



SCAN2FX

Photo Projector

Manual

Version 3.7.1
November 2019

1. Introduction

1.1 Background

SCAN2FX was developed out of the need to create photo-realistic assets, visualizations, structures and sets for production use in a more time efficient manner -- without the need for an extensive process, and without too many intermediate steps.

1.2 SCAN2FX Photo Projector

SCAN2FX Photo Projector allows users to align photos and panoramas with a 3D scene. SCAN2FX Photo Projector will estimate the 3D camera position and rotation from where the photo or panorama was taken of the scene. Knowing the 3D camera for a photo can be extremely useful as it allows you to then “project” that photo onto a mesh with a 3D rendering or 3D paint application.

This way staff can capture additional photos or panoramas of a laser-scanned scene and utilize the resulting images to fill in additional detail (e.g. for textures) where maybe a laser scanner did not capture sufficient detail or in areas hidden from the scanner (such as hidden corners or e.g. under desk). Also, an operator could conduct scans without color for maximum scan speed, and HDR panoramas from a separate camera could be used for texturing. The panoramas do not need to be taken from the same position as the scan.

This approach can be used for example, as a less time-consuming and more accurate alternative to photogrammetry. Rather than having to take many hundreds or even thousands of overlapping photos of a scene, you can take a few key photos of the scene where you need additional detail to enhance your automated, “one-button” press laser scans. Instead of running through a very time-consuming photogrammetry computation where you only see the results after possibly a day or more, you can immediately see how a photo lines up with your 3D scene and you can then control the alignment by picking additional points or adjusting the existing point correspondences. Especially with larger scenes, photogrammetry may result in inaccurate meshes or may fail in aligning at least some of the photos you had taken. Unfortunately, with photogrammetry, uniform surfaces or surfaces with little texture (such as modern building walls) often result in holes that you later need to manually model, resulting in a very time-consuming process. In contrast, a laser scan will capture those surfaces with correct and accurate geometry without a problem.

When it comes to the textures, photogrammetry may also not always yield the result you want when trying to obtain a “good looking” textured mesh with crisp textures especially for man-built / non-organic structures. Typically, in photogrammetry, a “black-box” algorithm computes the textures for you by blending a large number of photos (the ones that were aligned). In practice, this often results in artifacts, for example, when there is even a minute misalignment. A small lighting change over the course of the photo capture session can also result in different coloring and artifacts. Often, you will also notice blurred lines (e.g. for door

frames, etc.) where different images got blended even though there should be a clear, crisp edge. These “imaging” artifacts usually only become visible to you, after completing a full photogrammetry computation. Once done, you are then left with little or no remedy, and no simple controls to fix these artifacts. You could potentially try disabling certain photos manually but will then have to re-compute the whole model and texture again for a day, or several hours at least, risking further delays and costs.

With SCAN2FX Photo Projector you get more control over what texture gets applied exactly where and can add additional detail on top of the texture that was automatically computed by SCAN2FX Texture.

1.3 Additional Required Modules to Export the computed Cameras / “Photo Projectors”

To fully take advantage of SCAN2FX Photo Projector and export the computed cameras, you will need to purchase at least one of the SCAN2FX Exporter modules. Instead of bundling the exporters with Photo Projector, we offer them separately, so you can pick and choose exactly which modules you need for your specific workflow.

- **SCAN2FX Exporter for Maya**

In combination with SCAN2FX Photo Projector module, SCAN2FX Exporter for Maya will also export the computed cameras for any photo projections created with SCAN2FX Photo Projector. SCAN2FX Exporter for Maya will automatically create 3D cameras for each photo aligned, and already configured with the correct image backplane. The cameras could be used for 3D painting or also modeling work in Maya. You will be able to quickly align specific, individual photos with SCAN2FX Photo Projector and then export the cameras with SCAN2FX Exporter for Maya.

- **SCAN2FX Exporter for Mari**

In combination with SCAN2FX Photo Projector module, SCAN2FX Exporter for Mari will also export the computed cameras as “Projectors” for any photo projections created with SCAN2FX Photo Projector. SCAN2FX Exporter for Mari will automatically create projectors, already configured with the correct image. This capability can be useful when you want to add extra texture detail from photos taken of your 3D scene. You will be able to quickly align specific, individual photos with SCAN2FX Photo Projector and then export the cameras as projectors with SCAN2FX Exporter for Mari.

- **SCAN2FX Exporter for Nuke**

In combination with SCAN2FX Photo Projector module, SCAN2FX Exporter for Mari will also export the computed cameras as “Projectors” for any photo projections created with SCAN2FX Photo Projector. SCAN2FX Exporter for Nuke will automatically create 3D cameras, project3D nodes, mergeMats nodes to combine multiple projections, and the according image read nodes in Nuke. This capability can be useful when you want to utilize

accurate 3D projections for compositing or VFX. The projection can project the images onto cards, or other geometry imported into Nuke. This workflow allows to precise alignment of any photos or panoramas (including EXR / HDRIs) in 3D with your real-world environment.

- **SCAN2FX Exporter for Flame**

In combination with SCAN2FX Photo Projector module, SCAN2FX Exporter for Flame will export the computed cameras as “Projectors” for any photo projections. SCAN2FX Exporter for Flame will automatically create projectors and 3D cameras in an Action node, and import and hook up all necessary image clips. This capability allows creating complex 3D VFX and compositing with 3D-aligned projections of footage, photos, and panoramas (including EXR / HDRIs) of your scene. Flame’s shapes, g-masks and/or imported geometry can be used and the photos accurately projected onto the surfaces.

Photos and cameras aligned with SCAN2FX Photo Projector can also be utilized by **SCAN2FX Texture** to texture a mesh automatically. Texturing can be done by solely utilizing the photo projectors, by utilizing both photo projectors and scans equally, or by preferring photo projectors and using scans for additional fills in case photo projectors do not have coverage of certain parts of the mesh.

NEW with Release 3.6

In addition, SCAN2FX Photo Projectors and **SCAN2FX Texture** together also enable you to **colorize your project point cloud** with additional photos or panoramas aligned with Photo Projector.

The SCAN2FX process can greatly reduce the amount of time your team needs to spend to capture sufficient image data for creating a photo-realistic looking mesh models. With the manual alignment process with SCAN2FX Photo Projector, a few photos may be sufficient to adequately texture your model (rather than possibly thousands of overlapping photos for photogrammetry).

SCAN2FX creates for the first time a straight and efficient path to the most popular visual effects and 3D software packages, from your laser scans, designed with real production use in mind.

2. System Requirements and Version History

2.1 System Requirements

- FARO® SCENE 2019+ or SCENE LT 2019+
- Windows 10 (may work with previous versions, but not tested)
- At least one SCAN2FX Exporter Module or SCAN2FX Texture

- 3D application to import the data exported with the chosen SCAN2FX Exporter Module or SCAN2FX Texture

2.2 Version History

Release 3.7

NEW with Release 3.7

- **Fix for source image files with space not loading** – Now supports source image files with space. Make sure that there is no issues with Exporters and 3rd party software that does not support space characters in certain filenames.
- **Warning for Photo Projector if project root transform is non-zero** – Non-zero roots will causes issues when colorizing a point cloud. Make sure to set the project root transform to 0, 0, 0 (rotation and position) when colorizing point clouds. This is a work around due to an open FARO Scene bug.

Release 3.6

NEW with Release 3.6

- **SCAN2FX Texture Integration with SCAN2FX Photo Projector** – Now supports colorization of scanned project point clouds with the Photo Projectors (See Chapter 10 for details)

Release 3.5

- **SCAN2FX Texture Integration with SCAN2FX Photo Projector** – Photos from SCAN2FX Photo Projector can now be used to texture a mesh with SCAN2FX Texture
- **SCAN2FX Exporter for Nuke support** – Photo projectors can now be exported to Nuke
- **SCAN2FX Exporter for Flame support** – Photo projectors can now be exported to Flame
- **SCENE 2018 version** – optimized for SCENE 2018
- **General setting for Exporters to control photo export** – centralized setting instead of setting per Exporter

Release 3.4

- **Improved export alignment for certain portrait images** – SCAN2FX Exporter for Maya and SCAN2FX Exporter for Mari can now process currently JPEG photos with orientation flags (e.g. portrait images).

Release 3.2

- **Support for texturing/alignment with smaller objects** – settings to switch between small markers and larger (standard) markers to support the texturing / alignment of scanned objects (e.g. with handheld scanners)
- **New tool tips**

Release 3.1

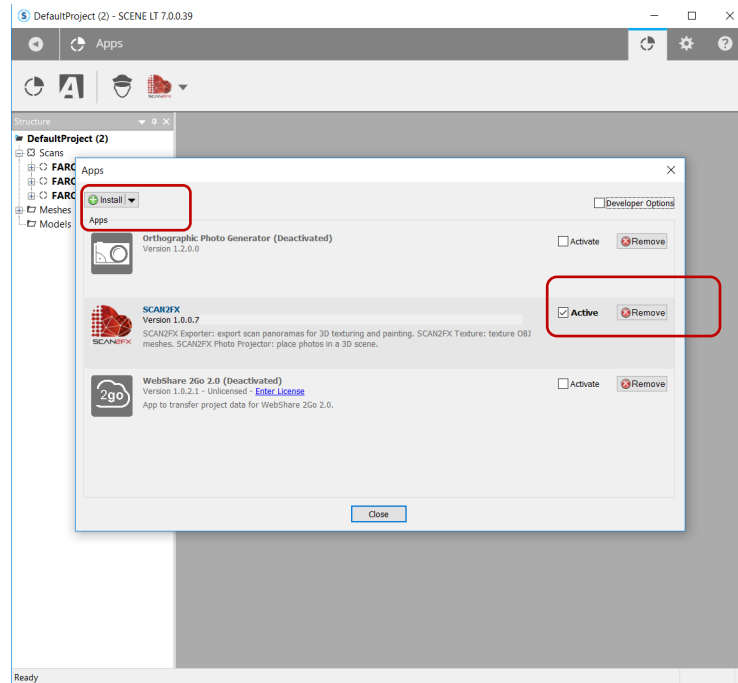
- **Improved Algorithms** – get correct camera estimates faster, with fewer points
- **Panorama Support** – compute 3D cameras from 360x180 panoramas
- **EXR Support** – load photos and panoramas in RAW EXR format
- **EXIF Support** – automatically loads focal length and sensor size from JPEG images
- **CR2 Support** – load photos and panoramas in Canon CR2 format (converts to PNG)
- **Exporter for Mari Update** – output panoramas from photo projector as native Mari panorama as well as individual Mari projectors for 3D painting
- **Exporter for Maya Update** – output panoramas from photo projector as set of native Maya cameras, projection shaders and image backplanes
- **New Settings / Option to Exclude Scans** – additional setting to exclude the scans in the project from the export, and only export the Photo Projector cameras
- **New 3D Camera Visualization** – new camera 3D visualization to better identify the direction of the camera for pinhole and panorama cameras

Release 2.0

- General Fixes and Improvements

3. Installation

1. Open SCENE or SCENE LT (tested with SCENE 2018 or higher, but may support other versions).
2. If you have a previous version of SCAN2FX installed, please remove this version first with the App Manager in SCENE or SCENE LT (in the new Scene User Interface: Apps -> Apps, and then click remove right of the application in the pop-up. In the previous User Interface: Tools -> Apps, and then click remove in the pop-up).



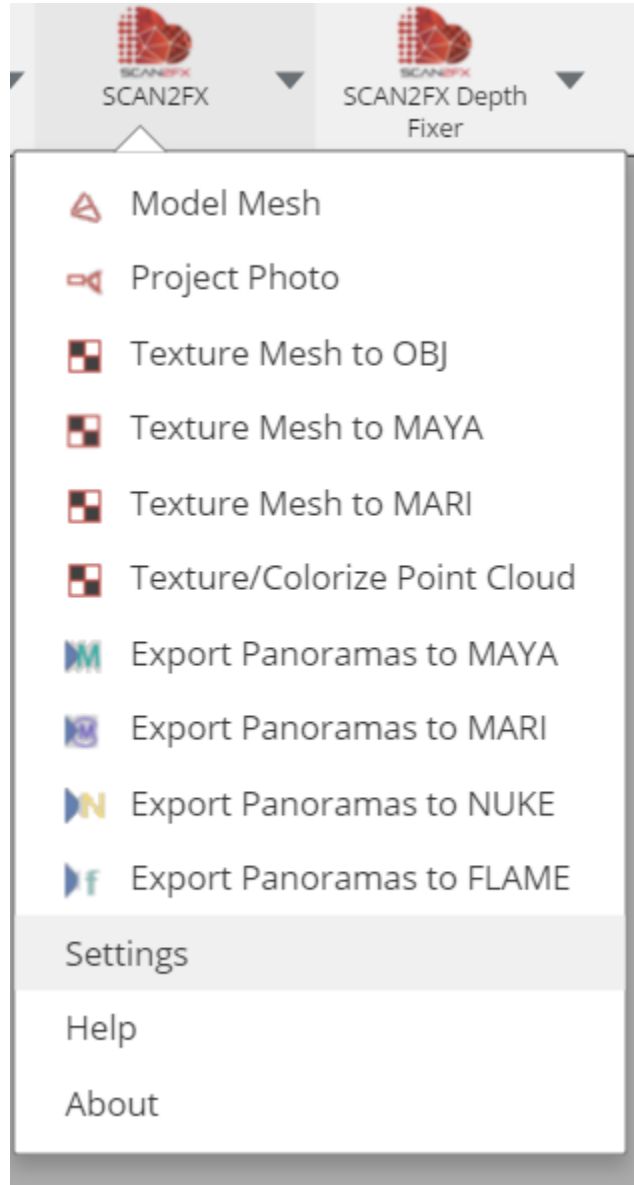
3. Install the downloaded SCAN2FX app by doing one of the following:
 - Drag & Drop the SCAN2FX.fpp file into SCENE.
 - Double click the SCAN2FX.fpp file in the Windows Explorer.
 - Click install in the App Manager in SCENE or SCENE LT to install the SCAN2FX app, and follow the instructions.
4. Once installed, the SCAN2FX icon should appear in the apps list.



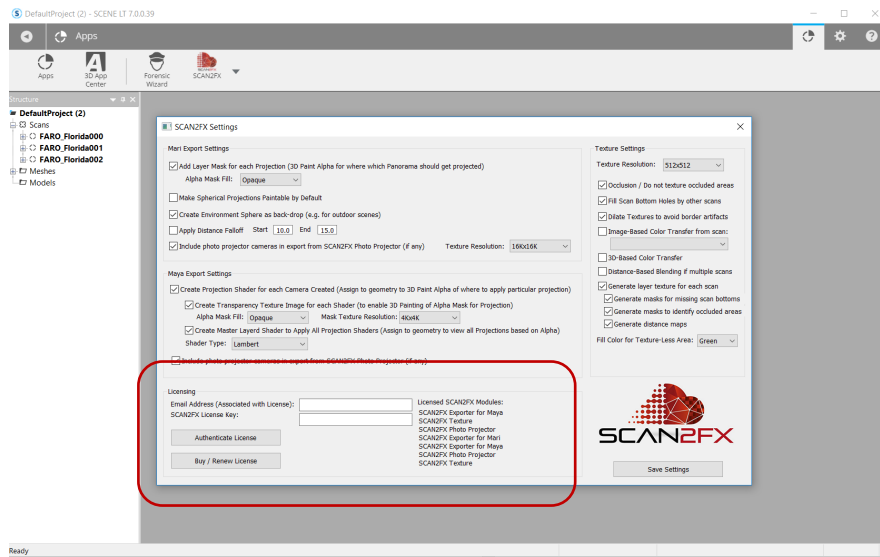
4. Licensing

To activate the SCAN2FX Photo Projector module, a valid license key needs to be authenticated. You can purchase the SCAN2FX Photo Projector module or also other modules, or all modules combined via the FARO® 3D App Center. If you are interested in a trial first, and do need a trial license, please email sales@scan2fx.com with your company information, intended use, and email address.

1. To activate your license, click on the red SCAN2FX icon as highlighted, and select Settings in the menu.



2. In the following pop-up dialogue, see the section “Licensing” at the bottom left of the dialogue box. Enter the email address that was used when purchasing the license and is associated with the license. And paste in your SCAN2FX license key.



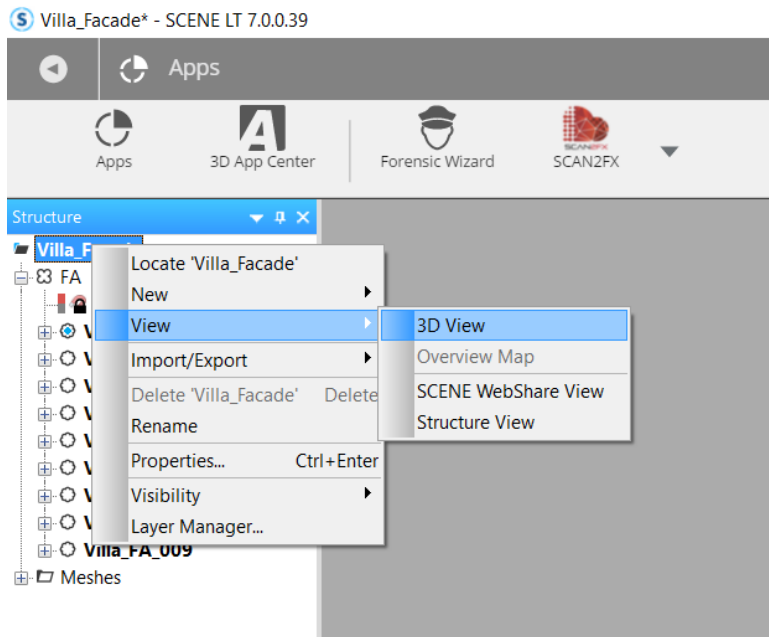
3. Click “Authenticate License” to connect to SCAN2FX cloud licensing server for authentication.

Please make sure that your computer is connected to the Internet for this step, as SCAN2FX will send this information to SCAN2FX’s licensing servers for license authorization. Each license key may enable one or more modules within SCAN2FX. The licensed SCAN2FX Modules will get listed on the right side of the email address and SCAN2FX license key box.

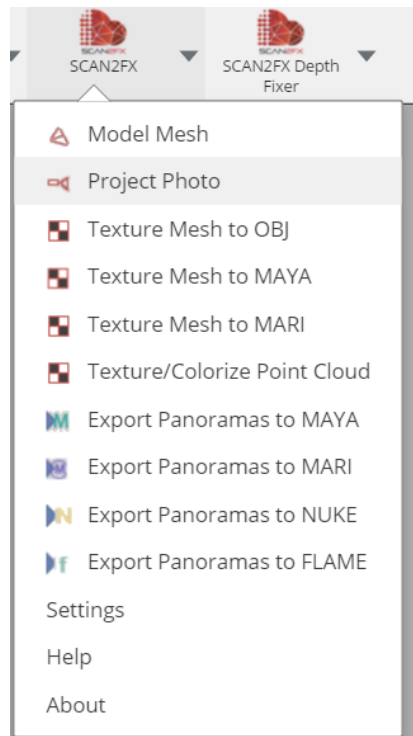
Finally, please note that all licenses in SCAN2FX are subscription-based, meaning they will expire after your service term and a renewal subscription needs to be purchased in order to continue using the module. When a licensing key gets entered the first time in SCAN2FX, this particular license key will be node-locked to the particular hardware and cannot be re-used on another machine. Please note that licenses are not transferable to other machines or hardware during the subscription term once they have been activated on one hardware. A new subscription can be purchased separately and assigned to the new or modified hardware.

5. Using SCAN2FX Photo Projector

Open a 3D view of your point cloud. SCAN2FX Photo Projector requires an active 3D view to work.



To get started, activate the SCAN2FX Photo Projector dialogue / tool box by clicking Project Photo in the SCAN2FX menu.



If you have no photo projector selected in your scene structure / graph, the SCAN2FX Photo Projector tool will pop up without any camera information visible as such:



You can now add the first image that you would like to align with the 3D point cloud.

Click **“Add Photo Projector”** and select a JPG, PNG, EXR or CR2 photo of your 3D scene to project. Select the file type you would like to display if you cannot see your file. If you want to align a panorama image, click **“Add Panorama”** and select the file accordingly.

Note: CR2 images will get converted to PNG automatically for you with `_scan2fx` added to the name, since most 3D applications (Maya/ Mari /etc.) do not support CR2. The conversion will reduce precision. To retain higher precision, you may want to use another application to convert to EXR first.

Note: If you use another file type for your photos, convert them to EXR (for 32-bit per channel / raw images) or PNG (for 8-bit per channel) first before using them in SCAN2FX Photo Projector. If applicable, you could later replace the images of your image backplanes with images of the other file type in your 3D application.

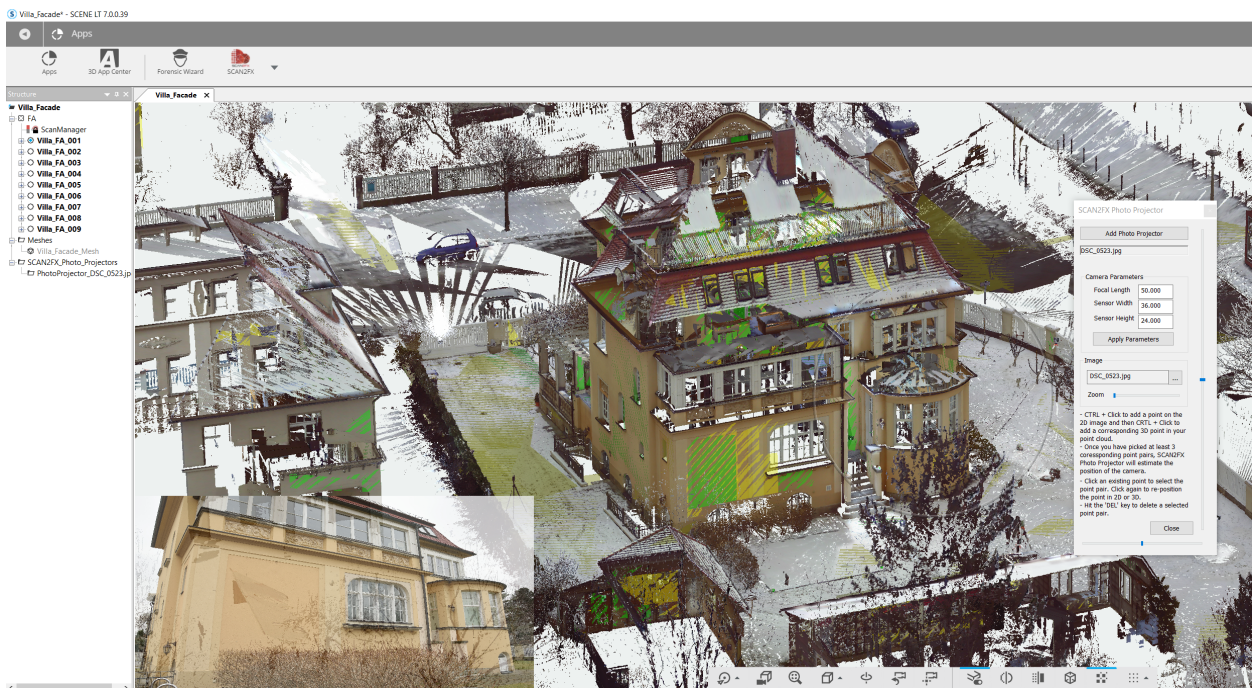
Click **“Open”** to add the selected photo as a photo projector.

The SCAN2FX Photo Projector will now display camera and image related information as well as provide further instructions and controls.

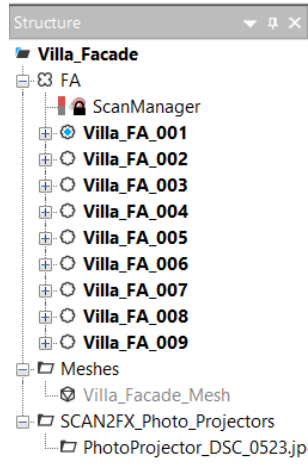
At the bottom left of your 3D view, the loaded image will get overlaid (slightly transparent so you can still see through the point cloud behind the image).

Finally, the scene structure/graph on the left shows a new folder called **“SCAN2FX_Photo_Projectors”** with a first photo projector. You can later click any of the existing photo projectors to pull up the information of a previously created photo projector.

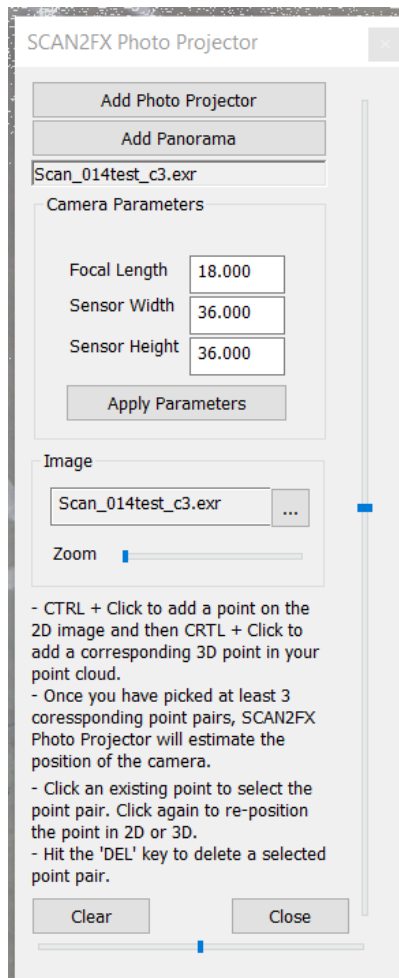
Right now, no camera / photo projector shows within the 3D point cloud as no alignment has been established yet.



Here in more detail the photo projector within the scene structure / graph:



The SCAN2FX Photo Projector now looks as follows:



Camera Parameters

As a first step, we should enter the correct camera parameters for the images in the according tool boxes under “Camera Parameters.”

These parameters are important for SCAN2FX Photo Projector correctly estimate the camera position.

NEW with Release 3.1

With SCAN2FX Photo Projector 3.1, for **certain JPEG images**, SCAN2FX can load the camera parameters automatically from the image. In the case of **360x180 panoramas**, you also **do not need to manually enter the camera parameters**.

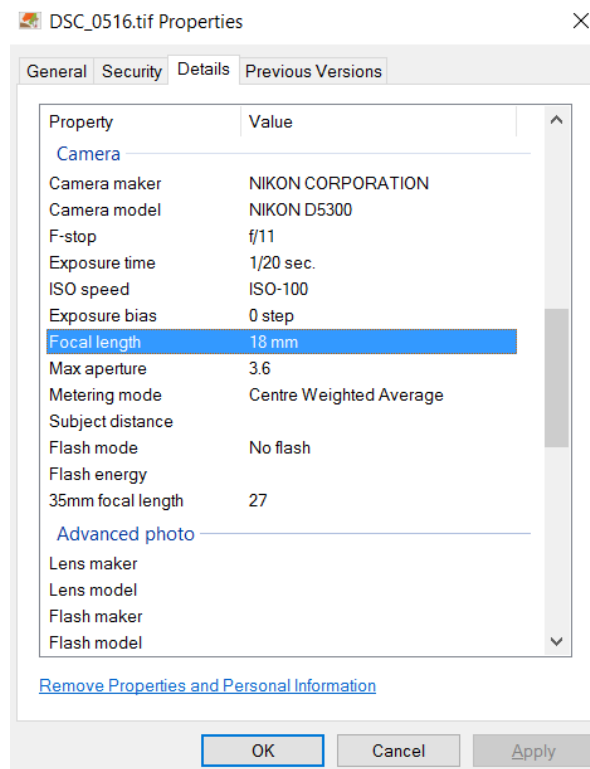
Otherwise, you should fill in the

- Focal Length (in mm)
- Sensor Width (in mm)
- Sensor Height (in mm)

To retrieve this information, you may be able to look at some of the meta data of your images.

Alternatively, you could note down the camera parameters while shooting.

For example, right clicking the image file in Explorer and checking properties, we see the following for one of our test images:



The focal length is listed as 18 mm (and seems to result in better camera estimates than the 35mm equivalent).

We also need to figure out the sensor size for this camera. We do so by searching for the camera model “Nikon D5300” on Google. We find that Nikon D5300 is a ASP-C camera.

Below you find some common sensor sizes:

Camera	Sensor Size
Full frame (DEFAULT in SCAN2FX) Canon 5DSR	36mm x 24mm
Full frame Canon 6D	35.8mm x 23.9mm
APS-C Nikon D5300	23.5mm x 15.6mm
Epic-W S35	29.90mm x 15.77mm
iPhone 6 / 6 Plus Rear Facing	4.8mm x 3.6mm

You can see that sensor sizes can vary from model to model and is important to enter the exact sensor width and height into SCAN2FX Photo Projector for best results.

Important Note: SCAN2FX assumes that there is no distortion in your images. As a result, please make sure to use distortion-free lenses and images for your photo capture, not fisheye lenses or panorama images.

We enter the correct information into the Photo Projector tool and click “**Apply Parameters**” to save the new parameters into the photo projector. SCAN2FX Photo Projectors get automatically stored as part of your SCENE project.

Image Swapping

At the top of the photo projector tool, you also the file name listed (DSC_0523.jpg) in this case and a box under Image allows you to replace the image with another image if needed. Click the button with the three dots (“...”) to swap out the image.

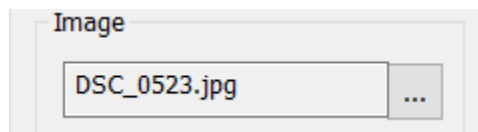
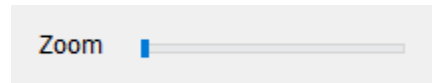


Image Controls (Zoom / Pan)

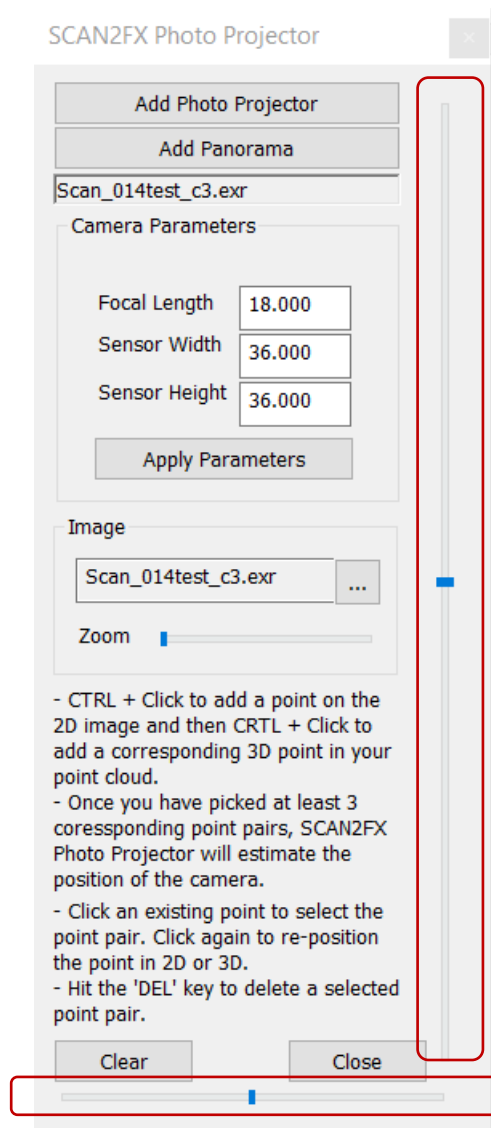
We also have several controls available to move about the photo on top of our 3D view:

The following bar allows you to zoom further into the photo e.g. when trying to precisely place an alignment point onto the 2D image.



On the right (top to bottom) of the SCAN2FX Photo Projector tool, there is also a sliding bar (centered initially). This bar allows you to pan the image from top to bottom.

At the bottom of the tool (from left to right), there is a 3rd sliding bar (centered initially). This bar allows you to pan the image from left to right.

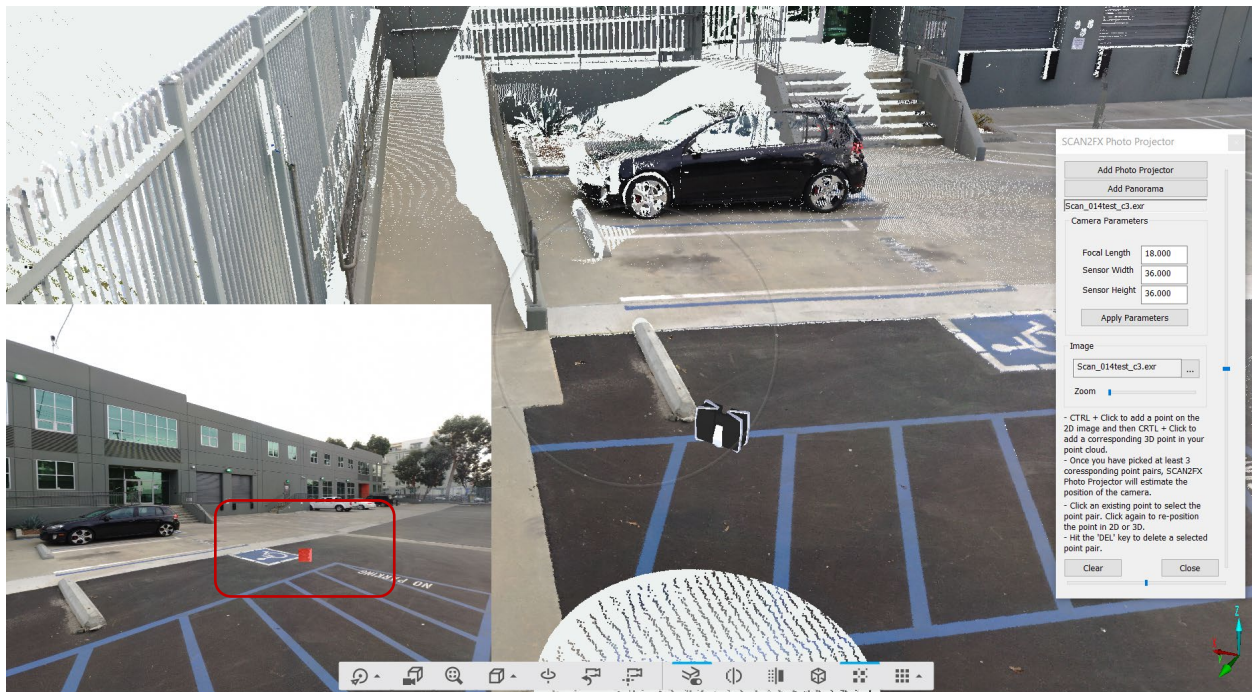


Creating an Alignment between your 2D Photo and the 3D Scene

Now we come to the exciting part.

Keep the “Ctrl” key pressed and click somewhere on the 2D image that is overlaid over the 3D scene. You may want to zoom in if you want to click on a particular detail of your photo to precisely target the 2D point.

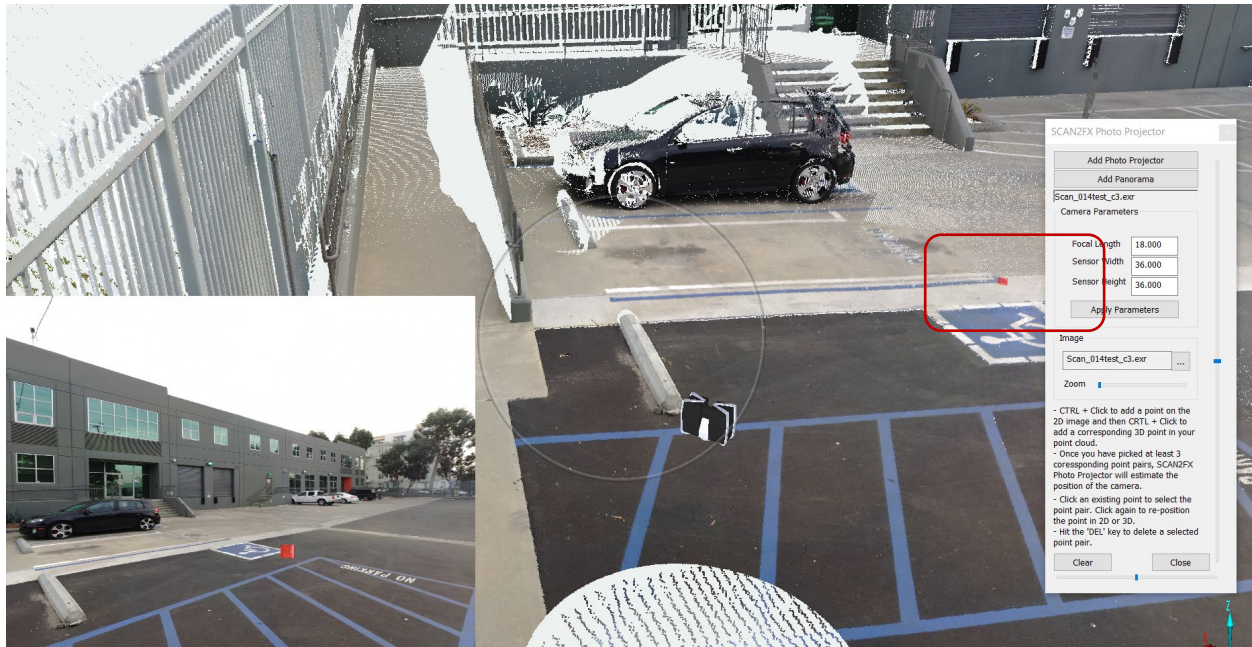
A red box will appear where you clicked.



Now we will try to identify the same corner in our 3D point cloud / model in the back.

We will again keep the “Ctrl” key pressed, but now click on the 3D part of the view (where no image is displayed). We will zoom out of the image a bit to have better view of the 3D point cloud.

A second red box gets added but now as a part of the 3D scene.



We will now repeat this process and pick more distinctive points in the 2D photo and their corresponding 3D point in the 3D scene. It is recommended to look at the scene from a similar perspective as the photo, and to use points that are not all in one plane (e.g. not all on one wall, but maybe on different walls) to get a better result later on.

We can move about the camera also to check that our 3D points are truly where they are supposed to be (e.g. when clicking on a faraway wall to verify that the red box was inserted at the right depth).

Starting with the 3rd point pair created, SCAN2FX Photo Projector will display an initial camera estimate of where in 3D scene the camera that took this photo was placed.

NEW with Release 3.1

This camera pose estimate is computed based on the provided camera pointers and the point correspondence provided. However, with only four point pairs, there are, in theory, several possible camera positions, as the camera position is not uniquely determined. However, with SCAN2FX's proprietary algorithms, Photo Projector is able to still estimate the camera even with only four points.



Lines now connect the 3D points picked to determine the camera position, which is presented by a gray camera icon or a gray panorama camera icon.

If needed, we can keep adding additional point pairs to get an even more precise camera position estimate (follow the red lines if you cannot see the gray box well).

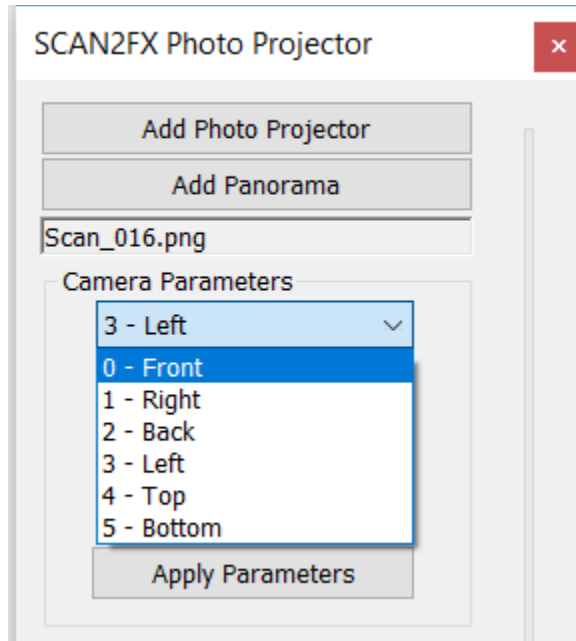
If adding a point pair drastically changes the position of the camera, it may make sense to delete the point with “DEL” key while the point pair is selected. Sometimes a 3D point that is not fully accurate (e.g. part of a tree in front of the building) may negatively impact the computation. It is recommended that you verify that the right 3D point was actually picked in the scene by moving the camera about. If something is off, delete a point and start over.

You will need to make sure to match each point for a precise camera estimate as small adjustments or even small inaccuracies in the camera parameters, may result in incorrect results.

NEW with Release 3.1

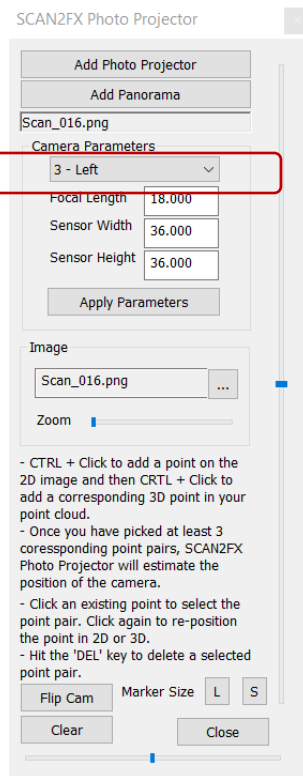
Creating an Alignment between your 360x180 panorama and the 3D Scene

When aligning a panorama, you simply pick one of the directions in the drop-down and align that particular image. The rest of the directions will be automatically lined up. Here are a few of the additional drop-downs displayed when working with a panorama:



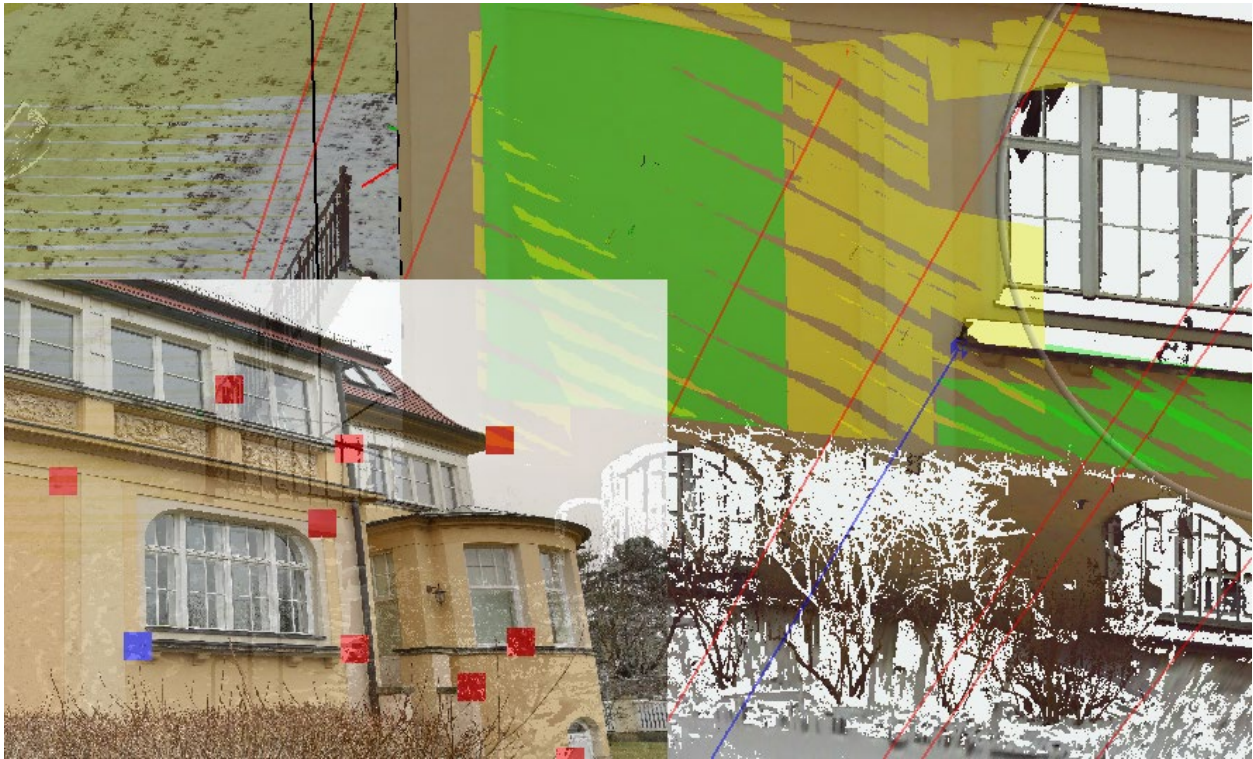
Make sure to click **“Apply Parameters”** after choosing the desired camera direction/perspective.

For panoramas, all the other options are the same with the addition of the direction drop-down as marked here:



Adjusting Points

To adjust some of the points, we can select a point pair and then move the 2D or 3D points. Click on one of the existing points in 2D and 3D to select it. SCAN2FX Photo Projector will highlight the selected 2D point as well as the corresponding 3D point blue. Also, the line from the estimated 3D camera to the 3D point is highlighted in blue now.



Now click somewhere on the 2D photo to move the 2D point to that position. Or click somewhere in the 3D scene to move the corresponding 3D point to that new position.

Deleting Points

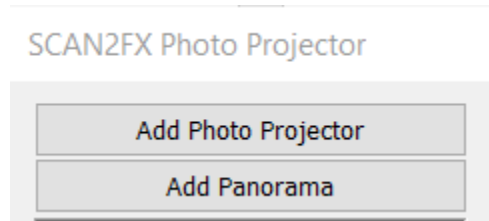
You can also delete points or point pairs. Select a point in the 2D photo or the 3D scene, then press the “DEL” key on your keyboard and both points will be deleted. Also, the camera will get recomputed to show you the resulting 3D camera pose without the point pair. If only a single point is selected, only that point gets deleted (either 2D or 3D).

Closing the SCAN2FX Photo Projector

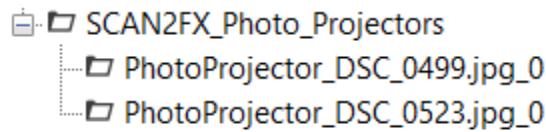
Finally, once all done, and your camera pose looks right, click the “Close” button to close the tool and save your latest camera pose. SCAN2FX Photo Projector will ask you if you want to save your SCENE project at this point to make sure the latest Photo Projector data is stored as well.

Adding Additional Photo Projectors to your Project

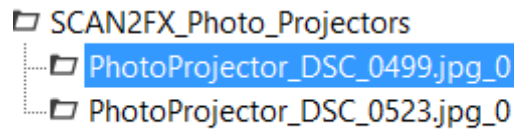
To add an additional photo projector to your project, just click the “Add Photo Projector” or “Add Panorama” button as before. The button is at the top of the SCAN2FX Photo Projector tool.



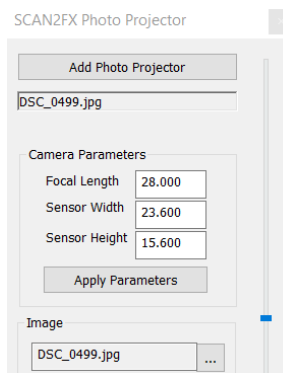
The additional photo projector immediately appears in the scene structure / graph and gets stored as part of your project.



To select one of the existing SCAN2FX Photo Projectors, simply select the node from the scene structure / graph while the SCAN2FX Photo Projector tool is open.



SCAN2FX Photo Projector will automatically switch over to that particular photo projector with the camera displayed in 3D (if already estimated) and displaying the correct photo and camera parameters that were previously entered.

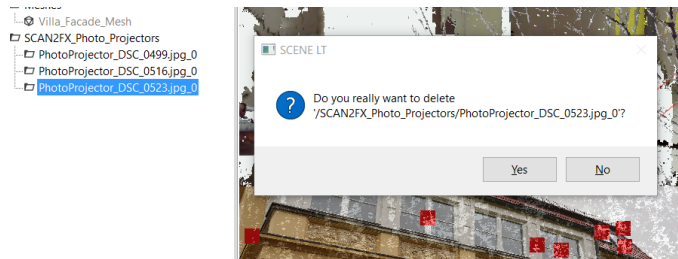


Here we repeat the alignment exercise on another photo. The gray box represents the camera with the red lines leading to the different 3D points. The photo on the left shows the corresponding points in 2D. In this case, the focal length was set to 18 mm with a sensor width of 23.6 and sensor height of 15.6.



Deleting an existing Photo Projector

Simply select the photo projector into the scene structure/graph and hit 'DEL.' Click 'Yes' in the dialogue box to confirm.



Saving your Photo Projectors

To save all your photo projectors, it is recommended to regularly save your SCENE project. The photo projectors get saved as part of your SCENE project.

6. Exporting your Photo Projectors

To export the computed cameras / photo projectors, you will need to purchase at least one SCAN2FX Exporter module.

When you export your panoramas the usual way, the SCAN2FX Exporter will also include the photo projectors contained within your currently open SCENE project in the export.

In the following pages, we will describe workflows and best practices for

6.1 SCAN2FX Exporter for Mari

6.2 SCAN2FX Exporter for Maya

Additionally, **SCAN2FX Exporter for Nuke** and **SCAN2FX Exporter for Flame** are also compatible, but not described in detail here. These exports are especially useful for projections and advanced VFX compositing. They also enable to photo project any EXR or HDRI panorama and then accurately 3D project the image data onto geometry in Nuke or Flame.

Tip: Please note that **Maya also can export the cameras in other formats** such as FBX for import into other 3D software, so you can use the computed cameras in other parts of your pipeline. You can also utilize this workflow to reconstruct the position of a person that took a photo of a scene (e.g. for forensic applications).

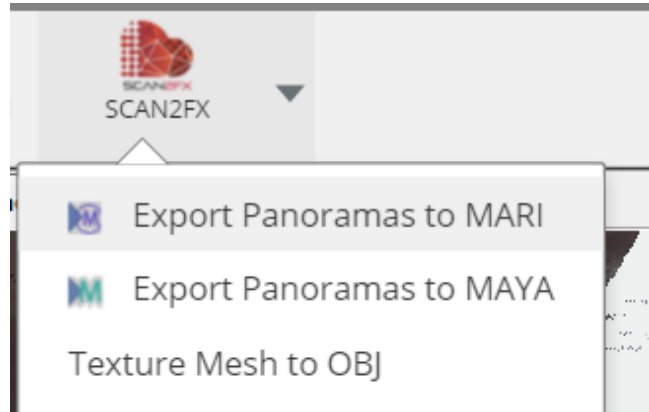
Note: Requires at least one SCAN2FX Exporter module

NEW with Release 3.5

6.1 SCAN2FX Exporter for Mari

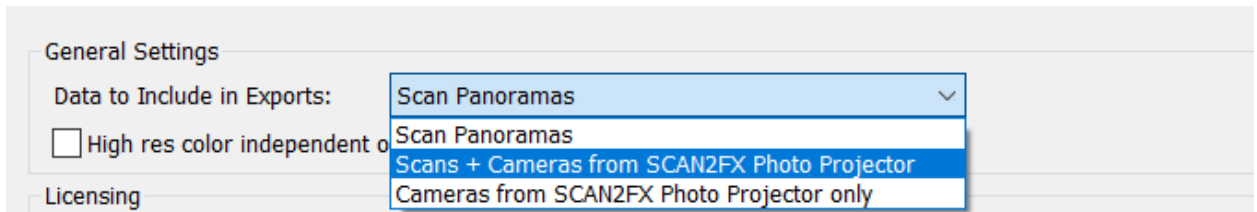
In the case of exporting with SCAN2FX Exporter for Mari, photo projectors will get created in Mari with each photo setup. You can then project those onto your mesh. Click **“Export Panoramas to Mari”** to run your export (this export will include the photo projectors if the setting is turned on).

Note: Requires SCAN2FX Exporter for Mari and the Foundry's Mari

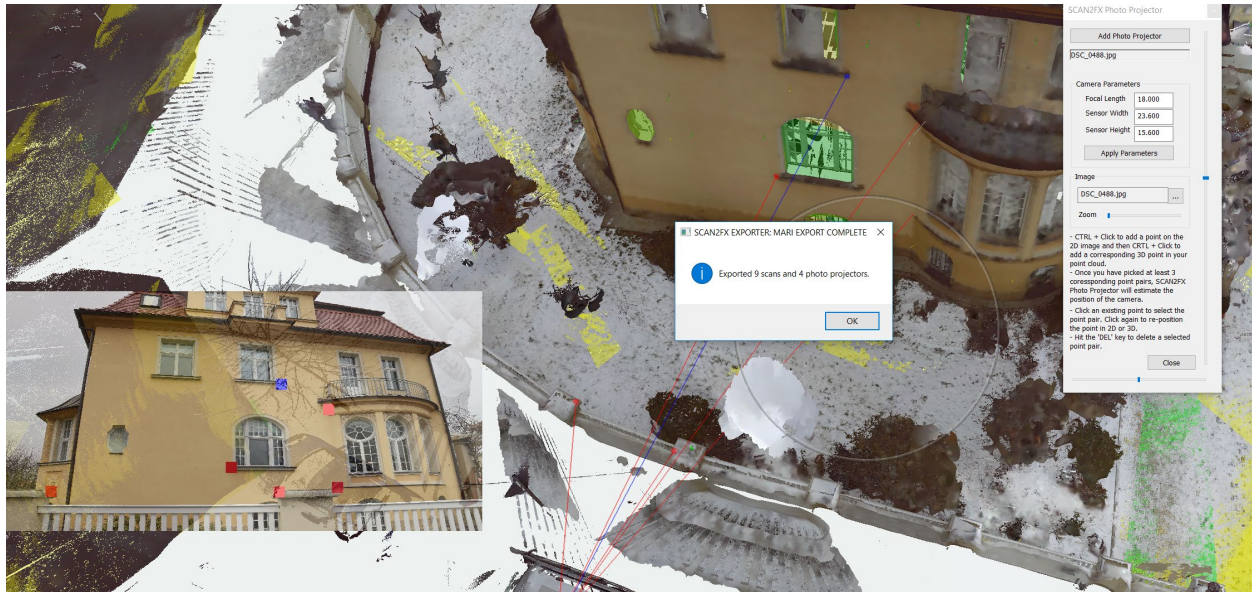


NEW with Release 3.5

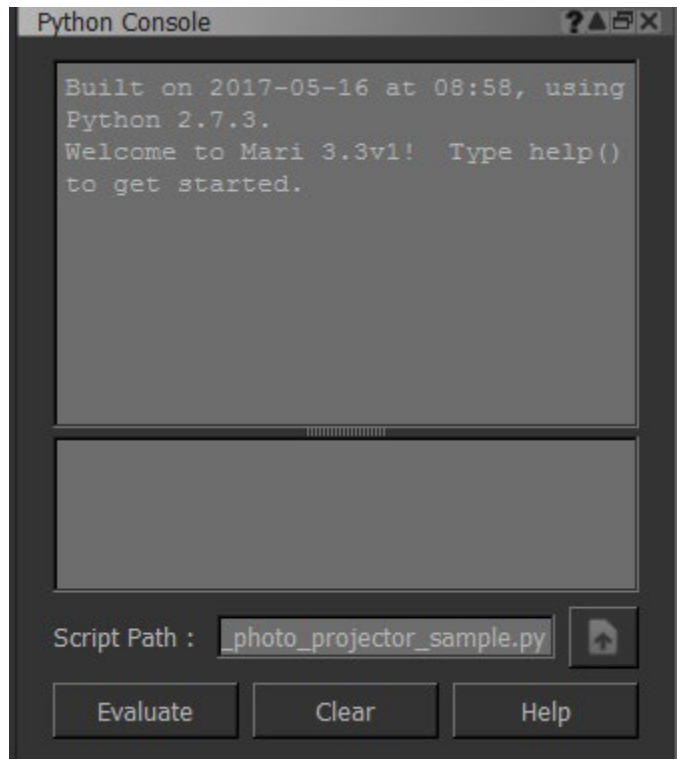
In the General settings, please make sure to have one of the “Data To Include” options selected that includes the “Cameras from SCAN2FX Photo Projectors”:



Once the export is complete, SCAN2FX Exporter will notify you about how many scans and how many photo projectors were exported.



As described in the SCAN2FX Exporter for Mari manual, you can now execute the Mari python script generated by SCAN2FX in Mari.

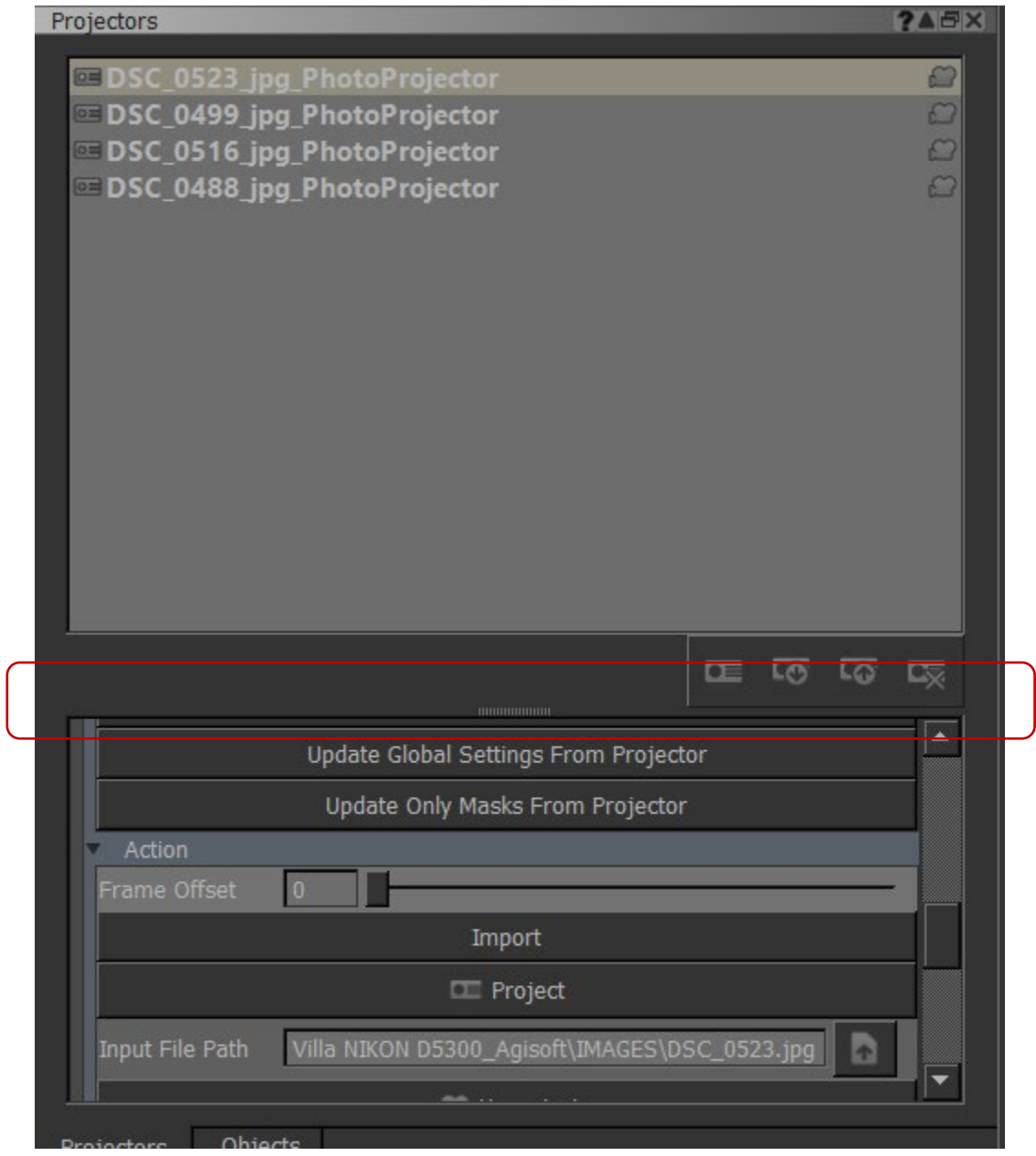


In this example, we exported four photo projectors from SCAN2FX Photo Projector corresponding to 4 different photos that were taken of the scene.

The “Projectors” palette shows the list of projectors. Each projector is automatically configured with the correct input image file so that each photo can then be projected onto your layers.

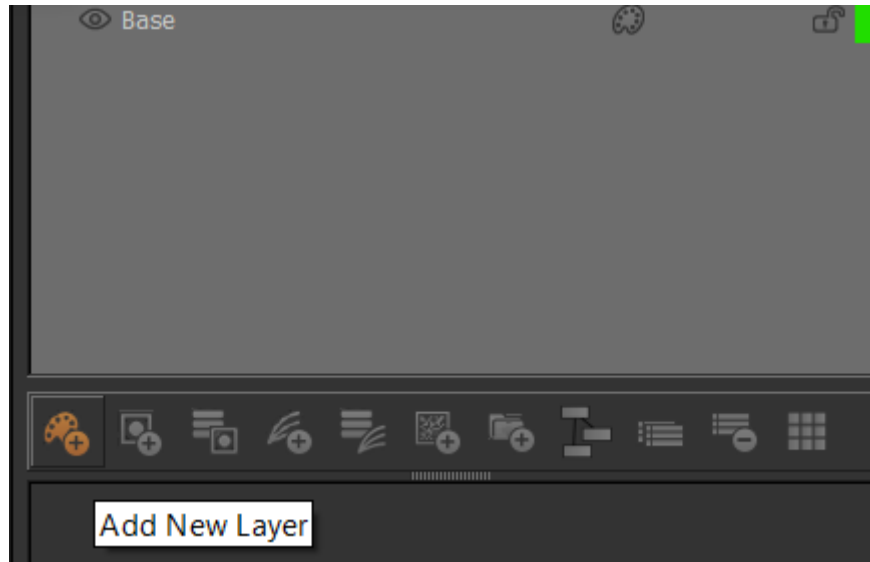
NEW with Release 3.1

Note: For Panoramas, SCAN2FX Export for Mari will generate 6 Projectors each as well as a projection layer in the layer stack (providing somewhat higher quality when painting).



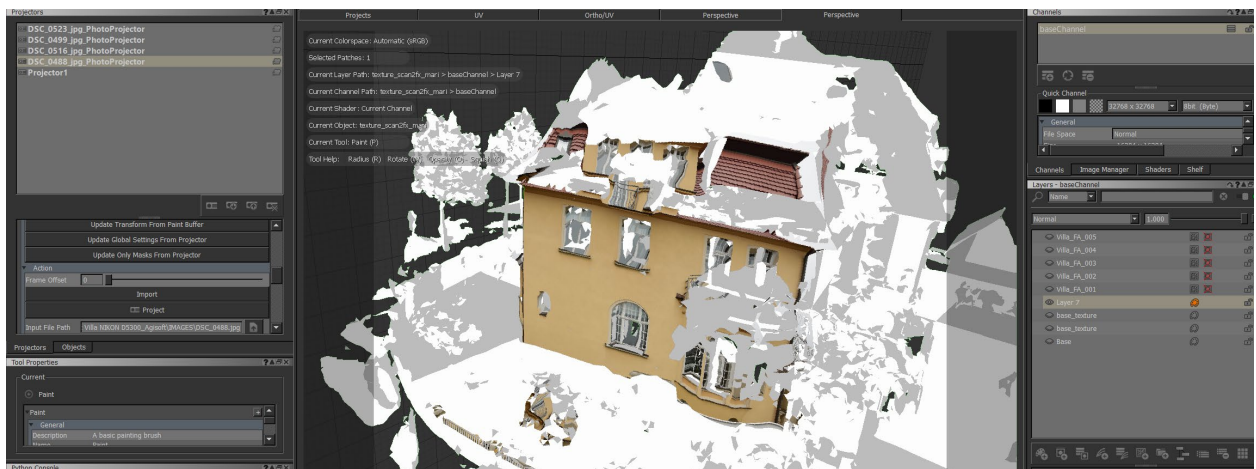
Click a projector to switch to the perspective of that viewport. If you feel like the perspective is correct, click “Project” in the properties to project the camera photo onto your currently selected layer.

You should ensure that you have a layer selected that is paintable. Or alternatively, you may want to add a new paintable layer on top of your existing layers to keep the photo projection separate without destroying an existing texture potentially.



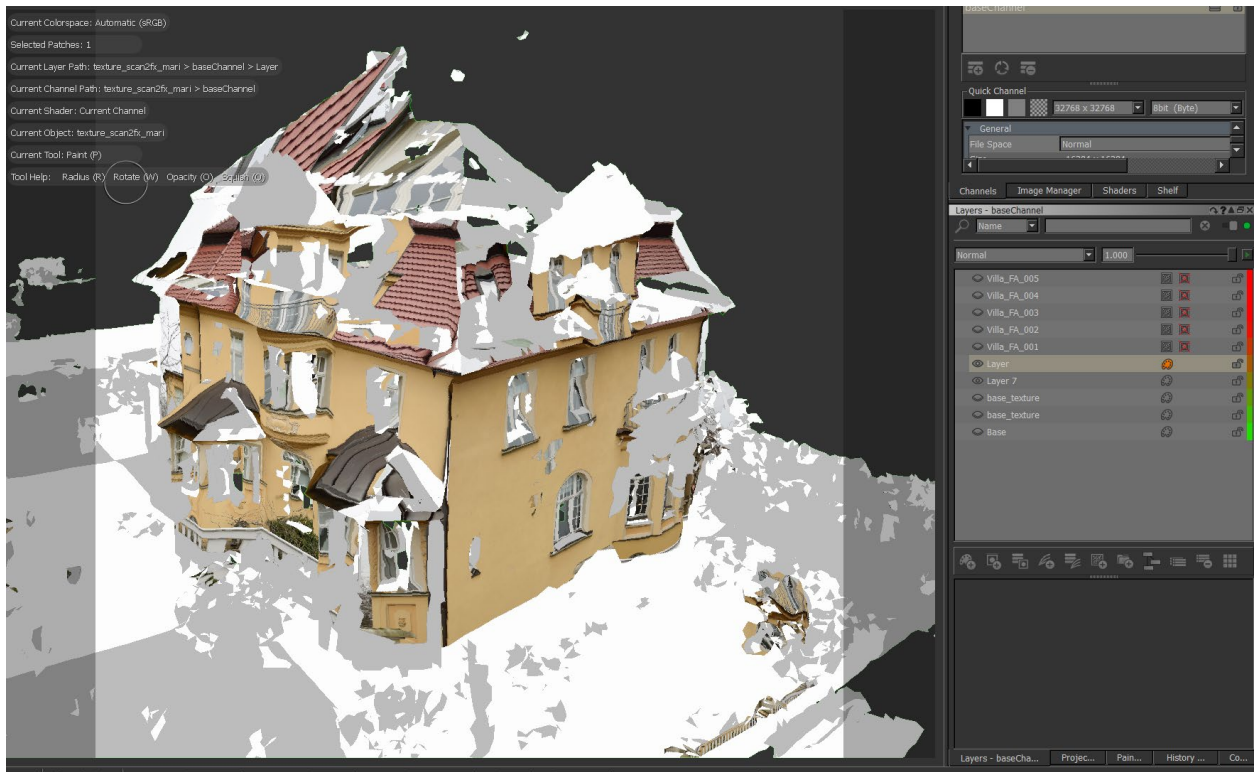
See the SCAN2FX Exporter for Mari manual for additional instructions, and tips & tricks how to best utilize the SCAN2FX data within the Foundry's Mari.

Here we projected one of the SCAN2FX projectors onto a layer. Mari considers occlusion in the projection and only projects the photo onto areas of the mesh visible from the camera.



A mask can then be added to further mask out the projection where it should not apply if necessary.

We can step through all our projectors to project the according photos as needed. If two photos overlap, masks can come in handy to blend the different photos together.



Tip: If a projector shows a clear misalignment, we can delete the photo projector and go back into SCAN2FX Photo Projector to modify the alignment points to achieve a better camera projection. Likely, this is happened because some of the points were slightly off, or not enough points had been selected. Also, the camera parameters may have been off.

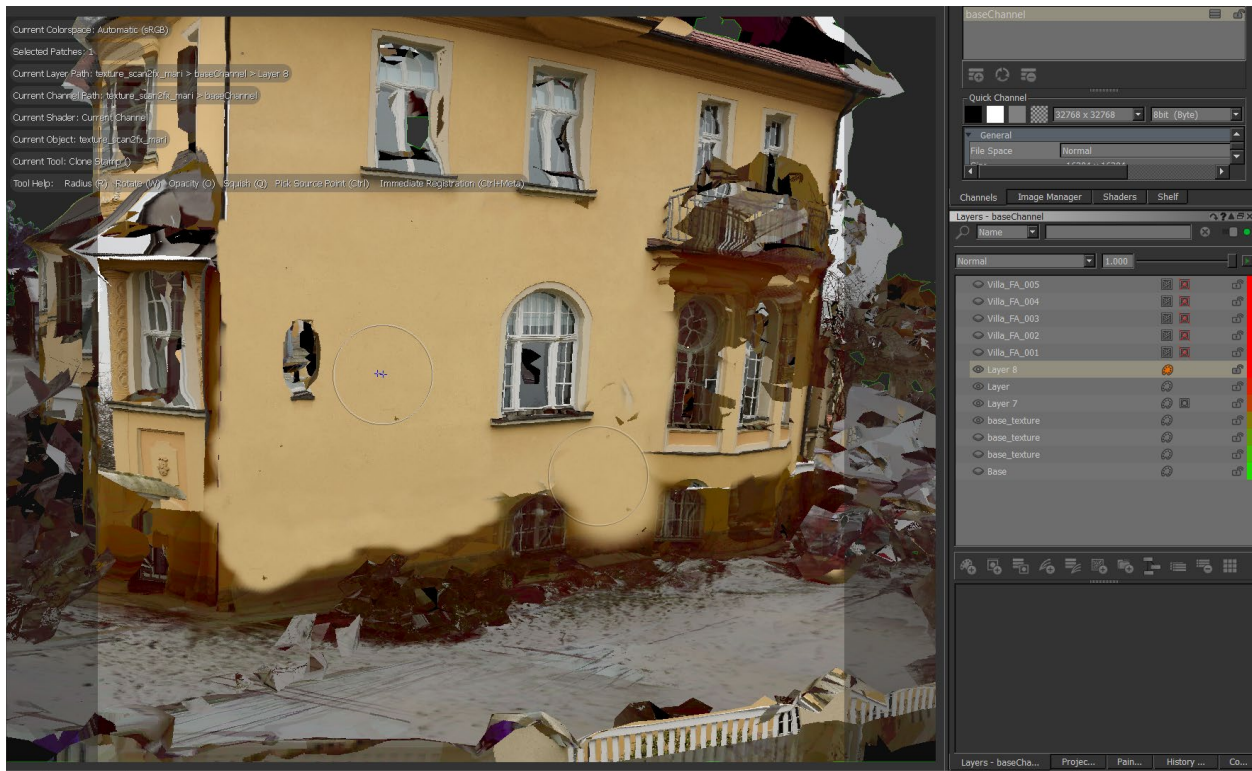
Make your changes in SCAN2FX Photo Projector (ensure you saved your project), and then run “Export Panoramas to MARI” again.

Mari also allows you to easily paint in sections. Note that the mesh has certain holes in the geometry and has not been cleaned up, but some areas are untextured. We select the “clone” brush and pick a source (Ctrl+Left Mouse Click).



We can also load a baseline texture from SCAN2FX Texture (a separate module), and then start blending our photo projection together with the baseline texture by creating blending transition.

Here we paint in the color of the photo slowly to cover the whole building front.

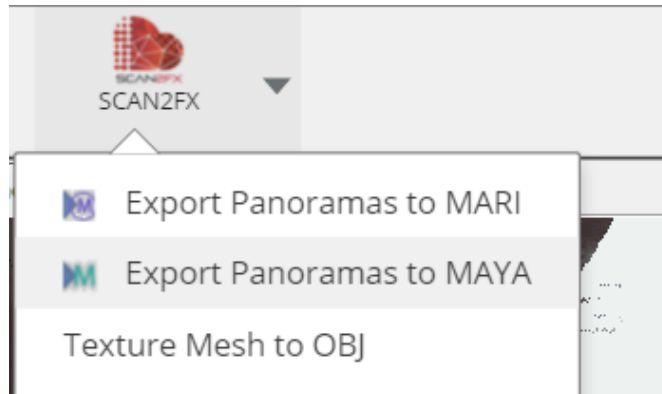


6.2 SCAN2FX Exporter for Maya

In the case of exporting with SCAN2FX Exporter for Maya, additional cameras will get created in Maya with each photo setup as camera image backplane.

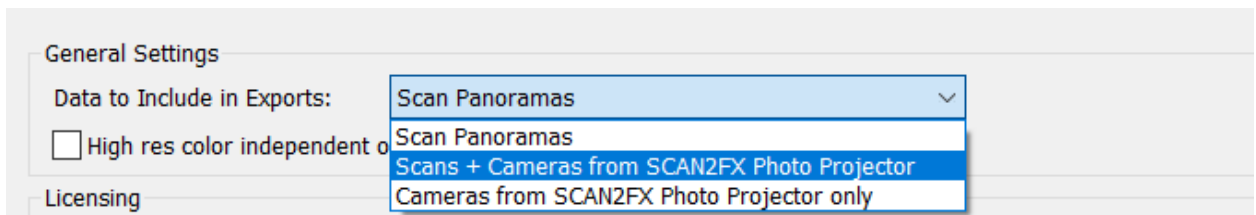
Click **“Export Panoramas to Maya”** to run your export (this export will include the photo projectors if the setting is turned on).

Note: Requires SCAN2FX Exporter for Maya and Autodesk Maya



NEW with Release 3.5

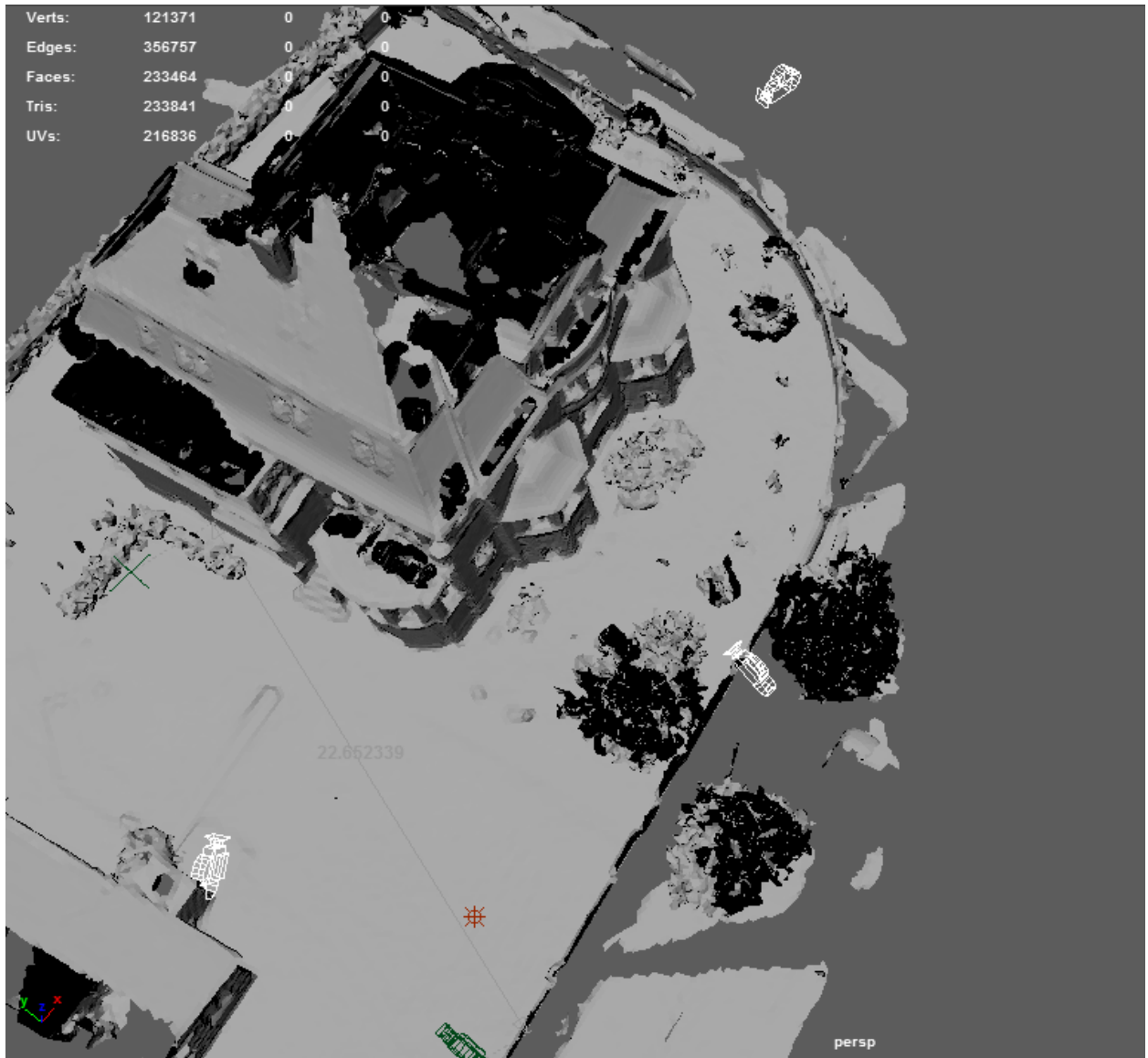
In the General settings, please make sure to have one of the “Data To Include” options selected that includes the “Cameras from SCAN2FX Photo Projectors”:



SCAN2FX Exporter for Maya will also create a shader material for each photo projector to allow the projection of the photo from the camera position onto a mesh or model for texturing.

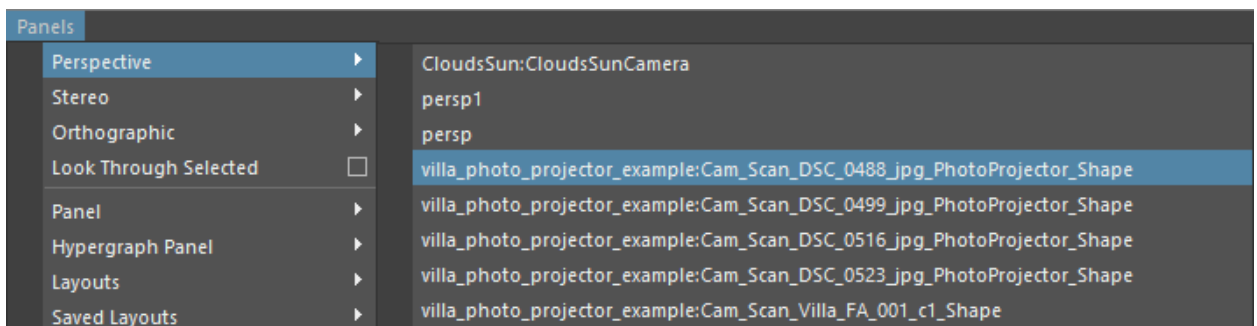
NEW with Release 3.1

For panoramas, SCAN2FX Exporter for Maya will create 6 separate cameras, and shader materials to cover the different directions.



The image backplanes can also be used for modeling.

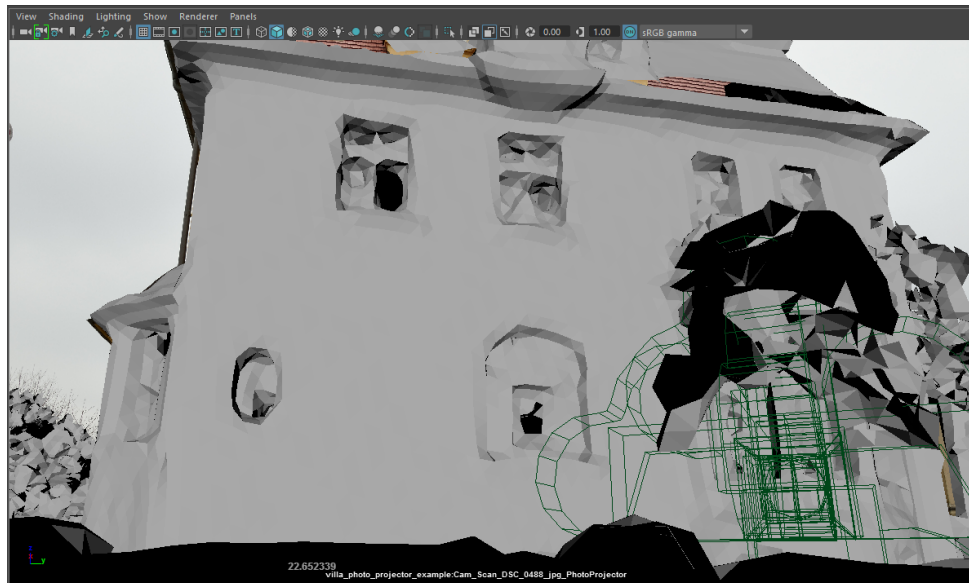
We now select one of the computed cameras to view the image backplane in the Maya Viewport:



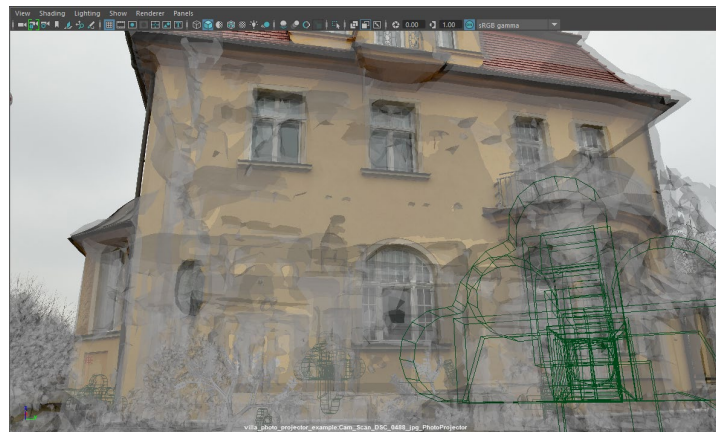
You can see how each camera is named. The first section is the name of the Maya .MA file you saved, followed by Cam and then the image that was used for the photo projector, followed by the keyword "PhotoProjector" to identify that this camera resulted from SCAN2FX Photo Projector rather than from the scan panoramas.

We already loaded a mesh into Maya of the 3D scene and are assigning a standard Lambert shader to the mesh. Make sure the mesh has a non-overlapping UV map assigned before painting.

We can see how almost only the gray sky is visible in the Viewport and how the mesh covers the building in the image. The mesh has a few holes where no 3D point cloud was captured, or the meshing failed. We can later use the photo to fill in a texture once we have created a fixed mesh by filling the holes.



We increase the transparency for our Lambert material to see how the mesh lines up on top of the image. The alignment in this example is near perfect.

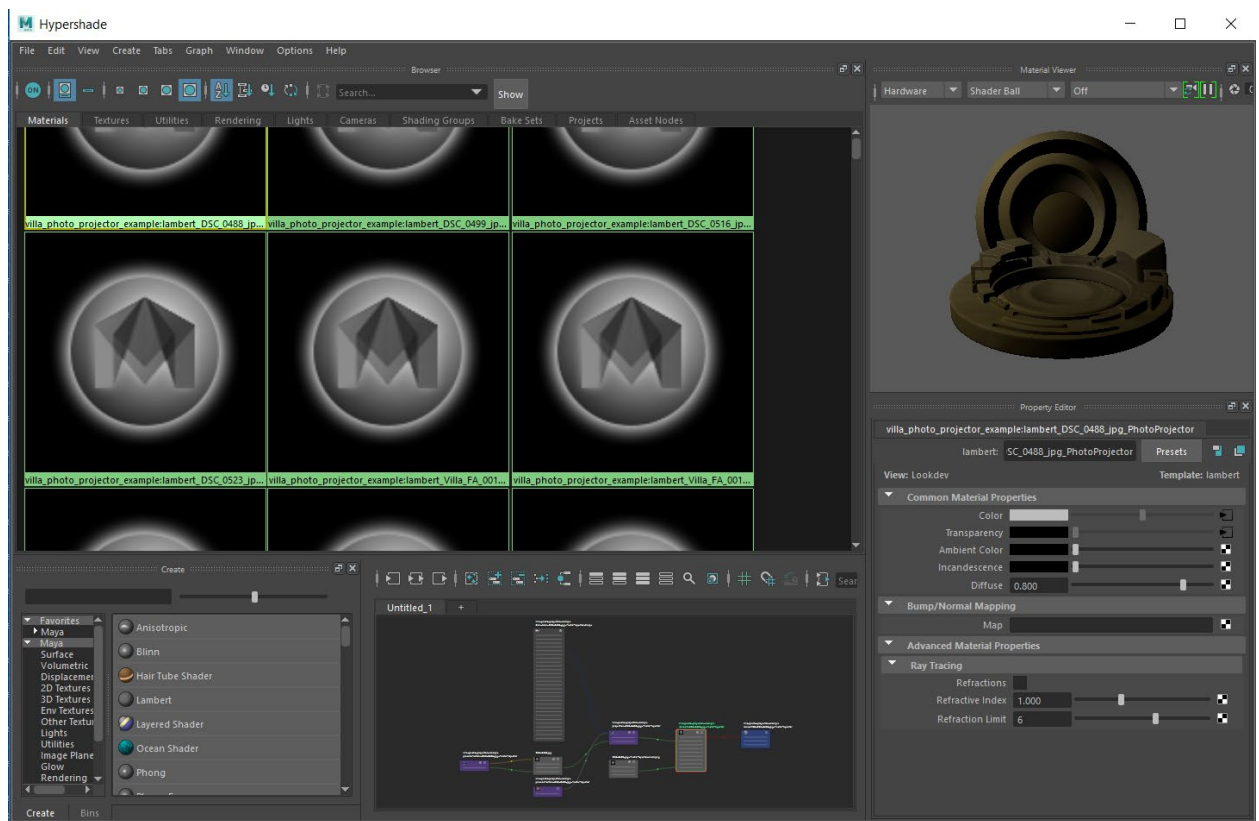


As a next step, we will assign the shader material that SCAN2FX Exporter created for the photo projector. SCAN2FX Exporter for Maya generates one shader per photo projector that allows to project the photo onto the mesh as texture.

The shader materials are listed under “Materials” in the Hypershade Editor and follow a similar naming convention. At the bottom Viewport, we can see the name of the camera we had picked earlier in white letters so now we can look up the according shader.

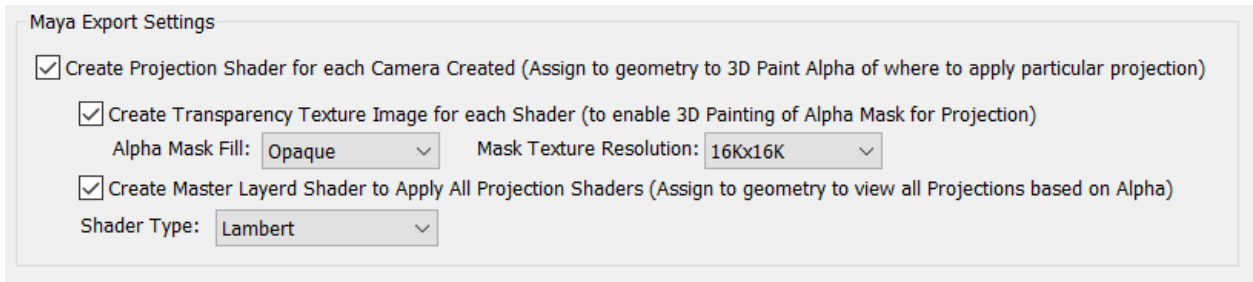
The shader in this example is called:

villa_photo_projector_example:lambert_DSC_0488_jpg_PhotoProjector. Again, you can see the name of the Maya .MA file we had exported from SCAN2FX Exporter, the name of the image used for the photo projector, and the keyword PhotoProjector to identify that this shader was a result of your work with SCAN2FX Photo Projector.



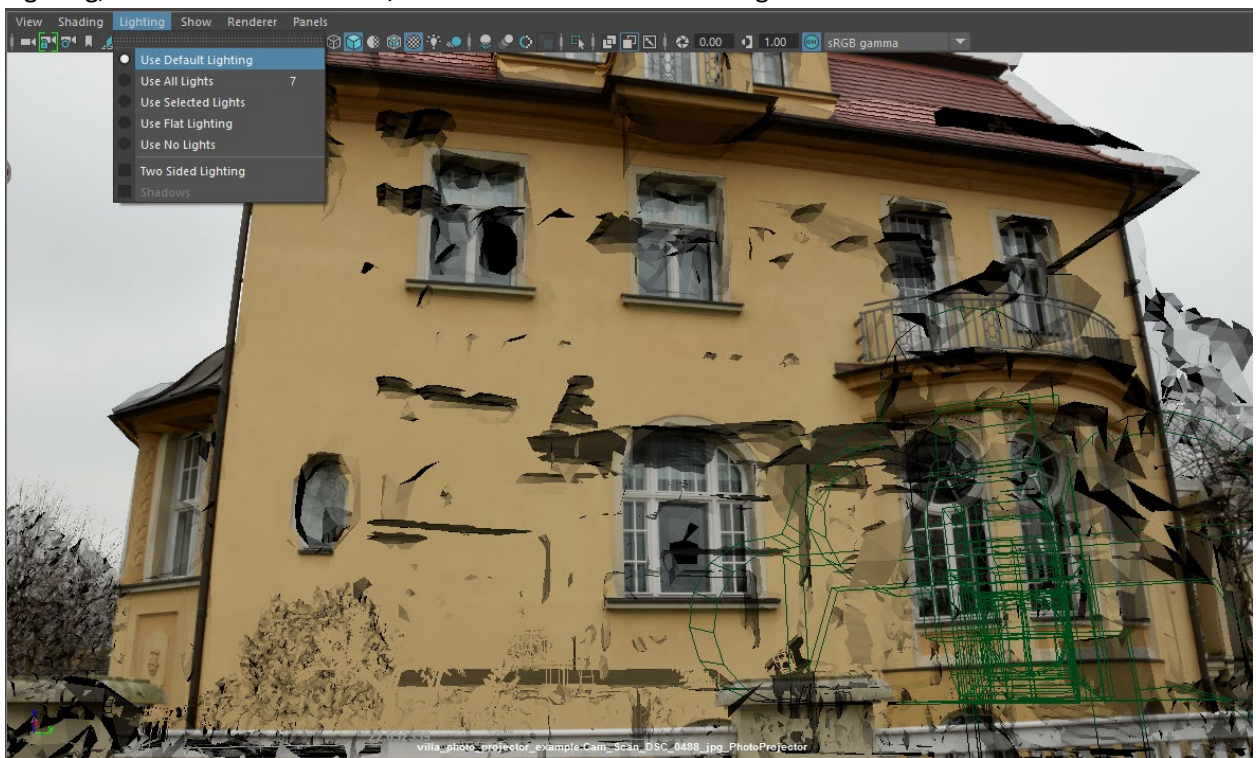
We assign the shader to the mesh by dragging it onto the mesh with the middle mouse button.

As “Create Transparency Texture Image for each Shader” was turned on in the SCAN2FX Exporter for Maya settings, SCAN2FX also automatically created a mask image file and assigned it to the transparency channel. This feature can be useful to immediately start 3D painting onto the transparency channel (e.g. to mask out portions where the photo should not get projected). Note that the mask will be either fully opaque or fully transparent depending on the SCAN2FX Exporter for Maya setting “Alpha Mask Fill.” Here are the settings as a reminder:

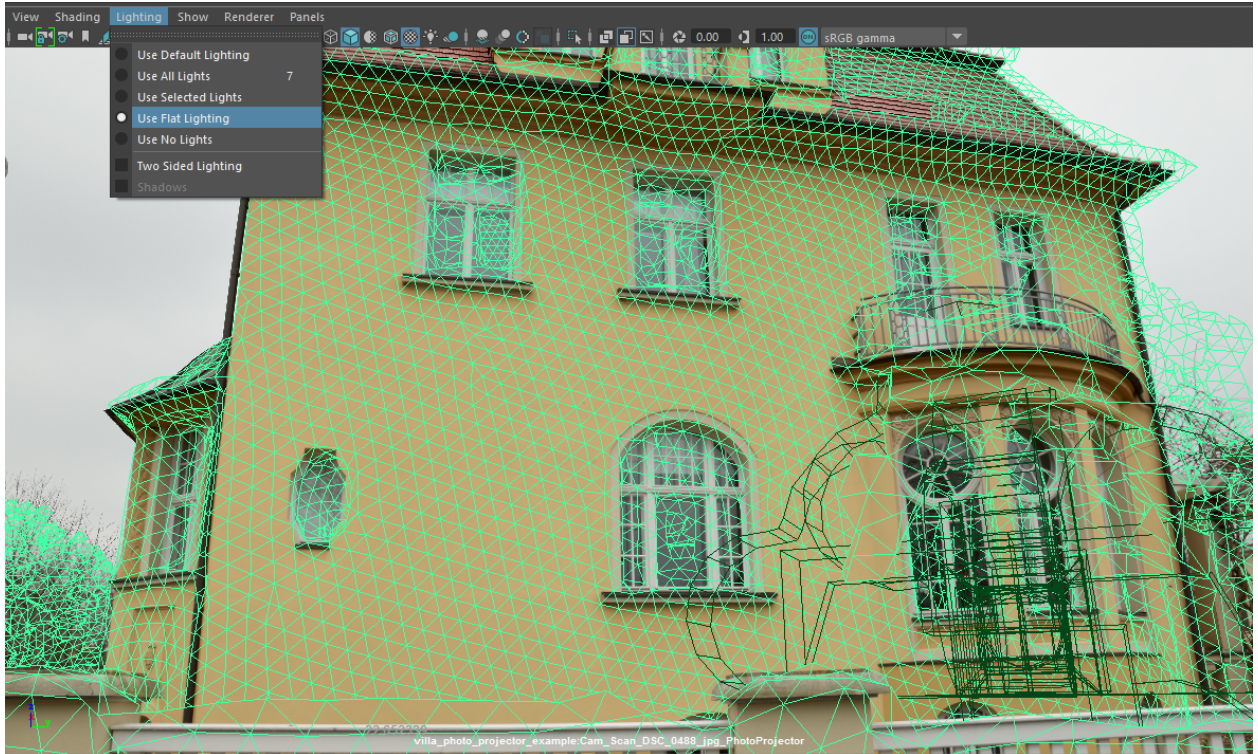


If you want to utilize 3D painting, make sure to set “Shader Type” to Lambert as “AI Standard” does not support 3D paint workflows yet as of Maya 2018.

With the shader assigned, we now see the photo projected on the mesh. With “Use Default Lighting,” we see certain darker / black areas due to the shading.



We now switch the lighting in the Maya Viewport to “**Use Flat Lighting,**” and the mesh almost becomes invisible against the image backplane. We have achieved a very good alignment and SCAN2FX Photo Projector computed the accurate 3D camera from where the photo of your 3D scene was taken.

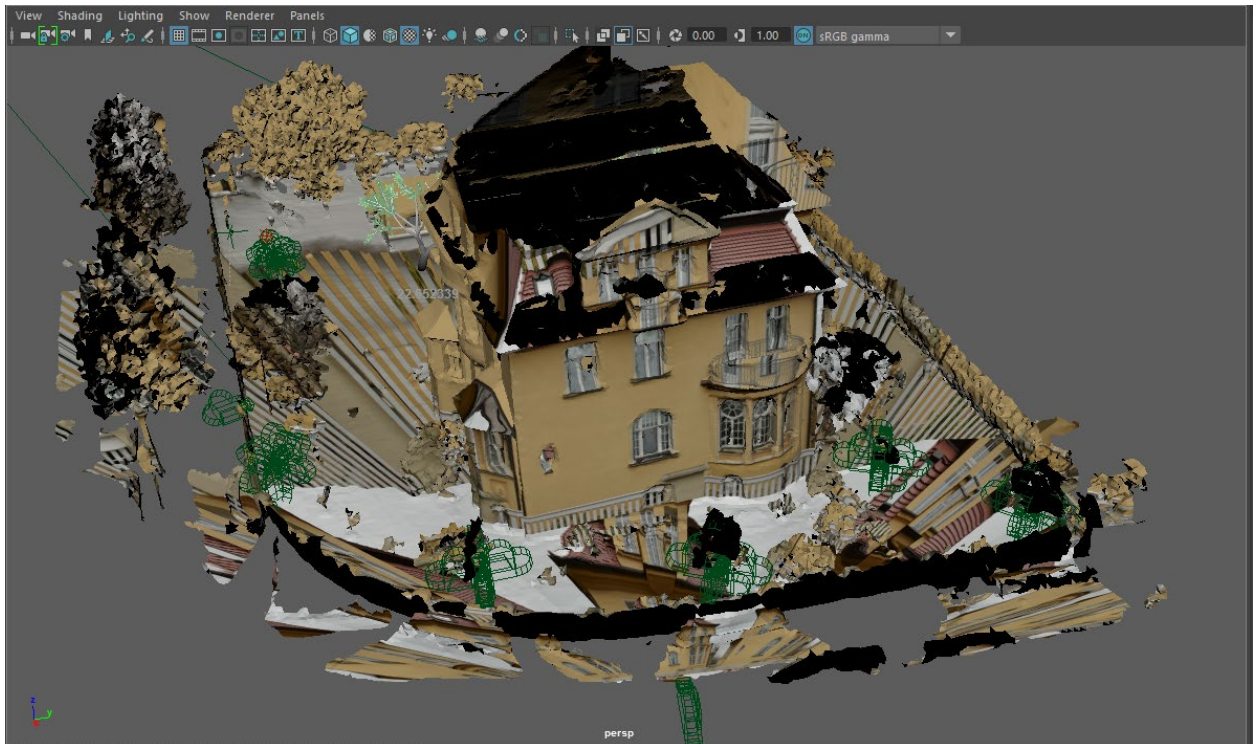


We selected the mesh so you can see the triangles overlaid.

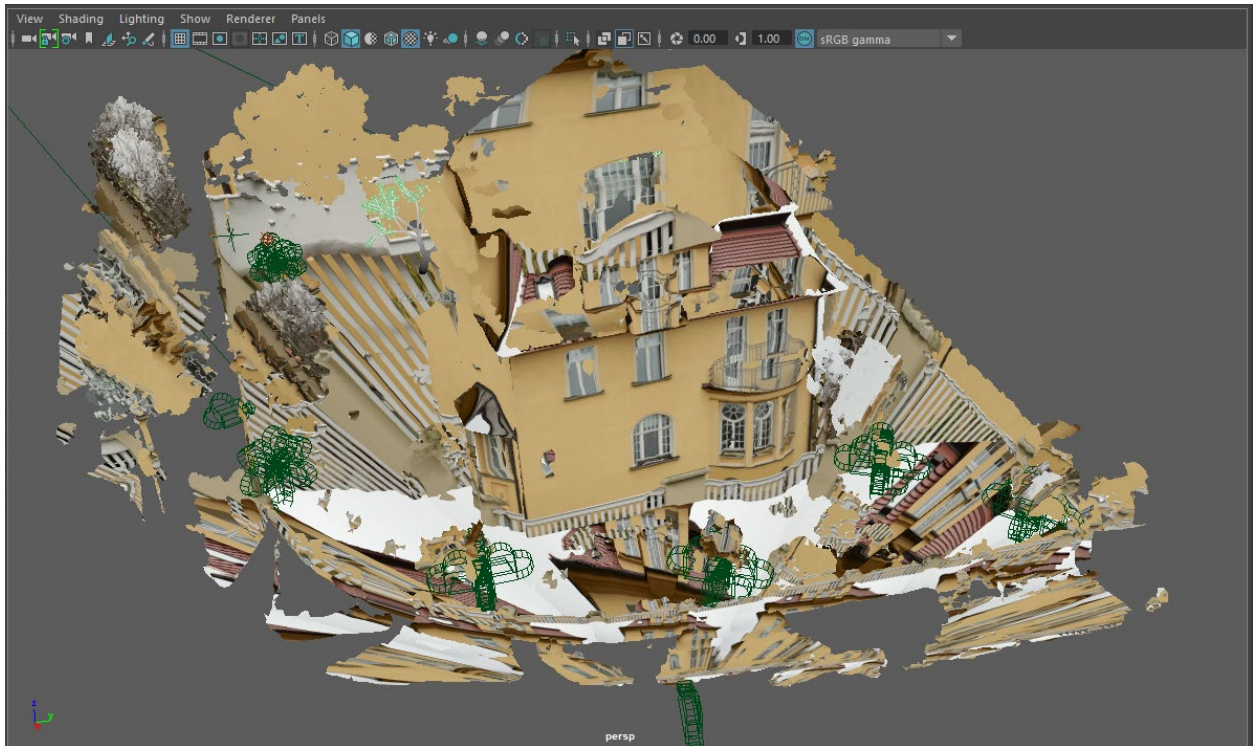
We will now switch to a different camera to see the mesh and texture from a different perspective.

We broke the transparency texture briefly to get a better view.

With Default Lighting:



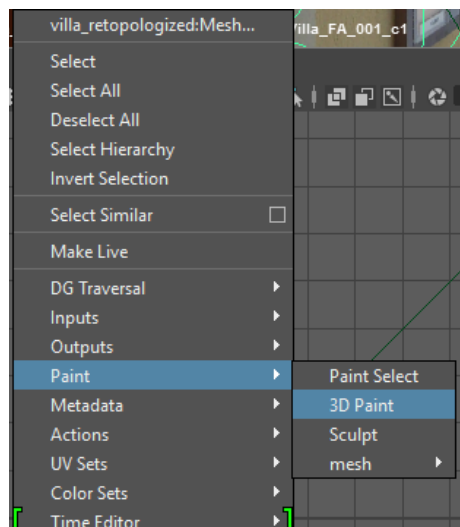
We will now switch to a different camera to see the mesh and texture from a different perspective.
With Flat Lighting:



You can see how the photos get projected literally “everywhere” on the mesh.

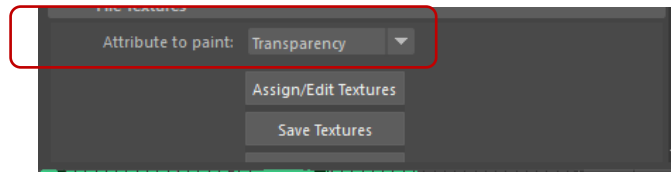
We can now utilize Maya’s 3D painting toolset (ensure the transparency mask is reconnected) to mask out the sections where we do not want Maya to project the photo.

Select the model and right click “3D Paint.” (Important: UVs need to have been generated by now – and without overlap!)



Important Note: Make sure to **not** assign the same material to more than one object! Otherwise Maya will show the following error when launching the 3D Paint tool (“// Warning: Some surfaces have no file texture assigned to the current attribute. //”) and 3D paint will not work.

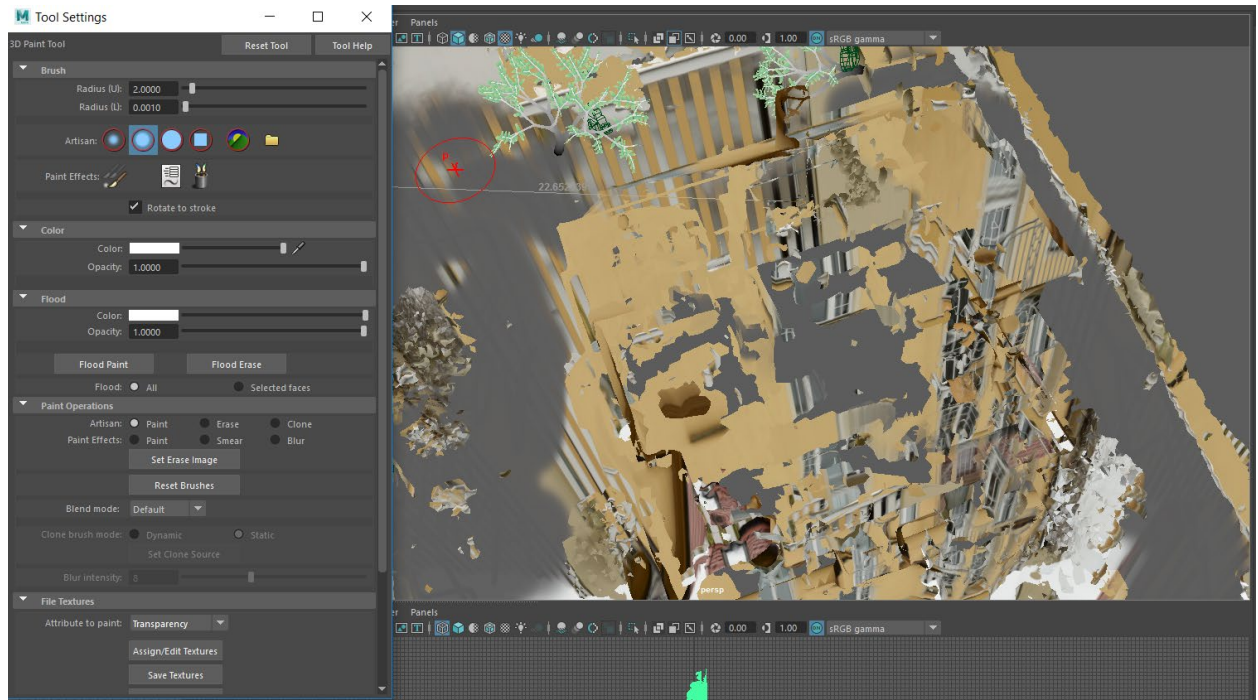
In the 3D Paint dialog box, first select “Transparency” as the Attribute to paint instead of Color (Note: if you created a transparency mask with SCAN2FX Exporter, this should work right away. Otherwise, you will have to manually create an image and configure a File node and 2D texture for transparency on your shader).



Also make sure to select “**Artisan**” to paint onto the texture under “Paint Operations” instead of “Paint Effects.”

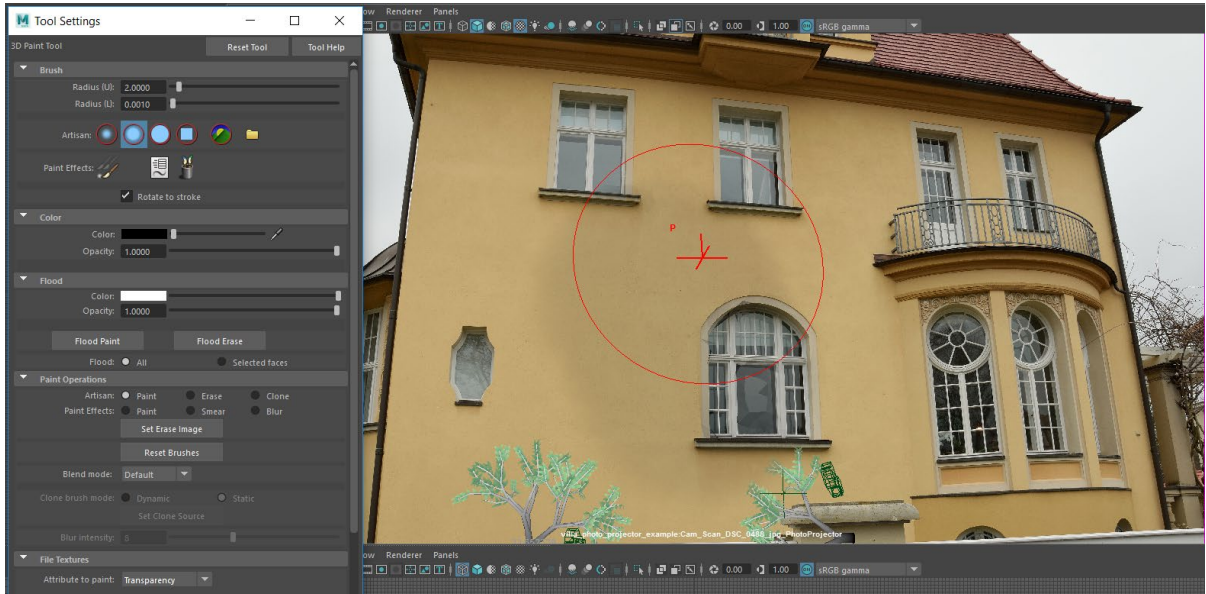
Tip: If the object is still selected, you may want to turn “Selection Highlighting” off in your Maya Viewport under the “Show” menu.

Pick white as “Color” and pick an appropriate “Brush Scale”, you now can paint in 3D onto your mesh and you’ll see the projection disappear where not desired. For your Maya Viewport, make sure to set lighting to “Flat” (to get the original lighting and colors) and to turn “Hardware Texturing” to On under Shading.

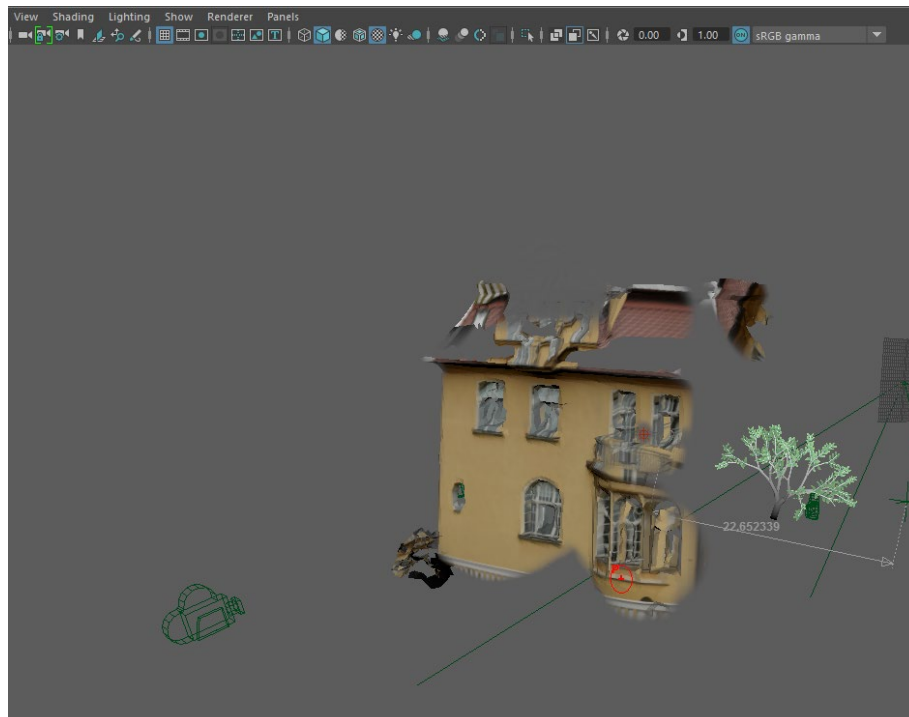


Alternatively, you can invert the process and “Float Paint” the transparency mask with white and paint in only the sections you want to project by using a black brush.

One useful technique for this process is to look through the relevant camera in the Viewport. Turn lighting to “Use Default Lighting,” and your painted area will appear slightly darker than the image backplane. We are starting to paint in the best parts of the photo that we want to use as texture:



We switch the camera perspective again, and now can see that only the portions where the photo captures the best “texture” are applied. The rest is masked out. The projection camera is visible in green on the left bottom of the screen.



You can now start building up your texture further by layering multiple projections. Or also combining the result with a baseline texture from the separately available SCAN2FX Texture or the projections from your scan panoramas that you may have generated during your export.

Note: if you run out of GPU memory with too many textures, either delete some of the projectors or shader materials you do not need as Maya may have loaded them into your GPU memory, or clamp your texture in the Viewport 2.0 settings. Under Maximum Texture Resolution Clamping in the Viewport 2.0 settings, you can enable Clamp Texture Resolution and reduce the Max Texture Resolution.

For additional instructions and tips & tricks how to best utilize the SCAN2FX data within Autodesk Maya, check out the SCAN2FX Exporter for Maya manual for additional instructions.

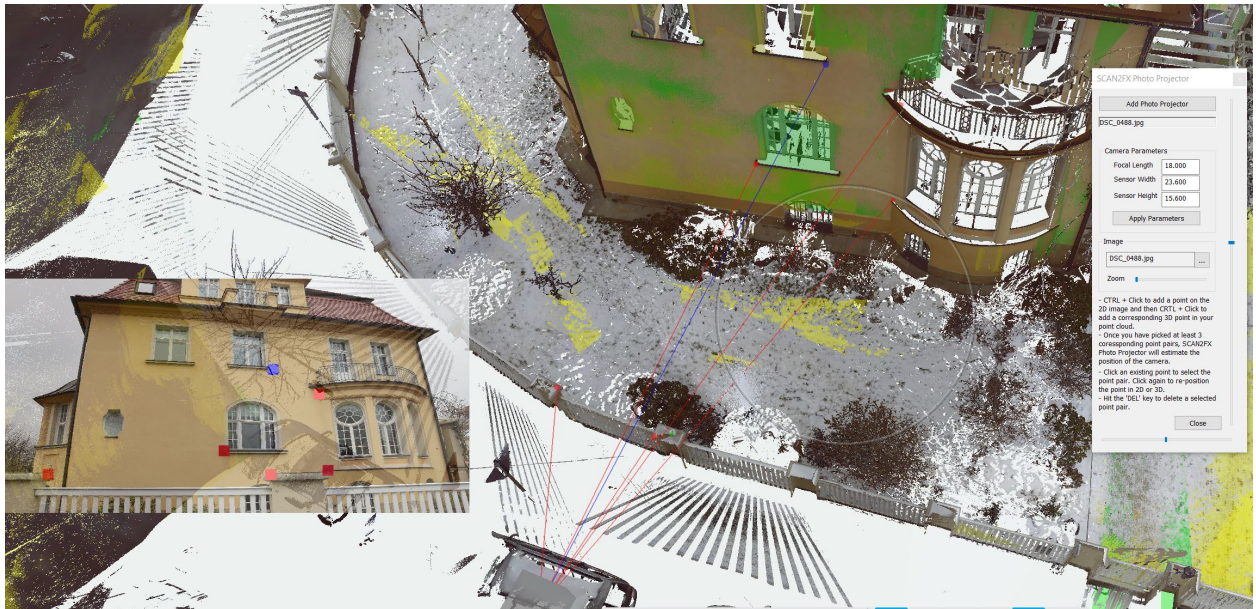
Tip: Please note that **Maya also can export the cameras in other formats** such as FBX for import into other 3D software so you can use the computed cameras in other parts of your pipeline. You could also utilize this workflow to reconstruct the position of a person that took a photo of a scene (e.g. for forensic applications).

7. Tips and best practices for working with the data from SCAN2FX Photo Projector

Capturing photos to resolve problems with the scan

In the below scene, during the laser scanning, a car was parked. Now while it is easy to delete the according 3D point cloud or mesh from the scene. Restoring image data behind a vehicle is not trivial.

However, you can later come back or have somebody else take one more photo of the building without the car. This photo can then be used to texture in that section of your scene.



7.2 Time of day change

Another application may be to scan during one time of the day and then take photos during another time of day or even season. As you may have noticed, the example villa in the photos was scanned in winter with snow on the grounds. While the photos, were taking at a different time without snow. This can be a useful technique especially with restrictions in schedule.

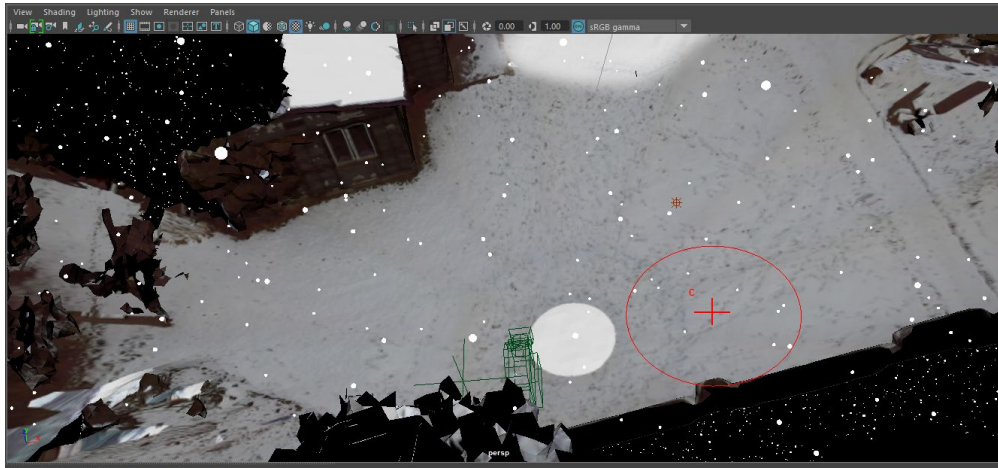
Taking additional photos or panoramas can be done with any standard DSLR camera without the need to have the more sophisticated and costly laser scanning equipment on site during the photo capture.

7.3 Filling in texture holes and scan bottoms

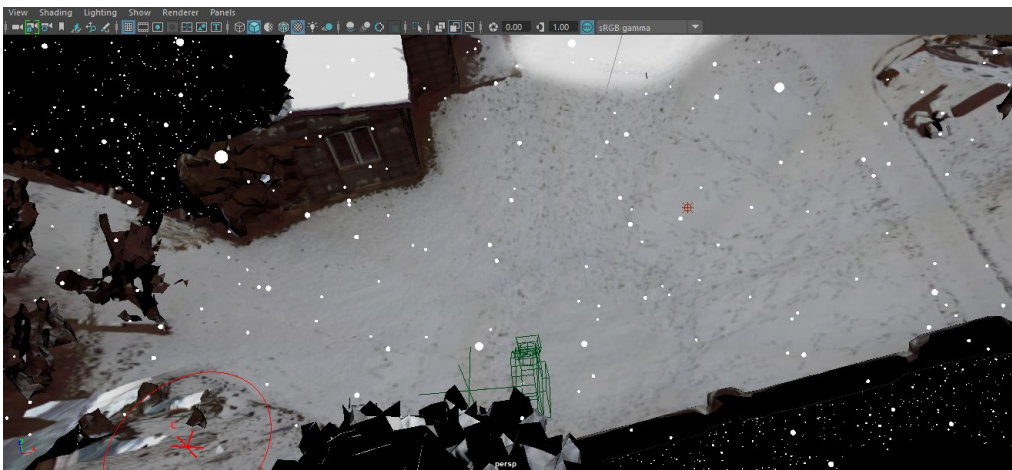
The cameras computed with Photo Projector can also be utilized to fill in holes in a texture.

For example, scan bottoms are a frequent problem and taking an additional photo of the ground where a scanner stood is very simple to do. You may want to pay special attention to exposures and changes in lighting, but a 3D paint application can help with blending in the photos with the texture generated with the scan panoramas.

Here is an example where a scan bottom gets painted in with a clone brush in a 3D paint module.



After painting in the “scan bottom” with the clone brush in Maya, it looks as follows:



7.4 Making the most of SCAN2FX by utilizing the full suite of SCAN2FX modules

SCAN2FX Exporter also exports the cameras and panoramas from the scanner that can then be used for texturing or even for modeling (e.g. with Maya).

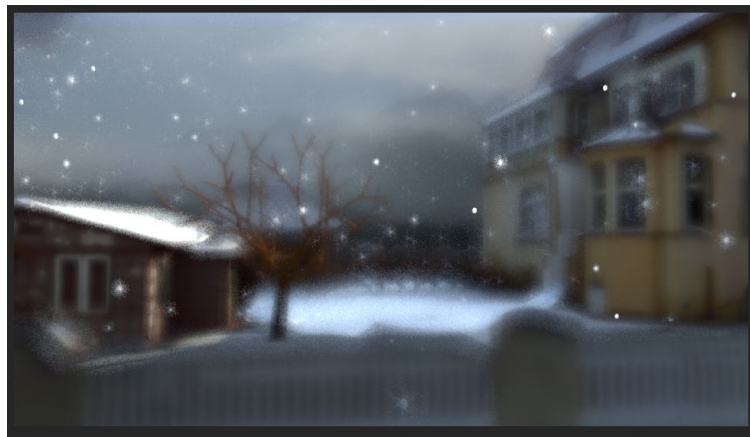
SCAN2FX Texture offers a more automated way to generate a baseline texture for your mesh from the panorama scans. The photos and cameras computed with SCAN2FX Photo Projector can add additional detail on top of the baseline texture generated with SCAN2FX Texture where needed.

Contact us today at sales@scan2fx.com to inquire about upgrading to the full SCAN2FX suite.

7.5 Utilize rendering engines to get most out of your textured mesh

Textured meshes open the world of many 3D rendering engines such as Arnold, Mentalray, Octane, Renderman, V-Ray, Renderman, or even Unreal Engine or Unity for real-time visualizations and games.

Lighting effects can be applied, or backgrounds replaced.



NEW with Release 3.1

7.6 Speed-up scanning by utilizing DSLR camera for coloring

Depending on your scanner model, especially HDR scans can take extra time, so some professionals have utilized separate DSLR photo panoramas to color scans or for texturing. SCAN2FX Photo Projectors enables the alignment of such photo panoramas to your 3D point cloud, as well as of individual photos.

So, if desired, you can load an EXR panorama stitched together with typical panorama stitching software, pick the points and then export that panorama camera for texturing. All this can be done without needing overlapping photos, and you could scan without color for maximum speed.

NEW with Release 3.1

7.7 Utilizing maximum quality HDR photography

SCAN2FX contains native support for 32-bit EXR, enabling a very high quality HDR workflow for texturing from photos and panoramas if desired.

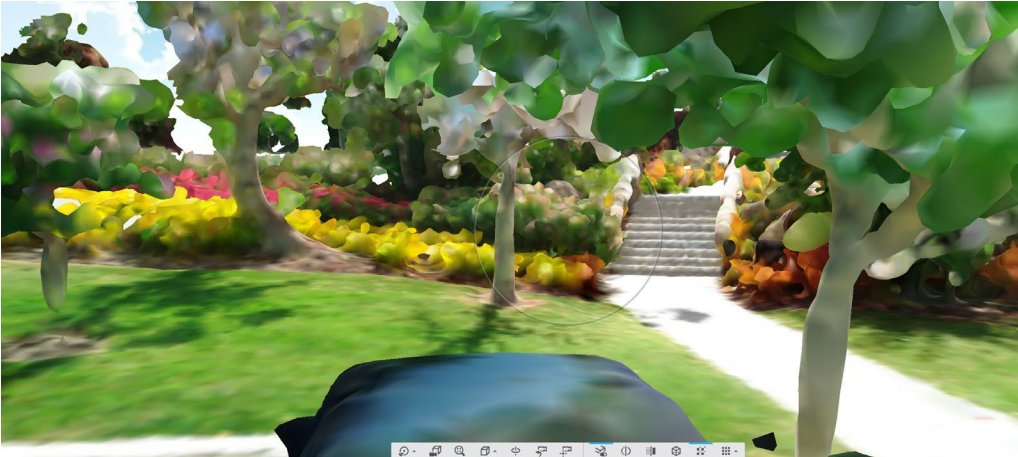
While with the latest generation of scanners, SCAN2FX's Texture and Exporter modules have unprecedented access to high resolution color data -- only available with SCAN2FX. However, 32-bit EXR photos can offer potential additional quality when needed.

8. Quality Achievable with SCAN2FX

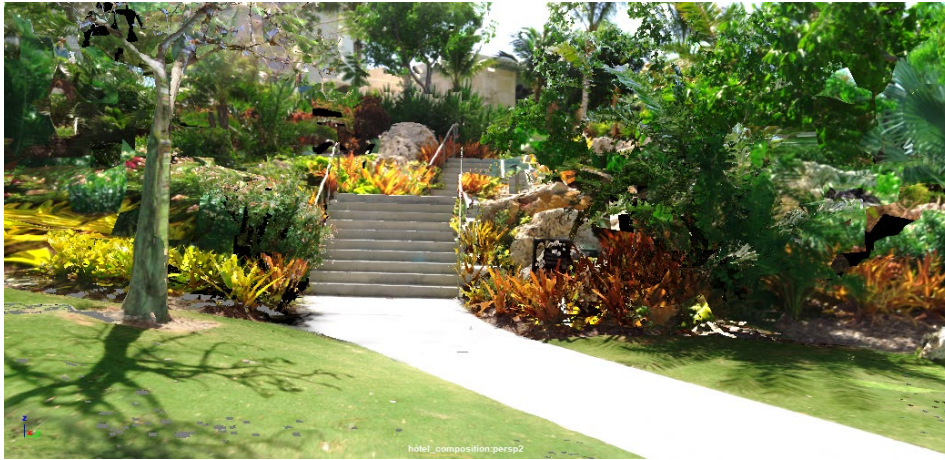
When you import a mesh from SCENE, many 3D applications (such as Mari or Maya) will not show any colors normally. SCENE only colors the vertices and does not generate textures when creating a mesh.

With SCAN2FX Photo Projector, you can align your photos in 3D with your 3D point cloud or mesh.

As a comparison, you see here the same mesh with vertex coloring in SCENE:



And then here the same mesh with textures applied in Maya generated with SCAN2FX (Viewport 2.0 preview):



A renderer can add additional effects such as depth of field, and lighting simulations:



NEW with Release 3.2

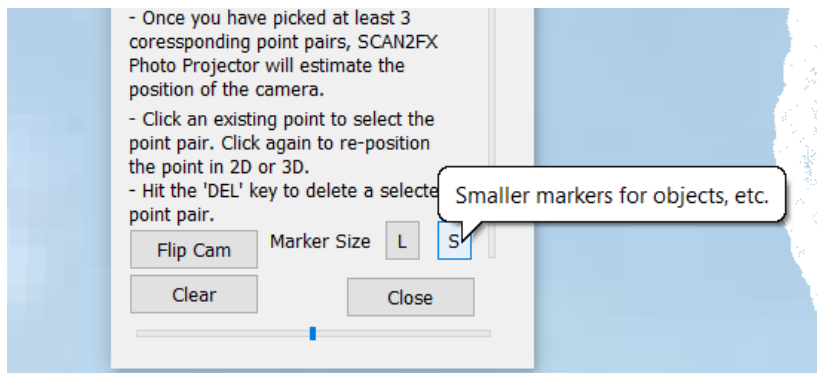
9. Aligning Photos to Objects or Small Items

With Version 3.1, SCAN2FX Photo Projector offers additional settings to make it easier to align photos to smaller objects.

You can import data from other handheld scanners as E57 into SCENE. In some cases, you may want to double check the scale and re-scale your point cloud. For example, Faro uses meter as units. While, some other popular handheld scanners may use centimeter as units, so you need to scale down the E57 point cloud before importing into SCENE.

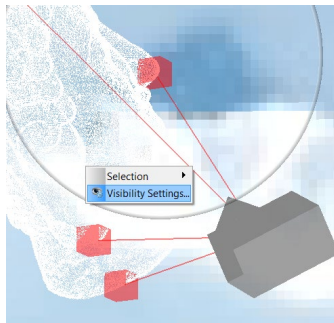
The upcoming **SCAN2FX Depth Fixer** module will also provide an **option to import OBJ meshes straight** into SCENE (with or without color texture), computing a colored point cloud automatically from the mesh. This workflow then enables to align high resolution photos of your object with SCAN2FX Photo Projector, without having to generate an E57.

Once you have your object imported into SCENE, click the “S” button for small Marker Size in the SCAN2FX Photo Projector tool. This option will alter the 3D marker and camera visualization to make it easier to work with smaller scale objects instead of the typical large-scale scans.

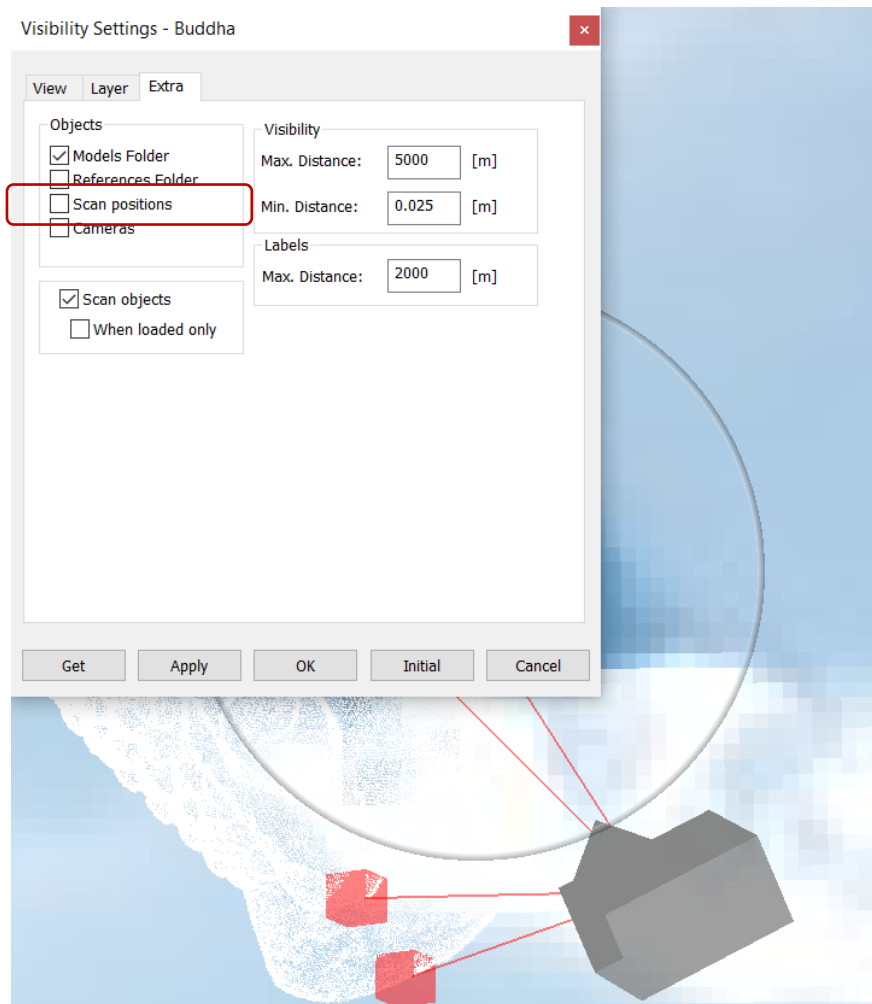


If you want to later switch back to the standard, large marker mode, simply click “L.”

You may also want to turn off the scanner icon as it may make it hard to see your object if it small. Right Click onto your 3D view, then click “Visibility Settings...”

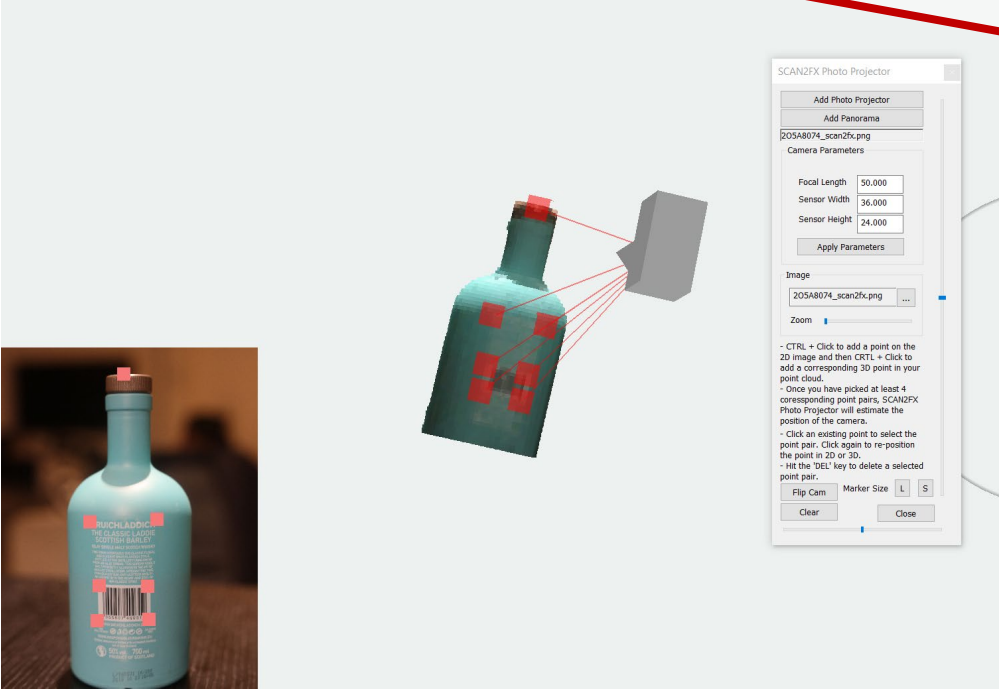


Turn off the checkbox right of “Scan positions” and click OK. The scanner icon will disappear, allowing for unobstructed display of the object’s point cloud.



An example of a mesh scanned with a handheld scanner with poor textures follows on the next page. With SCAN2FX Photo Projector, we can now 3D align photos taken with a DSLR.

EXAMPLE with Release 3.4

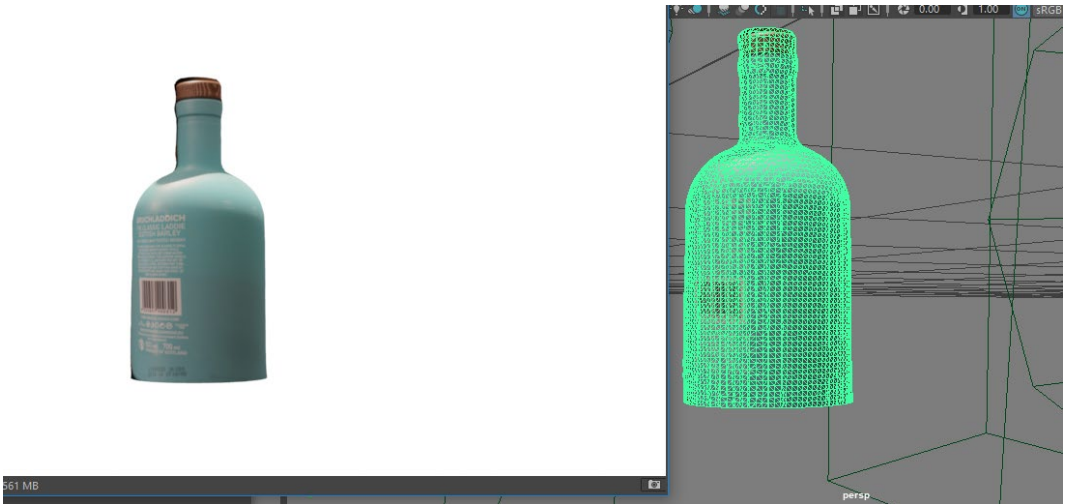


Exporting the cameras with one of the SCAN2FX Exporters, enables projecting the photos onto the mesh as a texture.

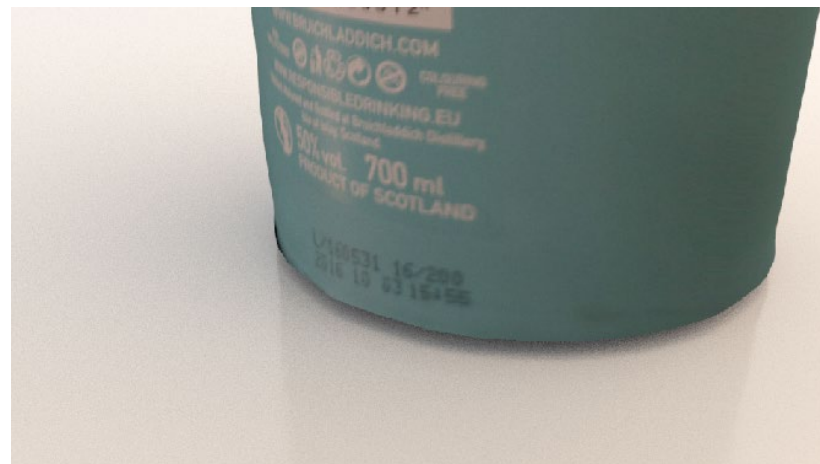
NEW with Release 3.5

Alternatively, you could also automatically texture your mesh with **SCAN2FX Texture** to obtain a textured OBJ mesh, utilizing any photos or panoramas that were aligned earlier.

Here, we utilize the optional SCAN2FX Exporter for Maya, and simply drop the shader for the camera onto the mesh in Maya. 3D painting onto the transparency layer can be used to adjust where which photo gets applied as texture. Also, a Layered Shader can then be utilized to superimpose other camera projections onto the same mesh:

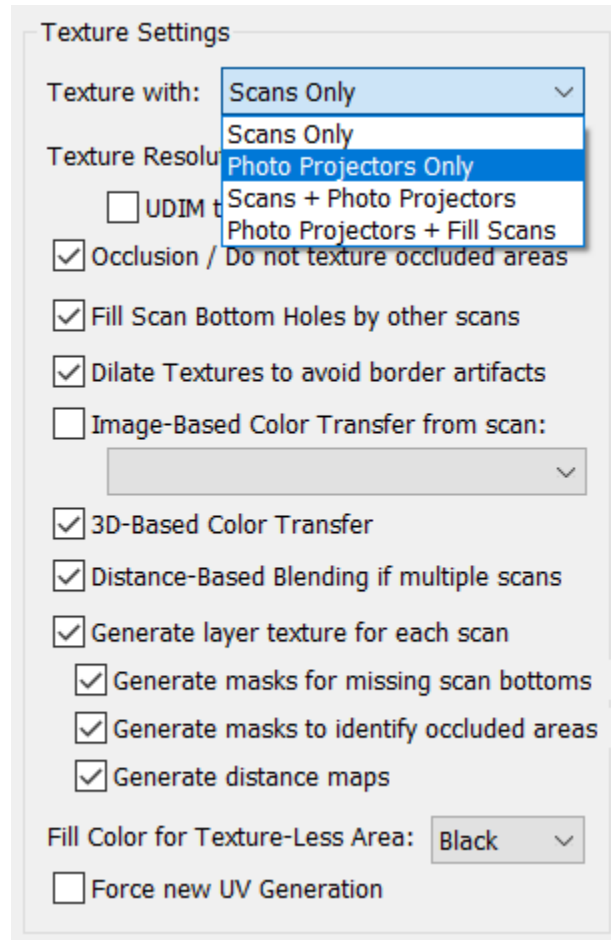


Given the high resolution of the DSLR photos and the close-up perspective of the photos, even small details such as the bottle's barcode become legible:



10. Texturing Meshes and Colorizing Point Clouds with Photos

With the optional **SCAN2FX Texture** module, the photo projectors can also be used for texturing starting with Version 3.500. Under “Texture Settings” / “Texture with:,” make sure to choose one of the options that includes Photo Projectors.



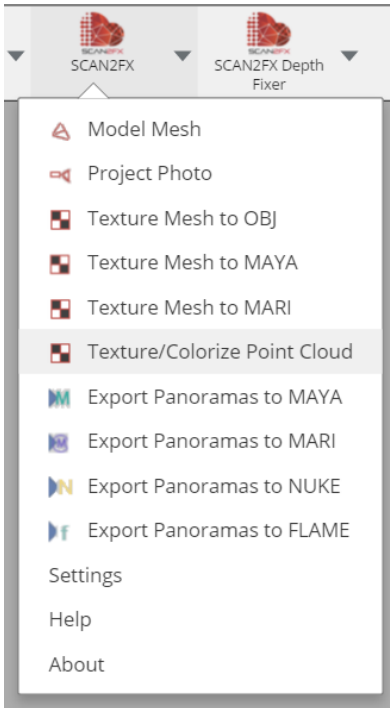
The **Photo Projectors Only** option will texture the mesh or colorize the point cloud only with the aligned photo projectors. This mode allows to completely replace the surface color with new photos (e.g. daylight photos for a scene that was scanned at night). This mode can also be handy for fast, grayscale scans to add high quality photo imagery e.g. from a DSLR.

The **Scans + Photo Projectors** option will equally utilize scan panoramas and photo projectors. This mode allows to cover additional areas that maybe were not scanned or add additional detail with close-up photos where the scanner was far away or could not reach an area.

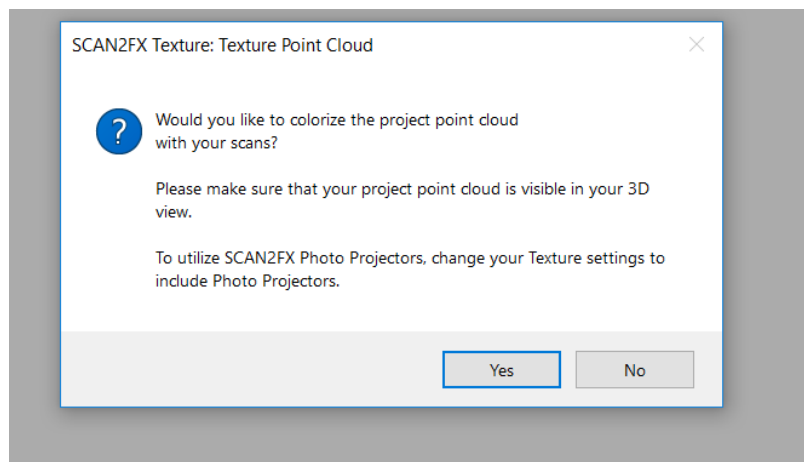
The **Photo Projectors + Fill Scans** option will always prefer the photos and then only use scans to fill any gaps on the mesh that were not covered by photos or panoramas aligned with Photo Projector. This will give you the high quality of your photos, but still enable to achieve the best coverage possible of your mesh when creating the texture.

Starting with SCAN2FX Photo Projector and SCAN2FX Texture 3.6, SCAN2FX Texture also enables to colorize a project point cloud.

To colorize the project point cloud, simply click “Texture/Colorize Point Cloud” in the menu (requires a SCAN2FX Texture subscription).



To confirm, click “Yes” in the dialogue. If you want SCAN2FX Texture to utilize the Photo Projectors with your photos for point cloud colorization, please make sure to set “Texture with:” in the settings to a setting including Photo Projectors. SCAN2FX Texture will utilize all Photo Projectors in your scene to colorize the project point cloud then.



Note: If you have converted or imported fill with SCAN2FX Depth Fixer, make sure those imported scans were a) processed, and b) a new project point cloud was generated to include these fill point clouds (make sure to delete the existing project point cloud before creating a new one).

11. Known Limitations or Considerations

11.1 FARO® SCENE Version

SCAN2FX Photo Projector has only been tested and qualified with FARO® SCENE 2019 and SCENE LT 2019.

Please email support@scan2fx.com if you think you may have identified an issue as we would love to hear from you.

11.2 Camera Parameters

You will need to pay proper attention to the camera parameters in order to achieve adequate results with SCAN2FX Photo Projector. Especially, make sure to look up the sensor width and height for your precise camera model. And record the focal length used during photo capture. Otherwise, the estimated camera poses can be greatly off.

NEW with Release 3.1

SCAN2FX Photo Projector can also read out the camera parameters automatically from JPEG images.

For 360x180 panoramas, SCAN2FX Photo Projector does not need you to enter camera parameters.

11.3 Distortion

SCAN2FX Photo Projector does not consider distortion. When taking photos, make sure to use a lens without or very minimal distortion at most (no fisheye lenses or panorama images). Or alternatively, if you have already computed a 360x180 panorama, you should not have any issues with distortions either.

11.4 Computation Time

The estimated camera pose gets computed as soon as you have added four valid point pairs to a photo projector. Add additional points as needed. Camera positions get computed in near real-time. However, the export with SCAN2FX Exporter may take a while depending on the number of scans and photo projectors in your scene.

11.5 Older Versions of Windows

During our testing, the SCAN2FX suite has been mainly used on Windows 10. There may be certain issues or layout problems under previous versions of Windows we may be unaware of. We have decided to focus our development on the most current versions of software and operating systems instead, so we can get more functionality implemented faster rather than trying to test with too many versions or older operating systems.

11.6 Internet Connection Requirement for Licensing

If you intend to use SCAN2FX without Internet connection, please authorize SCAN2FX when connected to the Internet and keep FARO® SCENE open. Please note that SCAN2FX will authorize all previously entered licenses on each application start. If SCAN2FX licensing servers are not reachable at the time of authorization, SCAN2FX will disable the according SCAN2FX menus.

11.7 Subscription-based Licenses

Please note that all licenses in SCAN2FX are subscription-based, i.e. they will expire after your service term and a renewal subscription needs to be purchased to continue using SCAN2FX. When a licensing key gets entered the first time in SCAN2FX, this particular license key will be node-locked to the particular hardware and cannot be reused on another machine.

11.8 Significant Changes in Hardware / No Transferability of License

Licenses are not transferable and once associated with a particular computer hardware are not transferable. Unfortunately, in some case where you purchase a new computer or change computers you may have to purchase a new subscription early while not getting a discount for the existing subscription. We hope you appreciate this policy and limitation in order to protect our work and intellectual property, and at the same time by purchasing your subscription you enable us to better support you and also to continue development of the SCAN2FX plug-in applications and modules for FARO® SCENE. Laser scanning add-on software is a small, highly specialized market as of now, and we need sufficient revenue to keep innovating and provide additional solutions.

11.9 Other Issues or Needs

If you have ideas for, or need particular solutions or enhancements, feel free to email us at sales@scan2fx.com to discuss options on how to support your business. We would love to hear from you.

12. Support & Training

If you have **questions or feedback**, please email us at support@scan2fx.com. Or contact us via our website at <http://scan2fx.com/?id=contact>. Additional premium support may be available at an extra cost.

If you have **additional requirements or special projects** you would like us to support, please contact us at sales@scan2fx.com with your requirements to discuss a possible collaboration and pricing.

To request a quote for **training**, please contact us at sales@scan2fx.com with your requirements and/or training needs for yourself or your team.

support@scan2fx.com