

Torino, 10th February 2020

Tangram Technical Note

Continuous Rotary Table

Rev.	Date	Change Reason
1	26-02-2020	First Release

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Overview

Since version 5.1 of Tangram, has been added the management of the 4th rotary axis, limited to Pantec control.

This new feature made is necessary to add a new configuration, new calibration procedure and new commands.

Requirements

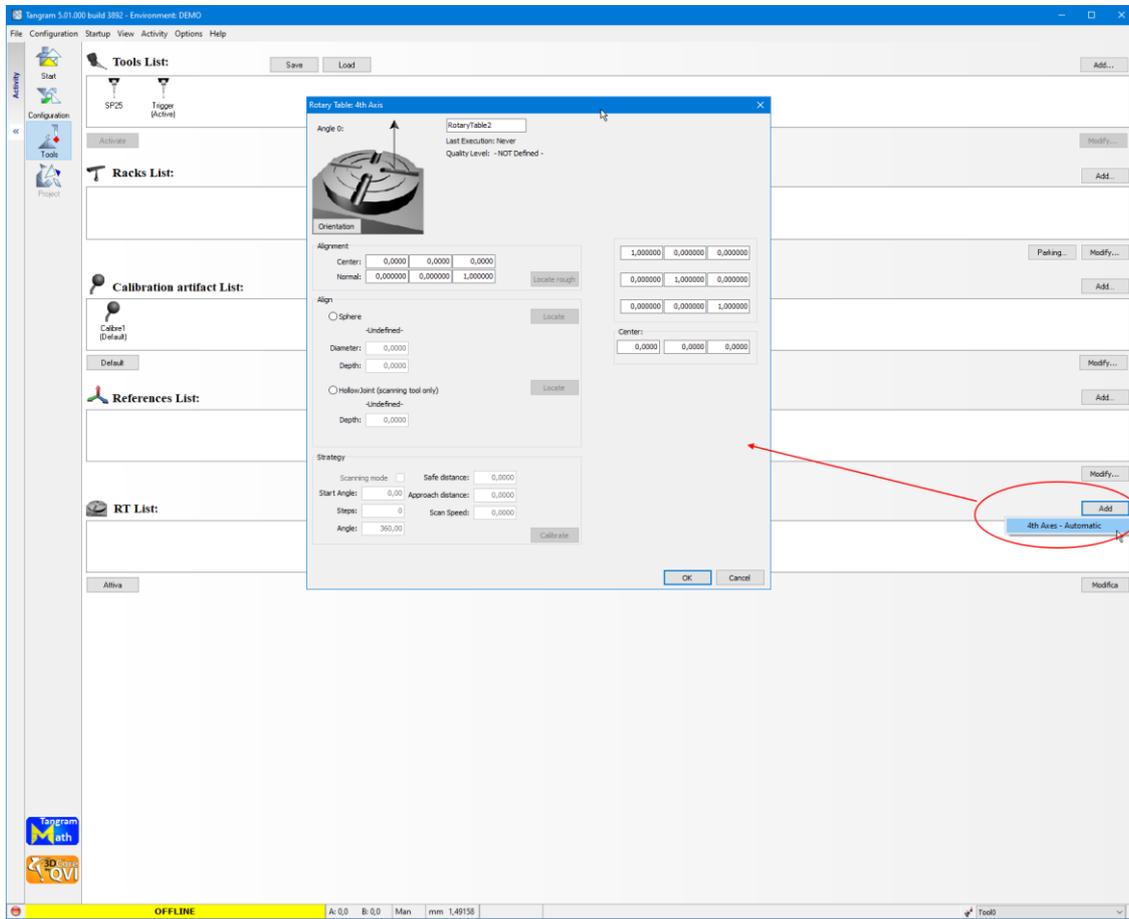
-
- Pantec Eagle PRO/4
- Pantec Firmware 31.4700005_20190923 or higher
- Tangram 5.1 or higher

Configuration in Tangram

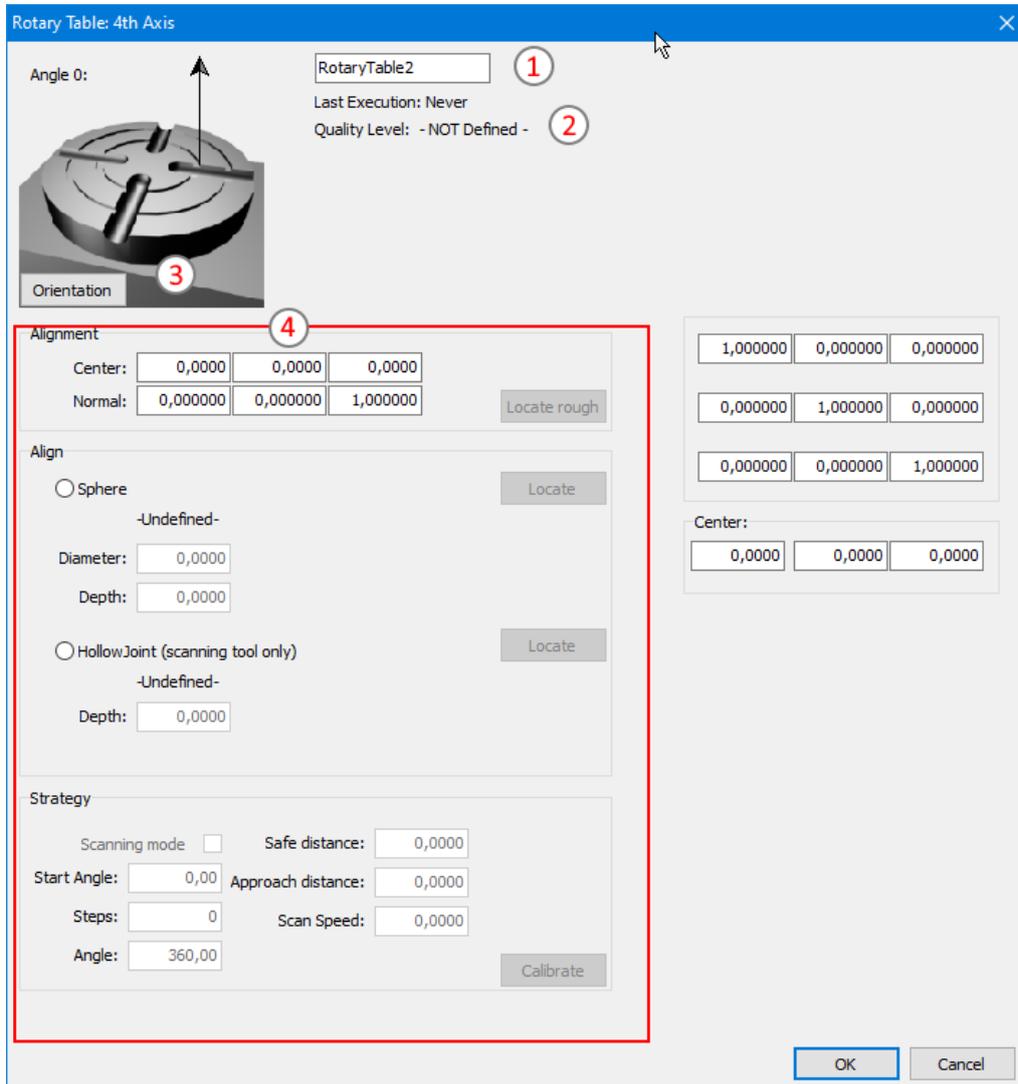
Add the Rotary Table (RT)

On the “Tools” panel there is a new entry.

Like for the others tools, the right button “Add” insert a new object.



Rotary Table Calibration



1: Name or the table

Just the mnemonic name of the table. It must be unique on the system.

2: Level of alignment

It shows the goodness of the alignment. It can be:

- "Not Defined": There are still no information where the table is located in the machine's volume..
- "Rough": only the first manual step is executed. The information is quite good to know where the table is, but absolutely insufficient for accurate measure.
- "Defined": The whole procedure is completed and the table alignment is defined (alignment procedure will be described later).

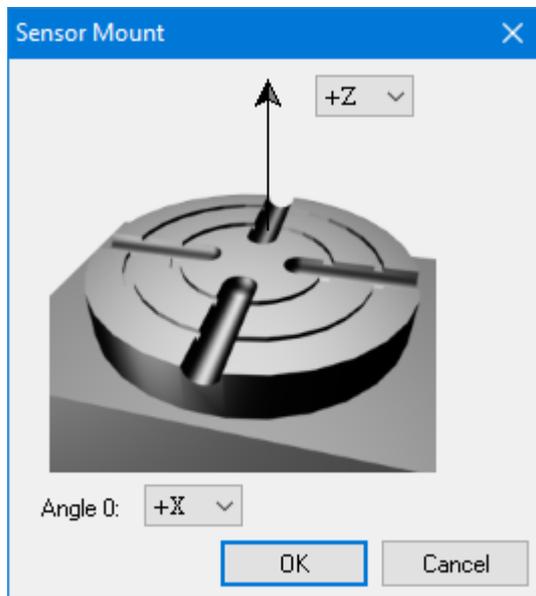
3: Mounting Orientation

It describes how the table is mounted on the machine.

It asks for two different axes, both must be defined using coordinate axes.

The primary axis indicates where the table is lying.

The secondary axis indicates along which axis the angle 0 is oriented.



4: Calibration Panel

It allows to calibrate the table (see next chapter).

Calibration of the table

To calibrate the table few steps are required in the following order:



The screenshot shows a software interface for table calibration, divided into three numbered sections:

- Step 1: Alignment**
 - Center: 454,8663, 67,6462, 39,4778
 - Normal: 0,000533, 0,000222, 1,000000
 - Button: Locate rough
- Step 2: Align**
 - Selected: Sphere
 - Coordinates: x: -15,6957; y: -51,7040; z: 56,4611
 - Diameter: 7,9997
 - Depth: 56,4603
 - Button: Locate
 - Selected: HollowJoint (scanning tool only)
 - Depth: 0,0000
 - Button: Locate
- Step 3: Strategy**
 - Scanning mode:
 - Safe distance: 10,0000
 - Start Angle: 0,00
 - Approach distance: 5,0000
 - Steps: 4
 - Scan Speed: 5,0000
 - Angle: 360,00
 - Button: Calibrate

1. Locate roughly the table by manual procedure (by joystick)
2. Locate a fixed element on the table in semi-automatic
3. Locate the table by an automatic procedure

Step1: Locate the table by manual procedure

In this phase it is required to measure the top plate of the table (by 3 points). After any point there is a feedback on the list.

After the plate, it requires to measure the external border of the circular plate (always by 3 points). After any point there is a feedback on the list.

At the end of the procedure, the table will be roughly positioned in the volume using the normal direction of the top plane and the center of the external circle.

There is not enough accuracy after this step, but good enough to continue in automatic during next steps.

Step2: Locate the fixed element (gauge)

Fixed element is a part on the table that rotate together with it and can be used to measure a known element in a known position with different angles.

During this step it is required to locate the gauge on the table by joystick.

There can be different kind of gauges used for this purpose. The procedure is prepared to support Sphere and Hollow Joint. At the moment, only the Sphere caliper is managed.

First of all, the table will ask to rotate at 0°. Take care the tips won't be damaged during the rotation: place the stylus higher than the sphere.

After the rotation it is required to touch the top of the sphere by joystick with the tip and the procedure will continue automatically.

Step3: Run the automatic calibration procedure

After the table position is roughly defined and the gauge is located, it is possible to proceed to run the complete procedure.

This procedure is completely automatic and will measure the fixed element at different angles computing the real center and the real orientation of the table.

Start Angle: the offset angle from the real position of the fixed element (at position 0° of the table) to the 1st measurement where the procedure starts.

Steps: the number of the steps required. More steps will increase the accuracy, but the required time to complete the procedure too.

Angle: the whole angle for the calibration. The steps will be distributed in this range. The best is 360°, but it could be configured with smaller angle for obstruction reason.

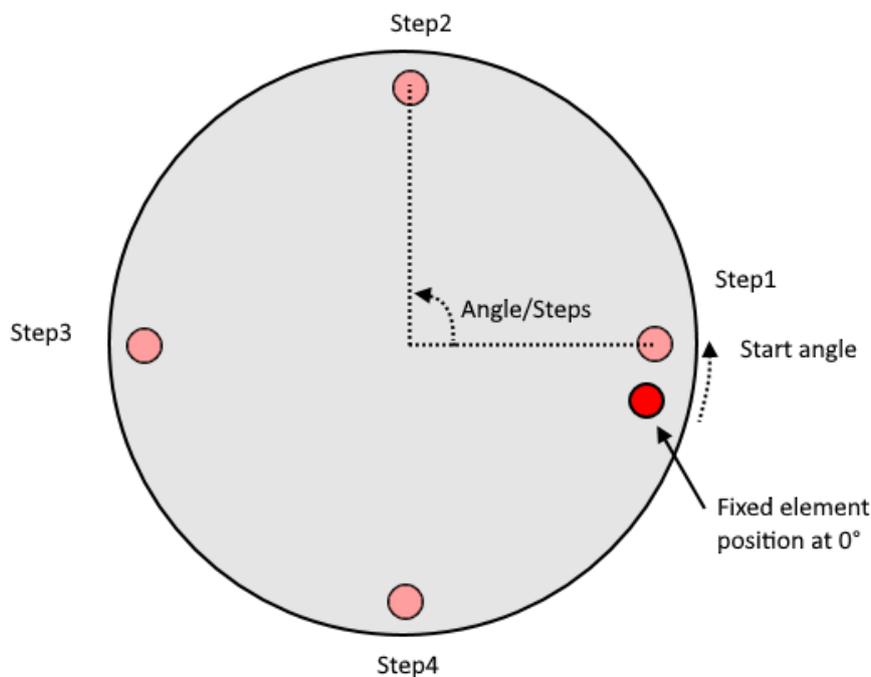
- If angle is 360°, at the end of the procedure the tip will be moved again to the 1st position

- if angle is less than 360°, the procedure will stop high above the last position.

Safe Distance: the distance from the top of the gauge, used when the table rotates.

Approach Distance: the distance used for pre-positioning during the gauge measurement cycle

Scan Speed: The speed used during the scanning. Still not used because the scanning is dedicated to the procedure that makes use of Hollow Joint gauge, still not available.



Machine Contexts / Rotary Table Context

In order to have the possibility to manage features on the rotary table (where the rotation effects their coordinates) and features related to the machine coordinate system (independent by the table angle), the concept of “**Context**” has been introduced.

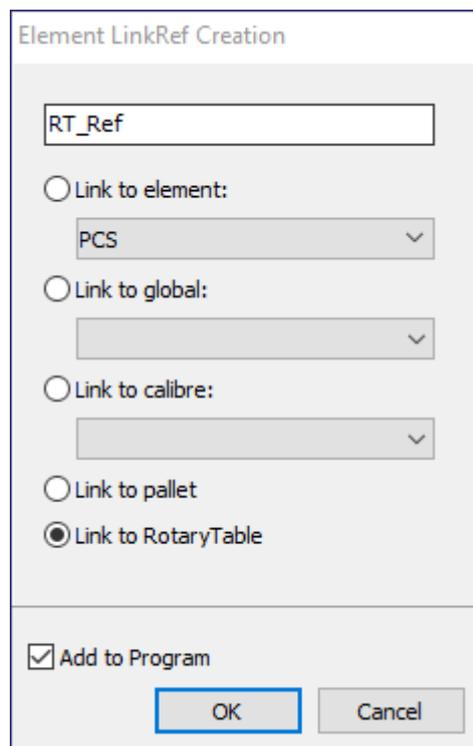
Each function in Tangram is now characterized by one of those contexts: Machine or RotaryTable.

- Machine context: the movements are completely independent by the 4th axis because the element is plugged outside the rotary table. Practical example are calibration gauges that must be fixed out of the rotary table.
- Rotary Table context: the movements takes care of the angle.
RT Mode inside the path will change the behavior regarding the table.

The context is defined only by the reference system associated to the element.

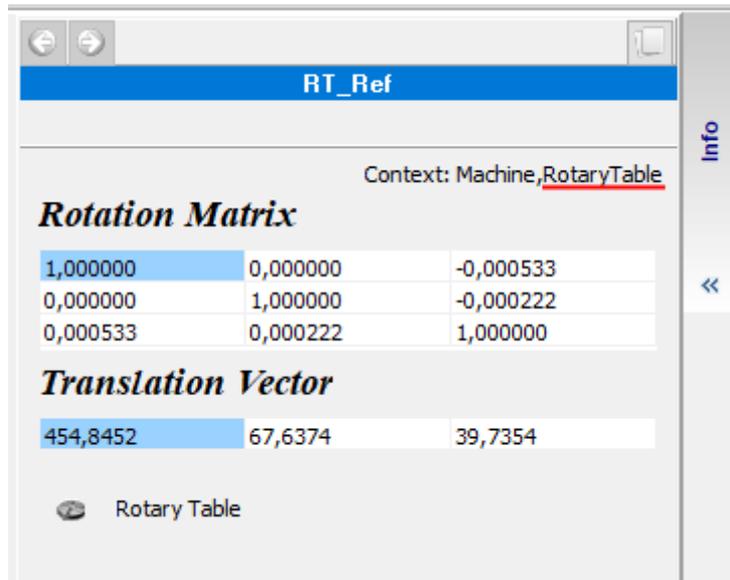
The entry point for the table context is a reference obtained by using a LinkRef element to join the Main Rotary Table reference (coming from the RT calibration procedure described above).

So in the LinkRef element has been introduced the option “Link to rotary Table”:



Selecting the entry “Link to RotaryTable” the context become “RotaryTable”. Any reference or geometric element that depends by it will inherits the same context.

The context to which the element belongs can be see in the “Element Information” panel.



The screenshot shows a software window titled "RT_Ref" with a blue header bar. Below the header, there are navigation icons (back, forward, refresh) and a "Info" sidebar on the right. The main content area displays the context "Machine, RotaryTable" and two data sections: "Rotation Matrix" and "Translation Vector".

Context: Machine, RotaryTable

Rotation Matrix

1,000000	0,000000	-0,000533
0,000000	1,000000	-0,000222
0,000533	0,000222	1,000000

Translation Vector

454,8452	67,6374	39,7354
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Rotary Table

Path Commands

In order to use the new facility, the path for the measuring element has some modification.

- New types of points:
 - RPos
 - RPos+
- Changed point types:
 - Pos
 - PMea

- The path has 2 different columns: RT Mode and R.

Pos

PCS

	Type	X	Y	Z	Cx	Cy	Cz	RT Mode	R	Tool
1	Pos	30,0000	0,0000	5,0000				0	0,0	0
2	Pos	-30,0000	0,0000	5,0000				0	0,0	0
3	Pos	30,0000	0,0000	5,0000				0	0,0	0
4	Pos	30,0000	0,0000	5,0000				1	90,0	0
5	Pos	30,0000	0,0000	5,0000				1	0,0	0

RT Auto Settings

By Tool
 By Angle 0,00
 By Axis +X

Inherit Points

Explose

Path Generator

Measurement Parameters

Mode

Manual
 CNC

Scan Attributes

OK Cancel

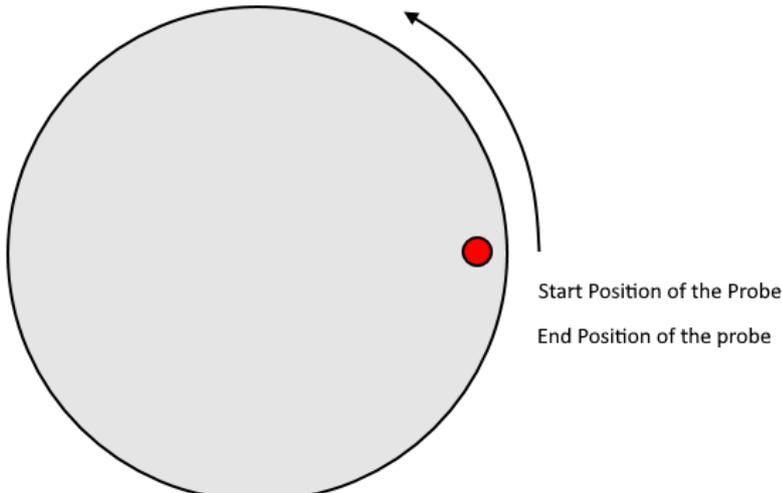
Depending by the Point Type, the behavior will be different according with these two columns.

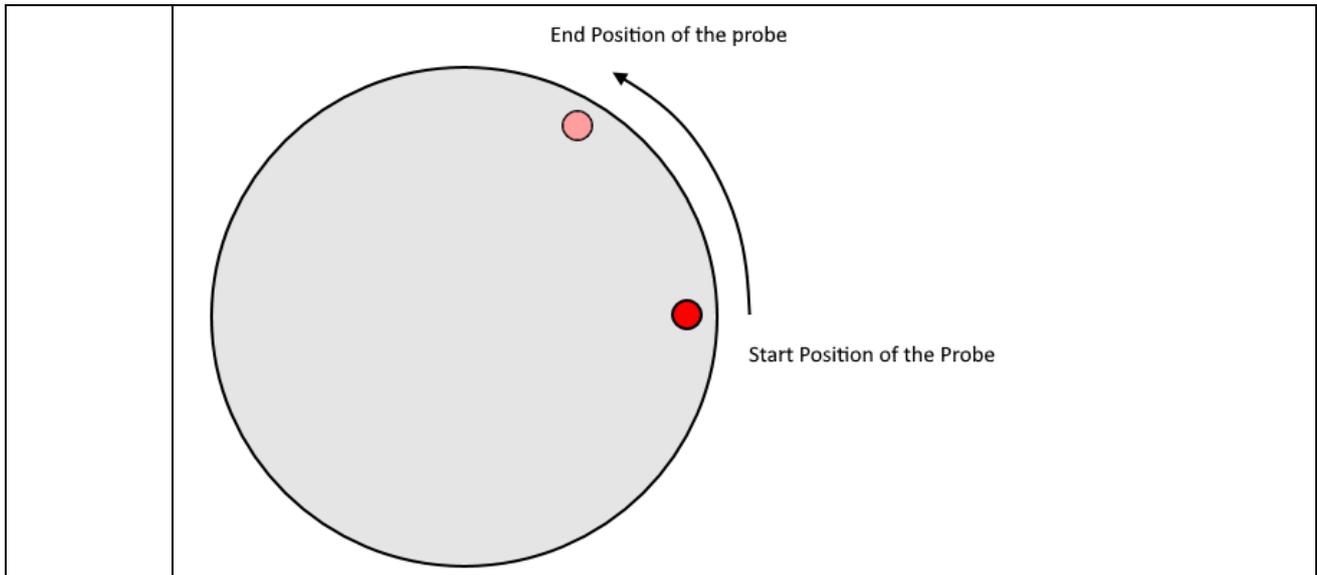
Point Type Summary

Point Type	RT Mode		
	0	1	2
RPos	<ul style="list-style-type: none"> R Rotate 4th axis at R angle without move XYZ 	<ul style="list-style-type: none"> R Rotate 4th axis at R angle, but maintaining the relative XYZ position 	
RPos+	<ul style="list-style-type: none"> XYZ. The movements will travel around the center of the table 	<ul style="list-style-type: none"> XYZR. Use R column Angle The movements will travel around the center of the table 	
Pos/PMea	<ul style="list-style-type: none"> XYZ. Use current angle 	<ul style="list-style-type: none"> XYZR Use R column Angle 	<ul style="list-style-type: none"> XYZR The real R angle depends by the "RT Auto Settings" panel

Rpos

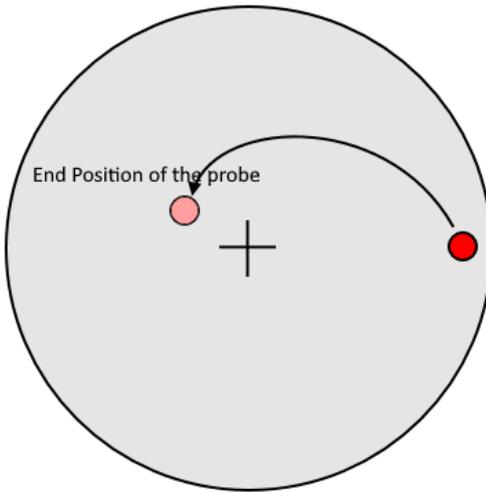
This movement rotate the table. It doesn't depend by the context of the element. It will be always rotate the angle of the table to reach the angle indicated in the R column value.

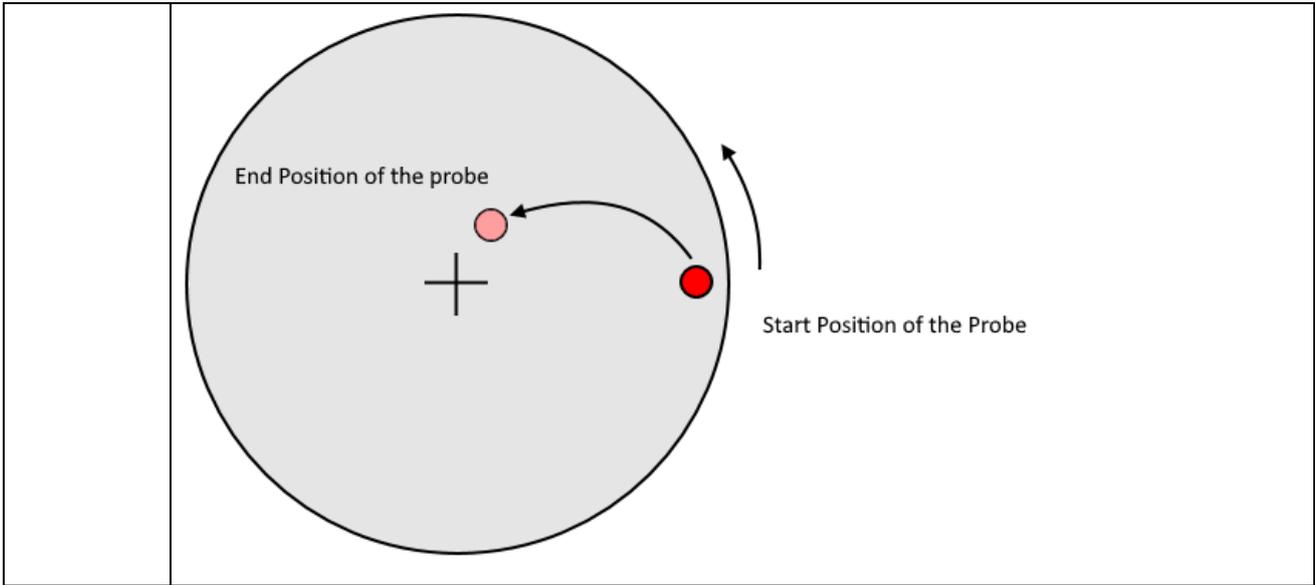
RT Mode	
0	<p>Only the table is rotated to reach the "R" angle. Probe doesn't move at all.</p> 
1	<p>Table is rotated to reach the "R" angle. The probe will follow the rotation maintaining the same relative position on the table</p>



RPos+

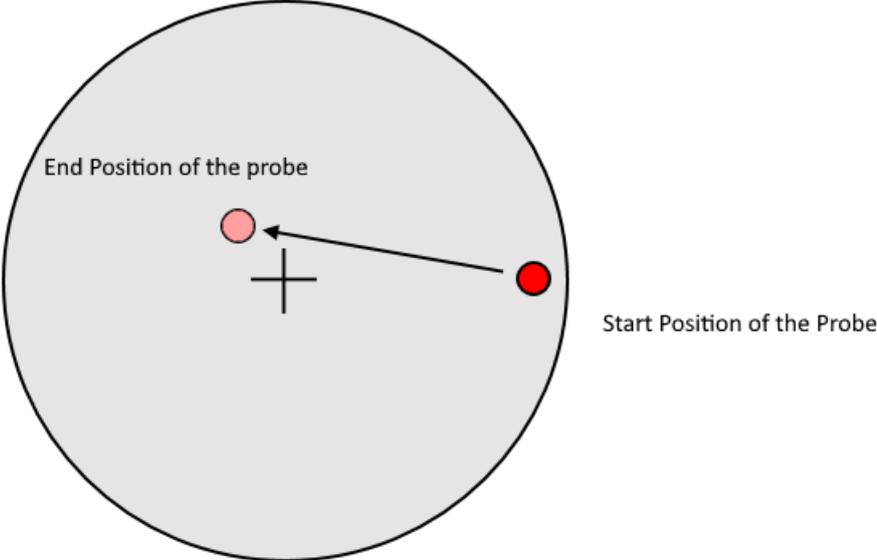
This movement makes moving the probe in a new position, but it will reach the destination not moving directly, but making a composed path around the center of the table. It could be useful for reaching a position at opposite side of the part.
Depending by RT Mode it can work in 3 or 4 axes.

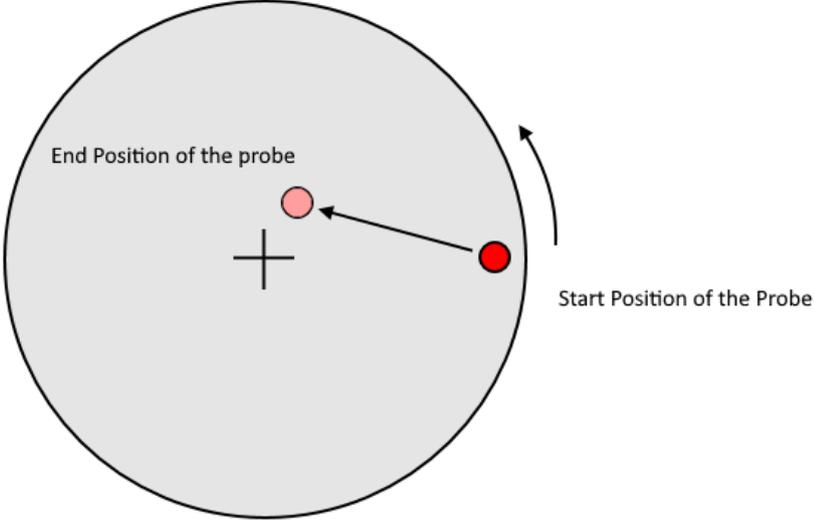
RT Mode	
0	<p>Machin moves the XYZ. The XYZ of the part depends by the current R pos. The movement will reach the new position by gradually vary the distance from the center of the table</p>  <p>End Position of the probe</p> <p>Start Position of the Probe</p>
1	It will move the XYZ and R together to reach complete 4 axes position.



Pos/Pmea

This movement moves in a new position moving directly to the destination using the shortest direction. Depending by RT Mode it can work with 3 or 4 axes.

RT Mode	
0	<p>Machine moves the XYZ axes, not the R This also in case the angle value is specified. It will be ignored.</p> 
1	It will move 4 axes (XYZ and R) together

	
2	<p>It will move the XYZ and R together but the written R value is not used. The R angle depends by the settings of the "RT Auto Settings" option (see next paragraph)</p>

RT Auto Settings (RT Mode = 2)

On the "Nominal Path" tab of the element, a small panel has been added.
The option settings inside this panel is only used for of "Pos" or "PMea", in case of RT Mode equal to "2"

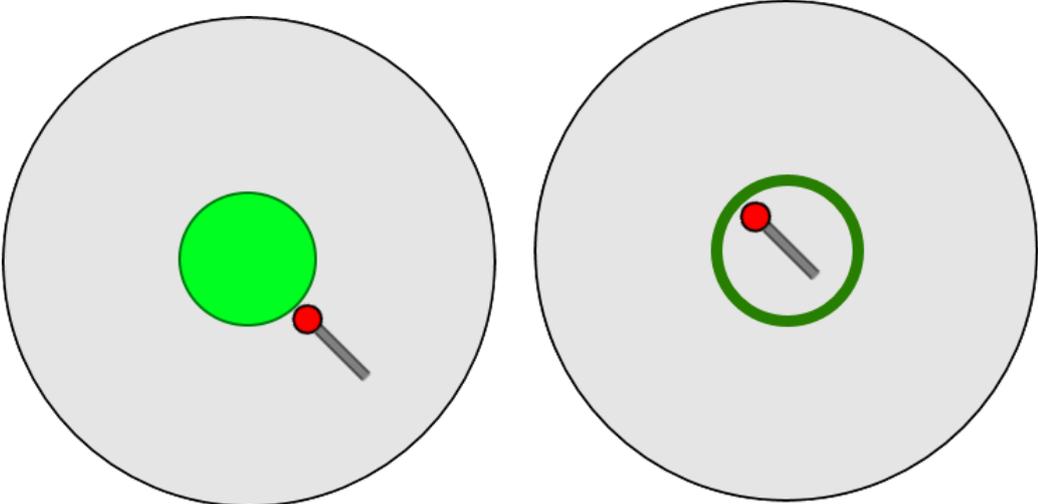
RT Auto Settings

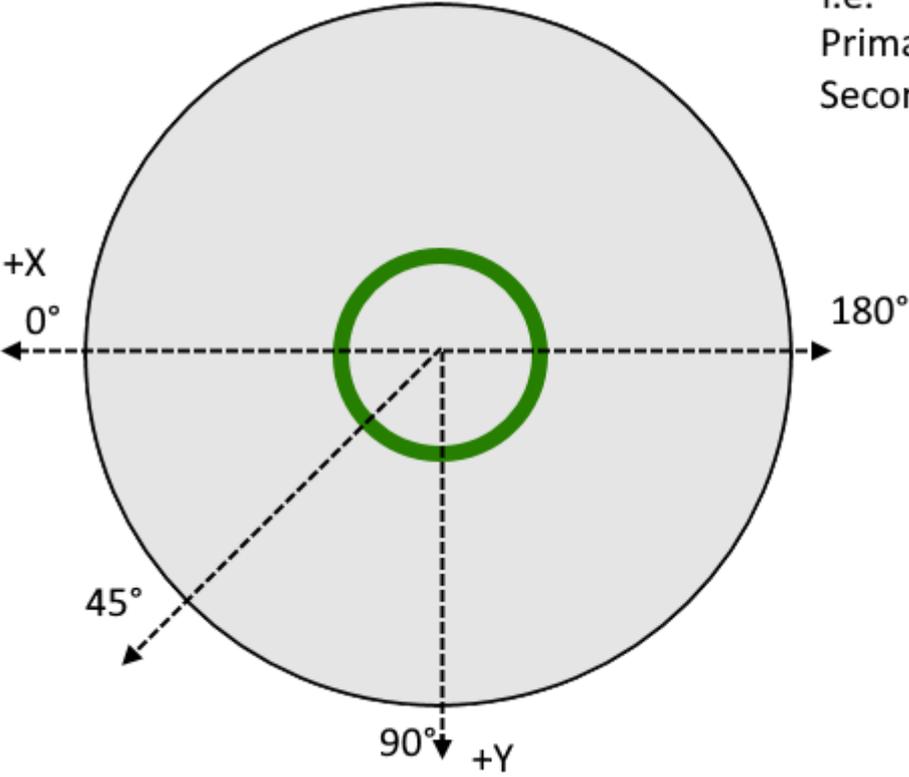
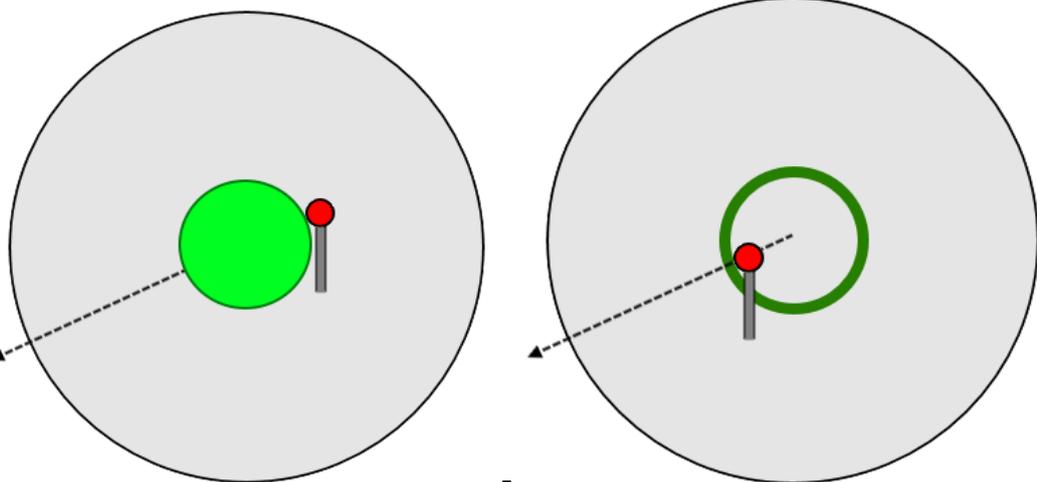
By Tool

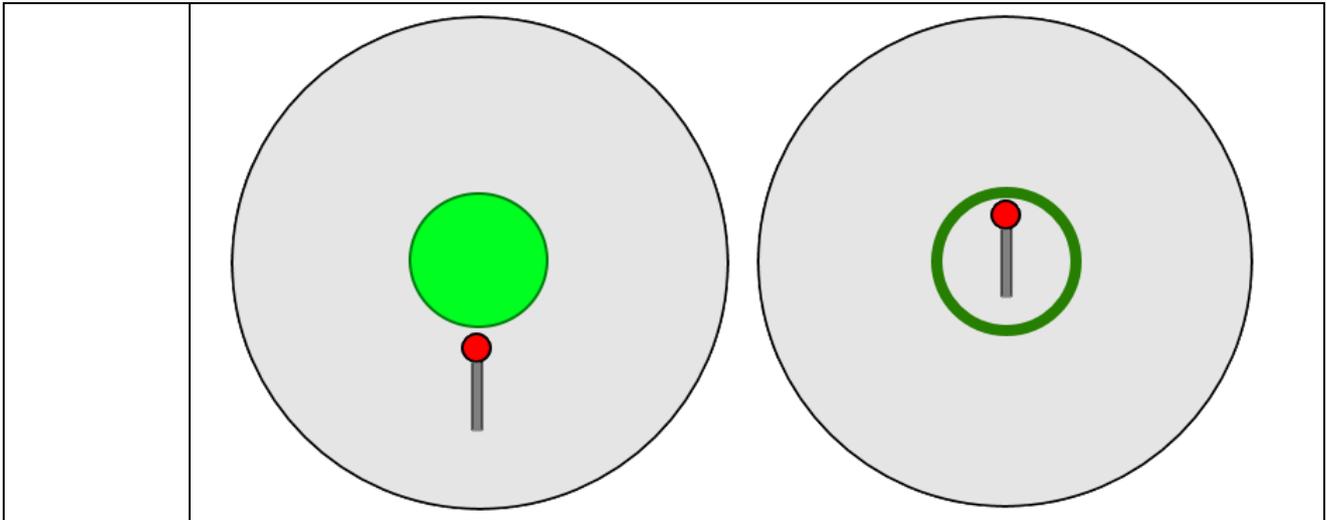
By Angle

By Axis

This panel represents the direction in which the measure is expected to be approached.
The software compute the best angle of the table to measure according to "RT Auto Settings".

By Tool	<p>The measure must be done with the surface perpendicular to the direction of the tip used. i.e. tip tilted by 45°</p> 
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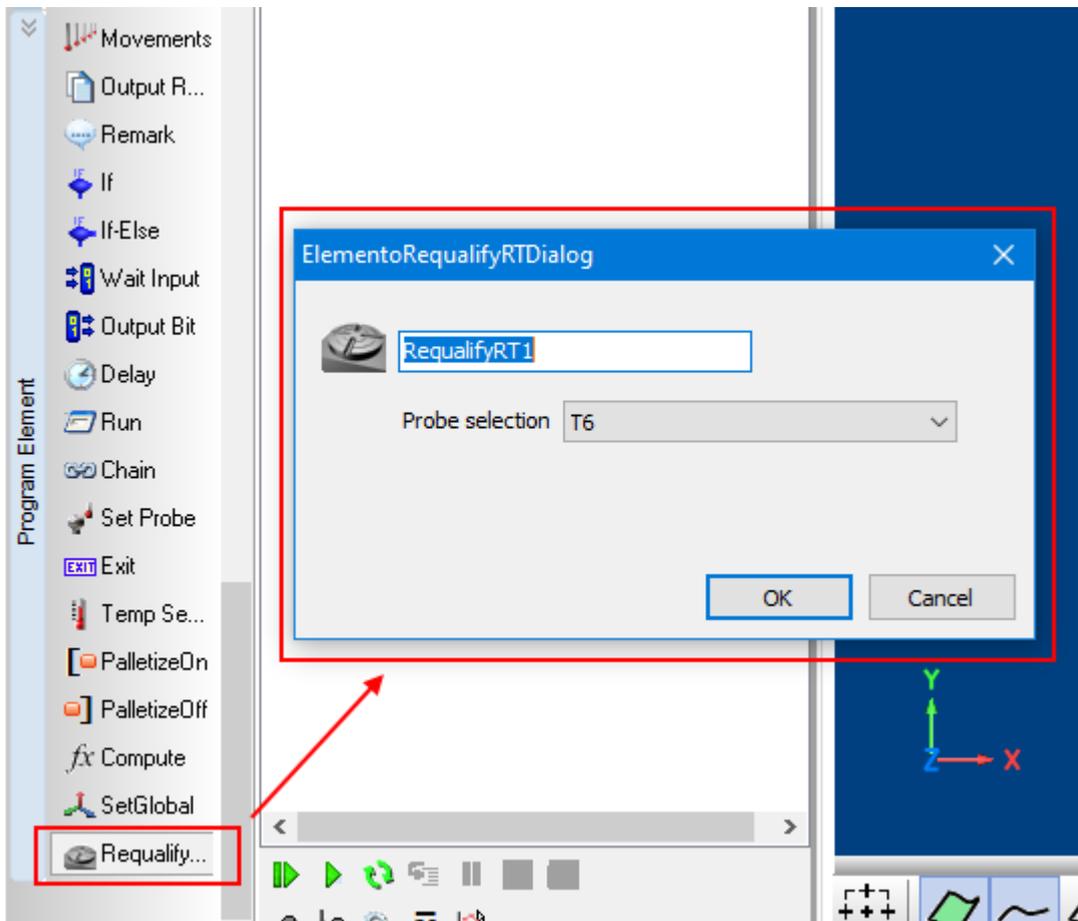
<p>By Angle</p>	<p>It requires to insert an angle. It represent the angle starting from secondary axis of the table around primary axis in counter-clockwise direction.</p> <p>i.e. Primary = +Z Secondary = +X</p>  <p>i.e. By Angle = 25°</p> 
<p>By Axis</p>	<p>It requires to insert an axis. It represent the direction requires to measure. i.e. By Axis = +Y</p>



Recalibration during the program

To preserve accuracy, it is important to keep under control the drift of the table with respect to the MCS and the same drift of the tool holder head when the thermal conditions vary. For this reason it is high recommended to repeat the calibration of the at the beginning of each program.

To dynamically re-calibrate the rotary table, has been added a new element called **Requalify RT**:



The only needed input is the probe to use during the procedure.

The procedure, if required, will proceed with a rotation or a tool changer. The attention to make this possible is the responsibility of the program.

During the execution it will run the same procedure of the Step3 of the Rotary Table Calibration. Will be used the same parameters configured in the Rotary Table Calibration itself (steps, angles, ...).

Note:

In addition, the tools could be subject to correlation variation, so in case of critical thermal environment and depending from the geometry of the tips, is also advisable the correction of the tools offset in the program.