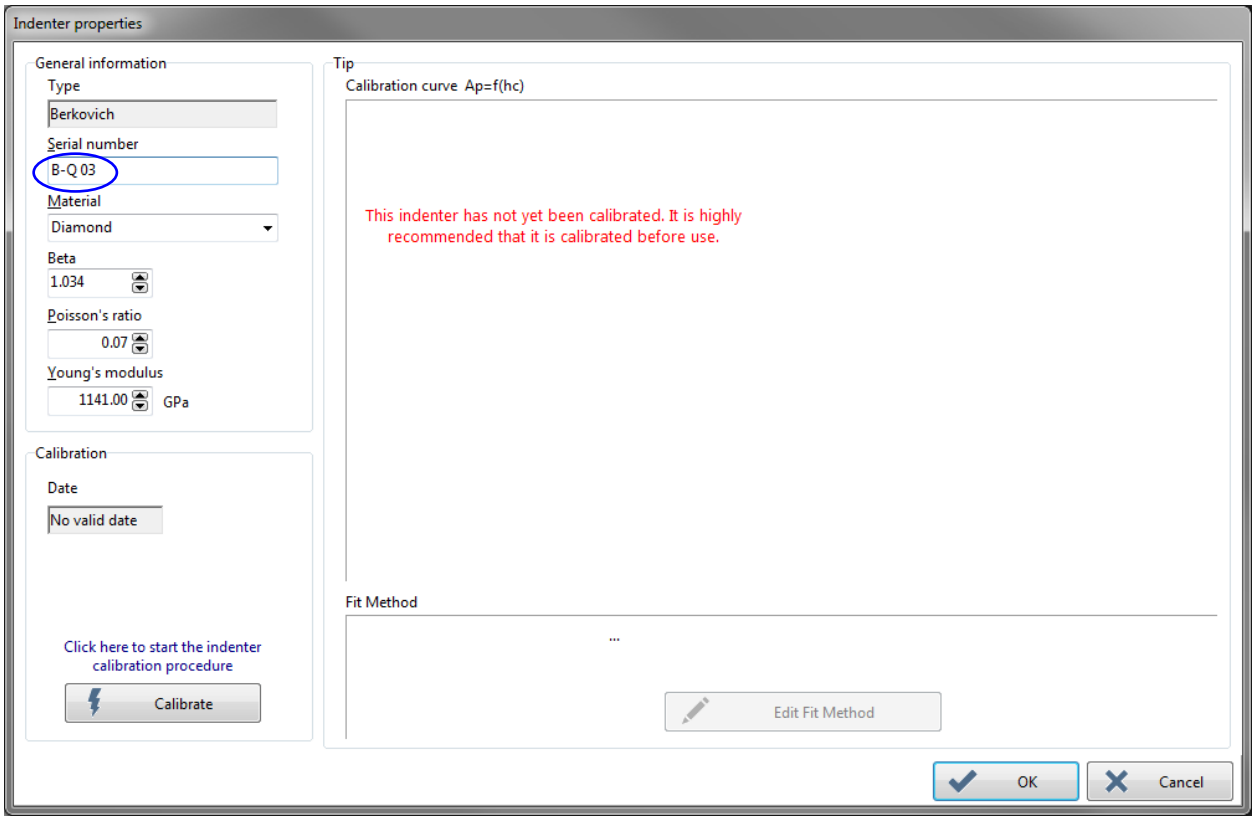


Fig.10 Define at least new indenter serial number

Refer to the new indenter certificate to type its *Serial number* [1] in the corresponding filed name (e.g. B-Q 03).

If necessary:

- Choose another material than diamond; type/edit or select it from **"Material"** combo-box.

- Theoretical *Poisson's ratio* and *Young's modulus* field values can be changed.
- *Beta* field coefficient value can be changed.

Click <OK> button (validation and creation).

[1] *See section 0 to localize the serial number directly on the indenter.*

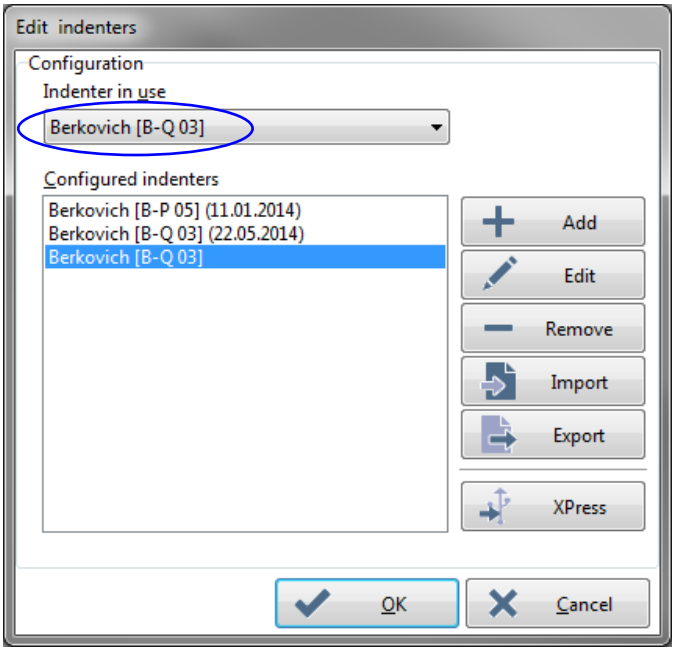
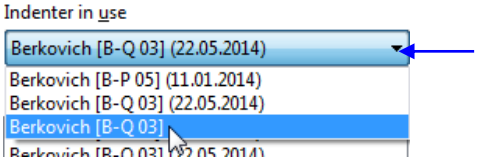


Fig.11 New indenter is selected

If <OK> button is directly clicked, the new indenter creation (in *Configured indenters*) is validated and saved but **not** selected; therefore,

select the indenter in use

from **"Indenter in use"** drop-down menu



and then click <OK> button (validation and saving).

5.7 SAMPLE HOLDER

If necessary, the height of the beam (where the measuring and imaging heads are mounted on) can be adjusted, depending on the height of the sample/sample holder in use; refer to the ***Step X00 Instruction manual and safety information*** in section ***Operating the instrument / Adjusting beam height***.

Reminders:

- See Universal adapter mounting/dismounting (section 5.2).
- ⚠ Each time the sample (the same or a different one) is re/installed in the sample holder, an ADO **should** be successfully (ADO) performed (section 5.11).
- ⚠ **Avoid** any collision with the heads, indenter/reference and objective(s) when a sample/holder is removed or installed/mounted.

ℹ The universal sample holder is used as an example in this document.

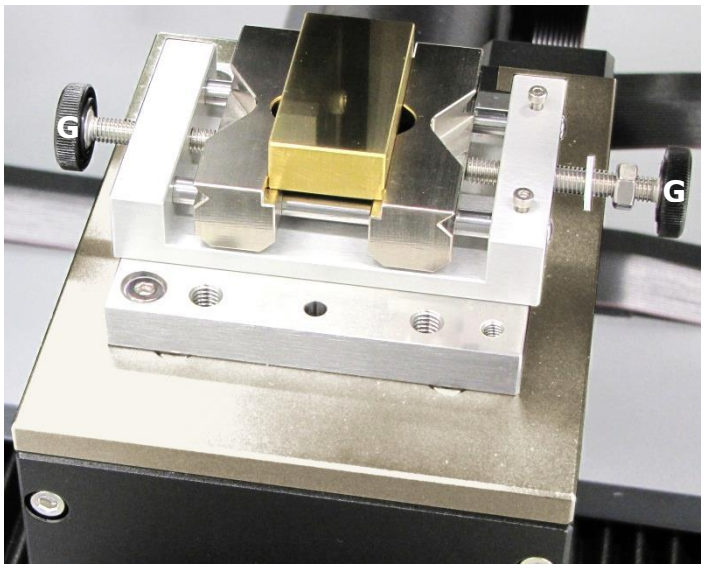


Fig.12 Sample solidly mounted in universal sample holder

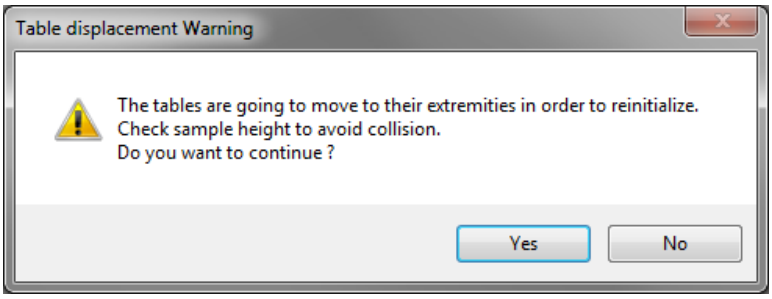
Mount the universal sample holder (2 screws[1] under clamp jaws) on the universal adapter.

Then install the sample as level as possible in the clamp jaws and tighten the 2 hand screws **G** to make sure that the sample remains solidly clamped.

[1] *Use Allen key 2.5 mm.*

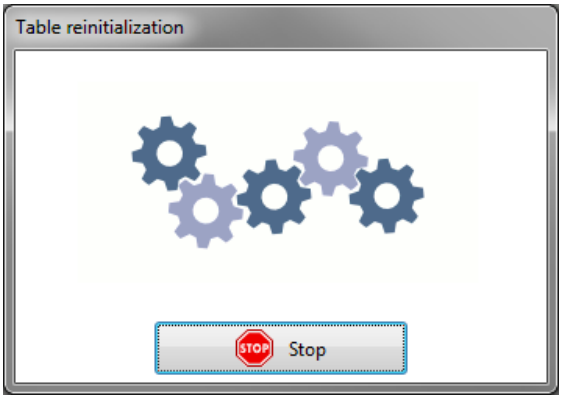
5.8 POSITION CONTROL

Select **"Instrument > Position control..."** from menu bar or click *Position control* icon on toolbar to open the *Position control* window (Fig.13).



After each power on of the Step, the software requires a reinitialization of the motorized tables before moving them.

Verify the sample height to avoid a collision and then click <Yes> button.



The motorized X and Y tables move to their extremities; wait.

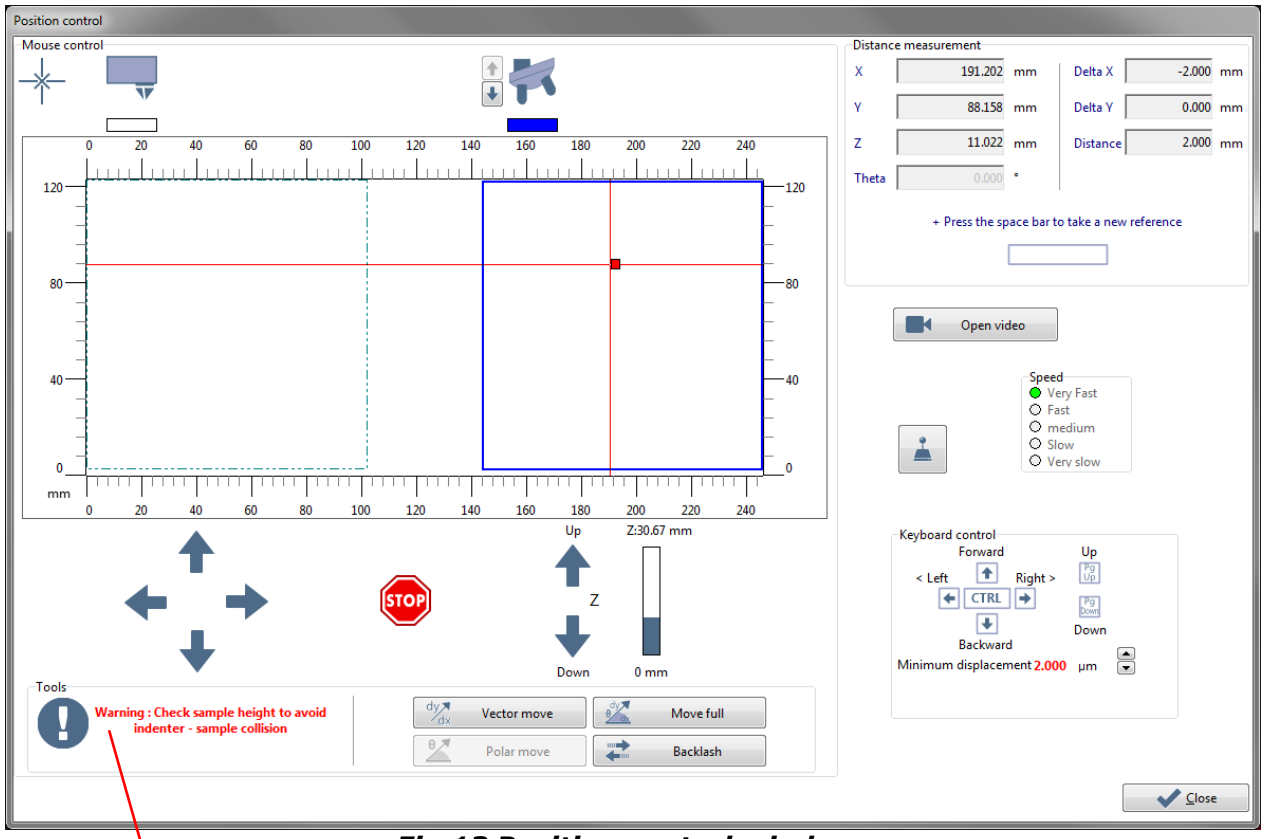


Fig.13 Position control window

Always avoid any collision with heads/indenter/reference/objective in use

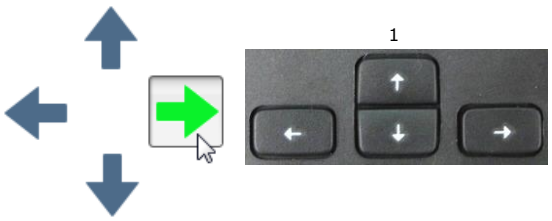
The Methods to move the motorized tables/sample either under the indenter, the video microscope or the optional AFM[1] are described on the following page (p. 39).

Read also Motorized video microscope module, p. 40.

[1] *Refer to the* **Common Scratch & Indentation software reference guide** *in section* **AFM measurement** *or refer to the* **AFM Wide Scan user manual**.

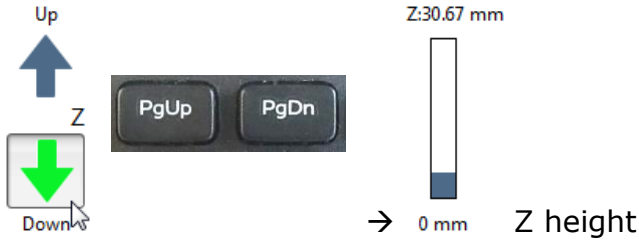
Methods to move

Some of the following methods are also applicable to other places in the software, **exceptions:** All '*arrow*' icons and vector move buttons are only available here in the *Position control* window (Fig.13).



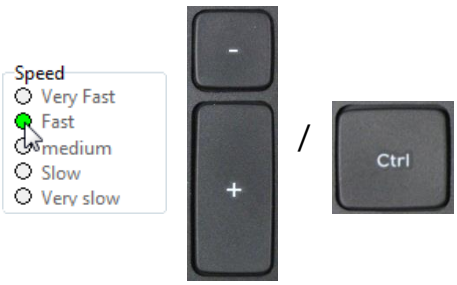
<u>To move motorized X, Y tables/sample</u>

One at a time, keep clicked one of '*directional arrow*' icons
OR
Keep pressed one of <'directional arrow'> keys[1]



<u>To move motorized Z table/sample</u>

Keep clicked *Up* '*arrow*' or *Down* '*arrow*' icon
OR
Keep pressed <PgUp> or <PgDn> key.



<u>To change moving speed</u>

Select one of *Speed* radio buttons
OR
Press <–> or <+> keys.

If <Ctrl> key is keep pressed before moving with the above methods, it increases the selected speed.

<u>Vector move buttons</u>

Click <Vector move> button and set values in the window which appears to move accordingly motorized X and/or Y tables. Clicking <Move full> button is similar but with motorized Z table in addition (the moving speed is automatic) **verify** the sample height to **avoid collision**.

<u>Backlash correction</u>

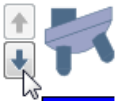
To achieve better final position accuracy, one can click <Backlash> button.

<u>Closing</u>

Click <Close> button to exit *Position control* window. The Z table is retracted (moving down).

[1] *Each single hit on one of* 'arrow' *keys corresponds to a single* Minimum displacement*:*
Click 0.250 µm *to decrease it (min.) or* 50.000 µm *to increase it (max.).*

Motorized video microscope module

If the video microscope module is motorized, **ensure** first that there is no **risk of collision** and then click  to lower the video microscope.

Click  to raise the video microscope.

5.9 VIDEO

To open the following *Video* window (Fig.14) from *Position control* window (Fig.13):

- *Click to move under the microscope*  icon. The sample moves under the video microscope (if it is not already there).

OR

- Click <Open video> button.

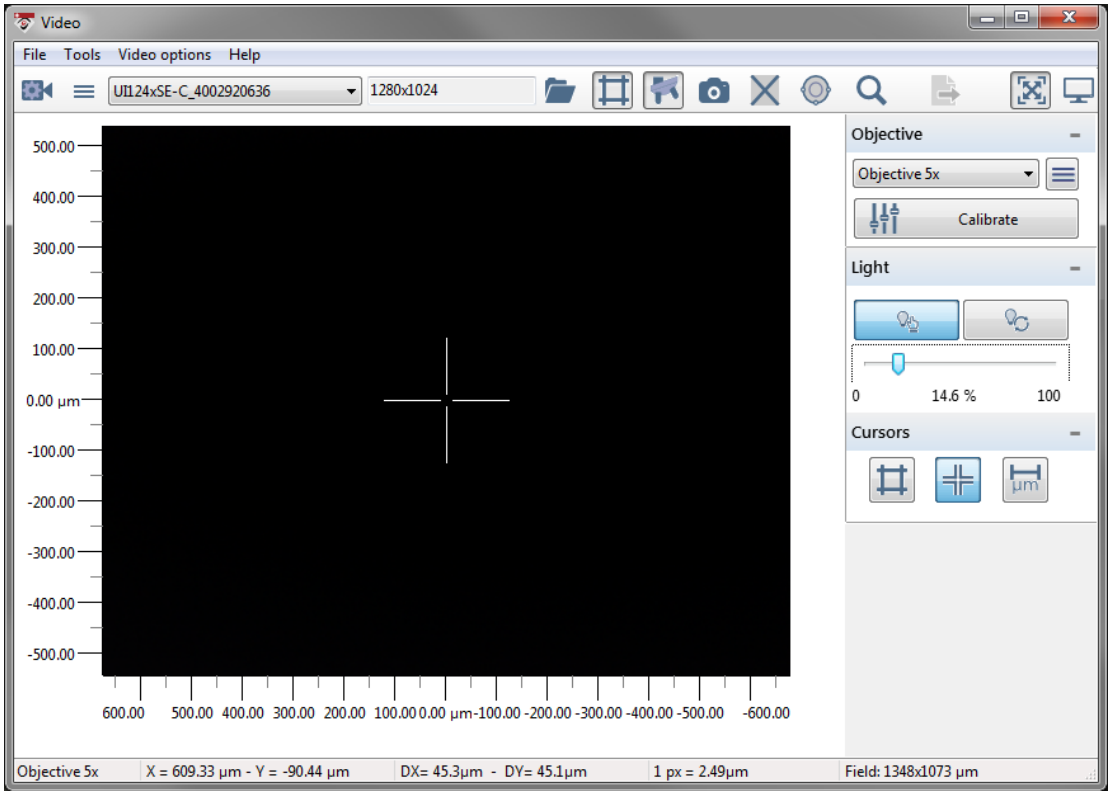
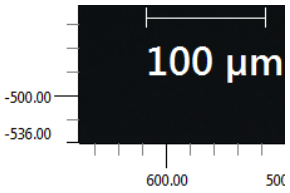


Fig.14 Video window

Click *Cursors*  icon on toolbar to open the following *Cursors* toolbox.

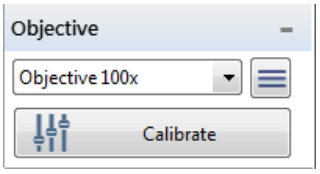


Click <*Crosshair*>  button to display the video crosshair on the middle of the screen (Fig.14).

(Click <*Scale*>  button to display the scale information on the screen.)

5.9.1 VIDEO MICROSCOPE

Click *Objectives* icon on *Video* toolbar (Fig.14) to open the following *Objective* toolbox.



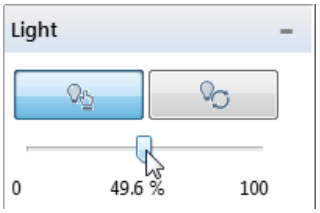
Displayed objective

When either the *Position control* window (Fig.13) or the *Analyze indentation* window (Fig.53) is opened, the displayed magnification of the objective should match the magnification of the hardware objective into working position; otherwise see section 5.4.

Front view

Manipulate only the turret (part with knurling, indicated with grey arrows on image) to rotate objectives into their working (vertical) position.

5.9.2 LIGHT ADJUSTMENT



Light intensity

There are 2 ways to adjust the light source of the video microscope:

Manual mode, click <*Manual light adjustment*> button and adjust the intensity in % by dragging the cursor.

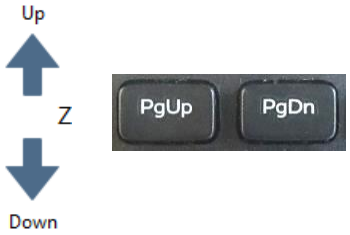
OR

Automatic mode, click <*Automatic light adjustment*> button.

5.9.3 FOCUS ADJUSTMENT

When raising the motorized Z table under the video microscope for the focus adjustment, **be constantly vigilant to avoid** a collision between the sample surface and the objective **but also** between the sample holder/sample surface and the indenter/reference.

Use the *Position control* window (section 5.8) to lower or raise the motorized Z table to adjust the focus on the sample surface using the *Video* screen (Fig.14).



5.10 INDENTER-MICROSCOPE DISTANCE CALIBRATION

This section explains how to prepare and perform the calibration procedure of the distance between the indenter and the video microscope. For more details and information about all features or for a microscope-AFM (optional) distance calibration, refer to the ***Common Scratch & Indentation software reference guide*** in section ***Managing the instrument / Calibration (Common tabs) /*** there are several sub-sections.

The round copper sample (provided) is usually used for this calibration.

As an example in this section:

- Another type of measuring head with Vickers indenter is used for the print screens, but the following explanations remain the same or are adapted for UNHT^3 with Berkovich indenter.
- The video microscope is equipped with the standard 5x objective and optional 20x and 100x objectives. See section 5.9.1 to know how to properly rotate the video microscope turret during the following calibration procedure.

5.10.1 SAMPLE HOLDER

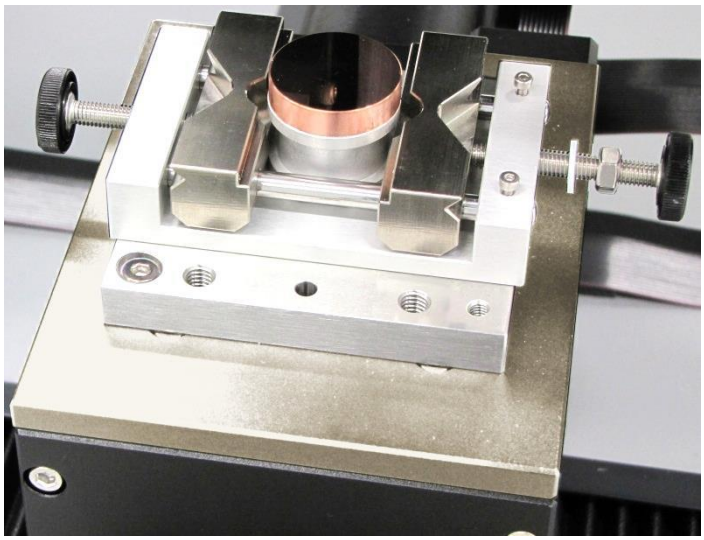
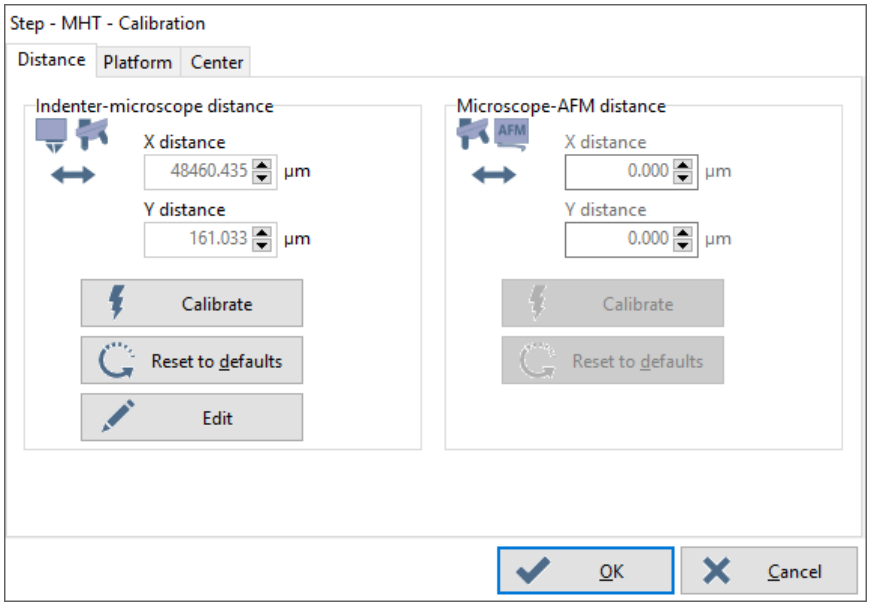


Fig.15 Copper sample/stud solidly mounted in universal sample holder

Properly mount the sample; **read** section 5.7 for explanations and **warnings**.

5.10.2 START CALIBRATION

Select **"Instrument > Calibration..."** from menu bar to open the following *Step - UNHT - Calibration* window.



Select *Distance* tab.

Then click <Calibrate> button to start the calibration procedure. The following window appears.

Fig.16 Distance tab

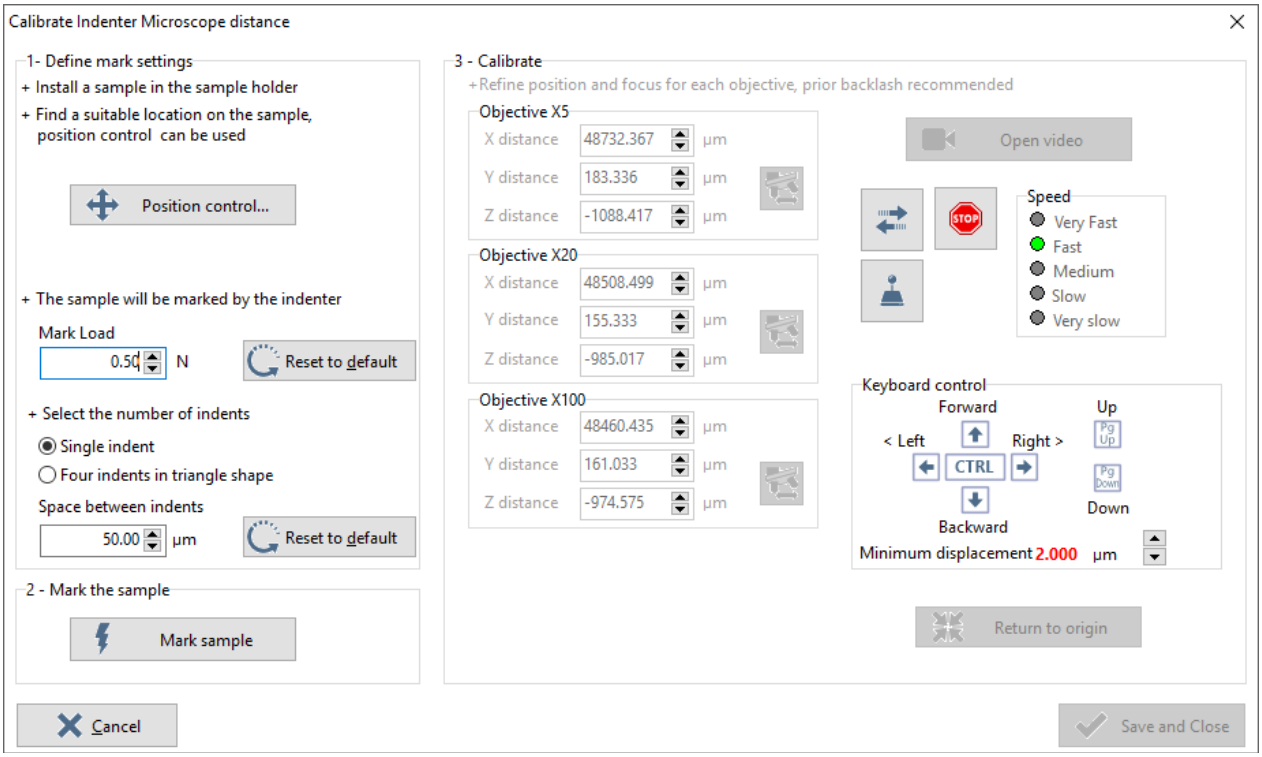


Fig.17 Calibrate Indenter Microscope distance window

See the following procedure explanations.

1. Define mark settings

Location

If it has not been done previously, move the sample under the video microscope to find a location[1] free of previous indents and clean, in order to perform the indentation mark(s) for the calibration.
To do this, click <Position control…> button (see explanations from Fig.13) and also use the *Video* window (section 5.9).

Load

In *Mark load* field, set a suitable value to generate a visible indent in the sample:
50 mN (0.05 N) is advised for copper sample and Berkovich indenter (Fig.17 shows 0.5 N (500 mN) which is suitable for another measuring head/ indenter).

INFORMATION: *If the load value is too big, the mark will be too large to fully see it on the* Video *screen for a high magnification objective (e.g. x100). But if the load is too low, the mark will be too small to see it on the* Video *screen for the x5 magnification objective.*

Number of mark(s)

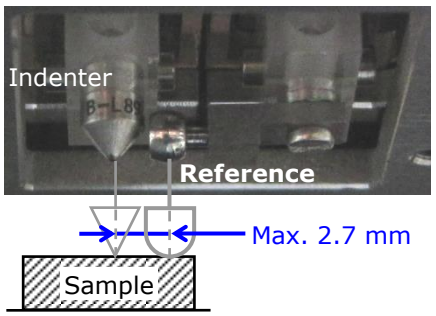
E.g. <single indent> radio button is selected, only one indentation mark will be performed (we assume a previous calibration has been done, otherwise the 4 indents in triangle shape should be used to better localize them on the sample with the *Video* screen).

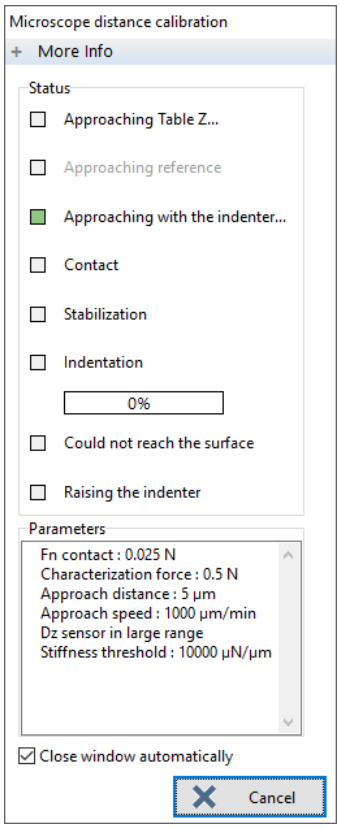
2. Mark the sample

Click <Mark sample> button to start the automatic indentation process, in order to mark the sample.

If the sample is located under the video microscope, a *Warning* window asks to move the sample under the indenter. ⚠ **Verify** the sample height to avoid a collision and then to continue, click <Yes> button (sample moves under the indenter; wait).

[1] ⚠ *The reference **should** be able to land on the sample as shown here.*





As soon as the sample is under the indenter, the *Microscope distance calibration* window appears for the automatic indentation process. This window is similar to the ADO window (see similar explanations from Fig.25) but here it is used only to mark the sample (automatic parameters).

At the end of the automatic process, another *Warning* window asks to move the sample under the indenter (for the calibration). **Verify** the sample height to avoid a collision and then to continue, click <Yes> button (sample moves under the microscope; wait).

3. Calibrate

Each available objective of the microscope should be calibrated one at a time by centering the indentation mark (previously done) on the *Video* screen.
It is advised to start with the smallest magnification x5.

Calibration procedure

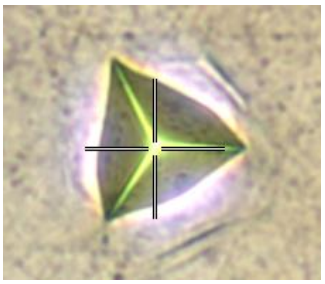
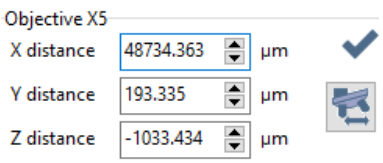


Fig.18 Real pyramid mark (e.g. centered with x100 objective)

INFORMATION: *The sample mark under the* Video *screen is identical as this image (Fig.18), that is to say a pyramidal mark made with Berkovich indenter in copper sample. The following images show a square mark, made with a different measuring head and indenter (Vickers), but the explanations remain the same.*



Correctly rotate the microscope turret to place the objective into working position → The corresponding *Objective X#* (e.g *X5*) *area* fields become active with the current *X*, *Y*, *Z distance* values (coming from the previous calibration).

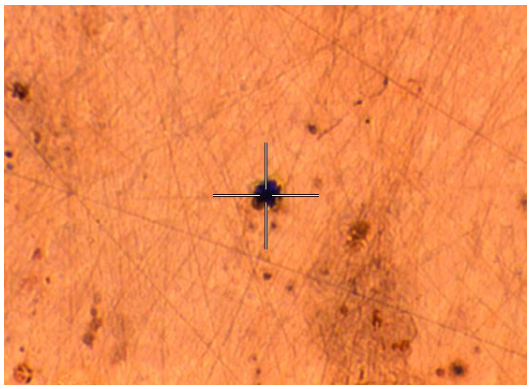


Fig.19 Mark centered on Video screen with x5 objective

Use Methods to move, p. 39 (**exceptions:** All '*arrow*' icons and vector move buttons) to precisely center the middle of the indentation mark on the *Video* screen crosshair and also correctly adjust the focus on the sample surface (if necessary, click <Open video> button to reopen the *Video* window). Then click *Redefine calibration distance indenter microscope from this new point*  icon in the active *Objective X#* area to valid the current positon/focus → a 'tick' icon appears.

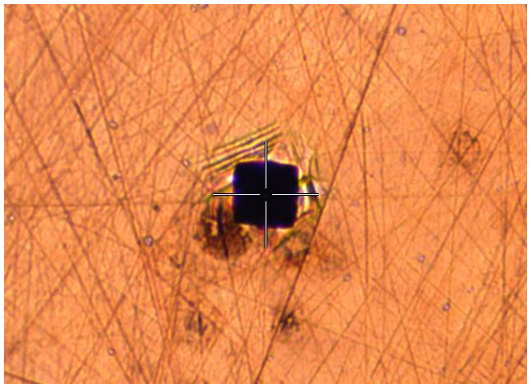


Fig.20 Mark centered with x20 objective

One at a time, repeat the previous calibration procedure for the remaining available objective (e.g. x20 and then x100).

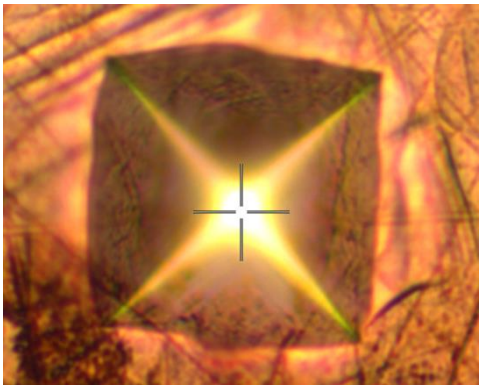


Fig.21 Mark centered with X100 objective

INFORMATION: *In case of<Four indents in triangle shape> radio button has been previously selected, center the indentation mark located* ***at the middle*** *of the triangle shape (for each objective).* E.g pyramidal marks made with Berkovich indenter.

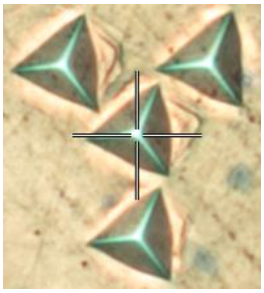


Fig.22 Middle mark centered

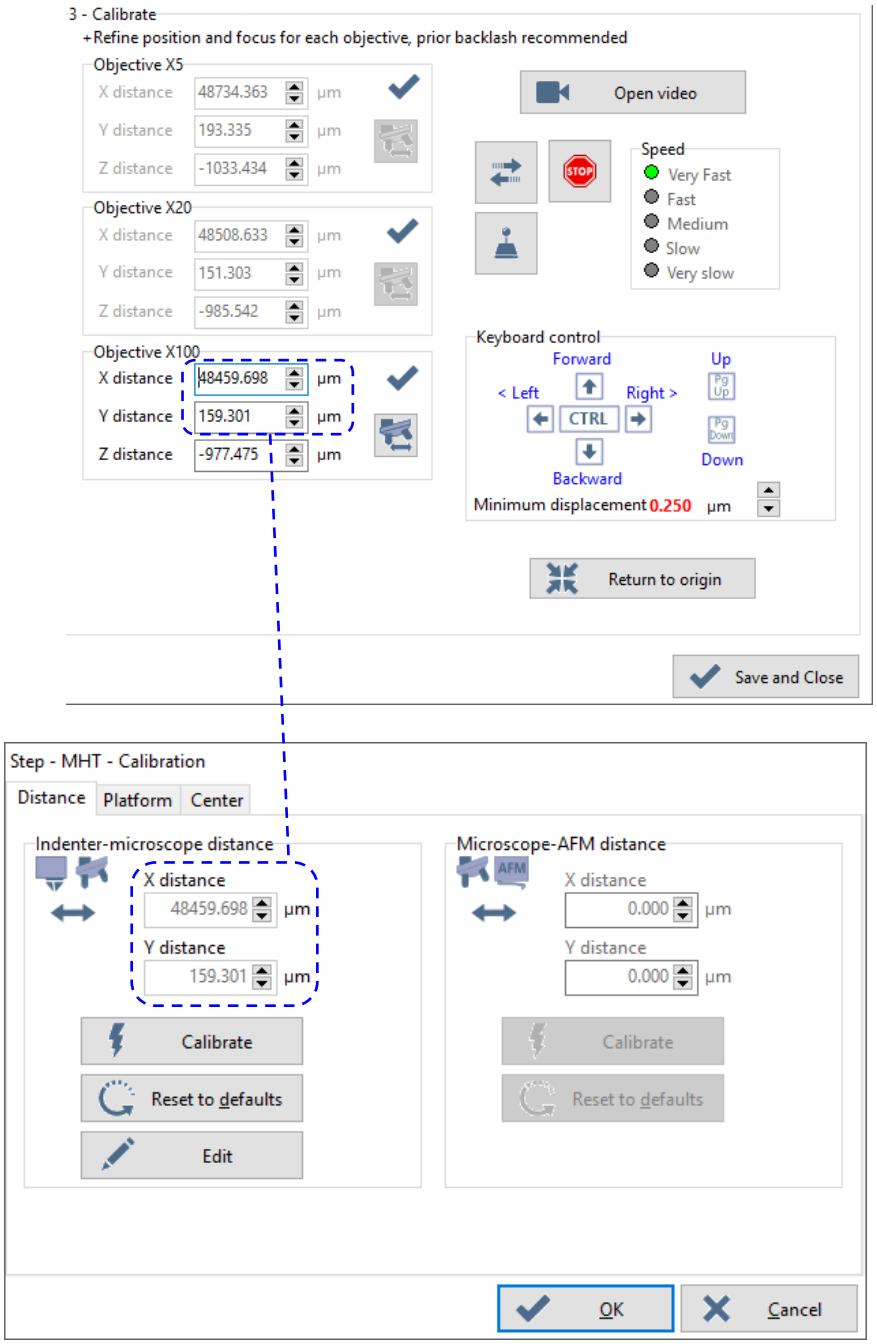


Fig.23 Distance tab with new values

When all available objective(s) are centered and validated, click <Save and close> button which becomes active (validation).

Only the new calibration values of the highest magnification (e.g. x100) are copied in *X* and *Y distance* fields.

Click <OK> button (validation and saving).

5.11 ADJUST DEPTH OFFSET (ADO)

Each time the indenter/reference or the sample is changed, or the topography on the sample area varies, an ADO procedure should be started:

- Because of the vertical variation between indenter and reference.
- To optimize duration of measurement(s).

On toolbar, the icon shows the state of the last ADO:
Successful → *ADO* icon with a green tick
OR
Not-successful → *ADO* *icon* with an arrow

See the following sections which explain how to perform a successful ADO. For more information about the ADO and its detailed features, refer to the ***Indentation software reference guide*** in section ***Adjusting depth offset (ADO)***.

5.11.1 FIND ADO LOCATION

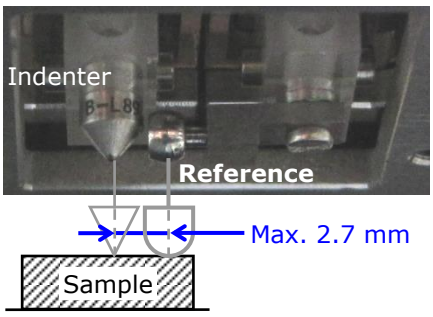
Move the sample under the video microscope to find a location[1] free of previous indents and clean, in order to perform the ADO indent; use the following tools:

- *Position control* (section 5.8)
- *Video* (section 5.9)

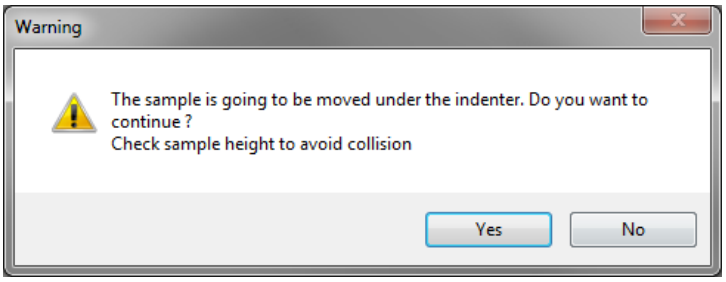
5.11.2 STARTING

Select **"Instrument > Adjust depth offset..."** from menu bar or click *ADO* / icon on the toolbar to start the ADO procedure.

[1] *The reference **should** be able to land on the sample as shown here.*



5.11.3 PROCEDURE



If the sample is located under the video microscope, this *Warning* window appears.

Verify the sample height to avoid a collision.

To continue click <Yes> button, the sample moves under the indenter; wait.

The following *Adjust depth offset parameters* window (Fig.24) appears.

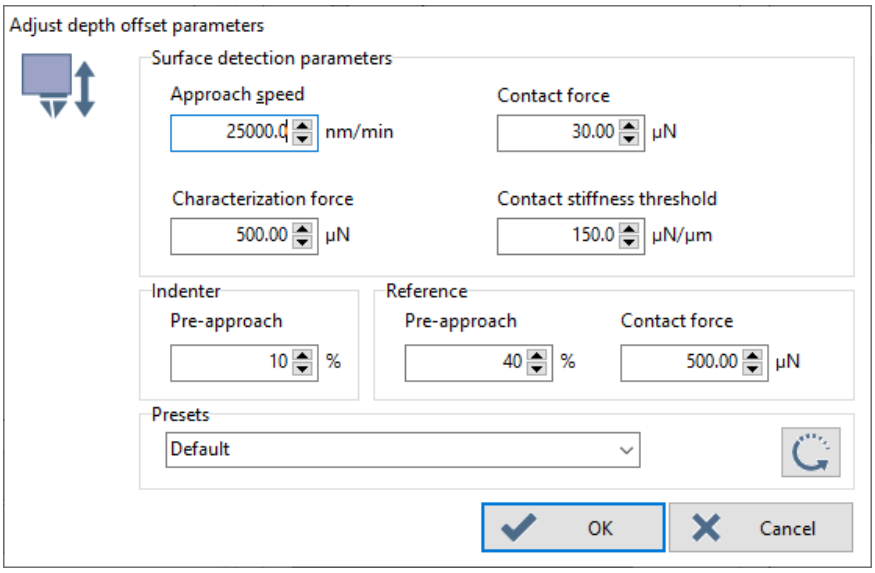


Fig.24 ADO parameters

Set the ADO parameters according to the sample in use/application. Parameters shown on Fig.24 are coming from the **"Presets > Default"** drop-down menu and are generally suitable to perform a successful ADO ( ) with hard samples.

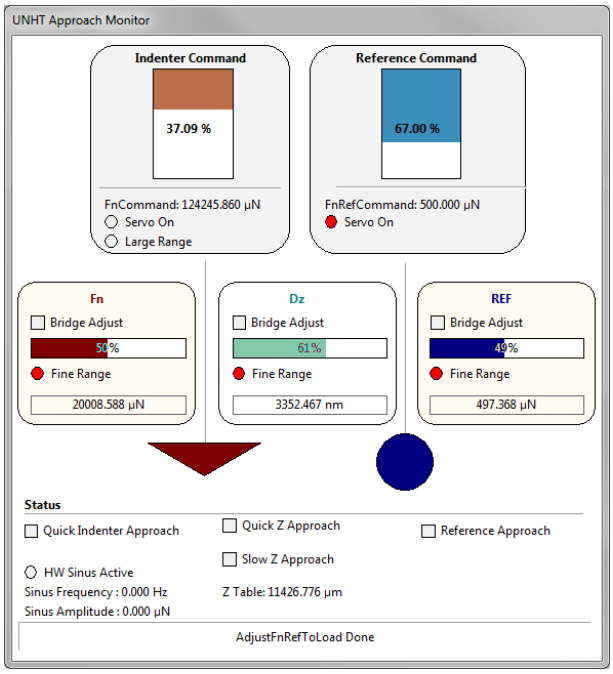
It is advised to never set a value greater than 70 % in *Reference* area *Pre-approach* field and lower than 5 % in *Indenter area Pre-approach* field.

Where 100 % means lower position of actuators displacement, it is the rest position.

Initial positions:

- Motorized Z table is at 0 mm, in lower (retracted) position.
- Indenter and reference are at 100 %, in lower (rest) position.

Click <OK> button. The following *Adjust depth offset in progress* window (Fig.25) appears and an automatic procedure starts.



This extra *UNHT Approach Monitor* window[1] is also present during the measurement.

Automatic procedure

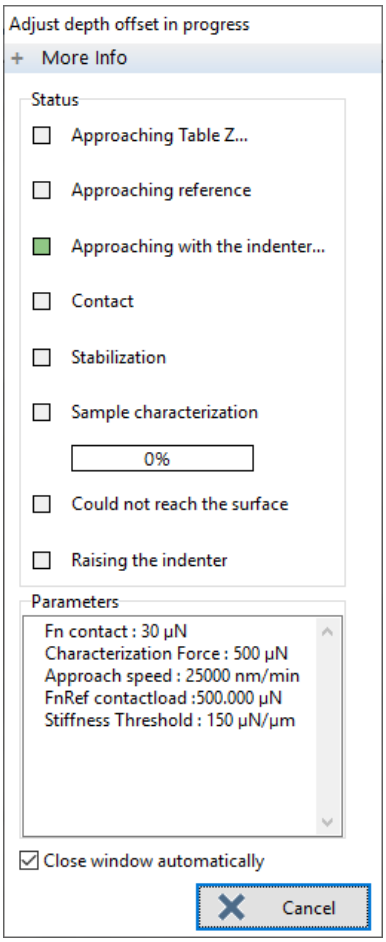


Fig.25 Adjust depth offset in progress window

Wait for the end of the automatic procedure sequences (each current status is shown in real time).
Otherwise if necessary, click <Cancel> button to stop any movements and to cancel the ADO but then, another ADO should be started again until it is successfully (ADO) performed.

[1] *Can be deactivated with the* .ini *file.*

At the end of the automatic procedure, the sample position **should** be shifted[1], in order to **avoid** performing the following calibration or measurement indent inside the current ADO indent. The following window (Fig.26) appears.

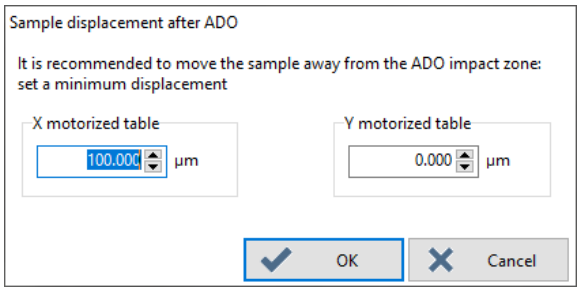


Fig.26 Sample distance displacement after ADO window

Set a **min.** displacement value (depending on current sample material: Approx. 20 x h_m) in *X* and/or *Y motorized table* field(s) and click <OK> button to move accordingly; wait.

OR

Click <Cancel> button and **use** the *Position control* (section 5.8) to **move** the sample into another suitable area.

Control that the ADO has been successfully performed (on toolbar). Otherwise see section 10.4 about a non-successful ADO (on toolbar).

[1] ***Not*** *too much, otherwise the sample topography may vary.*
IMPORTANT: *Pay attention to the displacement unit (e.g. µm here), which is set in the options; refer to the* **Common Scratch & Indentation software reference guide** *in section* **Customizing options / Preferences tab (units)**.

5.12 HEAD DYNAMIC CALIBRATION (WITH SINUS MODE)

The head dynamic calibration, only available with the Sinus mode, should have been performed at least once in order to be able to perform any Sinus measurements, including indenter Sinus calibration.

First it is recommended that an ADO have been successfully (ADO) performed (section 5.11).

Select "***Instrument > Hardware configuration...***" from menu bar to open the following *Step - UNHT - Hardware configuration* window and select *Dynamic ranges* tab.

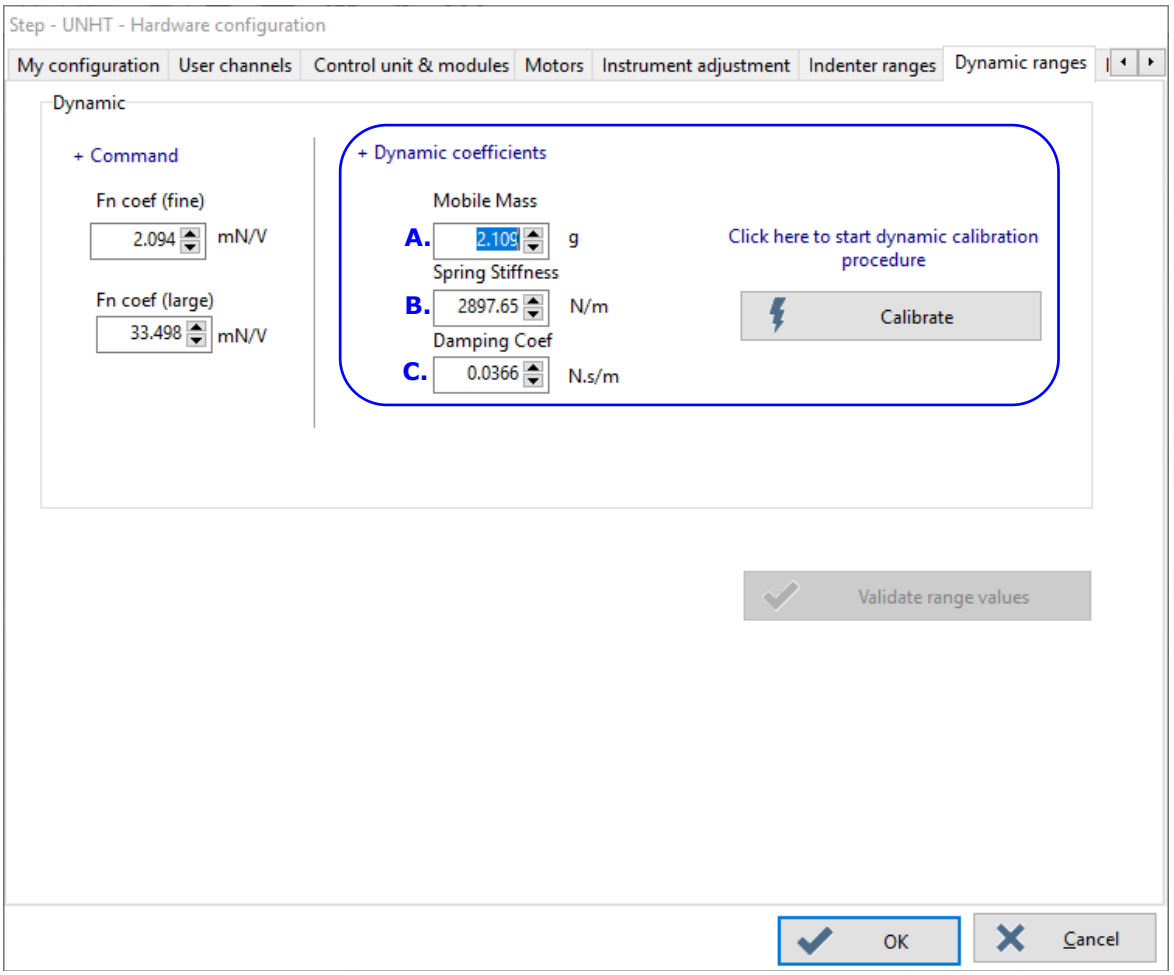


Fig.27 Dynamic ranges tab

Click <Calibrate> button to open the following *UNHT Head Dynamic Calibration* window; if already performed once, this calibration window (Fig.28) contains the last validated values - including the 3 values of Fig.27 - and curves of the previous calibration.

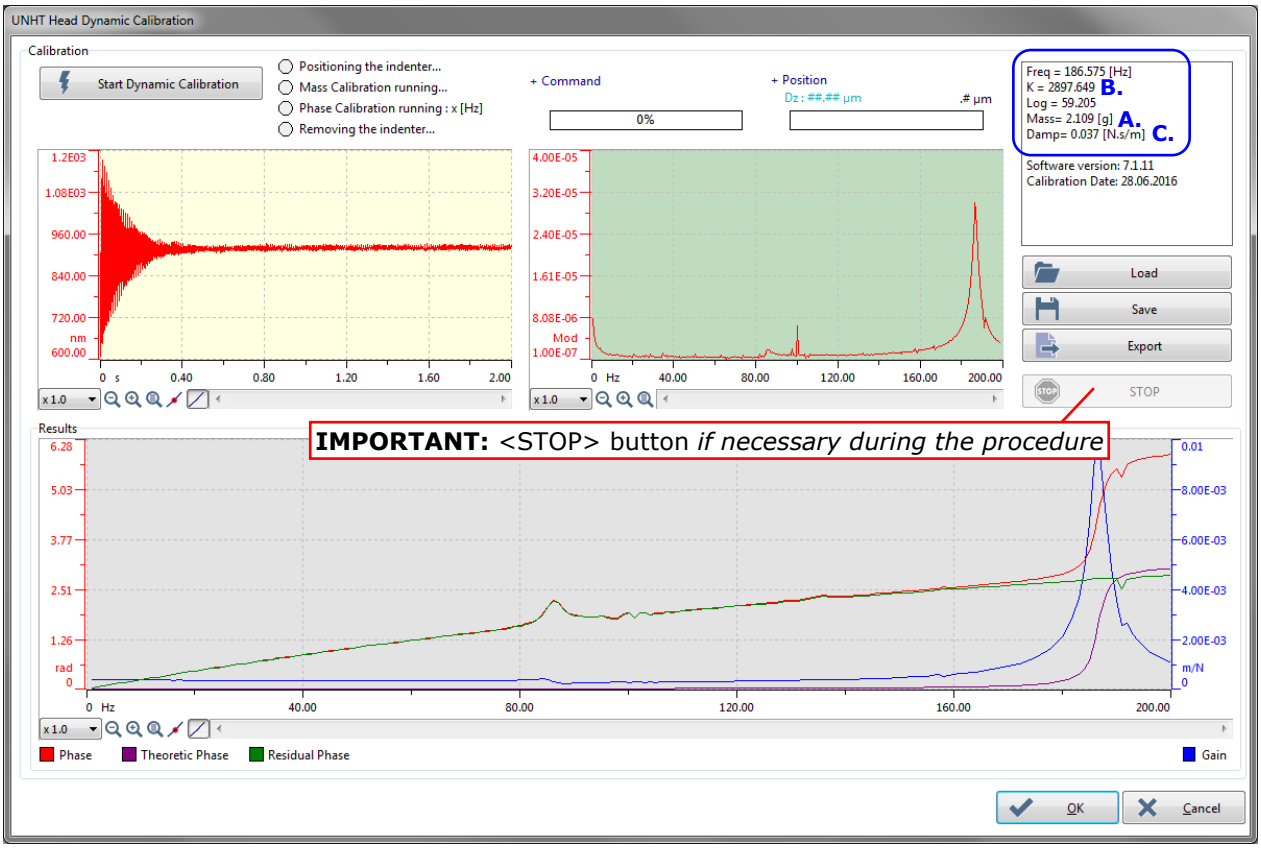


Fig.28 UNHT Head Dynamic Calibration window

Click <Start dynamic calibration> button to start the following semi-automatic calibration procedure.

If an ADO has not been yet successfully performed (ADO) a *Warning* window appears to ask if the dynamic calibration should be started anyway. It is recommended to click <No> button and first perform a successful (ADO) ADO (section 5.11).

Then the following additional *Head position* window (Fig.29) appears.

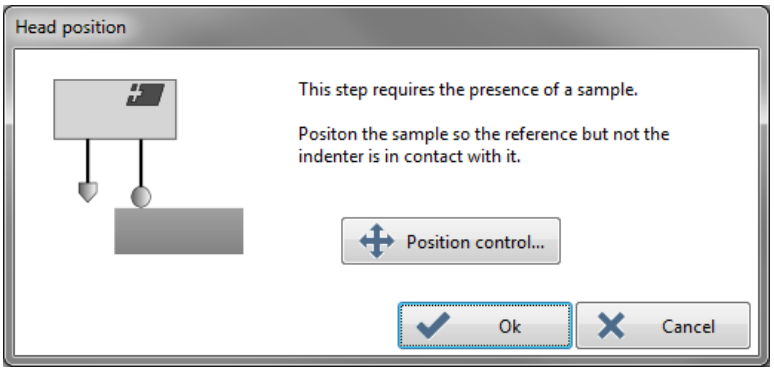


Fig.29 Head position window

Click <Position control…> button (see from Fig.13) and position the motorized X and Y tables in order the sample extremity is located under the UNHT^3 reference only, **not** under the indenter. ⚠ If the motorized Z table is manually raised (to better targeting), **never** touch the sample surface with the reference (/indenter).

Reminder:

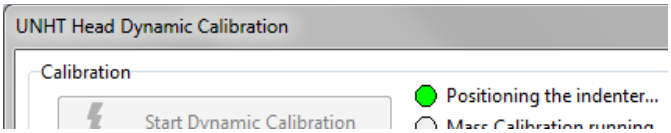
The spacing distance between the standard indenter and reference is: 2.7 ±0.1 mm

Before clicking <Ok> button to continue, be aware that in *UNHT Head Dynamic Calibration* window (Fig.28), <STOP> button will be active and can be clicked if necessary to interrupt any movement.

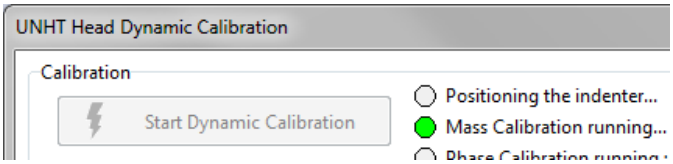
Then the motorized Z table automatically approaches (raises) until the sample surface contact the reference.

An *ADO in progress* window appears (it is similar than Fig.25, but here it is used only for the following head dynamic calibration; there is no need to set any ADO parameters).

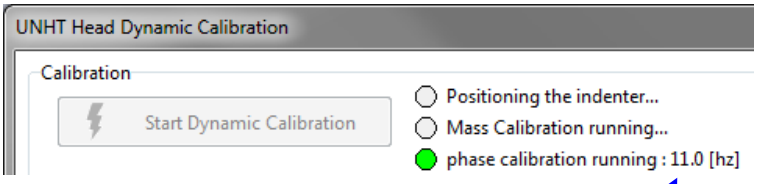
In *UNHT Head Dynamic Calibration* window (Fig.28)



1. *Positioning the indenter…* circle status blinks green; wait a few sec, the indenter is positioned at the displayed value.

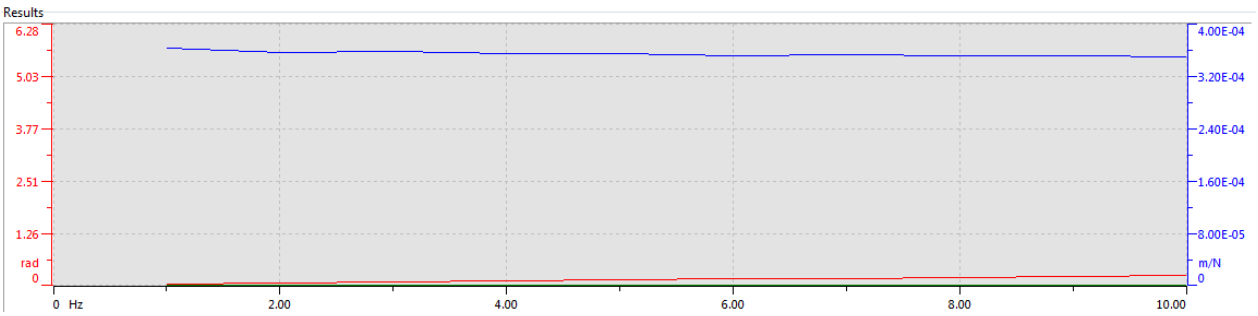


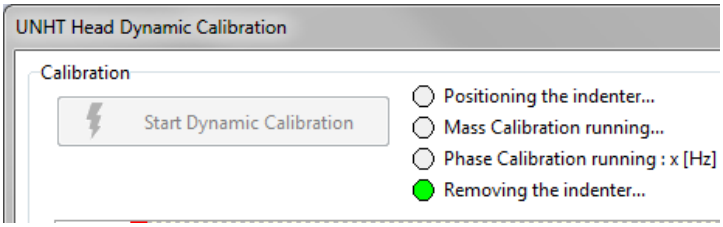
2. *Mass Calibration running…* circle status blinks green; wait a few sec, the mass calibration runs (the curves in the 2 upper graph areas are displayed/updated).



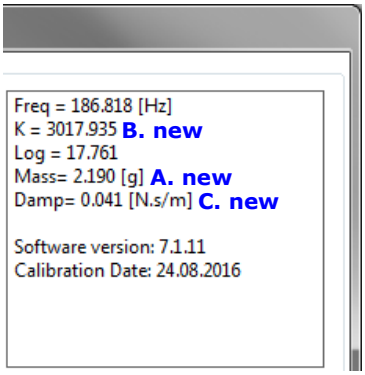
3. *Phase calibration running* circle status blinks green; wait some minutes:

The phase calibration runs: the frequency value increases (till 100 Hz) and the measurement curves are displayed on real time in the *Results* bottom graph area.



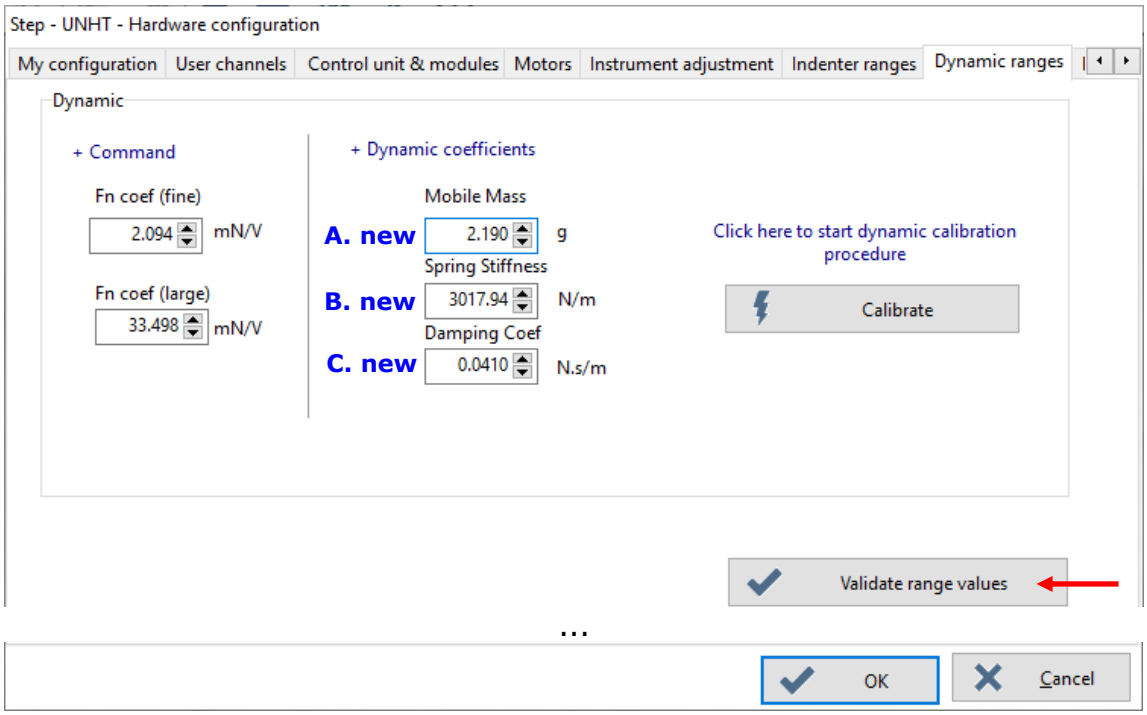


4. When the phase calibration measurement is done, the indenter and reference are retracted: *Removing the indenter…* circle status blinks green; wait a few sec.



The new calibration values are updated on the top right corner of the main window and all new curves are displayed accordingly in all graph areas.

Click <OK> button at the right bottom of the window (validation).



Back in *Hardware configuration* window, the 3 new *Dynamic coefficients* field values are automatically updated according to this last performed dynamic calibration.

IMPORTANT:

- *Do not forget to click* <Validate range values> *button (validation of these new range (calibration) values) and then click* <OK> *button (saving).*
- As new range values have been validated, a new and successfully (ADO) ADO should be performed (section 5.11).

5.13 CALIBRATION OF INDENTERS (QUASISTATIC OR SINUS)

The calibration of indenters can be either performed with the standard quasistatic **or** Sinus method; in case the Sinus calibration is selected, the dynamic calibration should have been previously performed (section 5.12). The quasistatic calibration is used as an example in this document, but specific explanations for the sinus calibration are described in addition.

It is highly recommended to perform a calibration of the indenter in use if:

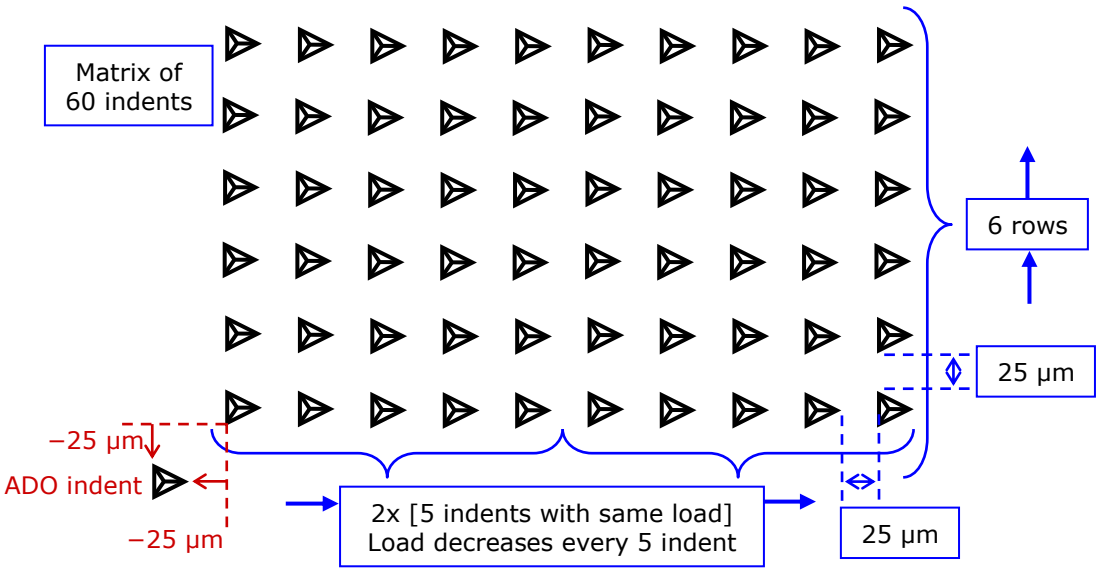
- It has never been done.
- It has already been done but some time ago, the indenter might have worn out in the meantime.

If the indenter is not calibrated, its geometry is approximated to a perfect shape tip. For Berkovich and Vickers indenters, the theoretical function $A_p = 24.5\ h_c^2$ is used to approximate the area function.

The certified reference Fused Silica sample **should** be used for this calibration.

The indenter calibration procedure is performed in order to define the A_p function of the indenter vs. the contact depth; it basically includes in the following order:

- Automatic ADO (with automatic move in X direction straight after the ADO)
- calibration measurements:
  - a matrix of indents for a **quasistatic** indenter calibration
    40 (5x8), 45 (5x9) or use as an example in this manual, 60 indents (10x6):



OR

  - a single row of a chosen number of indents for a **Sinus** indenter calibration (advised number is 5 indents)


(spaced by 25 µm)

- contact area determination (verification/redefinition of all contact points of the matrix of indents, removal of bad indents and fit method)

5.13.1 SAMPLE HOLDER

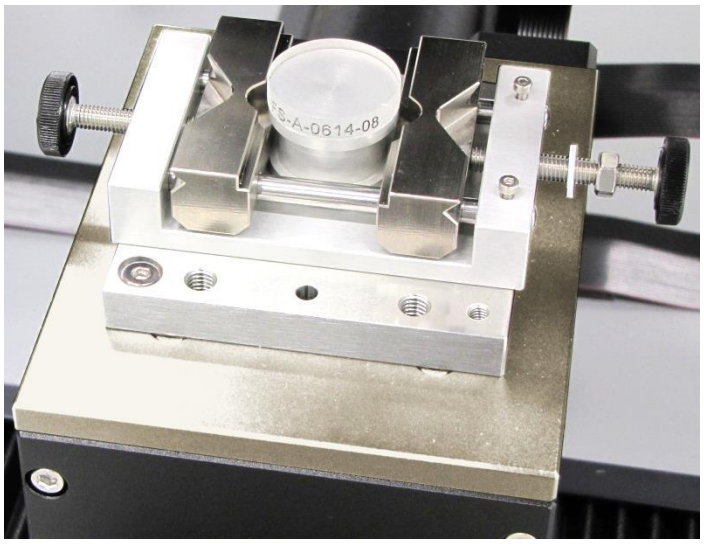


Fig.30 Fused Silica sample/stud solidly mounted in universal sample holder

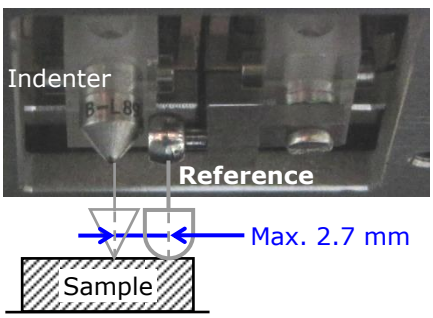
⚠ Properly mount the sample; **read** section 5.7 for explanations and **warnings**.

5.13.2 FIND ADO & CALIBRATION AREA

Move the Fused Silica sample under the video microscope to find an area[1] free of previous indents and clean, in order to perform the ADO indent and then the matrix of indents for the calibration; use the following tools:

- *Position control* (section 5.8)
- *Video* (section 5.9)

[1] ⚠ *The reference **should** be able to land on the sample as shown here.*



5.13.3 STARTING

Select **"Instrument > Indenters..."** from menu bar to open the following *Edit indenters* window (Fig.31).

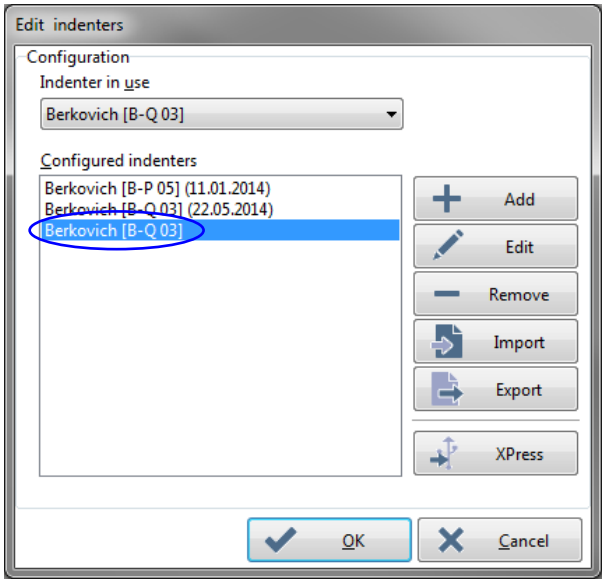


Fig.31 Edit indenter for calibration

The new **"Indenter in use"** has been previously created and selected (section 5.6.2), so it is automatically selected (highlighted) in *Configured indenters*.

Click <Edit> button.

The following *Indenter properties* window appears (Fig.32).

In *Configured indenters*: If a same indenter with an old calibration date is selected and then edited by clicking <Edit> button for a new calibration, the previous A_p curve (Fig.42) will be overwritten. Thus, it is advised to create a new indenter (section 5.6.2).

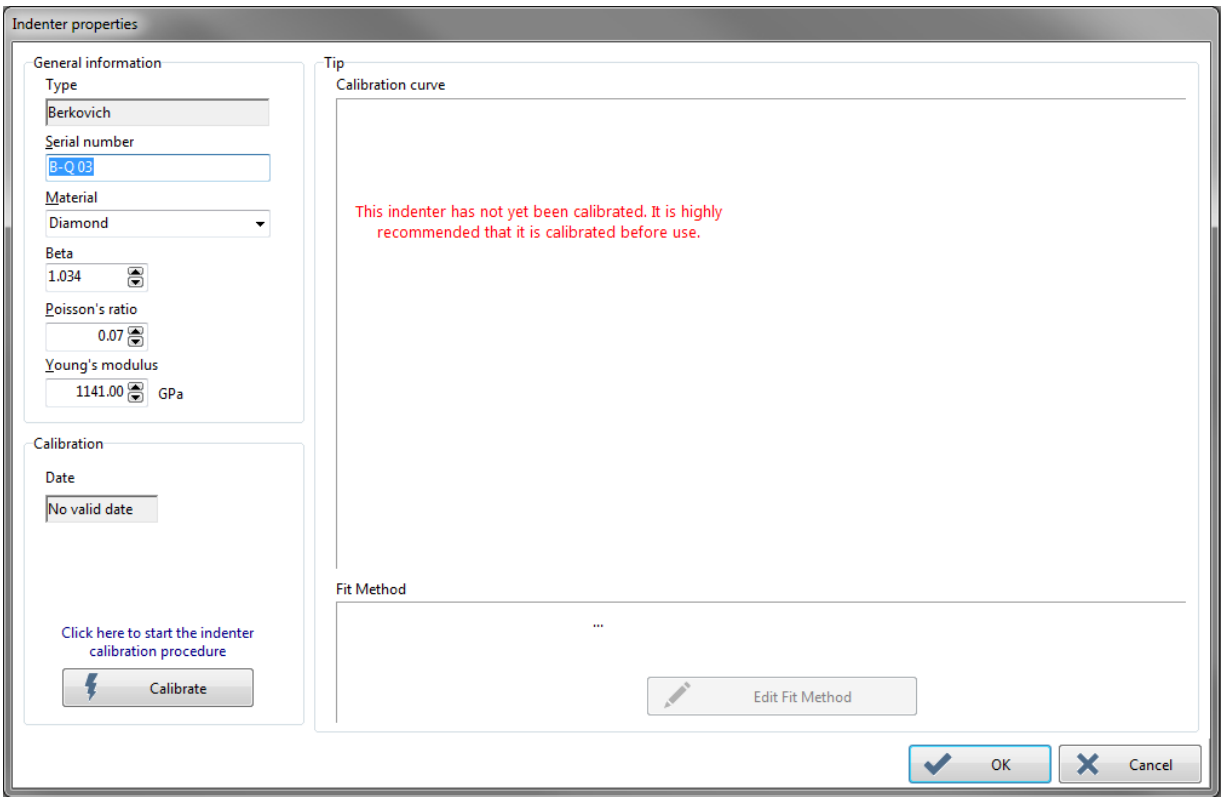
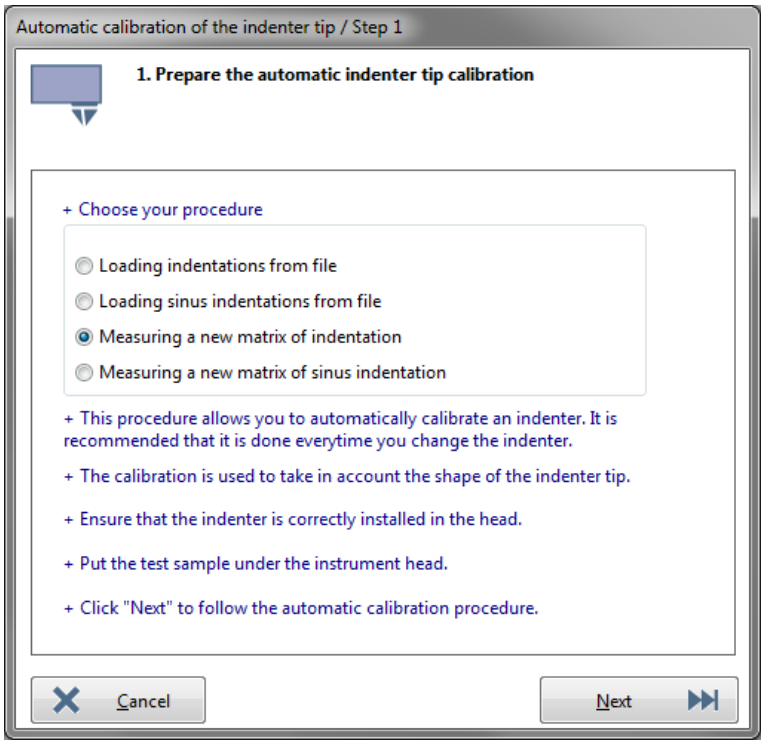


Fig.32 Perform indenter calibration

5.13.4 PROCEDURE

Click <Calibrate> button in Fig.32 to start the following indenter calibration procedure.



E.g. <Measuring a new matrix of indentation> radio button (quasistatic) is selected (by default).

OR

Select <Measuring a new matrix of sinus indentation> radio button (Sinus).

If necessary, a previous saved calibration file *.mit* can be reloaded by selecting

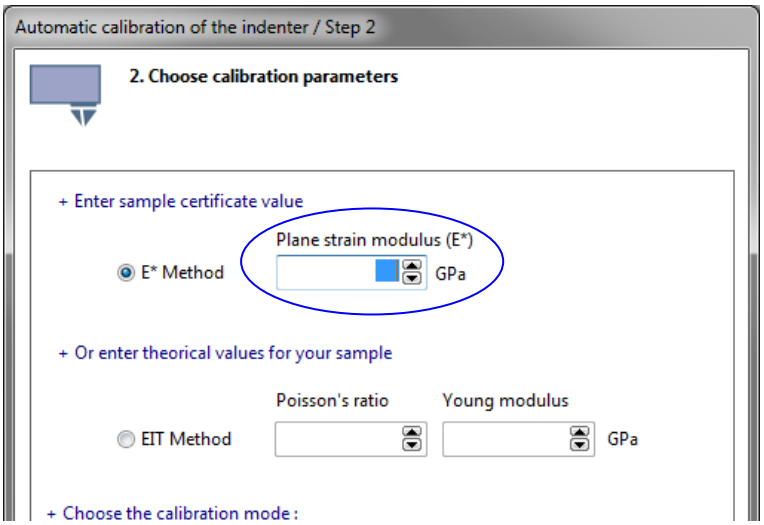
<Loading indentations from file> radio button (quasistatic)

OR

<Loading sinus indentations from file> radio button (Sinus)

Then click <Next> button.

Choose the indenter calibration parameters.



With certified value - **ADVISED**

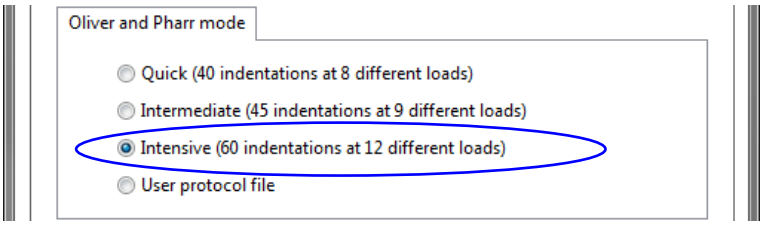
Select <E* Method> radio button, in its field set the *Plane strain modulus (E*)* value stated on the delivered certificate of the Fused Silica sample and press <Enter> key.

OR

With theoretical values

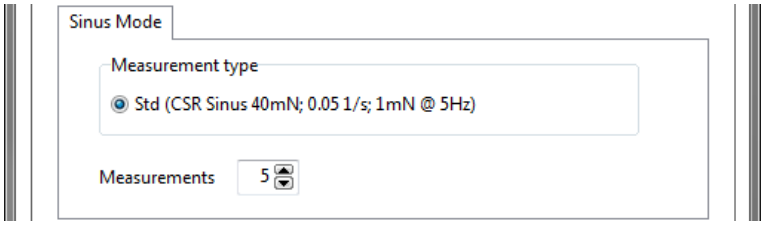
Select <EIT Method> radio button, in its corresponding fields set the *Poisson's ratio* and *Young modulus* values corresponding to the sample.

Then select the calibration mode:



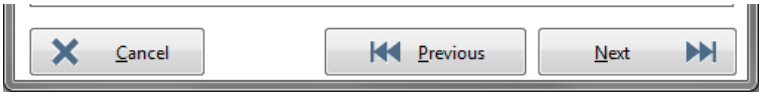
E.g. the quasistatic mode, <Intensive> radio button (matrix of indents) is selected (by default).

OR

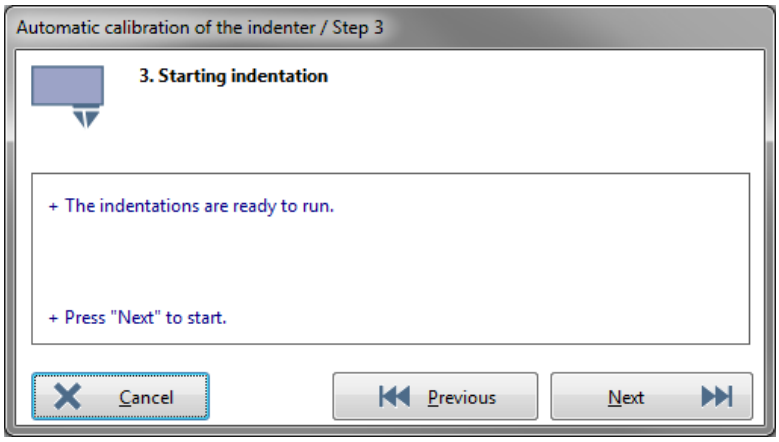


If previously the Sinus procedure has been chosen, the *Sinus Mode* <Std> radio button is selected:

Set the row indents number in *Measurements* field; advised value is 5. Every indent will be performed with Sinus Constant Strain Rate 0.05 1/s, load 40 mN, amplitude 1 mN, frequency 5 Hz.



And then click <Next> button.



Click <Next> button.

The following window (Fig.33) appears.

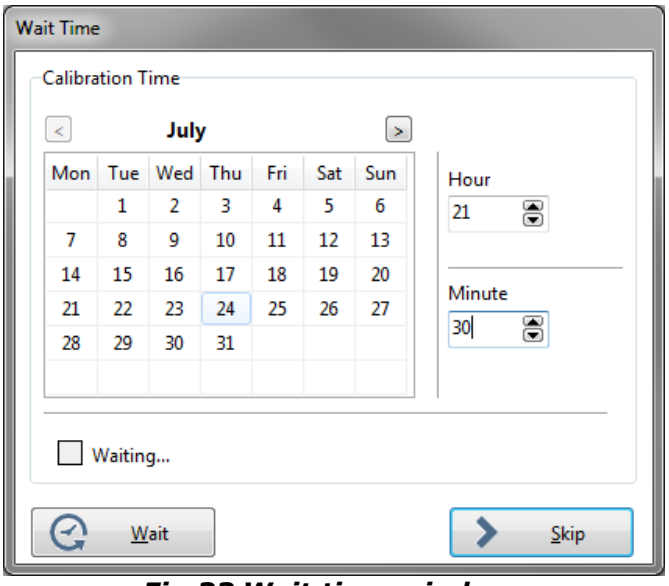


Fig.33 Wait time window

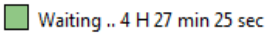
Click <Skip> button to directly start the automatic calibration measurements (matrix of indents).

OR

Delay the measurements, e.g. to have the lowest noise environment (during the night):

Set the time at which the measurements will start and click <Wait> button.

Remaining time before starting the measurements is displayed



(blinks).

5.13.4.1 Measurements

Then *ADO in progress* window (Fig.25) appears. (Here, there is no need to set any ADO parameters; they are automatic and optimized for this indenter calibration).

And then *Indentation running…* windows (Fig.52) appears; wait for automatic matrix of measurements for the calibration are performed.

E.g. quasistatic calibration matrix of indents is performed
(totally 60 indents)

- Each row includes 2x [5 indents at the same load].
- The load decreases every 5 indent.
- The weakest load is reached at the 6th row.

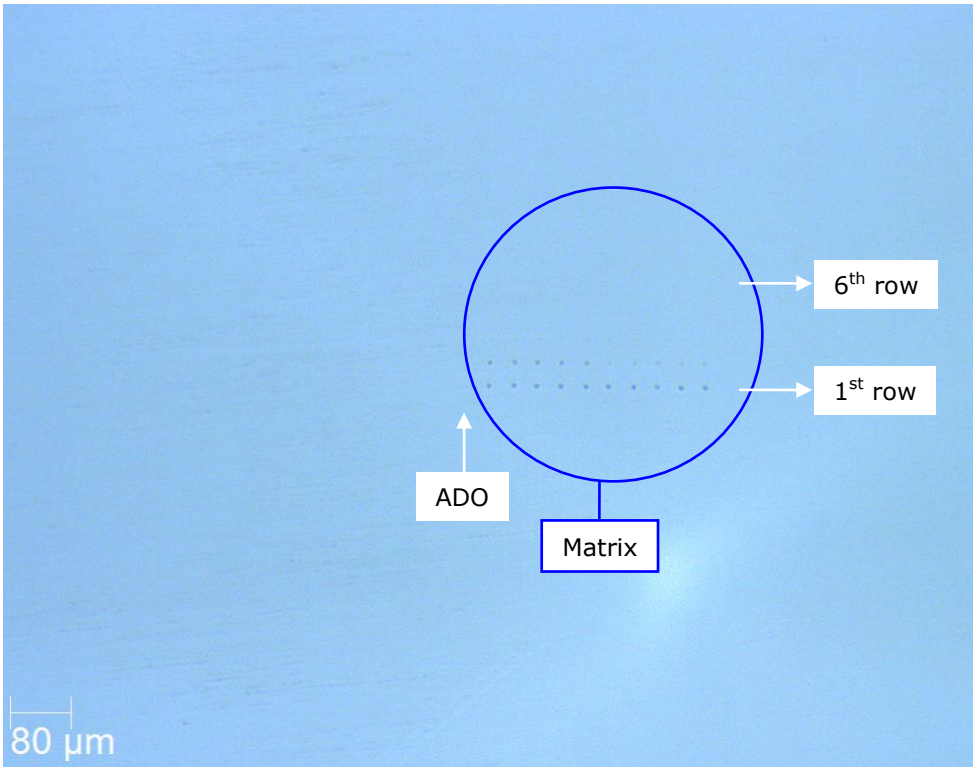


Fig.34 Matrix with 5x video microscope objective

Once the last measurement has been completed, the following *Save a calibration file* window (Fig.35) appears.

5.13.4.2 Saving

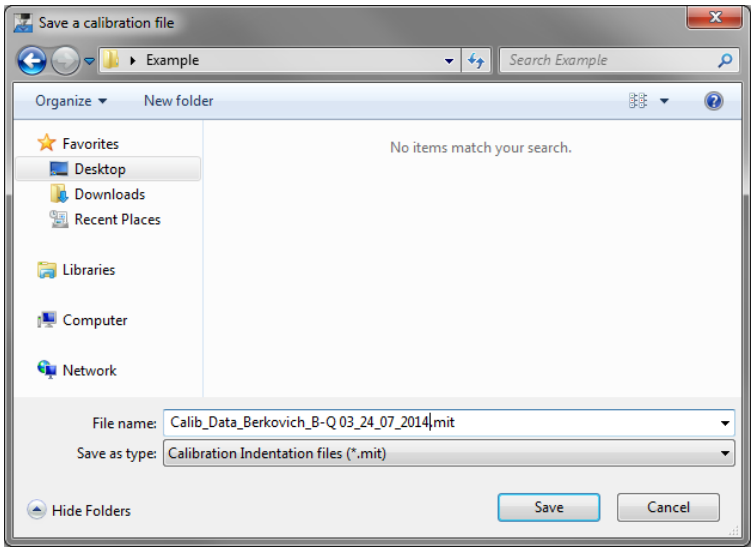


Fig.35 Save a calibration file window

Calibration date

The date which is included in the file name (in addition to the indenter serial number) corresponds to the date when the calibration measurements started (can be modified).

The date which is included in the *Indenter properties* window (Fig.42) and next to the serial number of **"Indenter in use"** + *Configured indenter* in *Edit Indenters* window (Fig.44) corresponds to the date of the last matrix indent measurement.

Choose a location to save the file of the indenter calibration measurements on the acquisition system and click <Save> button.

5.13.5 CONTACT AREA DETERMINATION ADJUSTMENT

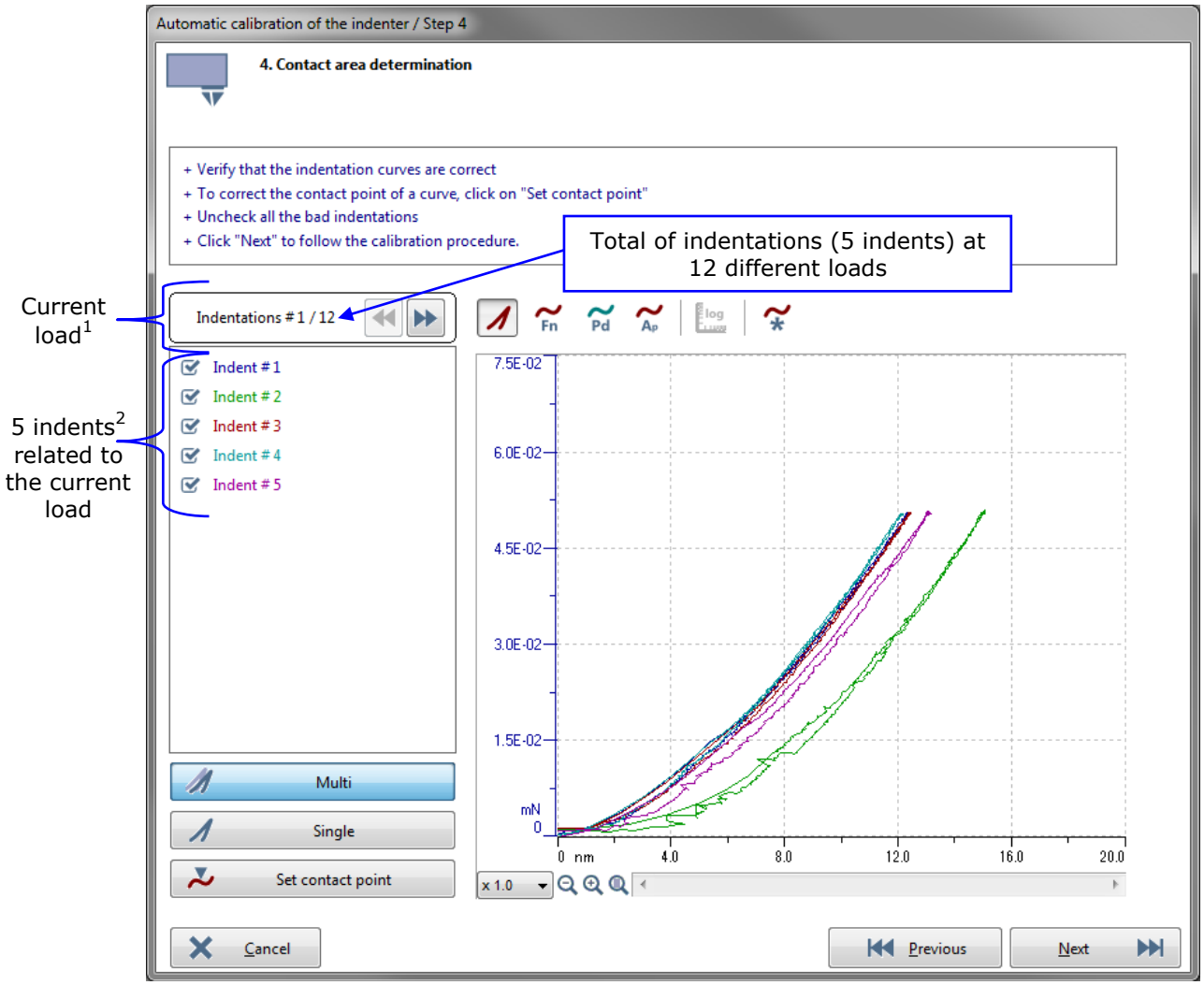
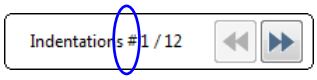


Fig.36 Contact area determination window

First all load indent automatic contact points should be verified/refined and then all bad indents should be excluded as explained in order in the followings sections.

It starts with the first indents[1] (e.g. 5) of the lowest #1 load[1] 

.

Click <Set contact point> button. The following *Set the contact point* window (Fig.37) appears, see the explanations in the following sections.

[1] *Not applicable for Sinus measurements (same load for all indents).*
[2] *With Sinus measurements, it could be less or more than 5 indents.*

5.13.5.1 Automatic contact points

Each indent contact point (several with matrix) has been automatically defined by the software → in Fig.37: Automatic positions of the red cursors on left graph area and *Detect contact point* icon is inactive on toolbar. However, it is advised to verify and if necessary to refine (more precisely) each contact point for all current indents[1] (e.g. 5) of all loads[2] (e.g. 12) as follows.

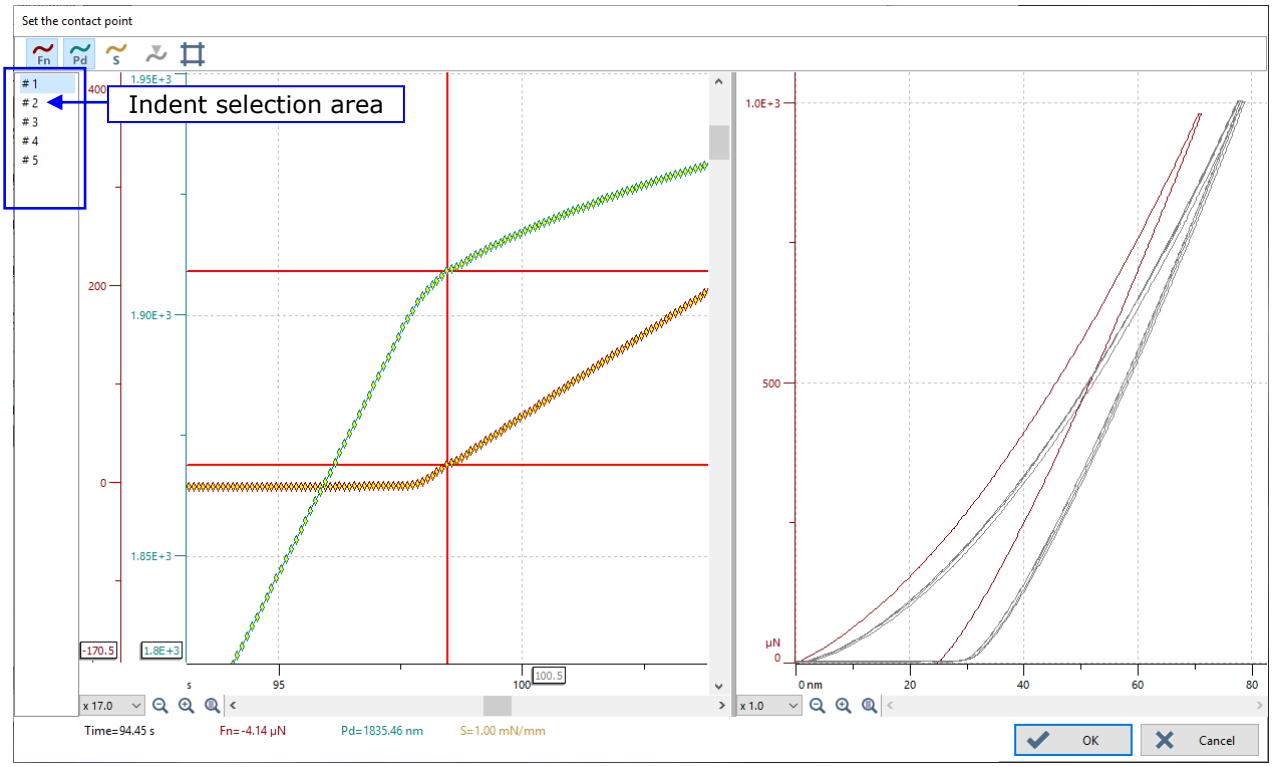
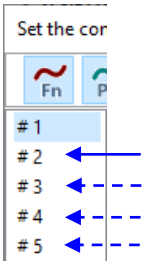


Fig.37 Set the contact point window

<u>Verify/refine contact point for each current load indent</u>



In the indent selection area, it starts with the first indent *#1* (highlighted). One at a time, select (highlight) each indent # to verify and if necessary refine its contact point as instructed in section 5.13.5.2.

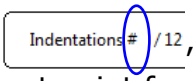
Once the 5 current load indents has been verified/refined, click <OK> button (validation and saving of each indent current contact point).

Then, <u>Select the next load</u>, p. 70.

[1] *With Sinus measurements, it could be less or more than 5 indents.*
[2] *Not applicable for Sinus measurements (same load for all indents).*

Select the next load

In *Contact area determination* window (Fig.36):

Click <'next'> button to skip to the next load 

, then click again <Set contact point> button and Verify/refine contact point for each current load indent, as explained in p. 69.

➔ Repeat the previous instructions for all available loads.

Click <'previous'> button to skip back previous load (to verify/refine again contact points if necessary).

When all indent contact points of all loads have been verified/refined (e.g. 5 x 12 = 60 indents), remove the bad indents of all loads (those which are shifted and/or have a bad shape) as instructed in section 5.13.5.3.

5.13.5.2 Verify/refine contact point procedure

The best contact point is located where the **F** red curve starts to rise[1] and/or **h** green curve starts to peak. If the red cursor are not at this specific location, double click to refine the new and more precise contact point → red cursors move accordingly (Fig.39).

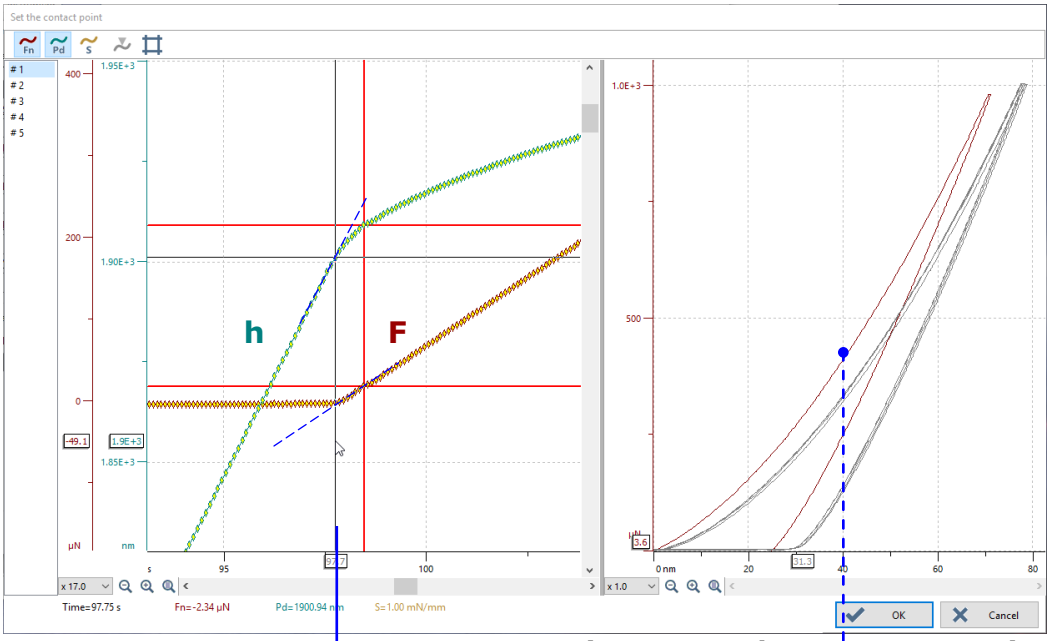


Fig.38 Auto detect contact point

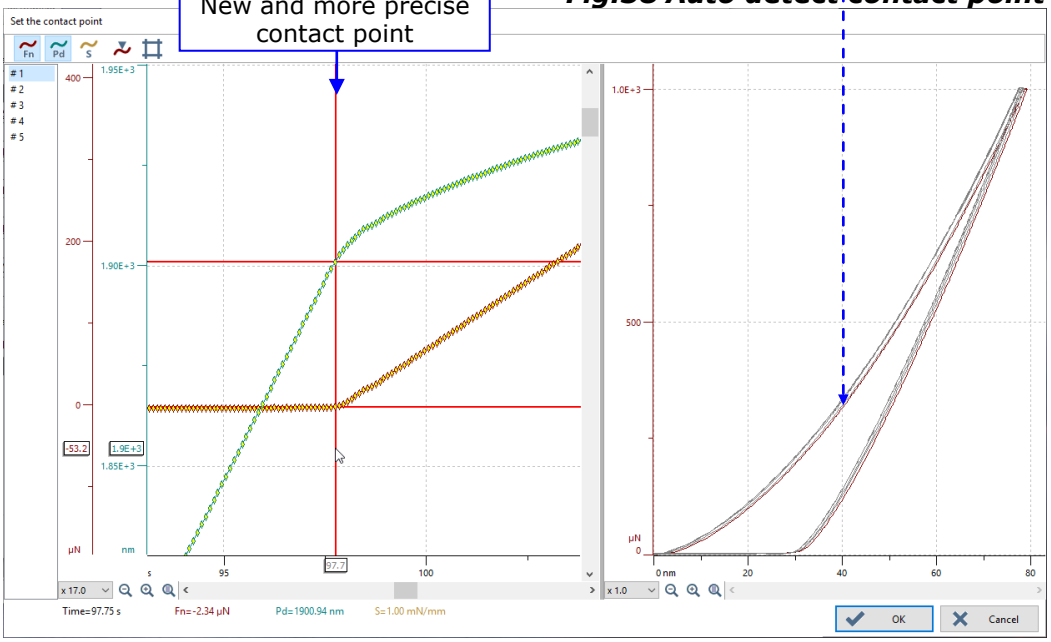


Fig.39 New user refined contact point

End of the verified/refined contact point procedure.
(Clicking *Detect contact point* active icon, recover initial automatic contact point → icon becomes again inactive).

[1] *The higher the load the more difficult it is to see the **F** red curve rising, so use the **h** green curve instead to determine the best contact point.*

5.13.5.3 Features and removal of bad indents

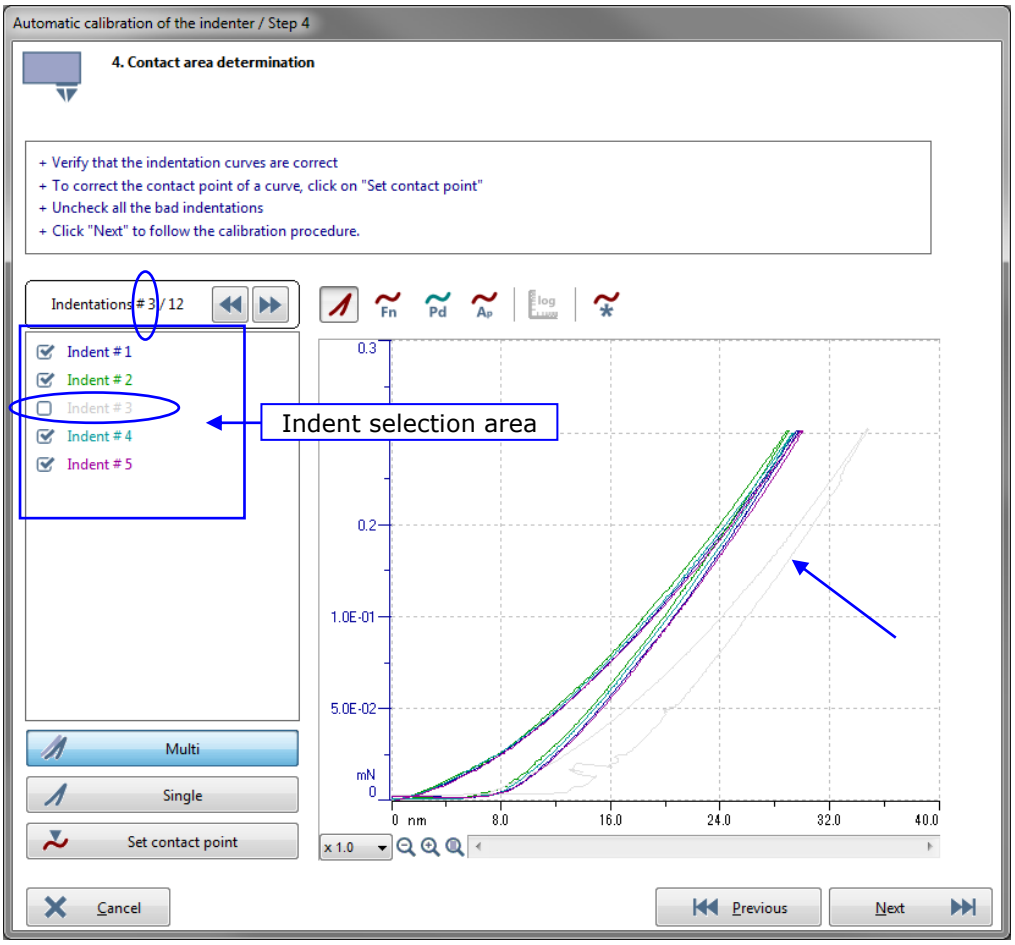


Fig.40 Bad indent #3 is removed

Display

Initially all *Indent #* boxes are checked in selection area.

By default <Multi> button is selected, otherwise click it to display each 5 indent curve[2] **on the same time** on the graph.

To display only 1 indent curve at a time on the graph, click <Single> button and place the mouse cursor on a desired *Indent #* Indent # 1 Indent # 2 Indent # 3 in selection area,

With <Multi> button selected, placing the mouse cursor on a *Indent #* Indent # 1 Indent # 2 Indent # 3 highlights the corresponding curve on the graph.

Graph area

Different types of curves can be selected to show the 5 indents[1] of the **current** load:

- By default *Indentation curve* icon is selected to show **F** vs. **h** curves (Fig.40).

or

- Click *Fn* icon to show **F** vs. **time** curves.

or

- Click *Pd* icon to show **h** vs. **time** curves.

OR

Circles can be selected to show indents (e.g. 5) of **all** loads (e.g. 12):

- Click *Ap icon* to show **Ap** vs. **hc** circles: The indents of the current load are represented by colored circles and the remaining indents of all other loads are represented by gray circles.
  By default a linear scale is displayed (*log* icon unselected) or click *log* icon (becomes selected) to display logarithm scales

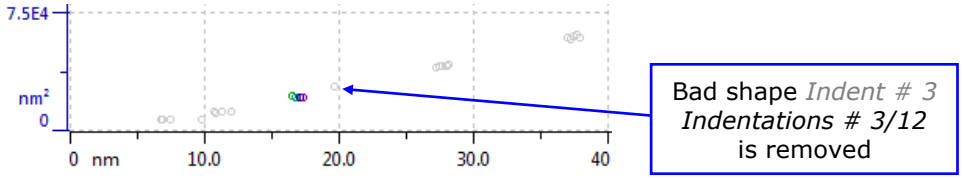


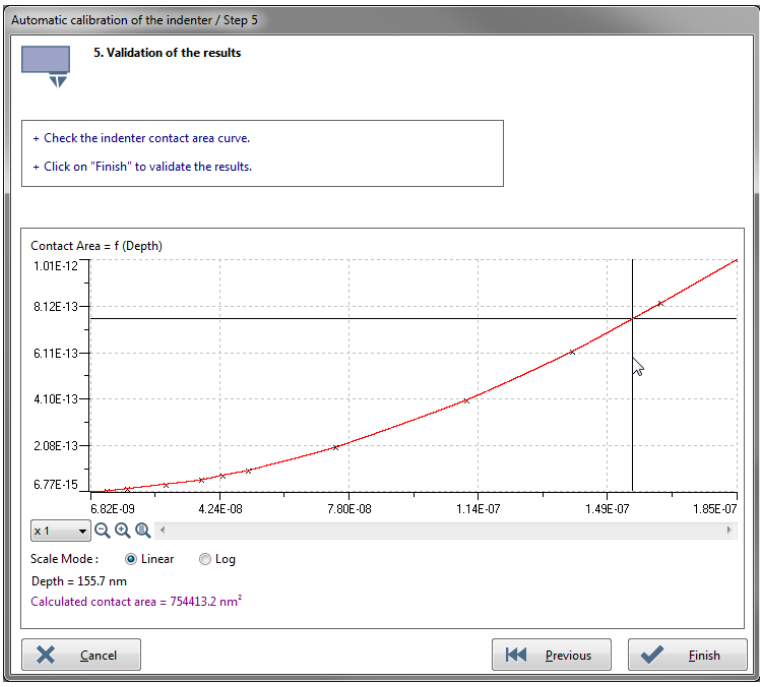
Fig.41 Circles are displayed

Click *Relevant only* icon to show the relevant curves or circles → the gray curves or circles are hidden from the graph (see above for gray circles, and see removal of bad indent below for gray curves/circles). Click again the selected icon to display the 5 indent curves or all indent circles.

Removal of bad indents

E.g. in Fig.40 for the selected load*: Indentations # 3/12*, the *Indent # 3* is totally shifted (even with a correct contact point) and has a bad shape; uncheck each bad *Indent #* Indent # 3 Indent # 4 box to exclude them Indent # 3 Indent # 4 → On the graph area it becomes gray → not relevant (excluded for the A_p determination).

When all bad indents have been removed, click <Next> button in Fig.40.



step 5

A_p curve appears.

The *Scale Mode:* can be changed from <Linear> to <Log> and vice versa (click the desired radio button).

Click <Finish> button.

5.13.6 EDIT FIT METHOD

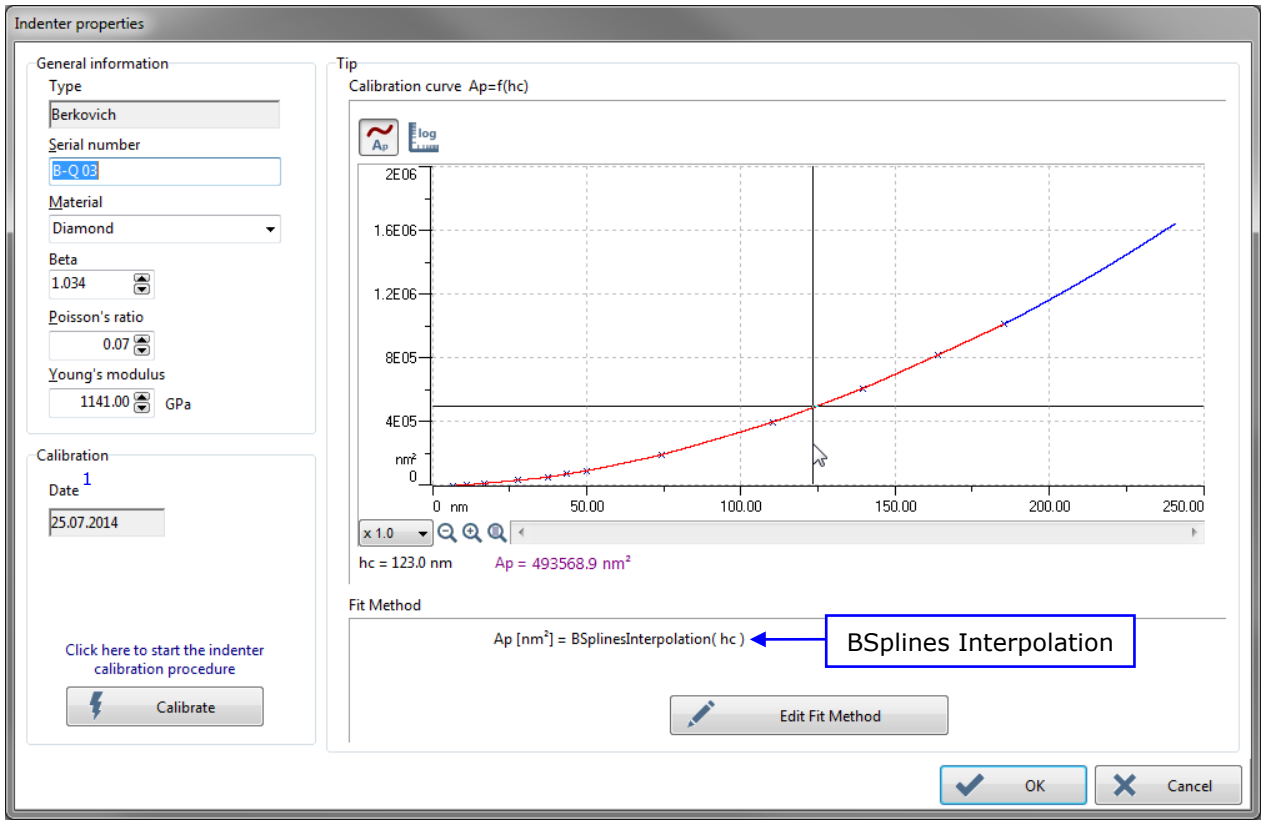


Fig.42 A_p curve appears in indenter properties window (linear mode)

The scale mode can be changed from linear *Ap*  icon to logarithmic *Log*  icon and vice versa (select desired icon). It is also applicable in the following *Edit fit method* window (Fig.43).

A_p curve appears in the graph area of the *Indenter properties* window and uses by default the automatic BSplines Interpolation Fit Method. However it is possible to use other methods: Click <Edit fit method> button to open the following *Edit fit method* window.

[1] *See Calibration date, p. 67.*

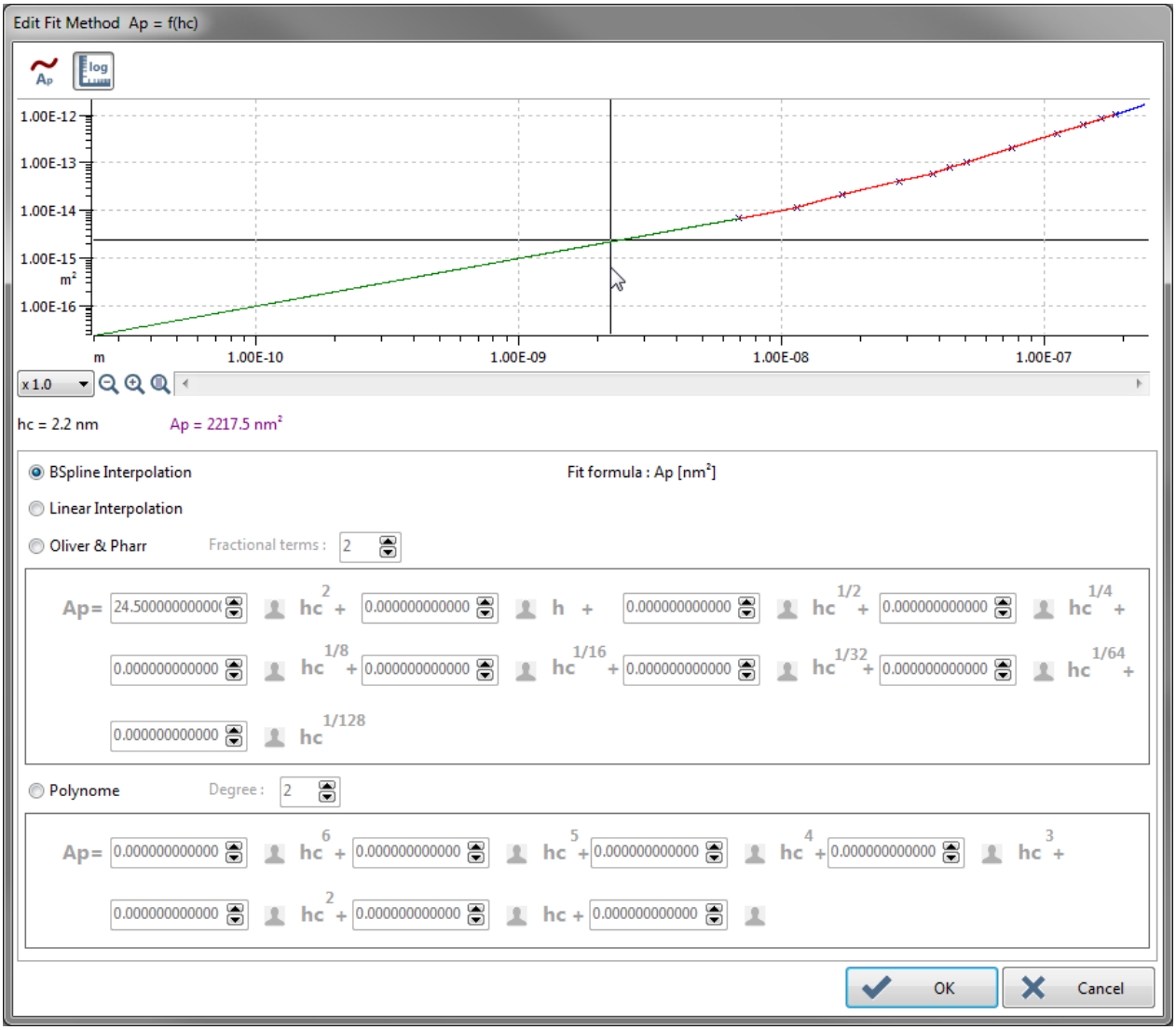


Fig.43 Edit Fit Method window (logarithmic scale)

Several edit fit method can be chosen, click the following desired radio button; for further explanations, refer to the ***Indentation software reference guide*** in section ***$A_p(h_c)$ Fit method of the calibration***:

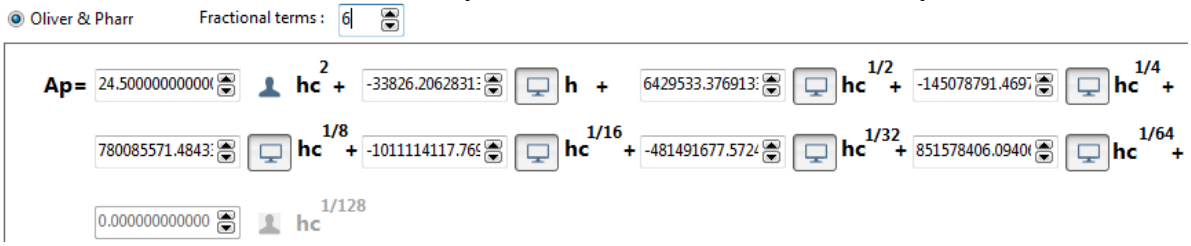
<BSpline interpolation> radio button (standard by default)

OR

<Linear Interpolation> radio button

OR

<Oliver & Pharr> radio button (and set *Fractional terms* fields)



OR

<Polynome> radio button (and set *Degree* fields)

Once the desired method has been selected (and set for *Oliver & Pharr* and *Polynome*), click <OK> button in Fig.43 (validation).

Then click <OK> in Fig.42 (validation and saving).

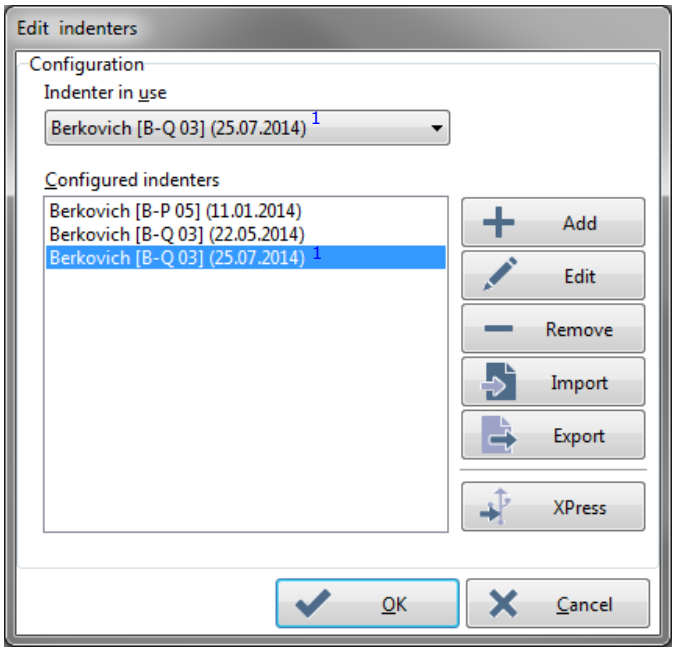


Fig.44 Indenter B-Q 03 25.07.2014 has been calibrated and is (still) selected

And then verify that the indenter in use, which has just been calibrated, is (still) selected.

Otherwise select it and click <OK> button (validation and saving, section 5.6.2).

The calibration date[1] has been automatically added next to the indenter serial number name.

[1] *See Calibration date, p. 67.*

6 INDENTATION MEASUREMENT PROCESS

This section explains how to prepare and carry out an indentation measurement.

For the following indentation measurement process example, the Fused Silica sample (provided) is in use.

6.1 SAMPLE HOLDER

The sample **should** be solidly mounted to prevent movement when under load.

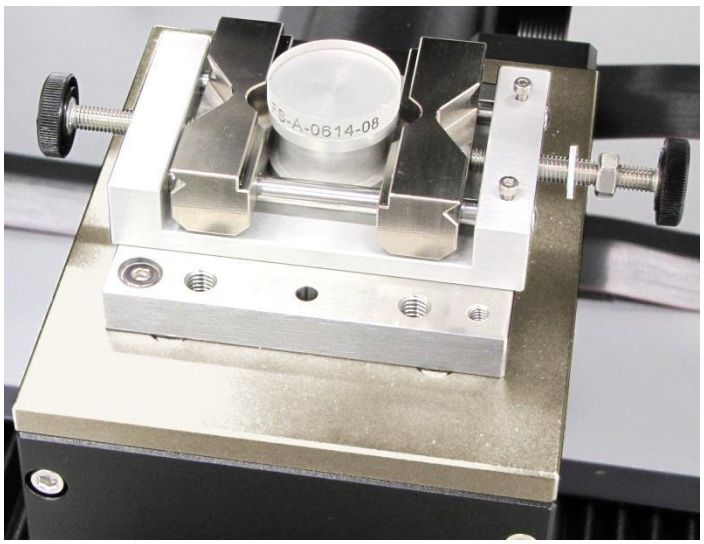


Fig.45 Fused Silica sample/stud solidly mounted in universal sample holder

Properly mount the sample; **read** section 5.7 for explanations and **warnings**.

6.2 OPEN OR CREATE NEW DOCUMENT

To start a new indentation measurement, a document should be opened or created as follows.

Select **"File > Open..."** from menu bar or click *Open* icon on toolbar to open an existing measurement document:

'*File name*'*.mit*

Select **"File > New..."** from menu bar or click *New document* icon on toolbar to create a new document. The following *Indentation group information* (Fig.46) window appears.

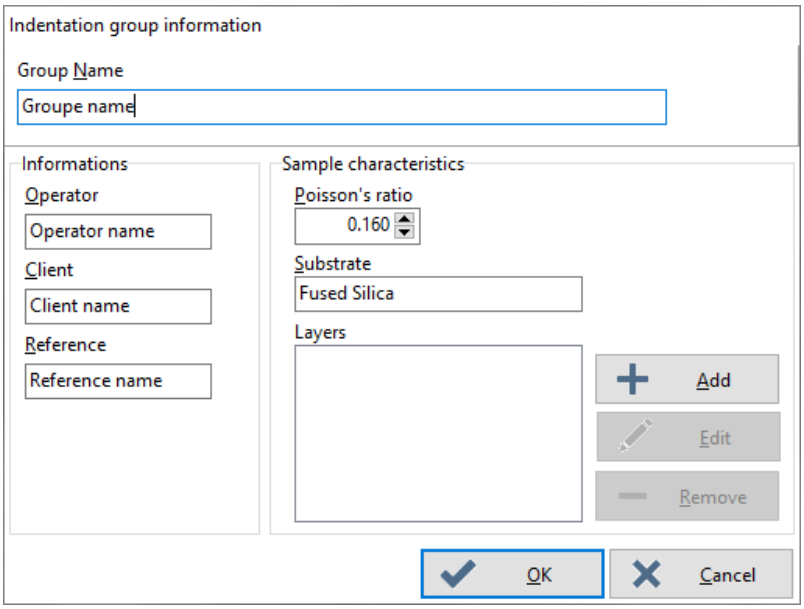


Fig.46 Indentation group information window

Fill in the fields and especially **set** the correct *Poisson's ratio* value, e.g. 0.160 corresponds to the Fused Silica sample in use (provided) → **Adapt** this value for each sample in use as it will affect the EIT main result.

Fused Silica sample has no coating. However if another sample with coating(s) is used, click <Add> button (many times if several layers) to open the following window (Fig.47).

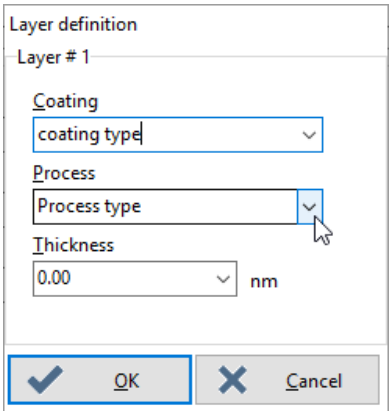


Fig.47 Layer definition window

Fill in or select the combo-boxes about the details of the layer definition.

Then click <OK> button (validation).

Then click <OK> button in Fig.46 (validation and creation of the new document).

6.3 PERFORMING AN INDENTATION MEASUREMENT

6.3.1 ADO

If an ADO has already been successfully ( ) performed on the **current** sample, **skip** this section. Otherwise an ADO should be performed (section 5.11).

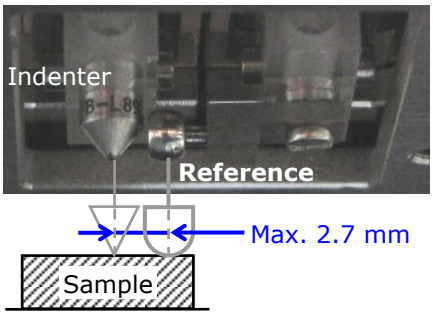
6.3.2 FIND MEASUREMENT AREA

Move the sample (e.g. Fused Silica) under the video microscope to find an area[1] free of previous indents and clean, in order to perform the indent (or matrix of indents) measurement; use the following tools:

- *Position control* (section 5.8)
- *Video* (section 5.9)

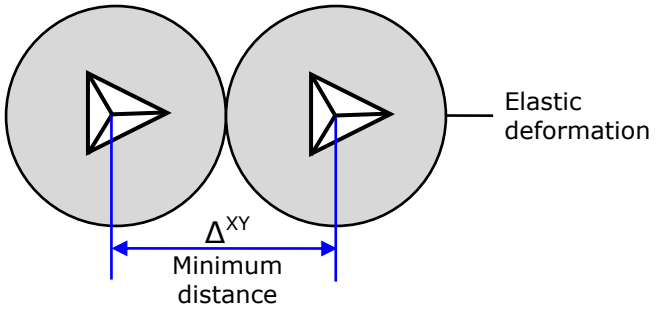
[1] :

- ***No**t too far from the current ADO indent (otherwise sample topography may vary).*
- *The reference **should** be able to land on the sample, as shown here.*



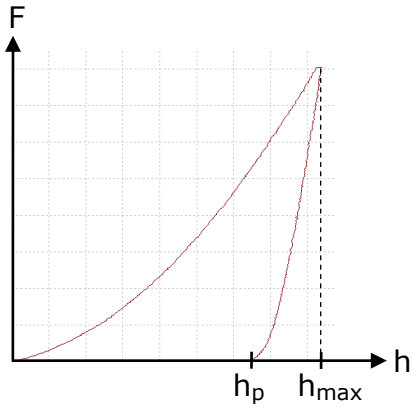
6.3.3 DISTANCE BETWEEN INDENTS

Indentation marks should be separated by a minimum distance to avoid influence of previous indent on the following one.



To avoid that elastic field of each indent overlaps, the minimum recommended distance between each indent in X and/or in Y directions should be:

$$\Delta^{XY} > 30 \times h_{max}$$



6.3.4 DEFINE INDENTATION MEASUREMENT PARAMETERS

The *Standard* measurement type is described in this section. However the *Sinus* measurement type is described in addition.

Select **"Instrument > Start a new indentation..."** from menu bar or click *Indentation* icon on toolbar to open the following *Define a new measurement* window (Fig.48).

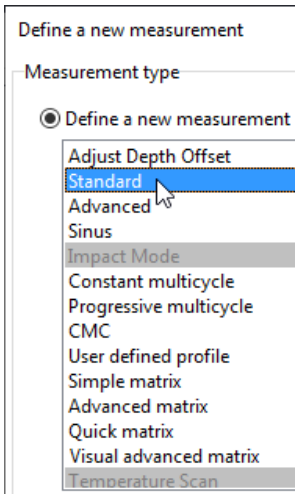


Fig.48 Measurement type selection

Double click on a measurement type, e.g. *Standard*.

The corresponding parameters window appears as follows (e.g. Fig.49).

For a *Sinus* measurement type, the dynamic calibration **should** have been previously performed (section 5.12). Then double click *Sinus* in Fig.48.

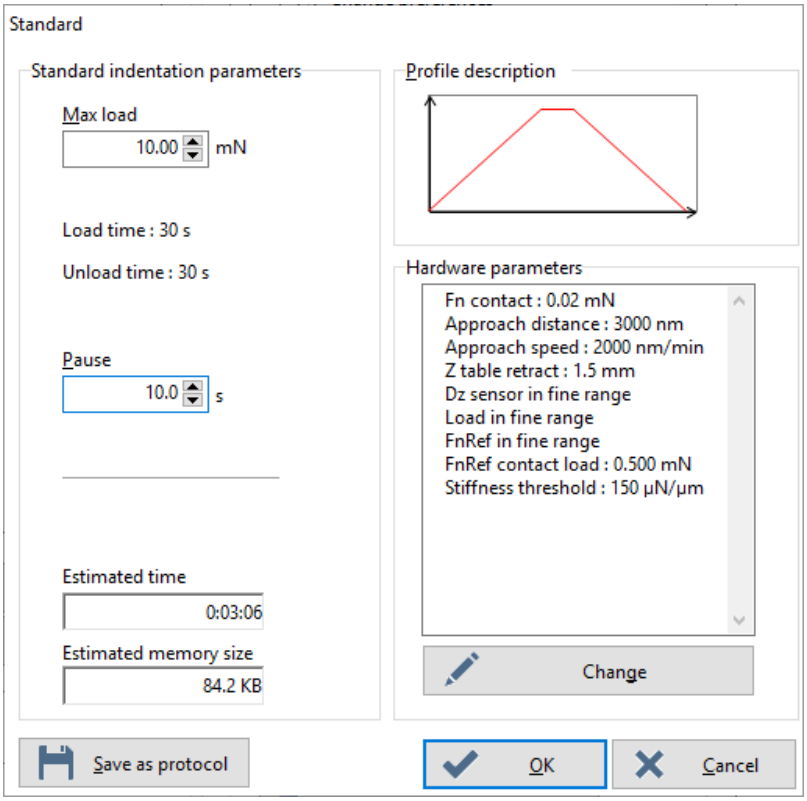


Fig.49 Standard window with measurement parameters

Click <Change> button to open the following *Step - UNHT - Hardware parameters* window which includes 2 tabs.

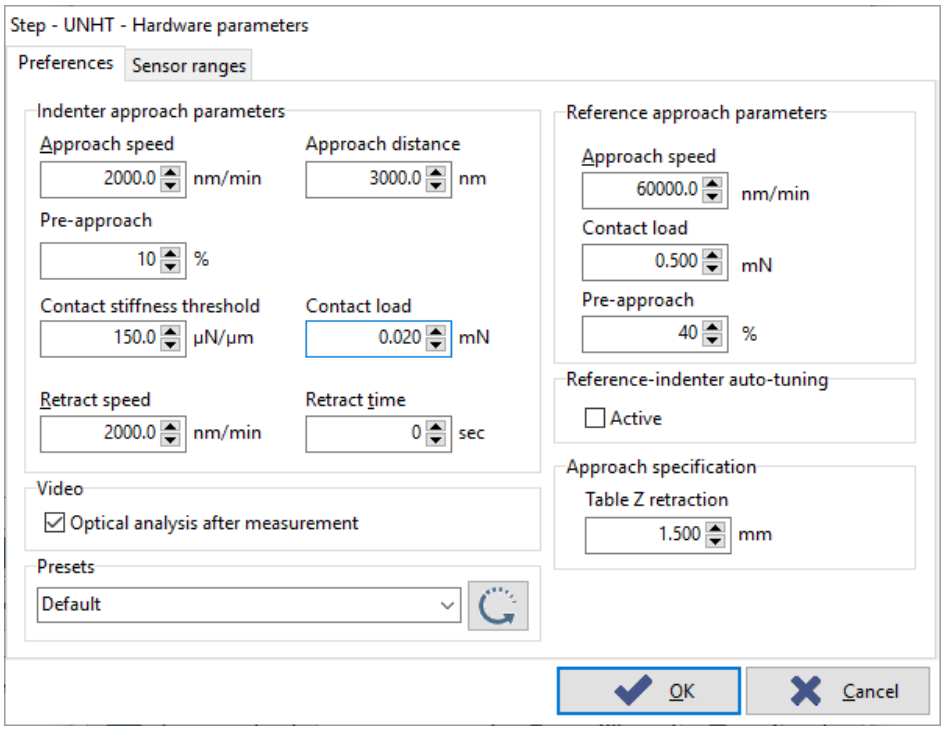


Fig.50 Preferences tab parameters

In *Preference* tab

Settings for the *Indenter approach parameters*, *Reference approach parameters* and *Approach specification* areas shown in Fig.50 are examples (suit for the Fuse Silica provided sample) and should be set according to the sample in use/ application.

It is advised to set the *Indenter* and *Reference Pre-approach* fields with the same values as set for the current ADO (Fig.24).

Optical analysis after measurement box is checked in *Video* area for section 6.3.6.

For more details and information about the remaining features (*Reference-indenter auto-tuning* and *Presets* areas), refer to the ***Indentation software reference guide*** in section ***Taking a new measurement / Setting the measurement type parameters / Measurement hardware parameters (head) / UNHT Preference tab*** and ***Preset of the preference parameters***.

Select *Sensor ranges* tab.

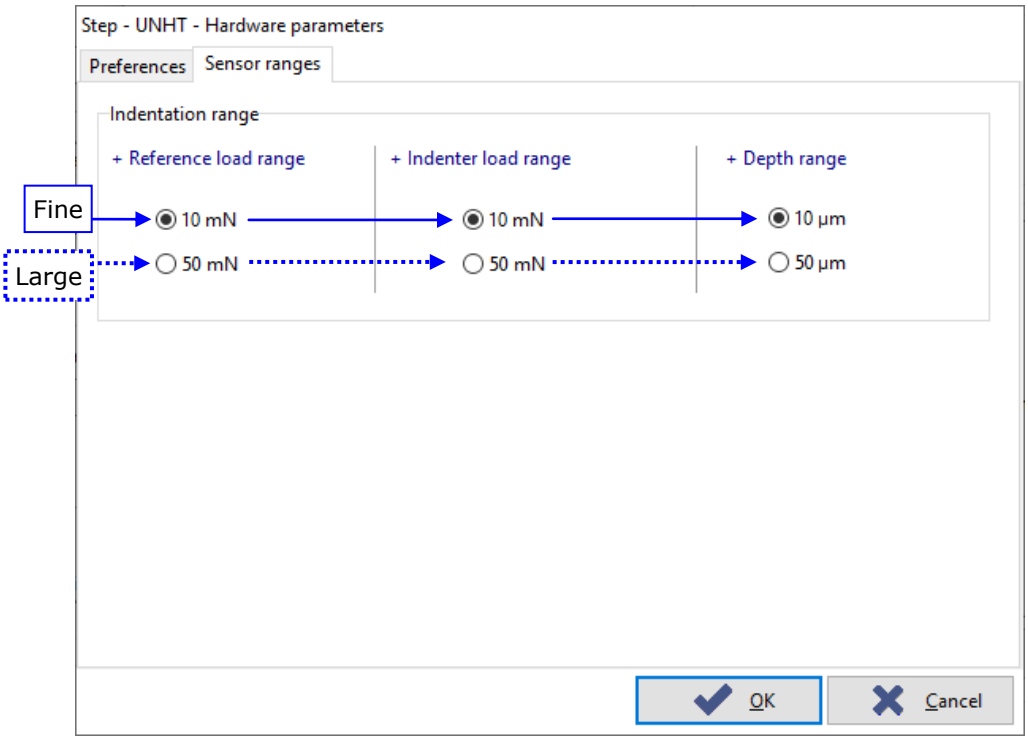


Fig.51 Sensor ranges tab parameters

Select the *Reference load range*, *Indenter load range* and *Depth ranges* <radio buttons> according to the sample in use/application (e.g. all fine ranges are selected in Fig.51).

It is recommended to use the fine *Depth range*. However if the depth saturates during the measurement, then select the large *Depth range*.
Depending on the instrument version, it is possible that the large *Depth range* value is different than the one shown above.

Click <OK> button (validation and saving for current parameters of the 2 tabs).

SETTING OF THE INDENTATION MEASUREMENT PARAMETERS

in Fig.49

Indentation measurement parameters shown in this section are suitable for the provided Fused Silica sample. For any other applications, the parameters should be set according to the type of the sample in use.

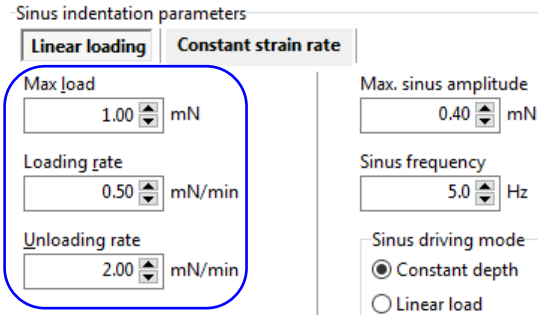
Standard indentation parameters area

Max load field: Set a suitable value, e.g. 10 mN (with Fused Silica sample).

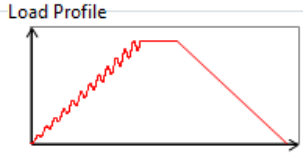
Load Time: 30 s *Unload Time: 30 s* info	For this kind of measurement, these values are automatic (30 sec). To change them, another type of measurement should be selected (Fig.48).
Pause field:	E.g. set to 10 sec (0 = no pause).
Estimated time inactive field	Information for the estimated measurement duration (depend on measurement and hardware parameter settings).
Estimated memory size inactive field	Information for the estimated RAM memory size needed to perform the measurement (depend on the measurement and hardware parameter settings).

For the following *Sinus* measurement type (some parameters are already explained above)

4 parameters are common for the 2 sinus measurements profiles (*Max. Sinus amplitude* and *Sinus frequency* fields and <Constant depth> or <Linear load> radio button).

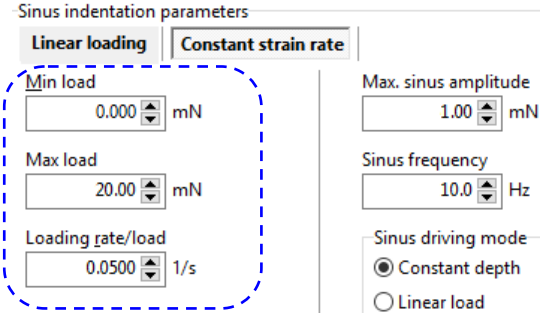


Select *Linear loading* tab

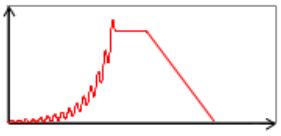


and set all these parameters.

OR



Select *Constant strain rate* tab

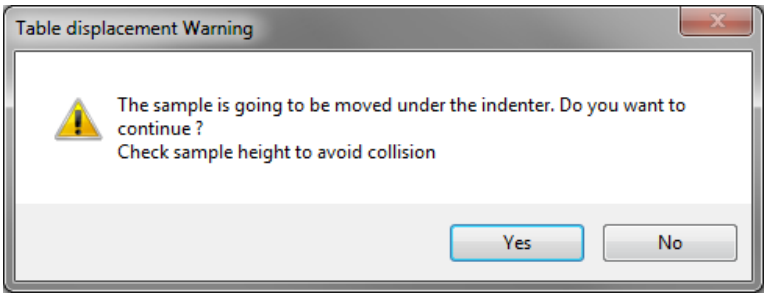


and set these parameters.

Then click <OK> button in *Standard* window (Fig.49, or other measurement type window: *Sinus…*) to run the indentation measurement (+ validation and saving of current parameters).

For further details about the Indentation measurement types, hardware preferences and measurement parameters, refer to the ***Indentation software reference guide*** in section ***Taking a new measurement / Selecting the measurement (type or protocol)*** and ***Setting the measurement type parameters***.

6.3.5 RUN INDENTATION MEASUREMENT



If the sample is located under the video microscope, this *Table displacement Warning* appears.

Verify the sample height to avoid collision.

To continue click <Yes> button, the sample moves under the indenter; wait.

The following *Indentation running…* window (Fig.52) appear; wait until the following automatic indentation measurement ends.

1. The motorized head module approaches (moving down)

   Status area (following squares blink)

   2. *Approaching Table Z…* Approaching Table Z...

   3. *Approaching reference %* Approaching reference 48.43 %

   4a. *Approaching Indenter* Approaching Indenter
   4b. *Stabilization [s]* Stabilization 15 [s]

   5. *Indentation running…* Indentation running... (e.g. Fig.52)

   6. *Removing the indenter…* Removing the indenter...

7. The motorized Z table retracts (moving down)

8. The motorized head module retracts (moving up)

Graph curves are displayed in real time.

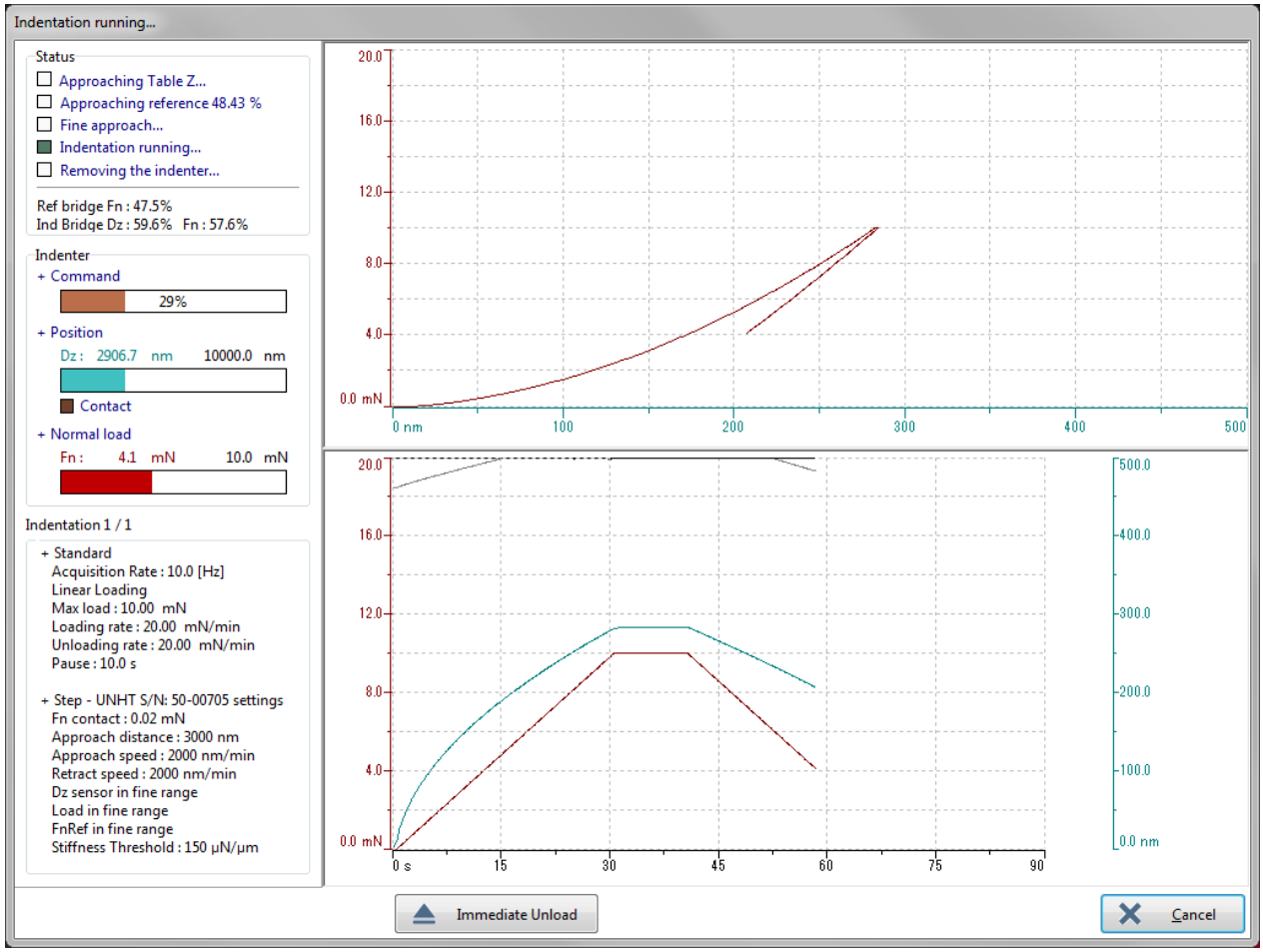
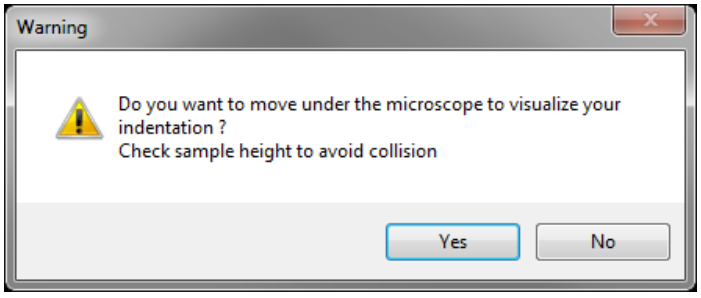


Fig.52 Indentation measurement is running



When the indentation measurement(s) is completed, it is possible[1] to move the sample under the video microscope, in order to analyze/visualize each indent (several if matrix has been performed).

First **verify** the sample height to avoid collision and then click <Yes> button; wait.

Then the following *Analyze indentation* window (Fig.53) appears.

1 If Optical analysis after measurement box has been checked in Fig.50 (Hardware parameters window/Preferences tab).

6.3.6 ANALYZE/VISUALIZE EACH SELECTED INDENT

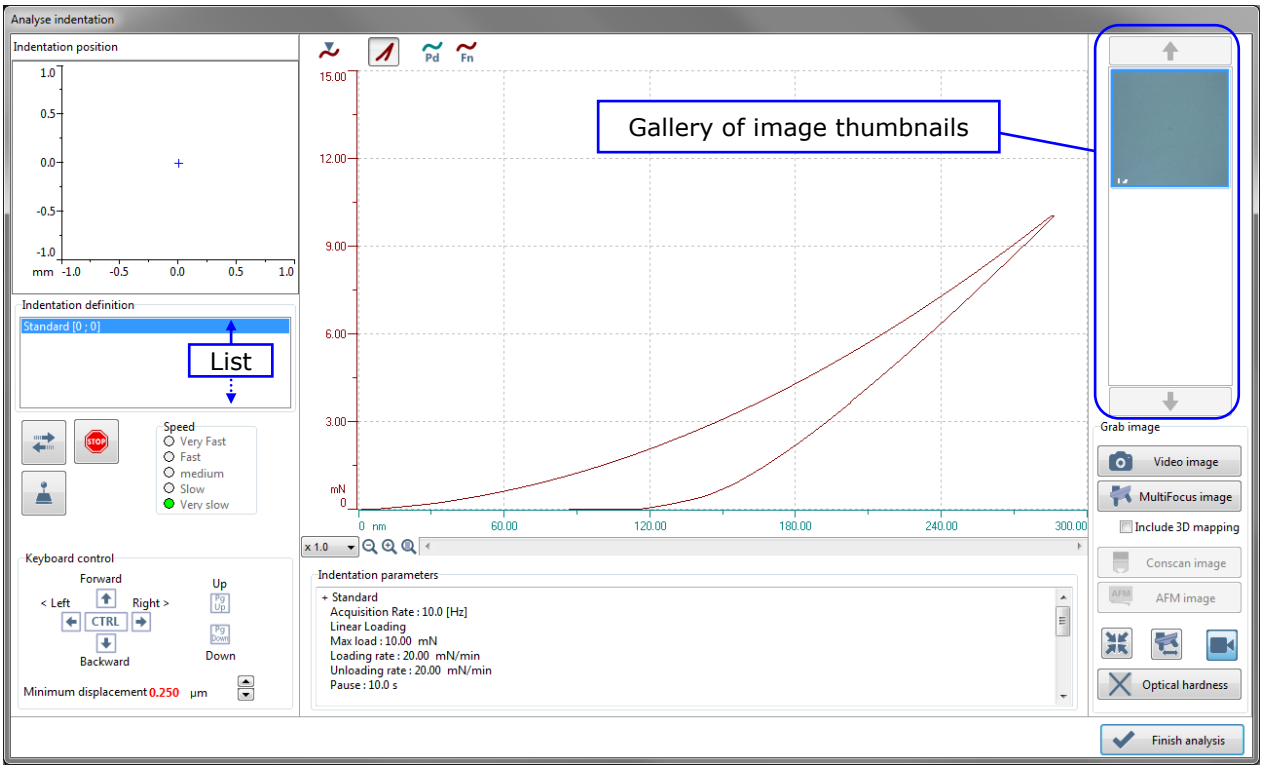


Fig.53 Analyze indentation window

The V*ideo* window (Fig.14) is opened, otherwise click *Show live image*  icon.

If there are several indents (matrix), select in the *Indentation definition* list each indent one by one to take Images, p. 89 (optical, optional AFM if available).

If the indent or one of the indents (matrix) is not exactly centered on the video screen crosshair, there is no need to restart a complete Indenter-microscope distance calibration (section 5.10), a recalibration can be performed from this window:

Retarget[1] the indent center on the video crosshair and click *Redefine calibration distance indenter microscope from this new point*  icon: New calibration values for *X*, *Y* and *Z distance* are automatically saved in the corresponding field of *Calibrate Indenter Microscope distance* window (Fig.17).

[1] *On the* Video *screen adjust the focus and move by using* Methods to move, p. 39 *(**exceptions:** All* 'arrow' *icons and vector move buttons). If necessary, click* Return to current indentation  *icon to return to the original video position (as it was before moving).*

Images

Images[1] can be taken by clicking <Video image> button (Fig.53), which opens *Edit an image* window (Fig.54).

Multifocus images can be taken by clicking <MultiFocus image> button (Fig.53).

For further details about *MultiFocus image*, refer to the ***Indentation software reference guide*** in section ***Taking a new measurement / Analyzing/visualizing the indentation(s) / Optical analysis (includes setting contact point)***.

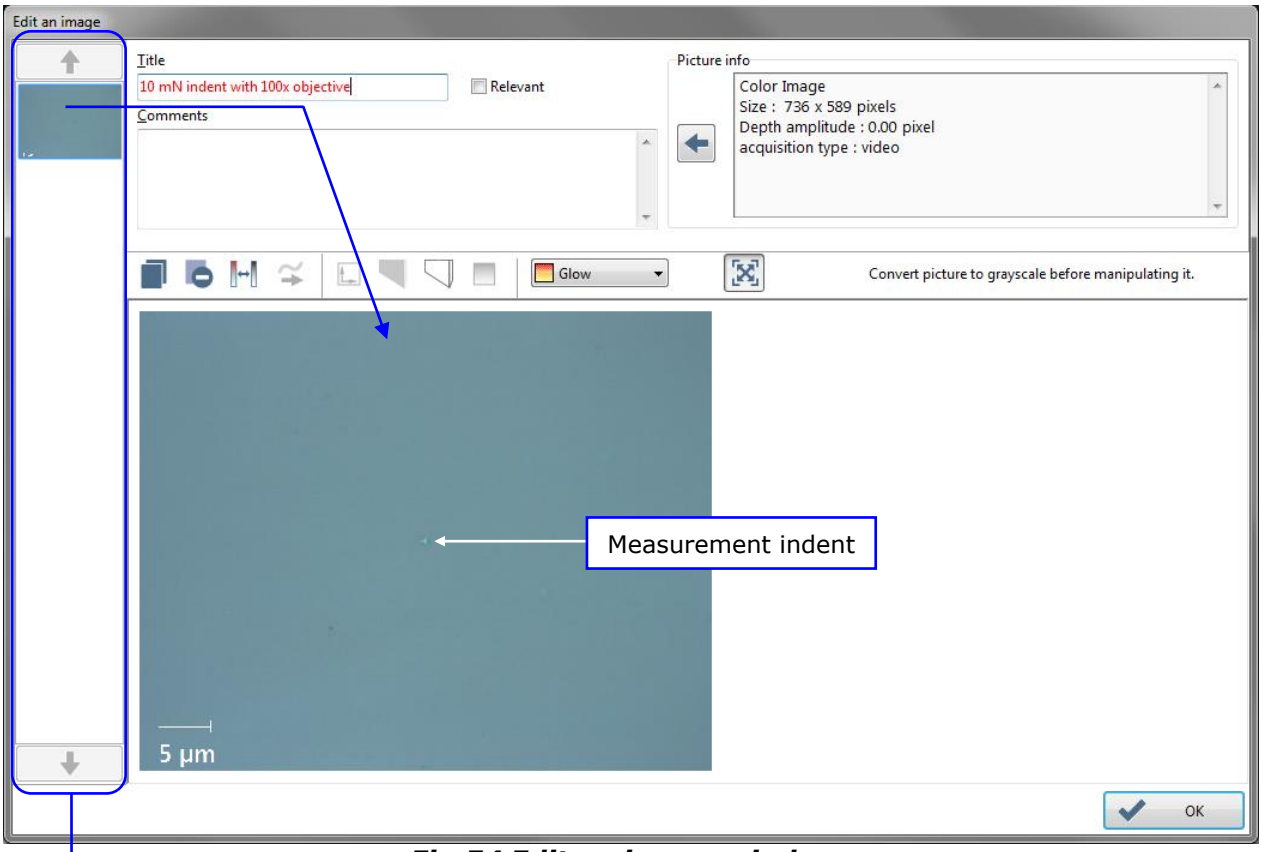


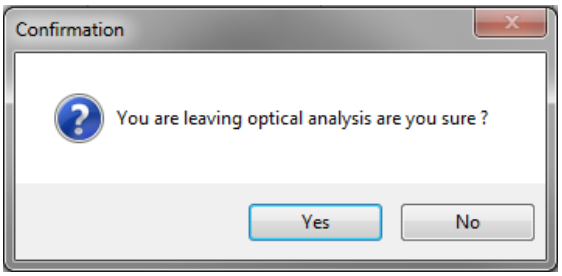
Fig.54 Edit an image window

If an image thumbnail is clicked, the corresponding image is displayed in large format. Additional options are available (as image title, comments…).

When <OK> button is clicked, the image thumbnail is created inside the gallery of the *Analyze indentation* window (Fig.53).

[1] *On the* Video *screen adjust the focus and move by using* Methods to move, p. 39 *(**exceptions:** All* 'arrow' *icons and vector move buttons).*

In *Analyze indentation* window (Fig.53), when the optical analysis is completed (for each indent if several and if needed), click <Finish analysis> button.

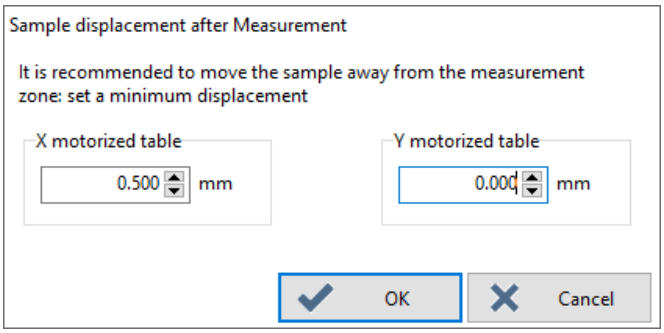


This *Confirmation* window appears.

If <Yes> button is clicked, it will not be possible to come back to this *Analyze indentation* window → The motorized Z table is retracted (moving down); wait.

6.3.7 SAMPLE DISPLACEMENT AFTER MEASUREMENT(S)

After the measurement(s) is performed or after visualizing the indentation(s) (previously described), the sample position should be shifted[1] to avoid performing the next indentation measurement inside the current measurement indent. The following window appears and is comparable to the one after the ADO automatic procedure; refer to the similar explanations from Fig.26.



[1] ***IMPORTANT:*** *Pay attention to the displacement unit (e.g. mm here), which is set in the options; refer to the* **Common Scratch & Indentation software reference guide** *in section* **Customizing options / Preferences tab (units)**.

7 RESULTS ANALYSIS

Results and graphic curves of the indentation measurement (sheet *1* bottom tab) are created in the main *Indentation Software* window (Fig.55); *Show the curve* view icon is selected (default) on toolbar.

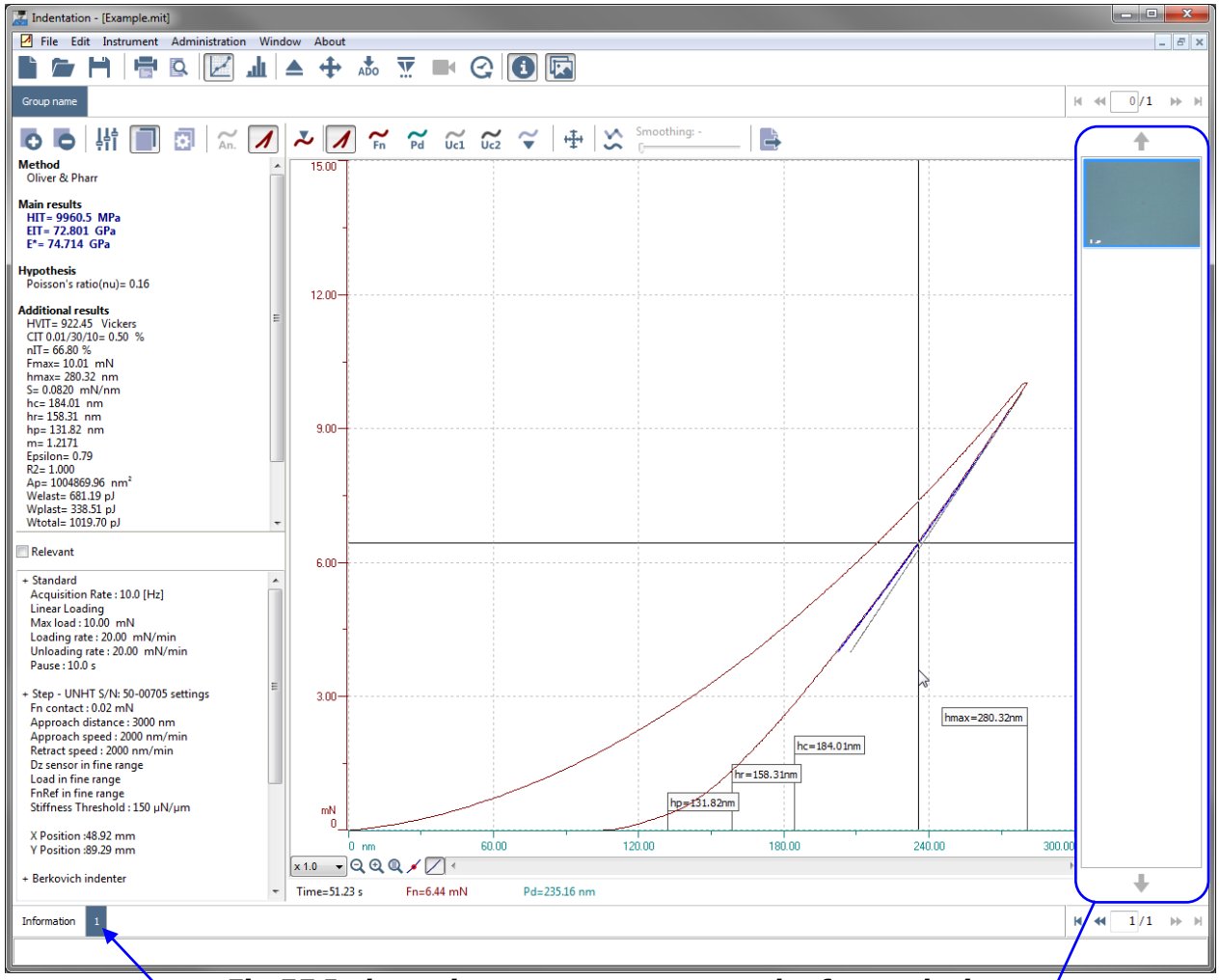


Fig.55 Indentation measurement results for analysis

Measurement sheet *1* bottom tab

Gallery of image thumbnails

7.1 VIEWING MODES

The previous graph area (Fig.55) shows the combined curves, force vs. indentation depth as *Indentation curve* icon is selected.

Other viewing mode(s) is available (Fig.56):

Click *Fn* icon to show/hide **F** red curve vs. time.

AND/OR

Click *Pd* icon to show/hide **h** green curve vs. time.

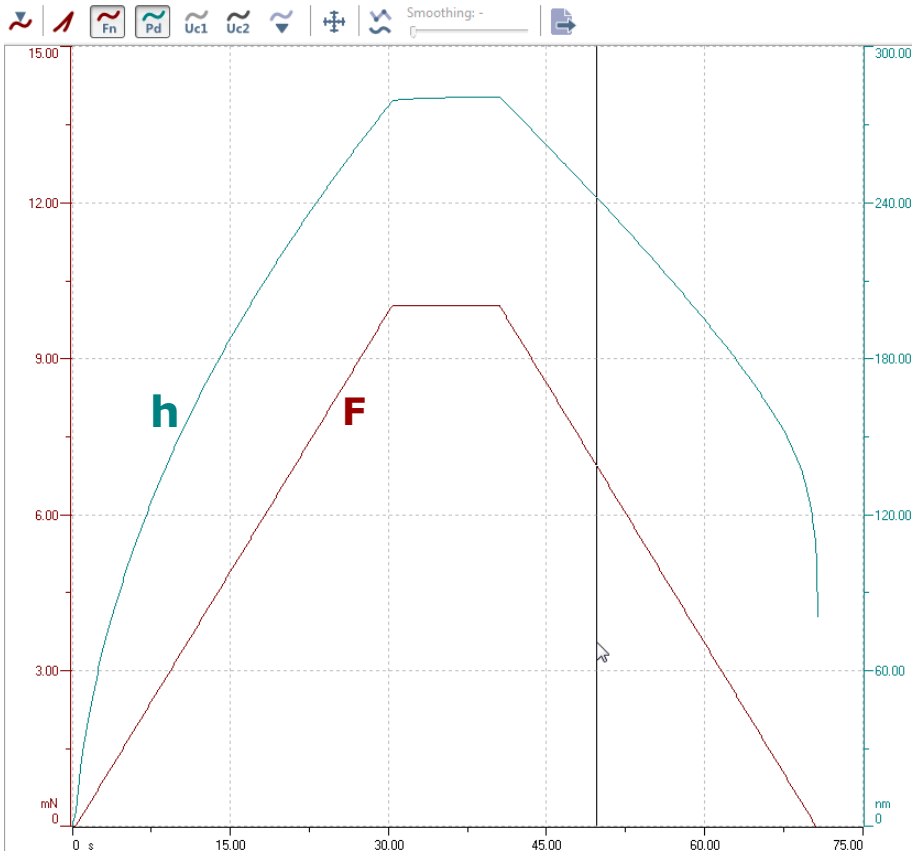
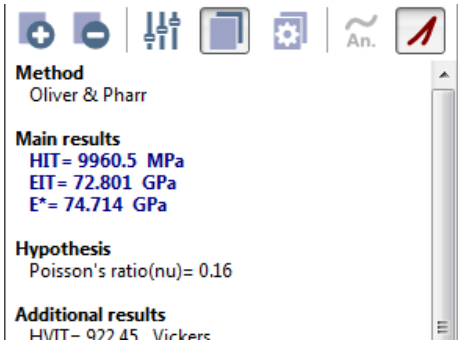


Fig.56 Both F and h vs. time are displayed

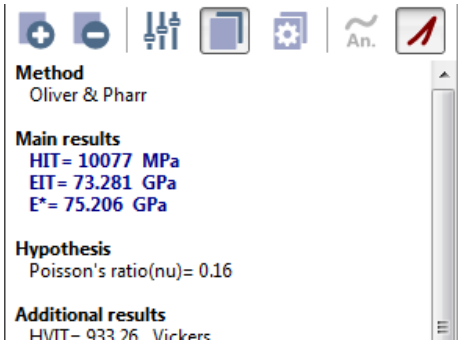
7.2 CONTACT POINT(S)

Each indent contact point[1] (several if matrix) has been automatically defined by the software. However, it is advised to verify and if necessary to refine (more precisely) each contact point as follows.

Select **"Edit > Indentations > Set contact point..."** from menu bar or click *Detect contact point* on additional toolbar (Fig.55) and follow the same explanations from section 5.13.5.1, **exceptions**: Here[1] there is only one indent (one load).

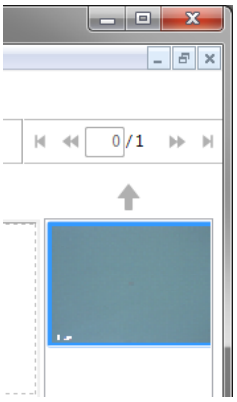


Here the results are calculated with the contact point automatically defined by the software → *Detect contact point* icon is inactive on *Set the contact point* window (Fig.38) toolbar.



Here the results are recalculated with the contact point more precisely refined by the user → *Detect contact point* icon is active on *Set the contact point* window (Fig.39) toolbar.

7.3 REVIEWING IMAGES



Double click one image thumbnail in the gallery of the result analysis main window (Fig.55) to open *Edit an image* window (Fig.54).

[1] *For our measurement example (Fig.49), only one indent (#1) is available.*

7.4 SINUS ANALYSIS

For Sinus measurement results

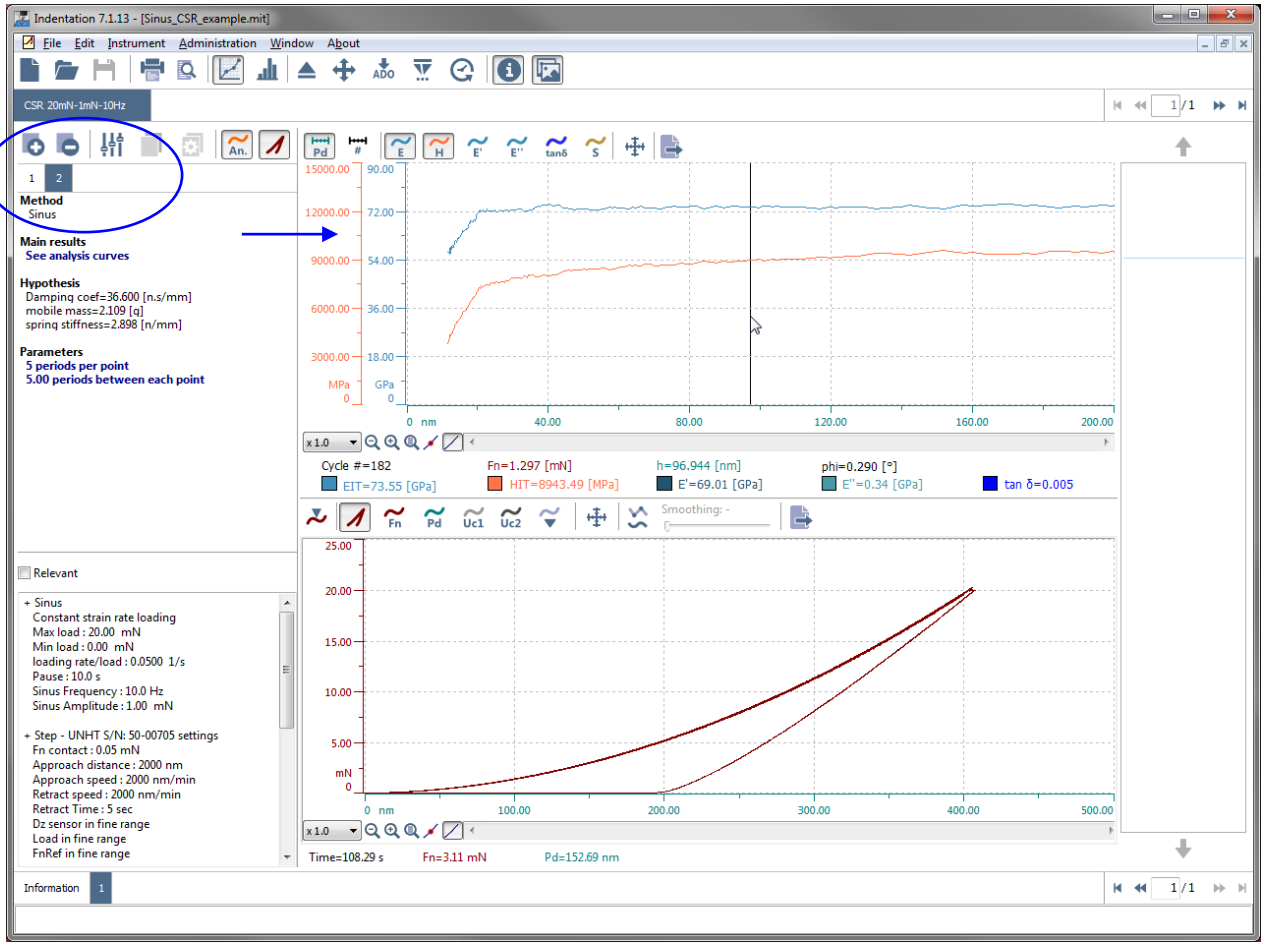
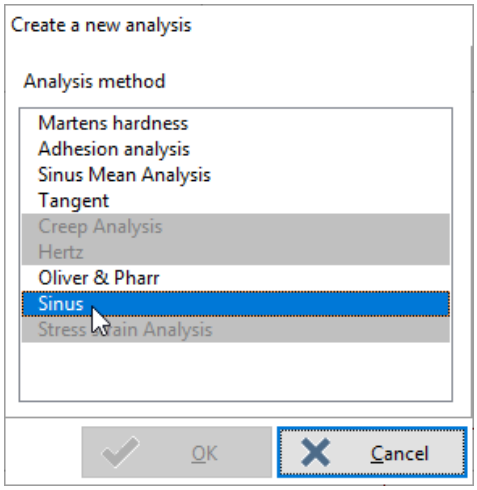


Fig.57 Main window with sinus analysis of results

On the left top side of the main window (Fig.57), *Add analysis* icon to add a new Sinus method analysis.



This window appears.

Double click *Sinus*.

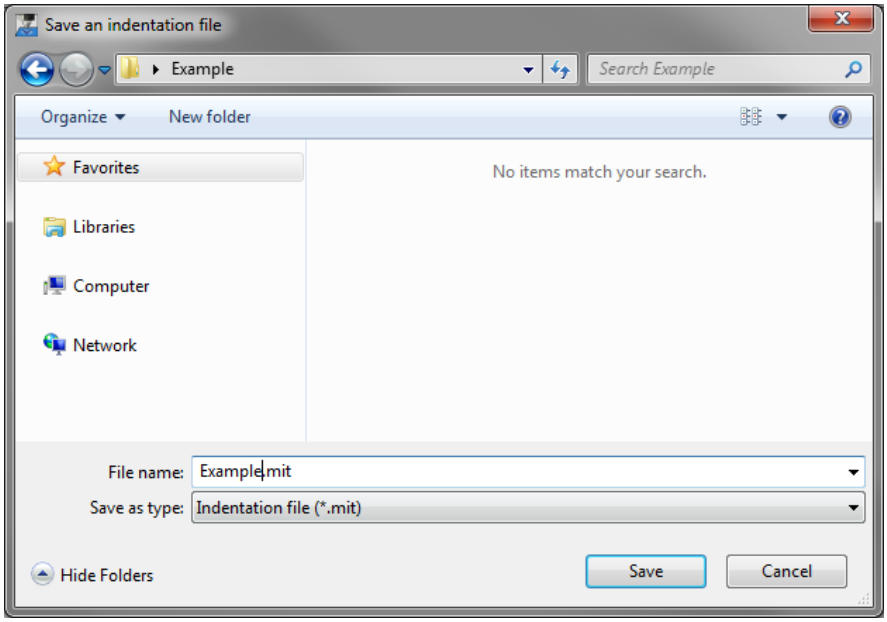
In the main window (Fig.57) a new tab (e.g. tab #2) appears with:

- Sinus analysis method results, parameters… on the left side
- an additional upper graph area with the sinus curve results

7.5 SAVE, PRINT, STATISTICS/EXPORT

7.5.1 SAVE

Select **"File > Save"** from menu bar or click *Save* icon on toolbar to open the following *Save an indentation file* window.



Choose a location to save the measurement file on the acquisition system.

Type a file name (automatic extension .mit)

Then click <Save> button.

7.5.2 PRINT

For further details, refer to the ***Common Scratch & Indentation software reference guide*** in sections ***Customizing options*** and ***Printing/PDF document reports***.

7.5.2.1 Report properties

Select **"File > Options..."** from menu bar to open the following *Options* window (Fig.58).

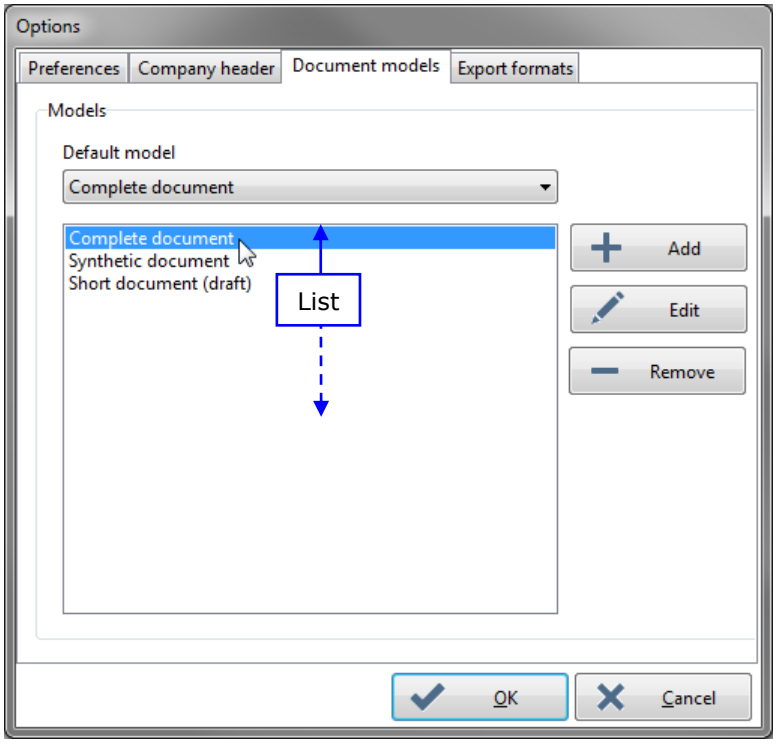


Fig.58 Document models tab

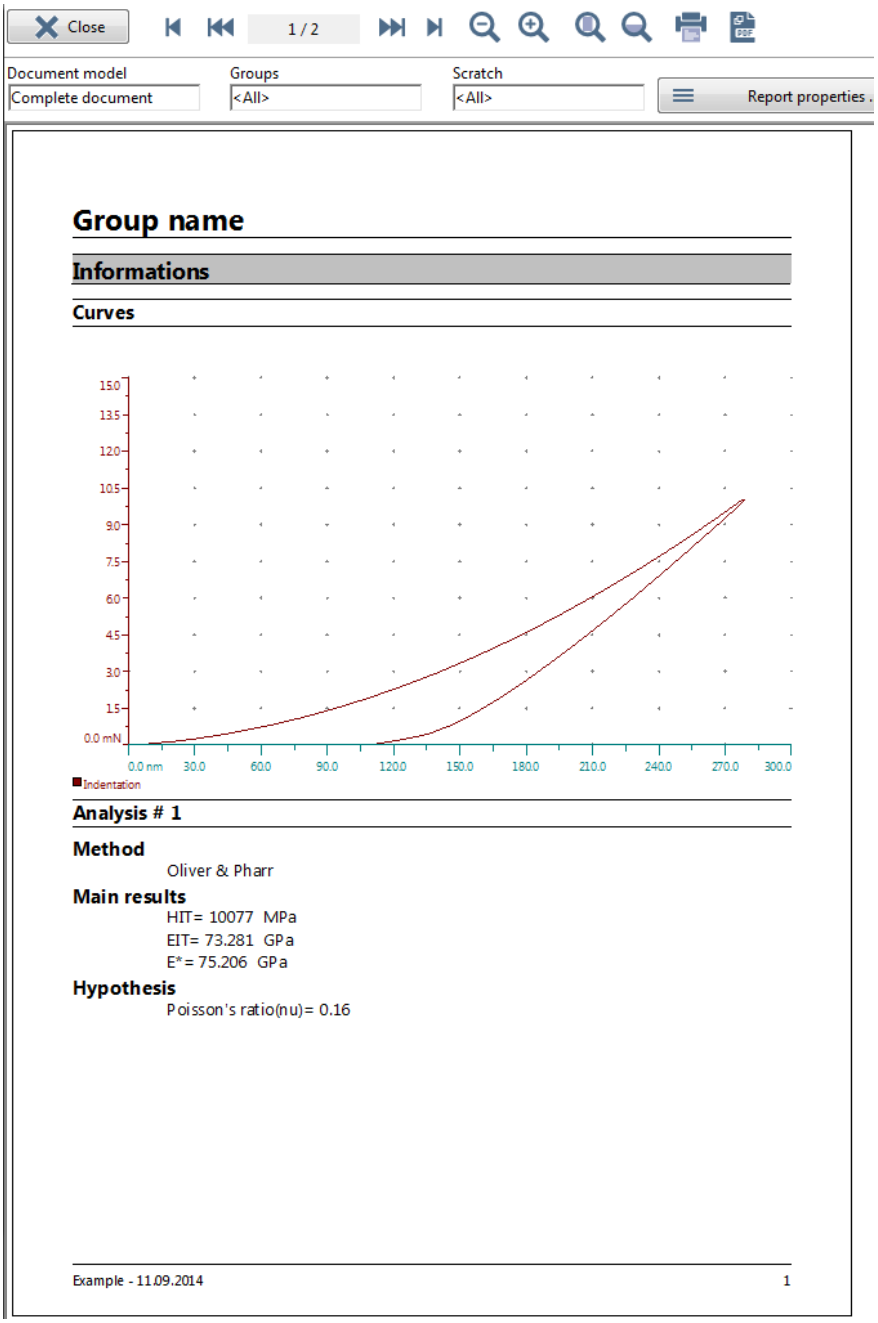
To edit/create document models:

Select *Document models* tab and click <Add> button to create a new model or select an existing document model in the list and click <Edit> button to change it.

Then the *Edit a document model* window appears and includes several tabs in which the report properties can be configured (for printing then).

7.5.2.2 Print preview

Select **"File > Print preview..."** from menu bar or click *Print preview* icon on toolbar to open the following '*Print preview*' window.



Print preview includes the configuration set in section 7.5.2.1 but it can also be changed by clicking <Report properties …> button, see Fig.60.

Click *Print* icon and see Fig.59.

Click *Save as PDF* icon and see *File info* area in Fig.61.

7.5.2.3 Print

Select **"File > Print..."** from menu bar or click *Print* icon on toolbar to open the following window (Fig.59).

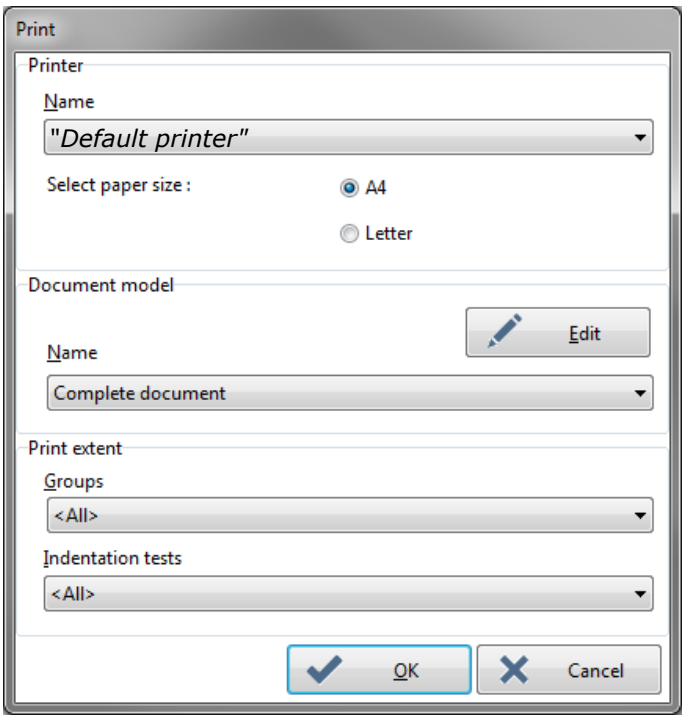


Fig.59 Print window

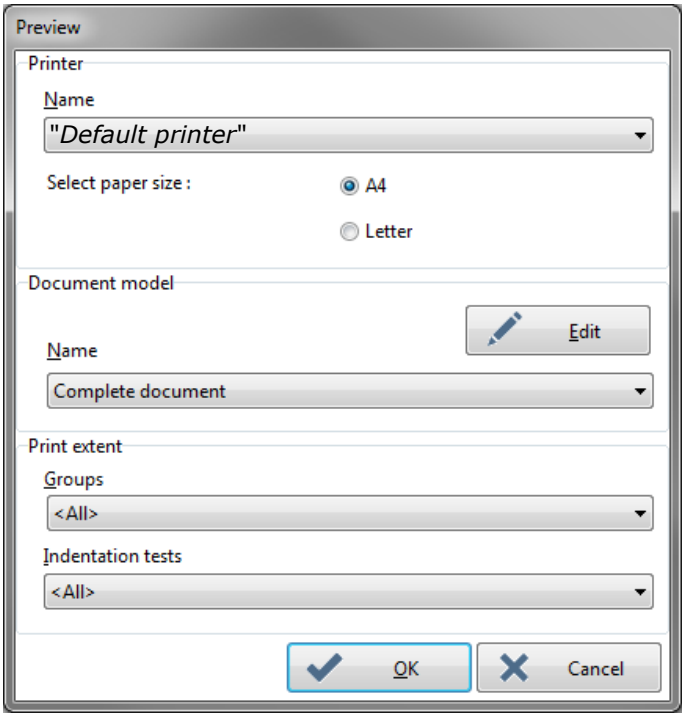
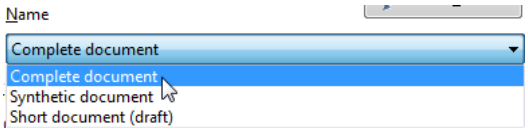


Fig.60 Preview window

Same Print or Preview windows

Print report properties can also be changed here as follows.

Select a *Document model* from **"Name"** drop-down menu.



Then click <Edit> button to open the *Edit a document model* window which includes several tabs in which the report properties can be configured (for printing then).

Other printing options are available as follows.

Select the desired group(s) of the indentation measurements that should be printed from **"<Groups > ..."** drop-down menu:

- **"<All>"** group(s),
- **"<All relevant>"**group(s), or
- one existing " '**Group name**' ".

Select the desired kind of indentation measurement(s) that should be printed from **"<Indentation tests > ..."** drop-down menu:

- **"<All>"** measurement(s), or
- **"<All relevant>"** measurement(s).

7.5.2.4 PDF

Select **"File > Save as PDF..."** from menu bar to open the following window (Fig.61).

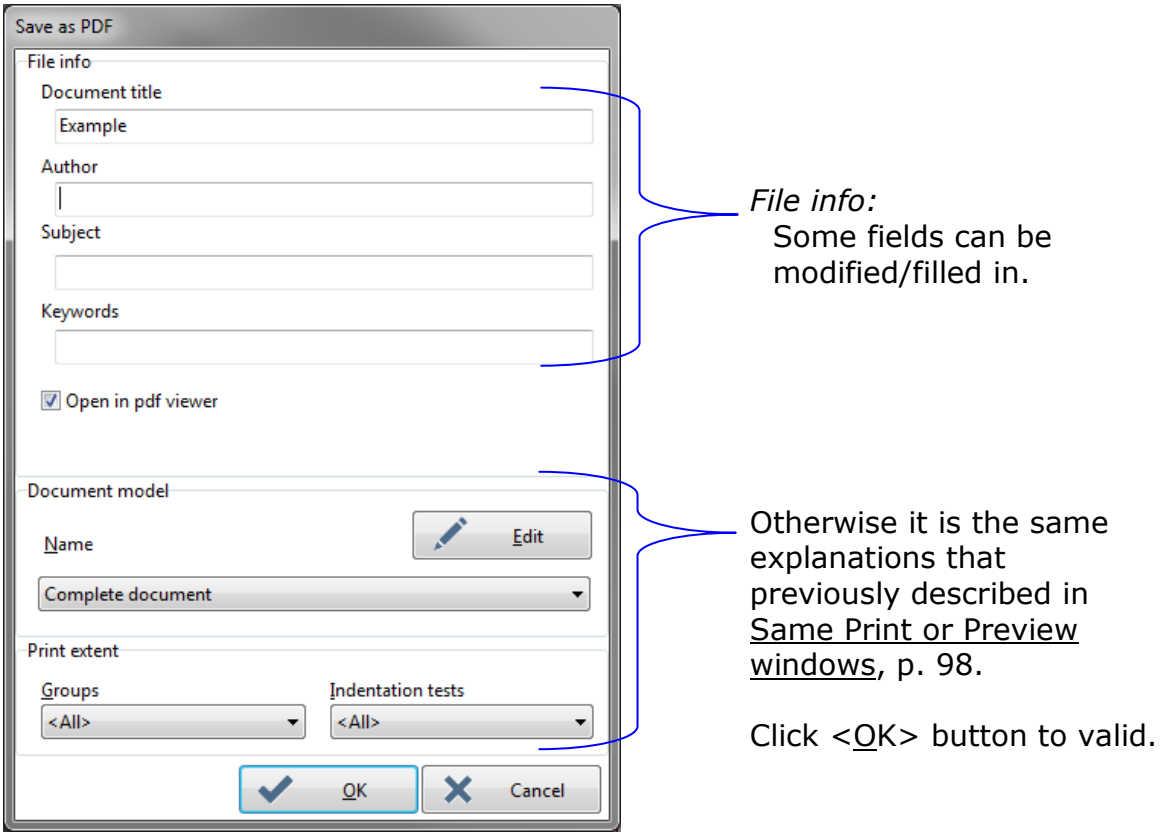
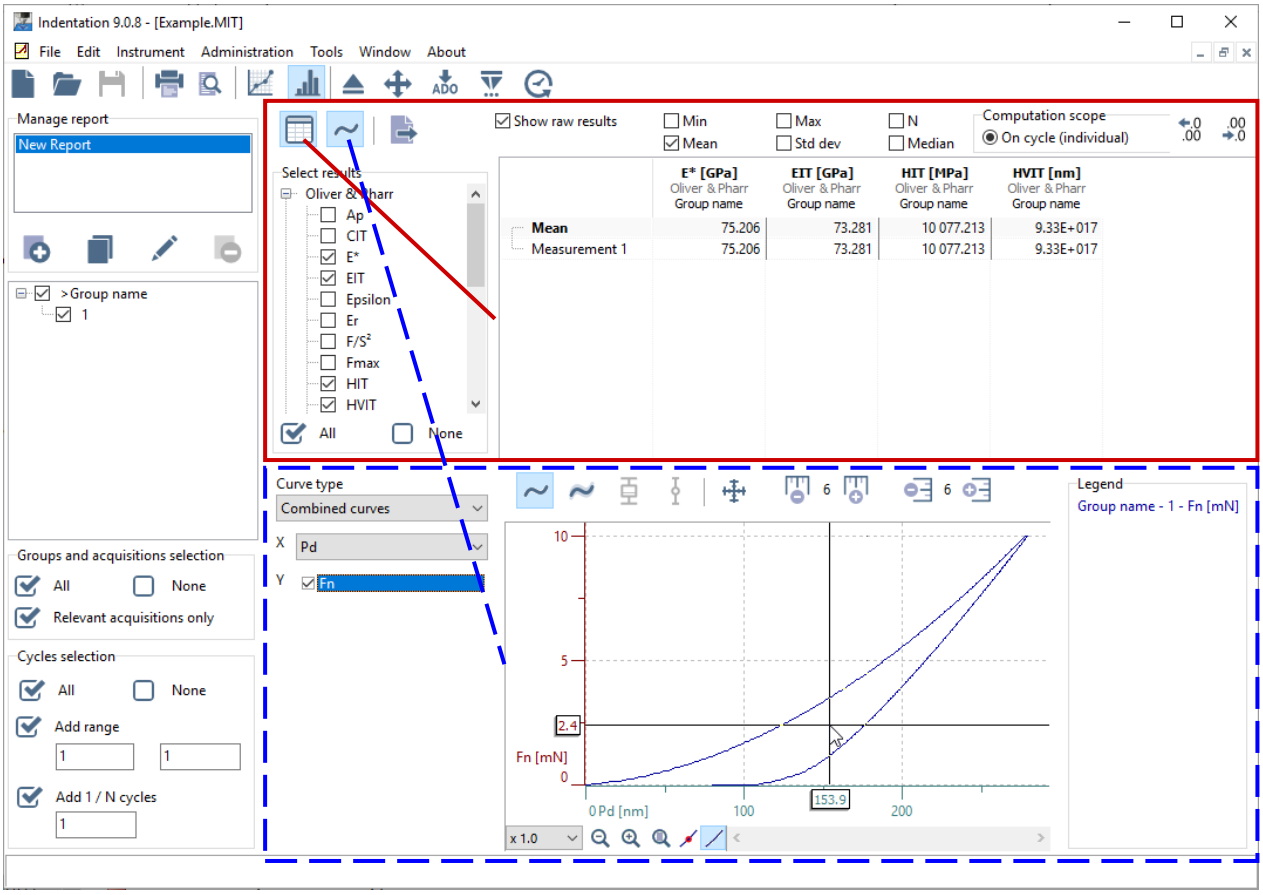


Fig.61 Save as PDF window

A 2nd *Save as PDF* window appears.
Choose a location to save the PDF file on the acquisition system.
Type a file name (automatic extension .pdf)
Then click <Save> button.

7.5.3 STATISTICS/EXPORT

Click *Show the statistics* icon on toolbar to show the statistics view; see the following main window.



In the current report (e.g. *New report* in *Manage report* area) or in each new one (clicking *Create a new report* icon)

In the tree, select by checking each group/measurement# boxes for which data/curves statistics should be performed; e.g. only 1 group and 1 measurement#1 is available here 

Click *Select statistics* icon to show/hide the statistics area and/or click *Curves* icon to show/hide the curves area. Select the desired data and options (in statistics area: Results tree check boxes, additional toolbars check boxes and options - in curve area: Drop-down menus, check boxes, additional toolbox icon options…).

Click '*Sheet*' icon to export in different ways the data/curve results in text files.

For further details about statistics (cycles…) and export, refer to the ***Common Scratch & Indentation software reference guide*** in section ***Statistics***.

8 PERFORMING A NEW MEASUREMENT

8.1 WITH THE SAME SAMPLE

To perform new indentation measurement(s) with the **same sample** and the **same indenter**, resume the procedure from section 6.3.

Otherwise if the indenter should be changed, resume the procedure from section 5.6.

8.2 WITH A NEW SAMPLE

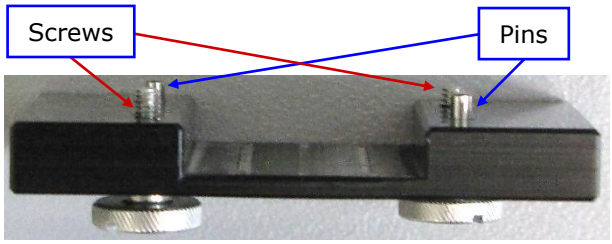
To carry out new indentation measurement(s) with a **new sample** but with the **same indenter**, resume the procedure from section 6.

Otherwise if the indenter should be changed, resume the procedure from section 5.6.

9 MOUNTING HEAD BOTTOM PROTECTION COVER

When the UNHT^3 is not in use, it is advised to mount its head bottom cover in order to protect the indenter and reference.

Avoid any collision with the indenter/reference during the following operations.



The cover is equipped with 2 captive hand screws in diagonal and 2 positioning pins in opposite diagonal.

Position the cover in order to see the 'U' shape in front of the head.

- Tilt the protection cover forward to better see and carefully place the 'U' shape over and around the indenter and reference, **avoid** any collision between the 'U' shape sides and the indenter/reference

- Then lightly press the protection cover against the head bottom.

- Search the 2 pin holes by doing **only** longitudinal movements **no** lateral movements. When cover pins are inserted, keep the cover pressed against the head bottom and (with other hand) tighten the 2 hand screws to lock the cover against the head bottom.

Fig.62 Head bottom

10 F.A.Q.

10.1 WHY IS THE INDENT NOT UNDER THE VIDEO CROSSHAIR?

Why is there an offset between the indent center and the video crosshair center after an indentation measurement?

➔ The distance between the indenter and the video microscope is wrong:

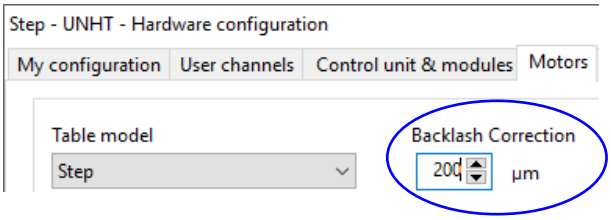
Perform a new Indenter-microscope distance calibration (section 5.10).

➔ The sample moves during the indentation measurement, due to the indentation force:

Tighten stronger the sample in the clamp jaws.

➔ There was play in motorized X, Y tables:

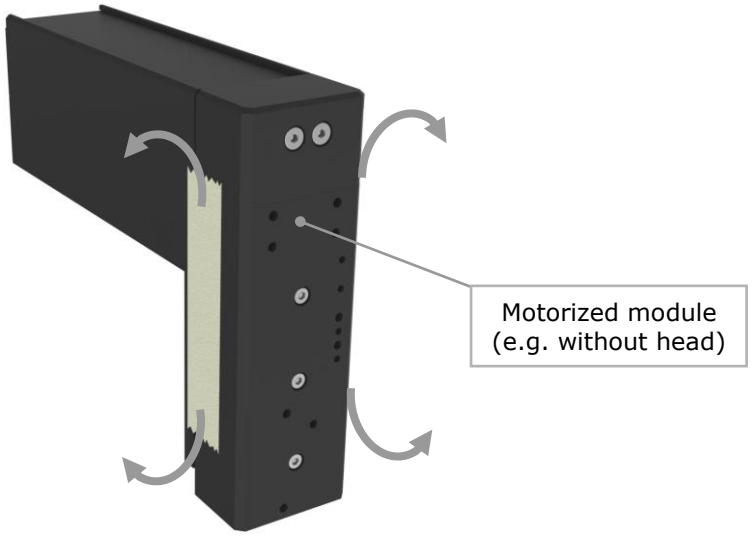
Select **"Instrument > Hardware configuration..."** from menu bar and in *Hardware configuration* window, click <Edit> button>. In the following *Step - MHT - Hardware configuration* window, select *Motors* tab and verify/set *Backlash Correction* field to 200 µm.



Then **click** <Backlash> button (backlash correction) in *Position control* window (Fig.13) after the last manual move of the targeting process. This will remove the play of motorized X, Y tables.

10.2 WHY CAN I NOT REACH THE CONTACT LOAD?

➔ The 2 pieces of masking tape on each side of the motorized head module are not removed:



Remove the 2 pieces of masking tape.

Masking tape should only be present if the head/instrument is being sent back (for transport).

10.3 WHY IS THE INDENT NOT AS EXPECTED?

Why is the indent non-conform, not repeatable?

➔ The distance between the indenter and the video microscope is wrong:

Perform a new Indenter-microscope distance calibration (section 5.10).

➔ The sample moves during the indentation measurement, due to the indentation force:

Tighten stronger the sample in the clamp jaws.

➔ The indenter extremity is:

► Dirty,

Clean indenter extremity and/or

Perform an indentation at 50 mN in copper to remove dirt ; see section 0

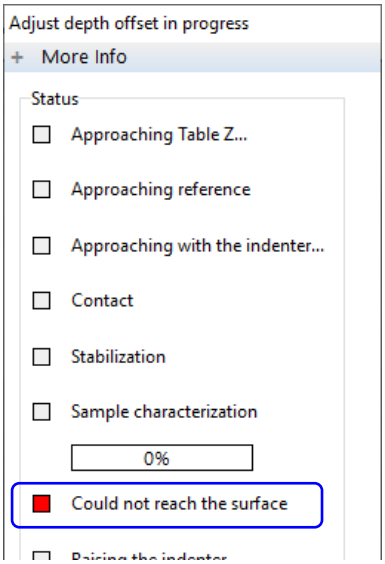
► Worn out for the application or damaged,

Verify the wear by performing an indenter calibration (section 5.13) and then if it is necessary,

Use a new indenter and review from section 5.6.

10.4 WHY IS THE ADO NOT SUCCESSFUL?

Why has the ADO **not** been successfully performed? The automatic procedure has been interrupted and sometimes the following error status appears.

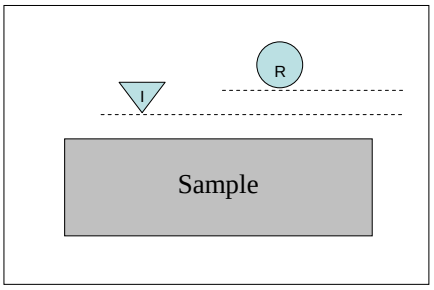


Could not reach the surface

Then there is no green circle with a tick on *ADO* ADO icon on toolbar.

➔ The ADO pre-approach parameters values for the indenter and the reference are not suitable and should be adapted:

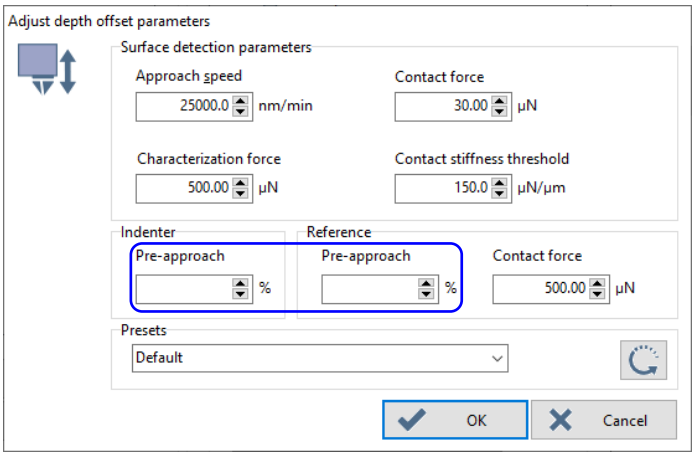
Case a)



Bad pre-approach

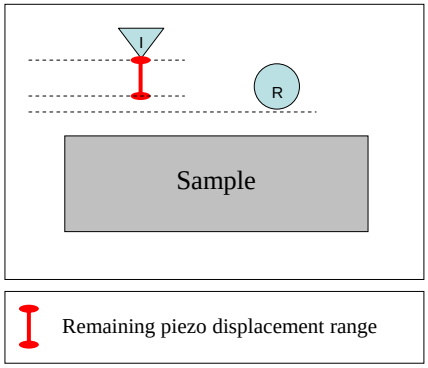
While the motorized Z table approaches (moving up), the sample surface touches both reference and indenter or only the indenter.

Depending on *Indenter* and *Reference Pre-approach* fields (in *Adjust depth offset parameters* window), either the indenter value should be decreased by 10 % or more, or the reference value should be increased by 10 % or more.



An ADO **should** be started again and if it is necessary, readjust those pre-approach values until it is successfully (ADO) performed.

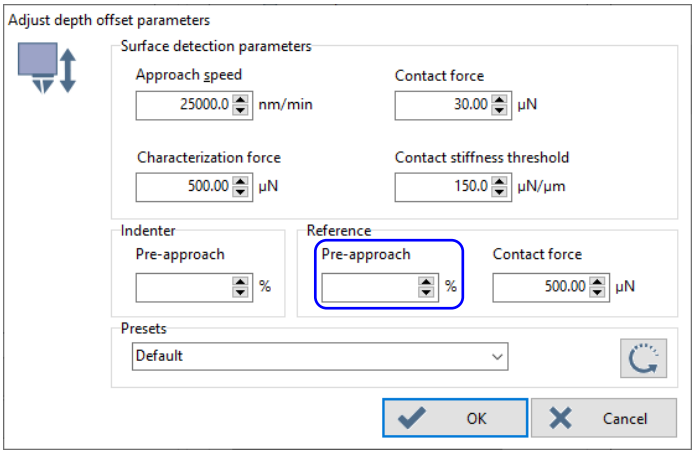
Case b)



Bad pre-approach

The reference touches the sample surface but the indenter goes (down) to ~ 100 % (max) without having touched the sample surface.

In this case (in *Adjust depth offset parameters* window) the *Reference Pre-approach* field value should be decreased by 10 % or more.



An ADO **should** be started again and if it is necessary, readjust this pre-approach value until it is successfully (ADO) performed.

If the value is set to the minimum (advised not less than 5 %) and there is still the error, it means the sample is tilted too much and should be leveled.

➔ The sample is tilted to much:

Level the sample and then an ADO **should** be started again until it is successfully (ADO) performed.

➔ <Cancel> button has been clicked during the automatic ADO procedure (this stops the procedure and cancel the ADO):

An ADO **should** be started again until it is successfully (ADO) performed.

See the ADO (section 5.11).

10.5 WHY IS THE DEPTH SIGNAL SATURATED?

See the following graphs.

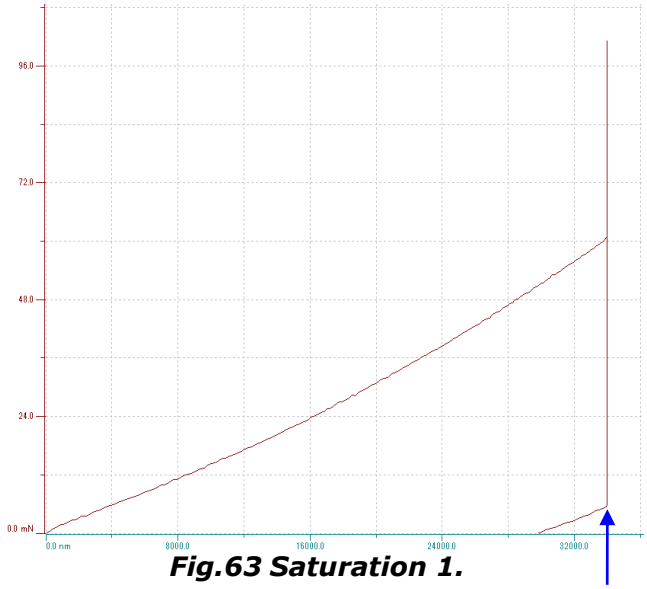


Fig.63 Saturation 1.

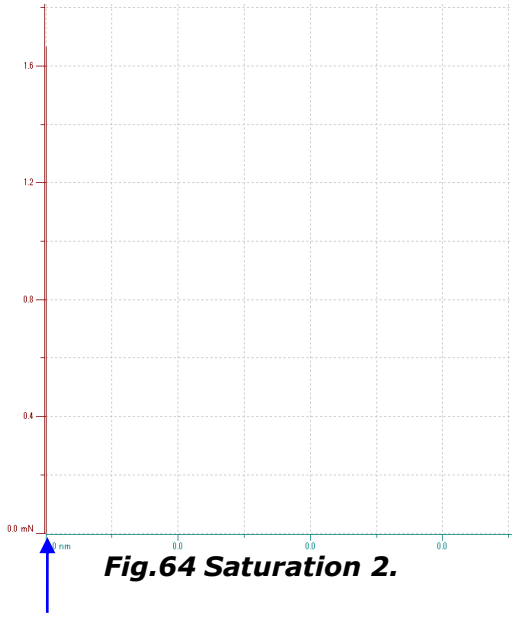
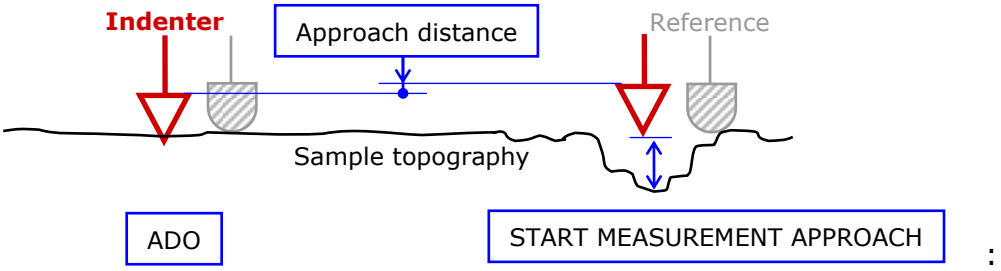


Fig.64 Saturation 2.

➔ The sample is very soft which gives a large penetration depth during the measurement (Fig.63) :

OR

➔ There is a certain relief on the sample (can be a too high roughness). The measurement is performed in a hole: the approach distance is increased which may saturate the depth (Fig.64)



:

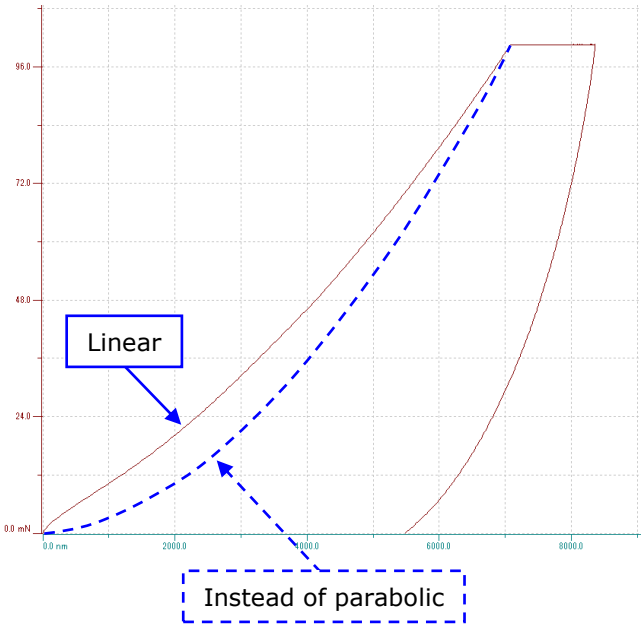
<u>Before starting a new measurement</u>

Select the <u>large</u> *Depth range* radio button, e.g. <50 µm> (instead of fine <10 µm>) in *Sensor range* tab of *Hardware parameters* window (Fig.51).

10.6 WHY IS THE FORCE DISPLACEMENT CURVE LINEAR?

Even with a Vickers or Berkovich indenter? See the following graphs.

The indenter is already in the sample surface before the approach



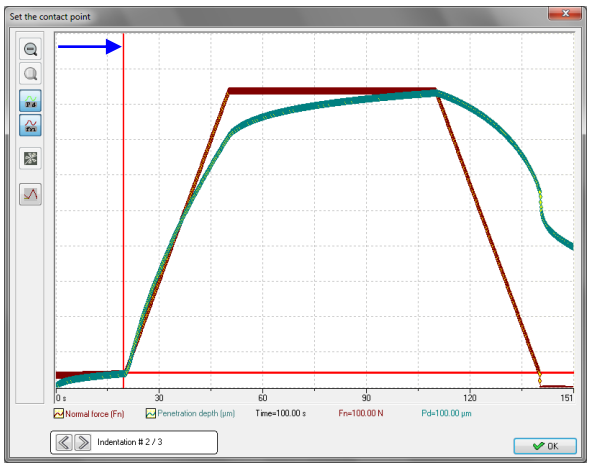
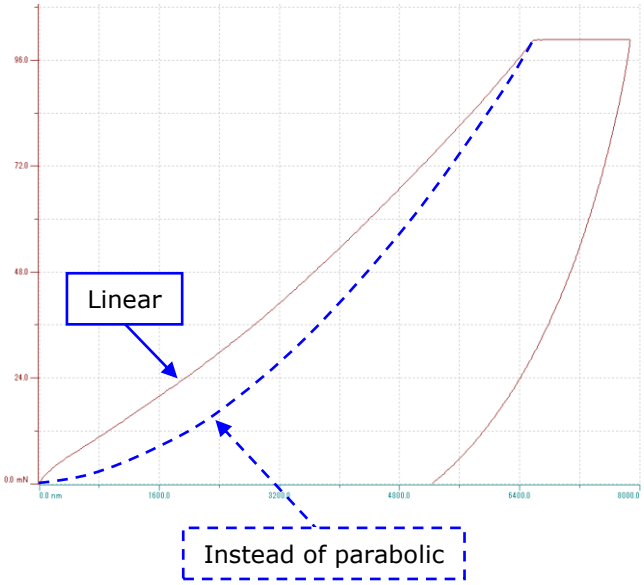


Fig.65 Approach very short (in Set the contact point window)



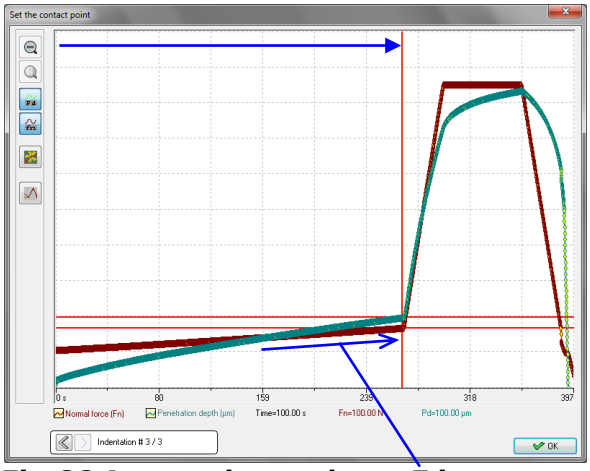
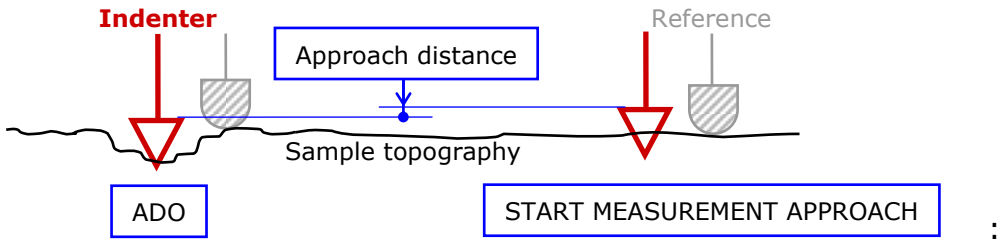


Fig.66 Approach very long, F increases (in Set the contact point window)

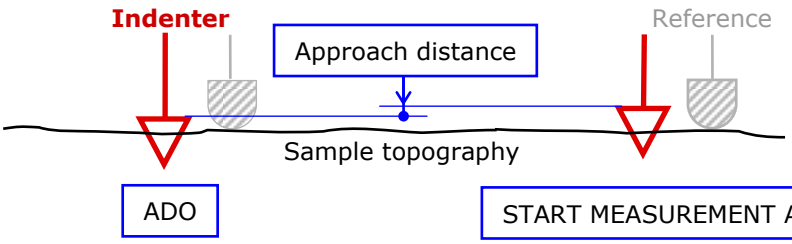
➔ The ADO is performed in a hole. Then the approach distance is not sufficient and this way the indenter starts the measurement already in the sample



:

OR

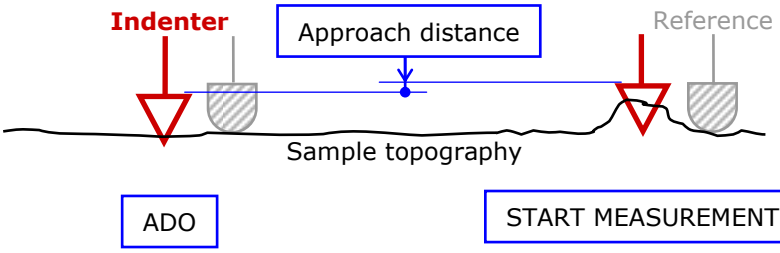
➔ During the ADO the indenter penetrates too much in the sample because of sample softness. Then the approach distance is not sufficient and this way the indenter starts the measurement already in the sample



:

OR

➔ There is a certain relief on the sample (can be a too high roughness). The measurement is performed on a bump: the approach distance is not sufficient and this way the indenter starts the measurement already in the sample

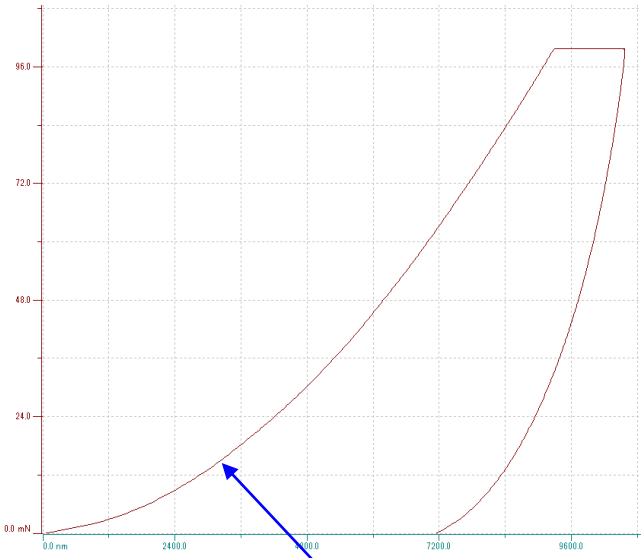


:

<u>Before starting a new measurement, in order to increase the approach distance</u>

Set a greater value in *Approach distance* field, e.g. > 3'000 nm in *Preferences* tab of *Hardware parameter* window (Fig.50).

If the value is too much increased, then it is possible that the depth signal saturates (section 10.5).



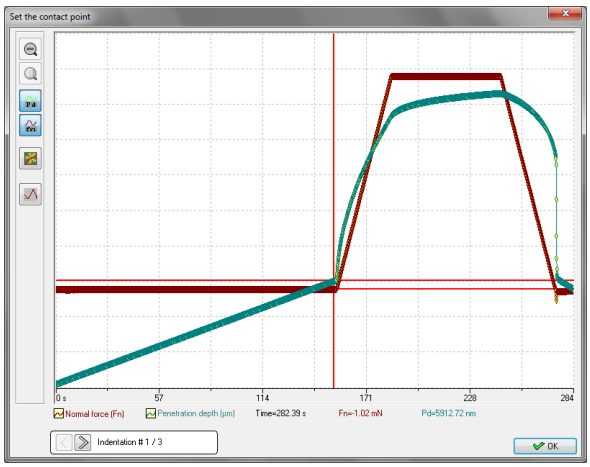
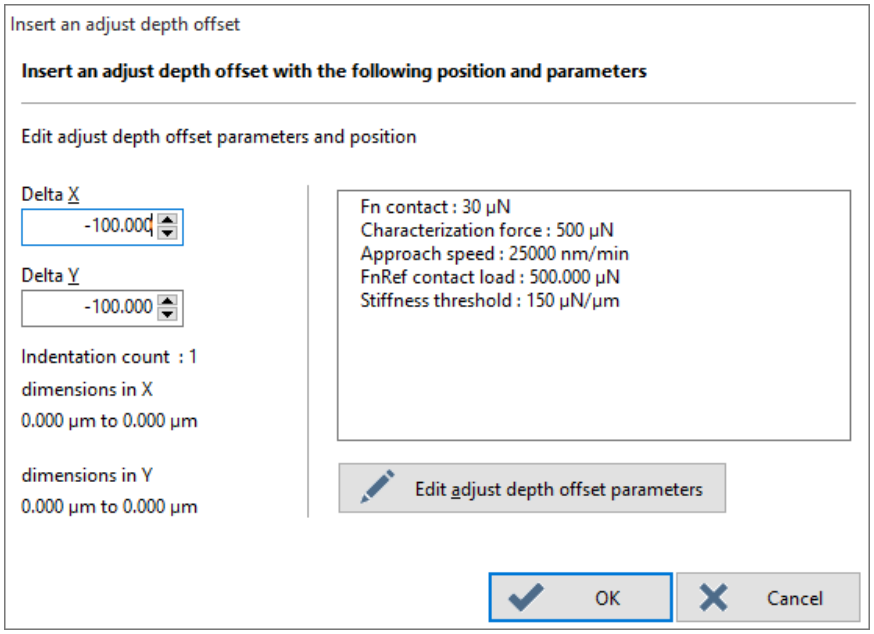


Fig.67 Approach Ok (in Set the contact point window)

Ok, parabolic curve (for Vickers and Berkovich)

10.7 WHY DOES THE INSERT AN ADJUST DEPTH OFFSET WINDOW APPEAR?

Why this window appears before running an indentation measurement?



➔ No ADO has been performed or the last ADO was **not** successfully performed (**no** green circle with a tick on *ADO* ADO icon on toolbar):

Edit these ADO parameters and position,

- click <Edit adjust depth offset parameters> button, this opens the *Adjust depth offset parameters* window (Fig.24).
- set suitable values[1] in *Delta X* and *Y* position fields, this will shift the current position for this ADO (and then when ADO procedure is finished, it will come back where it was before running the indentation measurement) and click <OK> button to start this ADO before running the indentation measurement.

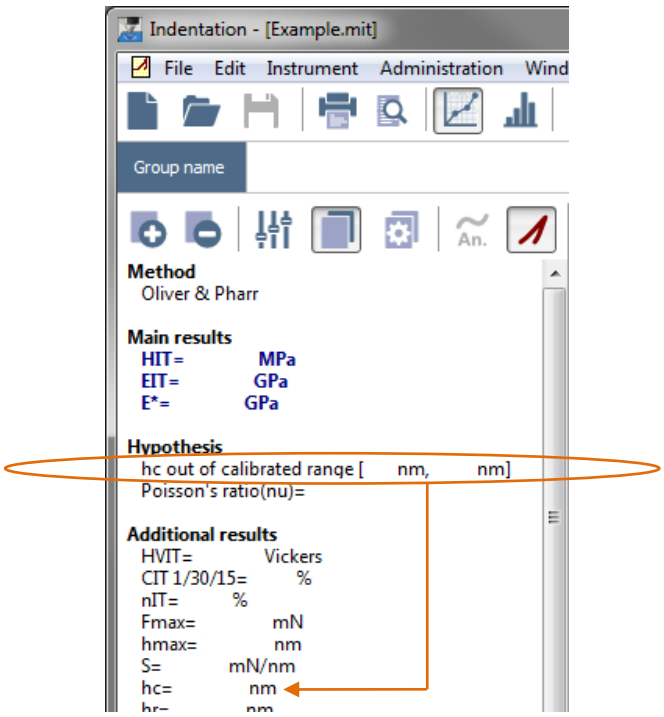
OR

Click <Cancel> button to abort this ADO which aborts also the indentation measurement. Thus an ADO with the standard method, described in section 5.11, should be successfully (ADO) performed before running an indentation measurement.

[1] ***Not*** *too much, otherwise the sample topography may vary.*
IMPORTANT: *Pay attention to the displacement unit (e.g. mm here), which is set in the options; refer to the* **Common Scratch & Indentation software reference guide** *in section* **Customizing options / Preferences tab (units)**.

10.8 WHY DOES "HC OUT OF CALIBRATED RANGE" MESSAGE APPEAR?

Why in the main result analysis window under *Hypothesis* does the message "*hc out of calibrated range [# nm, # nm]*" appears?



➔ The h_c of the measurement *Additional results* is out of the known calibration range:

Refer to the ***Indentation software reference guide*** in section ***Analysis of results / Hypothesis / Out of indenter tip calibration***.

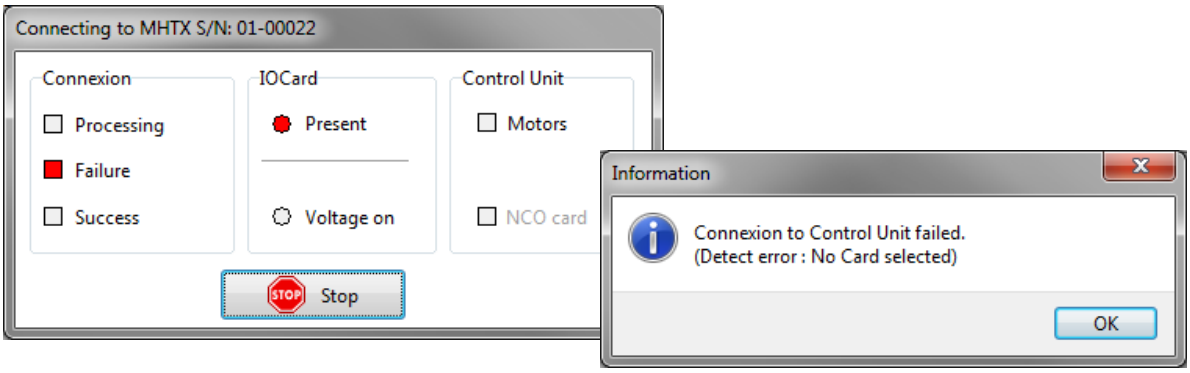
11 BLOCKING ERROR MESSAGES

This section shows the main blocking error messages and describes propositions to try removing the cause of each error. However if a problem persists, try switching off the system: First close the software, then shut down the acquisition system by software (Windows®) and then switch off the instrument using the main power switch. Wait about 20 sec, then switch on the instrument using the main power switch and then open the software and try again to see if this has solves the problem.

11.1 CONNECTION TO CONTROL UNIT FAILED.

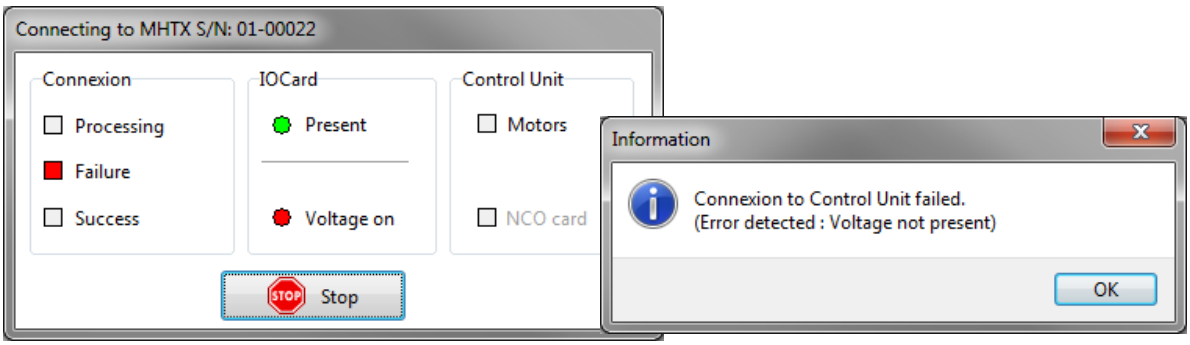
The control unit cannot connect.

(Detect error : No Card selected)



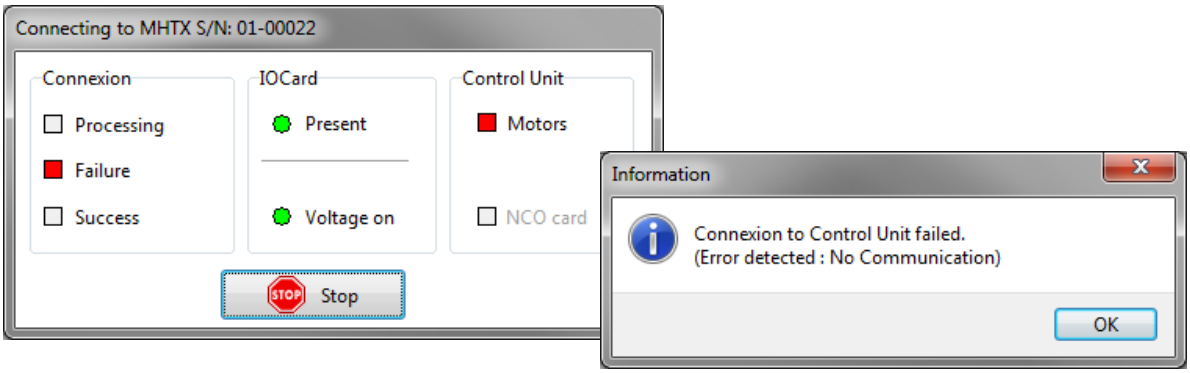
Verify that the IO card is selected (**"Instrument > Hardware configuration..."** menu bar / <Edit> button / *Control unit & modules* tab / <Choose card> button).

(Error detected : Voltage not present)



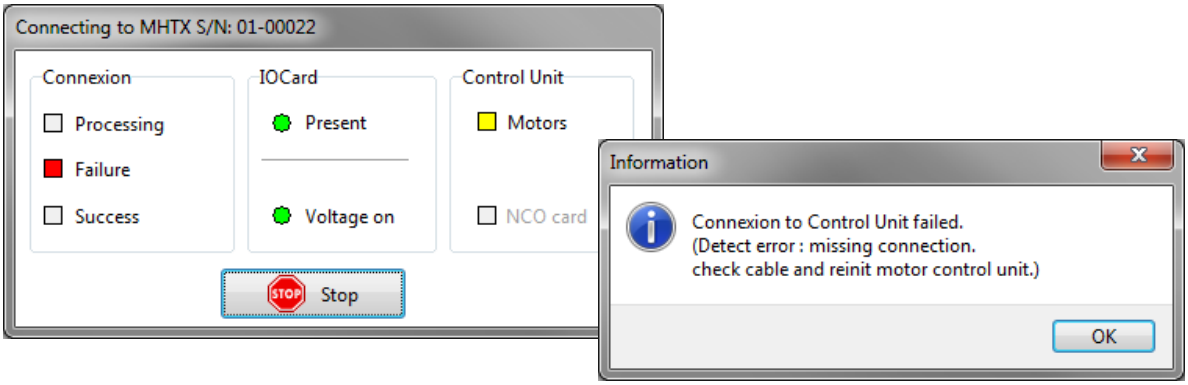
Verify that the Step is switched on (power cables plugged).

(Error detected : No Communication)



Verify that the communication Ethernet cable is connected (on acquisition system and on Step rear panels).

(Detected error : missing connection. check cable and...



Verify that the motor cables are connected to the Step.

11.2 YOUR INSTRUMENT RANGES HAVE NOT BE VALIDATED!

An ADO, calibration or measurement is not carried on.

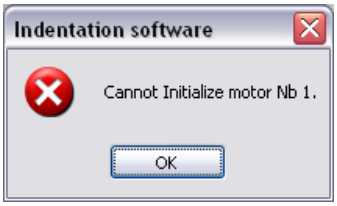
Refer to the ***Common Scratch & Indentation software reference guide*** in section ***Managing the instrument / Hardware configuration /*** '***Ranges***' ***tab(s)*** before starting a new measurement.

11.3 MOTORIZED TABLES

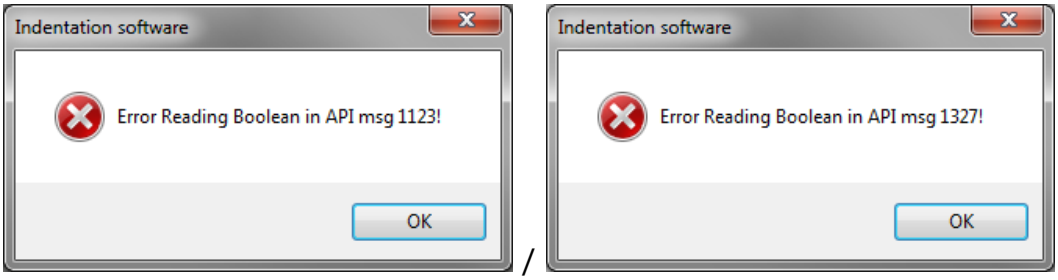
Motorized tables are no longer controlled: Fatal error.

Cannot get current position on motor 0

Cannot Initialize motor Nb 1.



Error Reading Boolean in API msg 1123 / 1327!



Close the software, then shut down the acquisition system by software (Windows®) and then switch off the instrument using the main power switch. Wait at least 20 sec, then switch on the instrument using the main power switch and then open the software.

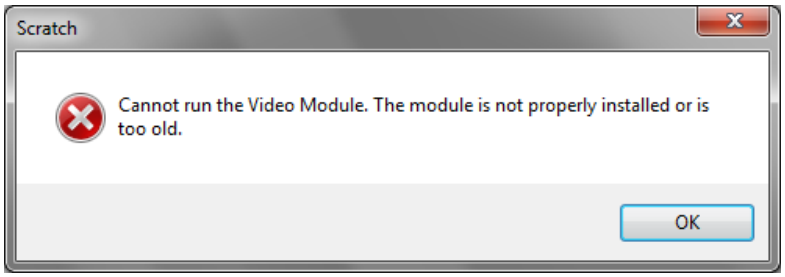
Verify the voltage network quality (it should be stable).

11.4 VIDEO SOFTWARE

The *Video Software* does not work.

Cannot run the Video Module. The module is not properly...

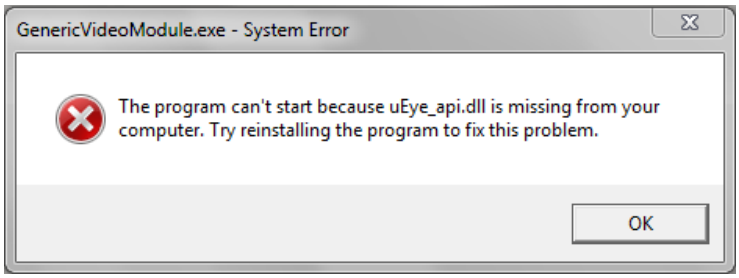
Cannot run the Video Software.

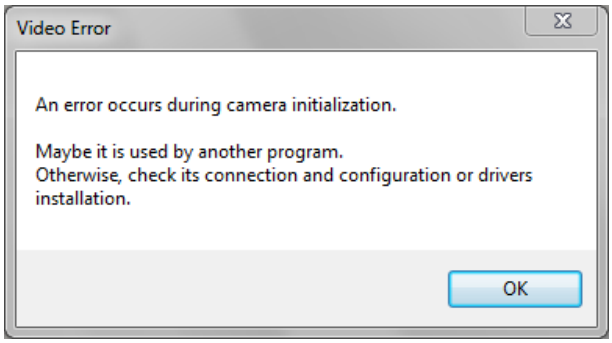


This software is too old or not properly installed; try to reinstall a recent Video Software.

The program can't start because uEye_api.dll is missing from...

Cannot properly use the software.

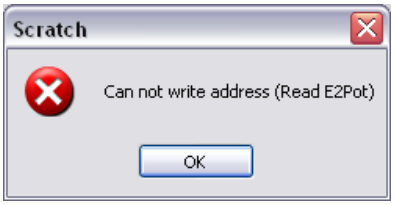




The camera driver is not properly installed; try to reinstall the camera driver (in the *setup Video.exe*).

11.5 CAN NOT WRITE ADDRESS

Communication trouble with video microscope light source.

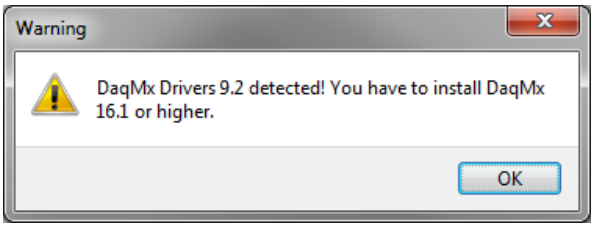


Verify that the video microscope cables are correctly plugged.

11.6 PREVIOUS DAQMX DRIVER VERSION DETECTED

When starting the software, if the following message appears,

DaqMx Drivers 9.2 (or *8.6*) *detected! You have to install DaqMX 16.1 or higher*



it means that a previous driver version (under DaqMx 16.1) is installed in the acquisition system.

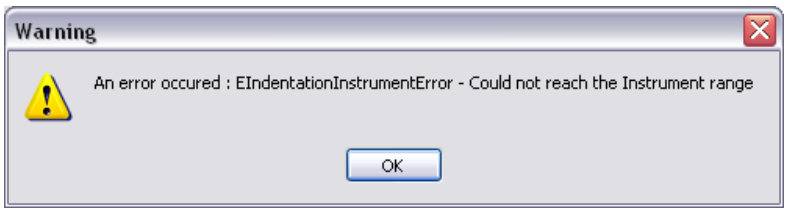
Contact us: www.anton-paar.com to ask for the latest driver version, in order to proceed with an update. Otherwise bad acquisitions can be performed and therefore wrong results can be obtained.

11.7 DURING AN ADO, A CALIBRATION OR AN INDENTATION MEASUREMENT

The ADO, the calibration or the indentation measurement is not carried on.

An error occurred : EIndentationInstrumentError - Could not...

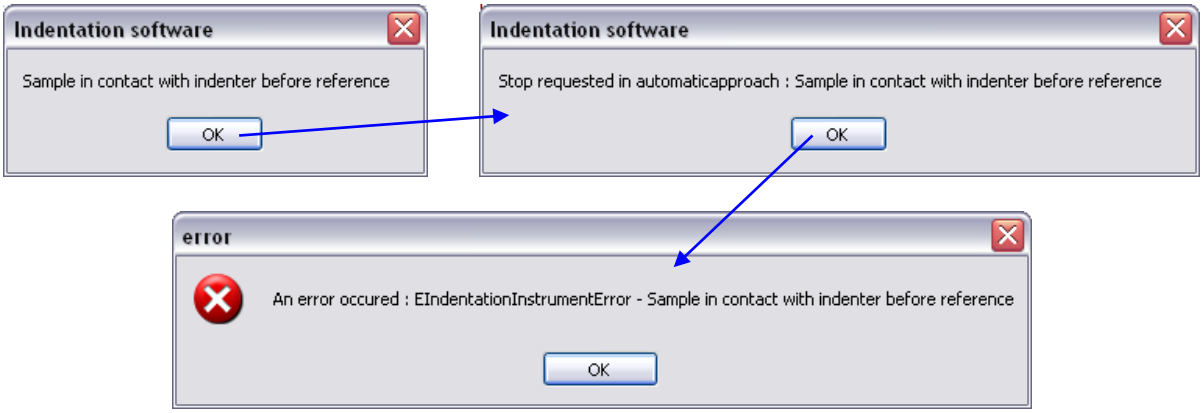
The instrument range cannot be reached.

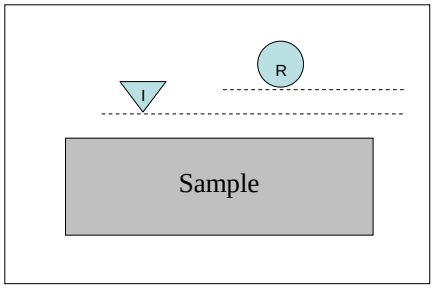


Start a new ADO until is successfully (ADO) performed before starting a new calibration or a new indentation measurement.

An error occurred: EIndentationInstrumentError - Sample in contact...

The sample surface has touched the indenter before the reference.

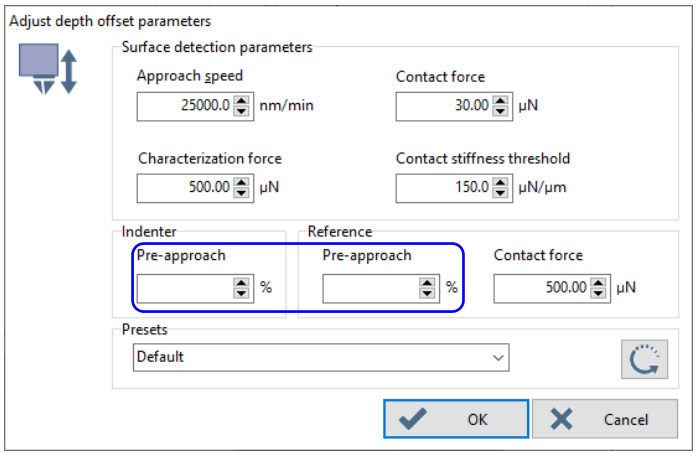




Bad pre-approach

While the Z table approaches (moving up), the sample surface touches both the reference and the indenter or only the indenter.

Depending on pre-approach parameters of the indenter and reference (in *Preferences* window and tab), either the indenter value should be decreased by 10 % or more, or the reference value should be increased by 10 % or more.



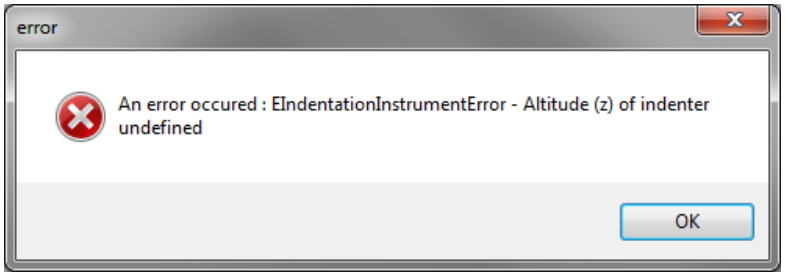
Start again the measurement and if necessary readjust those pre-approach values until the indentation measurement correctly runs until the end.

Otherwise start a new ADO[1] until it is successfully (ADO) performed before starting a new indentation measurement[1]

[1] *Previously, verify and if necessary, change the ADO parameters and then the hardware parameter preferences for the indentation measurement.*

An error occurred : EIndentationInstrumentError - Altitude (z) of...

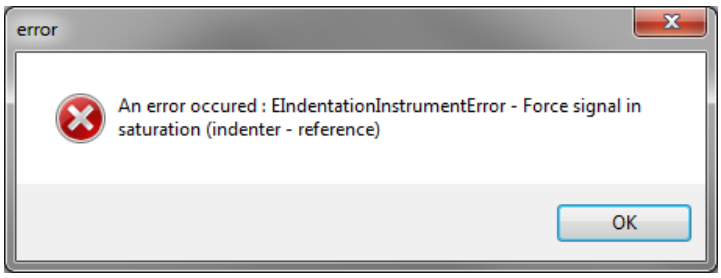
The altitude (z) of the indenter is undefined.



Start a new ADO[1] until it is successfully ( ) performed before starting a new calibration or a new indentation measurement[1]

An error occurred: EIndentationInstrumentError - Force signal...

The force signal is in saturation, the indenter-reference vertical distance is too large.

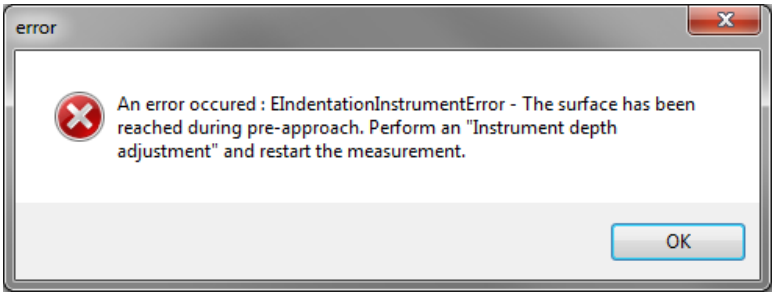


Start a new ADO[1] until it is successfully ( ) performed before starting a new calibration or a new indentation measurement[1]

[1] *Previously, verify and if necessary, change the ADO parameters and then the preferences parameters of the indentation measurement.*

An error occurred: EIndentationInstrumentError - The surface...

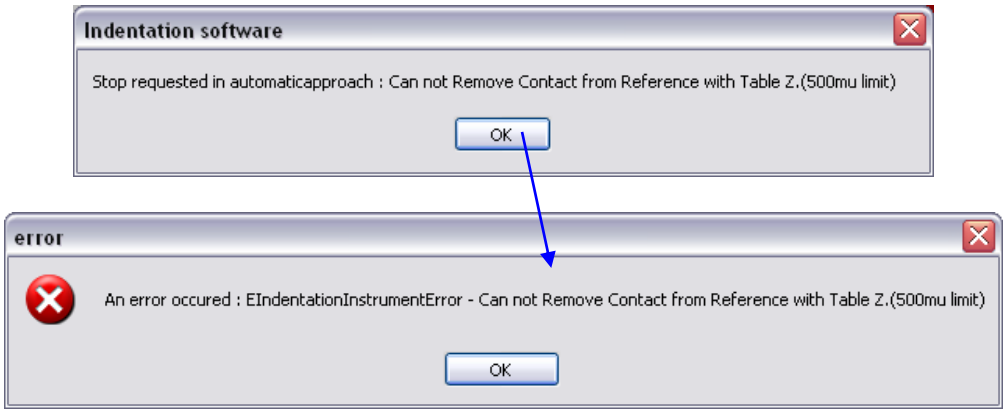
The sample surface has touched the indenter during the pre-approach.



Start a new ADO[1] until it is successfully (ADO) performed before starting a new calibration or a new indentation measurement[1]

An error occurred: EIndentationInstrumentError - Can not Remove from...

The reference contact cannot be removed with the motorized Z table.



Start a new ADO[1] until it is successfully (ADO) performed before starting a new calibration or a new indentation measurement[1]

[1] *Previously, verify and if necessary, change the ADO parameters and then the preferences parameters of the indentation measurement.*

If problems should be encountered, refer to this document and to the others mentioned.

Otherwise contact us,

www.anton-paar.com