ARTEC
STUDIO 15

USER GUIDE

Artec 3D

Contents

Popular Topics

Artec Studio is an industry-acclaimed software package for advanced 3D scanning and data processing. It enables you to scan countless objects using Artec scanners.

This manual will show you how to use the application as well as your 3D scanner to quickly and easily create great-looking 3D models. Use the left panel to get an overview of the entire manual, or refer to the *Quick Start Guide*. To get the most out of the documentation, review the various *terms* we use throughout. Consult the Index to find references for specific parameters that appear in processing algorithms. Also, take a look at the *Conventions and Acronyms* section for a key that describes how we highlight semantic elements.

The incomplete list of chapters below is intended to clarify the document structure.

- *3D Scanning at a Glance* (Quick Start Guide) is a brief overview of scanning and processing basics. It also covers *Autopilot* mode.
- *Using the Hardware* covers hardware-related matters: scanners, third-party 3D sensors and 3D mice
- *Scanning* explains the basic principles of object scanning and offers advice on how to conduct the scanning process to obtain the best results.
- *Viewing Scans and Models* describes ways in which to control an object's appearance in the *3D View* window and obtain the best view of the 3D model.
- *Projects, Scans and Models* contains information on data management, working with projects, exporting and importing data, undoing recent operations, and saving the history of project changes.

- *Data Processing* focuses on data-processing techniques: working with separate scans, alignment, fusion, filters, defect-elimination methods and texturing.
- *Additional Modes* demonstrates how to publish models on the Web; how to use additional features, such as employing several scanners to capture an object; and how to use measuring tools.

In addition to this manual, you can find practical tips and other information at the Support Center. If you encounter an issue when using our 3D scanners or applications, please submit a request.

Documentation for earlier versions of the software is available here.

CHAPTER 1

3D Scanning at a Glance

Before you start using the guide, we want to show you how easy 3D scanning can be. This brief summary will help you understand the 3D scanning process with the Artec 3D tools and get started quickly. If you prefer to begin with comprehensive and detailed information, you can skip this chapter.

The figure below schematically shows a typical common sequence of the 3D scanning and processing in the Artec 3D environment.

Scanning Working with a scanner, transferring data from the scanner to a PC (mobile device) for further processing.

Cleaning Rough cleaning of scans with the *Eraser* tool. Removal of the base surface and side objects.

Alignment Aligning multiple scans of the same object.

Registration Optimizing the position of frames within one or more scans.

Fusion Creating a mesh model on the base of scans.

Postprocessing Mesh simplification, smoothing and other optional steps.

Note: The need for a particular step depends on the individual case.

1.1 Preparation

1.1.1 PC Requirements

Besides a scanner itself, you need a PC to create and process models in Artec Studio. Your PC must run on the 64-bit version of Microsoft Windows 7, 8 or 10. The more powerful the PC, the better. The main memory (RAM) and graphics card are the most critical components (visit our FAQ page for more information).

1.1.2 Activation

Warning: Don't connect the scanner just yet! Continue reading for more information.

1. Register for an account at *my.artec3d*.
2. Sign in and download Artec Installation Center from the welcome page.
3. Install Artec Installation Center. When prompted, enter your email and password.
4. Plug the scanner into a power outlet, then connect it to your PC using the USB cable.
5. Wait for Windows to detect the scanner. Click *Activate*.
6. Click *Install* in the *Software* section to get Artec Studio running on your machine.

(For more details, see *User Account*, *Scanner Activation* and *Offline Activation*.)

1.1.3 Prepare Object and Scene (Common Recommendations)

Most objects are easily scanned, but observe the following recommendations for best results:

- Before scanning transparent, reflective or black objects, we suggest applying a powder coating or a special anti-glare spray.
- To scan monochrome objects with simple geometric shapes, do the following:
  - Add auxiliary objects (e.g., crumpled paper) to the scene
  - Paint markers (e.g., "X" shapes) on the surrounding surfaces
- Be sure to provide good ambient light.

A detailed information on preparing for different scanner types is available at the following links:

- for Micro
- for Leo
- for Ray

See also:

Selecting and Preparing Objects for Scanning.

1.2 Scanning

1.2.1 Scanning with Spider/Eva

1. Launch Artec Studio, then aim the scanner at the object.
2. Press ▶ on the scanner to start *Preview* mode. If your scanner lacks this button, first open the *Scan* panel.
   - *Geometry + Texture* is the default scanning mode and is suitable for most cases
   - For older PCs, *Geometry* mode is a good alternative
   - The *Real-time fusion* mode creates a model in real time, allowing you to skip postprocessing; click *Stop*, then select the *Real-time fusion* checkbox and click *Preview*.
3. Make sure the object is visible, then press ▶ once again to initiate recording. If possible, scan all sides of the object in one go, slowly moving the scanner around it as pictured below.

   Note: While scanning, pay closer attention to the object on the screen than to the actual object.

4. If you hear an alert sound and the screen displays an error against a red background, smoothly aim the scanner at the area you just captured. Possible reasons for the "Tracking lost" error include the following:
   - You are scanning simple geometric shapes
   - The part of the object you are scanning is too small
   - Scanner movement is too fast
5. Press ■ to display the scan in Artec Studio.

Turn and Scan (Optional)

Turn the object and capture any remaining unscanned regions (press ▶). Also, to facilitate alignment, record at least one previously scanned region.

See also:

- *Buttons and LED Indicators for Eva and Spider*

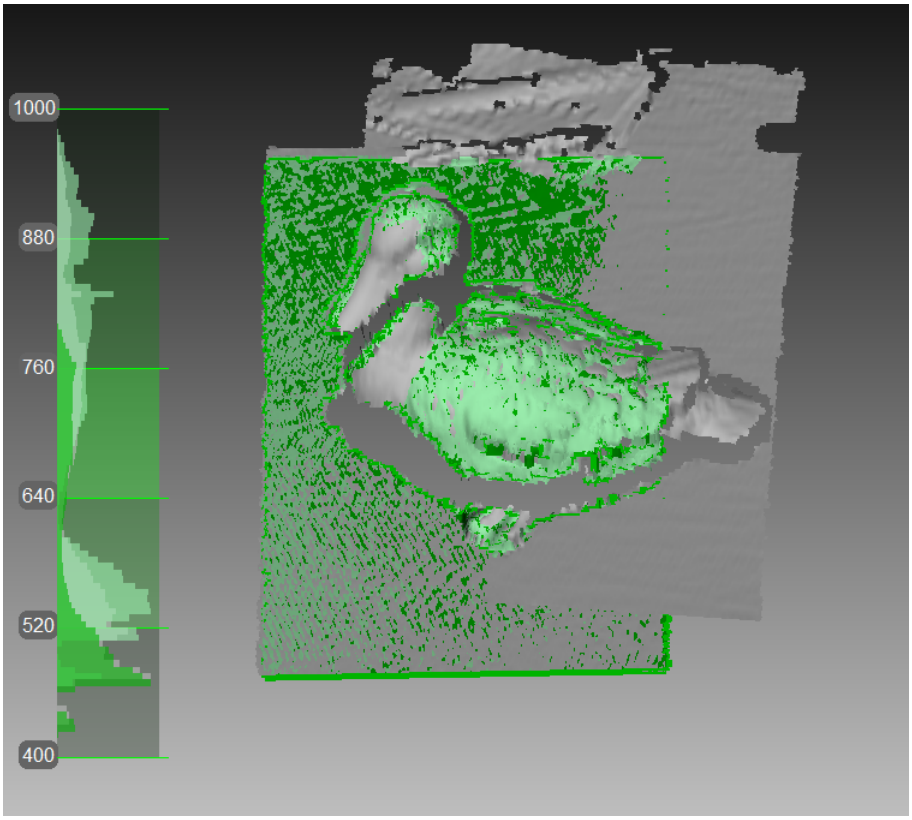


Figure 1: Scanning with Eva.

1.2.2 Scanning with Micro

1. Launch Artec Studio, connect the scanner to your PC and turn it on. Calibrate it if necessary.
2. Fit an object in the camera view. The object must be entirely visible. For large objects, consider removing extra spacers from the scanner.
3. Adjust *Brightness* and other settings as necessary. Tune it to minimize areas highlighted in red (potentially noisy areas).
4. Select *Scanning path*. For simple cases, use the *Preview* mode.
5. Click *Scan*. Micro will start capturing frame while swinging the L-shaped arm and rotating the turntable.

If necessary, flip the object and affix it. Then repeat the steps above to scan the remaining areas. You'll need to later *align* the scans obtained this way.

See also:

Scanning with Micro in details.

Figure 2: Aligned scans from Micro.

1.2.3 Scanning with Leo

Since Artec Leo is a self-inclusive device featuring computing and graphics processing units, you don't need to connect it to a PC running Artec Studio while scanning.

1. Tap *New project* or press the red button on the handle of the scanner. Leo will start preview, i.e. building surfaces without recording them.
2. Configure the Leo settings as you need.
3. Direct the scanner at the object. Practice your movements and assess the quality of the surface being reconstructed on the screen.
4. Once you're ready, tap  or press the red button on the handle of the scanner.
5. Scan the object from all possible sides.
6. Tap  or press the red button on the handle of the scanner.
7. Rotate or turn the object upside down to scan the missing regions.
8. Tap *Close* if you are done with the scan.

Once you have recorded a scan, it is added to the project.

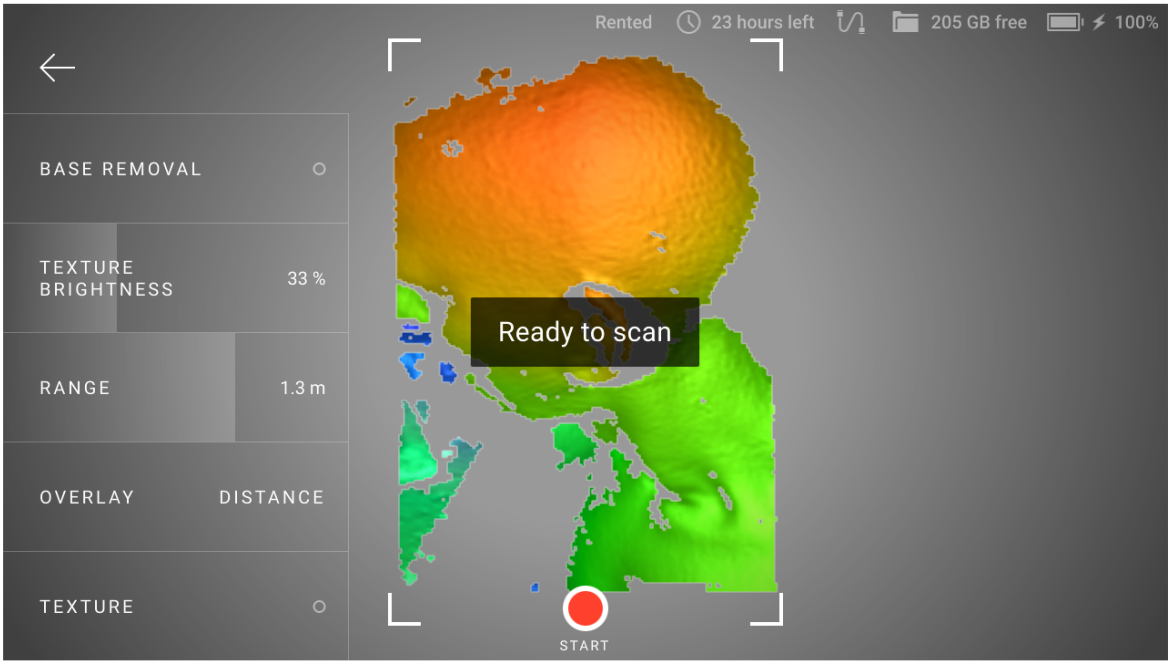


Figure 3: Scan screen.

It is possible to import projects from Artec Leo either over a network from Artec Studio or using a microSD card. See here for details.

See also:

Scanning with Leo in details.

1.2.4 Scanning with Ray

Note: Ray can work both through Artec Studio and the mobile application Artec Remote. This short introductory document will cover the work with Artec Studio.

1. First, you should make a preview scan for the following reasons: to get a low-resolution image of the area you are scanning so you can see the desired object; to estimate the required point density for scanning.
    1. Ensure Ray is connected to your computer.
    2. Launch Artec Studio.
    3. Open the *Scan* panel. Click *Scan with Ray*. The application will open the Ray scan panel.
    4. Click *Preview*. Ray will capture a preview.

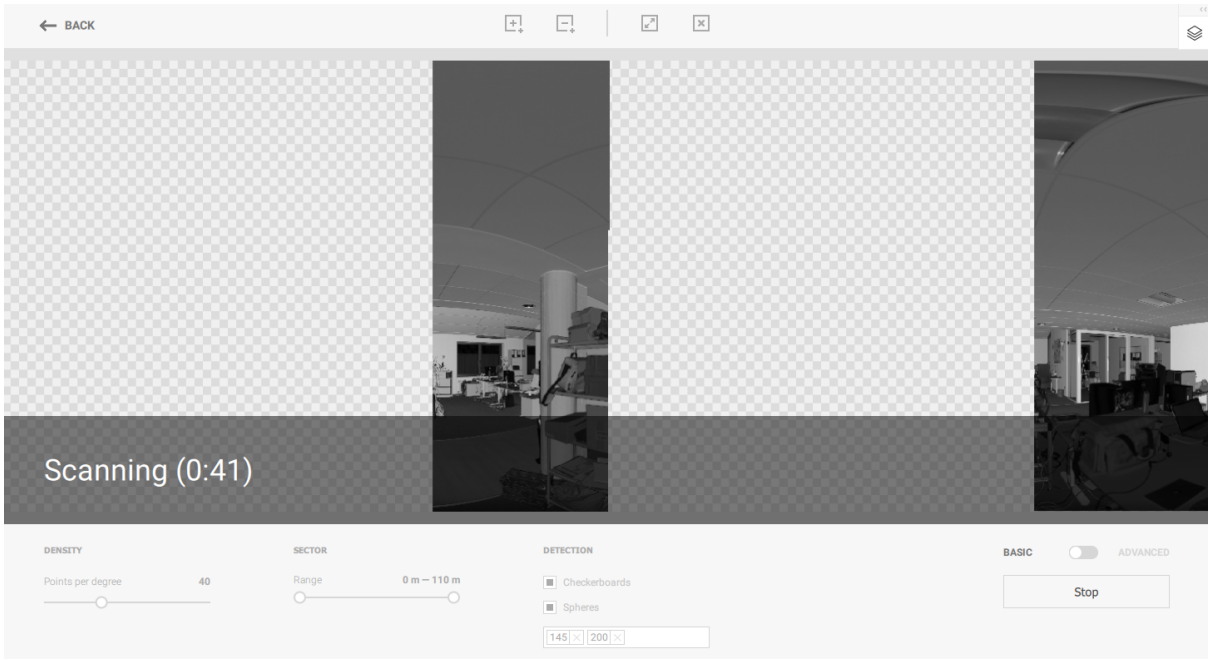


Figure 4: Ray preview scanning.

2. Once you have a preview, you can
    - Select the entire preview image to scan the whole space.
    - Locate and mark sections to scan particular objects in the scene using interface buttons like  and 
3. Adjust point density and other necessary settings.
4. Scan selected sections using the *Scan* button in Artec Studio.

See also:

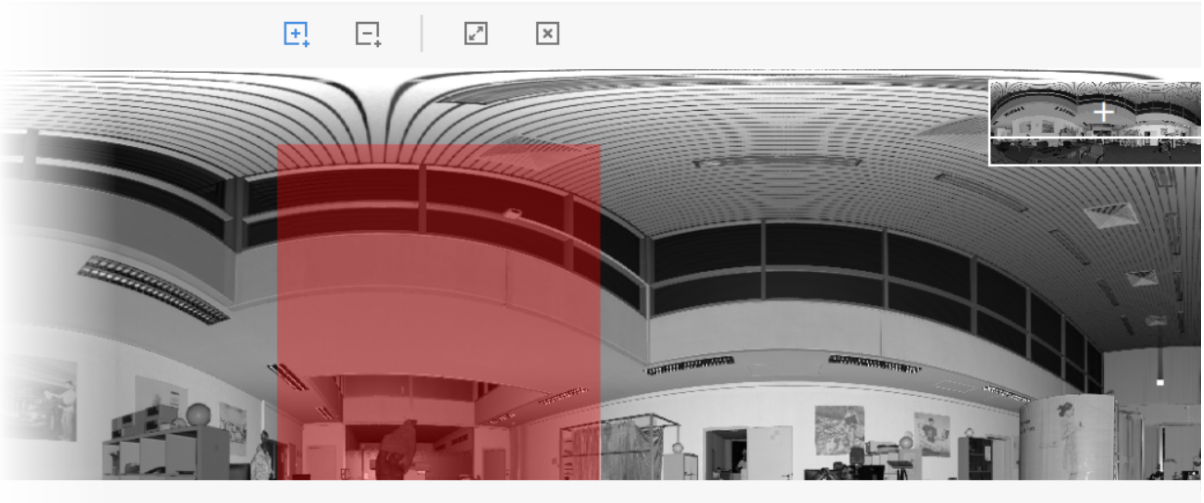


Figure 5: Marking section.

- *Tweaking Scanning Options*,
- *Scanning Procedure*,
- *Tracking Modes*, and
- *Scanning With Real-Time Fusion*.

1.3 Use Autopilot

For beginners, the easiest way to obtain a 3D model is by using *Autopilot*. It's also a great time saver for advanced users. If you prefer performing all the steps manually, refer to the *Process Manually* section.

Autopilot is a special mode that helps users obtain a complete 3D model without learning all the ins and outs of postprocessing. It consists of two major parts: semiautomatic (editing and alignment) and *automatic*.

Tweaking Autopilot Settings

- *Hole-filling method* (available options are *Don't fill*, *Watertight* and *By radius*) instructs the algorithm to fill or not fill holes in the model.
- *Model resolution*—the lower the resolution value, the sharper the shape and the more details you will see. If you're unsure, leave the value as Auto. Effectively, it's the same as *Creating Models (Fusion)* resolution. Note that the resolution should be no less than 0.5 for scans captured using EVA and no less than 0.1 for Spider.
- *Polygon count* determines how many polygons the resulting model will have. The greater the value, the better the quality and the larger the file size. If you're

unsure, leave the value as Auto. For more information, consult the *Mesh Simplification* section.

- *Texture*—clear this checkbox if you don't want to apply texture to the model.
- *Texture resolution* takes specific values in the range of 512x512 to 8192x8192 or 16384x16384 pixels depending on the available GPU memory.

To produce a model,

1. Click *Autopilot* in the left panel or hit `F9`.
2. Become familiar with the steps that you will perform in this guided mode (listed in the welcome screen).
3. In the *Workspace* panel, use the ✔ flag to mark all scans that you intend to use, then click *Next*.
4. Then specify the input parameters for the model-creation step and click *Next*. Primary settings may include the following:

   Note: We suggest consulting the tool tips, which you can reveal by clicking the ? button next to the option name.

   a. *Scan quality (geometry)*. Click ? to determine whether your scan of the object has the correct geometry by examining the tool-tip images.

   b. *Scan quality (texture)*. Click ?, look at the images and decide whether your scan has sufficient texture.

   c. *Hard-to-scan surfaces*. Select the checkbox if your object has surfaces that are difficult to capture. Consult the image samples by clicking the ? button.

   d. Decide on the *Object size* by referring to the image samples.

   e. Leave the default values for the remaining options in this window (sufficient for most cases). For advanced scenarios, you can tweak these settings (more details appear in the *sidebar*).
5. If necessary, erase any extraneous objects that can hinder processing and postprocessing. Learn how to use *Eraser* by consulting the *Erasing Portions of Scans (Eraser)* section.
6. Once you're done, click *Next*. If the object was captured over several scans, Autopilot will align them and show you the result. You can approve it or align the scans manually (consult *Manual Rigid Alignment Without Specifying Points*).
7. Click *Next*.
8. Autopilot will begin processing and then *postprocessing*. Once it's finished, a message will appear informing you that the model is ready. Click *OK*.

The automatic steps can be grouped as follows:

- **Processing**
  1. Global registration
  2. Outlier removal
  3. Fusion
- **Postprocessing**
  1. Small-object filter
  2. Mesh simplification
  3. Texturing

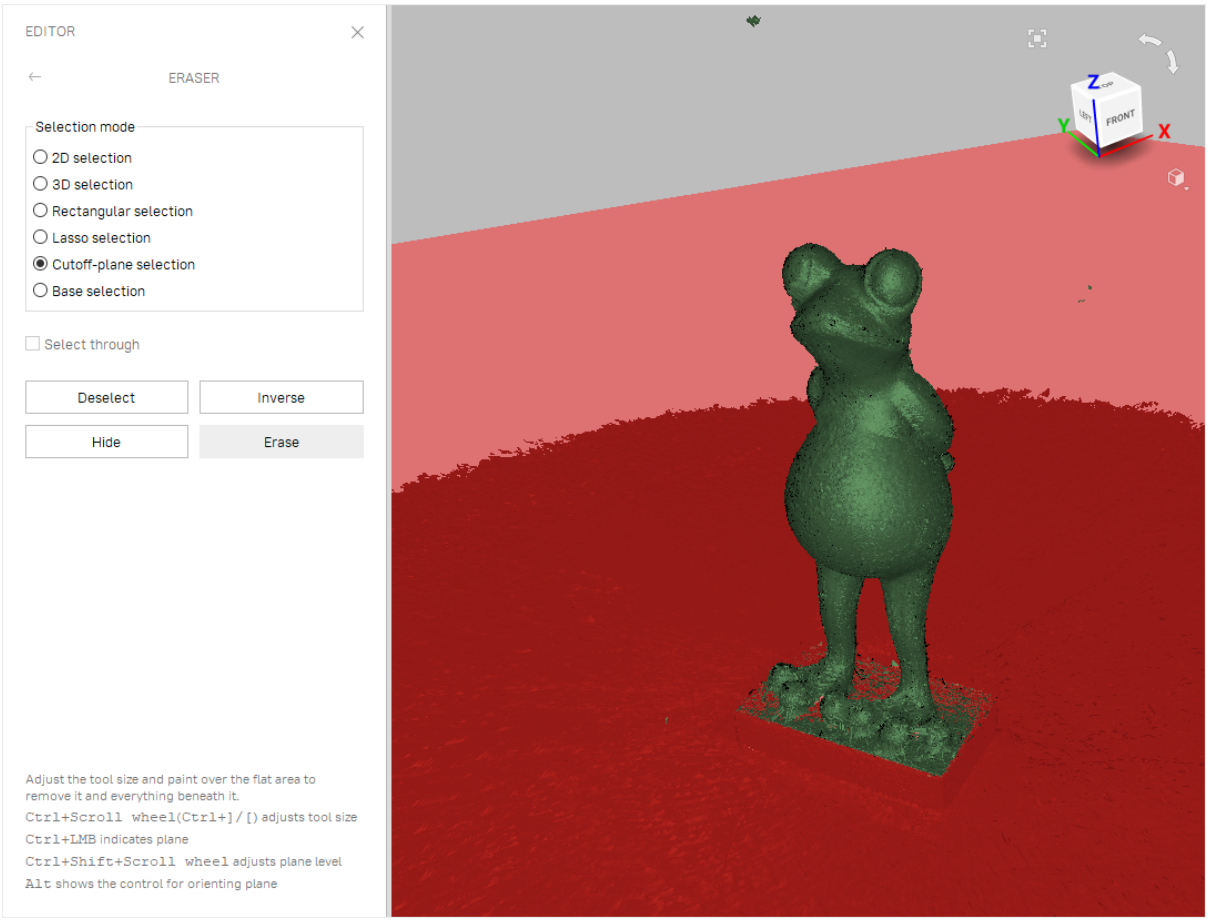
1.4 Process Manually

1.4.1 Crop Surroundings

Once you finish, click *File* and select *Save project*. Close the *Scan* panel. You can now crop the surroundings.

Purpose: To erase auxiliary surfaces (e.g., a table or floor).

Steps: Open *Editor* → *Eraser* → *Cutoff-plane selection*. Follow the panel instructions.



Tip: Use freely other types of the *Eraser* (not only *Cutoff-plane selection*) to remove other unwanted elements from the scan.

See also:

Editing Scans.

1.4.2 Align

Tip: If you have only one scan (see the *Workspace* panel), or if you used *Auto-alignment* during scanning, you can skip this step.

Purpose: To align several scans.

Steps:

1. Mark two or more scans using ✔, click *Align* and select those scans in the *Rigid* tab while holding the `Ctrl` key.
2. Click *Auto-alignment*.
3. If alignment fails owing to a lack of texture or lack of overlapping areas, manually match the features among the scans and click the *Align* button.

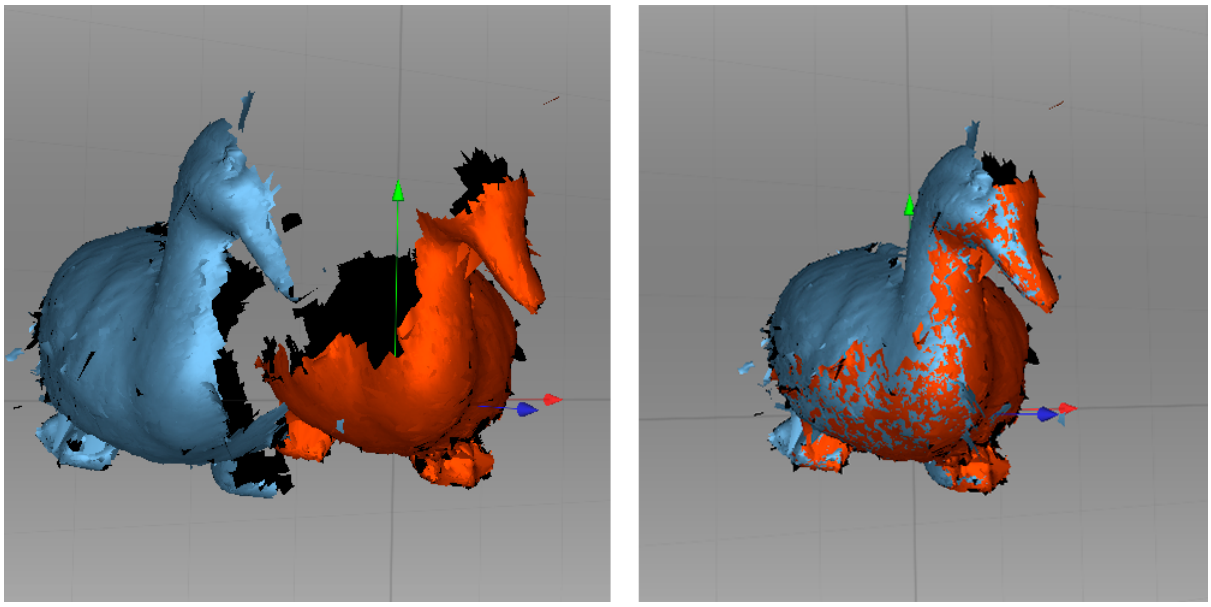


Figure 6: Two scans before and after alignment.

See also:

Alignment in details.

1.4.3 Global Registration

Purpose: To simultaneously optimize the frame position across all scans, thus preparing them for further processing.

Steps: Mark scans using ✔, then click *Tools* → *Global registration* → *Apply*.

Tip: If you see some obvious problems with preliminary (*Rough*) registration after scanning, try to resolve them by *Global registration* of each scan separately.

See also:

Global Registration in details.

1.4.4 Eliminate Noise

Purpose: To erase large outliers and some noise.

Steps: Open *Tools* → *Outlier removal* → *Apply*.

See also:

Editing Scans and *Eliminating 3D Noise (Outlier Removal)* for more details.

1.4.5 Fusion

Purpose: To create a model (a single surface, as opposed to the multiple surfaces that constitute the source scan).

Steps: Select *Tools* → *Smooth fusion* → *Fill holes* → *All (watertight)* → *Apply*.

Tip: To obtain sharper surfaces, select *Sharp fusion*.

In any case, *3D resolution* can be adjusted: the smaller the value, the more precise the resulting surface.

See also:

Creating Models (Fusion) in details.

1.4.5.1 Erase Flaws (Optional)

Purpose: To erase any outliers and poorly scanned regions.

Steps: Click *Editor* → *Defeature brush*. Follow the instructions.

See also:

Editing Scans

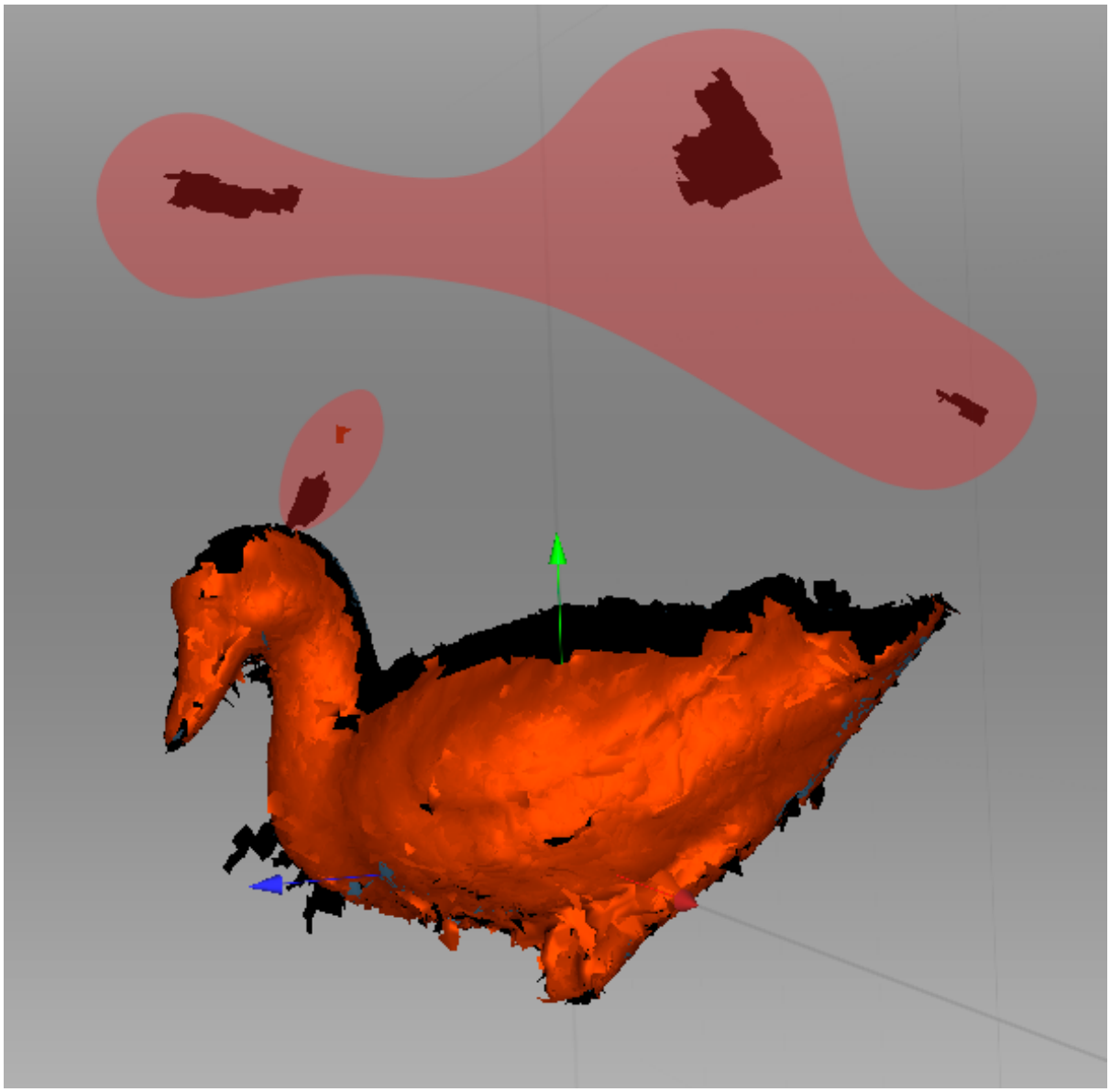


Figure 7: Outlier removal.

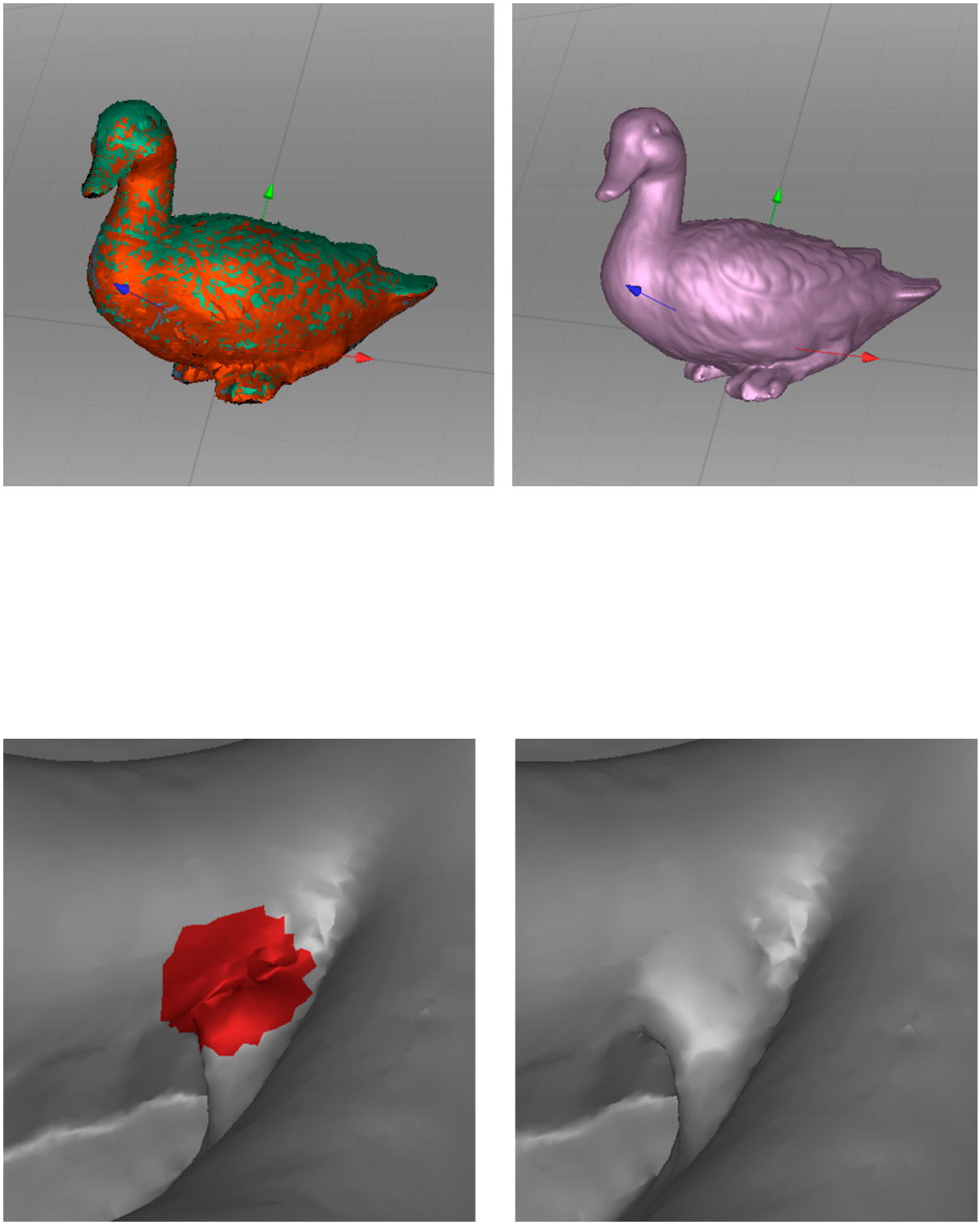


Figure 8: Using Defeature brush.

1.4.6 Simplify Mesh

Purpose: To reduce the file size by decreasing the number of polygons without significantly distorting the actual 3D geometry.

Steps: Click *Tools* → *Mesh simplification* → *Apply*.

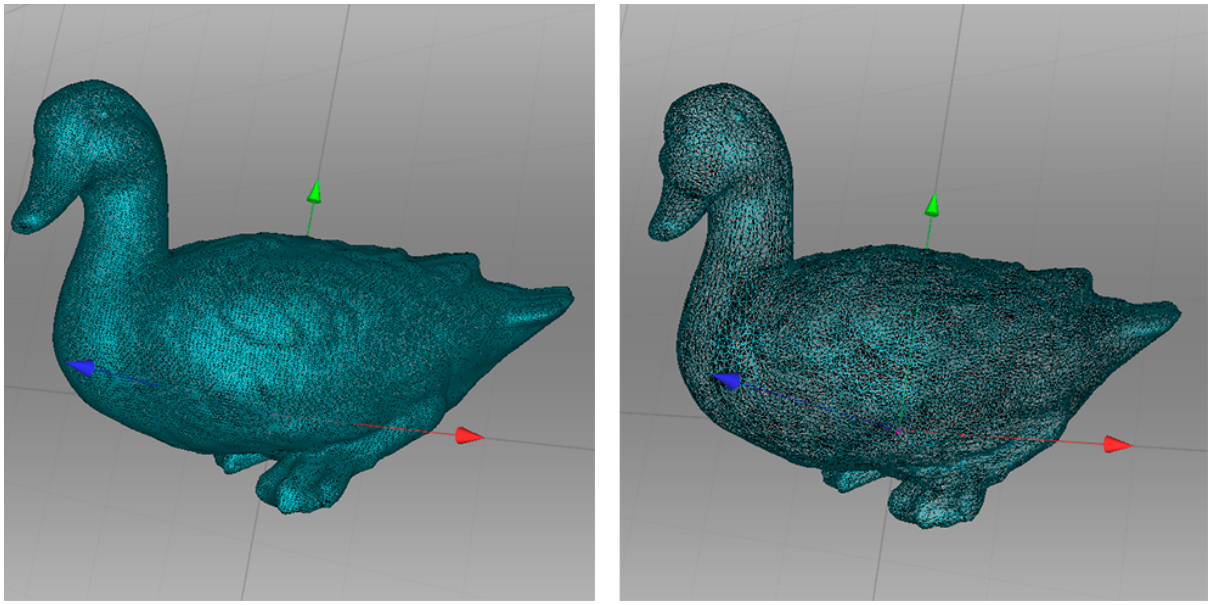


Figure 9: Mesh simplification.

See also:

Mesh Simplification in details.

1.4.7 Texturing

Purpose: To create a textured model.

Steps:

1. Click *Texture*.
2. Select a model (fusion output) and its source scan(s) in the corresponding fields.
3. Select texturing for *Export* → *Apply*.

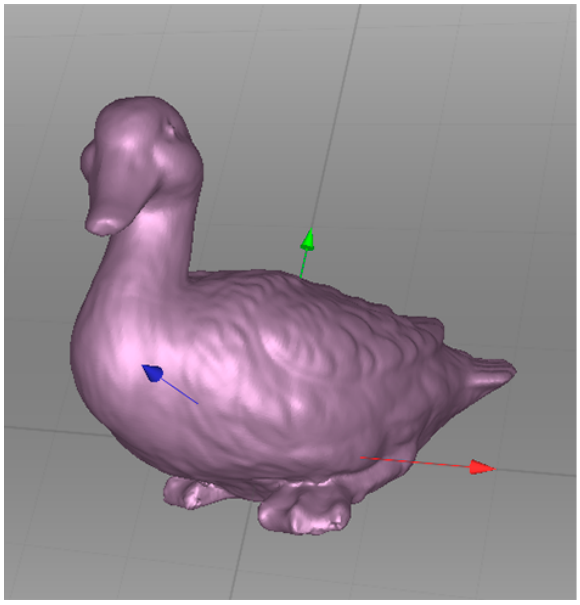
See also:

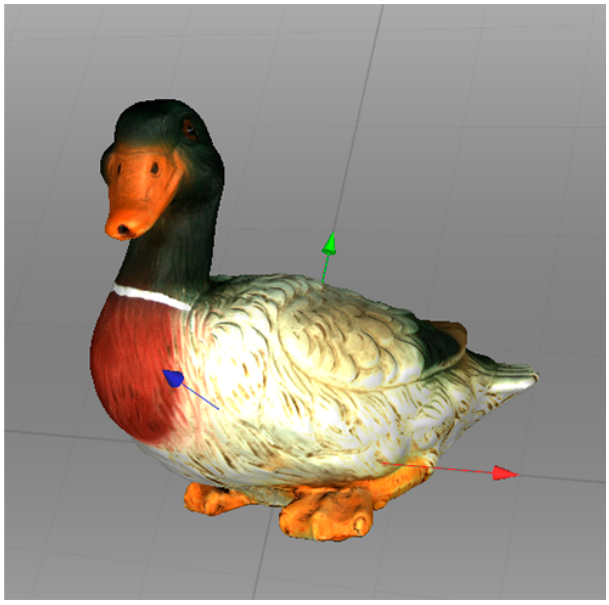
Texturing in details.

1.5 Export, Measure, Share

To export a model:

1. Open *File* → *Export* → *Models*.





2. Select a required format, specify the folder and file name, then click *OK*.

To measure the model:

1. Open *Measures*.
2. Select one of the following:
   - *Distance* for distance calculation: points are connected by lines (linear) or curves that pass over the model surface (geodesic)
   - *Sections* for area and volume calculation

Share the model on *viewshape.com* by opening the *File* → *Publish* toolbar.

See also:

Exporting Models, Scans and Point Clouds, *Measurement Tools* and *Publishing to the Web*.

1.6 Tips and Tricks

- You can reset all settings to their defaults using `F10` → *Scan* tab → *Reset to defaults*.
- To return any altered parameters in the *Tools* panel to their default values, click the adjacent button. A parameter lacking this button is set to the default value.
- Save screenshots by hitting `Ctrl+Shift+S`.
- Apply annotations using *Measures*: click `Ctrl+LMB` to tag a label and type text, then click or anywhere outside the label's pop-up window.

CHAPTER 2

Glossary

The following terms related to Artec Studio and 3D scanning appear regularly in this manual.

accuracy How closely a measurement matches the actual value of the quantity being measured.

Autopilot An advanced smart mode that guides the user through postprocessing in a few steps, automatically selecting the most effective settings and producing a 3D model.

bundle Capture of an object through simultaneous use of multiple scanners, whose numbers and relative positions are specified in the application.

CAD model

CAD object A feature-based, parametric solid model used in design engineering and manufacturing. It can be created in a CAD system, reverse-engineering software package or Artec Studio since version 15.

collection A set of scans (or models) for alignment. An alignment session may only have one collection of registered scans and several collections of unregistered ones.

fine registration A thorough frame alignment using an algorithm for relative positioning of sequential frame pairs.

frames 3D surfaces captured during a scanning session, collectively constituting a *scan*. The scan rate varies with scanner type and can reach a maximum of 15 frames per second using Eva.

fusion Process that creates a polygonal 3D model. It effectively melts and solidifies the captured and processed frames or point-cloud surfaces. Fusion can be run as a separate *algorithm* or throughout the scanning (*Real-time fusion*).

global registration Algorithm that optimizes the relative positions of all frames using a single coordinate system.

group A method of organizing *object*s in the *Workspace* panel hierarchy.

HD scan A scan that contains some frames of the high-definition (HD) resolution.

key frames Frames used by the global registration algorithm. The algorithm selects them automatically to fully cover the surface of the captured object using as few as possible.

mesh The surface geometry of a 3D model; it comprises a series of linked polygons.

model The 3D object that results from the fusion operation (in Artec Studio) or another modeling process in a different software package.

near and far cutting planes Planes that limit the space in which the scanner is capturing 3D frames. The device will ignore everything that is closer than the near cutting plane or more distant than the far cutting plane.

object A distinct entity in the scanned scene, or a generic term for all 3D data in Artec Studio: scans, point clouds, polygon and CAD models, and primitives.

origin The center of the coordinate system.

primitive

CAD primitive A simple *CAD model* created in Artec Studio and fitted to a polygon *model*.

project A method of managing the scanned material, processed data and user operation history, either in memory or on disk. Artec Studio project files use the *SPROJ* extension.

resolution The ability of a scanning system to capture detail in an object. See also 3D resolution.

rough registration Preliminary frame alignment performed during capture.

scan A sequence of frames captured in a single continuous movement of the scanner around an object or scene.

SD scan A scan that contains only frames of the standard-definition (SD) resolution.

section; in a point-cloud scan Corresponds to the region selected in the Ray preview area. The application may save these sections in the export files differently (*Merging Sections*).

section; in measurements Short for cross-section. Section is the plane that splits model or scan into two parts (*Sections and Volume*).

supporting surface A surface on which the object is resting (e.g., a table or the floor).

targets Stickers placed on the object being scanned to ease identification of the various regions. There are two types of targets: non-coded and coded. Unless the type is explicitly specified, the target is considered non-coded. Typically, a non-coded target is a round sticker that has a black ring with a white circle in the center; a coded target has a unique code ring that photogrammetry software can automatically recognize.

tracking Calculation of the scanner's position in a coordinate system relative to the scene.

transformation Any change in the position of a scan and/or its frames, for example, translation and rotation.

You can also find these terms along with some algorithm parameters in Index.

CHAPTER 3

Using the Hardware

3.1 3D Scanners

Artec Studio can work with one or more Artec 3D scanners. It offers tools to quickly create 3D models of physical objects. Besides managing the process of capturing objects, it lets you perform full data postprocessing, optimize mesh tessellations and apply other operations to obtain a quality 3D model. You can then send the complete model to a CNC machine or import it to another 3D-modeling application.

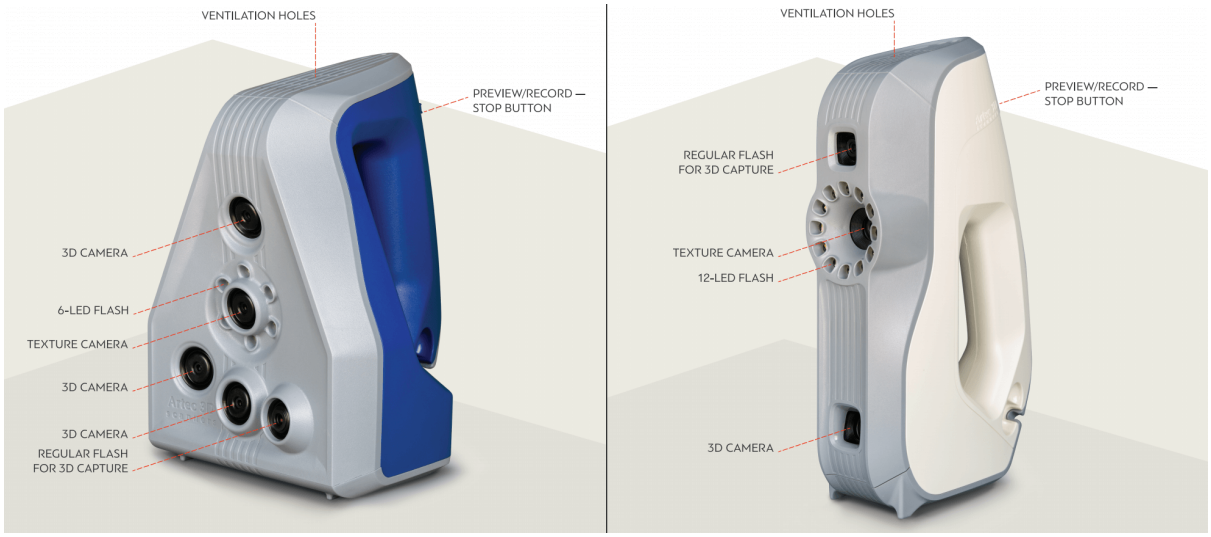


Figure 10: Features of Artec 3D scanners: Space Spider (left) and EVA (right).

Most Artec 3D scanners are specifically designed for handheld use, offering light weight and compact size. Being structured-light 3D scanners, they don't require you to place any special targets on the object you're capturing. Using them is easy—no special knowl-

edge or skills are necessary. To obtain a complete 3D model, simply scan the object from different angles and fuse the resulting scans into a single model using Artec Studio.

Depending on the size of the object you're scanning, use either Artec Ray, Leo and Eva, Spider or Micro. The primary difference between these models is the depth and field of view. They also differ in 3D resolution as well as point accuracy; consult the Artec web site and respective manuals for details.

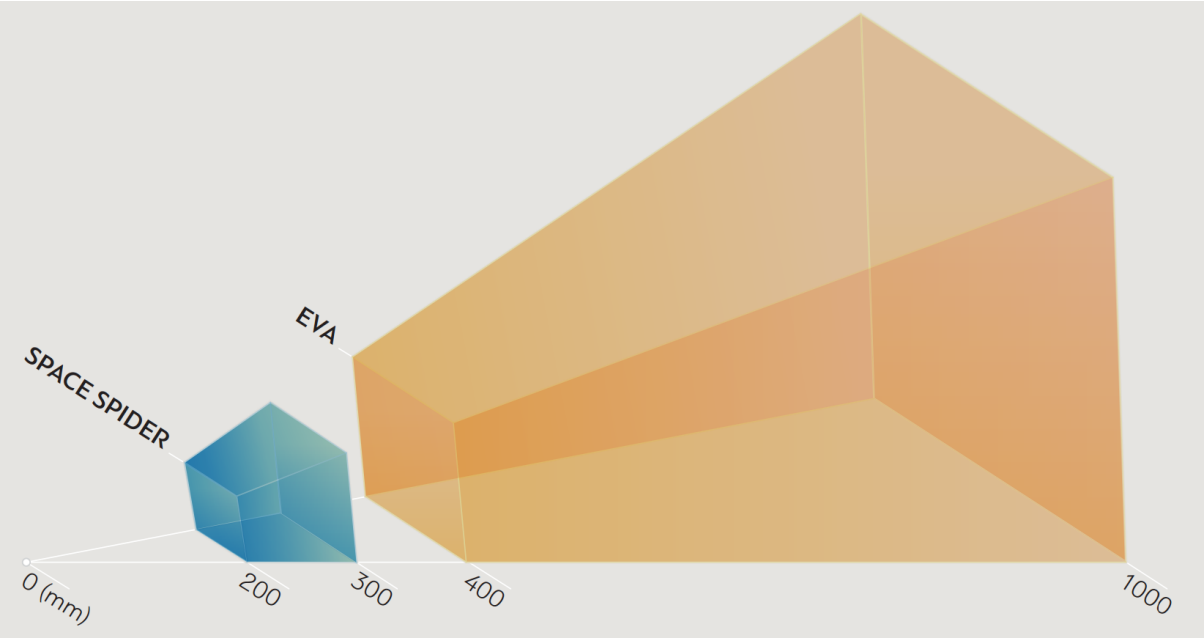


Figure 11: Fields of view for Eva and Spider 3D scanners.

You can combine several different scanner types while capturing a scene. In some cases when capturing complex shapes, this capability increases the scanning rate and enables you to achieve your desired precision.

3.2 Buttons and LED Indicators for Eva and Spider

3.2.1 LED Indicators

Artec scanners include built-in multicolor indicators. By explaining the meaning of these indicators, the list below enables you to keep track of the scanning process:

- **Steady blue**—scanner is booting up.
- **Flashing green**—Artec Studio cannot detect a 3D scanner.
- **Steady green**—scanner is connected to the application and ready to use.
- **Flashing red**—scanner is in *Preview* mode, or tracking in *Recording* mode is lost.
- **Steady red**—scanner is in *Recording* mode and object tracking is proceeding correctly.

3.2.2 Hardware Buttons

The Artec EVA and Artec Spider 3D scanners have three-position buttons on their bodies:

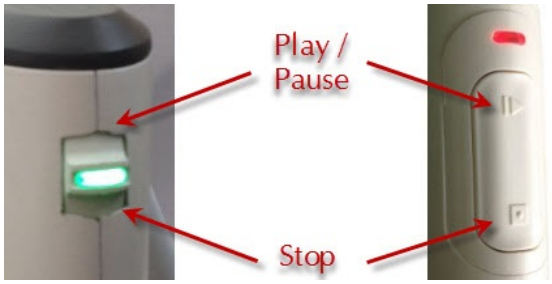


Figure 12: Scanner buttons: Artec Spider on the left and Artec EVA on the right.

- ▶ —press this button once to open the *Scan* panel and start *Preview* mode; press it once more to switch to *Recording* mode. Subsequently, pressing this button will switch between *Preview* and *Recording*.
- ■ —press once during a scan to stop the scanning process; press twice to stop scanning and close the *Scan* panel.

3.3 Hardware Synchronization for Eva

Artec EVA is equipped with two jacks designed for 6P6C connectors (RJ12). By creating a bundle, you can link multiple Artec EVA scanners to each other. The master device is a leading scanner that sends signals to the next slave device. Each subsequent device is connected to the previous one sequentially as Figure 13 shows. To connect the devices, you can use a standard phone cable (*RJ12 6P6C*) or any other cable that uses the conductor scheme shown in Figure 13. Each scanner should also connect to the PC via USB.

Warning: Only Artec EVA scanners can connect to each other. Do not connect Artec EVA to a telephone wall port!

3.4 Artec Turntable

Artec Turntable is designed to ease scanning of small and midsize objects by eliminating the need to rotate them manually. Both the rotary plate and the mat that comes with the turntable feature a special pattern to ensure robust tracking with Artec scanners. The mat is made of silicone, which prevents objects from sliding off the rotary plate.

To scan using Turntable, follow the steps:

1. Ensure your computer has a Bluetooth adapter that supports the 4.0 standard.
2. Add a new Bluetooth device.

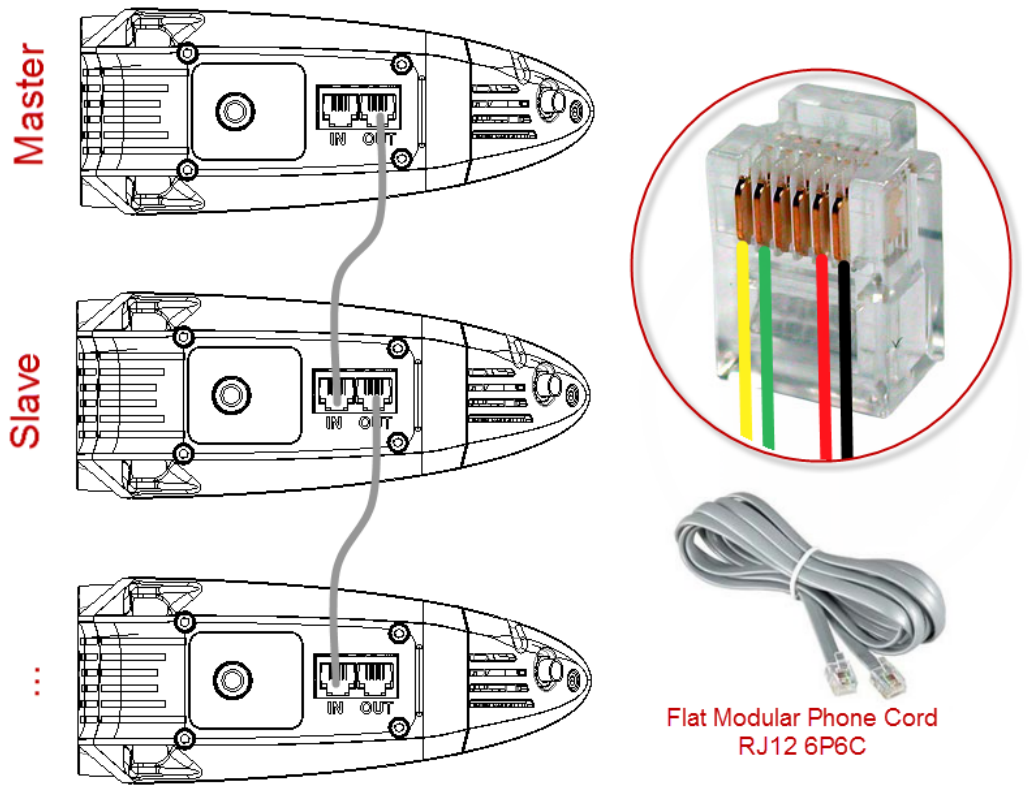


Figure 13: Synchronization scheme.
Jacks on the Artec EVA scanner shown at left and conductors in a 6P6C connector shown at right.

3. Open Artec Studio.
4. Access the *Scan* panel.
5. Select the *Use turntable* checkbox.
6. Place the object on the turntable.
7. Click *Preview*.
8. Click *Record* to start capturing. The turntable will start rotating.
9. Click *Pause* or *Stop*. The turntable will stop rotating.

3.4.1 Recovering Lost Tracking

If you experience a *tracking loss*, Artec Studio will pause the turntable. It also turns the rotary plate back by about 15 degrees. Once the application has recovered tracking, it resumes rotation.

3.5 3D Mouse

Artec Studio can work with 3Dconnexion manipulators.

Basic support includes navigation in *3D View* and the following commands:

- Home
- Fit to view
- Undo
- Redo

For 3D mouse to function, you need to install drivers from the manufacturer's web site. Additionally, you can assign four currently supported commands to the mouse radial menu or at least two of them to the hardware buttons for Artec Studio.

To assign a command to the 3D mouse button, follow the steps:

1. Open Artec Studio
2. Then open *3Dconnexion Properties* utility from the Windows tray
3. Click *Buttons*
4. Click on the > arrow on the right side of either button field. A flyout window will open for that 3D mouse button.
5. Open the *Artec Studio* category
6. Select either of the currently supported command.

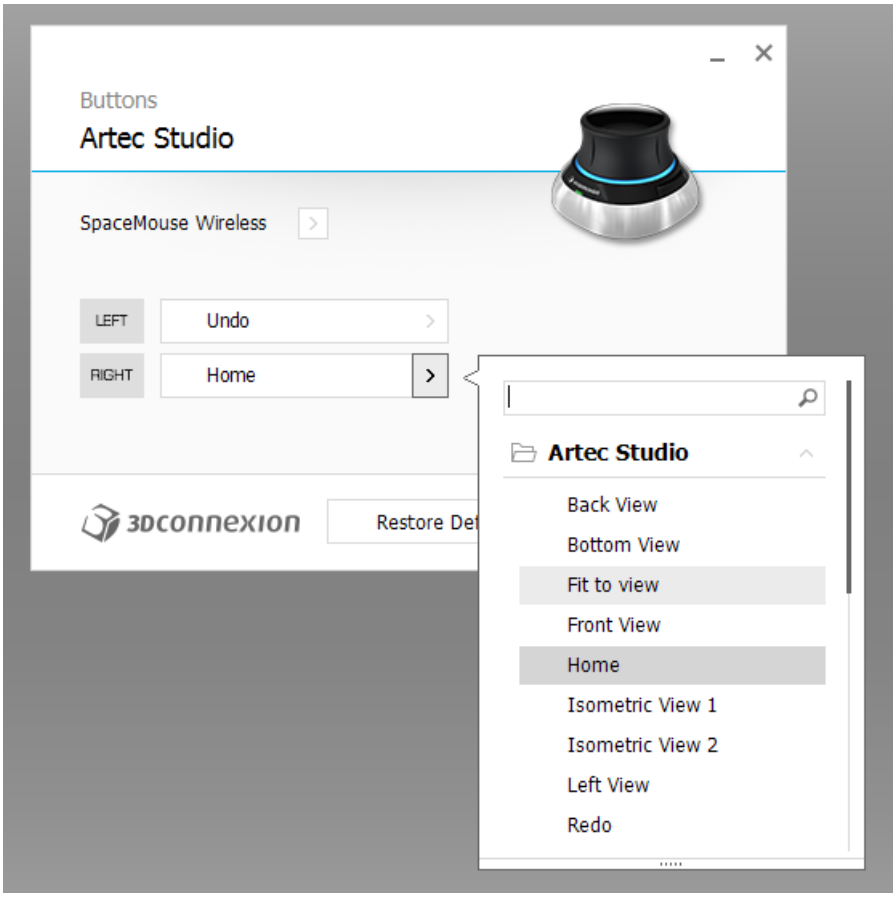


Figure 14: Assigning command to 3D mouse button.

If you want to assign several commands, create a new *Radial menu* (use the eponymous category in the flyout menu). For more information, consult the manual for your 3Dconnexion mouse.

To get used to navigating 3D content, use *3Dconnexion Trainer* or *3Dconnexion Demo* from the *3Dxonnextion Home* application.

Note: In Artec Studio, you move the camera around the object rather than the object itself.

3.6 Artec Battery Pack

Available as an accessory, battery pack allows you to scan anywhere without the need to be near a power outlet. Battery from this pack supports Artec EVA, Artec Spider and Artec MHT scanners and lasts for up to 6 hours of scanning.

Figure 15: Battery pack with Eva.

Battery pack includes the following items:

- Battery
- Battery pouch

- Power adapter (110–230 V → 19 V)

1. Fully charge Artec battery using its *Input* socket.
2. Plug the cable into the battery *Output* socket.
3. Then connect the cable to your Artec scanner.

Figure 16: Battery ports from left to right: Input, Output.

Important: Never confuse battery ports when connecting scanner.

CHAPTER 4

Installation

4.1 System Requirements

Your computer must meet the system requirements to use Artec 3D scanners.

In addition, take note of the following:

- **Real-time fusion mode** (*Scanning With Real-Time Fusion*): ensure that your graphics card has at least 1 GB of memory or your Intel HD Graphics chipset is 4600 or higher (consult the FAQ article for more information).
- **Using multiple scanners** (*Multicapturing*) requires your workstation to integrate as many independent USB host controllers as connected scanning devices. Upgrading your hardware with PCI/PCI Express USB cards may provide the required number of hosts.
- **Using HD mode**
  - If you are going to use the scanner in the HD mode, ensure that your Nvidia GPU has a minimum CUDA compute capability of 6.1, 2 GB of memory (4 GB for Leo scans) or more and your computer's RAM is at least 32 GB.
  - If your computer does not meet these requirements, you can still perform the HD reconstruction, but it may take up to several hours. In this case, it is recommended to use lower values of *HD data density* (see *Enabling HD Mode* for details).

4.2 User Account

To install Artec Studio and keep it up to date, register for a free account at *my.artec3d*. Registration is also required to activate an Artec 3D scanner. In addition, the site allows you to track all your Artec devices and products.

Your account at *my.artec3d* will be valid for all Artec sites and services (including *viewshape.com*).

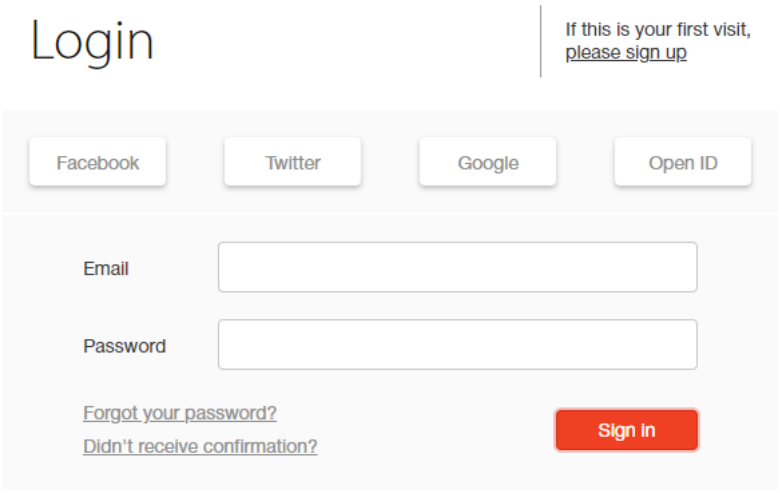


Figure 17: *my.artec3d* welcome screen.

To register, follow these steps:

1. Go to *my.artec3d* and click *please sign up*.
2. Fill in all the fields in the registration form (by clicking *Next*) and click *Create account*.
3. Receive a registration email that contains a confirmation link.
4. Click the link or copy it to your browser to confirm your registration and go straight to your *my.artec3d* account.

4.3 Scanner Activation

Before using your new Artec 3D scanner, you must activate it and link it to an account at *my.artec3d*. You can do so with the help of Artec Installation Center—a standalone utility available for download from *my.artec3d*. If you're a new user and don't yet have Artec Installation Center, please read *Running Artec Installation Center* below. Otherwise, proceed to *3D Scanner Activation Using Artec Installation Center*.

Warning: Do not connect your scanner to the USB port before installing Artec Installation Center.

4.3.1 Running Artec Installation Center

To use Artec Installation Center, first ensure that your computer is connected to Internet. Any computer with USB2.0 or USB3.0 ports will work. If necessary, you will be able to install and activate Artec Studio on a separate computer later. Also make sure that you already have a *my.artec3d* account; if not, see *User Account*.

1. Log into your *my.artec3d* account and download Artec Installation Center. The link for the Artec Installation Center executable is available in the *My software* section.
2. After downloading, open the folder that contains the executable and run it. Follow the instructions on the installation screens. Once Artec Installation Center is installed, you will see a dialog requesting your email address and password. Use your *my.artec3d* account to log in as Figure 18 shows.

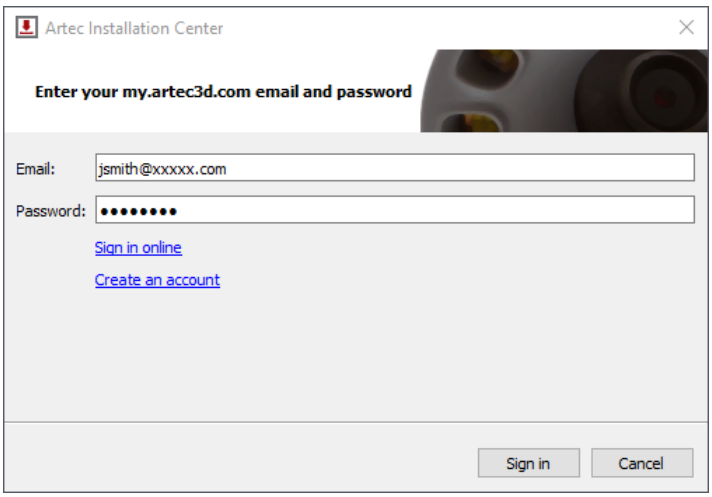


Figure 18: Authentication for Artec Installation Center

4.3.1.1 Logging Out and Switching Accounts

You may need to change *my.artec3d* account. Artec Installation Center displays the current user email in the top-right corner (Figure 35).

To log out of Artec Installation Center:

1. Click *Log out*.
2. Enter another user's email and password in the window that opens.
3. Click *Sign in*.

4.3.2 3D Scanner Activation Using Artec Installation Center

To activate a 3D scanner using Artec Installation Center, make sure your computer is connected to the Internet and that you have installed the application.

1. Run Artec Installation Center (go to the Start menu: click *Start* → *All Programs* → *Artec Group* → *Artec Installation Center*) to bring up the window shown in Figure 35.
2. Connect your new Artec 3D scanner to the computer and wait until Windows detects the device and installs the necessary drivers. You may see a notification similar to one shown in Figure 19.
3. Go to Artec Installation Center, click *Refresh* and wait for the new 3D scanner to appear in the hardware box. Click *Activate* (to the right of the serial number) to enable your 3D scanner. The status of the device should change to *Activated*, as Figure 20 shows.

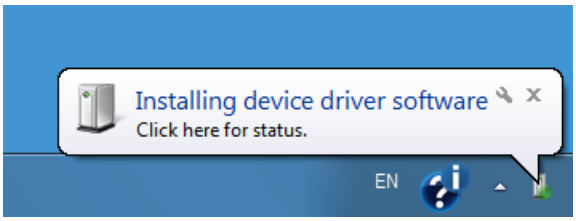


Figure 19: Windows notification indicating device installation.

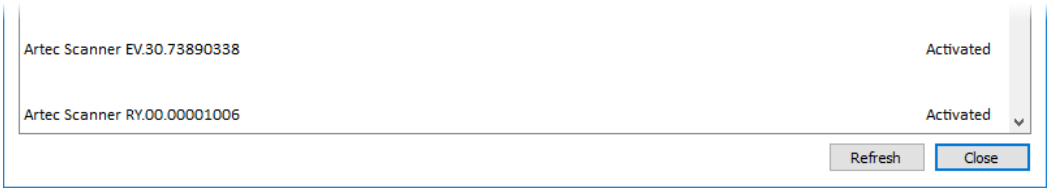


Figure 20: 3D scanner activated

4.4 Artec Studio Installation

There are two ways to download and install Artec Studio:

- Through Artec Installation Center (either during the installation process or by clicking *Install* in the application, as Figure 21 shows)
- From *my.artec3d*—log into the site, go to the *My software* page and download the executable (see Figure 22)

If you download the executable, run it to begin installation; otherwise, click *Install* in Artec Installation Center. To continue with the installation, click *Next* and proceed to the license agreement (see Figure 23). After reviewing the agreement, accept it by clicking *Yes*.

Specify the path to the installation folder (we recommend using the default location) as Figure 24 shows, then select the components you would like to install (see Figure 25):

Figure 21: Artec Installation Center is ready to install Artec Studio.

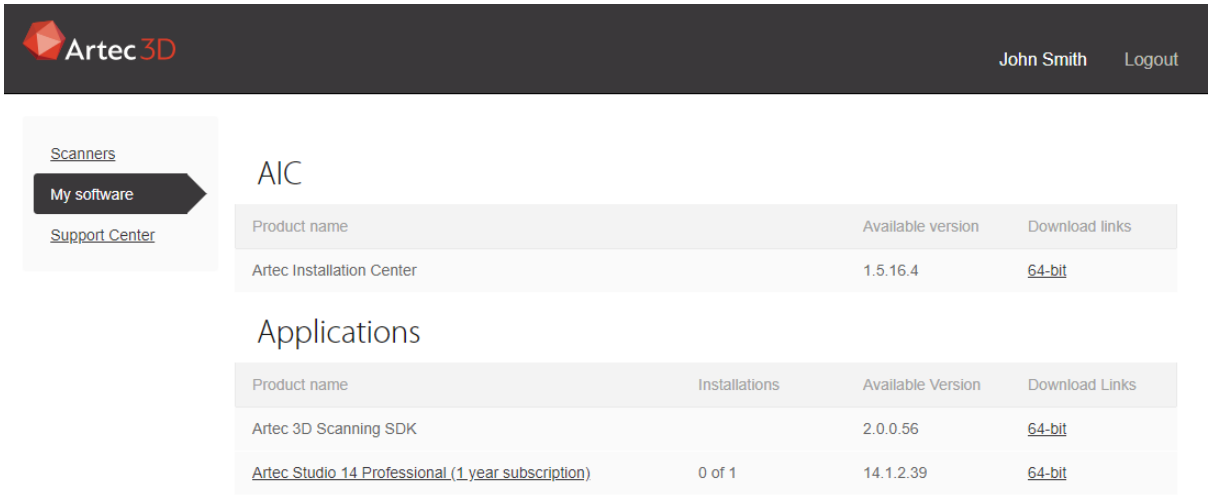


Figure 22: Portion of *My software* page at *my.artec3d*.

Figure 23: License agreement

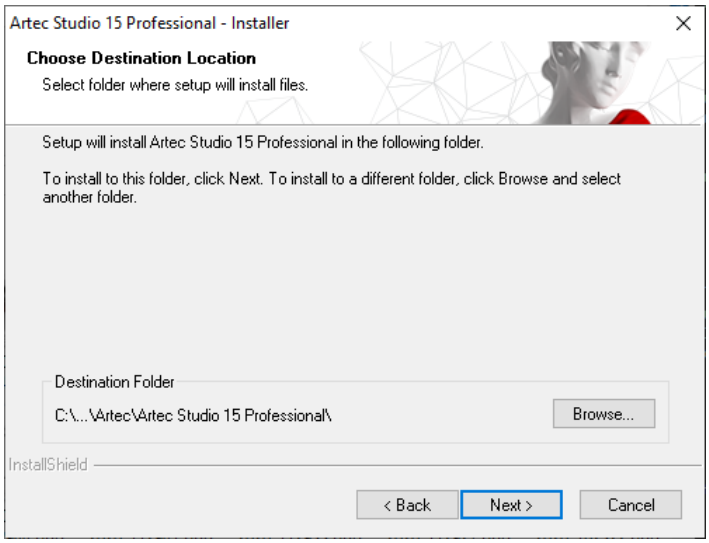


Figure 24: Installation location

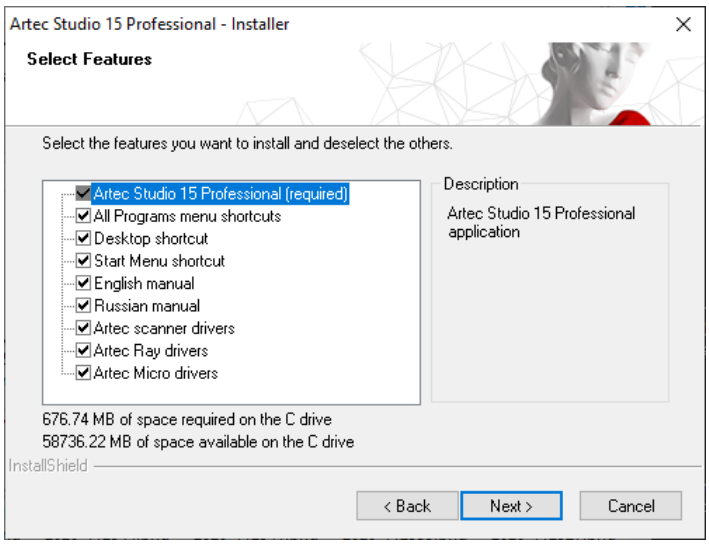


Figure 25: Select components to install

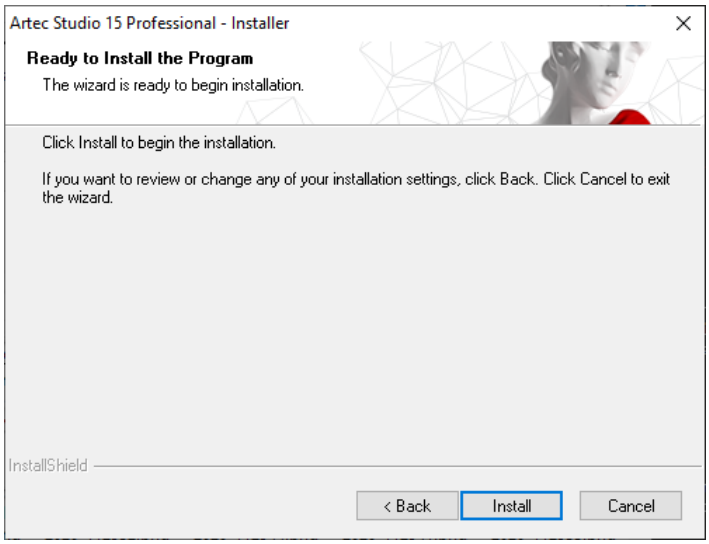


Figure 26: Click *Install* to begin the installation

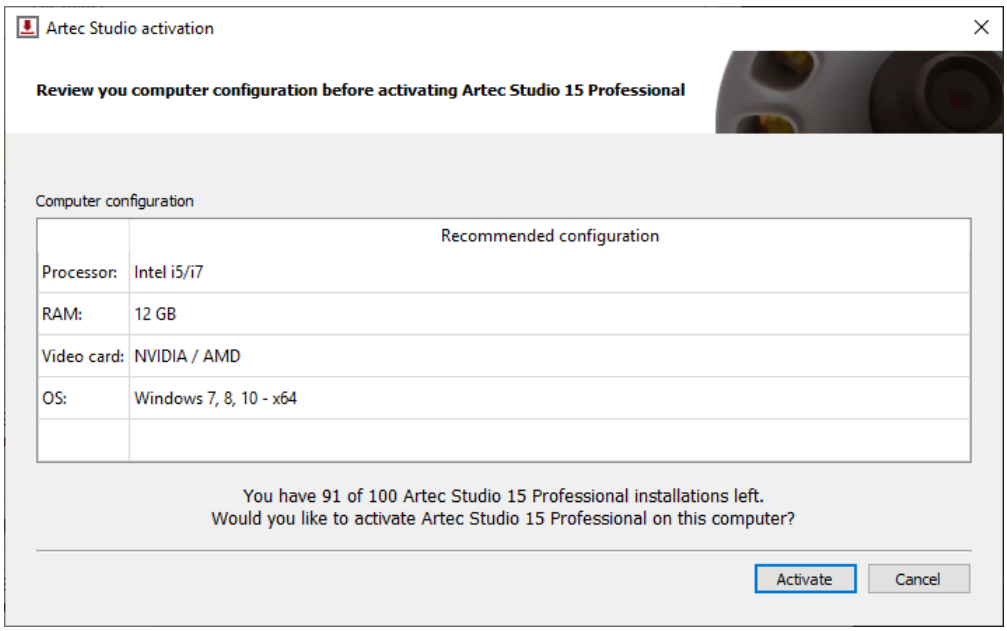


Figure 27: Artec Installation Center showing Artec Studio activation window

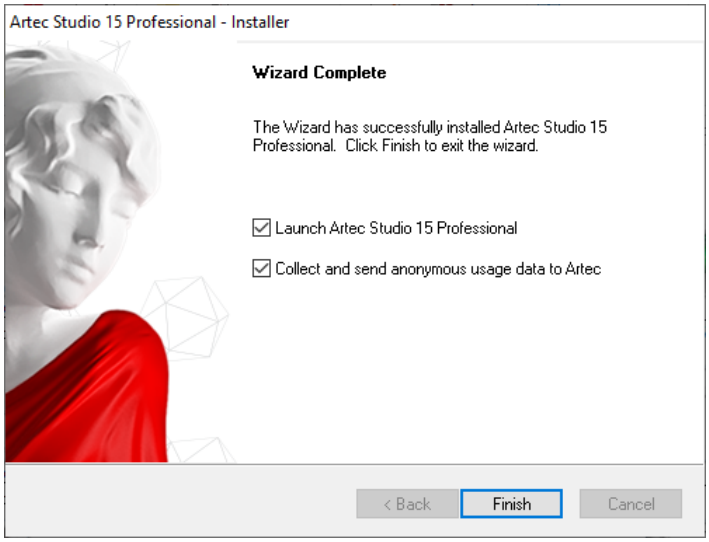


Figure 28: Finish installation

Program-menu shortcuts create icon in the Start menu

Desktop shortcut create icon on the desktop

Start-menu shortcut add shortcuts to the Start menu and Quick Launch panel

English manual install user manual in English

Artec scanner drivers install drivers for Artec 3D scanners

Artec Ray drivers install drivers for Artec Ray 3D scanner

Artec Micro drivers install drivers for Artec Micro 3D scanner

PrimeSense Carmine / Asus Xtion drivers install drivers for PrimeSense/Asus 3D sensors

Intel RealSense Runtime install drivers for Intel RealSense cameras

By default, the application will create all of the above icons and install the user manual and Artec 3D-scanner drivers. To continue with the installation, click *Next*.

If you have yet to install Artec Installation Center, a login dialog will appear, as Figure 18 shows. If you are not connected to the Internet, consult *Offline Activation* regarding offline activation of Artec Studio.

If you have yet to link to your account the computer on which you are installing Artec Studio, you will see the activation confirmation shown in Figure 26.

When the installation is complete (see Figure 27), the installer will offer to launch Artec Studio.

4.5 Offline Activation

If the computer on which you are installing Artec Studio lacks an Internet connection for security or other reasons, you may use the offline activation procedure to activate the software.

Note: Copies of Artec Studio activated offline cannot be deactivated, so use this option only if absolutely necessary.

Note: Before conducting offline activation, make sure the scanner (see *Scanner Activation*) and Artec Studio are tied to your *my.artec3d* account.

For offline activation, you need the following:

- Another computer connected to the Internet
- Artec Studio installation package (preferably, download it from *my.artec3d*)
- Flash drive or another storage medium to transfer files from the Internet-connected computer to the computer that will run Artec Studio

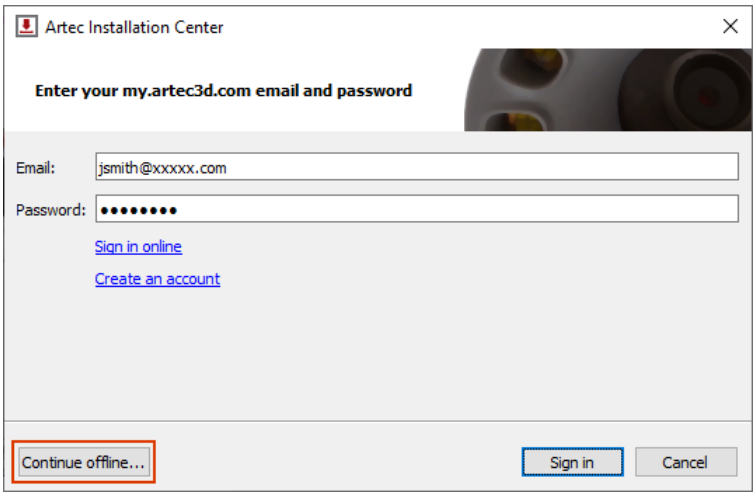


Figure 29: Artec Installation Center authentication dialog

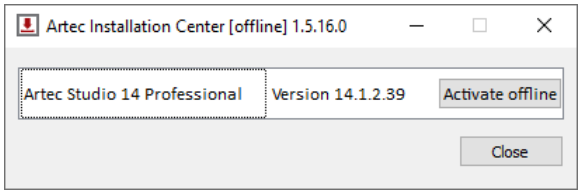


Figure 30: Artec Installation Center — Activate offline

Installation and activation procedure:

1. Start Artec Studio installation.

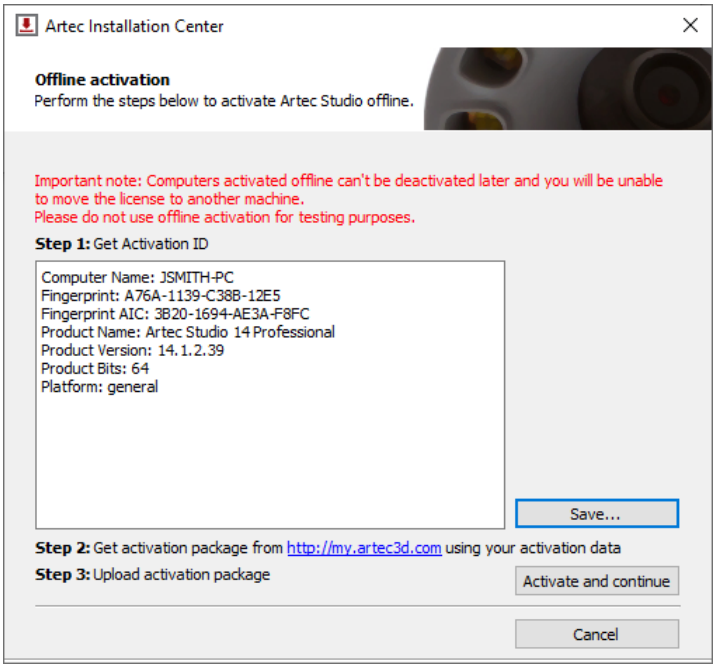


Figure 31: Offline-activation window

2. During installation the login/password dialog will be displayed as Figure 29 shows. Click *Continue offline...*.
3. Click the *Activate offline* button in the pop-up window.
4. In the offline-activation dialog (Figure 31), click *Save...* and save generated Activation ID file to a flash drive or other storage medium.
5. Log into your *my.artec3d* account and open *My software* page using the Internet-connected computer.
6. Find Artec Studio and click on it. A new page will appear, as Figure 32 shows.
7. Click the *Activate application offline* link then the *Select file* button and specify the Activation ID file path. Next, click *Activate*.
8. A new dialog will allow you to download an Offline Activation Data file; save it to the flash drive.
9. Return to the computer on which you are installing Artec Studio. Click *Activate and Continue* and specify the Offline Activation Data file.

Note: Once you create the Offline Activation Data File, *my.artec3d* will decrease the number of available activations by one.

Once you complete all the steps described above, your copy of Artec Studio will be activated and all of your Artec 3D scanners will be installed on the non-Internet-connected computer.

Note: If later you purchase another Artec 3D scanner, you must reinstall the application

Figure 32: Offline activation at *my.artec3d*.

and repeat the activation procedure described above to copy the new scanner's data files to your computer.

4.6 Deactivation

Note that deactivation is only possible for computers on which you activated Artec Studio online as *Artec Studio Installation* describes. Artec Studio installations activated offline cannot be deactivated.

Note: The number of deactivations may be limited, so deactivate Artec Studio only if you absolutely must move it from one computer to another.

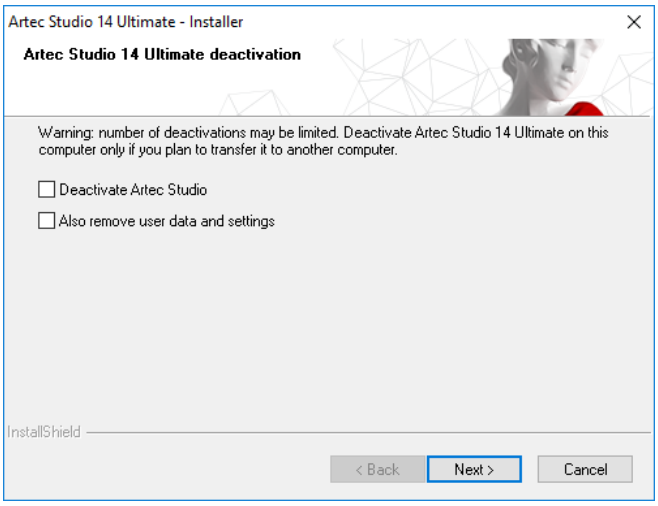


Figure 33: Deactivation of Artec Studio.

To deactivate a license on your computer, follow these steps:

1. Make sure the computer is connected to the Internet.

2. Go to *Control Panel* → *Uninstall Applications* and click on Artec Studio. The uninstallation process will start.
3. The dialog shown in Figure 33 will appear. Select the *I understand. Deactivate Artec Studio* checkbox.
4. Click *Next* to complete the uninstallation.

4.7 Managing Artec 3D Scanners and Products

Artec Installation Center manages applications and 3D scanners linked to your account.

It's a multifunctional supplement to Artec Studio that connects with *my.artec3d* and helps you install new applications, download updates and manage your 3D scanners. To launch Artec Studio for the first time, you must log into *my.artec3d*. After this one-time authentication, you need not provide your email address or password each time you launch the application.

When Artec Studio launches, Artec Installation Center checks for new updates; if an update is available for any installed product, the software will display a notification like the one shown in Figure 34.

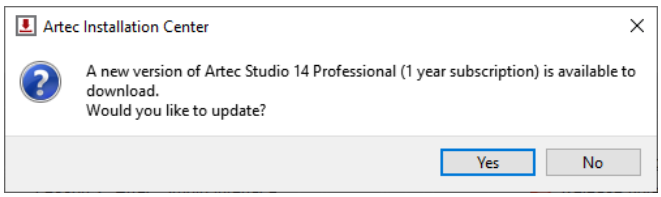


Figure 34: An Artec Studio update is available for download.

Once you log in, Artec Installation Center displays information about your products.

The *Software* section of Artec Installation Center provides all information about your software products:

- A list of all applications available to you
- Activation status of each application (application may or may not be activated)
- Total number of activations and number of activations you've used so far
- *Activate*, *Install* or *Update* buttons for any of these actions that are currently available to you
  - *Install*—appears if the software is not installed on the computer (installation usually means activation)
  - *Activate*—appears if the software is not currently activated on the computer. Activation decreases number of licenses by one for each computer.
  - *Update*—appears if a new version of installed software is available for download

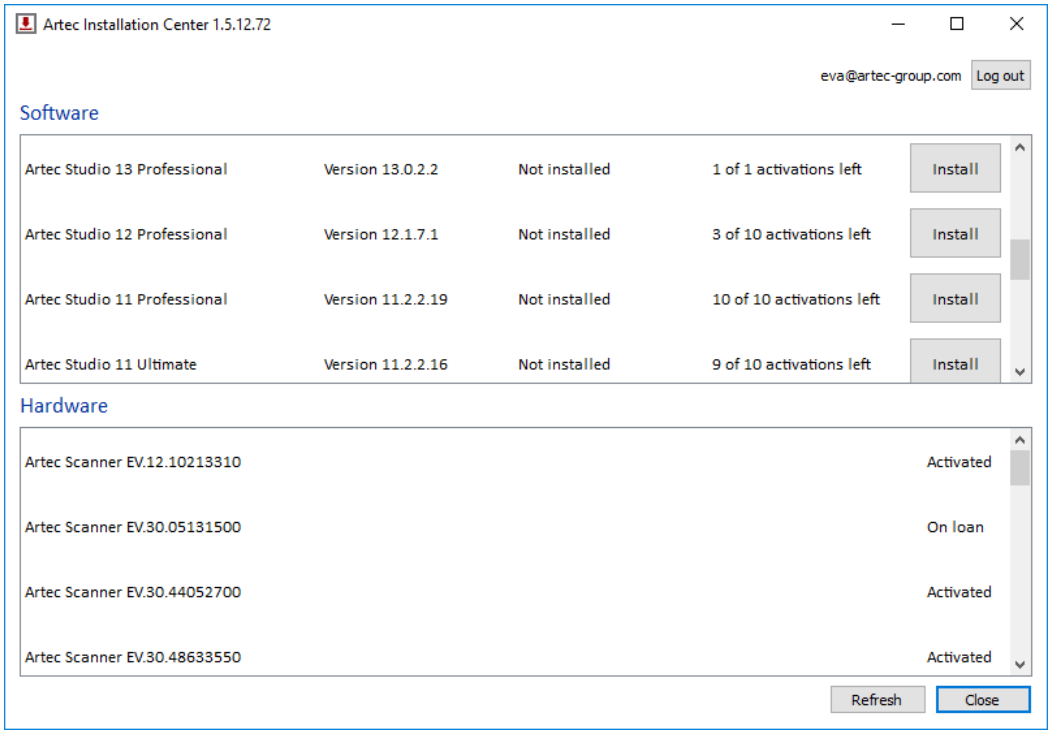


Figure 35: Artec Installation Center.

The *Hardware* section contains a list of the scanners that you own or have otherwise connected to your computer. For the first case, the *Activated* status or *Activate* button will be displayed, while in the second case, the *On loan* status or *Rent* button will be displayed.

A row of buttons appears at the bottom of the Artec Installation Center window:

Refresh —refresh the data displayed by Artec Installation Center

Close —exit Artec Installation Center

CHAPTER 5

Scanning

5.1 Scanner Buttons and Capture Modes

Your 3D scanner may be in one of the following capture modes (each of which has a corresponding color and flicker rate of the LED indicator on the device if you're using an Artec scanner):

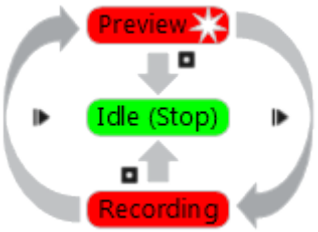


Figure 36: Understanding capture modes (colors correspond to scanner LED indicator colors).

Idle—the LED is steady green. This mode indicates either that the application has detected the scanner or that the user has clicked the *Stop* button in the *Scan* panel or pressed the ■ button on the scanner body (see Figure 12). In this case, the 3D scanner is not flashing.

Preview—the LED is flashing red. In this mode, the 3D scanner is capturing images, but the software is neither performing alignment nor recording captured frames. To start this process, either click the *Preview* button in the *Scan* panel (see Figure 50), press the ▶ button on the scanner body or hit the `F7` key on the keyboard. This mode is useful when doing the following:

1. Checking the 3D scanner's field of view

2. Determining the best position for the object
3. Preparing to recording and developing a scan procedure
4. Adjusting texture brightness

Recording—the LED is steady red Scanning takes place in this mode, with the software storing 3D data to disk or RAM. Activate this mode either by clicking the *Record* button in the *Scan* panel, hitting the `Space` key on the keyboard or pressing the ▶ button (do so once for *Preview* and a second time for *Recording*). To pause recording, either click *Pause* in the *Scan* panel, press ▶ on the scanner body or hit the `Space` key.

5.2 Selecting and Preparing Objects for Scanning

Artec 3D scanners employ the structured-light method of 3D reconstruction. Since they capture 3D frames using optical technology, some types of objects are difficult to scan. Certain techniques, however, enable successful scanning of such objects. For example, you can cover a transparent or dark object with a light paint or dust it with talcum powder. You can also use other easily removable substances or a special anti-glare spray.

Table 1: Hard-to-scan Surfaces

Surface Features	Possible Solutions
Black or very dark	Dust with anti-glare spray
Shiny or reflective objects	Dust with anti-glare spray, tilt scanner when capturing
Transparent (glass, certain kinds of plastic, etc.)	Dust with anti-glare spray
Thin edges	Add background geometry (e.g., crumpled paper)

Note: If your scanner supports the HD mode, then you can capture dark or shiny surfaces in high resolution, in their original shape and with no extra steps. See *HD Scanning and HD Reconstruction* for details.

5.3 Technique

Artec 3D scanners capture objects at a rate of 15 frames per second to ensure that adjacent frame areas overlap as you gradually move the scanner. Artec Studio uses features in overlapping areas to automatically align captured frames. It performs this task in real time, providing immediate access to the frames in a single coordinate system. You can evaluate the captured area after the scanning session to determine which parts of the object require additional scanning.

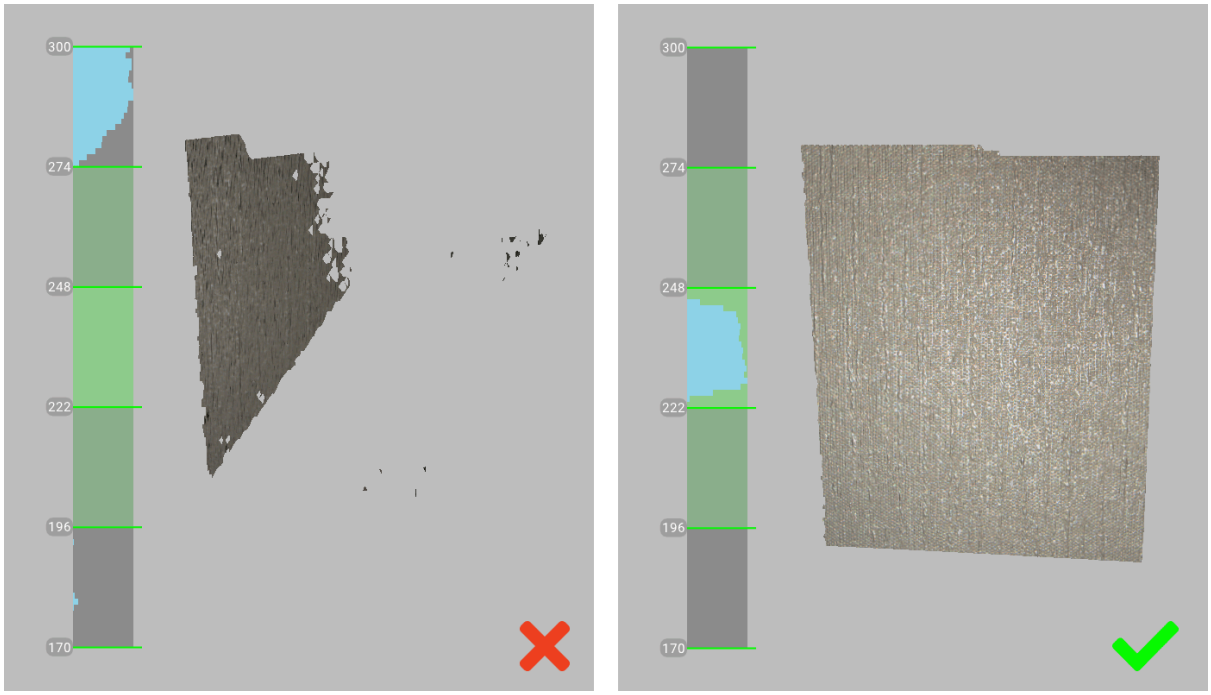


Figure 37: Scanner orientation and reconstructed surfaces.

To accurately capture an object or scene, follow these steps:

1. Pay closer attention to the object on the screen rather than looking at the actual object.
2. Ensure that Artec Studio can accurately register frames from the scanner. To this end, do the following:
    - Don't move the scanner too fast
    - Keep the object as close to the center of the field of view as possible
    - Maintain the scanner orientation in such a way that the field of view is sufficiently filled with surfaces (see Figure 37)
    - Try to position the scanner in the way the most surfaces in the field of view are colored in green which corresponds to the center of the range meter[1] (Figure 38)
3. If you're capturing an object over several scans, remember to capture a common area in each one to ensure successful alignment
4. If you're capturing an object in one scan, do so all the way around the object—regardless of direction—plus a little more (360+ degrees)

[1] Technically, the center of the range meter is the center of the depth of view. The 3D scanner has near and far cutting planes (see Figure 11) that determine the optimum distance between the scanner and the target object. Artec Studio offers the *Range meter* feature so you can easily visualize the distance between the scanner and the object during the recording process. The *Range meter* comprises a set of semitransparent diagrams located on the left side of the *3D View* window (see Figure 38). Each histogram displays the distribution of captured surface points by distance from the scanner. The color corresponds to the set of surfaces from which it was obtained: by default, gray indicates registered key frames, dark green indicates the last successfully registered frame and red indicates a registration error.

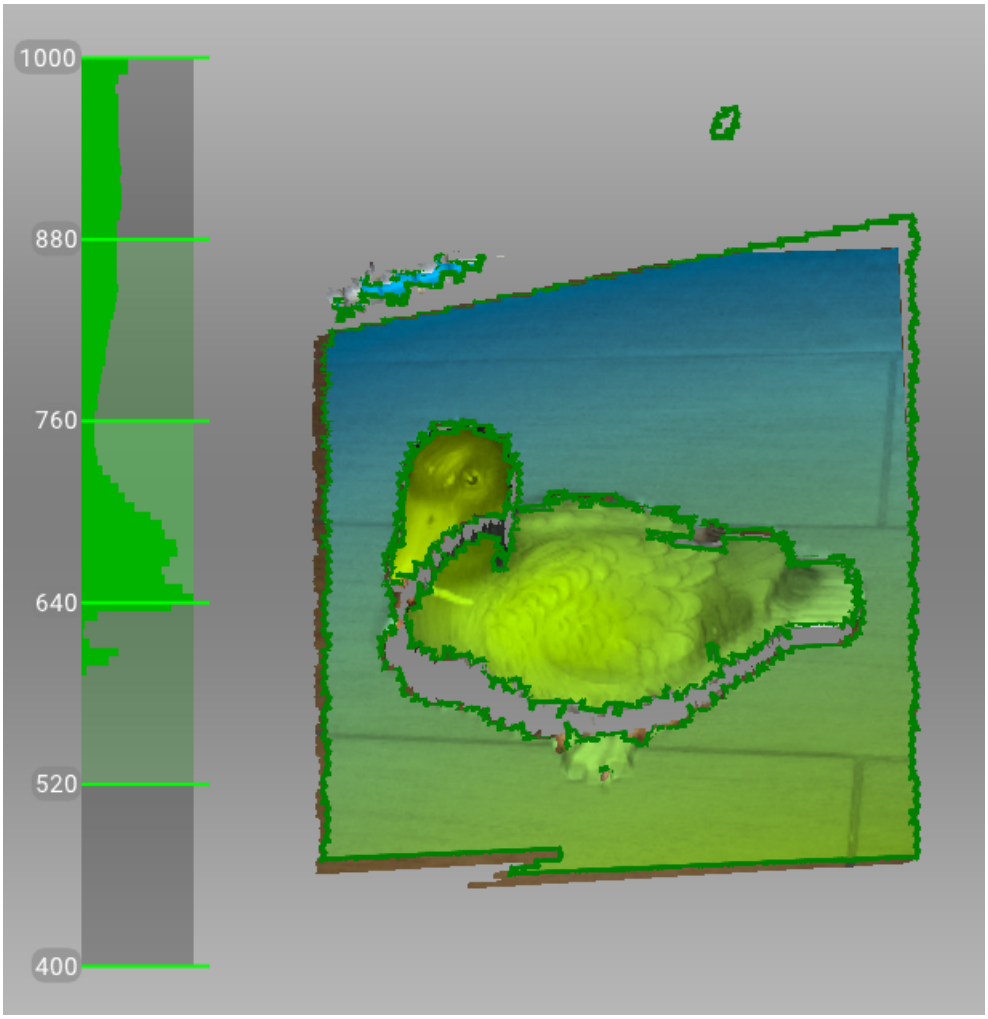


Figure 38: Distance meter and distance color showing surfaces that fall within the optimal range for Artec EVA.

5. Avoid capturing any objects that may change shape during the scanning process. When the geometry of the scene is changing, the system may fail to find the correct position of new frames relative to previously aligned ones. If you have captured unwanted objects, you must remove them later during the editing stage (see *Editing Scans*).
6. Don't record too many frames: ensure that you have sufficiently scanned all regions, but avoid scanning them twice, except when providing overlapping areas for subsequent alignment.

5.4 Scanning Procedure

Ins and Outs

- Artec Studio creates a new scan in the *Workspace* panel at the beginning of each session.
- When you start *Preview* mode, Artec Studio will hide all uploaded scans. This mode helps you to determine how well the 3D scanner sees the object, and it helps you to identify areas that may cause trouble during the scanning session. To begin the scanning process, click the *Record* button in the *Scan* panel or press the ▶ button on the device body.
- If your 3D scanner is equipped with a texture camera, Artec Studio will activate the scanner's texture flash and capture color images that it will later use to texture the 3D model.

1. Prepare the object and make sure it has enough geometry and texture details (see *Selecting and Preparing Objects for Scanning*).
2. Provide even lighting without using direct sunlight.
3. If you have connected just one 3D scanner to the computer, Artec Studio will select it automatically; otherwise, you must select the appropriate device from the dropdown list under the *Advanced* section of the *Scan* panel.
4. If your selected 3D scanner supports the HD mode (such as Artec EVA) and you want to get the scanned images in high-definition resolution, you need to select the *Use HD reconstruction* checkbox (see *Enabling HD Mode* for details).
5. Create a new project before getting started: select *File* → *New project* from the menu, or use the shortcut `Ctrl + N`. Once you have saved the project, you will be able to load or unload the scans as necessary and thereby limit RAM usage (see *Projects, Scans and Models* for details).
6. Decide how many sessions you need in order to capture the entire object. By using a special third-party rotating table, you may be able to avoid interrupting the session and eliminate the need to turn the object by hand. Depending on your choice, you may

- Turn the object
- Position yourself to gain access to the other area
- Use a rotating table

7. Click *Preview* or press ▶ on the scanner. Direct the scanner at the object and practice your movements around the object, taking into account the proper *Technique*.

> **Note:** If you have checked the *Enable automatic base removal* option (it is disabled by default), then first direct the scanner at the surface that supports the object.

8. Click *Record* to start capturing.
9. Gradually move the scanner while monitoring the process in the *3D View* window
10. Capture what you can and pause or cease recording by clicking the *Pause* or *Stop* button, respectively. Choose *Stop* if you must make adjustments to the object's positioning (see the next step).
11. Turn the object or otherwise adjust it as necessary, then capture any remaining unscanned regions.
12. Once you have successfully captured the object from all sides, click the *Stop* button or press ■ on the scanner body.

5.5 HD Scanning and HD Reconstruction

While all Artec scanners can scan 3D objects in the standard-definition (SD) resolution, Artec EVA and Artec Leo also support an HD mode — AI-powered scanning technology for ultra-sharp, clean, and detail-rich scans.

Key advantages of the HD mode:

- Scanning with a high resolution of up to 0.2 mm
- Broad range of objects that can be scanned flawlessly and in high detail: from smaller, intricate parts like valve handles, to larger areas with fine details like car engines
- Little to no noise in raw data for cleaner post-processed data and saved time for your final 3D model
- Capability to capture dark or shiny surfaces in high resolution, in their original shape and with no extra steps

To obtain HD scans from the data captured in the HD mode, Artec Studio provides you a special algorithm of HD data processing — HD reconstruction. This algorithm generates large, high definition frames with more details to give you complete surface geometry.

In general, the HD reconstruction is a time-consuming and resource-intensive operation. It requires:

- Powerful Nvidia video card
- Sufficiently large RAM

However, you can optimize the HD reconstruction by properly choosing its main parameter — *HD data density*, which determines the number of polygons per frame used for data processing. See *Enabling HD Mode* for details.

Important: To obtain HD scans with your 3D scanners, the HD mode should be enabled in advance, before scanning or importing the HD data.

To find out more on the HD scanning and HD reconstruction with Artec EVA, see *Notes on HD Scanning With Eva*.

Setting the HD mode for Artec Leo is described in the Artec Leo manual. For information on importing the HD data from Artec Leo, see *Opening a Project from Leo*.

5.6 Tracking Modes

Ins and Outs

- Artec Studio still records texture in *Geometry* tracking mode if the scanner incorporates a texture camera
- Continuous scanning in the hybrid tracking mode is easier with the *Scan using auto-alignment* option.

The software provides three *tracking* modes and one option:

***Geometry* + *Texture*, or hybrid** The optimal (and default) algorithm for 3D scanners equipped with a texture camera. It uses features from images obtained using the texture camera as well as geometrical features of the object and thus is more likely to successfully capture flat or textureless objects. The only possible drawback is greater CPU utilization compared with other algorithms, potentially decreasing the frame rate for less powerful computers. You can use this mode with Artec MHT, Artec EVA, Artec Spider and third-party 3D scanners.

Geometry The default algorithm for all 3D scanners that lack a texture camera (Artec EVA Lite). It uses only object geometry to align the scanned frames, making it suitable for objects that have a rich geometry but not objects with large flat, spherical or cylindrical parts. The Geometry tracking algorithm is the least CPU hungry.

Targets A special algorithm for scanning objects with special targets placed on their surfaces.

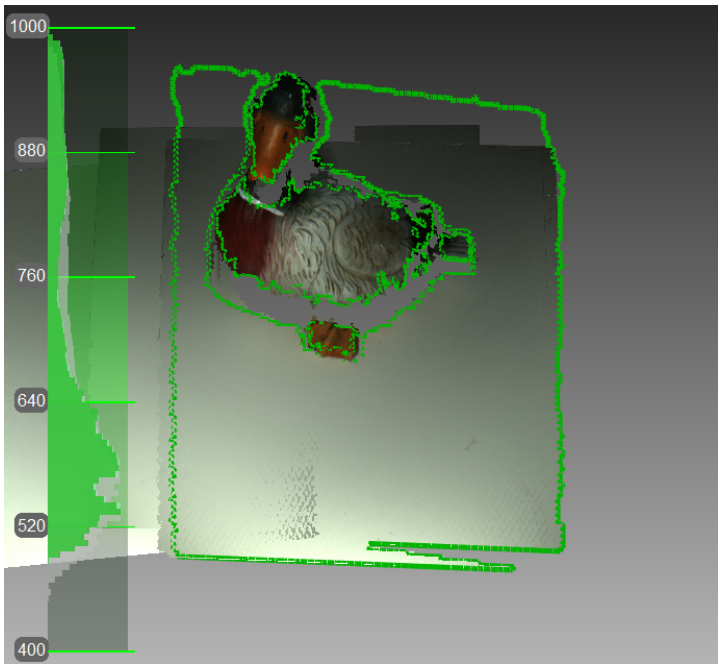


Figure 39: Texture tracking renders color object (scanner's current field of view outlined in green).

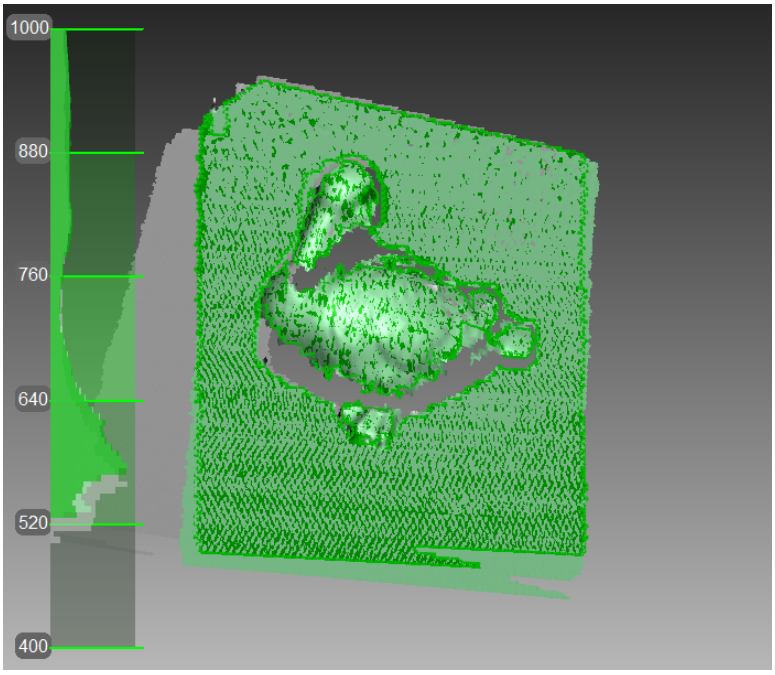


Figure 40: Main window when using Geometry tracking to scan objects.

***Real-time fusion* (option)** Available for both Artec 3D scanners and third-party 3D sensors, this option fuses the results immediately after scanning.

See also:

Tweaking Scanning Options

5.6.1 Base Removal: Erasing a Supporting Surface

Ins and Outs

- Base removal is available for all tracking modes.
- If you click *Stop* or press ◘, you should again identify the supporting surface.
- If the scene remains unchanged, you can also use the *Auto-align new scans with those marked in Workspace* option. In this case, the application won't prompt you to identify the base.
- If base detection is successful, the base will always render in *Recording* mode.

When you capture an object, you can often omit from the scan any surface that supports the object. The *Base removal* option serves this purpose. To employ this option, first indicate the surface on which the object is resting and then capture the object. If this approach is unsuitable for your situation, clear the *Enable automatic base removal* checkbox.

1. Open the *Scan* panel.
2. Check the *Enable automatic base removal* option (it is disabled by default).
3. Click *Preview* and direct your scanner at the surface that supports object (e.g., a table or the floor). A gray wireframe plane will appear, indicating the scene's base.
4. Once the application detects the base, it will display a message: "Now scan the object."

> **Important:** If Artec Studio fails to detect a supporting surface, you can still start recording.

5. Click *Record* (▮▶) and then direct the scanner at the object.
6. Scan the object freely. You can pause and resume the session as necessary.
7. Click *Stop*; all scans will move to the coordinate system with the Z axis normal to the base.
8. Close the *Scan* panel. The *Base removal* algorithm will remove the previously detected supporting surface. If not, *erase it manually*.

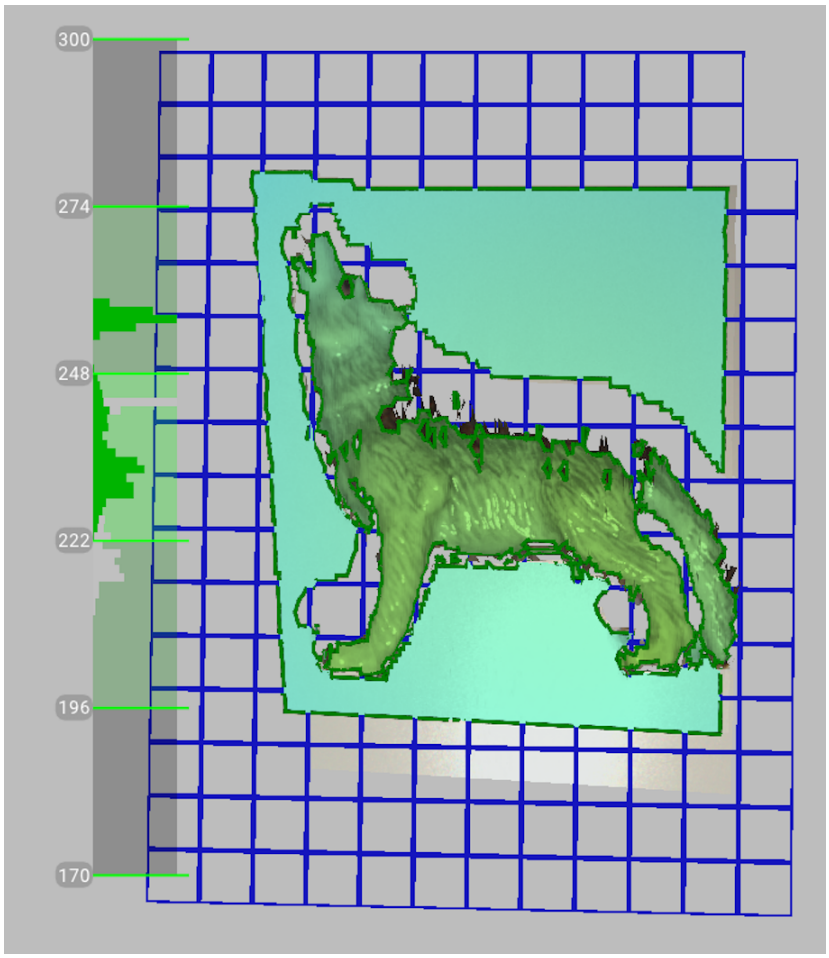


Figure 41: Scanning with the *Enable automatic base removal* option.

5.6.2 Resuming Scan After Lost Tracking

Artec Studio records adjacent frames on the basis of common surface features. If the scanner stops recognizing common features, it will stop capturing the scene. This situation is called lost tracking; if it happens, just direct the scanner at a recently captured region. There are, however, nuances, which we address below.

Table 2 lists several causes of lost tracking. The most common is moving the scanner too fast.

Table 2: Causes of lost tracking.

Reason	Possible Solutions
Moving the scanner too fast	Move the scanner more slowly or increase the *Scanning speed*
Scanner sees too few surfaces	Apply an anti-glare spray or direct the scanner at a larger part of the object; increase *Sensitivity* of Artec Spider
Object doesn't have enough features for successful tracking	Apply masking tape or draw markers on the surrounding surfaces, and/or move the scanner more slowly

The *Scan using auto-alignment* option may ease the process of resuming tracking (this option is enabled by default in the application settings). Note the following:

- Artec Studio switches almost instantly from displaying *Tracking lost* mode (see Figure 42) to *Searching for position*, which appears on a green background.
- To continue scanning, direct the scanner at a region you've already captured.
  - Try to maintain the original scanner orientation toward this region
  - You need not necessarily use the most recent one, but it should have sufficient texture features.
- If the application successfully resumes tracking, it will start recording in a newly created scan. This new scan will already be aligned with the previous one. All the scans will also be grouped.

The *Scan Using Auto-Alignment* section describes system behavior when this option is disabled.

5.6.3 Auto-align new scans with those marked in Workspace

Auto-alignment is a great timesaver and may help simplify further processing. But for projects that involve scans using *Geometry + Texture tracking* and for which the actual scene is unchanged, you can continue scanning immediately:

1. Ensure that the *Scan using auto-alignment* option is turned *on* in *Settings* (see *Capture*).
2. Mark previously captured scans using the ✔ icon in the *Workspace* panel.

Figure 42: Alert message: tracking lost.

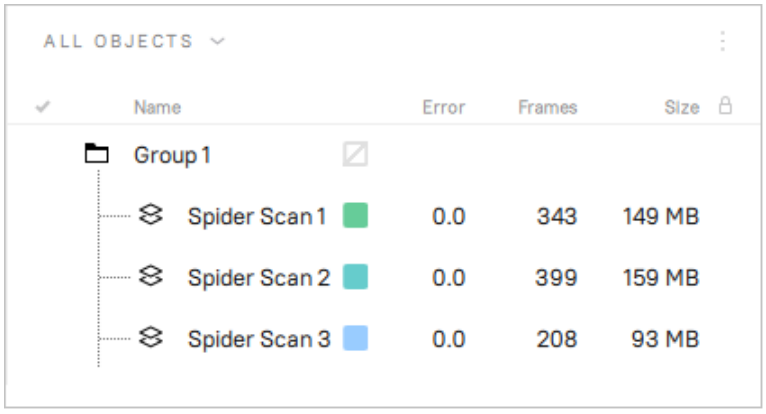


Figure 43: *Workspace* panel after resuming tracking.

3. Select *Geometry + Texture tracking* as well as the *Auto-align new scans with those marked in Workspace* checkbox in the *Scan* panel.
4. Click *Preview*, direct the scanner at a textured region you've already captured textured region—maintaining the original scanner orientation—and then click *Record*.
5. If tracking resumes successfully, Artec Studio will align the newly recorded scan with the selected ones.

5.6.4 Scanning With Real-Time Fusion

Real-time fusion is a special mode in which Artec Studio builds a 3D model in real time while you're scanning. It's the easiest and fastest way to obtain a model, but it cannot completely replace the normal workflow for processing raw scans after capturing them. Thus, we recommend avoiding *Real-time fusion* in the following cases:

- The scene is large and the amount of GPU memory is limited
- Objects have complicated shapes that cannot be captured in one scan session
- The object has small geometric details
- Extra-high accuracy is required

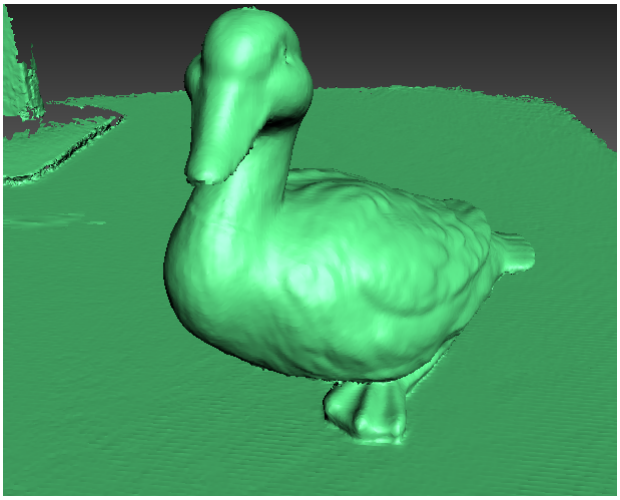


Figure 44: Real-time fusion model.

The *Real-time fusion* feature is available for each tracking method.

1. Open the *Scan panel*.
2. Select the required tracking mode.
3. Select the *Real-time fusion* checkbox[2].
4. Click *Preview* and then *Record*. Observe the recommendations in *Scanning Procedure*.

[2] If you selected the *Targets* mode and cleared the *Disable hybrid tracking for .obc* checkbox (see the *Photogrammetry Settings* section), Artec Studio will clear the *Real-time fusion* checkbox because it doesn't support this combination of options.

5. Pause and resume the session as necessary.
6. When you stop scanning, the *Workspace* panel will add one or more raw scans named `Spider Scan1`, `Spider Scan2`, `Spider Scan3` and so on, as well as one model named `Spider Scan1-Fusion`. The number of these raw scans corresponds to how many times you pause and resume scanning (see Figure 45).

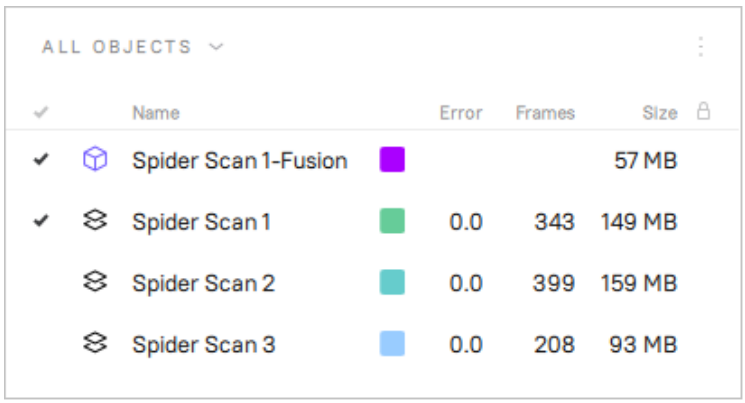


Figure 45: *Workspace* panel after using Real-time fusion.

You can access the *Settings* window and use the *Performance* tab to configure the following *Real-time fusion* settings (see *Real-Time Fusion Settings*):

Voxel size 3D resolution of the model (i.e., the size of the triangulation-grid step in millimeters). The smaller the value, the more geometric details you can detect and capture in 3D.

5.6.5 Target-Assisted Scanning

Generally, you don't need any special equipment to record using an Artec scanner. If the object has hard-to-scan regions, however, *targets* may be useful. In some cases, they can improve tracking and further registration.

5.6.5.1 Placing Targets

Whatever the method chosen, you should place at least non-coded *targets* on the object.

Attach non-coded targets (Figure 46) to the object using the following rules:

- Try to place them on flat elements
- Avoid uneven surfaces
- Avoid obstructing significant geometric elements

Note: You can specify the target size in the *Settings* dialog of Artec Studio, as *Photogrammetry Settings* describes. If you use non-coded targets from the *Scan Reference* kit, specify `5` mm for the inner diameter and `10` mm for the outer diameter. You should measure

Figure 46: Non-coded targets placed on an object.

targets from other suppliers and specify both diameters in the appropriate fields of the *Settings* dialog.

Place coded targets if your choice is photogrammetry (*Using Photogrammetry Solution (Scan Reference)*).

1. Prepare the objects and surrounding scene. All objects must remain stationary during measurement and capture.
2. Place the cross (Figure 48) on the scene, ensuring that it rests firmly, and it is seen from most points of view. Also double check that all targets on the cross are clearly visible.
3. Place the coded targets on the object and the surroundings. Note that you should distribute them such that at least six to eight coded targets are visible in each image. Random placement is preferable; avoid symmetry and target alignment.

Figure 47: Coded targets.

5.6.5.2 Using Artec Scanners Only

You don't necessarily need a photogrammetry kit to benefit from targets placed on the object you're scanning; Artec 3D scanners can do all the work. This mode employs extra-hybrid (Geometry + Texture + Targets) tracking and doesn't require you to upload an `OBC` file.

1. Open the *Scan* panel in Artec Studio. Select *Targets* under *Features to track*.
2. Scan the object from all sides
3. Run *Global registration*

Note: As you scan (without having uploaded an OBC file), the application registers the target coordinates. You can then *save an OBC file* and use it in later scanning sessions. We strongly recommend running *Global registration* first, however.

5.6.5.3 Using Photogrammetry Solution (Scan Reference)

By using a combination of special reference *targets* and photogrammetric measurements, you can scan large areas in one session, improve the accuracy of captured surfaces and boost productivity by reducing postprocessing time. The only downside of this method is the preparation. After scanning, however, you need not align the scanned surfaces, so you can immediately proceed to *Fusion* (see the order of postprocessing steps in *3D Scanning at a Glance*).

This synergy of technologies is possible thanks to Artec 3D-scanner and photogrammetry solutions. Several third-party photogrammetry offerings are available on the market. *Scan Reference* photogrammetry is one example. The *Scan Reference* kit includes hardware and software (see Figure 48), a digital camera, a reference-scale cross, non-coded sticky *targets* (which Artec Studio uses to match the captured 3D data to the photogrammetric measurements), and reusable magnetic coded targets (required to automatically carry out measurements in the *Scan Reference* software).

Figure 48: *Scan Reference* kit
The kit includes (from left to right) coded targets (foreground), a digital camera, a scale cross, a roll of tape with non-coded targets and a carry case.

To perform scanning using targets, follow these steps:

1. Take several photos of the object from different angles. To determine the appropriate number of photos, angles and targets for each image, as well as required settings for a calibrated digital camera, consult the *Scan Reference* user manual and FAQ article. General recommendations are as follows:

    a) Take photographs at a distance of 0.5–1.5 meters with enabled flash

b) Each photograph should contain as much targets as possible and each target should be captured at least in 10 photos

c) Entire cross should be captured in first 10–12 photographs

d) Capture the object from all sides

2. Move the cross and the coded targets away from the scene.
3. Connect the camera to a PC, then transfer and process the photos using the *Scan Reference* software. Once the calculations are complete, the software will display measurement results on the screen. These results can appear as a point table or a 3D model.
4. Save the point model in an `*.obc` file. This format is the software's default.
5. Open the *Scan* panel in Artec Studio. Select *Targets* under *Features to track*.
6. Click *Load targets from file* and specify the `OBC` file path.
7. Scan the object. When you finish, the software will align all scans.

Important: If you don't want the texture and geometry features to assist target scanning, select the *Disable hybrid tracking for .obc* checkbox (*Photogrammetry Settings*).

5.7 Using Certain Scanner Types

5.7.1 Notes on Scanning With Spider

Because Artec Spider has smaller field of view and provides higher accuracy in comparison with Artec EVA, scanning using it can pose difficulties. Consider the recommendations given in *Technique* and also the following:

- Opt for rotating table if possible
- Use a piece of paper with text on it as artificial texture
- Double check that objects don't change their shape and position
- Try tuning sensitivity in particular cases (see *Sensitivity*). Avoid extreme values.

We recommend using the Artec Spider scanner only after it reaches its normal operating temperature. As soon as you plug Artec Spider in or connect it to a PC, it starts warming up. If you open the *Scan* panel, you will see two lines that provide the device's current and optimal temperatures. Artec Spider will warm up faster when it's in *Preview* mode. The *Scan* panel also displays additional information about the time remaining until the scanner reaches its optimal temperature.

Note: Artec Spider can operate at temperatures beyond its optimal range, but the accuracy of captured surfaces may be lower.

5.7.2 Notes on Scanning With Third-Party 3D Sensors

Important: Support for third-party 3D sensors is only available in Artec Studio Ultimate 13 and older.

Third-party 3D sensors are not specifically designed to serve as 3D scanners. Because they are multipurpose devices made from inexpensive components, they can scan objects, but the texture and surface quality is far worse than that of professional Artec 3D scanners (see Figure 49).

When using third-party 3D sensors, bear in mind the following:

Providing good lighting is critical because none of the sensors offers built-in flash. Also, use of these devices precludes the ability to adjust the brightness of the texture you are scanning, so good lighting is crucial to obtaining a decent model. Avoid using too much illumination, and avoid using direct light or fluorescent lamps. Intel RealSense R200 is particularly sensitive to direct sunlight.

When using PrimeSense and Asus Xtion sensors, a special technique can help you capture surfaces with consistent brightness:

1. Click the *Preview* button
2. Direct the sensor at the object and hold it for 5 seconds while the sensor adjusts white balance and exposure
3. Click the *Record* button
4. Move the scanner slowly to capture the scene
5. While scanning, keep the sensor as close to the object as possible

Most third-party devices work in the Real-time fusion mode, except for *Kinect v2*. Moreover, this mode is default for Intel RealSense 3D sensors.

5.7.3 Notes on Scanning With MHT

The flash feature in an Artec MHT scanner has a very large but limited number of operation cycles, so ensure that you disable the scanner when it's not in use. Avoid leaving the Artec MHT on for a long time when using the maximum capture rate (15 frames per second). Artec Studio will automatically turn off the Artec MHT after five minutes of continuous operation. Normally the active mode/rest mode is 3 minutes of scanning and 7 minutes of rest; this mode is optimal and significantly increases the lifetime of the flash.

5.7.4 Notes on HD Scanning With Eva

To obtain a scan of high-definition resolution with the Artec EVA scanner, it should be connected to a computer with a powerful Nvidia video card and sufficiently large RAM.

The HD mode must be turned on before scanning. To do this:

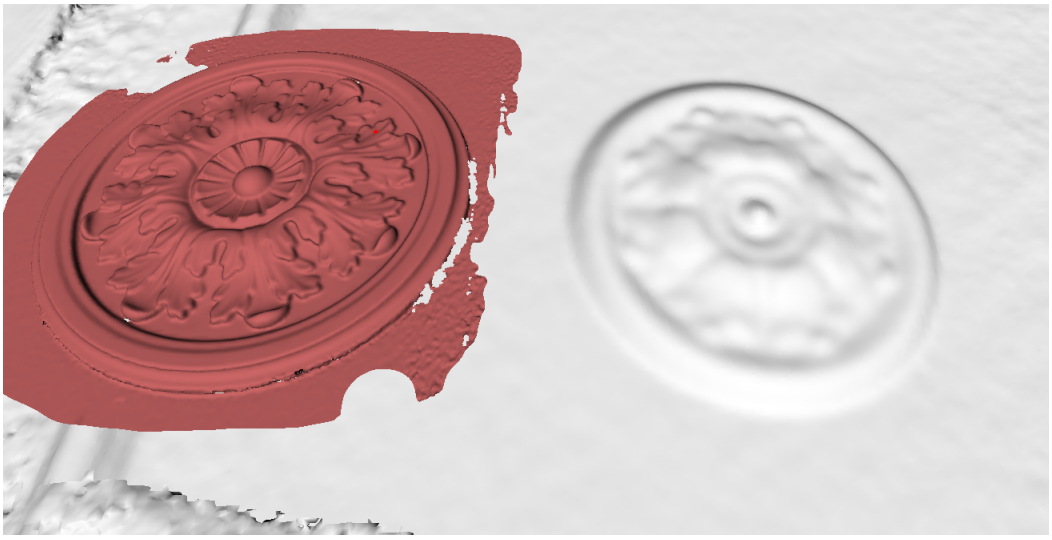


Figure 49: Object captured and processed
(Artec EVA scan on left and *PrimeSense* on right).

1. Check *Use HD reconstruction*.
2. Select the appropriate *HD data density* in the range from 1× to 36× using the eponymous slider (to find out more on the *HD data density*, see *Enabling HD Mode*).

Important: The HD reconstruction is a time-consuming and resource-intensive operation. If Artec Studio evaluates your computer's resources as insufficient for the selected *HD data density*, then the warning is displayed that the HD reconstruction can take up to several hours on your computer. For information on resources requirements, see the *Using HD mode* section in *System Requirements*.

After the HD mode is enabled, perform your scanning as usual. The raw scanning data will be stored in your computer's memory.

As soon as you close the *Scan* panel, the following will happen:

- Your scan of the SD resolution will appear in the *Workspace* panel.
- The HD reconstruction will start automatically. The corresponding progress bar will be displayed on the *Status bar*.

When the HD reconstruction is complete, an HD scan will appear in the *Workspace* panel in addition to the SD one. Its name will be marked with the letters "HD", for example: *Eva HD Scan 1*.

5.8 Tweaking Scanning Options

5.8.1 Enabling HD Mode

If your scanner supports the HD mode, perform the following steps to enable it:

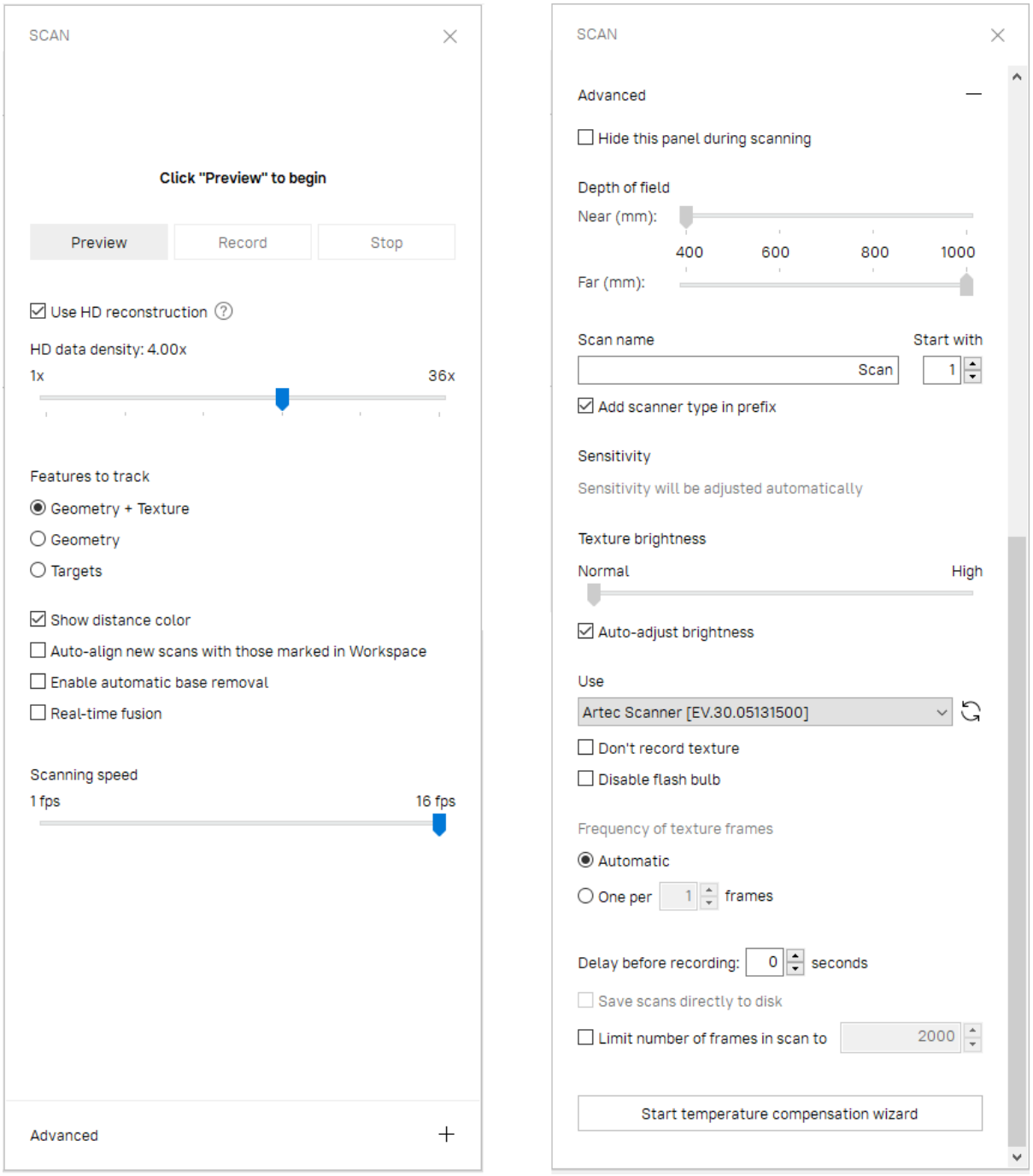


Figure 50: *Scan* panel: *Advanced* section hidden (on the left) and revealed (on the right).

- Check *Use HD reconstruction*.
- Select the desired *HD data density* using the eponymous slider.

The *HD data density* determines the number of polygons per frame that is used for reconstructing the scanned surfaces from the raw data.

The *HD data density* varies in the range from 1× to 36×. With the value of 1×, the number of polygons per frame is of the same order as in the case of the SD resolution. However, the surfaces reconstructed from the 1× HD data are cleaner than the ones based on the SD data. The density of 36× corresponds to ~3 million polygons per frame. The default *HD data density* is 4×.

Increasing the *HD data density* results in higher degree of resolution, coverage, and detail, but requires more memory and time for the HD reconstruction.

Note: The HD settings section is present in the Scan panel only if your 3D scanner supports the HD mode (such as Artec EVA).

To learn about additional options for adjusting the HD reconstruction, see *HD Reconstruction* in the Settings section.

See also:

HD Scanning and HD Reconstruction

5.8.2 Disabling Distance Color

The *Show distance color* option (Figure 38) highlights the reconstructed surfaces in the field of view based on the working range of a particular scanner.

Red	Surfaces are too close to the object.
Orange, green	Corresponds to the middle of range. Green represents the optimal distance.
Blue	Surfaces are too far away from the scanner and about to disappear.
No color	Surface is not being recorded.

In some cases you may need to observe how well texture is being recorded. Disabling this feature would then help. Clear the *Show distance color* checkbox in the *Scan* panel to this end.

5.8.3 Tuning Texture Brightness

Note: This option is available only for Artec 3D scanners equipped with texture cameras.

You can adjust the *Texture brightness* setting in *Preview* mode. Use the slider to increase or decrease the brightness of frames captured by the color camera (see Figure 51). Note that the texture brightness affects texture quality as well as tracking steadiness. Observe the recommendations in the Table 3.

Table 3: Adjusting texture brightness.

Surface Color	Recommendation
Dark or black	Increase brightness
Light-colored or white	Decrease brightness

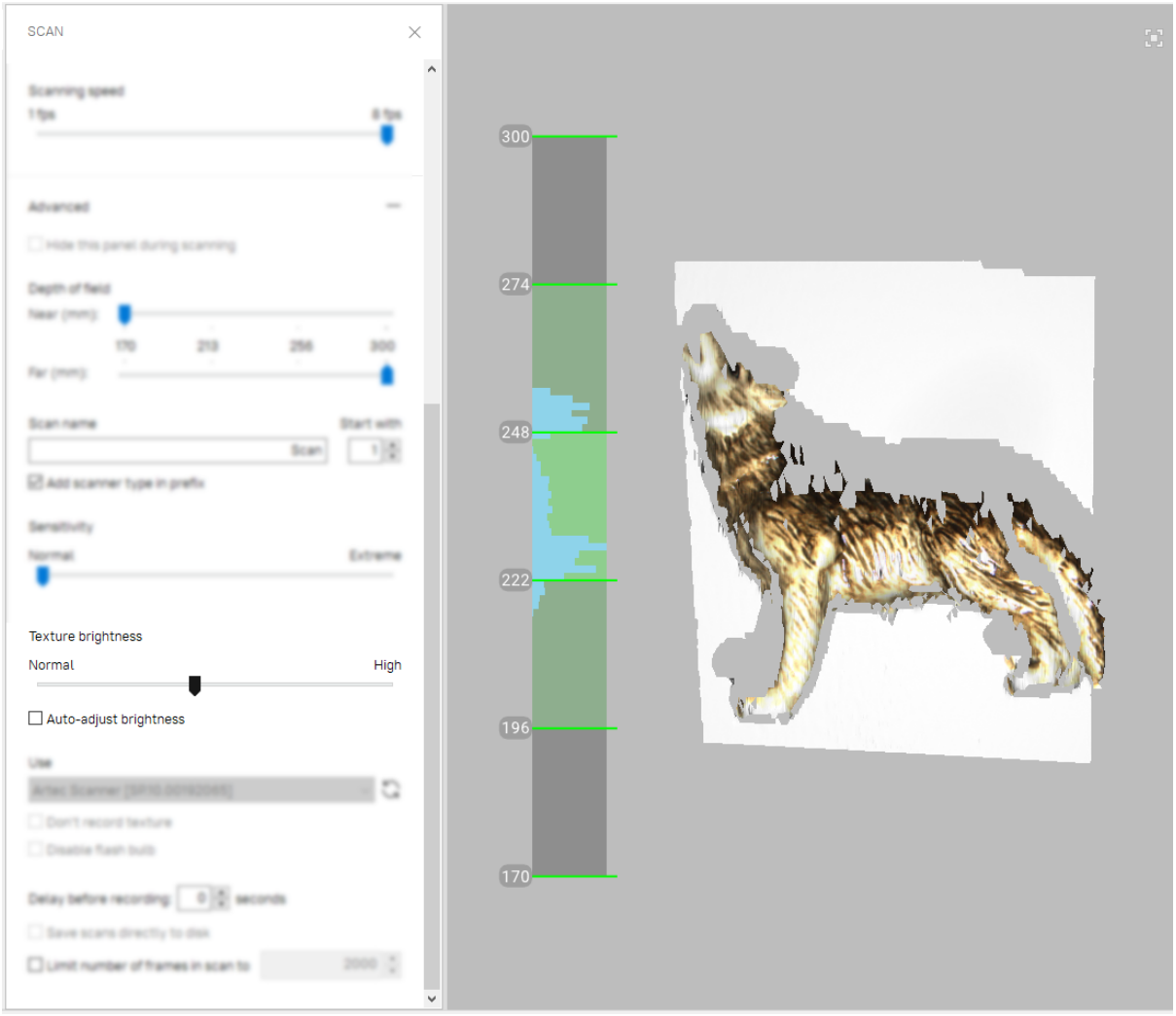


Figure 51: Increasing *Texture brightness* during *Preview*.

5.8.3.1 Preventing Overexposure

Artec Studio has error-proofing against overexposure. If the *Auto-adjust brightness* checkbox is selected and the specified value of *Texture brightness* causes texture to overexpose, the application will automatically decrease brightness to avoid damaging texture.

5.8.4 Sensitivity

You can tune the *Sensitivity* of Artec Spider scanner if the application fails to reconstruct particular surfaces. Increasing this setting enables the scanner to more easily capture black, reflective, translucent and fine objects (such as human hair). The higher the sensitivity, the noisier the recorded surfaces will be. Higher values may also reduce the scanning speed. For Eva and other Artec scanners, this setting is automatically adjusted.

5.8.5 Frequency for Capturing Texture Frames

By default, the *Frequency of texture frames* option is set to *Automatic*. In this mode, Artec Studio does not capture texture for every frame. To specify the frequency for capturing texture frames manually, do the following:

1. Check the *One per ... frame* radio button (see Figure 50, right).
2. Using the spinner near it, specify the desired frequency: *n*.

After that, the texture will be captured for every *n*-th frame.

5.8.6 Deactivating Scanner Flash

If circumstances prohibit you from using the scanner flash, follow the directions below.

Figure 52: Influence of ambient light on captured results.
On left: flash is turned off; ambient light is poor; results—dark texture. On right: flash is turned off; lighting conditions are improved; results—good texture.

Note that if you disable the flash, you should compensate by using bright ambient light. According to our tests, acceptable texture quality is obtainable with the flash disabled if the surface illuminance is at least 1 000 lux. Compare the models shown in Figure 52, which were recorded under different lighting conditions.

The following procedure captures the textured model without using the scanner flash:

1. Open the *Scan* panel and click the *Advanced* link
2. Turn off the texture flash by selecting the *Disable flash bulb* checkbox
3. Use good illumination. Avoid fluorescent lamps.
4. Click *Preview* and direct the scanner at the object

5. Adjust *Texture brightness* and *Texture exposure time*. In most circumstances, values should be as low as possible, because increasing the brightness also increases a texture noise, whereas increasing exposure time can blur the texture. Instead of adjusting sliders, try to further improve the lighting conditions.
6. Capture the scene
7. Perform required postprocessing as described in *Data Processing* to get a textured model
8. Adjust texture parameters for this model as described in *Texture Adjustment*. Pay particular attention to the *Hue* and *Saturation* sliders. The *Hue* slider allows you to correct unwanted texture color.

5.8.7 Tuning Exposure Time

You can alter texture exposure time in the *Preview* mode. Adjust this parameter in tandem with the *Texture brightness*. Increasing exposure time can blur the texture. Don't alter the default value unless it's necessary.

5.8.8 Disabling Texture Recording

Select *Don't record texture* checkbox if you don't want to store texture information in your scans. It is located in the *Advanced* section of the panel and disengages both texture camera and texture flash in the scanner. Note that this option is unavailable for Artec EVA Lite. Don't forget to select this checkbox once you have completed textureless scanning; otherwise, next time you want to start regular scanning the hybrid tracking mode could be unavailable.

Important: Just using the *Geometry* tracking mode it is still not sufficient for the application to don't record texture. Make sure you clear the eponymous checkbox.

5.8.9 Decreasing Scanning Speed

Artec EVA captures objects at up to 15 frames per second, whereas Artec Spider at 7.5. Default values ensure comfortable scanning with smooth movements. However, if you find scanning speed inappropriate, you can decrease it. In this case, Artec Studio will record fewer identical frames and register them faster. To this end, use the *Scanning speed* slider in the *Scan* panel.

Important: Decreasing scanning speed may hinder scanning. Don't use this slider unless it is absolutely necessary.

5.8.10 Limiting Number of Frames in Scans

Processing extra large scans might be problematic. To prevent Artec Studio from creating scans with an excessive number of frames, use the *Limit number of frames in scan to* counter. This counter defaults to `2000` frames in each scan.

5.8.11 Supplementary Settings

5.8.11.1 Scan Names and Starting Number

Customize scan names and starting number by entering your own values in the *Scan name* and *Start with* fields and changing the state of the *Add scanner type in prefix* checkbox. The software uses these values to create a scan title in the *Workspace* panel (see Figure 53, left). You can change the default values `Eva Scan` and `1` to, for example, `Capture` and `14`.

5.8.11.2 Saving Scans to Disk

Trigger a capture mode that simultaneously records scanning results to a disk by selecting the *Save scans directly to disk* checkbox. This option is enabled when you're working with an existing saved project (see *Saving a Project*) and can be useful when capturing large amounts of data on a computer with insufficient memory.

5.8.11.3 Delay Before Recording

Specify a delay (in seconds) before recording using the *Delay before recording* spinner under the *Advanced* section of the *Scan* panel. The countdown begins as soon as you click the *Record* button. To eliminate the delay, set the value to zero.

5.8.11.4 Depth of Field

Decrease specified operating-zone (*Depth of field*) by using the *Near (mm)* and *Far (mm)* sliders under the *Advanced* section of the *Scan* panel. Here you can only decrease range within the specified boundaries.

5.8.11.5 Specify Scanning Range

By default, Artec Studio provides the correct values for the minimum and maximum limits within which the cutoff planes are to be positioned. These values are different for each 3D scanner model, and they ensure that you capture good-quality 3D data. If high accuracy is a secondary concern, you can manually adjust the depth boundaries, allowing you to capture objects using an Artec L scanner or third-party 3D sensors positioned closer to or further from the object than is recommended. To do so, select the *Override default depth*

range checkbox in the *Settings* dialog in the *Scan* tab, then specify new boundaries for the scanning range in millimeters (For more details about scan settings, see *Capture*).

Warning: Custom depth-range settings may reduce accuracy.

5.8.11.6 Hiding Scan Panel During Scanning

To widen the viewport during scanning, software automatically closes the *Scan* panel once you start recording using Artec EVA or Artec Spider scanners. The *Hide this panel during scanning* checkbox is located in the *Advanced* section and is cleared by default.

5.8.11.7 Temperature Compensation Wizard

To enable metrology precision for Eva, run a temperature compensation. It will adjust the scanner settings to the ambient temperature. In *Advanced* section, click *Start temperature compensation wizard* and wait for a process to finish.

5.9 Troubleshooting

Issue	Possible Resolution
Geometry + Texture radio button missing from *Scan* panel.	You were probably scanning without texture. Clear the *Don't record texture* checkbox in the *Advanced* section.
Final model contains noticeable noise.	You likely scanned the affected areas improperly, or the scanner was too far from the object. Rescan those areas.
Tracking lost error persists.	Make sure *Scan using auto-alignment* is enabled in the *Settings* dialog and use *Geometry + Texture tracking*.

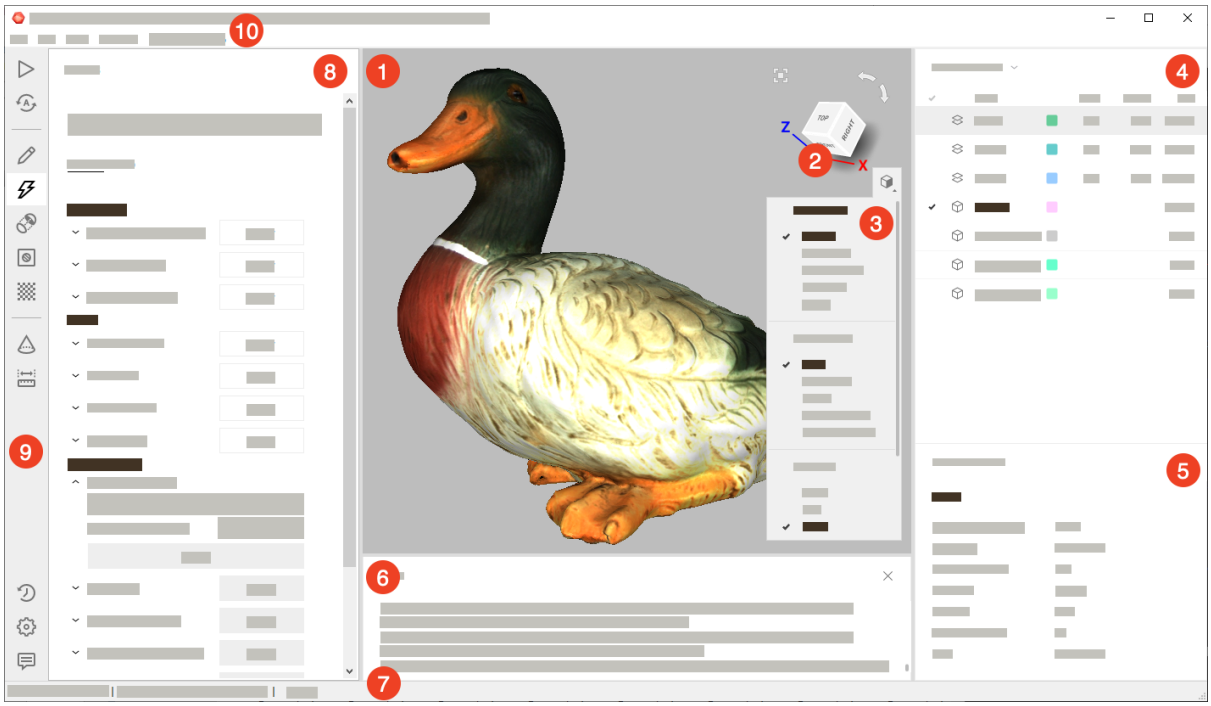
CHAPTER 6

Workspace and More

6.1 Artec Studio User Interface

6.1.1 Windows, Panels and Bars

When you launch Artec Studio, you will see the main application window, which allows you to perform all operations on scans and models.



The main window is divided into several sections:

Section	Intent and other information
1. *3D View*	Display all 3D data.
2. *Navigation cube*	Quickly orient objects.
3. *3D toolbar*	Alter 3D-data appearance and toggle display of coordinate grid.
4. *Workspace* panel	List and manage 3D objects as well as toggle their display and availability for tools.
5. *Properties* panel	Display detailed information for 3D objects.
6. *Log window*	Store records of any executed commands, specifying the time and details of each operation (error and troubleshooting messages).
7. Status bar	Contains information on memory availability and current usage by Artec Studio. It also has a progress indicator for any currently running task, such as algorithm execution, model and scan exporting, and so on.
8. Left panel	Accommodate panels for various application modes, including *Scan*, *Autopilot*, *Editor*, *Tools*, *Align*, *Fix holes*, *Texture*, *Construct*, *Measures*, *Settings*, *History* and *Feedback*
9. Left toolbar	Toolbar to start the above mentioned modes.
10. Menu bar	Dropdown menus with various commands.

If either of the panels is hidden, use the *File* → *Window* menu command to show it.

You can also quickly show or hide some of the panels/toolbars (namely, *Left toolbar*, *Workspace panel* and *Log window*) by clicking on the special bars marked with double arrows: «, », ⌄⌄, ⌃⌃. These bars are located along one of the borders of the corresponding panel or toolbar.

6.1.2 Primary Settings

To access the settings dialog, select *Settings...* in the *File* menu. The settings window has several tabs for various groups of application settings. To switch between the tabs, click the icon at the top of the dialog. For a detailed description of the tabs, see *Settings*.

To change the language, select the *Miscellaneous* tab (Figure 149) and then the required language from the list and click *OK*. You will be asked to confirm the operation and restart the application. Once you agree, Artec Studio will automatically restart using the new

interface language. If you choose not to restart, the changes will be applied the next time you start the application.

Under the *Performance* tab you can specify the maximum number of alterations to be saved, or specify maximum the size (in MB) of the history to be saved. The *Data-compression level* slider enables you to adjust the compression level when saving project data to a disk.

6.2 Workspace Panel

6.2.1 Object Types

After each scanning iteration, Artec Studio saves a separate *scan*. The list of all scans for a given project appears in the *Workspace* panel (see Figure 53). Afterwards, the algorithms, primarily *fusion*, yield *model*s.

Artec Studio can accommodate the following types of objects in *Workspace*:

Table 4: Object types in Artec Studio.

Type	Icon	Content	Origin
Scan		Set of frames	From scanners Eva, Spider, Leo, and Micro
Point-cloud scan		Point cloud	From Ray scanner
Model		Polygonal mesh	Algorithm output (fusion) or imported mesh
CAD model		CAD model	Imported
Cylinder		CAD primitive	Created in Artec Studio (see *Constructing CAD Primitives*)
Cone		CAD primitive	Created in Artec Studio
Plane		CAD primitive	Created in Artec Studio
Sphere		CAD primitive	Created in Artec Studio
Targets		Target cloud	Imported
Group		Group of objects	Grouping of objects listed above

See also:

Figure 55.

6.2.2 Object Columns

Object data in the *Workspace* panel is arranged in several columns:

✔	Scans marked with ✔ in this column will appear in the *3D View* window and will undergo processing by all Artec Studio algorithms and tools.
Icon	Each type of objects has a specific icon (see Table 4). This icon is always displayed to the left of the object or group name for improved visual perception of information in the *Workspace* panel.
Name	When a scan is created, Artec Studio automatically assigns it a name, such as `Eva Scan 1`, `Eva Scan 2` and so on, according to the values in the *Scan name* and *Start with* fields as well as the state of the *Add scanner type in prefix* checkbox in the *Scan* panel. To rename some object, follow *these instructions*.
Color	In this column, each object has a colored square (for example, ■) next to it for clarity and quick visual search. You can change the color by clicking on the corresponding square and selecting the desired color from the palette.
Type	The type of a loaded object. See *here* for details.
Error	The largest registration-error value among all frames in the scan. *More information*.
Frames	The number of frames loaded into memory along with the total number of frames constituting the scan (see *Memory Management: Object Unload*).
Size	The size (in MB) of a particular object in computer memory (not on a disk storage).
Scanner type	The type of the scanner that created the loaded object.
Texture frames	The number of captured texture frames. See *Texturing* for details.
Polygons	The number of polygons constituting the object.
🔒	Algorithms will not reposition the frames of the scans marked with 🔒, nor will they move the scans and other objects marked with 🔒.

Use the ⋮ button at the top right to select the columns to be displayed or to hide the panel. Change the column order by drag-and-dropping their headers.

Note: The column marked with 🔒 appears automatically if you set the *Lock registration* or *Lock position* status for one or more objects using the context menu (see *Operations with Objects* for details on the context menu operations).

6.3 Operations with Objects

In the *Workspace* panel, you can perform various types of operations with objects. All types of operations are available through the context menu called by clicking `RMB` on some object.

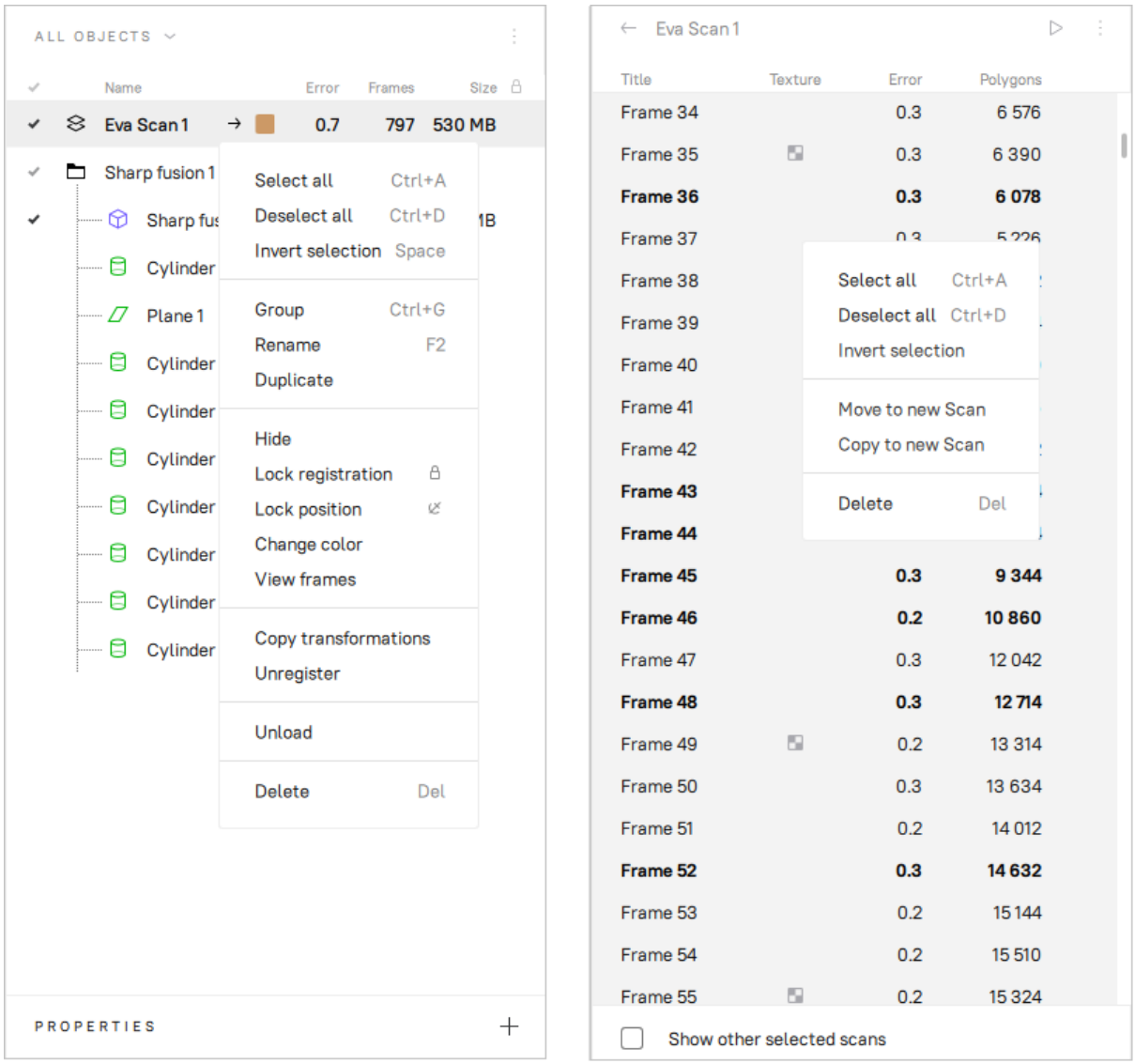


Figure 53: *Workspace* panel and respective context menus: object list on left and surface list on right.

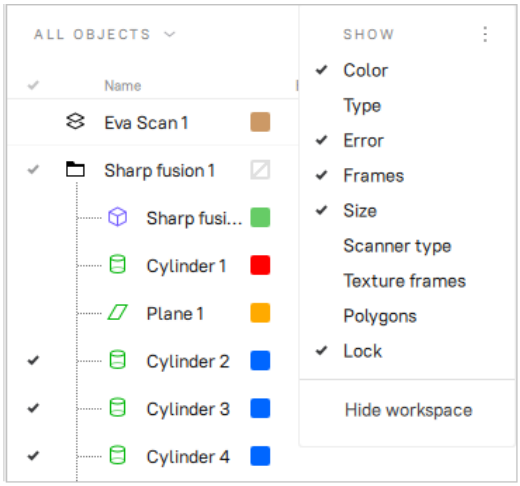


Figure 54: Selecting columns to be displayed.

Menu Item	Description
ALL OBJECTS filter	Instruct *Workspace* to display only particular *types of the objects* or all of them (see Figure 55).
Select all	Select (highlight) all objects for further operations on them. If only one or several objects of one group are selected in *Workspace*, the first run of this command will select all group objects, the second – all *Workspace* objects.
Deselect all	Reset any selection
Invert selection	Reset the current selection and select all other objects.
Group / *Ungroup*	You can group a few objects in the workspace according to some feature. Select required objects, call the context menu by clicking RMB and select *Group*. You will see that the objects are wrapped with a common header (for example, *Group 1*), which can be changed as well as the object names (see below). It is possible to create subgroups within groups. Resumed scans are also grouped automatically during scanning. Each scan imported from Leo will be included in a separate group inside the project group. See also *Actions with Groups*.
Rename	Select an object by clicking LMB on its name, hit F2 and specify a new object name in the opened dialog window. You can also rename many objects at once: select multiple objects (as described *above*) and then use F2 or RMB to rename them.
Duplicate	To make a complete duplicate of an object in the *Workspace*, right-click on the object and then select *Duplicate*. A copy of the object will be created with the name like Copy of Fusion 1.
Show	Display the selected objects in the *3D View* section. See *Selecting Scans and Models* for details.
Hide	Do not display an object in the *3D View* section (cancel the *Show* operation).
Lock registration	Set the Locked registration status ( ) to a scan, which blocks the reposition of the scan frames during *Global Registration*. See *Locking Object's Reposition* for details.
Lock position	Set the Locked position status ( ) to a scan, which blocks its reposition in some algorithms. See *Locking Object's Reposition* for details.
Unlock	Remove the Locked registration and Locked position statuses from an object.
Change color	Call the color palette to change the color of an object or a group. See also *Actions with Groups*.
Copy transformations	Save the transformations of a scan and its frames for their further transfer to another scan. See *Transferring Transformations* for details.
Unregister	Reset the positions of individual frames in a scan computed during its registration. See *Separating Scans* for a use case.
Unload	Unload objects from RAM memory. See *Memory Management: Object Unload* for details.
Delete	Delete objects from your project.
Any column header	Sort the objects by either of their properties. Clicks: ascending order → descending → initial.

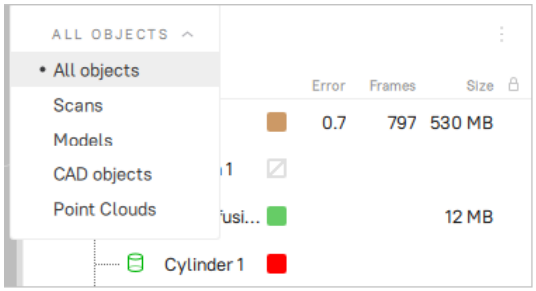


Figure 55: Filtering objects in *Workspace*.

6.4 Actions with Groups

In the *Workspace* panel you can perform the following actions with the groups of objects using the elements of the group header row:

Table 5: Actions with groups in the *Workspace* panel.

Action	How to perform
Select/Deselect	To select or deselect all objects in a group, click the group row in the column marked with ✔.
Set/Change group color	By default, the group color is not set (). To set or change the color of a group, click the group row in the *Color* column area and select the desired color from the palette. When the group color is set and the group is collapsed in the *Workspace* panel, then all objects in the group are painted in the group color. Otherwise, each object is painted in its own color.
Unset group color	To cancel the color setting for a group, right-click the group row in the *Color* column area.
Lock	To lock or unlock all objects in a group, click the group row in the *Lock* column area ( ). See *Locking Object's Reposition* for details.

6.5 Selecting Scans and Models

To view a scan or model in the *3D View* window or to *process* it, you need to mark it with the ✔ icon in the *Workspace* panel. To navigate scans and models, use keys ↑ and ↓ or click an arbitrary area except those in ✔, or color column ().

Purpose	Method	Alternate Method
Highlight an object in *Workspace* to view its properties or run a command from the context menu	Left-click on the scan name	–
Toggle visibility and availability for processing (flag ✔)	Left-click in the ✔ column	• Use the *Show* or *Hide* context-menu commands • Select the object name using Ctrl+Alt+LMB.
Batch selection (deselection) of objects for display and processing	Click ✔ in the rows of the required objects one by one	• Hit Ctrl+A (Ctrl+D) to select (deselect) all objects • Click LMB while holding Ctrl (Shift) to highlight a few objects and then hit Space • Click LMB on one of the ✔ flags and while holding down LMB, move the cursor through the other flags.
Select a single object for processing and deselect others	Select the object name using Ctrl+Alt+LMB	Use Ctrl+LMB in the empty area of the ✔ column

In addition to the methods in the table above, you can use commands from the context menu by clicking RMB on the objects.

See also:

The full list of *hot keys in workspace*.

6.5.1 Selecting Frames

Double-clicking the scan name (or using the *View frames* command in the context menu, or clicking the → button near the scan name) opens the surface list, revealing all frames in that scan (see Figure 53, right).

Highlighting specific frames will make them (and only them) appear in the *3D View* window.

You can select frames in a number of ways:

- Click `LMB` on the frame name to select it while clearing other selections.
- Click `LMB` while holding the `Ctrl` key to select several frames at once.
- Click `LMB` while holding the `Shift` key to select a sequence of frames in the specified range.
- Click `Ctrl+A`/`Ctrl+D` to select/deselect all frames.

To start a sequential frame demonstration, use the ▷ button at the upper right of the *Surface list*. To stop the demonstration, click ▯▯.

6.5.2 Object Properties

At the bottom of the *Workspace* panel, you can see a *Properties* section. Click on it to expand it. Then select any object to display its properties. If no object is selected, the global settings of the project will be displayed in the *Properties* section.

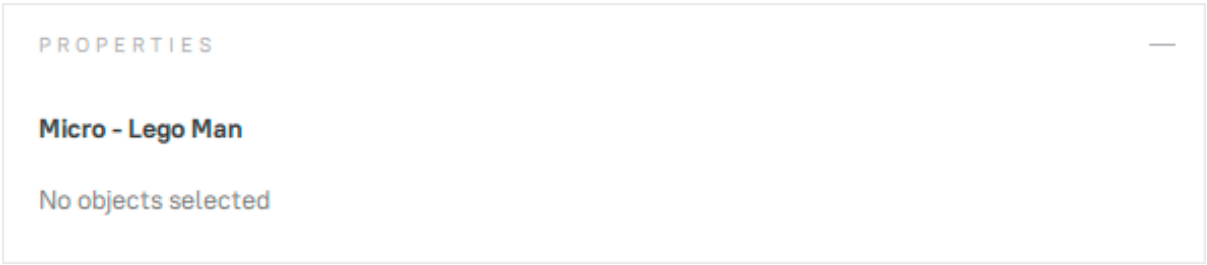


Figure 56: Properties without a selected object.

6.5.3 Selecting a Point-Cloud Scan

Point-cloud scans contain only one surface. Click `LMB` on a point-cloud scan and look at the *Properties* section:

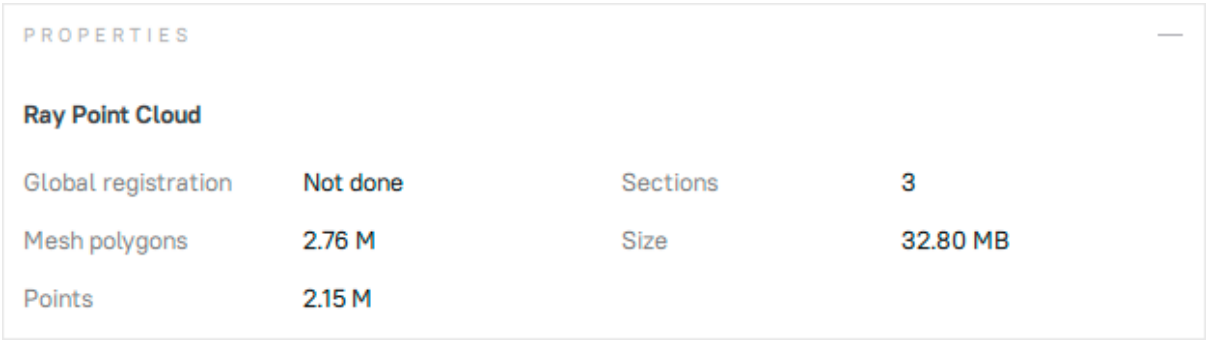


Figure 57: Properties of the point-cloud scan.

Parameter	Description
Global registration	Shows whether the *global registration* procedure has been performed.
Mesh polygons	Since Artec Studio doesn't display all the points constituting the scan, you can only see a mesh obtained from a simplified copy of the actual point cloud.
Points	Total number of points in the point cloud.
Sections	When you scan with Ray, you may select particular regions (sections) to narrow down the actual scene. This parameter stands for the number of these regions.
Size	The size (in MB) of the object in computer memory (not on a disk storage).

6.6 Memory Management: Object Unload

When working with a large data set, you may often find it necessary to free up RAM without deleting any of the project data. To this end, Artec Studio implements a mechanism for selectively loading scans. You can move to disk any currently unused scans to free up extra RAM. If a particular algorithm later requires any of the unloaded scans, the application will automatically reload them.

To change the loading status, select the scans (models) in the *Workspace* window, click RMB and then select *Unload* in the pop-up menu.

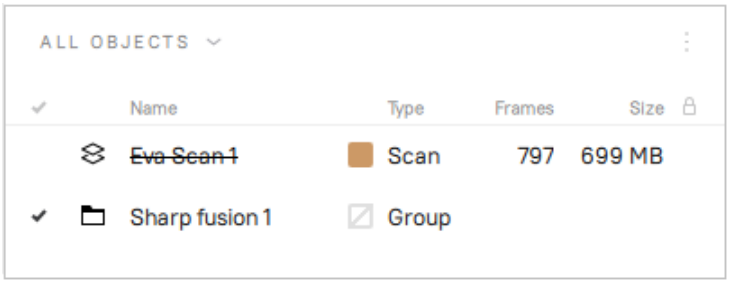


Figure 58: Unloaded scan.

Any scans (models) that are completely unloaded from memory will be displayed in a strikethrough font in the *Workspace* window and won't appear in the *3D View* window.

Algorithms may automatically change the loading status of project data in the following cases:

- You have selected unloaded scans for processing by clicking the ✔ flag. Artec Studio will load these scans into memory.
- Execution of the algorithm requires large amounts of memory. Artec Studio will unload unused scans, frames, textures or a combination thereof.
- Algorithm needs certain frames and it loads only them.

Note: In addition to 3D data, the change history can also consume a large portion of memory. For information on how to control the history size as well as how to unload or clear it, consult *History of Project Changes*.

CHAPTER 7

Viewing Scans and Models

7.1 3D Navigation

When you have finished scanning, Artec Studio displays the results in the *3D View* window.

7.1.1 Moving, Rotating and Scaling

You can control the observer's perspective in the *3D View* window by moving or rotating the observation point, or by zooming in or out. Use the mouse to control these effects.

Tip: You can also use 3D mouse to navigate 3D content (see *3D Mouse*).

7.1.1.1 Moving

Move the mouse pointer over the *3D View* window. Hold down the left (LMB) and right (RMB) mouse buttons simultaneously, then move the mouse to relocate the model. You can also use the middle mouse button to perform the same operation.

7.1.1.2 Rotating

To rotate around any possible axis, move the mouse pointer over the *3D View* window. While holding down LMB, move the mouse in the desired direction to rotate the model.

7.1.1.3 Flipping

To quickly rotate (flip) 3D data around a specific axis (or rather the axis perpendicular to the screen plane) in a specific direction, use the dedicated arc arrows ( ) near the navigation cube (see Figure 62) or the O key:

Using arrows

1. Click (LMB) one of the arrows ( ).
2. Still holding down LMB, move the mouse cursor in the direction of either of the arrows.

Using the O key

Press and hold the O key and drag the mouse cursor outside an imaginary ellipse that inscribes the *3D View* window.

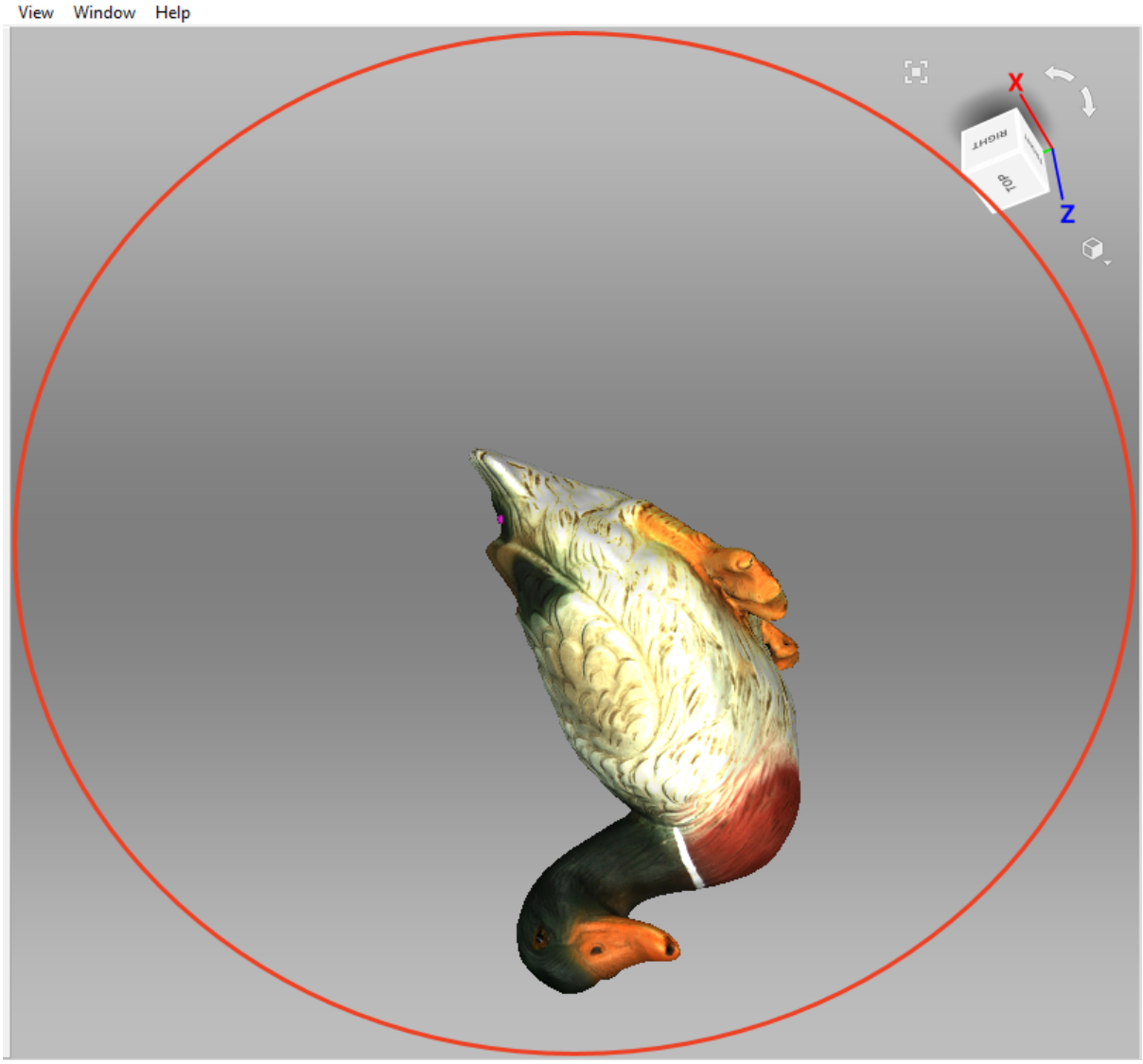


Figure 59: Imaginary ellipse inscribing the *3D View* window.

7.1.1.4 Zooming

Hold RMB and move the mouse. Moving left or up will zoom out, whereas moving right or down will zoom in. You can also use the mouse wheel to produce the same effect.

7.1.2 Global Coordinate System and Rotation Center

To enable or disable the global coordinate-system axes, select the *Show grid* option in the *View* menu or *Grid* in the *3D View* toolbar, or press G.

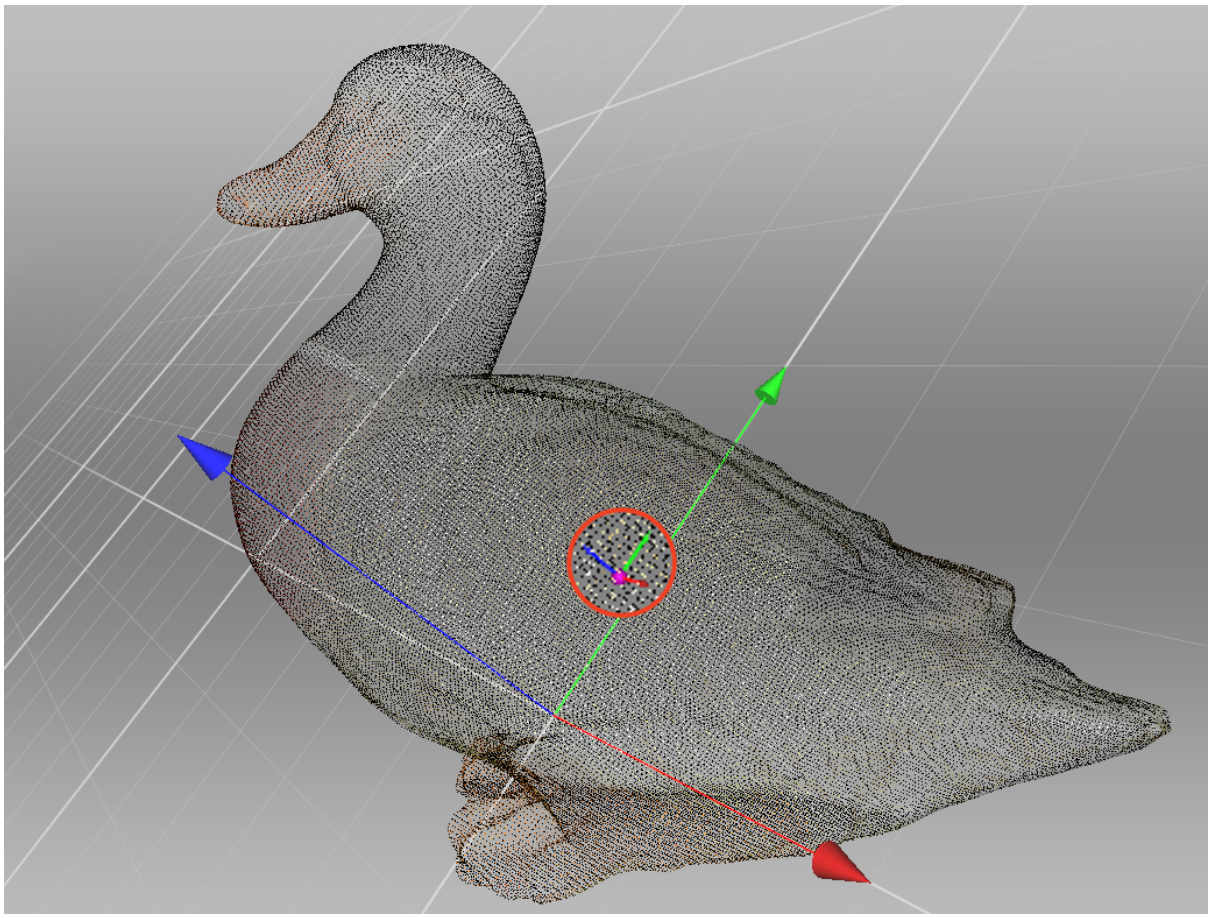


Figure 60: Custom rotation center.

When you rotate the model, the scene always turns around a certain point—the rotation center. By default, the rotation center coincides with the origin of the main axis grid. To change its location, double-click LMB at any point on the 3D model: the rotation center will move to this point. Setting the rotation center can be useful when you wish to view a particular object from all sides. Once it is set, rotate the view using LMB.

Artec Studio displays the rotation center as a small purple sphere with the three small coordinate axes (see Figure 60). If the rotation center coincides with the origin of the main axis grid, the purple sphere lacks small axes. If the rotation center hasn't been altered, it even lacks the sphere.

Application can set the rotation center to the center of mass of the object. Access the following menu command: *Edit* → *Cursor* → *Set to mass center*. To go back to the default state, select *Set to origin of axis grid*.

7.2 Choosing Projections

The *View* menu allows you to choose between perspective and orthogonal projections when displaying the model in the *3D View* window.

Perspective view is the central projection on a plane produced by direct rays that focus on one point: the projection center. This method produces a visual effect similar to human eyesight.

Orthogonal view is when the projection center resides infinitely far from the plane of projection; in this case, the projection rays are perpendicular to the observation plane. This method preserves parallel lines and is more commonly used for measurement (see *Measurement Tools* for details).

You can also change projection type in other ways:

- Hit `Ctrl + 5` on the main keyboard
- Hit `5` on the extended numeric keypad (numpad)

7.3 Viewpoints

To quickly toggle a camera view between several predefined positions, use navigation cube, *View* menu or the keyboard combinations listed in Table 6.

In comparison with the other ways, navigation cube provides more flexibility in orienting objects in the window. Apart from using labeled faces (*TOP*, *FRONT*, *LEFT*, etc.), cube allows one to orient scene to intermediate positions with the help of controls located on the edges and vertices (see Figure 61).

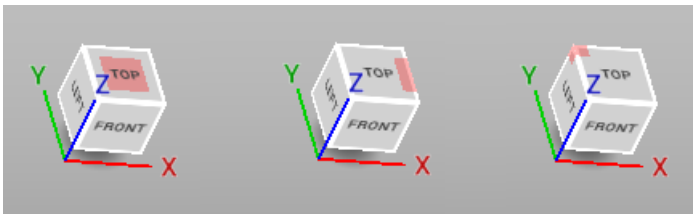


Figure 61: Navigation-cube controls (face, edge, vertex).

Table 6: Key combinations for switching viewpoints.

Viewpoint	Keyboard	Extended Numpad
Front	`Ctrl + Shift + 1`	`1`
Back	`Ctrl + 1`	`Ctrl + 1`
Right	`Ctrl + Shift + 3`	`3`
Left	`Ctrl + 3`	`Ctrl + 3`
Top	`Ctrl + Shift + 7`	`7`
Bottom	`Ctrl + 7`	`Ctrl + 7`

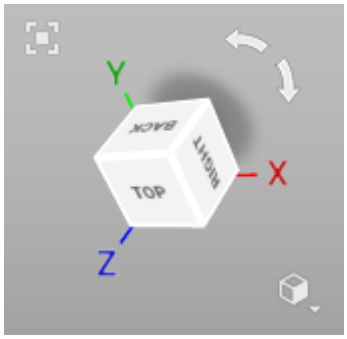


Figure 62: Navigation cube and arc arrows.

The *Home* command of the *View* menu or `H` keystroke restores the view to its original position.

The *Fit to view* menu option,  button or `F` keystroke automatically fits the object to the *3D View* window.

For point-clouds, you can have a look at scan from the Ray perspective. Open the right-click menu for this scan and select the *Go to scanner viewpoint* command to this end.

7.4 Displaying 3D Data

The toolbar on the right of the *3D View* window features controls for data-display modes.

If minimized, it can be opened by clicking button  in the *3D View* window (see Figure 62). All the commands for viewing and switching between modes are also available in the *View* menu.

7.4.1 Rendering and Shading Modes

Both the *View* menu and the *3D View* toolbar allow you to choose one of the following 3D rendering options for scanned frames:

Render solid the most common way to render with a solid fill on all faces using your selected shading method

Render wireframe display polygonal-mesh edges without applying a solid fill to the faces

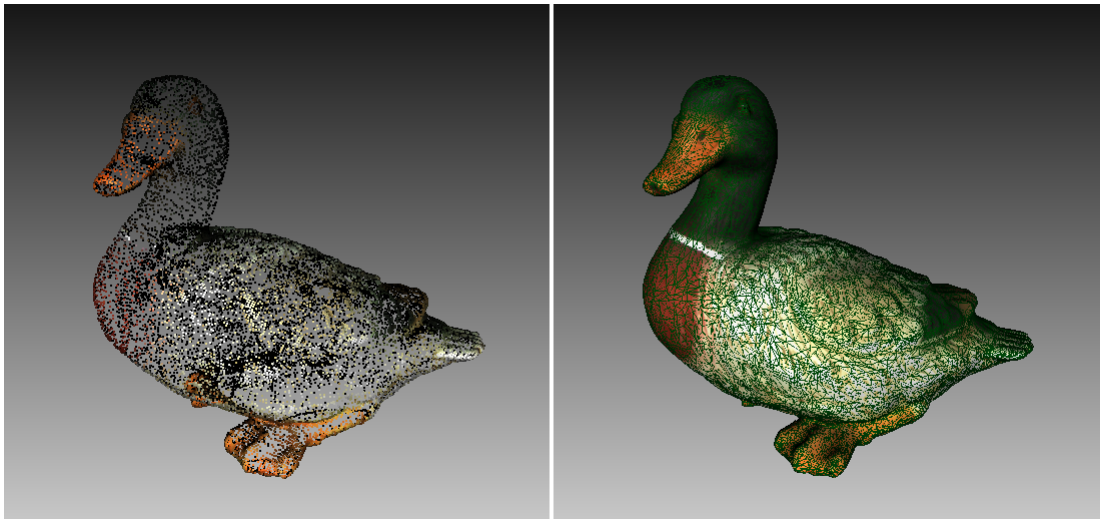


Figure 63: Examples of model using different rendering modes.
Point model on left and wire over solid on right.

Render points display polygonal-mesh vertices

Render wireframe over solid apply a solid fill to the faces and use a different color to display edges. This method enables you to visually assess the quality of the polygonal model (see *Mesh Simplification* for details).

Render points and solid automatically display scans in point view, but display models in solid-fill view. This mode eliminates the need to switch to another mode in order to find the best rendering approach for each surface type. It is enabled by default for the Artec Spider scanner.

For some examples of the various model-rendering modes, see Figure 63.

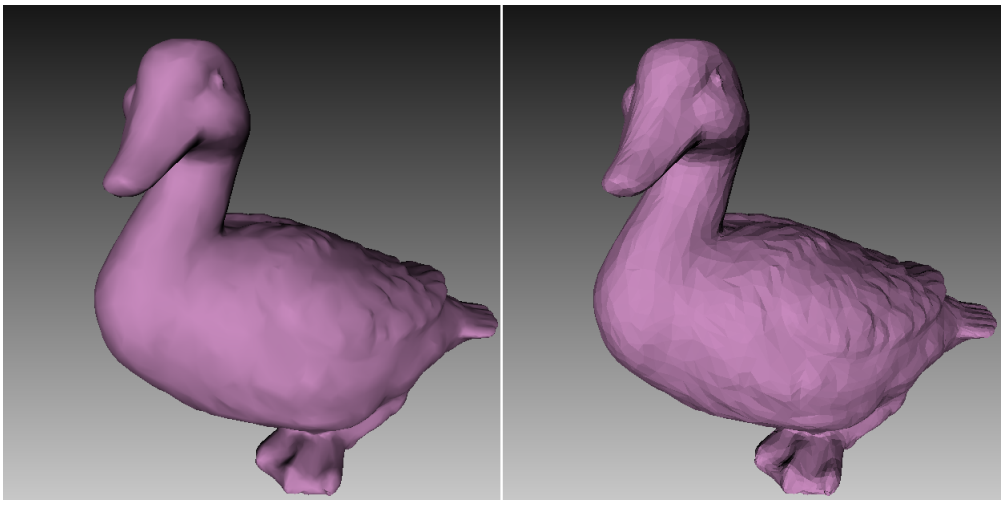


Figure 64: Smooth versus flat shading (respectively).

To choose a shading method for the solid fill, use the *View* menu:

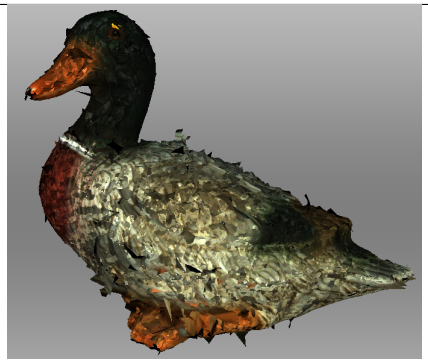
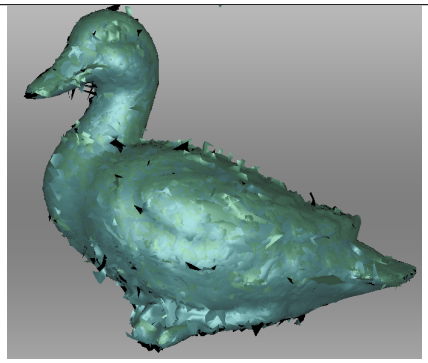
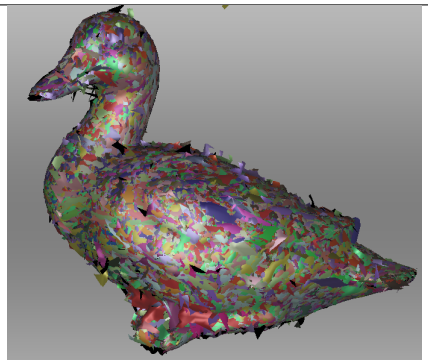
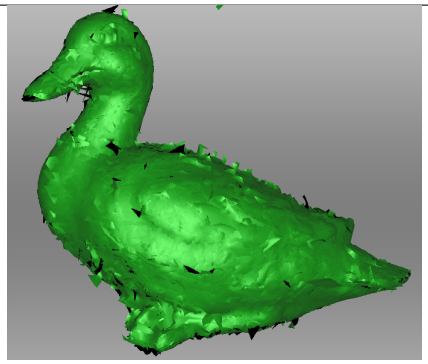
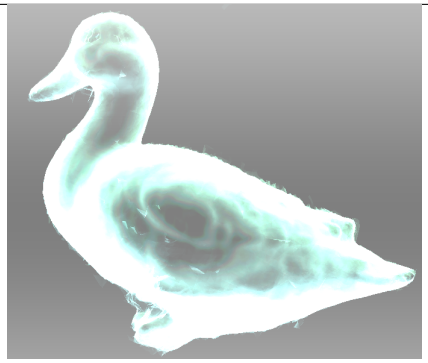
Smooth shading the color value for each point in a triangular face is calculated using color interpolation at the vertices

Flat shading all the points on a triangular face are assigned the same color

7.4.2 Lighting, Color and Texture

The *Lighting* option in the *View* menu or in the toolbar, or `L` hot key toggles the lighting in the *3D View* window. This option may be useful when you must turn the lighting off to see only the outline of the model or to assess texture quality.

The *Color* subgroup in the *View* menu or *Color mode* section in the toolbar list the methods for assigning colors to the surfaces in the *3D View* window:

Texture	displays textured data; otherwise, the software uses the scan's default color		Ctrl+Alt+1
Scan color	displays the default color of the scan; the figure depicts two scans		Ctrl+Alt+2
Surface color	displays each frame in a scan using a different color		Ctrl+Alt+3
Max error	colors the frames from Eva and Spider in accordance with their *registration quality* from green to red via yellow and orange; red indicates unacceptable values and registration errors		Ctrl+Alt+4
X-ray	beneficial for noisy data since it highlights only areas with high point density; it features a slider for adjusting its intensity		Ctrl+Alt+5

7.4.3 Back-Face Rendering

Artec Studio offers three methods for rendering a frame's back face:

Show assigns the back face the same color as the model

Cull the back face is not displayed

Black renders the back face in black

You can choose the mode from the *View* menu or from the toolbar in *3D View* window. See Figure 65 for examples that illustrate the different methods of back-face rendering. *Black* is the default mode.

Figure 65: Examples of different methods for back-face rendering.
Show back-face mode on the left, hide (*Cull*) in the middle and *Black* on the right.

7.4.4 Representation of Normals and Boundaries

The *Show normals* option in the *View* menu enables or disables rendering of normals for each vertex. By default, the normals point away from the model surface and toward the 3D scanner. You can change this direction using the *Invert normals* command. You can also switch between modes for displaying normals by hitting the N key with the *3D View* window active.

When working with edges, the *Show boundary* feature in the *View* menu allows you to enable and disable highlighting of the model's edges. To toggle this feature, hit the B key with the *3D View* window active.

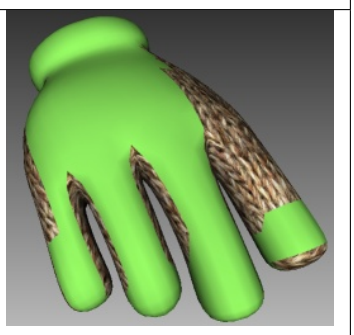
7.4.5 Rendering and Texturing Untextured Polygons

Textured models may have some untextured areas (for instance, the green area in the middle of Table 7). The *Render polygons without texture* option in the *View* menu allows you to toggle rendering of such areas.

If the texture of the imported model is smaller than the model itself, Artec Studio can wrap it to fill the untextured areas (see Table 7). The wrapping effect is similar to floor tiling

or a repeating wallpaper pattern—that is, the texture repeats periodically. To activate this option, enable the *Wrap texture coordinates* option in the *View* menu.

Table 7: Rendering and texturing untextured polygons.

Options Enabled	Result
None	
Render polygons without texture	
Wrap texture coordinates	

7.4.6 Displaying Boundaries of Texture Atlas

Textures applied to 3D models are obviously two-dimensional. You may, however, want to see the boundaries of each texture patch on the actual 3D surface. Artec Studio can display a texture-atlas file, such as the the middle image in Figure 110, with its boundaries highlighted (see Figure 66). Identifying the way in which the boundaries lie on the surface may, for example, help you determine whether you must simplify the model to get better texture application.

To enable boundary display, access the *View* menu and select *Show texture boundaries* or hit the `Shift+B` keys with the *3D View* window active. To disable this feature, make sure this menu command is unchecked.

Technically, this command also works for textures produced by triangle methods, but it provides no usable information.

Figure 66: 3D model with texture-atlas boundaries.

7.5 Saving Screenshots

You can capture surfaces displayed in the *3D View* window and save them in a graphics file. Unlike the conventional system `Print Screen` command, this option saves only the contents of the *3D View* window and uses the specified background color (see *Background for screenshots* transparent, black or white).

Tip: When saving screenshots in *X-ray* mode, avoid using transparent background.

To capture a screenshot, follow this procedure:

1. Select the *Save screenshot...* option in the *View* menu, or hit `Shift+Ctrl+S`.
2. In the dialog, specify the destination folder and file name, then click the *Save* button. Artec Studio will save the file in `PNG` format.

Note: If you save a screenshot using an existing file name, Artec Studio will overwrite that file without warning. Be sure to specify a unique file name to avoid overwriting other files.

CHAPTER 8

Projects, Scans and Models

A project encompasses all 3D data obtained by scanning and postprocessing that can be saved to disk and accessed for later use. In addition, it contains *command history* and *measurement* results. For each project, a corresponding folder contains all project data as well as a project file describing the structure of that data.

Artec Studio can display project statistics. It includes information on number of scans, surfaces (frames), polygons, vertices and UV coordinates. To access this data, call a right-click menu for any *Workspace* object and select *Project info*. If you want to collate data on the selected scans with the total numbers for the project, first mark the required scans using with the ✔ flag.

8.1 Creating a Project

To start a new project, select the *File* → *New project* menu option. It is a best practice to *save this project* to a specific folder before you start scanning. If you start scanning with the *Save scans directly to disk* option enabled or import scans from Ray, a temporary project is created in the Windows temporary folder or another directory if you specified one in *Settings*.

8.2 Saving a Project

You can save your project using the *File* → *Save project* menu option or by hitting `Ctrl + S`.

While you're working with a saved project, the header of the application window displays its full path. Save your project from time to time in the course of processing or otherwise

using the scanned material.

Note: Artec Studio saves data incrementally, meaning that if you save an existing project, the application will only save newly changed or added data.

8.3 Opening Project and Scans

To open an existing project, use the *File* → *Open project* menu option or hit `Ctrl + O`.

Note: Files from Artec Studio versions 8, 9, 10 and 11 are mutually compatible. Earlier versions, however, may be unable to open projects saved in a later version using the `SPROJ` format.

By default, when you open a project, the application will restore it to the state in which it was last saved (the three scan-loading states include loaded, unloaded and key frames only—see *Memory Management: Object Unload*). To load faster by opening the project without loading any scans, use the *Open project (unloaded scans)*... option from the *File* menu or hit `Ctrl + Shift + O`.

Note: When Artec Studio opens a project, it will determine the amount of available memory. If the scan you are trying to load requires more memory than is available in your system, the application will process it as an "unloaded" scan.

8.3.1 Opening a Project from Leo

You can obtain projects from Leo via direct connection to the scanner or using an SD card installed in the device.

8.3.1.1 Connecting to Leo

1. Ensure that your Leo scanner and your computer are connected to the same network and you authenticated using the same credentials
2. Click *File* → *Import* → *Leo project (connect to scanner)*
3. Wait for the application to show your Leo scanner. If no device is displayed or you are using a direct connection, follow the steps indented below:
    a. Click *Connect by IP*
    b. Specify IP address that you may find in Leo network settings
    c. Click *Add*

4. Select the required scanner and click *Connect*
5. Then using either LMB or ↑ and ↓ select the project that you want to load (Figure 68)
6. If the selected project contains HD data and you want to upload it, perform the following actions:
    a. Check *Use HD reconstruction*.
    b. Select the desired *HD data density* in the range from 1× to 64× using the eponymous slider.

    The *HD data density* determines the number of polygons per frame that is used for reconstructing the scanned surfaces from the raw data. With 1× the number of polygons is of the same order as for the SD resolution and 64× corresponds to ~5 million polygons per frame. Increasing the *HD data density* results in higher degree of resolution, coverage, and detail, but requires more memory and time for the HD reconstruction.

    Important: If Artec Studio evaluates your computer's resources as insufficient for the selected *HD data density*, then the warning is displayed that the HD reconstruction can take up to several hours on your computer. For information on resources requirements, see the *Using HD mode* section in *System Requirements*.

    ---
7. Click *Import*.

If you have enabled the HD reconstruction, it will start immediately after the data uploading finishes.

Wait for scans to appear in the *Workspace* panel.

The imported project and scans will be automatically grouped—the group with the project name will be divided into subgroups of scans (see *here* about grouping). The imported HD scans will have an "HD" mark in their names, for example: *Leo HD Scan 1*.

If the scans contain information on *supporting surface* and the *corresponding option* is enabled in *Settings*, Artec Studio will also launch base removal.

Note: You can import HD projects from Artec Leo multiple times with different values of *HD data density*.

8.3.1.2 Using SD Card

If you want to open Leo scans without having to connect to the device, use the following method:

1. On Leo, first copy a project to SD card.

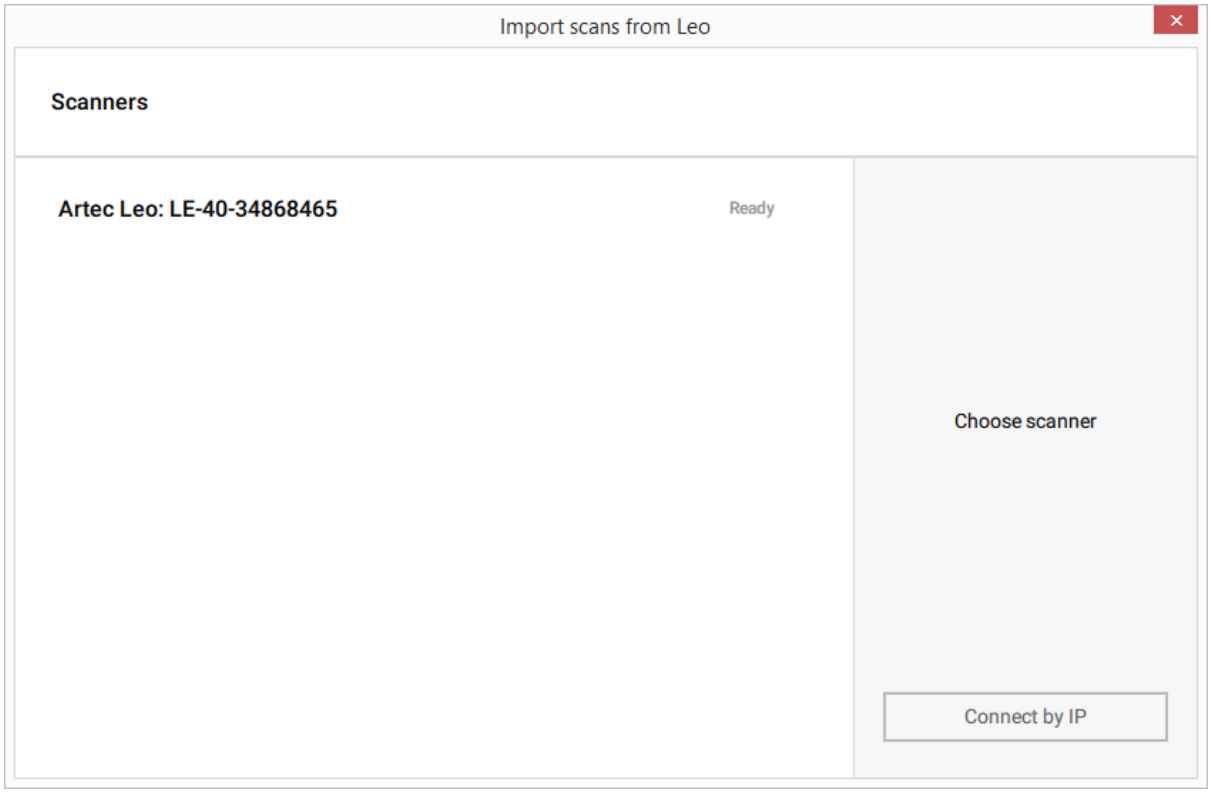


Figure 67: Scanner list and the *Connect by IP* button.

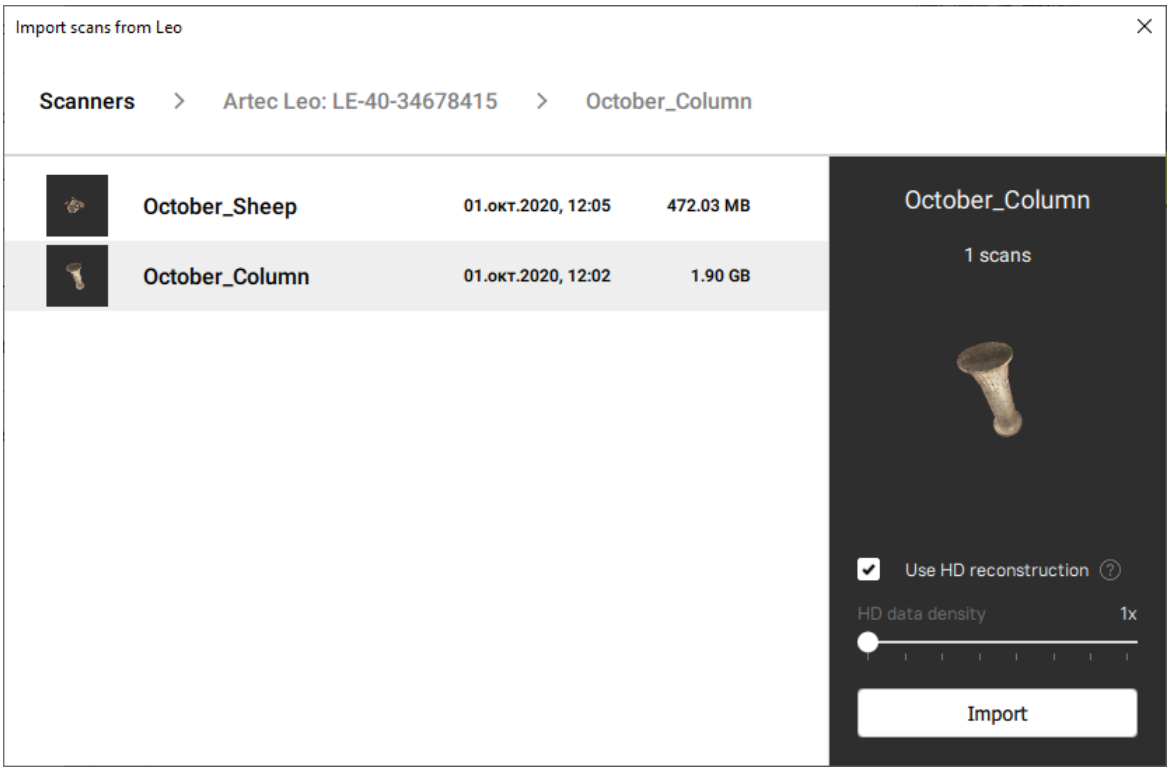


Figure 68: Dialog for selecting Leo projects to import.

2. Then insert the card into the computer with installed Artec Studio.
3. Click *File* → *Import* → *Leo project*
4. Browse for the required project folder
5. Select the folder containing Leo project and click *Select folder*. Import will start.

Note: HD data is not stored in the projects exported to an SD card.

8.4 Importing Models and Scans

Importing is another way to load data into Artec Studio in place of capturing or opening a project. You can import scan files created in earlier versions of the software, individual frames, point cloud data, as well as CAD models in the following formats:

`SCAN`	Artec 3D scan format
`PLY`	Stanford polygon file format
`STL`	Stereolithography file format
`VRML`	VRML file; actual extension is `*.wrl`
`OBJ`	Wavefront OBJ file format
`PTX`	Disney per-face texture mapping format
`C3D`	Artec Ray original point cloud
`BTX`	Artec Ray point cloud
`STEP`, `STP`	(CAD format) Standard for the Exchange of Product model data
`IGES`, `IGS`	(CAD format) Initial Graphics Exchange Specification
`X_T`	(CAD format) Parasolid XT data format

8.4.1 Importing Scans, Meshes or Point Clouds

To import a file, use the *File* → *Import* → *Scans, meshes or point clouds* menu option or hit `Ctrl + I`. Next, select a file for importing. You can also drag and drop a file into the main Artec Studio window, or just double click on it.

Note: The import process runs in the background, so you can continue working with the scans you've already loaded. The progress indicator for the import operation will appear at the bottom of the main application window. To abort the operation, click *Cancel* in the bottom-right corner.

Artec Studio will import frame files as individual single-frame scans. After importing each scan, the application calculates the *key frames* for any scan that contains more than one surface. Also, the application will check the surfaces for defects when the appropriate setting is enabled (see *Surface-Consistency Detection During Import*). If it finds defects, it

will show a dialog with a list of defective surfaces once the import operation is complete. You can then choose which ones should be corrected.

8.4.2 Importing CAD models

You can import CAD models created in different CAD programs and saved to the following formats: `STEP`, `STP`, `IGES`, `IGS`, `X_T`.

To import a file, use the *File* → *Import* → *CAD models* menu option. Next, select a file for importing. You can also drag and drop a file into the main Artec Studio window, or just double click on it.

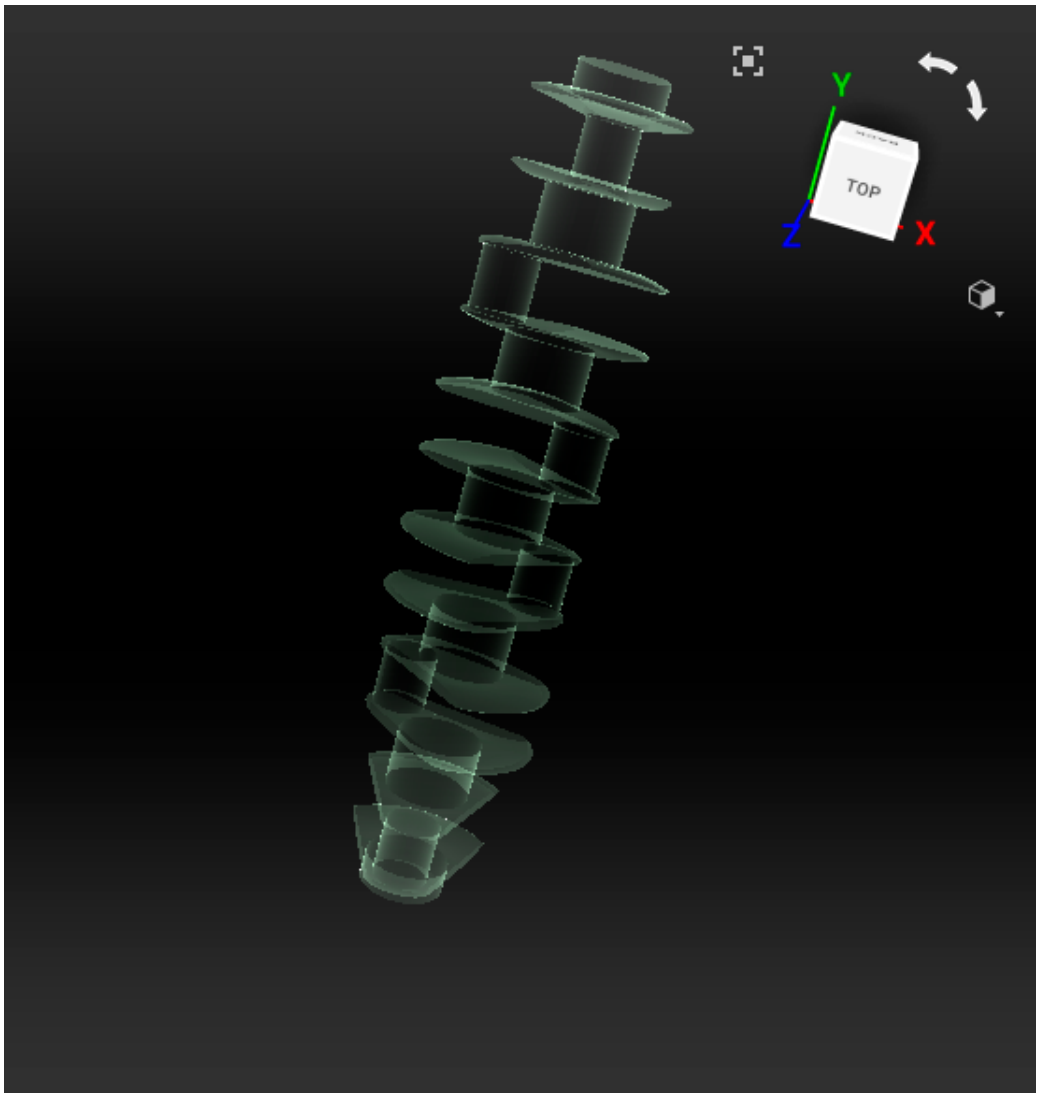


Figure 69: Imported CAD model.

8.5 Exporting Models, Scans and Point Clouds

When you want to store data for future processing, the best approach is to save the project as an SPROJ file or to export the data to the SCAN format. Any Artec Studio version can open the latter format. If you plan to use the data in other applications, however, you should save scans and individual frames in another format.

You may also need to perform one of the following tasks:

Export one or more scans	*File* → *Export* → *Scans*	Doing so will save all frames to folders with names that match the corresponding scan names. An exception is the SCAN format; in this case, Artec Studio not only stores the frame-by-frame scan structure, but it does so in a single file.
Export a single surface	*File* → *Export* → *Meshes*	It works for models. If you, however, marked several scans, models or frames using the ✔ button, Artec Studio will suggest merging them.
Export Ray scans	*File* → *Export* → *Point clouds*	It works for point-cloud scans from Ray.

8.5.1 Exporting Scans

To export scans:

1. Mark any scans you want to export using the ✔ button.
2. Select the *File* → *Export* → *Scans* command.
3. Click the … button to open and specify the destination folder.
4. Select *Scan export format* using the eponymous dropdown list.
5. If the selected format supports textures, also specify the texture format.
6. Select the *Apply transformation* checkbox, or leave it cleared (for more information, consult *Understanding How Artec Studio Applies Transformations*).
7. Click *OK*.

ply	Stanford polygon file format
stl	Stereolithography file format
obj	Wavefront OBJ file format
wrl	VRML file; actual extension is *.wrl
x	Direct X file format
scan	Artec 3D scan format
plyVC	Stanford polygon file format with vertex colors, actual extension is *.ply
obc	OBC point-cloud file

Note: The export process for models and scans runs in the background, so the application will allow you to continue working with the scans. The progress indicator for the export operation will appear at the bottom of the main application window. To abort the operation, click *Cancel* in the bottom-right corner.

8.5.2 Exporting Meshes (Models)

To export a mesh:

1. Mark one or more models using ✔ or select frames in the scan by clicking on them while holding the `Ctrl` key.
2. Select the *File* → *Export* → *Meshes* command.

   Tip: `Ctrl+Shift+E` hot key does the same.

3. Specify the destination folder, enter the file name, and select the appropriate mesh format from the dropdown list[1].
4. Click *Save*.
5. If the model has texture and the format supports it, specify the *Texture export format* in the new dialog (see *Storing and Exporting Color Information*).
6. Click *Export*.

`PLY`	Stanford polygon file format (standard and with the support for vertex color)
`STL`	Stereolithography file format
`VRML`	VRML file (1.0 and 2.0); actual extension is `*.wrl`
`OBJ`	Wavefront OBJ file format
`ASC`	Point cloud 3D format
`AOP`	American Academy of Orthotists and Prosthetists file format
`PTX`	Walt Disney Ptex: mesh with per-face texture mapping
`X`	Direct X file format (binary and text)
`XYZRGB`	XYZRGB file format
`E57`	ASTM E57 3D file format

See also:

Model Placement

[1] If you type an extension in the file name field, application will use it rather than the selected mesh file format.

8.5.3 Exporting CAD objects

You can export CAD primitives created in Artec Studio to the following formats: STEP, IGES, X_T.

To export CAD primitives:

1. Mark one or more CAD object using flag ✔ or *Workspace* menu commands.
2. Select the *File* → *Export* → *CAD objects* command.
3. Specify the destination folder, enter the file name, and select the appropriate format from the dropdown list.
4. Click *Save*.

8.5.4 Exporting Point Clouds

You can export point-cloud scans obtained from Ray scanner to either of the following formats (respective units are given in the third column):

PTX	Leica Geosystems Cyclone Point Cloud. **Important!** Don't confuse it with *Disney Ptex*.	Meter
XYZ	XYZRGB file format	Specified in *settings*
BTX	Artec Ray point cloud; various versions (v2, v3, v5, v6).	Micron

1. Mark one or more point-cloud scans using ✔ flag in *Workspace*. Ensure that you have selected a point-cloud scan by double-clicking its name: the panel must show point-cloud properties.
2. Select *File* → *Export* → *Point clouds*.
3. Specify the destination folder and required format and click *Save*.

8.5.4.1 Merging Sections

When exporting to PTX, ensure the *Export point clouds to PTX with merged sections* checkbox is marked in the Artec Studio settings. This option merges all sections (selections made during scan with Ray scanner) so that third-party software products can open the exported file.

8.5.5 Understanding How Artec Studio Applies Transformations

Artec Studio offers two options for exporting surfaces:

1. Store surfaces using the scanner coordinates and create XF text files that contain the coordinates calculated during registration. To use this approach, clear the *Apply transformations* checkbox.

2. Store surfaces that are relocated to the positions calculated during registration. In this case, XF files contain no relevant data. To use this approach, select the *Apply transformations* checkbox.

8.5.5.1 Special Aspects of Scan Placement

In most cases when you're exporting a scan to a common 3D-graphics format, you should select the *Apply transformations* checkbox. By doing so, you instruct third-party applications to display surfaces in the same way that Artec Studio does: that is, with the origin at the center of mass. If for some reason you need to store a scan in the scanner's coordinate system—in other words, with surfaces located at a distance from the origin that is equal to scanner's operating range—clear the *Apply transformations* checkbox.

Technically, Artec Studio saves scans in the scanner's coordinate system, but it displays them in a user-friendly manner by placing the origin at the center of mass. The actual positions of surfaces calculated during registration are stored in text (XF) files. Therefore, when you're importing files using Artec Studio, it makes no difference whether the checkbox was cleared when Artec Studio exported them. It does make a difference, however, for third-party applications that cannot read XF files simultaneously with 3D geometry.

8.5.6 Storing and Exporting Color Information

You can transfer color information for 3D surfaces in three ways. The most common is through a texture using a separate bitmap file (see *Applying Texture (Procedure)*). Another option is to save color information in each vertex of a mesh. The third is to assign a small textured fragment to each polygon. The two latter methods produce no texture files.

Colors stored in a vertex are blended throughout the polygon. As a result, you should avoid oversimplifying the exported mesh; otherwise, colors blended over a large face may fail to render true texture information.

Table 8: Formats that support color-information transfer.

Texture stored as a bitmap	PLY, VRML (*.wrl), OBJ, X, e57
Model file contains separate texture for each face	PTX
Formats that support vertex color	plyVC, XYZRGB

When exporting texture as a bitmap image, you can select one of the following formats: PNG, BMP or JPG. PNG format provides the best quality for a given file size thanks to its lossless image compression. JPG is the most compact format.

8.5.7 Exporting Target Coordinates

If you scan while in the *Targets* tracking mode *using only Artec scanners*, you can save an OBC file containing the target coordinates. Once you finish scanning, run *Global registration*, then do the following:

1. Use the ✔ button to mark any scans that you captured without having uploaded an OBC file.
2. Select the *File* → *Export* → *Scans* command.
3. Click the … button to open and specify the destination folder.
4. Select *obc* from the *Scan export format* dropdown list.
5. Click *OK*. The `targets.obc` file will appear in the folder you specified.

For more information on the OBC file structure, consult the FAQ.

8.5.8 Exporting to Leios

Artec Studio enables you to export files to *Leios* by accessing the *File* menu if the *Leios* software is already installed on your computer.

1. Select a model in the *Workspace* panel
2. Open *File* → *Export to Leios*
3. Then, in *Leios*, select millimeters as the length unit for the imported files.

8.5.9 Exporting to Geomagic Design X

Polygonal models created in Artec Studio are insufficient for most design needs. Geomagic Design X (formerly Rapidform XOR) is purpose built to create manufacturing-ready *CAD model*s directly from meshes.

To export a model,

1. Make sure Geomagic Design X is installed on your computer
2. In the *Workspace* panel, mark one model using the ✔ flag
3. Select the *Export to Design X* command from the *File* menu
4. Wait for the model in OBJ format to open in the reverse-engineering system.

8.5.10 Exporting to SolidWorks

Artec Studio allows you to export models to SolidWorks by using third-party plug-ins. It supports the following plug-ins:

- Geomagic for SolidWorks
- DezignWorks for SolidWorks

To export a model,

1. Make sure SolidWorks and either of the plug-ins are installed on your computer
2. In the *Workspace* panel, mark one model using the ✔ flag

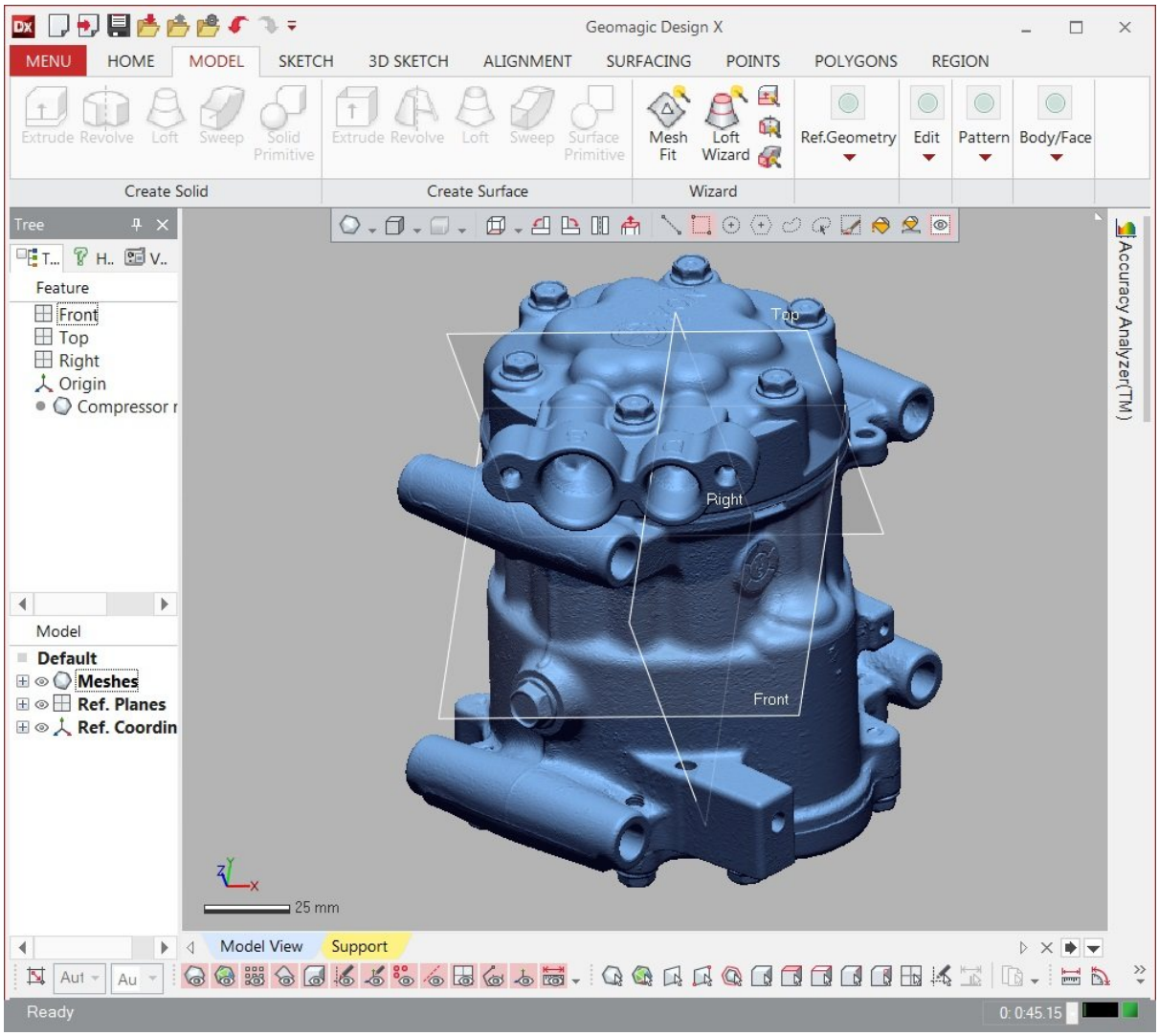


Figure 70: Model exported to *Geomagic Design X*

3. Select the *Export to SolidWorks* command from the *File* menu
4. Wait for the model to open in the CAD system.

8.6 History of Project Changes

Artec Studio stores all data changes, and you can later undo any unnecessary changes. You can see the saved changes and their use of memory in the *History* panel. To open the panel, click the button at the bottom left or hit `Ctrl+H`

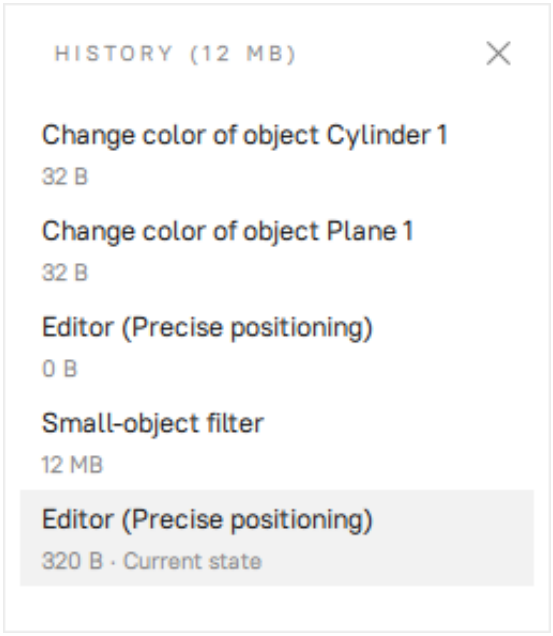


Figure 71: The History panel.

Click on the desired operations in the list to undo or redo them. Operations can be undone (redone) only sequentially, i.e. you cannot skip any of them selectively.

To quickly undo or redo the changes stored in the project history, you can also use the following options:

- Undo:
  - Hit `Ctrl+Z` or
  - Click in the lower-left corner of the main window
- Redo:
  - Hit `Ctrl+Y` or
  - Click in the lower-left corner of the main window

When you save a project, Artec Studio stores 3D data together with the history of changes. You can select the maximum length of the history in the settings window under the *Performance* tab (see *Command History*). In addition, the *Compact memory* button allows you

to save the history of changes on a local drive and thus free up RAM. Also, the *Clear command history* button clears the change history, likewise freeing up RAM, and makes the undo operation for the most recent changes unavailable. To clear the history, you can use the *Edit* → *Clear history* menu option in the main window or hit `Ctrl+Alt+H`.

See also:

Command History in the *Settings* section.

8.7 Autosaving a Project

A project can be saved by either the user or Artec Studio. The latter case is called autosaving. For temporary (i.e., unsaved) projects, autosaving is unavailable. The application autosaves a project in the following cases:

- Before running the texturing algorithm (see *Texturing*)
- When scanning is complete and the *Save scans directly to disk* option is selected (see *Scanning Procedure*)
- When unloading scans with unsaved changes (see *Memory Management: Object Unload*)
- When the *Save project before starting algorithms* setting is selected (see *Autosave Options*):
  - Before launching algorithms from the *Tools* panel
  - Before and after running the Global registration algorithm (*Global Registration*)
  - Before starting *Autopilot* (*Use Autopilot*).

CHAPTER 9

Data Processing

Once you have captured an object from all desired angles and created a sufficient number of scans, you can then build a 3D model. This chapter offers a detailed description of the process.

See also:

3D Scanning at a Glance.

- *Revising Scans* and *Editing Scans*
- *Alignment*
- *Global Registration*
- *Creating Models (Fusion)*
- *Editing Models*
- *Texturing*

9.1 Maximum Error and Registration Quality

Error is the parameter that reflects frame registration quality. For scans, it shows the maximum value among all the frames. The larger the value, the less accurate the alignment. Artec Studio displays noteworthy values only for scans that have passed *Fine registration*, *Align* and *Global registration*.

Table 9: Maximum error values for the scanner types.

	Good results	Acceptable	Unacceptable
Spider	0.0–0.1	0.2–0.3	0.4–...
Eva	0–0.3	0.4–0.9	1.0–...
Micro	0.0	0.1	0.2–...
Leo	0.0–0.5	0.6–1.3	1.4–...
Ray	0.1–0.9	1.0–2.9	3.0–...

Table 10: Other possible errors.

Error	Recommendations
Warning!	Check the frame list
Failed	Indicates unregistered frames in *Show all frames* mode

9.2 Revising Scans

As you begin building a 3D model, you may want to start by preprocessing your scans: separate misaligned areas (if any) into separate scans and cut out unwanted objects from the scene.

You may encounter the following problems:

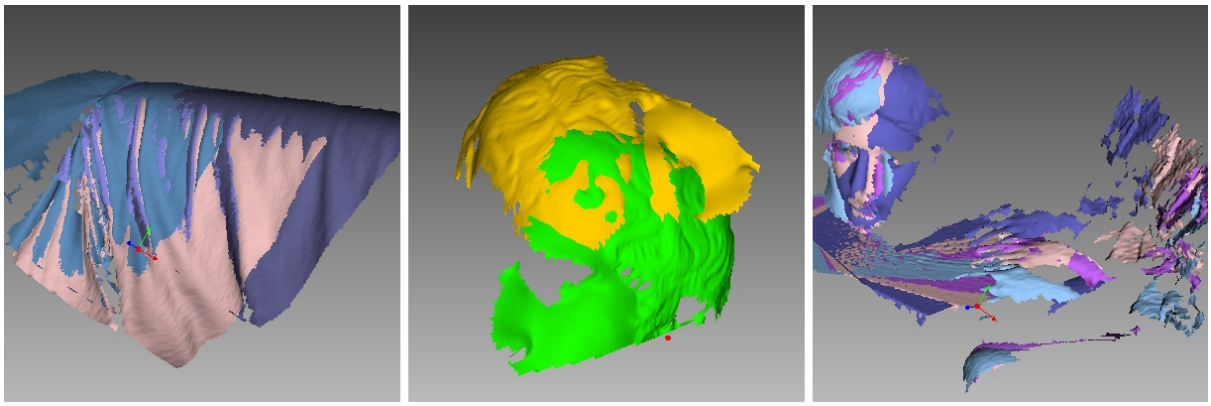


Figure 72: Possible scan errors.
Bad geometry on the left, scan misalignment in the middle and hands captured in frames on the right.

- Misaligned frames (see Figure 72, left)—may occur because of small size, an insufficient number of geometrical features on the object or an insufficient number of polygons in a frame.
- Misaligned parts (see Figure 72, middle)—occurs when the real-time alignment algorithm incorrectly determines the position of the new frame relative to previous ones.
- Unwanted objects in the frame (see Figure 72, right).

A visual inspection of the frames can be very helpful in determining problematic areas. To perform a visual inspection, select the scan and view all the frames that it contains by holding ↑ or ↓ on the keyboard. This technique can easily detect misaligned frames.

When viewing scans, application generally shows only *key frames* and textured frames. To display all the frames, select the *Show all frames* option in the *3D toolbar*.

See also:

Misalignment Detection.

9.2.1 Separating Scans

During the fine-alignment process, frames in certain scans may be misaligned. Sometimes it's possible to divide the problematic scan into several scans, where each part is registered fairly well. In this case, divide the scan. To move some of the frames into a new scan, use the following procedure:

1. Select in the *Surface List* panel the frames you want to move (see *Selecting Frames*).
2. Click RMB and select *Move to new scan* (Figure 53, right).

You can also fix alignment errors in another way: reset the current frame-transformation values and repeat the registration, making any appropriate changes to the settings. Select the desired scan in the *Workspace* panel, click on it using RMB and select *Unregister* from the dropdown menu. Doing so will reset the computed positions of individual frames in the scan. A dialog will then appear, prompting you to confirm the operation. To compute new positions, run the *Rough serial registration* and then *Fine registration* algorithms (see *Fine Registration*).

9.3 Alignment and Registration at a Glance

Registration and alignment tools perform similar tasks, however, they differ. Use the table below to get an insight into the details.

Table 11: Understanding registration and alignment modes.

Type	Purpose	Details
Fine registration	Adjusting frames' positions	Treat scans in *batch* separately. Starts once you leave *Scan* panel.
Align	Assembling scans	See also Table 12
Global registration	Optimizing frames within scans	Launch it for a pre-aligned batch of scans or for a single scan
Rough registration	Preliminary registration performed during scanning	No need to start it manually

9.4 Editing Scans

To edit scans, open *Editor* from the side panel and select the *Eraser* tool. You can also use *Positioning tool* or *Transformation tool* to orient the scanned data.

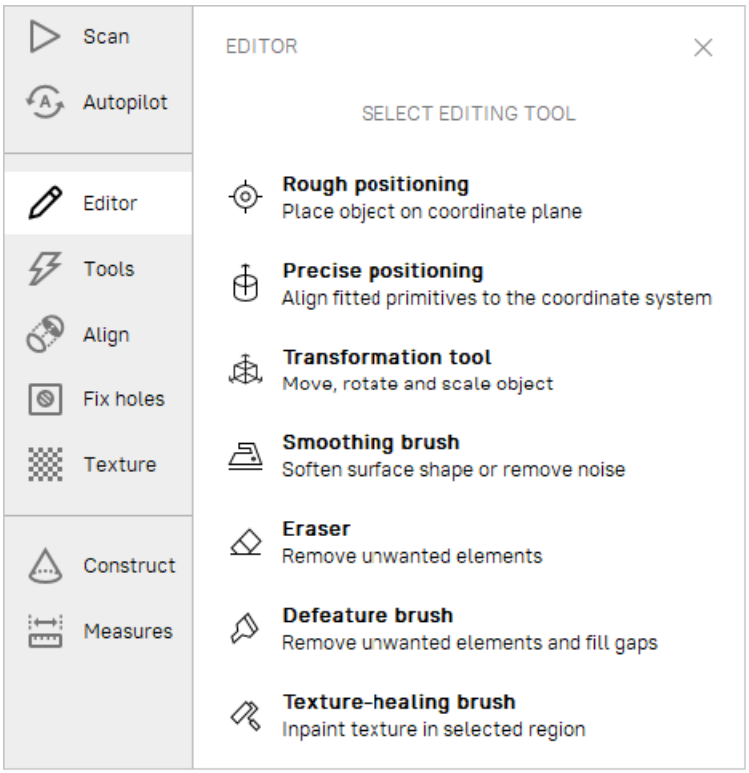


Figure 73: *Editor* panel.

9.4.1 Eliminating 3D Noise (Outlier Removal)

During the scanning process, so-called outliers may appear in the scene. Outliers are small surfaces unconnected to the main surfaces. They require removal because they may spoil the model or produce unwanted fragments. Artec Studio provides two ways to remove outliers: erase them before fusion (preventive approach) or after fusion ("furthering" approach—see *Small-Object Filter*). We advise using the former approach because it decreases the possibility of improper fusion by preventing noisy features from attaching to the main surface.

This outlier-removal approach is based on a statistical algorithm that calculates for every surface point the mean distances between that point and a certain number of neighboring points, as well as the standard deviation of these distances. All points whose mean distances are greater than an interval defined by the global-distances mean and standard deviation are then classified as outliers and removed from the scene.

For better results, we recommend running global registration before starting the algorithm. If you begin *Outlier removal* before doing so, a dialog will appear prompting you to perform global registration.

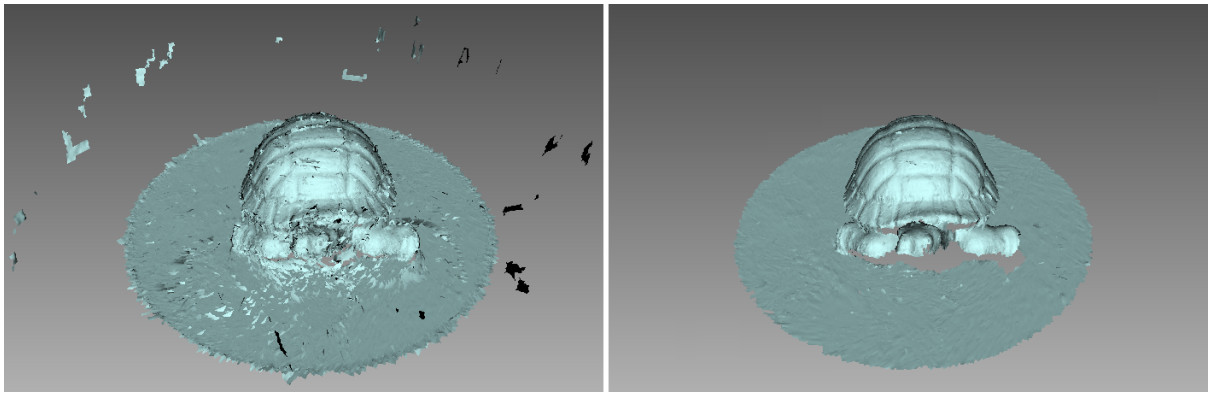


Figure 74: *Outlier removal*: before and after.

In most cases, none of the parameters accessible through the ⌄ button requires adjustment. But if necessary, you can change the values of these parameters:

- *3D-noise level* is a standard-deviation multiplier. We recommend choosing the value for this parameter according to the following guidelines:
  - `2` for noisier surfaces
  - `3` for less noisy surfaces
- *3D resolution, mm* should be set equal to the resolution of the *Fusion* process that you expect to run later.

Click *Apply* to run *Outlier removal*.

9.4.2 Erasing Portions of Scans (Eraser)

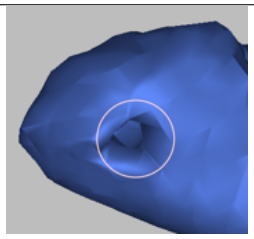
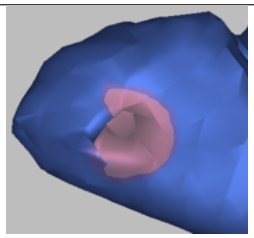
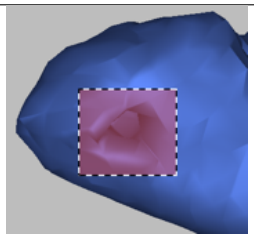
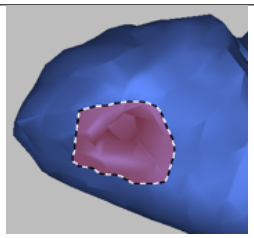
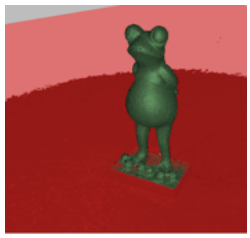
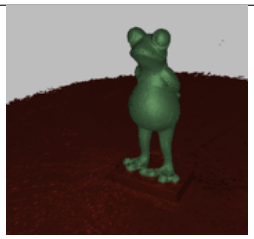
Nearly always, the scanning process will capture unwanted elements, such as walls, the operator's hands, surfaces on which the object is located and other extraneous objects. This unwanted data can hinder postprocessing. To avoid this problem, we recommend eliminating these objects before processing. Eraser offers several options to quickly and easily remove unwanted elements from the scene (see *Selection Types*).

1. Open the *Editor* panel using the side toolbar.
2. Open the *Eraser* tool by clicking  or by hitting `E`.
3. Select one or more scans in the *Workspace* panel.
4. In the *Editor* panel, choose the required *selection type*.
5. Consult the *instructions* for a specific mode and select regions on the scans that you want to erase. To clear all selections, click *Deselect*.
6. Click *Erase* to eliminate the area highlighted in red or to apply cutting plane (*Cutoff-plane* or *Base* selections).

To undo changes, click  in the *Workspace* panel or menu *Edit*, or hit `Ctrl + Z`. Each click of the *Erase* button generates a command history entry. To undo several operations,

use the dropdown menu of button and select the lowest entry.

9.4.2.1 Selection Types

Type	Illustration	Usage
2D		Hold down `Ctrl` and use `Scroll wheel` to adjust the tool size. Paint with `Ctrl+LMB` to create a selection.
3D		See above.
Rectangular		Use `Ctrl+LMB` to select a rectangular region.
Lasso		Use `Ctrl+LMB` to freely outline an irregular region. You can release `LMB` (not `Ctrl`) and then continue clicking on desired points to select a desired shape.
Cutoff-plane		Create selection as in *2D* mode. Once you have released the mouse button, a plane will appear. If necessary, adjust the plane level by using `Scroll wheel` while holding down `Ctrl+Shift` or orient the plane freely in 3D space. To this end, hit `Alt` to display the *designated control*. Then still holding the key, drag the required control ring.
Base		Select a flat area as in *2D* mode. The tool will automatically fit the base plane and select everything below it.

If the *Select through* checkbox is selected, all surfaces throughout the scan are affected.

If not, the brush only works on the visible surface.

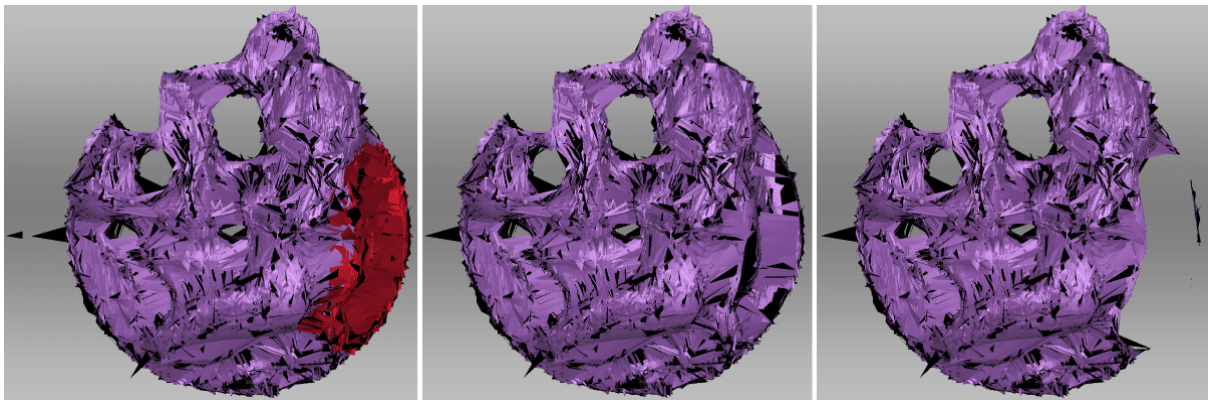


Figure 75: *Select through* in *2D selection*: disabled in the middle, enabled on the right.

Use the following general procedure to erase unwanted elements:

See also:

Hot keys in Editor.

9.4.2.2 More Actions With Selections

Apart from erasure, you can perform the following action with the selected regions:

- **Clear selection** to create a new one. Click *Deselect* or reselect the region manually while holding down `Ctrl+Alt`.
- **Invert selection** (clear the highlighted region and select the rest). It might be useful when working with large scans. Click *Inverse* or hit `I`.
- **Temporarily hide selection** if it obstructs the region you want to erase. Click *Hide* to this end. To display hidden polygons, click *Show*. Then select the region you want to erase.

9.4.2.3 Erasing Supporting Surface

Artec Studio offers two selection modes that differ from conventional brushes in the way how you select the area for erasure. First, you indicate the flat surface (table, floor or base) on which the object is resting. Then, application either determines the base plane and select the area underneath it (*Base selection*, Figure 76), or creates a cutting plane (*Cutoff-plane selection*) that divides the scan into two parts: the first will remain and the second will be erased (see Figure 77). You can orient this plane in any way you need.

Tip: Consider using the *Enable automatic base removal* option when scanning since it deletes the flat surface automatically after you close the *Scan* panel.

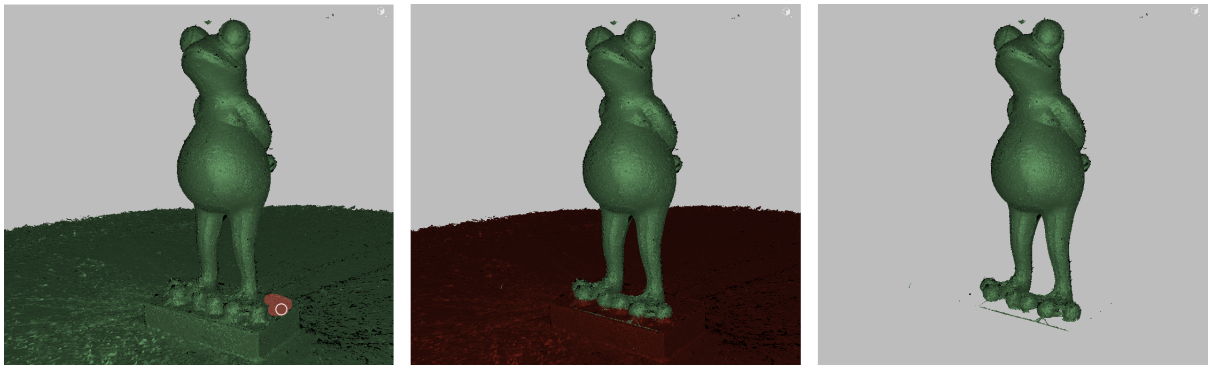


Figure 76: *Base selection* in action: indicating a flat region → defined base → removed base.

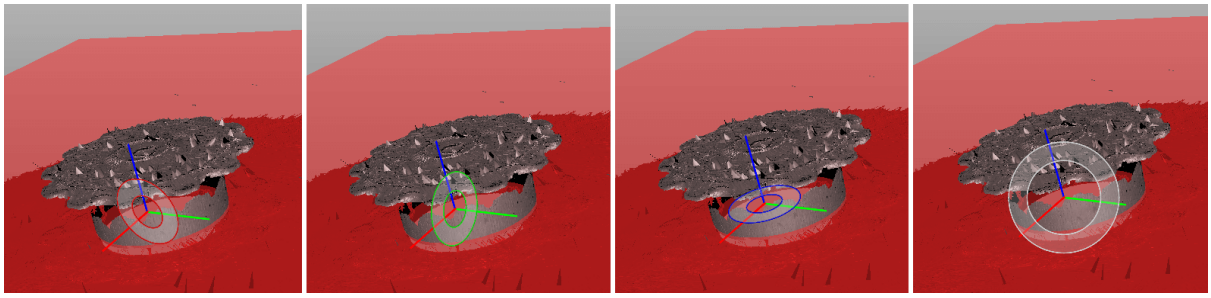


Figure 77: Various controls for orienting cutoff plane: around axes (X, Y and Z) and view direction.

9.5 Fine Registration

Fine registration is an algorithm designed to precisely align captured frames.

In a number of cases you can start the Fine registration algorithm manually using the *Tools* panel. To access a list of parameters, click the ⌄ button in the *Fine registration* section. The algorithm affects all scans marked with the ✔ icon in the *Workspace* panel (see *Selecting Scans and Models* for more information on scan selection), but it processes them separately.

Features	*Geometry and texture* or *Geometry*	The type of algorithm that will perform scan registration. The former is preferable as it takes both geometry and texture into account. If your scan entirely lacks texture, we recommend using *Geometry* option.
Downsampling	0.01–1	The option makes the input geometry data less dense to speed up the processing. Use lower values for objects with poor geometry. Designed for scans with HD reconstruction, this option can speed up processing in *Geometry and texture* mode.

9.6 Alignment

Although Artec Studio features continuous scanning, there may be some cases where the application lack sufficient information about the relative positions of multiple scans. To assemble all scans into a single whole, you must convert the data to a single coordinate system—that is, you must perform alignment using the *Align* tool.

Hint: First refer to *Auto-Alignment* and take a glance at the *Summary of Alignment Modes* section as well.

9.6.1 Selecting Objects for Alignment

In the *Workspace* panel, use the ✔ flag to mark all scans or *group*s that you intend to work with. Once you click *Align* in the side panel, the marked scans and groups will appear in the left panel already selected in the same order as they appear in the *Workspace* panel.

Note: *Workspace group* of scans is treated as a single entity. To release objects constituting the group, use the *Ungroup* item from the dropdown menu.

During the *Align* operation, Artec Studio divides the selected scans or groups into two *collection*s: registered (aligned) and unregistered (unaligned). The first collection initially contains only one scan (the first one in the list) or group, which are highlighted in blue. Collection name appears in bold and uses the same color icon (or). *Auto-Alignment*, however, may produce several collections of aligned scans.

The user's task is to align all scans to those that are already registered and to "assemble a model". In general, the procedure includes the following steps:

1. Click the required tab in the *Align* panel.
2. Select one scan or group ( ) from the unregistered collection in the *Align* panel. The name of unregistered scan appears in a regular typeface. When selected, the unregistered scan is marked by the green icon , whereas the group is marked by icon . You can select several scans using either of the following methods:
   - Press and hold down the `Ctrl` key, and then click each scan or group that you want to select
   - Click the first item, press and hold down the `Shift` key, and then click the last item.
3. If necessary, specify point pairs (for two scans) or sets of points (for more than two scans)
4. Click the desired alignment-command button (*Auto-Alignment* is the most recommended one). The command affects all scans selected in the *Align* panel plus the first one ( ).

Note: If other objects, except for scans, belong to a group, you can also position them simultaneously with the scans. Select the *Apply to all objects in parent groups* checkbox to this end.

Since each mode varies in its effects, see the details in the corresponding subsections for more information. Note that you can use either one mode or a series of modes (see comparison table in *Summary of Alignment Modes*): drag alignment, rigid alignment with and without point specification, automatic rigid alignment, and alignment with surface deformations.

9.6.1.1 Changing Object Status

If you have already aligned several scans, you should move them to the registered collection. Select them in the *Align* panel using LMB. Next, click RMB on the name of any scan and select the *Mark as registered* option from the dropdown menu, or just double-click its name in the list. At this point, Artec Studio will treat registered scans as one, so you cannot move them independently.

If you accidentally mark a scan as aligned, remove it from the registered collection by selecting the *Mark as unregistered* item from the dropdown menu, or just double-click it.

9.6.2 Displaying Objects in 3D View

Objects selected in the *Align* panel appear in the *3D View* window. Keys 1, 2 and 3 switch among objects in the *3D View* window:

1	Shows aligned scans, groups and *collection*s
2	Shows scans and groups that are currently under alignment
3	Shows all scans and groups

Navigation in align mode is similar to navigation in the *3D View* window:

Rotate	Hold LMB and move mouse
Zoom in/out	Scroll the Mouse wheel, or hold RMB and move mouse
Move freely	Hold LMB and RMB simultaneously, or hold the middle button, and move mouse

9.6.3 Summary of Alignment Modes

The table below provides basic information on the various alignment modes (see *Alignment*).

- **Object type** lists which scans and models you can use in a particular mode.

- **Scans per operation** is the number of scans required to use a particular mode.
- **Markers in set** prescribes how many markers (points) you can map in one point set. Some modes require point (marker) sets, but some don't.
- "—" means that markers are unnecessary.
- "0 or 2" means point specification is optional and, if you do specify them, only marker pairs are allowed.
- "At least 1" means you can specify an unlimited number of markers in one set.

Table 12: Parameters for alignment modes.

Mode	Object Types	Objects per Operation	Markers in Set	Notes
Rigid (markers)	Any	2	2	Considers only coordinates, not geometry
Rigid (meshes)	Any	2	0 or 2	Considers geometric features
Rigid (texture)	Scans with poor geometry	2	0 or 2	High resource consumption
Rigid (auto)	Any	Any number	—	Works if surface is well textured
"Drag"	Any	2	—	Interactive
Nonrigid	Polygon models	Any number	0 or 2	Deforms surfaces and textures; pre-alignment required
Complex	Any	1 (at least 2 for models)	At least 1	Precise and flexible

9.6.4 Drag Alignment

Drag alignment is always available, regardless of which tab is active in the *Align* panel. This mode allows you to align scans by manually dragging them in the *3D View* window.

Owing to the low accuracy of this approach, however, you can optionally use it for preliminary alignment before running more-accurate modes.

1. Select the scan you want to align, keeping in mind the recommendation in *Selecting Objects for Alignment*. Artec Studio allows you to select multiple scans, but note that it will align them with the registered scans as a single unit.
2. Holding down the `Shift` key and one mouse button, move and rotate the scan you're aligning (a green one) close to the registered scan (a blue one). Here is a list of allowed movements and corresponding buttons:
   - `Shift+LMB` to rotate
   - `Shift+LMB+RMB` to move

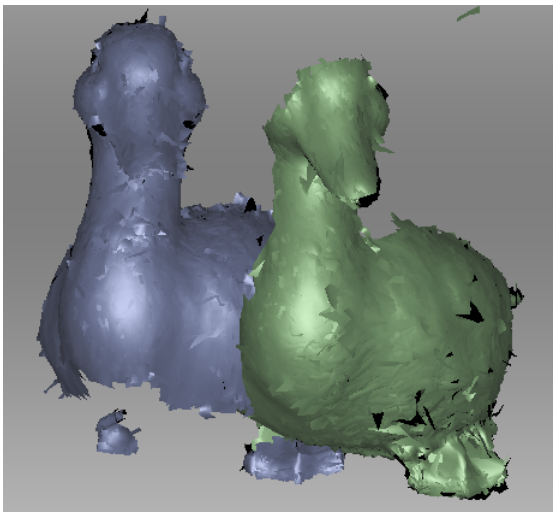


Figure 78: Dragging a scan

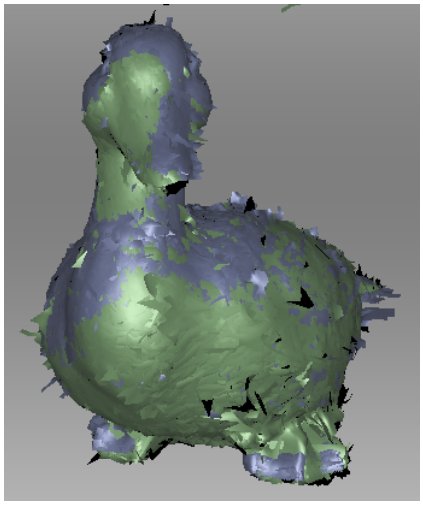


Figure 79: “Drag” alignment result

- `Shift+RMB` or `Shift+Scroll` to move only unregistered scan along the view direction

3. To confirm the alignment, release the mouse button(s) and the `Shift` key, then click *Apply*. Note carefully that any scans you are registering won't automatically move to the registered set (see Figure 79). You can do so manually as the *Changing Object Status* describes.
4. If you have several scans to align, repeat these steps for each one individually.

9.6.5 Auto-Alignment

Rigid alignment is a universal mode suitable for aligning most scans. Auto-alignment is the easiest approach, however. The advantages of this latter mode include the ability to align several scans at once and avoid the need to specify points; the only disadvantage is minimum requirements for the size of the overlapping areas in the scans you're aligning.

To perform auto-alignment, follow these steps:

1. Make sure the *Rigid* tab is selected in the *Align* panel (see Figure 80). The tool will automatically select all scans. Clear unnecessary selections by using the `Ctrl` key (see *Alignment*).
2. Click *Auto-alignment*. Ideally, Artec Studio aligns all the scans and marks them using the icon. It may, however, mark scans as registered even though the 3D surfaces failed to join properly.

Important: Auto-alignment may be unsuccessful if the scans have small overlapping area.

Auto-alignment may produce the following results:

- Aligned scans, marked with the icon (basic *collection* of registered scans)
- Unregistered scans, marked with the icon
- One collection ( ) or several collections (,) of registered scans. Scans forming this collection failed to align with the basic registered collection ( ), although they succeeded in aligning with each other.

We recommend resolving issues with unregistered scans or registered collections by aligning them manually as *Manual Rigid Alignment with Points* describes. Other methods may also help.

9.6.5.1 Managing Collections and Scans

You can perform the following actions on the scans from the list in the *Align* panel (right-click on the item to open the context menu):

- *Mark as registered*. Only available for single unregistered scans or *group*s (→)

- *Mark as unregistered*. Use this command to discard the alignment state of a particular scan (unavailable for scans)
- *Select collection* highlights the respective *collection* (, , and so on)
- *Mark collection as registered* converts all scans from the collection into the basic registered collection (→)

9.6.6 Manual Rigid Alignment Without Specifying Points

You can perform rigid alignment either with or without specifying points. If the scans are close to each other in distance (e.g., after "drag" alignment), or if they have a large overlapping area or rich texture, you can skip the task of point specification when aligning them.

Perform the following steps:

1. Make sure the *Rigid* tab is selected (see Figure 80).
2. Select the scan you want to align, as the beginning of *Alignment* describes.
3. Click *Align*. The result should be as Figure 82 depicts. If you are dissatisfied with this result, click and follow the recommendations in *Manual Rigid Alignment with Points*.
4. Select another scan from the list of unregistered scans and repeat the above procedure.
5. Click *Apply* to confirm your alignment results or *Cancel* to reject them.

9.6.6.1 Texture Alignment

If the object was scanned with texture, the texture-alignment feature may ease the alignment process. It uses texture-image characteristics of scanned objects and greatly decreases the possibility of incorrect alignment. This feature also helps to align objects with few or no geometrical features, such as round or flat objects with no corners. If an object has rich, nonrepetitive geometry, however, we recommend disabling texture alignment to reduce the algorithm's running time. Also keep in mind that texture alignment will be useless if the object texture is monochrome.

To enable texture alignment, select the *Enable texture alignment* checkbox at the bottom of the *Align* panel just before you perform Step 3 of the *procedure* above.

Note: Texture alignment is a resource-intensive algorithm that slows down the alignment process. We recommend using it only in cases where the object's geometrical features are insufficient.

9.6.7 Specifying Points and Editing Their Positions

Before considering how to align scans using points, it is helpful to highlight point-pair specification. The alignment algorithm uses pairs of point, or point sets in *Complex* alignment mode (*Complex Alignment*), to detect scan areas that should be brought close together.

To do point alignment, create several point pairs. To create one pair, mark one point on the aligned scan and then mark another one on the unaligned scan. Ensure that in each case the points for a given pair match a corresponding point on the surface of a real object; note, however, that high matching accuracy is unnecessary, since Artec Studio only uses the pairs to gain a rough approximation before performing precise registration. In the *Complex* mode, you can create a set of points (instead of just a pair), i.e. you can simultaneously specify more than two points in one or several unregistered scans and only one in the registered scan. All these points are connected by polylines and form a set.

When specifying points in the *Rigid* and *Nonrigid* modes, the application automatically creates pairs. Having specified one pair, you can immediately create the next one. In *Complex* mode you must confirm set creation by hitting `Space` or by clicking *New set* from the left panel, because the set may comprise multiple points (see Figure 81 and Figure 87).

You can toggle between the point pairs (sets) by hitting `Space` and `Backspace`, or by clicking `RMB` in the *3D View* window and selecting the relevant options from the menu. You can also relocate points in the pair (set). Hover the mouse cursor over the point until the pair (set) is highlighted in white, then drag the point to the proper position using `LMB`, or select the pair (set) and specify a new position using `LMB`. To confirm your actions and deselect the pair (set), hit `Space`. You can also remove either a pair (set) or one of its individual points: click on the point using `RMB` and choose the appropriate command from the menu. Alternatively, you can use `Del` to remove the selected pair (set).

9.6.8 Manual Rigid Alignment with Points

We advise using this mode for scans located at a significant distance from each other or when aligning polygon models with CAD models.

To use this approach, follow these steps:

1. Make sure the *Rigid* tab is selected (see Figure 80).
2. Select the object you want to align, as the beginning of *Alignment* describes.
3. Specify several point pairs (Figure 81), keeping in mind the recommendations from *Specifying Points and Editing Their Positions*.
4. Click *Align markers*. This mode takes into account only the coordinates of specified points and tries to reduce the distance between the markers for each pair.
5. Carry out Steps 3–5 of the *procedure* in *Manual Rigid Alignment Without Specifying Points*.

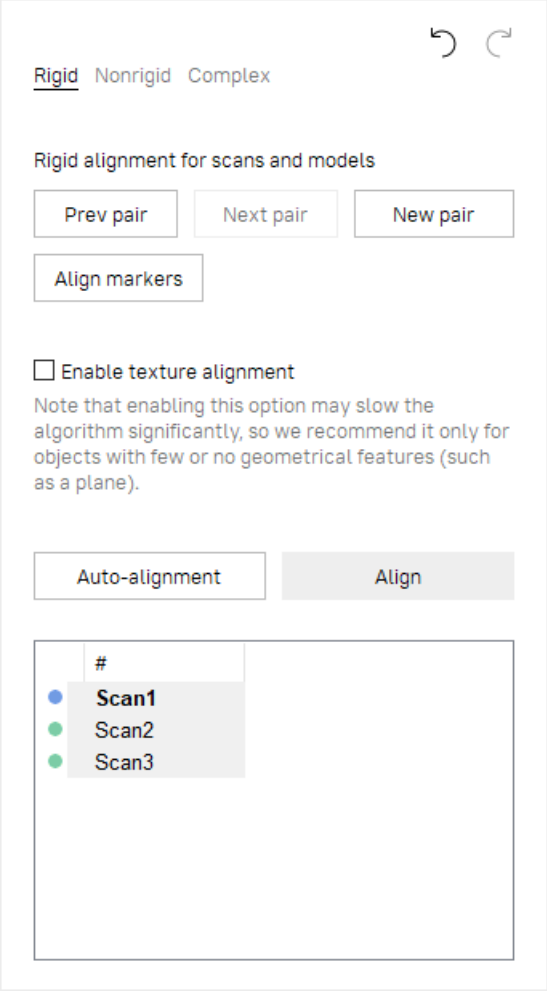


Figure 80: *Align* panel: *Rigid* tab.

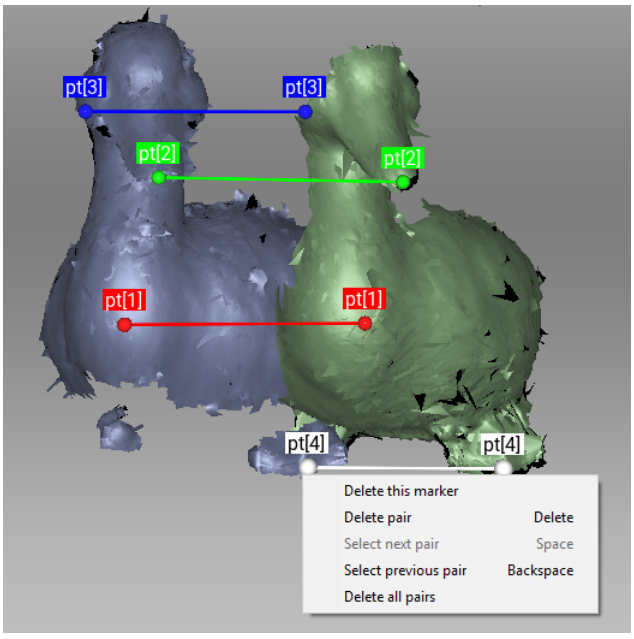


Figure 81: Creation of point pair.

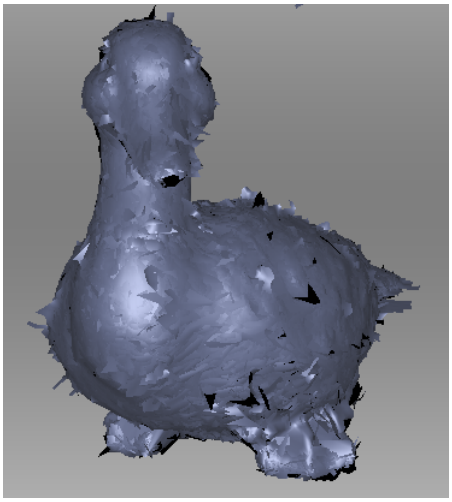


Figure 82: Alignment result.

9.6.9 Nonrigid Alignment

Whereas rigid alignment can only perform such transformations as translation and rotation, the nonrigid algorithm can deform 3D data. This algorithm is intended to process so-called nonrigid objects: objects whose shapes have changed during the scan (e.g., models of animals or humans—see Figure 84, left). Keep in mind that the surface Artec Studio produces as a result of the deformation may differ from the surface of the actual object.

Note: Nonrigid alignment works on models only. Thus, before you run it, prepare models by fusing the source scans. It is also necessary to first align models in rigid mode (see *Manual Rigid Alignment Without Specifying Points*, *Auto-Alignment* or *Manual Rigid Alignment with Points*).

To run the nonrigid alignment, follow these steps:

1. Make sure the *Nonrigid* tab is selected (see Figure 83).
2. Select the models you want to align, as the beginning of *Alignment* describes.
3. If the models differ significantly from each other, we suggest that you specify several point pairs, keeping in mind the recommendations in *Specifying Points and Editing Their Positions*.
4. Where necessary, adjust the deformation degree using the flexibility slider. The greater the flexibility value (i.e., the more "flexible" the deformation), the longer the computation will take.

> **Warning:** Avoid extreme *Flexibility* values. Applying very large values may result in major surface distortions and may slow down the algorithm. Extremely low values, on the other hand, barely deform surface

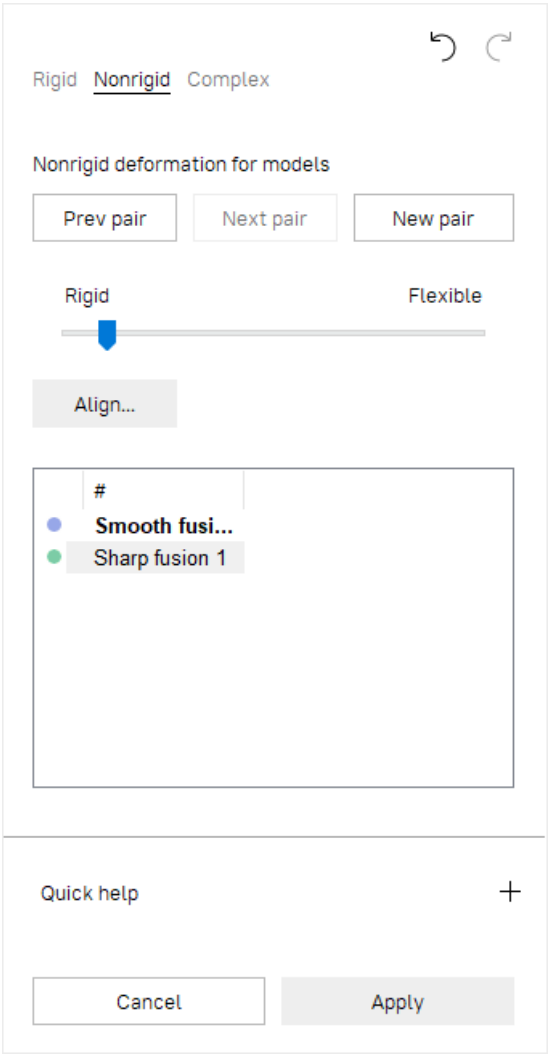


Figure 83: *Align* panel: *Nonrigid* tab.

Figure 84: Two models after rigid (left) and nonrigid alignment (right).

and often fail to produce the expected nonrigid-alignment results.

5. Click *Align*.... The algorithm will align models by deforming one of the model (see Figure 84, right). If you are dissatisfied with the alignment results, click ↺ and specify additional point pairs, or reposition the current pairs.
6. Select another model from the unregistered set and repeat the steps above.
7. Click *Apply* to confirm your alignment results or *Cancel* to reject them.

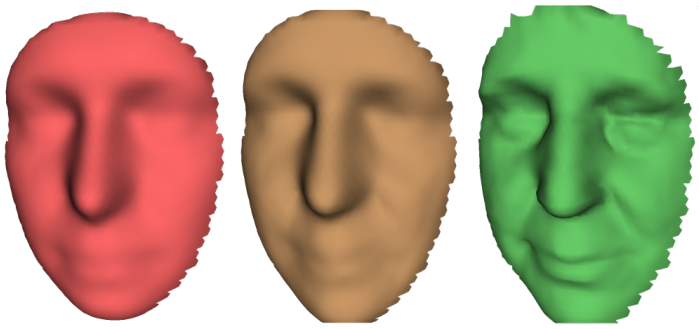


Figure 85: *Flexibility* slider in action: original model (left), nonrigidly aligned model with low *Flexibility* value (middle) and with high value (right).

Note: This version of Artec Studio does not support texture mapping on nonrigidly

aligned models.

9.6.10 Complex Alignment

Complex alignment allows you to align not only scan to scan, but surface to surface within a given scan (see the mode comparison in *Summary of Alignment Modes*). Relative to other modes, this one supports multipoint-set definition—that is, you can link more than two points. It's useful for aligning scans obtained during circular movements of the 3D scanner in cases where fine or global registration fails to align them. To run the *Complex* alignment, perform the following steps:

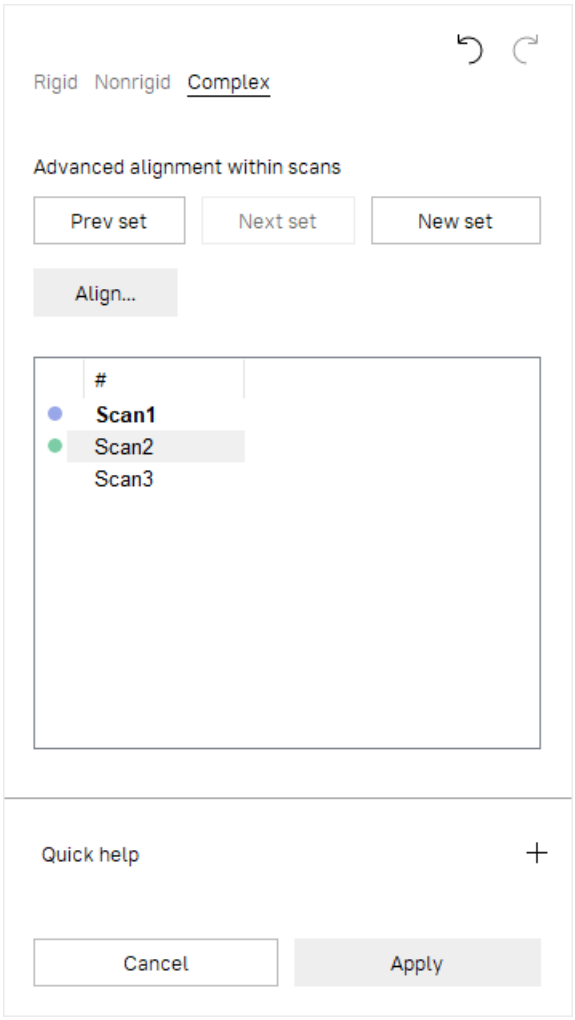


Figure 86: *Align* panel: *Complex* tab.

1. Make sure the *Complex* tab is selected (see Figure 86).
2. Select the scans you want to align, as the beginning of *Alignment* describes. This mode allows you to work even with just one registered ( ) scan.
3. Specify one or more point sets on the scan surface (see Figure 87), keeping in mind the recommendations in *Specifying Points and Editing Their Positions*.

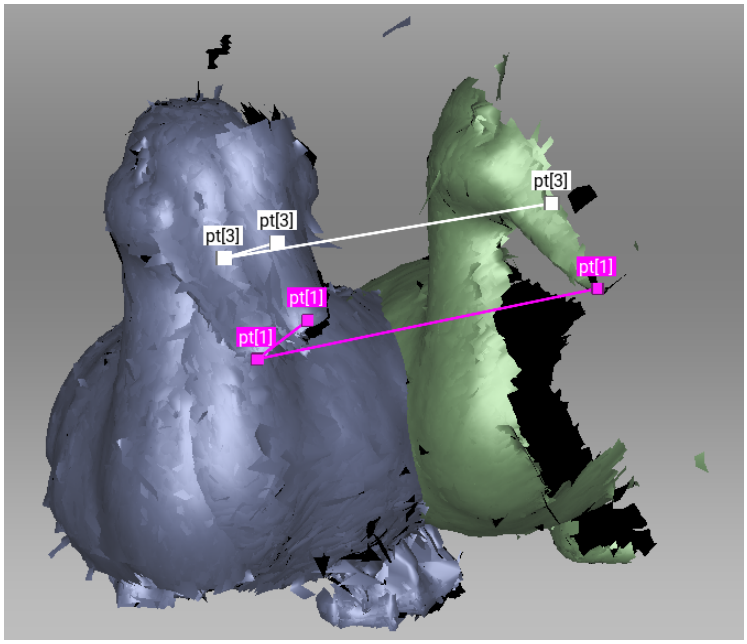


Figure 87: Before alignment: two point-set added.

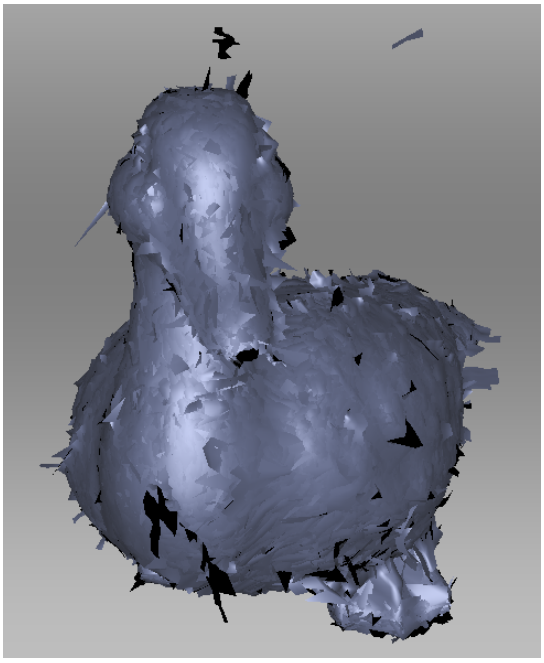


Figure 88: Alignment result.

4. Click *Align*... to run the alignment with your specified constraints (Figure 88 shows example results). If you are dissatisfied with the alignment results, click and specify additional point sets, or reposition the current sets. To redo an operation that you have undone, click .
5. Click *Apply* to confirm your alignment results or *Cancel* to reject them.

9.7 Global Registration

Once you have aligned all your scans, proceed to the next stage: global registration. The global-registration algorithm converts all one-frame surfaces to a single coordinate system using information on the mutual position of each surface pair. To do so, it selects a set of special geometry points on each frame, followed by a search for pair matches between points on different frames. To perform correctly, the algorithm requires an initial approximation, which a user ensures in the course of the *Align* operation.

Note: Global registration is a resource-intensive operation. Processing of large data sets may take a long time and require a large amount of RAM.

Before launching the global-registration algorithm, you can fix the position of some of the scans and/or their frames if necessary (for detail, see *Locking Object's Reposition*).

To launch the algorithm,

1. Select all aligned scans in the *Workspace* panel.
2. Open the *Tools* panel.
3. Locate the *Global registration* section.
4. Check the *Preset* field. It must display the actual scanner that was used to obtain the selected scans.
5. Click *Apply*.

9.7.1 Global-Registration Parameters

Features	*Geometry and texture* or *Geometry*	The type of algorithm that will perform scan registration. If an object has rich texture and poor geometry, consider using the *Geometry and texture* option. For objects with rich geometry, you can choose *Geometry* mode to increase the registration speed.
Focus on geometry	On/Off	Enable it for objects with rich geometry and poor texture. In comparison with *Geometry* mode, it also considers texture. If enabled, this option skips checking quality of geometry registration, taking the rich geometry for granted. It is only available for *Geometry and Texture* mode.
Key frame ratio	0–0.6	Determines how many surfaces are treated as key frames. Decreasing this parameter when processing a feature-rich object may speed up registration. Increase it if only the previous attempts to register scans failed. Technically, values higher than `0.7`, including `1`, are possible, but they may significantly slow down the algorithm.
Search features within, mm	3–5 mm (Spider); 5 mm (Eva/Leo) and 50 mm in *Geometry and texture* mode	To align frames, the algorithm needs information on how far away the identical features are distributed on the adjacent frames. Lower this search radius for objects with many repetitive features and increase for large objects to ensure the algorithm robustness. Increase this parameter sparingly since large values may cause erroneous registration and hinder calculation. Adjust it if *Fine Registration* completes with inappropriate values of *maximum errors*.
Downsampling	0.01–1	The option makes the input geometry data less dense to speed up the processing. Use lower values for objects with poor geometry. Designed for scans with HD reconstruction, this option can speed up processing in *Geometry and texture* mode. We recommend using a rule of thumb: divide 1 by the *HD data density* multiplier that you set in the *Scan* panel. For example,"0.25"for *4*×.

9.7.2 Locking Object's Reposition

When you perform operations that change the relative position of objects (such as *Global Registration*), it may be necessary sometimes to lock the repositioning of some of these objects. Consider, for example, the case where you work with several scans made in the *Target-Assisted Scanning* mode. The initial relative position of such scans in space should be preserved.

Artec Studio supports two types of locking mechanism:

- *Lock registration* ( ) - locks the repositioning of scan frames relative to each other during the global registration but allows you to move the scan itself. This mechanism applies only to scans containing frames, that is, obtained using handheld scanners such as Artec EVA, Spider, Leo, or Micro.
- *Lock position* ( ) - locks the repositioning of the object relative to the global coordinate system. This mechanism applies to scans and any other objects.

Note: *Lock registration* is the same mechanism that was called *Lock* in Artec Studio 15 and earlier.

The *Lock position* status affects not only the results of global registration but also the operations of *Positioning* and *Transformation* tools (see *Preparing Models To Export* for details). When using these tools, any reposition of objects with the *Lock position* status is blocked.

You can lock or unlock a specific object in the *Workspace* panel:

- using the context menu of this object, or
- by clicking the object row in the *Lock* column area ( )

To lock or unlock all objects in the *Workspace* panel, click the header of the *Lock* column ( ).

To lock or unlock all objects in a group, click the group row in the *Lock* column area ( ).

Note: When you change the lock status of several objects at once, the result of the mouse click will depend on the types of objects that are displayed in the *Workspace* panel or included into the group and on the current lock status of these objects.

9.7.3 Global Registration for Point-Cloud Scans

Global registration with the *Artec Ray* preset only runs on several point-cloud scans. Artec Studio offers four modes:

- *Targets* considers only targets (spheres and checkerboard targets)
- *Geometry Ray*. The prerequisite step for this mode is alignment. The scans must have sufficient initial approximations and may not have targets.

  - *Search features within, mm* defaults to 150 mm.

- *Targets and geometry*. Global registration first runs on the basis of targets, then on geometric features.
- *No targets (Geometry alignment)* is suitable for point-cloud scans captured without targets. It doesn't require alignment, but you need to run *Geometry Ray* afterwards.
  - *Distance from scanner, mm* is a radius around the scanner viewpoint from where the algorithm will take points. Alter it when you need to ignore the background 3D noise.
  - *Feature voxel, mm* is a volume measure to cull extra points from the algorithm input. The more the value, the more the points will be culled and the faster the algorithm. Increase it sparingly since it affects the algorithm accuracy.
  - *3D-noise level, (0.01-0.02)* is a factor to adjust the point culling. Increase it for point-cloud scans with noisy areas. Decreasing it will result in increasing the algorithm robustness and duration. The recommended range is 0.01–0.02.

9.7.4 Possible Global-Registration Errors

- After the global-registration algorithm finishes, the frames are in disarray (see Figure 89, left) or the frame positions are unchanged. This error occurs because the application is configured for a different scanner type than the one that captured the data. Change the device type in the application settings (see *Algorithm Settings*).
- The algorithm has completed successfully, but a gap exists between two or more scans (see Figure 89, right). Select just these scans in the *Workspace* panel and run the global-registration algorithm. If the scans have drawn closer to each other but have failed to align after the algorithm finishes, increase the number of iterations and rerun the algorithm. Repeat this process until you achieve full alignment, then run global registration once again for all data. If you are unable to align several problematic scans, try aligning just two of them, then gradually increase the number of scans until all of them are aligned.

9.8 Transferring Transformations

Sometimes it can be useful to transfer transformations from one scan to another (see *Use Cases for Transformations Transferring*). The transfer of transformations means that all transformations of scan frames resulting from the application of different Artec Studio tools are sequentially repeated for all frames of another scan. The transformations of the source scan as a whole are copied to the destination scan as well, including the global registration status.

Note: In general, you can transfer transformations from one scan to **any other** scan. However, of practical interest are only the cases when the source and destination scans

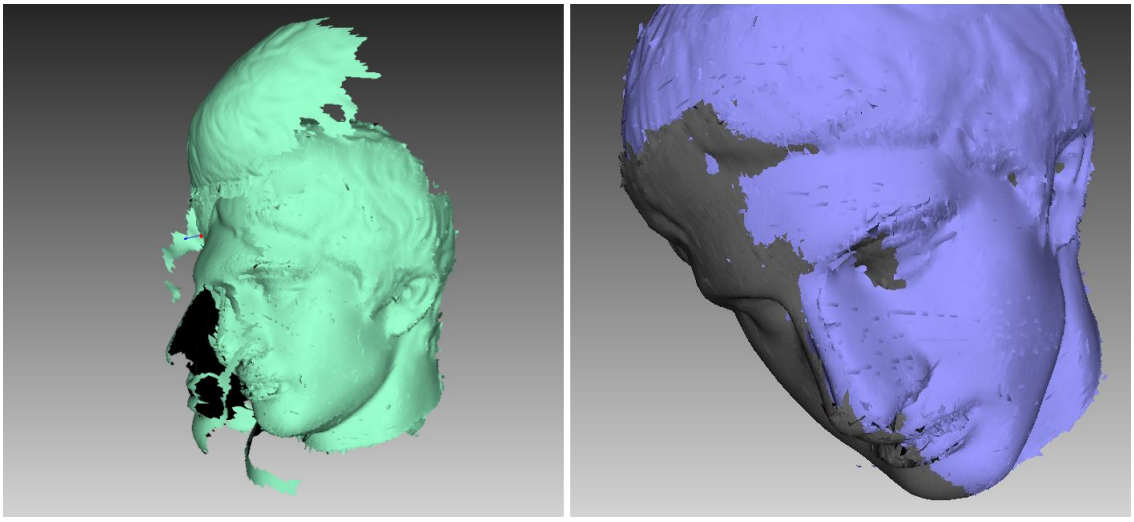


Figure 89: Global-registration errors: wrong settings on left and gap between scans on right.

are copies of each other.

To transfer the transformations from one scan to another, perform the following actions:

1. In the Workspace panel, right-click the source scan and choose *Copy Transformation* from the context menu (see Figure 90, left). The transformations of the source scan and its frames will be saved.
2. Select one or several destination scans.
3. Right-click the selected scan(s) and from the context menu choose *Paste from <source scan name>* (see Figure 90, right).

All saved transformations will be sequentially applied to the selected scans and their frames. After the transfer is finished, the information about the saved transformations will be erased.

You can use the corresponding buttons of the main window to undo and redo the transfer of transformations (see *History of Project Changes*).

9.8.1 Use Cases for Transformations Transferring

Use case 1: Saving time when processing HD scans

Global registration of HD scans is a very time-consuming operation: several times longer than it takes for SD scans. To save time, you can utilize the following scheme:

1. Make a copy of an HD scan.
2. Treating the scan copy as an SD scan, perform all the required transformations including the global registration.
3. Transfer the transformations from the copy to the original HD scan.

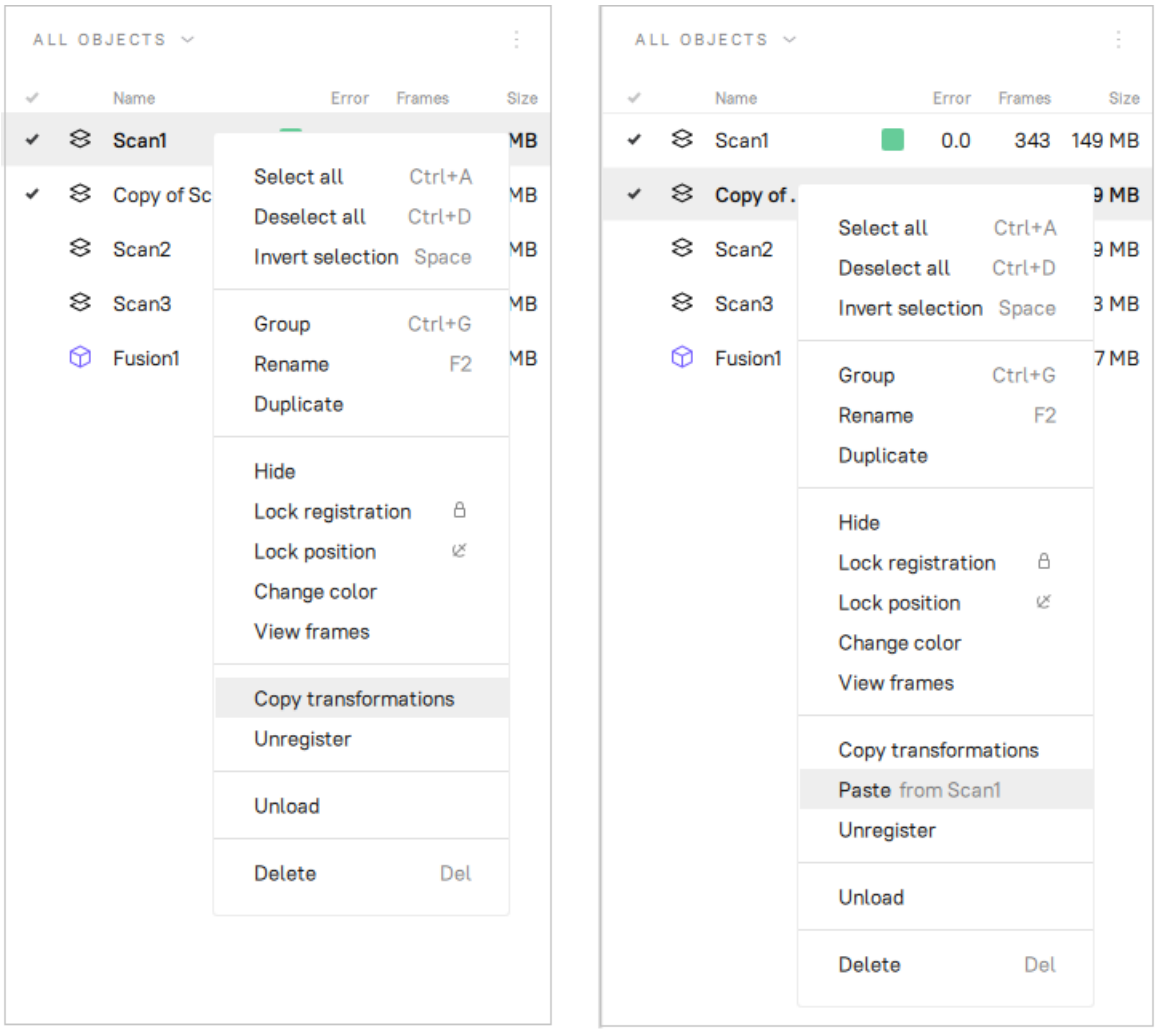


Figure 90: Transferring transformations: copying transformations (left) and pasting them (right)

Use case 2. Saving time when working with backup copies of scans

Global registration takes longer than any other scan and frames transformation. Therefore, replacing the *Global registration* with the transformations transfer may save time.

Consider the following scenario:

1. You make backup copies of scans and then only work with the original scans.
2. You remove some excess parts of the scans using *Eraser*, run *Global registration*, apply *Outlier removal* and finally perform the *Fusion* operation.
3. After examining the resulting model, you conclude that you removed too much when working with the *Eraser* and/or the *Outlier removal*.

You have to undo all previous operations and once again repeat the sequence of actions, including *Global registration*. To avoid the latter and save time, you can instead transfer the transformations from the current scans to their backups and then continue working with the backups.

9.9 Ray Scan Triangulation

Application offers two ways to convert point-cloud surfaces to the commonly used models:

- *Fusion* operation
- Special triangulation algorithm

The latter approach is preferable to fusion in terms of speed. It generates a polygonal mesh from the original point cloud by simplifying its structure.

To launch this algorithm, follow the steps:

1. Mark a scan from Artec Ray using flag ✔ in the *Workspace* panel.
2. Access *Tools* from the left toolbar.
3. If necessary, specify the *Decimation ratio* and set either of the threshold filters.
4. Click *Apply*.

Mode	*Simple*, *Adaptive (distance-aware)*	Adaptive takes into account the distance from the scanner, whereas Simple removes points with the fixed step (*Decimation ratio*)
Decimation ratio	1–10	The larger the value, the more the points will be culled. `1` leaves the point cloud unchanged. `2` culls half of the points, `4` keeps some 25% of the total amount of points, `10` about 10%.
Stitch sections	On/Off	Enable it to stitch sections of the point-cloud scans
Render mesh based on	*Vertex colors*, *Distinct colors for sections*, *One random color*	It can color an output model on the basis of *Vertex colors* or sections constituting the point-cloud scan. The latter yields multicolor model.
Desired edge length, mm		*Adaptive (distance-aware)* method tries to maintain this edge length for triangles within the entire model.
Polygon edge length (max), mm	Above 0.1 mm[1]	Algorithm will remove triangles whose edge lengths are greater than the specified value.
Polygon angle (min), deg	1–60[1]	Triangles with angles smaller than specified limit (in degrees) won't be created in the resulting mesh. Extremely large values that are out of the recommended range may yield no mesh.
Incidence angle (max), deg	0.1–90[1]	If the angle between the normal to triangle and the scanner view direction is larger than the specified one, this triangle is subject to removal.
Incidence angle between vertices (max), deg	0.1–90[1]	The algorithm will remove triangles whose edges form angles (toward the scanner viewpoint) greater than the specified limit (in degrees).

9.10 Creating Models (Fusion)

Fusion is a process that creates a polygonal 3D model. It effectively melts and solidifies the captured and processed frames. Fusion is the most interesting part of the processing task because a polygonal 3D model is what most people expect to see when performing a 3D scan. To this end, you can use one of the following algorithms, each of which has a self-explanatory name (see also the summary in Table 13):

- *Fast fusion* produces quick results.
- *Smooth fusion* is good for scanning the human body because of its ability to com-

pensate for slight movements by the person you're scanning.

- *Sharp fusion* perfectly reconstructs fine features and is suited to both industrial objects and human bodies. It is the only mode that allows you to use all the capabilities of a Artec Spider scanner.

Figure 91: Models of a human subject obtained using various algorithms: *Fast fusion* (left), *Smooth fusion* (middle) and *Sharp fusion* (right).

Figure 92: Models of a shoe sole obtained using various algorithms: *Fast fusion* (left), *Smooth fusion* (middle) and *Sharp fusion* (right).

Table 13: Comparison of fusion modes.

	Fast Fusion	Smooth Fusion	Sharp Fusion
Usage	Fast results for large data sets; also for measurements	Large, noisy data sets with patchy missing regions; scans of moving objects	Scans from Artec Spider; scans having regions with fine details and sharp edges
EVA	resolution no less than 0.5		
Spider	resolution no less than 0.15		
Leo	resolution no less than 0.6		
Fill holes	Not applicable	Available	
Features	Resulting surfaces are relatively noisy.	Smoother results. Can compensate for slight movements, but not recommended for accurate measurements. Relatively slow.	Higher level of detail. Faster than *Smooth fusion*, but may intensify existing noise.

To obtain a model:

1. Make sure the scans you intend to fuse have passed *Global registration*.
2. Select the scans in the *Workspace* panel using ✔.
3. Enter the *Tools* panel.
4. Select the necessary mode; optionally, specify parameter values.
5. Click *Apply*.
6. View the model in the *3D View* window and in the *Workspace* panel once the algorithm finishes. The model name will match the algorithm name.

The fusion algorithms use the following parameters:

- *3D resolution, mm* is the step of the grid (in millimeters) that the algorithm uses to reconstruct a polygonal model. In other words, this parameter defines the mean distance between two points in a model. The lower the *3D resolution* value, the sharper the shape. When specifying values, keep in mind the default values, lower limits in Table 13 and *Error*.
- *Fill holes* instructs the algorithm to fill holes in the mesh being reconstructed; option unavailable for *Fast fusion*. The methods for filling the holes are as follows:
  - *With radius smaller...* fills all holes with radius less than or equal to the specified value in the *Hole radius (max), mm* text box (in millimeters)
  - *All (watertight)* automatically fills all holes in the mesh
  - *Later, manually* prompts you to fill holes manually in the *Fix holes* panel, which opens automatically
  - *None* fills no holes

- *Remove targets* allows you to erase small embossments from surfaces on which targets are placed (see *Target-Assisted Scanning*). This checkbox is unavailable for *Fast fusion*.
- *Glare-noise reduction* allows you to significantly reduce the glare related noise in the models obtained from the scans made with Artec Micro. This checkbox is only available if you select *Artec Micro* in the *Preset* drop-down list and only for *Smooth fusion* and *Sharp fusion*.

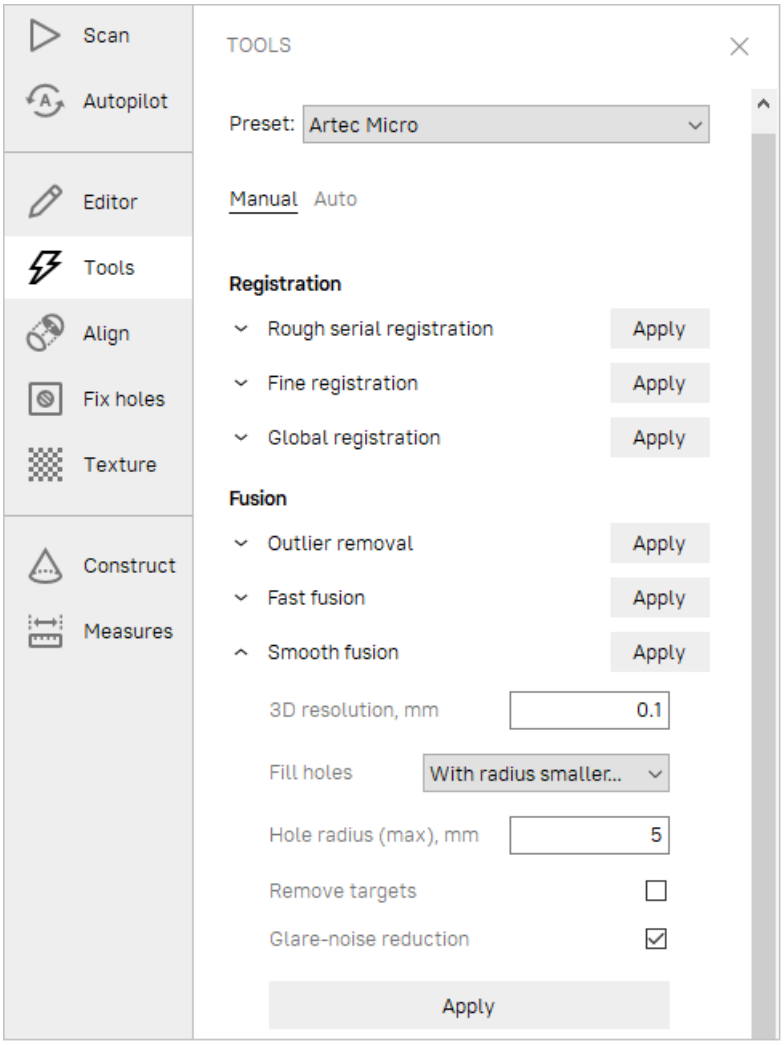


Figure 93: Tools panel: parameters of the fusion algorithm.

9.10.1 Fusion-Algorithm Errors

Occasionally, defects appear in the 3D model after fusion; some are correctable by creating additional scans, whereas others are correctable by using the model-processing tools described in the next section.

Errors that can be corrected by capturing additional scans include low-amplitude noise on the surface (see Figure 94, left). Normally, this error indicates that the affected area has a small number of frames. The number of frames needed to eliminate the noise depends on

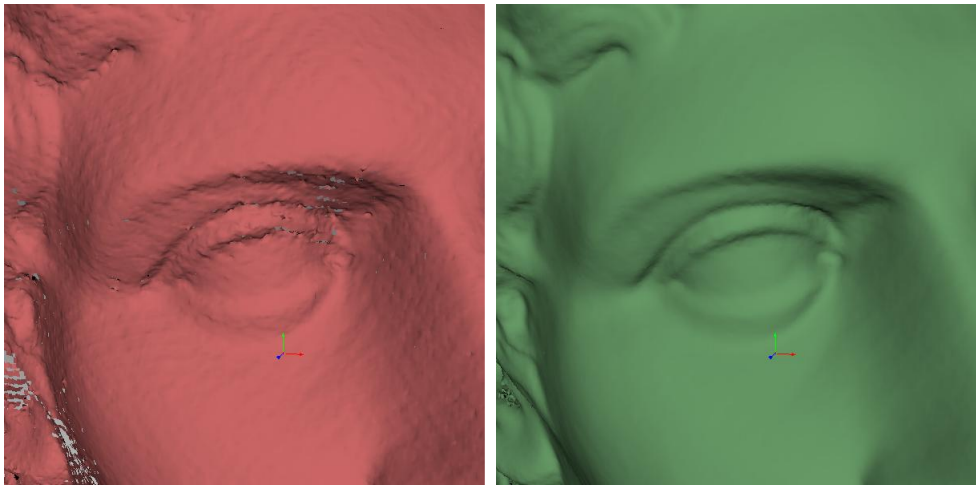


Figure 94: Surface noise caused by insufficient data (left) and improved model after adding one more scan (right).

the reflective properties of the object's surface. To correct the error, you need one more scan to cover the noisy area (see Figure 94, right).

Sometimes the cause of noise is an insufficient number of scanning angles. Areas captured at a larger angle have more noise than areas captured at a direct angle (i.e., 90 degrees). You can correct this error by scanning the area again using a better angle.

When the scanning conditions or the object features are such that you are unable to capture additional data, you can correct errors using the *Fix holes* (see *Hole Filling*) or *Smoothing* (*Smoothing (Tools)*) tools. If such errors are frequent, reduce the speed at which you move the scanner around the object, or increase the capture rate (see *Decreasing Scanning Speed*).

9.11 Editing Models

The resulting fusion model may contain surface defects due to scanning or registration errors. Artec Studio provides a number of tools to correct such errors:

- *Repair* corrects the model's triangulation errors.
- *Small-object filter* removes small objects located near the model surface.
- *Fix holes* semiautomatically fills holes and smooths the model edges.
- *Hole filling* fills holes in the model automatically
- *Smoothing* filters low-amplitude noise over the whole model
- *Smoothing brush* enables manual smoothing of the surface areas with the most noise
- *Mesh simplification* reduces the number of polygons in a model while minimizing lost accuracy
- *Isotropic remesh* creates isotropic mesh while keeping the processed mesh as close to the original as possible

Each algorithm processes all scans selected in the *Workspace* panel and replaces the original data with the results. If the algorithm is unsuccessful, you can restore the original data by clicking (*Undo*) in the *Workspace* panel.

9.11.1 Small-Object Filter

If you forgot to erase outliers before fusion (see *Eliminating 3D Noise (Outlier Removal)*), Artec Studio may solidify and preserve them in the scene as small, distant fragments.

You can effectively remove these remaining outliers by using a filtering algorithm.

To remove these artifacts, select in the *Workspace* panel only the model you are currently editing, then open the *Tools* panel. Click *Apply* next to *Small-object filter* to run the algorithm (see Figure 95). A window containing algorithm settings will appear when you click . You can adjust the following parameters:

- *Remove surfaces*
  - The *All except largest* option from the dropdown menu instructs the algorithm to erase all objects except the one with the most polygons
  - *Smaller than specified* erases from the scene all objects whose number of polygons is less than the amount specified in the *Polygon count (max)* parameter.
- *Polygon count (max)* is the maximum number of polygons for *Smaller than specified*.

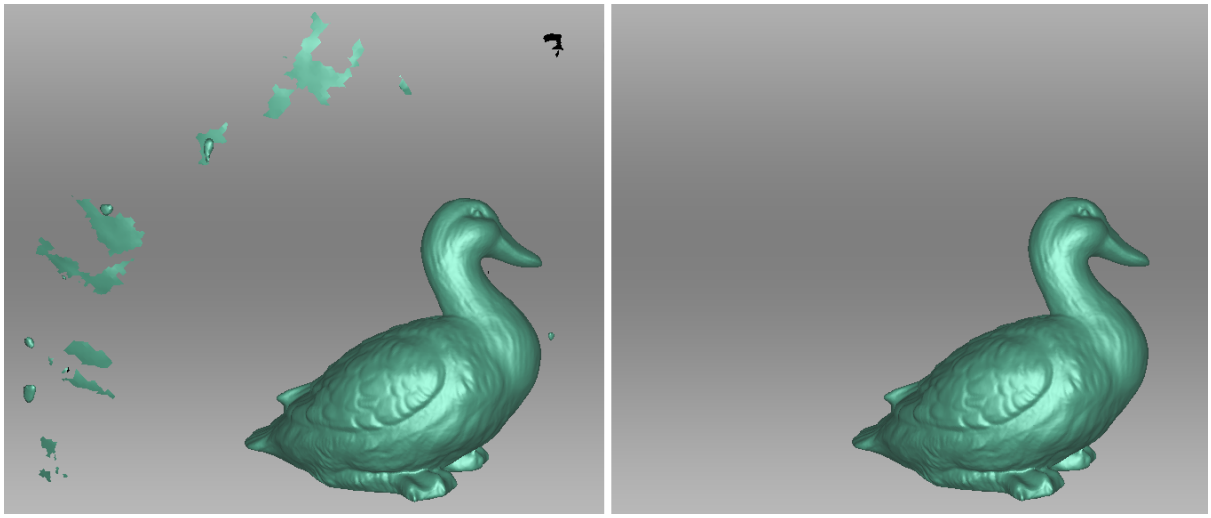


Figure 95: Filtering of small objects: before (left) and after (right).

9.11.2 Defeature Brush (Editor)

Erasing certain geometrical imperfections often demands further processing of the resulting holes in the model. The *Defeature brush* combines functions of the *Eraser* and *Hole filling* tools and may boost your productivity. To use it, follow these steps:

Warning: If you edit a textured model, note the following. Since the texture will incorrectly fit the altered surface, the Defeature brush will remove it from the model. So you will need to repeat *texturing* after you finish editing.

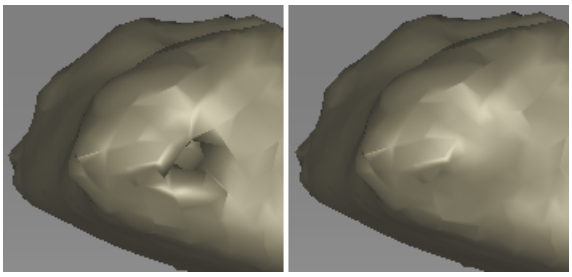
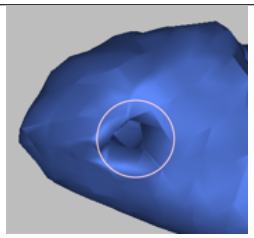
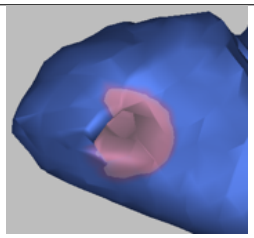
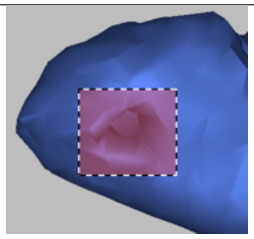
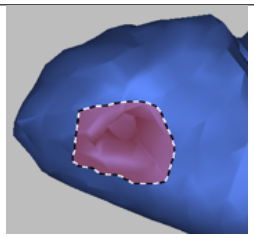


Figure 96: *Defeature brush*: imperfection on the scanned surface (left), results of applying the tool (right).

1. Select one model in the *Workspace* panel.
2. Open the *Editor* panel using the side toolbar and click either *Defeature brush* or hit `D`.
3. In the *Editor* panel, choose the required selection type.
4. Consult the *instructions* for each mode and select regions on the model that you want to modify. To clear all selections, click *Deselect*.
5. Click *Apply*. The software will delete the feature, close up the hole and smooth the surface.

To undo changes, click in the *Workspace* panel or menu *Edit*, or hit `Ctrl + Z`. Each click of the *Apply* button generates a command history entry. To undo several operations, use the dropdown menu of button and select the lowest entry.

9.11.2.1 Selection Types

Type	Illustration	Usage
2D		Hold down `Ctrl` and use `Scroll wheel` to adjust the tool size. Paint with `Ctrl+LMB` to create a selection.
3D		See above.
Rectangular		Use `Ctrl+LMB` to select a rectangular region.
Lasso		Use `Ctrl+LMB` to freely outline an irregular region. You can release `LMB` (not `Ctrl`) and then continue clicking on desired points to select a desired shape.
Cutoff-plane		Create selection as in *2D* mode. Once you have released the mouse button, a plane will appear. If necessary, adjust the plane level by using `Scroll wheel` while holding down `Ctrl+Shift` or orient the plane freely in 3D space. To this end, hit `Alt` to display the *designated control*. Then still holding the key, drag the required control ring.

If you need to deselect any region, hold `Ctrl + Alt` and reselect this region. To clear all selections, click *Deselect*.

If the *Select through* checkbox is selected, all surfaces throughout the model are affected. If not, the brush only works on the visible surface.

See also:

Hot keys in Editor.

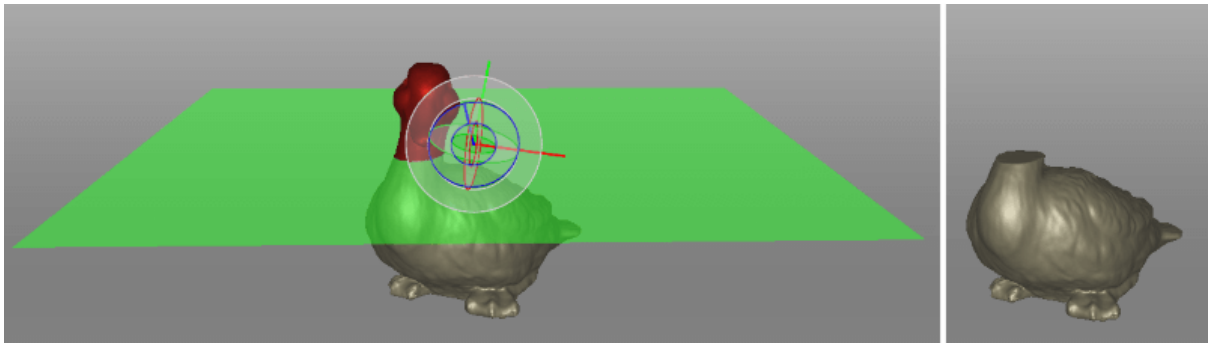


Figure 97: Applying *Cutoff-plane selection* in *Defeature brush*.

9.11.3 Smoothing

9.11.3.1 Smoothing (Tools)

The smoothing algorithm evens out noisy areas in the 3D model. Artec Studio provides two such tools: automatic smoothing of the entire model and manual smoothing of specific areas identified using a brush (see *Smoothing Brush (Editor)*).

To run the automatic smoothing algorithm, open the *Tools* panel and select *Smoothing*. You need only set the *Steps* parameter (the number of algorithm iterations to be performed).

9.11.3.2 Smoothing Brush (Editor)

The *Smoothing brush* is a tool that you can employ selectively in specific areas without touching areas that require no alteration (for more information about automatic smoothing, consult *Smoothing (Tools)*).

To use the *Smoothing brush*,

1. Select just one model.
2. Open the *Editor* panel, and click the  icon or hit `S`.
3. Hit `Ctrl`, an orange region will appear around the cursor in the *3D View* window.
4. Change brush size if necessary:
   - Use either the `Ctrl + [` and `Ctrl + ]` shortcuts or
   - Use `Scroll wheel`.
   - Enter a size (in millimeters) in the *Brush size* field.
   - Alternatively, you can adjust the slider bar in the *Smoothing brush* panel.
5. Set the smoothing strength if necessary:
   - Enter the desired value in the *Smoothing strength* field or
   - Adjust the slider bar.

6. Hold LMB and paint the surface region in order to smooth it. The tool will smooth the affected areas (see Figure 98, right).

To undo changes, click ↶ in the *Workspace* panel or hit Ctrl + Z as many times as needed to return to the original state of the model since each brush stroke generates a command history entry.

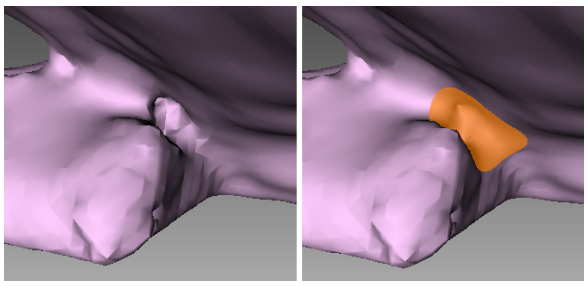


Figure 98: Before smoothing (left) and smoothing out a poorly captured area (right).

9.11.3.3 Smoothing Edges

The *Edges* tab allows you to smooth ragged edges of the model.

To smooth an edge or any part of it, follow the steps:

1. Open *Fix holes* → *Edges*. It will show the list of edges detected on the surface. These defects are sorted by their full length.
   - Mark the checkbox next to the edge in the list to select **a whole edge**[2].
   - In *3D View* window, hold down LMB and drag the square control to specify **a part of the edge**.
   - Use the *Select all* button to select **all edges**.
2. Artec Studio will highlight these edges in red and draw yellow curves alongside them depicting smoothed boundaries.
3. Use the *Strength* slider to control the edge-smoothing intensity as necessary.
4. Click *Smooth edges*.
5. Click *Apply* to confirm the results. If the results aren't satisfactory, use the ↶ button to cancel recent changes.

9.11.4 Hole Filling

Sometimes the shape of an object or the scanning conditions prevent you from properly capturing of all parts of the scene. As a result, the fused 3D model will have holes. In such instances, you can use either of the hole-filling tools to interpolate the surface.

[2] If the *Move camera to selection* option is checked, the model will automatically rotate to display the selected hole.

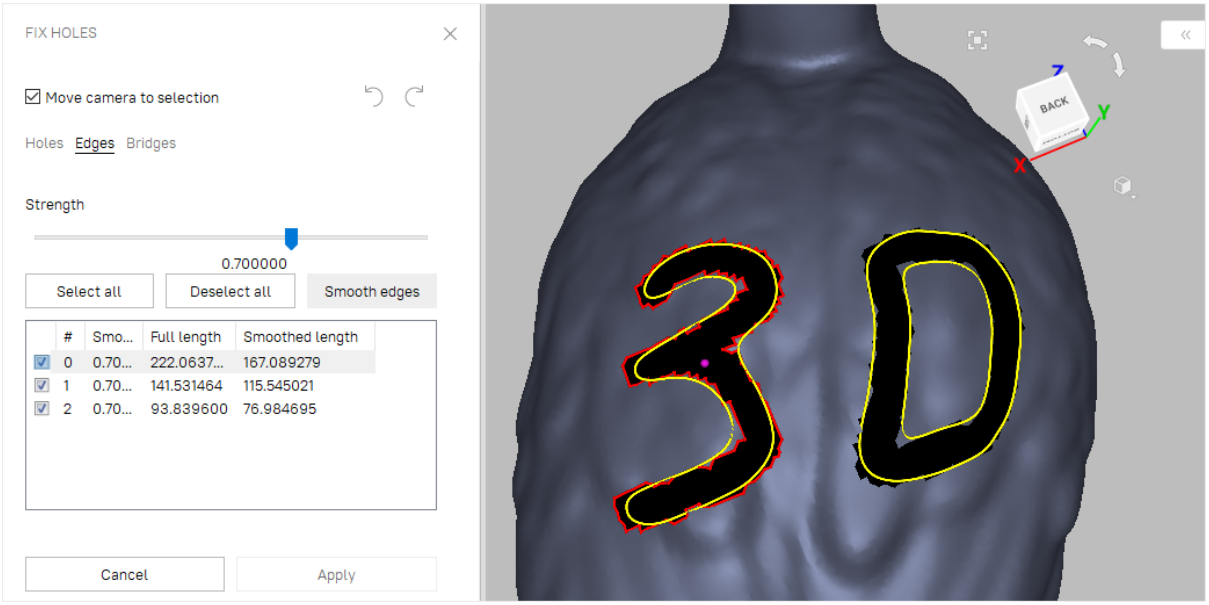


Figure 99: Boundary selection for edge smoothing

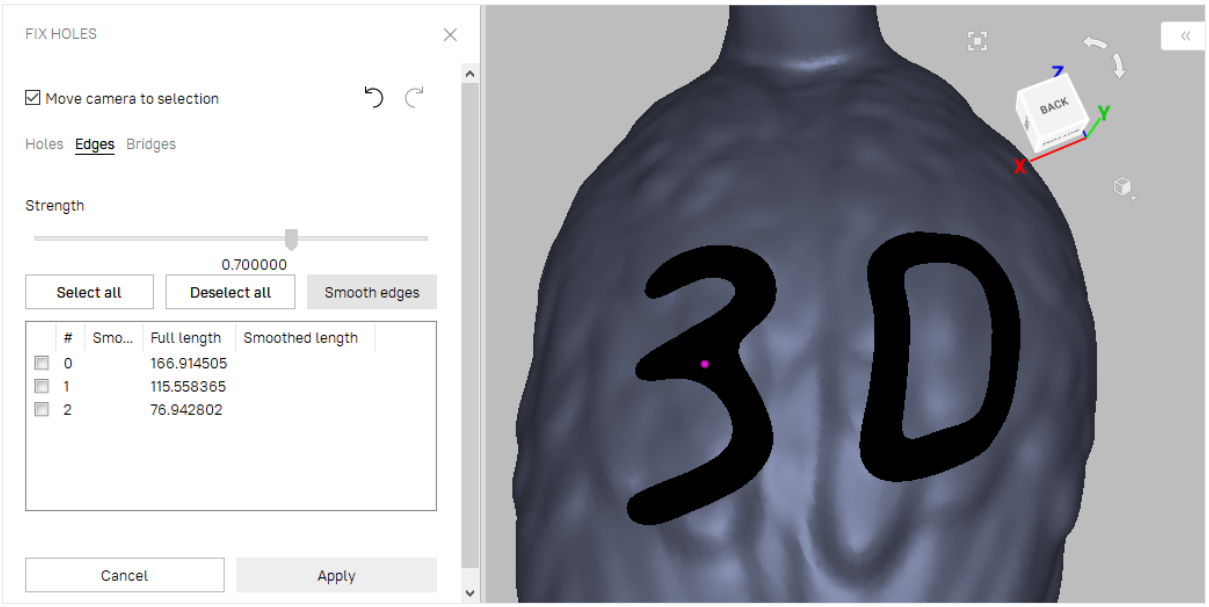


Figure 100: Edge-smoothing algorithm results.

- *Bridges or Smart Hole Filling*
- *Automatic Hole Filling*
- *Fixing Holes*

9.11.4.1 Bridges or Smart Hole Filling

The *Bridges* tab is intended to connect a pair of the edge fragments by constructing a surface that follows the curvature of the neighboring surfaces.

To create a bridge, follow the procedure:

1. Open *Fix holes* → *Bridges*. All holes will outline in red.
2. Specify two opposite fragments[3] between which a bridge will go (Figure 102). There are two ways to do this:

Quick method	Ctrl-key method
Perform the steps below **for each fragment**:	Click once anywhere in the *3D View* to activate this method and then perform the steps below **for each fragment**:
a. Point the cursor at the edge. A part of this edge will be automatically highlighted indicating a future fragment. b. Drag the cursor along the edge to find the desired fragment location. c. Click `LMB` to confirm the fragment.	a. Press and hold `Ctrl` and then point the cursor at the edge. b. Press and hold `Ctrl+LMB` to specify a fragment beginning. c. Still holding `Ctrl+LMB`, drag the cursor to specify the entire fragment. d. Release `Ctrl+LMB` to confirm the fragment.

3. Once you've confirmed the second fragment, a bridge preview will appear.
4. Drag the square sizing handles to adjust the bridge width and position as necessary.
5. Adjust *bridge curvature* on both sides and *Bridge smoothness* as necessary.
6. Click *Build bridge* to confirm your bridge.

The table below lists the possible actions matched with the options and commands for this tool.

[3] Normally a bridge goes between two opposite fragments of one hole. In complex cases, you may use fragments on different holes or edges.

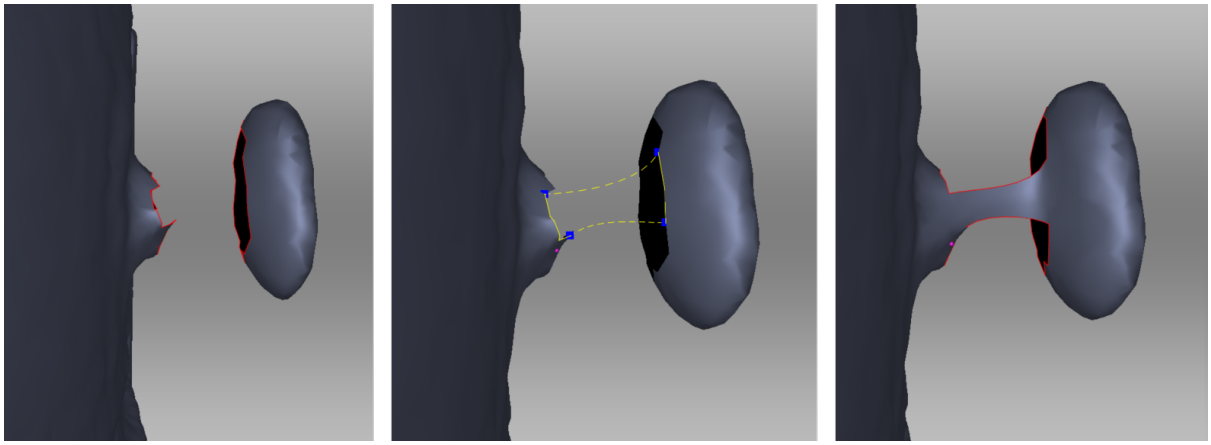


Figure 101: From left to right: original surfaces, bridge preview, actual bridge.

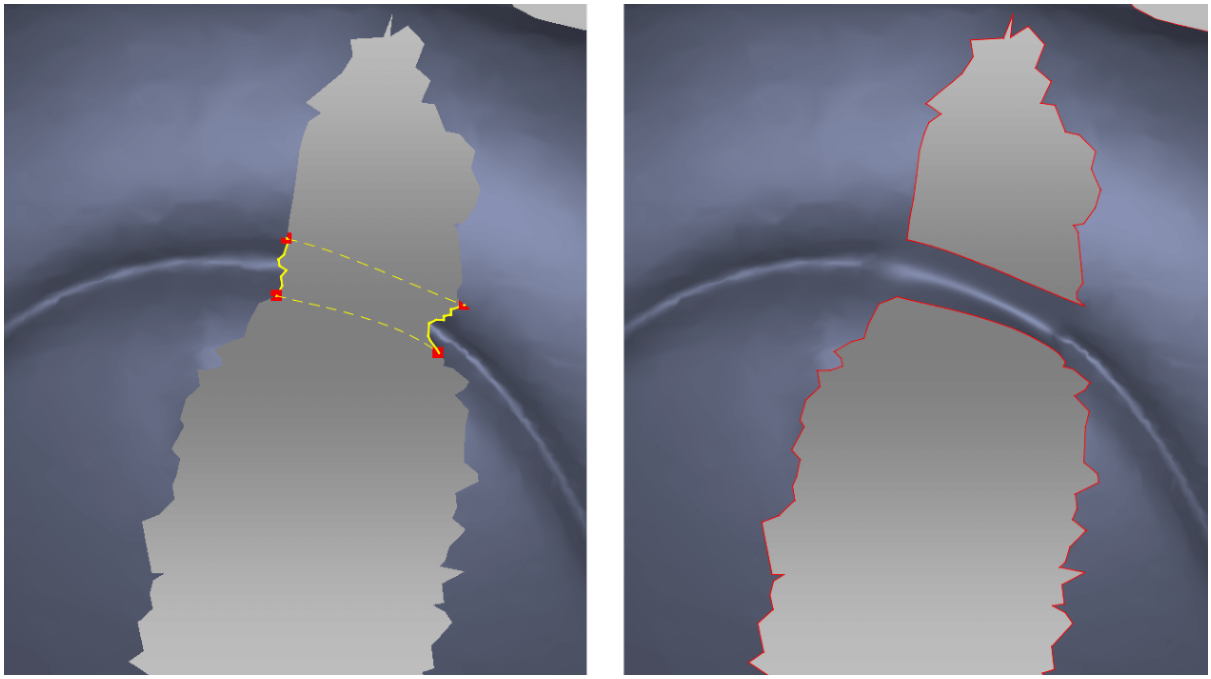


Figure 102: Specifying fragments. Correct fragments can resolve original geometry.

Prepare edges by removing raggedness	Select the *Smooth edges first* checkbox
Preserve the original geometry (Figure 102)	Clear the *Smooth edges first* checkbox
Smooth bridge surface	Use the *Bridge smoothness* slider
Edit bridge-preview position	Drag the square controls around the corners of the bridge preview
Adjust bridge tension	Use interactive sliders *Curvature (start, end)*
Delete bridge preview	Click *Clear preview* or `Delete` key

Smoothing or Keeping Edges

Smoothing edges might not always be beneficial to you. If the bridge failed to recreate the original geometry, try one or several actions from the following list:

- Clear the *Smooth edges first* checkbox.
- Use small or medium values of the *Bridge smoothness* slider (Figure 103).
- Select fragments correctly.

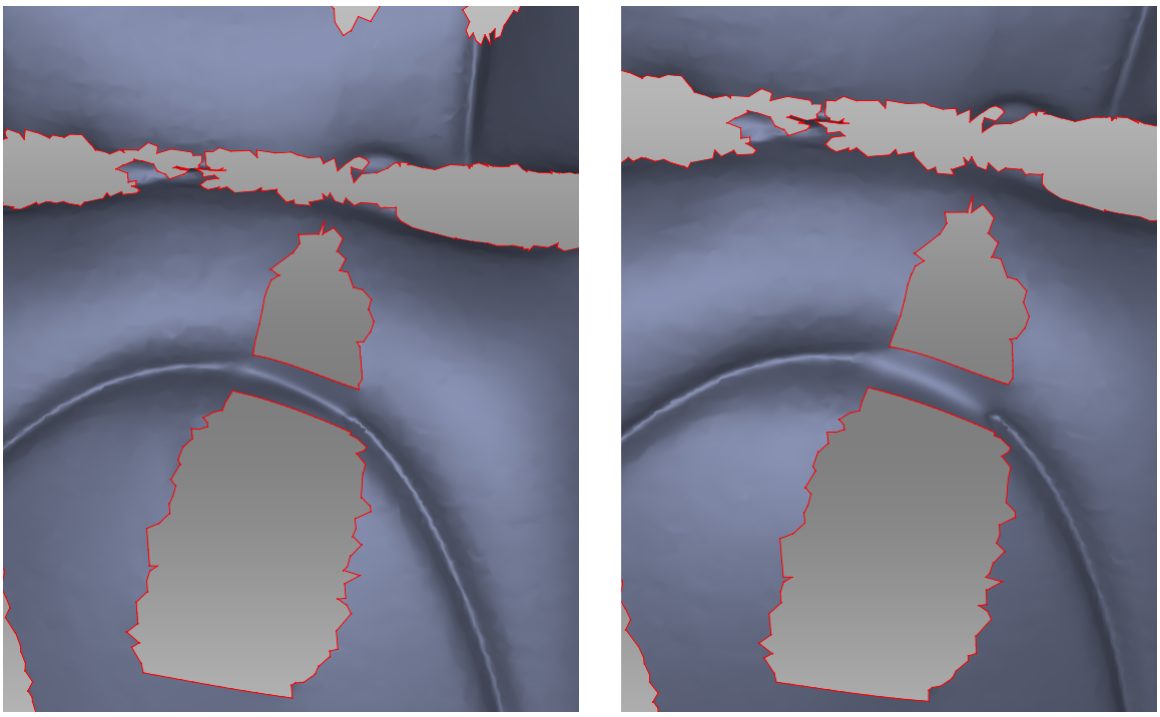


Figure 103: Small smoothness values on left and maximum on right.

9.11.4.2 Automatic Hole Filling

To quickly and automatically fill holes, use the *Hole filling* algorithm in the *Tools* panel. The algorithm only processes holes with perimeters below the threshold specified in *Hole perimeter (max), mm* (maximum length of the hole perimeter in millimeters).

Use button ⌄ to access this parameter.

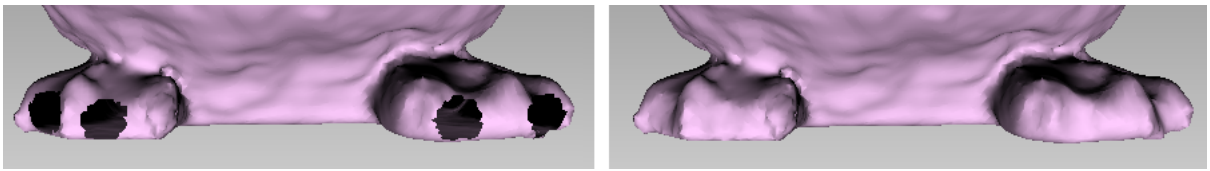


Figure 104: Hole-filling algorithm: original model on left, processed on right.

9.11.4.3 Fixing Holes

Unlike *Bridges*, the *Holes* tab provides flat hole filling.

1. Open *Fix holes* from the side panel.
2. Select the *Holes* tab. It will show the list of holes detected on the surface. These defects are sorted by their perimeter length.
3. Select a hole either in *3D View window* or mark the checkbox next to it in the list. Artec Studio will highlight these holes in red (see Figure 105).

   Note: If the *Move camera to selection* option is checked, the model will automatically rotate to display the selected hole.

   Hint: Use the *Select all* and *Deselect all* buttons in the panel to select or clear all selections, respectively.

4. Click *Fill holes* to repair your model.
5. Click *Apply* to confirm the results. If the results aren't satisfactory, use the ↺ button to cancel recent changes.

If you try to exit the *Fix holes* mode without accepting changes, the software will ask you for confirmation.

9.11.5 Mesh Simplification

The mesh produced after fusion may be less than optimal for some applications because it will contain a large number of polygons. This complexity will increase the amount of memory the model occupies, hindering further processing. To optimize the model size while retaining accuracy, use the *Mesh simplification* algorithm.

Select the model and open the *Tools* panel. You can choose from two algorithms.

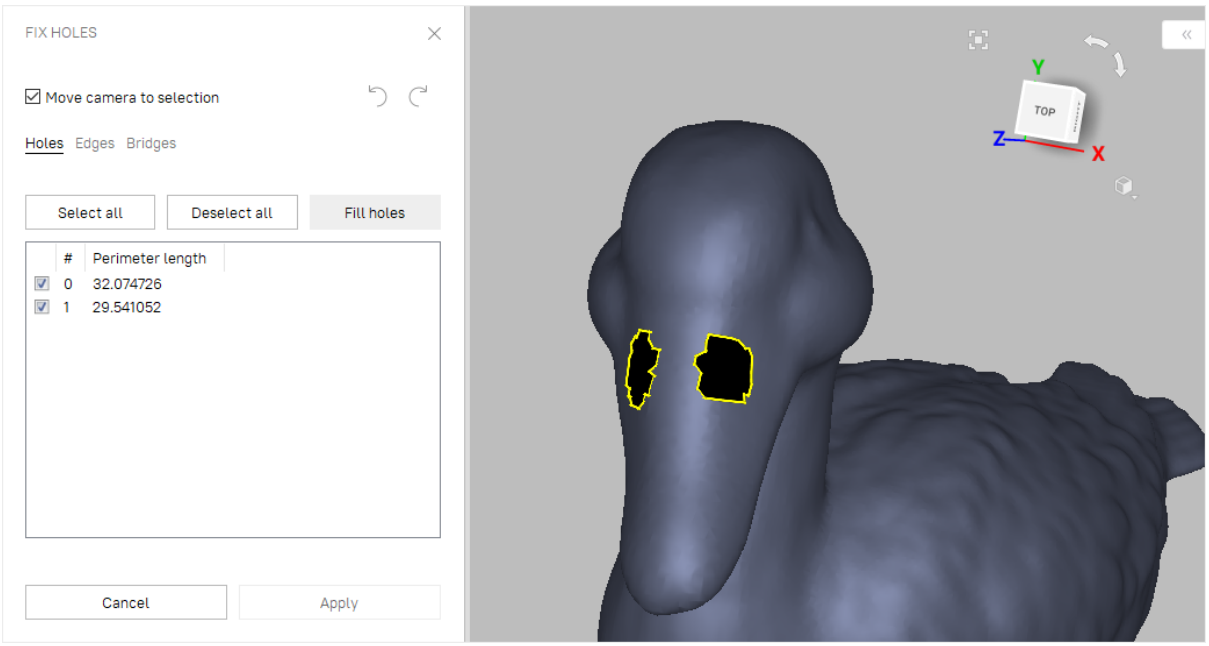


Figure 105: Two holes marked for correction.

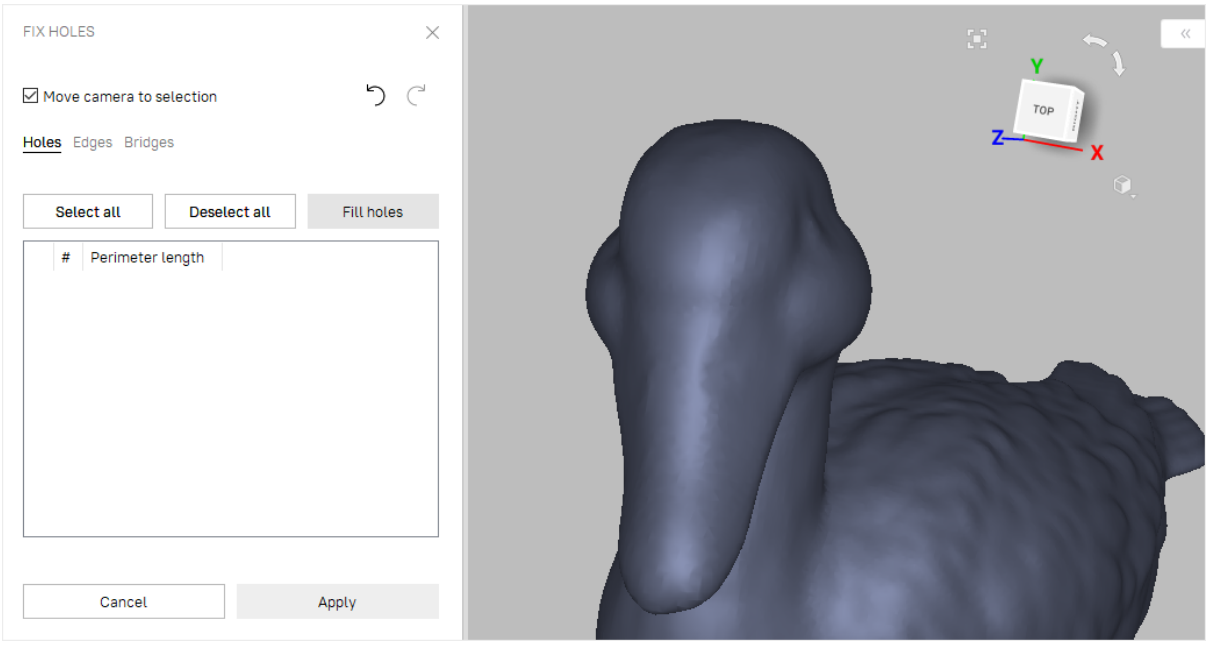


Figure 106: Result from running the *Fill holes* algorithm.

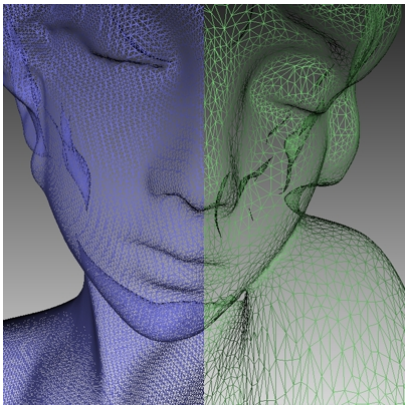


Figure 107: *Mesh simplification:* original mesh on the left, optimized mesh on the right.

9.11.5.1 Conventional Algorithm

Open the dropdown algorithm settings by clicking the ˅ button next to *Mesh simplification*. Select the appropriate processing method (determined by the *Target when simplifying*):

- *Shape deviation* optimizes model to a predetermined accuracy: the *Maximum shape deviation, mm* parameter defines the optimized model's maximum allowable deviation (in millimeters) from the original model. When the algorithm reaches this value, the optimization stops.
- *Remove small polygons* performs simple mesh optimization, removing triangles whose edge lengths are less than the *Polygon edge length (max), mm* value (in millimeters).
- *Polygon count* simplifies the model by targeting the number of triangles specified in the *Polygon count* text box. The algorithm minimizes the resulting model's deviation from the original model, but the final deviation value will remain unknown until processing concludes. Use this method when you know how many triangles the resulting model should have.

  Tip: To determine the number of triangles, reveal the *Properties* panel for the appropriate model in the *Workspace* panel.

- *Keep texture* is similar to the *Polygon count* algorithm, but intended for meshes with textures mapped by the *Atlas* method (see *Applying Texture (Procedure)*). This approach not only simplifies the polygon grid, reducing the number of triangles, but it preserves texture.

Tip: Since the UV methods tend to slightly reduce texture resolution, we recommend using either of them only when no raw scans are available. It is generally better to simplify models using one of the regular method and then reapply texture.

The three first algorithms in the list above have the additional parameter:

Keep edges maintains the model boundary. Mesh simplification on the scan edges may affect their geometry. Thus, if the shape of the boundaries is more important than the optimized mesh, select this checkbox. Otherwise, clear it, and the algorithm will simplify the boundary mesh.

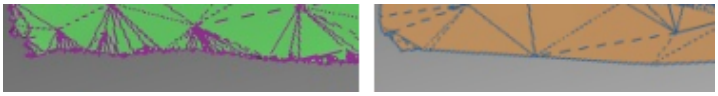


Figure 108: Boundary-appearance options: *Keep edges* enabled (left) and disabled (right).

After adjusting the algorithm settings, click *Apply* to start processing.

Note: Mesh simplification may take a long time when the parameters of the original and optimized models are significantly different (for example, if the deviation value is high in *Shape deviation* mode or if the required number of polygons in *Polygon count* mode is much smaller than the number in the original model). For very large 3D models the operation requires extensive memory resources and may fail owing to insufficient RAM. Free the memory by closing unused applications and by optimizing memory usage in Artec Studio, keeping in mind the recommendations in *Memory*, *Command History* and *Memory Management: Object Unload*.

9.11.5.2 Fast Mesh Simplification

The *Fast mesh simplification* algorithm works faster than the conventional one. To run it, perform these steps:

1. Open the dropdown algorithm settings by clicking the ⌄ button next to *Fast mesh simplification*.
2. Specify in the *Polygon count* text box the desired number of triangles for the resulting model. You can determine how many are in the actual model by double-clicking it in the *Workspace* window.
3. Set the *Nonstrict polygon count* option:
   - If this checkbox is cleared, the value specified in the *Polygon count* text box remains constant.
   - If this checkbox is selected and the algorithm is unable to produce a surface with the specified number of triangles (*Polygon count*), Artec Studio will automatically update this value. In other words, improving the quality of the resulting surface is the primary objective.
4. Click *Apply* to run the algorithm.

9.12 Texturing

Artec scanners are equipped with a color camera, allowing you to capture 3D surfaces with texture and expanding the range of objects available for scanning. Texturing is a process that projects textures from the individual frames onto the fused mesh.

9.12.1 Preparing Model

To take advantage of texture, do the following:

1. Make sure the *Don't record texture* checkbox is cleared.
2. Adjust the capture frequency for texture frames if necessary (see *Texture-Recording Mode* or *Frequency for Capturing Texture Frames*).
3. Avoid turning off the flash bulb.
4. Adjust the texture brightness in *Preview* mode by using the eponymous slider in the *Scan* panel.
5. Scan the object using a tracking algorithm of your choice. Captured frames are marked with the checkerboard icon in the *Workspace* panel (surface-view mode) (see Figure 53, right).
6. Process the data and create a model, consulting the list in the beginning of *Data Processing* or *Use Autopilot*.
7. Run a mesh-simplification algorithm for the resulting model (see *Mesh Simplification*) to accelerate the texturing process.
8. Use the *Texture* panel to apply the texture to the model.

9.12.2 Applying Texture (Procedure)

The 3D model obtained after fusion contains no texture information. To apply textures onto a model, do the following:

1. Open the *Texture* panel
2. Choose a model from the first list (see Figure 109); Artec Studio will apply the textures to this model
3. Select from the second list the scans from which you created the model (these scans have the required textures)
4. Next, choose a method for applying textures to the model. Artec Studio offers two methods:
    - *Preview* (triangle map)
    - *Export* (texture atlas)

5. Select the required *Output texture size*[4] and other options as necessary (*Supplementary Settings*)
6. Click *Apply* to start the texturing process[5]
7. Finally, when the texture is ready, *adjust it* as necessary.

To reduce or increase the resolution (*Output texture size*) of the already applied texture, you can re-apply it several times faster by enabling the *Export (reuse UV map)* option.

To replicate texture from a textured model instead of raw scans, use the *Export (transfer from model)*. Ensure that you've selected this model in the *Select texture source* field. Using texture from a textured model might be useful in the following cases:

- Original scans are lost.
- Intention to replicate texture altered using *Texture healing brush*.
- Speed up texturing identical models or models undergone *Defeature brush* operations.

Warning: We recommend that you avoid applying texture to models that have undergone major changes in geometry or orientation. The algorithm will apply the texture incorrectly if you have done any of the following:

- *Position* or *transform* the model relative to its source scans
- *Nonrigid Alignment*
- Erase major parts of the model

Perform these operations only after texturing.

9.12.3 Modes

Table 14: Comparison of the texture-applying methods.

Mode	Texture Distortion	Speed	Number of Textures	Texture-Resolution Management
For preview	Does not preserve aspect ratio of triangles	Fast	One or more	Adjust triangle size and texture-image resolution
For export	Preserves aspect ratio of triangles	Slow	Only one	Adjust texture-image resolution

[4] Texturing with the 16K resolution (16384x16384) is only available if your graphics card features at least 3 GB of GPU memory.

[5] To optimize resource utilization, Artec Studio unloads all surfaces from memory, except those needed for texturing, before running the applying procedure. For a more detailed description of selective project-data loading, see *Memory Management: Object Unload*.

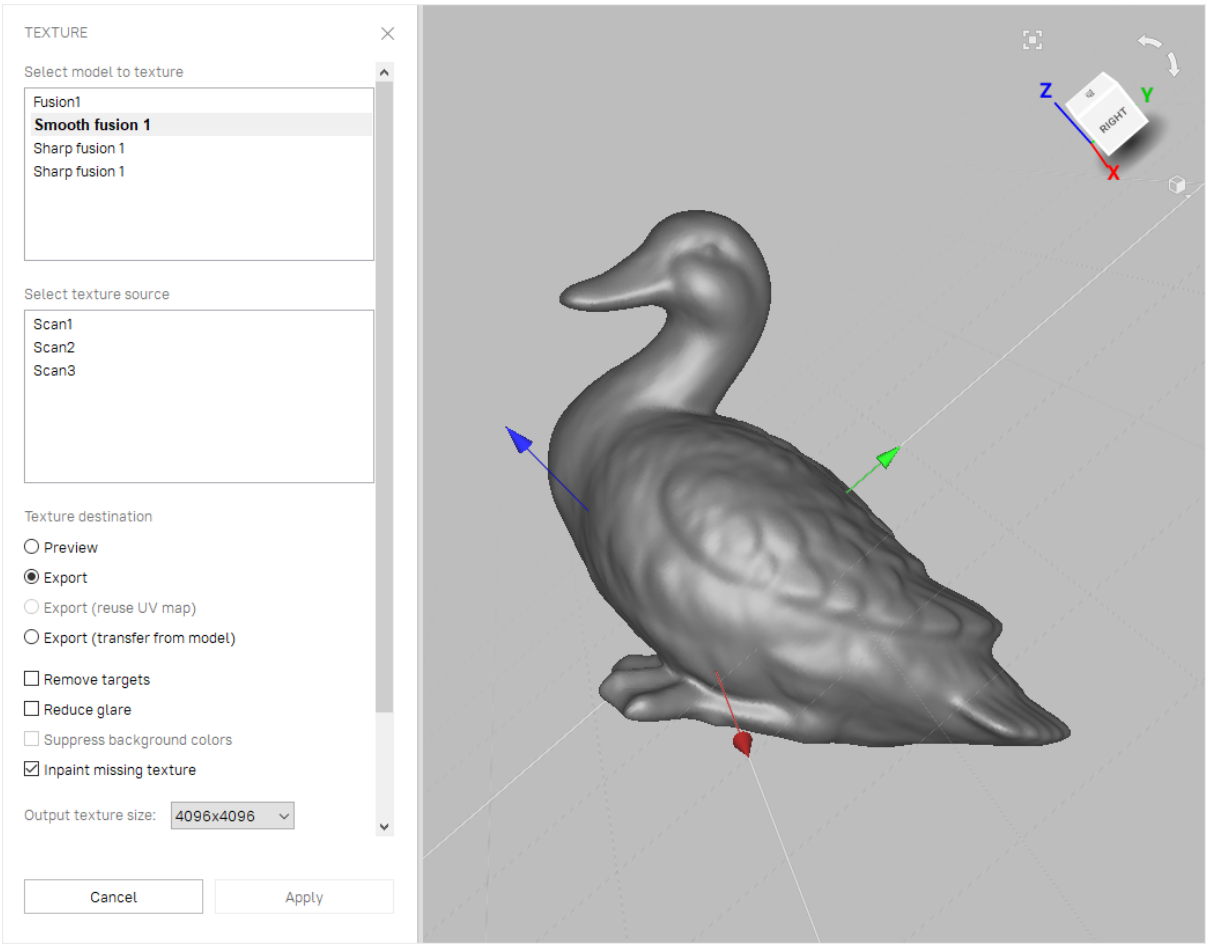


Figure 109: Choosing a texture-application method and adjusting its parameters.

9.12.3.1 Texturing for Preview (Triangle Map)

The *Preview* method transfers all textured triangles to a square texture image (or a series of images). You can adjust the *Triangle size (in pixels)*[6] using the eponymous slider (see Figure 110, right). To select the resulting texture size, use the dropdown list (maximum texture size depends on the capabilities of your graphics card). After changing the triangle/texture size, the estimated number of textures will appear in the *Estimated* area at the bottom of the panel; the actual number may differ slightly, however.

9.12.3.2 Texturing for Export (Texture Atlas)

The *Export* method cuts the surface into pieces, then unfolds and nests these pieces flat and fits them into the specified image size (see Figure 110 (middle) and Figure 66 in *Displaying Boundaries of Texture Atlas*). This method takes longer to run than *Preview*, but the resulting texture is much more convenient for manual editing.

Figure 110: Texture mapping methods: mesh with texture applied (left), texture-atlas sample (middle) and triangle-map sample (right). The latter covers only a portion of the mesh surface (the rest two images not shown).

9.12.4 Supplementary Settings

To modify a texture using an inpainting technique, use one of these two options:

9.12.4.1 Inpaint Missing Texture

This option allows you to apply a texture to regions with no texture information by spreading it from the neighboring regions.

[6] Triangle size is determined by the number of pixels per side.

9.12.4.2 Remove Targets

Remove targets is similar to inpainting. It paints out targets by applying surrounding texture information (targets are used to facilitate scanning—see *Target-Assisted Scanning*). This option makes sense if you enabled *Remove targets* before producing this fusion model (see *Creating Models (Fusion)*).

9.12.4.3 Enable Texture Normalization

Enable texture normalization aims to compensate for uneven lighting caused by movement of a scanner's flash unit during capture. We don't recommend clearing this checkbox.

9.12.4.4 Reduce Glare

Reduce glare is intended to eliminate glare spots on texture. This option is only available for *Texturing for Export (Texture Atlas)* and requires many texture frames captured from different perspectives.

1. Check whether the source scans include sufficient number of frames (especially texture frames). If necessary, increase *texture-frame rate* and rescan.
2. Select the *Reduce glare* checkbox.
3. Adjust the *Reduction level* slider as necessary. Avoid extreme values.

Hint: Glare reduction is a time consuming algorithm. If you plan to obtain a high-resolution texture, we advise you to first tweak the settings on low values (for example, 512 x 512) and then reapply texture with the required *Output texture size*.

9.12.4.5 Suppress Background Colors

Object's surfaces may inherit texture information from the surroundings. To diminish this impact, use the *Suppress background colors* option. This option is only available for *Texturing for Export (Texture Atlas)*, requires the enabled *Reduce glare* option and a sufficient number of texture frames captured from different perspectives.

1. Ensure the *Reduce glare* checkbox is selected.
2. Select the *Suppress background colors* checkbox.
3. Adjust the *Reduction level* slider as necessary. Avoid extreme values.

9.12.5 Texture Adjustment

After the texturing is complete, you can adjust the texture on the model (see Figure 113).

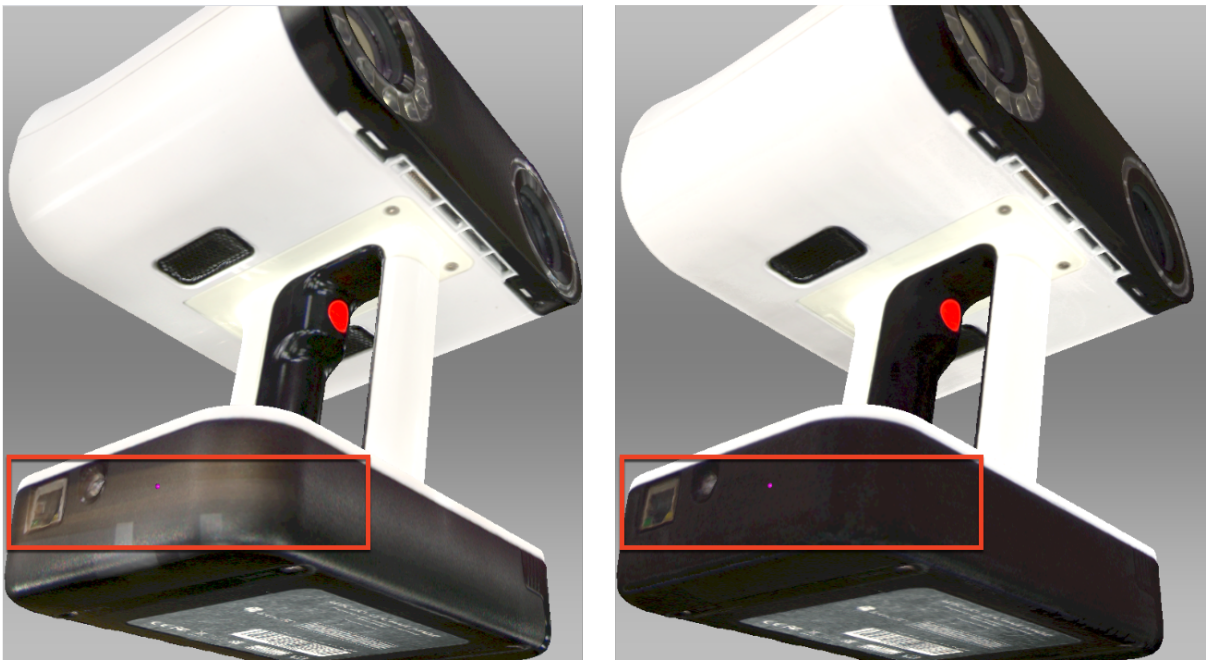


Figure 111: Diminishing background color impact.

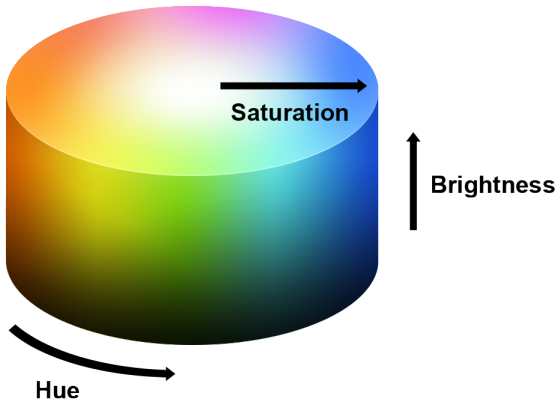


Figure 112: Hue, saturation and brightness representation.

You can adjust the following texture parameters by way of the corresponding sliders (see Figure 112 for details):

- Brightness
- Saturation
- Hue
- Contrast
- Gamma correction

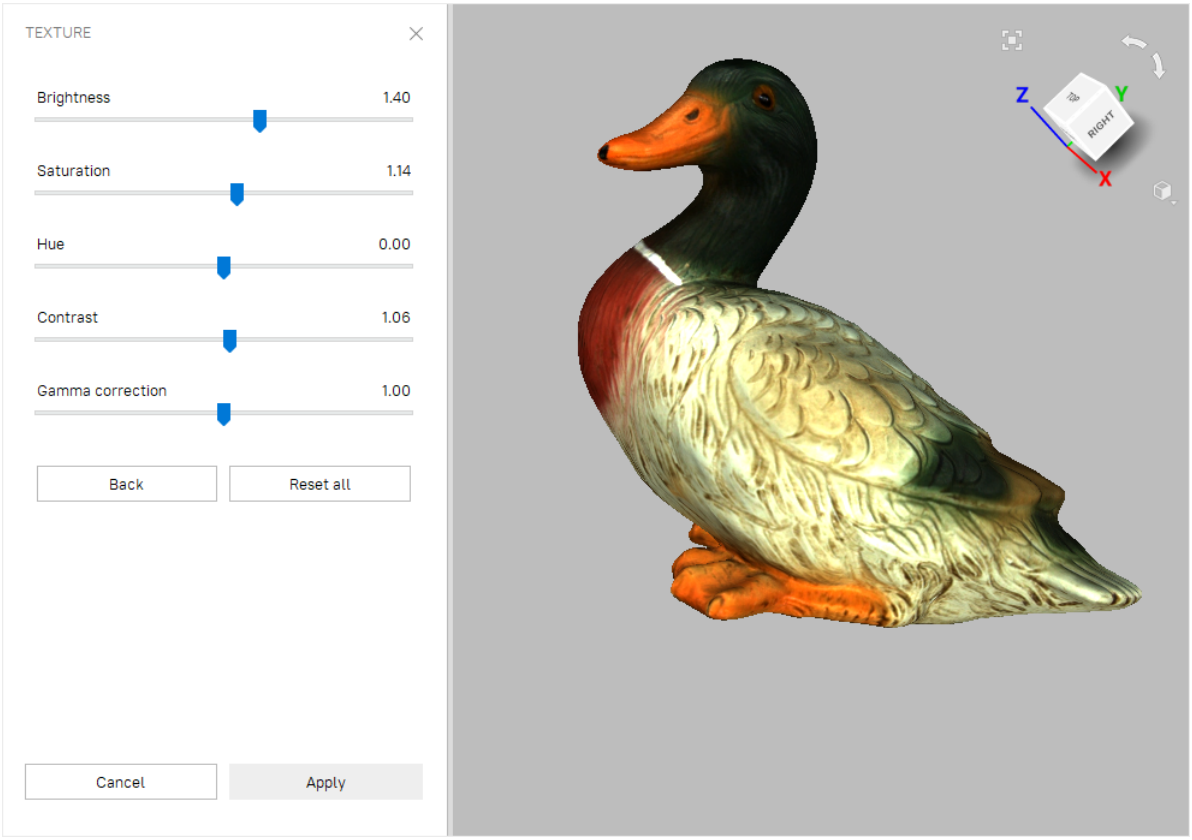


Figure 113: Texture adjustments.

The initial position of the *Hue* slider corresponds to the current texture color. Dragging it left or right corresponds to rotation counterclockwise or clockwise, respectively, on the color wheel.

After making the necessary changes, click *Apply* to transfer the resulting textured model to the *Workspace* panel.

To reopen the texture-adjustment dialog, follow the steps:

1. Select a textured model in *Workspace*.
2. Use RMB to call the context menu.
3. Select the *Adjust texture* command from the list.

9.13 Texture-Healing Brush: Manual Inpainting

You can manually inpaint missing textures by using the *Texture-healing brush*. This tool is based on the same algorithm as the *Inpaint missing texture* option covered in *Applying Texture (Procedure)*. The inpainting algorithm uses texture information from neighboring regions to fill in areas with missing or incorrect texture. Left image in Figure 114 shows a small texture imperfection: a felt-tip pen mark on the figurine. Results of inpainting this region appear in Figure 114 (right).

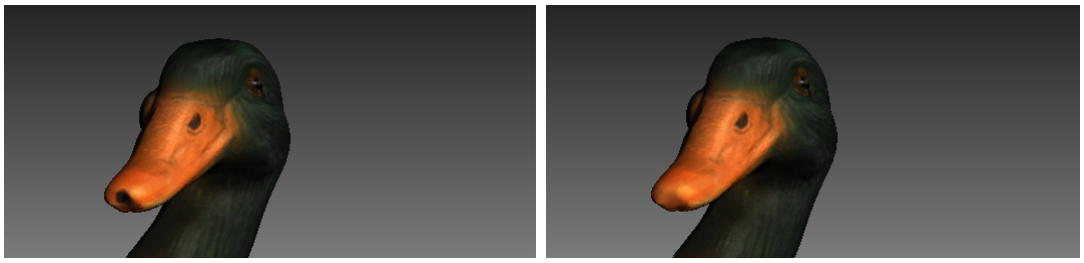


Figure 114: Texture-healing brush: before application (left) and after (right).

To launch the tool and inpaint a texture, do the following:

Hint: We advise you to first back up your model by selecting the *Duplicate scans* command from its context menu since the undo function is unavailable in this tool.

1. Mark the model textured for *Export* with the ✔ flag.

   Important: This version of Artec Studio does not support texture restoration on the models 'textured for *Preview*' (triangle map) and in regions of any models that have been corrected using the *Defeature brush*.

2. Open the *Editor* panel by clicking its icon in the side toolbar.
3. Select the *Texture-healing brush*.
4. Hold down `Ctrl` while using `Scroll wheel` or `[` and `]` keys to adjust the tool size. It should not exceed the size of the region that needs texture correction.
5. Paint over the region of interest using `LMB` while holding down `Ctrl` so that the tool (a circle or a spot) only rolls over the problem area. Try to avoid touching neighboring areas. Use the *Deselect* button to clear all the selections.
6. Repeat the previous step as necessary.
7. Click *Apply* to accept the changes or close the panel to reject them.

Note: If you paint an area in which the number of polygons exceeds the value specified in the settings dialog (see *Warnings*), a message will appear prompting you to either ignore the value, which means that processing may take longer, or cancel the operation.

9.14 Preparing Models To Export

9.14.1 Moving, Rotating and Scaling (Transformation Tool)

The *Transformation tool* allows you to move, rotate, scale and mirror objects relative to the global coordinate-system axes.

To access this tool, open the *Editor* panel and select *Transformation tool* or hit T. The panel will open, displaying four tabs that correspond to different modes for altering the object position in the global coordinate system. The name of the active mode appears at the bottom of the *3D View* window.

To revert your changes inside the tool, use the *Reset* button. Artec Studio applies changes when you leave the tool. Use the (*Undo*) button in the *Workspace* panel or hit Ctrl+Z to reset changes after you close the tool.

Hint: To quickly move objects to the origin and align them with the camera viewport, use the *Auto-position* button.

Note: The *Transformation tool* does not affect objects with the Locked position status ( ). See *Locking Object's Reposition* for details.

9.14.1.1 Translate

To enter translation mode, click the *Translate* tab or hit T. Three input fields will appear in the *Editor* panel showing the current origin coordinates (in millimeters) of the local coordinate system. The initial position of the local coordinate system will be in the center of the global one. To translate an object, do either of the following:

- Enter the new coordinate values for the local system using the input fields in the *Editor* panel. To adjust the position only along a specific axis, first hit the corresponding X, Y or Z key.
- Translate the object in the *3D View* window by dragging the corresponding control (see Figure 115):
  - *Square* in the center to move it freely
  - *Arrow* to move it along a specific axis
  - *Lines between arrows* to move it along the two axes simultaneously

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Note: Orienting the object may be easier if you first specify a new position for the origin of the local coordinate system: double-click on the desired surface point in the *3D View* window.

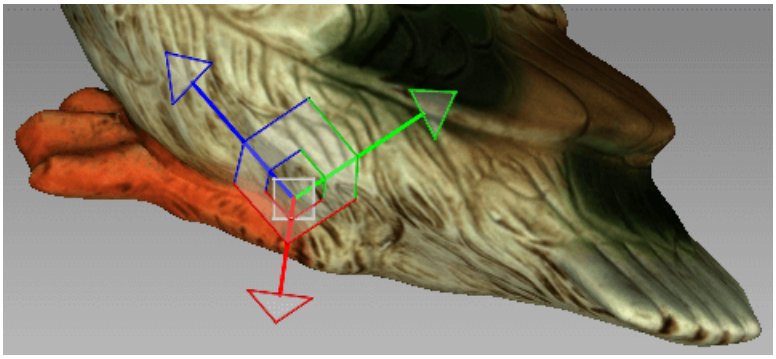

Figure 115: Translation control

9.14.1.2 Rotate

To enter rotation mode, click the *Rotate* tab or hit R. Three input fields containing the Euler-angle values will appear in the *Editor* panel. Initially, all values are set to zero. To rotate the object, do either of the following:

- Enter the new angle values (in degrees) using the input fields in the *Editor* panel.
- Drag one of the three circles (see Figure 116) to rotate the object. Hitting the key that corresponds the required axis (X, Y or Z) will hide the controls for the other axes.

Note: Orienting the object may be easier if you first specify a new position for the center of the local coordinate system: double-click on the desired surface point in the *3D View* window.

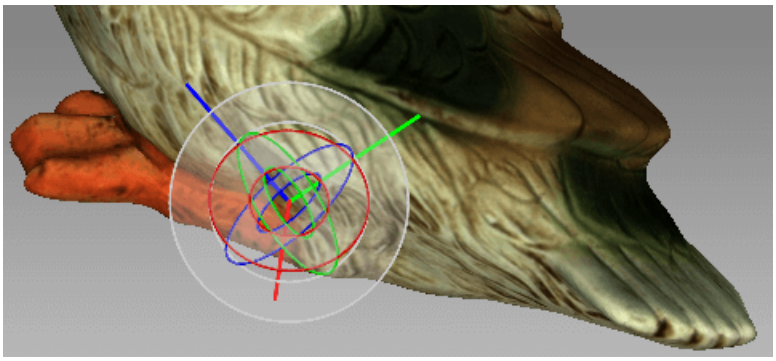

Figure 116: Rotation control

9.14.1.3 Scale

To enter scaling mode, click the *Scale* tab or hit S. A single input field with the current scale value (1.000) will appear in the *Editor* panel. You have two options for scaling the object:

- Enter the new scale value in the field.

- Drag the origin of the control (Figure 117) or either of its round ends in the *3D View* window.

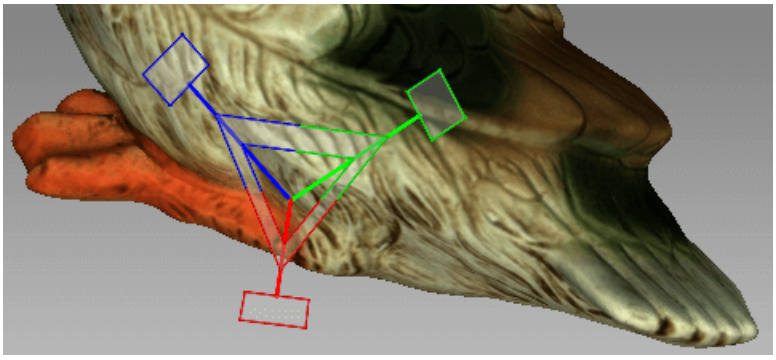

Figure 117: Scaling control

9.14.2 Placing Objects on Coordinate Plane (Positioning Tool)

You may need to place the model on one of the coordinate planes (e.g., for aesthetic reasons or when preparing the model for measurements, for capturing a screenshot, for exporting and so on). Instead of adjusting the model position using the *Rotate* and *Translate* modes of the *Transformation tool*, you can use the special *Positioning* tool. To do so, follow these steps below.

1. Open the *Editor* panel from the side toolbar and click either *Rough positioning* button or hit `P`.
2. Choose the *Rough* tab—a rough positioning is available for all the *object types*, whereas the *Precise* option works only with CAD objects.

   See also:

   Positioning CAD Primitives
3. Ensure that the coordinate axis grid is shown. Otherwise hit `G` or select the *Grid* command from 3D toolbar.
4. Choose the coordinate plane in which you want to place the model by activating one of the following options: *XOY*, *YOZ* or *ZOX*. Note that you may skip this step and return to it after Step 3.
5. Use `LMB` to specify at least three points on the surface; the plane will automatically pass through their center of mass (see Figure 118). The following conditions will then apply:
   1. For each additional point you specify, Artec Studio rebuilds the plane. Click *Clear points* at any time to redefine the points.

      Note: Three points determine a plane. When you're dealing with nonplanar surfaces, however, three points may be insufficient. In that

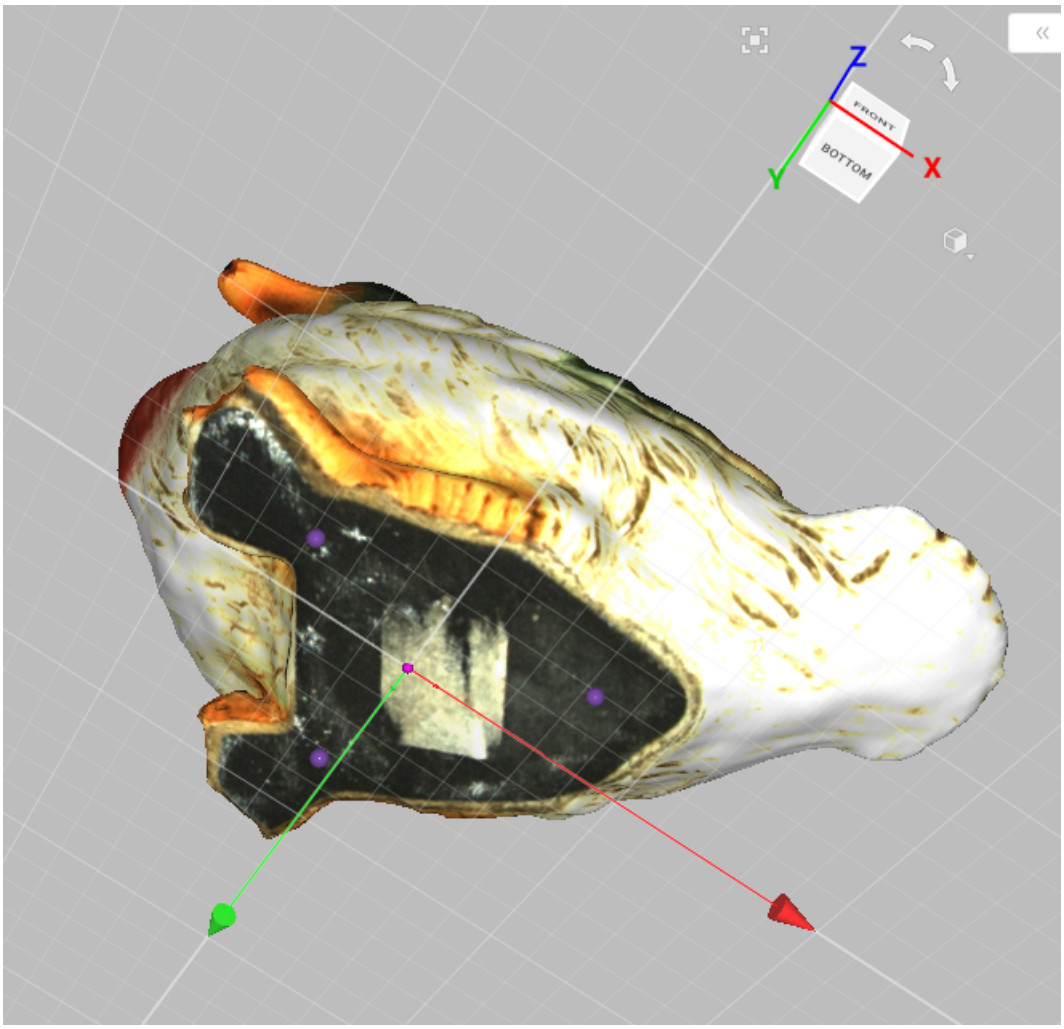

Figure 118: Positioning the model in the global coordinate system.

case, the more points you specify, the more precisely a plane will fit the surface.

2. In addition to the plane passing through the center of mass of the points you select, the coordinate origin will shift to that location as well.
3. The position of the coordinate origin is adjustable, as described below.

6. Invert the direction of the coordinate axis, if desired, by clicking the *Invert Z* button for the XOY plane, *Invert X* for YOZ, or *Invert Y* for ZOX.
7. If appropriate, adjust the model's position relative to the coordinate origin:
   1. `Shift + LMB`—rotate the model around the axis that is currently normal to the plane
   2. `Shift + RMB`—move the model along the plane in a fixed direction
   3. `Shift + LMB + RMB`—move freely along the plane
8. Hit *Apply* to fix the model on a specified plane or close the panel to cancel positioning.

To discard changes of object position, hit `Ctrl+Z`.

Tip: The *Enable automatic base removal* option may come in useful to position scans automatically after the scanning completes (see *Base Removal: Erasing a Supporting Surface*.)

Note: The *Positioning* tool does not affect objects with the Locked position status ( ). See *Locking Object's Reposition* for details.

9.15 Advanced Techniques

9.15.1 Automatic Processing

See also:

Use Autopilot

Automatic processing is a special mode for the *Tools* panel that saves time and simplifies postprocessing. It allows you to run all postprocessing algorithms from the *Tools* panel (*Rough*, *Fine* and *Global registration*; *Fast*, *Smooth* and *Sharp fusion*; *Small-object filter* or *Outlier removal*; *Hole filling*; *Mesh simplification* and *Smoothing*) with a click of just one button.

Each algorithm setting and parameter is based on the values for a preset configured in the manual mode. To change these values:

1. Switch to *Manual* mode.

2. Select a specific scanner type via the *Preset* dropdown list.
3. Use the expand ⌄ button to reveal parameters for the required algorithms.
4. Make the necessary alterations and click *Apply*.
5. Switch to *Auto* mode.
6. Select the checkboxes near the algorithms you intend to run.
7. Click *Go!* to begin automatic processing.

Changing the scanner preset type resets all the parameters to the default ones (for the selected preset).

Keep in mind that the algorithms run in the order in which they are listed, starting with *Rough serial registration* and ending with *Isotropic remesh*. Thus, if you want to run the *Small-object filter* before *Fast fusion* or *Global registration*, for instance, you must do so manually.

Unlike manual processing, automatic processing runs without the need for constant user attention, so it is more convenient when processing large objects: you can configure the settings, start the process and leave it unattended. It can also process objects of any size, reducing the number of mouse clicks to get the result.

9.15.2 Mirroring

Artec Studio allows to mirror the 3D data. The application uses the local rotation center as a mirroring center (see *Global Coordinate System and Rotation Center*). If it isn't specified, Artec Studio employs the global coordinate center.

To mirror the model, follow the steps:

1. Open *Editor*
2. Access *Transformation tool*
3. Select the *Mirror* tab
4. If necessary, double click the model to specify a rotation center
5. Select an axis to mirror the object along. Press the respective button—for example, *Along axis Y*.

To revert your changes, use the *Reset* button. For details, consult *Moving, Rotating and Scaling (Transformation Tool)*.

9.15.3 Isotropic Remesh

Isotropic remesh is an operation that modifies 3D model in the way that new mesh triangles have uniform size. Software packages where the models from Artec Studio are intended to be used may impose these requirements.

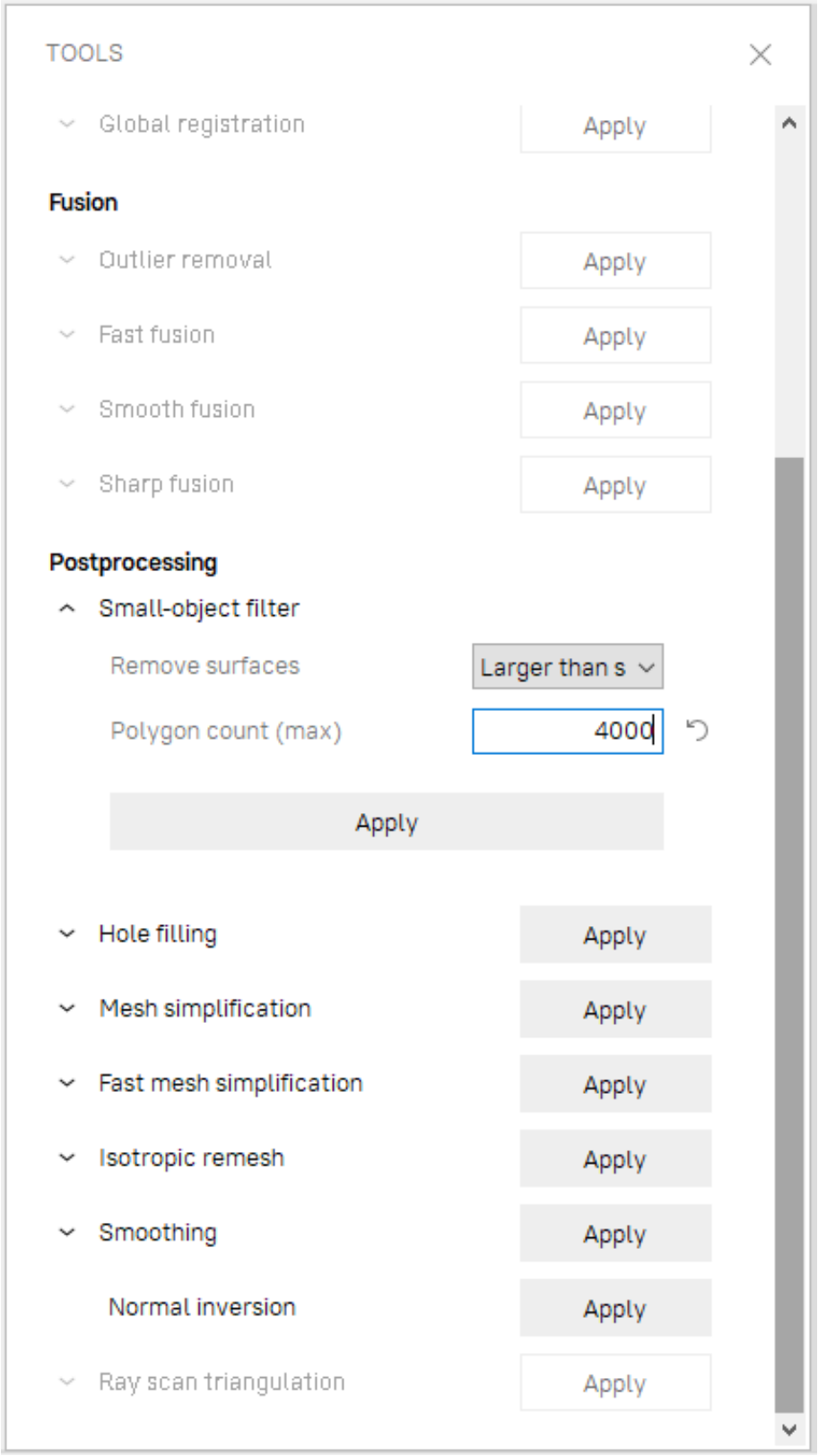

Figure 119: Manual adjustment for the specific scanner type.

Figure 120: Mirroring in action.

The algorithm produces an isotropic mesh, but doesn't necessarily decrease the polygon count. However, the output file is often smaller than the original one through the uniform triangles.

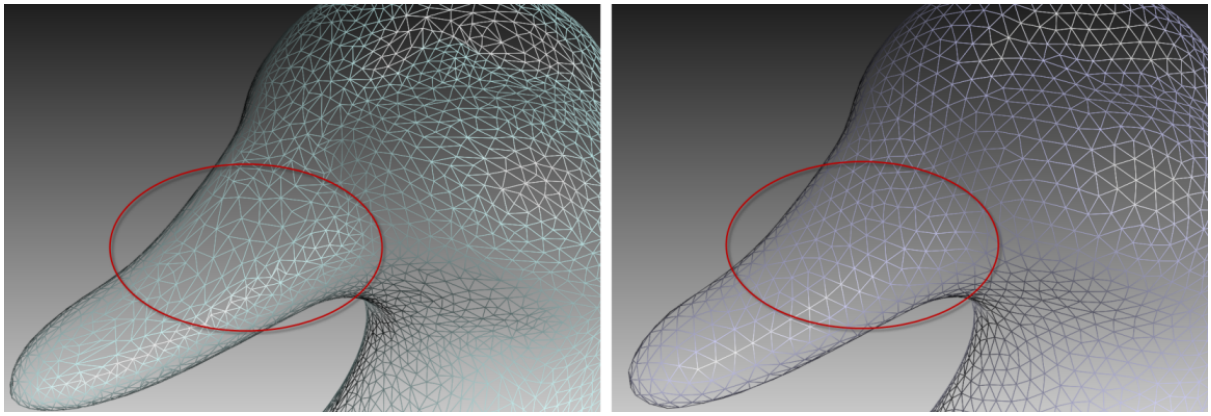

Figure 121: Isotropic remesh operation in action: original model on left, processed one on right.

To produce a uniform mesh,

1. Mark the model using the ✔ flag
2. Open the *Tools* panel
3. Locate the *Isotropic remesh* section
4. Click ⌄ and specify *3D resolution, mm* as necessary
5. Click *Apply*.

9.15.4 Normal Inversion

Normal direction determines the visibility of a surface in 3D graphics. Learn how to show normals of the objects in Artec Studio *3D View*, see *Representation of Normals and Boundaries*.

Normal inversion allows one to turn the model inside out. This operation may be useful when you need to manufacture some mating parts, like molds; or obtain a model based on its cast (e.g., turn the footprint cast into a shoe last, see Figure 122).

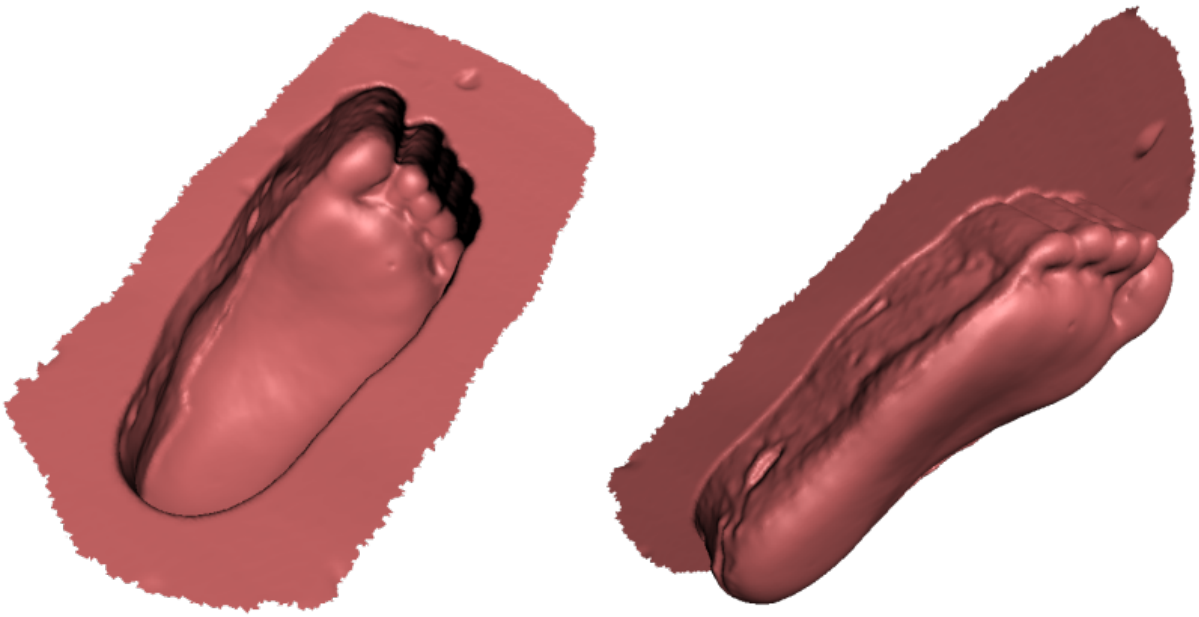

Figure 122: Normal inversion application: obtaining a foot model (right) from its cast (left).

To invert normals on a particular model,

1. Mark the model using the ✔ flag
2. Open the *Tools* panel
3. Locate the *Normal inversion* section
4. Click *Apply*.

9.15.5 Correcting Triangulation Errors

Some algorithms may introduce triangulation errors into the resulting model. These errors include the following:

- *Unattached vertices*. Points that are not vertices of any of the triangles
- *Vertices with identical coordinates*. Vertices that have the same coordinates
- *Faces containing invalid vertices*. Triangles that point to nonexistent vertices

- *Singular faces*. Triangles for which at least two of the three vertices coincide.
- *Faces with equal signature*. Faces with fully coinciding sets of vertices
- *Edges incident to three or more faces*. Edges that are adjacent to three or more faces
- *Faces with wrong orientation*. Faces whose normals point in a direction opposite to those of the adjoining faces

To correct these errors, mark a model in the *Workspace* panel by using the ✔ flag and hit `Ctrl + R` or select the *Window* → *Repair* menu command. If the algorithm detects no triangulation errors, Artec Studio will notify you that it has found no defects. Otherwise, the *Repair* panel will open, displaying the above-mentioned list of defects to be corrected. Next to the names of the defects, a column will appear stating the number of defects of a certain type found in the model. You can select all defects by pressing *View all*. Doing so will display in the model all the defective vertices and triangles using colored points. You can disable display of any particular defect type by removing the ✔ icon next to the corresponding name, or disable them all by clicking *View none*. To correct the defects, click *Repair all*. Clicking the *Apply* button accepts the changes.

CHAPTER 10

Working with CAD objects

Starting from version 15, you can work with CAD objects in Artec Studio. You can both create CAD primitives and then export them into CAD files or *import* CAD objects designed in external applications. This allows you to:

- Modify and design new parts for existing objects.
- Reverse engineer scanned objects.
- Ensure quality control by comparing scanned objects to their CAD models.

10.1 Constructing CAD Primitives

*CAD primitive*s are constructed on the basis of polygonal meshes (models) and then are fit into the latter.

At present it is possible to construct the following types of primitives:

- Cylinder,
- Cone/Truncated cone,
- Sphere,
- Plane.

To construct a CAD primitive, follow these steps:

1. Load a polygonal model in which you will fit the CAD primitive.
2. Open the *Construct* panel.
3. Select one of the available primitive types you want to construct (in the example below it is the *Cylinder*).

Figure 123: From left to right: original object, scanned model, a set of constructed primitives.

4. Choose *Selection type* and specify the required area on the model:
    - *2D brush* or *3D brush* slightly differs in how they work: the former specifies the model surface on the basis of the current viewpoint, whereas the latter works over the surface. Use the *Brush size* slider to change the brush size.
    - *Lasso* and *2D brush* allows you to select the model's backface using the *Select through* checkbox.

    To select an area on the model, use `Ctrl+LMB` above the model surface.
5. Once the required area has been selected, choose a *Fitting mode*:
    - *Expanding* is the fastest one, it allows selecting only portion of the surface where to fit the future primitive.
    - *Robust* is the optimal one, it is tolerant to extraneous selections.
    - *Exact* works exactly with the selected region.
6. Click the required primitive icon on the *Primitive type* bar.
7. If the selected primitive (cylinder or truncated cone) should fit into a hole of a given depth, such as a hole in a plate, then check the *Smart height evaluation* option. In this case, Artec Studio will use an algorithm that provides a more accurate fitting of the primitive to the model.
8. Click *Fit cylinder* button (or *Fit sphere*, etc.) to confirm your choice. Artec Studio will create a CAD primitive and fit it into the selected area.

Use the *Invert* button to invert selections, and also use the *Deselect* button to reset all the selections you made.

See also:

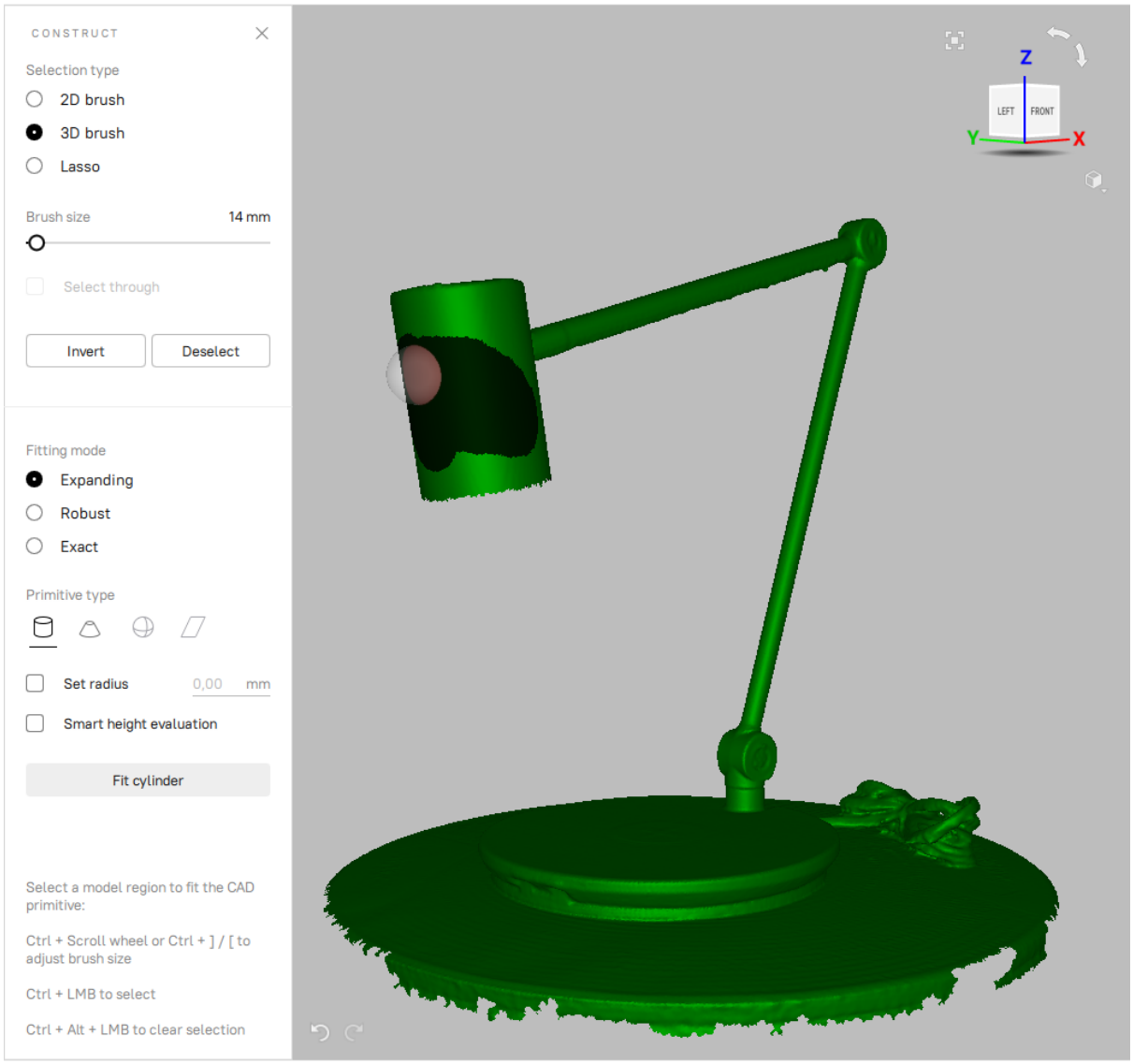

Figure 124: Construct panel: specifying region using the *3D brush*.

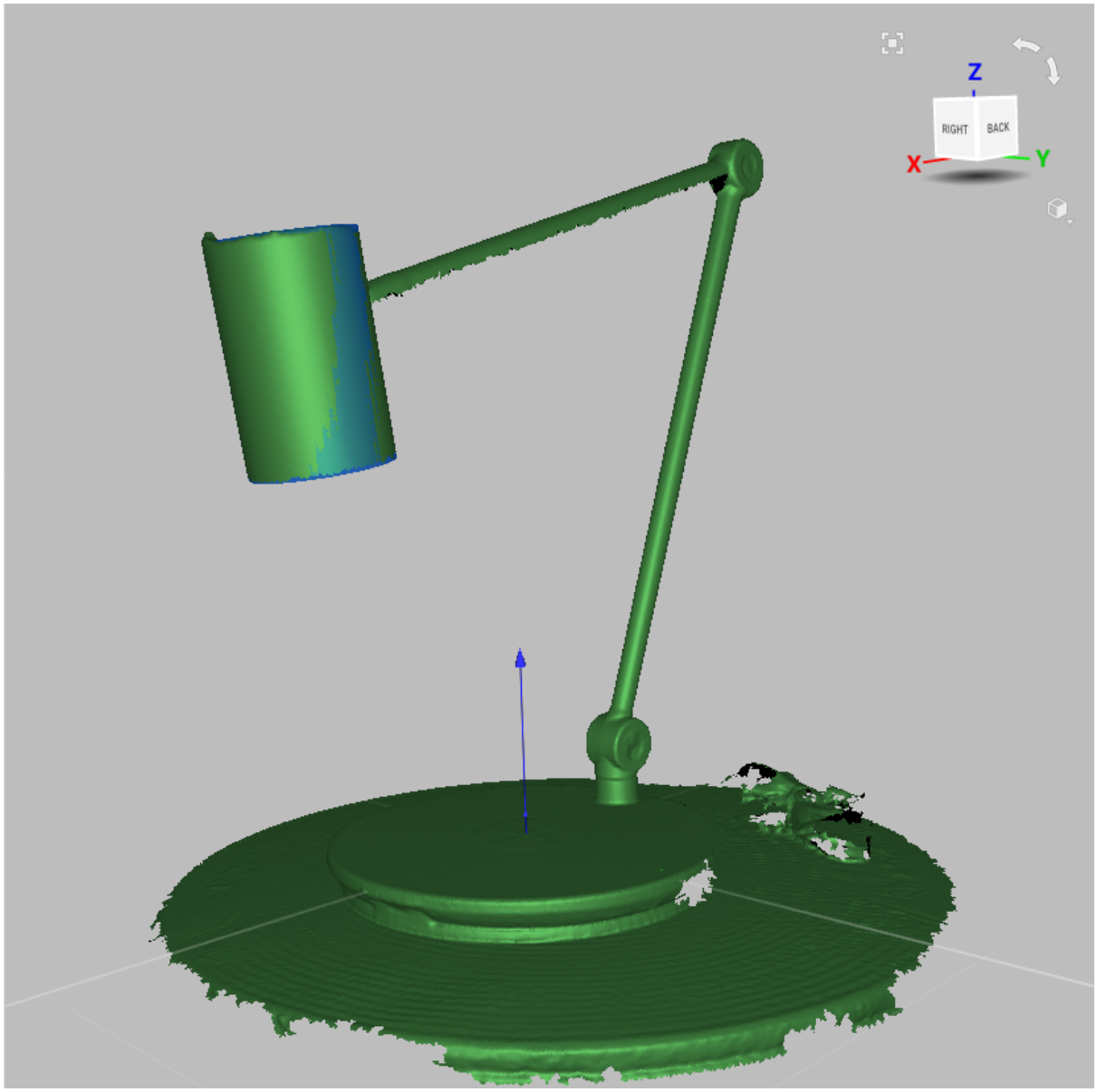

Figure 125: Cylinder (blue) fit into the model.

Importing CAD models

10.1.1 CAD Primitive Properties

To see the properties of the created CAD primitive, do the following:

1. Click the name or the icon of the primitive in the *Workspace* panel.
2. At the bottom of the *Workspace* panel, click the *Properties* section to expand it.

In the *Properties* section you will find the following general properties of the selected CAD object:

- *Size* — the size (in MB) of the object in computer's memory
- *Root mean square* — the deviation between the CAD object and the model to fit into (measured as the square root of the arithmetic mean of the squared distances between them)

The presence of geometric parameters in the *Properties* section will depend on the type of the selected CAD primitive.

Table 15: Presence of geometric parameters in the *Properties* section for different CAD primitives.

Parameter	Cylinder	Truncated cone/Cone	Sphere
Radius	Yes	Yes (large and small radii)	Yes
Height	Yes	Yes	No
Angle	No	Yes	No

10.2 Positioning CAD Primitives

The *Precise positioning* mode benefits from the presence of parametric data in the scene. Use the *Precise* mode to quickly and accurately position CAD primitives, and thus scans and models to which they belong.

1. In the *Workspace* panel, select the models and primitives you want to align.
2. Open *Editor* → *Precise positioning*.
3. In the *Primitives* box, select the CAD primitive you intend to position. Below the *Primitives* box you will see the available positioning options (see Table 16 for details), which appear as buttons and vary with the type of the selected primitive.
4. If some other objects belong to the parent group of the selected primitive and you want to apply the same positioning actions to them, check *Apply to all objects in parent groups*.
5. Click either of the self-explanatory positioning buttons. Artec Studio will position the primitive in accordance with the selected option and disable this button. You

will see the alignment information in the *Primitives* box next to the name of the selected primitive.

Every positioning action is recorded in the local history, so you can undo or redo it:

- To undo an action, use *Edit* → *Undo* or Ctrl+Z.
- To redo an action, use *Edit* → *Redo* or Ctrl+Y.

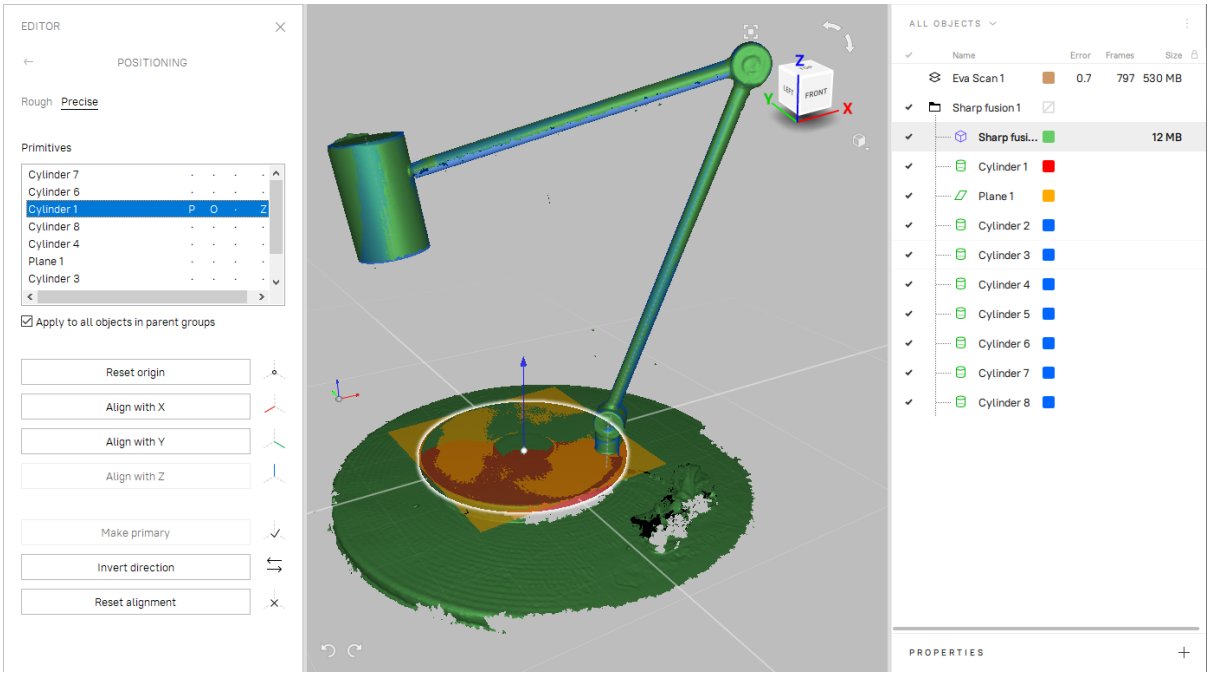

Figure 126: Editor → Precise positioning: the aligned CAD primitive is highlighted.

Table 16: Actions for primitives.

Button	Purpose	Status
Move to origin	Place the selected primitive's point to the coordinate origin. For details, see *Primitives' Points To Use for Positioning*.	*O*
Align with X/Y/Z	Align the primitive with the respective axis.	*X*, *Y* or *Z*
Align with YOZ/XOZ/XOY	Align the *plane* primitive with the respective coordinate plane.	*YOZ*, *XOZ* or *XOY*
Any	CAD primitive that you first align with any coordinate axis or plane is considered primary. A primary object will be given a priority when conflicting alignments occur.	*P*
Make primary	Make another object primary and remove this status from the current primary one	
Reset origin	Undo the *Move to origin* action.	
Invert direction	Invert direction of the axis or plane in the applied alignment	*I*
Reset alignment	Reset all the positioning actions applied to the primitive	

Note: The *Precise positioning* tool does not affect objects with the Locked position status ( ). See *Locking Object's Reposition* for details.

See also:

Exporting CAD objects, *Distance Maps* and *Sections and Volume*.

10.2.1 Primitives' Points To Use for Positioning

Depending on the type of a CAD primitive, you can use the following points in the *Move to origin* action.

Table 17: Primitives' points to use in the Move to origin action.

Type of primitive	Points for positioning
Cylinder	3 points: the center of the cylinder and the intersections of the cylinder axis with its bases
Plane	The center of the plane
Sphere	The center of the sphere
Cone	3 points: the cone vertex, the middle of the cone axis, and the intersection of the axis of the cone with its base
Truncated cone	3 points: the middle of the cone axis and the intersections of the axis of the cone with its bases

To select the center of a primitive for using in the *Move to origin* action, click the primitive or select it in the *Primitives* box. The selected point and the outline of the primitive will be highlighted in white (Figure 127, left).

When you hover the cursor over the primitive's axis, other points for positioning will appear on it. To select any of the possible positioning points, click on it. The selected point will be highlighted in white (Figure 127, right).

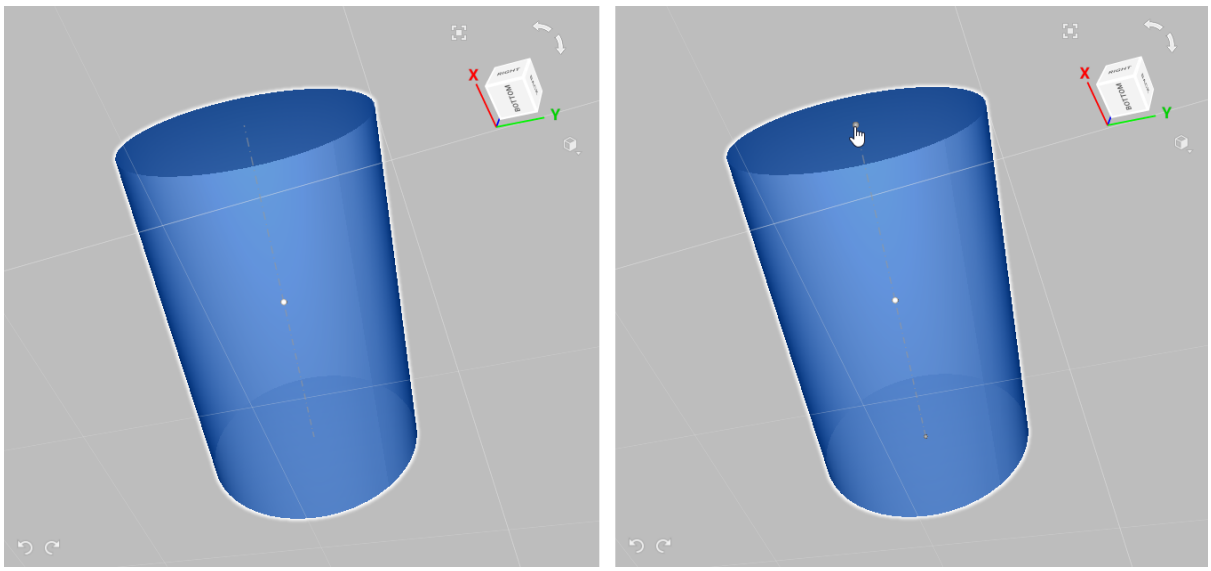

Figure 127: Selecting a point for positioning.

10.3 Working with Imported CAD Models

Imported CAD models can be aligned or *compared* with polygon models (fusion operation outputs).

10.3.1 Alignment

When aligning CAD models with polygon models, don't use Nonrigid alignment and employ many point pairs (5–6 pairs). Consult *Manual Rigid Alignment with Points* and *Specifying Points and Editing Their Positions* for details.

CHAPTER 11

Additional Modes

This chapter describes other Artec Studio modes, such as

- *Publishing to the Web*
- *Multicapturing*
- *Measurement Tools*
- *Copying Log Records*
- *Feedback Form*

11.1 Publishing to the Web

Having models on a web may simplify the process of collaboration among users. Artec Studio allows you to publish your 3D models on the Web through *viewshape.com*. Viewshape is a service that uses WebGL to render 3D models in a web browser. You can see published models at *viewshape.com* or embedded at other websites, blogs or social networks. Models can be shared privately so that only those who know the unique URL can see, comment on and use them.

To publish a model,

1. In *Workspace*, select only one polygon model.
2. Select *File* → *Publish*.
3. Click *Log in...*.

4. Specify your *my.artec3d* email and password in the window that opens (see Figure 128).
5. Click *Login*.

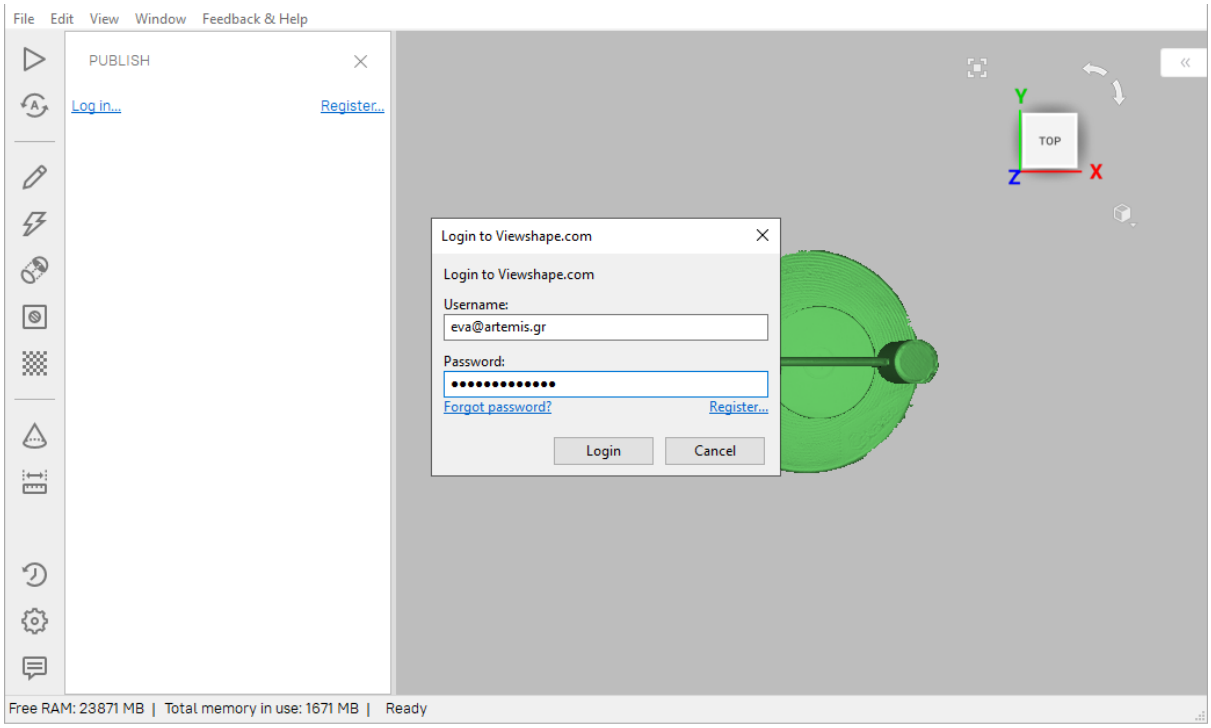

Figure 128: Viewshape.com login window.

After you successfully login, you will see the window with the found issues. Follow the steps below to continue uploading:

1. Adjust model's position in the *3D View* window to see how it will appear on the Web.
2. Specify the *Rotation angle* and *Preview* it when necessary.
3. Select visibility options (*Public* or *Private*).
4. Select the *Allow 3D-model download* checkbox if you don't mind if other users to download your model.
5. Choose whether to employ WebGL: use *Show* to display a full-featured 3D model and rotate it freely, or use *Don't show (spin image only)* to display images of the model captured from different angles. You can rotate these images only around the vertical axis.
6. Select a *License* type for your model.
7. Specify the *Collection* in your gallery to which you want to publish the model, or create a new one.
8. Set the *Model name*.
9. Provide the *Model description* as necessary.
10. Click *Publish*. Your model will appear on the site.

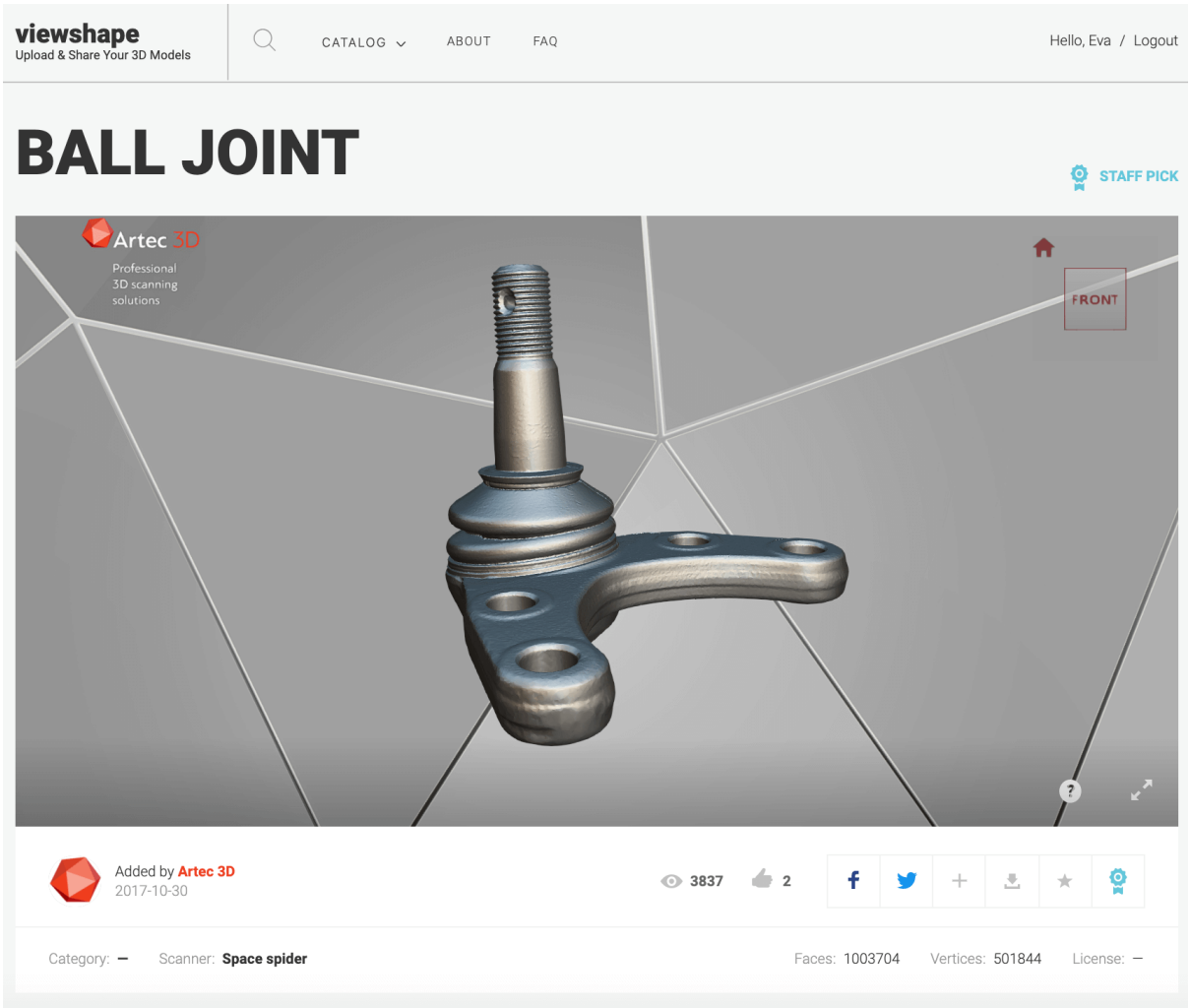

Figure 129: 3D model at Viewshape.

11.1.1 Model Requirements

WebGL is a progressive API, but it is not very powerful. If your model contains several million polygons and several very high-resolution textures, you will have difficulty rendering it in a browser. Therefore, to produce a model that looks good, you must first optimize it. We recommend the following model parameters:

- Fewer than 1000000 (300000 for Trial version) polygons
- Texture size of 4096×4096 (1024×1024 for Trial version) pixels
- Texture mapped using Atlas method (mandatory)
- Model positioned appropriately to rotate around Y axis

Using `LMB` in the *3D View*, you can rotate the model around its center of mass. Because translation is impossible here, you should rotate the model to the position in which you want it to appear on the web.

If the model parameters fail to satisfy the requirements and recommendations listed above, a yellow notification will appear at the bottom of the window, along with a button that instructs Artec Studio to fix the issue.

11.1.2 Fixing Issues

If your model suffers from one or more issues, click the *Fix issues* button. The software will open the new panel.

Artec Studio can currently identify two issues: very dense meshes and incorrect texture mapping. If the mesh is too dense, you must first simplify the model. The simplification tool is available in the *Issues found* dialog. If the texture is mapped using the *Preview* method (triangle map), you can remap it by clicking *Fix texture*. The *Texture* panel will then open, allowing you to fix it using the *Export* method (texture atlas) and the recommended resolution.

Once you have resolved all the issues, click *Back to Publish* to return to the *Publish* panel and resume the publication process.

11.2 Multicapturing

Artec Studio enables synchronized scanning with multiple scanners. This mode is helpful when capturing a large object from several angles using more than one scanner simultaneously. Multicapturing with several scanners implies that the system knows their position in advance. This condition simplifies and accelerates data processing considerably. For this reason you must calibrate the relative positions of the scanners before capturing. The resulting calibration data, which includes scanner IDs and their spatial orientations, is referred to as a *bundle*.

Important: Using multiple Artec scanners requires your workstation to integrate as many independent USB host controllers as connected scanning devices.

The entire procedure is given below and covered in the following sections.

1. Calibrate the relative position of each device (i.e., create a bundle)
    1. Capture the test object using all bundled scanners (see object requirements in *Bundle Creation*)
    2. Manually align the resulting scans using the *Align* tool to compute the relative position of all scanners
    3. Create the bundle using the *Create bundle* panel
2. Use the *Multi* panel to capture scans

11.2.1 Bundle Creation

11.2.1.1 Preparation

Perform the following steps to prepare the devices and the environment:

1. Select device positions. The scanners' combined field of view should cover the required area.
2. Fix the scanners in the chosen positions. If you plan to use hardware synchronization (see *Hardware Synchronization for Eva*), attach the scanners to the tripods by securing them with thumbscrews while allowing the wires to hang freely.
3. Select and set up the calibration object. Any object with a geometry-rich surface is a candidate. Avoid selecting objects with simple geometries for calibration (e.g., planes, spheres or cylinders). You may use several objects as a composition when creating a bundle. We recommend object installation at the distance corresponding to the middle of the operating range for the chosen device type.

11.2.1.2 Capturing

4. Use either the *Capture* or *Multi* panels to make scans. The latter option is more convenient, as it allows you to capture the video data stream simultaneously from several scanners. For details regarding this mode, see *Performing Multicapture*.

If you install the scanners at **small angles** relative to each other (i.e., you can see the same object area simultaneously through different scanners), you need **not rotate the object**. In this case, you can take calibration scans either sequentially or concurrently. In case of sequential scanning, make sure the object is fixed safely and remains motionless during the scan.	If you set up the scanners at a **large angle** and their fields of view have no overlap, use the *Multi* panel to start the capture sequence and **then turn** (move) the object to enable all scanners to capture the same parts. **Note!** It is important that all scanners capture a large portion of the object or scene (but not necessarily the same portion) in each frame, because the position of all subsequent frames—as well as the scanners themselves—will be determined by their predecessors. Also, the relative positions of the scans will determine the intercalibration of the devices.

11.2.1.3 Alignment

5. If the cameras are far from each other and the object was moving, then you should register the scans using the *Fine registration* and *Global Registration* algorithms.
6. Next, proceed to the *Align* panel and align the captured scans as *Alignment* describes. At that point, everything will be ready for bundle creation.

11.2.1.4 Bundle

7. From the menu, select *File* → *Create bundle*. A warning message will appear if you forget to align the scans. Otherwise, the bundle-creation panel will appear (see Figure 130). The *3D View* window will show the selected scans, the position and viewing direction of the scanners (by means of an appropriately colored pyramid), the device ID, and the scanner coordinates. It will display a list of connected devices and corresponding information.
8. Add a device to the bundle or remove one by inverting the ✔ image in the leftmost column of the list. The order of devices in a bundle refers to the scan order in the *Workspace* panel.
9. A bundle name will appear in the field at the top of the bundle-creation panel. By default it contains the serial number of the bundled scanner. Before creating the bundle, you can easily change this name by typing in the corresponding field. Click *Apply* at the bottom of the panel to create and install the bundle.

Note: Once you have created the bundle, you can no longer move the scanners relative to one another. If even one device has changed position, you must recreate the bundle.

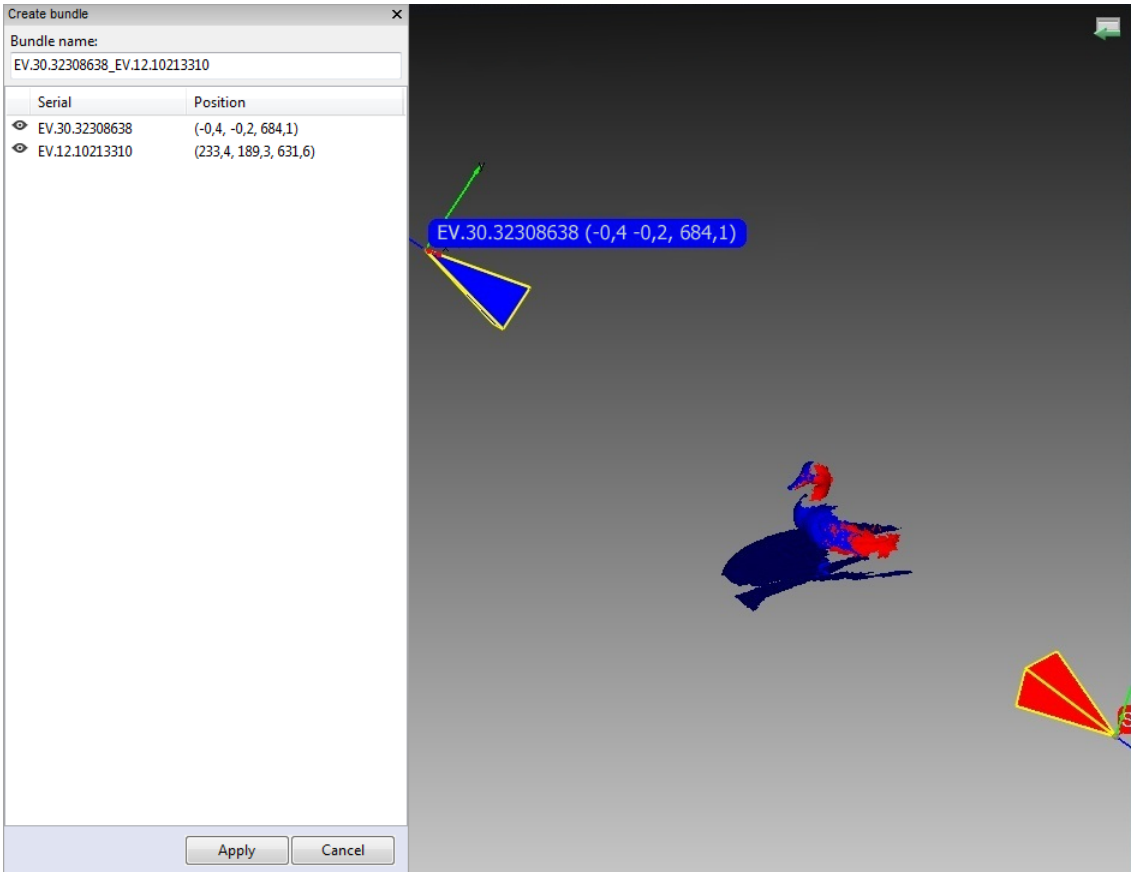

Figure 130: Bundle-creation window.

11.2.2 Performing Multicapture

Multi mode allows you to capture 3D reality simultaneously from several devices.

1. Select *File* → *Multicapture (bundle)*. The panel will open (see Figure 131).
2. Either use one of the existing bundles or specify the scanner list manually.

Note: In multicapture mode the system possesses information about the relative scanner positions. Therefore, scans captured by bundled scanners differ from manual scans in that the matching frames from different scanners are already in the same coordinate system.

---

1. Select the *Use bundle* checkbox. A dropdown list of all installed bundles will appear in the panel. Active bundles are highlighted in black, inactive bundles in gray. Artec Studio considers the bundle active if all bundled devices are installed and connected to the PC.
2. Select *Synchronization type* from the *Options* tab in the *Multicapture* panel.
   - In *Software* mode, scanners are synchronized via USB, *Windows* and Artec Studio, and the slave-scanner actuation time always varies (~10 milliseconds) owing to the numerous links in the chain.
   - In *Hardware* mode, scanners are synchronized via cables (see *Hardware Synchronization for Eva* for details). Hardware synchronization provides high precision and repeatability for slave-scanner actuation time (about 1 millisecond with a precision of less than 10 microseconds, thanks to microelectronic processes).

   Note: We recommend hardware synchronization in most circumstances; when capturing moving objects, it is mandatory.

   ---
3. Click *Preview* to start capture.

11.2.2.1 Tweaking Multicapture Options

You can store multicapture data either as separate scans (use the *Separate scans* radio button) or as a single scan in which every frame represents an aligned union of corresponding frames from all bundled devices (use the *Merge frames* radio button).

If you need to capture frames with a certain delay between the scanners, enter the delay value in the *Delay between frames* field. Unlike the *Scan* mode, the *Multicapture* mode captures each frame independently without attempting to align each subsequent frame with the previous one, so it makes sense.

Sometimes, limiting the cameras' field of view is necessary (e.g., to cut off extraneous distant objects). Two sliders in the *Depth of field* area set the near and far scanning boundaries. The application sets work-area boundaries for each device independently in the device tabs (see Figure 131, right). By default, the minimum and maximum boundary values for the corresponding device type are set to the recommended range; we encourage

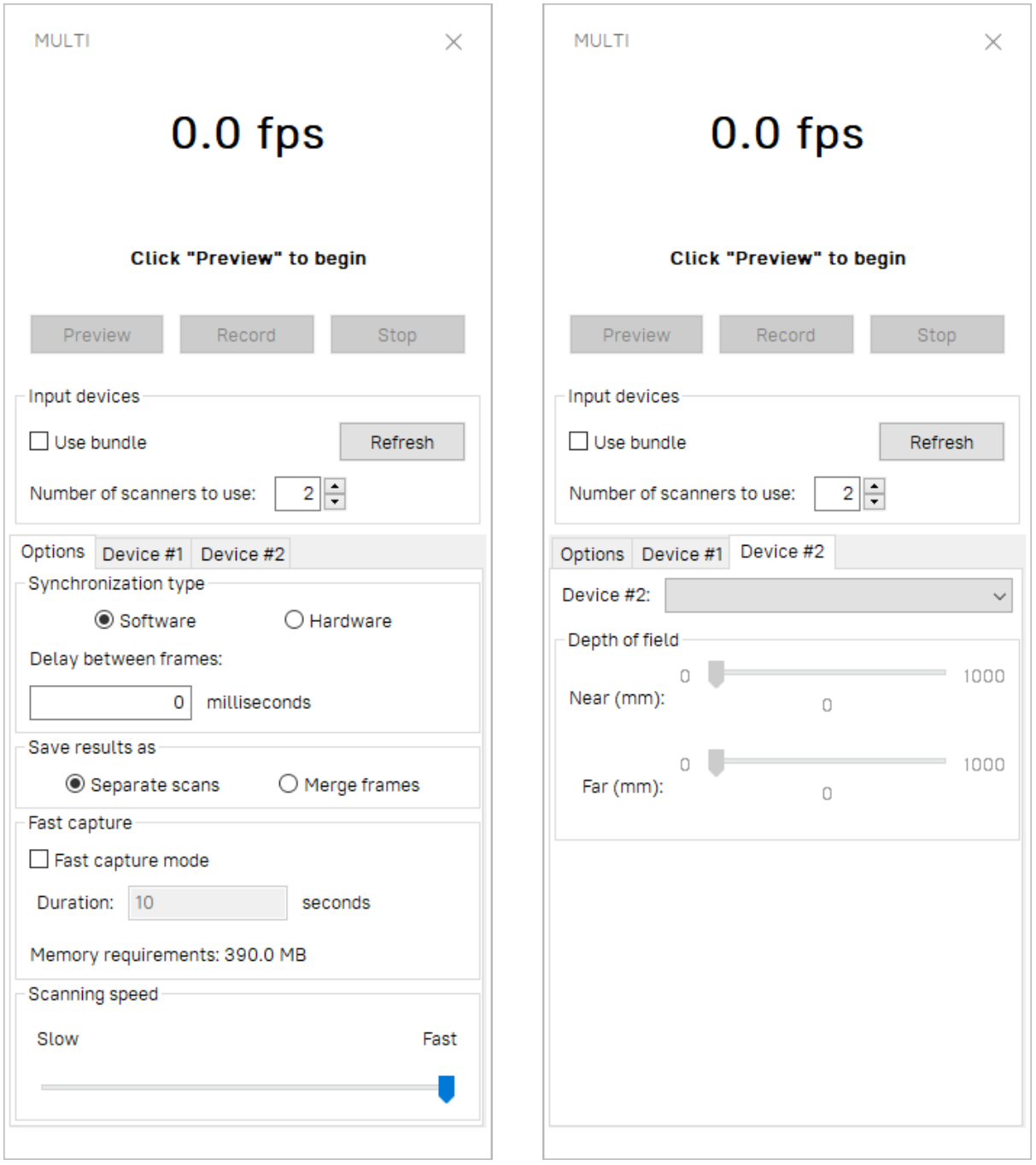

Figure 131: Multicapture panel: *Options* tab on left, *Device* tab on right.

you to avoid changing them. However, if you're using Artec L scanners or 3D sensors, it may become necessary. To change these values manually, mark the *Override default depth range* checkbox in the *Scan* tab of the *Settings* dialog and enter the appropriate values in the fields below.

Note: For most scanner types, redefining the recommended depth range may reduce accuracy.

Fast capture mode instructs Artec Studio to store raw scanned data in memory and processes frames after completing the capture sequence. It allows to save processor time on building and rendering surfaces. And if the number of processor cores is less then doubled number of scanners in the bundle, it can also increase scanning speed.

To enable it,

1. Check the *Fast capture mode* box.
2. Enter the desired capture duration in seconds. The application will automatically recalculate and display the required amount of memory.

Artec Studio saves multicapture parameters when you exit the application and reapplies them the next time you start it.

11.3 Measurement Tools

Artec Studio offers a number of measurement tools, including

- Distance
  - Linear measure
  - Geodesic measure
- Sections and Volume
- Distance map

The corresponding buttons reside in the upper part of the *Measures* panel.

To work with these tools

1. Mark the ✔ checkboxes of each desired scan or model so that objects will will be displayed in the *3D View* window.
2. Select the measurement tool you need and click on the object surfaces to create measurement lines, planes, etc.

The coverage below takes a closer look at the different measurement tools and their features.

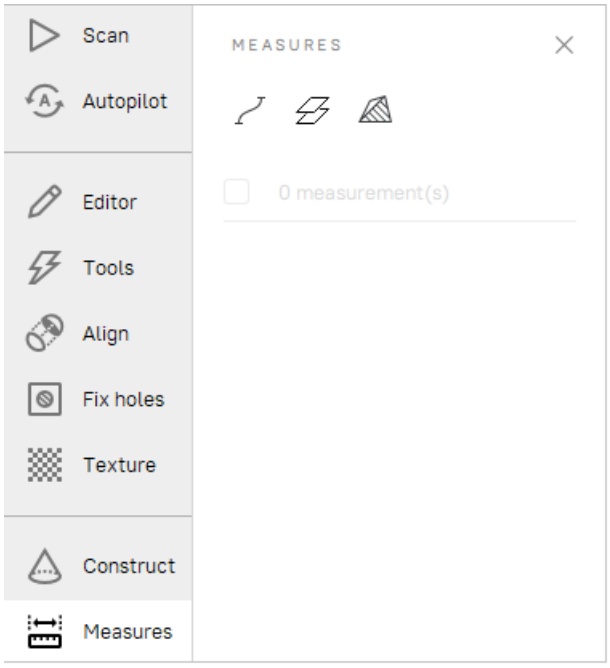

Figure 132: The *Measures* panel.

11.3.1 Distance

11.3.1.1 Linear Distance

When you select *Measures* → *Distance* ( ), the linear measurement will be used by default. Don't mark the *Geodesic* checkbox.

The linear-measurement tool allows you to measure distances between selected points and to measure the total length for a string of multiple points. You can enter a name for the new measurement by typing it in the *Name and color* field. Click on the color circle next to the field to choose a color of the measurement projection. The application creates new measurements with default names `Linear 1`, `Linear 2` and so on.

To measure distances between points,

- Use `LMB` to sequentially set the points on the model in the *3D View* window. The application will add these points to the current point list (in the *Measures* panel), which will also display linear dimensions and point coordinates.
- When you roll the cursor over any one of these points in the *3D View* window, the point will be highlighted; you can then drag it to another location using `LMB`. When you release the mouse button, the point will fix to its new location.

> **Note:** You can't set a point outside the object's surface; in this situation, if you release the mouse button, the point will return to its original position.

After you click *Save measurement*, the application will return to the original *Measures* panel and will display a list of all saved measurements along with editing and deletion options.

Figure 133: Linear measurement.

11.3.1.2 Geodesic Distance

Geodesic distance is defined as the length of the shortest path over a surface between several given points. To activate the geodesic measurement, mark the *Geodesic* checkbox in the *Measures* → *Distance* panel and select a point-cloud scan or model to start using the tool.

Working with geodesic measurements is similar to working with linear measurements (see *above*).

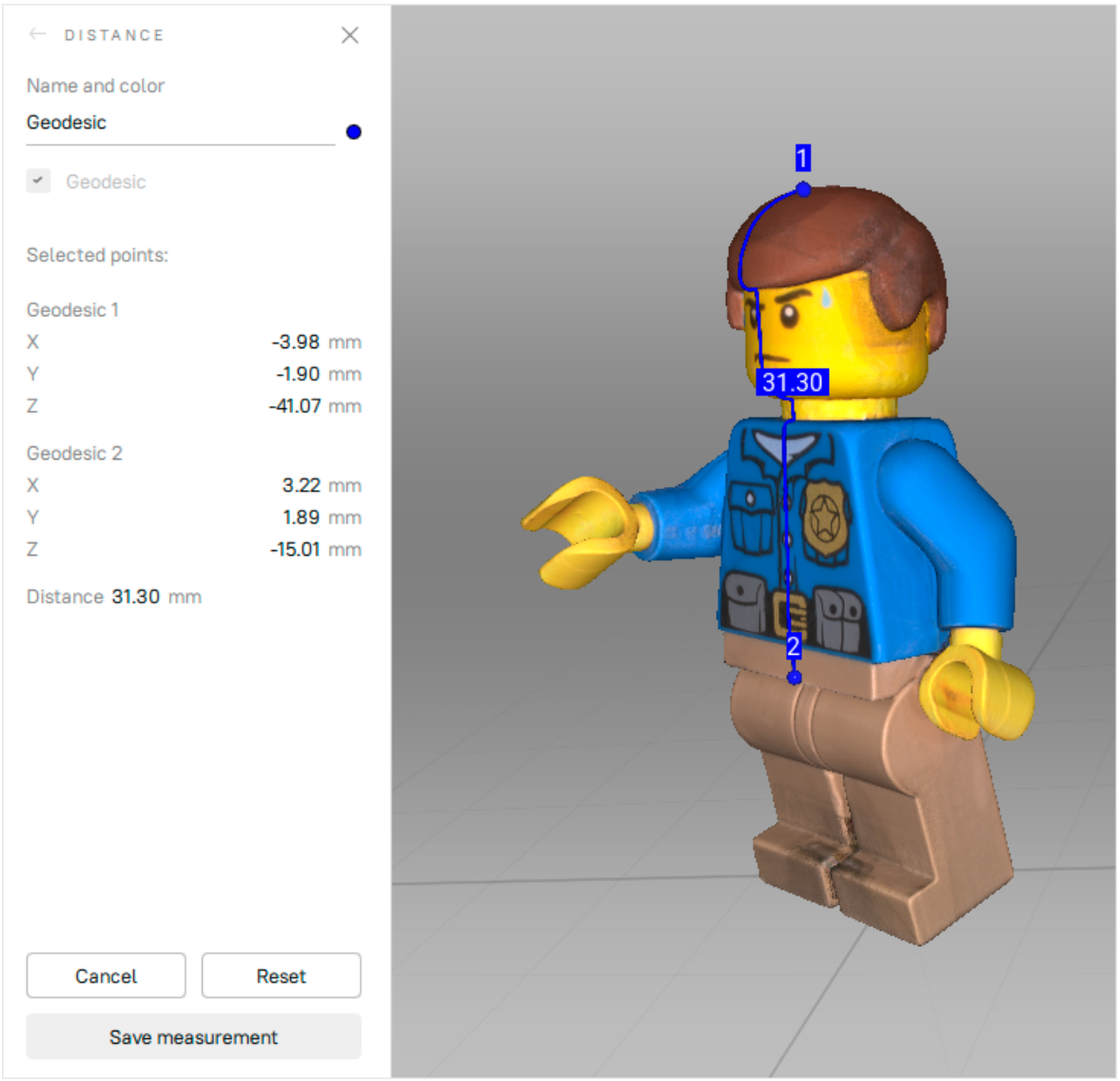

Figure 134: The Geodesic measurement.

Calculation of the shortest path is a time-consuming process that is accompanied by a progress-bar window. Also keep in mind that the shortest path between different surfaces or disconnected parts of the same surface is not defined. Therefore, the program will display an error if you select points on parts of a surface that are not connected to each other.

Note: The geodesic algorithm is complex, and computations for a large number of vertices may take a long time. Therefore, if you choose the first point on a surface containing more than 150000 points total, the software will warn you that it may be a lengthy operation. You can either use the mesh-optimization algorithm beforehand (see *Mesh Simplification*) or delete the parts of the surface that you don't need.

The left panel in this mode is similar to the one for linear-measurement mode (see *Linear Distance*).

11.3.1.3 Exporting Linear (Geodesic) Measurements

Once you have made and saved the required measurements, you can export them. Go to the general section *Measures*, select the desired measurement(s) and click on *Export...* You can export measurements in the following formats: `CSV` and `XML`.

11.3.2 Sections and Volume

Section is the plane that splits model or scan into two parts. Once created, it can provide you with data on volumes and areas of these parts as well as area and perimeter of the contour, i.e. the line formed as an intersection of the plane with surface.

To create a section of the object, follow the steps:

1. Select one or more models or scans and click *Measures* → *Sections & Volume* ( ). Models are preferable, since they contain only one surface.
2. Change the section name in the *Name* field as necessary.
3. Select a constrain type in the bottom of the panel: *Parallel to* either plane or *Unconstrained (3 points)*
4. Use `LMB` to mark points on the object's surface:
    1. Mark only one point to specify a plane in parallel with one of the coordinate planes (XOY, YOZ, XOZ).
    2. Mark three points to specify the plane that passes through them exactly.
    3. Mark more than three points to specify the plane that passing through their center of mass.
5. Redefine your point selections, if necessary, before you use *Calculate*; to do so, click the *Reset* button.
6. Orient plane position as necessary. Choose a tool: *Translate*, *Rotate* or *Scale*. You can either specify numerical values (in the global coordinate system) in the text fields or drag the controls (which are also called *gizmo*) in the *3D View* window. For instance, enlarge *Scale* to make the plane cross the whole surface.
7. Click *Calculate*.

Note: The control principles of the section gizmos are the same as for the model gizmos. See *here* for details.

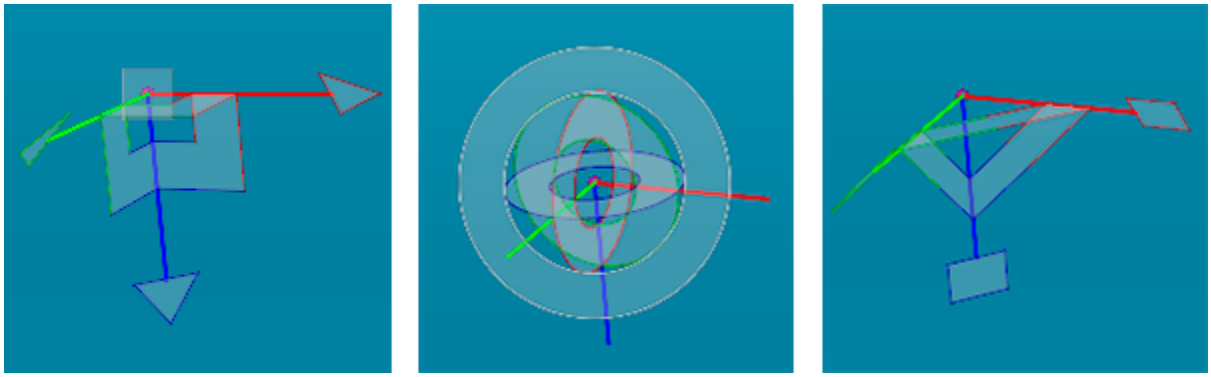

Figure 135: Gizmo types for the Translate, Rotate and Scale modes.

To create a series of sections

1. Specify the quantity of planes you want to create by entering the value in *Planes* and define the spacing in the *Spacing* (in *mm*) field.
2. Then select from the *Direction* list one of three directions (*Positive*, *Negative* or *Both*) in which to create the new planes.
3. Click *Calculate*.

Once you have created the section(s), the *Section* panel will display its geometrical information. This information includes perimeter and area for contours as well as area and volume for parts of meshes. Besides displaying geometrical values, Artec Studio will show a list of meshes and contours that allows you to highlight them in the *3D View* window by clicking on them in the list.

11.3.2.1 Comparing Values

The *Section* panel allows you to compare contours and mesh parts. To this end, select either two contours or two mesh parts from the list using the `Ctrl` key. Artec Studio will calculate the differences between the areas and perimeters of the contours and the difference between volumes and areas for mesh parts. These values will be available in the lower part of the *Section* panel (see Figure 138).

11.3.2.2 Volume and Surface Area of Models

To calculate the entire volume and surface area

1. Select one or more models in the *Workspace* panel.
2. Check *Measure entire model* in the *Sections & Volume* panel.
3. Click *Calculate*.

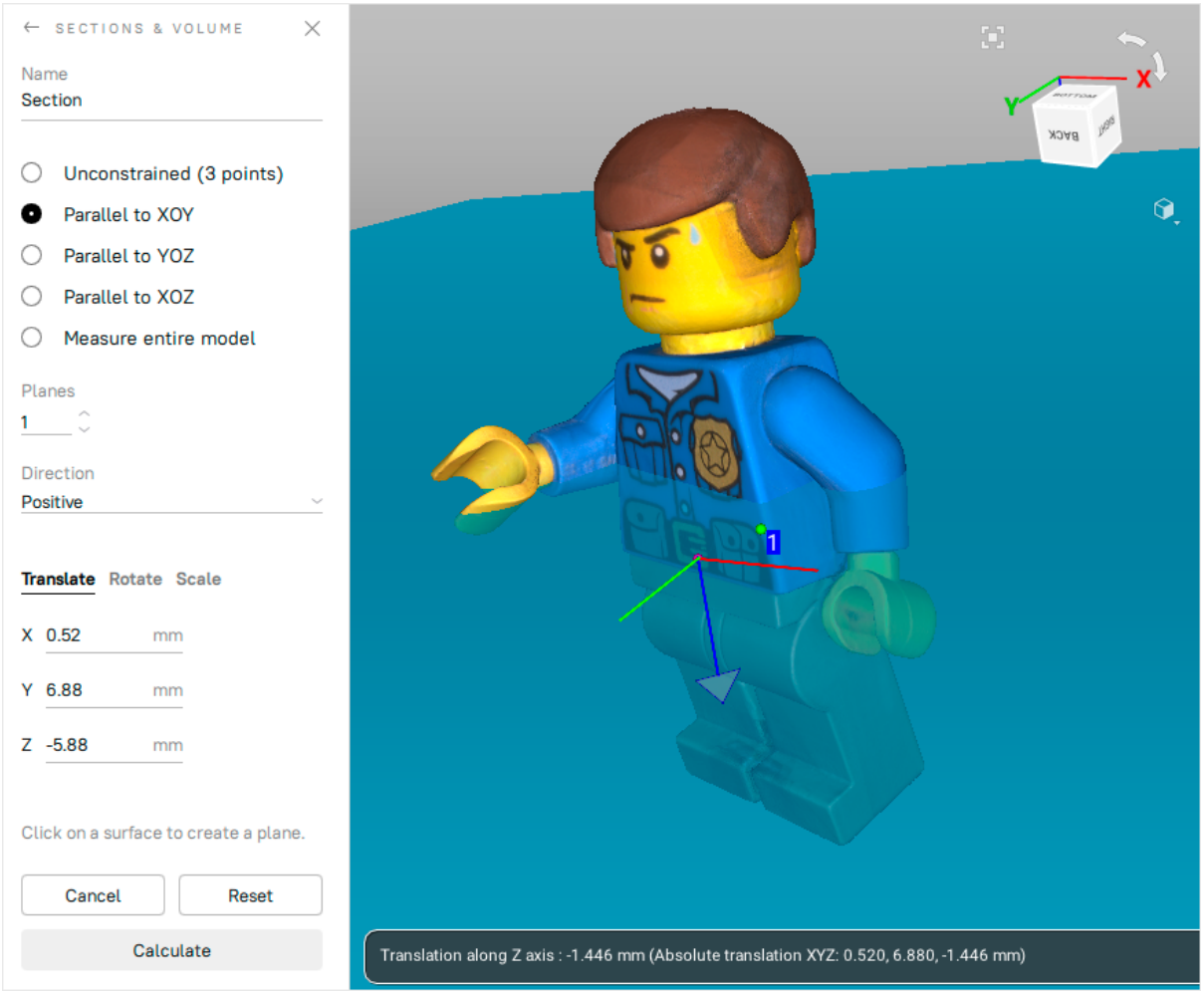

Figure 136: Orienting new section in the *Translate* mode.

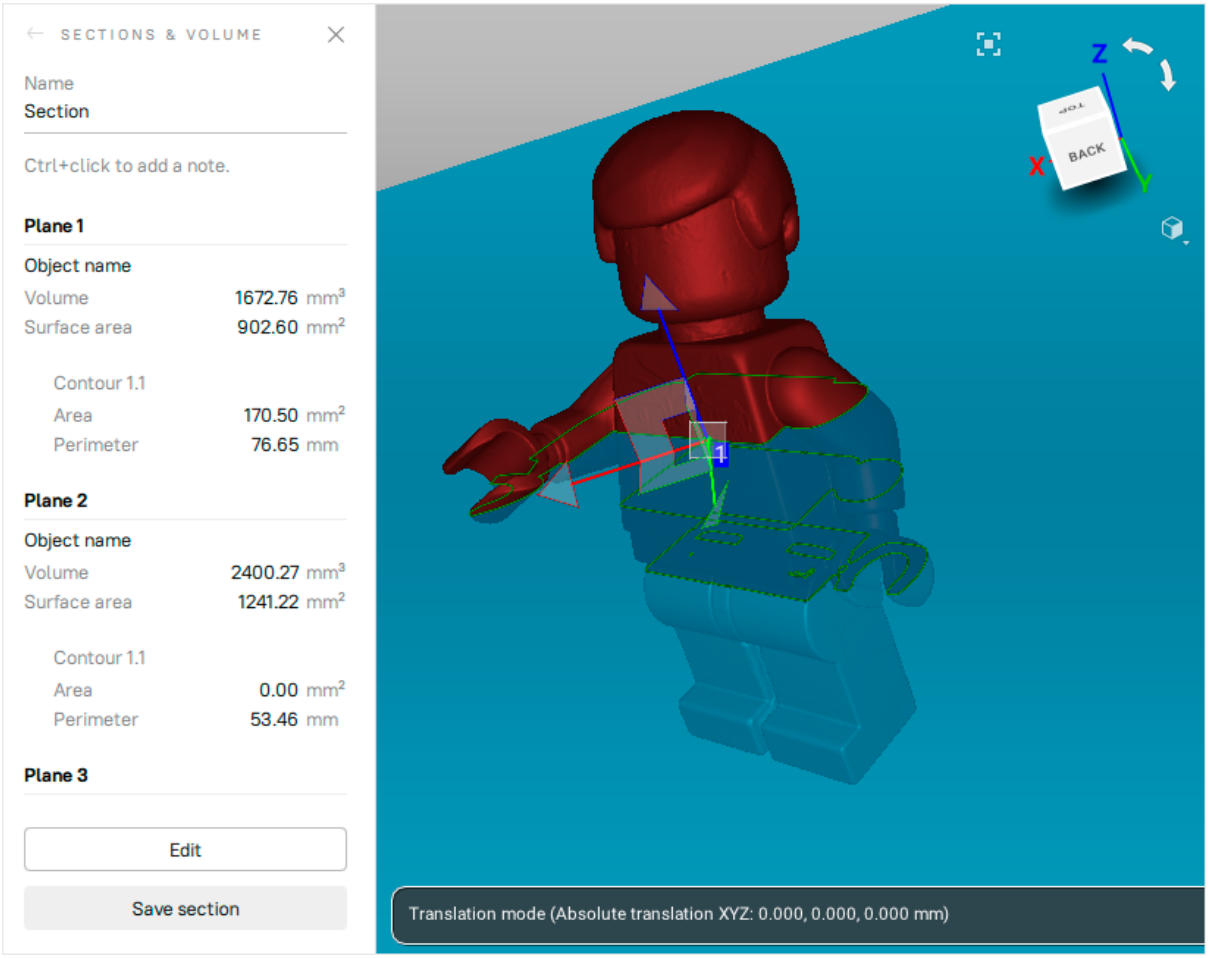

Figure 137: Calculating with three planes.

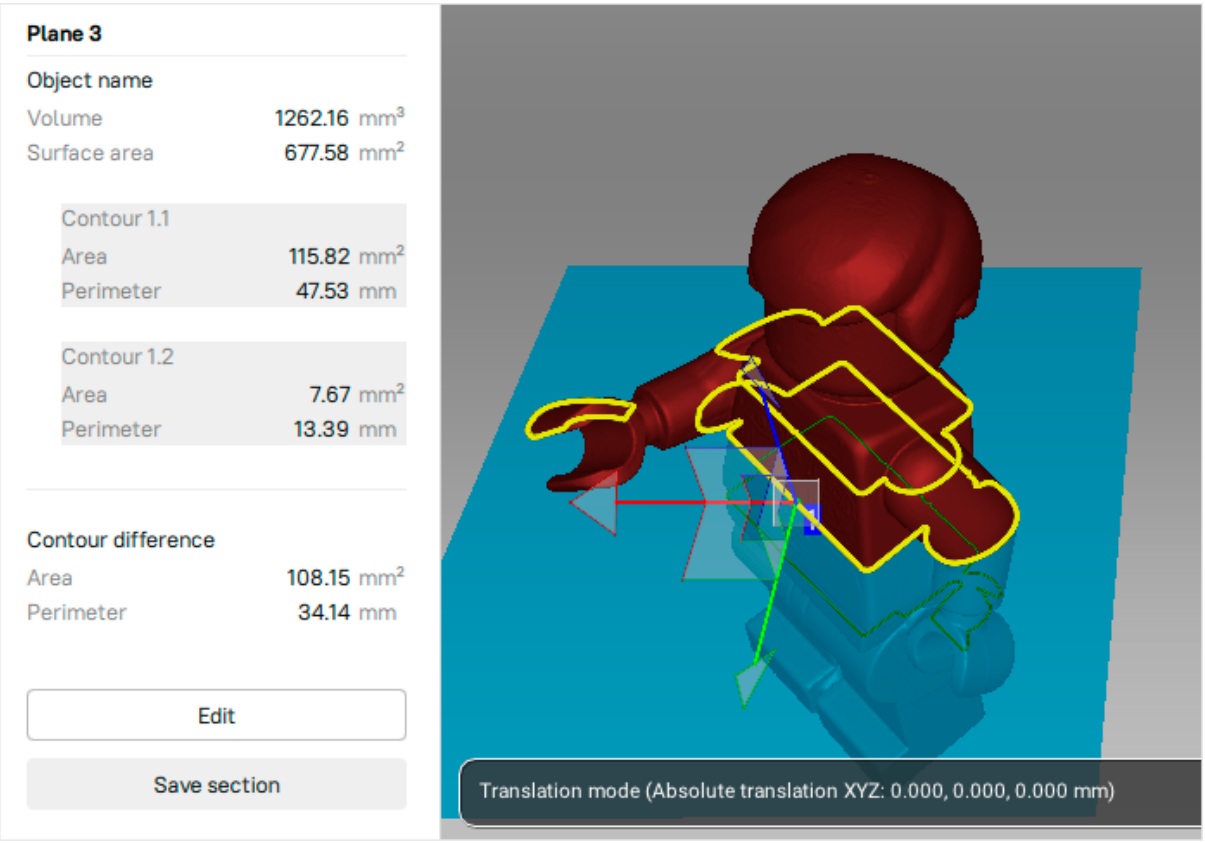

Figure 138: Calculating the contour difference.

Artec Studio will calculate the parameters for all the selected models.

11.3.2.3 Exporting Sections

Once you have made and saved the required measurements, you can export them. Go to the general section *Measures*, select the desired measurement(s) and click on *Export...* You can export measurements in the following formats: `CSV`, `XML` or `DXF`.

Also, if you have SolidWorks installed, the *Export to SolidWorks* button will be accessible.

11.3.3 Distance Maps

You may often find it necessary to compare two models and assess the deviation of their forms. For instance, quality control may require comparison of the original model with the scanned one. You can handle these tasks by using *Distance map*.

Note: Artec Studio can only compare models or scans containing a single surface.

Use this tool as follows:

1. Select two *aligned* models for comparison.

2. Click the *Measures* → *Distance map* ( ).
3. If necessary, specify the name of the distance map in the *Name* field of the *Distance map* panel. By default the application creates new distance maps under the names `Map 1`, `Map 2` and so on.

> **Note:** The direction along the normals of the first scan is considered positive; the opposite direction is considered negative. The button swaps scans.

4. Specify the *Search distance* value (in *mm*), a maximum range in millimeters for calculating distances between surfaces. You can adjust the actual range subject to this maximum after the calculation finishes.
5. Click *Calculate*.

Once the process is complete, the distance map will appear in the *3D View* window and the calculation results in the *Distance map* panel.

You can analyze the calculation results and the distance map:

- On the basis of the *Search distance* value you entered, Artec Studio calculates the following:
  - *Mean absolute distance*
  - *Mean absolute deviation*
  - *Mean signed distance*
  - *Root mean square* (RMS)—the square root of the arithmetic mean of the squared distances
- A distance map is a colored rendering on the particular surface regions. You can read the corresponding distance values and their distribution from the graduated scale and histogram that appear adjacent to the model. The map color changes from blue, which corresponds to a negative distance, to red, which corresponds to a positive distance.
  - Green means the distance between surfaces in this region is close to zero.
  - Gray highlights any surfaces with distances that exceed the specified *Search distance*.
  - Orange and bright blue correspond respectively to distances that are slightly above and below the limiting values of the scale.
- The graduated scale ranges from the positive value to the negative value of the *Error scale*. You can adjust this range using the *Error scale (mm)* slider or text box. Its maximum value cannot exceed the *Search distance*.
- If you move the mouse cursor to a particular point on the map, the exact distance will appear nearby.

To save the current distance map and quit this mode, click *Save map*.

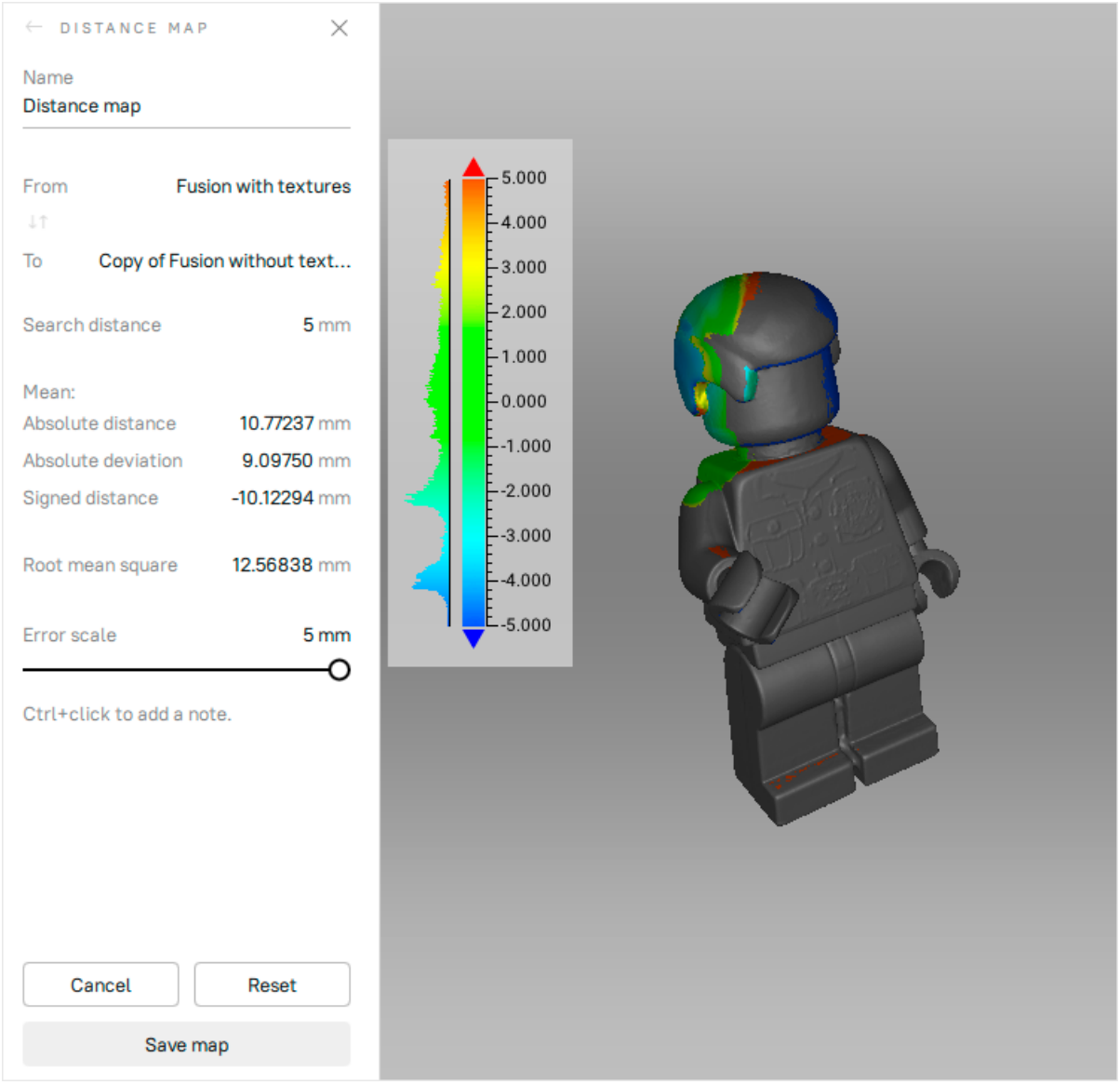

Figure 139: Surface-distance map calculated for two models.

11.3.3.1 Exporting Distance Maps

Once you have made and saved the required measurements, you can export them. Go to the general section *Measures*, select the desired measurement(s) and click on *Export*... You can only export distance maps in the `CSV` format.

11.3.4 Notes (Annotations)

Notes allow you to mark noteworthy points on the surface (parts of the object) and fix the calculated values on distance maps. Notes are available in all the *Measures* modes.

To make a note, just click `Ctrl+LMB` on the desired surface and you will see an editable label. Type any text into this label.

For example, in the *Distance* mode:

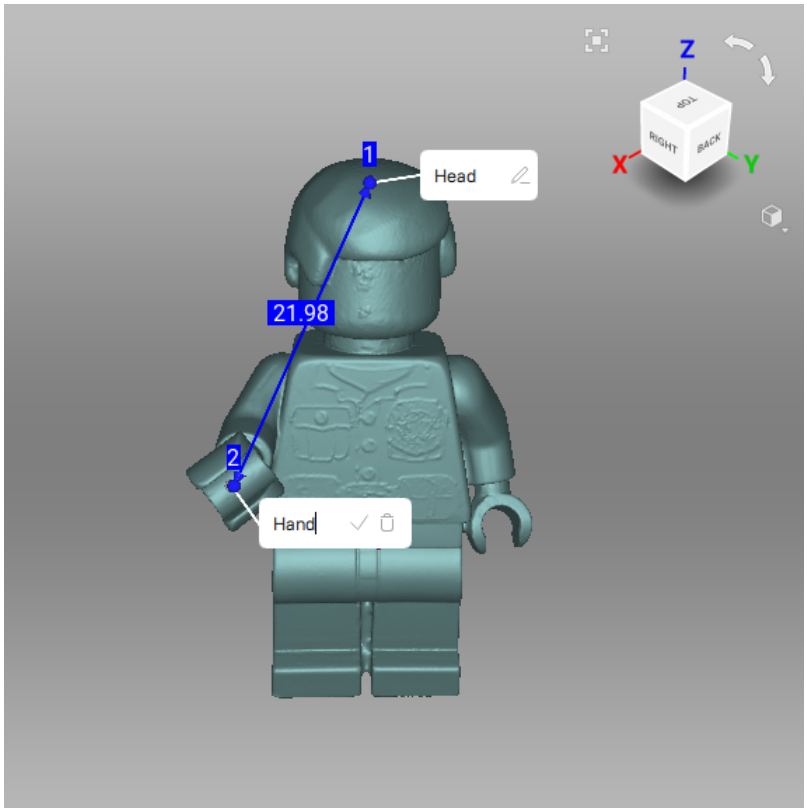

Figure 140: Notes on the model surface (Distance mode).

Use the following buttons to control your notes:

- is for committing notes
- is for editing notes
- is for removing notes

Note: To commit a note, you can also click anywhere outside the note's pop-up window.

In the *Sections & Volume* and *Distance map* modes, it works just the same. But in the *Distance map* mode, if you create the note on the colored part of the model, the note will automatically fix the calculated signed distance at that point (see the figure below).

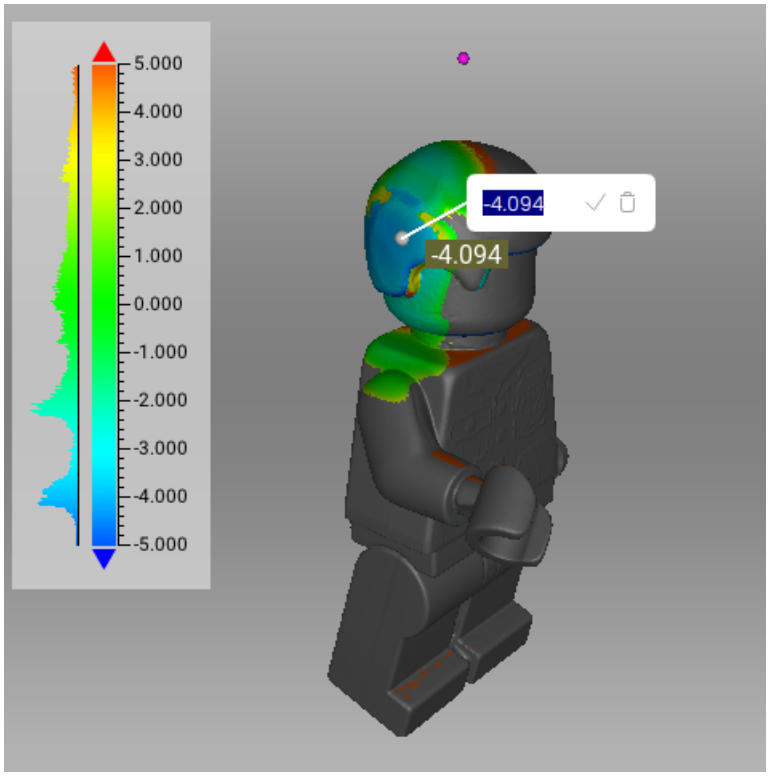

Figure 141: Note on the distance map.

11.3.4.1 Exporting Notes

Notes are exported with the measurements in which the notes are made. See *Exporting Linear (Geodesic) Measurements* and *Exporting Sections*.

The export of linear measurement with notes to XML is shown below.

```
<?xml version="1.0" encoding="utf-8"?>
<Linear title="Linear">
        <Annotation>
                <coord>vector float : 3; 11.39915; -1.54995; 24.
↪40591</coord>
                <text>string : Hand</text>
        </Annotation>
        <Annotation>
                <coord>vector float : 3; -2.042809; -1.170498; 39.
↪77322</coord>
                <text>string : Head</text>
```

(continues on next page)

(continued from previous page)

```
        </Annotation>
        <point_0>
                <coord>vector float : 3; -1.869595; -1.218353; 39.
↪71429</coord>
                <length>float : 0</length>
        </point_0>
        <point_1>
                <coord>vector float : 3; 11.40365; -1.638699; 24.
↪64325</coord>
                <length>float : 20.0871</length>
        </point_1>
</Linear>
```

11.4 Copying Log Records

If for some reason you need to copy the log records, for example, to provide information to our support center, you can do this using the context menu of the *Log* window:

- To copy a single log record to the clipboard, right-click it and select *Copy*.
- To place the entire log content to the clipboard, right-click any line of the *Log* window and choose *Select all*.

11.5 Feedback Form

We're always here to help, and we welcome constructive input from our customers. If you have a question, comment or suggestion about an Artec product, the feedback form is a quick and easy way to get in touch with us. Simply provide a valid email address (or use default MyArtec email) and type in your question or comment, and we'll direct it to the proper staff members. If appropriate, we'll respond with an answer to your question or a request for further information so we can better assist you. To use the feedback form, you must agree to our terms of service.

CHAPTER 12

Settings

This chapter describes Artec Studio settings that you can change through the *Settings* dialog. To display this dialog, select *Settings...* from the *File* menu or hit the `F10` key.

The user-adjustable settings are divided into categories under separate tabs. These categories include the following:

- General
- Performance
- Scan
- UI
- Miscellaneous

12.1 General

The *General* tab contains basic Artec Studio settings and includes the following options (see Figure 142):

- *Project-storage folder*
- *Autosave* options
- *Import/export* options
- *Default import units* and *Default export units*
- *View control* settings

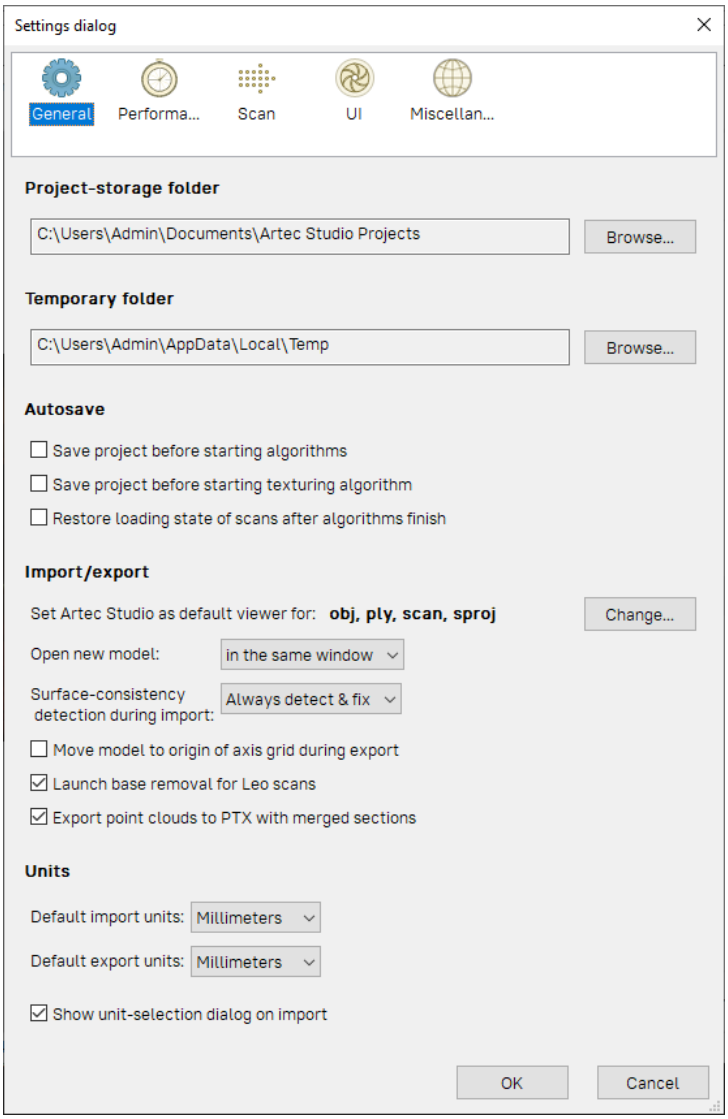

Figure 142: *General* settings page.

12.1.1 Project-Storage Path

Project-storage path is a default path which Artec Studio will use in the project saving dialog (*Saving a Project*). The default location is Windows user's `Documents` folder. You can alter this path by editing the field content or clicking *Browse...* and afterwards specifying the required folder.

12.1.2 Temporary Folder

A newly created and yet unsaved project is stored at the location specified in the *Temporary folder* field. The default path is the Windows temporary folder. To change this folder, use the *Browse...* button or enter a new path in the field.

Artec Studio automatically clears project folder. You can access Windows temporary folder and remove the unwanted projects as necessary.

1. Open the *Explorer* window.
2. Type `%temp%` in the address bar and hit `Enter`.
3. Locate folders that have GUID names in braces `{ }`.

12.1.3 Autosave Options

When the *Save project before starting algorithms* option is enabled, the application will always save your project before running any processing routines. The *Restore loading state of scans after algorithms finish* checkbox allows you to control loading of selected scans once the algorithm is complete. Artec Studio always loads selected scans into memory before launching an algorithm; if a scan is not loaded at this point, the application will automatically save it to the hard drive after the algorithm finishes, freeing up memory. For more information about autosaving projects, see *Autosaving a Project*.

12.1.4 Registering Artec Studio as Default Viewer

Artec Studio supports various file formats. To make it the default application for supported formats, click *Change...* and select the formats you want the application to open by default (see Figure 143):

**.sproj*	Project files for Artec Studio
**.scan*	Single-scan export/import format
**.ply*	Format for saving polygonal models obtained using 3D scanners
**.stl*	3D-model export format for fast-prototyping equipment
**.wrl*	Virtual-reality files in VRML 1.0 and VRML 2.0 format
**.obj*	Texturized 3D models; Wavefront OBJ format

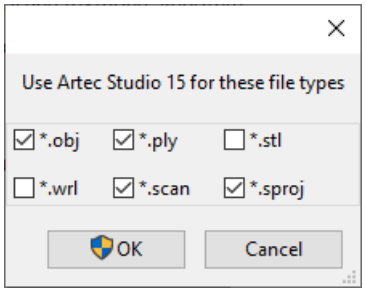

Figure 143: Making Artec Studio the default application for various file types.

For more information on importing and exporting files, see *Exporting Models, Scans and Point Clouds* and *Importing Models and Scans*.

12.1.5 Opening Files

Artec Studio can serve as the default viewer for `SPROJ`, `SCAN`, `PLY`, `STL`, `OBJ` and `VRML` (`*.wrl`) formats. To open each subsequent file in a new application window, select *Open new model in a new window*. If the *Open new model in the same window* option is selected, Artec Studio will use existing windows to display subsequent files.

12.1.6 Surface-Consistency Detection During Import

The *Surface-consistency detection during import* option instructs Artec Studio to examine imported files for defects. Select one of the following parameters:

Do not detect. Disable automatic surface-consistency detection.

Detect & ask. Enable automatic surface-consistency detection; Artec Studio will prompt you to start defect correction.

Always detect & fix. Enable automatic surface-consistency detection and correction.

12.1.7 Model Placement

When exporting, the application can automatically center scans and models on the origin of the axis grid. To enable this option, select the *Move model to origin of the axis grid during export* checkbox. If the checkbox is cleared, the application will save the model's current placement on the axis grid when exporting surfaces.

12.1.8 Base Removal for Leo Scans

The *Enable automatic base removal* option in the *Scan* panel only works for scans from Eva and Spider and other handheld scanners connected to computer. To enable automatic base removal for scans from Leo, select the *Launch base removal for Leo scans* checkbox. The algorithm will start after the application *imports that project*.

12.1.9 Point-Cloud Export

The *Export point clouds to PTX with merged sections* ensures a successful import of the exported files in third-party software products. See *Merging Sections*.

12.1.10 Units

In Artec Studio, all software operations use millimeters as the default measurement unit. If you need to import or export a model in other units, change the settings under *Units*. The software applies these settings only when importing or exporting a model or a point-cloud scan.

Selecting the *Show unit-selection dialog on import* option enables you to choose on import which measurement unit was used to create the scan (see Figure 144). Artec Studio supports units of millimeters, centimeters, inches and meters. If in most cases you import data in a particular measurement unit, but you might occasionally import models created using another unit, you should enable the *Only if object is less than __ mm* option and enter the threshold value. In this case, the unit-selection dialog will only appear if the model dimensions are below the threshold value.

The *Default import units* and *Default export units* dropdown lists determine the default measurement units for importing and exporting models. When exporting point-cloud scans (Artec point cloud and Leica Geosystems Cyclone Point Cloud), application will ignore the specified units. See *Exporting Point Clouds* for details.

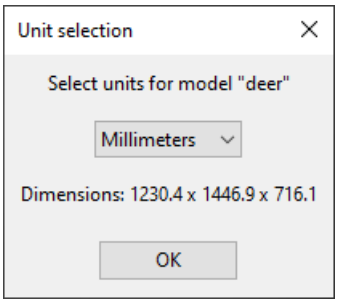

Figure 144: Unit-selection window.

12.1.11 View-Control Settings

Artec Studio allows you to use `Scroll wheel` to zoom in on the model in the *3D View* window. You can take advantage of this capability in two ways:

- Clear the *Mouse-wheel zoom to cursor* checkbox to enable zooming to the center of the screen. In this case, you must keep the target area in the screen center and readjust its position from time to time.
- Select the *Mouse-wheel zoom to cursor* checkbox to enable interactive zooming to the mouse-cursor position. In this mode, you need only keep the cursor on the target area while spinning `Scroll wheel` forward and backward.

12.2 Performance

The following parameters are user adjustable by way of the *Performance* tab (see Figure 145) multithreading, memory usage, command-history storage, compression levels for stored data, texture-recording mode and *Real-time fusion* settings.

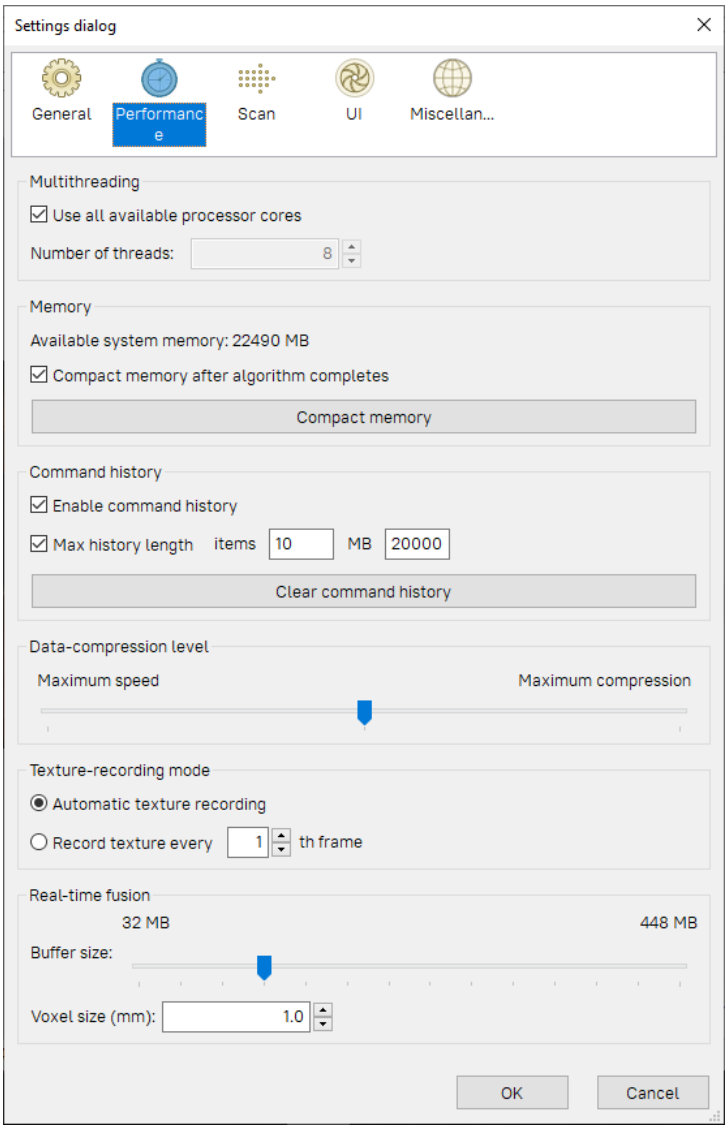

Figure 145: Performance-tab options.

12.2.1 Multithreading

On computers that feature multicore processors, Artec Studio uses all cores by default. If you would like to limit the number of cores the application employs, clear the *Use all available processor cores* checkbox and enter the number of concurrent threads manually.

12.2.2 Memory

Under *Memory*, the *Settings* dialog shows RAM availability. If the current amount is insufficient, you can try to increase it by clicking the *Compact memory* button. Artec Studio will clear the command history and attempt to optimize memory allocation. Clicking *Compact memory* won't permanently delete the history, but simply unload it from memory. The *Undo* command will reload it. For more information about saving projects, see *History of Project Changes*.

Note: You cannot unload the command history from memory if you haven't saved the project. Save the project and try again.

Artec Studio automatically optimizes memory allocation after each algorithm finishes. This function is handled by the *Compact memory after algorithm completes* checkbox. In contrast to the button, it doesn't unload command history.

12.2.3 Command History

Under the *Command history* section you can limit the amount of history Artec Studio will save. By default, the maximum values are set as a certain number of commands and size on disk (in MB). If necessary, you can clear the *Max history length* checkbox. Doing so means the program will save all history for each project from the beginning. You can clear the project history by clicking the *Clear command history* button; the application will prompt you to confirm this action.

Note: Once you clear the history, you cannot return to an earlier project version.

12.2.4 Data-Compression Level

The *Data-compression level* slider allows you to change the amount of file compression when saving data. Higher compression saves disk space, but loading and saving these scans takes longer.

Important: Maximum compression settings are optimized to ensure that the shape of your models and frames will be preserved. Insignificant deformation may, however, occur. Change the slider position as necessary.

Table 18: File compression in Artec Studio.

Slider Position	Type	Compatibility	Output File Size
Left	No compression	All versions	Large
Middle	Medium compression (lossless)	All versions	Medium
Right	Maximum compression (lossy)	Artec Studio 12 and later	Small

12.2.5 Texture-Recording Mode

By default (*Automatic texture recording* enabled), Artec Studio doesn't capture texture for every frame. You can, however, manually specify the frequency for capturing texture frames by using the spinner in the *Record texture every __th frame* option.

12.2.6 Real-Time Fusion Settings

Real-time fusion offers two optional settings (see *Scanning With Real-Time Fusion*):

Voxel size (mm). The fusion resolution. It affects the algorithm's performance and quality. The lower the value, the sharper the shape of the model. Note that specifying low values may produce noisy surfaces.

Buffer size. Amount of GPU memory employed to reconstruct a Real-time fusion object in the scene. The default value depends on the computer's available GPU memory. Note that Artec Studio may fail to correctly determine the upper limit if your computer has an Intel HD Graphics card. The more memory you have, the larger the scene you can scan in Real-time fusion mode. The slider doesn't define the total finite memory size, however; the algorithm employs system memory (RAM) when GPU memory is consumed.

Note: Avoid altering the *Buffer size* unless you have started noticing artefacts while scanning.

12.3 Scan

The *Scan* tab allows you to edit the parameters that the application uses both while scanning and while postprocessing the results (see Figure 146).

12.3.1 Algorithm Settings

Artec Studio automatically selects and displays settings for each scanner type in the *Current scanner type* dropdown of the *Settings* dialog and in the *Preset* dropdown of the *Tools*

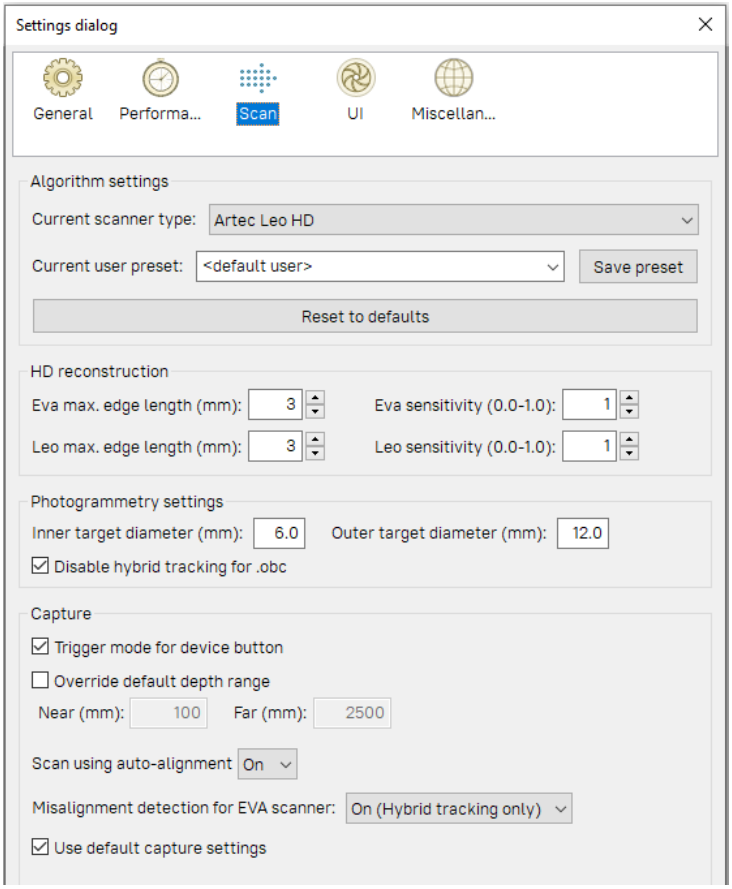

Figure 146: Scan-settings tab.

panel. If it fails to correctly identify your scanner type or you process scans from different scanners, select the appropriate scanner type manually. To reset all settings to their default values, click *Reset to defaults*.

Current user preset allows you to save the current parameter values in the *Tools* panel. By selecting a saved preset, you can change all settings at once. Note that this option applies only to the selected device type.

12.3.2 HD Reconstruction

When using Artec EVA or Artec Leo in the HD mode, you can adjust the following parameters that influence the results of the HD reconstruction:

- The maximum edge length (in mm) of the polygons used for the HD reconstruction
  - *Eva max. edge length (mm)*
  - *Leo max. edge length (mm)*
- Sensitivity
  - *Eva sensitivity (0.0-1.0)*
  - *Leo sensitivity (0.0-1.0)*

Higher sensitivity results in more detailed reconstruction of scanned surfaces, on the one hand, and in higher noise level, on the other:

- sensitivity of 0.0 means maximum noise filtering
- sensitivity of 1.0 means no noise filtering

You can vary the sensitivity with the step of 0.01.

12.3.3 Photogrammetry Settings

Photogrammetry settings allow you to define the target size. *Inner target diameter (mm)* corresponds to the diameter of the white circle in the middle of the target; *Outer target diameter (mm)* corresponds to the outer diameter of the target's black ring. The most popular targets have diameters of `6` mm and `12` mm; the values `5` mm and `10` mm correspond to the *Scan Reference* target. See *Target-Assisted Scanning* for details.

The *Disable hybrid tracking for .obc* checkbox ensures that tracking is purely based on targets. Select the checkbox if you don't want the texture and geometry features to assist target scanning (*Using Photogrammetry Solution (Scan Reference)*).

12.3.4 Capture

The *Capture* section covers settings related to the trigger button for the Artec MHT scanner, as well as the scanning-depth range and individual frames acquired during the scan.

The first option is the *Trigger mode for device button* checkbox, which changes the button behavior on the Artec MH and Artec MHT scanners. For details regarding these buttons, see *Scanner Buttons and Capture Modes*.

The scanner has a defined depth range. If it's too close to the object, it may fail to capture all or part of the object. On the other hand, if the scanner is too far away, various types of 3D "noise" will appear in the scene, complicating the postprocessing effort and affecting the final results. Therefore, you should position the scanner as close as possible to the object without crossing the cutoff plane. Default settings for each 3D scanner contain minimum and maximum limits within which you can position the cutoff planes. The scanner model determines these values. If you are using an Artec L scanner or 3D-sensor and high accuracy is of lesser importance, however, you can adjust the depth boundaries manually, allowing you to scan closer to or further from the object than the recommended distances indicate. To this end, mark the *Override default depth range* checkbox and enter new range values.

Warning: Redefining the depth range may reduce accuracy.

12.3.4.1 Scan Using Auto-Alignment

The *Scan using auto-alignment* option is enabled by default and is covered in the *Resuming Scan After Lost Tracking* and *Auto-align new scans with those marked in Workspace* sections. The application's behavior varies depending on this option's value, as Table 19 shows.

Table 19: Application behavior with option enabled and disabled.

Scan Using Auto-Alignment	*On*	*Off*
Tracking Mode	Geometry + Texture	Geometry or Geometry + Texture
Audio Notification?	Yes (see *Audio Notification*)	Yes
Message in *3D View*	Searching for position: Point 3D Scanner at the object to continue	Tracking lost: Repeat scan using slower motions or additional features
Instructions	Direct the scanner at any already captured region with sufficient texture, maintaining the original scanner orientation relative to the object	Direct the scanner at the last captured region
Data Recording	Handled in a newly created scan	Handled in the same scan

12.3.5 Misalignment Detection

In some cases, Artec Studio may incorrectly determine relative frame positions, resulting in misalignment. When this error occurs, you must restart the scanning session and remove the misaligned scans. Alternatively, you can attempt to fix the misalignment by

breaking the scan into several segments. Further information about addressing this problem by dividing scans is available in *Separating Scans*. To prevent possible misalignment and improve your scanning experience, Artec Studio features a *Misalignment detection for EVA scanner* setting that functions during the scanning process. However, if you have difficulty maintaining the tracking when scanning particular objects, you can disable this setting.

Options are as follows:

- *On (Hybrid tracking only)*. The default value, option works for *Geometry + Texture tracking* mode.
- *On*. The option works for all tracking modes, including *Geometry*.
- *Off*. The option is turned off for all trackers.

12.3.5.1 Default Capture Settings

Artec Studio allows you to change the characteristics of single-frame surfaces as the scanner captures them. To change the default parameters, clear the *Use default capture settings* checkbox and change the settings manually in the displayed window. The options below are user adjustable:

Important: We recommend using default settings. Poorly chosen settings may reduce data quality.

Triangles step. Point density for a frame mesh.

Minimum object size. The smallest object scanned, by number of polygons.

Length filter threshold. Triangle-filtration threshold by edge length (maximum possible size in mm).

Interpolate. Use interpolation for parts of surface that are missing data.

Max interpolated length. Maximum size of areas to be interpolated (in mm).

Max angle. Triangle-filtration threshold by maximum angle (in degrees) between the triangle's normal and the camera's sight vector.

Geometry registration threshold. The higher the threshold, the stricter the quality requirements for the geometry being scanned. Therefore, determining the proper geometry in the scene is more difficult in such cases. Subsequently, Artec Studio runs geometry registration less frequently, making way for texture registration. Works with *Geometry + Texture tracking* only, values are between 0 and 1.

12.4 UI

The *UI* page allows you to edit user-interface settings (see Figure 147) and covers the following categories:

- Audio notification
- Workspace colors
- Warnings
- Surfaces that Artec Studio displays during a scan

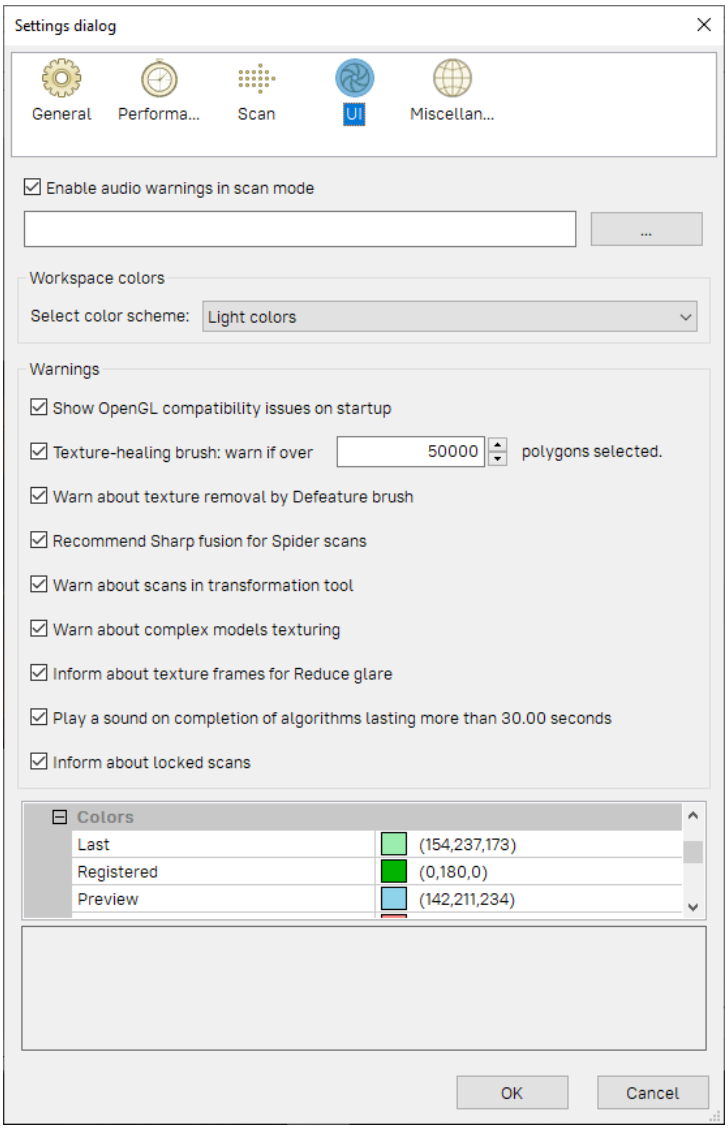

Figure 147: Interface-settings tab.

12.4.1 Audio Notification

Sometimes, automatic alignment in real time is impossible during the scanning process, and the program is unable to align the previous frame with the current one (see *Resuming Scan After Lost Tracking*). When this situation occurs, Artec Studio issues an audio warning that stops once you reposition the scanner and the software again finds its location in 3D. To enable or disable this feature, use the *Enable audio warnings in scan mode* checkbox. A standard “beep-sound” is the application’s default sound. You can choose any `WAV` file as the warning sound. To this end, click the … and specify a file path.

See also:

Warnings in Tools and Editor.

12.4.2 Workspace Colors

Artec Studio automatically chooses display colors for newly created scans. You can select any of the standard palettes:

- Full palette
- Light colors
- Web-safe colors
- Random colors
- Monochrome

12.4.3 Warnings

The *Warnings* options allow you to toggle certain notifications. They include the following:

12.4.3.1 Startup Checks

Show OpenGL compatibility issues on startup. Artec Studio requires *OpenGL* version 2.0 and some *OpenGL* extensions to function properly; your PC may or may not currently support these capabilities. Selecting this option activates a display window on startup containing information regarding possible missing extensions.

12.4.3.2 Warnings in Tools and Editor

If you are familiar with these algorithm peculiarities, you may disable these notifications.

Texture-healing brush: warn if over __ polygons selected. This checkbox instructs the application to display a warning if you exceed the maximum number of polygons to be inpainted at one time. This limit reduces the potential for the computer to hang up. Specify a suitable value for your system, or clear this checkbox if you require no warnings of this kind.

Warn about texture removal by Defeature brush. Be ready that *Defeature brush* won't preserve texture in the corrected areas, so the application notifies you of this.

Recommend Sharp fusion for Spider scans. Artec Studio will recommend switching from *Smooth fusion* to *Sharp fusion* for scans from Spider, since the latter yields more detailed models.

Warn about complex models texturing. If you are attempting to texture a high polygonal model, Artec Studio will suggest that you simplify it first.

Warn about scans in transformation tool. We advise that you refrain from repositioning source scans as it may result in the incorrect texture application. The message may remind you about it.

Inform about texture frames for Reduce glare. Since this option in the *Texture* panel requires many texture frames, Artec Studio will advise you to adjust frame-recording settings.

Play a sound on completion of algorithm lasting more than 30 seconds. This setting allows you to get distracted while the application is busy running algorithms and performing commands. Once the application finishes any of these processes, it chimes.

Inform about locked scans. Artec Studio will remind you that some of the scans selected for *Global registration* have or marks (see *Workspace Panel*). This message allows you to unlock them or run the algorithm without changing scans' status.

12.4.4 Displaying in 3D View Window

You can change the way you see surfaces and points during the scanning process, adjust their colors as well as the background color, and specify the mode for frame playback. To these ends, use the settings below:

12.4.4.1 Display

Last scanned surfaces. Number of visible surfaces most recently captured that will appear in *3D View* during scan.

Visible surfaces. Total number of visible surfaces displayed during scan (equal to the number of most recently scanned surfaces plus the number of key frames to display).

Disable smart simple rendering mode. Smart simple rendering mode ensures that 3D content is rendered without simplification if computer resources allow it. Once the system experiences lags, it automatically turns on simplification.

Polygon limit for conventional simple rendering mode. Maximum number of polygons in the viewport beyond which Artec Studio will switch to simple rendering mode during 3D navigation.

Point-cloud polygon limit. If the polygon count of a point-cloud surface exceeds the specified value, Artec Studio will render a simplified copy of this surface having no more than specified polygons.

Spherical target diameters. List of diameters of the target spheres used during scanning with Ray. Use semicolon ; as a delimiter between values in millimeters in the field.

Point size. Number of pixels for rendering each point when using the *Points* or the *Points and solid* rendering mode.

Animate movements. It shows movement of the 3D data when Artec Studio repositions or reorients it. Disable this option on slow computers.

12.4.4.2 Colors

Last. Color of last scanned surfaces.

Registered. Color of correctly aligned surfaces.

Preview. Color of surfaces in preview mode.

Dropped. Color of unaligned (and thus dropped) surfaces.

Key frames. Color of key frames (surfaces).

12.4.4.3 Screenshots

You can specify the default screenshot size in pixels (see *Saving Screenshots*):

- *Width*
- *Height*

If your system configuration is incompatible with the specified settings, Artec Studio will save a screenshot of the maximum possible size.

12.4.4.4 Playback

See also:

Selecting Scans and Models

Repeat. Continuously loop the frame sequence in the surface-view mode of the *Workspace* panel.

FPS. Speed (in frames per second) at which frames appear during playback.

12.4.4.5 Background

Color. Background color; the application may automatically alter this color in certain modes, such as *X-ray*.

Dropped color. Background color when misalignment occurs while scanning.

Texture. Display patterned (*chessboard pattern*) or plain background.

Gradient. Gradient or monochrome background color.

Background for screenshots. Application will use this background color when *saving screenshots*, the actual background color will remain unaltered.

12.4.4.6 Welcome Screen

Don't show. Disable the welcome screen.

Figure 148: Example of altered background.

12.4.4.7 Autopilot

Don't show greeting screen. Disable the *Autopilot* screen showing the steps to pass in this mode

12.5 Miscellaneous

12.5.1 Usage Information

You can help us improve the quality and performance of Artec Studio by allowing us to collect and send usage information to Artec Group. This information will not be used to identify you, and it excludes your project data, 3D surfaces, textures and any other data that you obtain and process using Artec Studio. By default, the *Collect and send anonymous usage data to Artec* checkbox is selected. We recommend leaving this checkbox marked so we can better improve the application.

When installing Artec Studio, you can decide whether you want it to collect and send usage data. The same checkbox described above also appears in the final installation dialog (see Figure 27).

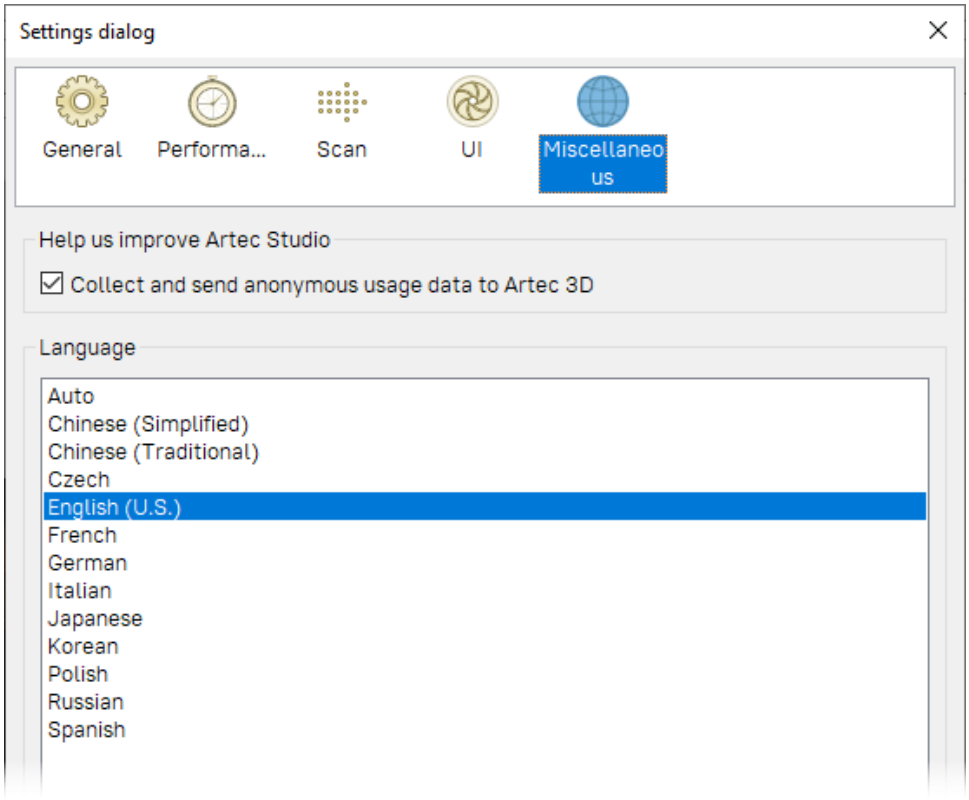

Figure 149: Miscellaneous-settings tab.

12.5.2 Language

The Artec Studio interface supports several languages:

- *Auto*—automatic language selection on the basis of system settings
- *Chinese (Simplified)*
- *Chinese (Traditional)*
- *Czech*
- *English (U.S.)*
- *French*
- *German*
- *Italian*
- *Japanese*
- *Korean*
- *Polish*
- *Russian*
- *Spanish*

To switch between languages, choose the one you want and click *OK*. The program will then prompt you to restart. If you agree, the application will restart automatically using the newly selected interface language. If you choose not to restart, the changes will take effect the next time you start the application.

Note: To change the language, Artec Studio must restart.

CHAPTER 13

Scanner Calibration and Correction

The Diagnostic Tool is a special utility that enables you to calibrate Artec 3D scanners and correct an existing calibration. In general, calibration is the process of checking and adjusting a scanner's measurements by comparing them with the standard (etalon) values. Every Artec scanner is delivered pre-calibrated.

In some cases, owing to careless handling or transportation (jolts, accidental drops or some other reason), the scanner may fail to capture surfaces properly. The scanned surfaces may only be partially reconstructed or may contain holes (for example, the results of bad reconstruction are noticeable on the blue surface in Figure 154). You can resolve these issues by correcting or calibrating the scanner.

Depending on the scanner model, the Diagnostic Tool can operate in one of the three working modes:

- Correction for Artec MHT, Artec MH, Artec L and Artec EVA scanners
- Correction for Artec Spider scanner
- Calibration of Artec Spider scanner

Note: Calibration is available only for Artec Spider scanners.

13.1 Suggestions for Use

Correction differs from calibration in that it preserves the current calibration: it only changes the correction ratio so as to enable good reconstruction.

Important: Application of the correction does not guarantee that captured geometric shapes and linear measurements will be accurate. Use this procedure as a temporary measure until calibration is performed.

Table 20: Correction versus calibration.

Mode	Characteristics	Speed	For Spider?	For EVA, L, MHT?
Correction	Inexact	Fast	Yes	Yes
Calibration	Exact[1]	Prep required	Yes	No

13.2 Launching Diagnostic Tool

To launch the Diagnostic Tool, first ensure that the scanner you intend to diagnose appears in Artec Installation Center as either *On loan* or *Activated*. You can launch the tool either through the *Start* menu by clicking *Start* → *All Programs* → *Artec Group* → *Artec Studio* → *Diagnostic Tool* or in Artec Studio by selecting the *Run Diagnostic Tool* command from the *File* menu.

If you have several scanners connected, select the appropriate one from the dropdown list.

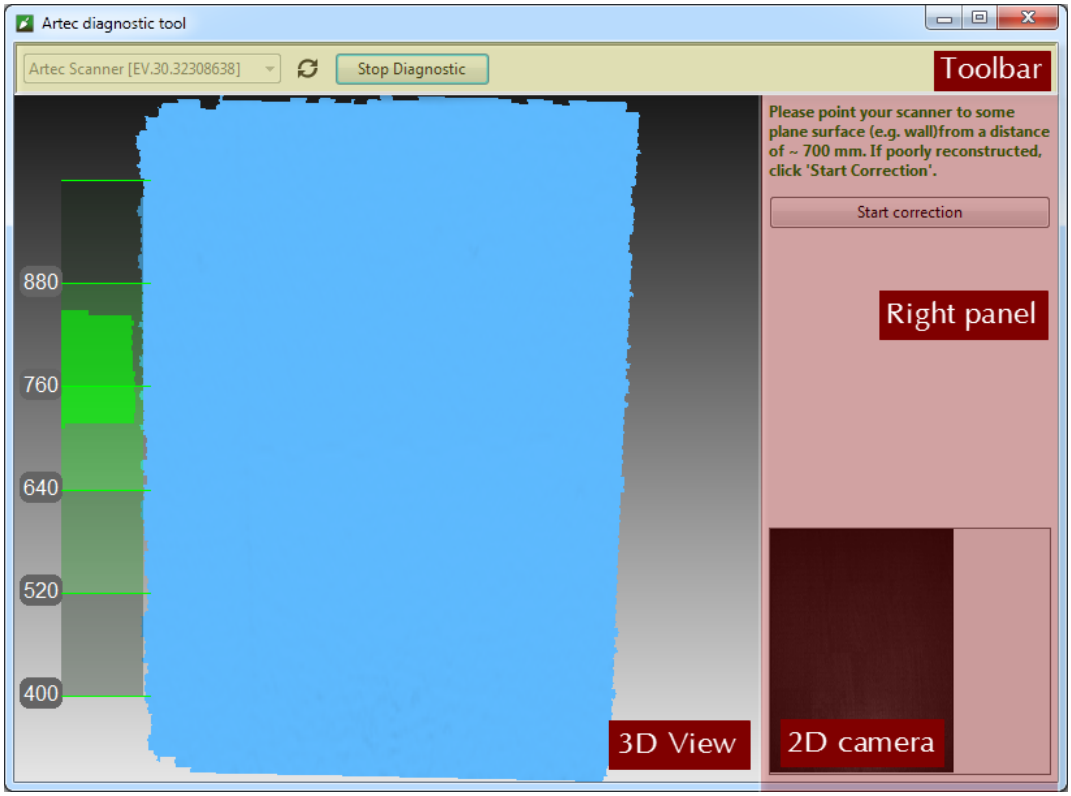

Figure 150: Diagnostic Tool window.

The utility window contains three sections: the *3D View* panel, the right panel and the

toolbar (see Figure 150).

13.3 Scanner Correction

Important: Apply correction sparingly as a temporary measure until calibration is performed.

13.3.1 Correcting Field of View for EVA, MHT, MH and L Scanners

The Artec EVA, Artec MHT, Artec MH and Artec L scanners only allow you to correct their current calibration data on field of view.

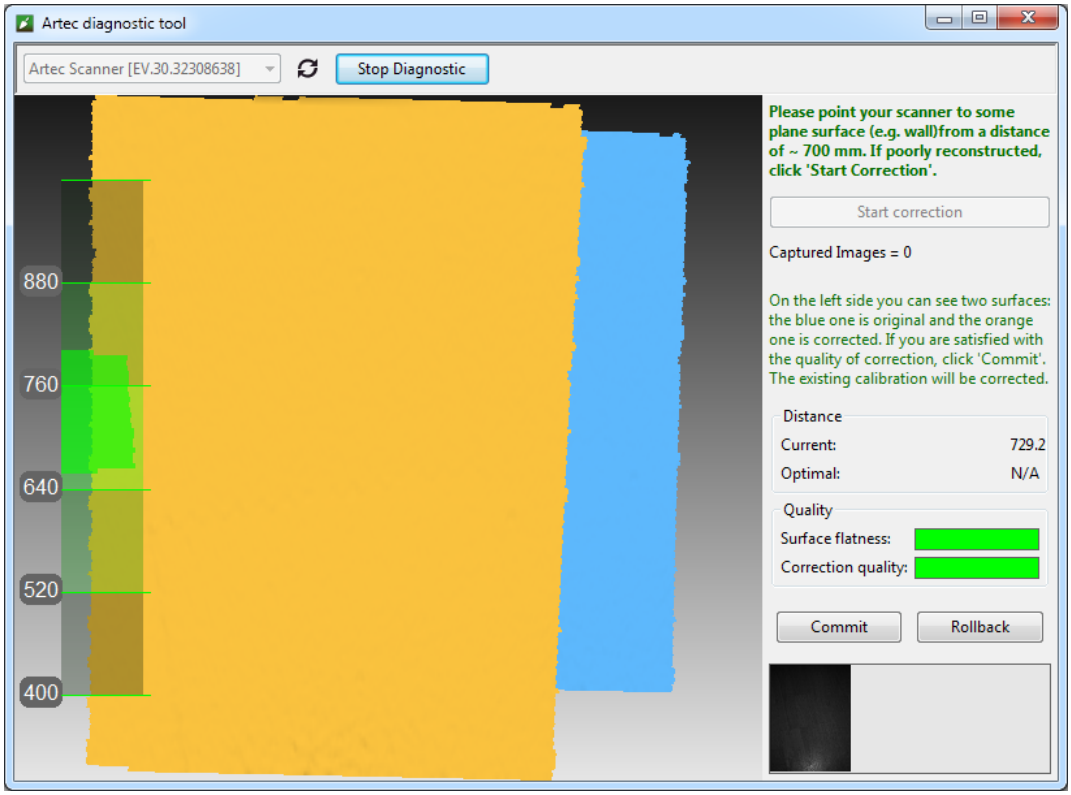

Figure 151: Artec EVA correction results.

1. Launch the Diagnostic Tool as *Launching Diagnostic Tool* describes.
2. Select the scanner you want to diagnose.
3. Click *Start diagnostic* or press the ▶ button. The scanner will start the preview, a range meter will appear in the *3D View* window and another panel will appear on the right showing a 2D camera preview.
4. Direct the scanner at the right angle to a flat, light (but not shiny) monochrome surface (e.g., a wall or floor) from a distance of 650–700 mm for an Artec MHT,

Artec MH or Artec EVA scanner or a distance of 850–900 mm for an Artec L scanner. The tool will render the surface in blue in the *3D View* window.

Note: If the rendered surface is not flat and contains holes, the correction is worth performing.

5. Click *Start correction* or press the ▶ button on the scanner. In addition to the blue surface, a yellow surface will appear in the *3D View* window. Blue corresponds to the surface captured using the original calibration data; yellow corresponds to the surface captured using corrected calibration data.
6. Two indicators in the right panel can help you assess the surface quality (green stands for good results, yellow for satisfactory and red for unsatisfactory). If the corrected (yellow) surface has no holes and is sufficiently flat, and if the correction results meet your expectations, click *Commit* or press the ▶ button on the scanner. Otherwise, click *Rollback* or press ■ on the scanner.

13.3.2 Correcting Calibration Data for Spider

Correction for Artec Spider differs slightly from correction for Artec MHT and Artec EVA scanners.

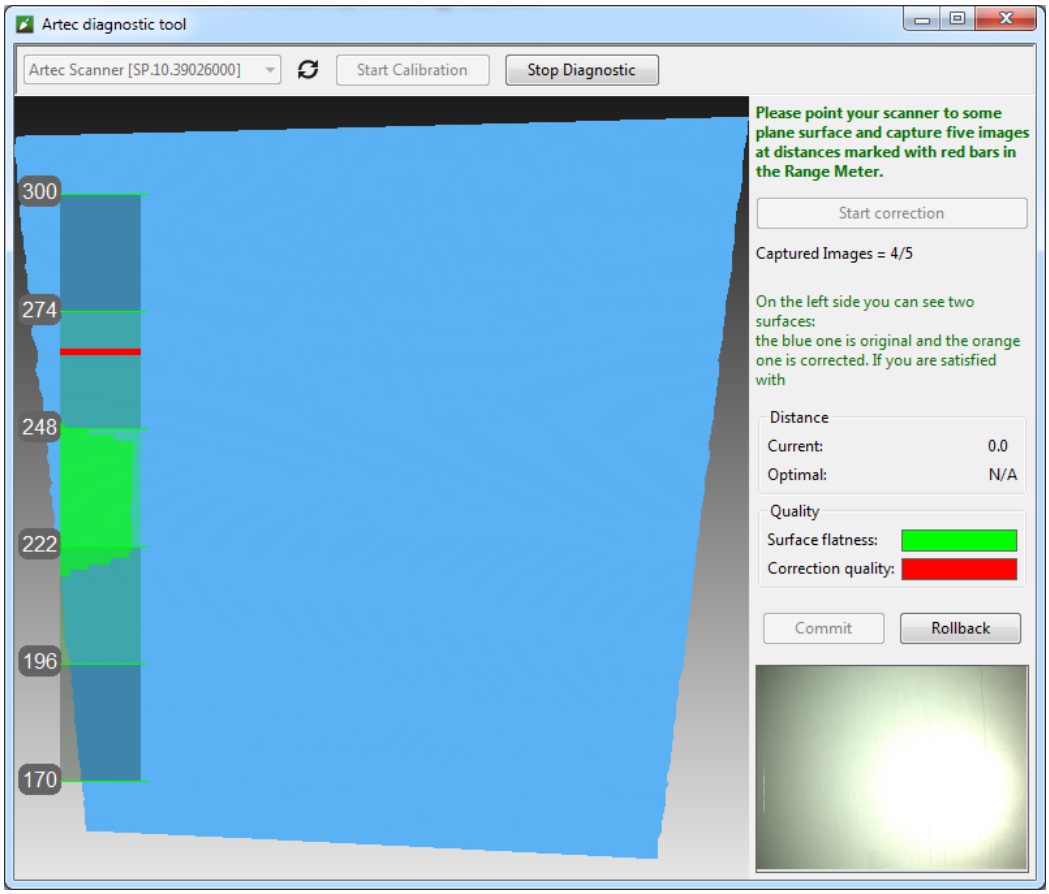

Figure 152: Artec Spider correction process.

1. Launch the Diagnostic Tool as *Launching Diagnostic Tool* describes.
2. Select Artec Spider from the dropdown list.
3. Click *Start diagnostic* or press the ▶ button; the scanner will start the preview, a range meter will appear in the *3D View* window and another panel will appear on the right showing a 2D camera preview.
4. Direct the scanner at the right angle to a flat light monochrome surface (e.g., a wall) from a distance of 190–270 mm. The tool will render the surface in blue in the *3D View* window.

   Note: If the surface, when captured from a distance within the suggested range, fails to render as flat or contains holes, correction is worth performing.

5. Place the scanner on a desk or attach it to a tripod, keeping a distance of about 190 mm from the flat surface (see the range meter in the *3D View* window).
6. Click *Start correction* or press the ▶ button on the scanner. A red mark will appear on the range meter.
7. Move the scanner smoothly toward the flat surface such that the histogram peak coincides with the red mark on the range meter (see Figure 153).
8. Look for a new red mark to appear higher on the range meter. Smoothly move the scanner away from the flat surface to approach the red mark.
9. Repeat Step 8 three more times. Once you finish, the calculation will start. A yellow plane that corresponds to the surface you captured using the corrected calibration settings will then appear in the *3D View* window (see Figure 154).
10. If the yellow surface has no holes and is sufficiently flat, and if the correction results meet your expectations, click *Commit* or press the ▶ button on the scanner. Otherwise, repeat Steps 7–9, click *Rollback* or press ■ on the scanner. Two indicators on the right panel can help you assess the surface quality (green stands for good results, yellow for satisfactory and red for unsatisfactory).

13.4 Spider Calibration

To carry out the calibration, you will need the following additional equipment: a calibration rig, a scanner stand and a pattern. Assembly instructions for the scanner stand and calibration rig appear in *Assembling the Scanner Stand* and *Assembling the Calibration Rig*, respectively.

1. Unfold the pattern and place it on a desk or any hard, planar surface.
2. Align the scanner stand with the rectangle marked on the pattern, paying close attention to the orientation of the slots in the stand cover (see Figure 155).

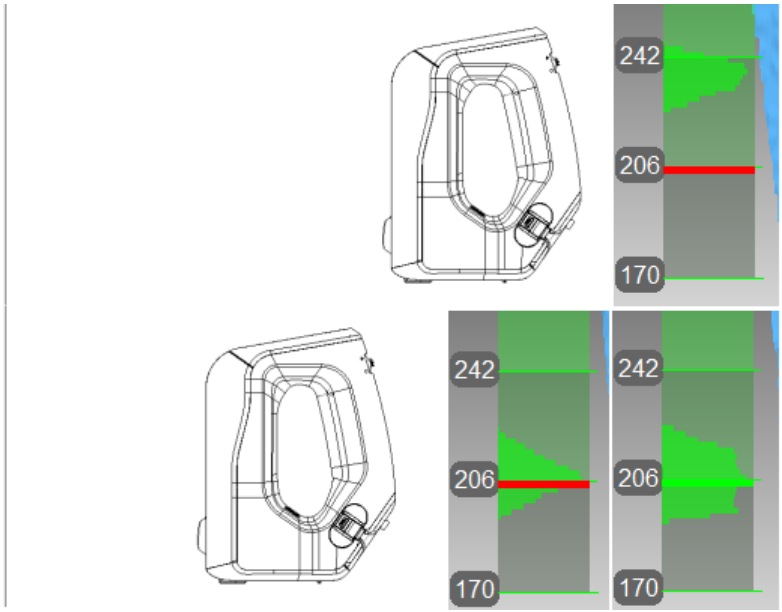

Figure 153: Artec Spider scanner's position and corresponding distance on the range meter.

Approaching the read mark (at the top), reaching the required distance (at the bottom).

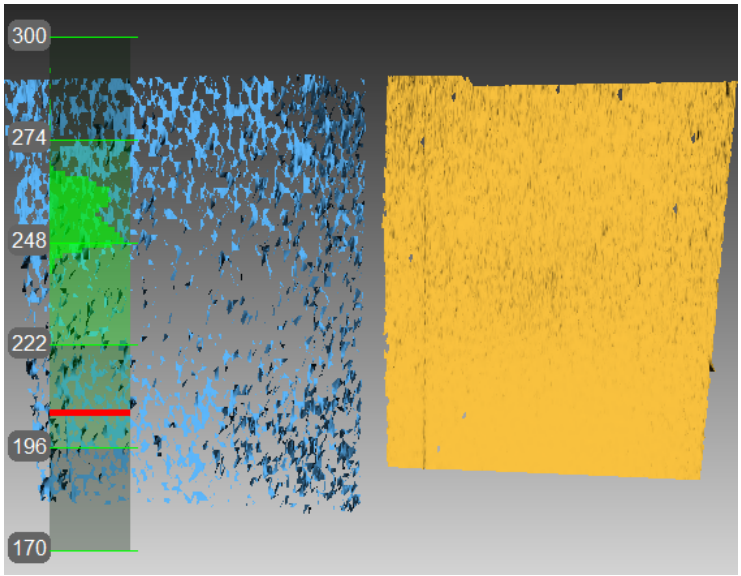

Figure 154: Artec Spider correction results.

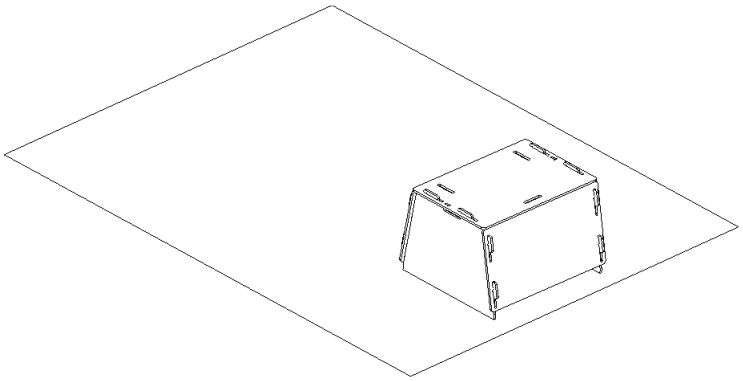

Figure 155: Scanner stand resting on a pattern.

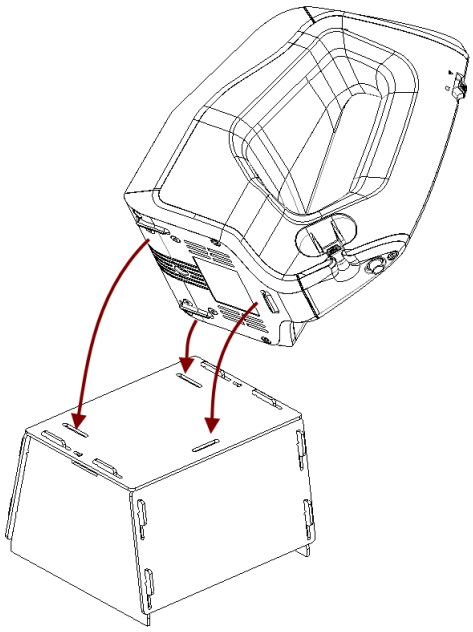

Figure 156: Placing Artec Spider on the stand

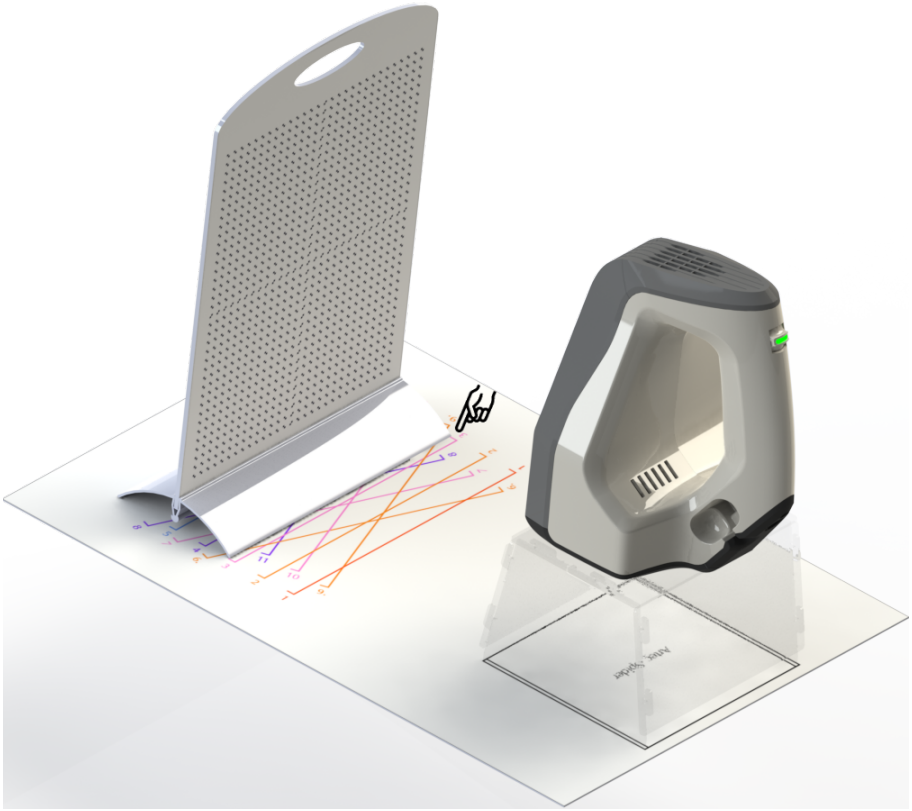

Figure 157: Calibration rig, pattern and scanner stand with Artec Spider.

3. Place the scanner on the scanner stand, making sure that you insert the three scanner stems in the three slots of the stand cover (see Figure 156).
4. Set the calibration rig on the pattern, turning its marker side toward the scanner as Figure 157 shows.
5. Launch the Diagnostic Tool as *Launching Diagnostic Tool* describes.

> **Note:** You should conduct the calibration only after the scanner has warmed to the optimal temperature.

6. Click *Start calibration*. A dialog box will open (see Figure 158); enter the serial number of your calibration rig (it appears on the board). If the scanner temperature is outside the optimal range—for example, you just connected the device to a power outlet—the tool will notify you of this condition (see Figure 159). We advise against clicking *Skip* and instead recommend waiting for the Artec Spider to reach its optimal temperature.
7. Place the rig in its initial position such that the front edge of its base coincides with the color line numbered 1 on the pattern. As you do so, also keep an eye on the *3D View* window for a red plane (current position) and a green plane (target position)—see Figure 160. Once the red plane coincides with the green one, stop moving the rig and wait for the scanner to capture the plane.
8. Wait for the tool to instruct you to move the rig to the next position on the pattern;

the number for that position will appear on the screen. Move the rig and again wait for the scanner to capture the plane.

9. Repeat the preceding step for the remaining positions sequentially. Depending on the version of your calibration kit, the pattern will have 11 to 15 positions.
10. Once you have captured the last position and the calculations have concluded, a message will appear prompting you to either overwrite the existing calibration or keep the current one. Before you decide, direct the scanner at a flat, nonglossy surface (e.g., a piece of paper) from a distance of about 200 mm. Assess the quality of the reconstructed surface and check for any holes.
11. Click *Yes, apply the calibration* if no holes appear on the surface and you are satisfied with the reconstruction results. To reject the new calibration, click *No, keep the old one* (see Figure 161).

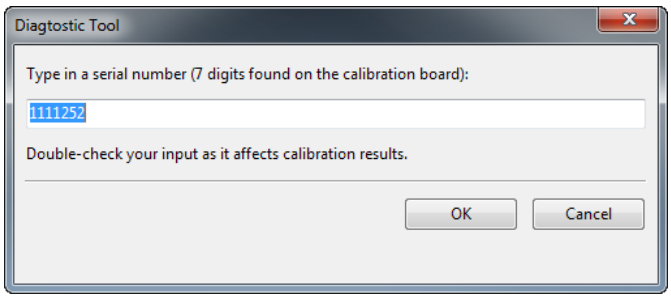

Figure 158: Entering serial number of calibration board.

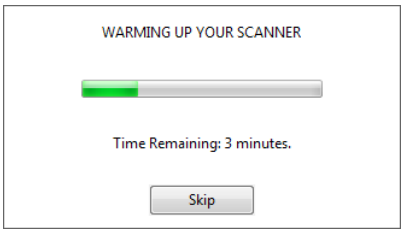

Figure 159: Warming up the scanner.

13.5 Notes Regarding Scanner-Calibration Files

Calibration and correction results reside in files that you can access as follows. Their location is

`C:\Users\%name%\AppData\Roaming\Artec\Artec Installation Center\Devices\SP.00.00000000.`

Here, `%name%` is the current user folder and `SP.00.00000000` is the folder corresponding to the scanner serial number. Note the following information regarding calibration and correction.

- Once you apply correction results, the software will create an `ACD` file.

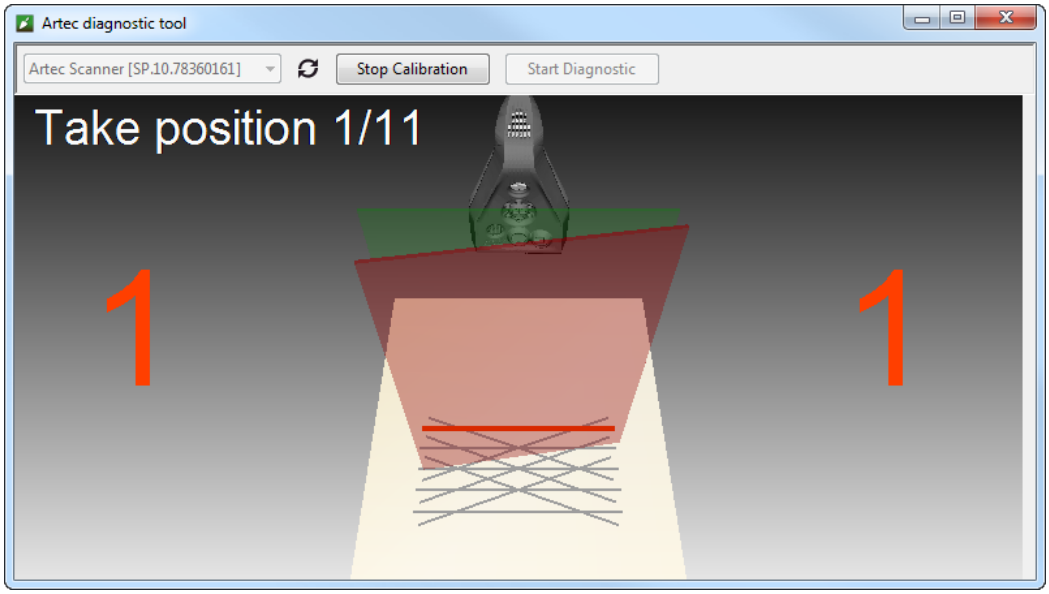

Figure 160: Moving calibration rig to position number 1.

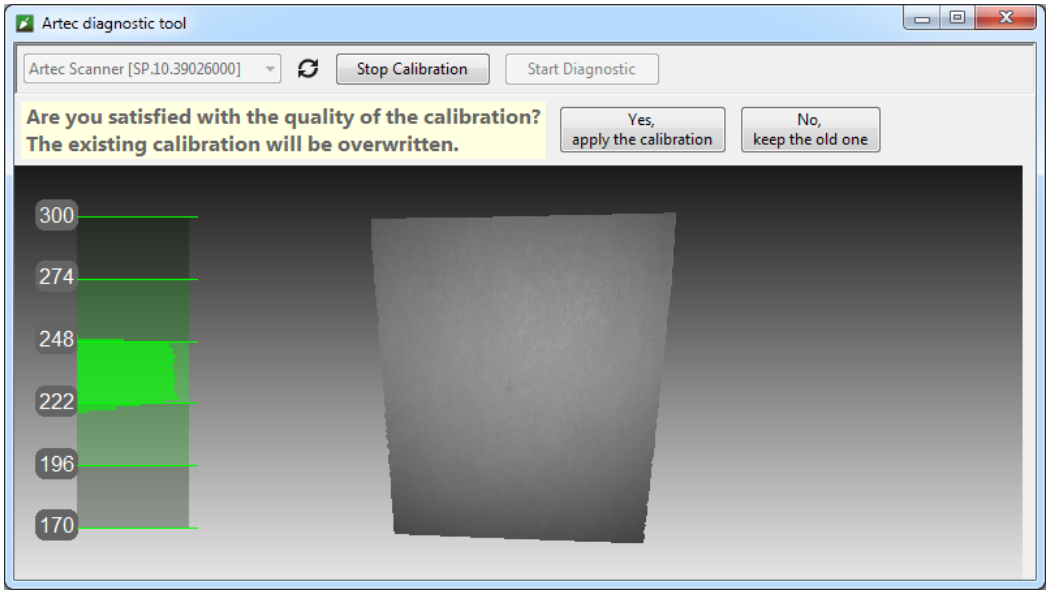

Figure 161: Assessing calibration results.

- Once you apply calibration results, the software will create ACD and CORR files.
- All newly created files have names of the form YYYYMMDD_HHMMSS, with the characters corresponding to the date and time of the file's creation.
- Original ADD and CORR file names are based on the scanner serial number and have the form SP.00.00000000.

Note: You can restore the initial calibration by removing the ACD and CORR files whose names have the form 20131121_101010.

Note: If you use the scanner on several computers, you need not recalibrate it on every one. Simply copying the ACD and CORR files to the above-mentioned folder on each computer may be sufficient.

13.6 Assembling the Scanner Stand

The scanner stand comes unassembled with Artec Spider and consists of five parts (see Figure 162): two side walls, one front and one back wall (these parts are identical, however), and a cover. Before beginning assembly, lay them all out as Figure 162 shows. Then follow these steps:

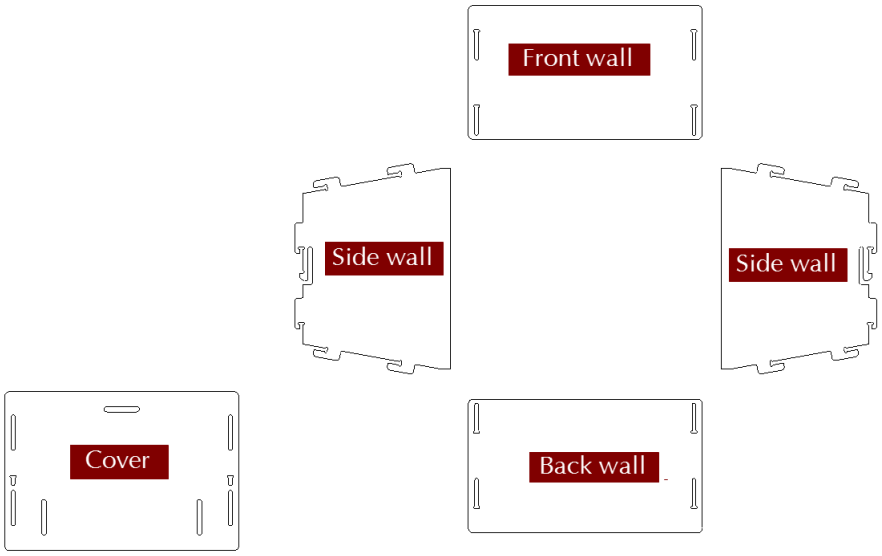

Figure 162: Parts of the scanner stand.

1. Raise the two side walls to the upright position, as Figure 163 shows. Noting carefully the orientation of the T-shaped slot, install the front wall to the side walls using the two pairs of hooks. Press the front wall and slide it down against the stop. Make sure the three walls are properly aligned with each other.
2. Install the back wall in the same way (see Figure 164).

3. Paying attention to orientation of the slots, install the cover using the upper hooks of the side walls (see Figure 165).
4. Press your thumbs against the T-shaped holes on the cover and shift it toward the back wall until you hear a click (see Figure 166).

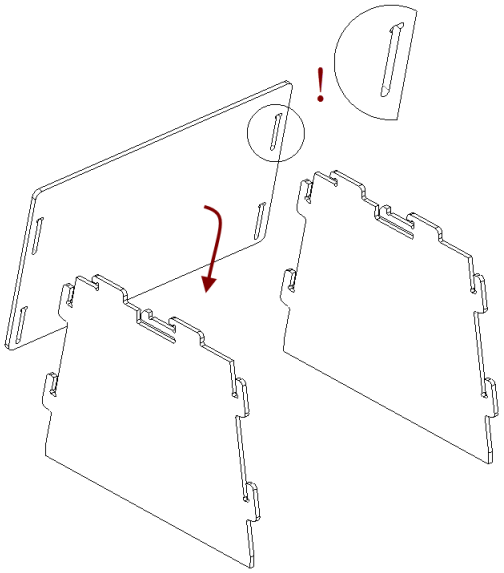

Figure 163: Assembling the front wall.

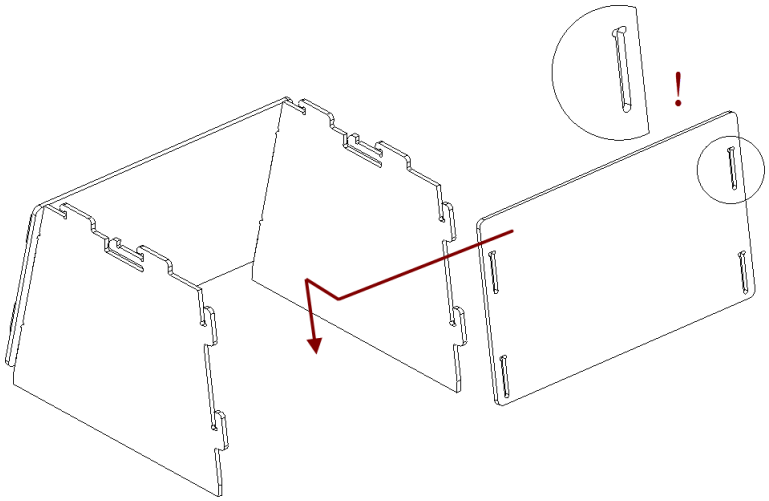

Figure 164: Assembling the back wall.

The scanner stand is now ready to use.

Note: To disassemble the stand, release the detents in the cover's T-shaped slots (see Figure 162) using a thin object like a ballpoint pen. Repeat the assembly steps in reverse order (from Figure 166 to Figure 163), moving the parts in the opposite directions.

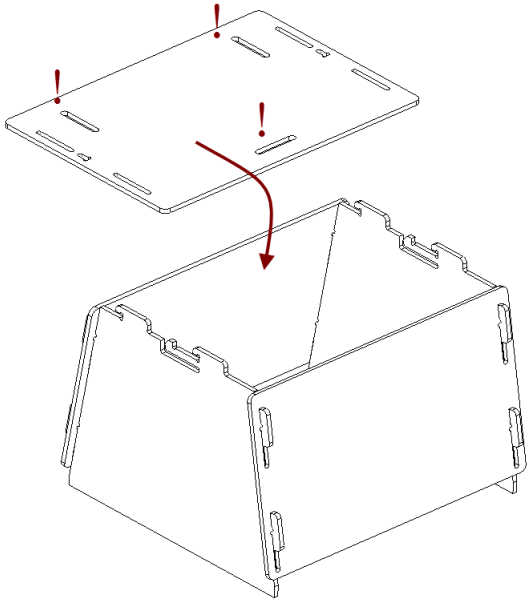

Figure 165: Mounting the cover.

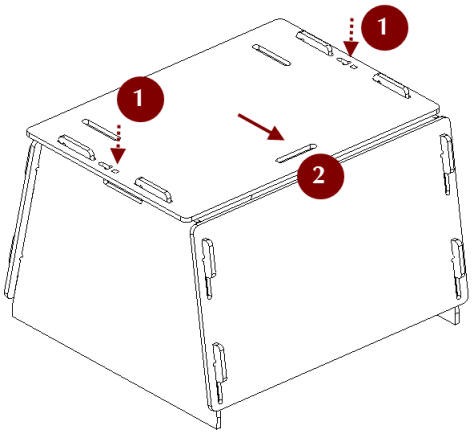

Figure 166: Latching the cover.

13.7 Assembling the Calibration Rig

The calibration rig comes only with Artec Spider and consists of the base and the board. To assemble the rig, follow these instructions:

1. Press the hinge of the base against your forefingers.
2. Unfold the bent leaves of the base, pressing on their edges with your thumbs.
3. Insert the board into the slot, as Figure 167 shows.

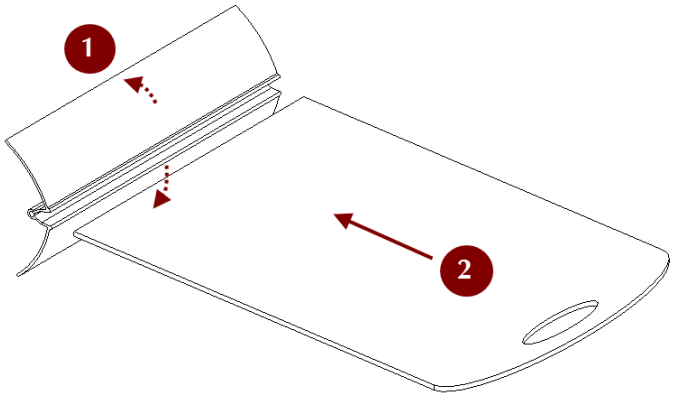

Figure 167: Assembling the rig.

CHAPTER 14

Switching from Artec Studio 14

Since version 15, Artec Studio has more comprehensible names for the algorithm parameters (*Tools* panel). The glossary below lists these new names in alphabetical order and provides their former names used in version 14. Links lead to the corresponding sections covering these parameters.

3D resolution resolution; everywhere: in Fusion, Outlier removal.

3D-noise level Either *std_dev_mul_threshold* in Outlier Removal, or *minDistBetweenDescriptors* in Global registration for point-cloud scans.

Adaptive (distance-aware) *Adaptive*; in Ray scan triangulation.

All (watertight) *Watertight*; in Fusion.

All except largest *Leave_biggest_object*; in Small-object filter.

Decimation ratio *decimationStep*; in Ray scan triangulation.

Desired edge length *edgeLength*; in Ray scan triangulation.

Distance from scanner *effective_dist_from_scanner*; in Global registration for point-cloud scans.

Distinct colors for sections *SectionColor*; in Ray scan triangulation.

Feature voxel *voxelSide*; in Global registration for point-cloud scans.

Features registration_algorithm; in registration algorithms.

Fill holes *Fill_holes*; in Fusion.

Focus on geometry First introduced in version 15.

Geometry Geometry (unchanged); in registration algorithms.

Geometry and texture Geometry_and_Texture; in registration algorithms.

Geometry Ray *Geometry_Ray*; in Global registration for point-cloud scans.

Hole perimeter (max) *max_hole_len*; in Hole filling.

Hole radius (max) *max_hole_radius*; threshold radius in Fusion.

Incidence angle (max) *maxIncidenceAngle*; in Ray scan triangulation.

Incidence angle between vertices (max) *maxTriangleAngularSize*; in Ray scan triangulation.

Keep edges *keep_boundary*; in Mesh simplification.

Keep texture *UV_Triangle_quantity*; in Mesh simplification.

Key frame ratio *key_frame_ratio*; in Global registration

Later, manually *Manually*; one of the options in Fusion.

Maximum shape deviation *error*; in Mesh simplification.

Mode *method*; in Ray scan triangulation.

No targets (Geometry alignment) *Geometry_alignment*; in Global registration for point-cloud scans.

None *Skip*; one of the options in Fusion.

Nonstrict polygon count *force_constraints*; in Fast mesh simplification.

One random color *None*; in Ray scan triangulation.

Polygon angle (min) *minTriangleAngle*; in Ray scan triangulation.

Polygon count tri_num or *Triangle_quantity*; in Mesh simplification.

Polygon count (max) *threshold*; in Small-object filter.

Polygon edge length (max) Either *maxEdgeLength* in Ray scan triangulation, or *remesh_edge_thr* in Mesh simplification.

Remove small polygons *Remesh*; in Mesh simplification.

Remove surfaces *mode*; in Small-object filter.

Remove targets *remove_targets*; in Fusion.

Render mesh based on *colorMode*; in Ray scan triangulation.

Search features within feature_search_radius; in Global registration.

Shape deviation *Accuracy*; in Mesh simplification.

Simple *Simple* (unchanged); in Ray scan triangulation.

Smaller than specified *Filter_by_threshold*; in Small-object filter.

Steps *steps*; in Smoothing (*Tools*).

Stitch sections *useWholeCloudTriangulation*; in Ray scan triangulation.

Target when simplifying *stop_condition*; in Mesh simplification.

Targets *Targets* (unchanged); in Global registration for point-cloud scans.

Targets and geometry *Targets_Geometry*; in Global registration for point-cloud scans.

Vertex colors *SourceColor*; in Ray scan triangulation.

With radius smaller... *By_radius*; determines which holes to fill in Fusion.

CHAPTER 15

Hot Keys

15.1 Scanning

Open *Scan* panel	`F7`	Anywhere exc. modal dialog
Toggle between *Preview* and *Record* modes	`Space`	*Scan* panel
Open *Multicapture* panel	`F8`	Anywhere exc. modal dialog

15.2 Workspace

Select one scan and deselect the rest	`Ctrl+Alt+LMB`	*Workspace* panel
Select one scan and deselect the rest	`Ctrl+LMB`	*Workspace* panel, first column
Select all scans/models or frames	`Ctrl+A`	*Workspace* panel
Deselect all scans/models or frames	`Ctrl+D`	*Workspace* panel
Select/deselect the highlighted scan	`Space`	*Workspace* panel
Invert selection of scans/models	`Ctrl+Alt+A`	*Workspace* panel
Select only key frames	`Ctrl+K`	*Workspace* panel → Surface list
Select only textured frames	`Ctrl+J`	*Workspace* panel → Surface list
Rename scan/model	`F2`	*Workspace* panel
Group objects	`Ctrl+G`	*Workspace* panel
Start/stop playback scan frames	`Ctrl+P`	*Workspace* panel
Delete selected frames/scans	`Del`	*Workspace* panel (including surface list)

15.3 Save, Export and Import

Create new project	`Ctrl+N`	Anywhere exc. modal dialog
Save project	`Ctrl+S`	Anywhere exc. modal dialog
Open existing project	`Ctrl+O`	Anywhere exc. modal dialog
Open existing project with scans unloaded (to save memory)	`Ctrl+Shift+O`	Anywhere exc. modal dialog
Import 3D files	`Ctrl+I`	Anywhere exc. modal dialog
Export meshes	`Ctrl+Shift+E`	Anywhere exc. modal dialog
Clear command history	`Ctrl+Alt+H`	Anywhere exc. modal dialog
Save screenshot of *3D View* window	`Ctrl+Shift+S`	Anywhere

15.4 Viewing 3D Content

Fit to view	F	*3D View* window
Place coordinate origin to the viewpoint center (Home)	H	*3D View* window
Display/hide coordinate axis grid	G	*3D View* window
Set rotation center to the object's center of mass	Ctrl+Shift+C	*3D View* window
Set rotation center to the origin of axis grid	Ctrl+Shift+M	*3D View* window
Change rendering mode to *Texture*	Ctrl+Alt+1	*3D View* window
Change rendering mode to *Scan color*	Ctrl+Alt+2	*3D View* window
Change rendering mode to *Surface color*	Ctrl+Alt+3	*3D View* window
Change rendering mode to *Max error*	Ctrl+Alt+4	*3D View* window
Turn on/off lighting	L	*3D View* window
Display/hide normals	N	*3D View* window
Display/hide boundaries	B	*3D View* window
Display/hide texture boundaries	Shift+B	*3D View* window
Toggle between perspective and orthogonal views	5 (numpad) or Ctrl+5	*3D View* window

15.4.1 Switching Viewpoint

To front	1 (numpad) or Ctrl+Shift+1	*3D View* window
To back	Ctrl+1	*3D View* window
To left	3 (numpad) or Ctrl+Shift+3	*3D View* window
To right	Ctrl+3	*3D View* window
To top	7 (numpad) or Ctrl+Shift+7	*3D View* window
To bottom	Ctrl+7	*3D View* window

15.5 Editor

Activate *2D selection* mode	`Shift+Alt+1`	*Editor* → *Eraser*
Activate *3D selection* mode	`Shift+Alt+2`	*Editor* → *Eraser*
Activate *Rectangular selection* mode	`Shift+Alt+3`	*Editor*
Activate *Lasso selection* mode	`Shift+Alt+4`	*Editor*
Activate *Cutoff-plane selection* mode	`Shift+Alt+5`	*Editor*
Activate *Base selection* mode	`Shift+Alt+6`	*Editor* → *Eraser*
Display control for adjusting cutoff plane	`Alt`	*Eraser/Defeature brush* → *Cutoff-plane selection*
Move cutoff plane	`Ctrl+Shift+Scroll`	*Eraser/Defeature brush* → *Cutoff-plane selection*
Change tool size	`Ctrl+[` and `Ctrl+]` or `Scroll Wheel`	*Editor* panel → any tool
Select the entire surface below the cutoff plane	`Ctrl+Q`	*Eraser/Defeature brush* → *Cutoff-plane selection*
Clear selection of 3D regions	`Ctrl+Alt+LMB`	*Editor*
Invert selection	`I`	*Editor* panel → any tool → *3D View*
Delete selected region	`Delete`	*Editor* → *Eraser*

15.5.1 Transformation Tool

Enable *Translate* transformation	`T`	*Editor* → *Transformation*
Enable *Rotate* transformation	`R`	*Editor* → *Transformation*
Enable *Scale* transformation	`S`	*Editor* → *Transformation*
Translate (rotate/scale) the model along (around/in direction of) X axis	`X`	*Editor* → *Transformation* → any mode → *3D View*
Translate (rotate/scale) the model along (around/in direction of) Y axis	`Y`	*Editor* → *Transformation* → any mode → *3D View*
Translate (rotate/scale) the model along (around/in direction of) Z axis	`Z`	*Editor* → *Transformation* → any mode → *3D View*

15.6 Aligning Scans

Display aligned scans/models	`1`	*Align* panel
Display unaligned scans/models	`2`	*Align* panel
Display all scans selected for alignment	`3`	*Align* panel
Manually align scans	`Shift`	*Align* panel
Switch between point sets/pairs	`Space` and `Backspace`	*Align* panel → points
Confirm creation of point set	`Space`	*Align* panel → *Complex*

15.7 Starting Tools, Modes and Dialogs

Open *Autopilot*	F9	Anywhere exc. modal dialog
Open *Tools* panel	Ctrl+T	Anywhere exc. modal dialog
Open *Align* panel	Ctrl+L	Anywhere exc. modal dialog
Open *Fix holes* panel	Ctrl+B	Anywhere exc. modal dialog
Open *Repair* panel	Ctrl+R	Anywhere exc. modal dialog
Open *Measures* panel	Ctrl+M	Anywhere exc. modal dialog
Open *Texture* panel	Ctrl+U	Anywhere exc. modal dialog
Open *Editor* panel	Ctrl+E	Anywhere exc. modal dialog
Start *Eraser* tool	E	*Editor* panel
Start *Defeature brush*	D	*Editor* panel
Start *Positioning* tool	P	*Editor* panel
Start *Transformation* tool	T	*Editor* panel
Start *Smoothing brush*	S	*Editor* panel
Start automatic processing (don't confuse with *Autopilot*)	Ctrl+G	*Tools* → Auto
Open web manual	F1	Anywhere
Open local User Guide file	Ctrl+F1	Anywhere
Call *Settings* dialog	F10	Anywhere exc. modal dialog
Show/hide *Workspace* panel	F11	Anywhere exc. modal dialog
Show/hide *Log* window	Ctrl+Alt+L	Anywhere exc. modal dialog

CHAPTER 16

Conventions and Acronyms

Portions of this user guide are highlighted to draw your attention. For example,

Note: Important information appears in specially formated paragraphs.

The following examples illustrate our conventions:

- Panel and element names that appear in the application window use italics: e.g., *Workspace*, *File* and *Texture*
- Buttons, checkboxes and elements of dropdown lists in panels and application menus are italicized and underscored: *Invert*, *Apply* and so on
- Shortcuts, individual keys and hardware buttons use gray highlighting: e.g., `Ctrl + A`
- Characters that appear in a field, file extension, or directory or file path employ the following style: `Scan 1`, `SPROJ`, `C:\Program Files`, and so on.

Note the following abbreviations and icons:

- `LMB`—left mouse button
- `RMB`—right mouse button
- ⏯—*Play/Pause* button on the scanner body

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