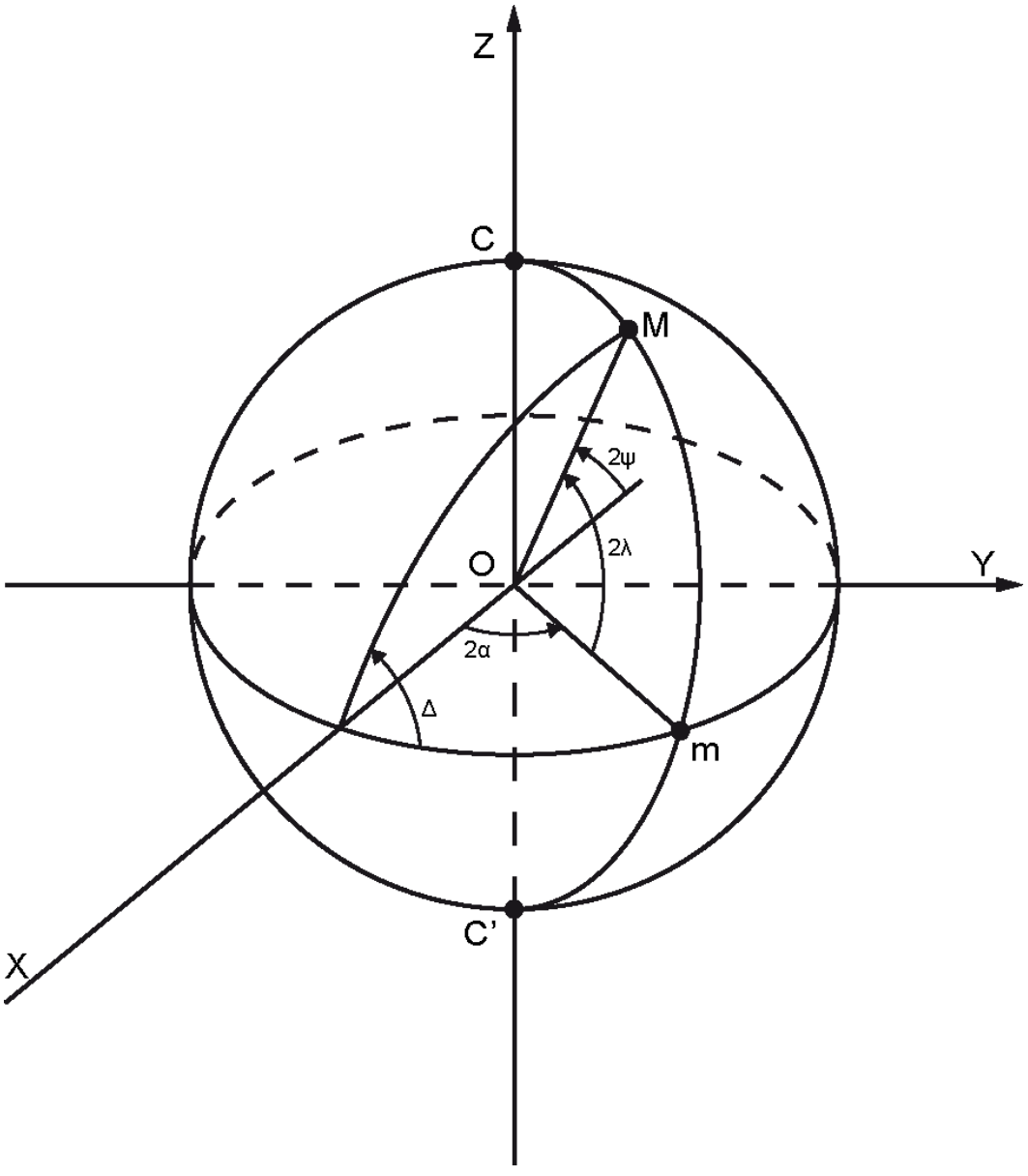
HEXAGON
MANUFACTURING INTELLIGENCE

Version 4.1.0

RDS DATA COLLECTOR

USER MANUAL



RDS Data Collector

User Manual

HexagonMI.com

Hexagon Manufacturing Intelligence
Division ROMER
Z.A. des Bois Blanche.
F- 41800 MONTOIRE-sur-le Loir France.
Tel: +33.2.54.86.40.40
ROMERfr.service@hexagonmetrology.com

Hexagon Manufacturing Intelligence Inc.
3536 Seagate Way
OCEANSIDE, California 96056 U.S.A.
Tel: +1 760-994-1401
techsupport@ROMER.com

INTRODUCTION

Dear customer, thank you for purchasing a HEXAGON MANUFACTURING INTELLIGENCE product. Before starting any operation about your new HEXAGON MANUFACTURING INTELLIGENCE® 3D measuring arm, please read carefully those instructions.

You will find here a guide to use your software in best conditions.

For any other device or option, not described in this manual, please refer to the different complete manuals (RDS Manual, Software manual, options …).

For any further question, please contact your local Hexagon Manufacturing Intelligence agent.

TRADEMARK NOTE

IMPORTANT NOTE

DISCLAIMER NOTE

All non-authorised modification, repair or bad use of the HEXAGON MANUFACTURING INTELLIGENCE system will automatically void the original manufacturer's guaranty. The manufacturer is not responsible for damages to the software or hardware caused by unauthorised handling, or use, of this material. For information regarding the warranty, repair, technical assistance, last updates and current information prices, please contact your local Hexagon Manufacturing Intelligence agent.

Conventions Used in this Guide

This manual uses the following conventions to alert you to information that varies from optional to critical in nature. These guidelines are used to distinguish the difference between these passages:

WARNING

A Warning indicates a hazardous situation, which, if not avoided, could result in death or serious injury.

CAUTION

A Caution, used with the safety alert symbol, indicates a hazardous situation which, if not avoided, could result in minor or moderate injury

NOTICE

A Notice is used to indicate useful, but not critical note about the operation of your HEXAGON MANUFACTURING INTELLIGENCE system or its sub-parts. Information contained in a Note is not safety related.
Failing to heed this advice may result in damage to your HEXAGON MANUFACTURING INTELLIGENCE system or in wrong measurements.

Information indicates an advice, or link to another documentation.

Symbols

Symbol	Location	Description
	Manual	Item for all users
	Manual	Item only for Level 2 Technicians
	Manual	General danger
		Read the manual before use
	Manual	Electric risk
	Manual	Chemical risk
	Manual	Pinch Risk
	Manual	Cutting Risk
	Manual	Laser risk
	Manual	Feature is standard / Correct operation
Opt.	Manual	Feature is optional
	Manual	Feature is not available / Incorrect operation
	Back Panel	For ROMER Absolute Arm specific USB cable only

Important safety note

The following directions should enable the person responsible for the product, and the person who actually uses the equipment, to anticipate and avoid operational hazards.

The person responsible for the product must ensure that all users understand these directions and adhere to them.

The user of ROMER 3D measuring arm must read carefully all full safety notes in Appendix regarding mechanical and electrical safety, battery, correct use of the device and all other safety information before unpacking the system.

WARNING

Adverse use can lead to injury, malfunction and damage. It is the task of the person responsible for the equipment to inform the user about hazards and how to counteract the. The product is not to be operated until the user has been instructed on how to work with it.

Responsibilities

Manufacturer of the product

Hexagon Manufacturing Intelligence Division ROMER, F-41800 Montoire-sur-le Loir, hereinafter referred to as ROMER, is responsible for supplying the product, including the user manual and original accessories, in a complete and safe condition.

Manufacturer of non-HEXAGON MANUFACTURING INTELLIGENCE accessories

The manufacturers of non-HEXAGON MANUFACTURING INTELLIGENCE accessories for the product are responsible for developing, implementing and communicating safety concepts for their products, and are also responsible for the effectiveness or those safety concepts in combination with the HEXAGON MANUFACTURING INTELLIGENCE product.

Person in charge of the product

The person in charge of the product has the following duties:

- To understand the safety instructions on the product and the instructions in the user manual.
- To be familiar with local regulations relating to safety and accident prevention.
- To inform HEXAGON MANUFACTURING INTELLIGENCE immediately if the product and the application becomes unsafe.
- To ensure that the national laws, regulations and conditions for the operation of radio transmitters are respected.

WARNING

The person responsible for the product must ensure that it is used in accordance with the instructions. This person is also accountable for the training and the deployment of personnel who use the product and for the safety of the equipment in use.

CONTENTS

A. PRESENTATION

A.1 What is RDS data collector

RDS data collector is a part of RDS package software, which pilot Multi Gages and ROMER arms (ABSOLUTE ARM, Cimcore CA7, and Infinite).

It is the program used to manage maintenance on those measuring systems.

Main functions on RDS Data Collector are about calibration, verification, certification, diagnostic. They are all under the form of script processes.

A.2 RDS profiles

According to the selected RDS profile (see RDS User manual), functions can be available or not in RDS Data Collector.

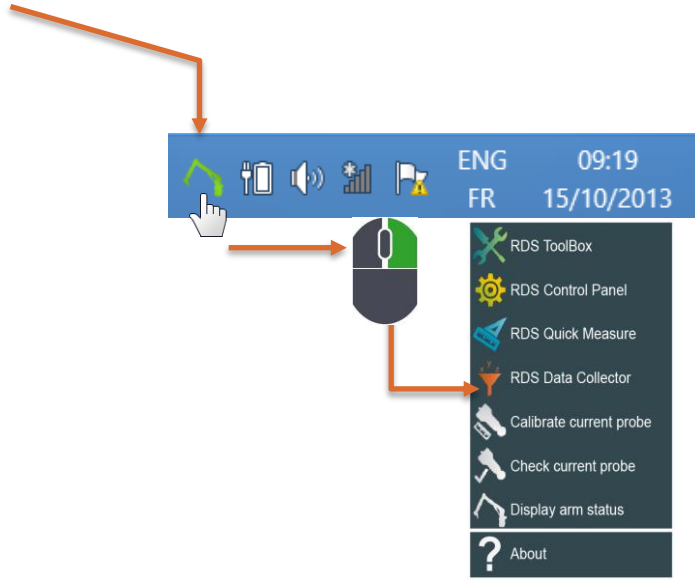
	End User level			Maintenance level	
	Standard	Advanced	Admin	Support	Service
Accessories calibration		✓	✓	✓	✓
Verifications	✓	✓	✓	✓	✓
Certifications	✓	✓	✓	✓	✓
Machine calibration				✓	✓
Arm Status	✓	✓	✓	✓	✓
Analysis mode		✓	✓	✓	✓

This manual only refers to the End User level.

For Maintenance levels, please refer to RDS Maintenance manual.

A.3 Access application

Check that RDS service is running and arm connected. A small green arrow must appear in the taskbar in order to work.



RDS Data Collector can be run as well from Windows start menu.

If Arm status is “not connected” please refer to RDS Service manual to connect the system.
Launch RDS Data Collector. After some seconds, script selection screen appears.

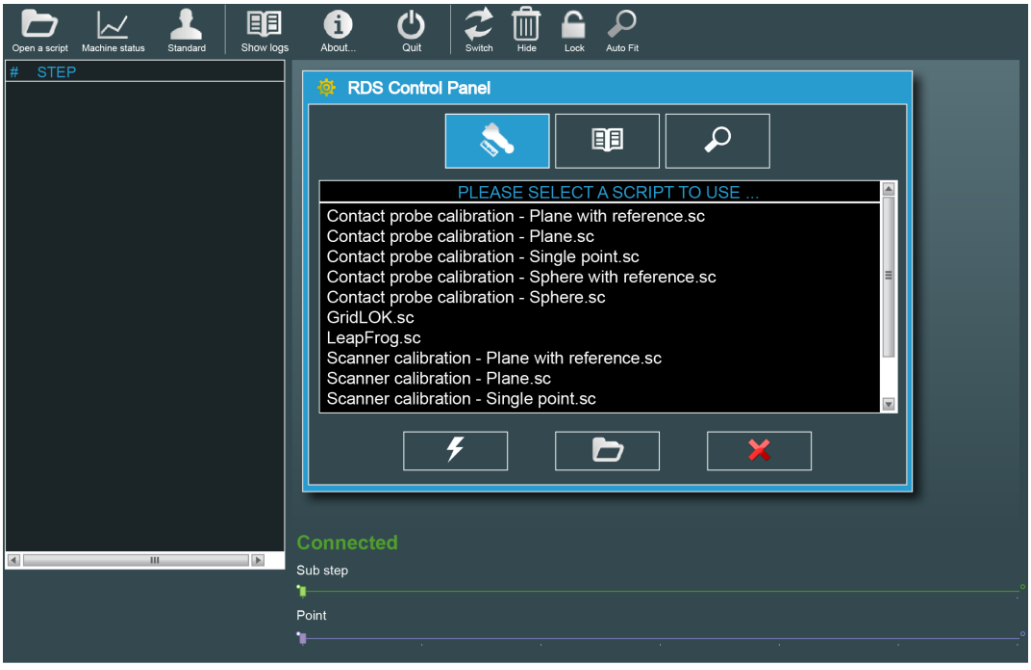
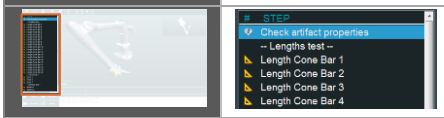
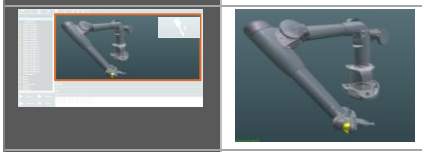
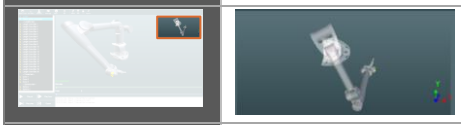
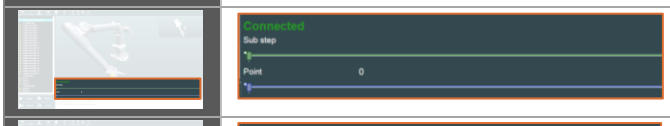
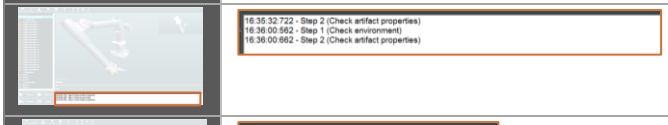
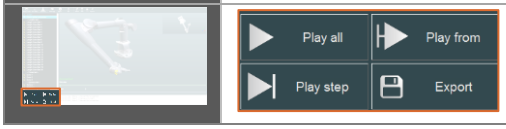


Fig. 1 : RDS Data Collector opening

B. DESCRIPTION OF THE PROGRAM

B.1 Overview of the screen

	Menu Toolbar
	Auxiliary view toolbar
	Script content steps
	Main 3D graphic view
	Auxiliary graphic view
	Step description zone
	Information Log report (can be hidden)
	Execute buttons

To run an operation the operator has to execute a script, which is divided in steps and sub-steps.

Steps may consist in

- points measurement
- calculation process
- instruction messages
- warning messages
- information messages
- dialog box to enter values

Scripts can be execute all, or step by step, or from one step.

B.2 Main screen description

Screen is divided in 4 parts:

B.2.1 Toolbar

Main toolbar	
	Select the script to open
	Display in real-time the components of the arm
	Switch between Capture and Analysis mode (Advanced profile or upper)
	Show the selection box for User profiles
	Toggle the information bar (rds.log)
	Display the version of software
	Close the application

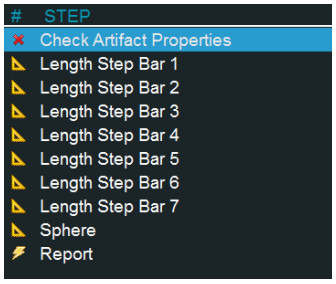
● Available / ● Not available / ● Under condition

Auxiliary graphic view control	
	Switch the main and auxiliary views on the fore/background
	Hide the auxiliary view
	Lock the auxiliary view
	When activated, automatically resize the view when starting a new step.

● Available / ● Not available / ● Under condition

B.2.2 Script content

Left list shows selected script name and all steps contained in the script.



- During script execution, a colour icon appears besides step as below:

- No icon: information step.
- Question bubble : value entry step
- Yellow set square : Measurement step
- Yellow flash : result step
- Root : calculation step
- Blue arrow: it's the current step.
- Pen: the step is being replayed.
- Green check: Step has been correctly ran
- Red cross: An error occurred during step execution or the step has been cancelled.

- Some contextual buttons allows choosing the way to play script:

- Play all: Every step is played sequentially.
- Play from: Execution begins at step selected by user.
- Play step: Only selected step is played.
- Export : Exports the measurements points and clouds in several available file format

When script is running, a "Stop" button automatically appears.

B.2.3 3D displaying

A large window space is reserved to 3D representation. This part has several objectives:

- In capturing mode,

- It provides to user a real-time representation of connected arm.
- It helps user to capture points by displaying an arm reference and optionally the measuring artefact (Length ball bar for instance).

- In analysing mode (Calibration centres Levels only),

- It gives the opportunity to graphically show how points have been taken.
- It is useful to compare taken points with reference positions.

By default, when a script is played, scene camera is automatically moved in order to present the best view.

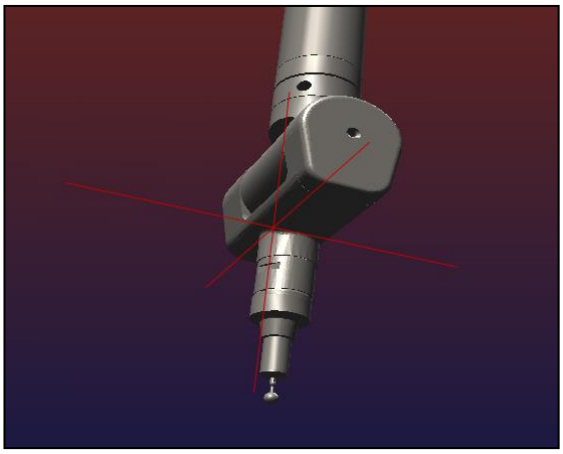
- Scene Controls

	Right mouse button + mouse move	Rotate scene toward pivot (red cross).
	Left and Right mouse button + mouse move	Translate scene
	Left Shift key + Left and Right mouse button + mouse move	Translate scene along X
	Right Shift key + Left and Right mouse button + mouse move	Translate scene along Y
	Left Ctrl key + Left and Right mouse button + mouse move	Translate scene along Z
	Mouse wheel	in and out zoom
	Shift key + Right mouse button + mouse move	in and out zoom

To help you manipulating camera, a red cross appears at the center of the screen when you rotate or translate the view.

Cross represents scene pivot point; Rotations are done using this special point.

To change the rotation center, do a translation of the view and move the desired rotation center to the center of the screen.



It is also possible to control the view using pad:

Key	Function
H	Display Help
A / Z	Rotate around X axis
Q / S	Rotate around Y axis
W / X	Rotate around Z axis
4 / 6	Horizontal camera pan
2 / 8	Vertical camera pan
+ / -	Zoom in / out
R	Display / Hide Axis

Several renderings are available for the arm:

Function Pad	Rendering
F1	Points
F2	Flat wireframe
F3	Smoothed wireframe
F4	Flat Shading
F5	Smoothed Shading

B.2.4 Auxiliary graphic view

A second graphic view is displayed to help the user on the location to measure.

This view is automatically switched on the foreground when the probe approaches the target position.

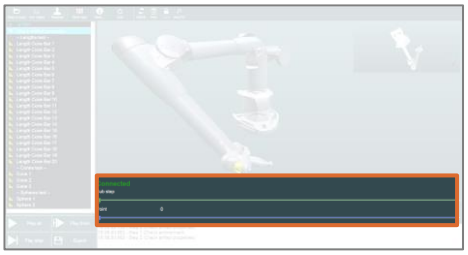
It can also be switched manually, and the orientation can be locked

The auxiliary view is automatically activated on arm calibration scripts and on scanners Calibration scripts.

On calibration scripts, it shows the calibration scene from a top view.

On scanner Calibration scripts, it shows the laser and stripes. (See § D.2 Hexagon Manufacturing Intelligence scanner).

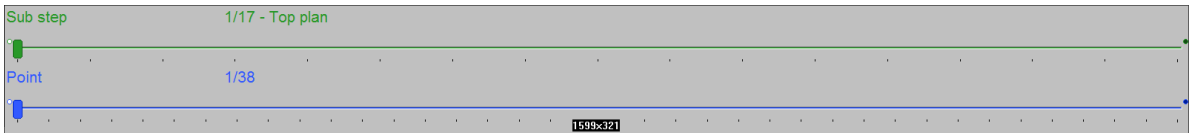
B.2.5 Step description zone



At the bottom of the screen, user will find an area containing information regarding current step execution.

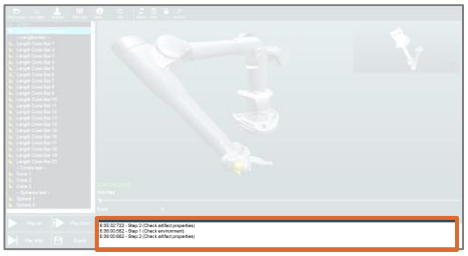
For instance, if we execute a points' capture sequence, area will show:

- Current sub step index and its description.
- Current point index versus amount of wanted points.
- A list showing important information concerning script execution.



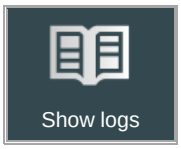
Sub step scroll shows the main operations of the current step. Point scroll shows the amount of ALL the points for the step, not only the current sub step.

B.2.6 Log information bar



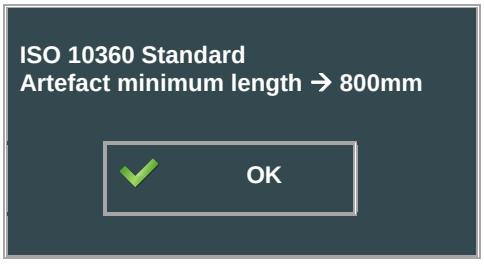
This displays the log of events for RDS Data Collector: each action, error… is memorized in the log file (RDS.log).

This zone can be hidden or shown with the button on the top Toolbar:



B.2.7 Message box

It's a simple information dialog box. It gives to user some details about step execution.

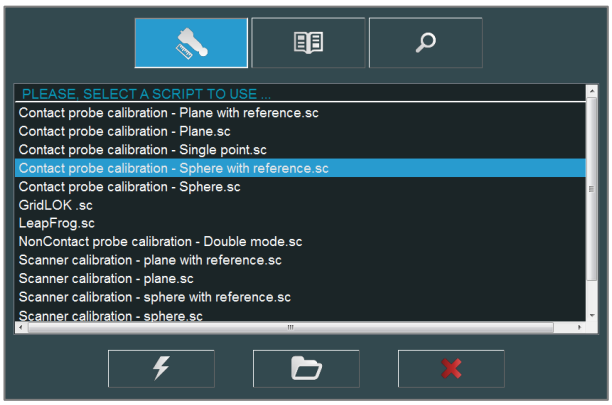


C. RUN A SCRIPT

C.1 Select and execute a script

C.1.1 Description

When you launch the application, script selection screen is automatically displayed.



Scripts are sorted by categories:

	Accessories calibration	Calibration of probes, scanners and volume extensions
	Certifications	Checkings and certifications according to official standard (B98 / ISO10360 / VDIVDE)
	Diagnostic tools	Quick checks for probes, NCP and scanners.

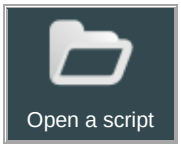
Choose a category, a script and press “Open” button.

Main screen appears as below, the script is ready to be played.

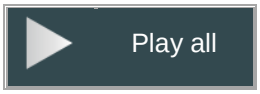
The script can be directly played when selected by pressing “Run” button instead of “Open” or by double clicking on the script.

C.1.2 Select a new script

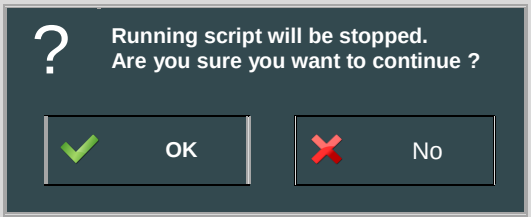
To access script selection box again, press the “Open” button on the top toolbar.



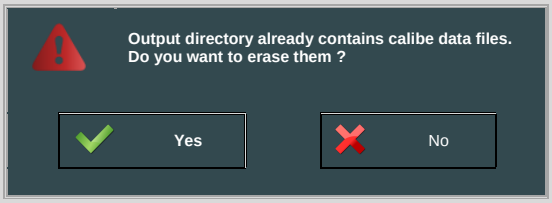
Click on “Play all”, the script starts and the 1st step becomes highlighted.



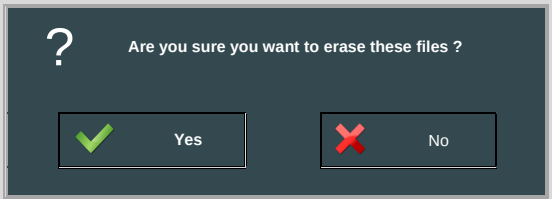
If a script is already running when pressing “Open a script”, RDS Data Collector asks to confirm stopping the script.



RDS Data Collector always memorizes calibration and verification data in calibration folder. If this folder already contains data when execute a script, following message will appear (calibration installer only):



Press Yes if the existing data can be deleted or No is you want to keep them (in this case, if the script creates files that already exist, they will be overwritten one by one). A confirmation message then appears:



C.1.3 Available scripts

According to the type of machine and accessory, different types of scripts are available:

		Arms						Tracker
		TKJ contact probe	Threaded contact probe	Touch trigger probe	Tube Probe	HP-L-8.9	Other Hexagon Scanners	LAS-20-8 Scanner
Accessories	Plane	✓	✓	✓			✓	
	Plane with reference	✓		✓			✓	
	Single Point	✓	✓					
	Sphere	✓	✓	✓		✓	✓	✓
	Sphere with reference	✓		✓		✓	✓	
	Tube				✓			
Certifications	B89 Ball bar	✓	✓	✓				
	B89 Cone bar	✓	✓					
	ISO10360 Ball bar	✓	✓	✓				
	ISO10360 Cone bar	✓	✓					
	ISO10360 Step bar	✓	✓	✓				
	VDIVDE Ball bar	✓	✓	✓				
	VDIVDE Cone bar	✓	✓					
	VDIVDE Step bar	✓	✓	✓				
	Plane Checkout							✓
	Sphere Checkout					✓	✓	✓
Diag. tools	Sphere check	✓	✓	✓		✓	✓	✓
	Plane check	✓	✓	✓		✓	✓	
	Distance check	✓	✓	✓		✓	✓	
	Tube length check				✓			
	Free digitize					✓	✓	

C.2 Dialog boxes

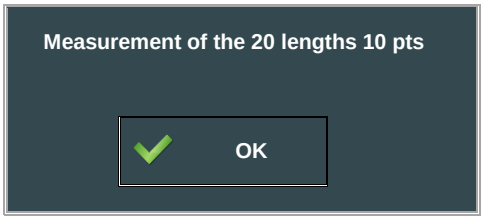
During the execution of the script, dialog boxes may be displayed:

Dialog boxes can be validated of cancelled using mouse or pressing a long time (about 1 second) on the arm buttons.

	Use a long left button (BP0) pressure to cancel a window
	Use a long right button (BP2) pressure to validate a window

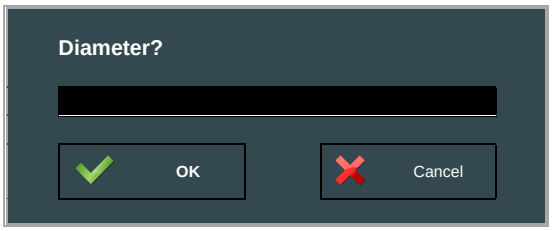
C.2.1 Message box

Message boxes are displayed to give information or recommendations to the user.



C.2.2 Input box

According the artefact referenced by the script, some details are asked to user. In example below, user must fill out the real length bar value. Be aware that these values are saved in destination calibration file.



By pressing “Cancel”, script execution is aborted.

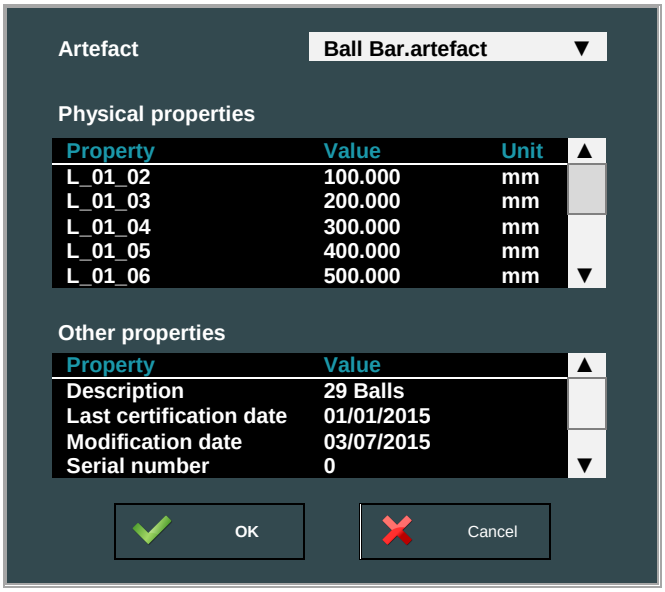
C.2.3 Artefact selection box

When running a certification or calibration script, artefacts values can be memorized and stored in the computer. A dialog box appears to select the appropriate artefact and modify the values

When RDS displays the artefact selection box, a drop-down list of artefact is available. This list contains all the memorize artefact, fitting with the type of selected script (“Cone bar” for calibration or certification with cone bar, “Ball bar” for certification with ball bar, …)

- Select an artefact

Choose the artefact in the list and check / modify the values



By default, one memorisable artefact is available for each type of artefact :
“Cone Bar – Default.artefact”
“Step Bar – Default.artefact”
“Ball Bar – Default.artefact”
“TBar – Default.artefact”

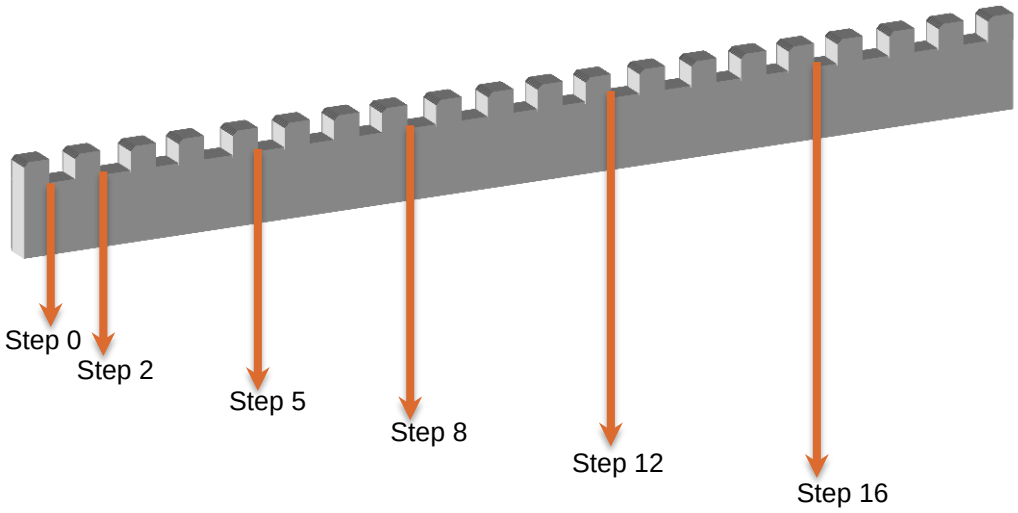
All other available artefact (“Cone Bar.artefact”, “Step Bar.artefact”, “Sphere Bar.artefact”, “TBar.artefact”) are only temporary artefacts and are overwritten each time a script is run.

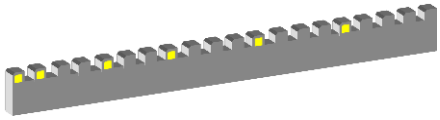
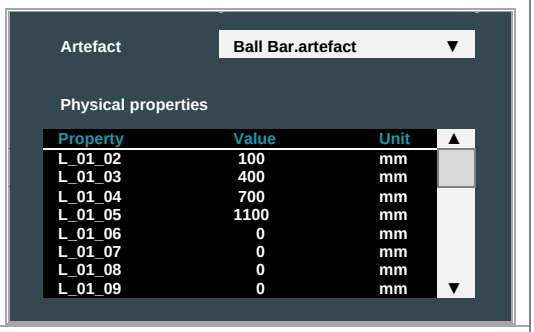
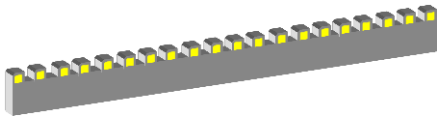
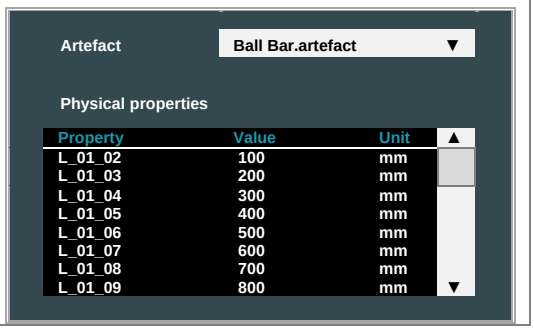
- Number of used lengths

The standard artefacts allow entering up to 30 distances: even if the certifications need only 5 lengths, it is possible to enter all 30 lengths, RDS automatically use the correct length.

For example:

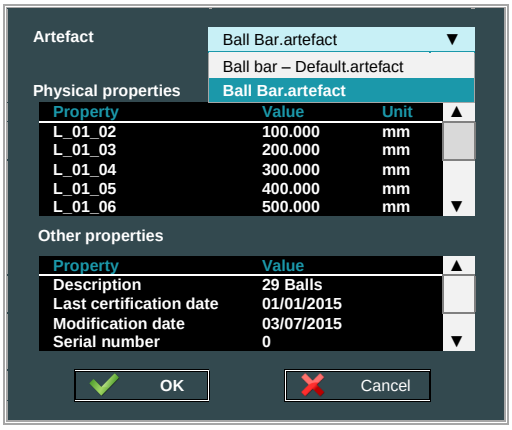
The step gage below has20 steps, but only 6 are necessary to run a VDEVDI certification; the user decides to use (following the standard recommendations) steps N0, 2, 5, 8, 12 and 16.



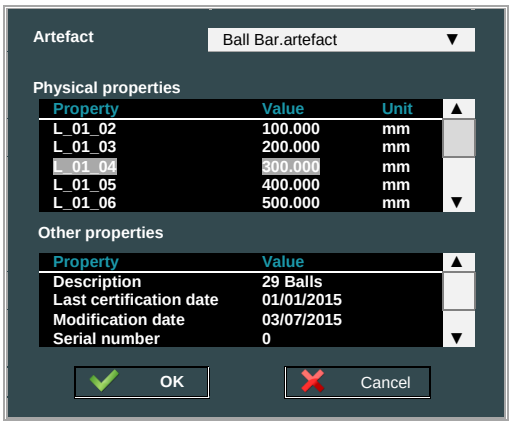
Solution		
1	Only consider the 5 used lengths and miss the other ones :	 
2	Consider all the lengths, RDS detects automatically the correct values	 

How to create and memorize a new artefact

1. Run the appropriate script, to get the correct type of artefact
2. At the prompt of the artefact selection box, select the temporary artefact (“Cone Bar.artefact”, “Step Bar.artefact” or “Sphere Bar.artefact”)



3. Enter the real lengths.



4. Press OK

5. Access the artefact folder (C:\Users\Public\Documents\ROMER\RDS\Artefacts\) and save the chosen artefact under new name (make a copy of the file and rename the copy)

   The new name must contain the type of artefact (“cone”, “step” or “sphere”)

   For example : “Hexagon Step Bar N1.artefact”

Always keep the original temporary artefact file (“Cone Bar.artefact”, “Step Bar.artefact” or “Sphere Bar.artefact”).

Each default artefact proposes 30 lengths (31 points): to get more lengths, please contact regional agent.

C.3 Capturing mode

C.3.1 Introduction

Capturing mode is used to generate calibration files. Be aware that existing files will be updated if you capture points in this mode.

For Calibration Level, to check if you are in capturing mode or analyse mode, look at application title.

C.3.2 Execution

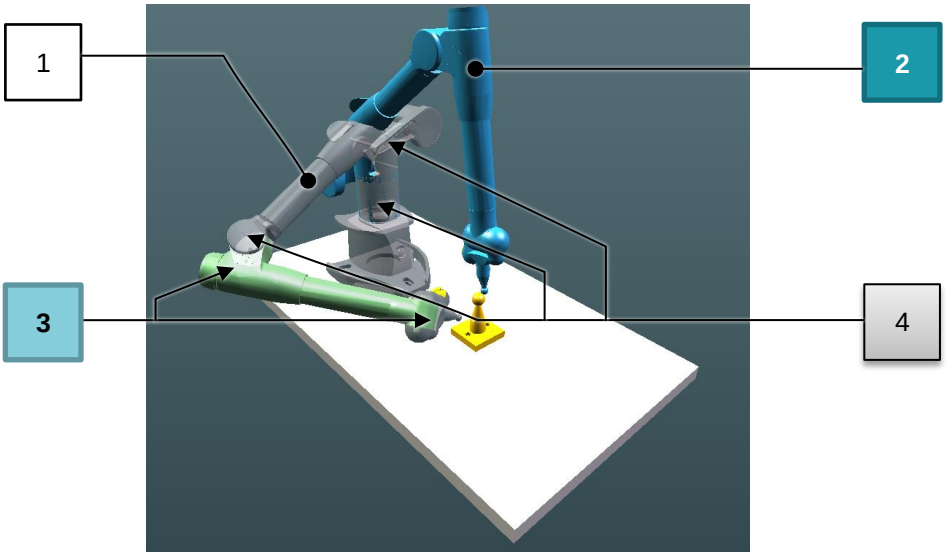
Once a script is open, the user can execute all, step by step, or from one selected step.
Depending script content, several events can happen:

C.3.3 Points capture

Points capture is the most important action; it allows generating calibration data files that will be used to calibrate a machine, a probe, to generate a calibration certificate, and so on.

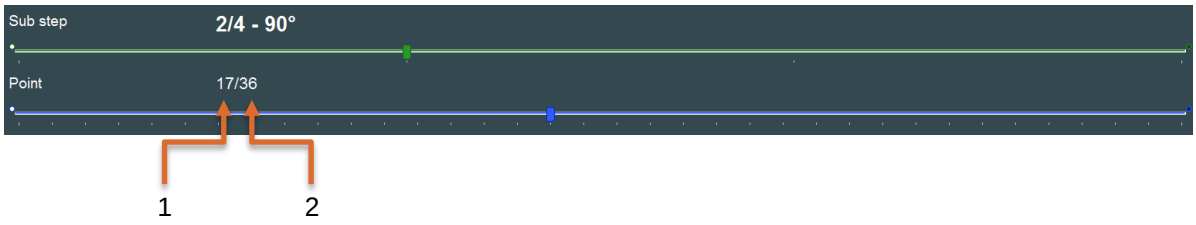
In this mode, several things happen:

- Real-time arm representation is enabled. Arm is grey-coloured and is displayed in transparency.
- If reference angles are stored in script files, reference arm is displayed. This blue-coloured arm shows for every point what the optimal position to capture point is.



1. Phantom real-time arm
2. Position arm to reach
3. Axes have correct angle
4. Axes have incorrect angle

- Contextual bottom area has been updated, it contains now current point index and wanted amount of points. In current example, we need to capture 17 points for sub-step, then 36 points before completing action.

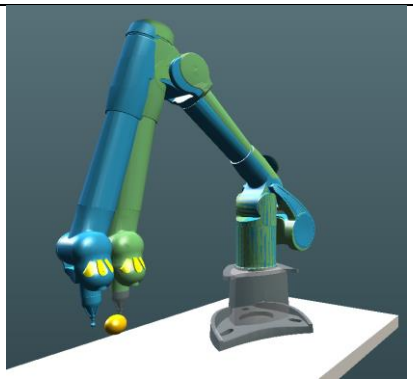
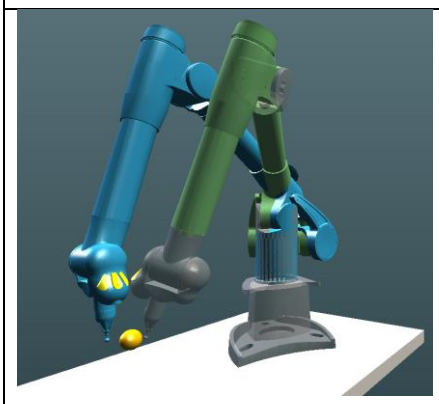


1. Current point index
2. Wanted amount of points

Points capture automatically ends up when wanted amount of points is reached.

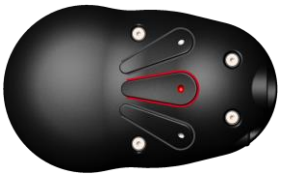
C.3.4 Positioning the arm

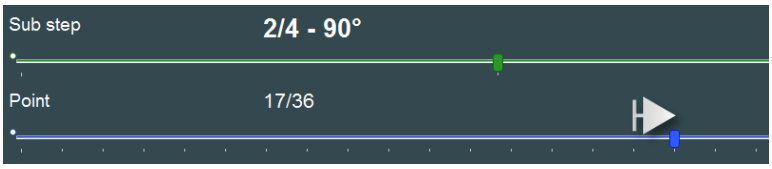
As you understood it, objective will be to capture points by following displayed blue arm. To help user, real-time arm aspect, changes depending its position. Indeed, a correct positioned axis will appear in green colour, or in grey colour in other cases.

Example of a correct position: all axes are green.	
	Example of a wrong position (D axis not correct, E Axis is reversed): Some axes are grey.

C.3.5 Take a point

Press middle button (BP1) to take a point. Current point index is updated in contextual area.

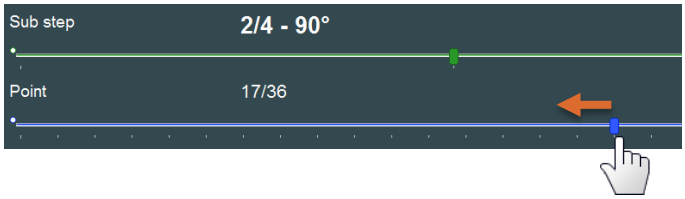




C.3.6 Cancel a point

If you want to cancel a point to retake it for instance, press left arm button (BP0).

Moreover, you can use scrollbar located below 3D representation area to go directly to an already taken point.



To cancel all points for the actual step, do a long-click on left arm button (BP0) or move completely back the scrollbar.

C.3.7 Digitize with a laser scanner

To take stripes of scan with Hexagon Manufacturing Intelligence scanners, according to the settings on Control Panel, press and hold main button to scan, and release it to stop, or press once to start and a second time to stop. Several sequences can be performed before validating the cloud. Then a scan can be started and stopped, started again and stopped again, as many times as you want.

To validate the cloud, press “Next” button or press the right button (BP2) on portable measuring arms.

The validation cannot be done until the scan is not stopped.

- Guided scanning

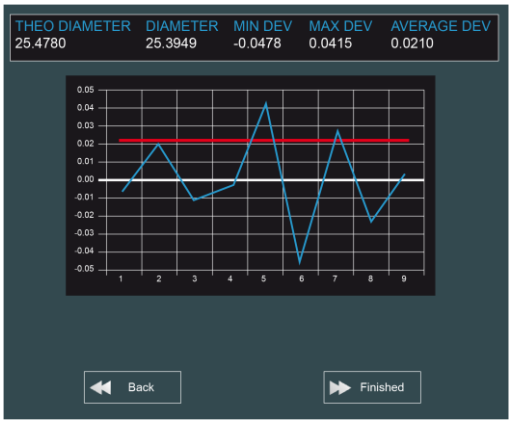
For scanner calibration operations, the measurement is guided: a window guides you to place the laser at the correct position.

The scan can be started before or once the laser is inside the window: the stripes are kept only when the laser is inside the window.

C.3.8 Calculations

During script execution, some calculations are done and results displayed to user. Objective is to help user having the best calibration.

Results shown and interpretation depends on calculation asked (refer to corresponding script chapter). Below, you'll find the example of a "cone" calculation.



At this step, you've got two possibilities:

- Validate results

and continue in script execution by pressing "Validate" button or by using a long middle arm button pressure.

- Refuse results

and re-execute current step by pressing "Re-execute step" or by using a long right arm button pressure.

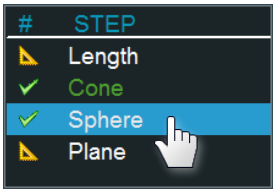
C.4 Export

When a script is done, all the measured points (for probing) or clouds (for scanning) are memorized in RDS files. Those files can be exported in special file formats, to be opened or imported by other software.

Format	File extension	Probed points	Digitized cloud
PolyWorks point cloud	*.psl	×	✓
ScanWorks point cloud	*.swl	×	✓
Ascii space separated point cloud	*.asc	×	✓
Ascii ‘,’ separated point cloud	*.csv	×	✓
Ascii ‘;’ separated point cloud	*.csv	×	✓
XYZ point cloud	*.xyz	×	✓
XYZ probed points	*.xyz	✓	×

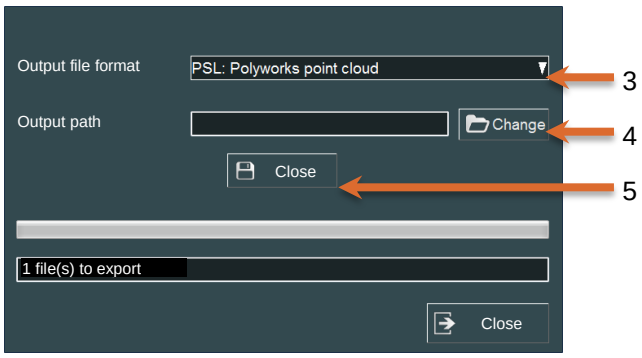
Process

1. Select the script step(s) to export

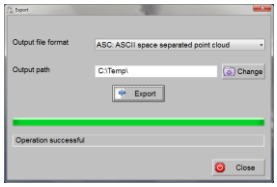


2. Click on the Export Button

Export Window appears:



3. Select the type of file to export
4. Select the destination path
5. Click on « Export » Button
6. Once the progress bar is over and the message « Operation successful » displayed, the file is ready.



D. ACCESSORIES SCRIPTS

Accessories may be contact probe calibration, non-contact Probe (NCP) for tube or scanner calibration and also reference script for Leap-Frog or LOKs.

D.1 Contact probe calibration

D.1.1 Description

- Contact Probe calibration Overview

To obtain accurate measurement results, each probe must be calibrated with the ABSOLUTE ARM it is being used on. Each unique set of probe calibration data is stored in the memory on the arm. The ABSOLUTE ARM checks each time when a probe was changed. If the new probe has not previously been calibrated with this particular arm, the user will be prompted to proceed with the probe calibration procedure described below.

If the probe has been already calibrated, when the operator connects the probe, RDS simply selects the correct probe file.

For contact probe calibration, several methods are available:

Plane method	consists of measuring a levelled plane with the probe to calibrate in different orientations
Plane with reference method	same as plane, but the plane is first measured with the reference probe (15mm)
Single point method	consists of taking points, keeping the ball probe in a seat (cone).
Sphere method	consists of measuring a certificated sphere with the probe to calibrate in different orientations
Sphere with reference method	same as sphere, but the sphere is first measured with the reference probe (15mm)

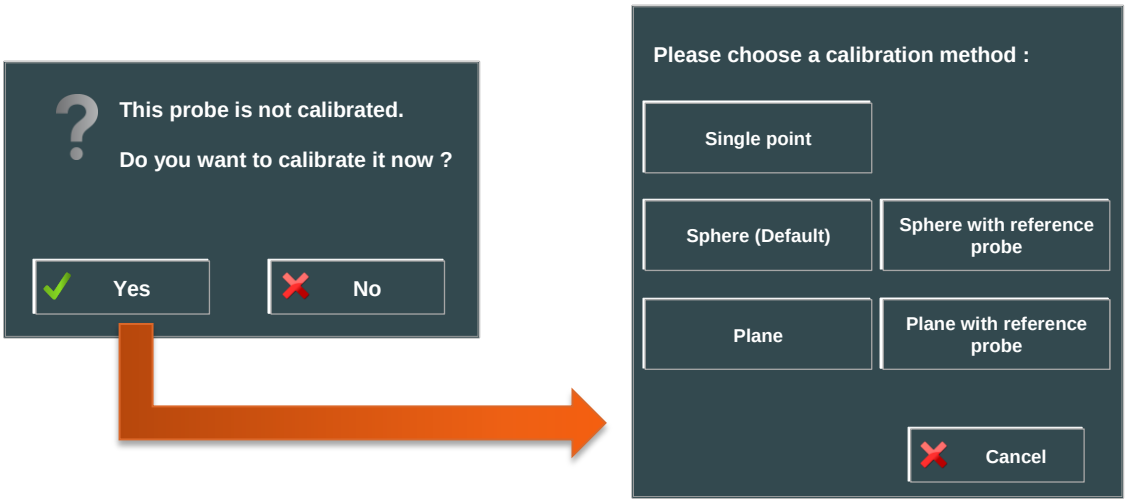
Specific offset probes should be calibrated using "Sphere with reference method".

In case of specific customized probe, a specific probe calibration script can be done. Contact your local agent.

NOTICE
It is highly recommended to proceed a Probing Quick Check once the probe calibration is over. This should be operate each time a probe is calibrated, to validate the good quality of the calibration.

New Probe

When a new probe is connected to the arm, a message automatically appears, asking about calibration for this new probe, and which calibration process, then RDS Data Collector automatically opens, starting probe calibration process.



Single point method cannot be used with a Touch Trigger Probe

In case of bad accuracy, or change of sensor, it is possible to recalibrate a probe already calibrated, using RDS Data Collector

If the diameter of the final stylus has changed, then first access to RDS Control Panel to edit and modify the diameter of the probe (read RDS Service Manual).

Access the probe calibration script

There are different reasons and ways to access to the probe calibration:

- ***Probe is new***, then RDS automatically propose and give choice of the method, then the script is run automatically.
- ***Probe has been already calibrated***, but has been damaged or gives bad results : user should access to desired script
- ***Stylus of the probe has been changed*** and the diameter is no more the same: user should enter RDS control panel to edit the diameter, then access to the desired script.
- Access to a script can be done directly ***from the final software***, asking for probe calibration
- Access to a script can be done ***right clicking on RDS icon*** in Windows task bar and choosing “calibrate current probe”
- Access to a script can be done from ***RDS control panel***, clicking on “Calibrate” in Probes tab.

D.1.2 Contact Probe calibration – Plane and Plane with reference methods

The process is the same for both methods, "Plane" doesn't use reference probe measurement

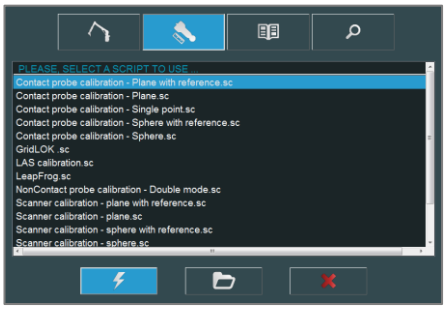
Principle

Probe calibration needs a levelled plane (some cm2) and contains 3 steps:

	Measurement of the plane with reference probe (15mm Probe #1) (only "Plane with reference" method)
	Measurement of the plane with the probe to calibrate
	Calculation and validation

Start Up (Plane and Plane with reference methods) (step1)

1. Select the script, and then run.

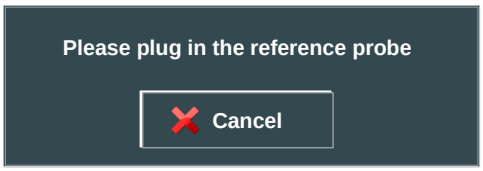


1. The System will prompt the user through each calibration step. Be sure to follow the instructions in each dialog box.

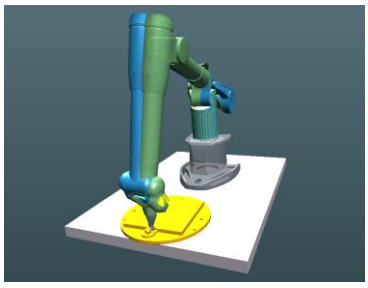
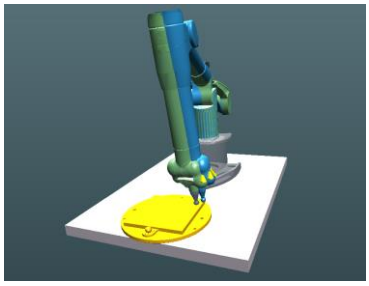
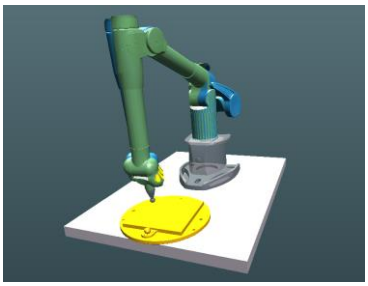
2. The Reference Plane should be placed so that the forearm and the wrist point straight down at the center of the plane, as shown below.

- Measurement with reference probe (only Plane with reference method) (step2)

3. When prompted, insert the 15mm steel reference probe (the prompt is automatically validated as soon as the probe is plugged).

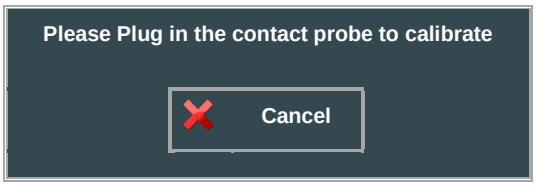


4. Take 3 points on equilateral triangle on the plane. The graphic shows the location of the points to be used.

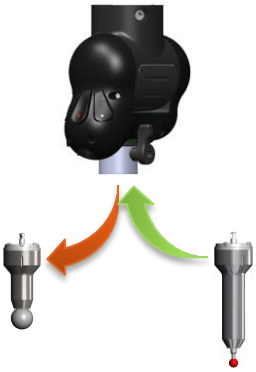




- Probe-to-calibrate measurement (plane and Plane with reference methods) (step3)

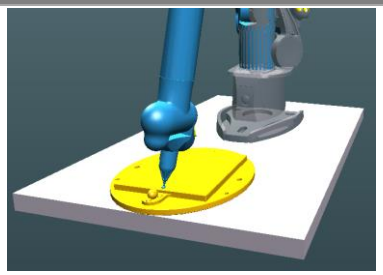
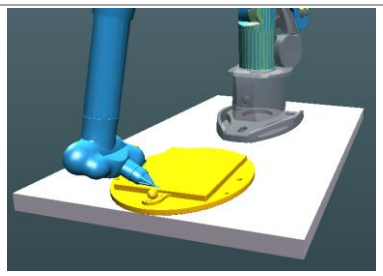
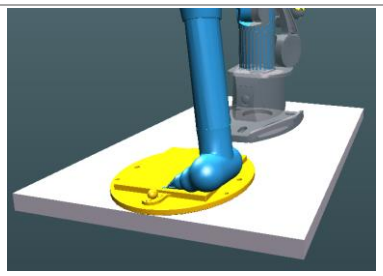
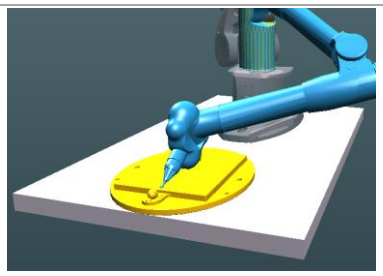
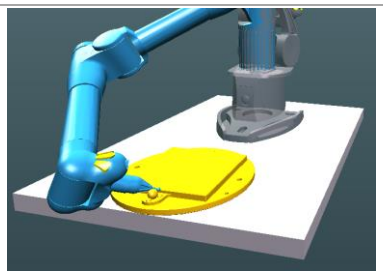
5. The following message appears.



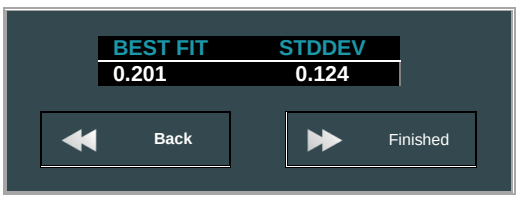
6. At this prompt, remove the reference probe and insert the probe to be calibrated (the prompt is automatically validated as soon as the probe is plugged).



7. Then 5 sets of the 3 points pattern would need to be measured with the new probe. Please follow closely the probe orientation display on the screen (buttons side toward the base of the arm). A total of 15 points are needed.

Orientation		
1		(3 points): probe is vertical
2		(3 points): probe is inclined 45°, buttons up (plane made by probe axis and F arm axis is normal to the calibration plane).
3		(3 points): probe is inclined 45°, buttons down (plane made by probe axis and F arm axis is normal to the calibration plane).
4		(3 points): probe is inclined 45°, F axis open (F arm axis parallel to the calibration plane)
5		(3 points): probe is inclined 45°, F axis closed (F arm axis parallel to the calibration plane)

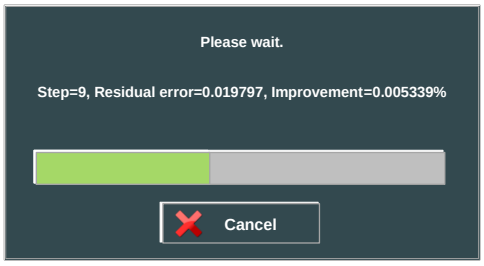
8. Once all 36 points are measured the best-fit before calculation would be displayed,

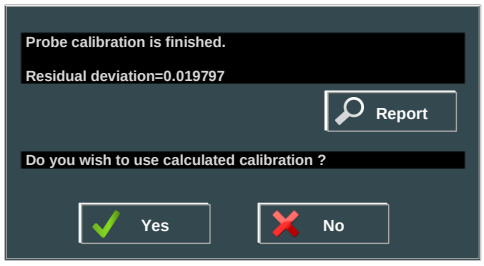


9. If result is too far (a bad measurement occurred) click on « Back » to remeasure the plane, otherwise, click on « Finished » to run the calculation.

- Calculation (step4)

10. Then calculation starts: at the end of the calculation, residual error is displayed: click on Yes to keep the new calibration or No to cancel this calculation.





Residual deviation value for Plane with reference method is the maximum deviation between all the points and the reference plane.

Residual deviation for Plane without reference is the standard deviation between all the points and the least-square calculated plane.

If this value is more than 1.0, probe is notified as "badly calibrated".

Once the "Yes" button is clicked, RDS ask for the name to give to the probe, and calibration data are automatically saved into the arm memory.

D.1.3 Contact Probe calibration – single point method

Principle

This process is using a seat (cone or corner) in which the ball of the probe is positioned. Then 20 points are measured in this hole (“wrist” measurement):

	Measurement of seat with the probe to calibrate
	Calculation and validation

Start Up (Step1)

1. Access to the script, and then run all steps.

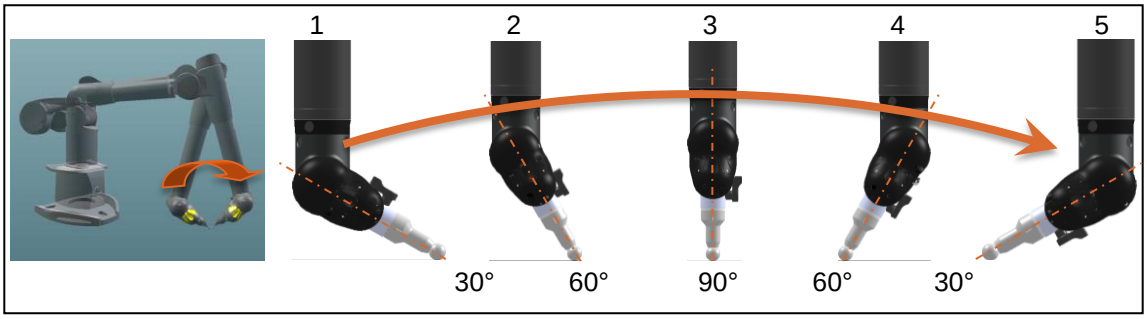
2. The System will prompt the user through each calibration step. Be sure to follow the instructions in each dialog box.

3. The Reference seat should be placed so that the forearm and the wrist point straight down at the seat, as shown below.

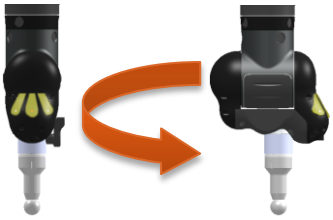
Wrist measurement (step 2)

4. The Elbow is vertical (“12 O’ Clock”), and 20 points are taken, moving only E and F Axes :

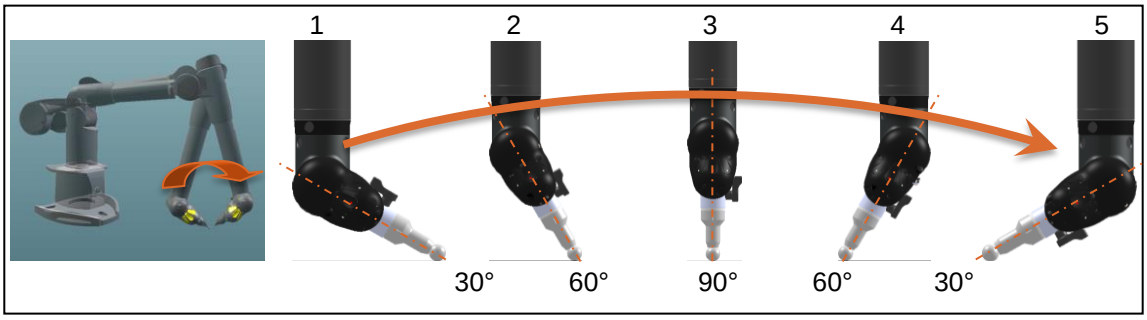
- 5 points, Buttons on the left, turning F axis



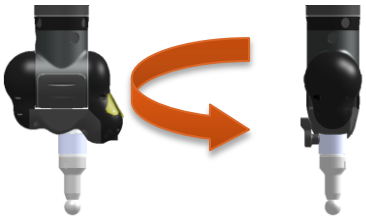
- Then turn E axis with 90° (buttons opposite to the base)



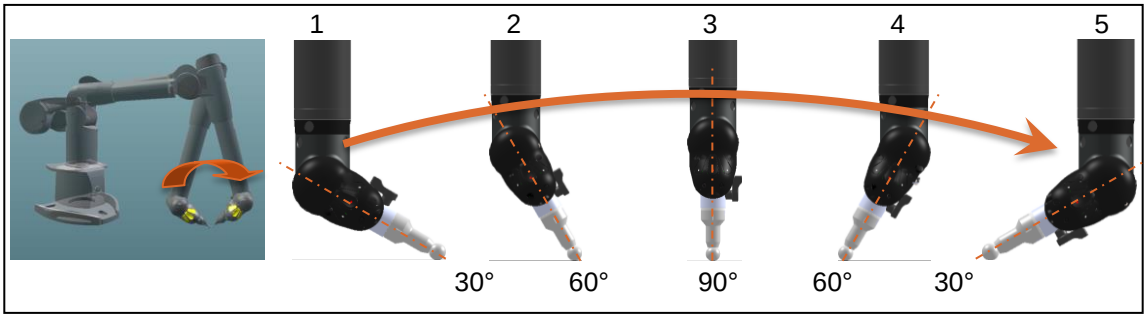
- Measure 5 points, turning only F axis



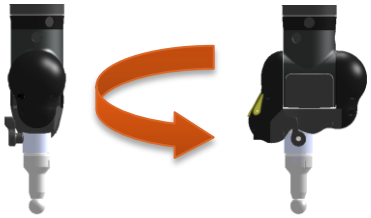
- Then turn once again E axis 90° (buttons on the right)



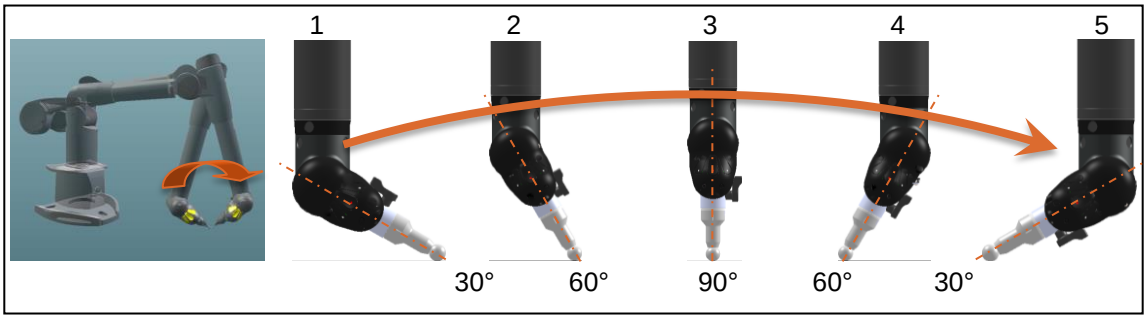
- Take 5 points, turning only F axis



- Turn again E axis 90° (buttons face to the base)



- Take 5 points, turning only F axis



- Error before calculation :

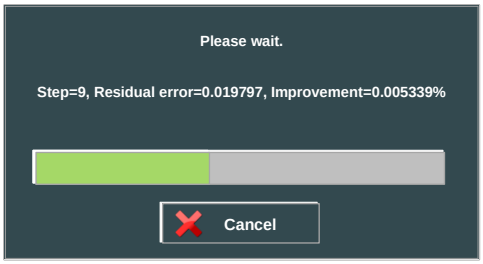
5. Once the 20 points are measured, errors before calculation are displayed.

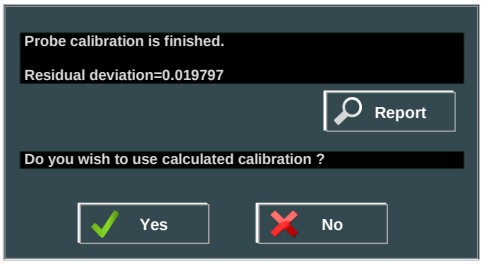
Deviations that are displayed are deviations between each of the 20 points and the middle point.

6. If a bad point has been done, click on « Back » to remeasure the 20 points, otherwise, click on « Finished » to run the calculation.

- Calculation (step3)

7. Then calculation starts: at the end of the calculation, residual error is displayed: click on Yes to keep the new calibration or No to cancel this calculation.





Residual deviation value is the best-fit value (=maximum deviation) between all the points and the calculated middle point.

If this value is more than 1.0, probe is notified as "badly calibrated".

8. Once the "Yes" button is clicked, RDS ask for the name to give to the probe, and calibration data are automatically saved into the arm memory.

D.1.4 Contact Probe calibration – sphere and sphere with reference methods

The process is the same for both methods, "Sphere" doesn't use reference probe measurement

Principle

Probe calibration needs the certified calibration sphere (included in the arm case) and contains 3 steps:

	Measurement of the sphere with reference probe (15mm Probe #1) (only "Sphere with reference" method)
	Measurement of the sphere with the probe to calibrate
	Calculation and validation

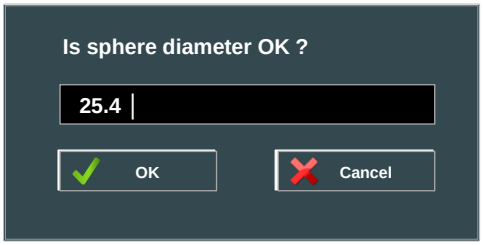
Start Up (sphere and Sphere with reference methods)(Step1)

1. Access to the script, then run all steps

   The System will prompt the user through each calibration step. Be sure to follow the instructions in each dialog box.

2. The Reference Sphere should be placed so that the forearm and the wrist point straight down at the pole of the sphere, as shown below.

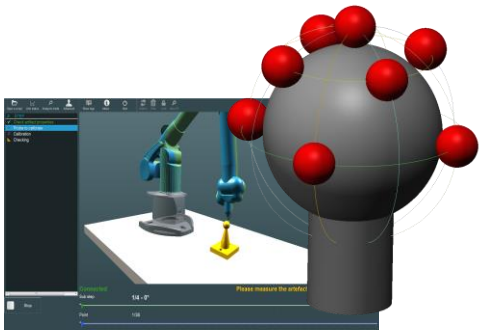
3. Enter the Calibration sphere size, in millimetres, in the box provided. The size of the sphere should be noted on the stem of the artefact. Click OK to continue.

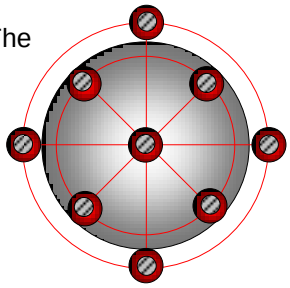


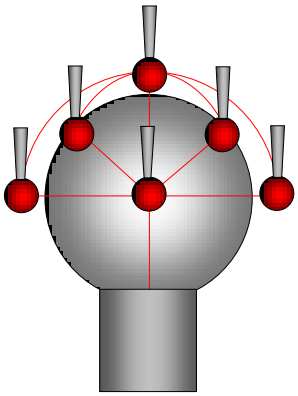
Measurement with reference probe (only Sphere with reference method) (step2)

4. When prompted, insert the 15mm steel reference probe (the prompt automatically closes when the probe is plugged in).

5. Take nine (9) points on the upper hemisphere of the artefact. The graphic shows the location of the points to be used.

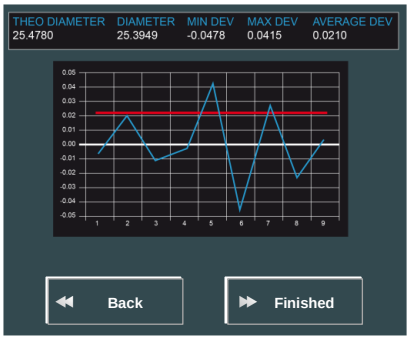






Note the orientation of the wrist, the button side of the wrist should be pointing toward the base of the Arm.

6. Once you have taken 9 points, the variation of the 9 points taken will be shown.



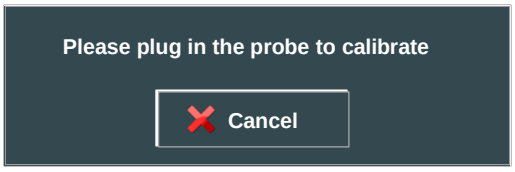
Incidental errors, with a few measurements significantly higher or lower than the rest, could be the result of improper probing: i.e. trigger pressed when probe was not in contact with the calibration sphere, or too much pressure applied on the probe shaft. Please re-execute the measurement.

Systematic error, consistence over or under size measurement, may be a result of the wrong parameters having been entered for the calibration sphere size. Restart the Probe Calibration and confirm that the correct sphere diameter was entered.

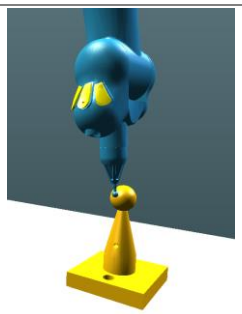
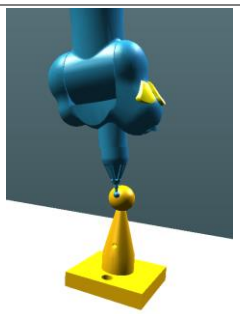
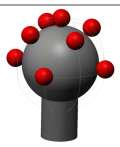
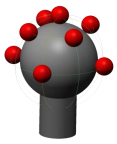
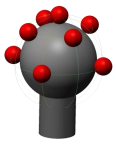
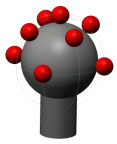
Probe-to-calibrate measurement (Sphere and Sphere with reference methods) (step3)

7. Click on Validate to continue.

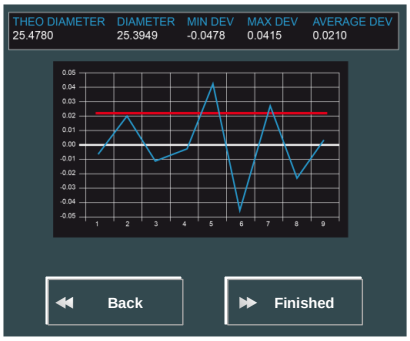
8. At this prompt, remove the reference probe and insert the probe to be calibrated (the prompt will automatically close when the probe is plugged in).



9. At this stage, 4 sets of the 9 points pattern would need to be measured with the new probe. Each set represents a 90deg twist on the wrist. Please follow closely the wrist orientation display on the screen. A total of 36 points are needed.

			
Buttons toward the arm	90° on E	90° on E	90° on E
 9 points	 9 points	 9 points	 9 points

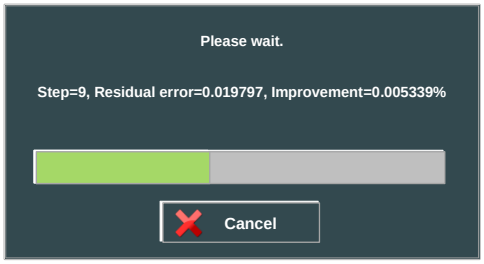
10. Once all 36 points are measured the result would be displayed, the same rules on measurement result in reference probe measurement applies here.

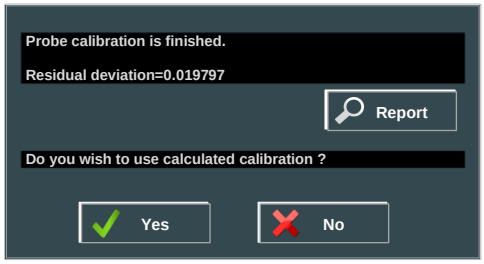


11. If a bad point has been done, click on « Back » to remeasure the 36 points, otherwise, click on « Finished » to run calculation.

Calculation (step4)

Then calculation starts: at the end of the calculation, residual error is displayed: click on Yes to keep the new calibration or No to cancel this calculation.





Residual deviation value for Sphere with reference method is :

$$\frac{\text{Best-fit} + \text{deviation diameter} + \text{deviation center}}{3}$$

Residual deviation value for Sphere without reference method is :

$$\frac{\text{Best-fit} + \text{deviation diameter}}{2}$$

If this value is more than 1.0, probe is notified as “badly calibrated”.

Once the “Yes” button is clicked, RDS ask for the name to give to the probe, and calibration data are automatically saved into the arm memory.

D.2 Hexagon scanner calibration

D.2.1 Description

HP-L-20.8, CMS108, HP-L-8.9, RSx (for arms) and LAS-20-8 (for trackers) scanners have to be calibrated on the machine before any use. This operation has to be done in case of arm recalibration, or if a new scanner is mounted on the machine, or also if the scanner itself has been repaired or recalibrated.

For Non-Hexagon Scanners, please refer to the appropriate documentation.

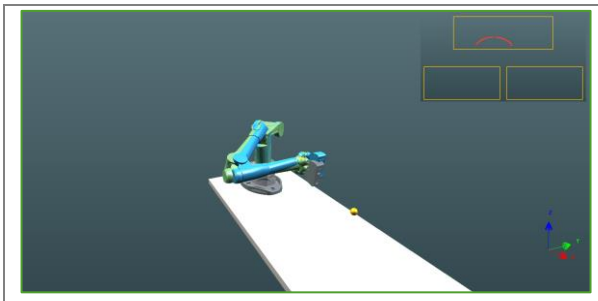
New Scanner

If a new scanner is mounted on the arm, then once plugged, RDS recognizes it as a new mounted scanner, and may ask for a few questions:

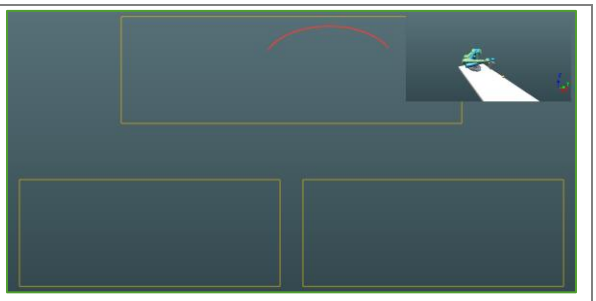
- Type of probe: RDS recognize a new probe and ask for the type: HP-L-20.8, CMS108, RS1, 2 or 3 or other type of scanner.
- In case of a Hexagon scanner, RDS proposes to calibrate it and several methods are available :
  - Plane method.
  - Plane_with_reference method (measuring ref plane with Reference probe).
  - Sphere method
  - Sphere_with_reference method (measuring ref sphere with Reference probe).

Graphic view

The graphic view shows the orientation and position of scanner to reach. When approaching the target position, then RDS switches the main graphic view and the scan auxiliary graphic view, to help in details the zone to scan, and shows the scan lines.



Focus on the main view: RDS shows how to orientate the arm.

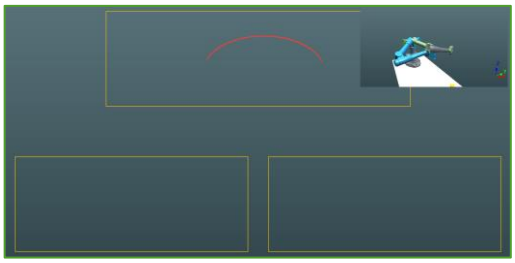


RDS Detects scanning lines and switches to the scan view.

It is possible to switch manually and lock the focus on the scan view. See “Main screen description” chapter.

Get scan lines inside the target zone

To obtain the best calibration result, the calibration artefact digitizing needs to cover a sufficient range. RDS ensure this requirement by defining calibration zones, represented on the graphic view by rectangles.

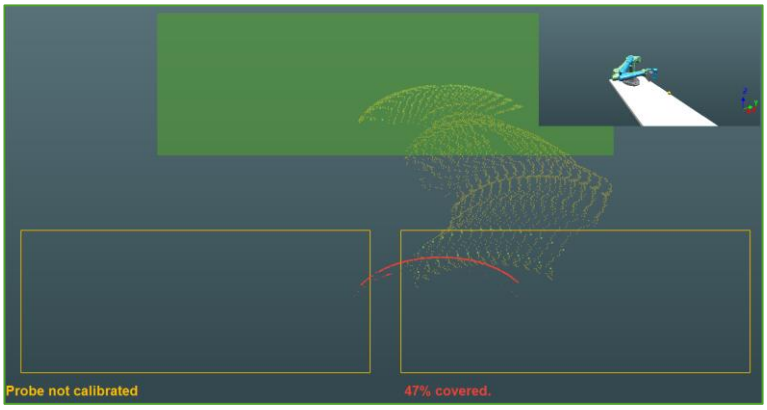


- While digitizing, RDS detects the scanning lines inside the target squares (highlighted in green) and indicates to the user the percentage of target coverage reached.

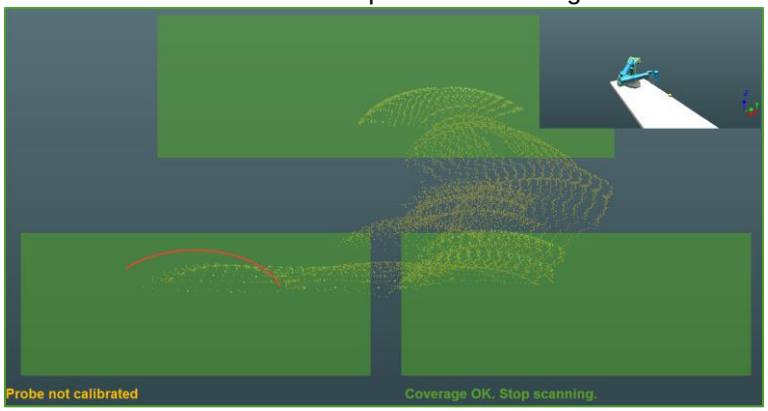
As soon as one target square is completed, it becomes green.

On the following example, the centred "top" target has been digitized enough (filled green), now the scanner is capturing scanning lines on the right "bottom" target, but not enough lines have been captured yet in it to validate it.

Only 47 % the required zone have been reached, the user cannot go forward.



- Once all the target squares are completed (=green), the coverage is OK. RDS automatically stops the acquisition and asks the user to stop the scanner to go to the next step of calibration.

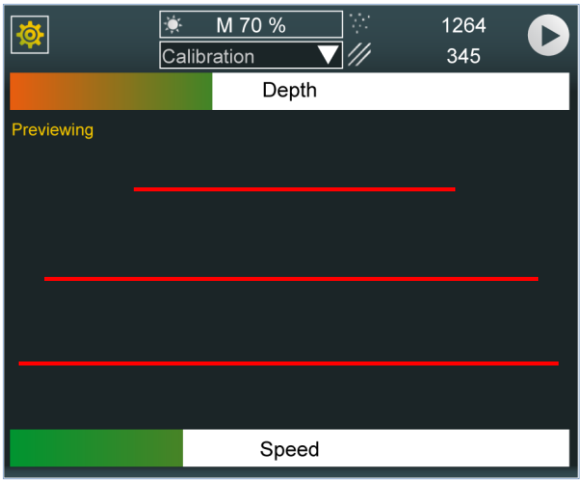


With the Leica scanner, no need to press on the button: as soon as the coverage is completed, RDS stops the acquisition and jump to next step of the calibration.

D.2.2 Scanner calibration - Plane Methods (Arm)

These methods consist by measuring a reference artefact plane with reference probe (only for Plane_with_reference method), then by scanning it moving the scanner around the plane, 3 stripes have to be taken:

- 1 near position
- 1 middle position
- 1 far position.



NOTICE
A low quality plane may result in bad calibration
➢ Do not use other artefact plane than the provided one.

Principle

Probe calibration needs a flat plane (not provided) and contains 3 steps:

	Measurement of the plane with reference probe (15mm Probe #1) (only “Plane with reference” method)
	Scan of the plane with the scanner to calibrate
	Calculation and validation

Start Up (Plane and Plane with reference methods)(Step1)

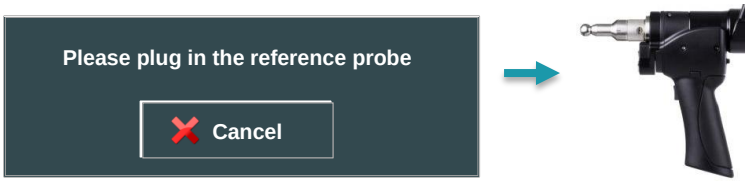
1. Open the script, then run all steps

   The System will prompt the user through each calibration step. Be sure to follow the instructions in each dialog box.

2. The plane should be placed so that the forearm and the wrist point straight down at the pole of the plane, as shown below.

Reference Plane (Only for Plane_with_reference method)

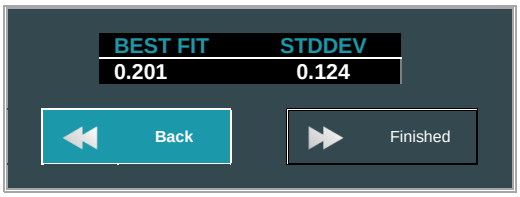
1. Insert 15mm Ref Probe



Don't forget to move the probe switch to the correct position

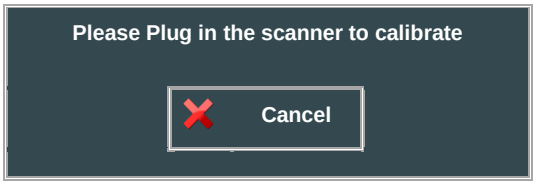
2. Take 5 points on plane with 15mm ref probe

3. Check reference plane results and "Validate"

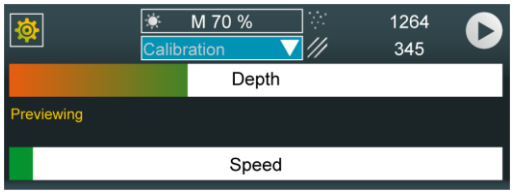


Use the scanner

4. Mount the scanner to qualify or simply remove the reference probe (for Absolute SI). On 7 axes arms, move the probe switch to the correct position.

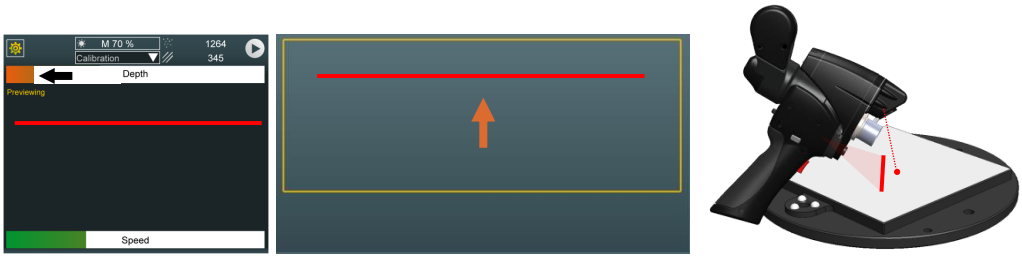


5. Wait for the scanner to be ready : RDS automatically select a “Calibration” scanning profile with the appropriate settings for the scanner calibration sphere.

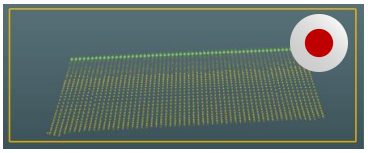


Take Low position scan stripes

6. Position the scanner at about 45° to the plane, in low position (close to the plane)

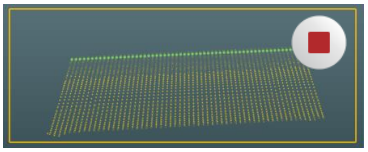


7. Start acquiring stripes



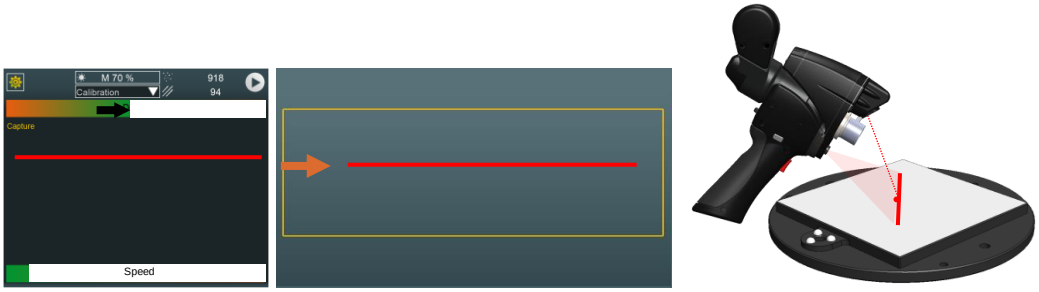
Rotate the scanner 360° around the plane, keeping low position.

8. Only once the coverage is 100%, stop acquiring stripes to validate and jump to next step.

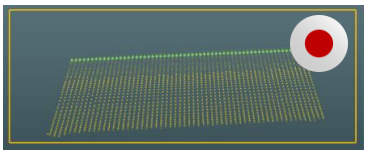


Take Middle position scan stripes

9. Position the scanner at about 45° to the plane, in middle position (mid distance from the plane)

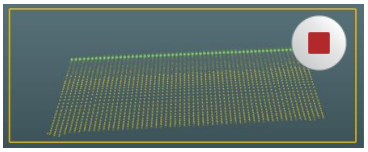


10. Start acquiring stripes



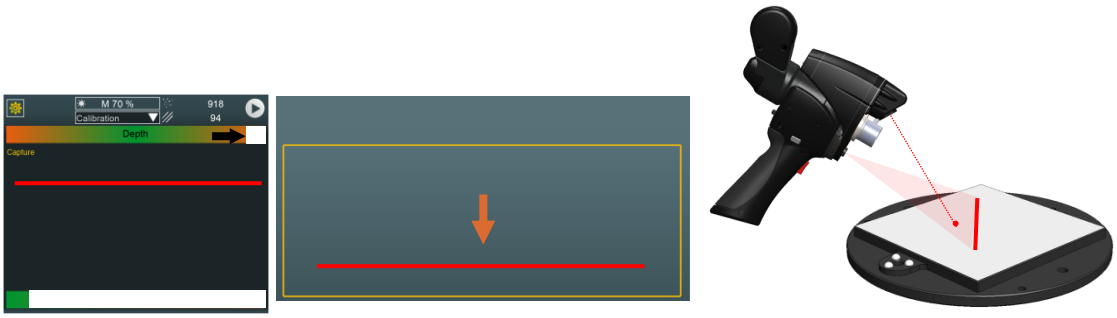
Rotate the scanner 360° around the plane, keeping middle position.

11. Only once the coverage is 100%, stop acquiring stripes to validate and jump to next step.

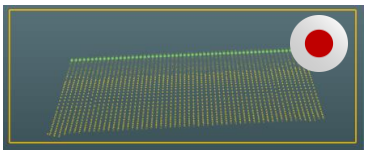


Take Far position scan stripes

12. Position the scanner at about 45° to the plane, in far position (high distance from the plane)

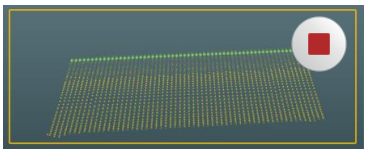


13. Start acquiring stripes



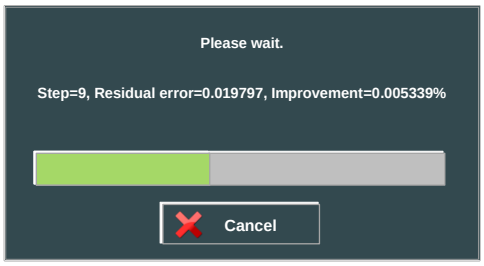
Rotate the scanner 360° around the plane, keeping middle position.

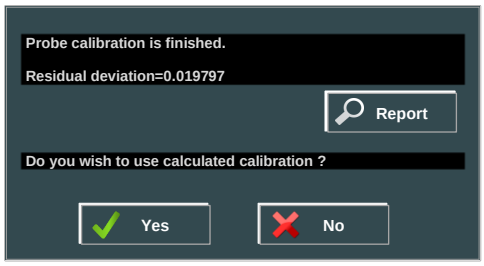
14. Only once the coverage is 100%, stop acquiring stripes to validate and jump to next step.



Calculation

After all the measurements, the calculation automatically starts.
At the end of calculation, click on yes.





The residual error is Least Squares value of distances divided by data set amount of points (to have a comparable value independent of amount of points)

The report details are memorized in a "Probe Calibration Report.txt" file on C:\Users\Public\Documents\Romer\RDS\CalibData.

For more details, please contact your local agent.

D.2.3 Scanner calibration - Sphere methods (Arm)

These methods consist by measuring a reference artefact sphere with reference probe (only for Sphere_with_reference method), then by scanning it from 5 orientations of the scanner, 3 set of stripes have to be taken:

	Measurement of the sphere with reference probe (15mm Probe #1) (only “Sphere with reference” method)
	Scan of 3 sides of the sphere, covering the field of view of the scanner to calibrate
	Scan of the whole sphere.
	Calculation and validation

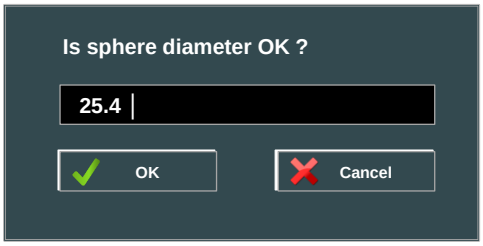
Run the script

1. Open the script in “Accessories Calibration”.
   Then click on “Play All”.

Artefact Properties

2. The calibration sphere that has to be used should be placed at 50% of the measurement volume.

3. When prompted, enter the diameter value

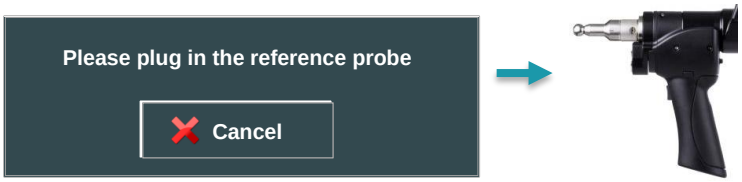


NOTICE

Do not use other artefact sphere than the provided one; it has been designed to give optimal results.

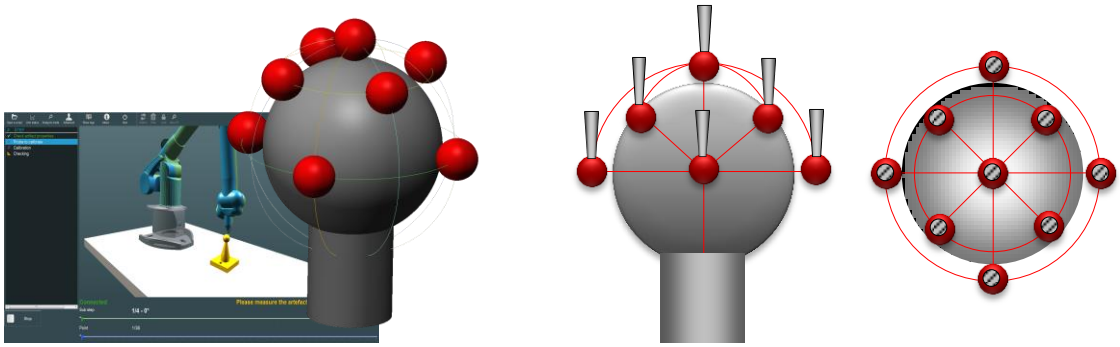
Reference Sphere

4. Insert 15mm Ref Probe

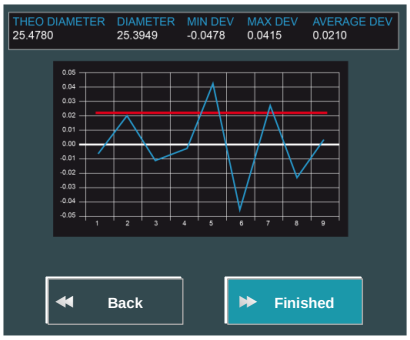


Don't forget to move the probe switch to the correct position

5. Take nine (9) points on the upper hemisphere of the artefact. The graphic shows the location of the points to be used.

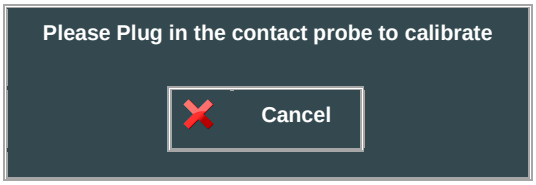


6. Check reference sphere results and validate



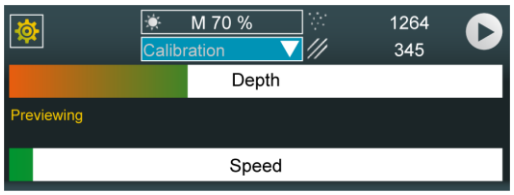
Use the Scanner

7. Mount the scanner to calibrate or simply remove the reference probe (for Absolute SI)



Don't forget to move the probe switch to the correct position

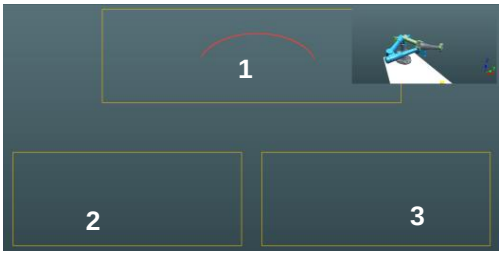
8. Wait for the scanner to be ready: RDS automatically select a "Calibration" scanning profile with the appropriate settings for the scanner calibration sphere.



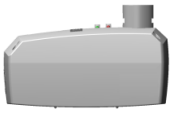
Field measurement

For each of the 3 orientations of the scanner, scan the sphere in order to cover the 3 target squares:

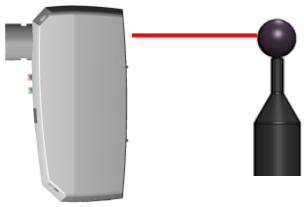
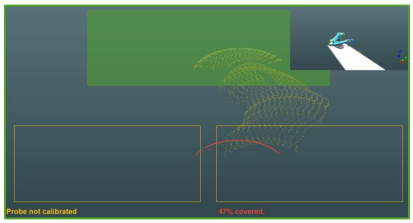
- 1 near centred position (#1)
- 1 far left position (#2)
- 1 far right position (#3).



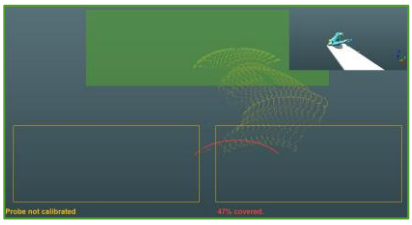
The 3 wrist positions are the following: 3 positions, at 90° each other



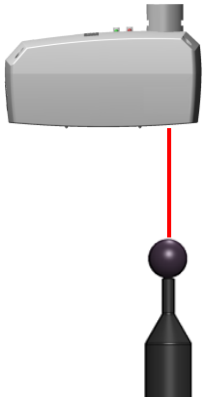
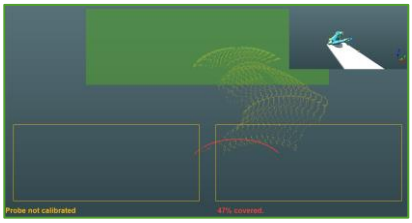
9. Position the scanner horizontally, at 0°, and scan, covering the 3 target squares. Validate by pressing stopping the scan (right button).

10. Position the scanner horizontally, at 90°, and scan, covering the 3 target squares. Validate by pressing stopping the scan (right button).

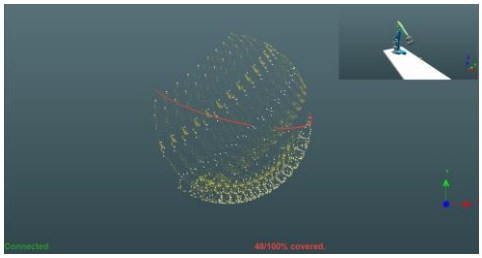
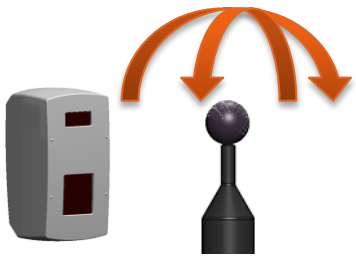



11. Position the scanner vertically, at 0°, and scan, covering the 3 target squares. Validate by pressing stopping the scan (right button).

- Global sphere measurement

Digitize the whole sphere with the scanner: wait for the 100 % coverage at least to stop digitizing. Validate by pressing on BP2 (right button).

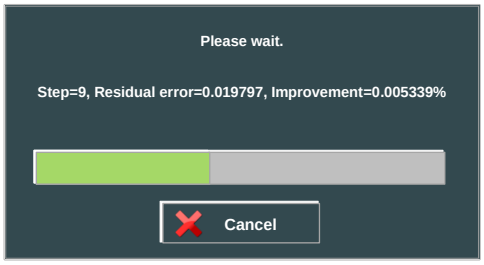



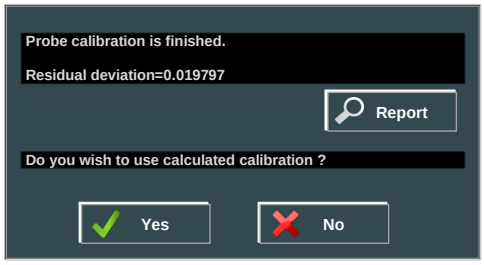
It is still possible to continue scanning even once the covered is completed, to enhance the quality of calibration, however, the calculation may be longer.

Calculation

After all the measurements, the calculation automatically starts.

At the end of calculation, click on yes.





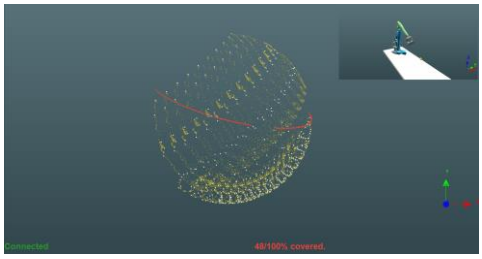
The residual error is Least Squares value of distances divided by data set amount of points (to have a comparable value independent of amount of points)

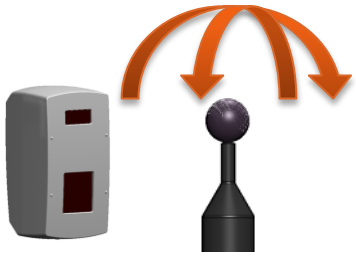
The report details are memorized in a "Probe Calibration Report.txt" file on C:\Users\Public\Documents\Romer\RDS\CalibData.

For more details, please contact your local agent.

Checking

After the validation of the calculation, RDS proposes to do a checkout on the artefact sphere: scan stripes over the calibration sphere, and validate with the right button or click on “Next”.





Then deviations are displayed:

	▼ Results on the global sphere, using all sub spheres together ▼ Results on each sub sphere alone		
X;Y;Z	✓		Coordinates of the digitized sphere
Max	✓	✓	Maximum error to the digitized sphere
Stddev	✓	✓	Standard deviation of all the errors
Theo Diameter	✓	✓	Nominal diameter of the artefact
Diameter	✓	✓	Calculated diameter of the digitized sphere
Deviation	✓	✓	Error of the diameter value
Rejected %		✓	% of the points rejected for the calculation (points digitized not on the artefact)

In the present case, there is only one sub sphere, thus global sphere and sub sphere are identical.

D.2.4 LAS-20-8 calibration - Sphere method (tracker)

As the LAS-20-8 contains several faces, each face has to be calibrated independently from the others. The user can decide to calibrate one face only or several faces. In this second case, the calibration script must be played once for each face.

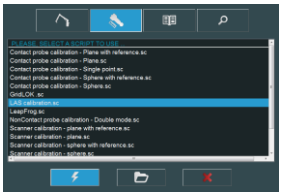
Once the process is started with one face, only this face can be used to complete the calibration.

The calibration method consists by scanning a sphere:

	Scan of one side of the sphere, covering the field of view of the scanner to calibrate
	Scan of the whole sphere.
	Calculation and validation

Run the script

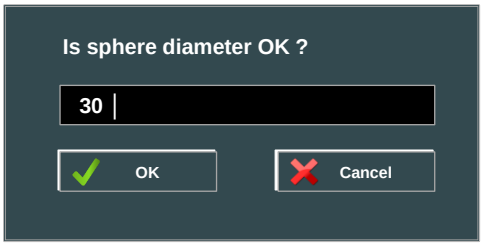
1. Select the script in “Accessories Calibration” and press “Run”.



Artefact Properties

2. The calibration sphere that has to be used should be placed at a correct distance from the tracker.

3. When prompted, enter the diameter value

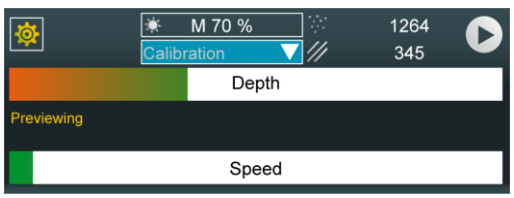


NOTICE

Do not use other artefact sphere than the provided one; it has been designed to give optimal results.

Use the Scanner

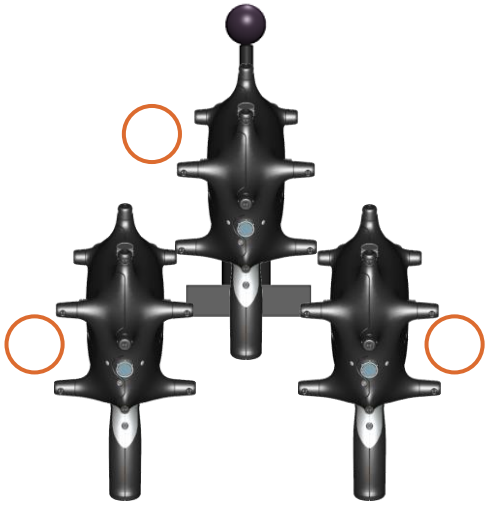
4. Wait for the scanner to be ready: RDS automatically select a “Calibration” scanning profile with the appropriate settings for the scanner calibration sphere.

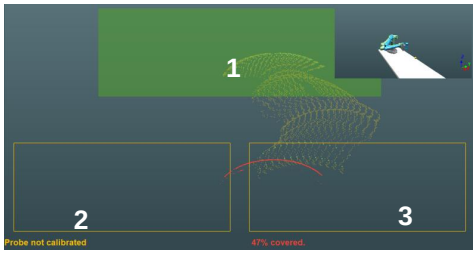


Any face of the scanner can be used, however, once the process started with one face, only this face becomes available.

Field measurement

5. From the same orientation of the scanner, scan the sphere in order to cover the 3 target squares:
   - 1 near centred position (#1)
   - 1 far left position (#2)
   - 1 far right position (#3).

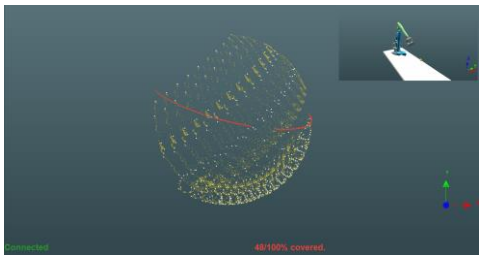




Once the coverage is completed, press “Next” to validate the acquisition.

Global sphere measurement

Digitize the whole sphere with the scanner: wait for the 100 % coverage at least to stop digitizing.
Once the coverage is completed, press “Next” to validate the acquisition.

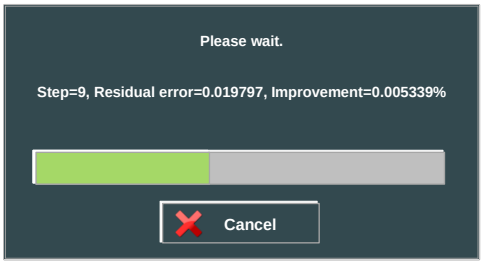


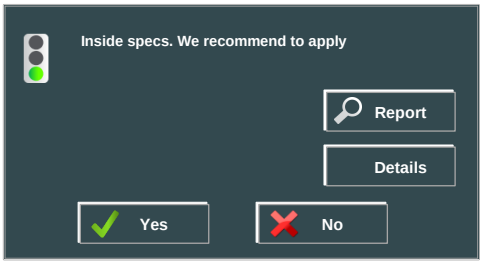
It is still possible to continue scanning even once the covered is completed, to enhance the quality of calibration, however, the calculation may be longer.

Calculation

After all the measurements, the calculation automatically starts.

At the end of calculation, RDS shows the status.





The details button shows the deviations details before and after calculation.

If a green light appears (= result OK), the calibration can be validated. Otherwise, proceed again with the calibration.

The residual error is Least Squares value of distances divided by data set amount of points (to have a comparable value independent of amount of points)

The report details are memorized in a "Probe Calibration Report.txt" file on C:\Users\Public\Documents\Romer\RDS\CalibData.

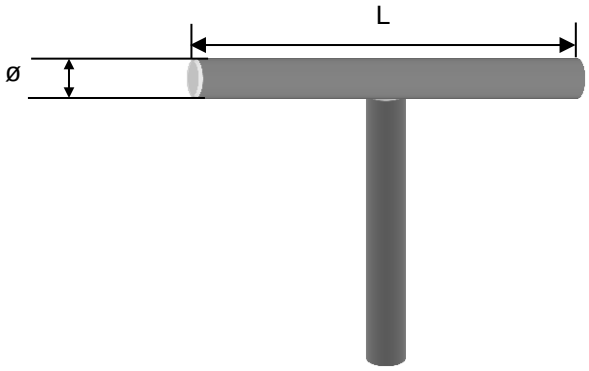
For more details, please contact your local agent.

D.3 Non-contact tube probe calibration

This script has to be used to calibrate a tube non-contact probe.
An artefact is necessary: a T-tube with an adapted diameter.

D.3.1 Description

Non-contact Tube probes (NCP) are calibrated on a tube artefact
The artefact that is used for the calibration measurements is a T composed by 2 cylinders, perfectly straight, with a constant and known diameter, with ends perfectly perpendicular to the axis of the cylinder, and with a known horizontal length.



Probe size	Recommended artefact diameter	Recommended artefact length
12.5 mm	6.35 mm (¼ ‘’)	100 mm
25 mm		
50 mm	12.7 mm (½ ‘’)	100 mm
75 mm		
100 mm	25.4 mm (1 ‘’)	100 mm
150 mm		

Non-contact Tube Probe process consists by measuring points on several sections and ends of the artefact, from different orientations of the probe.

D.3.2 Script

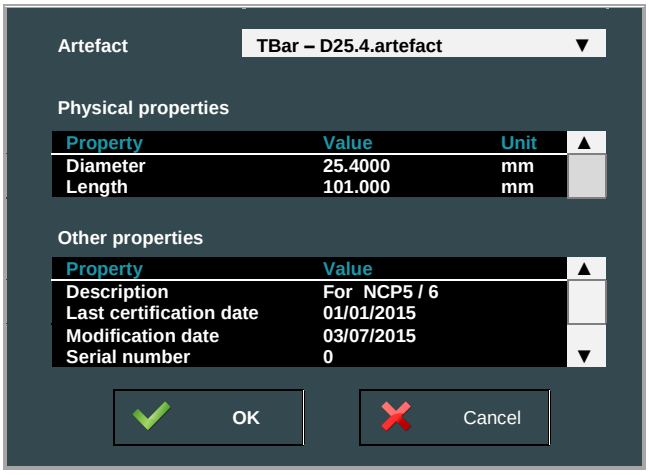
Select “Non-contact-Probe calibration” script, then play all.

Preparation

Place and fix the tube artefact in front of the arm, keeping the known length part of the tube in horizontal position.

Artefact properties(step1)

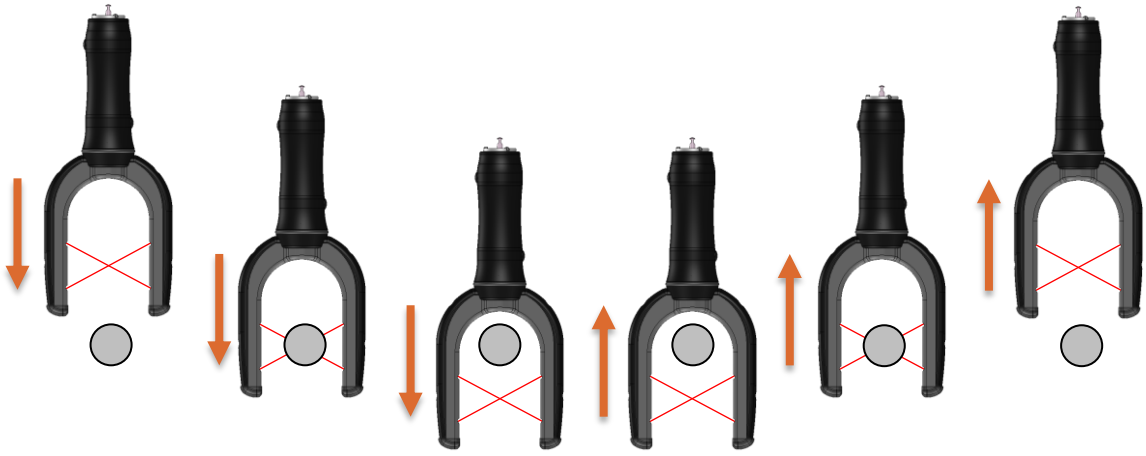
RDS ask for the artefact: Select the correct artefact if it has been memorised or enter the diameter and length, then press “select”.



Straight measurement

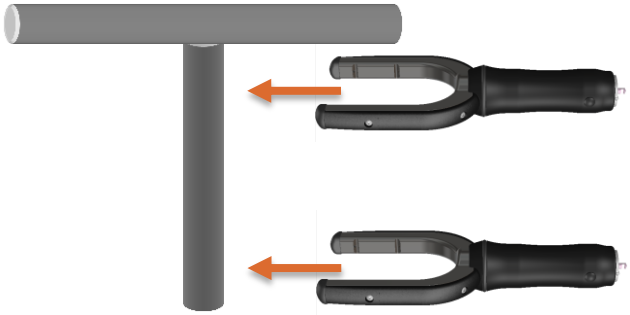
To measure a straight, the two beams of the probe have to be cut moving down then moving up (“double precision”).

One beep is emitted each time a beam is cut or released, that means 8 beeps (=8 events) for one point



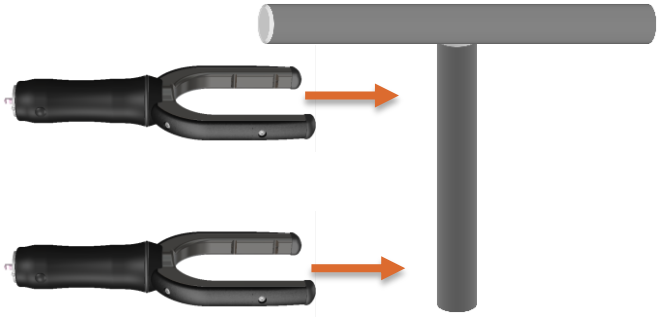
- Vertical tube measurement – right

Measure one point (8 beeps = 8 steps) on the high section of the vertical tube from the right side of the tube, then one point (8 beeps = 8 steps) on the low section. Keep the probe as perpendicular as possible to the tube.



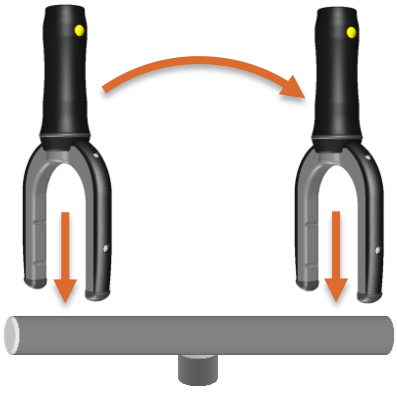
- Vertical tube measurement – left

Measure one point (8 beeps = 8 steps) on the high section of the vertical tube from the left side of the tube (opposite to previous measurement), then one point (8 beeps = 8 steps) on the low section. Keep the probe as perpendicular as possible to the tube.



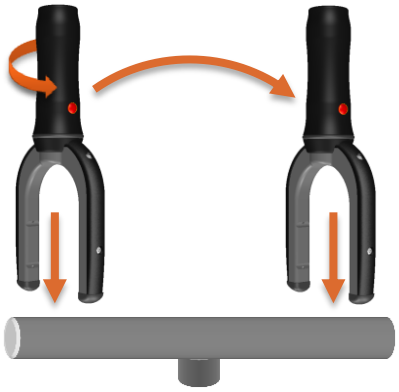
- Horizontal tube measurement – button Inside

Measure one point (8 beeps = 8 steps) on the right-end section of the horizontal tube, keeping the probe button toward the arm (INSIDE), then one point (8 beeps = 8 steps) on the left-end section, still with the probe button INSIDE. Keep the probe as perpendicular as possible to the tube.



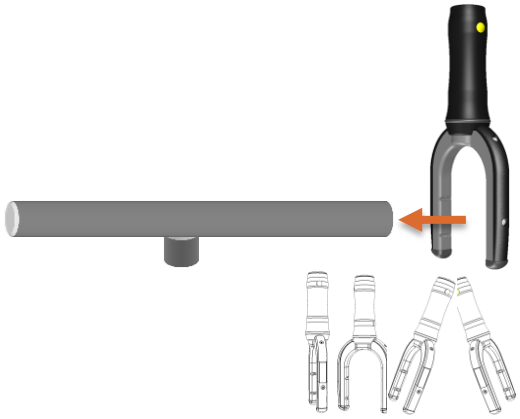
- Horizontal tube measurement – button Outside

Measure one point (8 beeps = 8 steps) on the right-end section of the horizontal tube, keeping the probe button opposite from the arm (OUTSIDE), then one point (8 beeps = 8 steps) on the left-end section, still with the probe button OUTSIDE. Keep the probe as perpendicular as possible to the tube.



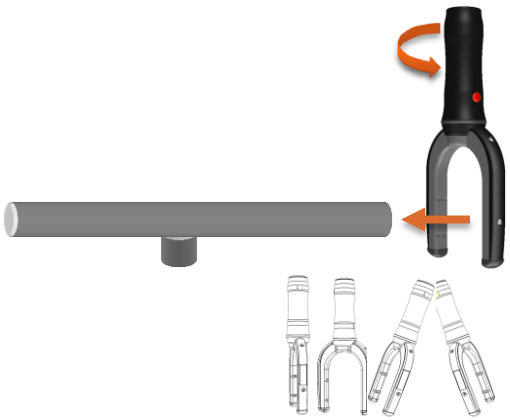
- Horizontal tube right extremity measurement – button right

Measure 5 times the RIGHT extremity of the horizontal tube (4 pts each time), keeping the probe button on the RIGHT. Give different angles for each of the 5 times.



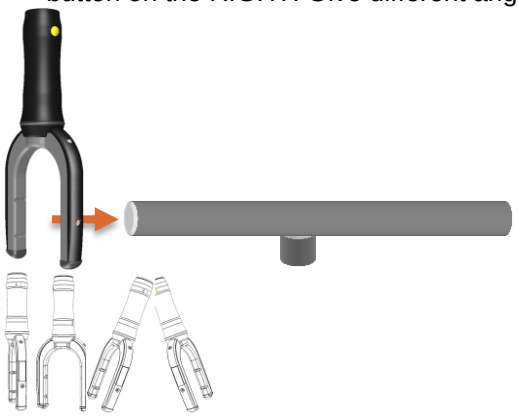
- Horizontal tube right extremity measurement – button left

Measure 5 times the RIGHT extremity of the horizontal tube (4 pts each time), keeping the probe button on the LEFT. Give different angles for each of the 5 times.



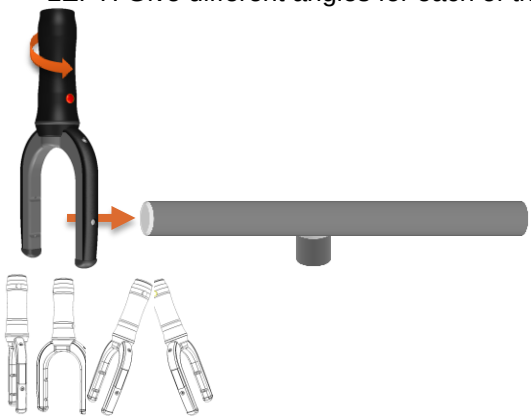
Horizontal tube left extremity measurement – button right

- Measure 5 times the LEFT extremity of the horizontal tube (4 pts each time), keeping the probe button on the RIGHT. Give different angles for each of the 5 times.



Horizontal tube left extremity measurement – button left

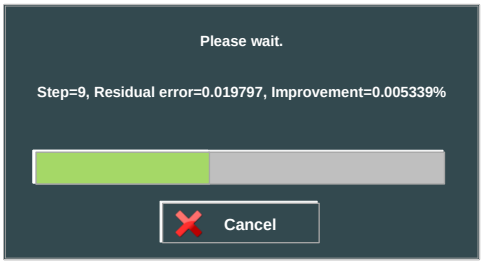
- Measure 5 times the LEFT extremity of the horizontal tube, keeping the probe button on the LEFT. Give different angles for each of the 5 times.

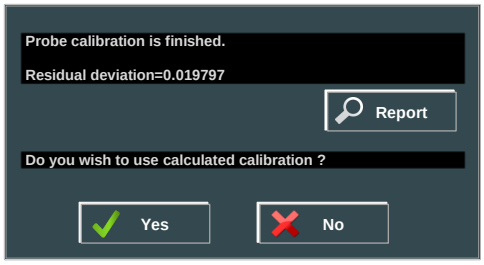


Calculation

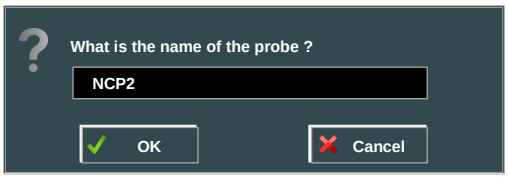
After all the measurements, the calculation automatically starts.

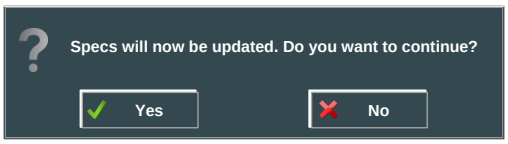
At the end of calculation, check the details and click on yes.

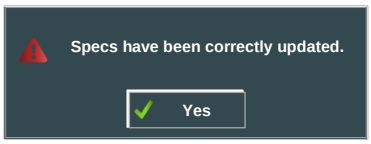




Enter then the name to give to the probe and validate both next prompts







D.4 Arm positioning

D.4.1 Leap-Frog

RDS Service can manage a leap frog utility to be able to move the arm, keeping the memory of the original position.

To make a new Leap-Frog, RDS data collector is used.

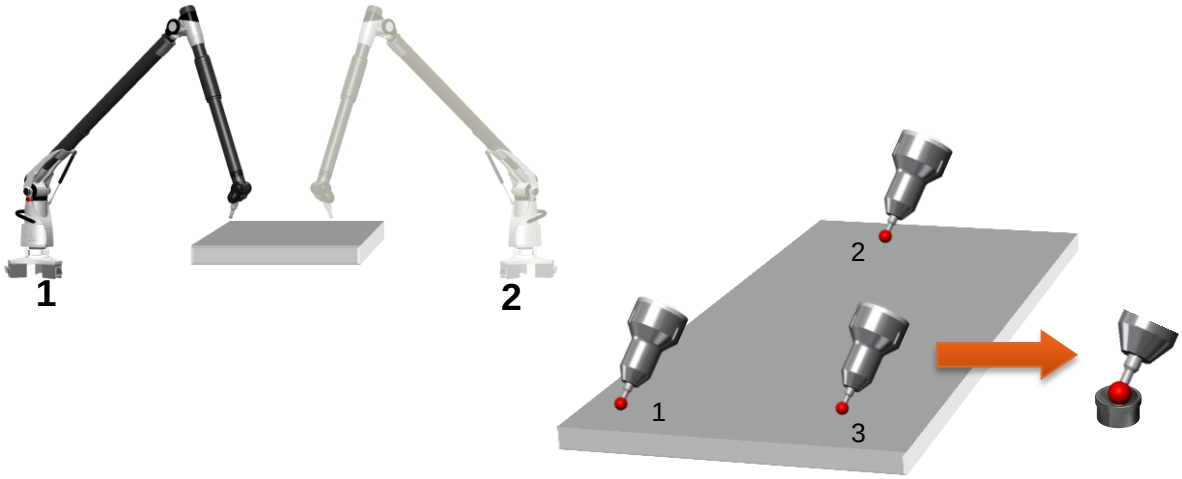
For more explanations, please refer to RDS User manual.

The Leap-Frog script consists by measuring 3 points before moving the arm, then the same three points after moving the arm.

Select the script “Leap-Frog.sc” in Accessories calibration folder, then Play All.

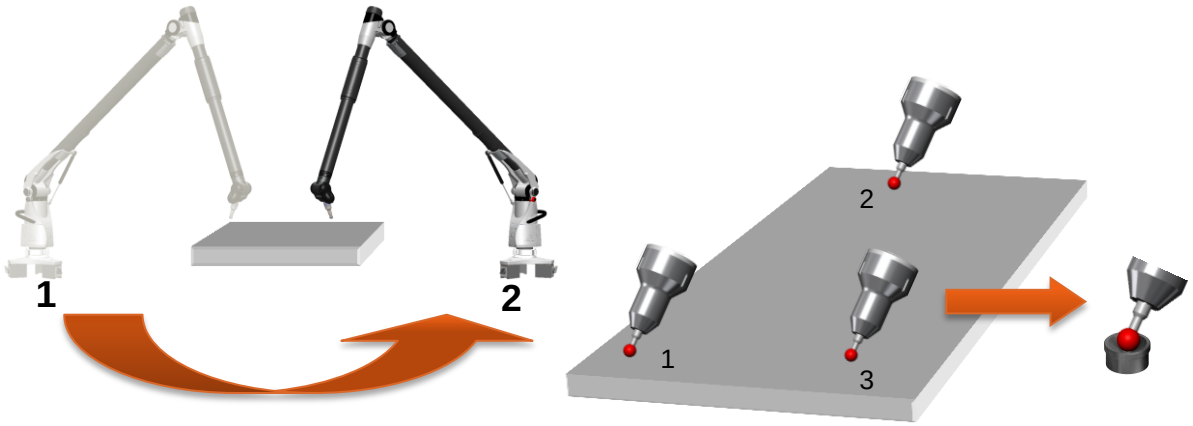
- 1st Measurement

Measure three distant and not aligned points from the first position. Those points have to be accurate points (cones, seats …)



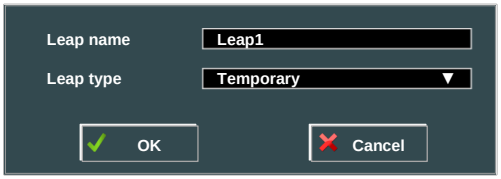
- 2nd Measurement

Displace the arm to the target position and measure the same three points from the second position, in the same order.



- Calculation

Once the last point is taken, RDS calculates the Leap-Frog matrix, and ask for the name and type of Leap-Frog (see RDS User manual).



E. CERTIFICATIONS SCRIPTS

The verification scripts are used to do machine checking for certification or in case of doubt on the accuracy of the machine.

Different scripts are available, depending on the type measuring (B89 for ABSOLUTE arm and ISO 10360 for Multi Gage) system and type of certificated bar:

- Step bar

- Ball bar

- Cone bar

B89 must be used for ABSOLUTE arms. Those scripts refer to “ASME B89.4.22-2004” standard, which consist in measuring 20 lengths (short or long depending on the position) in measurement volume, 10 points on a cone in 3 positions, and 3 times a sphere by 9 points.

For more detailed information, please refer to the standard.

ISO 10360 script must be used for Multi Gages. Those scripts refer to ISO 10360-2:2001 international standard, which consist in measuring a 5 lengths artefact in 7 different positions, 3 times each, then a sphere with 25 points.

For more detailed information, please refer to the standard.

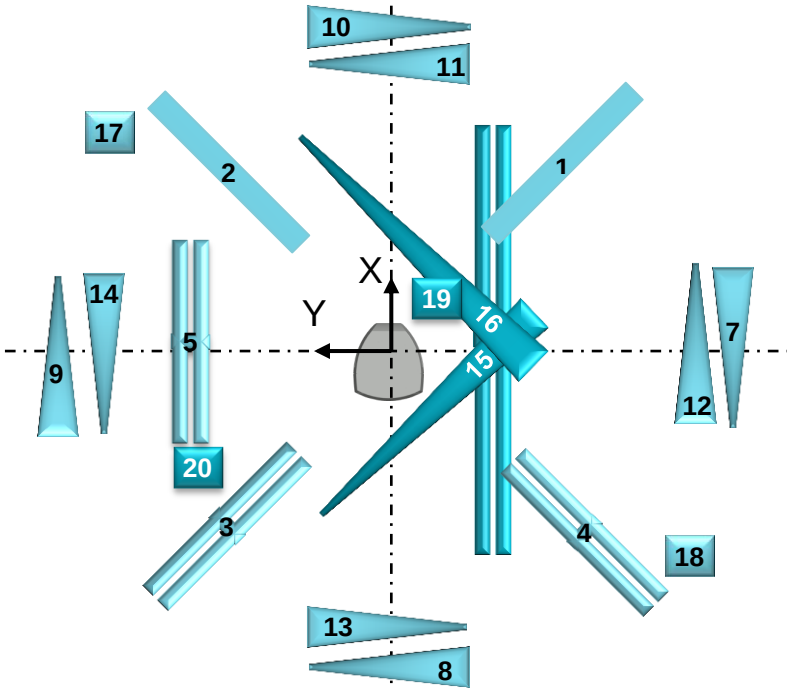
E.1 B89 certification (Arm)

E.1.1 B89 Positions

- Length test (volumetric performance test) :

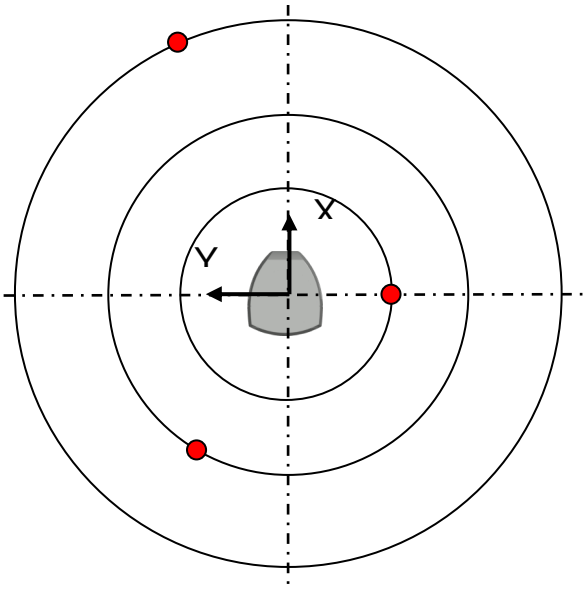
2 different lengths used	
	Short (between 50% and 75% of radial length of Arm)
	Long (between 120% and 150% of radial length of Arm)

20 locations of measurement (1 length measurement only for each, short or long depending on location)	Pos°	Length	Incline	Distance	Height	Direction	Quadrant
	1	Short	Horizontal	Near	Low	Radial	8
	2	Short	Horizontal	Near	Low	Radial	5
	3	Short	Horizontal	Near	High	Radial	2
	4	Short	Horizontal	Near	High	Radial	3
	5	Short	Horizontal	Far	High	Tangent	1&2
	6	Long	Horizontal	Near	High	Tangent	3&4
	7	Short	45°	Far	Medium	Tangent	4&7
	8	Short	45°	Far	Medium	Tangent	6&3
	9	Short	45°	Far	Medium	Tangent	1&6
	10	Short	45°	Far	Medium	Tangent	1&8
	11	Short	45°	Far	Medium	Tangent	5&4
	12	Short	45°	Far	Medium	Tangent	5&2
	13	Short	45°	Far	Medium	Tangent	2&7
	14	Short	45°	Far	Medium	Tangent	3&8
	15	Long	45°	Near	Medium	Tangent	2&8
	16	Long	45°	Near	Medium	Tangent	1&7
	17	Short	Vertical	Far	Medium	Tangent	1&5
	18	Short	Vertical	Far	Medium	Tangent	7&3
	19	Long	Vertical	Near	Medium	Tangent	2&6
	20	Long	Vertical	50%	Medium	Tangent	4&8



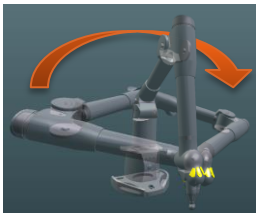
Single point test (single point articulation test): (3 times)

- Single points measured on a seat (cone)

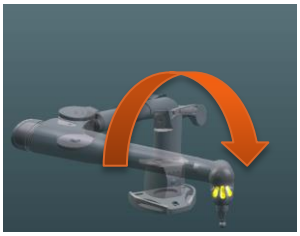


- 3 locations
  - 20% Vol – 0° rotation
  - 50% Vol – 120° rotation
  - 80% Vol – 240° rotation

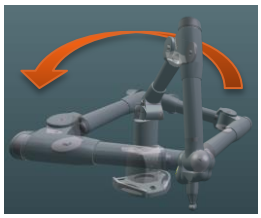
- 10 points for each measurement
  - ✓ Pt1 : Elbow left down
  - ✓ Pt2 : Elbow left up
  - ✓ Pt3 : Elbow up
  - ✓ Pt4 : Elbow right up
  - ✓ Pt5 : Elbow right down



Twist wrist 180° then same positions:

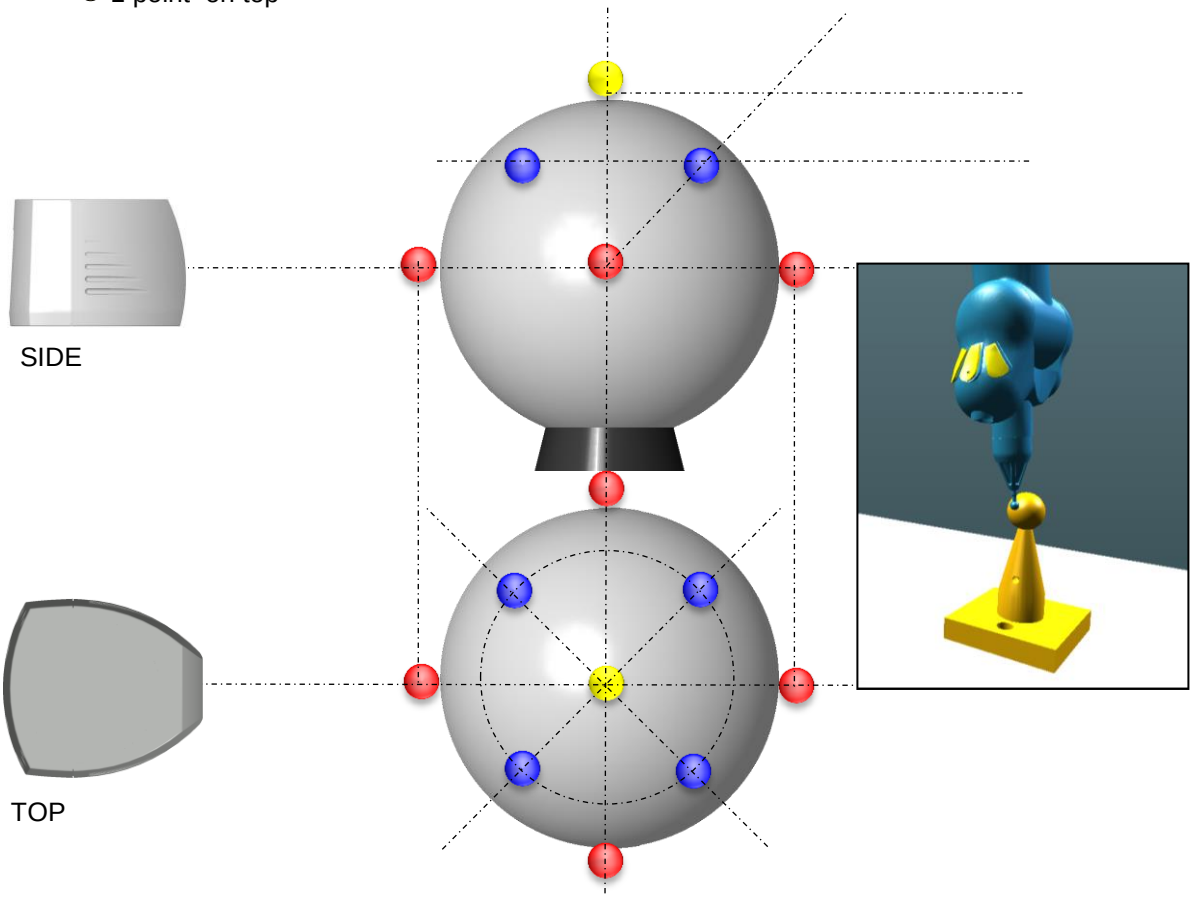


  - ✓ Pt6 : Elbow left down
  - ✓ Pt7 : Elbow left up
  - ✓ Pt8 : Elbow up
  - ✓ Pt9 : Elbow right up
  - ✓ Pt10 : Elbow right down



Sphere diameter test (Effective diameter Performance Test):

- Sphere measured 3 times at the same location (50% of measurement capacity)
- 9 points for each measurement
  - 4 points on Equator equally distributed
  - 4 points at 45° Latitude, equally distributed, 45° rotated from Equator points
  - 1 point on top

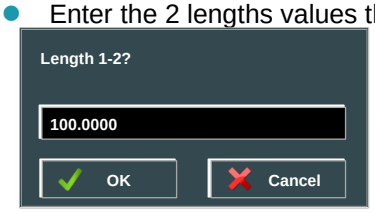


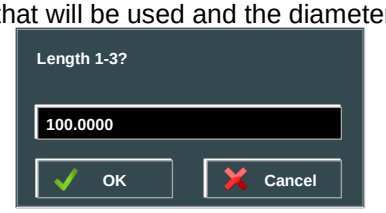
E.1.2 B89 Ball Bar certification

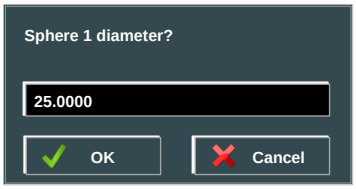
This script is designed as standard script for B89 using a Ball bar

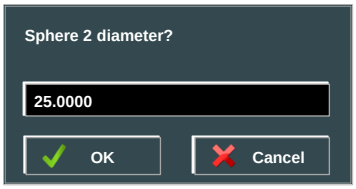
Step 1 : Nominal values of the artefact

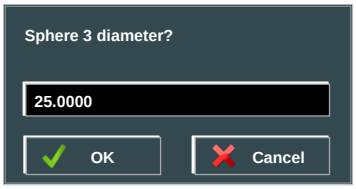
- Enter the 2 lengths values that will be used and the diameter of the spheres.



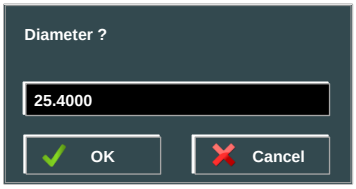








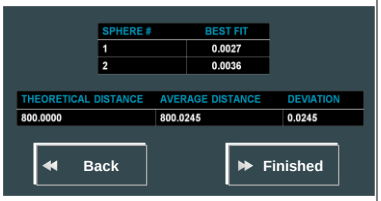
- Enter the diameter of the Diameter test sphere



Steps 2 to 22: Volumetric Performance Test:

Measure the 20 lengths: for each, measure the 2 spheres of the artefact with 5 points per sphere.
At the end of the step, RDS Data Collector shows the deviations

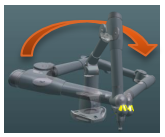
Best-fit on each sphere	Maximum deviation from the 5 points to the mean sphere.
Theoretical distance	Value entered on step1
Average distance	Measured distance from the center of the 2 mean spheres.
Deviation	Error between the Average distance and the Theoretical distance.



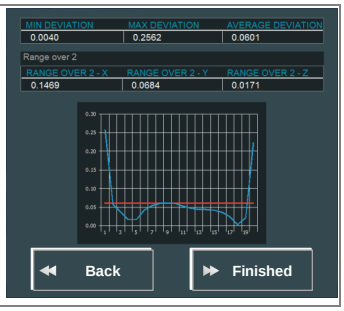
Press “Finished” to go to next step, or “Back” if a mistake has been done.

- Steps 23 to 26: Single Point Articulation test:

Measure the 10 points on the cone 3 times (3 different locations).
At the end of the step, RDS Data Collector shows the deviations.



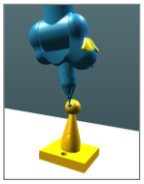
Min / Max deviations	Extreme deviations from the 10 points and the middle point
Average deviation	Mean value from the 10 points to middle point
Range	Range between min and max
Graphic	Shows the deviations of all the 10 points, and mean value.



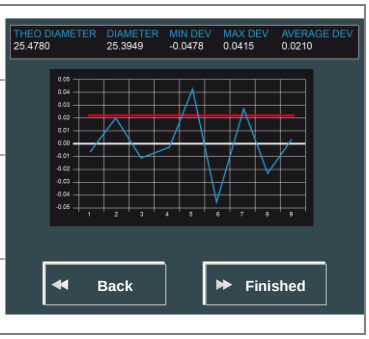
Press “Finished” to go to next step, or “Back” if a mistake has been done.

- Steps 27 to 30: Effective diameter Performance Test:

Measure the sphere 3 times at the same place, with 9 points for each sphere.
At the end of the step, RDS Data Collector shows the deviations



Theoretical diameter	Value entered on step1
Diameter	Diameter of the measured sphere (least squares)
Min / Max deviations	Extreme deviations from the 9 points and the theoretical diameter (based on the calculated best-fitted sphere center)
Graphic	Shows the deviations of all the 9 points, and mean value.



Press “Finished” to go to next step, or “Back” if a mistake has been done.

Check if all results are fitting with the specifications of the measuring system. If they do not, please contact your calibration center.

- Ending : RDS Toolbox Package creation

Once all the steps have been played, RDS asks if a package has to be created for Hexagon database (see RDS User manual).

At the end of the Length test, a result file is created in the calibration folder: "B89 lengths report.txt"

Arm ID 17
Generated by RDS Data Collector v4.1.0
Generation date 2015/09/22 12:19:18

Volumetric performance Test

	LReal	LTheo	Dev	Dev²
1	380.061227	380.05816	0.00306698	9.4064E-06
2	380.058819	380.05816	0.00065916	4.3449E-07
3	380.067791	380.05816	0.00963135	9.2763E-05
4	380.079741	380.05816	0.02158138	0.00046576
5	380.057451	380.05816	0.00032316	5.0252E-07
6	800.080774	800.087573	-0.00654771	4.6225E-05
7	380.058483	380.05816	-0.00137491	1.0443E-07
8	380.051612	380.05816	0.00417557	4.2872E-05
9	380.056785	380.05816	0.00252183	1.8904E-06
10	380.062336	380.05816	0.00367906	1.7435E-05
11	380.060682	380.05816	0.00162056	6.3596E-06
12	380.061839	380.05816	-0.00128998	1.3535E-05
13	380.059781	380.05816	-0.00967752	2.6262E-06
14	380.05687	380.05816	-0.01094185	1.664E-06
15	800.077895	800.087573	0.00832515	9.3654E-05
16	800.076631	800.087573	0.00771158	0.00011972
17	380.066485	380.05816	0.01349986	6.9308E-05
18	380.065872	380.05816	-0.0003814	5.9468E-05
19	800.101073	800.087573	0.00306698	0.00018225
20	800.087191	800.087573	0.00306698	0.00018225

Max Dev 0.0215838
Range 0.0325223
2 RMS 0.0132358

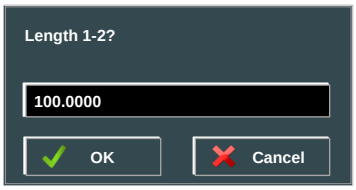
E.1.3 B89 Cone Bar certification

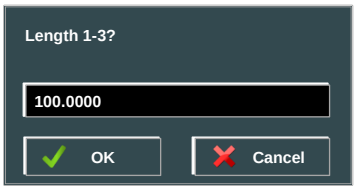
This script is designed as standard script for B89 using a cones bar.

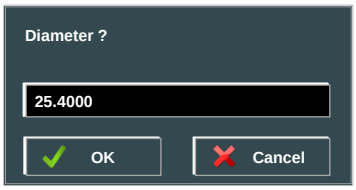
For 7 axes arms, use "B89 Cone Bar – Sx" script instead of "B89 Cone Bar".

- Step 1: Nominal values of the artefact

Enter the 2 lengths values that will be used and the diameter of the sphere.



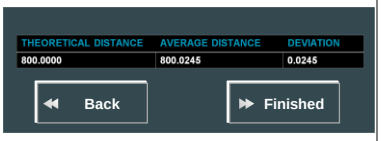




- Steps 2 to 22: Volumetric Performance Test:

Measure the 20 lengths: for each, measure the 2 cones of the artefact with 5 points per cone.
At the end of the step, RDS Data Collector shows the deviations

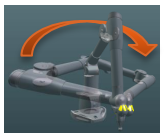
Theoretical distance	Value entered on step1
Average distance	Average measured distance from the 2 x 5 points.
Deviation	Error between the Average distance and the Theoretical distance.



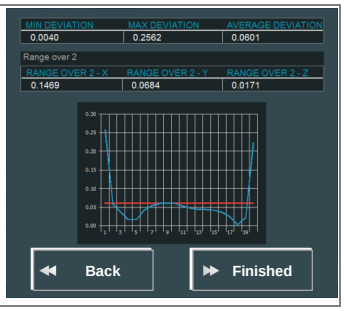
Press "Finished" to go to next step, or "Back" if a mistake has been done.

- Steps 23 to 26: Single Point Articulation test:

Measure the 10 points on the cone 3 times (3 different locations).
At the end of the step, RDS Data Collector shows the deviations.



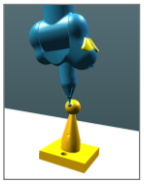
Min / Max deviations	extreme deviations from the 10 points and the middle point
Average deviation	mean value from the 10 points to middle point
Range	range between min and max
Graphic	shows the deviations of all the 10 points, and mean value.



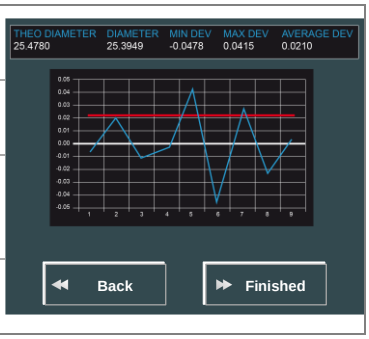
Press “Finished” to go to next step, or “Back” if a mistake has been done.

- Steps 27 to 30: Effective diameter Performance Test:

Measure the sphere 3 times at the same place, with 9 points for each sphere.
At the end of the step, RDS Data Collector shows the deviations



Theoretical diameter	Value entered on step1
Diameter	Diameter of the measured sphere (least squares)
Min / Max deviations	Extreme deviations from the 9 points and the theoretical diameter (based on the calculated best-fitted sphere center)
Graphic	Shows the deviations of all the 9 points, and mean value.



Press “Finished” to go to next step, or “Back” if a mistake has been done.

Check if all results are fitting with the specifications of the measuring system. If they do not, please contact your calibration center.

Ending : RDS Toolbox Package creation

Once all the steps have been played, RDS asks if a package has to be created for Hexagon database (see RDS User manual).

At the end of the Length test, a result file is created in the calibration folder: "B89 lengths report.txt"

Arm ID 17
Generated by RDS Data Collector v4.0.0
Generation date 2011/11/22 12:19:18

Volumetric performance Test

	LReal	LTheo	Dev	Dev²
1	380.061227	380.05816	0.00306698	9.4064E-06
2	380.058819	380.05816	0.00065916	4.3449E-07
3	380.067791	380.05816	0.00963135	9.2763E-05
4	380.079741	380.05816	0.02158138	0.00046576
5	380.057451	380.05816	0.00032316	5.0252E-07
6	800.080774	800.087573	-0.00654771	4.6225E-05
7	380.058483	380.05816	-0.00137491	1.0443E-07
8	380.051612	380.05816	0.00417557	4.2872E-05
9	380.056785	380.05816	0.00252183	1.8904E-06
10	380.062336	380.05816	0.00367906	1.7435E-05
11	380.060682	380.05816	0.00162056	6.3596E-06
12	380.061839	380.05816	-0.00128998	1.3535E-05
13	380.059781	380.05816	-0.00967752	2.6262E-06
14	380.05687	380.05816	-0.01094185	1.664E-06
15	800.077895	800.087573	0.00832515	9.3654E-05
16	800.076631	800.087573	0.00771158	0.00011972
17	380.066485	380.05816	0.01349986	6.9308E-05
18	380.065872	380.05816	-0.0003814	5.9468E-05
19	800.101073	800.087573	0.00306698	0.00018225
20	800.087191	800.087573	0.00306698	0.00018225

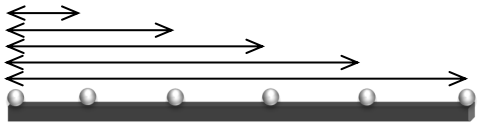
Max Dev 0.0215838
Range 0.0325223
2 RMS 0.0132358

E.2 VDIVDE Certification (Arm)

E.2.1 VDIVDE Positions

Length test : Rules

- 7 Locations of Length gage
- 5 different lengths on gage
  - ✓ Greatest length at least 66% of useful measurement range
  - ✓ Shortest length less than 30mm



- For each location , 3 measurement of the 5 lengths
  - ✓ 1st measurement : Pt0 Elbow Left – Pt1 Elbow Right
  - ✓ 2nd Measurement : Pt0 Elbow Right – Pt1 Elbow Left
  - ✓ 3rd measurement : Pt0 Elbow Left – Pt1 Elbow Left
- Remesuring: maximum 5 of the 35 lengths may have one of the 3 values out of specs and then shall be remesured 10 times. All 10 have to be inside specifications.

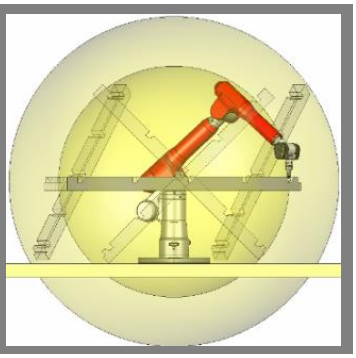
Length test artefact size

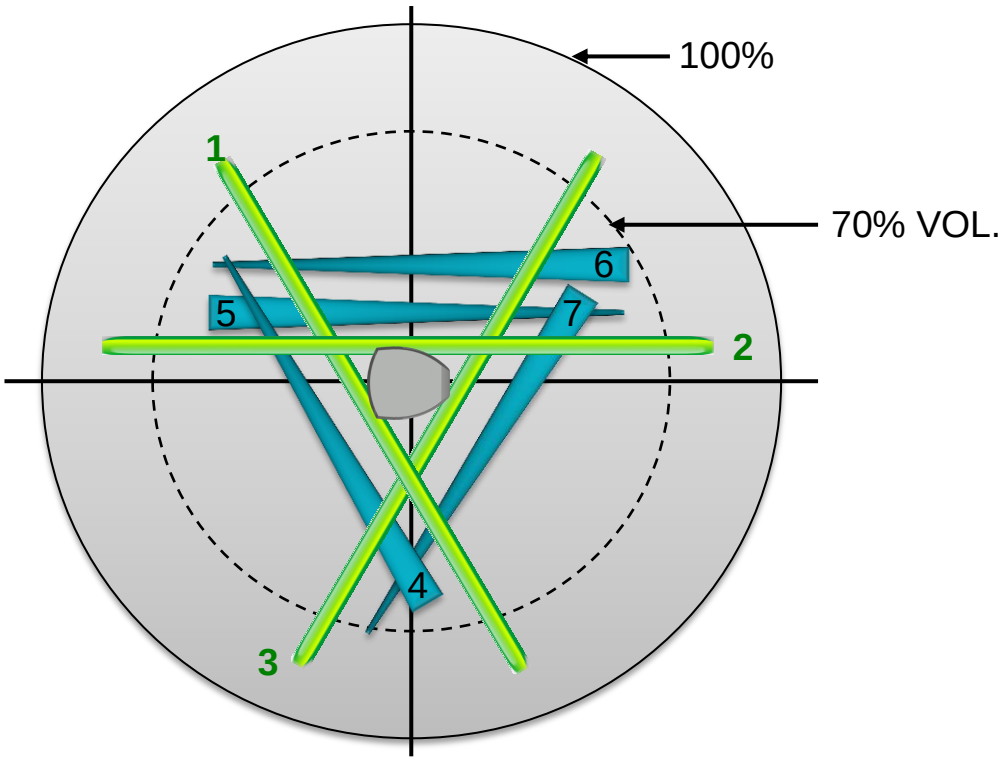
According to the size of arm, the greatest length must be at least 66 % of the measurement range. It means the following sizes:

Size of arm	Shortest length	Recommended Greatest length
1500	< 30mm	1000mm
2000	< 30mm	1400mm
2500	< 30mm	1700mm
3000	< 30mm	2000mm
3500	< 30mm	2400mm
4000	< 30mm	2700mm
4500	< 30mm	3000mm

- Locations of the gage

	Pos.	Incline	Distance from Arm	Direction
	1	Horizontal	Near	Tangent
	2	Horizontal	Near	Tangent
	3	Horizontal	Far	Tangent
	4	45°	Near	Tangent
	5	45°	Near	Tangent
	6	45°	Near	Tangent
	7	45°	Near	Tangent

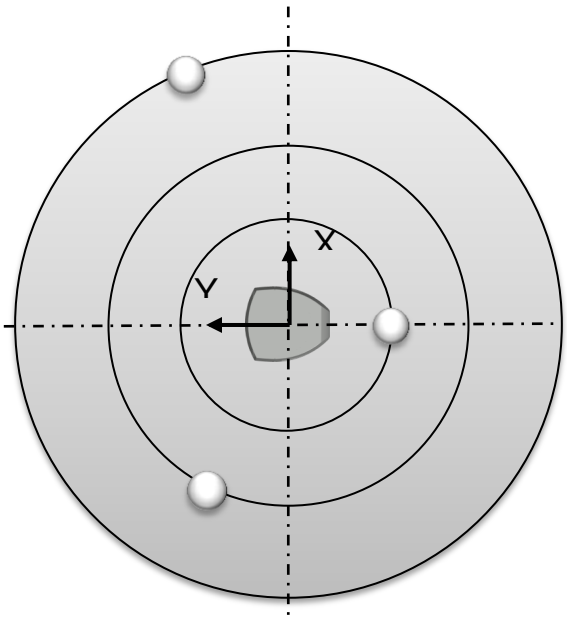




Sphere test :

Sphere diameter between 10 and 50mm

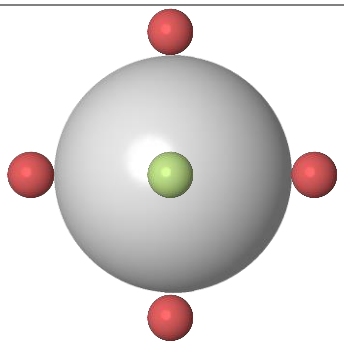
- 3 locations
  - 0° / 20% range / -20 % High
  - 120° / 50% range / 0% high
  - 240° / 80% range / +50% high



- 5 x 5 Points for each location using 5 orientations of the probe

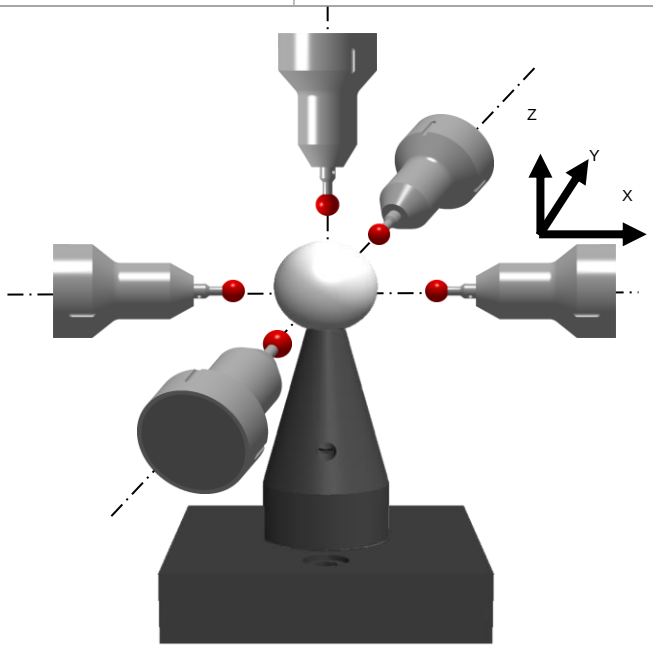
5 points

- 1 Pt on Pole
- 4 Pts on equator, distributed at 90° each other



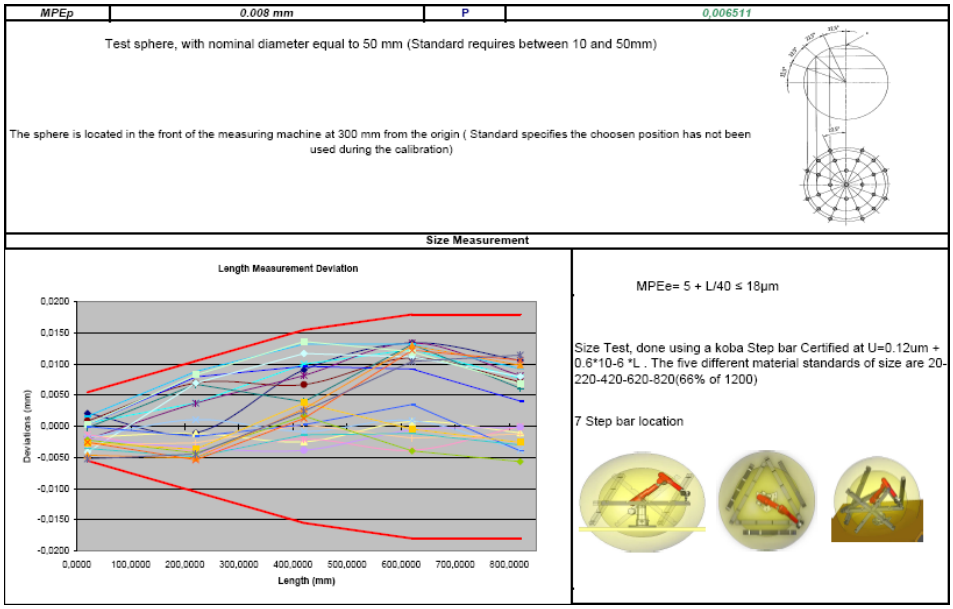
5 orientations

- Probe from the top (Z+)
- Probe from X+
- Probe from X-
- Probe from Y+
- Probe from Y-



Results

At the end of the process, RDS generates a report including the results.



On this report, are shown:

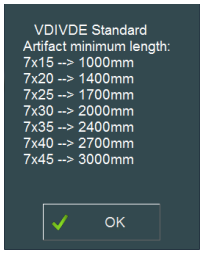
- **Sphere test results :**
  - MPEp (Maximum Permissible Error for Probing) value and P value (Probing value) : P must be less than MPEp
  - Nominal sphere diameter.
- **Size Test**
  - Graphic with MPEe (Maximum Permissible Error for Size) curve and all E values (lengths deviations): all deviations must be within MPEe graphic.
  - MPEe definition and characteristics of the artefact.

E.2.2 VDIVDE Ball bar certification

This script is designed as the standard script for VDIVDE using a ball bar

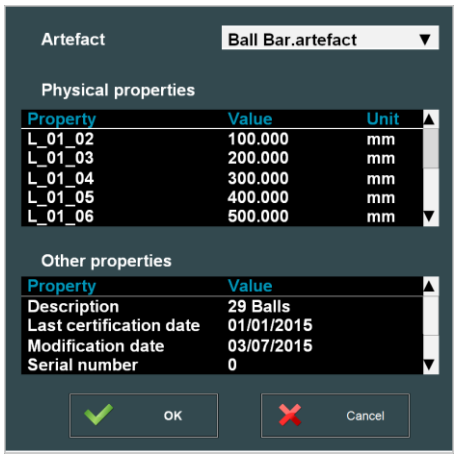
Preliminary step : reminder

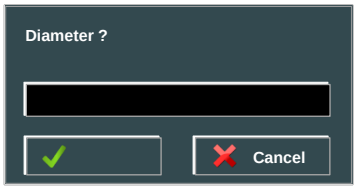
When entering the script or “Play all”, RDS DC reminds you about the minimum artefact lengths to use according to the size of arm:



Step 1 : Nominal values of the artefact

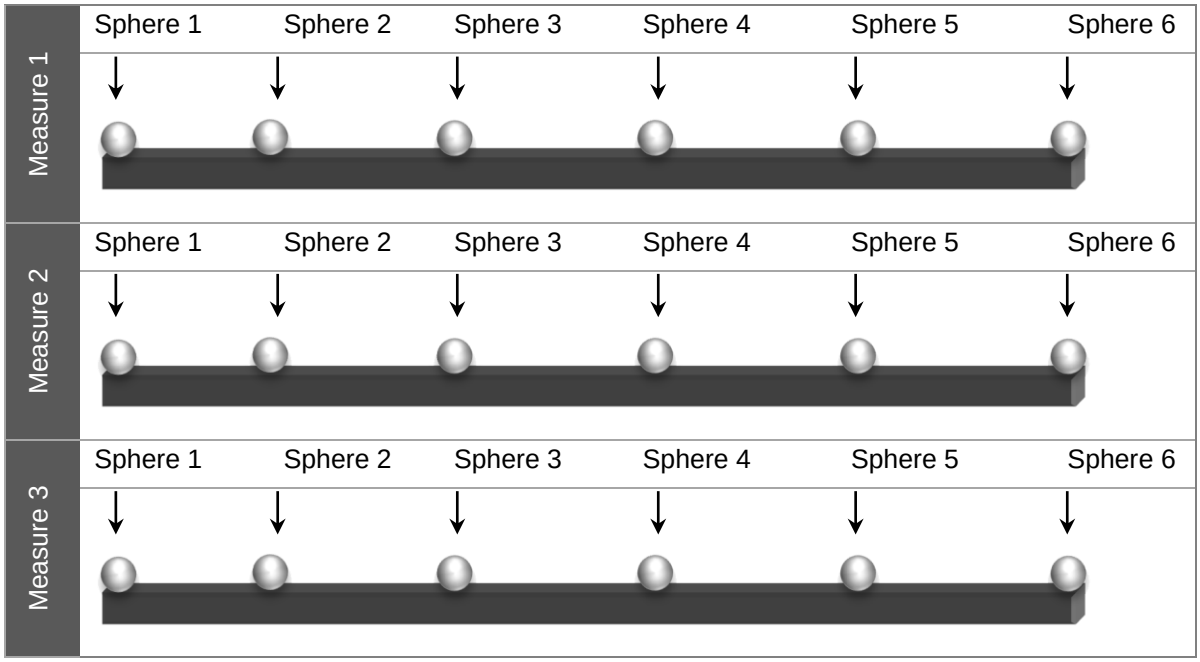
Select the artefact and / or enter the 5 distances and the diameter of the sphere.





Steps 2 to 8 : Size test

Measure the 7 sets of 5 lengths: for each, measure the 6 spheres 3 times (5 pts per sphere) (18x5 = 90 Points):



At the end of each step, RDS Data Collector shows the deviations

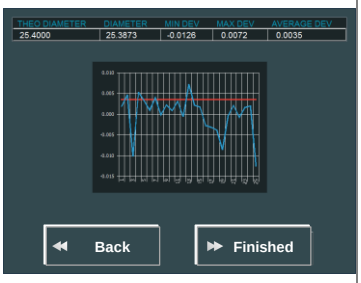
Theoretical distance	Value entered on step1.
Average distance	Measured average distance from the 3 measurements on the 2 steps of the artefact.
Deviation	Difference between the average measured distance and the theoretical distance.
Sequences (1/2/3)	Details of the 3 deviations between the measurement and theoretical values.
Maximum deviation	Is highlighted in Red.
Lengths Graphic	Shows the 5 average deviations.
Sphere Graphic	Shows the best-fit values of the 18 measured spheres.

Press “Finished” to go to next step, or “Back” if a mistake has been done.

- Step 9 to 11: measure the sphere at the 3 locations with the 5 x 5 specified points.

At the end of each step, RDS Data Collector shows the deviations

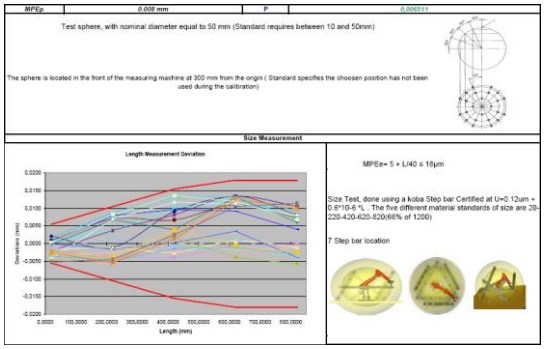
Theoretical diameter	Value entered on step1
Diameter	Measured diameter (least square)
Min / Max deviations	Extreme deviations from the 25 points and the theoretical diameter (based on the calculated best-fitted sphere center)
Graphic	Shows the deviations of all the 25 points, and mean value.



Press “Finished” to go to next step, or “Back” if a mistake has been done.

Check if all results are fitting with the specifications of the measuring system. If they do not, please contact your calibration center.

- Step 12 (Report) : generates an Excel Report

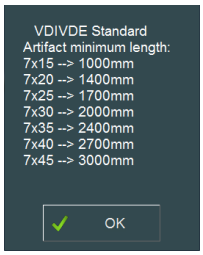


E.2.3 VDIVDE Cone Bar certification

This script is designed the standard script for VDIVDE using a cone bar

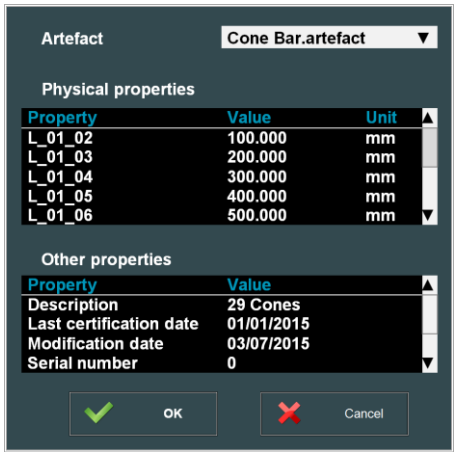
- Preliminary step : reminder

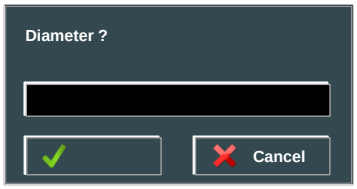
When entering the script or “Play all”, RDS DC reminds you about the minimum artefact lengths to use according to the size of arm:



- Step 1: Nominal values of the artefact

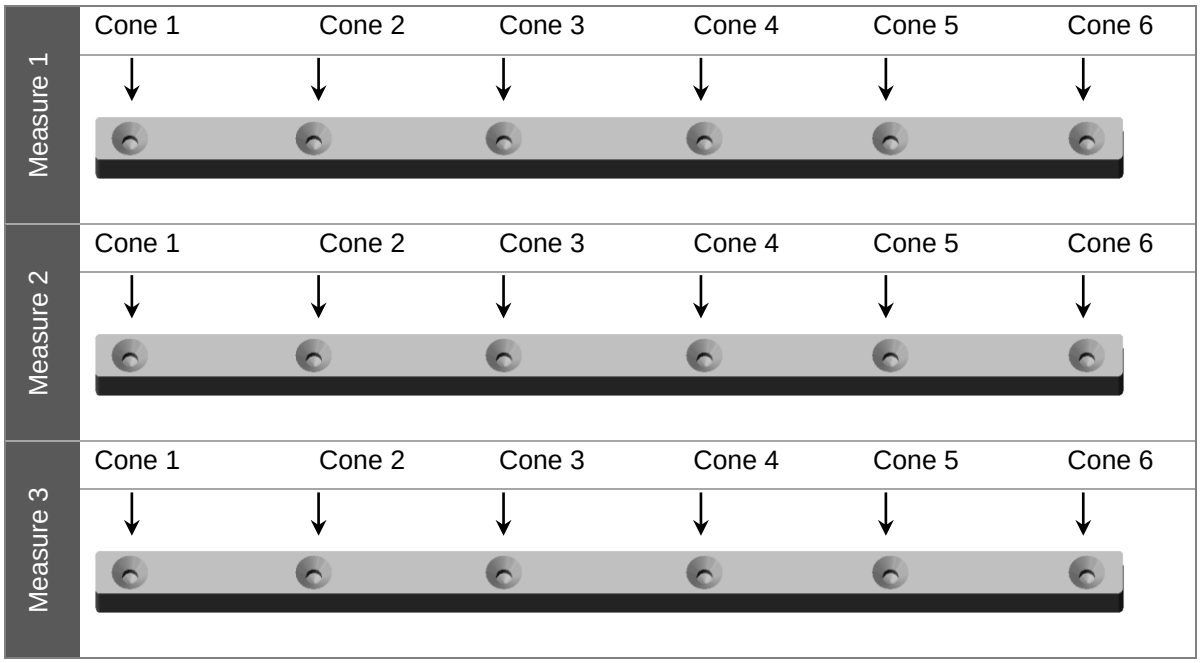
Select the artefact and / or enter the 5 distances and the diameter of the sphere.



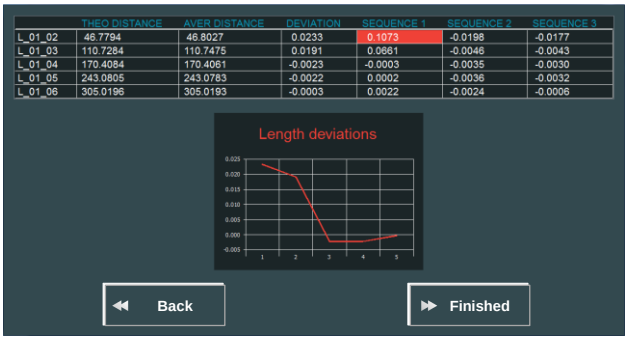


- Steps 2 to 8 : Size Test :

Measure the 7 sets of 5 lengths: for each, measure the 6 points 3 times (18 Points):



At the end of the step, RDS Data Collector shows the deviations



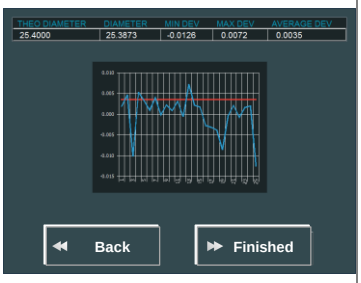
Theoretical distance	Value entered on step1.
Average distance	Measured average distance from the 3 measurements on the 2 steps of the artefact.
Deviation	Difference between the average measured distance and the theoretical distance.
Sequences (1/2/3)	Details of the 3 deviations between the measurement and theoretical values.
Maximum deviation	Is highlighted in Red.
Graphic	Shows the 5 average deviations.

Press “Finished” to go to next step, or “Back” if a mistake has been done.

- Step 9 to 11: measure the sphere at the 3 locations with the 5 x 5 specified points.

At the end of each step, RDS Data Collector shows the deviations

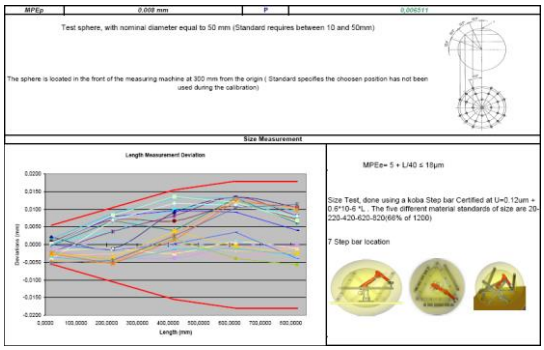
Theoretical diameter	Value entered on step1
Diameter	Measured diameter (least square)
Min / Max deviations	Extreme deviations from the 25 points and the theoretical diameter (based on the calculated best-fitted sphere center)
Graphic	Shows the deviations of all the 25 points, and mean value.



Press “Finished” to go to next step, or “Back” if a mistake has been done.

Check if all results are fitting with the specifications of the measuring system. If they do not, please contact your calibration center.

- Step 12 (Report) : generates an Excel Report

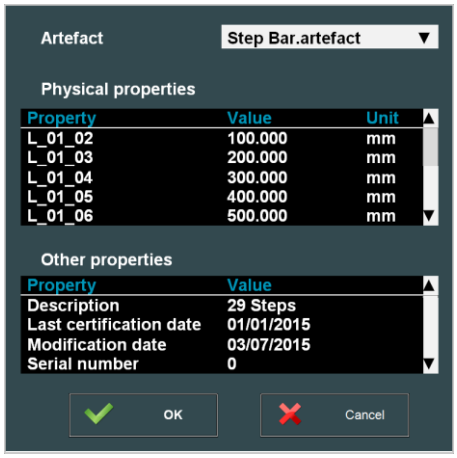


E.2.4 VDIVDE Step Bar certification

This script is designed the standard script for VDIVDE using a Step bar

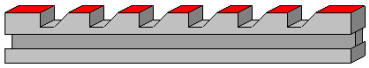
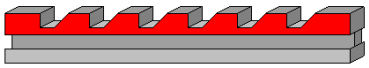
- Step 1: Nominal values of the artefact

Select the artefact and / or enter the 5 distances and the diameter of the sphere.

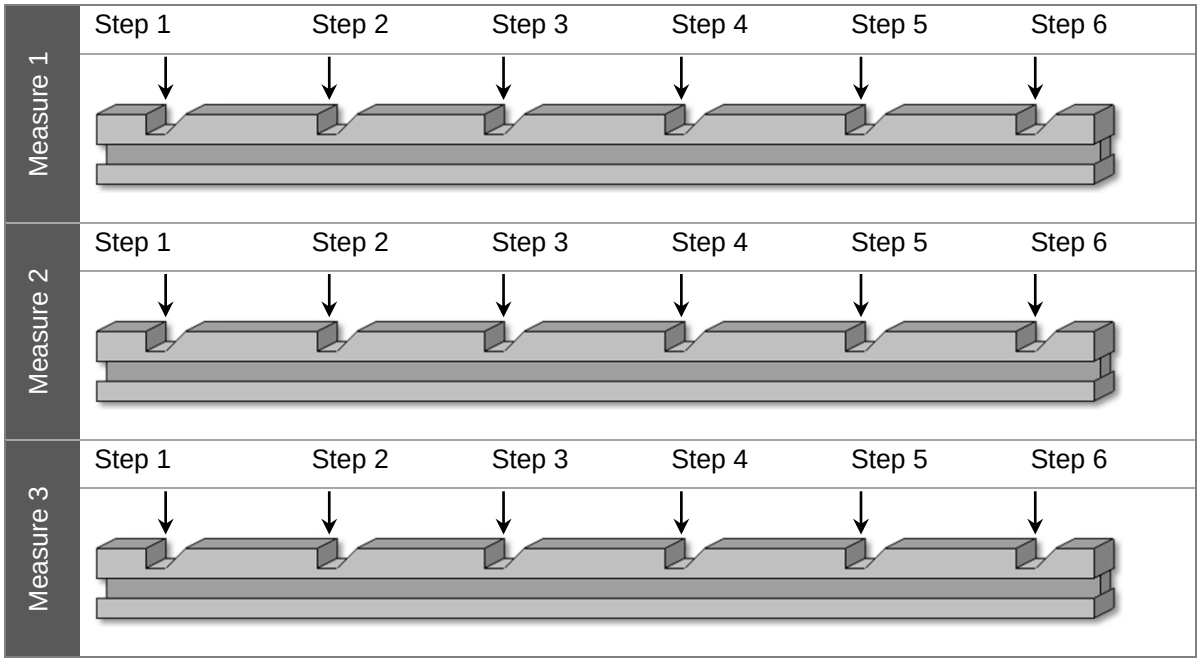


- Steps 2 to 8 : Size Test :

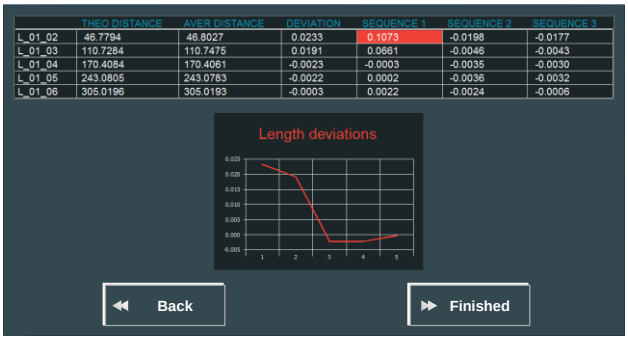
Measure the 7 sets of 5 lengths: for each:

measure first Top plane (4 points)	
measure then side plane (4 points)	

Then measure the 6 steps 3 times (18 Points):



At the end of the step, RDS Data Collector shows the deviations



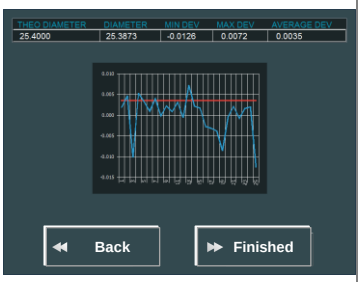
Theoretical distance	Value entered on step1.
Average distance	Measured average distance from the 3 measurements on the 2 steps of the artefact.
Deviation	Difference between the average measured distance and the theoretical distance.
Sequences (1/2/3)	Details of the 3 deviations between the measurement and theoretical values.
Maximum deviation	Is highlighted in Red.
Graphic	Shows the 5 average deviations.

Press “Finished” to go to next step, or “Back” if a mistake has been done.

- Step 9 to 11: measure the sphere at the 3 locations with the 5 x 5 specified points.

At the end of each step, RDS Data Collector shows the deviations

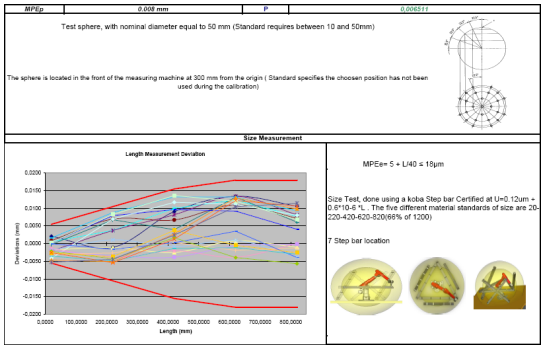
Theoretical diameter	Value entered on step1
Diameter	Measured diameter (least square)
Min / Max deviations	Extreme deviations from the 25 points and the theoretical diameter (based on the calculated best-fitted sphere center)
Graphic	Shows the deviations of all the 25 points, and mean value.



Press “Finished” to go to next step, or “Back” if a mistake has been done.

Check if all results are fitting with the specifications of the measuring system. If they do not, please contact your calibration center.

- Step 12 (Report) : generates an Excel Report



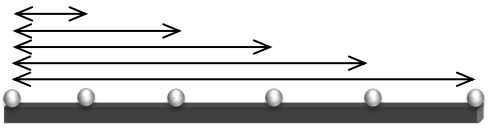
E.3 ISO 10360 Certification (Arm)

E.3.1 ISO 10360 Positions

Length test : Rules

- 7 Locations of Length gage
- 5 different lengths on gage

  - Greatest length at least 66% of useful measurement range
  - Shortest length less than 30mm



- For each location , 3 measurement of the 5 lengths

  - 1st measurement : Pt0 Elbow Left – Pt1 Elbow Right
  - 2nd Measurement : Pt0 Elbow Right – Pt1 Elbow Left
  - 3rd measurement : Pt0 Elbow Left – Pt1 Elbow Left

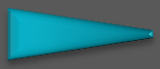
- Remesuring: maximum 5 of the 35 lengths may have one of the 3 values out of specs and then shall be remesured 10 times. All 10 have to be inside specifications.

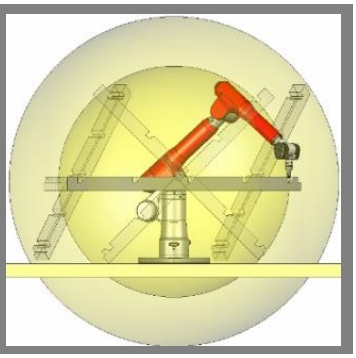
Length test artefact size

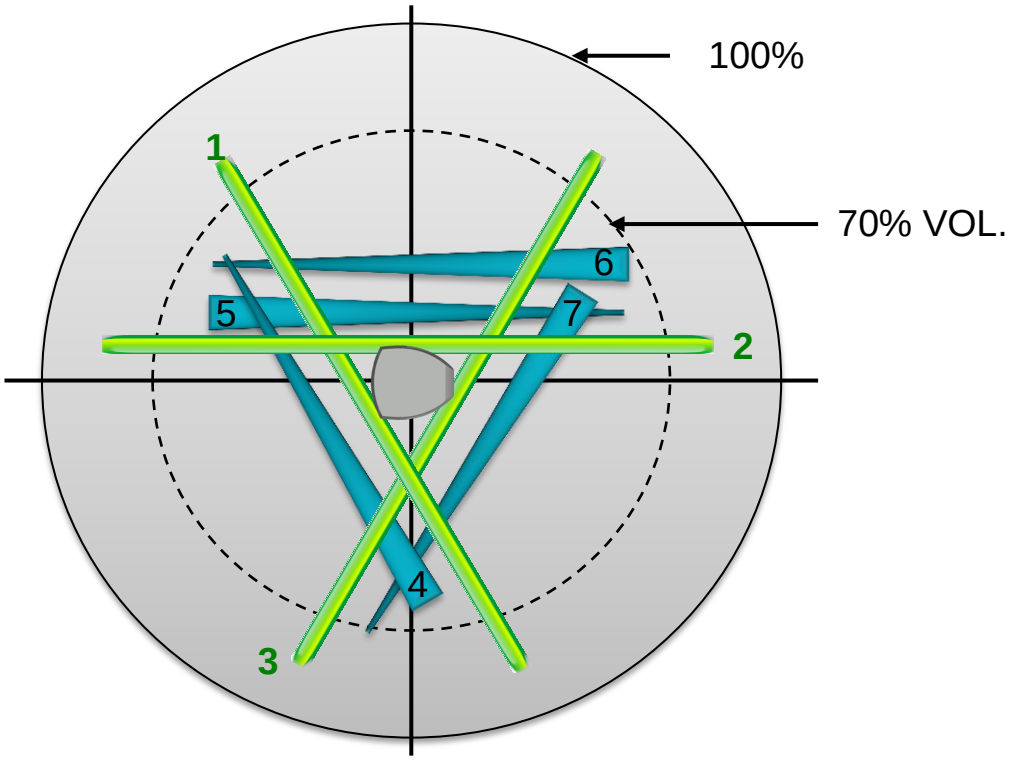
According to the size of arm, the greatest length must be at least 66 % of the measurement range. It means the following sizes:

Size of arm	Shortest length	Recommended Greatest length
1200	< 30mm	792mm
1500	< 30mm	1000mm
2000	< 30mm	1400mm
2500	< 30mm	1700mm
3000	< 30mm	2000mm
3500	< 30mm	2400mm
4000	< 30mm	2700mm
4500	< 30mm	3000mm

Locations of the gage

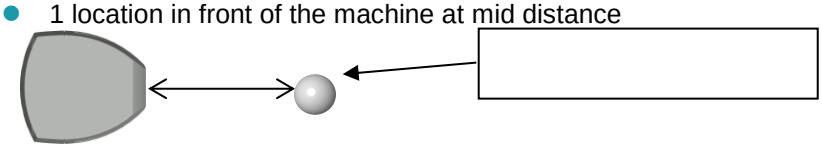
	Pos.	Bar inclination	Distance from Arm	Direction
	1	Horizontal	Near	Tangent
	2	Horizontal	Near	Tangent
	3	Horizontal	Far	Tangent
	4	45°	Near	Tangent
	5	45°	Near	Tangent
	6	45°	Near	Tangent
	7	45°	Near	Tangent





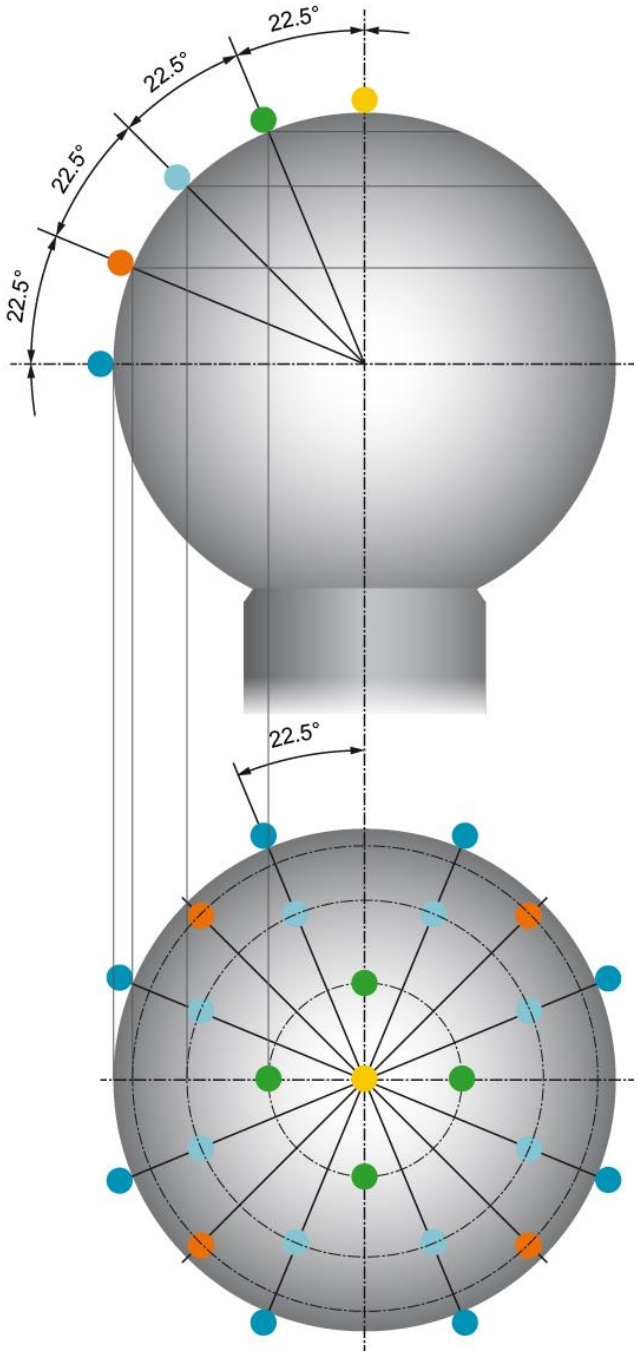
Sphere test :

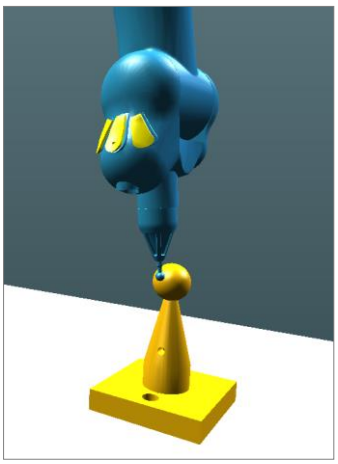
- 1 location in front of the machine at mid distance



- Sphere diameter between 10 and 50mm
- 25 Points on the sphere (see Fig)

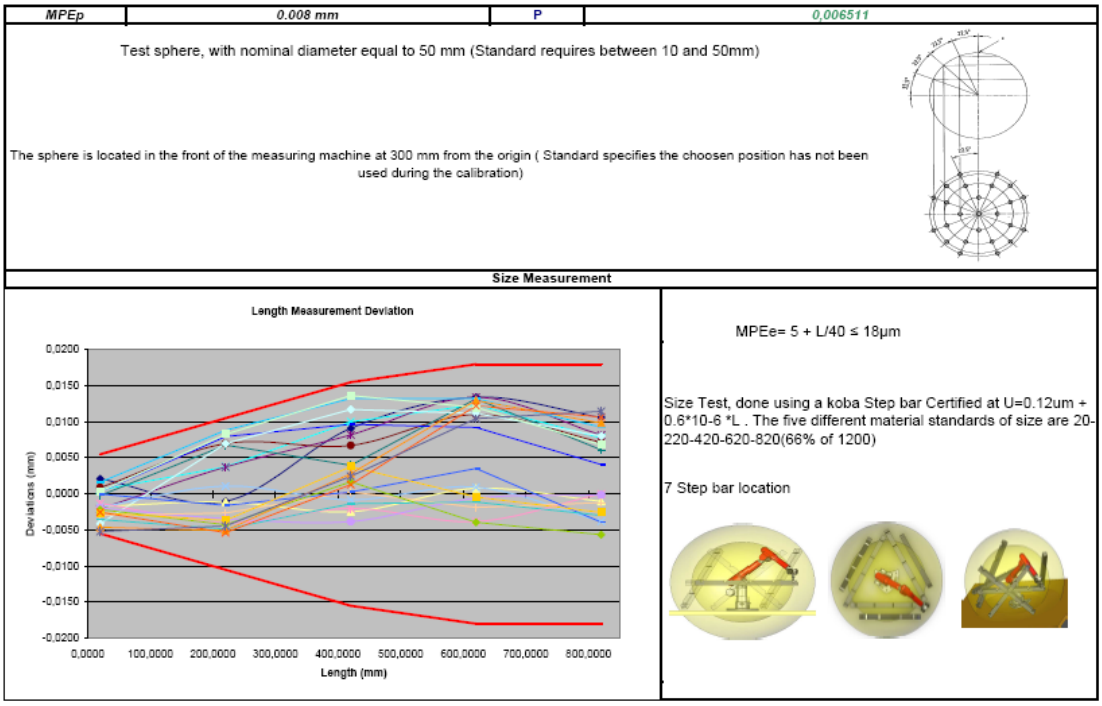
1 Pt on Pole
4 Pts 22.5° below Pole
8 Pts 45° below pole and rotated 22.5° from previous group
4 Pts 67.5° below pole and rotated 22.5° from previous group
8 Pts on equator, and rotated 22.5° from previous group





Results

At the end of the process, RDS generates a report including the results.



On this report, are shown:

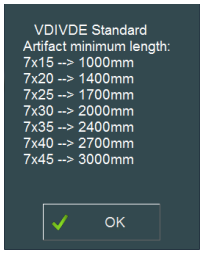
- **Sphere test results :**
  - MPEp (Maximum Permissible Error for Probing) value and P value (Probing value) : P must be less than MPEp
  - Nominal sphere diameter.
- **Size Test**
  - Graphic with MPEe (Maximum Permissible Error for Size) curve and all E values (lengths deviations): all deviations must be within MPEe graphic.
  - MPEe definition and characteristics of the artefact.

E.3.2 ISO 10360 Ball Bar certification

This script is designed for the ISO 10360 standard using a ball bar

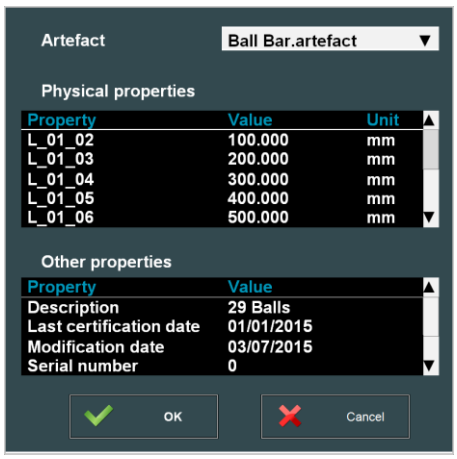
- Preliminary step : reminder

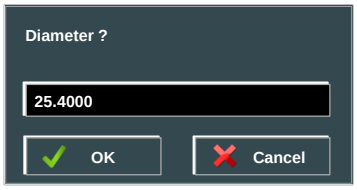
When entering the script or “Play all”, RDS DC reminds you about the minimum artefact lengths to use according to the size of arm:



- Step 1 : Nominal values of the artefact

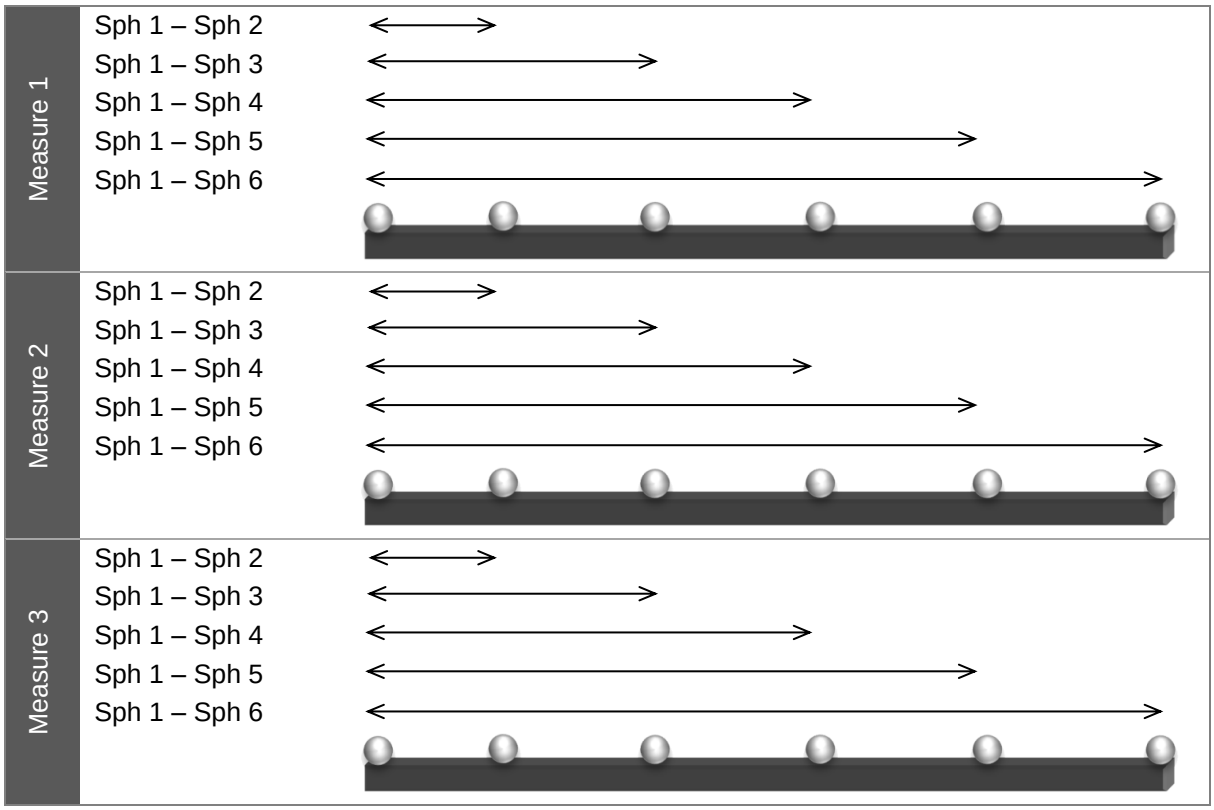
Select the artefact and / or enter the 5 distances and the diameter of the sphere.





Steps 2 to 8 : Size Test

Measure the 7 sets of 5 lengths: for each, measure the 5 distances 3 times (5 pts per sphere) (30 Spheres > 150 Pts):



At the end of each step, RDS Data Collector shows the deviations

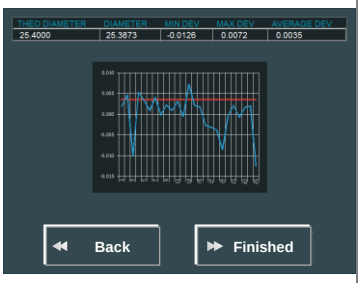
Theoretical distance	Value entered on step1.
Average distance	Measured average distance from the 3 measurements on the 2 steps of the artefact.
Deviation	Difference between the average measured distance and the theoretical distance.
Sequences (1/2/3)	Details of the 3 deviations between the measurement and theoretical values.
Maximum deviation	Is highlighted in Red.
Lengths Graphic	Shows the 5 average deviations.
Sphere Graphic	Shows the best-fit values of the 18 measured spheres.

Press “Finished” to go to next step, or “Back” if a mistake has been done.

- Step 9: measure the sphere with the 25 specified points.

At the end of the step, RDS Data Collector shows the deviations

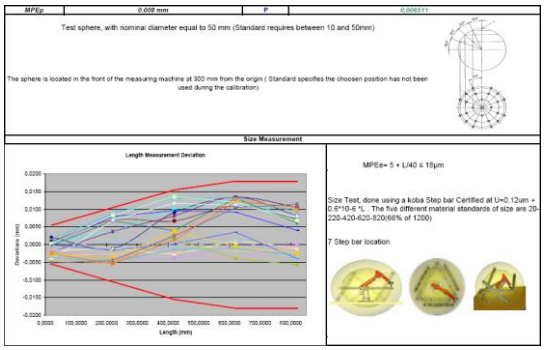
Theoretical diameter	Value entered on step1
Diameter	Measured diameter (least square)
Min / Max deviations	Extreme deviations from the 25 points and the theoretical diameter (based on the calculated best-fitted sphere center)
Graphic	Shows the deviations of all the 25 points, and mean value.



Press “Finished” to go to next step, or “Back” if a mistake has been done.

Check if all results are fitting with the specifications of the measuring system. If they do not, please contact your calibration center.

- Step 10 (Report) : generates an Excel Report

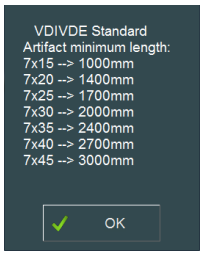


E.3.3 ISO 10360 Cone Bar certification

This script is designed for the ISO 10360 standard using a Cone bar.

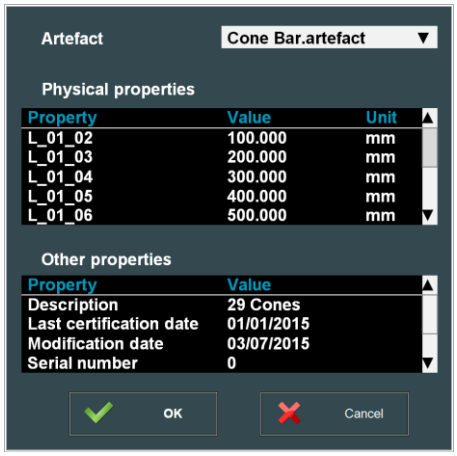
Preliminary step : reminder

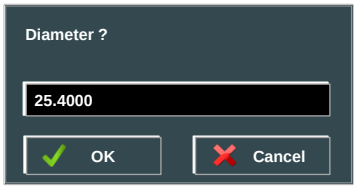
When entering the script or “Play all”, RDS DC reminds you about the minimum artefact lengths to use according to the size of arm:



Step 1: Nominal values of the artefact

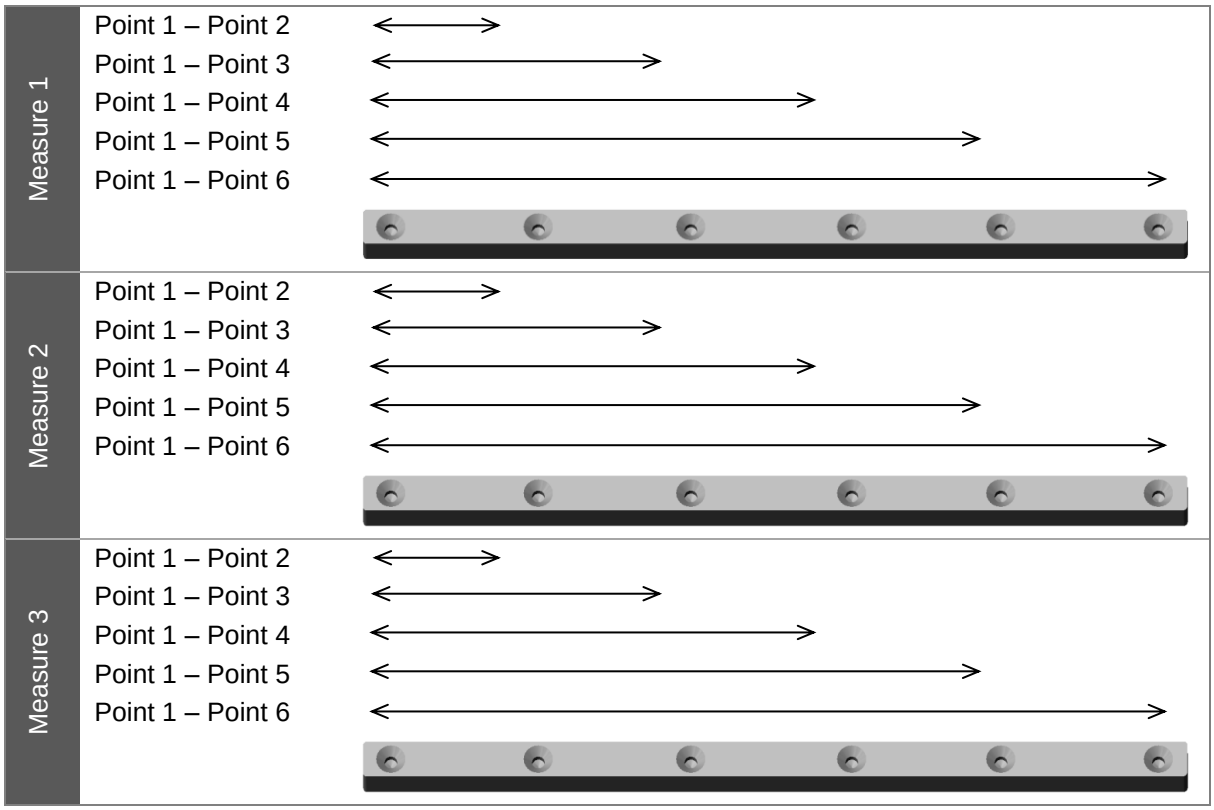
Select the artefact and / or enter the 5 distances and the diameter of the sphere.



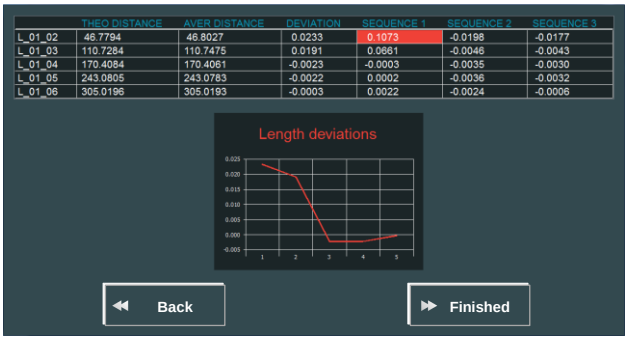


- Steps 2 to 8 : Size Test :

Measure the 7 sets of 5 lengths: for each, measure the 5 distances 3 times (30 Pts):



At the end of the step, RDS Data Collector shows the deviations



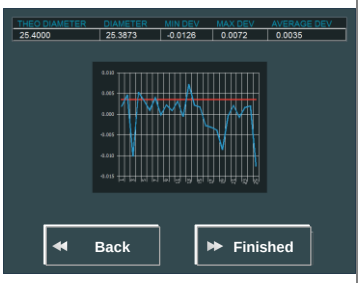
Theoretical distance	Value entered on step1.
Average distance	Measured average distance from the 3 measurements on the 2 steps of the artefact.
Deviation	Difference between the average measured distance and the theoretical distance.
Sequences (1/2/3)	Details of the 3 deviations between the measurement and theoretical values.
Maximum deviation	Is highlighted in Red.
Graphic	Shows the 5 average deviations.

Press “Finished” to go to next step, or “Back” if a mistake has been done.

- Step 9: measure the sphere with the 25 specified points.

At the end of the step, RDS Data Collector shows the deviations

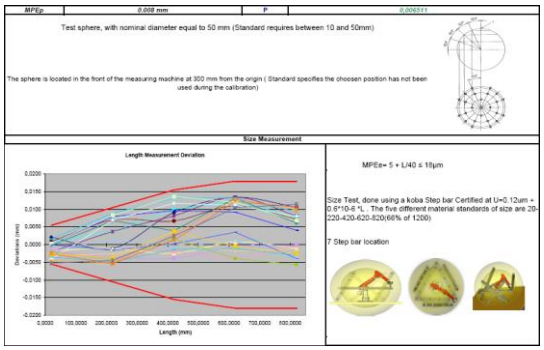
Theoretical diameter	Value entered on step1
Diameter	Measured diameter (least square)
Min / Max deviations	Extreme deviations from the 25 points and the theoretical diameter (based on the calculated best-fitted sphere center)
Graphic	Shows the deviations of all the 25 points, and mean value.



Press “Finished” to go to next step, or “Back” if a mistake has been done.

Check if all results are fitting with the specifications of the measuring system. If they do not, please contact your calibration center.

- Step 10 (Report) : generates an Excel Report

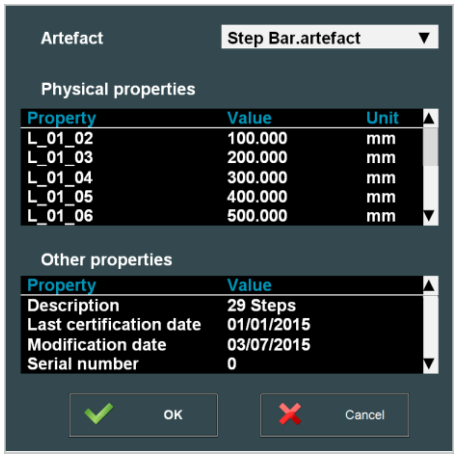


E.3.4 ISO 10360 Step bar certification

This script is designed for the ISO 10360 standard using a step bar

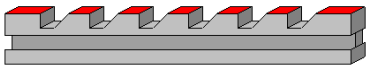
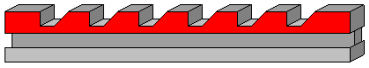
- Step 1: Nominal values of the artefact

Select the artefact and / or enter the 5 distances and the diameter of the sphere.

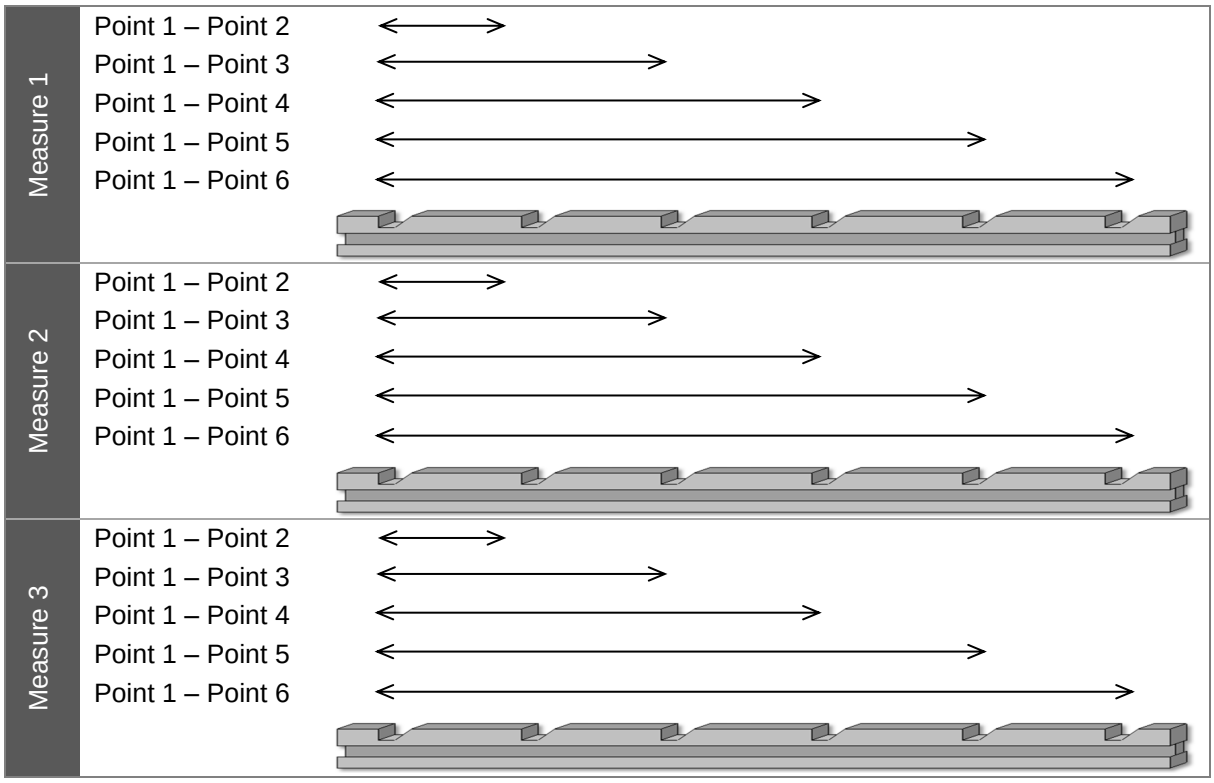


- Steps 2 to 8 : Size Test :

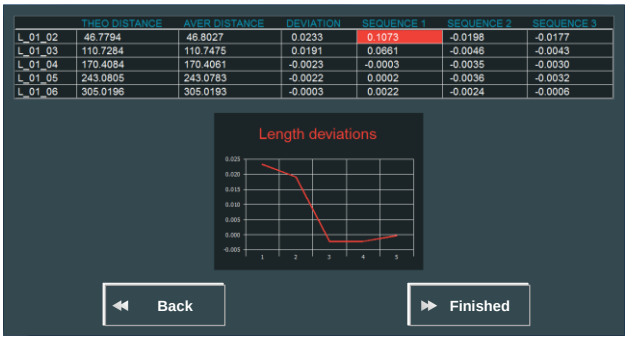
Measure the 7 sets of 5 lengths: for each:

measure first Top plane (4 points)	
measure then side plane (4 points)	

Then measure the 5 distances 3 times (30 Points):



At the end of the step, RDS Data Collector shows the deviations



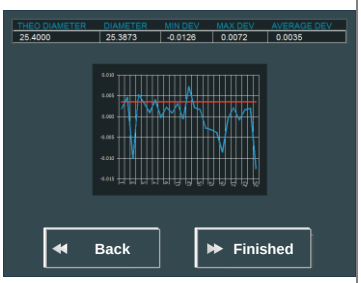
Theoretical distance	Value entered on step1.
Average distance	Measured average distance from the 3 measurements on the 2 steps of the artefact.
Deviation	Difference between the average measured distance and the theoretical distance.
Sequences (1/2/3)	Details of the 3 deviations between the measurement and theoretical values.
Maximum deviation	Is highlighted in Red.
Graphic	Shows the 5 average deviations.

Press “Finished” to go to next step, or “Back” if a mistake has been done.

- Step 9 to 11: measure the sphere at the 3 locations with the 5 x 5 specified points.

At the end of each step, RDS Data Collector shows the deviations

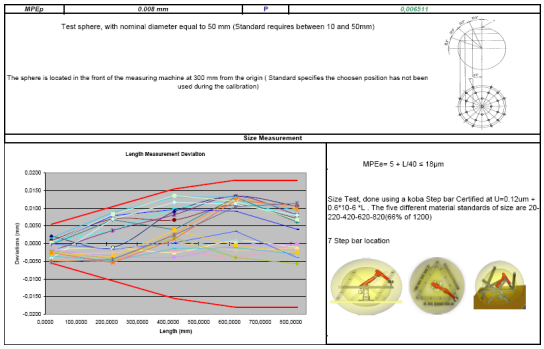
Theoretical diameter	Value entered on step1
Diameter	Measured diameter (least square)
Min / Max deviations	Extreme deviations from the 25 points and the theoretical diameter (based on the calculated best-fitted sphere center)
Graphic	Shows the deviations of all the 25 points, and mean value.



Press “Finished” to go to next step, or “Back” if a mistake has been done.

Check if all results are fitting with the specifications of the measuring system. If they do not, please contact your calibration center.

- Step 12 (Report) : generates an Excel Report

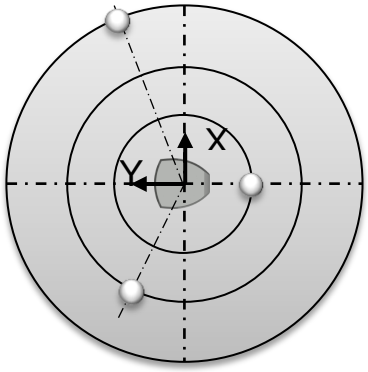


E.4 Scanner Check-Out (Arm)

E.4.1 Description

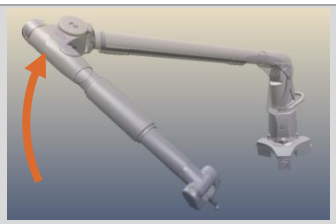
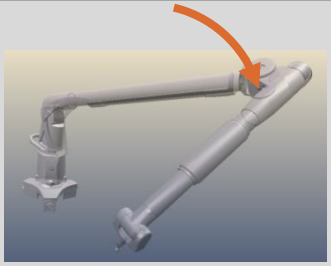
In order to check the accuracy of a scanner with the arm, a script is proposed, asking a sphere digitizing in 3 locations:

- 20 % of the measurement volume of the arm
- 50 % of the measurement volume of the arm
- 80 % of the measurement volume of the arm



For each place, several orientations of the arm and of the scanner are used to digitize the sphere

5 positions of the elbows of the arm:

Elbow right down	
Elbow right up	
Elbow vertical	
Elbow left up	
Elbow left down	

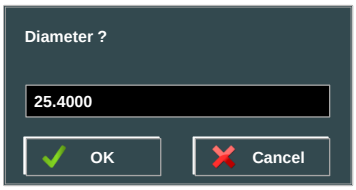
For each orientation of the elbow, 6 orientations of the scanner:

 Start at 45° on one side of the sphere	 Rotate F axis of 45° (vertical)	 Rotate once again F axis of 45°
 Return E axis of 180°	 Rotate F axis of 45° (vertical)	 Rotate once again F axis of 45°

E.4.2 Procedure

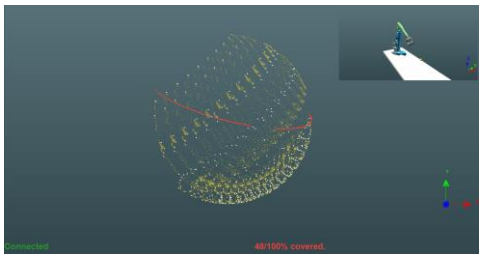
Run certification script “Scanner CheckOut.sc”

- Step 1: Nominal diameter of the artefact



- Step 2: Scan the sphere from the 3 locations.

For each location, use the 6 angles of scanner for each of the 5 orientations of the arm. Validate for each orientation of the arm (5 sub-spheres).



At the end of each step, RDS Data Collector shows the deviations

	3D distances
Name (x-y)	Spheres implied
3D distance	Deviation between each of the 5 sub spheres (all combinations).

	▼ Results on the global sphere, using all sub spheres together	▼ Results on each sub sphere alone	
X;Y;Z	✓		Coordinates of the digitized sphere
Max	✓	✓	Maximum error to the digitized sphere
Stddev	✓	✓	Standard deviation of all the errors
Theo Diameter	✓	✓	Nominal diameter of the artefact
Diameter	✓	✓	Calculated diameter of the digitized sphere
Deviation	✓	✓	Error of the diameter value
Rejected %		✓	% of the points rejected for the calculation (points digitized not on the artefact)

Check if all results are fitting with the specifications of the measuring system. If they do not, please contact your calibration center.

F. DIAGNOSTIC SCRIPTS

This script tab is used to quickly check the arm without doing a complete certification.

Notice that the result given by a diagnostic cannot be used as a checking report. This is only used to diagnose quickly. These tests have to be interpreted by the user.

F.1 Probing tests

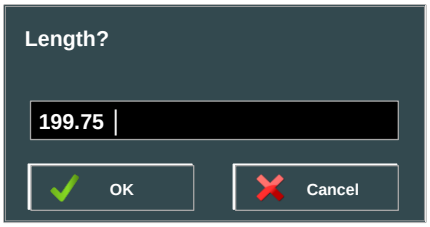
F.1.1 Probing quick check

The purpose of this script is to check the accuracy of the system using B89 concept: 3 steps are used:

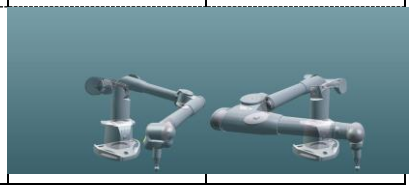
- one length measurement using a calibration bar (volumetric test)
- one cone measurement (single point test)
- one sphere measurement

Step 1 : Volumetric Performance Test:

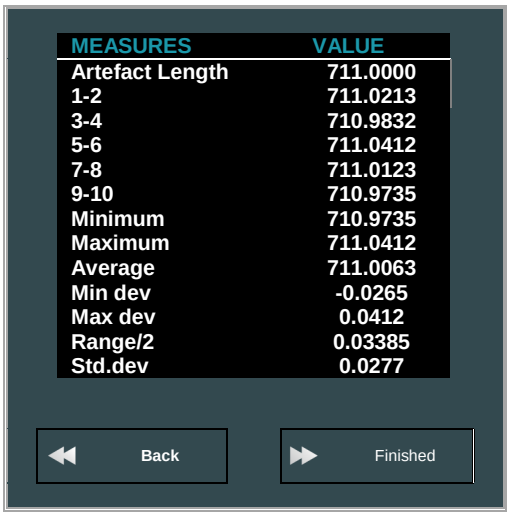
1. Enter the length value that will be used



2. Measure 5 times the length bar, moving each time the elbow of the arm

Mes1 : Elbow left	Mes2: Elbow up	Mes3 : Elbow right	Swap the Wrist of the arm	Mes4 : Elbow right	Mes5 : Elbow left
					

3. RDS Gives the deviations



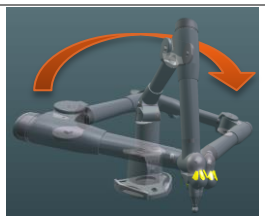
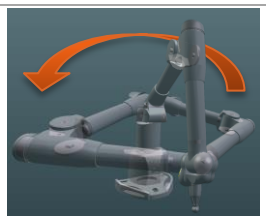
Then press “Back” to measure again or “Finished” to proceed with the next step.

Step 2 : Single point test

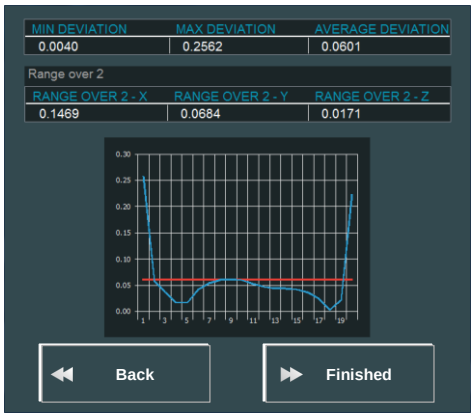
1. Measure the 10 points on a seat (cone) moving the axes of the arm as following :
   - ✓ Pt1 : Elbow left down
   - ✓ Pt2 : Elbow left up
   - ✓ Pt3 : Elbow up
   - ✓ Pt4 : Elbow right up
   - ✓ Pt5 : Elbow right down

Twist wrist 180° then same positions:

   - ✓ Pt6 : Elbow left down
   - ✓ Pt7 : Elbow left up
   - ✓ Pt8 : Elbow up
   - ✓ Pt9 : Elbow right up
   - ✓ Pt10 : Elbow right down

• Pt1 : Elbow left down • Pt2 : Elbow left up • Pt3 : Elbow up • Pt4 : Elbow right up • Pt5 : Elbow right down	
Twist wrist 180° then same positions :	
• Pt6 : Elbow left down • Pt7 : Elbow left up • Pt8 : Elbow up • Pt9 : Elbow right up • Pt10 : Elbow right down	

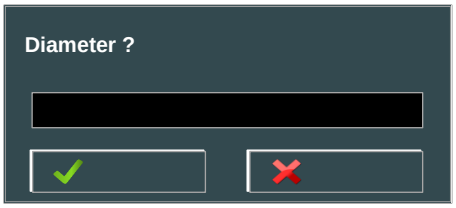
RDS gives single point deviations:



Then press “Back” to measure again or “Finished” to proceed with the next step.

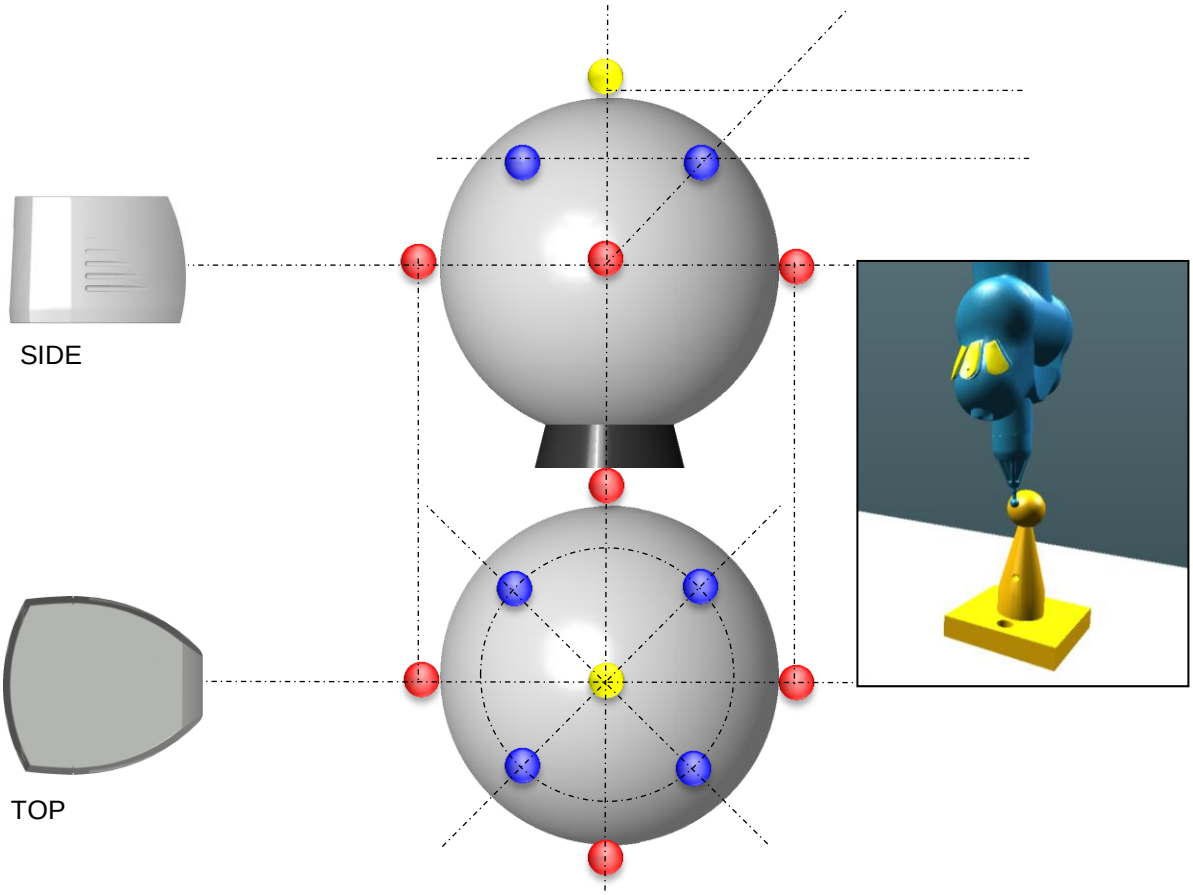
Step 3 : Sphere diameter test :

Enter the diameter of the sphere.



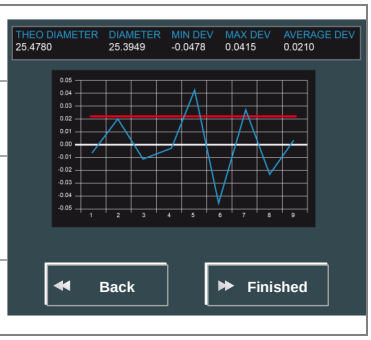
Measure 9 on the sphere as followed:

- 4 points on Equator equally distributed
- 4 points at 45° Latitude, equally distributed, 45° rotated from Equator points
- 1 point on Top



RDS gives diameter deviations:

Theoretical diameter	Value entered on step1
Diameter	Diameter of the measured sphere (least squares)
Min / Max deviations	Extreme deviations from the 9 points and the theoretical diameter (based on the calculated best-fitted sphere center)
Graphic	Shows the deviations of all the 9 points, and mean value.

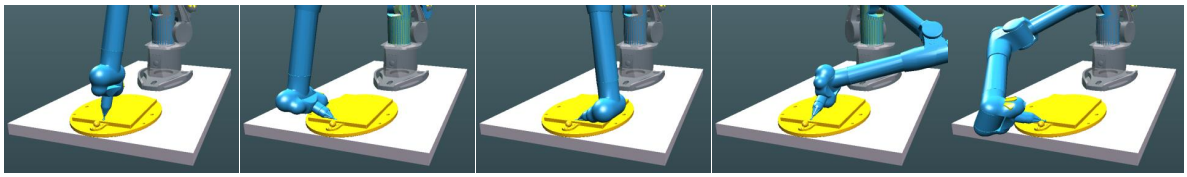


Then press “Back” to measure again or “Finished” to proceed with the next step.

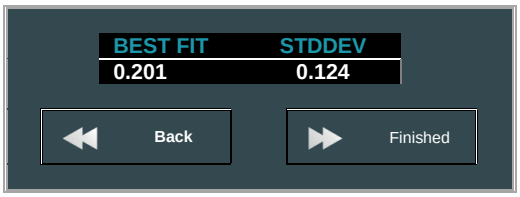
- Step 4 : plane test

This test consists by measuring a levelled plane by 9 points, and then the best-fit of the measured plane is displayed.

The purpose is to give different orientations of the axes of the arm for each point.



Then RDS gives the flatness results:



Press “Back” to measure again or “Finished” to end the Quick Check.

F.2 Scanner test

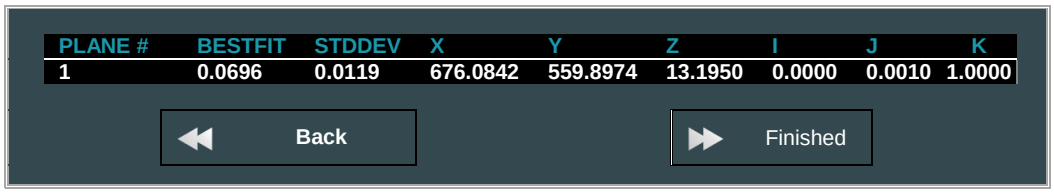
F.2.1 Scanner quick check

This diagnostic script can be used to combine plane, sphere, and distance test on a scanner.

Plane test

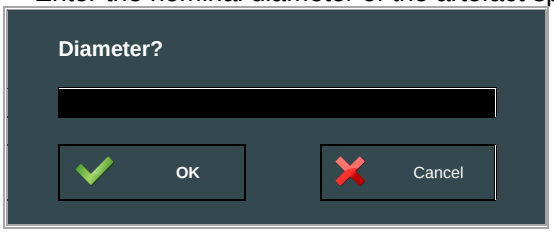
Take stripes on the artefact plane, giving several orientations to the scanner,

Then RDS gives these deviations of the single plane.



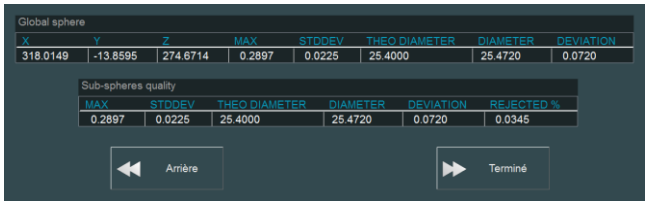
Sphere test

- Enter the nominal diameter of the artefact sphere



- Then scan the sphere, giving several orientations to the scanner.

- RDS shows the errors

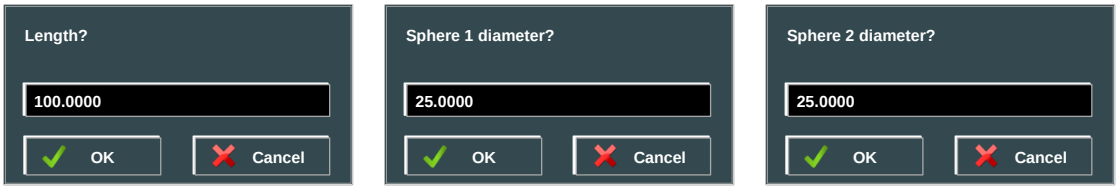


	▼ Results on the global sphere, using all sub spheres together ▼ Results on each sub sphere alone		
X;Y;Z	✓		Coordinates of the digitized sphere
Max	✓	✓	Maximum error to the digitized sphere
Stddev	✓	✓	Standard deviation of all the errors
Theo Diameter	✓	✓	Nominal diameter of the artefact
Diameter	✓	✓	Calculated diameter of the digitized sphere
Deviation	✓	✓	Error of the diameter value
Rejected %		✓	% of the points rejected for the calculation (points digitized not on the artefact)

In the present case, there is only one sub sphere, thus global sphere and sub sphere are identical.

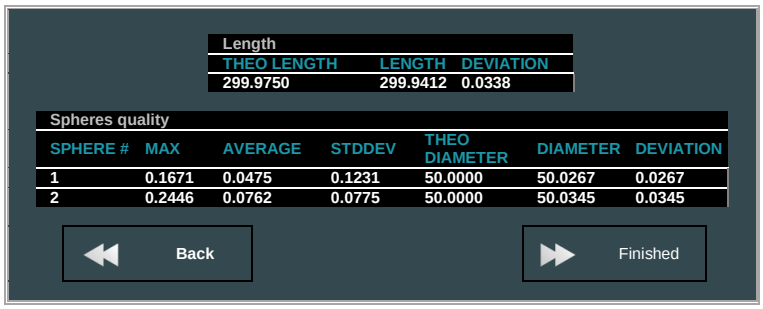
Distance test

1. Use a calibrated ball bar.
2. Enter the nominal distance between the spheres and the nominal diameter of each sphere.



3. Then scan both spheres (don't forget to validate each sphere with the right button (BP2)).

4. RDS shows the errors on the length and on each sphere.

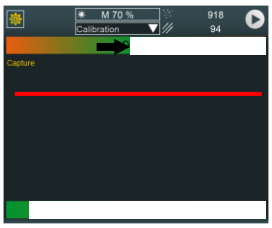


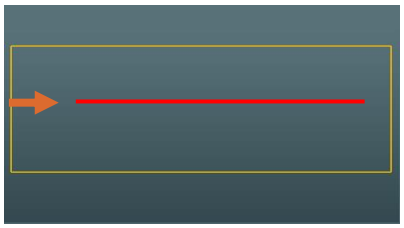
F.2.2 Scanner – 3 planes distance

A deeper test for scanners can be used to investigate on scanning loss of accuracy, consisting by scanning an artefact plane 3 times :

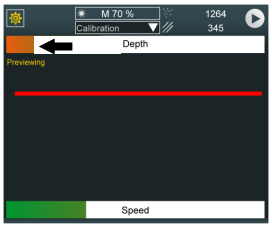
- 1 middle position
- 1 near position
- 1 far position.

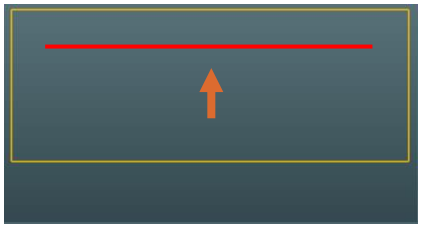
1. Select and run the script
2. Digitize the plane, keeping the scanner at a mid-range distance from the plane, with one orientation only. Press Next or use BP2 to proceed next sub-step



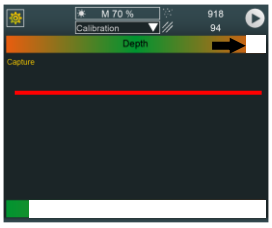


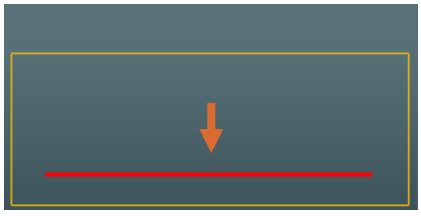

3. Digitize again the plane, keeping the scanner near from the plane, with the same unique orientation as before. Press Next or use BP2 to proceed next sub-step



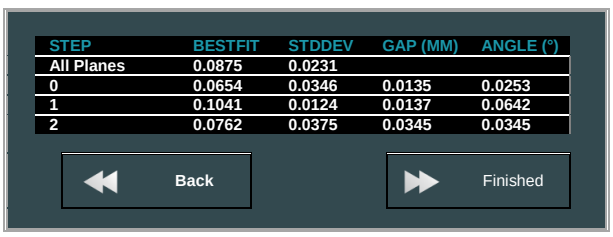



4. Digitize again the plane, keeping the scanner far from the plane, with the same unique orientation as before. Press Next or use BP2 to proceed next sub-step





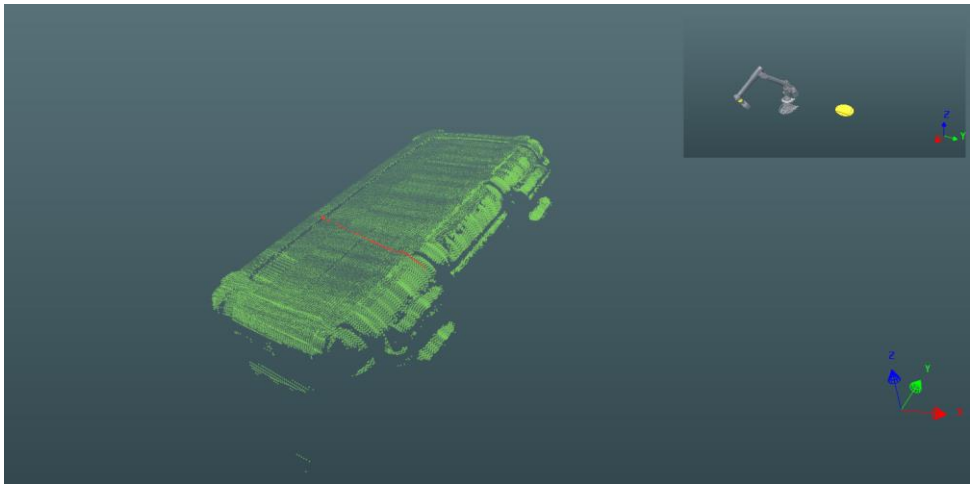

5. Once the 3 planes are digitized, RDS shows the errors of each plane and the deviations between each plane and the global one.



F.2.3 Scanner – Digitize

In case the measurement software doesn't contain any RDS plug-in to scan directly in, or if the final software is not available, the digitizing can be performed inside RDS Data Collector: a special script is available for simply digitize and export a cloud of points.

Simply run the script then proceed to the scan.

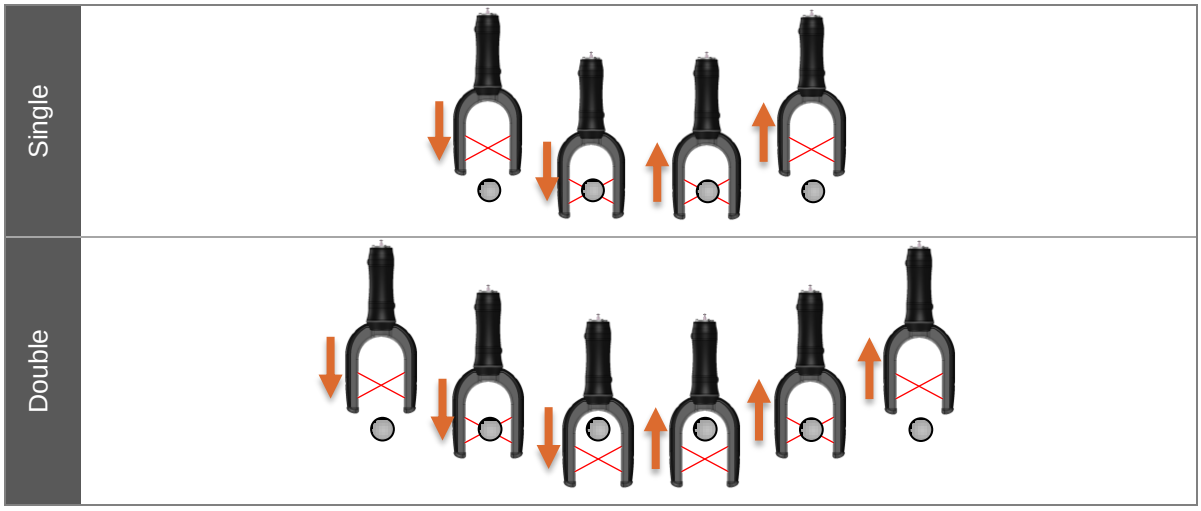


A second execution of the script overwrites the existing data. Only end the scan once you are certain not to forget data or export the existing data before run again.

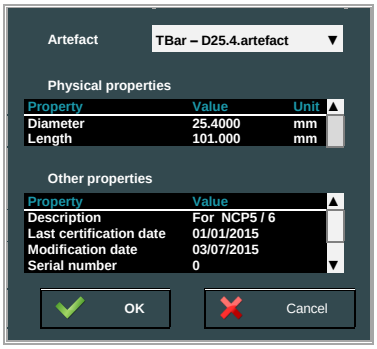
F.3 Non-contact tube probe test

F.3.1 Non-contact probe quick check

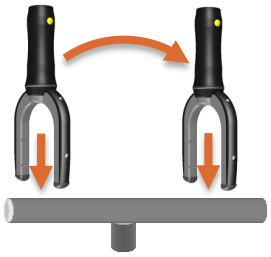
This simple checkout consists by checking the length of a straight tube. 1 script is available for each mode:



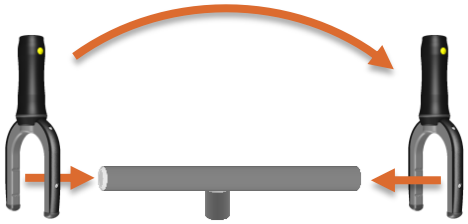
1. Select the artefact and / or enter the diameter and length of the T-bar.



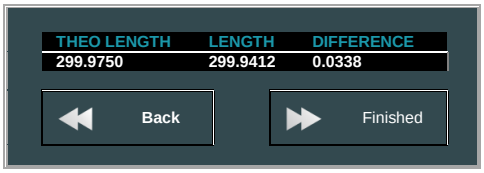
2. Measure the 1st side of the straight then the 2nd side



3. Measure the 1st end of the tube then the 2nd end



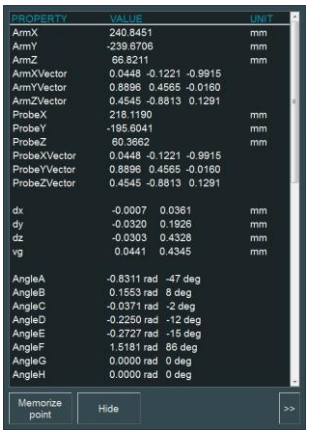
4. RDS displays the measured length



G. EXTENDED FEATURES

G.1 Arm status

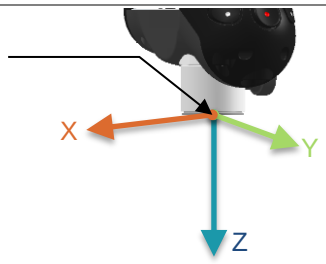
At every moment, it's possible to have details about data coming from RDS Service. To do this, press the button "Arm Status".

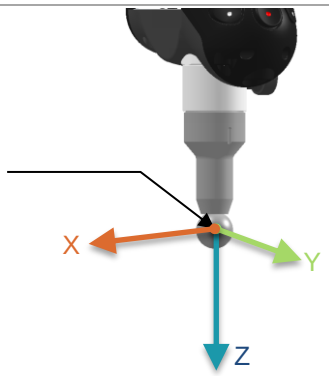


Arm status dialog box provided these values:

- Real-time 3D positions of

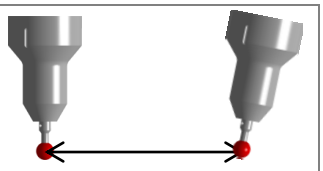
ArmX ArmY ArmZ	Coordinates of the Probe Junction according to the arm coordinates system.
ArmXVector ArmYVector ArmZVector	Cartesian coordinates of each vector components of the probe junction according to the arm coordinates system. (for each, U / V / W components)
ProbeX ProbeY ProbeZ	Coordinates of the Probe tip (center of the ball) according to the arm coordinates system.
ProbeXVector ProbeYVector ProbeZVector	Cartesian coordinates of each vector components of the probe tip according to the arm coordinates system. (for each, U / V / W components)





- Distance between memorized point and current point.

Dx Dy Dz	Components values of the distance. (Real time / Max)
vg	True position distance (Real time / Max)



To memorize a point, press main button (BP1)

- Arm axes angles

AngleA AngleB AngleC AngleD AngleE AngleF AngleG AngleH	Absolute angles values of each encoder of the arm, in radians and degrees. (α rd ; α°)

- Encoder raw values

EncoderA EncoderB EncoderC EncoderD EncoderE EncoderF EncoderG EncoderH	Absolute raw angles values of each encoder of the arm.

- Probe information :

EventType	It represents the status of the arm (hexa code)
Buttons	Left, Middle and Right buttons binary status (BP0 / BP1 / BP2)
ExternalSwitch	External switch binary status (0 / 1)
Timstamp	
TriggerIndex	

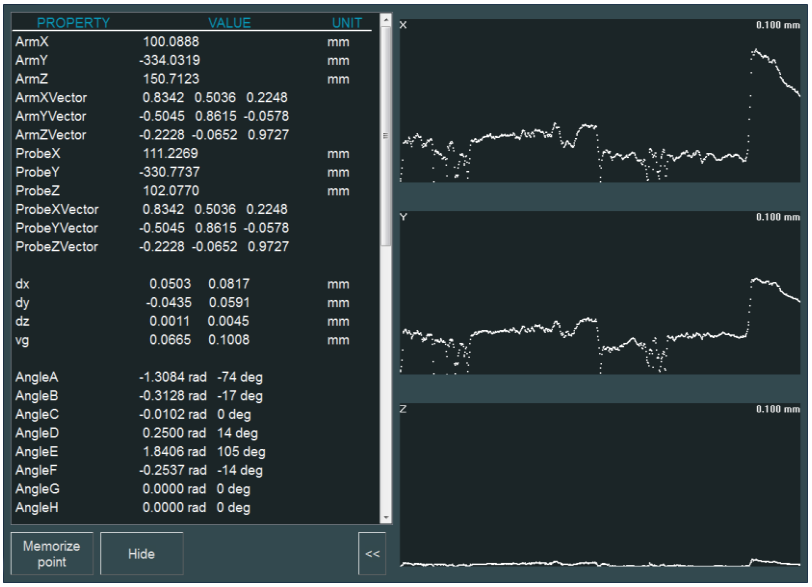
- Scanner information

NbScannerPoints	Number of points recognized by the scanner
NbValidScannerPoints	Number of point validated by the scanner after filtering
ScannerX	X coordinate of the laser line in the scanner reference (Min; Max; range)
ScannerY	Y coordinate of the laser line in the scanner reference (Min; Max; range)
ScannerZ	Z coordinate of the laser line in the scanner reference (Min; Max; range)
SystemX	X coordinate of the laser line in the arm reference (Min; Max; range)
SystemY	Y coordinate of the laser line in the arm reference (Min; Max; range)
SystemZ	Z coordinate of the laser line in the arm reference (Min; Max; range)
FirstScanPoint	Index and coordinates of the 1st valid point in the scanner reference
LastScanPoint	Index and coordinates of the last valid point in the scanner reference
FirstSysPoint	Index and coordinates of the 1st valid point in the arm reference
LastSysPoint	Index and coordinates of the last valid point in the arm reference
CMSDebugInfo.iVal	
CMSDebugInfo.iVal1	
CMSDebugInfo.iVal2	

Buttons

At the bottom of the screen, 3 buttons can be used:

Memorize point	or press arm middle button: to memorize the current point in this window.
Hide	to close this window.
>>	opens a second part of the window that displays the real time points on each axis X, Y, and Z (then "<<" hides these graph).



The graph represents the real time deviation of the current point of the center of the probe to the memorized one, in X, Y and Z axes.

The scale of the graphic view is auto-adjusted according to the max deviation.

To reset the graph and the scale, press main button (BP1) to memorize a new point.

G.2 Analysis mode

G.2.1 Introduction

In a normal way of using RDS Data Collector, when a script is executed, capturing mode is used: when a point has to be taken, the user must take a point with the measuring device.

With Level 1 installation, it is possible to use the previous taken points instead of new points, and then see one by one the previous points.

This mode has been realized to help user understanding calibration results. Analysing mode allows replaying an already done calibration without modifying original calibration files.

It means that points don't need to be remeasured.

Even Arm connection is not necessary.

For Example: B89 verification has been done and shows that the arm needs a recalibration. Once recalibration has been done, new configuration files have been generated then it is possible to reedit the B89 test without remeasurement: all measurements have been already memorized, and can be used to get results after recalibration.

Any measurement step can be simulated, using the previous data (previous axis information).

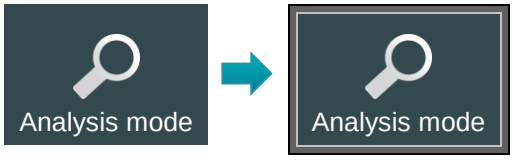
This mode is also useful to check if measurement positions have been correctly taken, by checking the colour of the axes for each position.

G.2.2 Switch to analysing mode

User switches to analysis mode by pressing the magnifying glass button.

If script is already running, stop it before switching mode.

To check if you are in analysis mode, look if the button is on or not



Off On

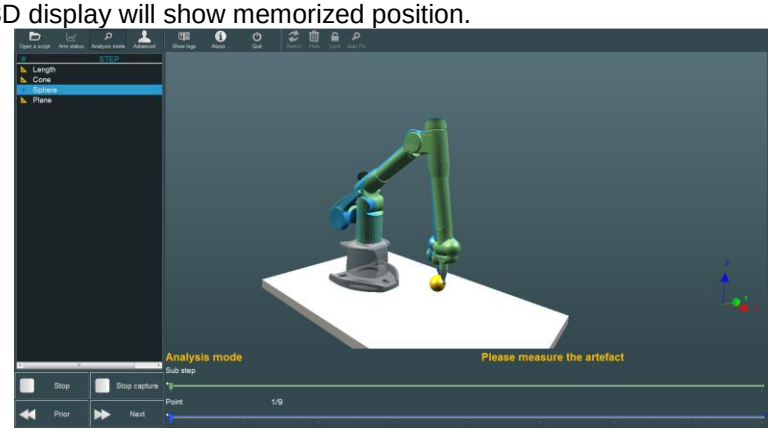
Also on the description zone, a warning reminds that the analysis mode is active:

Press once again this button to switch back to capturing mode.

G.2.3 Process

The process is the same as for Capture mode: the choice between Capture mode and analysing mode only depends if the button is on or off.

- Select and simply open the script
- Click on  to choose Analysis mode: the real time arm disappears from 3D view.
- Then execute one or all steps: RDS data collector will read the memorized file corresponding to current position.
- Then use the same way as “capture mode” to simulate taking or cancel points: instead of real time points, 3D display will show memorized position.



- In execute buttons

Prior	Can be used to jump to previous step
Next	Can be used to jump to next step.
Stop capture	Can be used to stop simulation, and shows directly result with previous measurements and new calibration.
Stop	Can be used to definitely stop the process

To navigate between taken points, use the bottom scrollbar below the 3D representation.

Go to forward points :

Go to backward points :

H. APPENDIX

H.1 Troubleshoot

H.1.1 Frequent questions

Calibration	
Calibration process gives very high errors	Check the regional settings: group separator must be “space” character and decimal symbol must be a dot.
Contact or Touch trigger Probe calibration gives a bad result	Check that the diameter of the stylus is correct.
When doing a machine calibration process, the “Measure repartition per axis” step shows the message 	Bad calibration files or old calibration files that don’t fit with the connected arm are still present on the calibration folder : Delete all old *.calib files in RDS\CalibData\ folder

H.1.2 Contact us

In case the problem could not be solved using the above help, please get all the following information and send to your local Hexagon Manufacturing Intelligence agent.

ARM ABSOLUTE	
Type	
Serial Number	
Your Company name	

SOFTWARE	
Software	☐ GPad ☐ GTube ☐ PCDMIS ☐ 3Dreshaper ☐ PowerINSPECT ☐ Metrolog ☐ PolyWorks ☐ Other
Version	

Connection		
Type	☐ USB	☐ Wifi
CPU Wifi IP@		
RDS Wifi IP @		

Accessories	
Scanner	
CPU IP@ for Scanner	
LEDs status	

Boards versions	
Mother Board	
Encoders boards	
Probe Board	

Diagnostic information	
Sounds	
Status of the LEDs	
Tests with different materials	
Ping answer	

H.2 Format of export files

H.2.1 PolyWorks point cloud (*psl)

H.2.2 ScanWorks point cloud (*.swl)

```
1→1.000000CRLF
ScanPass0→1→4067CRLF
Hexagon_ScannerCRLF
Hexagon_Scanner→1→981→0→0→0.000000→0.000000→0.000000→0.000000→0.000000→0.000000CRLF
411.790253→407.381775→110.880409CRLF
411.793823→407.428070→110.814781CRLF
411.795044→407.467316→110.721733CRLF
411.792694→407.479156→110.647804CRLF
411.795349→407.520264→110.562294CRLF
411.795441→407.531921→110.488716CRLF
411.801117→407.574524→110.410309CRLF
411.801819→407.585663→110.334618CRLF
411.807953→407.627350→110.252983CRLF
```

H.2.3 Ascii space separated point cloud (*.asc)

```
411.790253 407.381775 110.880409CRLF
411.793823 407.428070 110.814781CRLF
411.795044 407.467316 110.721733CRLF
411.792694 407.479156 110.647804CRLF
411.795349 407.520264 110.562294CRLF
411.795441 407.531921 110.488716CRLF
411.801117 407.574524 110.410309CRLF
411.801819 407.585663 110.334618CRLF
411.807953 407.627350 110.252983CRLF
```

H.2.4 Ascii ‘,’ separated point cloud (*.csv)

```
411.790253,407.381775,110.880409CRLF
411.793823,407.428070,110.814781CRLF
411.795044,407.467316,110.721733CRLF
411.792694,407.479156,110.647804CRLF
411.795349,407.520264,110.562294CRLF
411.795441,407.531921,110.488716CRLF
411.801117,407.574524,110.410309CRLF
411.801819,407.585663,110.334618CRLF
411.807953,407.627350,110.252983CRLF
```

H.2.5 Ascii ‘;’ separated point cloud (*.csv)

```
411.790253;407.381775;110.880409CRLF
411.793823;407.428070;110.814781CRLF
411.795044;407.467316;110.721733CRLF
411.792694;407.479156;110.647804CRLF
411.795349;407.520264;110.562294CRLF
411.795441;407.531921;110.488716CRLF
411.801117;407.574524;110.410309CRLF
411.801819;407.585663;110.334618CRLF
411.807953;407.627350;110.252983CRLF
```

H.2.6 XYZ points (cloud or probed) (*.xyz)

```
LH1CRLF
 411.790253 ; 407.381775 ; 110.880409CRLF
 411.793823 ; 407.428070 ; 110.814781CRLF
 411.795044 ; 407.467316 ; 110.721733CRLF
 411.792694 ; 407.479156 ; 110.647804CRLF
 411.795349 ; 407.520264 ; 110.562294CRLF
 411.795441 ; 407.531921 ; 110.488716CRLF
 411.801117 ; 407.574524 ; 110.410309CRLF
 411.801819 ; 407.585663 ; 110.334618CRLF
 411.807953 ; 407.627350 ; 110.252983CRLF
```

HEXAGON
MANUFACTURING INTELLIGENCE

Hexagon Manufacturing Intelligence helps industrial manufacturers develop the disruptive technologies of today and the life-changing products of tomorrow. As a leading metrology and manufacturing solution specialist, our expertise in sensing, thinking and acting – the collection, analysis and active use of measurement data – gives our customers the confidence to increase production speed and accelerate productivity while enhancing product quality.

Through a network of local service centres, production facilities and commercial operations across five continents, we are shaping smart change in manufacturing to build a world where quality drives productivity. For more information, visit HexagonMI.com.

Hexagon Manufacturing Intelligence is part of Hexagon (Nasdaq Stockholm: HEXA B; hexagon.com), a leading global provider of information technologies that drive quality and productivity improvements across geospatial and industrial enterprise applications.

H00002008 / rev08 – V4.1.0

USER MANUAL,RDS Data Collector