Lasertex

Volumetric compensation
of Tools Machines

# Lathe Measurement System

# LMS-5

## Installation and Operation Manual

Revision B.1

# *Contents*



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# 1. System description

Lathe Measurement System LMS-5 is innovative, compact and easy to use device useful in measurements of a number of errors that can occur during the operation of lathes, not only numerical, but also manual. Some methods are also very useful and can be used to test various milling machines. The measurement is made by measuring the amplitude position of the laser beam with the high speed detector system. All measurement methods comply with ISO 230 standards.

LMS-5 consists of a rugged case with stabilized laser source, a measurement detector, charger and a set of necessary cables.

## Safety considerations

The Lathe Measurement System LMS 5 is a Safety Class I product designed and tested in accordance with international safety standards. It is also a Class I Laser product conforming to international laser safety regulations. The instrument and the manual should be inspected and reviewed for safety markings and instructions before operation.

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## Warnings

For proper operation of the laser measurement system LMS-5 the following conditions must be met:

The Laser Head must not be put near to strong magnetic fields.

Keep the optical components clean and avoid scratching them.

When the optics is dusted, clean it with pure ethanol or isopropanol.

Do not use the system beyond its work conditions.

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## 2. System elements

Lathe Measurement System LMS-5 consists of the elements described below:

- Laser Source Unit LMS5-L,
- Beam Detector Unit LMS5-D,
- USB charger,
- Magnetic fixture,
- USB cables,
- USB memory with LMS Software.

### System architecture

The architecture of LMS-5 is shown in Figure 2.1. Two main elements are the Laser Source Unit (LMS5-L) and Beam Detector Unit (LMS5-D).

The laser unit works as a source of a visible (635nm) laser wavelength with stabilized output power. The laser units generates two beams perpendicular to each other. It is battery operated and works wirelessly with the use of Bluetooth connection. Single battery charging allows for more than a day of constant measurements. The laser unit can be connected to a PC computer over the micro-USB connector with limited functionality. The same connector is used for battery charging. Any popular cell phone battery charger can be used.

The laser light is detected by the Beam Detector Unit LMS5-D. In the opto-electronic circuit inside the measurement heads, the optical signal is converted to the signal position and transferred over Bluetooth or USB interface to a PC computer running the LMS Software application. Depending on the application the laser unit needs to be rotated or not. The rotation is necessary in Axial measurements while during axes straightness and squareness measurements only linear movement of the Detector unit suffices.

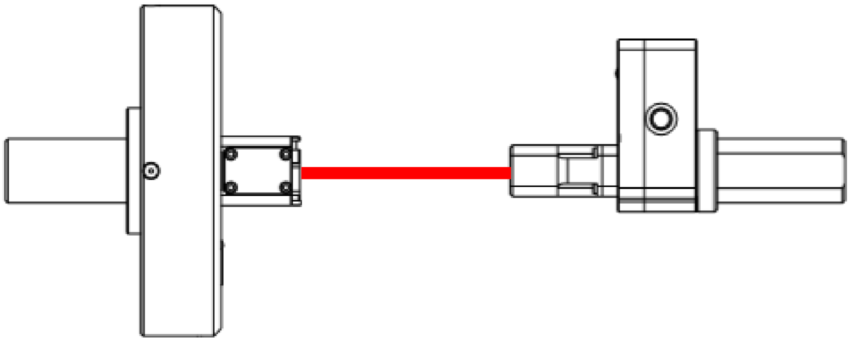


**Figure 2.1.** *The architecture of the LMS-5 lathe measurement system. Position of the beam generated by the Laser Source (left) is detected by the Detector Unit (right).*

## Laser Source Unit LMS5-L

The Laser Source Unit LMS5-L is 635nm fibre laser based device generating two perpendicular monochromatic beams. The shape of the unit was especially designed to support measurement of rotational axes. The important elements of the laser unit are shown in Figure 2.2.

The laser has to be mounted on the machine with the use of the **MOUNTING ROD**. The rod is made of hardened steel with diameter of 25mm and h6 tolerance.

On top of the unit there can be found the **POWER ON BUTTON** and two LEDs: **POWER LED** (red) and **BT LED** (blue). If the button is pressed for more than 3 seconds, the device will switch on signalising this with generation of the laser beam and with switching on blue LED. If the laser is correctly connected to a PC over Bluetooth then the blue LED will blink. The red LED (Power LED) signalises charging of the laser unit from a USB source connected to the **MICRO USB** connector. Switching the device off requires pressing the power button for longer than 3 seconds or until the normally blue LED changes its colour to red.

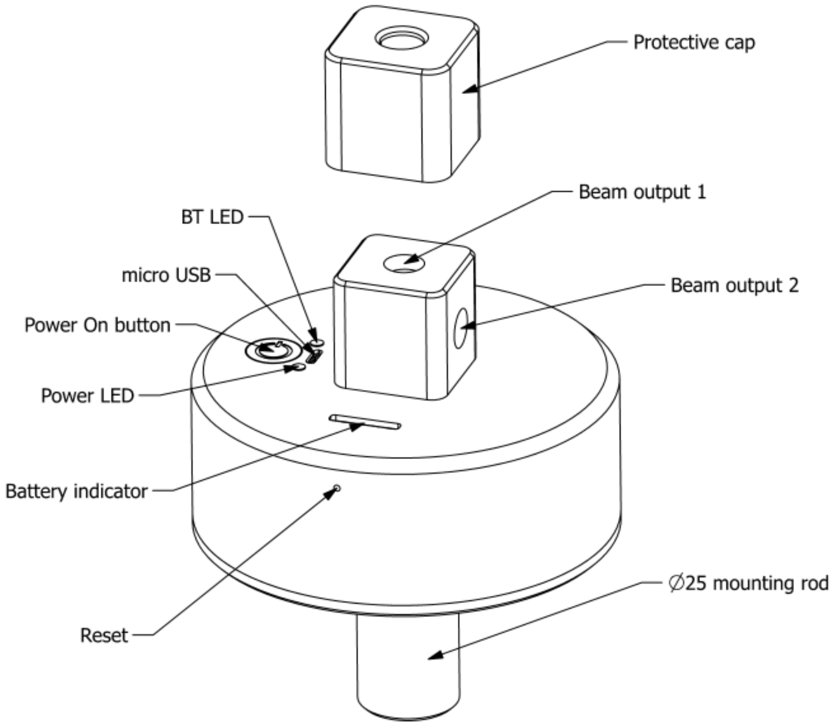



**Figure 2.2.** *Laser Source Unit LMS5-D. Explanations in the text.*

The laser has two **BEAM OUTPUTS** perpendicular to each other with precision stated in the calibration certificate and not worse than +/- 3 arcseconds. Although the output power is very small but the Beam output 2 can be shielded with the **PROTECTIVE CAP**. The cap should be taken off only when the perpendicular beam is used (for example in measurements of axes perpendicularity).

On top of the unit there is placed a simple **BATTERY INDICATOR** showing the current battery state. The state can be controlled also when the device is switched off. If the device stops behaving improperly then it can be resetted by pressing a hidden button covered by the **RESET** hole.

## Beam Detection Unit LMS5-B

The Beam Detection Unit LMS5-B is a state of the art laser beam position detector delivering data in two dimensions. It is accepting the beam from two directions shown in Figure 2.3 as **BEAM INPUT 1** and **BEAM INPUT 2**. It consists an internal optical filter thus the reading is not sensitive to the level of external light. The Detector is switched on and off in the same way like described for the Laser unit – by long pressing of the **POWER ON BUTTON**. The meaning and behaviour of two LEDs is also the same as described in the previous paragraph. The Unit can be charged either with the use of the delivered charger or any USB port with the use of micro USB cable. For connection to a PC a Bluetooth interface should be used.

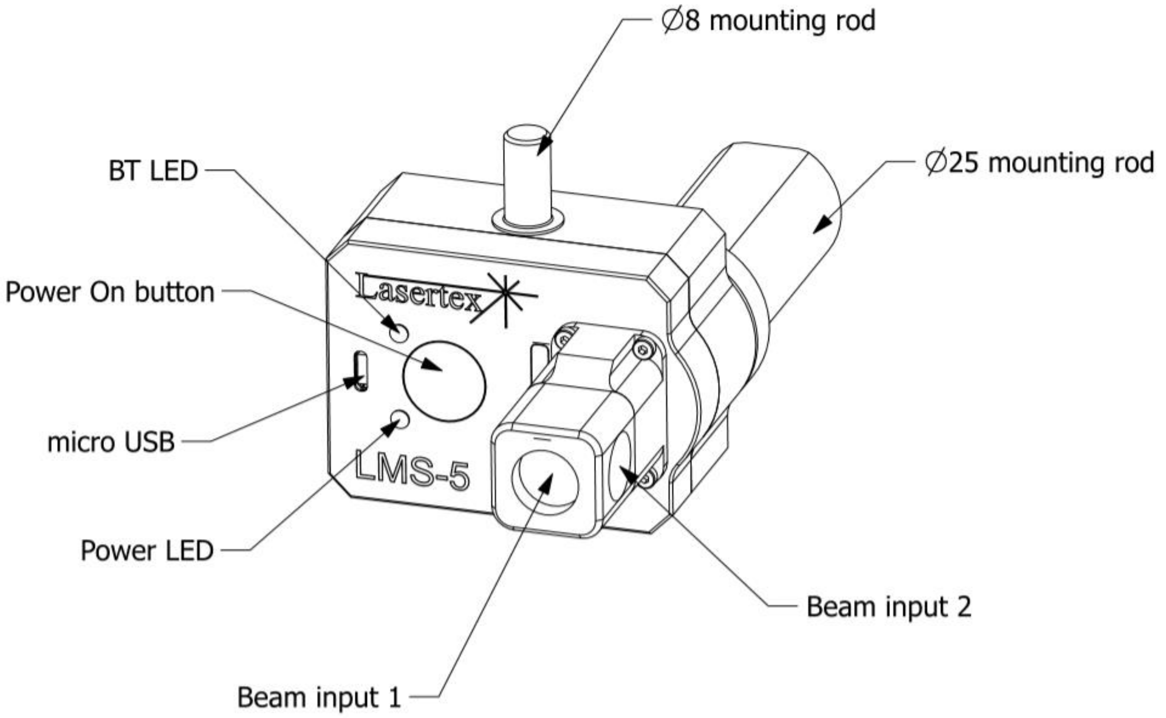



**Figure 2.3.** *Laser Source Unit LMS5-L, view 1.*

The detector has two **MOUNTING RODS**. The main one is the ϕ25 h6 rod with the flattened surface. The flat surface is made for repeatable positioning of the detector in toolholders. The smaller rod plays an auxiliary function. It should be used only when there is no other possibility of attaching the detector to the machine.

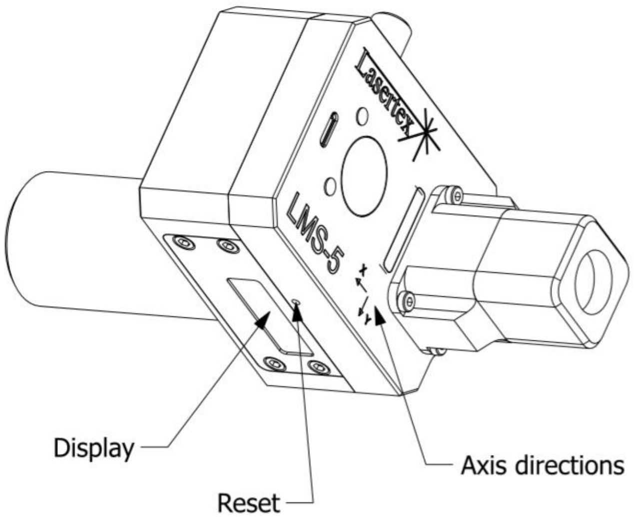



**Figure 2.4.** *Laser Source Unit LMS5-L, view 2.*

The state of the battery and values of the beam position are shown on the **DISPLAY** (Figure 2.4). The operation of the Display is described in more details below. The inscriptions **AXIS DIRECTIONS** on the top of the detector are showing the meaning of ***X*** and ***Y*** on the Display and in the LMS5 Software on the PC. In the Detector there is also a hidden **RESET** button that should be used only when a device malfunctioning is noticed.

The Display in the detector unit plays an auxiliary role allowing to use the device in a standalone mode. The possible states of the Display are shown in Figures 2.5a-2.5e. The information shown on the Display are available in three different modes (units are always μm):

- **Absolute** mode (Fig. 2.5a) – in this mode there are displayed absolute X and Y positions of the laser beam (Fig. 2.5b). This is the default mode after device start up. Short press of less than 2 seconds of the *Power On* button changes the mode to *Relative*.
- **Relative** mode (Fig. 2.5d)– in this mode there are displayed X and Y positions of the laser beam relative to a chosen point. Entering to Relative mode sets the current beam position as the reference. Short press of less than 2 seconds of the *Power On* button sets new reference point. Leaving

the mode is possible by two consecutive short presses on the *Power On* button.

- **Axial** mode (Fig. 2.5e) - in this mode the centre of the circle made by the beam is displayed if only the radius of the circle exceeds 40 μm during 5 seconds window. Otherwise the display will look like shown in Figure 2.5c. To use this mode the laser has to rotate with at least 12 rotations per minute. Short press of less than 2 seconds of the *Power On* button sets new reference point as the last detected centre. Leaving the mode is possible by two consecutive short presses on the *Power On* button.

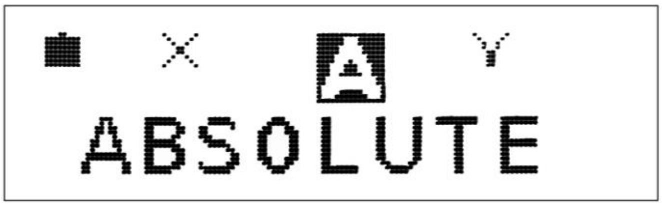



**Figure 2.5a.** *Appearance of the LMS5-D unit Display during device start up and during switching to Absolute beam position mode.*

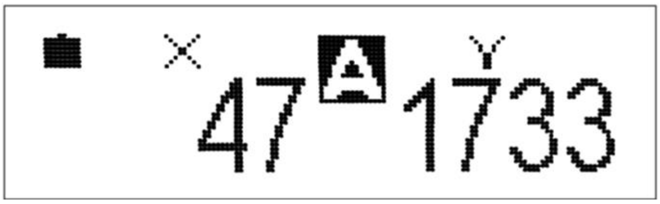



**Figure 2.5b.** *Appearance of the LMS5-D unit Display during operation in Absolute beam position mode.*

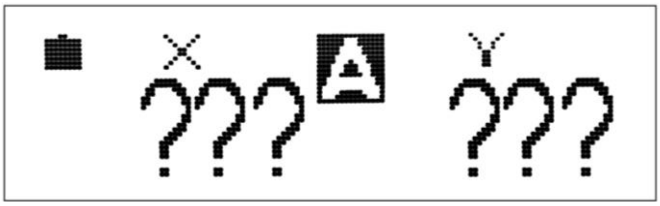



**Figure 2.5c.** *Appearance of the LMS5-D unit Display when no beam is detected.*


**Figure 2.5d.** *Appearance of the LMS5-D unit Display during switching to Relative beam position mode.*

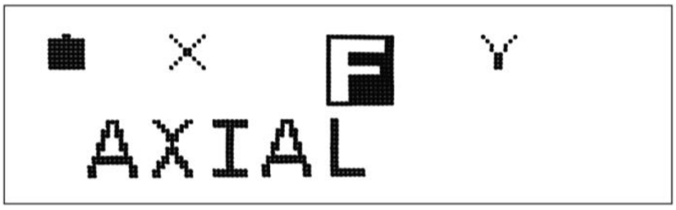


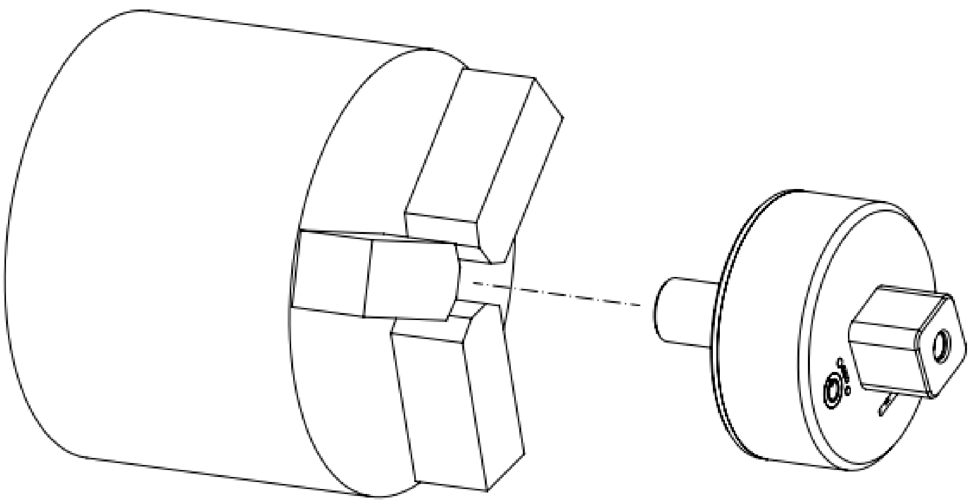

**Figure 2.5e.** *Appearance of the LMS5-D unit Display during switching to Axial measurement mode.*

In the top left part of the Display there is a battery display indicator. The reversed letter denotes the current operation mode: A stands for Absolute, R stands for Relative and F stands for Axial.

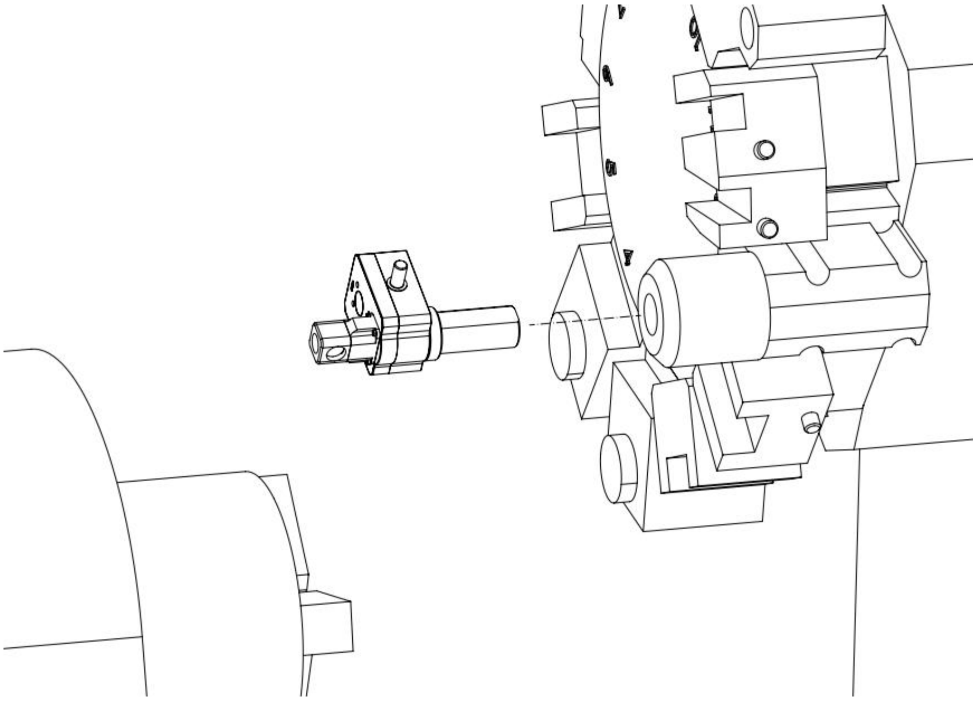
## 3. Basic configuration

Lathe Measurement System LMS-5 is design to be very simple to use. In majority of lathes the optical system setup has only a few steps shown below. This configuration is suitable for both Axial and Straightness measurements.

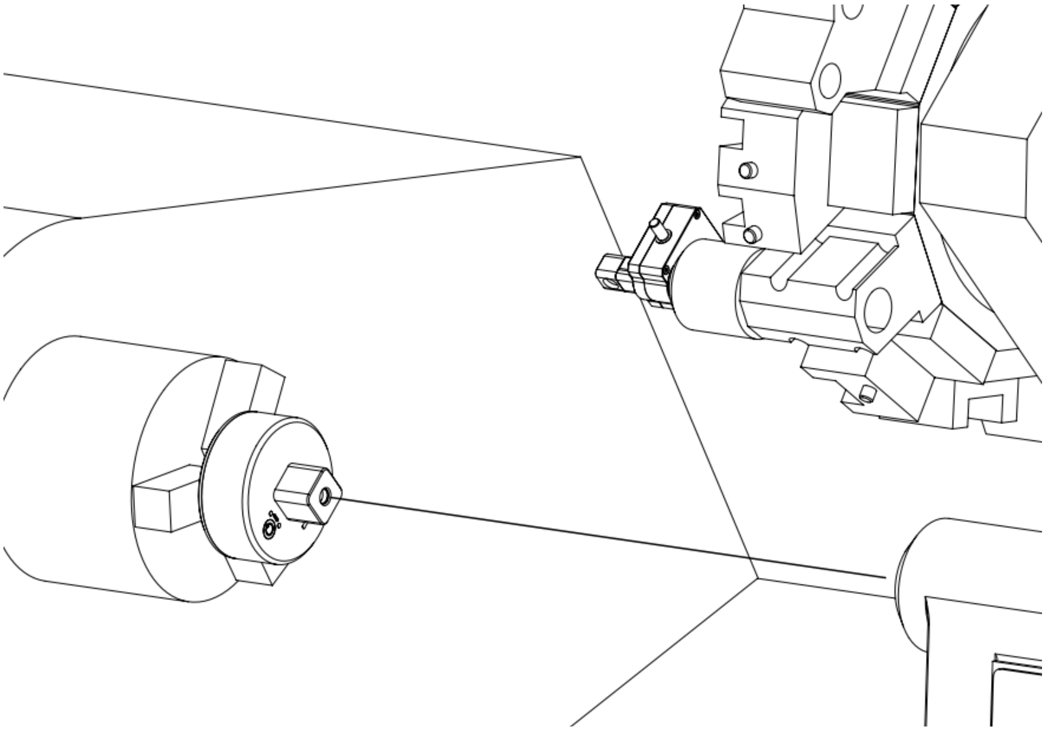
A. Mount the Laser Unit inside the machine spindle.



B. Mount the Detector Unit in the toolholder.



C. Switch on laser and detector (press power buttons for 3 seconds). Connect LMS5 Software if necessary



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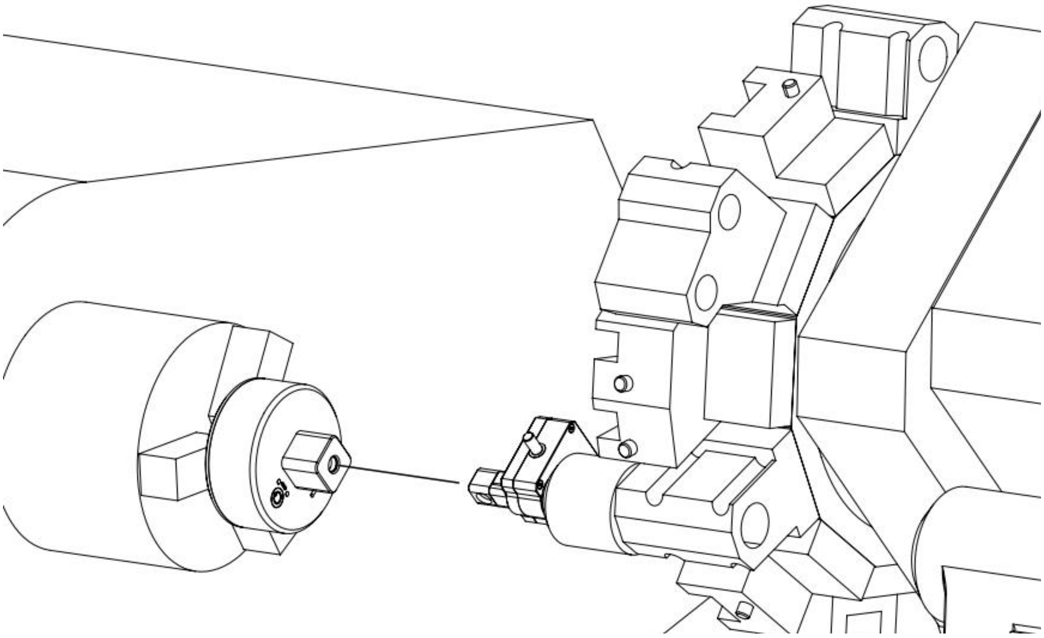
D. Move the Tool Turret so that the laser beam falls into the detector input.



# 4. LMS5 Software

The device is delivered with the supporting software for a PC computer with Microsoft Windows operating systems. Application requirements:

Operating system: Windows 32/64bit 7/8/8.1/10

CPU desktop: Intel i3 2375M 1,5 GHz or better / AMD A4-5000 1,5GHz or better

Memory: 2GB RAM or more

Hard drive: 50MB free hard disk space

Interfaces: USB type A

Screen resolution: 1280x768 or higher

## Software installation

The software installation package is located on the USB memory stick that is included to the measurement system. LMS5_Install application can be launched from the USB memory. The installation process should start automatically. First the window with requirements should appear (see Figure 4.1).

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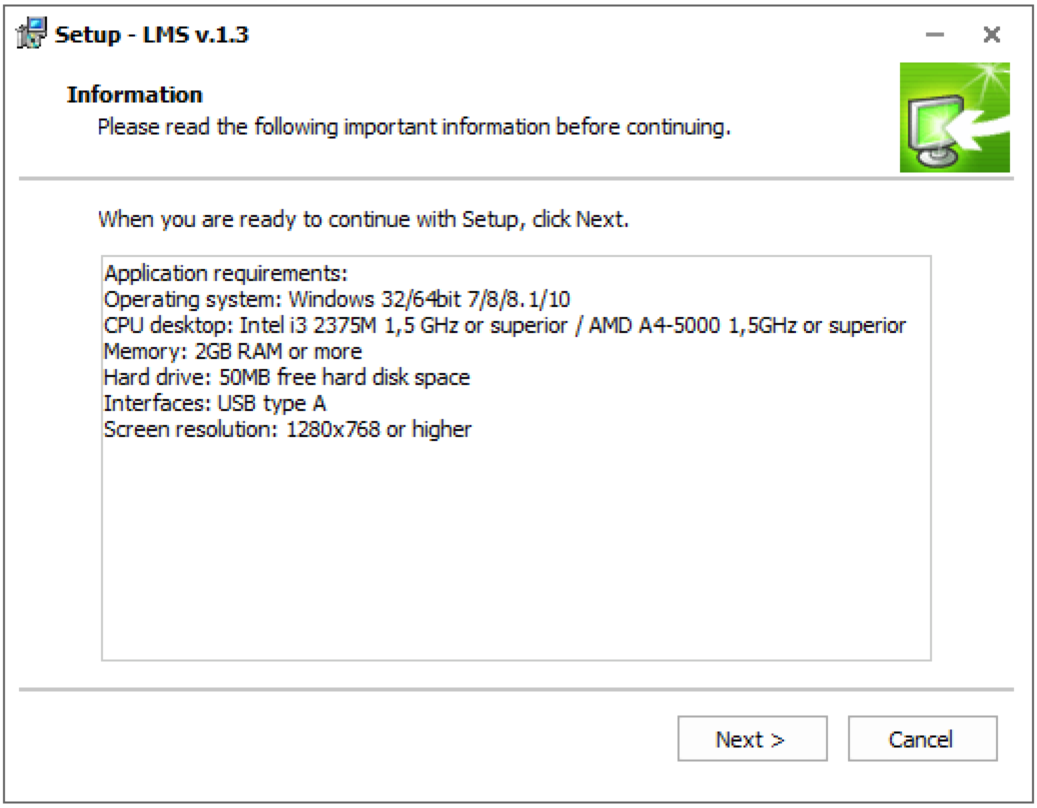


**Figure 4.1**. *LMS5 application setup window.*

After installation of the main software there will be installed FTDI drivers for supporting USB communication with the detector unit. The drivers are available after installation in the /LMS5/FTDI Driver catalogue. The installation is finished when the window as shown in Figure 4.3 appears.

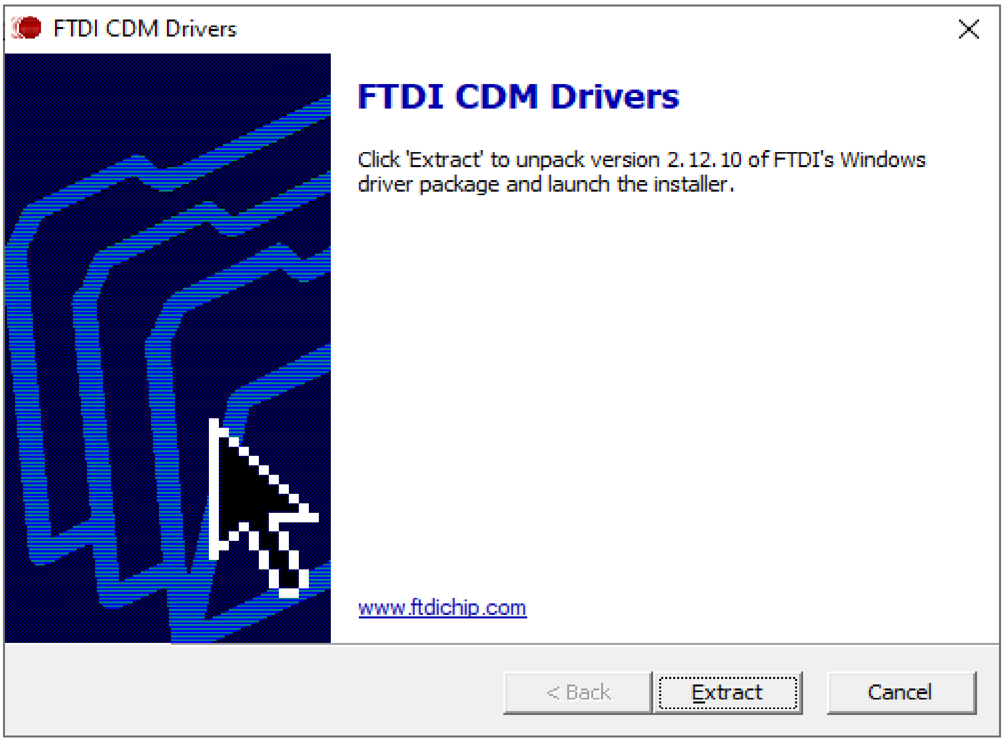


**Figure 4.2**. *FTDI setup window.*

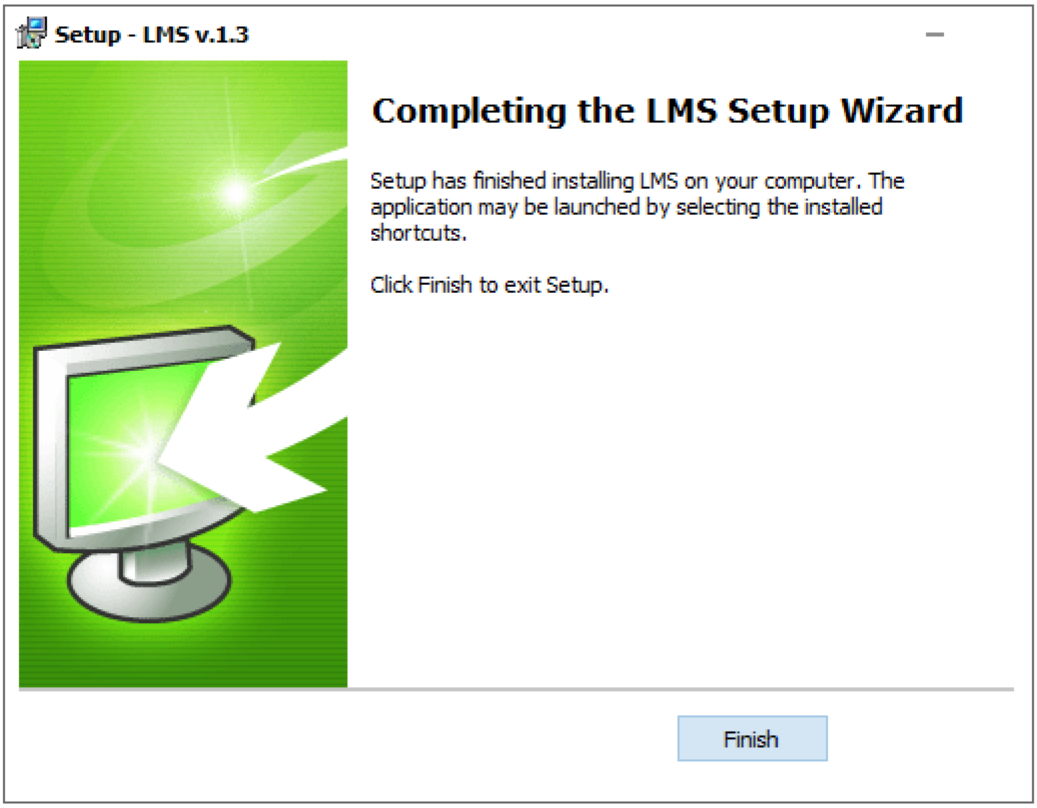


**Figure 4.3**. *Installation complete window.*

## Main window of LMS5 Software

The main window of the software consists a main and a supporting panel – see Figure 4.4. In the main window either a measurement may be chosen – Axial, Straightness, Squareness or Live Measurement, a configuration may be entered or the software may be closed. The auxiliary panel delivers information about the connection to a Detector Unit and displays the position of the laser beam.


**Figure 4.4**. *Main window.*

During standard operation the detector needs to be connected to the PC first. In order to achieve this in the main window the elements of the *Detector* panel are to be used. First the search button  should be pressed in order to find the LMS5 detectors visible to the computer. After a few seconds the list of all visible detectors will be shown. Then the right detector should be chosen and the connection button  should be pressed. After successful connection the elements in *Detector* panel should start displaying the status of the detector – beam strength, battery level and beam position (Figure 4.5).


**Figure 4.5**. *Appearance of the Main window after successful connection.*

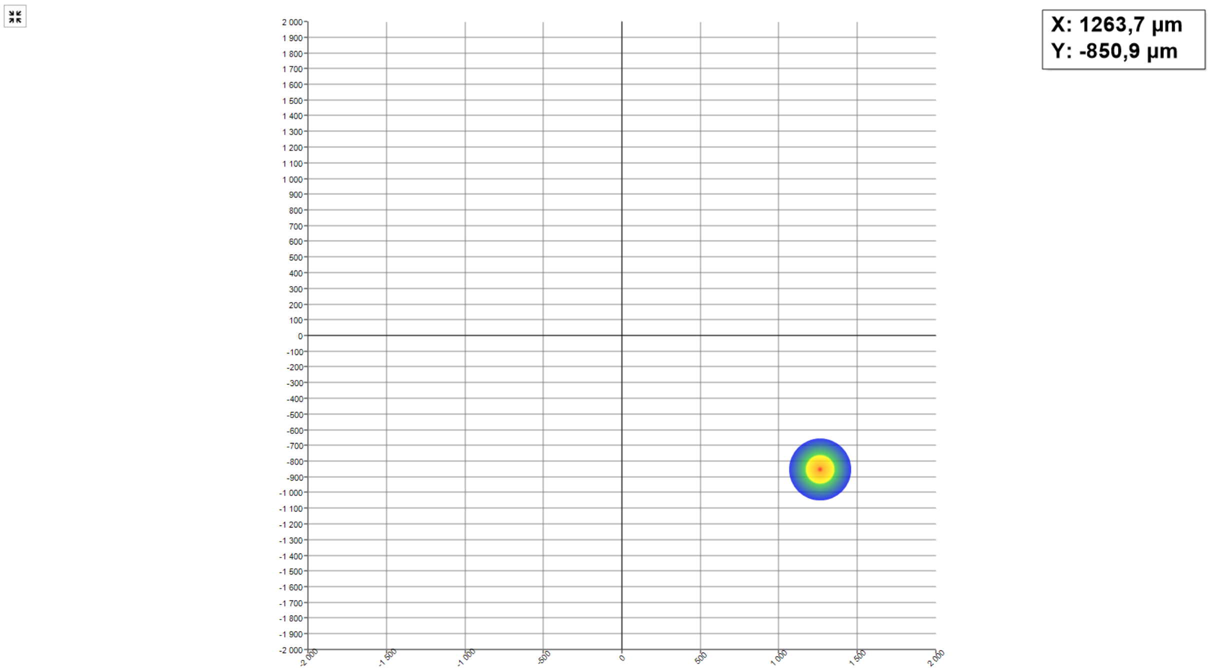


**Figure 4.6**. *Alignment panel after magnification.*

When the detector is connected and the beam from the laser is within the detection range then on the *Alignment* panel in the top left part of the main window, there are displayed information about the laser beam position (graphically and numerically) and the quality of the beam (gauge on the top of the panel). During standard measurements the displayed quality has to exceed 90% to warranty linear measurements.

The alignment window can be zoomed to the full screen (Figure 4.6) by pressing zoom button . The magnified panel can be unzoomed by pressing the unzoom button in the lop left corner or by pressing Esc button on the keyboard.

## Configuration window

When the Configuration button is pressed then one of the *Settings* windows will appear – Figures 4.7 – 4.11.


**Figure 4.7**. *Appearance of the Settings window – Language choice.*

With the Configuration it is possible to change the program language (Figure 4.6), the units used across various software options (Figure 4.7) or the data averaging (Figure 4.10). It is also possible to add a new logo file that would appear on printed reports (Figure 4.8) or check the current versions of firmware (Figure 4.9).

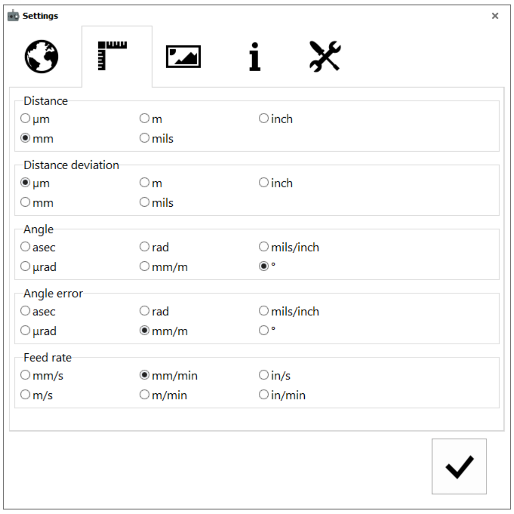


**Figure 4.8**. *Appearance of the Settings window – Units choice.*


**Figure 4.9**. *Appearance of the Settings window – Logo picture choice.*

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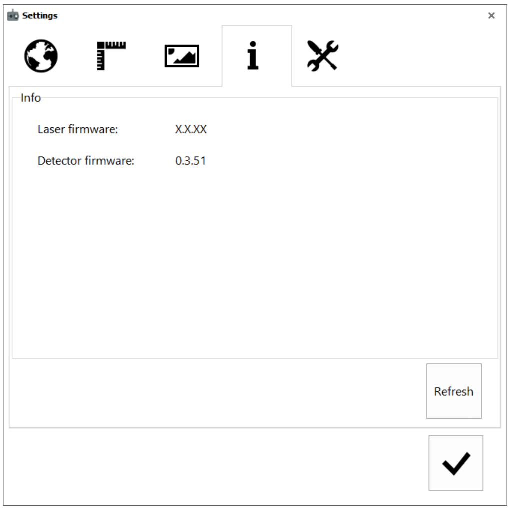
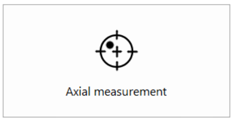



**Figure 4.10**. *Appearance of the Settings window – Firmware versions.*


**Figure 4.11** *Appearance of the Settings window – Data averaging choice.*

## Axial measurement window

When the axial measurements are requested then the *Axial measurement* 

button is to be pressed. In the windows that would appear (Figure 4.12) either a new measurement can be started or an old result can be read analysed or printed.

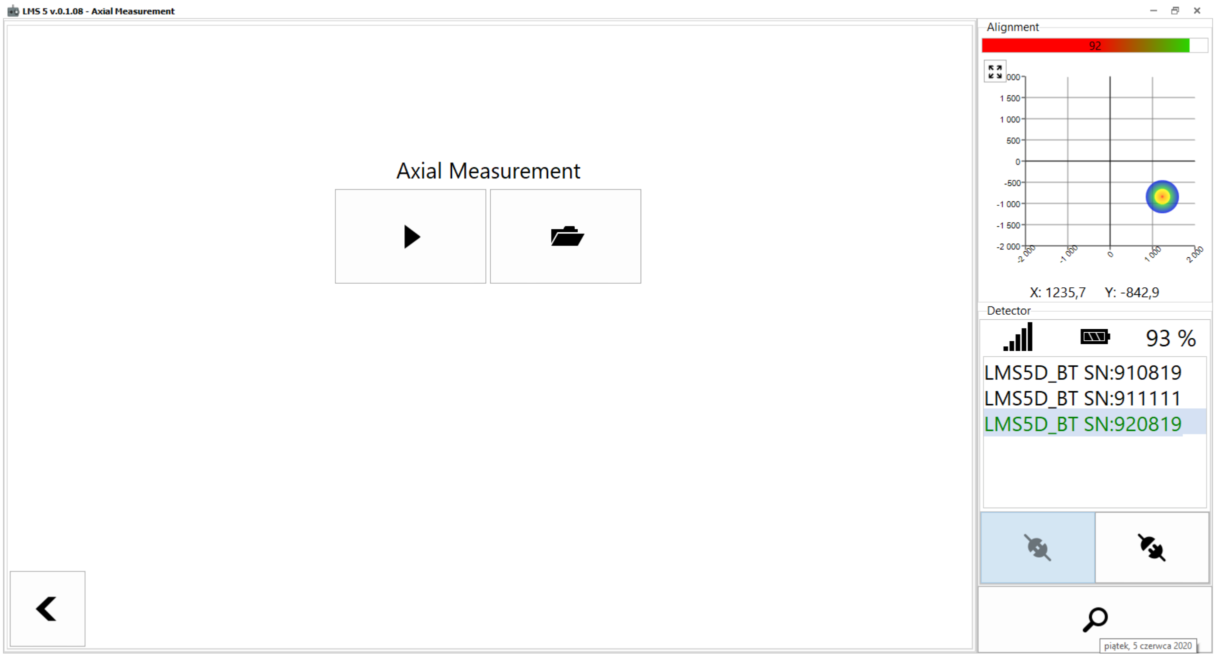



**Figure 4.12** *Axial measurement window – initial screen.*

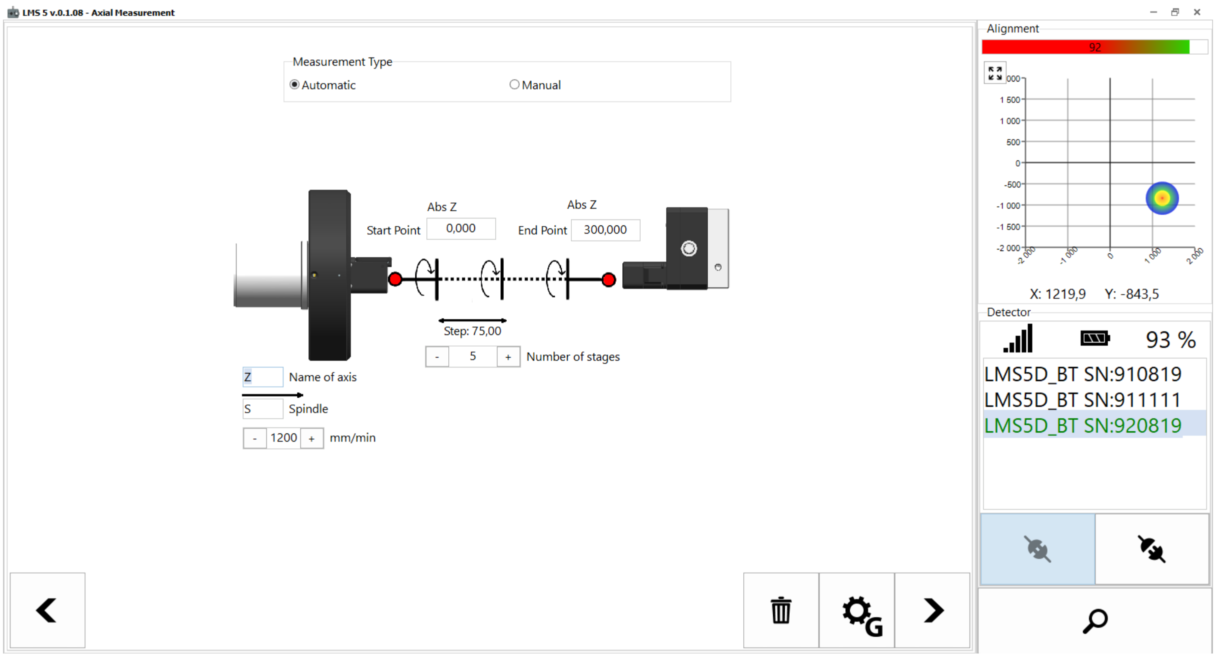



**Figure 4.13** *Axial measurement window – Measurement Configuration.*

The Axial measurement may be performed in two modes: Automatic or Manual. Both modes require configuration as shown in the Measurement Configuration window (Figure 4.13). First the alias names of the measured axis and of the machine spindle are to be inserted into the appropriate fields Z Name of axis S Spindle . Default values are Z for measured axis and S for spindle. Next the spindle rotation speed should be modified. The value is depended on the required accuracy and the expected measurement time and should not exceed 100 rpm.

The machines coordinates of the measured axis edge points are to be inserted in the *Start point* and *End point* fields Start Point Abs Z 0,000 End Point Abs Z 300,000 with the amount of required measurement stages placed in to *Number of stages* field - 5 + Number of stages.

After the configuration is finished, the g-codes program can be generated for the machine. After pressing the button the window would appear as shown in Figure 4.14. Depending on the measurement mode (Automatic or Manual) and the type of the CNC controller (Siemens, Fanuc), the generated program will be different.

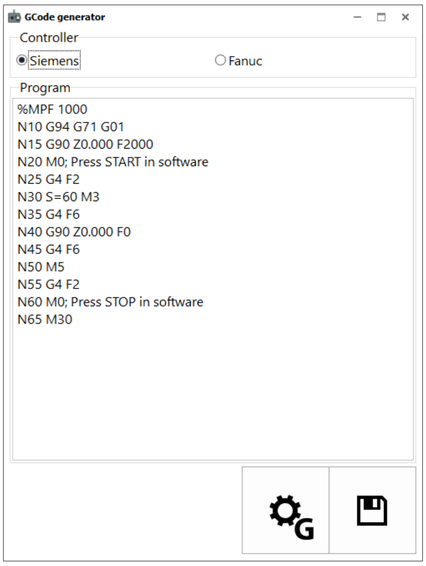



**Figure 4.14** *Axial measurement window – Gcodes generation.*

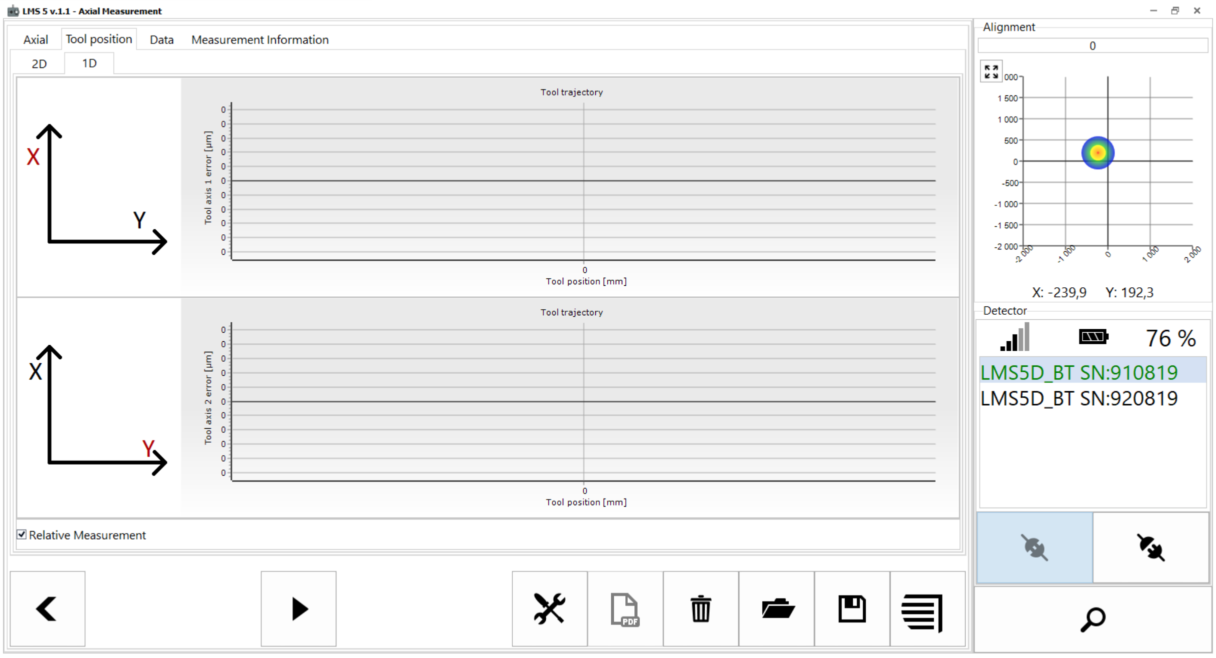



**Figure 4.15** *Axial measurement window – Measurement window.*

Pressing the continue button opens the measurement window as shown in Figure 4.15. The new measurements can be started with the Start button. If previous results are necessary then they can be read with the Load measurement button. Final results can be either printed or saved. If the measurements are to be repeated then the old measurements should be erased with the Clear data button. The return to previous screen is possible with Back button. The return to the main screen is possible with the Main menu button.

In the additional Settings window the results can be rotated either to gravity or by a certain angle. It also possible to choose here the statistical methods for processing the

straightness data – End Points, Minimum Zone, Least Square Error or Raw Data methods can be selected.

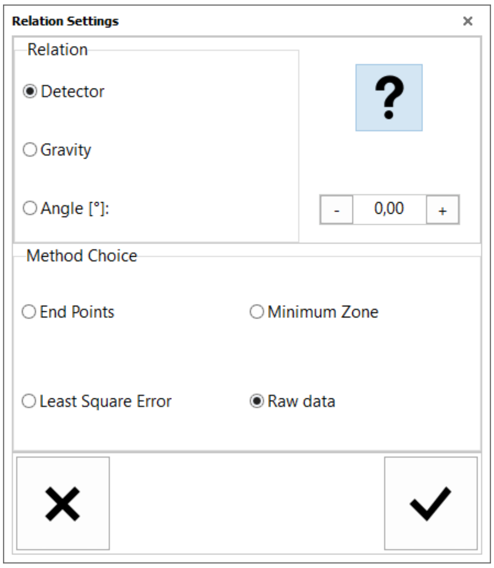



**Figure 4.16** *Axial measurement window – Settings window.*

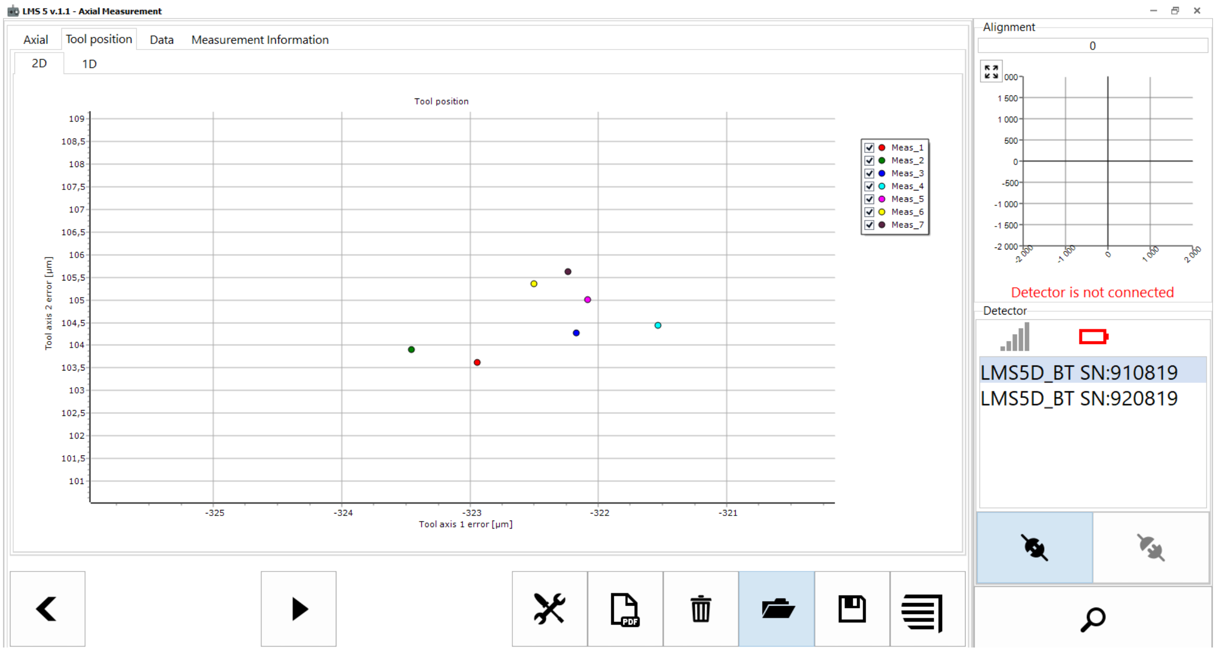



**Figure 4.17** *Axial measurement window – Tool position panel 2D.*

The measurement window consists of four different panels: *Axial*, *Tool position*, *Data* and *Measurement Information*. The view of the *Tool position* panel is shown in Figure 4.16. It is possible to view here the measurement results either as two straightness plots in **1D** option (Fig. 4.15) or as a machine tool trajectory in **2D** option (Fig. 4.17). The marking of ***X*** and ***Y*** in this window are in agreement with physical axis marking printed on the detector. In the *Axial* panel the radial runout of the machine can be observed and analysed – Figure 4.18. The measurement data may be also viewed as a results table when the *Data* panel is chosen – Figure 4.19. The value of total errors calculated from the performed measurements are shown here. The data entered into the fields present on *Measurement Information* panel (Figure 4.20) will be added to the report printout.

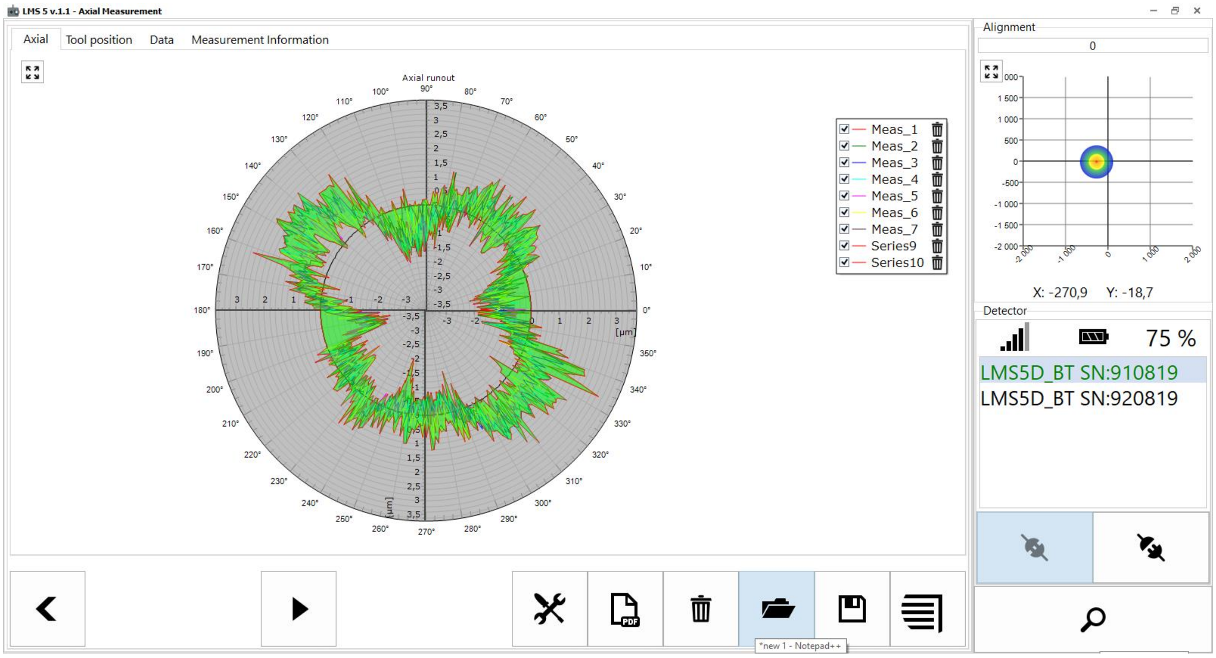



**Figure 4.18** *Axial measurement window – Axial panel.*

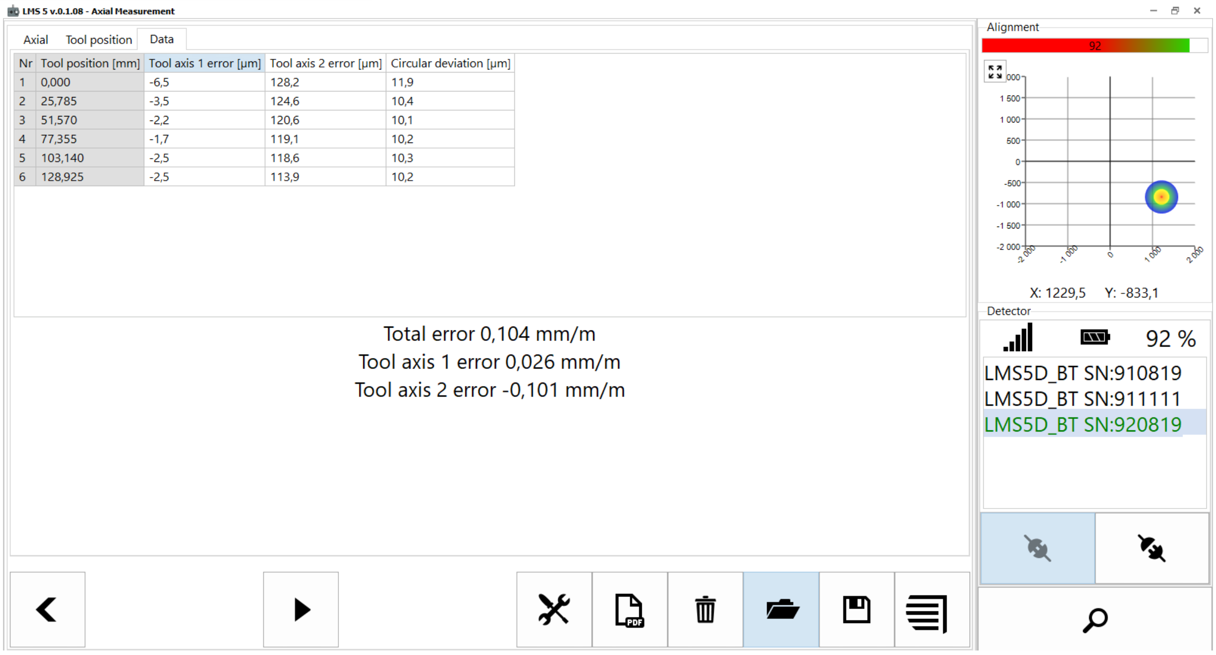



**Figure 4.19** *Axial measurement window – Data panel.*

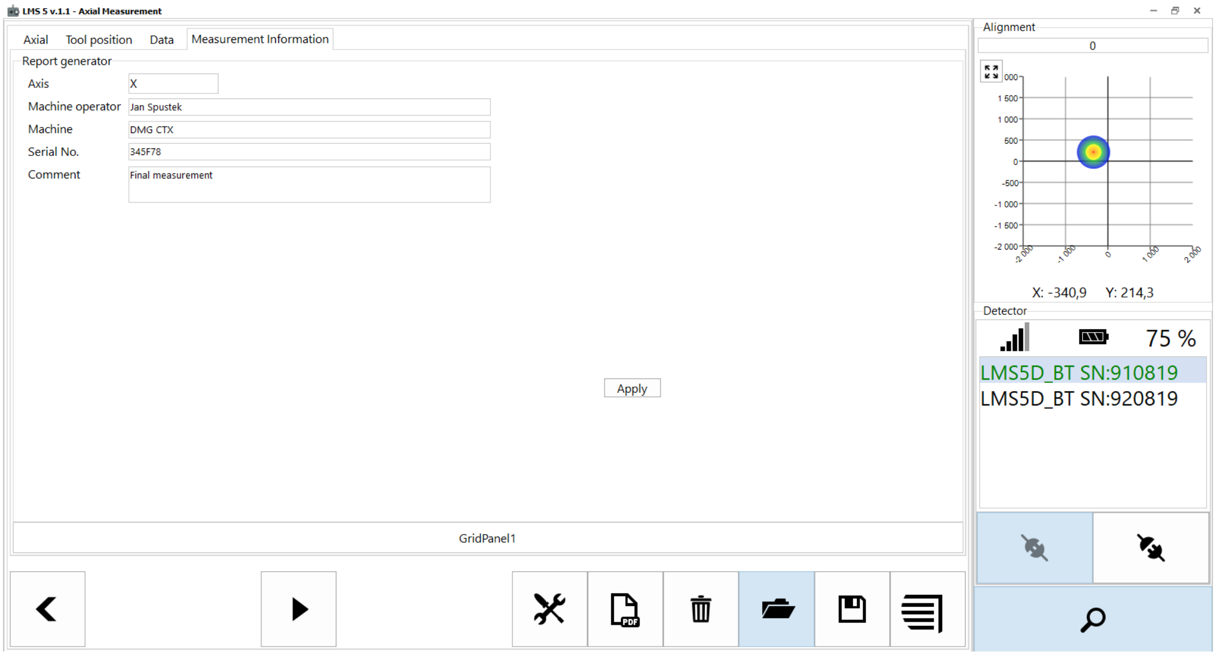
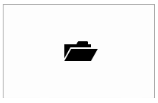



**Figure 4.20** *Axial measurement window – Measurement Information panel.*

## Straightness measurement window

When the axis straightness measurements are requested then the *Straightness measurement* 

button is to be pressed. In the windows that would appear (Figure 4.21) either a new measurement can be started  or an old result can be read  analysed or printed.

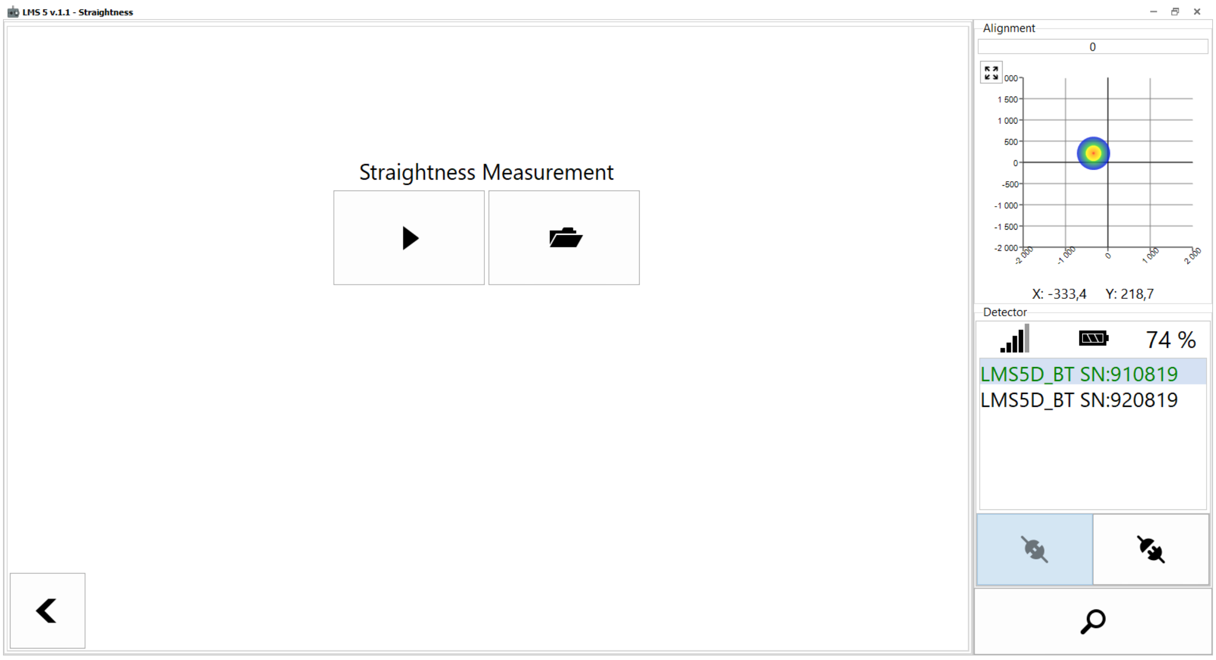



**Figure 4.21** *Straightness measurement window – initial screen.*

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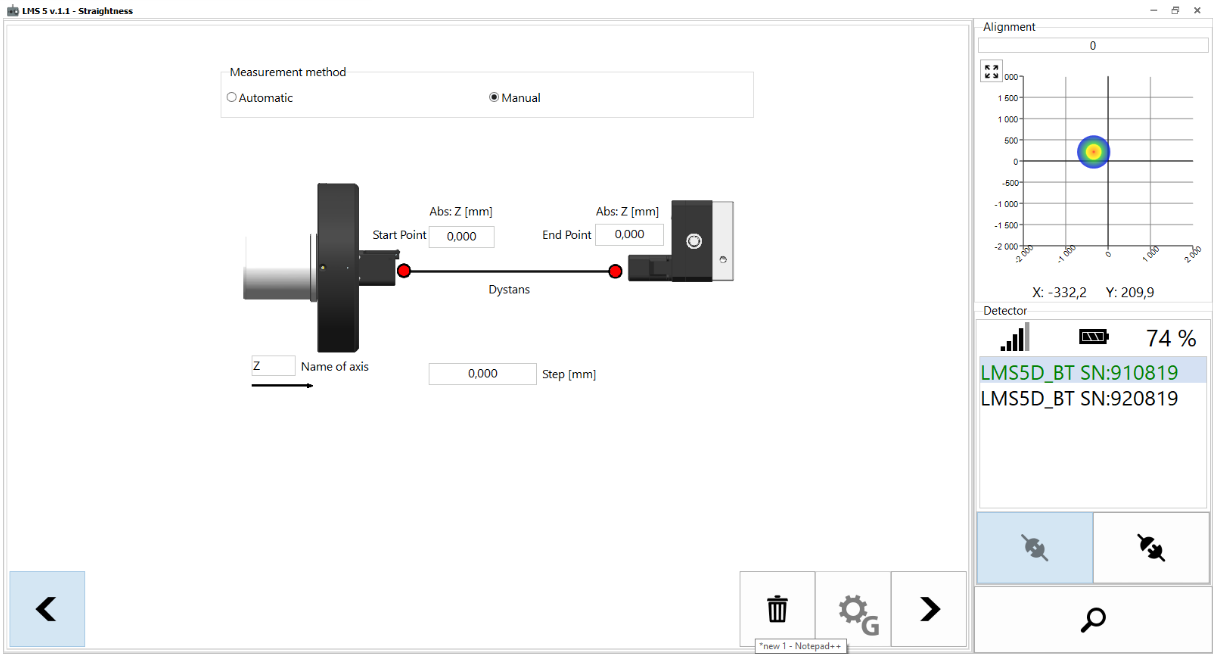
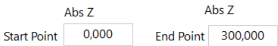



**Figure 4.22** *Straightness measurement window – Measurement configuration choice.*

The Straightness measurement may be performed in two modes: Automatic or Manual. Both modes require configuration as shown in the Measurement Configuration window (Figure 4.22). First the alias names of the measured axis needs to be inserted into the appropriate field 

.

The machines coordinates of the measured axis edge points are to be inserted in the *Start point* and *End point* fields 

with the distance between measurement stages placed in the *Step* field 

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After the configuration is finished, the g-codes program can be generated for the machine. After pressing the  button the window would appear as shown in Figure 4.23. Depending on the measurement mode (Automatic or Manual) and the type of the CNC controller (Siemens, Fanuc), the generated program will be different.

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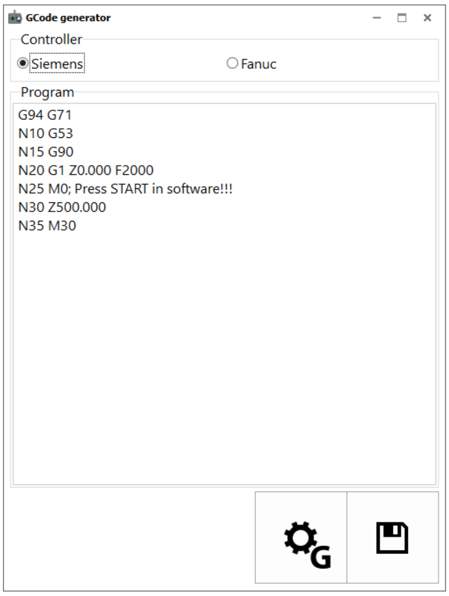


**Figure 4.23** *Straightness measurement window – Gcodes generation.*

Pressing the continue button opens the Straightness Measurement window as shown in Figure 4.24. The new measurements can be started with the Start button . If previous results are necessary then they can be read with the Load measurement button . Final results can be either printed or saved . If the measurements are to be repeated then the old measurements should be erased with the Clear data button . The return to previous screen is possible with Back button . The return to the main screen is possible with the Main menu button .

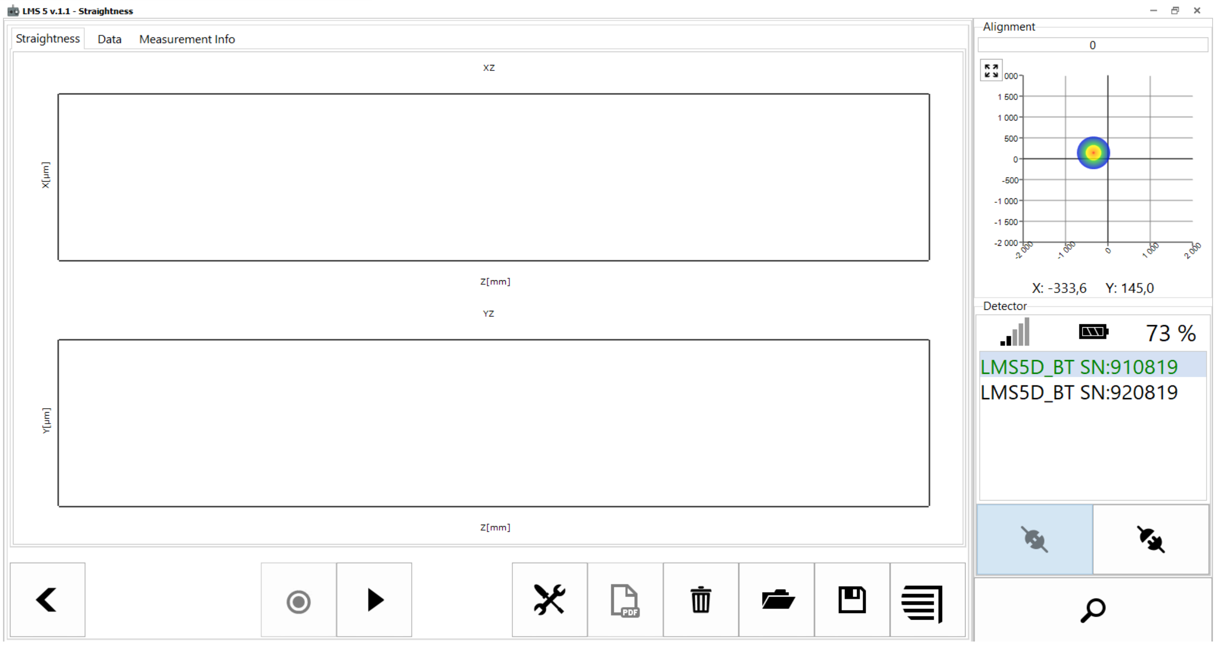


**Figure 4.24** *Straightness measurement window – Data panel.*

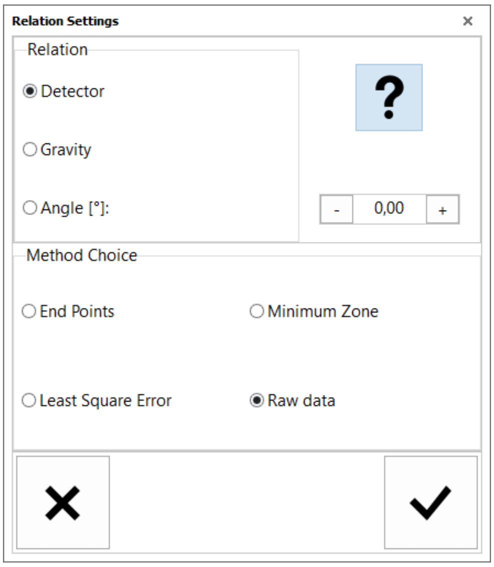


**Figure 4.25** *Straightness measurement window – Settings window.*

In the additional Settings  window the results can be rotated either to gravity or by a certain angle. It also possible to choose here the statistical methods for processing the

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straightness data – End Points, Minimum Zone, Least Square Error or Raw Data methods can be selected.

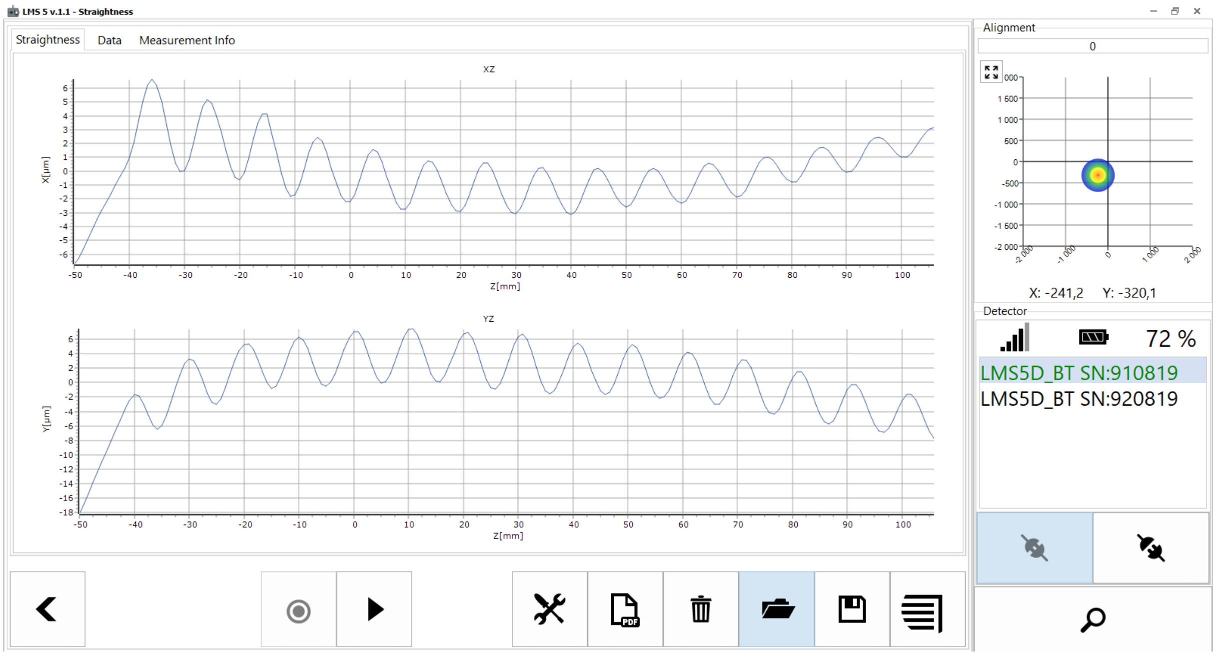
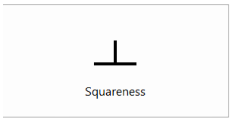
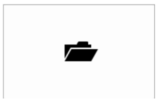



**Figure 4.26** *Straightness measurement window – Straightness panel.*

The measurement window consists of three different panels: *Straightness*, *Data* and *Measurement Information*. The appearance of the *Tool position* panel is shown in Figure 4.26. It is possible to view here the measurement results as two straightness plots. The marking of ***XZ*** and ***YZ*** in this window are in agreement with physical axes X and Y marked on the detector. The measurement data may be also viewed as a results table when the *Data* panel is chosen. The value of total errors calculated from the performed measurements are shown here. The data entered into the fields present on *Measurement Information* panel will be added to the report printout.

## Squareness measurement window

When the axis squareness measurements are requested then the *Squareness measurement* 

button is to be pressed. In the windows that would appear (Figure 4.27) either a new measurement can be started  or an old result can be read  analysed or printed.

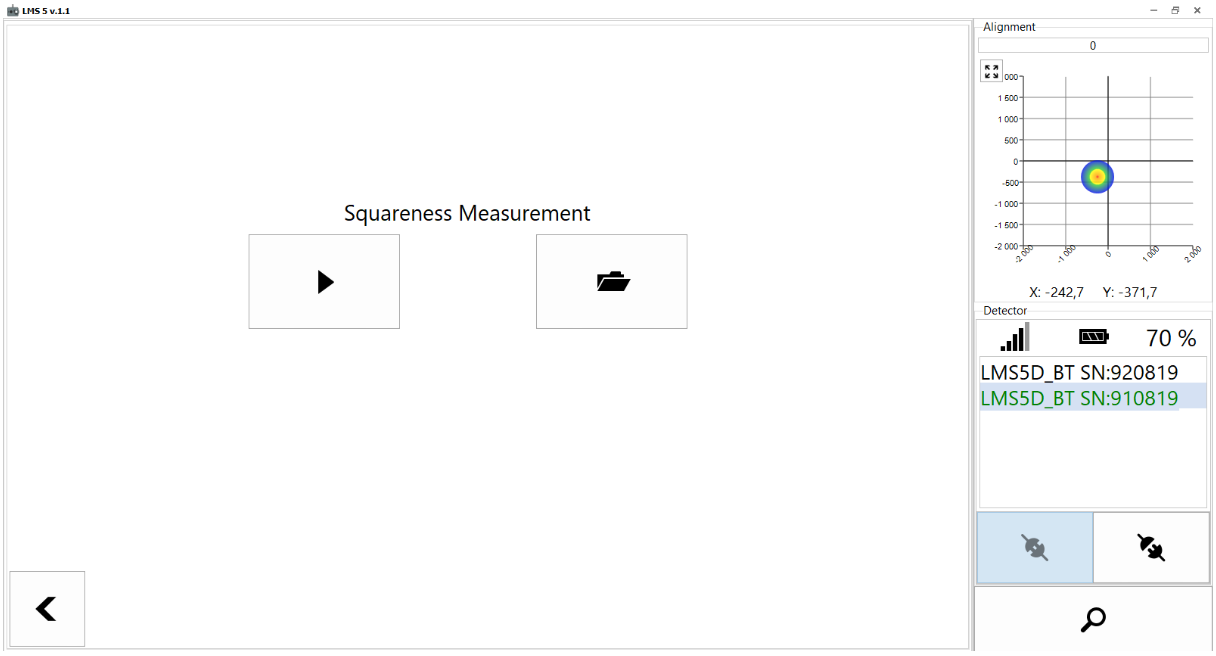



**Figure 4.27** *Squareness measurement window – initial screen.*

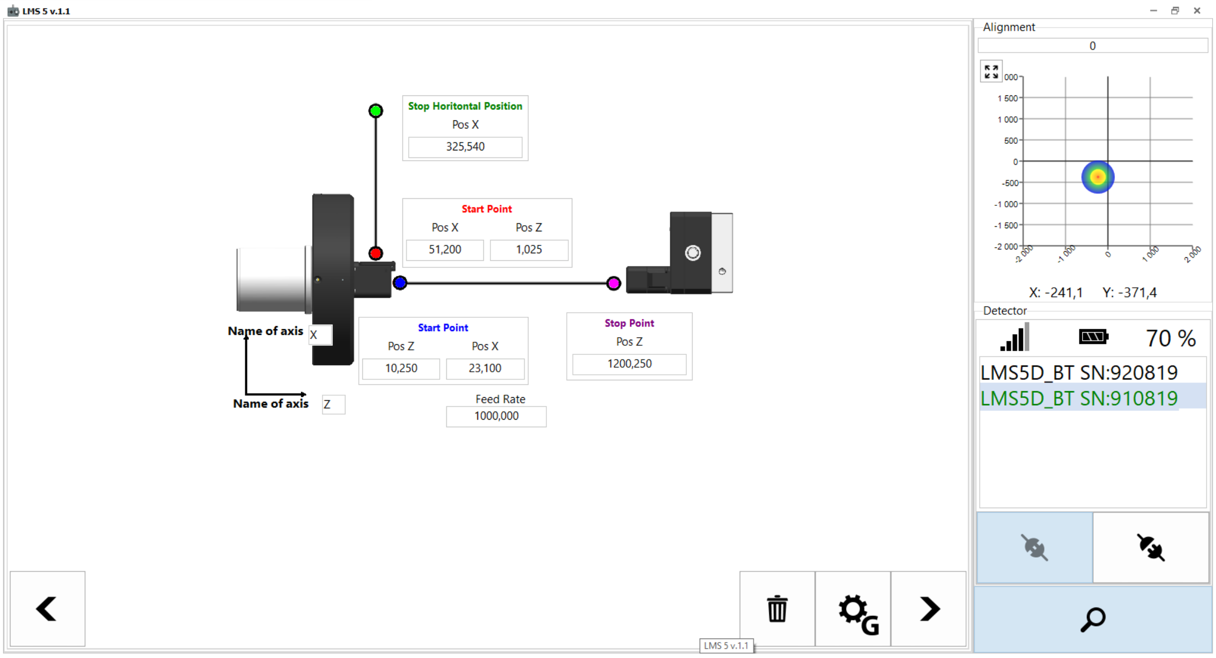



**Figure 4.28** *Squareness measurement window – Measurement configuration choice.*

The Squareness measurement can be performed either as a fully automatic measurement with configuration window shown in Figure 4.28 or by opening two performed straightness measurement.

In case of the automatic method it is necessary to generate a proper g-code program for the machine. To this first the alias names of both measured axis need to be inserted into the appropriate fields 

. Next the coordinates of the edge points are to be inserted in the coloured marked fields in Figure 4.28.

After the configuration is finished, the g-codes program can be generated for the machine. After pressing the  button the window would appear as shown in Figure 4.29. Depending on the measurement mode (Automatic or Manual) and the type of the CNC controller (Siemens, Fanuc), the generated program will be different.

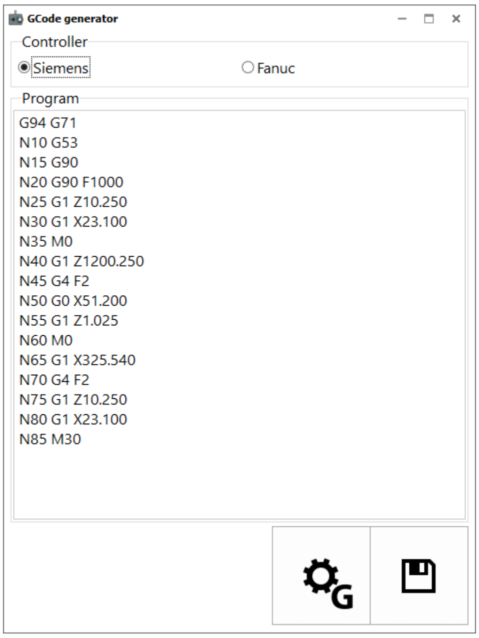



**Figure 4.29** *Squareness measurement window – Gcodes generation.*

Pressing the continue button opens the Squareness Measurement window as shown in Figure 4.24. The new measurements can be started with the Start button. If previous results are necessary then they can be read with the Load measurement button. Final results can be either printed or saved. If the measurements are to be repeated then the old measurements should be erased with the Clear data button. The return to previous screen is possible with Back button. The return to the main screen is possible with the Main menu button.

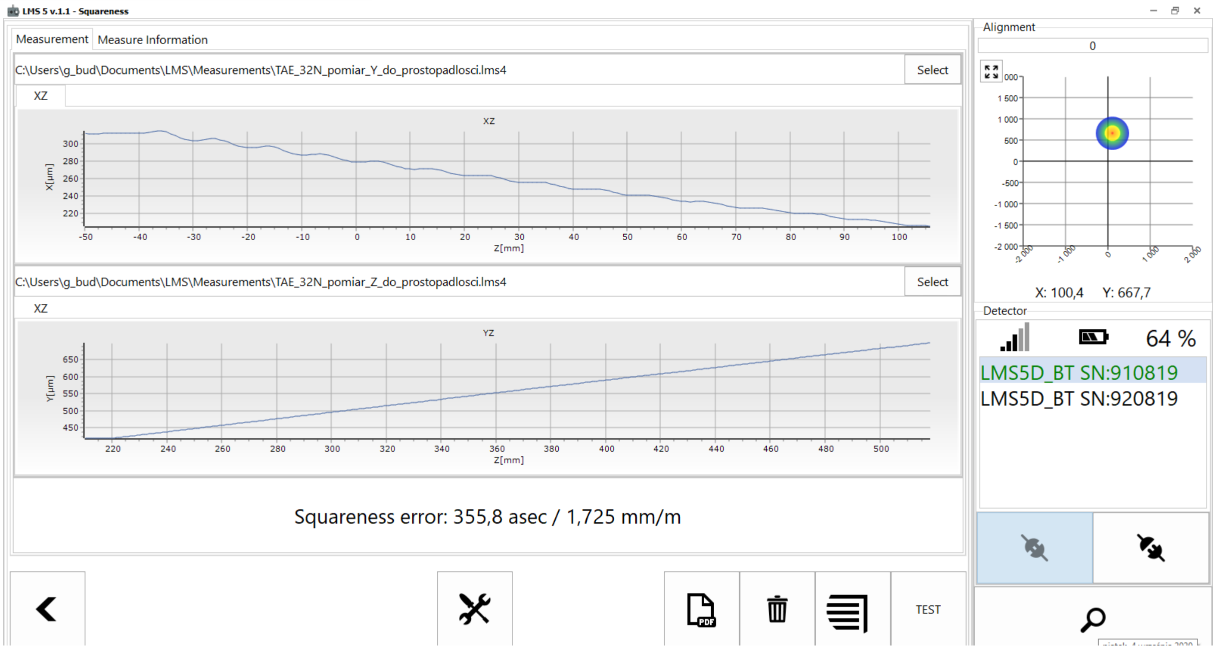



**Figure 4.30** *Squareness measurement window.*

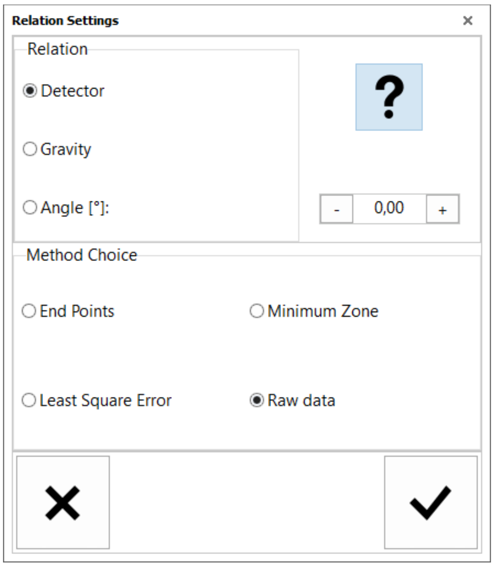



**Figure 4.31** *Squareness measurement window – Settings window.*

In the additional Settings  window the results can be rotated either to gravity or by a certain angle. It also possible to choose here the statistical methods for processing the

straightness data – End Points, Minimum Zone, Least Square Error or Raw Data methods can be selected.

The measurement window consists of two panels: *Measurement* and *Measure Information*. The appearance of the first panel is shown in Figure 4.30. It is possible to view here the measurement results as two straightness plots. If the measurement was performed in the automatic mode then data on both plots will be displayed right after the measurements. Otherwise the data on each plot have to be uploaded manually with the *Select* buttons. The marking of ***XZ*** and ***YZ*** in this window are in agreement with physical axes X and Y marked on the detector. The value of out-of-square error is are shown below plots. The data entered into the fields present on *Measurement Information* panel will be added to the report printout.

## 5. Measurement procedures

LMS5 is a device for delivering multiple information about numerical and manual machine tools in a simple way. All possible information are gathered with three different measurements: Axial, Straightness and Squareness. Moreover when either Axial measurement or Squareness measurement is performed then Straightness measurement becomes redundant. In the following paragraphs there are explained measurement procedures for the supported measurement types.

### Axial measurements

Axial measurements are the type of tests performed when the laser source is rotating. Both laser source and detector can be moved along the laser beam. It's the simplest way of checking various errors of a lathe spindle or a milling machine head. It is possible to configure the device to expect data either in **Manual** or in **Automatic** mode. In both modes the laser source unit is to be mounted in the spindle.

#### Axial measurement – stage 1

Measurement starts when the rotation of the spindle begins – see Figure 5.1. The direction of rotation is not important. Only the maximum rotation speed is limited (see Technical Data chapter for more details). The optimal rotation speed depends on the measurement type but for most cases is between 10 and 100 rpm.

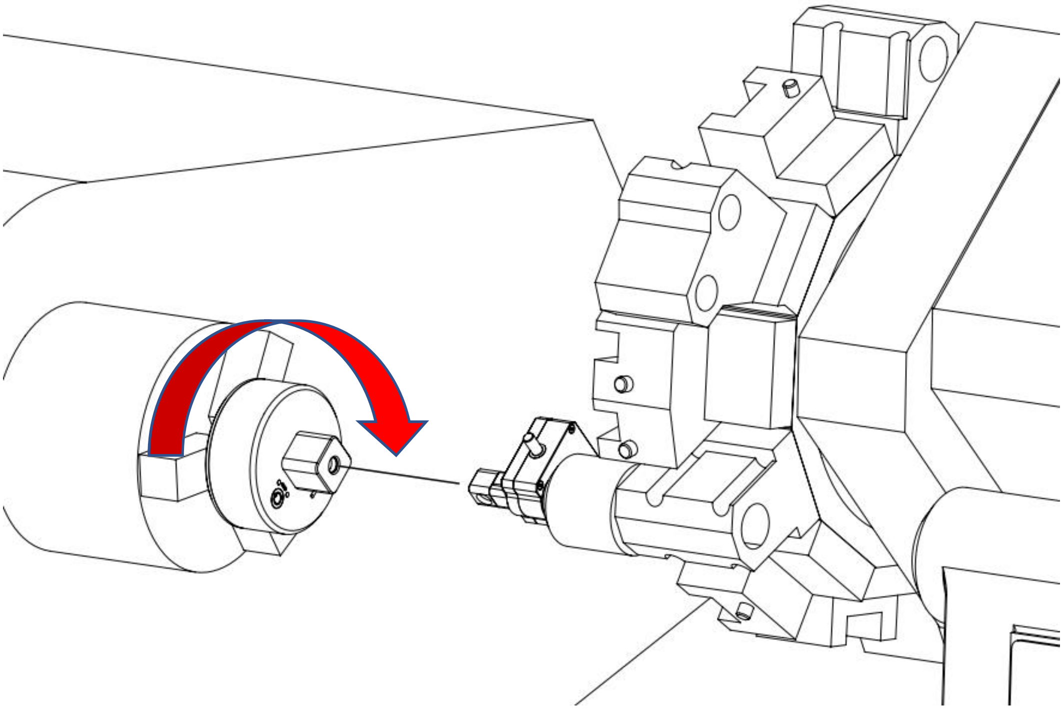


**Figure 5.1** *Axial measurement – stage 1: spindle rotation.*

### Axial measurement – stage 2

In the next stage the detector should be mounted on a tool turret or a tailstock and then placed as closed to the laser source unit as possible (Figure 5.2) – be very careful for the elements **not to collide**!!!

The next measurement stage depends on the chosen mode.

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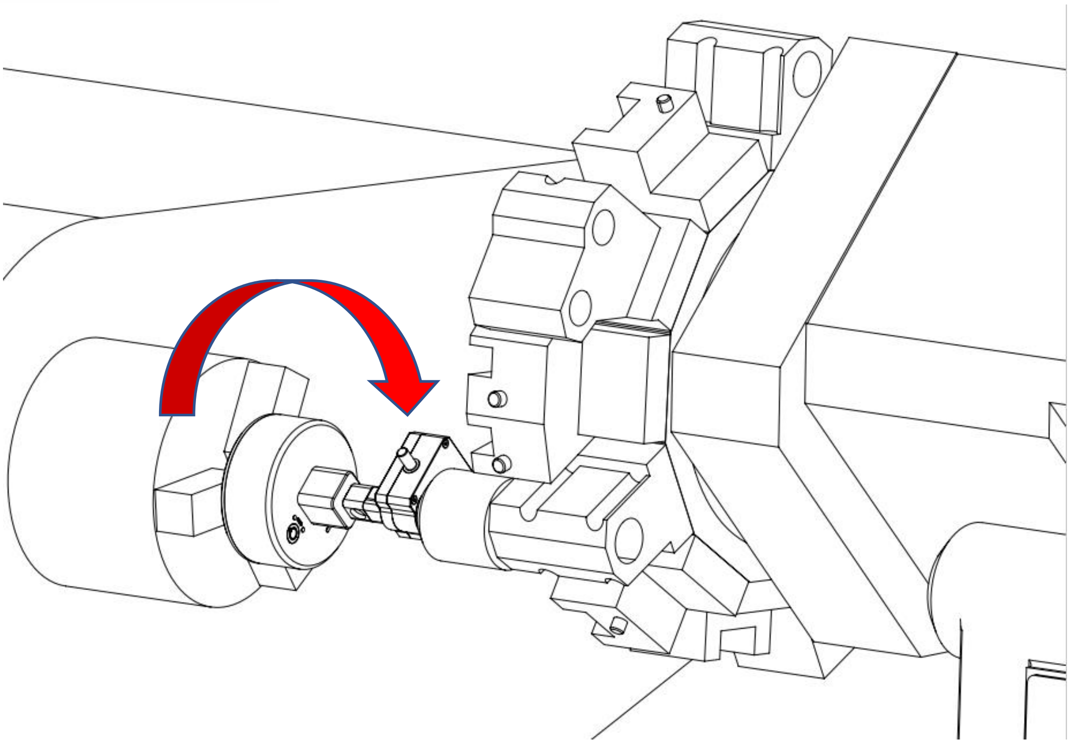

**Figure 5.2** *Axial measurement – stage 2: preparing start position.*

## Axial measurement – stage 3 in manual mode

In the **Manual mode (see Figure 5.3)** the software has to be started with properly chosen value of the Step, i.e. the distance between measurement points. The measurement can be started by pressing the Start button in the software. After the laser source rotates at least once the measurement of the point can be stopped by pressing the Stop button in the software. Than the machine element with the detector unit is to be moved to next point, measurement is to be started for at least one rotation and then stopped. It is possible to finalize measurement procedure before the number of points set in the *Step* is reached.

The Manual mode is especially useful during tests of manual machine tools.



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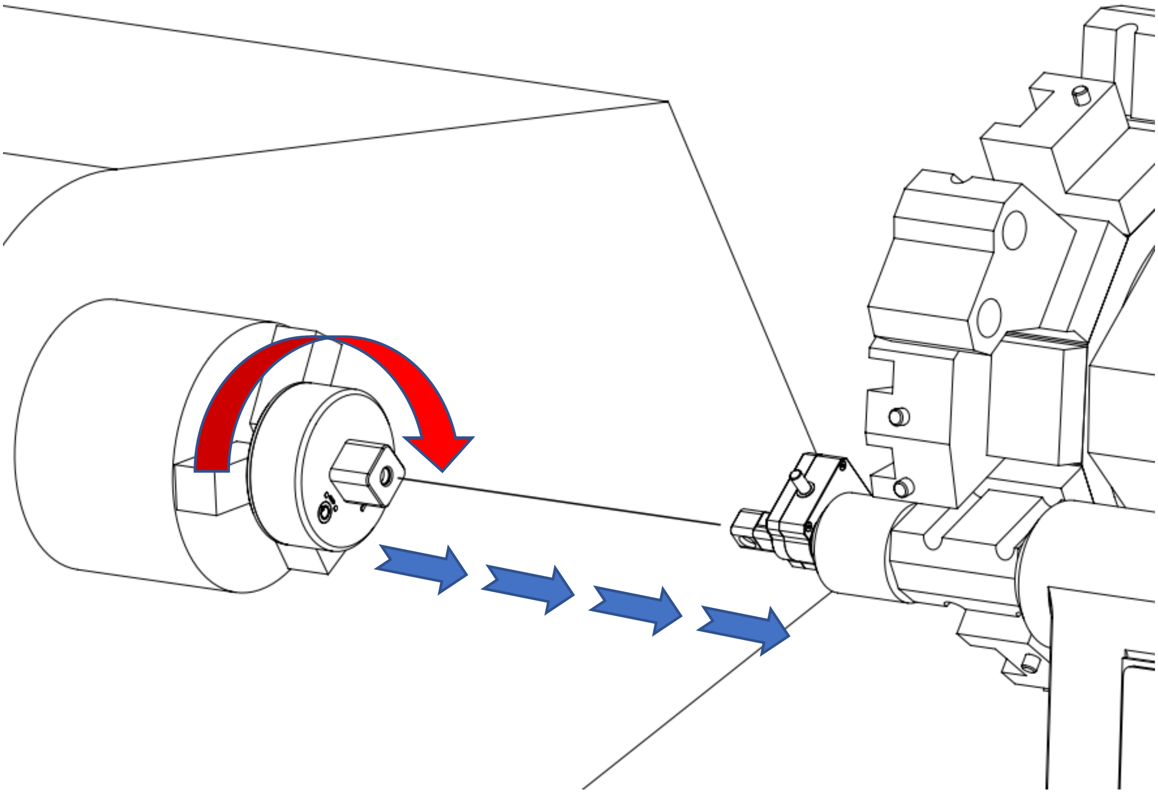

**Figure 5.3** *Axial measurement – stage 3 in manual mode.*

### Axial measurement – stage 3 in automatic mode

In the **Automatic mode (see Figure 5.4)** the software gathers necessary information without the need for user intervention during measurement process. It is important to use the g-code program generated during Axial measurement configuration in LMS5 Software. The measurement is started by pressing the Start button in the software and then starting the g-code program in the machine controller. The whole measurement will be performed automatically. The user **must not** modify the machine feed rate during the measurement procedure. After the test is finished, machine would return to the start position, stop and the obtained results would be displayed.

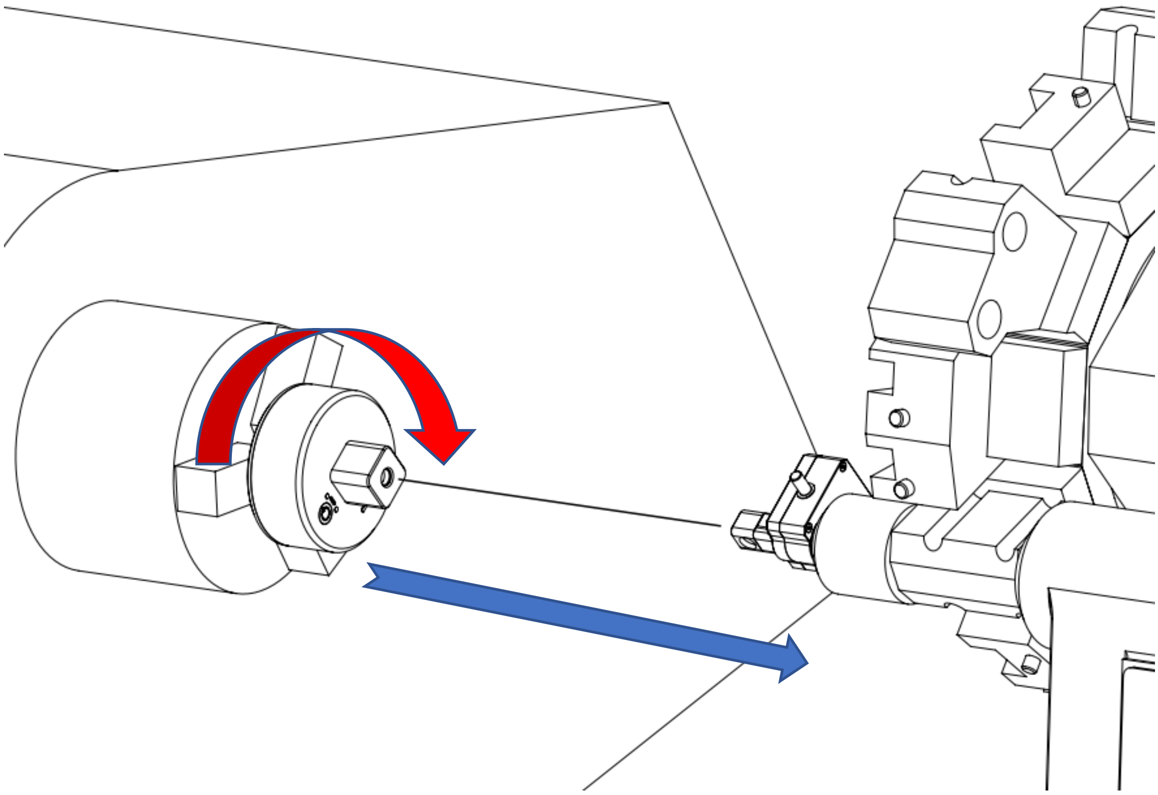

**Figure 5.4** *Axial measurement – stage 3 in automatic mode.*

## Axial measurement – stage 4

During the last measurement stage the received results should be analysed. The Axial measurement delivers various information yet their meaning depends on the physical configuration used and on the tested machine type. For example after Axial measurement of a standard lathe like in Figure 5.4 errors G2, G4, G5, G6, G7 and G8 as defined in ISO 1708:1989 can be received after only one complete measurement cycle.

## Straightness measurements

Straightness measurements are the type of tests performed when the laser source is not rotating. Both laser source and detector can be moved along the laser beam. The results of a single straightness measurements can be used as a part of Squareness measurement. It is possible to configure the device to expect data either in **Manual** or in **Automatic** mode.

### Straightness measurement – stage 1

Before the measurement the laser source and the detector are to be mounted so the laser light falls onto the detector during the whole movement range of the machine. None of the device elements is to rotate. When the elements are aligned along the laser line then they should be placed as close to each other as possible, in a start position. Be very careful for the elements **not to collide!!!**

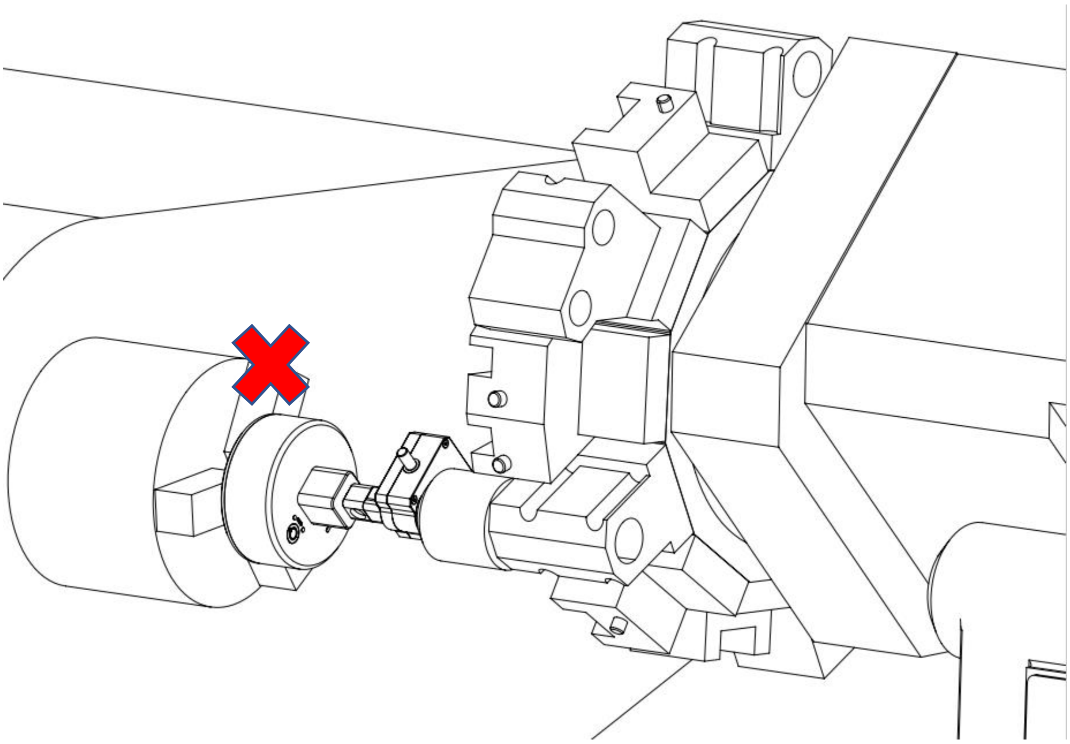

**Figure 5.5** *Straightness measurement – stage 1: preparing start position*



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The next measurement stage depends on the mode chosen in the LMS5 Software.

### Straightness measurement – stage 2 in manual mode

In the **Manual mode (see Figure 5.3)** the software has to be started with properly chosen value of the Step, i.e. the distance between measurement points. The measurement can be started by pressing the Start button in the software. After the laser source rotates at least once the measurement of the point can be stopped by pressing the Stop button in the software. Than the machine element with the detector unit is to be moved to next point, measurement is to be started for at least one rotation and then stopped. It is possible to finalize measurement procedure before the number of points set in the *Step* is reached.

The Manual mode is especially useful during tests of manual machine tools.

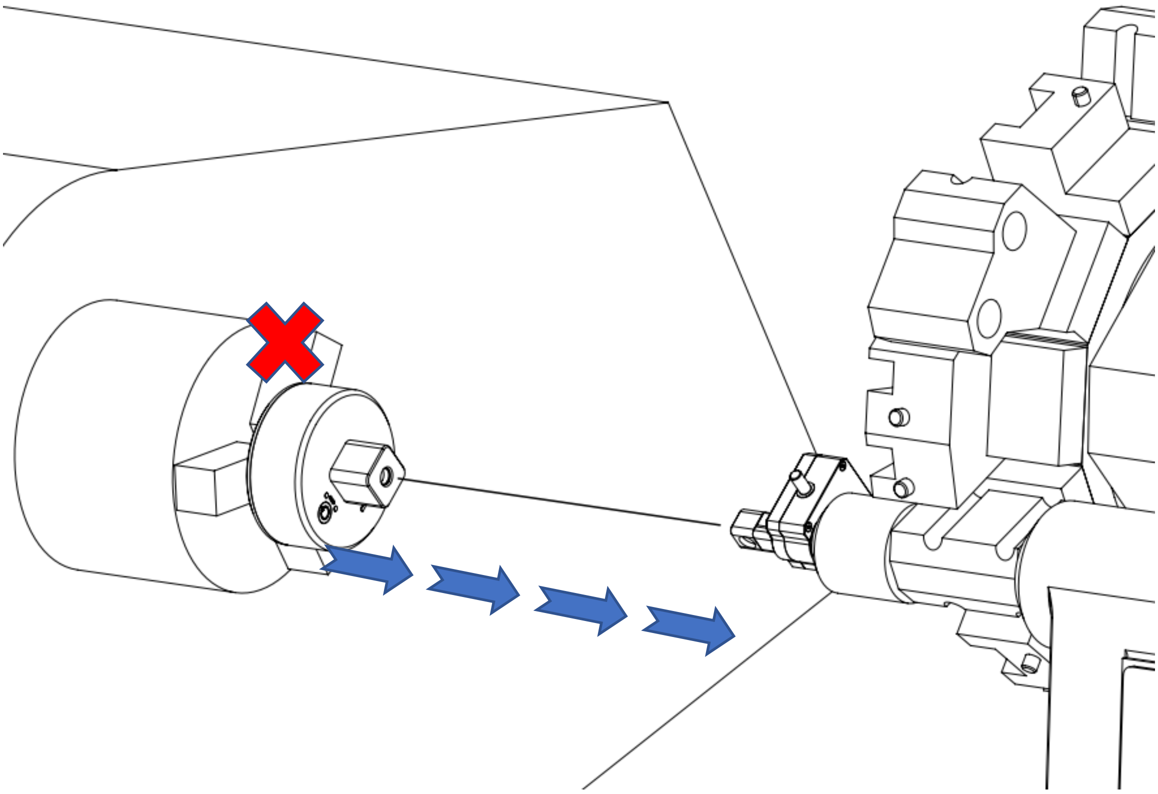

**Figure 5.6** *Axial measurement – stage 2 in manual mode.*



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### Straightness measurement – stage 2 in automatic mode

In the **Automatic mode (see Figure 5.4)** the software gathers necessary information without the need for user intervention during measurement process. It is important to use the g-code program generated during Axial measurement configuration in LMS5 Software. The measurement is started by pressing the Start button in the software and then starting the g-code program in the machine controller. The whole measurement will be performed automatically. The user **must not** modify the machine feed rate during the measurement procedure. After the test is finished, machine would return to the start position, stop and the obtained results would be displayed.

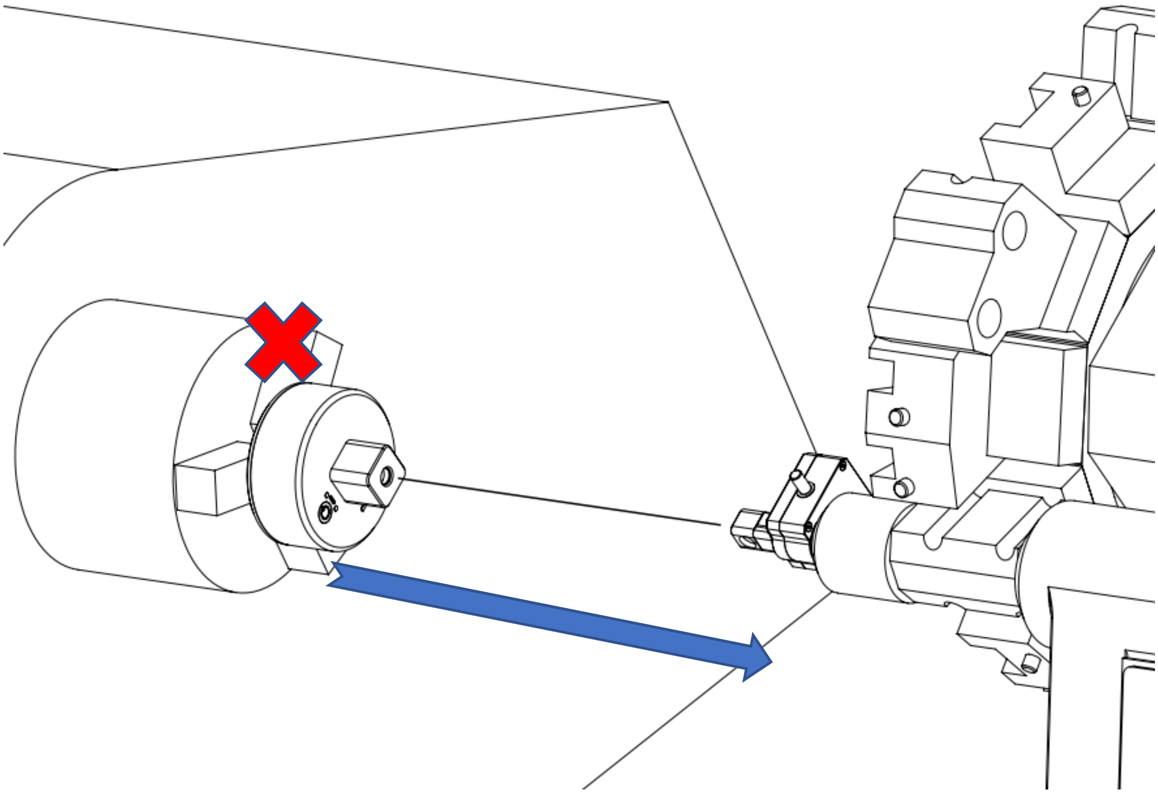

**Figure 5.7** *Axial measurement – stage 2 in automatic mode.*

### Straightness measurement – stage 3

During the last measurement stage the received results should be analysed. For the analysis the data can be view as raw reading or processed with one of three possible statistical methods: End Points, Minimum Zone or Least Square Fit. Usually the last one is chosen.

## Squareness measurements

Squareness measurements are performed when there is a need to check is two axes are perpendicular to each other. Both laser source and detector can be moved along the laser beam but none of them is rotating. It is possible to configure the device to expect data either in **Automatic** mode or the data from two separate Straightness can be manually loaded and analysed. Below there is describe preparations and the procedure itself for automatic measurements.

### Squareness measurement – stage 1

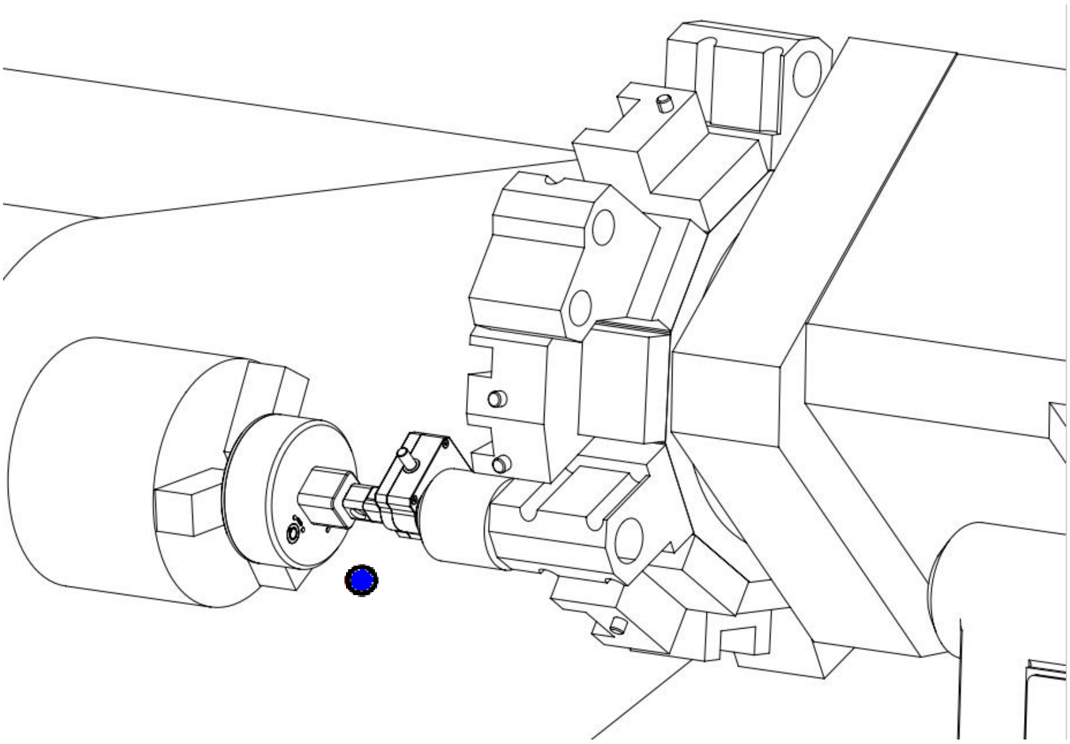

**Figure 5.8** *Squareness measurement – stage 1: position of machine in blue point*

Before the measurement the laser source and the detector are to be mounted so the laser light falls onto the detector during the whole movement range of the machine in the first measured axis. None of the device elements is to rotate. When the elements are aligned along the laser line then they should be placed at the begin and end position of the axis. The coordinates of both points should be read and entered to the LMS5 software on the Squareness configuration screen (blue and violet point).

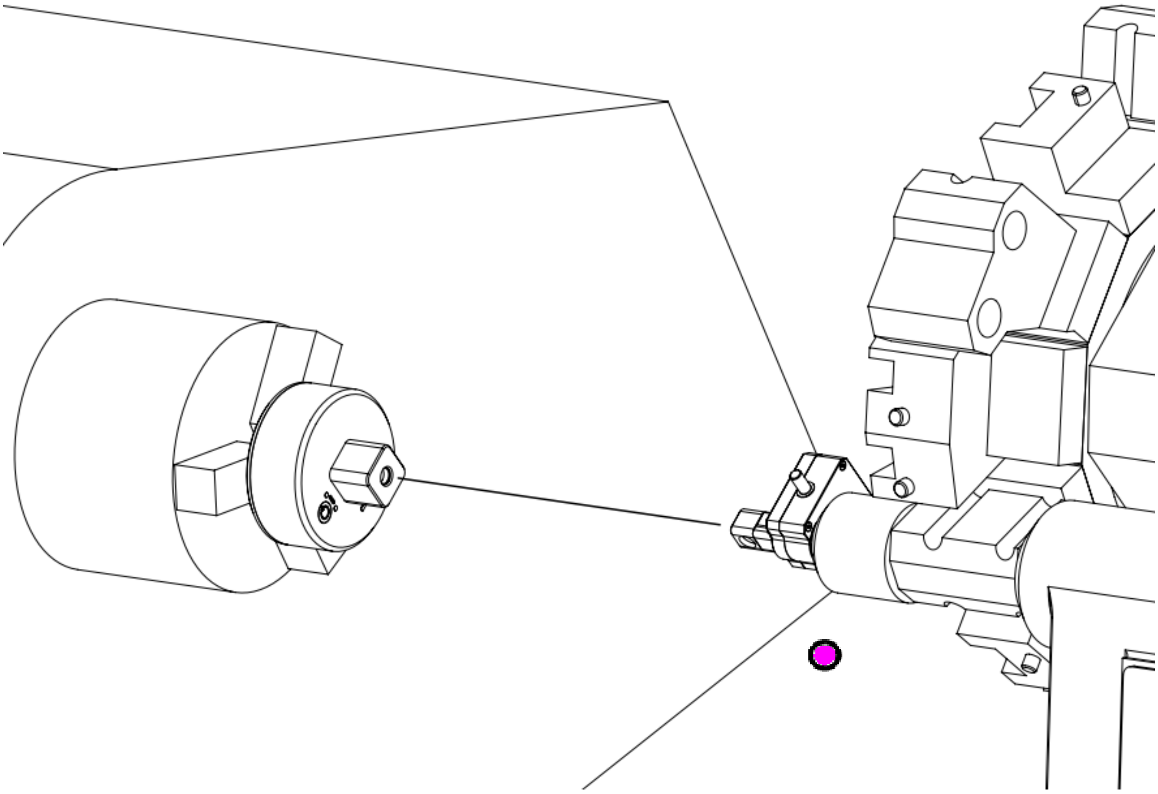

**Figure 5.9** *Squareness measurement – stage 1: position of violet machine in point*

### Squareness measurement – stage 2

In the second stage the elements should be aligned along the laser line in the second measured axis, i.e. along the second output beam. Then the detector should be placed at the begin and end position of this axis. The coordinates of both points should be read and entered to the LMS5 software on the Squareness configuration screen (red and green point).


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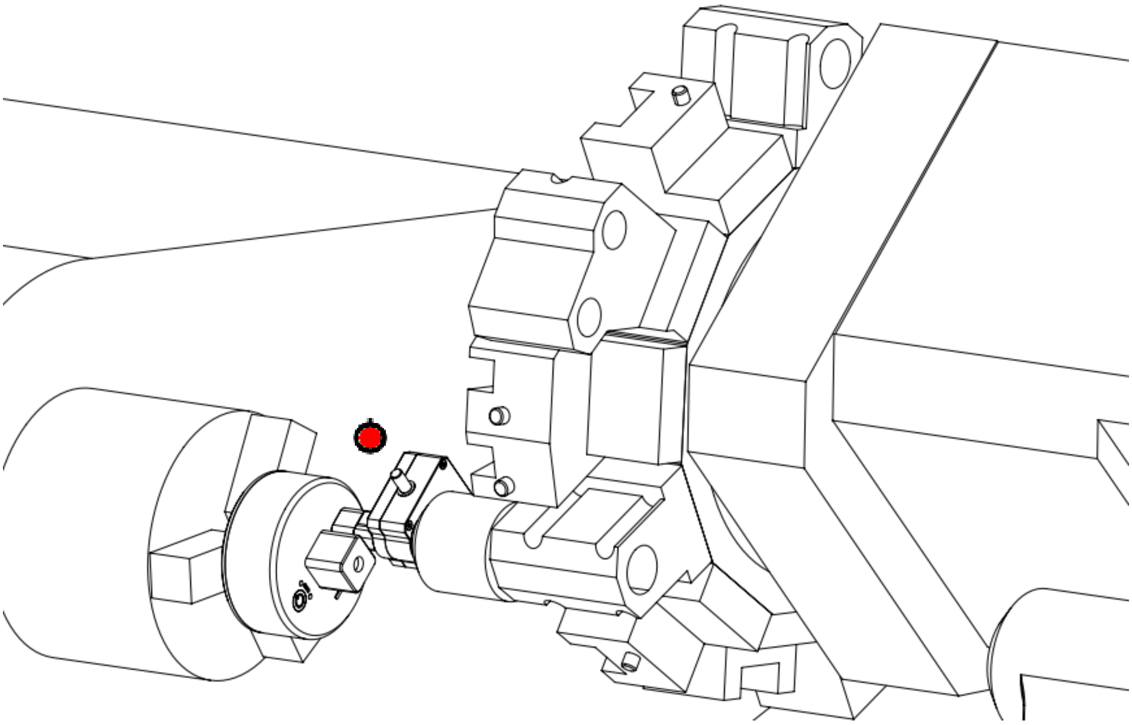

**Figure 5.10** *Squareness measurement – stage 2: position of machine in red point*

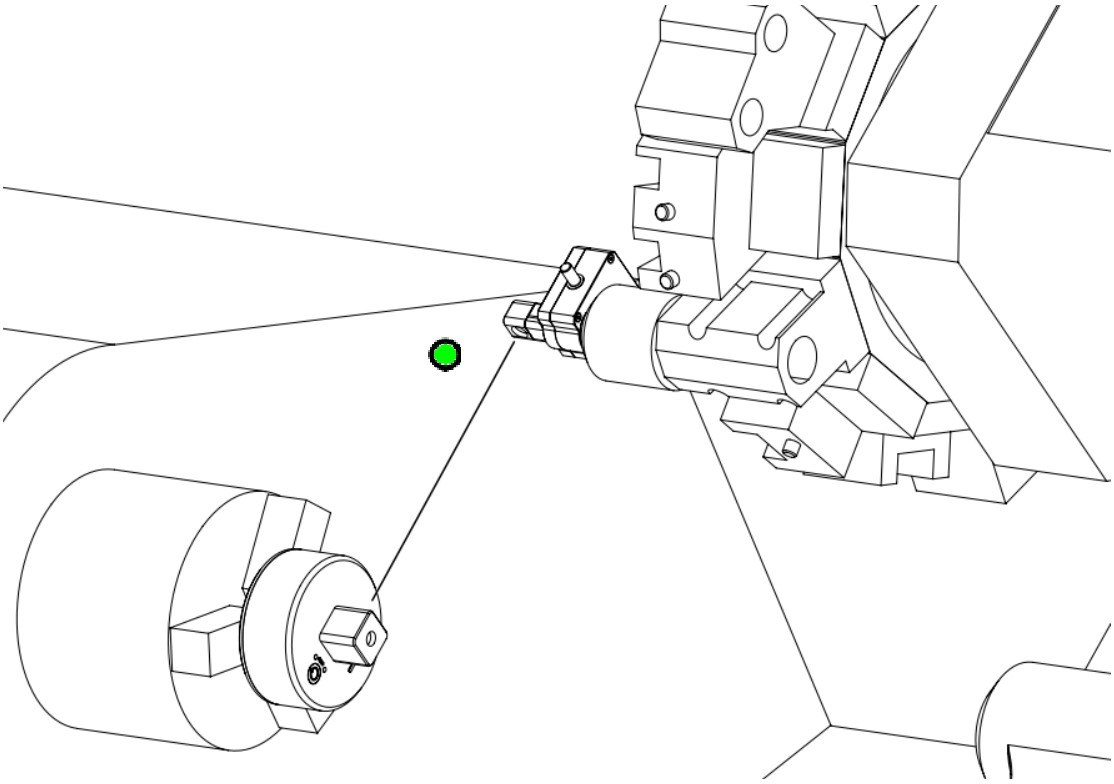

**Figure 5.11** *Squareness measurement – stage 2: position of machine in green point*

## Squareness measurement – stage 3

The g-codes software should be uploaded to the machine tool controller and should be executed. The detector will be automatically placed in the initial point of the measurement – i.e. at the coordinates of the blue point from the configuration screen and the machine will stop waiting for starting the data registration in the software. After the Start button in the software is pressed, also the machine is to be started. The measurements will continue and finish automatically.

## Squareness measurement – stage 4

During the last measurement stage the received results should be analysed. For the analysis the data can be view as raw reading or processed with one of three possible statistical methods: End Points, Minimum Zone or Least Square Fit. Usually the last one is chosen.

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## 6. Technical data

### Laser Source Unit:

| | |
|---|---|
| Laser source type | Intensity stablilized semiconductor laser |
| Wavelength | 635nm |
| Diameter of laser beam | ~ 4mm |
| Output power of laser | <0.6mW |
| Laser head dimensions | 130x110 mm |
| Laser head weight | 790g |
| Battery life | >18h |
| Charging time | ~ 3.5h |
| Battery type | LI-ION 2050 mAh |
| Ambient temperature range | 10 - 40 C |
| Safety class | Class 1 laser device according to PN-91/T-06700 |
| USB port | Micro USB |

## Beam Detector Unit:

| | |
|---|---|
| Measurement range | 2mm |
| Measurement accuracy | <5um |
| Detector dimensions | 130x70 mm |
| Detector weight | 450g |
| Battery life | >12h |
| Charging time | ~ 3.5h |
| Battery type | LI-ION 2050 mAh |
| Ambient temperature range | 10 - 40 C |
| Comunication interface | USB/Bluetooth |
| USB port | Micro USB |

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