RANGEVISION

Setup and calibration

PRO

Contents

Introduction

Thank you for choosing RangeVision product.

Please read this manual before using RangeVision 3D scanner. Here are described the procedures for preparing the scanner, installing the required drivers, calibration procedure, scanning procedure, and tips for acquiring high-quality three-dimensional object model.

Information may be amended from time to time. These changes will be inserted into the new versions of the manual, or in the additional documents and publications.

Warning!

1. Turn off the main power at least several minutes after turning off the projector. In case of immediate power shutdown, projecting module mirrors cooling will stop, which can lead to its failure.
2. Do not expose the scanner to liquids.
3. Do not use liquid cleaners or aerosol cleaners.
4. Do not store or use the scanner in dusty or humid environments.
5. Do not expose the scanner and its components to contamination, shock or drops.
6. Do not connect power to a faulty wall outlet.
7. Do not aim the scanner at people and animals in order to avoid directing the bright projectors light at the eyes.
8. Patterns and holes are provided for ventilation of the scanner to ensure its reliable operation and to prevent overheating. Do not block or cover the openings.

Specifications for PRO:

FOV	[L]	[M]	[S]
Scanning area (WxHxD), mm	550x340x360	320x210x200	140x90x80
3D-resolution, mm	0,18	0,10	0,04
Scanning distance, mm	900	520	350

Specifications for PRO Base:

FOV	[L]	[M]	[S]
Scanning area (WxHxD), mm	520x390x360	280x210x200	115x85x80
3D-resolution, mm	0,25	0,13	0,05
Scanning distance, mm	900	520	260

Technical specifications:

Camera resolution for PRO Base/PRO	3/6 Mpix
Scanning module dimensions (WxLxH)	408x380x125 мм
Output data format	STL, OBJ, PLY, ASCII
Light source	LED
Scanning principle	Structured light
Scanning module weight,	≤ 6,5 kg
Operating system	Windows 7/8/10 64bit
Power source	100-240 V, 350 W

System requirements:

- operating system - Windows 7/8/10 64bit,
- processor - Intel Core i3/i5 1.8 GHz and better,
- graphics card with HDMI output,
- RAM - not less than 8 GB.

Preparing for work

Package contents

RangeVision 3D scanner is supplied in a plastic box with lodgement, optionally can be supplied in a protected road hard case.

The scanner is equipped with at least one scanning area. Scanning area is a set of interchangeable optics, calibration plate and stand for the calibration plate.

№	Name	qty.
1	Scanning module:	
	Installation construction with projector	1
	Cable kit for connection to a PC (2 USB + HDMI)	1
2	Machine vision camera	2
3	Tripod	1
4	Calibration plate	1-4*
5	Kit of interchangeable optics	1-5*
6	Stand for the calibration plate	1-2*
7	USB disk with the software	1
8	The electronic key	1
9	Matting spray	1
10	Markers for scanning	1
11	Power Cord 5 m	1
12	USB hub	1
13	Hex key	1
14	Rotary table + cables	1*

* - depends on the equipment

Installing software and drivers

Get the RangeVision software (equipped with the scanner) and run the installer - RangeVision ScanCenter NG setup.
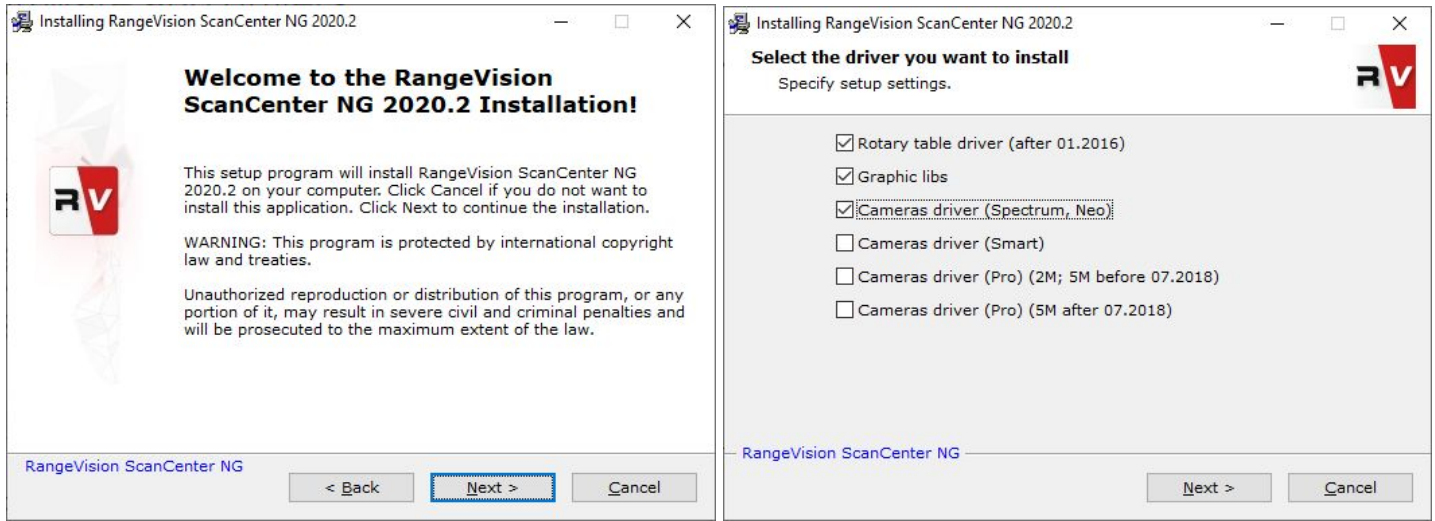
Following the prompts, select the desired language, type and path for installation. After the files have been copied install drivers and graphics libraries, necessary for the correct operation of RangeVision 3D scanner. The old version of drivers can be helpful if some camera connection problems occur.

If you have access to the Internet, RangeVision ScanCenter NG will automatically notify you when updates are available. You can check for updates manually by clicking About → Check for Updates.
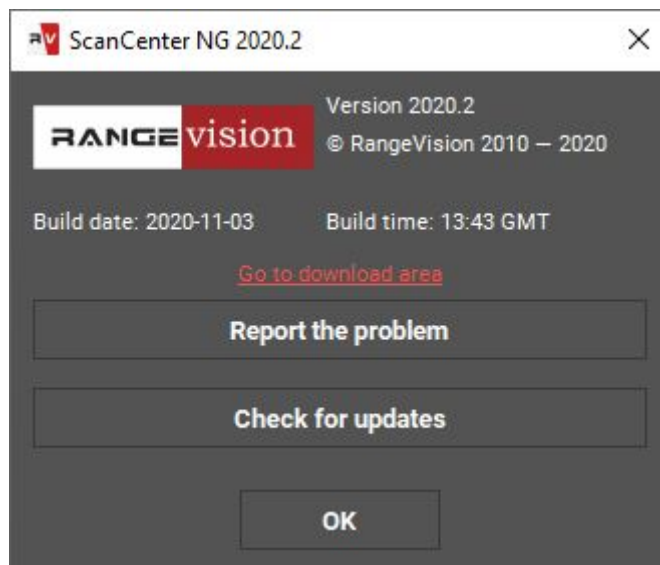
Setting up your computer for the work with the scanner

For the correct operation of RangeVision 3D scanner you will need to setup your computer. This procedure is performed once before the first use of the scanner.

Connecting projector

Turn on the projector and connect it to the HDMI-port of your video card. After connecting the projector, it should be displayed in the system. If the computer has several video outputs, define the one to be used.

> **?** If the second monitor (projector) is not defined by the system, check the cable connections and restart the computer. Also, try to connect the cable to your computer when the projector is on, if it was off earlier.

1. Right click on the desktop, select Screen resolution.
2. Make sure that the projector has been successfully recognized by the system and that both connected screens are displayed.
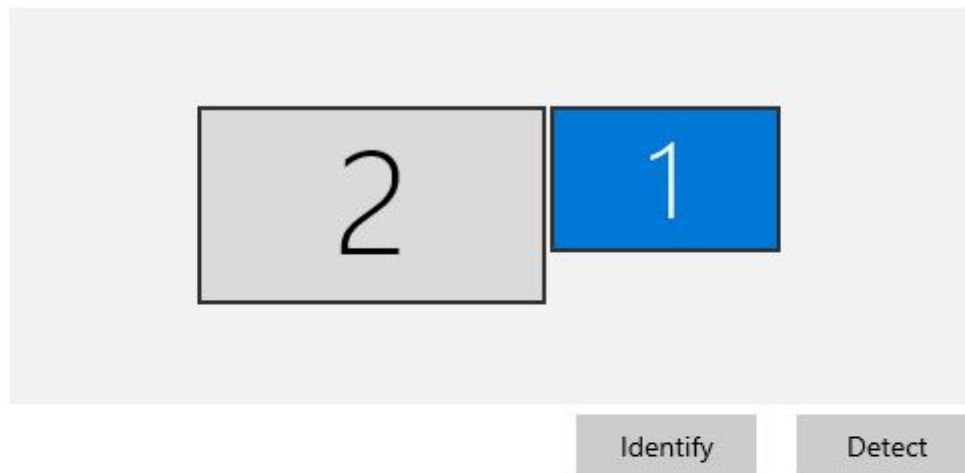

Multiple displays

Multiple displays

Extend these displays

☐ Make this my main display

Configuring computer parameters

To avoid a recurrence of the problems during the scanner operation, you must turn off the screensaver and sleep mode.

By clicking right mouse button on the desktop, select Personalize → Screensaver and turn off the screensaver, disable turning off the display and putting the computer in sleep mode.
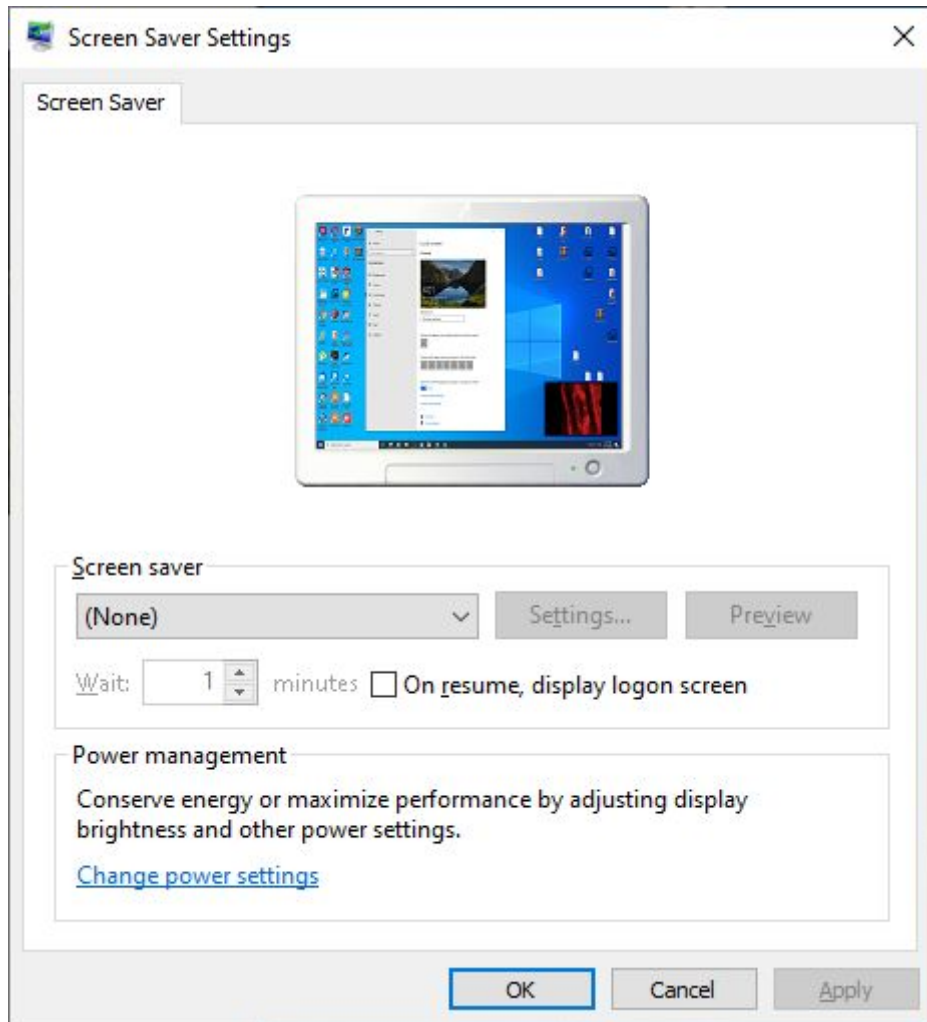
Scanner Assembly

Carefully get the scanning module and all accessories out of the plastic case.

1. Set the tripod on the flat and stable surface.
2. Fit the scanning module on the tripod.
3. Attach the cameras to the scanner, if they are not attached yet. Cameras must rotate around their axis facing each other, not in opposite directions.
4. Install the camera lens kit (if not yet installed). Choice of lenses is described in the section dedicated to Scanner Setup.
5. Connect USB cable to the scanner and to the computer. Connection should be made after the driver installation.
6. Connect the power cord (220V) to the projector and turn on the main power. The switch is located on the bottom of the scanner next to USB, HDMI and power sockets.
7. Connect HDMI cable to the scanner and to the computer.
8. Turn on the projector by pressing the button on top of the scanning module.
9. Insert the electronic key into a free USB port.
10. Connect the rotary table (if equipped) to your computer using the USB cable. The TL model also requires to connect the power cord (3m cable).
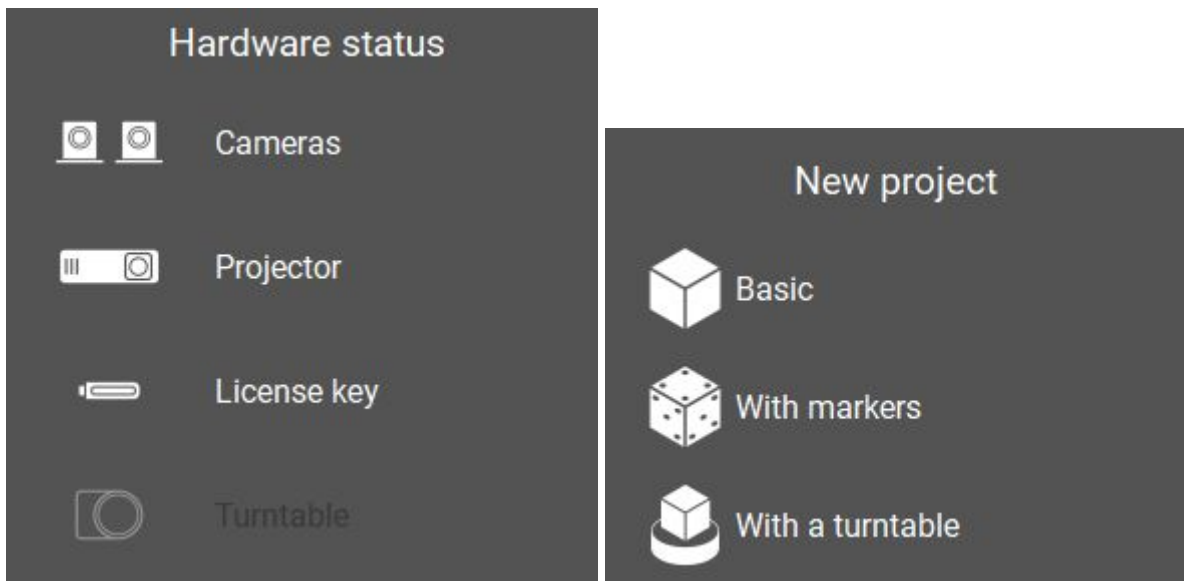
Scanner setup

ScanCenter NG launch

Run RangeVision ScanCenter NG.
If the scanner is not connected or drivers aren't installed, an indication will appear on the Start Screen, as shown below:
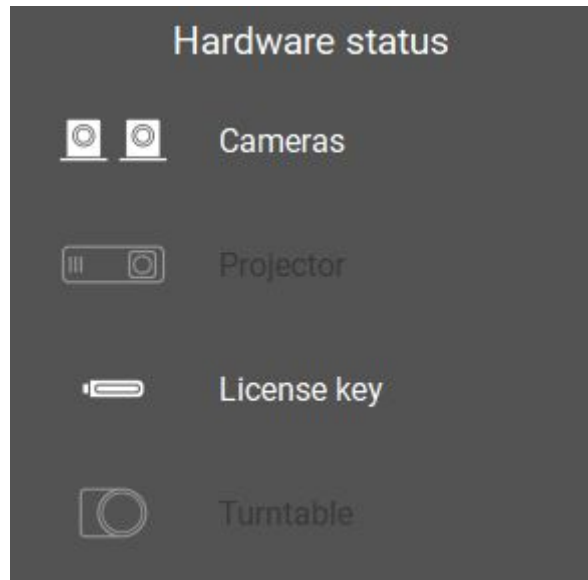
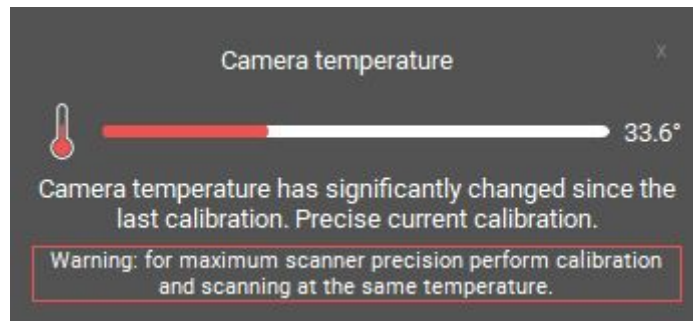Check the connection of cables, power supply, and then click Update. If you are sure that all the components of the scanner are connected correctly and the connection error persists, manually select hardware in Hardware settings. If necessary, contact the technical support of your reseller. If the scanner is not connected intentionally and none of the components can be found, only the processing functions of ScanCenter NG will be available.

In the case if all the settings are correct, after starting the program, you should see the image from the cameras in the main application window.

Hardware status

Cameras

Projector

License key

Turntable

New project

Basic

With markers

With a turntable

For normal operation, some scanner models requires warming up. If the cameras aren't warmed up enough, the program at startup will notify you about it.
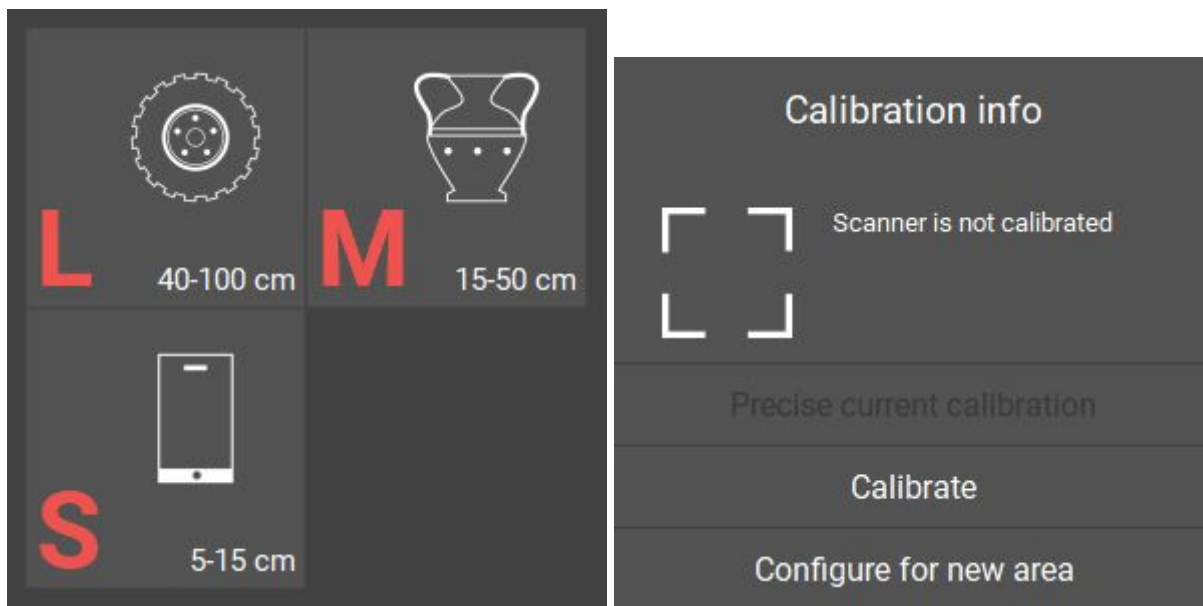

Camera temperature

33.6°

Camera temperature has significantly changed since the last calibration. Precise current calibration.

Warning: for maximum scanner precision perform calibration and scanning at the same temperature.

After warming up the value of the current temperature of the cameras is shown in the Toolbar while hovering over the icon.

Cameras temperature is 44°

Select scanning zone

After preparatory actions on setting up the computer, you should carry the scanner setting procedure. Select Configure scanner for a new area in Calibration window on the Start screen and follow the instructions for each step.

Before beginning the configuration, select the desired scan area (zone), depending on the object scanned. Scanning area is a set of interchangeable optics, calibration plate and stand for the calibration plate, which help to configure the scanner to scan a certain area. In the majority of cases, scan area is correctly matched, if the size of the object approximately equals to the size calibration plate.

Calibration field parameters

Take the necessary calibration to configure the scanner to the selected scan area. Make sure that the scan area is included in the package of your scanner.
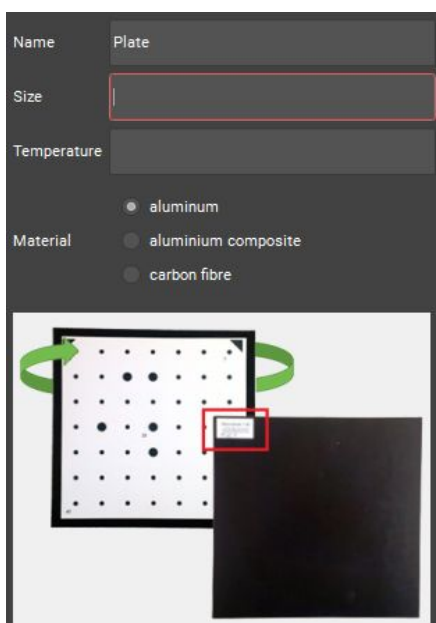
The exact size and measurement temperature are written on the label on the reverse side of the calibration plate.

Enter these values into the Configuration Wizard or select from the drop-down list of previously entered values.

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Lenses installing

Set the cameras lenses, corresponding to the selected scanning zone. The scanning zone number is specified on the lens. Securely tighten the objectives. Try not to touch or let any dust on the objectives and cameras lenses.

Blue Light

For scanning with unfavorable external lighting conditions it is recommended to use the "blue light" technology (may not be included in the package. In order to do this Blue Light filters must be installed on the cameras lenses and the corresponding mode must be activated in ScanCenter NG options. Do not activate this mode with no filters installed and vice-versa.

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While installing Blue Light filters, be gentle and do not put too much force to avoid damaging the thread.

Placing the calibration plate

Set the calibration plate in front of the scanner.

To install calibration plate, use special stands.

For plates L and M use a large stand with special slots for plate installation.
For plate S a small stand is used.

Initial setup of cameras and lenses

When you first set up the scanner, image from the cameras may be too bright or too dark due to different external lighting conditions. Adjust camera lenses, so that the brightness is acceptable: without the red overexposed areas and not too dark.

Lens adjustment is carried out by rotating the ring on the objective. Loosen (do not unscrew!) the retention screw and rotate the ring.
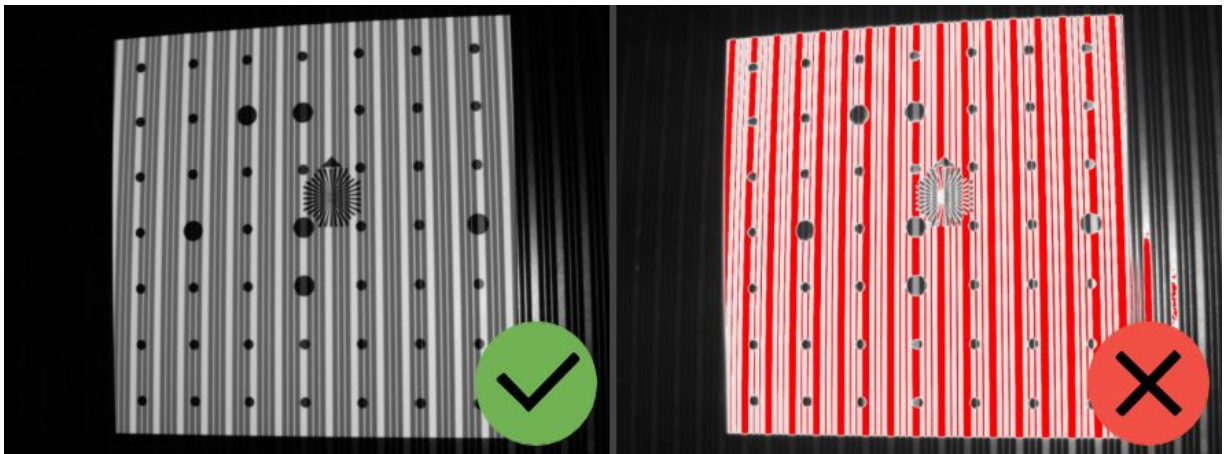
Lens adjustment is carried out by the following elements:

1. The iris tuning ring.
2. The iris ring retention screw.

Do not completely remove the retaining screws of the lens rings, it is enough just to loosen them. After you finished tuning the lens, lock the adjustment rings with the screws provided.

Finding a working distance

The scanner has a working distance (distance to the object) for each scanning area. When you configure your scanner, this distance is determined by calibration plate. To find a working distance place the calibration plate in front one of the cameras (see diagram). By moving the field closer to or further away from the camera, align the far markers of calibration plate with the blue grid on the camera view, as shown in the figure below. Blue vertical lines in the camera view must match the marks on the calibration plate.

Calibration field
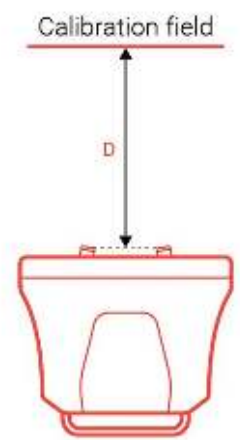
In Hardware settings → Cameras menu use Preview smoothing to enable or disable interpolation of camera preview images. In some cases interpolation can make the images too blurry.
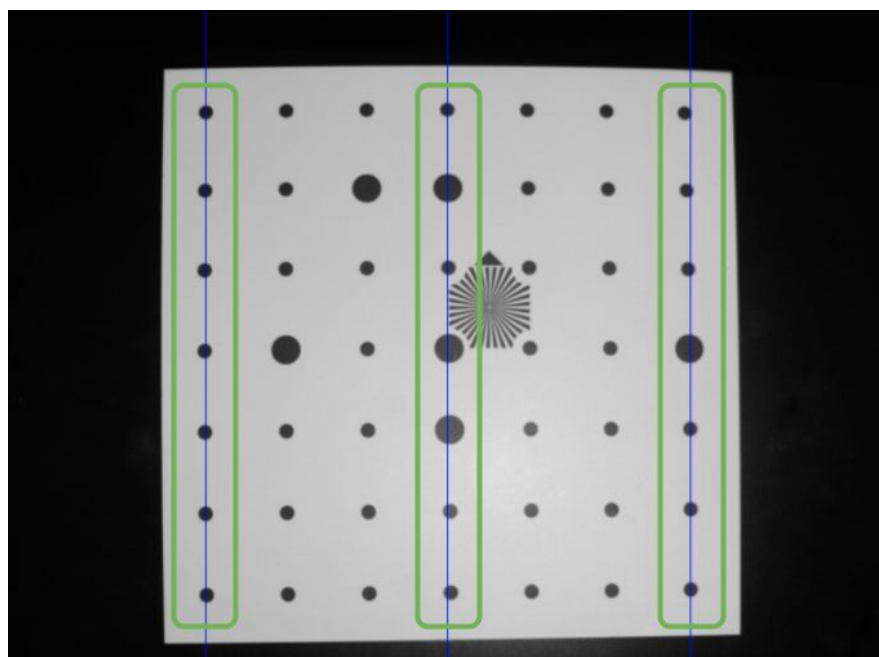
Adjustment of the projector focus

During the scanner operation the projector projects structured light to the object - coded lines and stripes. To ensure that the lines are sharp, the projector must be focused on the working distance of the scanner.

By switching the mode "Lines and Stripes", adjust the focus of the projector, so that the lines on the calibration plate were as sharp as possible. Using the zoom ring set the minimum possible area of projector light.

After changing the illumination area check the projector focus.
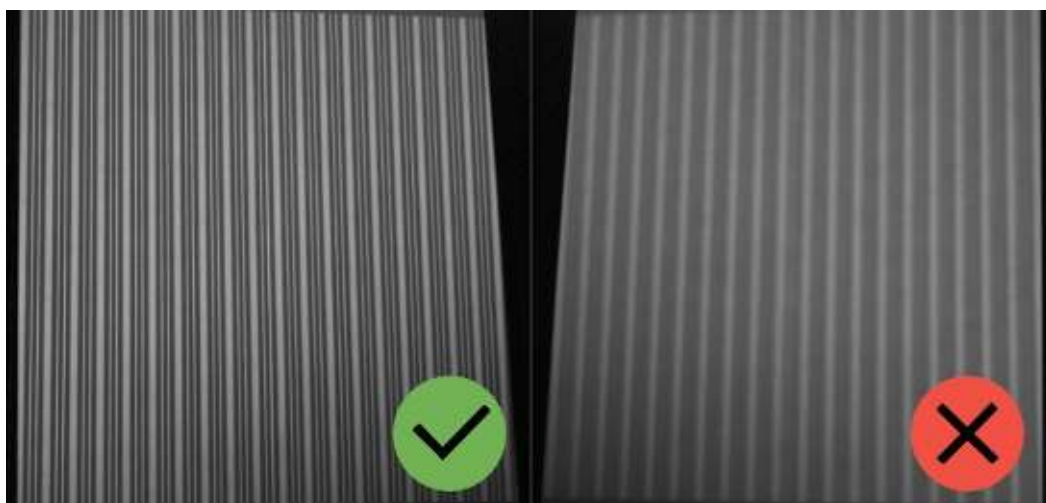
Minimum light area allows you to configure focus for any calibration plate. For other projectors, depending on the scan area, using the zoom ring you can select that area of light, in which all the plate will be lit, or use special lenses.

Bringing the cameras together

For the work of the scanner it is necessary to point both cameras to the same position on the specified working distance. Install the calibration plate in front of the scanner on the found working distance (if you changed its position after the projector focusing procedure.

Turn on the Cross light mode and aim the scanner to the calibration plate. It is not necessary to combine cross with marks on the plate at this stage, the focused projector should be projecting a cross on any surface, located at the working distance from the scanner.

Install the cameras in position, corresponding to selected scan area. To do this, unscrew the mounting screws, move the camera to the desired position, and then put the screws back.

Next, rotate the cameras so that the vertical line of the light cross lies approximately on the central vertical blue line in the both camera views as shown below. After that, securely tighten the screws.
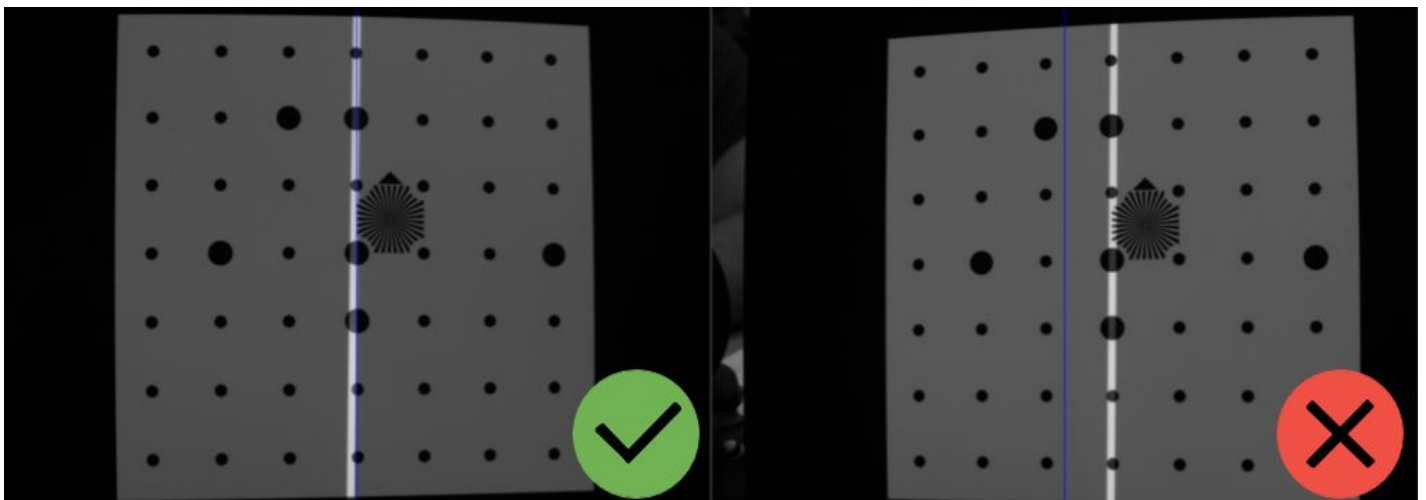
Final calibration of the cameras

Make sure that the projected cross matches the blue grid and move on to the next step.

Adjust the lenses diaphragms. Set the exposure for the cameras between 30 and 60 (less if the object, which you are planning to scan is dark and more if it is bright). By default the value is 45.

Areas illuminated with red mean overexposed areas with too bright image.

Configure lenses iris so that the lines on the calibration plate are as bright as possible, but without a significant amount of excessive light. Image brightness of both cameras must be the same!

In order to better align the same exposure on both chambers, you can leave a small area with excessive light (red area). The same "figure" of area with excessive light on both cameras will allow to more accurately set up the diaphragm of lenses.
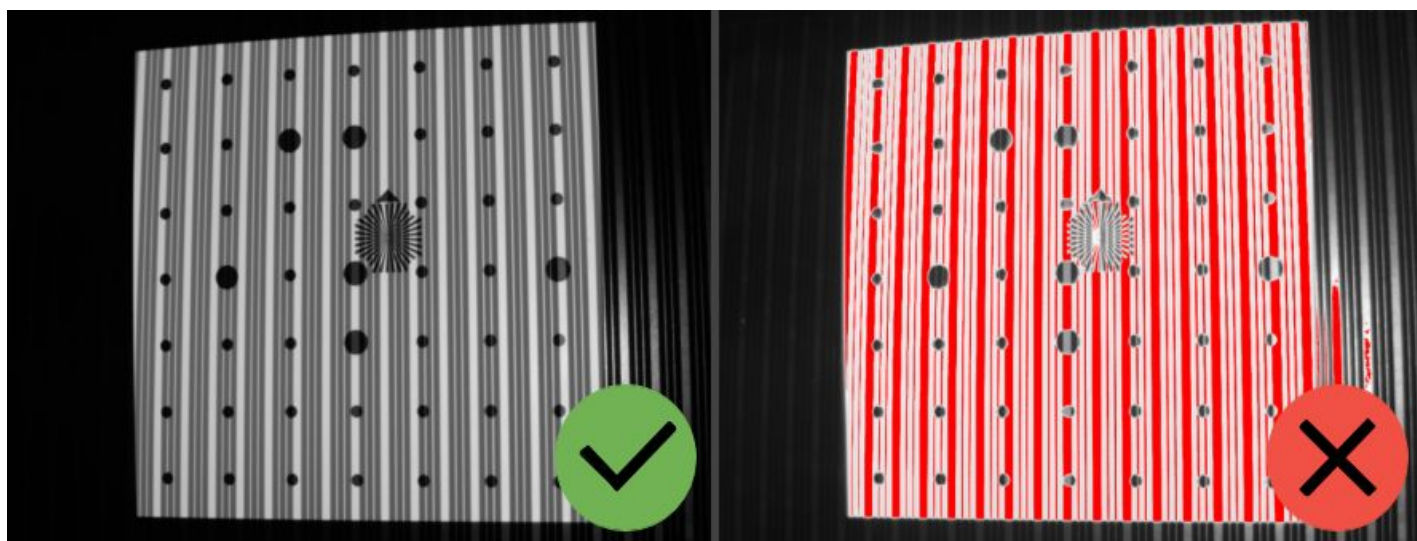
The lens focus is set during the scanner manufacturing and does not need to be adjusted by the user.

If you are setting up the 4th scanning area, it may be necessary to decrease the brightness of lines and stripes due to the close distance to object. In the menu Brightness setup decrease the brightness value, as shown in the figure. Brightness value of lines is approximately 2 times greater than the brightness of the stripes. Visually lines and stripes must be the same brightness.

Lines brightness

255

Stripes brightness

150

Markers brightness

150

Upon completion of all scanner adjustments, you should fulfill the following conditions:

- cameras are pointed to one point, located at the working distance from the scanner;
- cameras and the projector are focused on the same working distance;
- at the standard values of electronic exposure (30-60) images from the cameras are not excessively bright and not too dark;
- all the adjustment and the clamping screws are tightened.

Cameras heating

Temperature of cameras can differ as much as 40° C between standby and active modes. Ambient temperature of surrounding air has a great effect on time the cameras need to get to an optimal working temperature.

If the cameras temperature has stabilized within ± 2° C for 5 minutes it means that scanner is ready for work.

In different conditions it can take different amounts of time to get to stable working temperature. Average heating time in office conditions is 15 - 20 minutes.
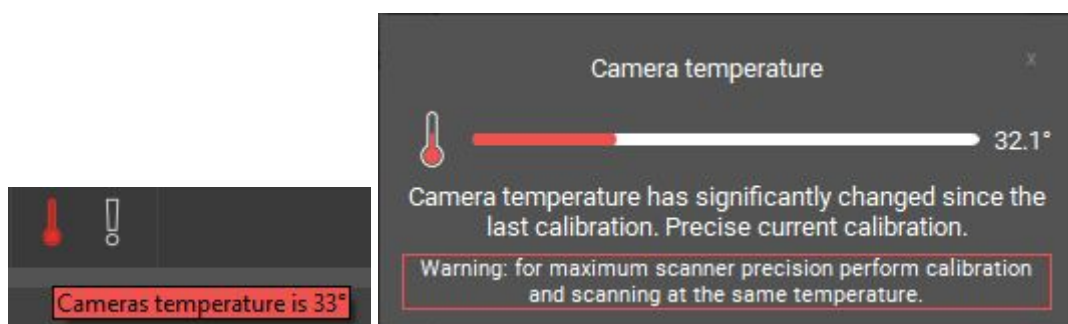
> In order to reach and maintain the highest level of scanning accuracy follow these cameras heating instructions:
>
> 1. Begin the calibrating process only after the cameras temperature has stabilized.
> 2. If the scanner was previously calibrated with different ambient lighting and temperature conditions, repeat full calibration.
> 3. If the cameras have been powered OFF, allow additional time after powering ON to get to stable working temperature.
> 4. Disconnecting cameras while working on a project is not recommended.

When the temperature reaches the optimal level, red indication disappears

Cameras temperature is 49°
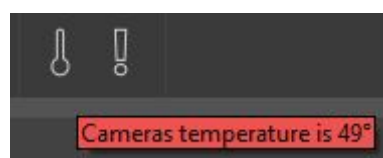
If the temperature deviates 5° C or more from the previous calibration value, a message appears and the indicator becomes red.

Cameras temperature is 33°

Camera temperature

32.1°

Camera temperature has significantly changed since the last calibration. Precise current calibration.

Warning: for maximum scanner precision perform calibration and scanning at the same temperature.

Calibrating the scanner

You need to perform calibration in order to ensure the work of the scanner after the adjustment of lenses. Specifically for this purpose we use the calibration plate, which is pre-measured with high accuracy. Scanning software analyses the image of the plate, obtained from the cameras and compares it with the mathematical model, marked by the algorithm.

There are 3 types of calibration: Full calibration, fast calibration (orientation) and Calibration of turntable (finding the table axis).

Full calibration is used:

- if the lenses of the cameras need to be reconfigured (for example, if you change the scanning area),
- if you suspect that scanning accuracy got worse,
- after transporting the scanning complex.

Fast calibration is used:

- if you suspect that the camera moved due to unreliable mounting,
- if you want to check the accuracy of performed calibration,
- before the work with the scanner (recommended).

Calibration of rotary table is performed:

- in case of any change in the position of the rotary table to the scanner (when scanning on the turntable).

Calibration of rotary table is described in the Scanning on the turntable section.

Calibration plate

Calibration plate is a special plate with markers, the distance between which is measured with high accuracy. It is used for setting up a scanner and its calibration.

For each scanning zone a separate calibration plate is used. There are three plates: L is the largest and S is the smallest. The approximate size of plates is specified in the Scanner setup section.

For calibration of rotary table on the S scan area you should use the "axis evaluation" plate. In the picture below you can see different calibration plate examples.
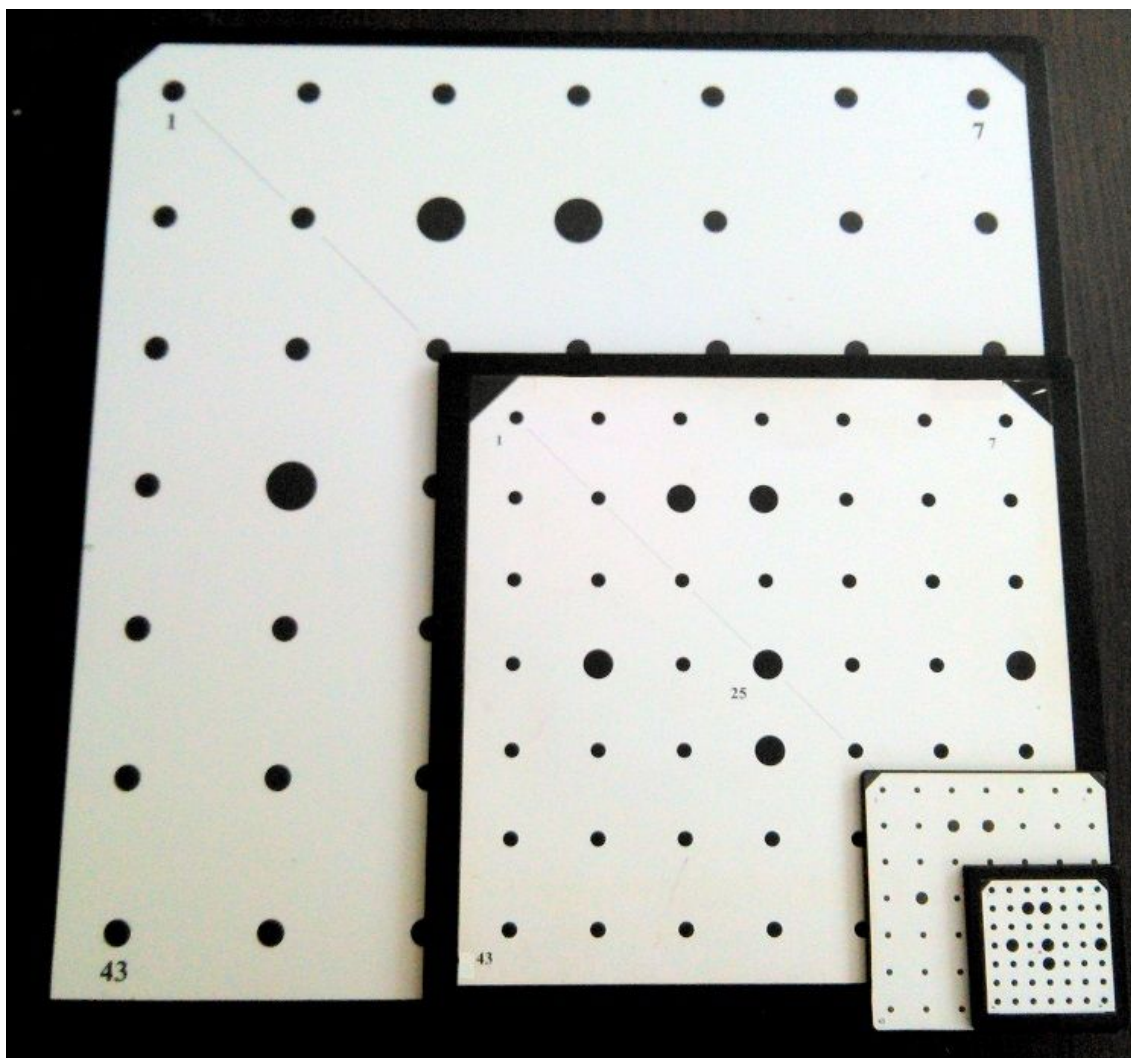
Full calibration

> **!** During and after the calibration process you should not adjust camera lenses.

> **?** Calibration should be performed in the same light, in which an object will be scanned. If there is too much change of level in lighting conditions it is necessary to recalibrate the system. It is not allowed to carry the calibration procedure on direct sunlight.

> **?** During calibration it is desirable to refocus the projector. To defocus a projector it is easier to use the zoom ring instead of the focus ring. For Acer projectors move zoom ring from one extreme position to the other, and the projector will be defocused; return it to the original position after calibration.

Full calibration dialog box opens automatically after the Configuration wizard, or manually from the menu Configuration → Full calibration.

Calibration procedure:

1. In the dropdown list the previously selected (in configuration wizard) calibration plate parameters are chosen. Compare them to the actual calibration field, choose from the list, if needed. Focal distance of the lenses is detected automatically, and is only allowed to change by technical support specialist when calibration problems occur.

> **!** Check that the size of the plate, specified in the software, matches the one you use. Incorrectly specified plate size can result in distorted 3D models.

2. In accordance with the text prompt and symbol image install the calibration plate in the desired position. The brightness of the images of calibration plate can be adjusted with exposure controller. You should not allow very dark images or images with excessive brightness areas. Press the Capture button. Original plate position - the position at the working distance from the scanner (marking on the view from cameras matches the markers on the plate), the cross is projected on the central marker.

Some lighting conditions can create a large shiny spot on the calibration plate, which disrupts the calibration process. In this case, activate the Black projection mode and increase the exposure value so that markers are visible (calibration will be done without projector light).

3. If the plate is placed incorrectly, a message will appear. Correct the placement and repeat the capture.
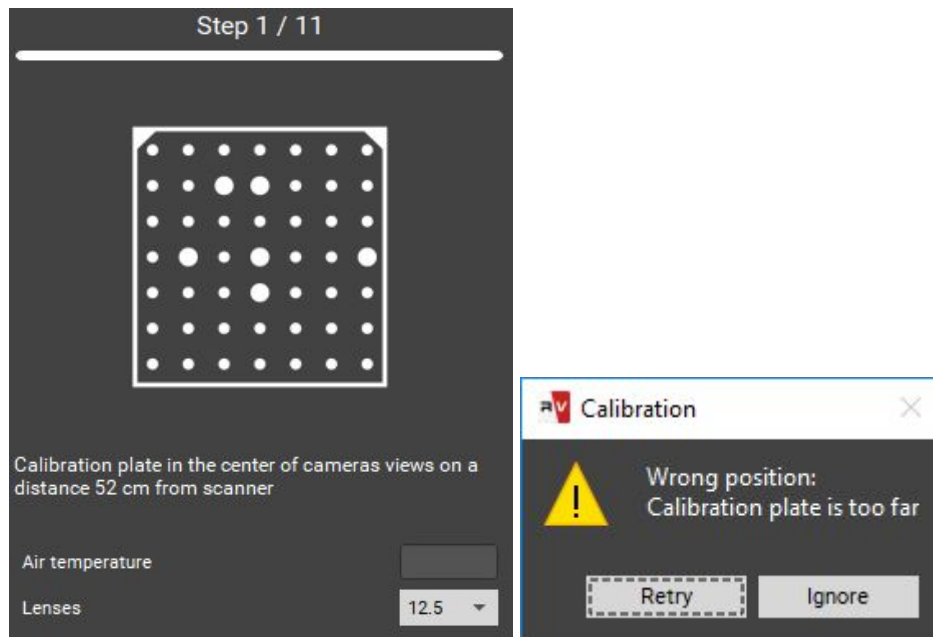
In case if not all marks are found on the image, you will also see an error message. It may mean the following:

● not all markers are visible on one of the snapshots,
● not all markers are lit by the projector,
● calibration plate is mounted at large angle to the scanner,
● the plate is too close or too far from the scanner - the image is not sharp,
● the plate is damaged or dirty.

Please correct all deficiencies and press Capture .

After all the necessary snapshots are taken, wait for the result of calibration procedure. Resulting accuracy of calibration is specified in pixels. A good result is accuracy no worse (not higher) than 0.05 pix. If you get a higher result, repeat the calibration, carefully checking the plates position and brightness. If is is necessary, repeat calibration without blue light and filters.

Calibration result in pixels is not equal to scanner accuracy in millimeters!

While working with the scanner, don't forget to once in a while perform orientation - it also serves as an accuracy indicator. If the accuracy during orienting starts to be very different from the original one, you need to re-calibrate the equipment.

Some advice on calibration:

1. Do not change the distance from the center of the plate to the scanner when turning the plate. The exception are only snapshots in positions 10 and 11.
2. Do not rotate the plate at a very high angle. Ensure that all marks on the plate are visible from both cameras, when you turn the table.
3. Be careful with calibration plates! It is not permitted to contaminate or perform any mechanical damage to the surface with the marks. After the use store the plates in designated case.
4. Before the calibration procedure ensure that cameras and cables are secure in the designated position.
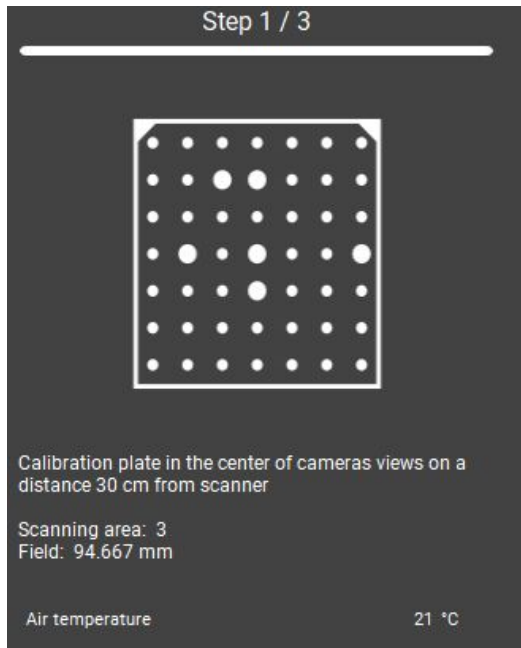
Fast calibration

When scanning large objects and moving the scanner frequently, the scanner eventually may report that it cannot find markers. In such case you need to perform fast calibration.

Step 1 / 3

Calibration plate in the center of cameras views on a distance 30 cm from scanner

Scanning area: 3
Field: 94.667 mm

Air temperature   21 °C

The fast calibration can be accessed from the Calibration window on the Start screen.

- mount the calibration plate at the central position in the distance to the scanner (the first calibration position),
- press the Capture button,
- next, following the steps, make two more shots,
- after this the accuracy will be shown. It should be approximately equal to the accuracy value of the last calibration.

If the accuracy during orienting starts to be very different from the original one, you need to re-calibrate the equipment.

Example: The initial accuracy is 0.024, accuracy after fast calibration is 0.065. The value exceeded 0.05, re-calibration is required.
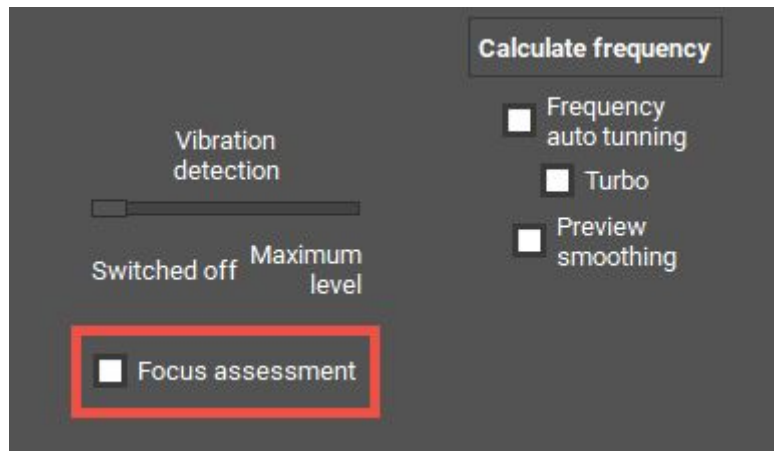
Focus assessment during calibration

While performing the calibration steps it is important to not deviate too much from the working distance in order to keep the calibration field in focus.

The focus assessment option can help with this task. It is located in the Hardware settings → Cameras menu.

When activated, the software will monitor the calibration snaps and will suggest repeating a step if low marker sharpness is detected.

Markers going out of focus can be caused by incorrect plate position or lens adjustment.

RangeVision, 2020