3D Scanner Heavy Duty Quadro

EVIXSCAN 3D

User guide

designed by

evatronix

Contents

1. General

1.1. Safety Manual

NOTE: Improper use of this device may cause damage, damage of other equipment connected to it, electrical shock, injury and even death to the user. Before using the unit, read and understand the user manual.

NOTE: The eviXscan unit meets the stringent requirements for electromagnetic compatibility (EMC). However, it may affect the operation of other devices.

NOTE: The device is equipped with a class 1 laser in accordance with the documents DIN EN 60825-1:2008-05. It is a safe device, but you should avoid looking at the laser beam. Looking directly into the beam with the use of optical elements (magnifiers, binoculars or telescopes) can be dangerous to health.

NOTE: Avoid looking directly into the projector's beam. Avoid a situation where the user is standing facing in front of the light beam.

NOTE: Due to the continuous development of its products, the manufacturer of the device reserves the right to make changes in design described in this guide without notifying the user.

1.1.1. General rules of procedure with the device

- Due to its structure, this unit can be and is a source of interference. Do not use the unit in places and situations where it is prohibited to use devices that can cause interference or other risks. Caution should be exercised in situations where human life could be at risk. Such situations include, e.g. the presence of medical equipment, pacemakers and other devices whose failure could affect human life or health. Connecting signal inputs and outputs to a PC may cause interference by the system. The user must be aware of this risk and must take all precautions so as to prevent the measuring system from emitting interference above the permissible standard.
- The device can optionally be watertight, but normally it is only dust-proof. Protect from humidity. Do not allow the situation which could result in the unit being exposed to moisture due to the temperature difference between the unit and the environment. If it gets wet, do not switch the unit on before it dries.
- Make sure the unit is kept in places free of dust and other dirt.
- Protect the unit against mechanical damage. Do not expose it to overload caused by e.g. falling or shaking.
- Protect the unit from ESD and other situations, in which an electric field, magnetic field or any radiation could damage the unit. Beware of electrostatic discharge that can damage eviXscan and the equipment connected to it. Remember that in the case of electrostatic discharges, ensuring the zero-point potential is insufficient.
- While cleaning the unit, do not use substances that can damage its electronics or housing and other components.

- Remember to backup all important data on the computer you are connecting the eviXscan system to.
- Before connecting to another device, make sure that all the rules of safety and electromagnetic compatibility are observed.
- The housing of the eviXscan 3D measuring unit can present a mechanical hazard. Keep the unit or its components away from children. Keep in mind the small elements, long wires, sharp and hard spots in the housing as well as other mechanical and electrical hazards. Also make sure the system or its components do not cause any injuries in those it comes in contact with.
- While using the device, be sure to follow the law and adhere to the generally recognized standards and customs. Do not allow the use of the unit to violate the rights of others. This is important because of the unique features of the unit, which can seriously make life difficult for other people if used inappropriately.
- Never exceed the permissible voltages.
- Only use the appropriate plugs and other joints that will ensure safe use and secure the system against damage.
- When you connect other devices to the system, first connect the grounds of the equipment..
- Regardless of the permissible operating voltage of the unit, keep extra precautions when working with voltages above 30V AC effective, 42V AC peak and 60V DC. These voltages can endanger health and life.
- Before opening the device, disconnect it from other devices. This provision does not allow the user to open the device without losing the warranty, unless they had received such authorization upon purchase.
- When servicing the unit, only use the manufacturer’s recommended spare parts. If you have questions, contact the manufacturer of your local sales representative.
- Avoid making short circuit on the output lines of the unit.
- Make sure that the power is supplied the computer and the unit from the same power strip. This will reduce the unit’s sensitivity to electromagnetic interference from the emerging current loops.
- Do not use the unit or its components if they are damaged, wet or dirty. Before each use, inspect the unit and its equipment for damage. If the unit is not working properly, or if in doubt, contact an authorized service center or manufacturer.

1.1.2. Environmental protection

This product contains substances hazardous to health and the environment. For this reason, the unit must not be disposed of with other household waste. Should you wish to get rid of the device, dispose, reuse or recycle its components, the correct procedure is to take the unit to a designated collection point. In some cases, the unit can be given to the retailer upon the purchase of another device. Remember that through the proper disposal of the unit, you are preserving valuable resources and avoiding risks posed by improper waste handling. For detailed information on the available collection points, please contact your local authorities. Improper disposal of waste involves legal penalties.

1.1.3. Initial start-up, general recommendations

Proficient use of the eviXscan 3D measurement system requires reading the unit's documentation thoroughly. Depending on the type of device, the set is supplied with a user manual intended for the specific type of scanner. Regardless of the type of the scanner, all devices must go through a commissioning process, which involves following several basic steps:

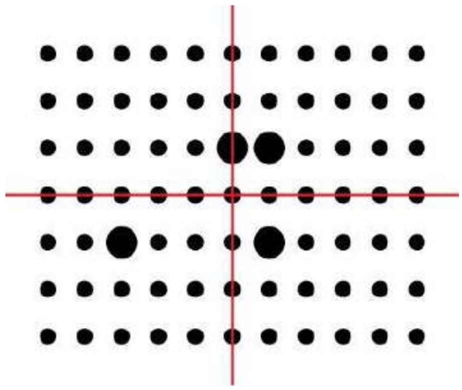
- **Unpacking the unit.** If you receive a new scanner, check in the presence of the courier, if there are no grounds to question the form of transport for possible damage to the 3D scanner
- If the device has been transported from a cold place, be sure to **wait the necessary time** for temperature of the unit or its equipment, especially the calibration charts, to prevent moisture condensation on the inside or outside of the device. To do this, leave the unit in its case until the temperature of the equipment reaches room temperature. If you change the temperature from -5 to +10 degrees C, please wait at least 1:30 hours.
- **Install the unit on the tripod**, prepare all cables and signal wires
- Start your computer and connect the signal cables.
- **Run the unit driver wizard.** Remember that the scanner may not work due to the current state of your system. Sometimes the operating system with too many software and drivers installed on it can prevent the proper working of the scanning system. Make sure the operating system and the computer as a whole is intended solely to support the 3D scanner.
- **Calibrate the unit** if the scanner requires a calibration process.
- **Scan** according to the guidelines contained in the user manual.

1.2. System requirements

	Configuration	
	Minimal	Recommended
Operating System	Microsoft Windows 7 or newer, 64bit	
CPU	Intel i5	Intel i7
RAM	16GB	32GB
Graphics Card	GeForce GTX500 or better	
Interface	1x USB 3.0 + 1x HDMI 1 USB port for table + 1 USB port for the dongle	

1.3. Glossary

- **3D scanner** – a device for measuring the size and shape of objects by optical methods. The eviXscan 3D scanners use structured light.
- **Artifact** – calibrated cube with unique markers, used to pre-align different scanner shots to a common frame of reference.
- **Calibration chart configuration file** – a file with a name corresponding to the calibration chart ID, which contains information about its unique characteristics. It is used during the calibration process.
- **Calibration chart ID** – an ID number that identifies the calibration chart; it is marked on the label located on the back of the chart. An example of ID: „A3T0H69V48D5N01000018".
- **Calibration chart, calibration target** – equivalent terms for a rectangular array of black spots the size of A3 sheets, used during the scanner calibration process.
- **Dongle** – device connected to the USB port, whose presence is required when attempting to generate point clouds or to run calibration.
- **Front of the calibration chart** – surface of the calibration chart with visible black spots.
- **Left side of the calibration chart** – part of the calibration chart located on the left side as viewed from the scanner towards the calibration chart.
- **Left/right sensor** – sensor on the left/right side of the light source facing the direction of the light source.
- **Light source, projector** – equivalent terms for the device used to display patterns.
- **Marker** – a characteristic circular pattern placed as a sticker on the scanned object, in order to merge different scanner shots to a common frame of reference.
- **Middle of the calibration chart** – a specific point on the calibration chart, used as a landmark during the calibration process.



- **Model (eviXscan environment)** – a set of scans. A single model should contain a series of scans of the same object.
- **Right side of the calibration chart** – part of the calibration chart located on the right side as viewed from the scanner towards the calibration chart.
- **Scan (eviXscan environment)** – a virtual model that reflects the shape of the scanned object from the given shot. Any scan can be displayed as a 3D point cloud, a mesh of triangles, or as the

so-called mesh surface. Each scan has an assigned set of information required for re-generating it.

- **Scan baseline images** – a set of photos needed to generate the scan properly.
- **Scan density** – amount of points that scanner can generate on $1mm^2$. This value depends on resolution and position of sensors and light source. It does not depend on scanner accuracy.
- **Scanner accuracy** – is equal to maximum of difference between scan points and real object points. It depend on scanner optics, calibration process, scanner configuration, scanning object and environment where scanning process take place. It does not depend on scanner resolution and scan density.
- **Scanner calibration** – defining the parameters of optical sensors and their relative positions, using a series of images of the calibration chart.
- **Scanner configuration (eviXscan environment)** – understood as a description of the physical configuration of the device along with its calibration carried out for the optical system. Thus, it is possible to create multiple scanner configurations in the environment on a single physical 3D scanner. Scanner configurations will typically have a calibration of the light path formed under different conditions.
- **Scanner resolution** – value related to camera resolution. Maximum of scanner resolution is equal to maximum of camera resolution. This value determine maximum points that can be generated from single scanning process. eviXscan software is capable to lower this value, using "Limiting the scanning area" tool. It does not depend on scanner accuracy.
- **Scanning process** – the process of obtaining and storing the information necessary to build a scan.
- **Sensor, camera** – equivalent terms for the device used for image acquisition.
- **Sight, Ellipses** – patter displayed by the light source of the scanner used to establish relative position to scanning object.
- **Stripes, F0** – pattern displayed by the light source of the scanner used to establish brightness level.
- **Triangulation, generating a mesh** – connection of adjacent points in the 3D point cloud by triangles to form the mesh surface.

2. Description of the unit

2.1. Package Contents

The eviXscan 3D Heavy Duty Quadro set consists of the following components:

- eviXscan 3D Heavy Duty Quadro scanner;
- tripod with head;
- calibration chart (A3) with frame and calibration pads (2x A3 pad for Inner and Outer scanning range);
- wiring for the scanner (5-meter harness with 1x USB 3.0, 1x HDMI and power supply);
- dongle key USB2.0;
- carrying cases for the scanner and the calibration charts;
- marker kit.

Optionally, the set can be purchased with:

- mobile tripod base;
- high-performance workstation;
- automated rotary table with wiring (USB 2.0 cable, AC adapter, power supply cable) and model for calibration.
- toolkit box (artifacts, unique markers, gloves, remote control and batteries);
- column stand with single pedal caster lock;

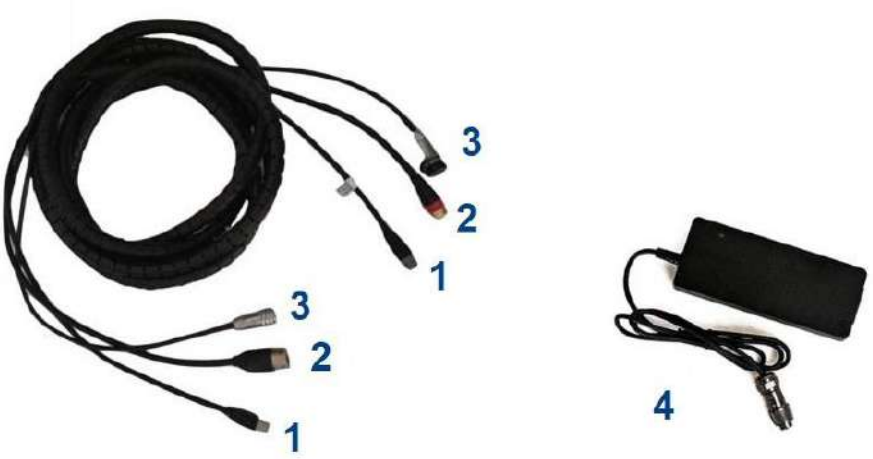
2.2. Component Description

- **Scanner** – the eviXscan 3D Heavy Duty Quadro is an optical scanner based on blue light using the LED technology.

Scanner is equipped in two sets of cameras, which allows to use two scanning ranges without need to recalibrate the unit. In the wide range, the cameras are widely spaced (1), which allows the measurement in a space of dimensions up to 370x265x150 mm with points density up to 41 pt./mm^2. In the narrow range cameras are mounted close to each other (2), so you can scan in the measurement space of 150x115x90 mm, achieving the highest accuracy and density of points up to 232 pt./mm^2. On the front side of scanner, there are filters in front of the lenses and the image projection system (3) – make sure they are clean before and during operation. After finishing the work, mount the filter covers.

On the bottom of the scanner there are: USB3.0 type B plug-in (4), HDMI plug-in (5), power supply connector (6), power switch (7), mounting plate (8) and air filters for cooling system (9) - make sure they are clean before and during operation.

- **Wiring** – a 5-meter harness for connecting the scanner to a PC with AC adapter (4). The harness consists of: USB3.0 cable (1), HDMI cable (2), and power supply cable (3).



- **Rotary table** – optional accessory to automate the scanning process. This device allows automated rotation of scanning objects.

  The tables come in two versions:

  – EV23 with max. load of 20 kg – table diameter 25 cm,

  – EV24 with max. load of 200 kg – table diameter 50 cm.

The rotary table has power input (2) and USB interface (1). The set includes a USB A-A 5m cable (3), AC adaptor 24VDC 2.5A (4) and table positioning model (5).

- **Dongle USB** – the dongle is required to run the eviXscan software in its full functionality; without it you can only view the previous scans.

- **Calibration chart** (1) – calibration charts used for calibrating the scanner's measuring area. The set includes mounting frame, which consist of arms (2), bolts (3), base (4) and A3 calibration pads (5)(6).

NOTE: DO NOT TOUCH THE SURFACE OF THE CHART WITH THE MATRIX BLACK OF BLACKDOTS IN BLACK FRAME, NOR ALLOW IT TO BE SOILED OR DAMAGED.

- **Case** – an accessory for safe transportation of the scanner and the scanner peripherals;
- **Documentation** – this manual;
- **Software** – the eviXscan software used to run the scanner and its peripherals (table);
- **Whitener** – spray for coating objects with white powder before scanning. Not included in all kits due to export restrictions;
- **PC (option):**

  – high-performance workstation,

  – necessary expansion cards.

3. Installation of the eviXscan 3D Heavy Duty Quadro

3.1. Unpacking

When proceeding to unpack the set, place each transport box with its lid facing upwards. After opening the butterfly locks, the lid of the box can be opened.

3.2. 3D Scanner

3.2.1. Assembly

- The first step is to deploy the tripod on a stable and level surface. The tripod legs should be spread wide enough to provide a stable support for the scanner. Then tighten the binding screws and attach the head.

- Tighten the screws to lock the head rotation in all three axes.

- After making sure that the tripod is stable and has blocked movement, tilt the mounting protection lever of the head and lock it, as shown in picture below (2) Level the tripod head using the bubble levels (1).

- After preparing the tripod and the base, take out scanner from case gripping the handles with both hands. Then place the scanner's mounting plate in the tripod head, locking the fixing mechanism.

- When the mounting protection lever snaps on the scanner mounting plate, keep holding the scanner with one hand by the handle and use the other hand to tighten the lever, making sure that it is completely tight and that there is no perceptible clearance.

- If the eviXscan Heavy Duty Quadro set was purchased with a mobile tripod base, the scanner can be moved easily by placing the tripod on top of the base. It is recommended to remove the scanner from the tripod before fixing the tripod base.

You must first spread the base.

All the arms of the base should be spread so that the lock snaps in each of them.

Before you set the tripod on the base, make sure that the lever lowering the wheels is up, and the wheels are not touching the ground.

Set the tripod on the base so that each leg is in the base slot. Adjust the height of the tripod and tighten all tripod locks, so as to prevent any elements of the tripod from shifting under the weight of the scanner.

Level the tripod head using the bubble levels.

Transporting the scanner on the base is possible after lowering the wheels. Just use your leg to lower the lever. After moving the tripod, lift the wheels immediately to protect the set against accidental displacement.

3.2.2. Wiring connection

Before connecting scanner make sure that power switch is in position OFF – position 0. Connection of harness to the scanner should start from choosing correct end of the harness, as shown in the picture below.

Then connect the wires to the scanner in the following order:

1. Power supply (female connector);

2. HDMI plug-in;

3. USB3.0 type B plug-in.

The other end of the harness consist of following connectors

1. **Power supply (male connector);**
2. **HDMI plug-in;**
3. **USB3.0 type A plug-in.**

Cables (2, 3) should be connected to the PC, accordingly to HDMI and USB3.0 interface. Power supply connectors from harness (1) and AC adapter (4) should be connected in accordance with the red dot marker.

3.2.3. Turning on/off the device

Before proceeding to further work, connect the power supply to the mains, remove covers from the cameras and the image projection system and start the device by turning power switch ON - position “I”. After switching on the scanner, wait a few seconds until the projector (image projection system) is started. After finishing work, put the covers back on and turn the scanner off by setting the power switch to the OFF – position “O”, then disconnect the mains supply.

3.3. Rotary table

Set the table on a stable, flat surface, connect it with the USB A-A cable (1) to the computer using USB interface. Then connect the power supply by joining connectors coming from table (2) and from AC adaptor (3). Connect the AC adaptor to the mains.

3.4. Calibration chart

Frame which holds calibrating chart, can be fixed in two ways, depending on the scanning range we would like to calibrate.

- Horizontal (1) for inner range calibration;
- Vertical (2) for outer range calibration.

In order to assemble the frame of the calibration chart, the arms should be screwed to the base using appropriate holes depending on whether you want to set the chart horizontally (1) or vertically (2). Then, by holding the handle, slide the calibration board so that it is perpendicular to the frame base.

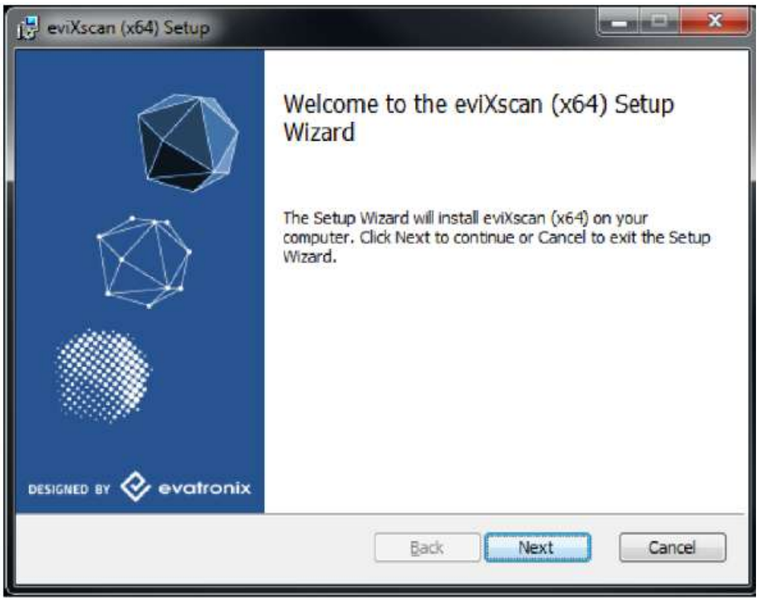
NOTE: DO NOT TOUCH THE SURFACE OF THE CHART WITH THE MATRIX OF BLACKDOTS IN BLACK FRAME, NOR ALLOW IT TO BE SOILED OR DAMAGED.

4. Software installation

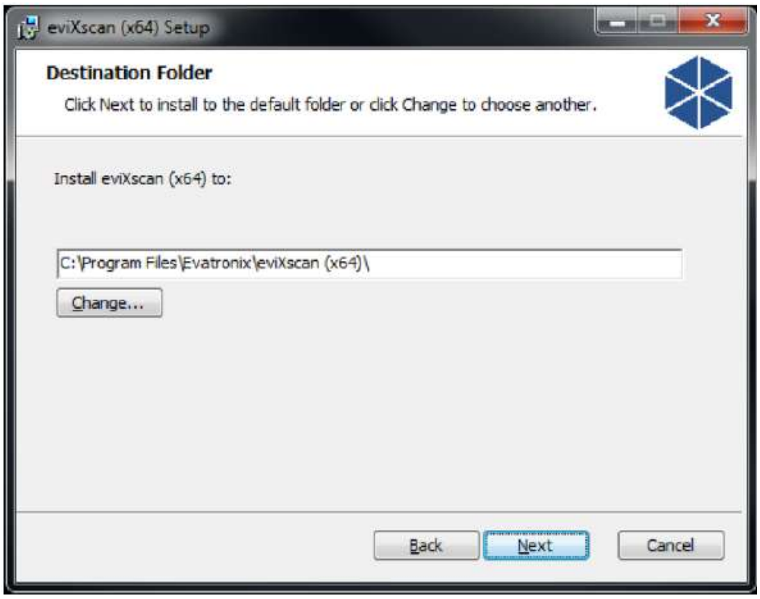
4.1. eviXscan application

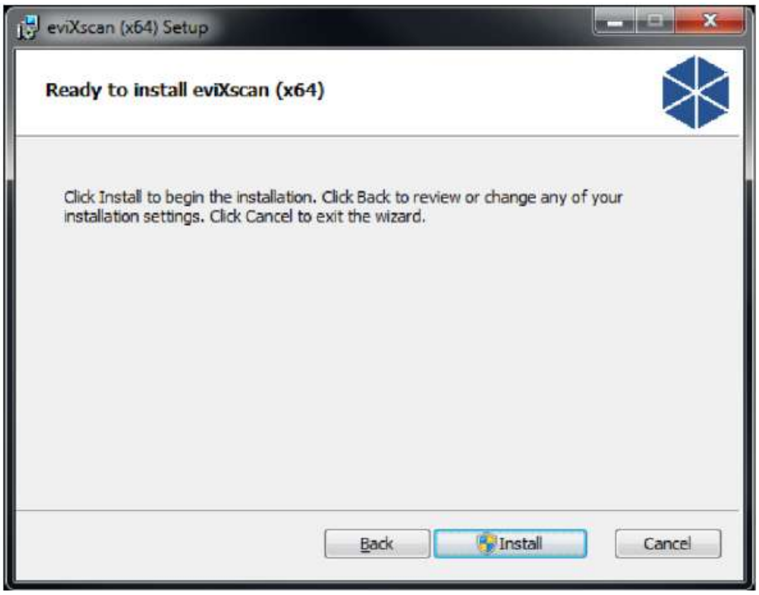
To install the eviXscan software, do the following:

- On the installation media, locate and run the file eviXscan.[version].setup.msi. (where [version] is specifying the version of the software, e.g. eviXscan.1.0.70.setup.*msi*).

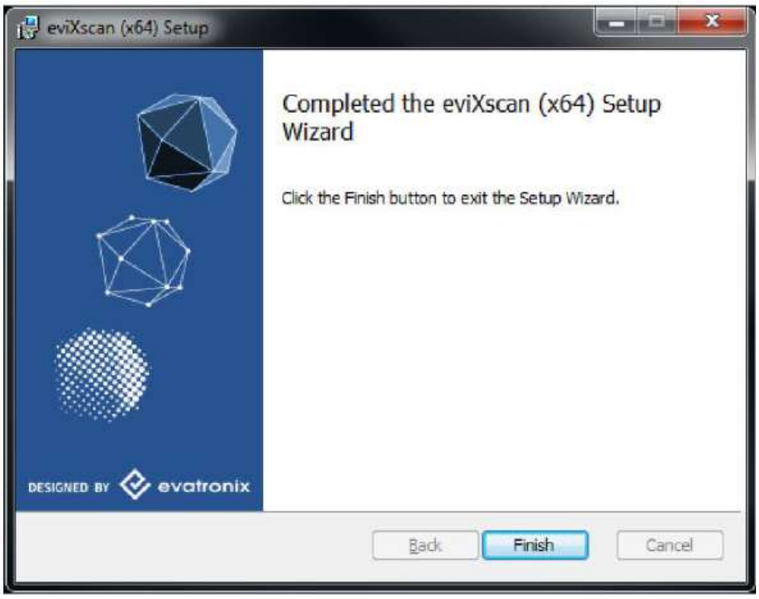


- Accept the installation steps in the wizard by clicking [Next] and confirm by clicking [Install].





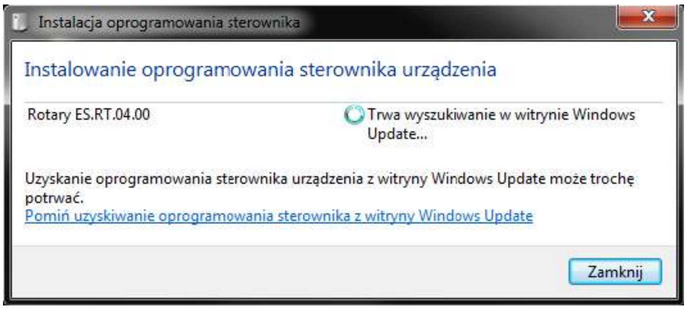
- Close the wizard by clicking [Finish].



4.2. Drivers

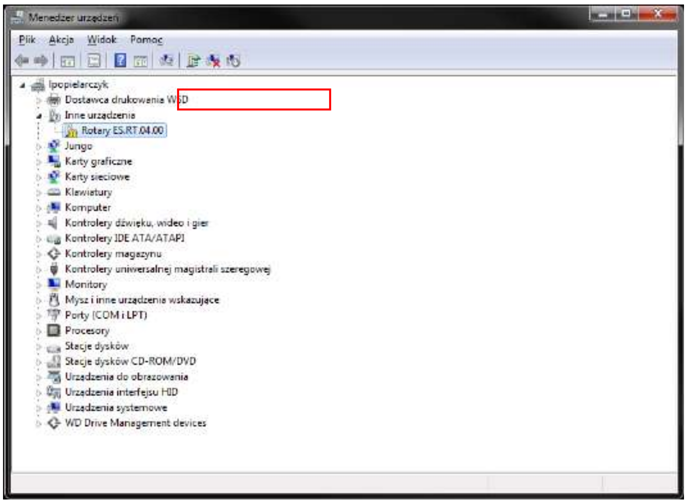
4.2.1. Rotary table

Rotary tables are controlled via the USB interface. It is necessary to install appropriate drivers to support them. The installation process should start automatically by Windows Update mechanism, after first connection device to the PC.



If the installation using described above mechanism fails, do the following steps:

- In [Device Manager] locate the node representing the connected rotary table.

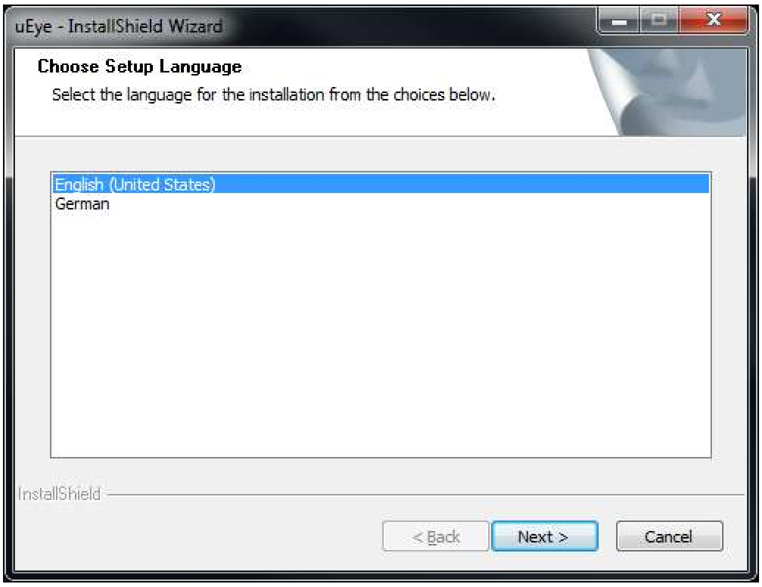


- In the context menu, click [Update Driver Software …].
- In the [Driver Update Wizard] window, click [Browse my computer] for drivers software.
- On the installation media, locate folder **CDM 2.08.28 WHQL Certified x64**, enter its directory in the box titled [Search for driver software in this location:] and click the [Next] button.

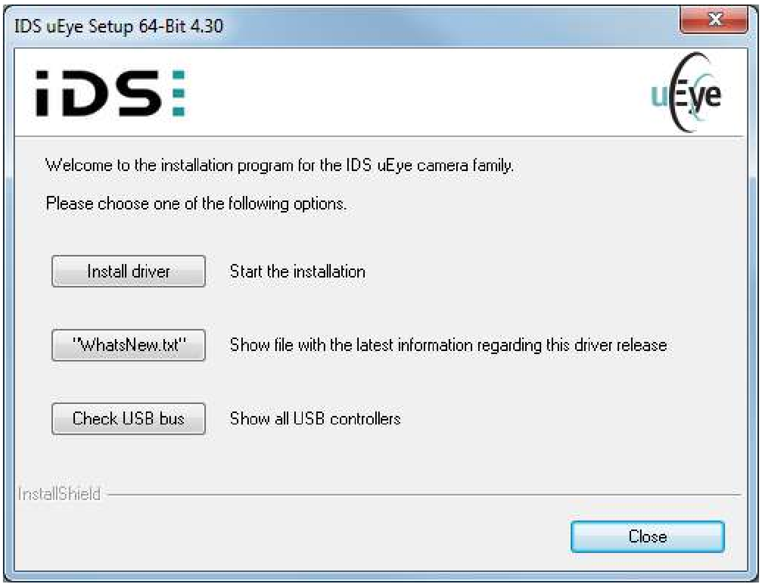
4.2.2. Cameras

In order to be able to operate the cameras, it is necessary to install the software provided by the manufacturer. Its version adequate is distributed with the eviXscan installer. To install the camera software, do the following:

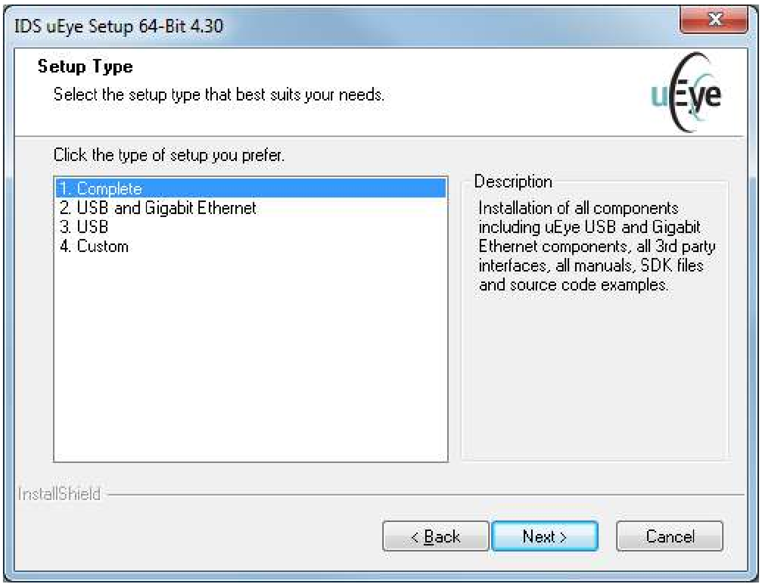
- On the installation media, locate and run file *uEye64_[version]_WHQL.exe*.
- In the window that pops up, select the installation language and click [Next].



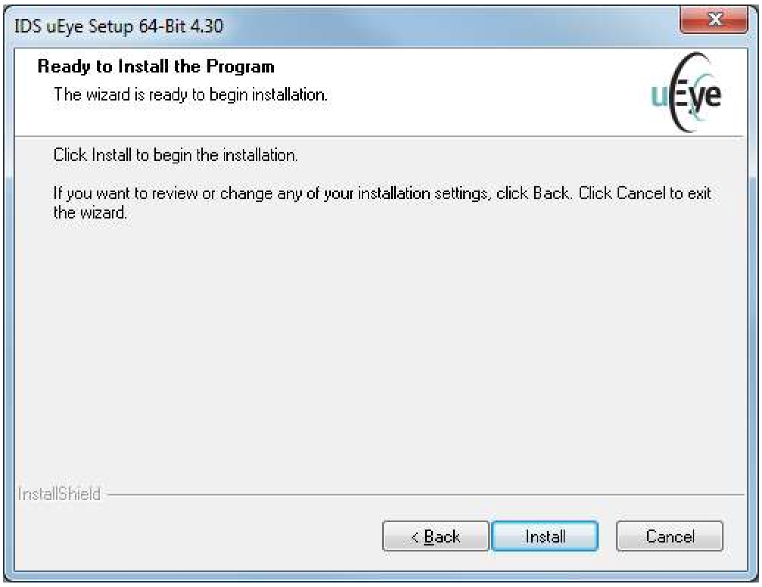
- Click [Install Driver].



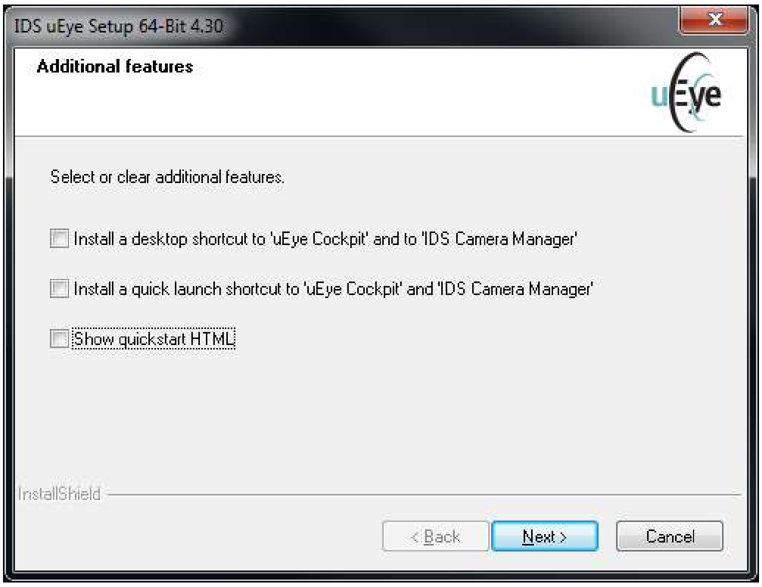
- Select the Complete installation of the software components and accept the installation steps by clicking [Next].



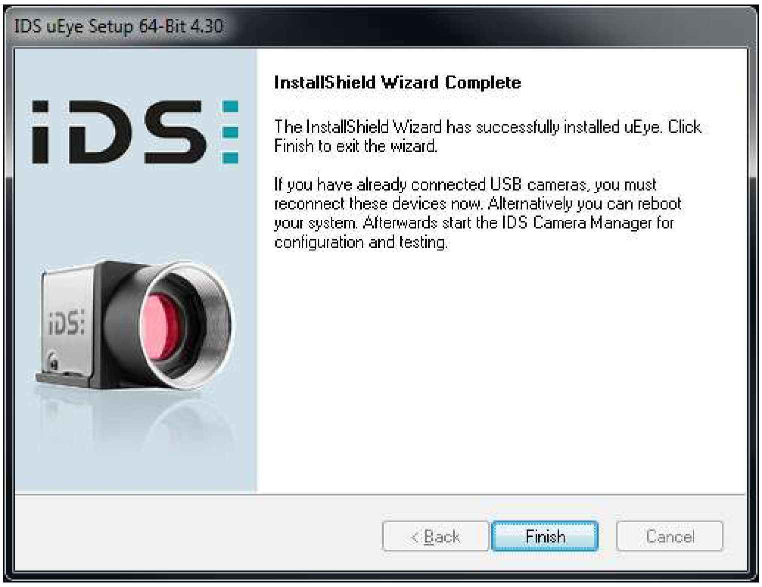
- Begin the installation process by clicking [Install] button.



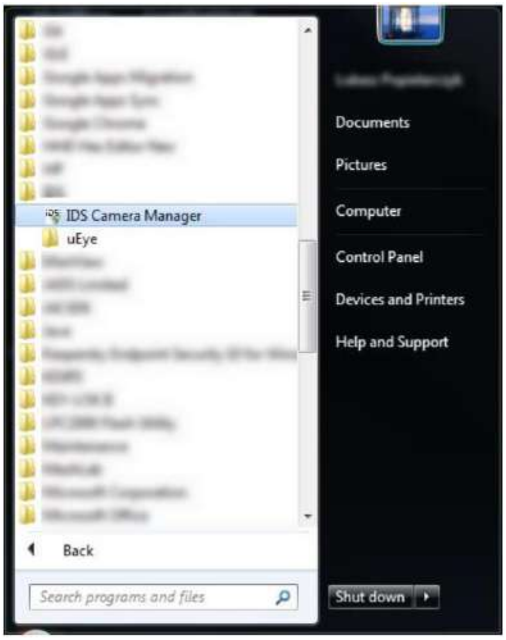
- Uncheck the proposed options and click [Next].



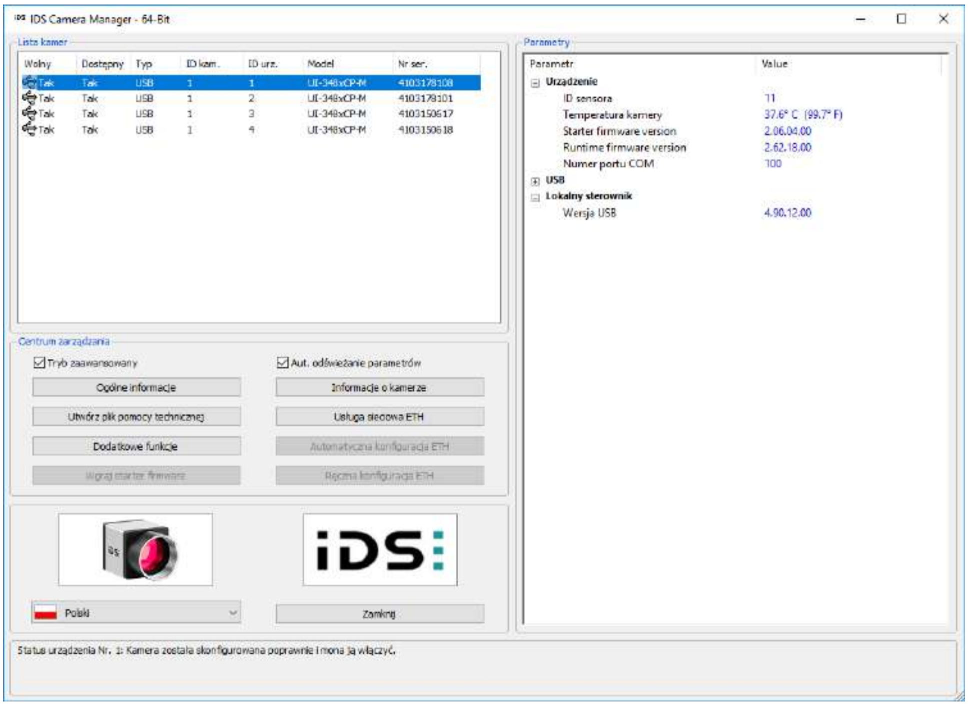
- After installation, click [Finish].



- To ensure that drivers have been installed correctly and whether PC connects to the cameras, locate and run the IDS Camera Manager.



- In the opened window you should see four available cameras, like in picture below. Close the window by clicking [Close].



5. eviXscan software description

The eviXscan software allows the user to carry out a complete scanning process, from detection of calibration patterns, all the way to exporting the scans to a selected file format. The possibilities of the program include:

- **Detection** of the calibration pattern.
- **Calibration** of the optical system.
- **Scanning** together with the selection of parameters providing the best result.
- **Rearrangement of the existing scan** with different parameters without having to re-capture images.
- **Automatic registration of scans** (transformation to a common reference system) using:
    - rotary table,
    - artifacts,
    - markers.
- **Exporting scans** to one of the following formats:
    - **asc** – text 3D point cloud,
    - **bin** – binary 3D point cloud,
    - **stl** – STL format (STereoLithography file),
    -
    - **ply** – PLY format (PoLYgon file format),
    - **obj** – OBJ format (geometry definition file format).

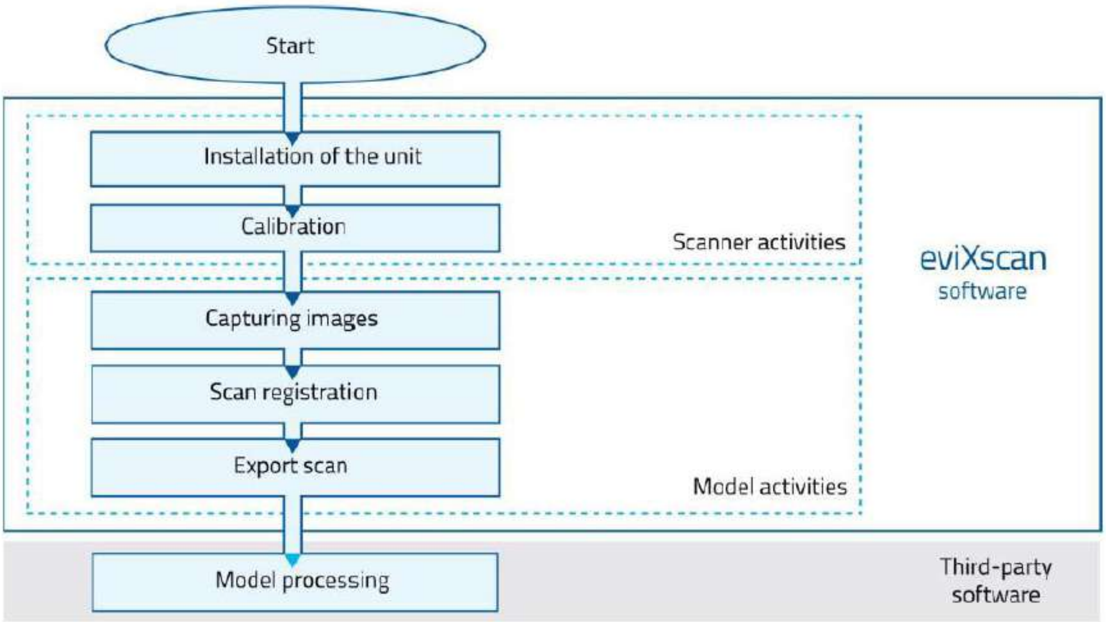


Fig. 5-1. The standard scanning process using eviXscan system.

5.1. Main window

The main window will automatically appear when you start eviXscan.

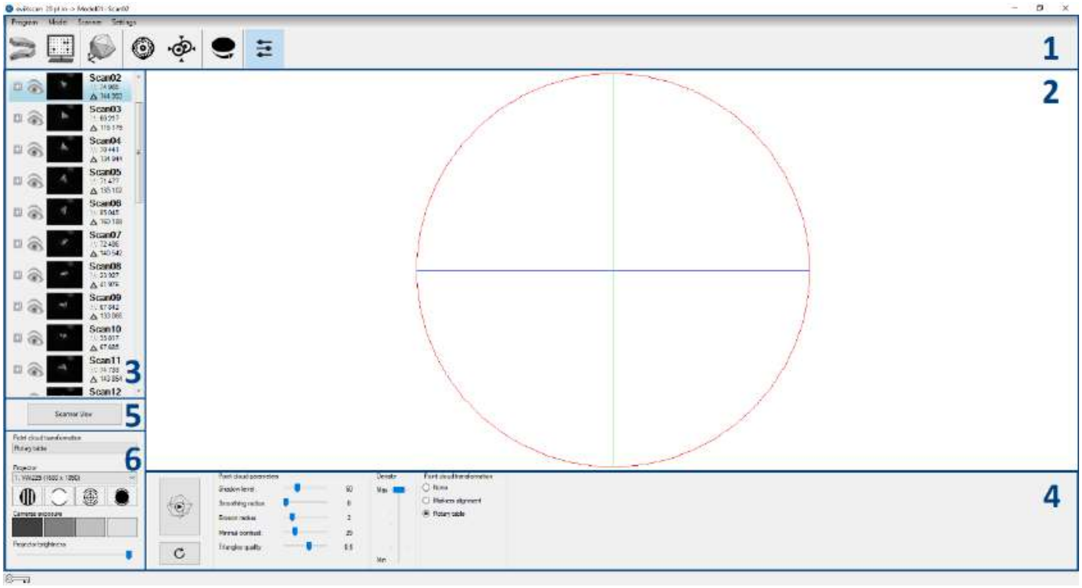
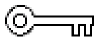
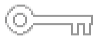


Fig. 5-2. View of the main window

The title bar of the main window contains information about the currently loaded model and the selected scan (eviXscan Scanner01 -> Model01 -> Scan02).

The footer of the window contains a visual message about detecting the dongle:

 - dongle detected

 - dongle not detected

If the dongle is not detected, only viewing and exporting scans is enabled. Moreover, the footer also contains information about the operations currently being performed during data processing.

Description of individual sections:

1. Menu section
2. View section
3. Model section
4. Scan generation section
5. Preview from sensors button
6. Projector and brightness section.

5.1.1. Menu section

This section is divided into two sub-sections:

- Toolbar (1),
- Drop-down menu (2).

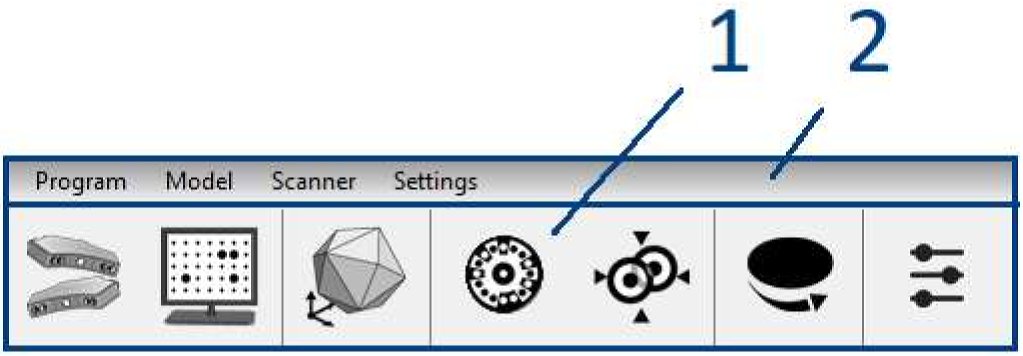


Fig. 5-3. Menu division into sub-sections

Toolbar

The toolbar contains buttons used while working in the eviXscan environment; selection is made by left-clicking. When you move mouse over the button, it displays information about the name of its feature. Depending on whether the eviXscan software is in the capture or display mode, the toolbar icons adjust to the current state and needs. The following pictures show the functions available on the toolbar in the capture mode, and in the display mode.

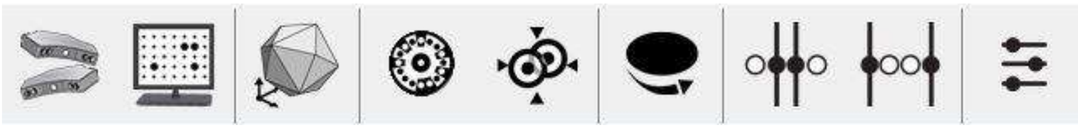


Fig. 5-4. Toolbar view in display mode

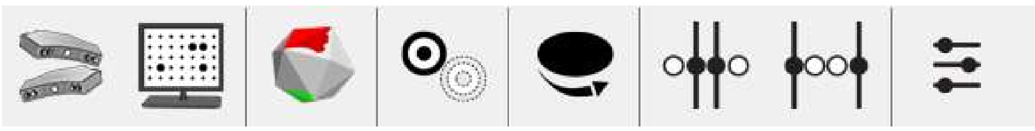
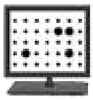


Fig. 5-5. Toolbar in capture mode

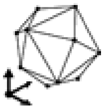
The individual buttons represent:

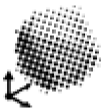
 Opens the window for managing the previously created scanner configurations.

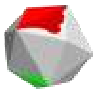
 Opens the scanner calibrate window (active when scanner configuration is selected/created).

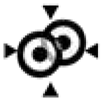
 Context menu, allow to choose displaying method of scans.

 Display 3D model as surface.

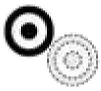
 Display 3D model as triangles.

 Display 3D model as points.

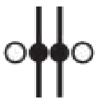
 Enables/disables coloring for brightness levels.

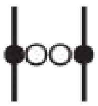
 Aligns the selected scans using markers (unique and non-unique) and artifacts, not including previous alignment.

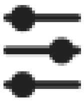
 Aligns the selected scans using markers (unique and non-unique) and artifacts, including previous alignment (e.g. using rotary table).

 Enables/disables the marker view in images.

 Opens the peripheral devices window.

 Enables/disables laser pointers for inner range.

 Enables/disables laser pointers for outer range.

 Enables/disables advanced scan generation parameters view .

Drop-down menu

The drop-down menu (1) contains four major fields (Fig. 5-3). The full structure of the drop-down menu is as follows:

1) **Program**,
    a) **Close** – closes eviXscan,
2) **Model**,
    a) **New** – opens the new model creation window,
    b) **Open** – opens a window where you can load an existing model,
    c) **Close** – closes the currently used model; editing it any further will be enabled only after reloading,
3) **Scanner**,
    a) **New** – opens the new scanner configuration window,
    b) **Open** – opens a window where you can load an existing scanner configuration,
    c) **Calibration** – opens the scanner calibration window,
    d) **Close** – closes the currently used scanner configuration; further operations requiring the scanner configuration (e.g. scan calibration) will be enabled only after creating a new scanner configuration or load an existing one,
4) **Settings**,
    a) **Language** – allows selecting language (requires restarting the software),
    - **English** – changes the software language to English,
    - **Polish** – changes the software language to Polish,

    b) **Projector** – allows configuration of the light source,
    - Ethernet configuration – (only for older models of Heavy Duty Quadro) opens the program to configure the Ethernet network for the light source,
    - Color – allows changing the color of the light source,
        - Default – blue
        - White – the patterns displayed by the light source are white,
        - Red – the patterns displayed by the light source are red,
        - Green – the patterns displayed by the light source are green,
        - Blue – the patterns displayed by the light source are blue.
    - Range – allow to configure projector for specific range. This option is shown only for HD scanners.
        - Near – configure projector for near range,
        - Far – configure projector for far range,
        - Configure – Allow to more precisely customize configuration for projector, it also allow to override near and far option,

    c) **Artifacts** – opens the artifact file management window.

5.1.2. View section

The View section is responsible for the visual representation of data. This section may be in one of three modes:

- 3D model.
- Scan images.
- Sensor view.

3D model view

The 3D model view allows viewing the scans in 3D space, which allows observing the scan results in real time. Scans can be viewed in the form of a point cloud, a triangle mesh or a mesh surface. The display of scans can be changed using the appropriate buttons on the toolbar (Fig. 5-6).

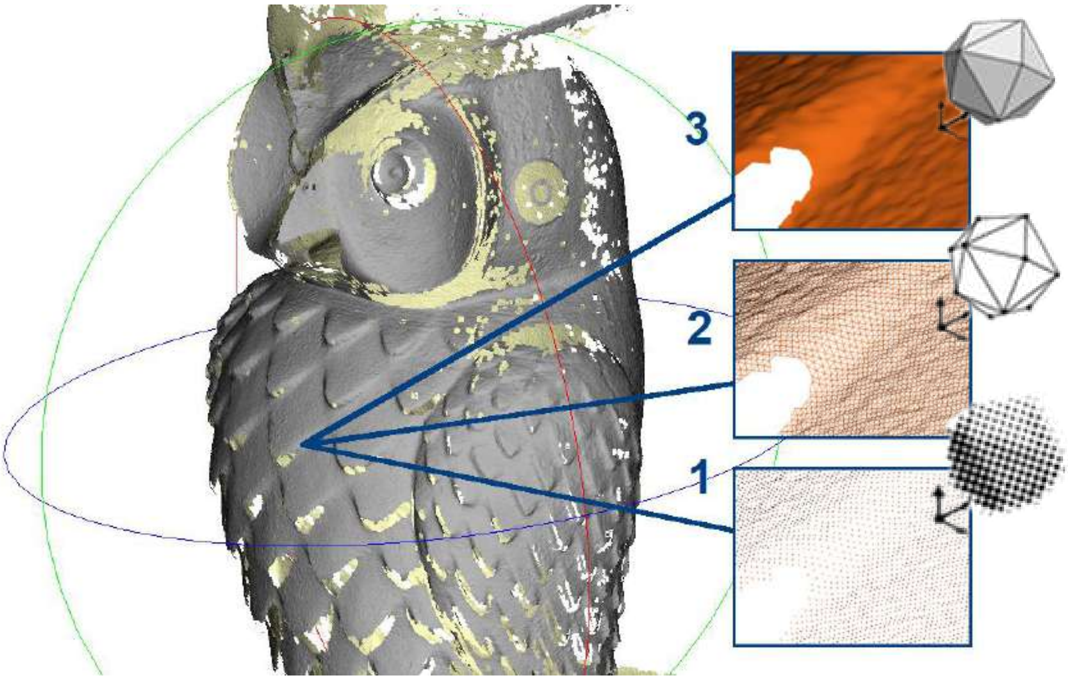


Fig. 5-6. An example of 3D view 1 – displayed as points, 2 – displayed as a triangle mesh, 3 – displayed as a surface.

To show/hide the scan in 3D preview, left-click the icon for that scan; double-clicking a particular scan on the list will set the 3D camera view in a position that shows the selected scan.

Changing the position in 3D space

Using the mouse, you can make changes in the position of scans in space. The graphics engine enables:

- Rotate – by holding the right mouse button,
- Move – by holding the middle mouse button,
- Zoom in/zoom out – mouse wheel

Scan images preview

This feature allows you to view all the scan images, making it easier to diagnose the possible causes of distortion or failure to complete the scan (e.g. a shifting of the object while making a series of scans, or overexposure of part of the picture). In addition, image preview makes it easier to choose the level of shade and allows selecting the scanning area in the left camera image.

To view images of the scan, left-click the icon ⊞, on the list of scans in the model section, then a list of reference images for each scan will appear below the scan thumbnail; after selecting one of them, the two images will be displayed in the view section (Fig. 5-7).

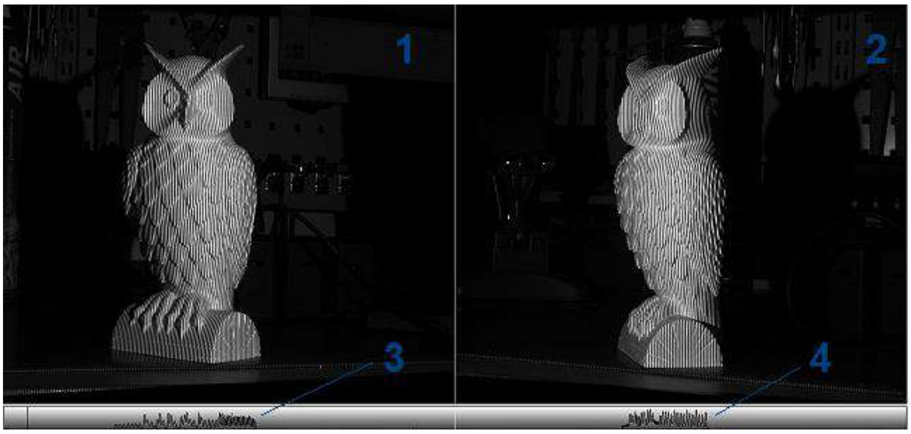


Fig. 5-7. A sample preview of the photo image

As you can see in the figure, the top of the preview contains images from the left and right cameras (1 and 2), while below are the graphs of brightness levels for each camera (3 and 4). Charts of brightness levels are generated for the horizontal line appointed by the mouse; in the absence of the cursor on the image, a graph will be generated for the middle line. The vertical line on the brightness graph represents the column that is appointed by the mouse.

Sensor view

The sensor view is very similar to the preview of scan images. In addition to the image and the brightness level charts, there are additional fields to support sensors. In order to launch the preview, press the [Scanner View] button with the number 5 in Figure 4-2.

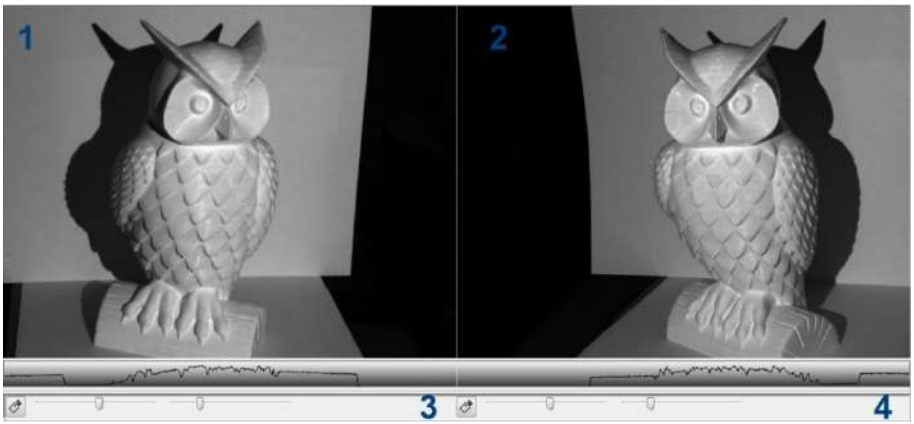


Fig. 5-8. Sensor preview. 1 – image view from left sensor, 2 – image view from right sensor, 3 – settings bar for the left sensor, 4 – settings bar for the right sensor.

Sensor setting bar

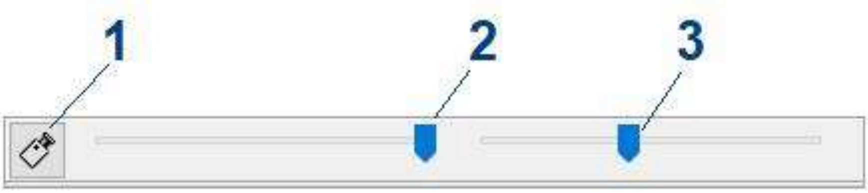


Fig. 5-9. View of the sensor settings bar 1 – enables/disables the sensor, 2 – PixelClock setting slider for the sensor, 3 – slider for setting the exposure time of the sensor.

The sensor setting bar is used to set parameters for image acquisition by the sensor (Figures 5-9). The individual numbers represent, respectively:

1. **Sensor on/off switch**
2. **PixelClock setting slider** – this parameter is responsible for rate at which the sensor takes pictures. This parameter should be adjusted to fit the configuration of the scanner, as well as equipment that is running eviXscan. Higher PixelClock results in faster image capture, and requires a more stable and faster connection between your computer and the camera. The optimal setting for this parameter is one, in which the pictures are taken at maximum speed, while maintaining the smooth display of image preview.
3. **Settings slider for the sensor exposure time** – this parameter defines the exposure time of the sensor matrix. It should be increased when the images are too dark (underexposed), and reduced when they are too bright (overexposed) (see below: Coloring brightness levels). In an exceptional situation you can change value by moving a slider, however it is recommended to choose the exposure from 4 predefined values Fig. 5-10.

When handling the PixelClock or exposure time slider, an additional window pops up with information about its actual value. Value of exposure has to be the same for both cameras.

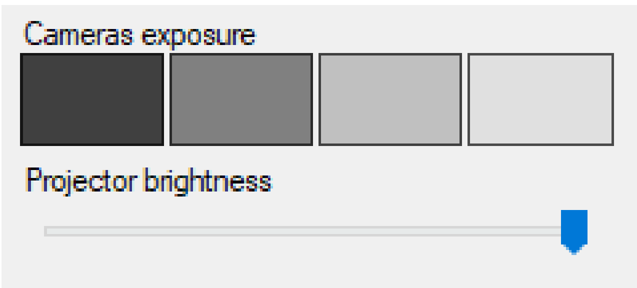


Fig. 5-10. Predefined values of exposure and projector brightness slider

Respectively these are:

Exposure value 8.33ms, best for small ranges and when environment light is intensive.

Exposure value 16.67ms, use when 8.33 value generate not enough green points.

Exposure value 33.33ms, use when 66.76 value generate to much red points.

Exposure value 66.67ms, best for dark scanning object and when environment light is insufficient.

States of the sensor settings bar:

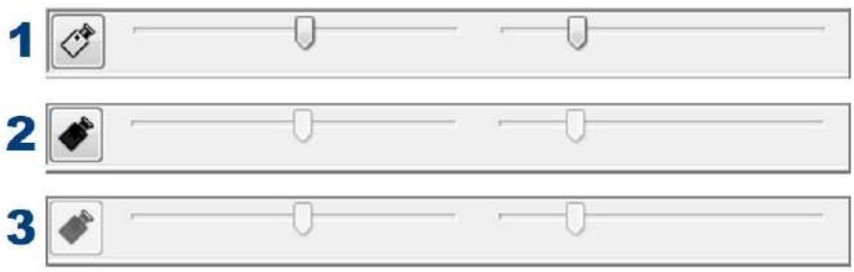


Fig. 5-11. Three states of the sensor settings bar

The sensor settings bar can take three different states depending on the state of the application; they are shown in Figure 5-11. The individual states represent.

1. **Normal status** – the sensor is detected and configured correctly; also, video transmission from the sensor to the workstation is running, and it is possible to preview the image in the preview window. It is possible to set both PixelClock and the exposure time of the sensor. Calibration of the scanner configuration and the scanning itself is enabled only when the two cameras are in this state.
2. **Sensor switched off** – the sensor is detected and configured correctly, but the image transmission from the sensor is disabled by the user, or the device is occupied by another application. In this case, PixelClock and exposure time settings are inactive.
3. **No sensor** – the sensor has not been detected or configured correctly, or connection with it has been lost. No operations on the sensor are possible.

Scan image/sensor view preview feature

Both the scan images preview and the view of the sensors provide similar feature; the two views are used to select the appropriate parameters of the scan, depending on the user's needs. The main difference is the moment when the given preview is used. The sensor view is used before scanning, and the image preview is used afterwards to diagnose base images and to convert the scan with different parameters. Both views will be considered identical and will be referred to as image previews.

- Switching on a preview of a single image

To switch the view to the left or right image, click on the selected image with the middle mouse button. Clicking the middle mouse button on the image will return to view the pair of images.

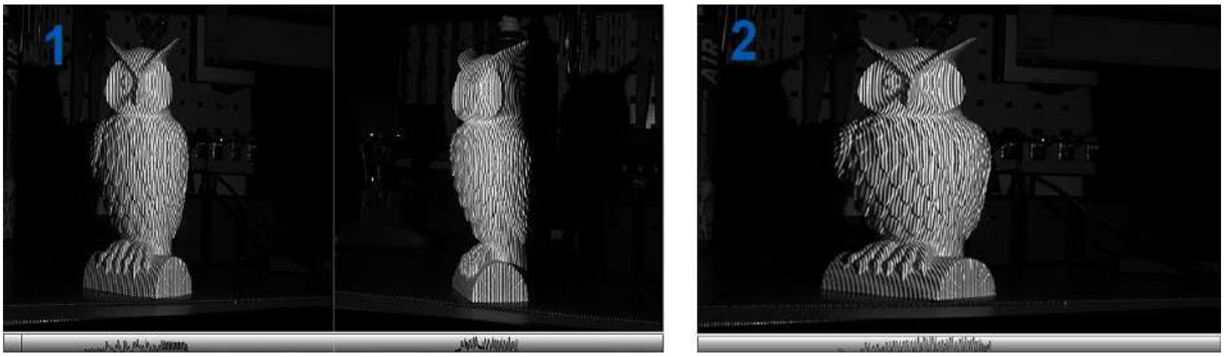


Fig. 5-12. 1 – view of both images, 2 – view of left image only.

- Expanding a selected section of the image

In order to view an image in better detail, the software allows zoom of selected section of the image; to do this, double-click the picture with the right mouse button. The zoom window will then appear. This window moves with the mouse cursor, displaying its surroundings. It is possible to smoothly increase/decrease the zooming using the mouse wheel as well as resize the zoom window; to this end, hold the right mouse button and use the wheel to resize the zoom window.

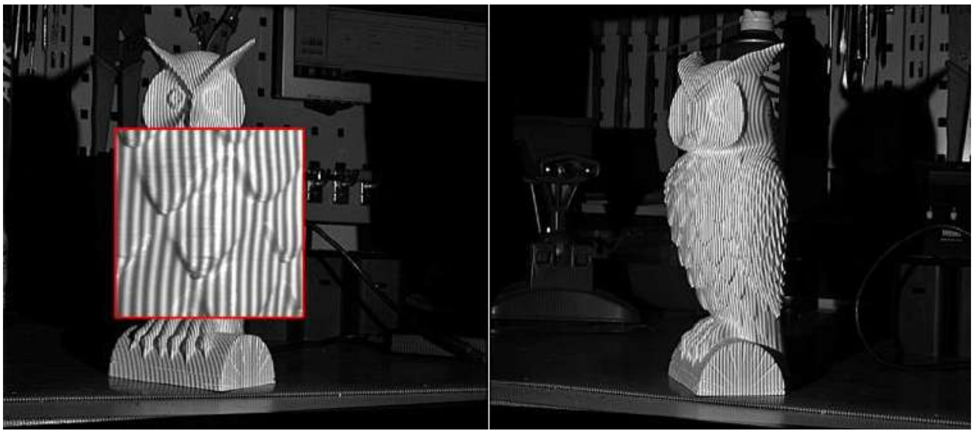


Fig. 5-13. Exemplary presentation of an expanded section of the image

Scaling the brightness level graph

In order to better observe the brightness levels in the images, the software enables gradual scaling the brightness level graph. In order to re-scale the brightness level graph, double-click the graph underneath the image view. It is possible to set the size of the chart area at one of three levels.

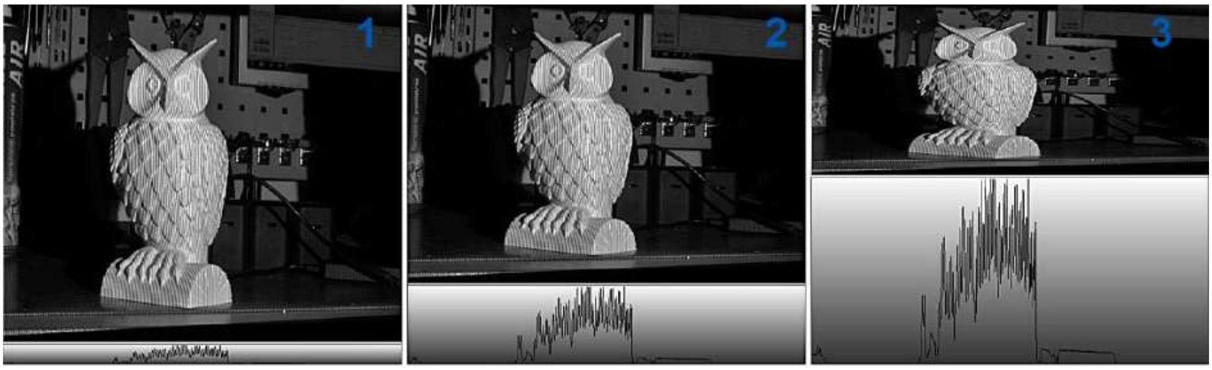


Fig. 5-14. Presentation of three values of the brightness level graph.

Brightness level coloring

When you click [Brightness level color rendering] on the toolbar, the images will be colored appropriately, depending on their brightness levels. This option should be used in two cases: when you set the sensors' shutter speed and when setting the level of shade.

Setting the sensor exposure time

The sensor's exposure time affects the level of brightness of the image, so you should scale brightness levels while setting this parameter. Setting the exposure time requires the following steps:

- In the projection section, display the pattern [A0]
- Click [Scanner View]
- In the toolbar, select [Brightness level color rendering]
- Change the sensor's exposure time in such a way that it is as large as possible, while there are no points marked in red. Best if you select one of 4 predefined exposure.

[ ].

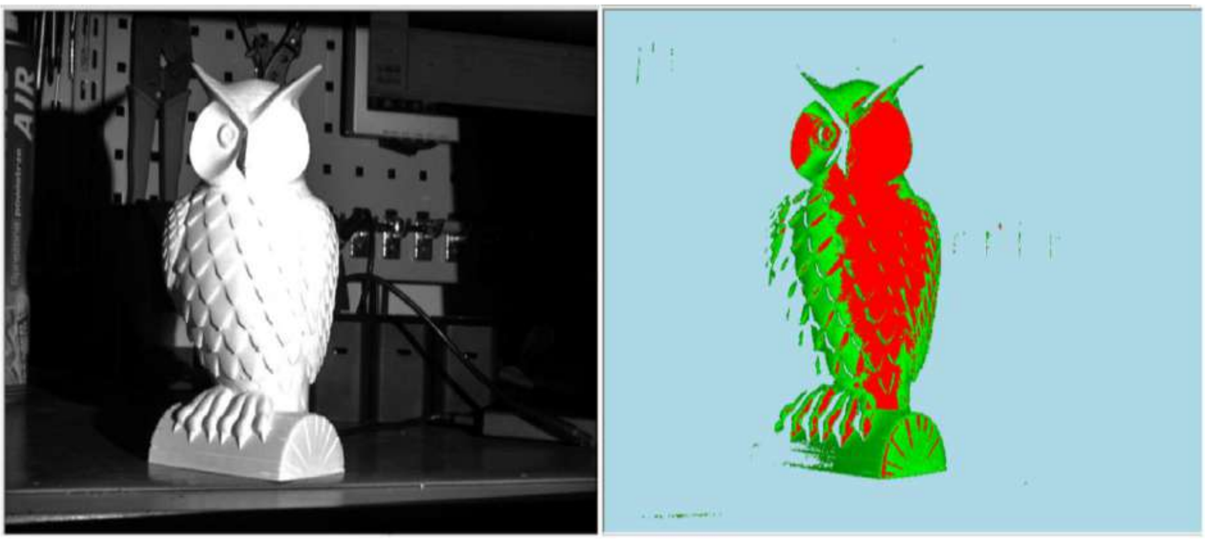


Fig. 5-15. Example of scaling brightness levels with the pattern [A0 ◡]

Figure 5-15 shows an example of scaling brightness levels with the pattern [A0]. It can be observed that the exposure of cameras has been chosen incorrectly, as the scanned object shows points marked in red, so these points will be not generated during the scanning process. The points marked in blue (the whole background) will be classified as a shade; they will not be taken into account when generating a 3D point cloud.

■ Setting the shade level

The level of shade is the brightness level on the input images, below which the image is recognized by the scanner as a shade. All points with brightness below this level are not taken into account when generating the 3D point cloud. This parameter can be changed smoothly with a slider in the scan generation section. When setting the level of shade, the image "A0" is analyzed; therefore, in case viewing the video feed, you should enter the Projector section and select the pattern [A0 ◡], then click [Scanner View]. In the | 37 | case of displaying a captured images of scan, select the "A0" image of that scan. Figure 4-16 shows an example result of scaling brightness levels with image "A0". All points marked in green will be taken into account when generating a scan, while points marked in blue and red will be rejected.

Limiting the scanning area

It is possible to limit the scanning area. This feature is very useful when in the scanned object is surrounded by items that should not be scanned. The scanning area is always of rectangular shape.

To limit the scanning area, left-click the left area of the image. The click-point (P1) will be the initial corner of the rectangle forming the area. Then you need to select the area and left-click it again. The second click-point (P2) will be the final corner of the rectangle limiting the scanning area. Everything inside the rectangle will be taken into account when generating point cloud.

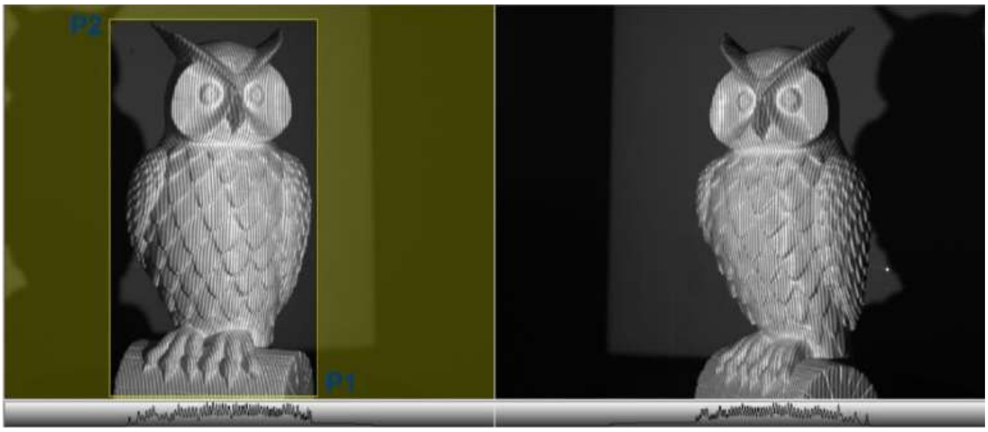


Fig. 5-16: Example of the scanning area selection

To disable the limit on the scanning area and analyze the entire image, double-click the left mouse button on the left image.

Determining the distance between the scanner and the scanned object

After selecting the pattern [Ellipse] in the projector section, the left camera feed will show a green rectangular area. Using the displayed sights pattern and the green area, you can determine the distance between the scanned object and the scanner. The optimal distance is set when the center of the displayed pattern is within the green area.

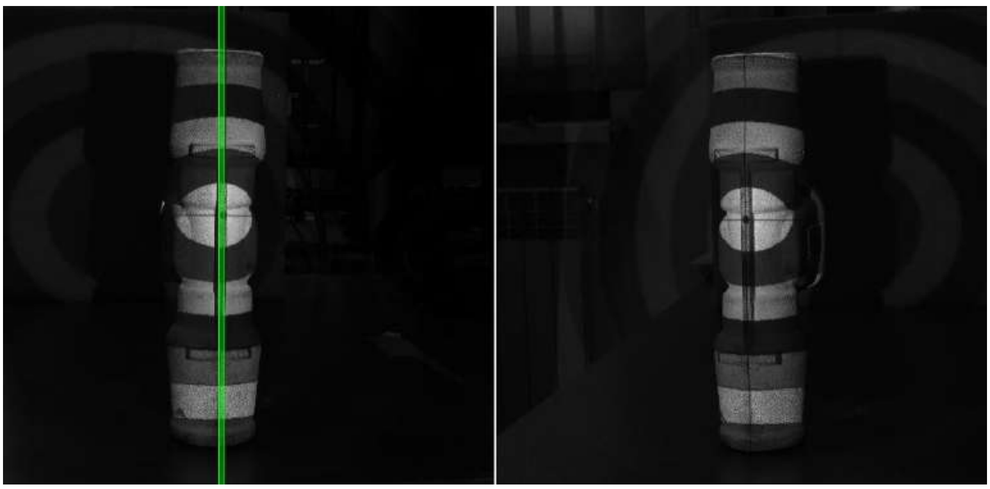


Fig. 5-17. A properly set distance of the scanner.

It is also possible to determine the correct scanner distance from the object being scanned by using lasers. In this case, it is not necessary to control the position on the eviXscan screen, but directly on the scanned object. Depending on used scanning range, the corresponding lasers should be selected:

- outer
- inner

To set the correct distance, do the following:

1. From the projector section, select the Ellipse [ ].
2. Turn on the lasers for the range in use, by clicking the appropriate icon on the toolbar [,].
3. Change the scanner's distance from the object until the lasers cross each other and cross with middle of the ellipse Fig.5-18.

Fig. 5-18. A properly set distance of the scanner

Picture below shows the preview of the cameras in eviXscan software, after a properly set distance with the use of lasers.

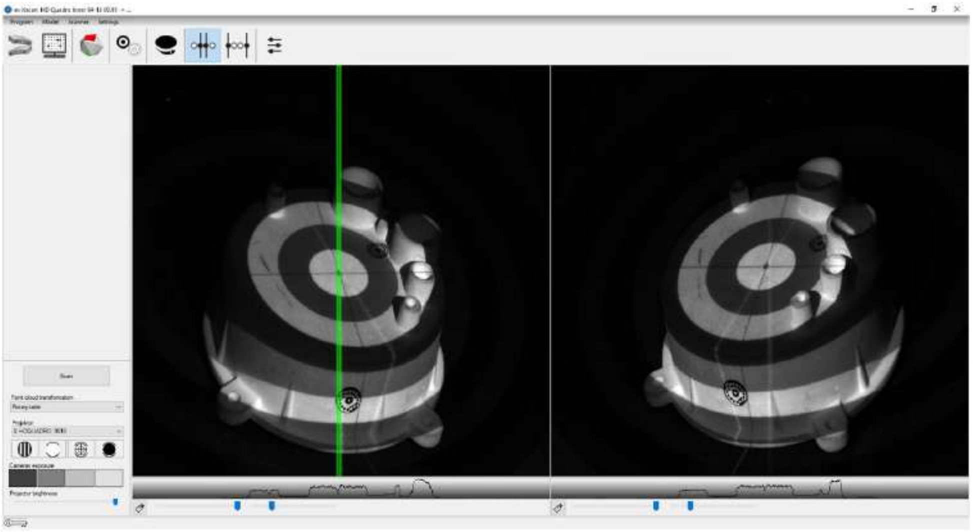
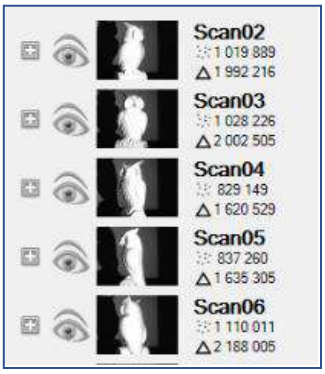


Fig. 5-19. Preview of cameras in eviXscan for a properly set distance with the use of lasers Fig. 5-18.

5.1.3. Model section

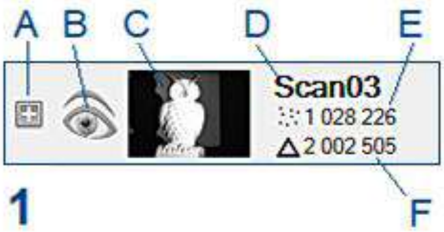
The model section contains a list of scans belonging in that model. When no model has been loaded, or you have created a new model, the list is empty. Once the scan is complete, it is automatically added to the open model; however, if no model is opened, the scan cannot be made.



▶ Fig. 5-20. View of a sample model

■ Description of a single scan list item in the model section

Each scan in the model contains a set of data necessary for its re-generation (e.g. with changed parameters). In the model section you can read the basic information about a particular scan.



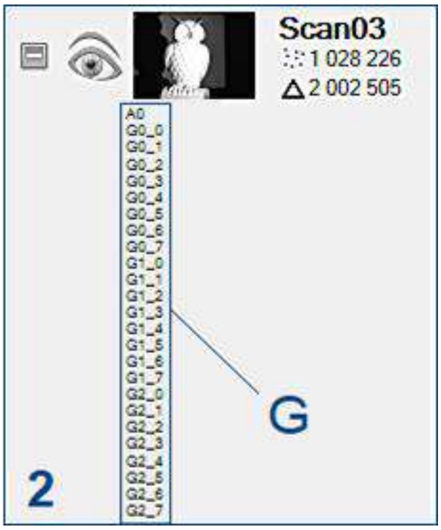


Fig. 5-21. View of a single scan in the model section:
▲1 – brief view, ▶2 – detailed view

Figure 5-21 shows two possible views for a single scan in the model. The first of these is a brief, but when you click the ⊞, the view is extended by a list of base images for each scan. The individual elements represent, respectively:

- A – The button showing/hiding the list of base files,
- B – The button showing/hiding the scan view in your 3D scans browser,
- C – Left sensor thumbnail view,
- D – Name of the scan,
- E – Number of points in the scan,
- F – Number of triangles in the scan,
- G – List of the scan's base images.

■ Scan selection

To select a particular scan from the list of scans in the model section, left-click on it. After selecting a particular scan, it is highlighted in the list of scans and in the 3D view. You can also navigate the list by using "up" and "down" arrows to select the scan you are interested in.

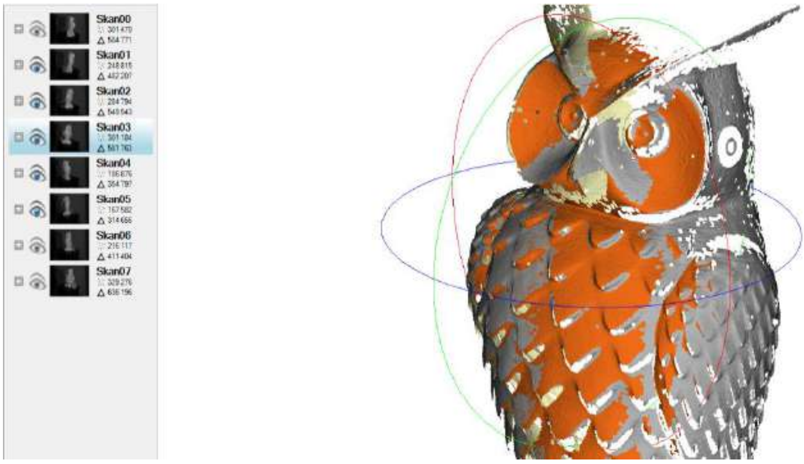


Fig. 5-22 Highlighting the selected scan.

After selecting the scan, it is possible to re-generate it with different parameters in the scan generating section 5.1.4.

■ Selecting multiple scans

The software allows you to select a larger number of scans (e.g. in order to export, align, show/hide or remove). The selected scans are highlighted in the 3D preview. Multiple scans can be selected in two ways.

- **Selecting neighboring scans**:

  – select the initial scan,

  – select the final scan while holding SHIFT.

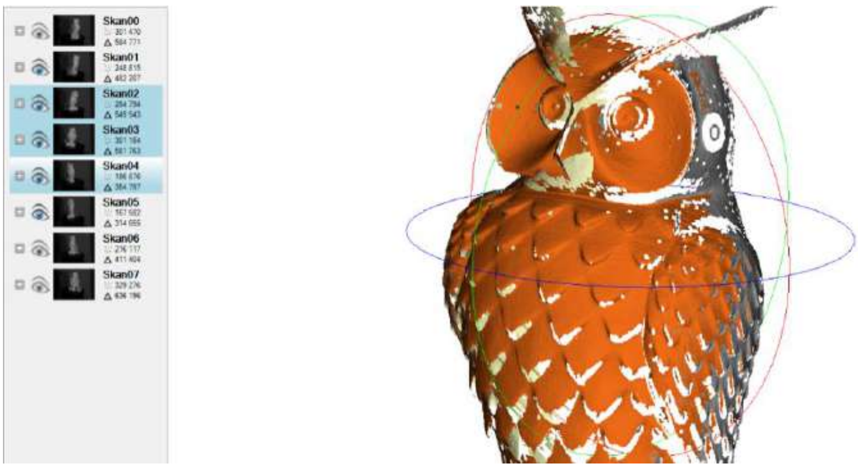


Fig. 5-23. Example showing the selection of neighboring scans. Initial scan "Scan02", final scan "Scan04".

- **Selecting any scans:**

  – selection of individual scans is done by left-clicking them while holding the CTRL key. Should the scan have been selected already, it will be deselected.

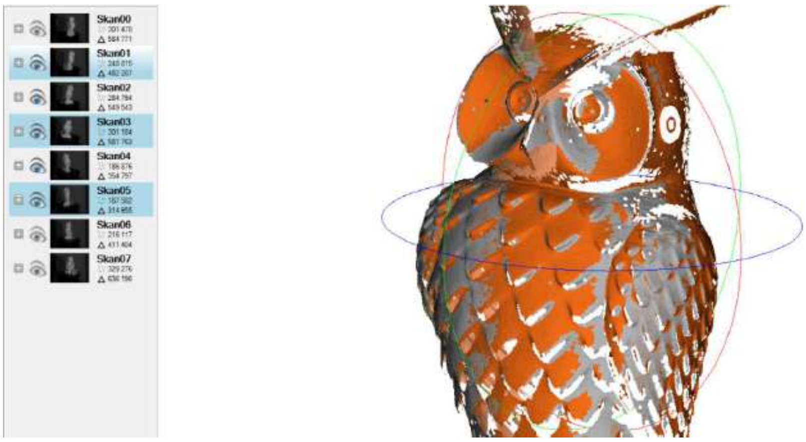


Fig. 5-24. Example showing the selection of any scans.

NOTE: Although several scans are selected, only the last selected scan will be processed in generation section. It is additionally highlighted in gray in the model section, e.g. in Fig 5-23 it is “Skan04”, while in Fig. 5-24 it is “Skan01”.

Base scan images preview

The software provides an overview of the base images of the scan. To do this, you must enable the detailed view of the scan using the button or the right arrow for the highlighted scan. When a given image is selected, the view will automatically switch to the image preview. You can then change the displayed base images by navigating through the list with the "up" and "down" arrow keys. Use the "left" and "right" arrow keys, you can switch between 3D scan view and the base images view.

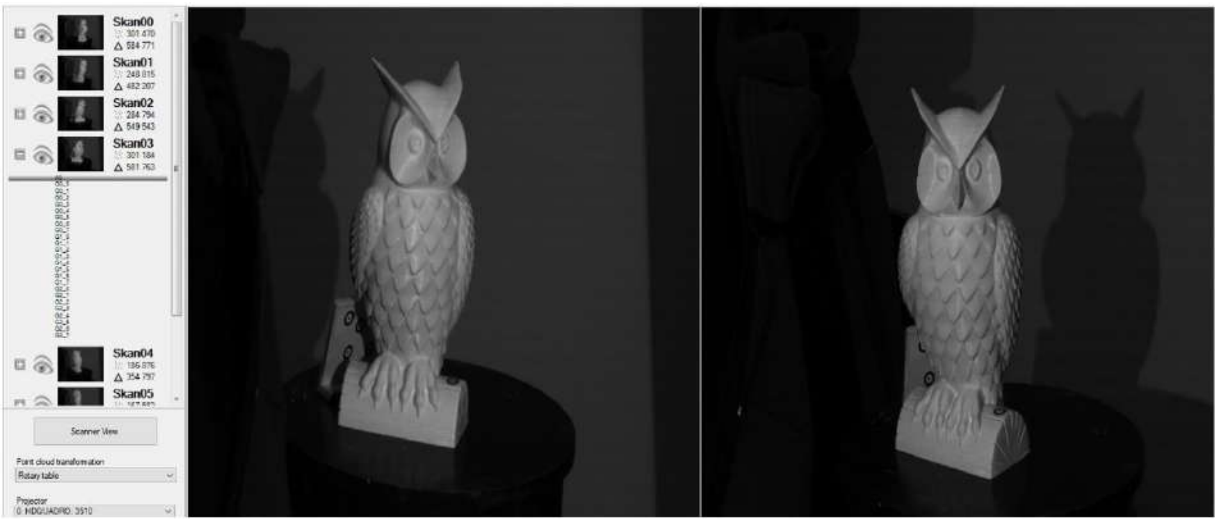


Fig. 5-25. Example of base scan images preview

Model section pop-up menu

The model section has a simple pop-up menu for operations on individual scans. It opens by right-clicking on any of the scans in the model list.

The pop-up menu includes 4 options:

- Export – export selected scans,
- Open directory – opens the model directory,
- Align – aligns the selected scans,
- Delete – deletes the selected scans.

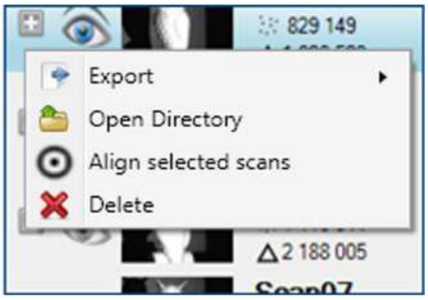


Fig. 5-26. View of the pop-up menu

Exporting scans

The allows you to export the selected scans into one of the formats listed at the beginning of chapter 4. To export the scan data follow these steps:

1. In the model list, select the scans to export.
2. Right-click on the selected scans to open the pop-up menu.
3. Select [Export ], from the pop-up menu, which will open the export window.

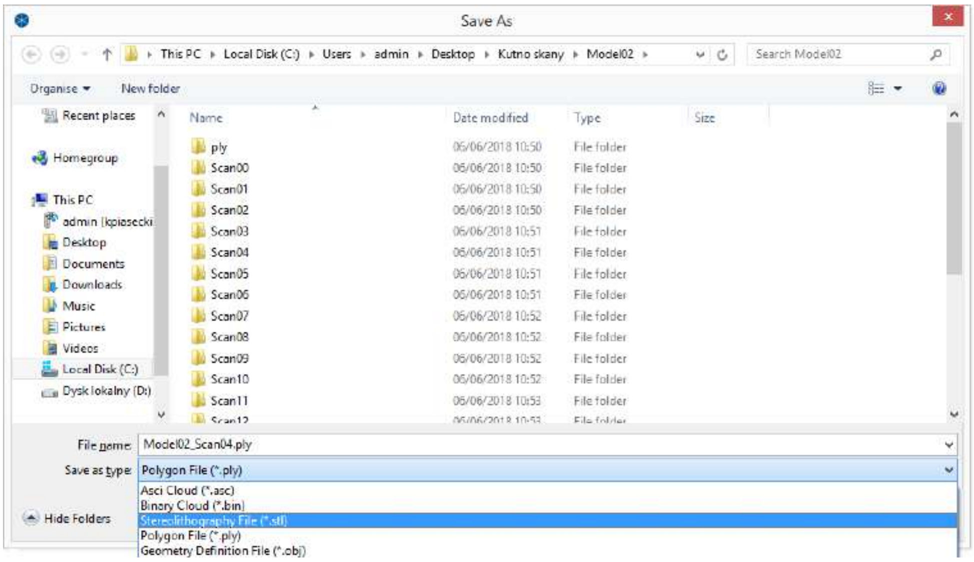


Fig. 5-27. Scan export window

4. In the export window, select the destination for the exported scans (the default is the model directory), the format of the exported scan (default PLY) and the prefix for the name of the exported scans (default model name).
5. Then click [Save].
6. Exported scans will be saved in a target location, each scan in a separate file, whose name consists of a combination of the prefix and the name of the scan.

5.1.4. Scan generation section

In this section you will find all the settings used to generate the scans, both during the scanning stage and while re-generating the scan. The layout of this section depends on the application's status, [ ]icon is used to switch the view of scan generation parameters.

The scanning status is activated by clicking [Scanner View] and the status of re-generating is triggered when choosing any scan from the list of scans in the model.

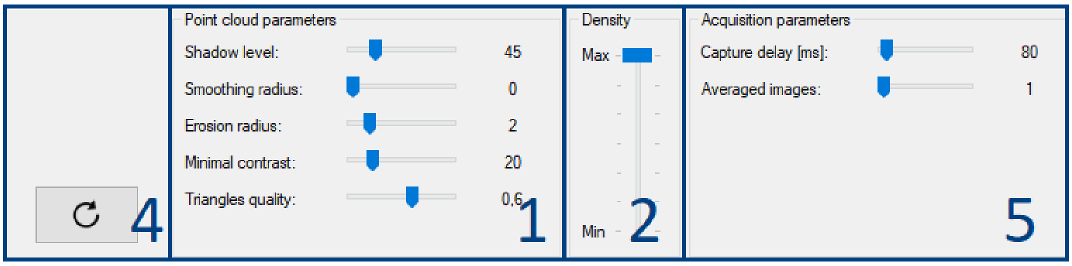


Fig. 5-28. View of the scan generation section during scanning

Figure 5-28 shows the view of the scan generation section during scanning in this section you can distinguish individual areas:

1) Parameters of the generated point cloud.

2) Slider adjusting the scan's point density.

4) Reset to default button

5) Parameters of acquisition

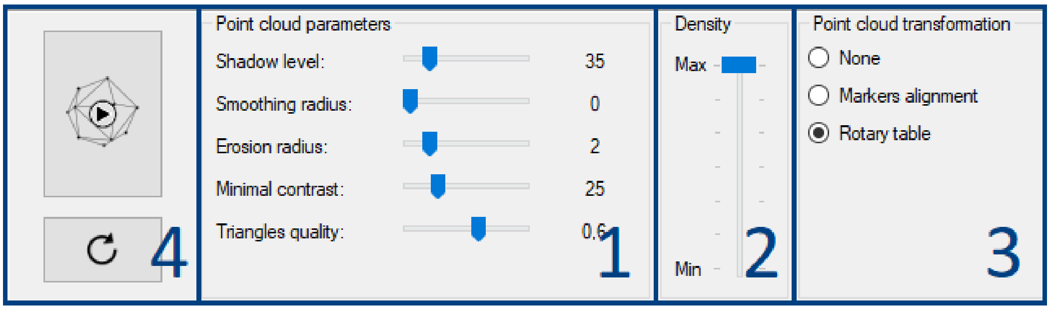


Fig. 5-29. View of the scan generation section after selecting the scan

Figure 5-29 shows the view of the scan generation section with previously made pictures. This option is useful when you need to generate a scan with different parameters. In this section you can distinguish the following areas:

1) Parameters of the generated point cloud.

2) Slider adjusting the scan's point density.

3) Scan alignment parameters (Point cloud transformation).

4) Button to generate a scan and to reset parameters to default value.

Parameters of the point cloud

These parameters are used to generate a point cloud. Their setting should depend on the configuration of the scanner, external factors (mainly lighting) and the type of the object being scanned. Ensuring optimal settings allows acquiring a scan with less noise (noise stands for incorrectly generated points), and a larger coverage of the scanned model (a larger portion of the scanned object is mapped in the starting point cloud).

Shade level

This parameter may be varied in the range [0-200]. It is used mainly for cutting out areas that are too dark in the image while analyzing the images from the sensors, so that the output scan is free of some of the noise, points that do not belong in the scanned model, or are not sufficiently visible. All of the spots in the image whose brightness is lower than the shade level are recognized as a shadow, and thus will not be analyzed while generating a 3D scan. This setting makes good use of the [Brightness level color rendering] option that can be found on the toolbar. The default value for this parameter is 60.

Fig. 5-30. Example of the view for different shade level settings: 1 – value 10, 2 – value 80, 3 – value 160.

Figure 5-30 shows an example of the image view for different shade level settings. It can be observed that for the value of 10, the surroundings of the scanned object was classified correctly, which will result in the appearance of points in these places on the output scan.

Whereas for the value of 160 it can be seen that most of the actual object's surface was classified as a shadow, which will result in very little coverage of the scanned object by the point cloud. The optimal shade level in this case is 60.

Minimal contrast

This parameter can be changed in the range of [0 – 100]. It is the difference of brightness levels for a series of images, below which the program recognizes the point as incorrect. Lowering this parameter can cause better coverage of the scanned object by the point cloud, but also an increase in noise.

Smoothing radius

The eviXscan environment enables a gradual smoothing of the output point cloud of the scanned object. You can choose the value of smoothing by using the [Smoothing radius] parameter. This parameter may be varied in the range [0 - 2], wherein 0 means no smoothing, and 2 is the maximum smoothing. Smoothing may prove to be a useful tool as it allows the elimination of some of the noise appearing on the surface of the scan, resulting e.g. from the noise in the sensor matrices or the very structure of the object. It should be noted here that during the smoothing operation, the level of detail of the scan is reduced, so this parameter should be selected according to current needs.

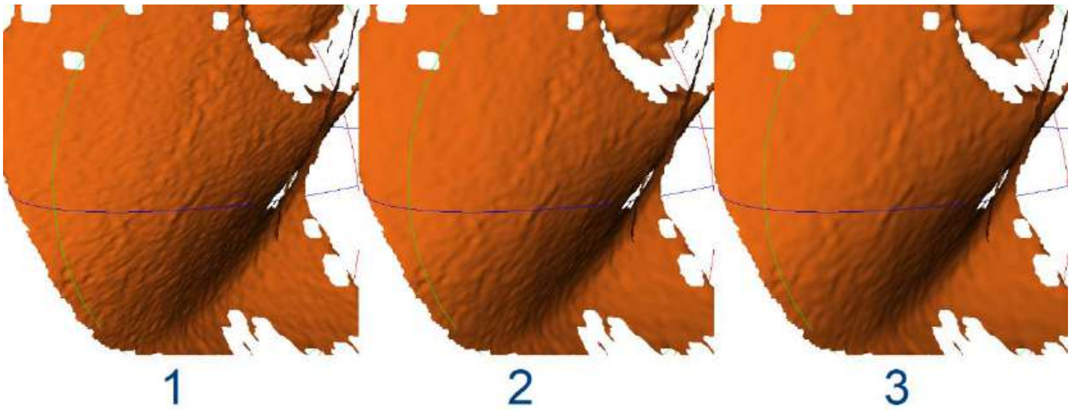


Fig. 5-31. An example of the smoothing effect: 1 – no smoothing, 2 - smoothing 1, 4 - smoothing 2.

Erosion radius

Most inaccuracies and noise in the scan occurs on the outskirts of the scan, so the software enables gradual erosion of the scan's edges to speed up and facilitate scan processing. The radius of erosion can be varied in the range [0 - 7], wherein the parameter 0 is no erosion, and 7 - the maximum erosion. Erosion works on all edges of the scan, so if there are openings in the scan, they will be expanded. This parameter should be chosen according to current needs..

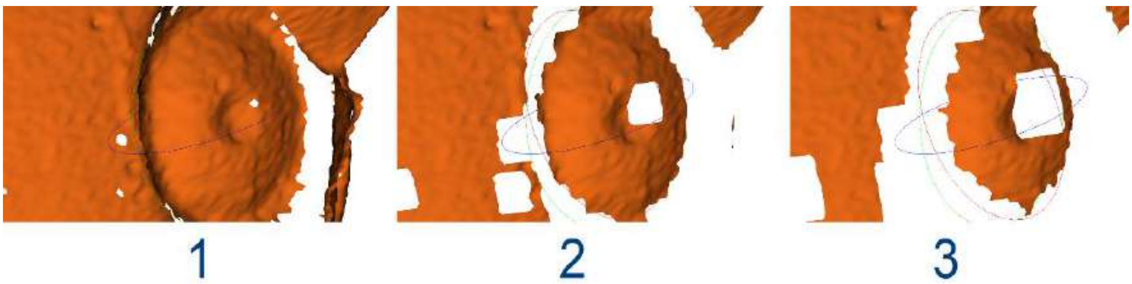


Fig. 5-32. An example of the erosion effect. 1 - no erosion, 2 - erosion with a radius of 4 , 3 - erosion with a radius of 7.

Triangles quality

This parameter limits the generation of triangles based on the similarity to an equilateral triangle. This parameter has a value in the range [0 – 1], where 1 means that the triangle is equilateral while 0 means any triangle. All triangles whose quality is below the value specified by the [Minimum triangle quality] parameter will be considered invalid and will not be added to the starting mesh.

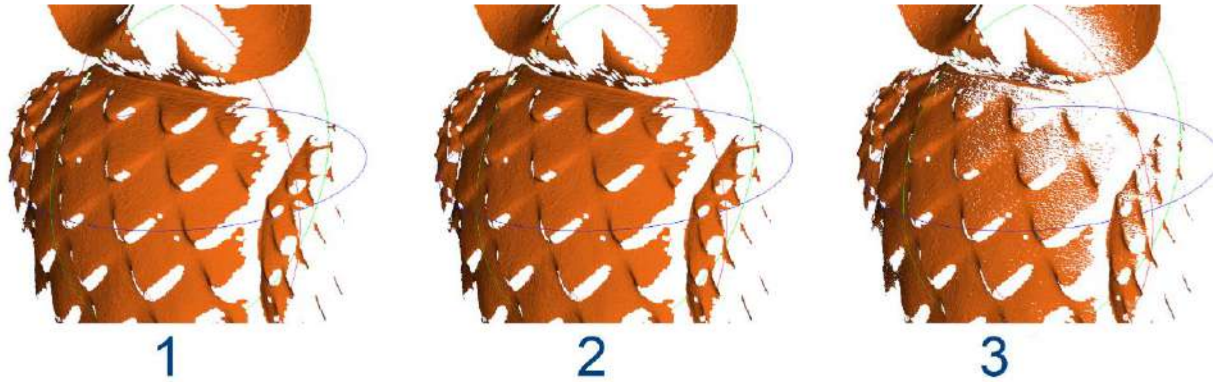


Fig. 5-33. Example of mesh generation. 1 - Minimum triangle quality = 0.0 (no triangles are rejected), 2 - Minimum triangle quality = 0.6 (default), 3 - Minimum triangle quality = 0.9

Scan density

The program makes it possible to gradually reduce the density of the output scan, where a large scanning details is not required. The main advantage of reducing the density is the smaller amount of points and triangles in the output scans, which entails a smaller amount of occupied memory and accelerated calculations in the software used for scan processing. After changing the density, the software will automatically rebuild the scan and the 3D view will show the result of the thinning of the scan.

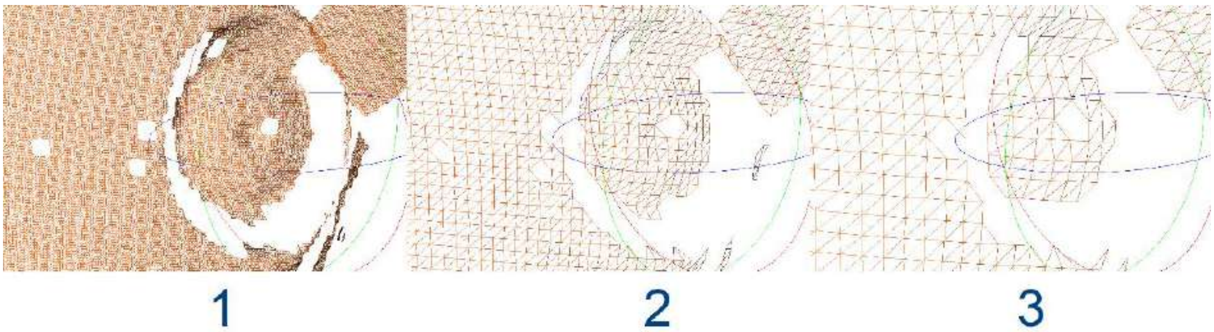


Fig. 5-34. An example of the effect of reducing the scan's density 1 – base scan, 2 – 9-fold reduction in the number of points, 3 – 25-fold reduction in the number of points

Scan alignment parameters

Each scan made in the eviXscan environment has two potential sources of transformation, enabling its alignment with other scans. These are markers or rotary table. A third option that can be set is the lack of any transformation.

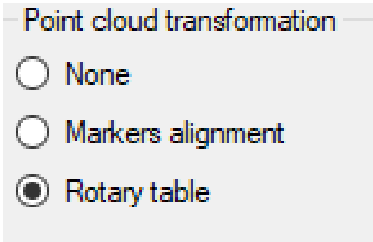


Fig. 5-35. A view of the parameters field for point cloud transformation.

In the case of selecting a points' alignment algorithm before scanning, the software attempts to automatically match all scans made using the selected technique. When the data necessary for the execution of the selected method is unobtainable (e.g. markers not detectable, the absence of a rotary table), the software does not perform any point transformation. You can change the transformation parameters for an existing scan, insofar as it contains the data needed to execute the target alignment method. It is possible to align it to other scans by selecting the aligned scans and choosing the [Align the selected scans] option.

Acquisition parameters

- Capture delay [ms]

Delay in milliseconds used while capturing base images. For example for delay equal 100ms and 21 base images, whole scanning process will not take less than 2.1 second. If you select delay time that is too short, some images may show the object illuminated by the previous pattern. Increasing the parameter extends the time it takes to acquire the images.

- Average images

This parameter can be changed in the range of [1 – 10]. It represents the number of averaged images in order to eliminate noise of the sensor matrix. Increasing the number of averaged images will cause a longer scan acquisition time, but will reduce the impact of temperature noise on the accuracy of scanning.

5.1.5. Projector section

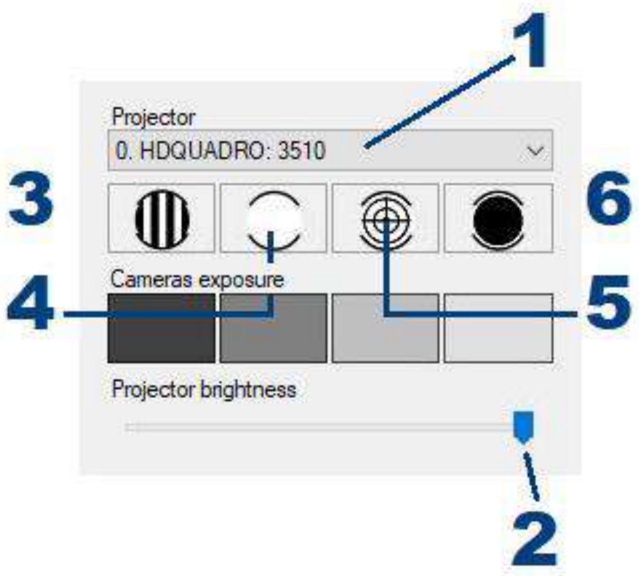


Fig. 5-36. Projection section view

The projector section is responsible for managing the information to be displayed by the light source. To configure the light source, select HDQUADRO (xxxxOptoma WXGA) from the drop-down list labeled 1 in Figure 5-36.

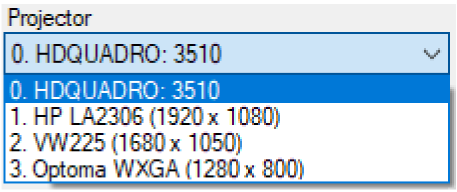


Fig. 5-37. Drop-down list of projectors for Heavy Duty Quadro.

NOTE: Before configuring the projection system, make sure that the system has selected the correct projector resolution (1280x800), if not, this should be changed in the system settings.

After choosing the correct light source, you can change the brightness using the slider indicated with the number 2 in Figure 4-35. When you hover your mouse over the slider, a window is displayed with information about the current value of the parameter. It should be noted that reducing the intensity of the light source is not recommended and should only be done when suitable lighting conditions of the object cannot be achieved for the given scanning conditions by changing the exposure time of sensors.

A description of the patterns displayed using the light source section

The projector section gives the light source the ability to display four useful reference images. In order to view the given pattern, click on the thumbnail. Hovering the cursor over the thumbnail of a given pattern will show its name. The individual thumbnails are indicated in Figure 4-35 with the numbers 3-6 and stand for, respectively:

3 – pattern [F0]– used with old models when setting the sensors' exposure time (see section 4.1.2 Scaling brightness levels, and setting the focus of the light source and sensors (scanner Pro+). In new models and new scanner HD firmware this pattern is used to set focus of sensors and light source.

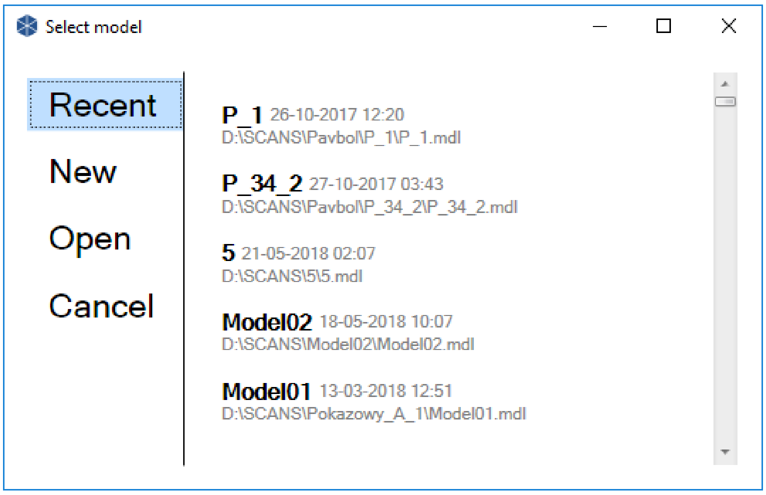
4 – pattern [A0] – used to set light shade and exposure level (see section 4.1.2 Scaling brightness level graph).

5 – pattern [Ellipses] – used when setting the distance between the scanning and the scanned object or the calibration chart (see section 5.1.2).

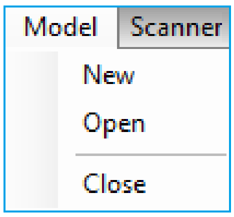
6 – pattern [Switch off] – used to switch off the light source when not in use.

5.2. Model management

Each start of eviXscan software, model management window will appear.



▼Fig. 5-39. View of the [Model] menu



▲Fig. 5-38. Model management window

Allow to open recent models. Create new one or choose model that was not opened in system previously. There is also a way to open this window via menu Model -> New/Open.

5.2.1. Creating a new model

Creating a new model is done by clicking [New] in model management window.

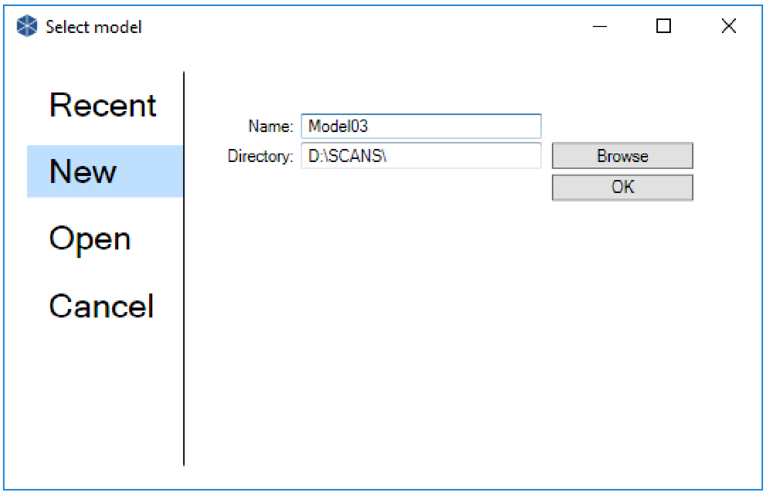


Fig. 5-40. View of the new model creation window

In this window, specify the location of the created model by clicking [Browse]; this will open the target folder selection window Fig. 5-41.

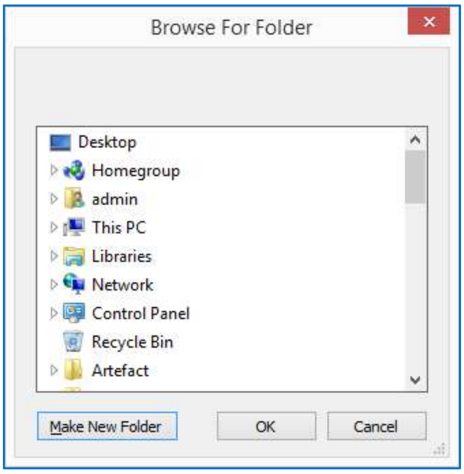


Fig. 5-41. Preview window to choose the destination folder for the new model

Select the destination folder and click [OK]. If the option [Set as Default] was checked, the selected path will be set as the default for subsequent created models. By default, the model name will be set as ModelXX, where XX is the subsequent model number. You can rename the model during its creation by changing it in the [Name] field. When you click [OK] a directory will be created for the new model in the specified location, which has the same name as the model name, and the newly created model is automatically selected as active in the eviXscan.

5.2.2. Loading an existing model

Using model management window software can also load an existing model. To do this select [Open] in the [Model] menu, then open the model selection window. Once there, select the model *.mdl file and click [Open].

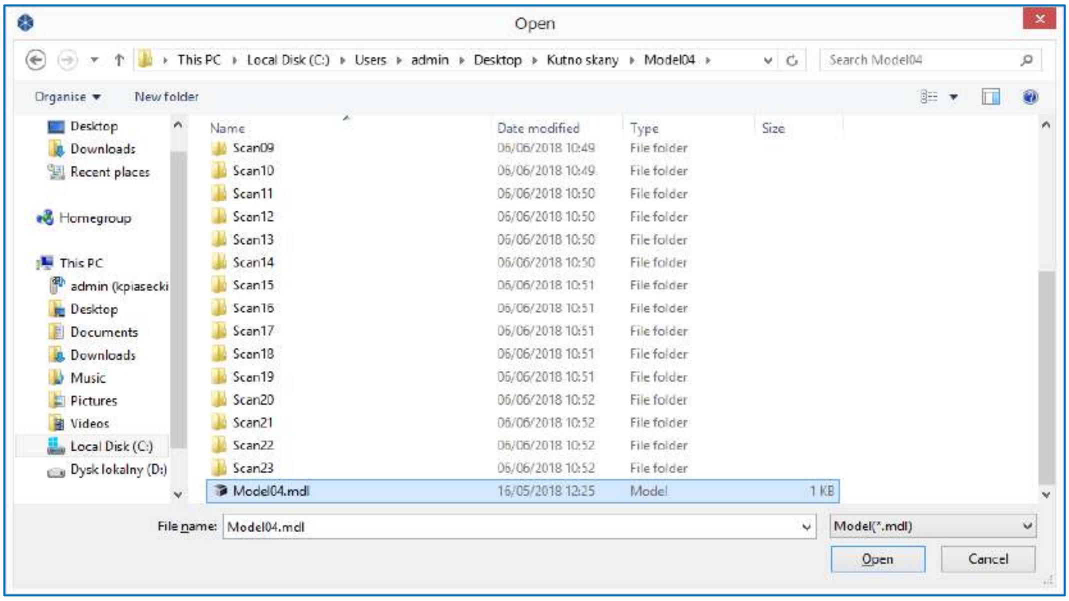


Fig. 5-42. Existing model selection window

5.3. Scanner configuration management

Scanner configuration in the eviXscan environment understood as the physical configuration of the device along with its calibration carried out for the optical system. Thus, it is possible to create multiple configurations in the environment on a single physical 3D scanner. Scanner configurations will typically have different calibration of the light path. The software allows opening the configuration management window in two ways:

- By selecting [Open] in the [Scanner] menu.
- By selecting the button  on the toolbar.

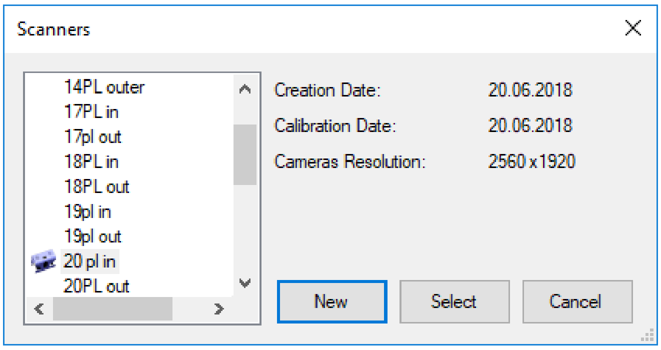


Fig. 5-43. View of the scanner management window.

The scanner configuration management window is divided into 3 sections:

1. Available scanner configurations section
2. Selected scanner configuration section.
3. Operation buttons section.

5.3.1. Available scanner configurations section

This section contains a list of available configurations, along with the currently selected configuration. The selection of the specific configuration in the list is done by clicking the left mouse button. Right-clicking opens a pop-up menu.

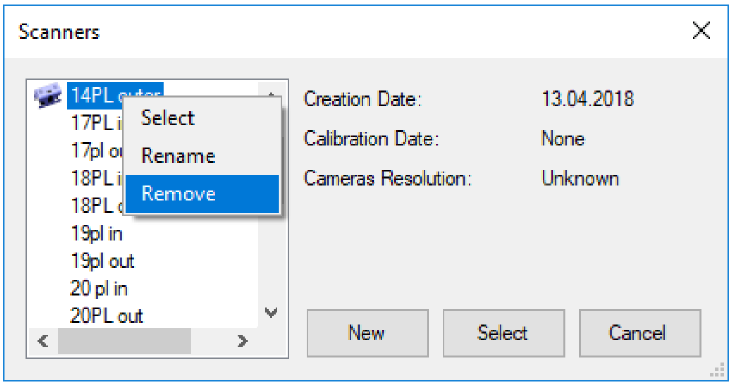


Fig. 5-44. View of the configuration selection pop-up menu

The configuration pop-up menu includes such fields as:

- [Select] – selects the configuration as active and closes the management window,
- [Change name] – allows changing the name of the scanner configuration,
- [Delete] – deletes the scanner configuration from the list.

5.3.2. Selected scanner configuration section

This section is responsible for presenting the basic information on the selected configuration. It contains information such as:

- Creation date - shows when the configuration was created.
- Calibration date - shows when the configuration was last calibrated.
- Camera resolution – shows the resolutions of sensors used in the configuration.

5.3.3. Operation buttons section

It contains the basic buttons to operate the scanner configuration window, such as:

- [New] – opens the new scanner configuration window
- [Select] – sets the currently selected configuration as active and closes the configuration management window
- [Cancel] – closes the configuration management window. The configuration, which was active before the configuration management window had been opened remains active.

5.3.4. Camera selection window

To create a new scanner, click [New] in the scanner management window or select [New] in the [Scanner] menu. This opens camera selection for a new scanner configuration.

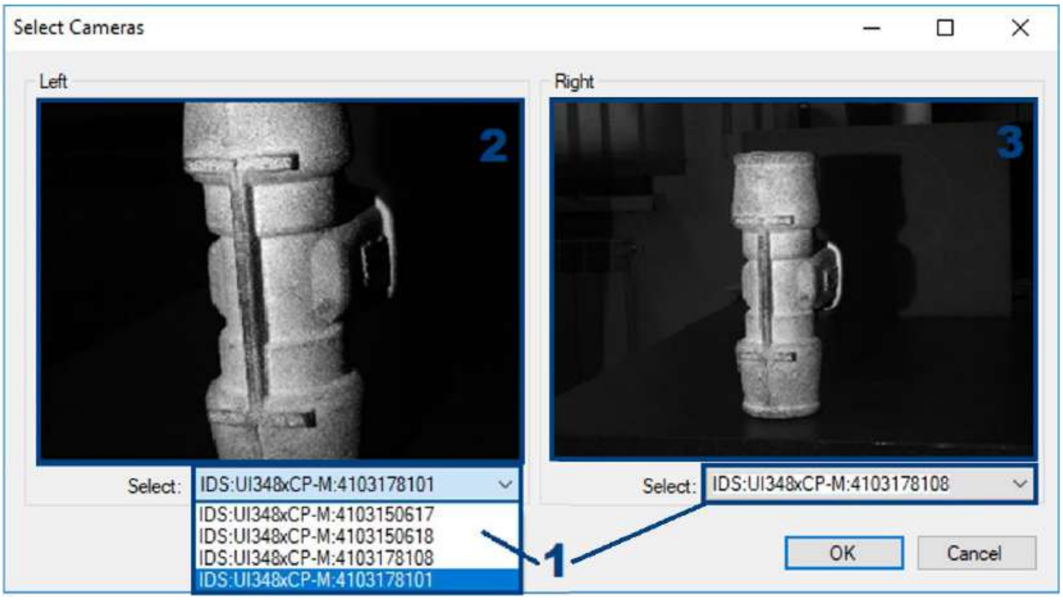


Fig. 5-45. View of the camera selection for a new scanner configuration, 1 - drop-down list of available cameras, 2/3 – preview of the selected camera image.

The creation stage for a new scanner configuration boils down to identifying the left (2) and right (3) sensor. This is done by making a selection from a drop-down menu (1) on each side Fig. 5-45.

Cameras can be determined by comparing their serial numbers. The camera with the lowest number is the left camera of the outer range. The camera with the highest number is the right camera on the outer range. The other two cameras belong to the inner range and accordingly the one with the lower number is left and one with a higher number is right. By the left/right camera we understand the sensor located on the left/right side of the light source (standing behind the scanner) Fig. 5-46.

For example, in the below picture we can identify cameras in the following way:

- IDS:UI348xCP-M:4103150617- left camera outer range (LZ)
- IDS:UI348xCP-M:4103150618- left camera inner range (LW)
- IDS:UI348xCP-M:4103178101- right camera inner range (PW)
- IDS:UI348xCP-M:4103178108- right camera outer range (PZ)

Fig. 5-46. Camera designation

We can also identify the cameras by covering one of the cameras and analyzing the image of the sensor in Fig 5-45. marked as 2 and 3. For example, if you want to define the right inner range (PW) camera, cover to corresponding sensor, and then select from the list the number of the camera which view is obscured Fig. 5-47.

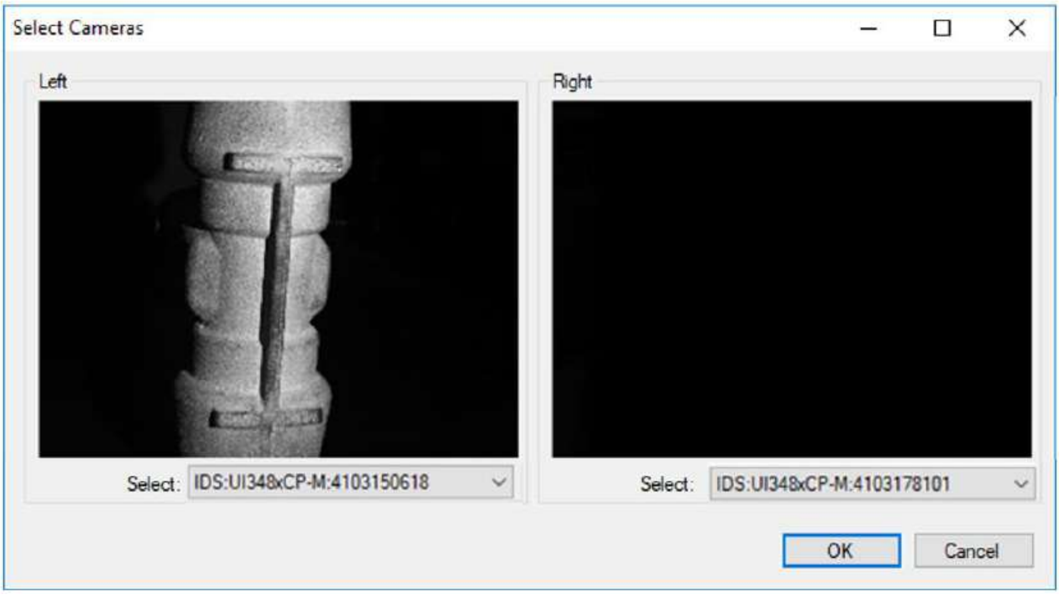


Fig. 5-47. Example of camera identification by covering sensor

After correct selection of both sensors, in the preview window should appear images seen by the sensors – as in Fig. 5-48.

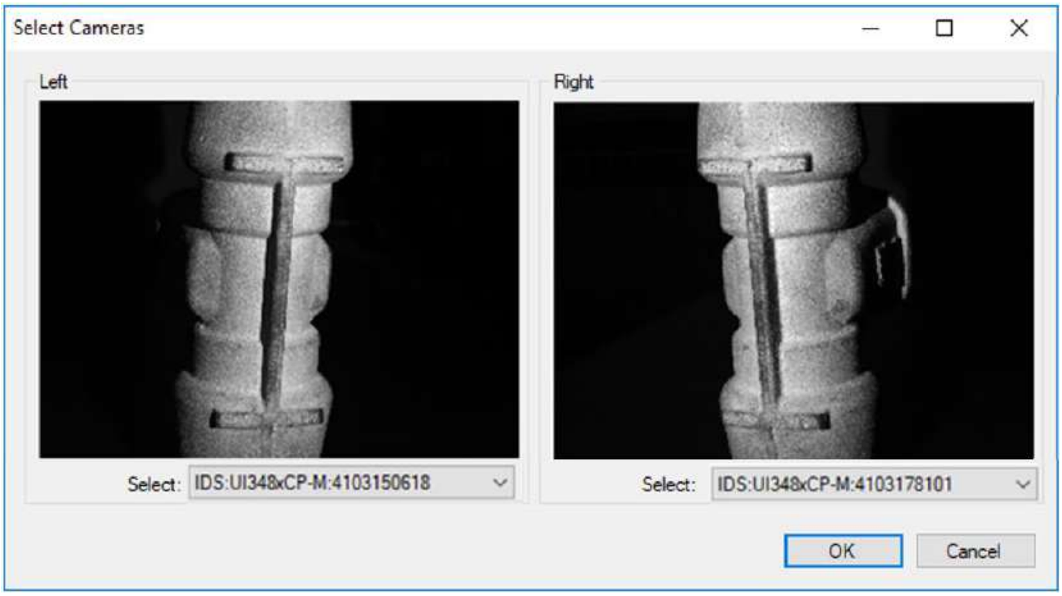


Fig. 5-48. Preview of correctly defined cameras – inner range

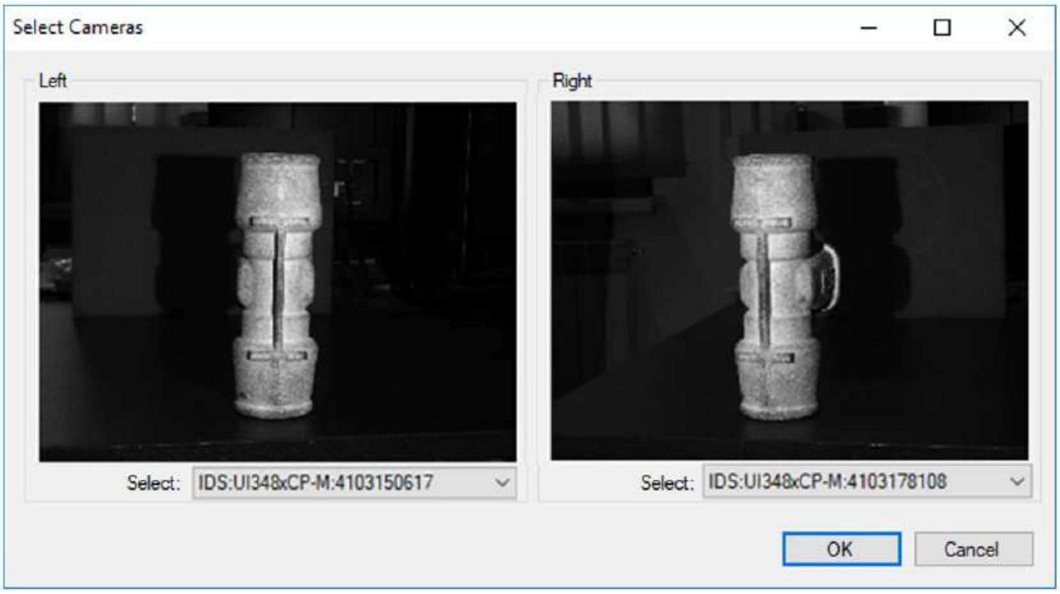


Fig. 5-49. Preview of correctly defined cameras – outer range

If the sensors had been used in a recently added scanner, the software adapts them to the sides in the configuration identical to the recently added configuration. Always be absolutely sure that the sensor is assigned to the correct side. The left side means that from the perspective of the light source, the sensor is on the left side of the light source, and the right one is on the right.

After selecting the appropriate sensors, click [OK], then the configuration will be added to the list and receive a name with the subsequent number (e.g. "Scanner15") and will be set as active. The camera selection window will be closed automatically.

NOTE: In case the number of sensors on the list is less than 4, you should check the physical connection to a computer and the system configuration

5.4. Scanner calibration window

The scanner calibration is one of the main factors affecting the accuracy of the optical measurement system. Making scans without calibrating is impossible, which is why a separate chapter focuses on this stage (see Chapter 6)

The scanner calibration window allows for comprehensive calibration of the scanner's optical system. To calibrate, determine the parameters of the calibration chart and take a series of images in different positions.

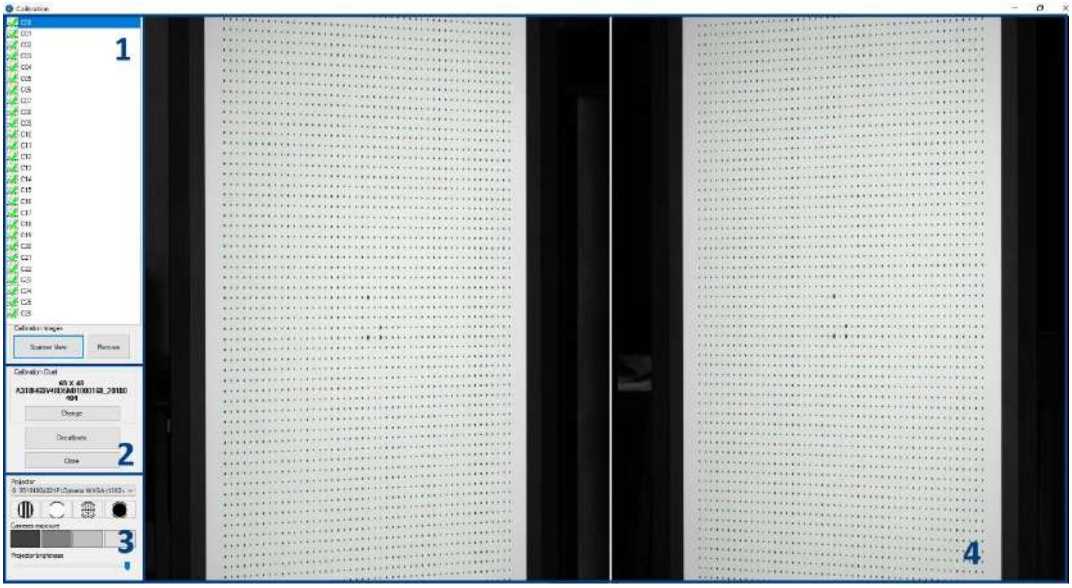


Fig. 5-50. View of the calibration window

The calibration window can be divided into four sections:

1. Calibration images section
2. Image preview section
3. Operation buttons section
4. Light source section.

The light source section is described in detail in section 5.1.5, so this chapter will not discuss it.\

5.4.1. Calibration images section with image preview:

Figure 5-51 shows the calibration image section in both modes, the preview mode and the creation of calibration images. Both modes are very similar. The section contains a list of calibration images made to date, with names starting with the letter "C" (Calibration) and subsequent number starting with 00. These names allow for easier navigation through the calibration instructions that can be found in Section 6. Apart from the name, you can also notice the icon indicating whether the pattern is correctly detected.

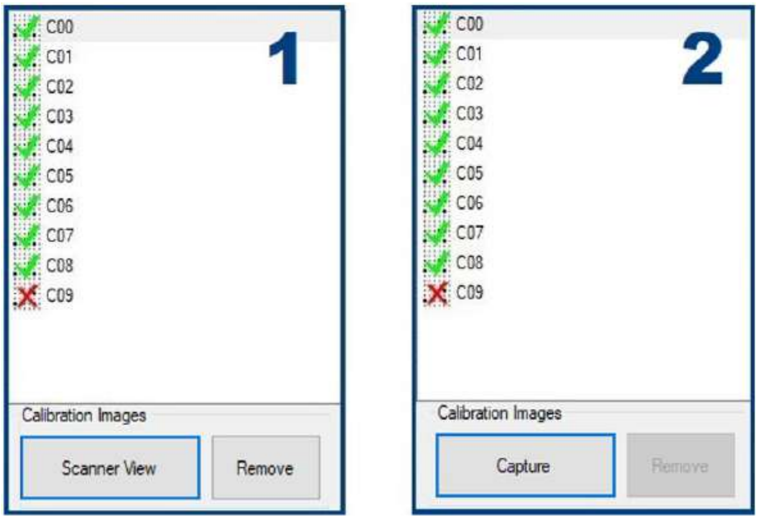


Fig. 5-51. Preview of the calibration images section in two possible modes 1 – calibration image preview mode, 2 – calibration image creation mode

– calibration pattern detected in both images.

– pattern not detected on the left or right images.

If the calibration pattern was not detected in either picture, the two images are not included in the calibration process.

■ Calibration image creation mode

In the calibration image creation mode, the preview section shows the video feed from sensors. After clicking [Capture], images will be taken, and the calibration chart automatically detected. The images are then added to the list, along with the pattern detection status mark. After selecting a specific image, you can verify the detected points in the calibration chart, and if necessary, remove it using the [Delete] button. The application automatically switches to this mode when you open the calibration window, or when you click [Scanner View] in the calibration image preview mode.

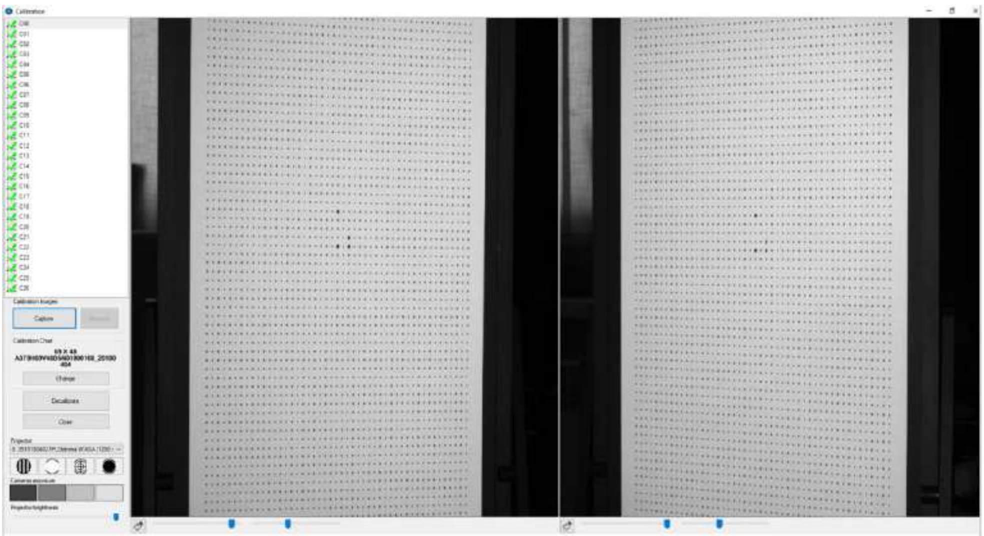


Fig. 5-52. View of the calibration window in the image creation mode

Calibration image preview mode

In order to go to the calibration image preview mode, select a specific image from the list. The images preview section will then show the images with detected (or undetected) calibration charts, the [Capture] button will be replaced with [Scanner View], and the [Delete] button will activate, allowing the removal of a calibration image. Another way to remove an image is to right-click on it and select the delete option from the popup menu. The [Scanner View] button lets you switch to the image creation mode.

Fig. 5-53. View of the calibration window in the image preview mode

Operation buttons section

This section contains basic information about the calibration pattern; the example 4-50 contains:

- 69 x 48 – size of the calibration pattern (69 columns and 48 rows)
- A3T0H69V48D5N010000168_20180 404 – Calibration chart ID

In addition, this section contains three buttons used during calibration:

- [Change] – opens a window for changing the calibration pattern
- [Calibrate] – calibrates the scanner configuration for specific calibration images and calibration pattern
- [Exit] – closes the calibration window

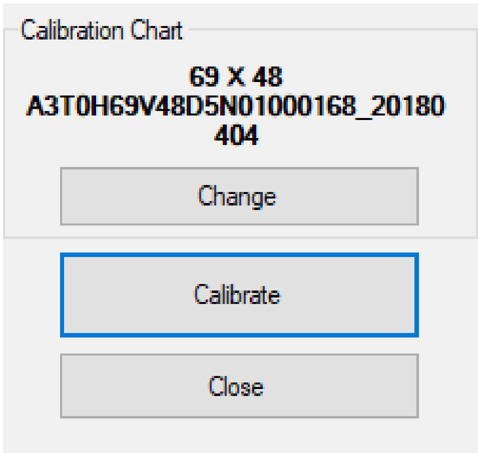
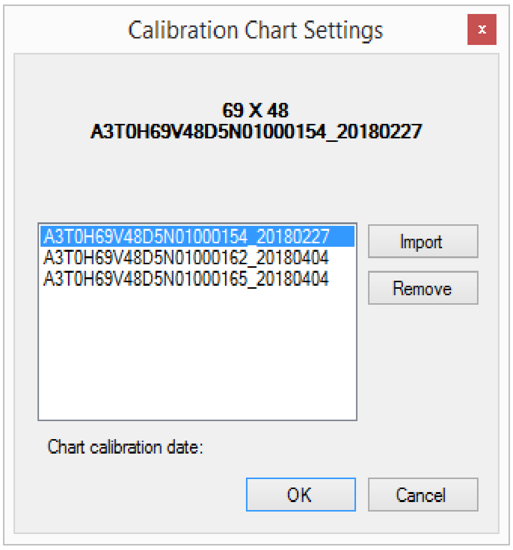


Fig. 5-54. View of the operation buttons section

Once the calibration is complete, it becomes impossible to change the calibration pattern and shooting more calibration images, and the [Calibrate] button changes to [Decalibrate]. To change the calibration parameters or calibration images, the scanner must first be decalibrated.

5.4.2. Changing the parameters of the calibration pat

The parameters of the calibration pattern can be changed in the [Calibration Chart Settings]; to open it, click [Change] in the operation buttons section of the calibration window. In Window "Calibration Chart Settings" a list will appear with the available calibration patterns. When you select one of them, information in the will appear in the upper part of the settings window, stating the number of columns and rows of the pattern as well as the unique number that identifies a particular calibration chart. The date of the chart's calibration will appear below the list of available patterns.



▶ Fig. 5-55. View of the calibration pattern selection window

To add new calibration patterns to the software, click [Import]; a selection window will then open, where you can select a configuration file (with the extension *.md). Each calibration pattern has its own unique ID number and a configuration file (supplied with the pattern).

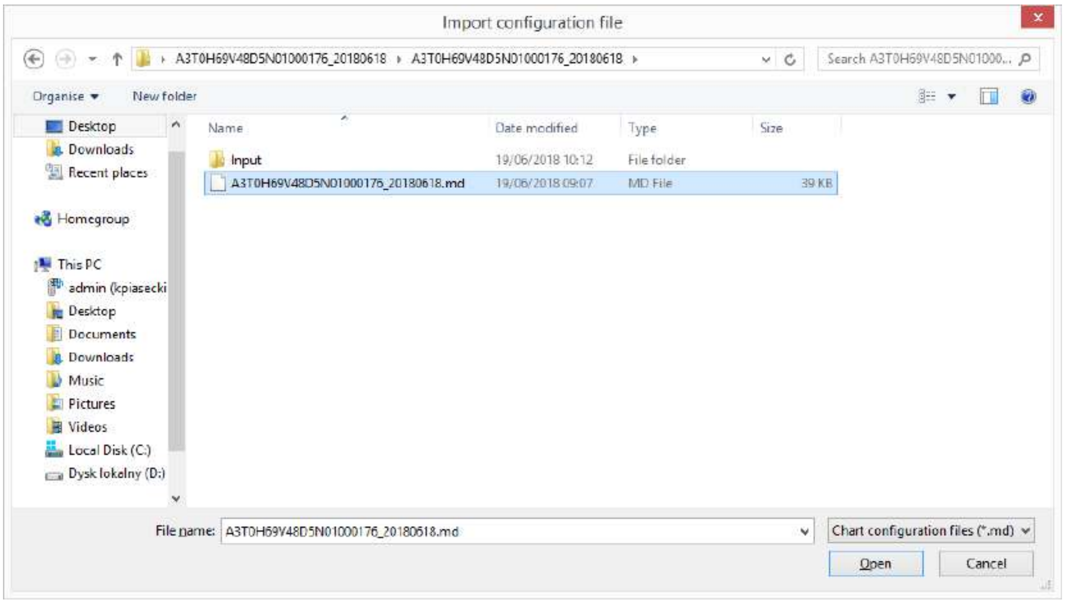


Fig. 5-56. View of the calibration pattern import window

After importing a given calibration pattern, it is stored in the software. Re-importing the file with the same ID number of the calibration pattern will display a message about overwriting information about the pattern. The pattern can be deleted by selecting it in the list and clicking [Remove]. After changing the calibration parameters, the calibration pattern will be detected automatically for all previously taken images.

NOTE: Before proceeding with the calibration, make sure that the active calibration chart ID matches the number on the sticker on the back of the calibration chart. Loading a wrong file, which does not match, results in poorer calibration accuracy and as a consequence poorer results in scanning.

5.5. Alignment with markers and artifacts window

Optical measurement systems for single measurement give information about the object's shape as seen from a given perspective. Additional information is needed in order to bring multiple shots into a common frame of reference. There are 3 ways to solve this problem, we can align scans using:

- Markers (non-unique) (1),
- Unique markers (2),
- Artifacts (3) - a set of calibrated unique markers.

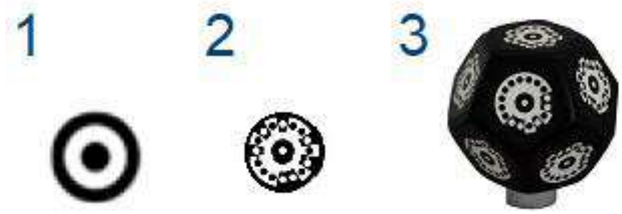
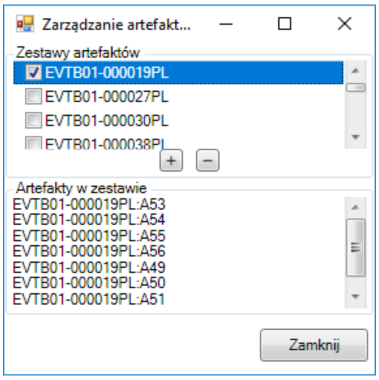


Fig. 5-57. 1 - marker, 2 – unique marker, 3 - artifact

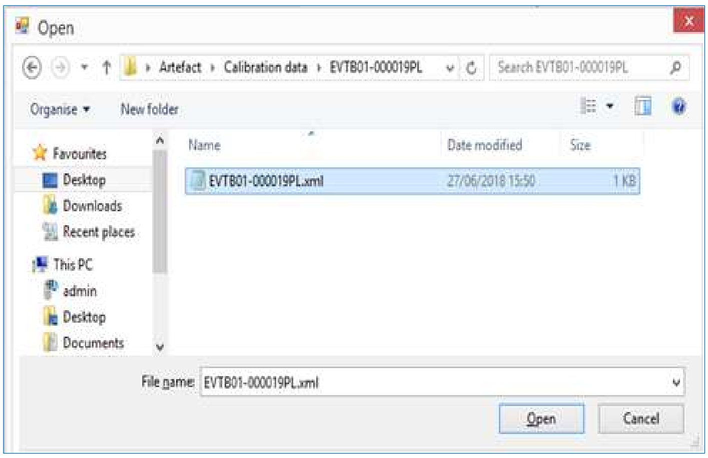
5.5.1. Artifacts management window

Artifacts have a unique calibration file dedicated for a particular set. To add a new artifact reference file to the software, select [Artifacts] from the [Settings] drop-down menu. The artifacts management window opens. After clicking [⊞] sign, locate and open the configuration file (containing the extension *.xml).



▲Fig. 5-58. Artifacts management window

Each set of artefacts has its unique identification number, located on the sticker on the packaging and the corresponding configuration file (provided with the kit). The name of the imported file must match the name of the set. After importing a given pattern, it is stored in the software. Re-importing a file with the same identification number will result in a request to overwrite the information. The pattern can be removed in the Artefact Management window (Figure 5-58.) By selecting it in the list and clicking the [⊟] button. Activation / deactivation is done by selecting [☑] / deselecting [☐] checkbox next to the file name.



▲ Fig. 5-59. The view of the import window of the artifact configuration file

5.5.2. Detection of markers

A necessary condition for correct detection of markers is correct calibration of the scanner configuration. Detection of markers is carried out directly on the view from the sensors for the scale of the scanner configuration. To do this:

- Go to the preview of sensor images by clicking [Preview].]
- On the toolbar, click [Show / Hide markers], then the detected markers will be marked on the preview. In the case of unique markers, the number of the recognized marker will also be displayed in the left corner of the view of each sensor.

In order for a marker to be used at the aligning stage, it must be visible and correctly identified by both left and right sensors (Fig. 5-60.). For example, in the picture below, the markers (1), visible only by the right sensor, and the marker (2) not recognized (not highlighted) on the left sensor and not visible by the right sensor will not be used for aligning. In the picture Fig.5-61. all markers have been correctly identified and will be used in aligning.

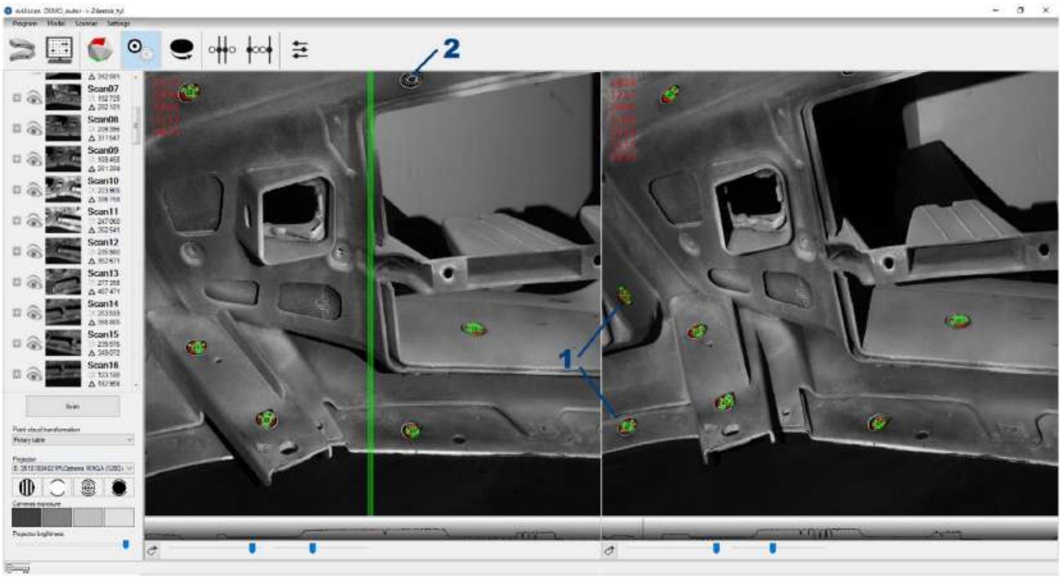


Fig. 5-60. Presentation of detected unique markers on the scan preview.

Detection of markers for a scanner shot is performed automatically after generating a 3D point cloud. In order to observe the markers detected for an image, follow the steps below:

- Select a scan from the model list
- Go to the image preview mode by clicking the image A0
- On the toolbar, click [Show/Hide markers]; the image will then be completed with the detected markers.

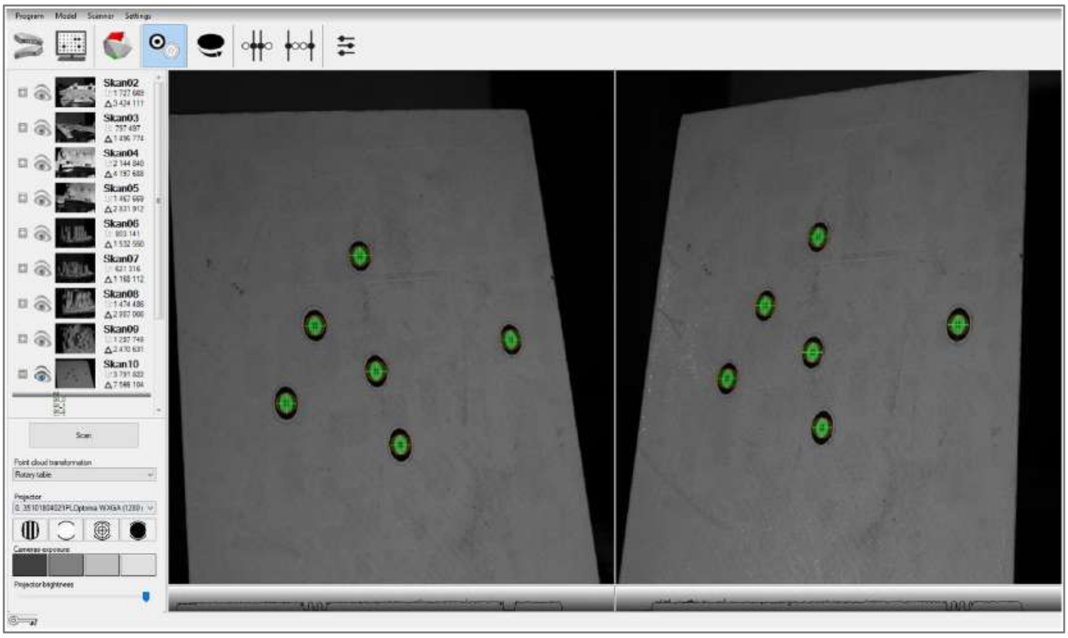


Fig. 5-61. Presentation of detected non-unique markers in the picture.

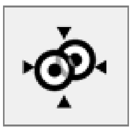
5.5.3. Aligning scans using markers

The following scan aligning methods are used depending on the used tool:

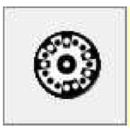
- Marker (non-unique)- in order to match two scans, it is necessary to specify at least 3 common markers on them. An important condition when submitting scans using non-unique markers is the fact of the unique placement of markers for different scanner shots.
- Unique marker - in order to match two scans, it is necessary to specify at least one common marker on them.
- Artifact- in order to match two scans to each other, it is necessary to specify for each of them at least one marker from the cube.

For unique markers and artifacts, it is also possible to align groups of scans taking into account their previous transformations (e.g. scanned using a rotary table). In this case, it is enough that one of the scans from each series will meet the above requirements.

In order to align multiple scans, select the selected scans and choose one of the two matching methods from the toolbar menu:

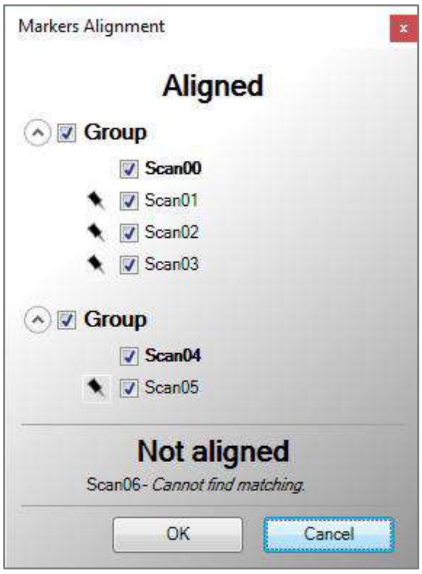


Aligns selected scans using markers (unique and non-unique) and artifacts, not taking into account previous transformations.

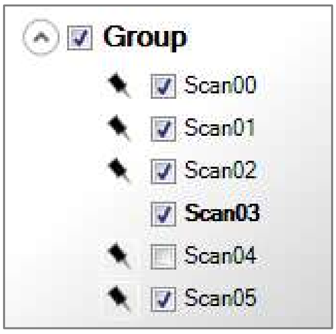


Aligns selected scans using markers (only unique) and artifacts, taking into account previous transformations (e.g. using a rotary table).

After selecting the matching method, the [Markers Matching] window will open. Figure 5-62 shows the result of a sample scan match using markers. You can observe that two match groups have been created. The first group contains 4 scans, where the base scan is "Skan02", while the second group contains 2 scans, of which the base scan is "Skan05". You can delete any scan from the matching group by unchecking it in the list.



►Fig. 5-62. An exemplary view of the window aligning scans by markers



The software also allows you to set any group scan as the base by clicking the pushpin icon for it. The scan set as the base does not have such an icon. All other scans will be transferred to the scan coordinate system set as the base when you click the [OK] button.

After accepting the transformation, all scans will be assigned to the base scan coordinate system.

◄Fig. 5-63. Removing Skan04 from alignment

5.5.4. Changing the base scan after approving the transformation

After approving the alignment of the scans using markers, all the scans will be brought down to a common frame of reference. This frame may be changed, where there is a need to re-align the scans relative to one another. You can then select another scan as the base, which will result in changing the frame of reference; to do this, follow these steps:

a) Select the scan that is to be the base scan
b) In the scan generating section, set its [Point cloud transformation] parameter as none.
c) Select the group scans and choose [Align selected scans]
d) Select the specific scan as a base scan
e) Click [OK]

5.6. Rotary table window

The rotary table allows the pre-orientation of scans using marker method. To open the window responsible for peripheral support, click on the toolbar button [Rotary table].

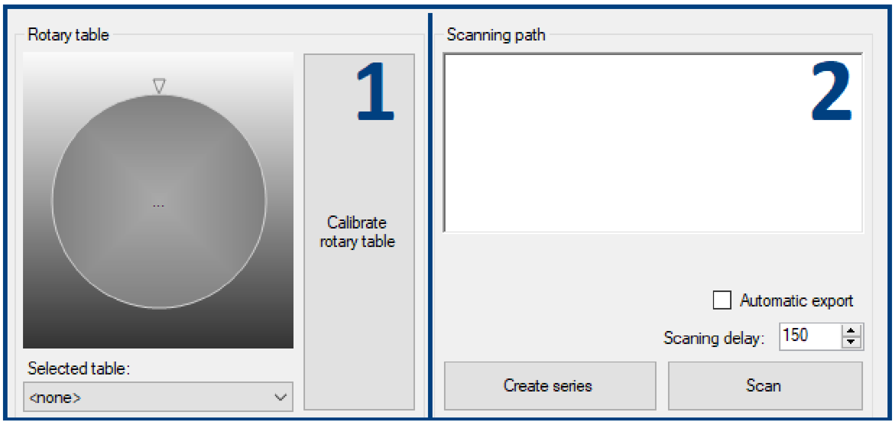


Fig. 5-64. Rotary table window view.

The rotary table window includes all features necessary to properly manage peripherals supporting scan alignment. This window can be divided into 2 sections:

1 – Section responsible for handling the rotary table.

2 – Scanning path section.

5.6.1. Handling the rotary table

To enable support for the rotary table, choose the appropriate device from the dropdown menu described as [Selected table].

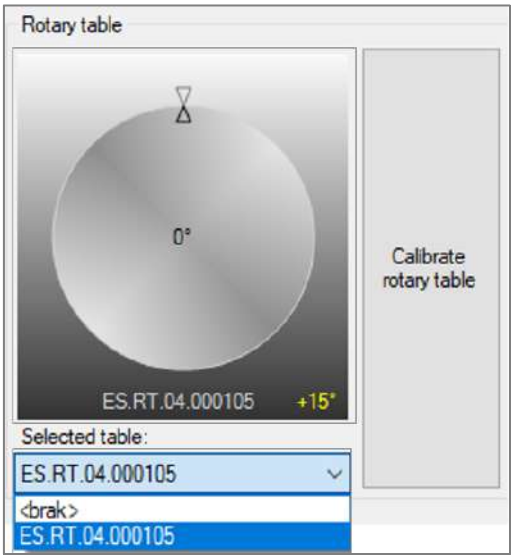


Fig. 5-65. Table selection from ta drop-down menu

Once the software has successfully connected to the device, the current position of the table will be set as 0°. In contrast, the table's indicator will change to the one shown in Figure 5-66.

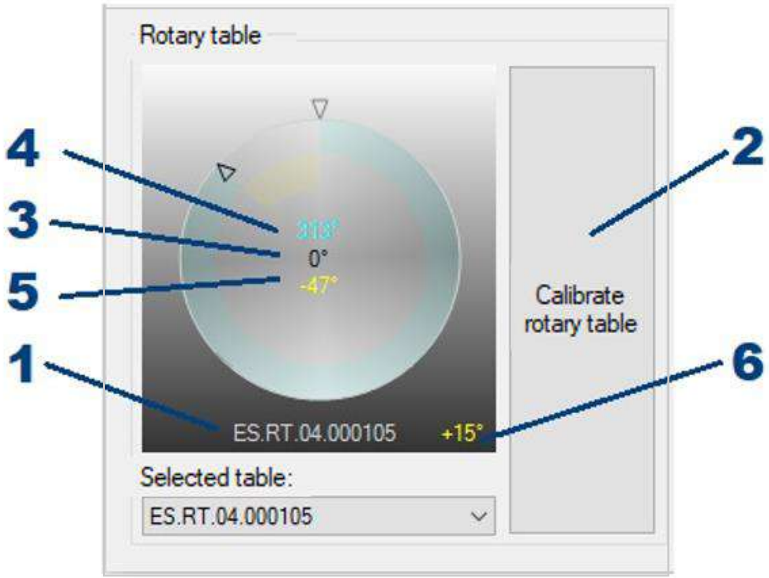


Fig. 5-66. View of the rotary table handling section

Figure 5-66 shows the view of the rotary table section, along with an indication of its most important elements; when you hover your mouse cursor two colors will appear for selection, used to manually rotate the table. The blue selection color means a position in which table will be after the turn, while yellow means the angle by which the table will turn. In addition, the disk of the virtual table will show the values of absolute and relative positions of the table.

Other highlighted features include:

1 – ID of the table.

2 – Rotary table calibration button that opens a window to calibrate the table.

3 – The current value of the table's rotation angle.

4 – Target position of the table, where it will be upon clicking the left mouse button.

5 – Relative angular value, by which the table rotates when you click the left mouse button; a negative value means the table rotates counterclockwise, and a positive one – clockwise.

6 – The value adjusted with the mouse scroll wheel in the range [-90°, 90°]; it represents the angle by which the table rotates when you click the right mouse button.

Rotary table calibration window

Calibration of rotary table is understood as the determination of the table's rotation axis in the reference system of the scanner. Calibration is require to scanning using rotary table. In order to calibrate the table, click [Calibrate rotary table], which opens the window for determining the axis of the rotary table.

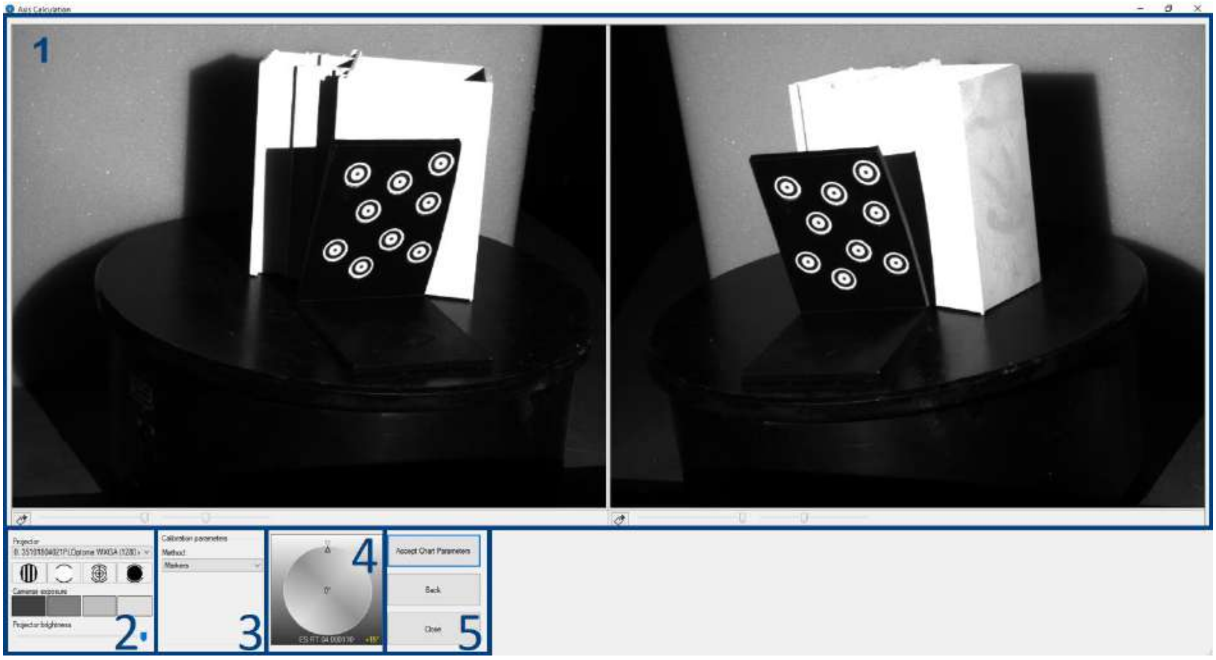


Fig. 5-67. Rotary table calibration window

Figure 5-67 shows the rotary table calibration window, along with the major sections selected; these are as follows:

1 – Sensor view/Image preview section.

2 – Light source handling section – allows changing the parameters of the light source in such a way as to be able to detect the calibration pattern.

3 - Rotation axis section – allow to select method of detecting rotary axis (markers and calibration chart) and contains basic information about designated axis of rotation.

4 – Table handling section – allows rotating the table manually.

5 – Operating buttons section – includes the basic buttons necessary to designate the table's axis.

Process of calibrating the table rotation axis

The scanned object should be placed in the middle of the rotary table, select the appropriate scanner inclination angle and the correct distance from the scanned object (p.46). Then, without changing the position of the scanner or table, set the positioning pattern on it so that the markers are visible on the view of both cameras (Fig. 5-66). If the object being scanned prevents it, you can remove it from the table for the time of calibration, remembering not to change the position of the table relative to the scanner after calibration.

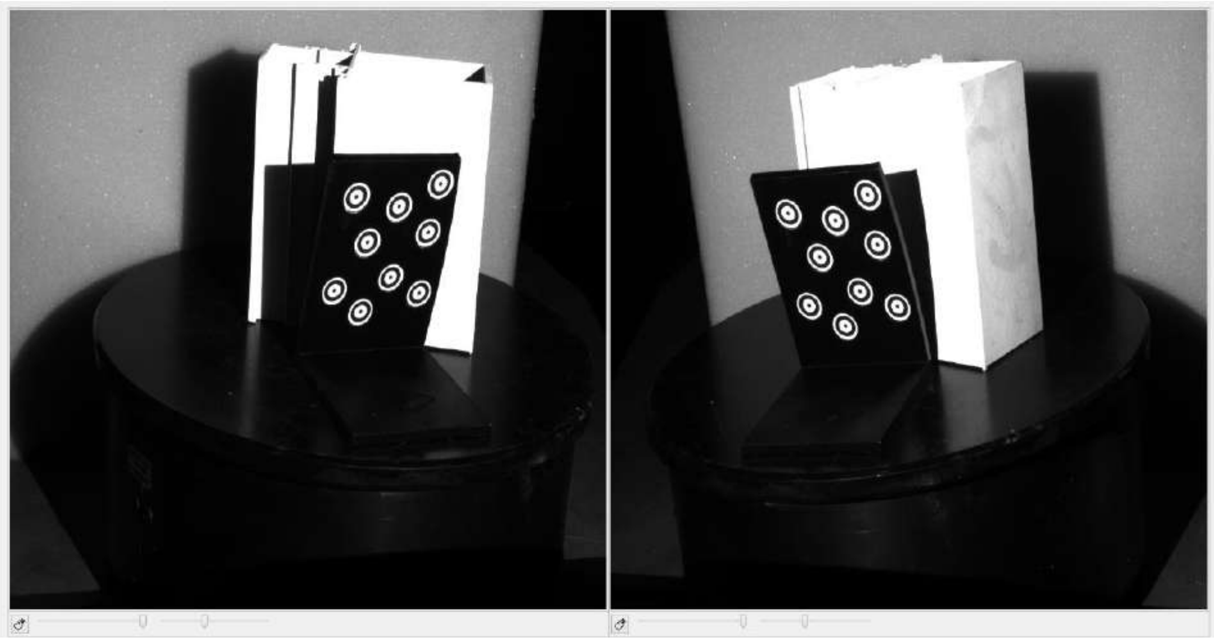


Fig. 5-68. Properly set calibration pattern for the table - camera preview

In the open window of the rotary table calibration, after clicking the [Set Axis Position] button, the software guides the user through the following steps to determine the table rotation axis.

The procedure for determining the axis of the table consists in making three photos of the table with markers in various angular positions. In the buttons section, the [Back] button will appear, allowing you to return to the previous step of determining the table axis.

The calibration of the table remains correct until the table and scanner's position remains unchanged. If the position is changed, the table must be calibrated again, previously deleting the old calculation, using the [Remove Axis Data] key.

NOTE: Possible problems with the detection of markers may result from improperly selected exposure settings and projector brightness, which results in the underexposure of the markers on the positioning model.

A badly designated axis of the table will result in bad alignment of future scans. Moving the table or scanner after determining the axis of the table results in the loss of the table calibration

In order to determine table rotation axis, do the following:

1. In the rotary table calibration window, select "Markers" from the drop-down list as the calibration method (1), as shown in Figure 5-69.

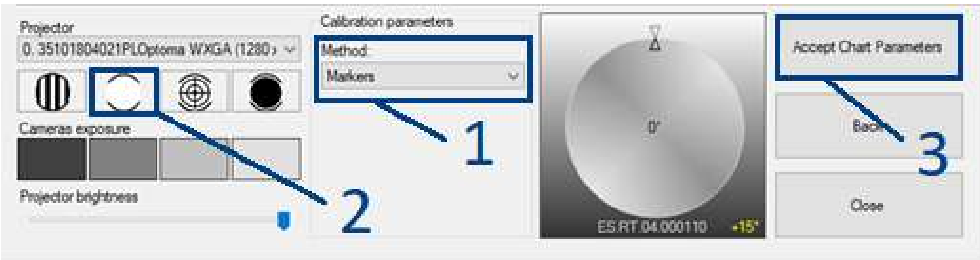


Fig. 5-69. Rotary table calibration window

2. Make sure that the scanner displays the A0 (2) pattern. We never calibrate on the Ellipse pattern (viewfinder) or on F0 (bands).
3. Click the [Accept Parameters] button (3).
4. By clicking the [Take Pictures] x 3 and [Accept Photos] x 3 buttons, three pictures must be taken at the table angles differing by at least 10º and not larger than 80º. If it is possible to take pictures at a larger angle, this should be done, the larger the angle results the more accurate calibration. Make sure that at least 4 of the same markers are detected in all pictures. The calibration model should not move when the table is rotated.
5. Click the [Calculate] button.
6. After correct calibration of the table, the "Table axis calculated" message will be displayed. Confirm the notification with the [OK] key, then exit the table calibration window with the [Close] button, then the main program window will automatically open, in the scan execution mode.

It is also possible to make a calibration using markers glued to the table top or using an object with glued markers. When calibrating this way, remember that at least 4 common markers should be visible in 3 photos. Markers should be glued in accordance with the instructions in chapter 7.2.

These examples can be seen in the pictures below.

Fig. 5-70. Calibration of the table with the use of sticker markers

After calculating the axis of rotation in the [Axis Data] section, information about the axis of rotation most recently set for the given scanner will appear, such as:

• Date of axis designation.

• Table positions in which calibration photos were taken to determine the axis. After clicking on a given item, the photo preview window will be displayed with the calibration pattern detected.

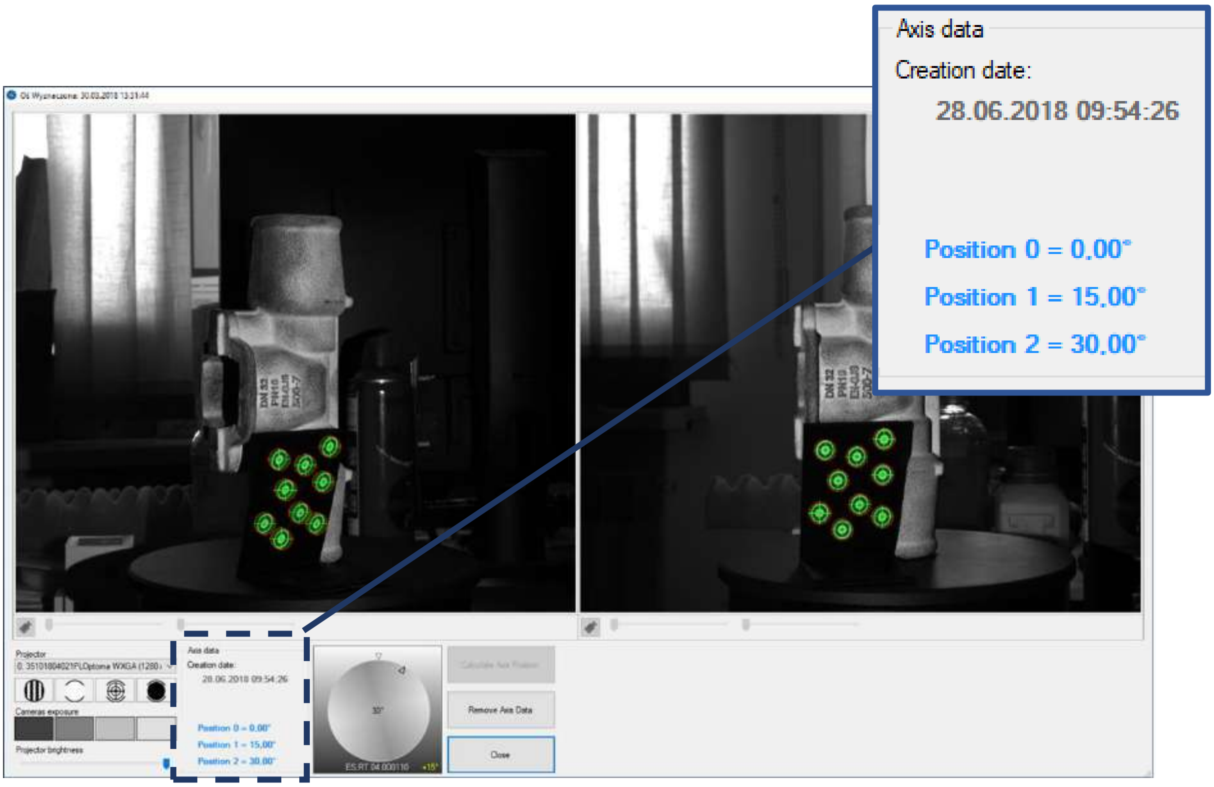


Fig. 5-71. An example of a preview of the rotary table calibration after determining the axis

Scanning using a rotary table

Scanning using a table can be done in two ways:

1 - Through the scan path.

2 - By manually (using the table control) changing the table position and performing another scan. In this case, in the scan generation section, select [Refresh table] as the option of the [Point transformation] parameter.

5.6.2. Scanning path section

After determining the axis of the rotary table, it is possible to automate the process of scanning and aligning the scans. To do this, use the [Scanning path] section in the mechanical peripheral window.

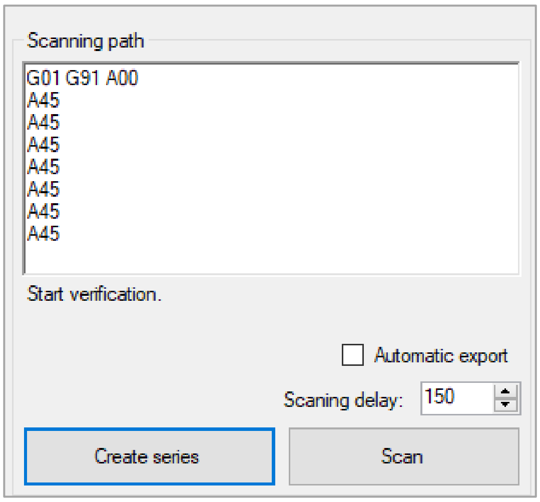


Fig. 5-72. Example of the view of the scanning path section

The scanning path uses scripts in the simplified version of the G code to manage automatic scanning. After entering the script. the [Scan] button is activated, causing the execution of the script. The script will be verified before being executed. The software also allows you to automatically create a control script using the rotary table by pressing the [Create series] button; it then automatically opens the scanning parameter selection. Fig. 5-73.

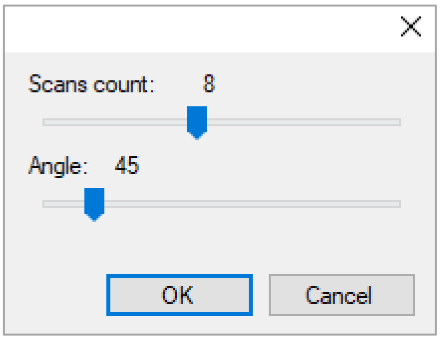


Fig. 5-73-. View of the automatic scanning parameter selection.

This option allows setting the number of scans in the series in the range of [2 – 16] and selecting the angle of rotation between scans in the range [1 – 359]. After pressing [OK], the script is automatically created in the [Scanning path]. Regardless of the script settings, the table will always move along the shortest path (i.e. instead rotating by 350°, it will rotate by -10°).

Supported G code commands

- **G00** – flag indicating that the next movements of rotary table are not working movements, i.e. the object will not be scanned between movements.
- **G01** – flag indicating that the next movements of rotary table are working movements, i.e. the object will be scanned between movements.
- **G90** – flag indicating that the values of movement parameters will be given as absolute values (e.g. A45 – represents rotating the table to the position 45°).
- **G91** – flag indicating that the values of movement parameters will be given as values relative to the current position (e.g. A45 – represents rotating table by 45°).
- **AX** – represents the command of moving the rotary table by the angle of X, where a positive value indicates clockwise rotation (e.g. A45).

Scanning Delay

This parameter can be changed in the range on 0 – 5000 [ms]. When scanning using peripheral devices, you can set a delay between the end of the device's movement and commencement of scanning in order to stabilize the position of the scanned object.

6. Calibration process

6.1. Calibration purpose

The purpose of calibration is to create a model describing the environment, in which the source of light is located, as well as sensors and other components of the scanner. This model is needed while generating the point cloud. In order to run the calibration correctly, turn the scanner on and leave it for some time, until the sensors and the light source heat up. You should also make sure that the scanner and the environment have a constant temperature during calibration and scanning. It is also necessary to carry out calibration at the same temperature as the subsequent scans. After calibration, you cannot physically change anything in the cameras, e.g. unscrew the domes, loosen and tighten the lenses, set up filters on the cameras, change the aperture or exposure of cameras . Any such change will require re-calibrating the scanner.

The scanner should be calibrated every day before the scanning takes place. **The visible effects of discalibration are double edges on individual scans**. Less visible faults include **errors in sizes** and **various deformations** of the scans. If any of these cases should be observed, you must re-calibrate the scanner.

6.2. Scanner workspace

The scanner's workspace (scanning area) is defined as the area created by the of field of view of the left and right sensors and the depth of focus of both cameras and the light source. From the user's perspective, it is an area in space where the scanned object should be placed.

Heavy Duty Quadro scanners have a fixed position of sensors and light source. This defines two areas of scanning that are scaled to each other while maintaining the proportions. The table below shows the dimensions of the work area for both ranges of the Heavy Duty Quadro scanner.

Inner measurement range	Outer measurement range
150 x 115 x 90 mm	370 x 265 x 150 mm

Table 6-1. Workspace of Heavy Duty series scanners.

Scanner workspace:

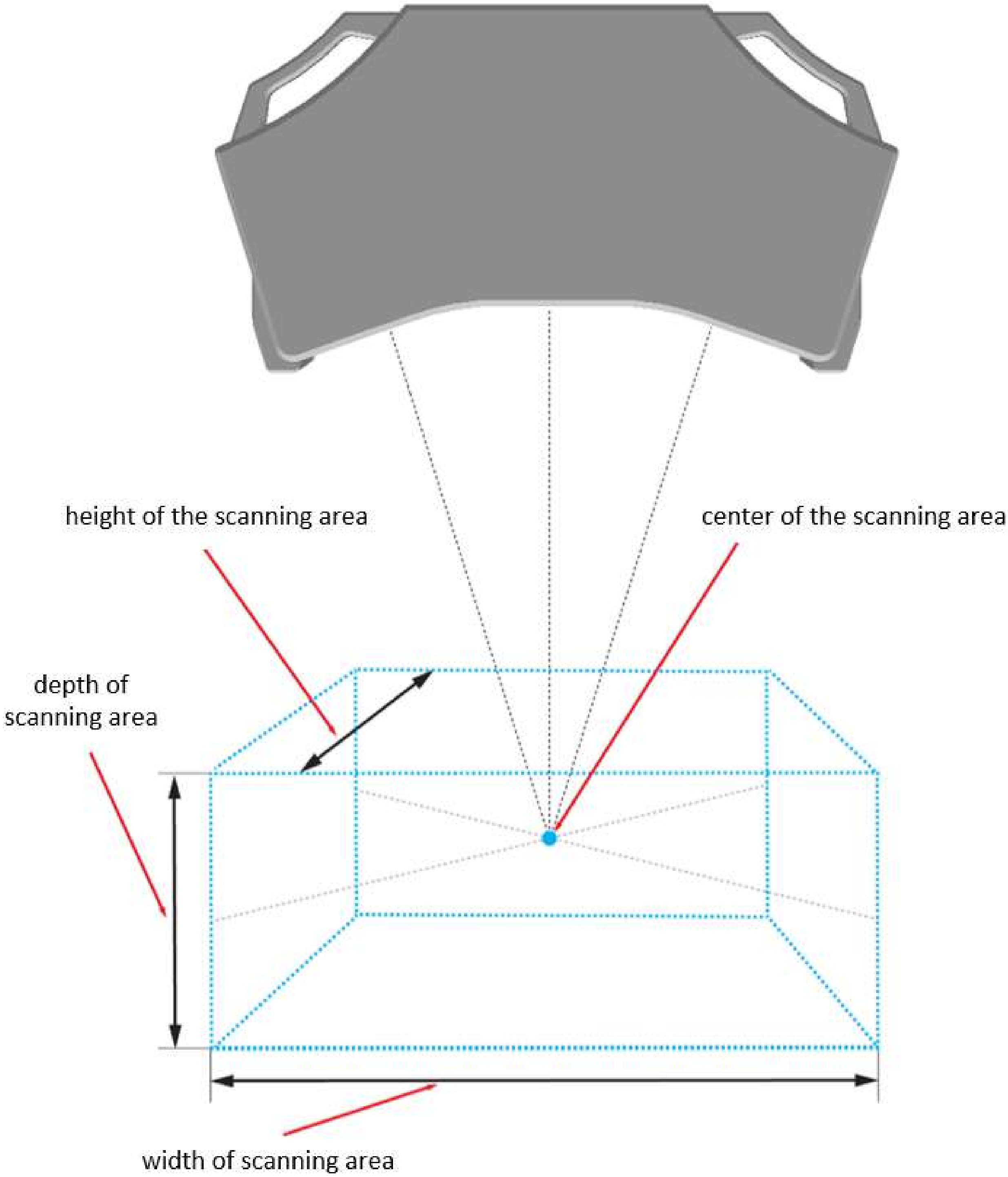


Fig. 6-1. The scanning are

6.3. Performing the calibration process

The calibration process consists in taking a series of photos of the calibration chart set in the working area (scanning area) of the specified scanner range. To go to the calibration process, it is necessary to have the scanner configuration already created with correctly defined cameras (right / left) for the given range (described in chapter 5.4.). After selecting the correct configuration from the Menu section, click the [Calibrate] button. After opening the calibration window, select the calibration chart with which we will carry out the calibration process [Calibration chart -> Change].

6.3.1. Base calibration image

To inform the eviXscan environment, which scanning range has been defined by the user, take a picture of the calibration table in the zero position, so-called base photo. The preparation for taking this image looks similar in both cases:

1. Select according to the calibrated range and securely attach (e.g. stick to the table top) the calibration pad. Drawing of the scanner presents the scanner's orientation towards the calibration chart. The pad will serve as a scheme for positioning the calibration chart.

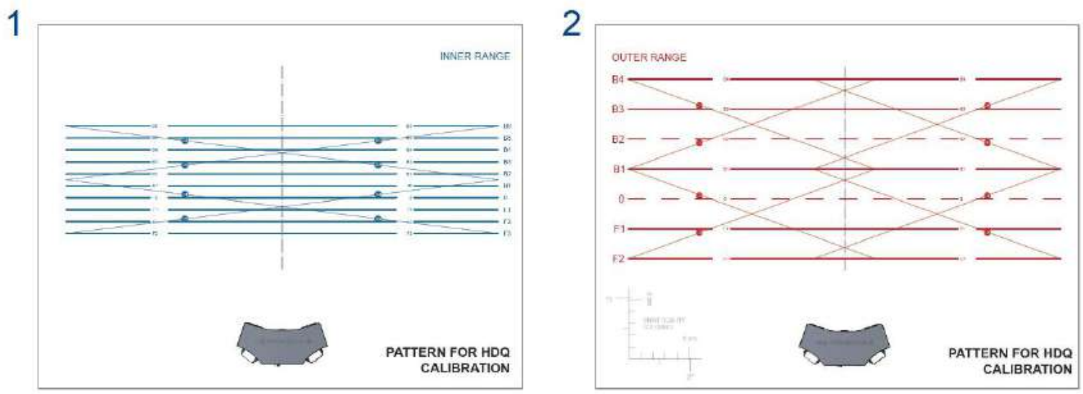


Fig. 6-2. Calibration pads, 1 – inner range, 2 – outer range

2. Assemble the calibration chart. Horizontal setting (1) for the inner range or vertical setting (2) for the outer range.

Fig. 6-3. Correctly assembled calibration chart

3. Set the calibration board symmetrically on the 0 line, according to the indentations in the base. The plane of the black dots should be oriented towards the scanner.

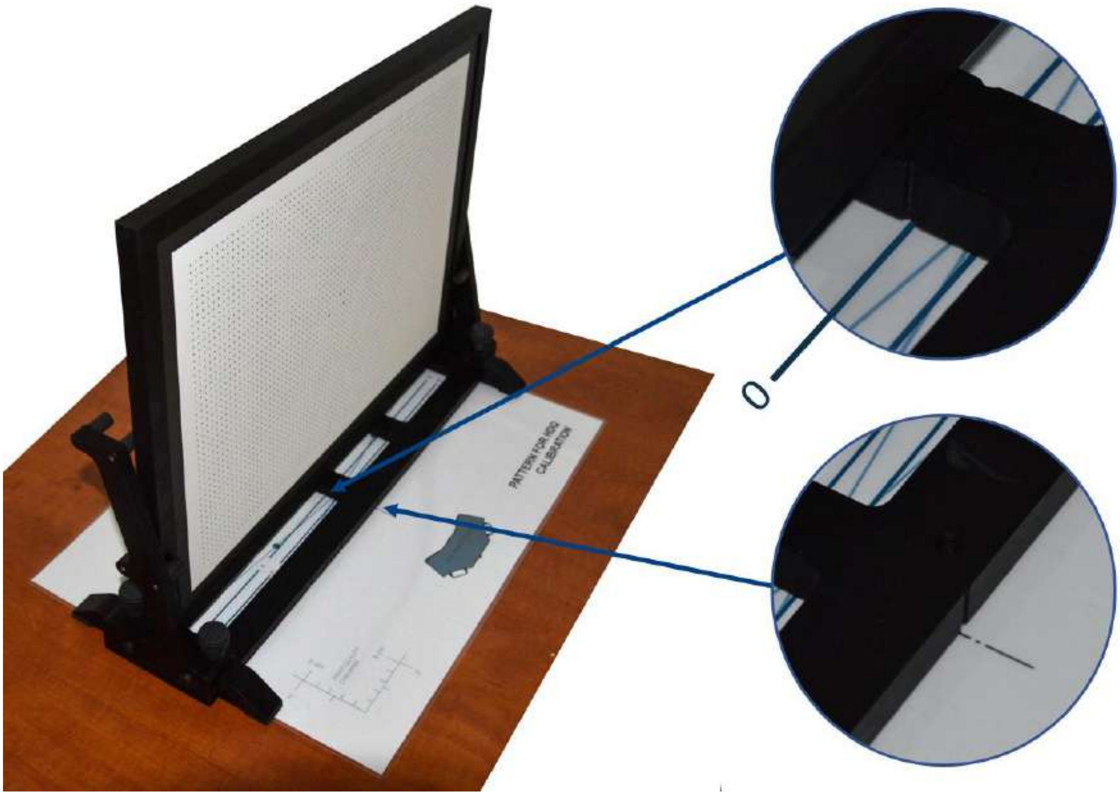


Fig. 6-4. Correct positioning of the calibration table on line 0 for the internal range

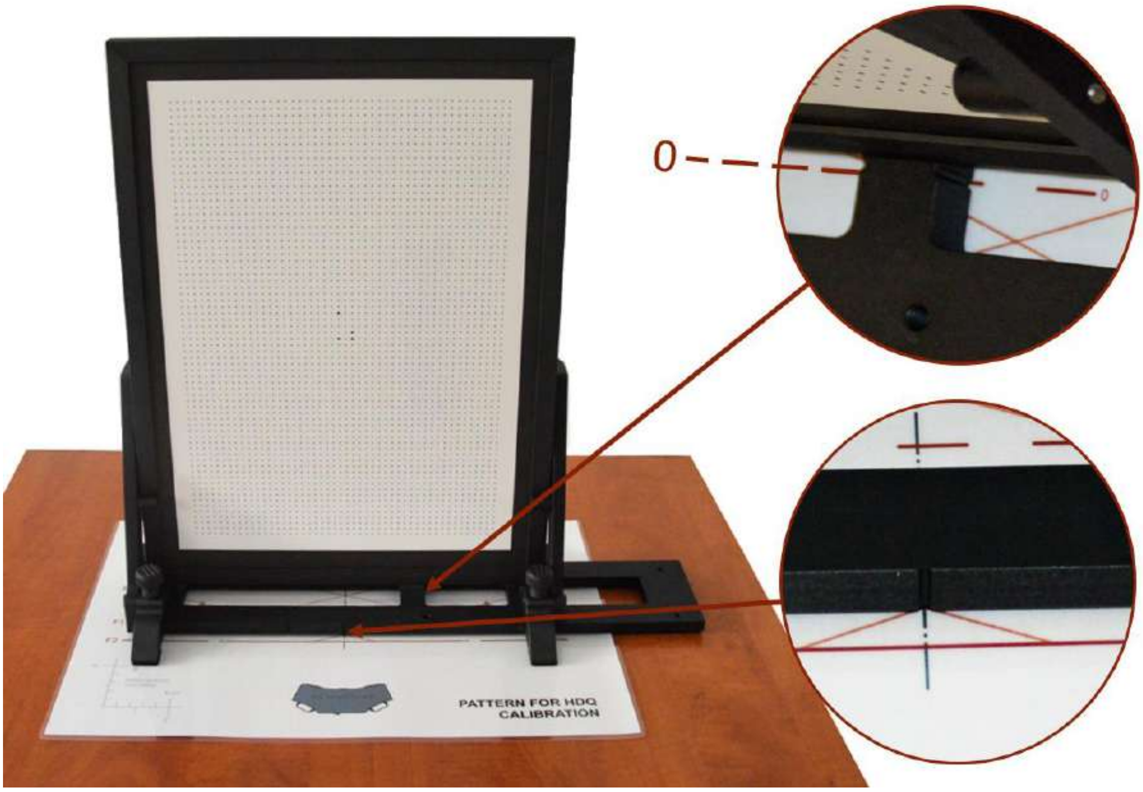


Fig. 6-5. Correct positioning of the calibration table on line 0 for the outer range

4. Set the distance between scanner and calibration chart using the [Ellipse ⊕].

The setting must meet the following conditions:

- Orient the scanner so tat the distance of both sensors from the array (plane with dots) is the same and the image projection path makes a right angle with this plane.

Fig. 6-6. Correct setting of the scanner relative to the calibration table

- By manipulating the scanner height, the viewfinder and the lines of the displayed ellipse should be fitted into the center of the calibration table, shown in the pictures below, in sequence for the internal and external range.

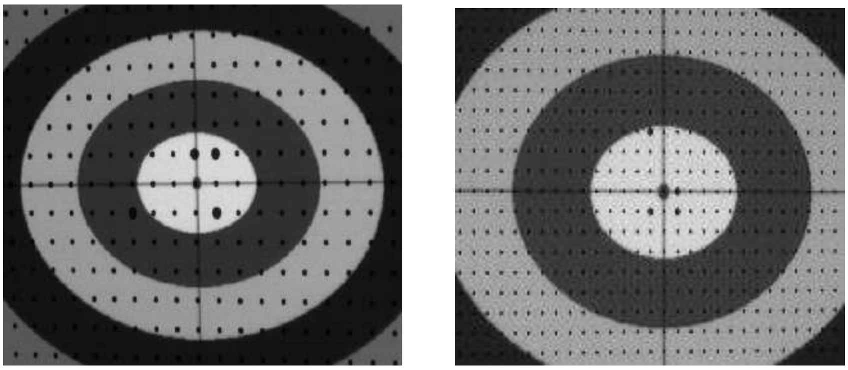


Fig. 6-7. Specific elements of the calibration with its center

- When performing the calibration process in the eviXscan software, a semi-transparent green vertical bar will be applied to the image from the left camera. It should match the black vertical line of the [Ellipse ⊕] pattern. This can be achieved by moving or zooming the scanner to the calibration table.

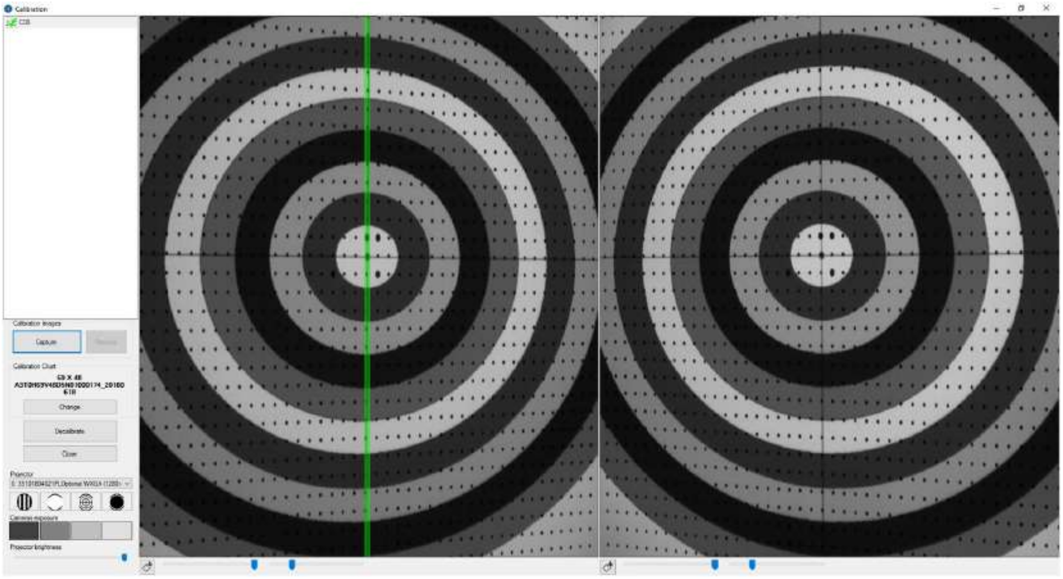


Fig. 6-8. Correctly positioned calibration chart relative to the scanner for the inner range

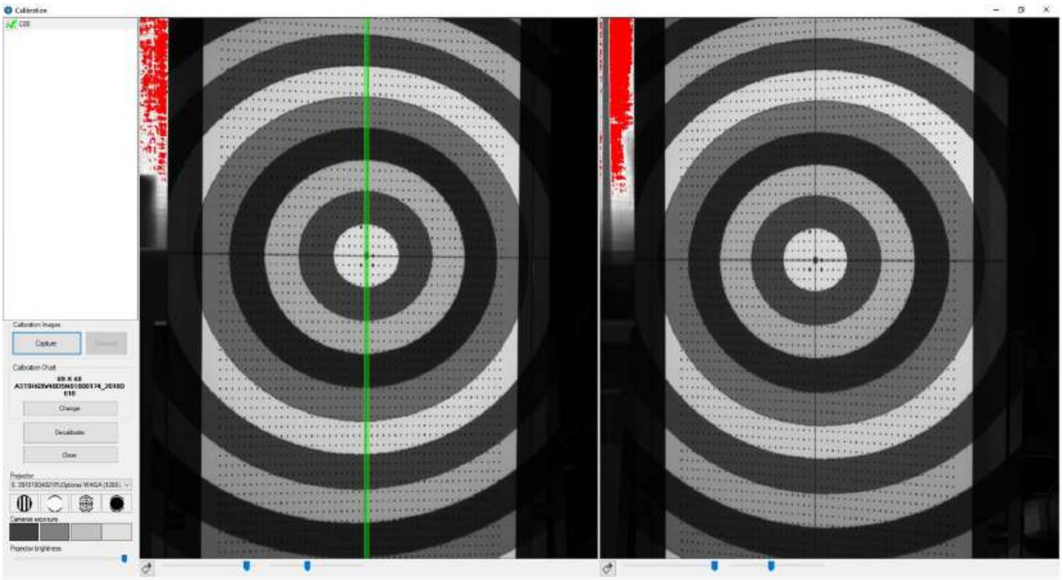


Fig. 6-9. Correctly positioned calibration chart relative to the scanner for the outer range

5. After correct setting of the calibration table relative to the scanner (see image above), change the pattern displayed by the light source to [A0 ◌].

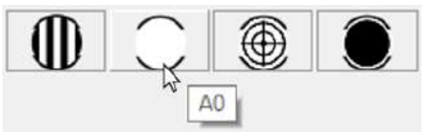


Fig. 6-10. Choosing the right projection pattern for calibration photos

6. Then set the exposure and brightness of the projector, as per previous recommendations (section 5.1.2 sensor settings bar). It is necessary to control the brightness so that the sensors do not have overexposure (red areas) and the black points of the calibration table are clearly visible. Below is an example of incorrectly chosen brightness parameters

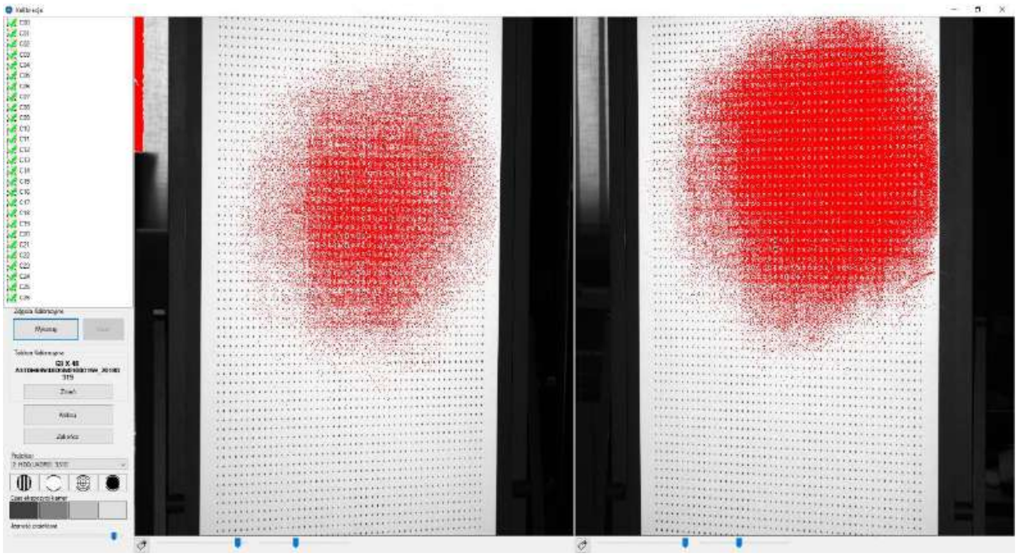


Fig. 6-11. Red burns due to incorrect brightness parameters

7. Then take the picture with [Scan]. In the window of the calibration photo section, a base image named C00 will appear along with an icon informing about the proper detection of the pattern [ ]. If the pattern has been detected incorrectly [ ], adjust the settings, delete and then repeat the picture. Depending on the calibrated range, the image of the zero position may look as follows:

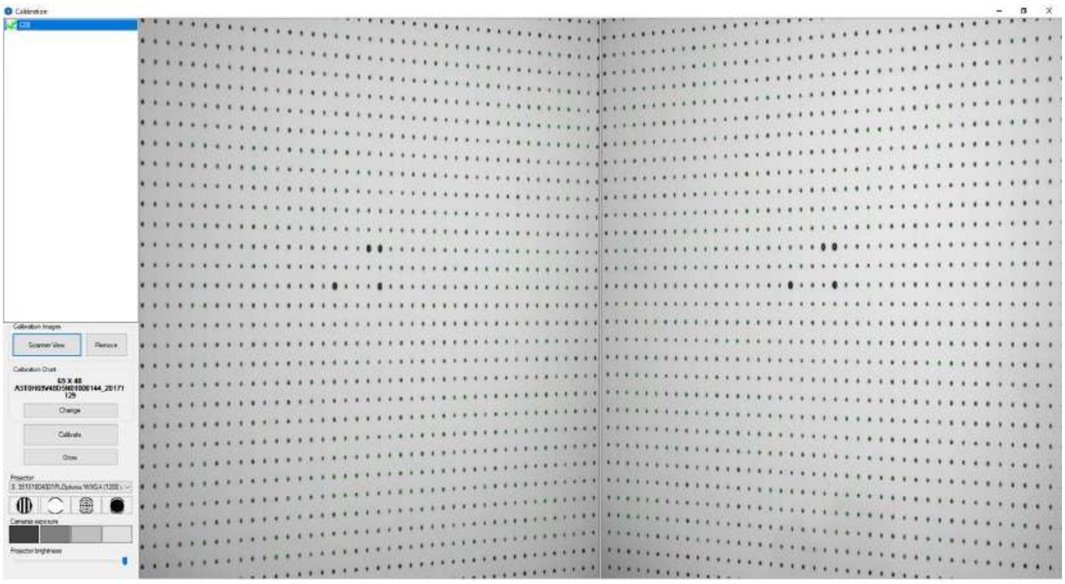


Fig. 6-12. A preview of the zero image for the internal range

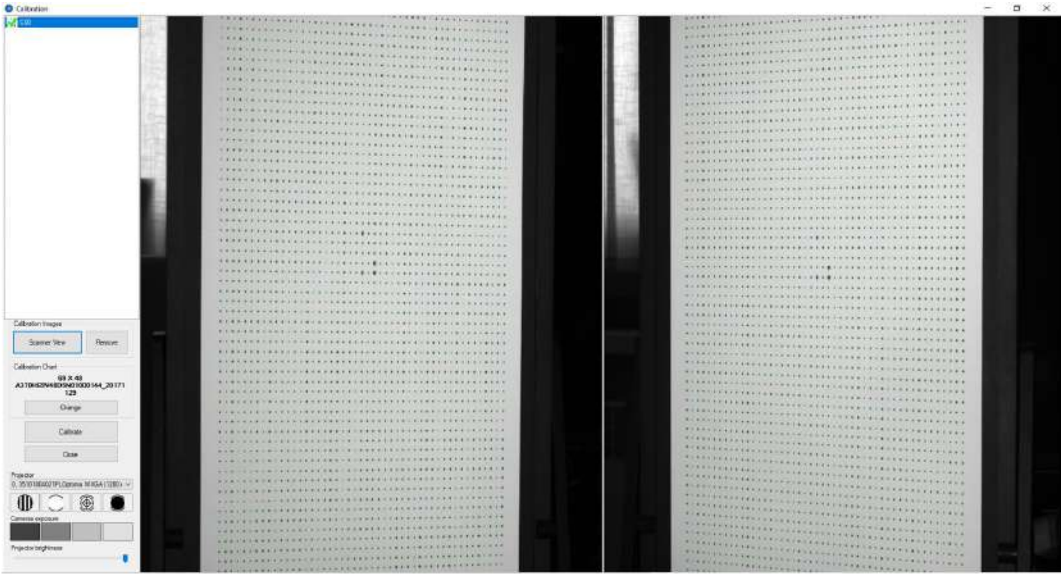


Fig. 6-13. A preview of the zero image for the outer range

NOTE: After the base image has been taken, the scanner and schematic pad cannot be moved. The following pictures are taken after manipulating the positon of the calibration chart.

6.3.2. Calibration of inner range

The inner range calibration process consists of 18 photos, which can be divided into the following groups:

1) One photo of the calibration table in the zero position (this picture is described above).

2) 9 photos of the calibration table perpendicular to the scanner

3) 4 photos of the calibration table diagonally in the scanning area.

4) 4 photos of the inclined calibration table.

During the calibration of a given range, after scanning the base image, the scanner remains stationary. Please refer to section 6.3.1 for information on setting up the scanner when taking a base image. The following pictures are taken by manipulating the position of the calibration chart. Each photo for calibration must be made with the pattern [A0]. The order of shooting is not important (after the base photo). The overexposure of the sensors (exposure, brightness of the projector) should be monitored on a current basis, so that no red areas appear in the pictures. During taking next shots, the software will also inform you about wrong photos []. All incorrect photos should be taken again.

1) **Take a picture of the calibration chart in the zero position C0**
   (described in chapter 6.3.1.).

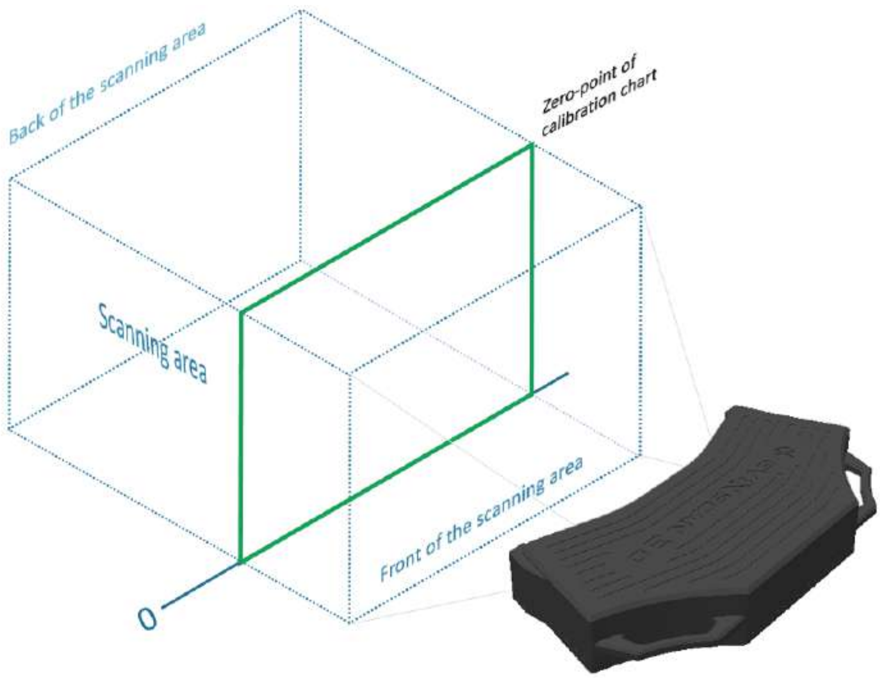


Fig. 6-14. Scheme of setting the calibration table in the working area of the scanner at position 0

2) 9 images of the calibration chart perpendicular to the scanner

Take 9 pictures by moving the chart on the remaining lines, parallel to the "0" line. Six behind the zero position (lines B1-B6) and three in front of the zero position (lines F1-F3). The chart should be placed on the following lines according to the indentations in the base.

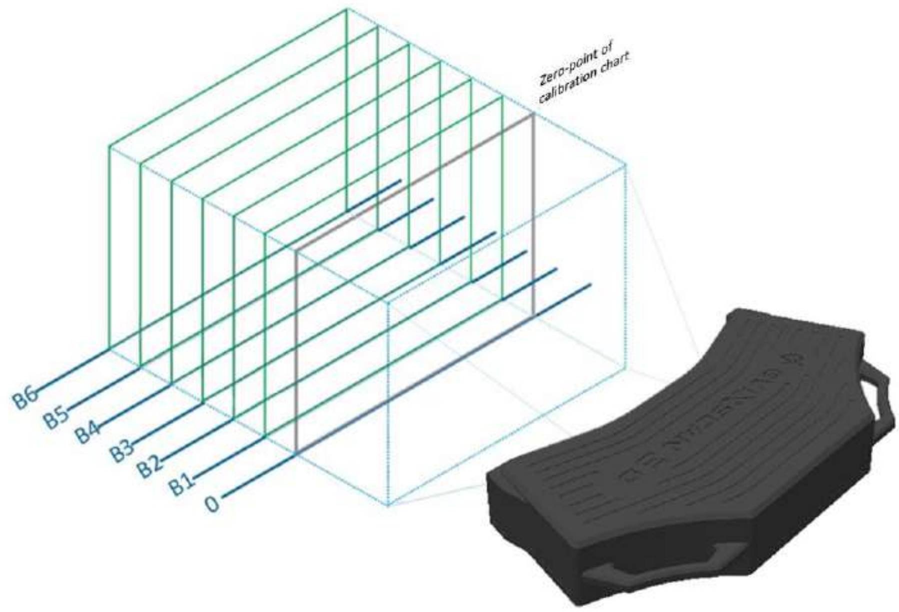


Fig. 6-15. Scheme of setting the calibration table in the working area of the scanner at position B1-B6

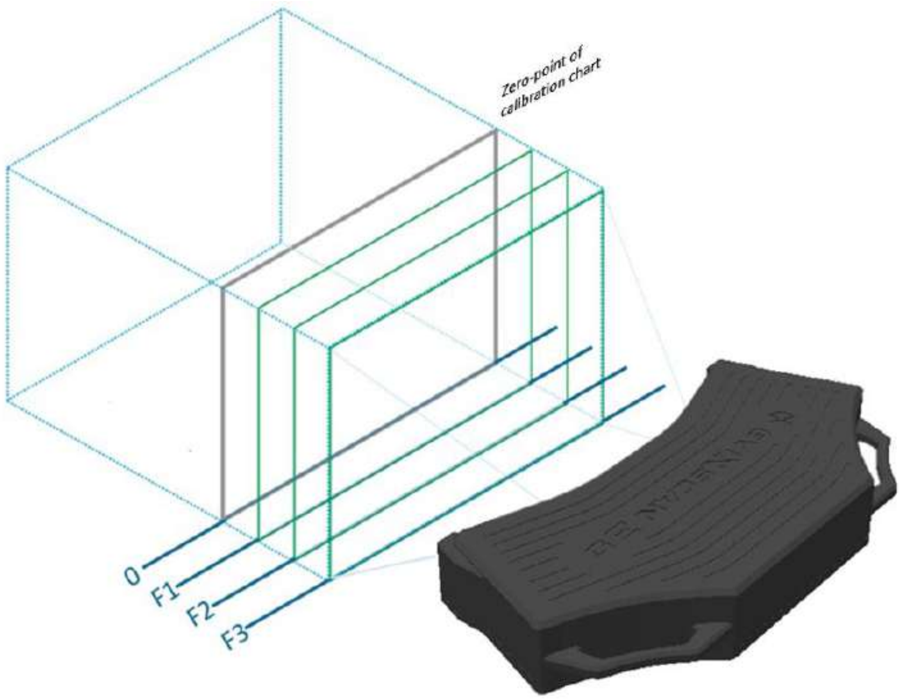


Fig. 6-16. Scheme of setting the calibration table in the working area of the scanner at position F1-F3

For each position, take a calibration picture by clicking [Scan]. Photographs from C1 to C9 will be taken.

3) Four photos of the calibration chart diagonally in the scanning area

The chart should be moved according to the diagonal lines of the working area: D1, D2, D3 and D4. The center of the board should be within the range of the image projection path.

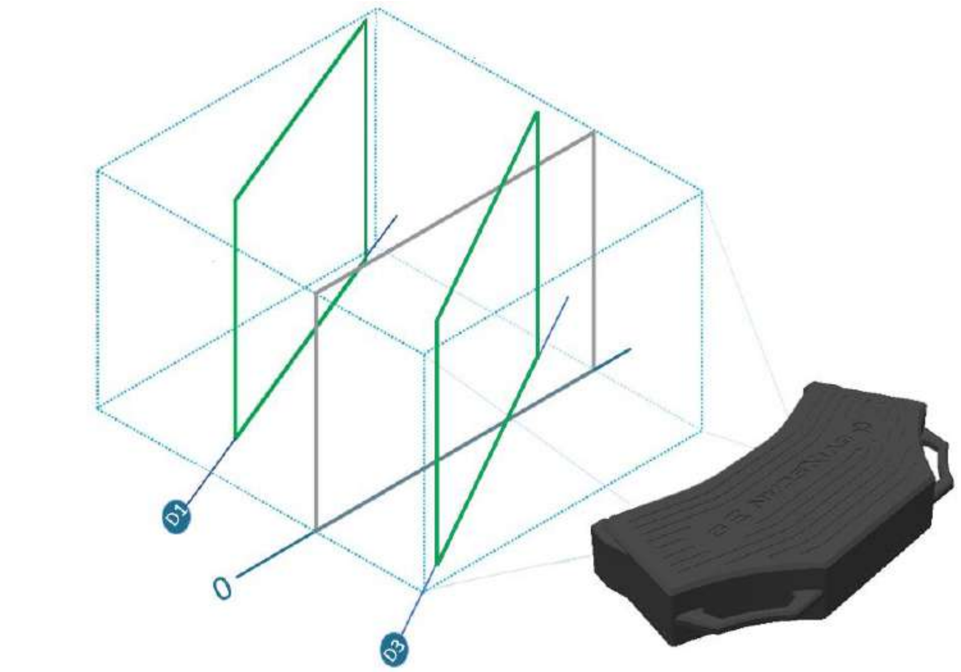


Fig. 6-17. Scheme of setting the calibration chart in the working area of the scanner at position D1 and D3

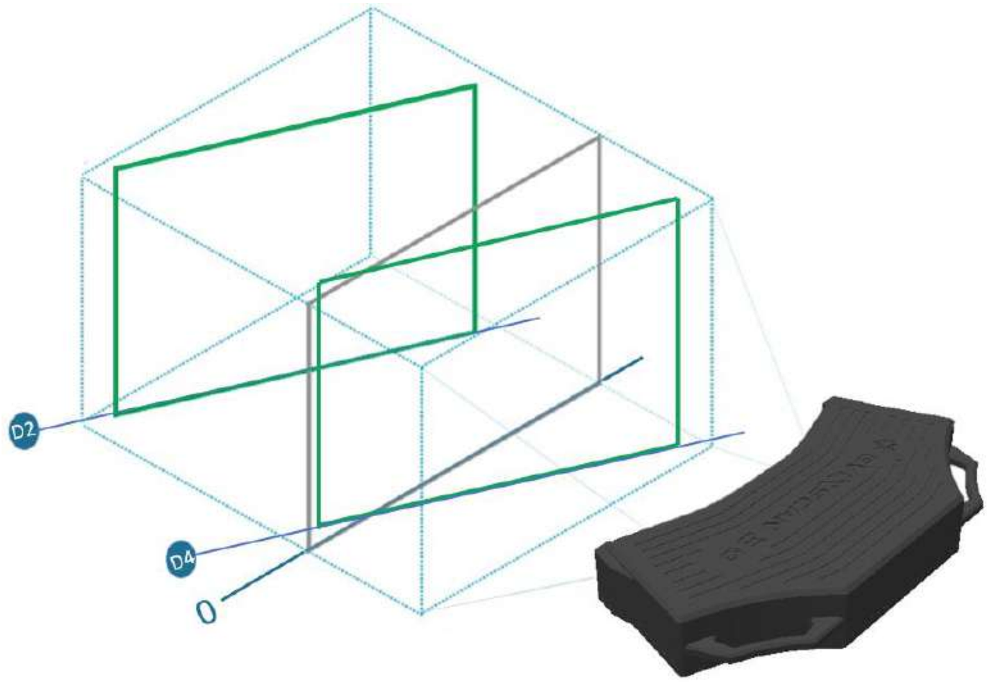


Fig. 6-18. Scheme of setting the calibration chart in the working area of the scanner at position D2 and D4

For each position, take a calibration picture by clicking [Scan]. Photographs from C10 to C13 will be taken.

4) Four photos of the tilted calibration chart

In this step, take two pictures of chart tilted forwards, and two pictures of chart tilted backwards. In order to tilt the calibration table, hold it by the handle take out of the frame, and slide it into the correct frame mountings. To obtain the inclination in the opposite direction, remove the chart from the frame, turn it 180 degrees and then re-insert the chart. The pictures below illustrate how to assemble the calibration table leaning back and forth.

Fig. 6-19. Correct installation of the tilted calibration table forwards and backwards for the inner range

2 pictures of the plate leaning forward. When taking pictures of the chart tilted forwards, set the chart so that the vertical indentation in the base coincides with the center line of the scanning area (as in the case of the base image) and the horizontal notches in the base coincide with the following lines:

- line B6 - picture for the back of the scanning area
- the geometric center of the scanning area that lies between line B1 and B2 - the image for the front of the scanning area.

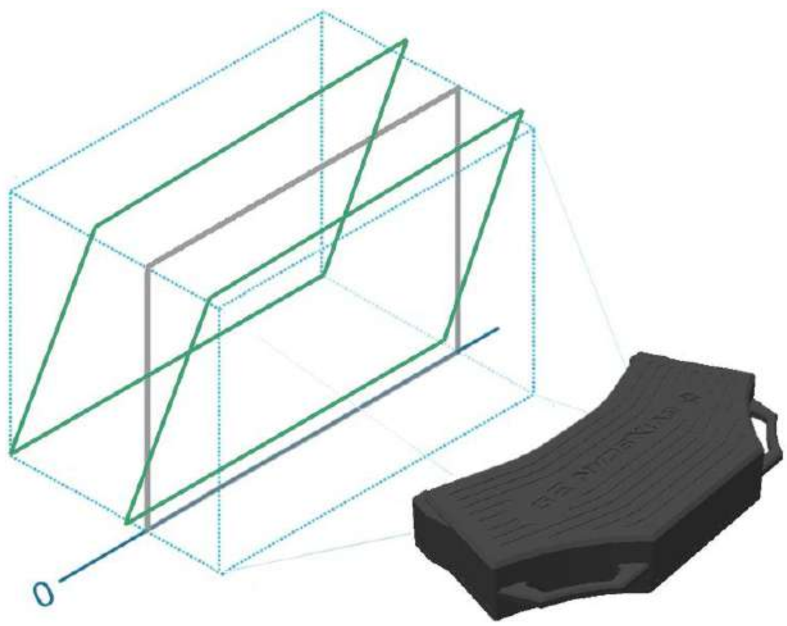


Fig. 6-20. Scheme of setting the calibration table tilted forwards in the working area of the scanner

2 pictures of the backwards leaning plate. If the calibration table is tilted backwards, the notches in the base should coincide with the lines:

• line F3 - photo for the front of the scanning area.

• the geometric center of the scanning area, which is between line B1 and B2 - the image for the back of the scanning area

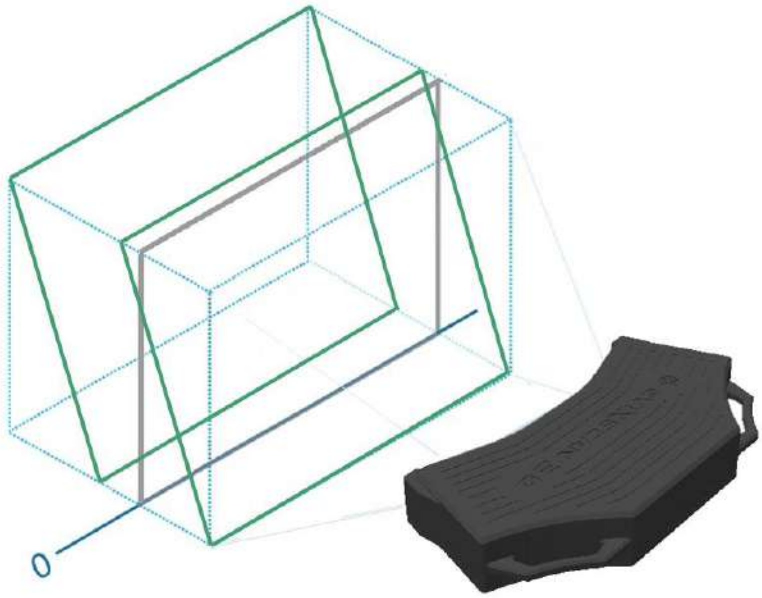


Fig. 6-21. Scheme of setting the calibration table tilted backwards in the working area of the scanner

For each position, take a calibration picture by clicking [Scan]. Photographs from C14 to C17 will be taken.

Confirmation of calibration pictures

After completing all steps, make sure that the calibration chart ID (2) you have loaded matches the number on the calibration table sticker and that the calibration section contains 18 pictures (photos named C00-C17) correctly identified by the software [ ] (1). Then confirm the pictures with the [Calibrate] button (3). The software will generate a configuration file for the current sensor settings, and the screen will display information on the correct calibration, which should be confirmed by clicking [OK]. The software will automatically move the user to the Scan View window and the scanner will be ready for use.

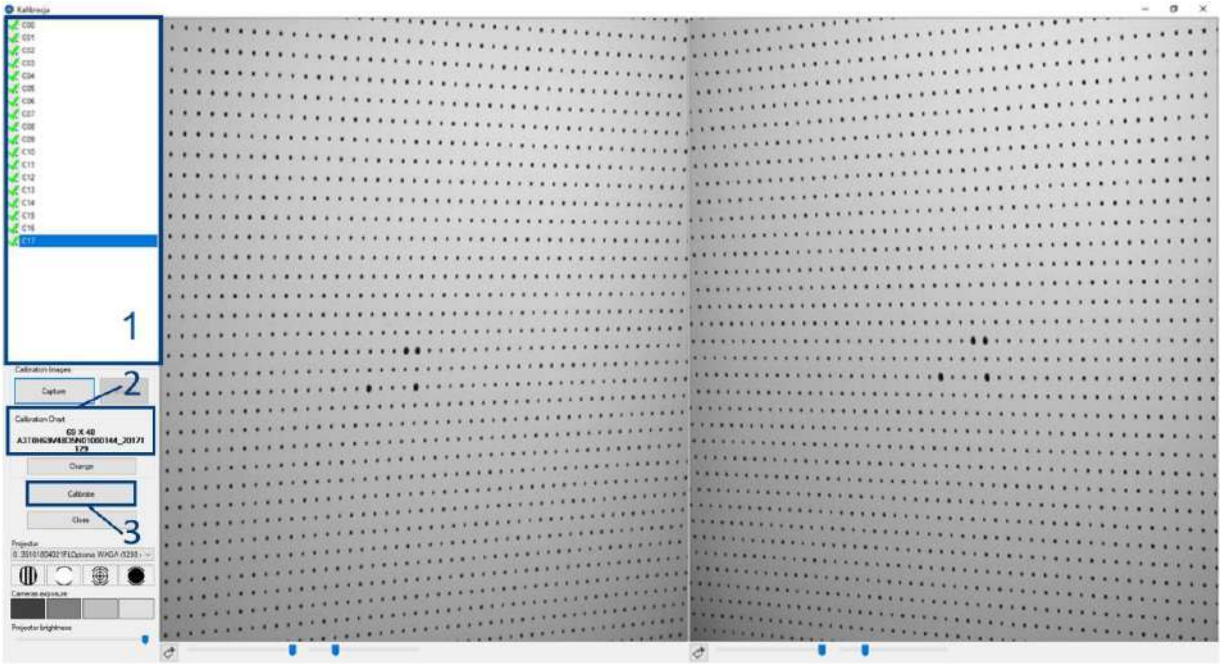


Fig. 6-22. Scanner calibration window with correctly taken photos for the inner range

6.3.3. Calibration of outer range

The outer range calibration process consists of 27 photos, which can be divided into the following groups:

1) One photo of the calibration table in the zero position (chapter 6.3.1).

2) 14 photos of the calibration table perpendicular to the scanner

3) 8 photos of the calibration table diagonally in the scanning area.

4) 4 photos of the inclined calibration table.

During the calibration of a given range, after scanning the base image, the scanner remains stationary. Please refer to section 6.3.1 for information on setting up the scanner when taking a base image. The following pictures are taken by manipulating the position of the calibration chart. Each photo for calibration must be made with the pattern [A0]. The order of shooting is not important (after the base photo). The overexposure of the sensors (exposure, brightness of the projector) should be monitored on a current basis, so that no red areas appear in the pictures. During taking next shots, the software will also inform you about wrong photos []. All incorrect photos should be taken again.

1) **Take a picture of a calibration chart in zero position C0**
(described in chapter 6.3.1.).

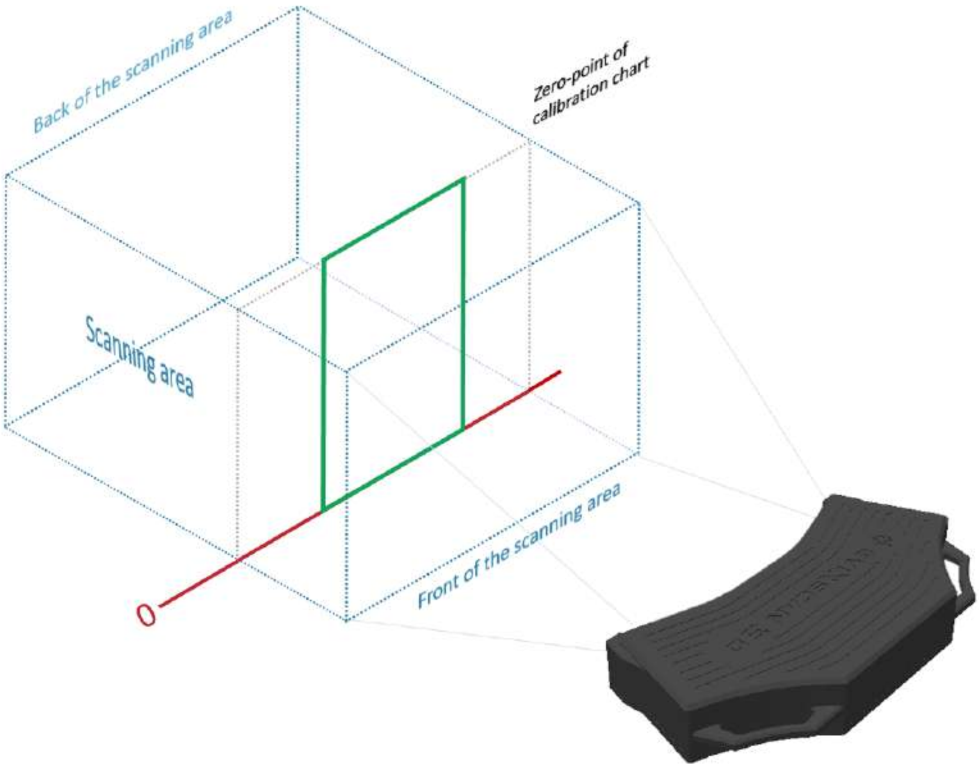


Fig. 6-23. Scheme of setting the calibration table in the working area of the scanner at position 0

2) 14 images of the calibration chart perpendicular to the scanner

Take 14 pictures, 7 photos for the right and left part of scanning area. by moving the chart on the lines from F2 to B4

7 pictures for the left part of the scanning area

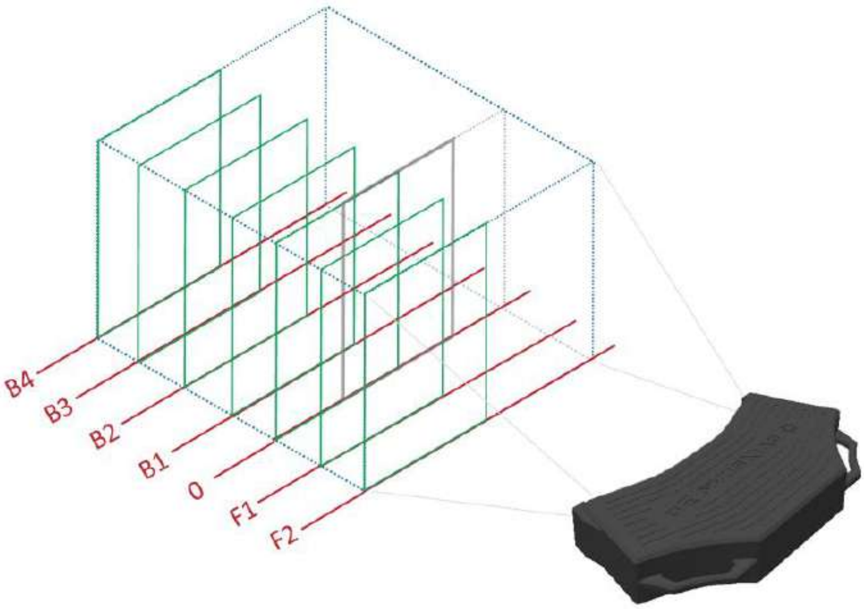


Fig. 6-24. Scheme of setting the calibration chart in the working area of the scanner at position F2-B4

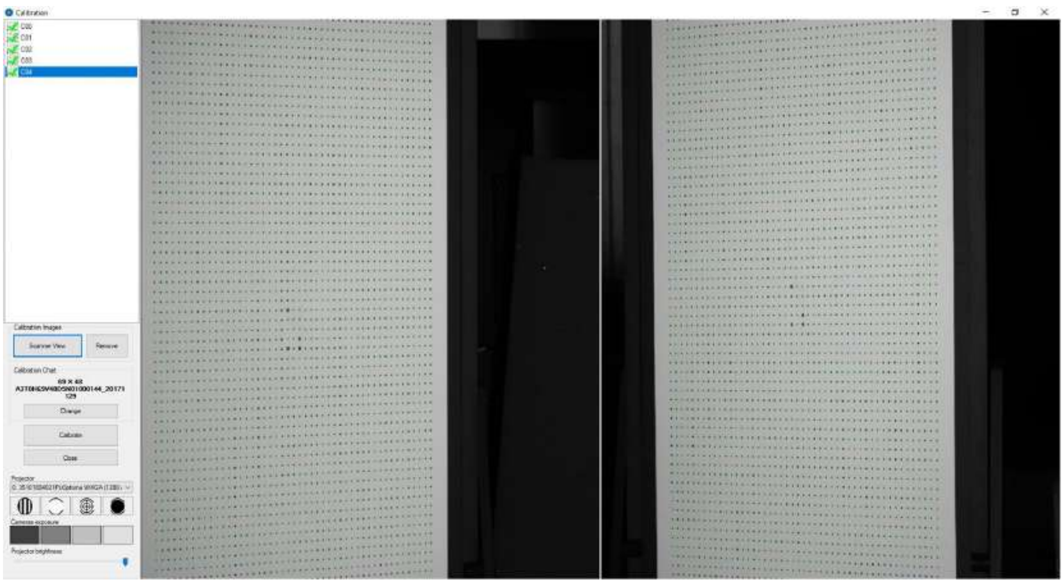


Fig. 6-25. A preview of an example photo for the left part of the outer range scanning area

For each of the seven positions, move the calibration chart to the left side of the scanning area so that the points on the left side of the calibration table are maximally aligned to the left edge of the left camera view, but do not go beyond the image seen from the cameras, as shown in Figure 6 -25.

For each of these seven positions, take one picture with the [Scan] button. As a result, we'll get pictures with names from C1 to C7.

7 pictures for the right part of the scanning area

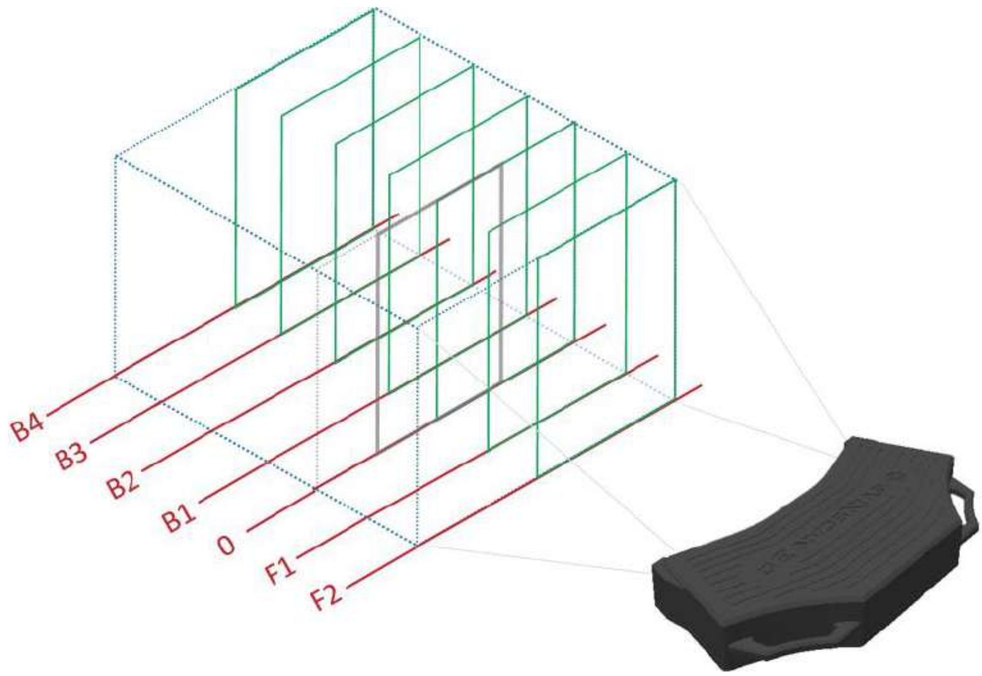


Fig. 6-26. Scheme of setting the calibration chart in the working area of the scanner at position F2-B4

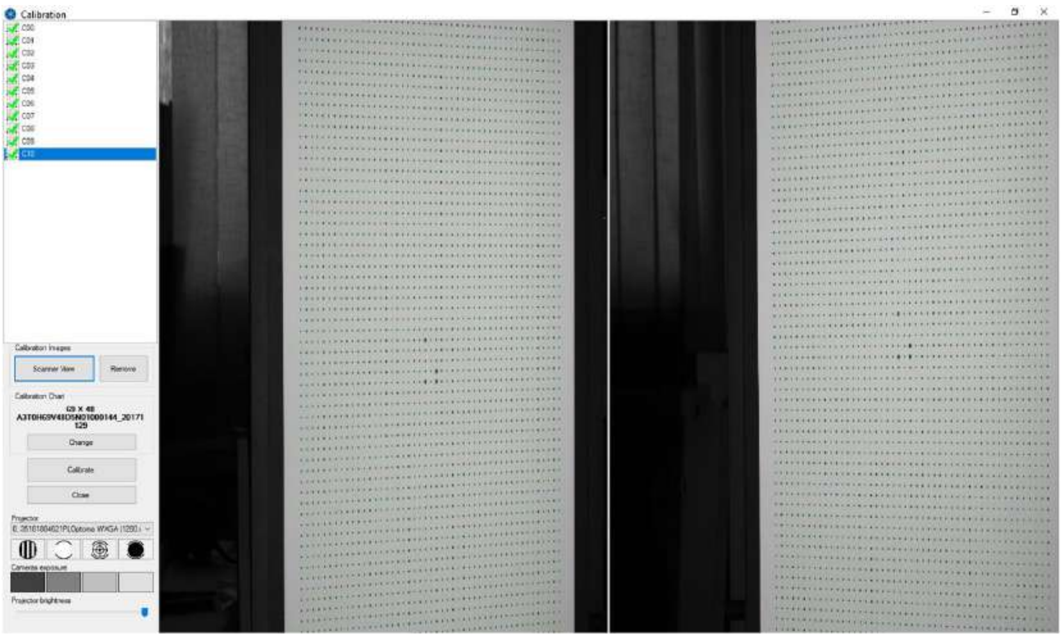


Fig. 6-27. A preview of an example photo for the right part of the outer range scanning area

We do the same for the right side of the scanning area. For each of the seven positions, move the calibration chart to the right side of the scanning area so that the points on the right side of the calibration table do not go beyond the image viewed from the cameras and are maximally to the right edge of the right camera view, as in Fig. 6-27.

For each of these seven items, take one picture with the [Scan] button. We will get pictures with names from C8 to C14.

3) 8 pictures of the calibration chart at the diagonals of the scanning area

In this step, take eight calibration pictures by moving the chart according to the diagonal lines of the working area: D1-D8. Four images of the table for the right and left of the scanning area will be taken. The board should be set on diagonals D in accordance with the horizontal notches in the base.

4 pictures of the calibration chart for the left part of the scanning area

The table should be moved according to the diagonal lines of the working area: D1, D2, D3 & D4

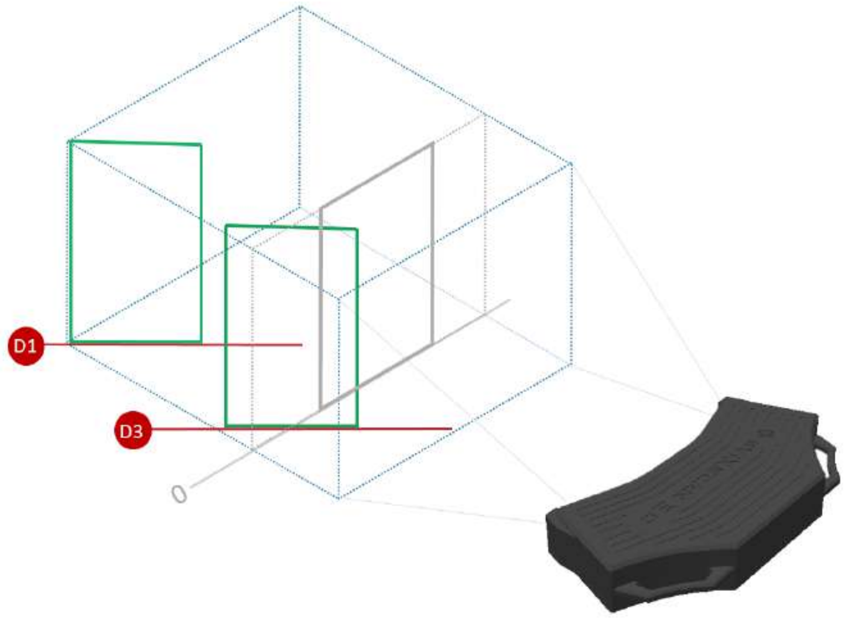


Fig. 6-28. Scheme of setting the calibration chart in the working area of the scanner at position D1 and D3

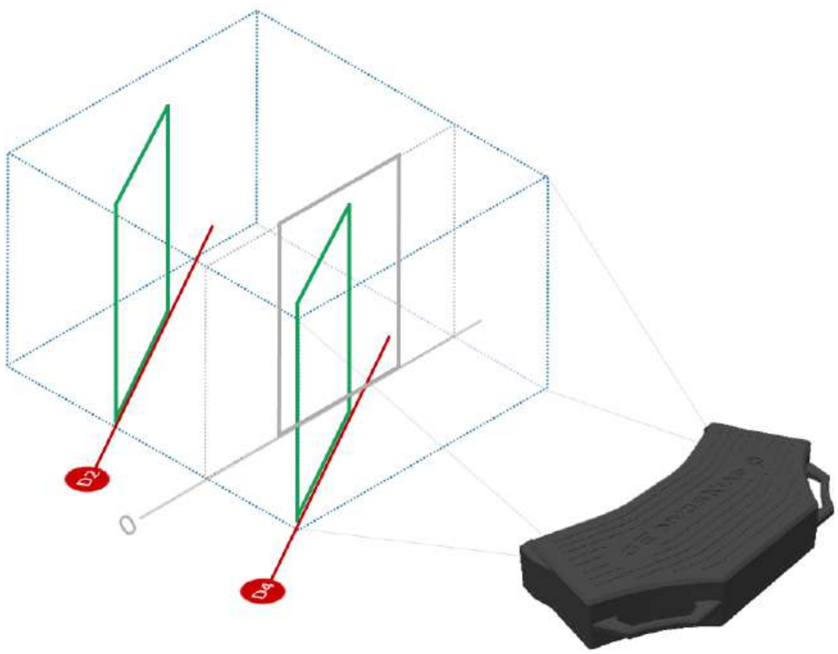


Fig. 6-29. Scheme of setting the calibration chart in the working area of the scanner at position D2 and D4

For each of the four positions, the calibration chart should be moved on the left-hand side until the left-hand view of the camera, the points on the left side of the calibration chart will be maximally aligned to the left edge of the preview but will not go beyond the image viewed from the cameras as in the pictures below Fig.6-30 and Fig. 6-31.

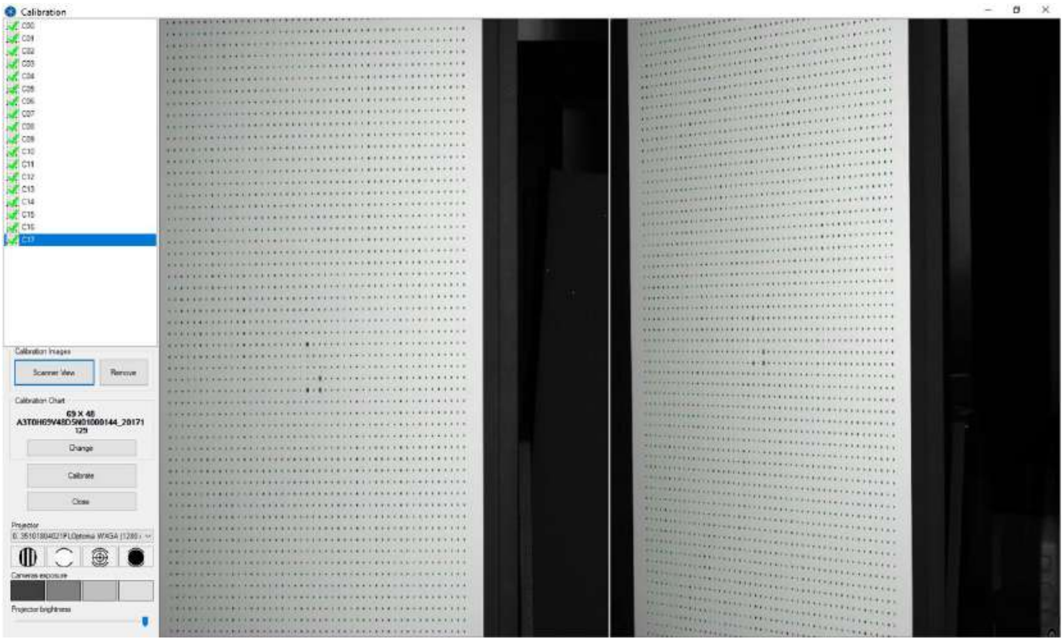


Fig. 6-30. A preview of an example picture of the calibration chart at the position D3 for outer range

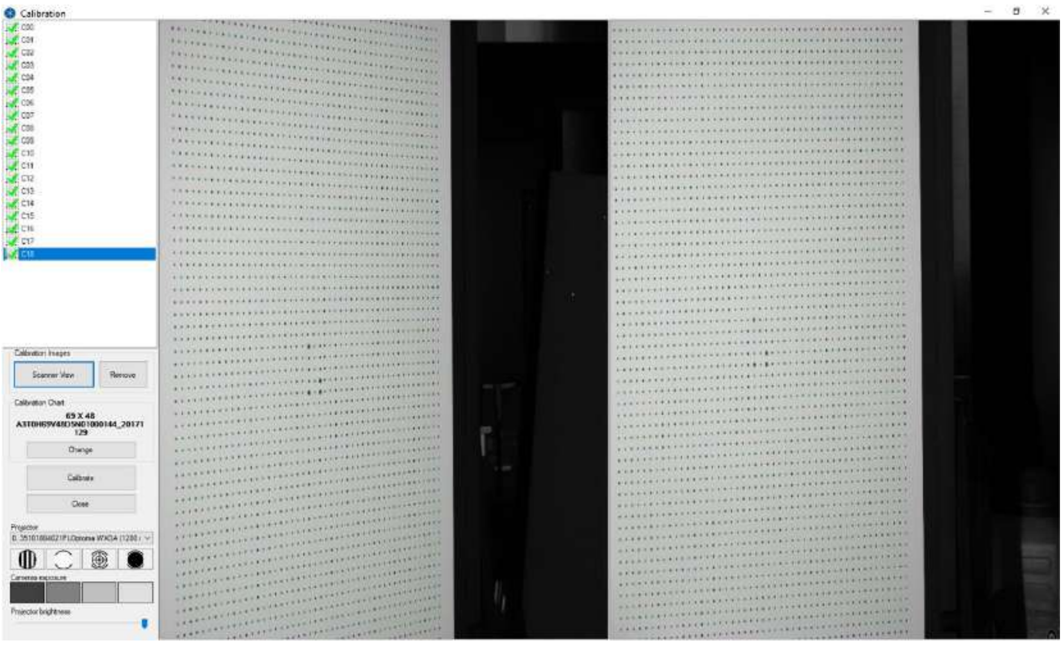


Fig. 6-31. A preview of an example picture of the calibration chart at the position D4 for outer range

For each of these seven positions, take one picture with the [Scan] button. As a result, we'll get photos with names from C15 to C18.

4 pictures of the calibration chart for the right part of the scanning area

The table should be moved according to the diagonal lines of the working area: D5, D6, D7 & D8.

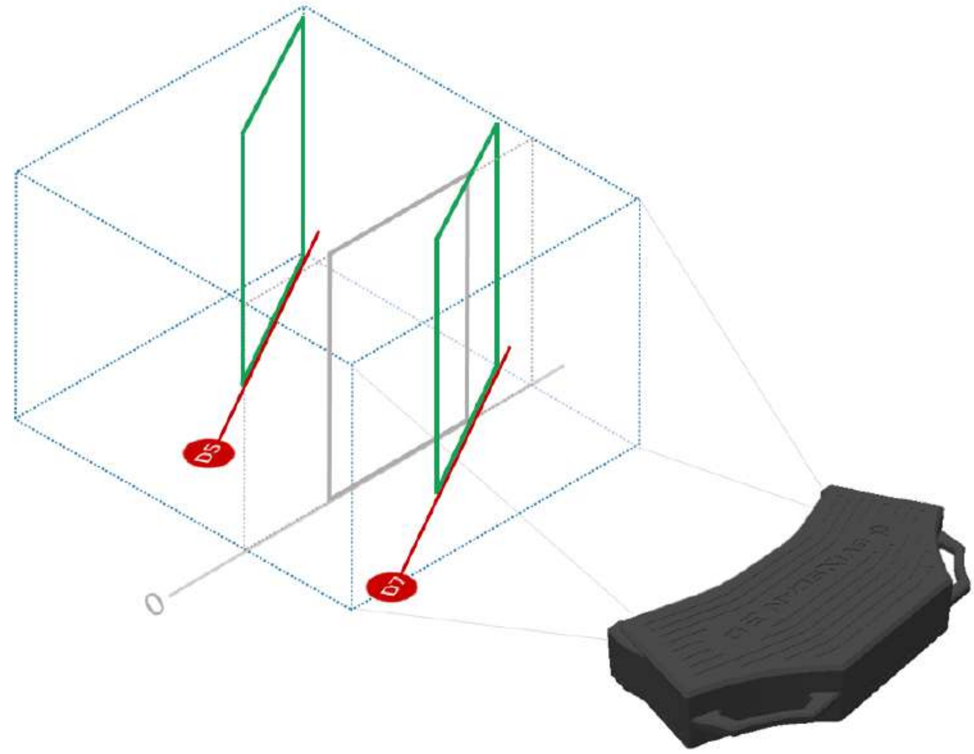


Fig. 6-32. Scheme of setting the calibration chart in the working area of the scanner at position D5 and D7

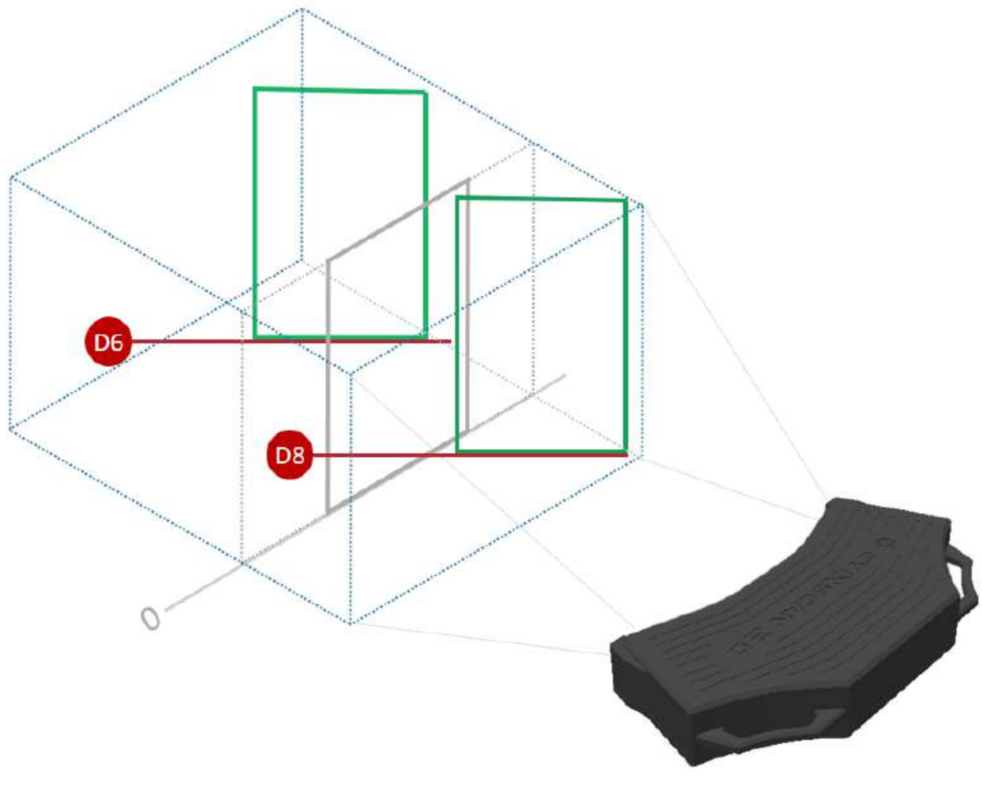


Fig. 6-33. Scheme of setting the calibration chart in the working area of the scanner at position D6 and D8

For each of the four positions, move the calibration chart along the line to the right, until the right camera view, the points on the right side of the calibration table will be maximally aligned to the right edge of the preview, but will not go beyond the image viewed from the cameras, as in the pictures below Fig. 6-34 and Fig. 6-35.

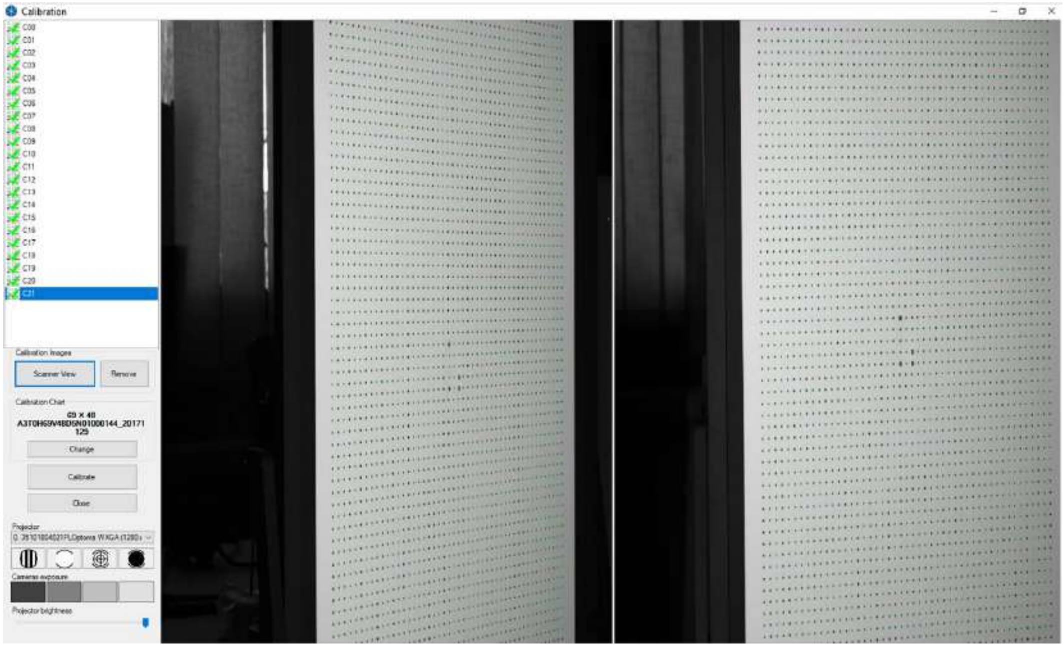


Fig. 6-34. A preview of an example picture of the calibration chart at the position D7 for outer range

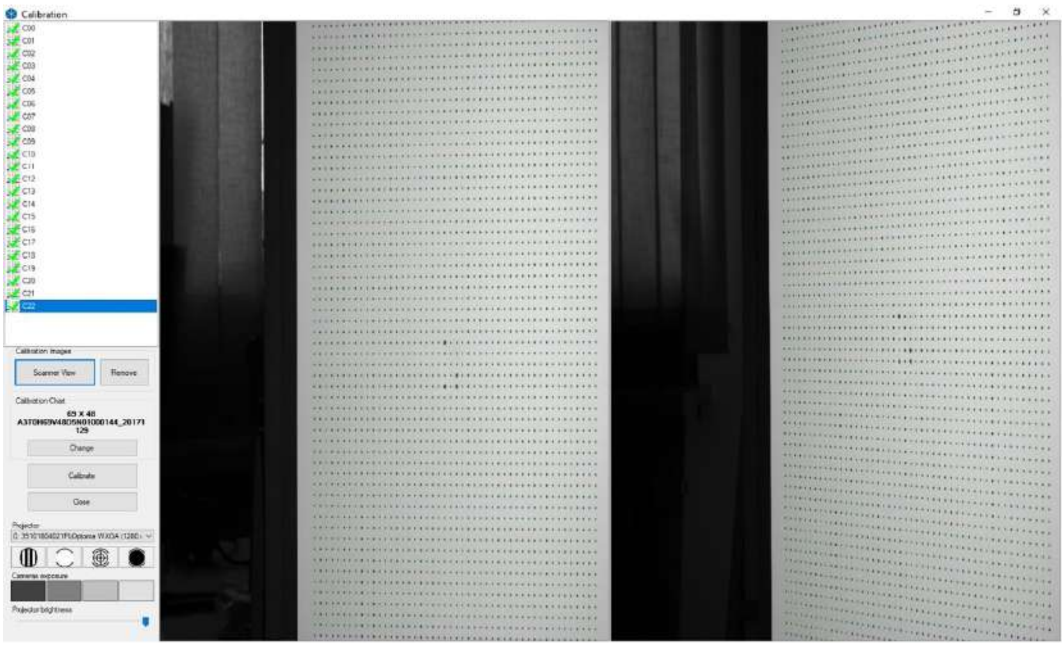


Fig. 6-35. A preview of an example picture of the calibration chart at the position D8 for outer range

For each of these seven items, take one photo with the [Scan] button. As a result, we'll get pictures with names from C19 to C22.

4) Four pictures of the tilted calibration chart.

In this step, take two pictures of chart tilted forwards, and two pictures of chart tilted backwards. In order to tilt the calibration table, hold it by the handle take out of the frame, and slide it into the correct frame mountings. To obtain the inclination in the opposite direction, remove the chart from the frame, turn it 180 degrees and then re-insert the chart. The pictures below illustrate how to assemble the calibration table leaning back and forth.

Fig. 6-36. Correct installation of the tilted calibration table forwards and backwards for the outer range

2 pictures of the plate leaning forward. When taking pictures of the chart tilted forwards, set the chart so that the vertical indentation in the base coincides with the center line of the scanning area (as in the case of the base image) and the horizontal notches in the base coincide with the following lines:

- line B4 - picture for the back of the scanning area
- line B1 - picture for the front of the scanning area

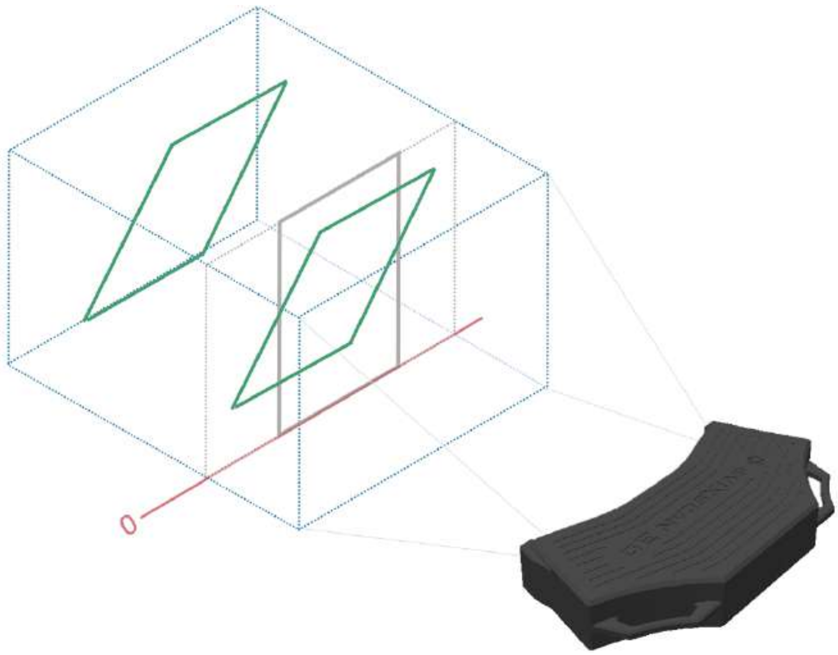


Fig. 6-37. Scheme of setting the calibration table tilted forwards in the working area of the scanner

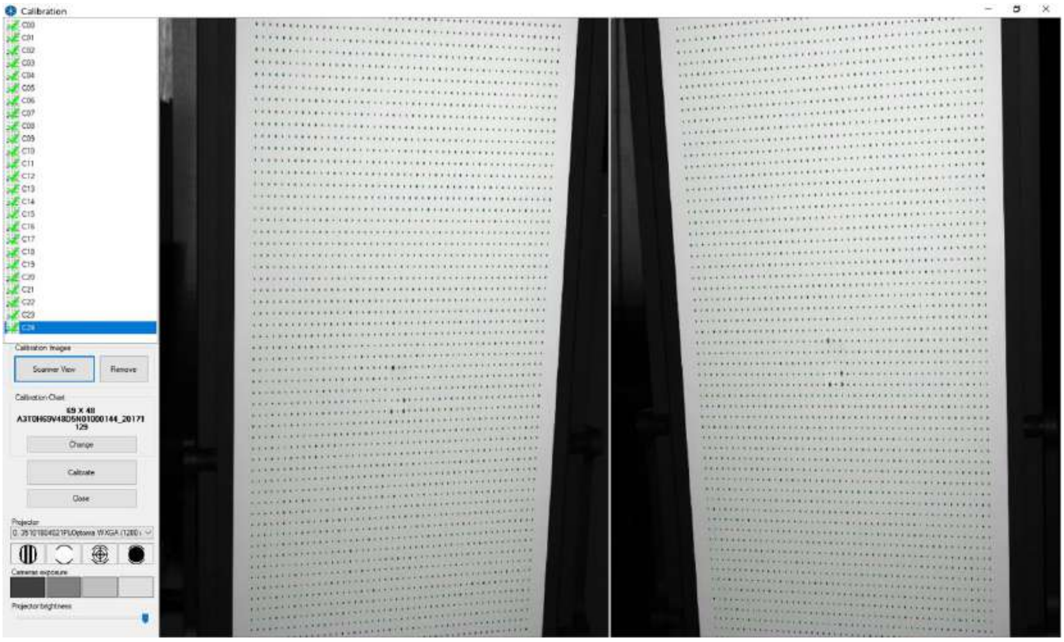


Fig. 6-38. A preview of an example picture of the calibration chart tilted forwards for outer range

2 pictures of the backwards leaning plate. If the calibration table is tilted backwards, the notches in the base should coincide with the lines:

• line F2 - photo for the front of the scanning area.

• line B1 - photo for the back of the scanning area.

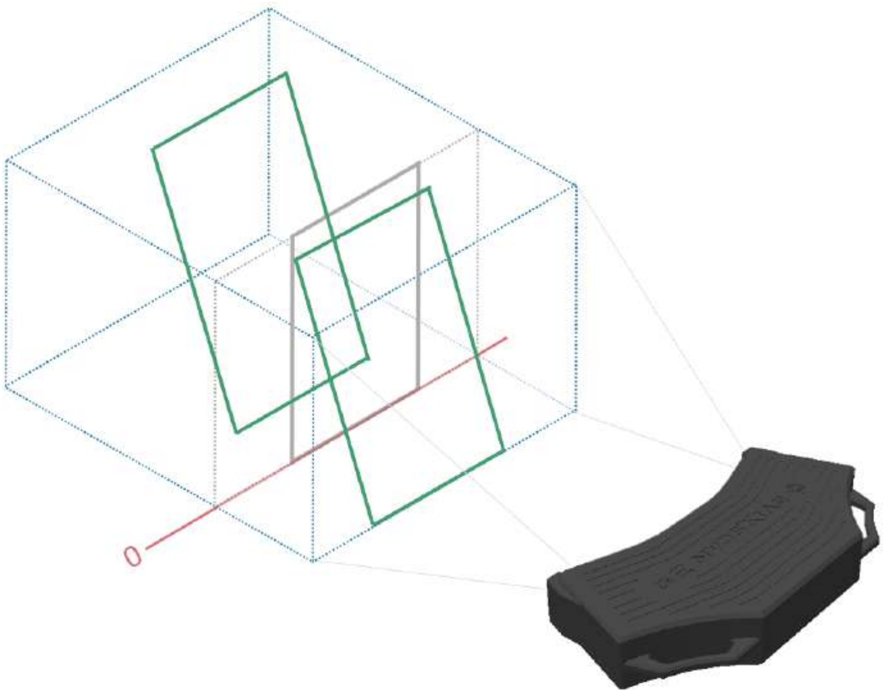


Fig. 6-39. Scheme of setting the calibration table tilted backwards in the working area of the scanner

Fig. 6-40. A preview of an example picture of the calibration chart tilted backwards for outer range

For each setting, take a calibration picture by clicking [OK]. Photographs from C23 to C26 will be taken.

Confirmation of calibration pictures

After completing all steps, make sure that the calibration chart ID (2) you have loaded matches the number on the calibration table sticker and that the calibration section contains 27 pictures (photos named C00-C26) correctly identified by the software [] (1). Then confirm the pictures with the [Calibrate] button (3). The software will generate a configuration file for the current sensor settings, and the screen will display information on the correct calibration, which should be confirmed by clicking [OK]. The software will automatically move the user to the Scan View window and the scanner will be ready for use.

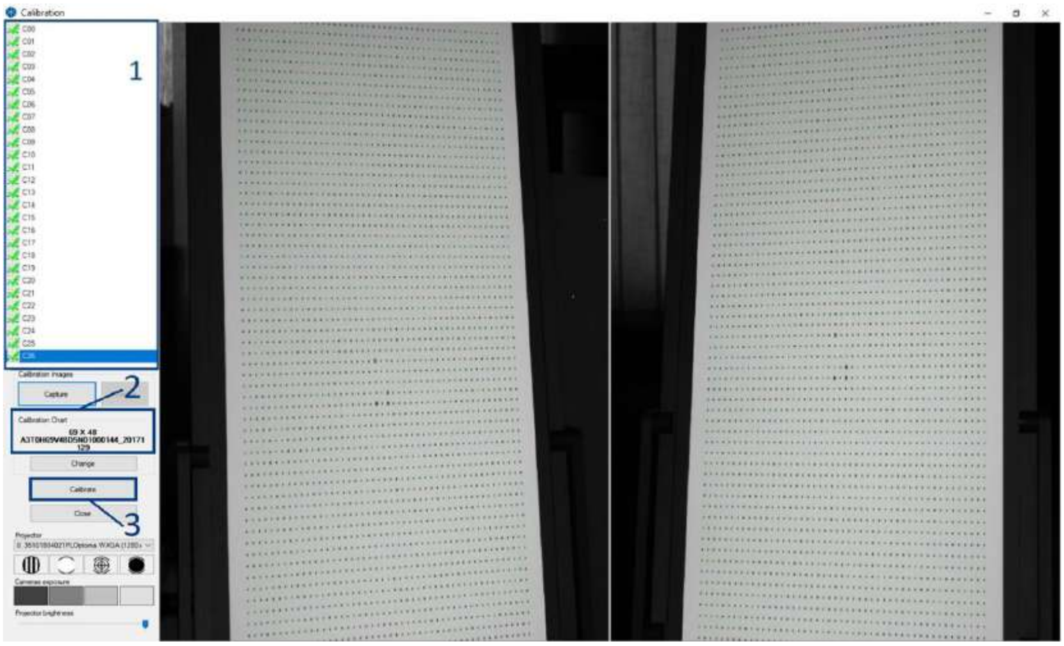


Fig. 6-41. Scanner calibration window with correctly taken photos for the outer range

7. Scanning process

7.1. Preparation of object

Scanned object has to be cleaned (purified from dust, pollen, lubricants, etc.). If the object is made of glass or is transparent, spray it with matting powder. The matting spray should also be used when the scanned object absorbs or dissipates light.

7.1.1. Object whitening

Matting spray is used to cover scanning object with white, mat powder. Single layer of powder does not extend 0,002 [mm], so it does not change significantly scanning accuracy. Using spray is recommended when object has reflective or absorbing surface.

Preparation of object before whitening

Object has to be clean before using spray. It is recommended to remove all dust, grease and other contaminations. Next, shake spray can, you can do it few times and check from 20 cm on the random surface if single stream is uniform (it is not recommend to use scanning object for that test).

Recommended technique: movement of stream has to be smooth. Through whole process spray has to be at the same distance and parallel to the scanning object. Recommended distance: from 10 to 30 [cm], it depends on spray stream pitch. It is important to do all movement, parallel to the object surface, this will create the same thickness of spray cover on whole surfaces. Before repetition, pressing on button must be reduced and pressed again while returning. This will decrease pilling up covers. When whitening is done, and you want to move object to scanning place, move it gentle. Covered surface should not be touch, each contact with surface determine poor accuracy.

Object has to be covered with uniform layers, without any color contrast. Figure 7-1. shows object not enough covered on the left and correctly covered on the right.

Fig. 7-1. Sample model **badly** and **properly** matted

7.1.2. Marker placement

Markers must be detected correctly on the left and right images of scans for properly alignment. The effectiveness of detection depends on the appropriate positioning.

Markers should be positioned as follows:

- On the scanned object or objects whose position does not change relative to the object being scanned;
- In places where their background is bright (white);
- On smooth surfaces (planes, cylinders/sphere with a radius at least twice the radius of the marker);
- Away from the object's edges and bends.
- Away from other markers.
- In such a way as to not create polygons.

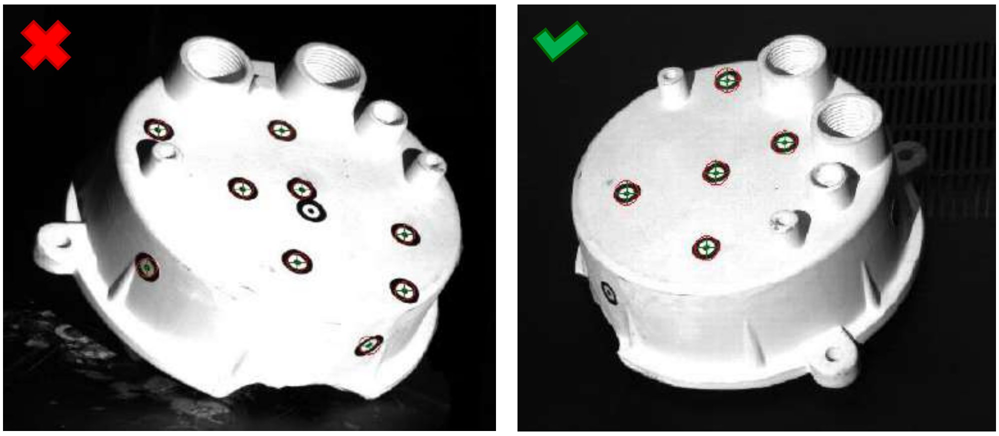


Fig. 7-2. **Wrong** sticky markers – two markers too close to each other and **correctly** positioned markers

7.2. Scanning process

7.2.1. Selection of the scanning method

Prior to the scanning process, select the best scanning method for a given object. There are three ways available (Fig. 7-1):

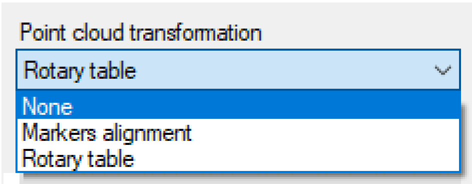


Fig. 7-3. Types of point cloud transformation

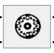
- **None** – A single scan.

  Use this method when you don't have to scan the entire model, but it is sufficient to perform a single scan of the model parts, e.g. for measurement purposes. Also used for scanning flat, small details within the scanning range, where a single scan is sufficient (e.g. coins, bas-reliefs).

- **Markers alignment** –execution of multiple scans combined with markers without the use of a rotary table.

  Use this method if you do not use a rotary table for scanning. Markers are glued to the scanned object, thanks to which the eviXscan program automatically connects the scans, creating an oriented group of scans. Typically, this method is used for models with large dimensions that do not fall within the scan range of the scanner.

- **Rotary table** – execution of a series of scans using a rotary table.

  During each scanning using the rotary table, this type of adjustment should be used, also in the case of rotary table scanning with unique markers or artifacts. In this case, the scans are automatically oriented relative to the axis of the table, and then, using the [] function, scans are matched with markers / artifacts. The option is used for small- and medium-sized models within the scanning range.

8. Technical support

In case of problems, please contact our technical support:

Tel. +48 33 499 59 32

e-mail: support@evatronix.com