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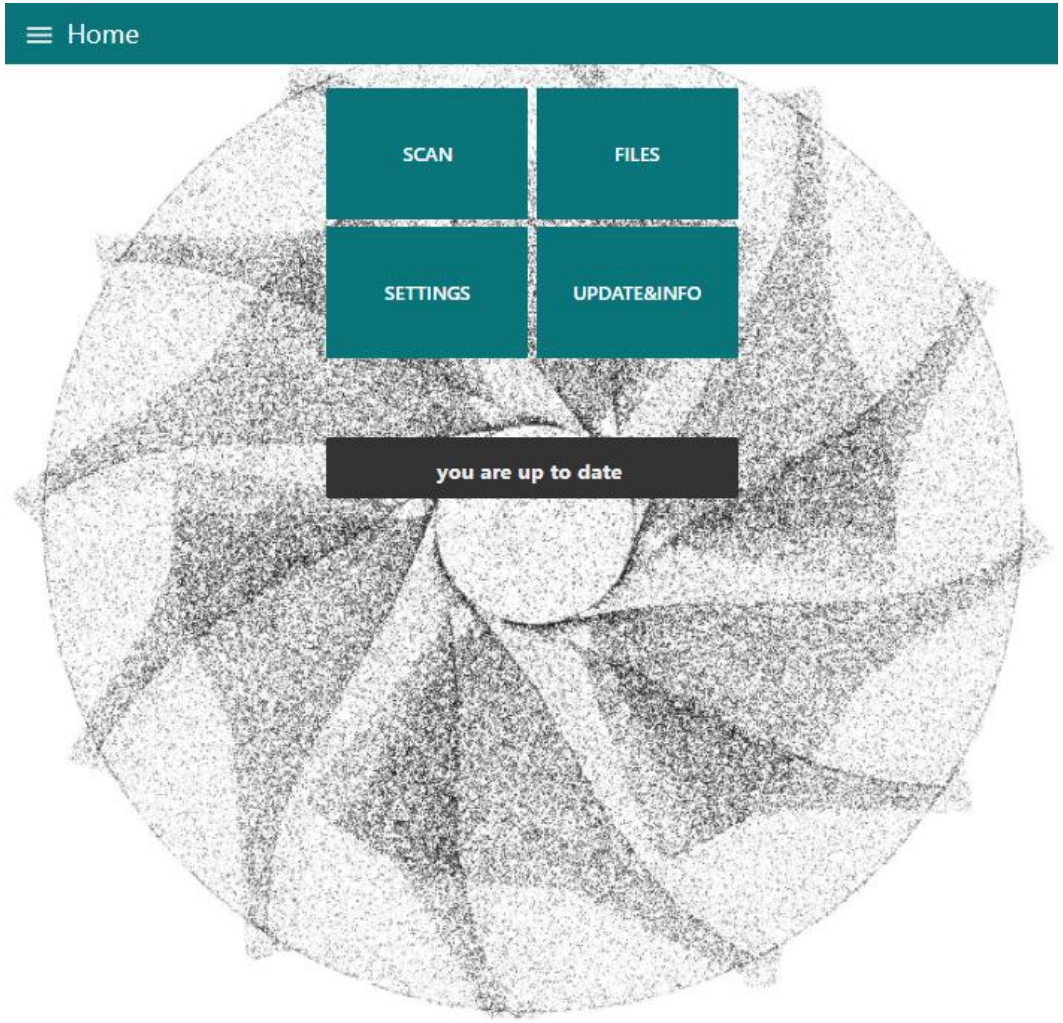


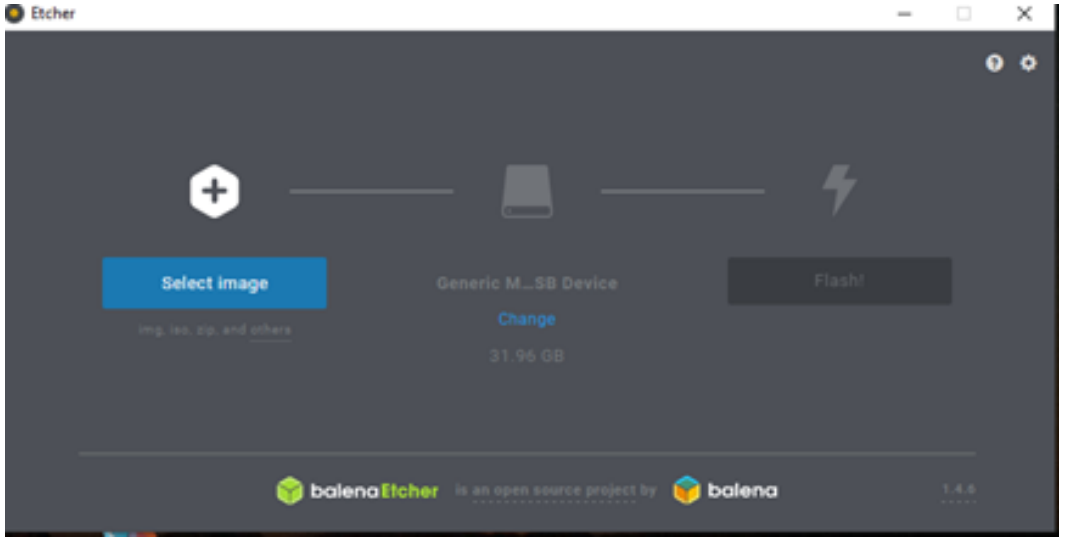
OPENSCAN

GETTING STARTED – SET UP THE RASPBERRY PI

In case you have bought the SD-Card from the OpenScan.eu shop, you can skip this step :)

In any other case:

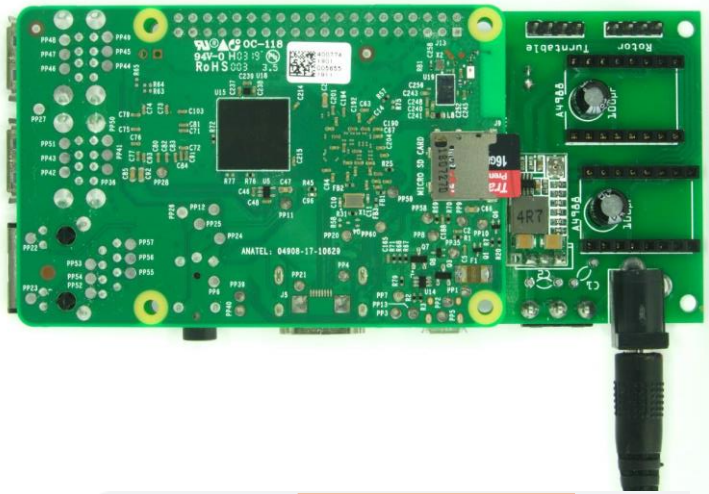
- Use a Micro SD Card with at least 16GB
- Download and Install Belena Etcher www.belena.io

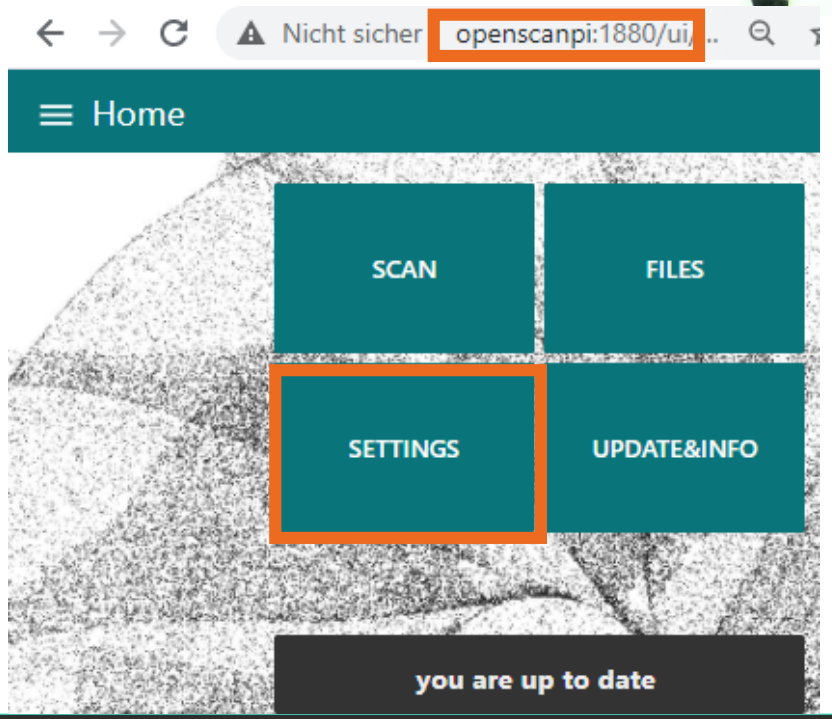


- Download the current OpenScan image from www.openscan.eu/ and flash the image file to the SD Card with Belena Etcher (this will format and delete all previous files on the SD Card)

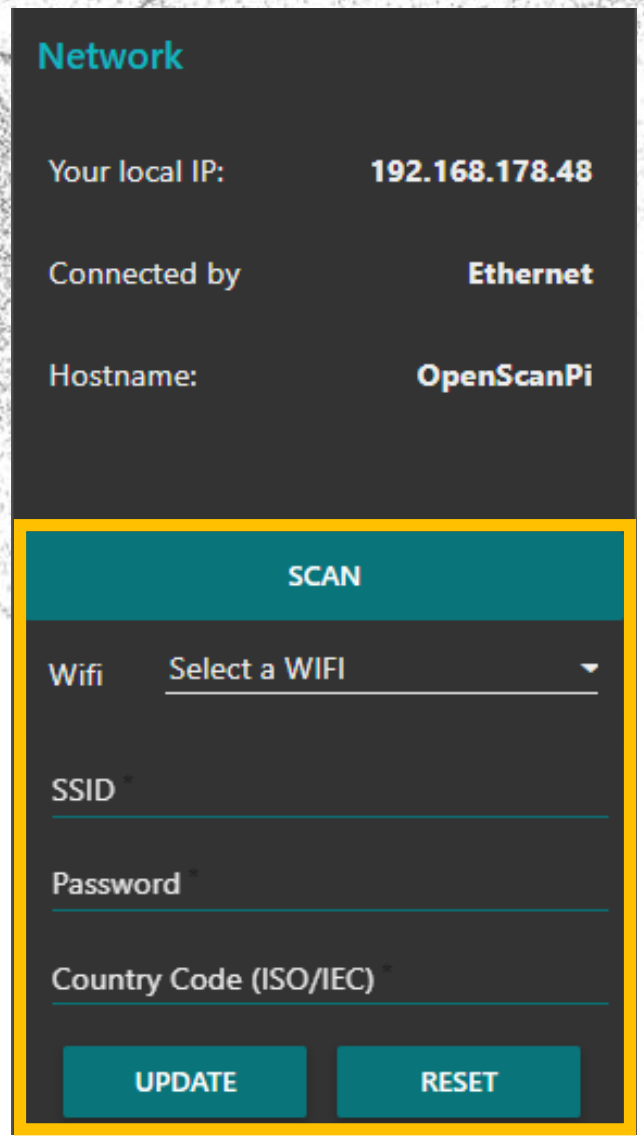
GETTING STARTED – SET UP NETWORK CONNECTION 1

- IMPORTANT: In case you can not connect the Raspberry Pi to your router via Ethernet (needed for setup only), you will have to add your Wifi credentials to the *wpa_supplicant.conf* in the boot directory of the SD Card and skip the rest of this page.
- Insert the SD Card to your Raspberry Pi
- Connect the Raspberry Pi via Ethernet to your router and connect the Raspberry Pi to a power supply (either Micro USB/USB C, or via the OpenScan Pi Shield – *see right*)
- Go to a PC/Tablet/Smartphone, which is connected to the same network and open the following address ***openscanpi:1880/ui***
- It might take up to 5min for your pi to boot for the very first time
- Once the page is loaded click on *Settings.*

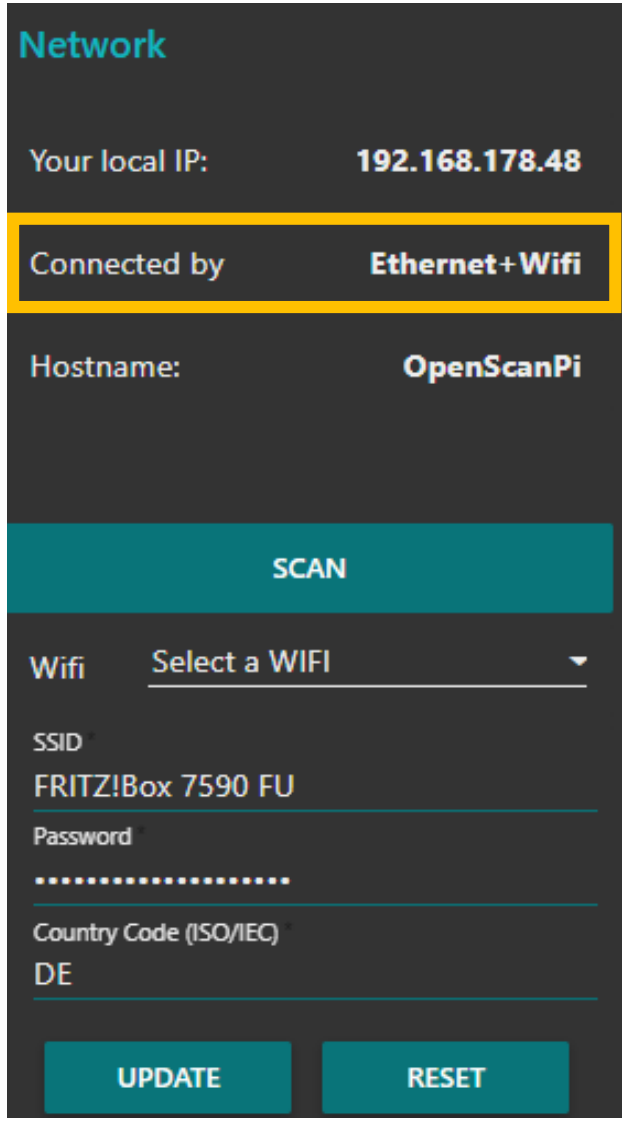




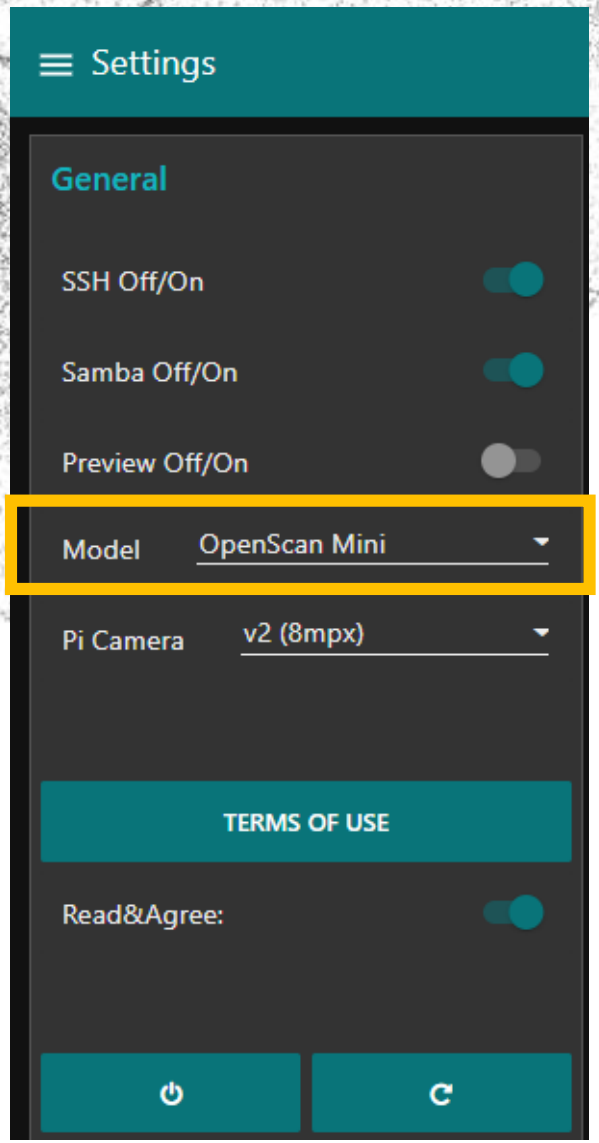
GETTING STARTED – SET UP NETWORK CONNECTION 2



- *SCAN* for Wifi connections and wait 5-10s
- Select your Wifi
- Enter your Network Password and Country Code
- *DE-Germany, GB-Great Britain, US-United States OA, AT-Austria, CH-Switzerland, FR-France … see Wiki ISO_3166-1_alpha-2*
- IMPORTANT: Currently it is only possible to add ONE Wifi via the interface. The updated Wifi will overwrite and thus delete any prior Wifi connection. In case you need multiple Wifi connections, you need to use the command line interface or modify the *wpa_supplicant.conf* accordingly.
- confirm with *UPDATE*
- After 10-60s and a browser refresh, you should be able to see *Ethernet+Wifi* connection



GETTING STARTED – CHOOSE YOUR MODEL



It is necessary to choose the hardware used, which will set some specific parameters (Motor steps per rotation, acceleration, image orientation...)

Currently there are three options:

(1) OpenScan Mini (with Pi Camera)

(2) OpenScan Classic (with Pi Camera)

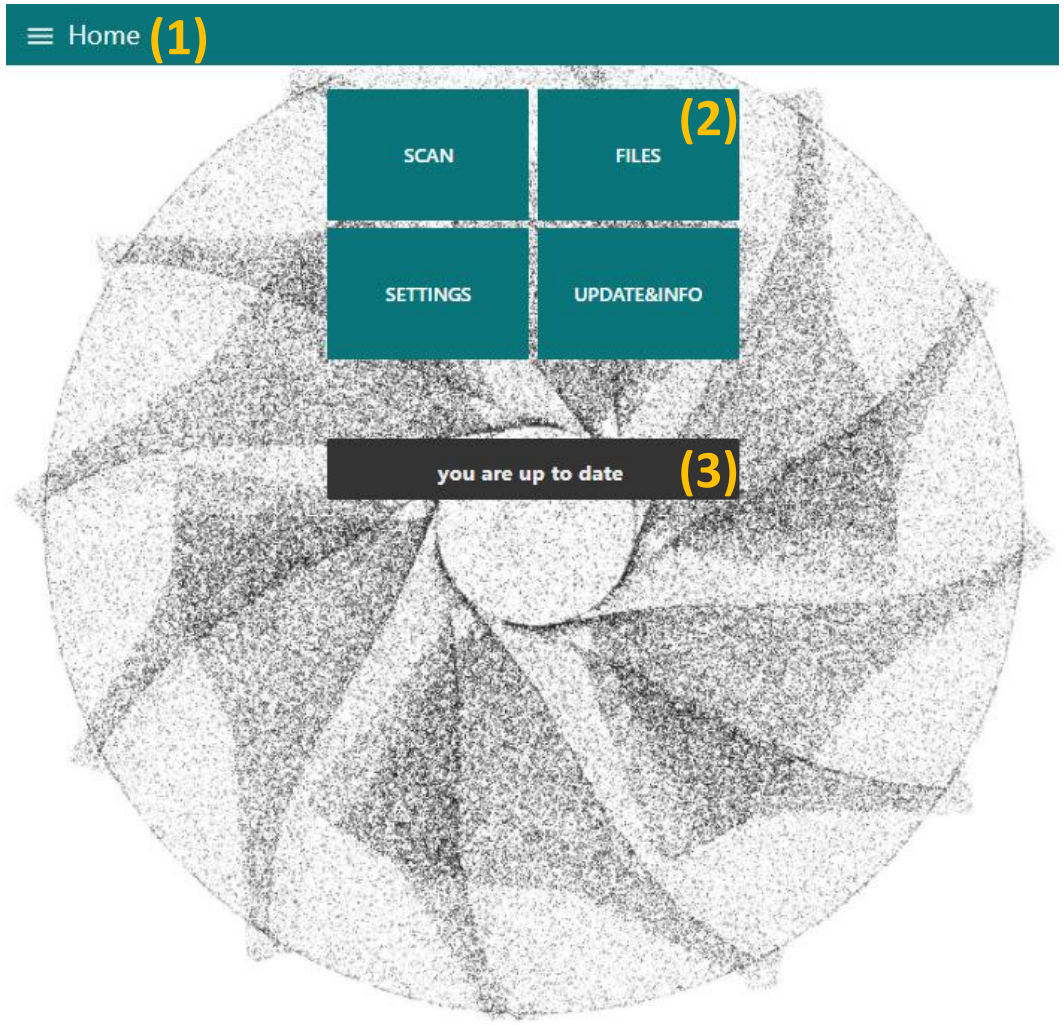
(3) OpenScan Classic (with External Camera) - where you can trigger a camera via the pins on the front panel

Note: In order to use the USB-triggering functionality you will have to change to *Developer Mode* (see *Overview-Update&Info*)

OpenScan Classic

OpenScan Mini

OVERVIEW - HOME

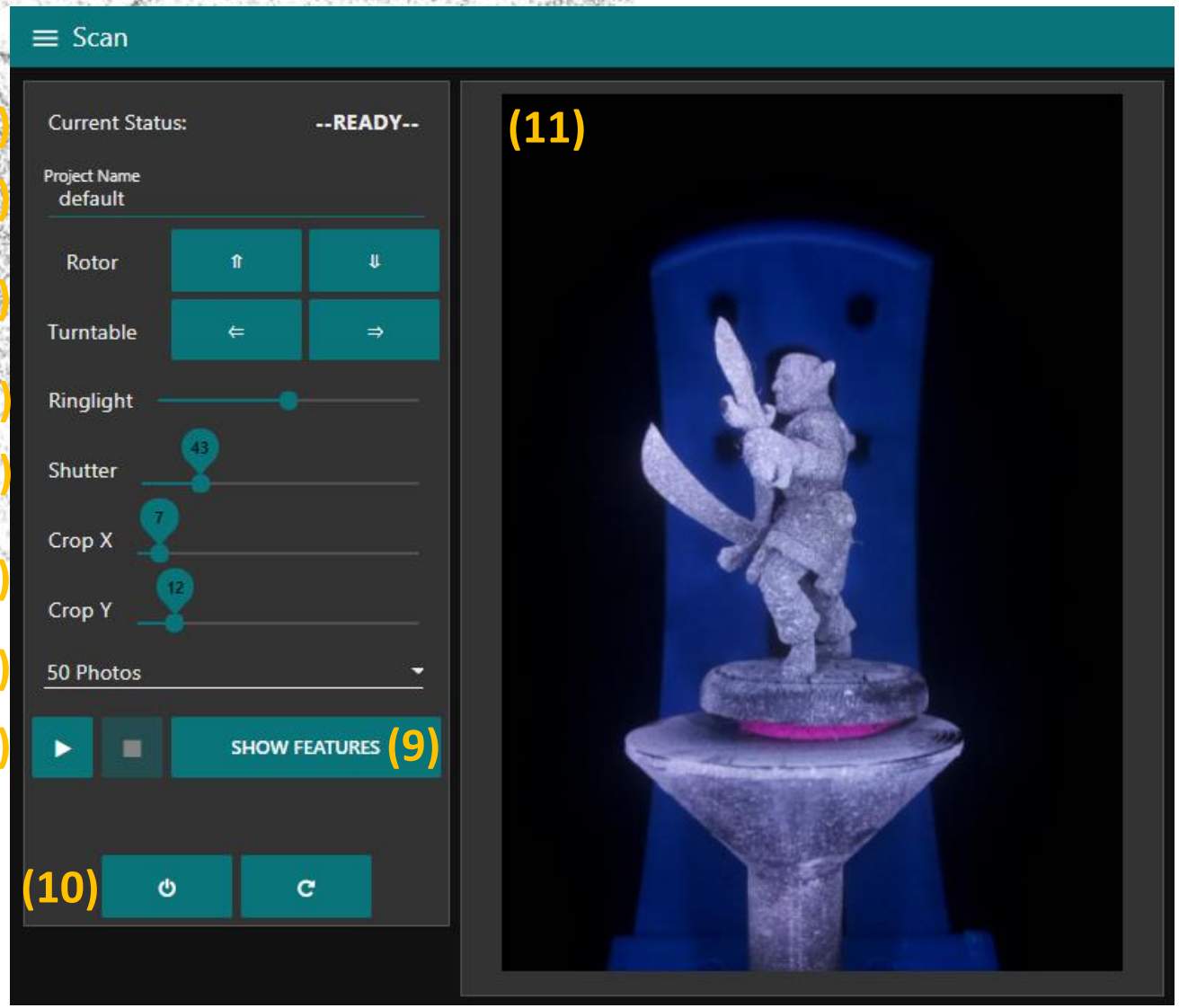


(1) Navigation bar

(2) Quick Navigation

(3) Status message, whether there is any update or server message (internet connection required)

OVERVIEW - SCAN



(1) State of the Device/Routine

(2) Text input the project name, which will be used to label the zip-file

(3) Move the Rotor and Turntable

(4) Switch to control the Ringlight LEDs

(5) Shutter speed of the Pi Camera (ms)

(6) Crop the image to reduce filesize and reconstruction time

(7) Set the number of photos used in the routine

(8) Start (and stop) the routine with the given number of photos

(9) Calculate the visible features to evaluate the setup and object (internet connection required)

(10) Shutdown or Reboot the device (please always use the shutdown button and wait 5-10s before powering of the device)

(11) Preview Image showing the current camera view

OVERVIEW - FILES

A file browser to manage, download and delete your image sets.

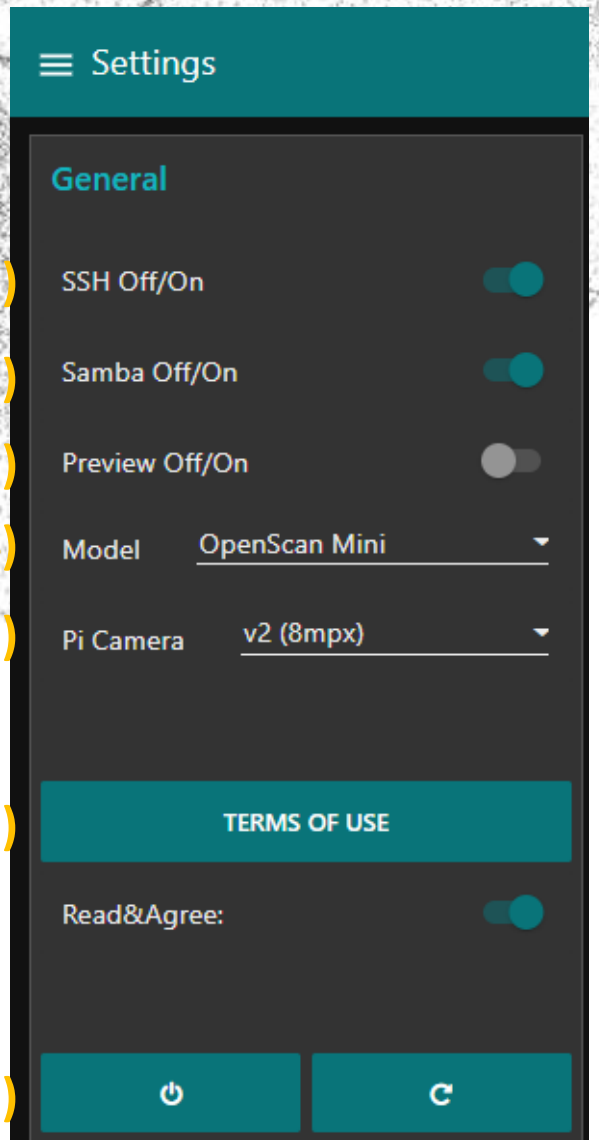
(1) Sort the sets by clicking on the names of the column

(2) Select an individual set by clicking on the row and pressing this button to delete this set.

(3) Download the zip files by clicking on the *Download* link

(4) Delete ALL stored image sets to free some diskspace

OVERVIEW - SETTINGS 1



(1) Turn on or off SSH (which can be used to directly connect to your pi via Putty or Filezilla). You can reach the pi via

Address: *openscanpi* (or local ip)

User: *pi*

PW: raspberry

(2) Turn on or off Samba filesharing (credentials as above)

(3) Turn on or off the preview functionality. Turning it on increases the overall time of the routine by ~1s per Photo but will show a live preview ;)

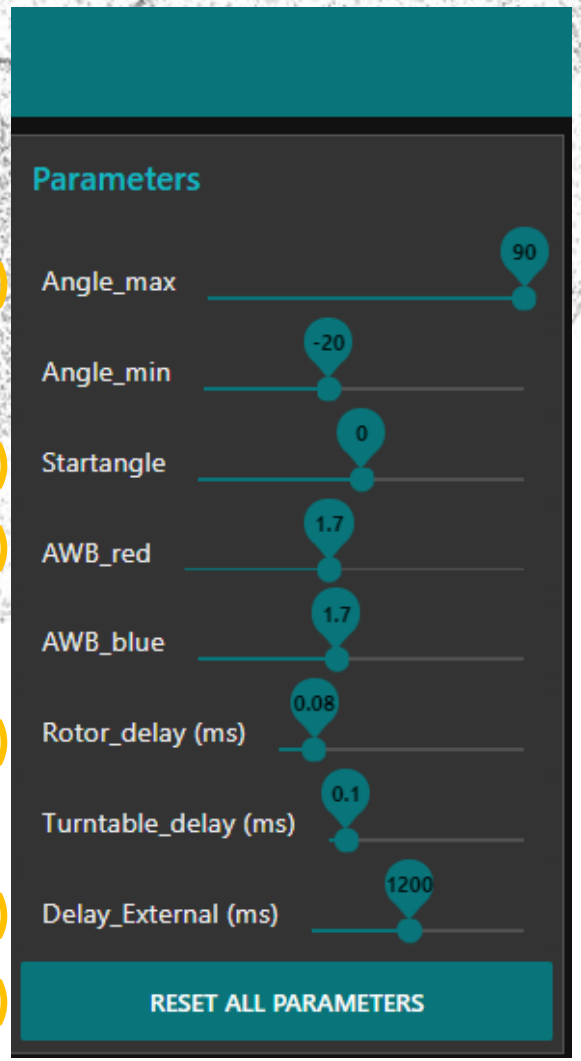
(4) see *Getting Started – Choose your model*

(5) select the model of the picamera (if you use a different version)

(6) To use the *Show Feature* Function, you need to agree to the Terms of Use.

(7) Shutdown or Reboot the device (please always use the shutdown button and wait 5-10s before powering of the device)

OVERVIEW - SETTINGS 2



(1) Set the upper and lower angle limit for the rotor during the routine. The chosen number of photos in *Overview–Scan–(7)* will be equally spaced within this boundaries.

(2) Set the starting position of the camera. (usually no change needed)

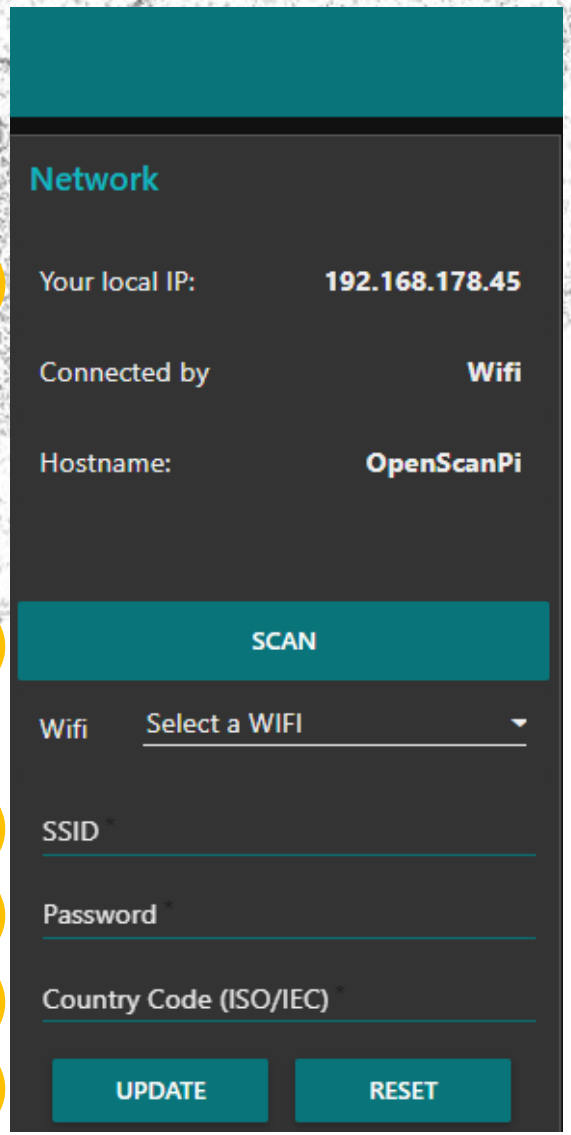
(3) Set the auto-white-balance gain values for the pi camera. Typical values are between 0.9 and 1.9. (usually no change needed)

(4) Set the delay between each step of the motor. The higher the value, the slower and quieter the movement of the motors.

(5) When using an external camera (*see Overview-Settings1-(4)*) you can set the delay time to trigger the camera via the front panel pins.

(6) Reset all parameters to the default values

OVERVIEW - SETTINGS 3



(1) Some Network information

(2) Scan for Wifi networks (might take 5-10s before you can select your Wifi from the dropdown menu)

(3) The SSID of the chosen Wifi

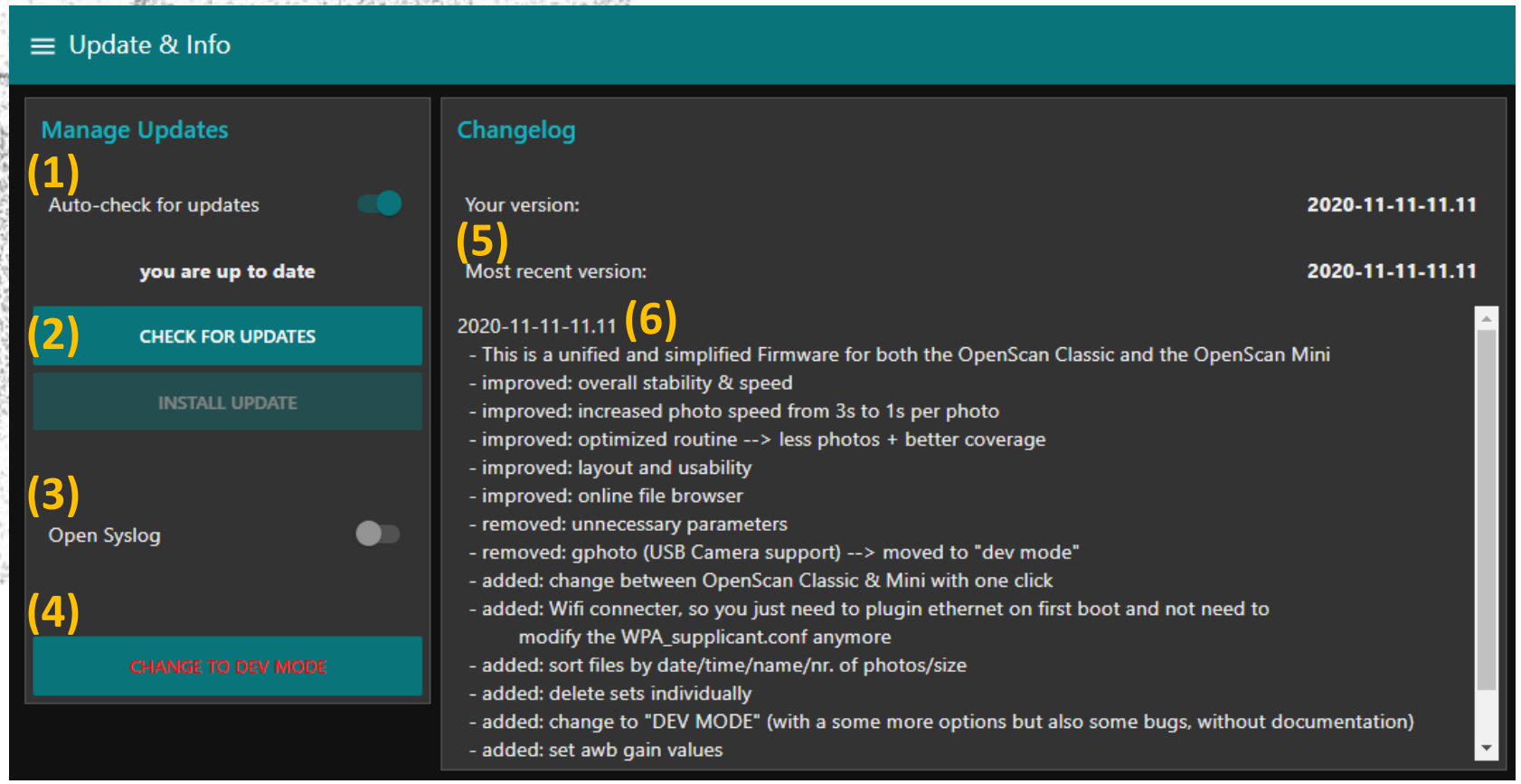
(4) Set your Wifi password

(5) Set your country code (see ISO/IEC list online)

(6) BEFORE CLICKING *Update*, make sure to double check the entered values. In case of some wrongly entered values, you will disconnect the device from the current Wifi and need to follow the steps in:

Getting Started - Set up the Network Connection

OVERVIEW – UPDATE & INFO



(1) Auto-check for updates each time after booting the device (you will be asked before any updates get installed) - internet connection required

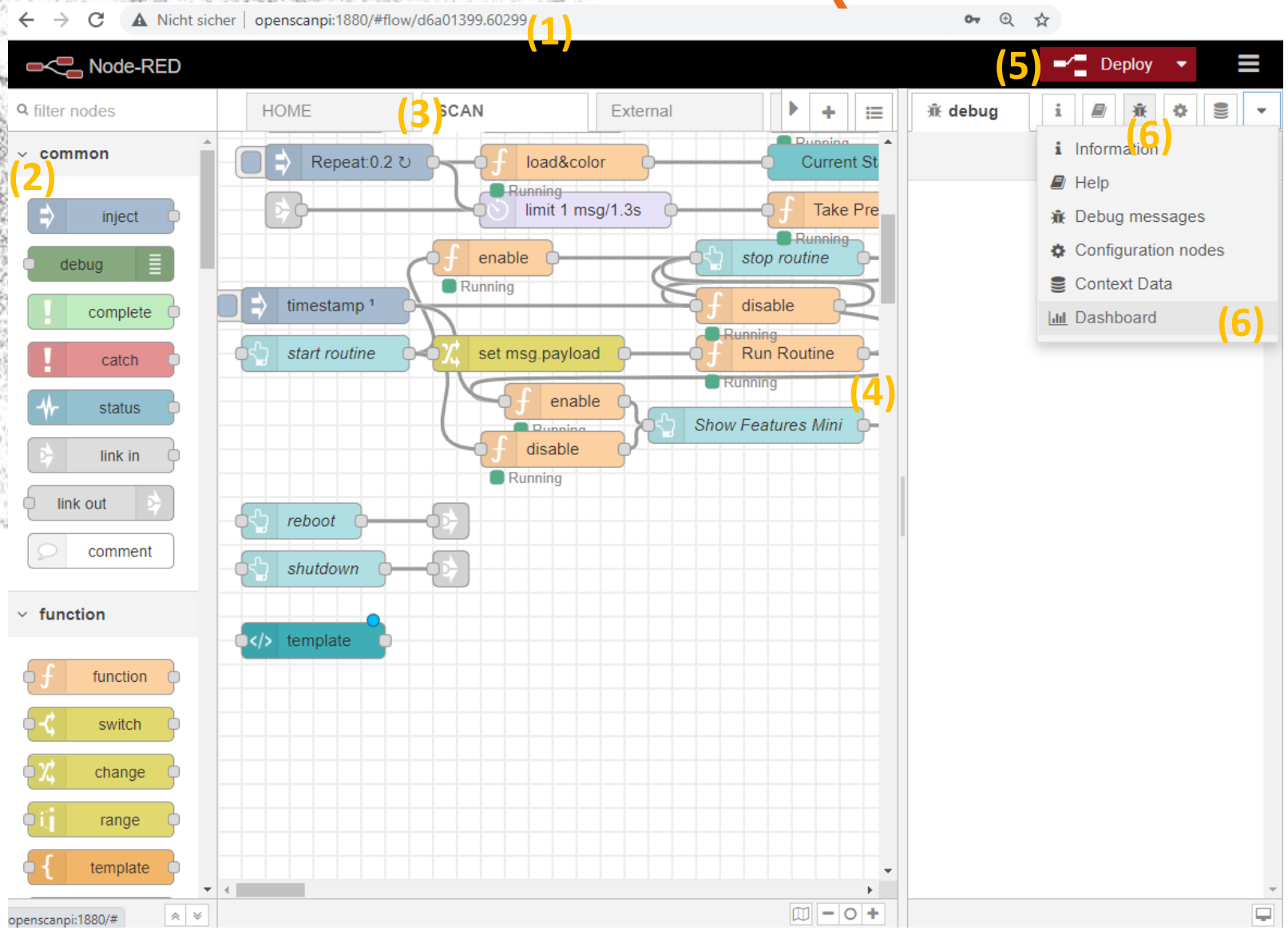
(2) Manually check for updates

(3) In case of some errors you can open the syslog here and copy the .txt file

(4) Change to *Developer Mode* which contains some more functions but is a bit messier and might contain some bugs (USB-DSLR triggering is only available in Dev Mode)

(5) The version of your firmware and the most recent available one
(6) Changelog. If you find any bugs or issues or need new functionalities, please contact me at info@openscan.eu

OVERVIEW – BACKEND (EXPERTS & CURIOUS ONLY ;)



(1) enter the programming backend (node-red) via

openscanpi:1880

(2) Add custom nodes

(3) Navigate between the different flows

(4) Inspect individual nodes. Blue ones are usually visible interface elements (e.g. buttons, sliders, etc.) triggering some actions. Red is the main programm code (Python).

(5) Apply changes by clicking deploy (Be carefull ;)

(6) In case of some errors, inspect the debug mode

(7) In order to adjust the layout, click on *Dashboard* where you can arrange, delete and add new user interface elements

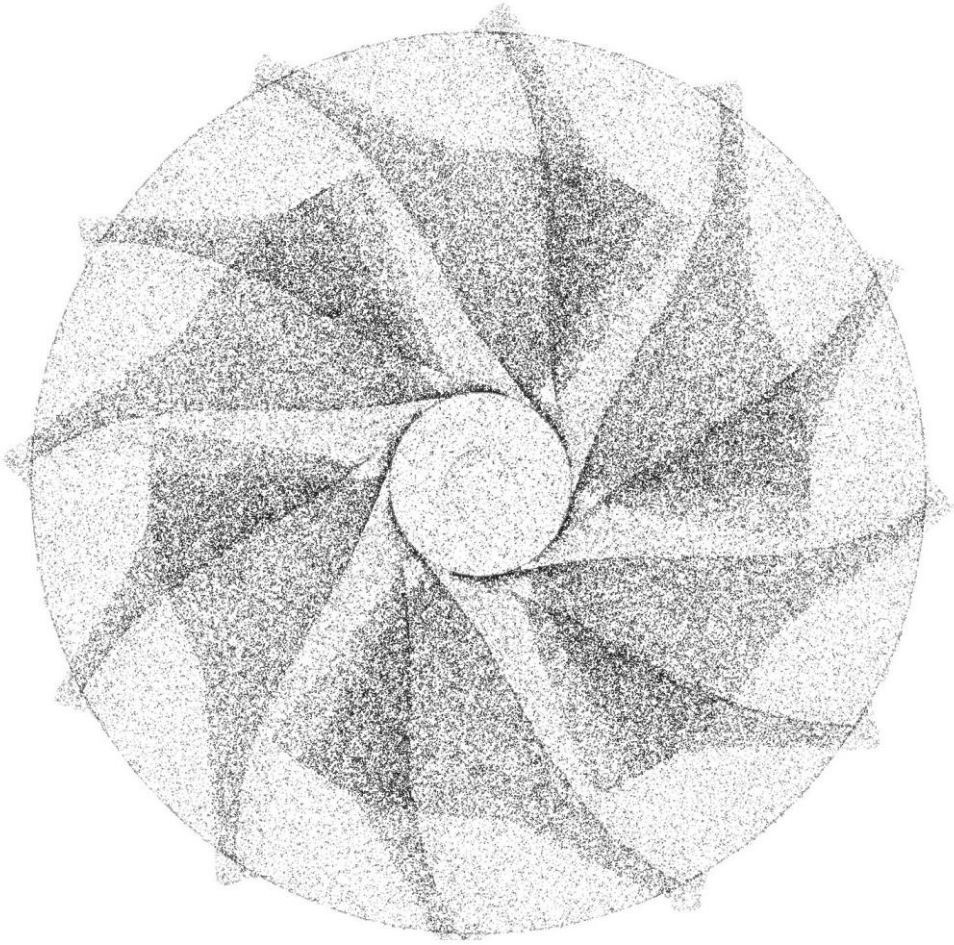
FIRMWARE - WORKFLOW

Understanding the scan object and the hardware is your key to successful scanning.

It is important to spot possible challenges before approaching a scan and to avoid unnecessary reconstruction times (and frustration ;)

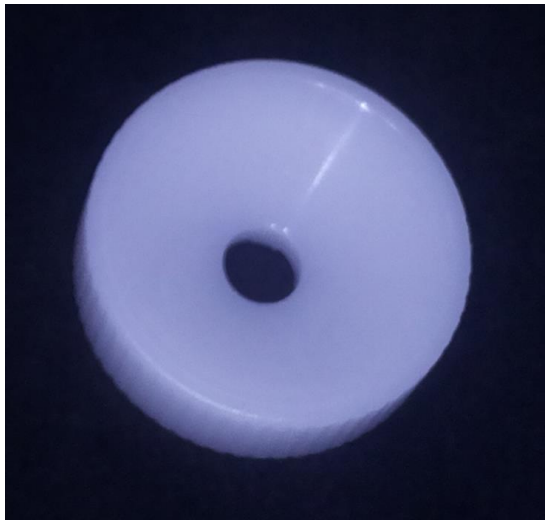
Even after several hundrets of successful scans you will still find some objects posing new challenges.

So have fun and keep exploring :)



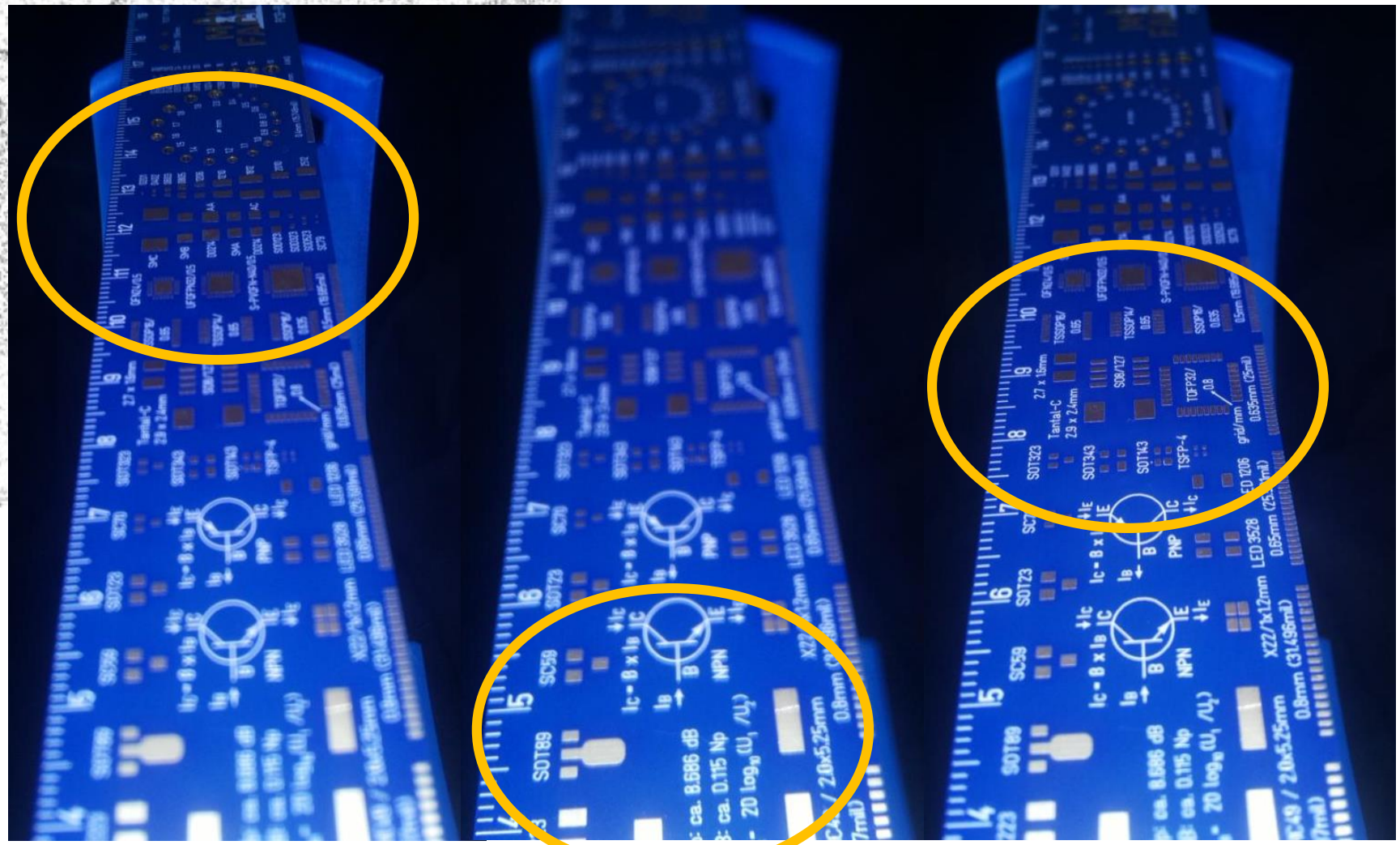
OPENSCAN

WORKFLOW – FOCUS THE PI CAMERA



- This is a very important step.
- On the OpenScan Mini, it needs to be done once. On the OpenScan Classic it is necessary to adjust the focus every time you change the camera-object-distance
- Take your time!
- For the Pi v2 camera, you will need the focus adjustment tool (*right*) to gently turn the lens until the object is in focus. This is quite fiddly so please be patient and take your time. (For first timers this can take 15-30min...)
- You can place a ruler across the turntable to help identify the sharp vs. blurry areas.
- Do not turn the lens more then 180° as it might fall of the housing!
- See the next page for more details

WORKFLOW – FOCUS THE PI CAMERA

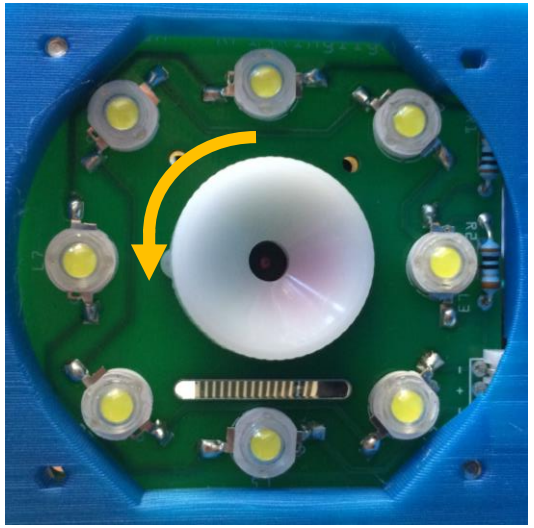


Focus to far

Focus to close

Focus ideal

Turn the camera adjustment tool counter-clockwise to move the focus closer to the camera.



Note that the center (axis of the turntable) is at roughly 10cm, so the area in focus should be a little bit in front of that (i.e. from 6-12cm in the shown case)

WORKFLOW – UNDERSTANDING THE OBJECT

!!! Important !!!

Before starting a scan it is absolutely necessary to analyze and understand the scan object. As with any 3d scanning technology, not every type of surface can be scanned equally well. Especially in the beginning it can be quite frustrating to not succeed scanning a particular object. To avoid this frustration here are some general information to keep in mind.

Problematic for photogrammetry are:

- *Uniformly colored areas* (e.g. plastic, metal...) - The software won't be able to find features in those areas
- *Reflective areas* (e.g. metal, painted surfaces...) - Reflective highlights will create false features which will throw off the software
- *Transparent or translucent materials* (e.g. glass, fruits...) - Translucent material has features under the surface which will throw off the software
- *undercuts and holes* - Areas which are not visible from multiple angles can not be reconstructed

There are a couple of methods that help dealing with those problems, mainly covering the object with scanning spray or something similar (e.g. dry shampoo, baby powder, chalk/marking spray...) to create thousands of tiny surface features.

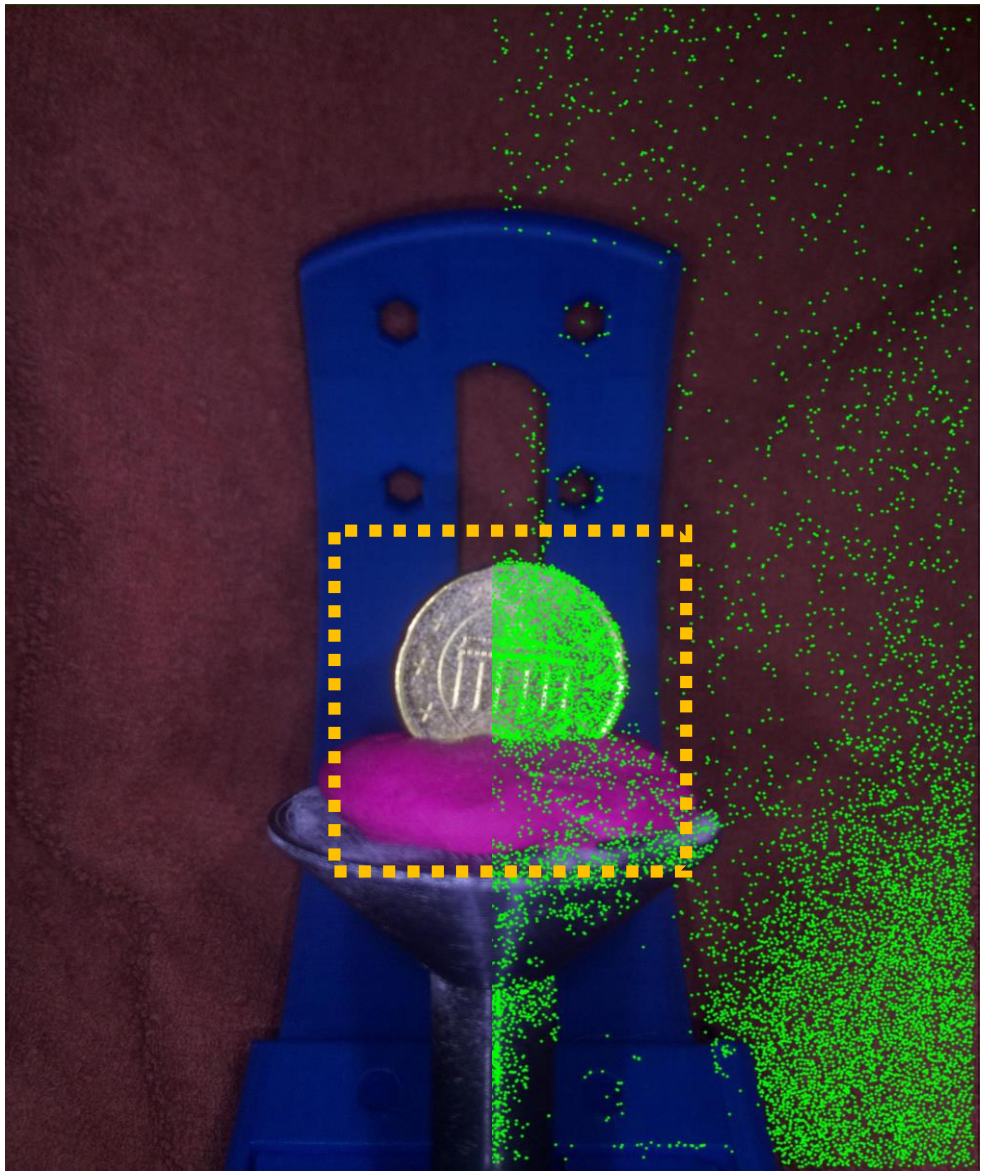
Furthermore you can use the *Show Features* Function in the Scan-Tab to make visible what the software recognizes as features. Those features will be marked as green dots.

WORKFLOW – UNDERSTANDING THE OBJECT

Another major issue is created by a feature-rich background which will throw off the reconstruction software. Those features are marked as green dots (accessible via *Show Features* in the Scan Tab)

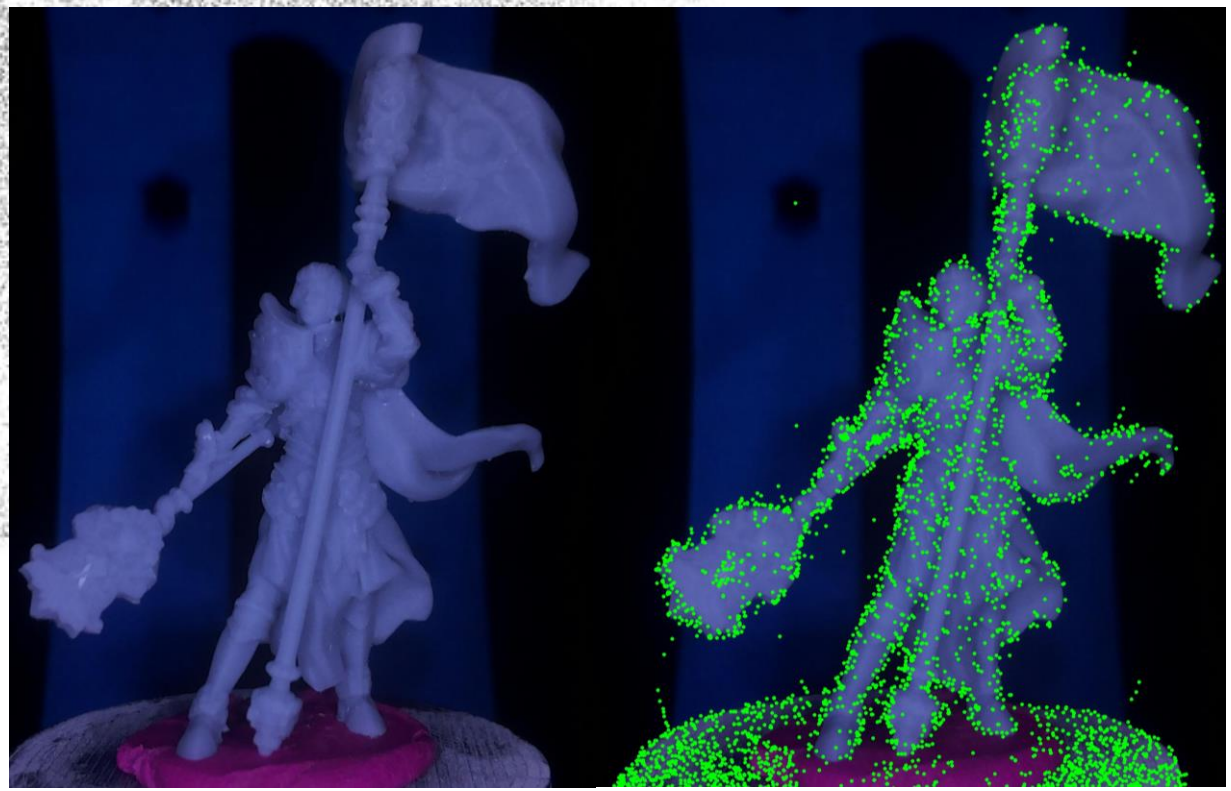
There are several ways of dealing with this issue:

- Increase the illumination by switching on the second ringlight and lower the shutter speed (the background will turn dark)
- Check the focus of the camera, so that only the object is in focus and the area behind the scanner should be blurry
- Clear the space behind the scanner. Even wallpaper might introduce to many distracting features.
- Crop the image to the area needed and avoid unnecessary areas (red dotted square)
- It is okay (and even helpful), when the turntable introduces some more features, as these will help with the reconstruction.



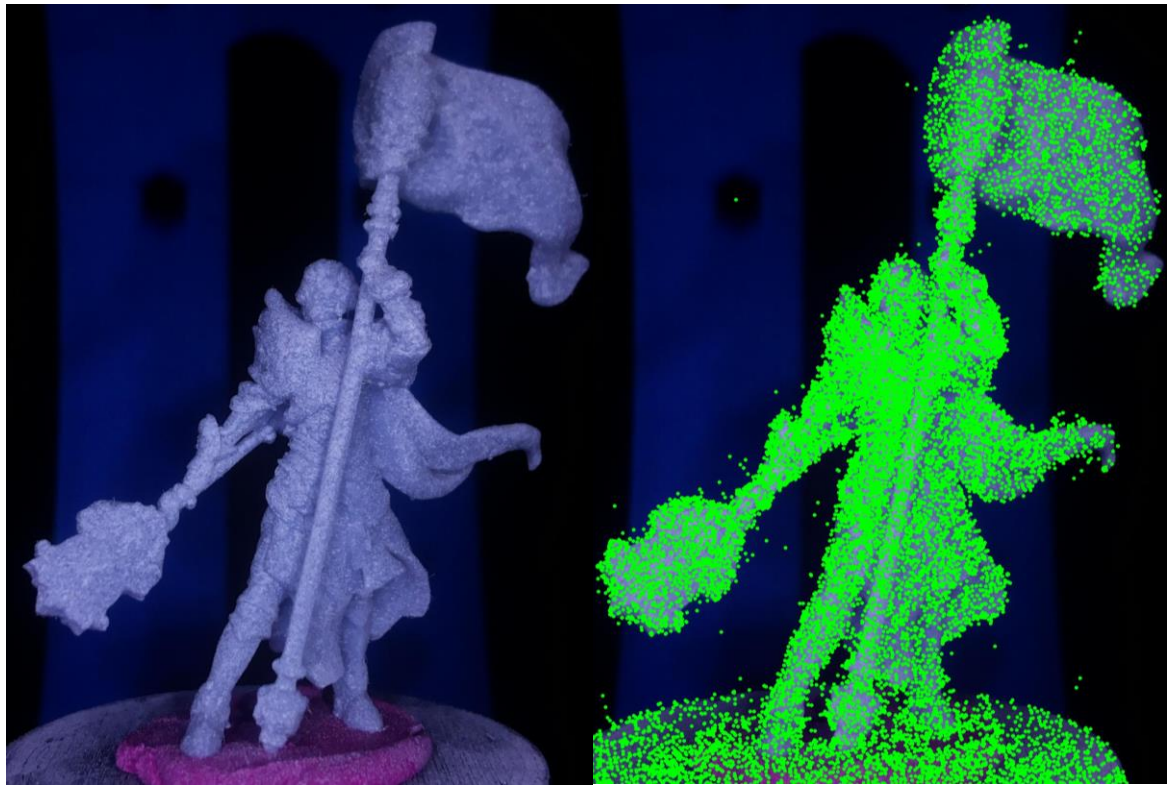
WORKFLOW – UNDERSTANDING THE OBJECT

Uniformly colored areas



3D printed Miniature – without chalk spray

- not many features are detected, so the software will struggle to align the images and/or reconstruct the model

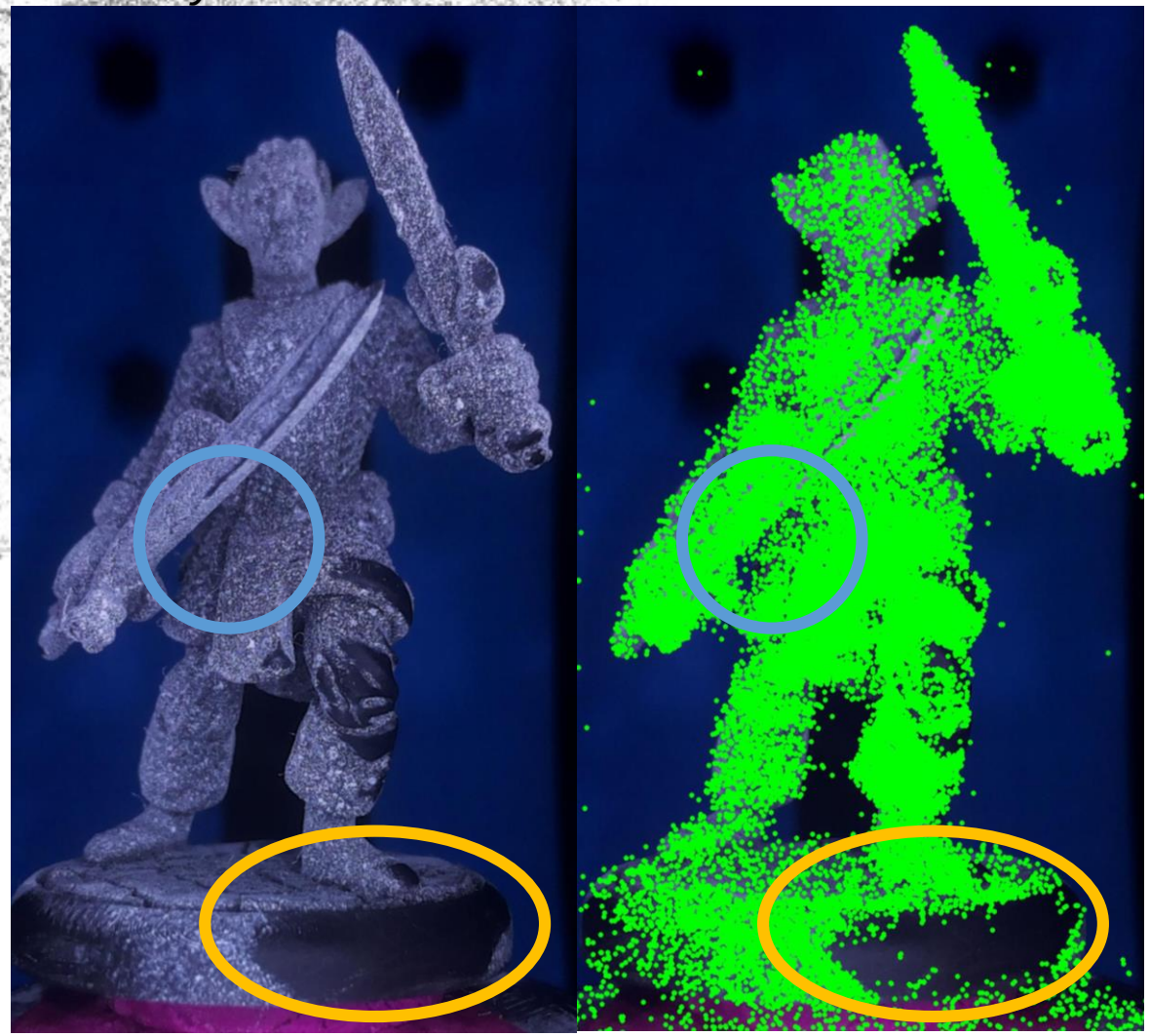


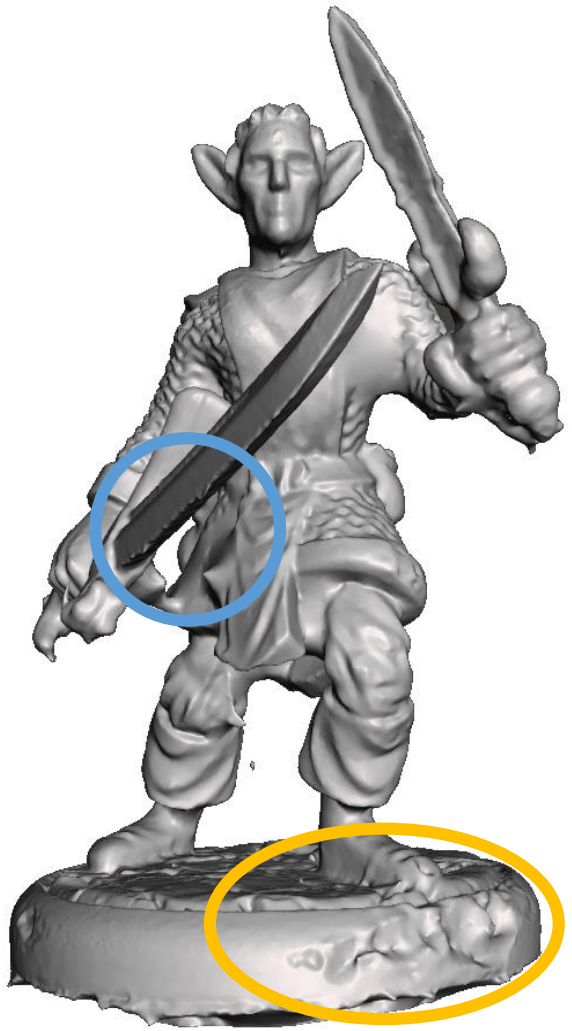
3D printed Miniature – with chalk spray

The whole surface is covered evenly with features. Note that the chalkspray is not 100% covering the object but instead creating a lot of visible small dots

WORKFLOW – UNDERSTANDING THE OBJECT

Uniformly colored areas & undercuts



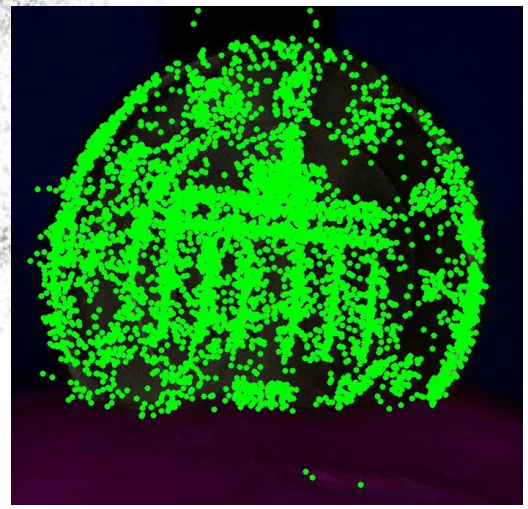


Blue area: this undercut area is not visible on many photos and thus not reconstructed well. In this set, only 50 photos have been used and increasing the number to 100 or 150 is highly adviced.

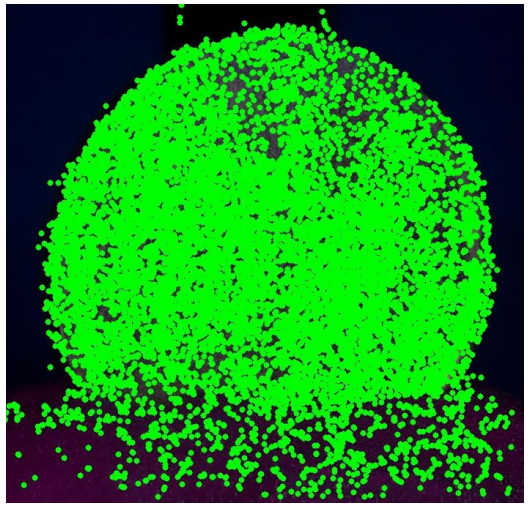
Orange area: In the marked area the chalk has been removed, this area can not be reconstructed properly. It takes some practice to create uniformly covered surfaces and to apply the chalk spray evenly. It is noteworthy, that less chalk (i.e. more destinctive features) is better then a fully covered surface.

WORKFLOW – UNDERSTANDING THE OBJECT

Reflective surfaces



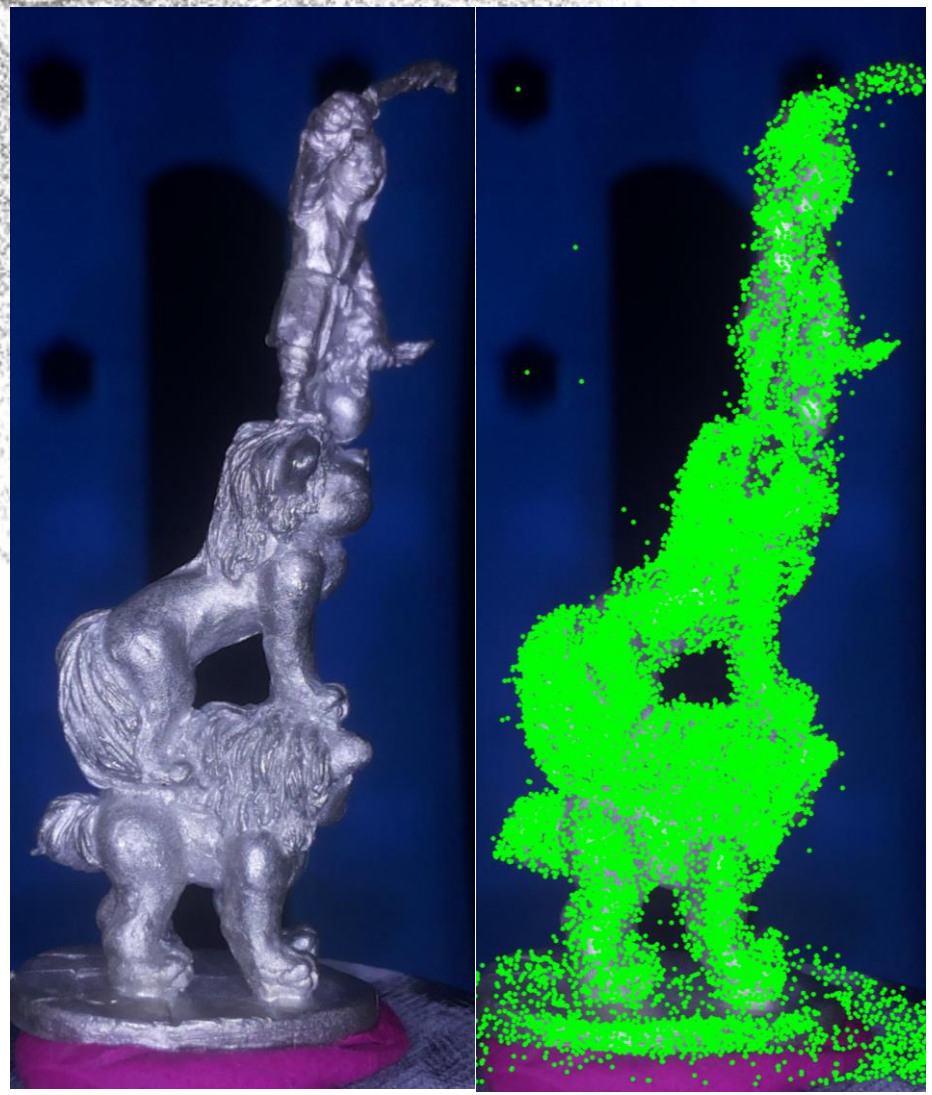
Reflections will cause false-positive features. As the reflections move from photo to photo, this will distract the algorithm of the photogrammetry software.

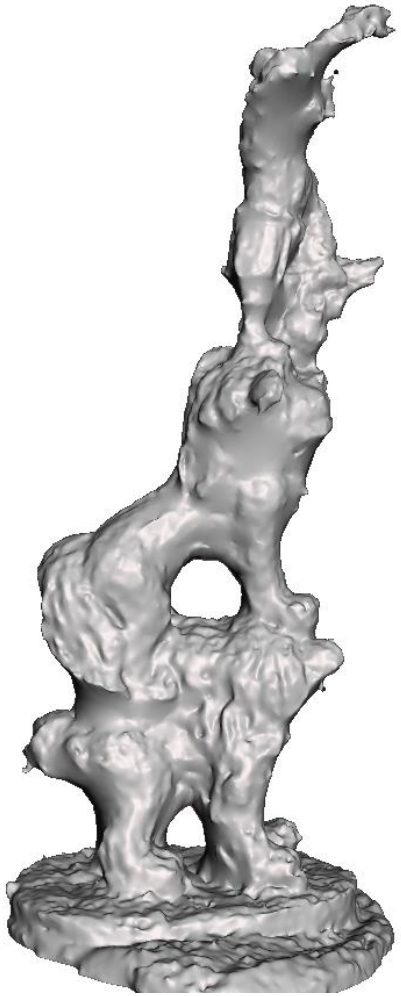


Adding chalk spray might create enough additional features. But still the reflections could cause some issues. This might be fixed by using a polarizer, which will cancel all reflections.

WORKFLOW – UNDERSTANDING THE OBJECT

Reflective surfaces





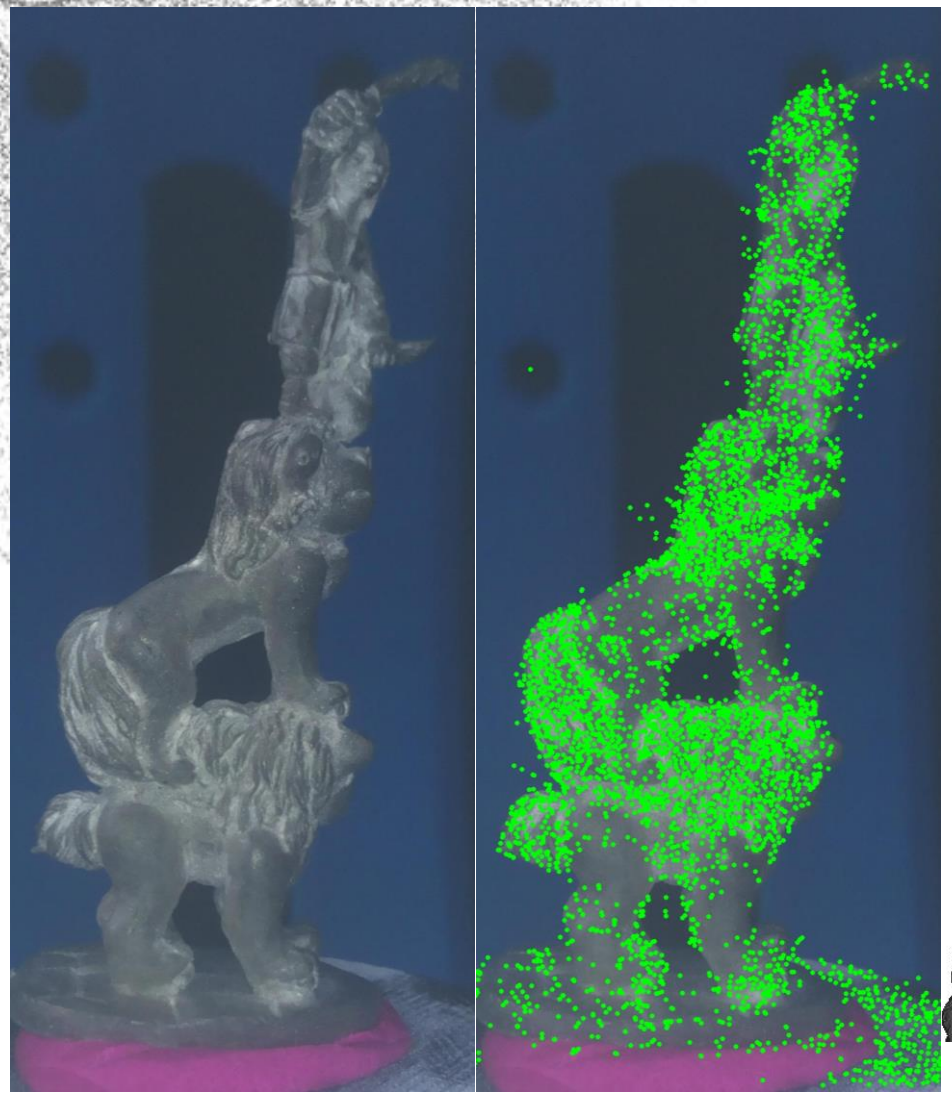
In this example of a 4cm tall iron-cast figurine, the reflections caused many false features.

The reconstruction was only possible with a large number of photos (200) and only part of those have been accepted by the software.

So always check for visible reflections and either use a polarizer (see next page) and/or add chalk spray

WORKFLOW – UNDERSTANDING THE OBJECT

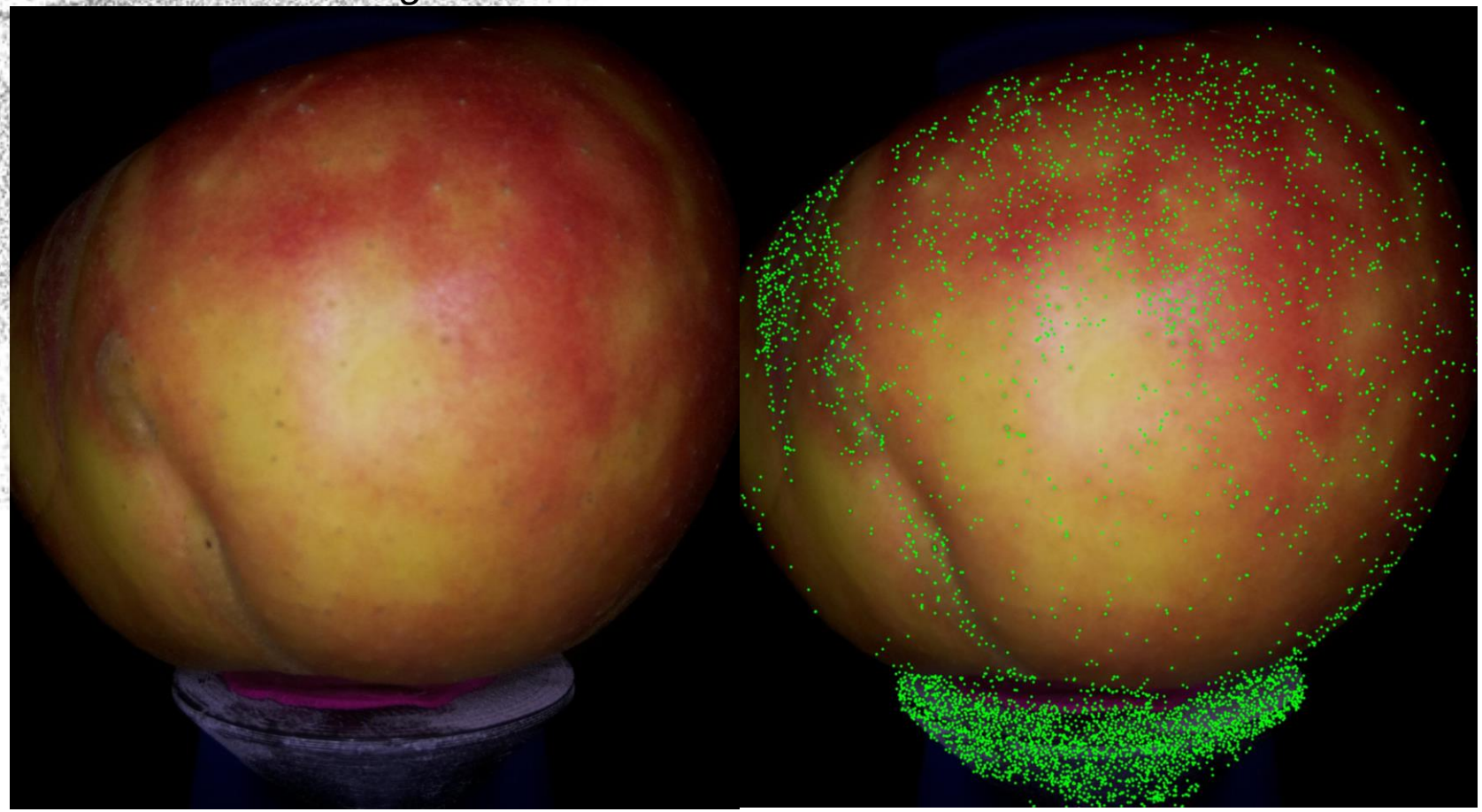
Reflective surfaces



Using the polarizer seemingly decreased the number of features. But the quality of those features increased, as those are destinctive and recognizeable from different views. Thus the overall result came out much better.

WORKFLOW – UNDERSTANDING THE OBJECT

Subsurface Scattering



Subsurface Scattering appears, when the light can penetrate the object slightly and get bounced back from underneath the surface.

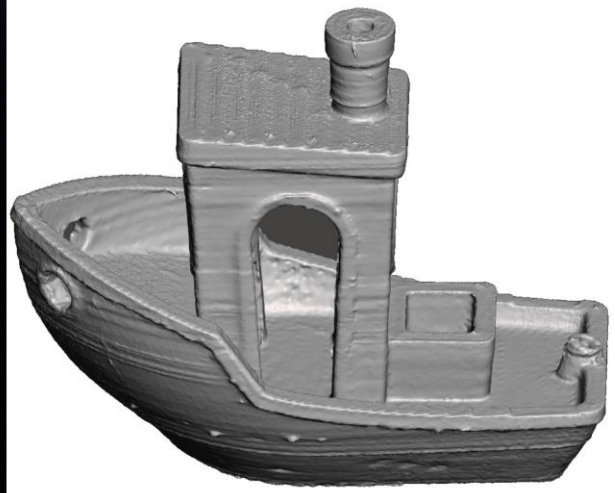
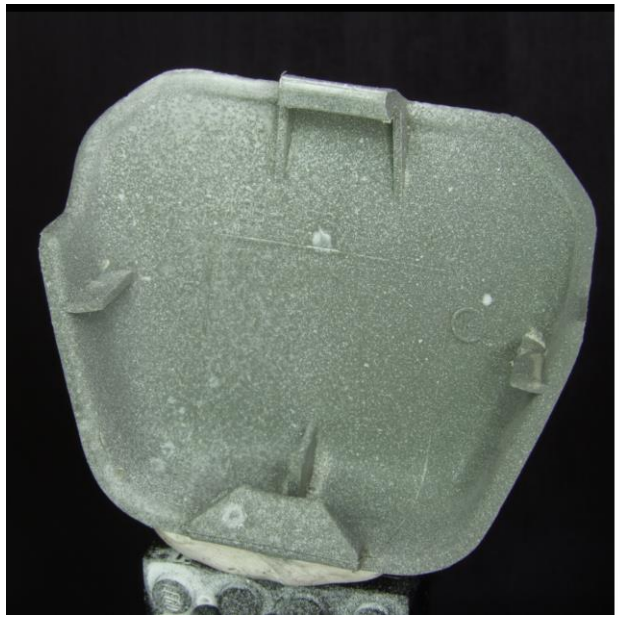
The photogrammetry software will struggle to find distinct features and thus the reconstruction is likely to fail.

Covering the object in chalk/flower/babypowder will solve this issue.

Note that the object holder creates a lot of features, which generally help the reconstruction.

WORKFLOW – UNDERSTANDING THE OBJECT

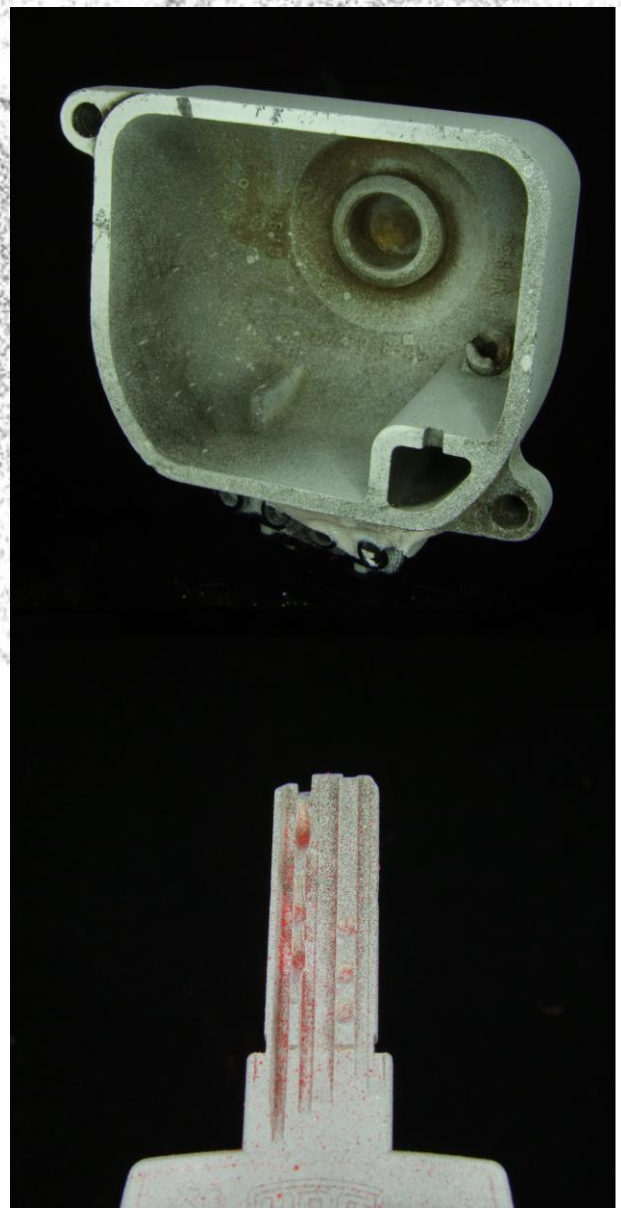
But now it is time for some positive examples :)

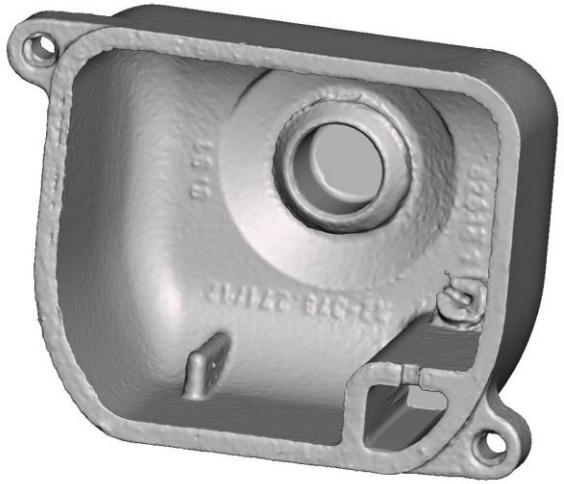




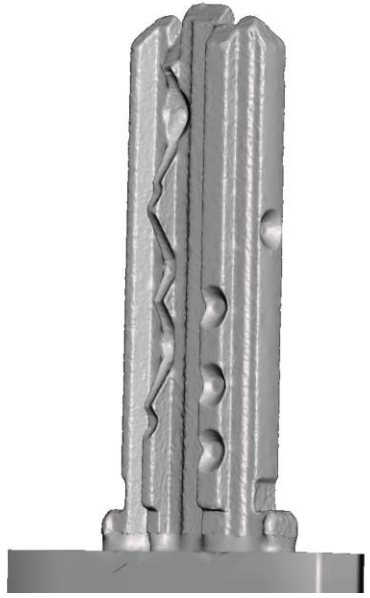

You see, that I use scanning spray for most objects. For particular delicate objects I use a self-vanishing scanning spray, namely AESUB blue, which will disappear after 30-60 minutes without leaving any traces. I am not affiliated with this company but I can highly recommend this product.

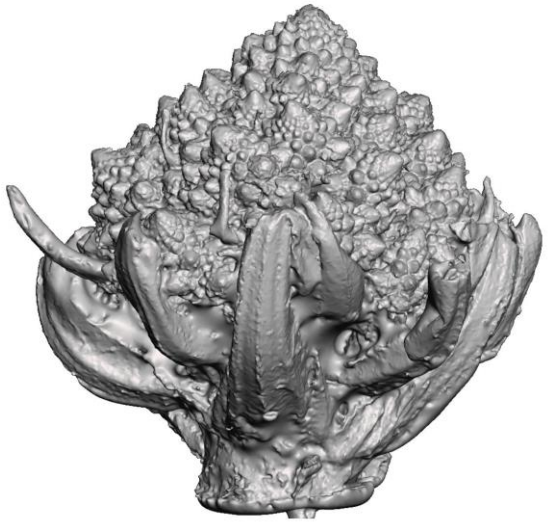
There have been more self-vanishing scanning sprays on the market, but due to some changes in the industry, the substance needed (Cyclododecan) is no longer available and thus AESUB seems to be the only company being able to produce such a product.

WORKFLOW – UNDERSTANDING THE OBJECT

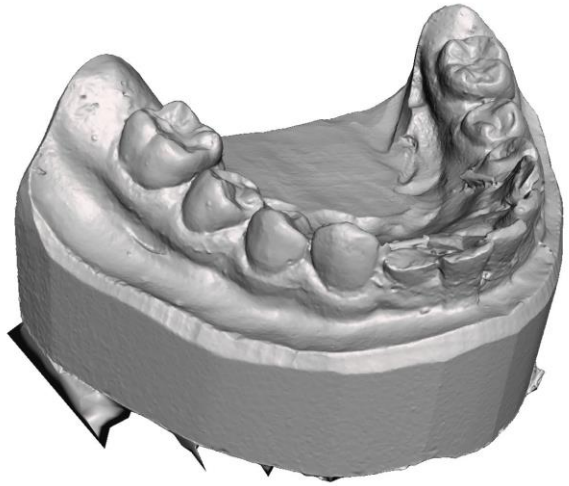


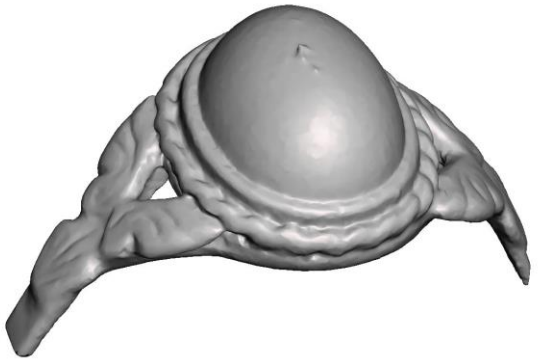


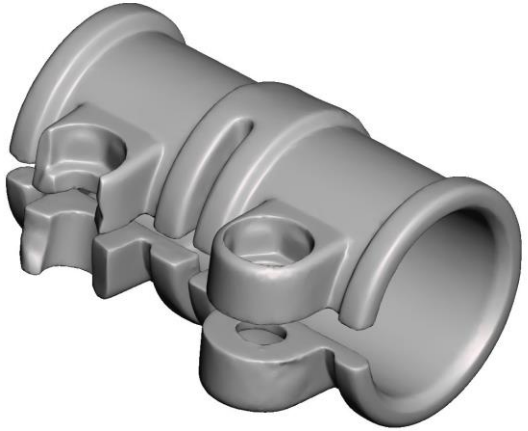




WORKFLOW – UNDERSTANDING THE OBJECT



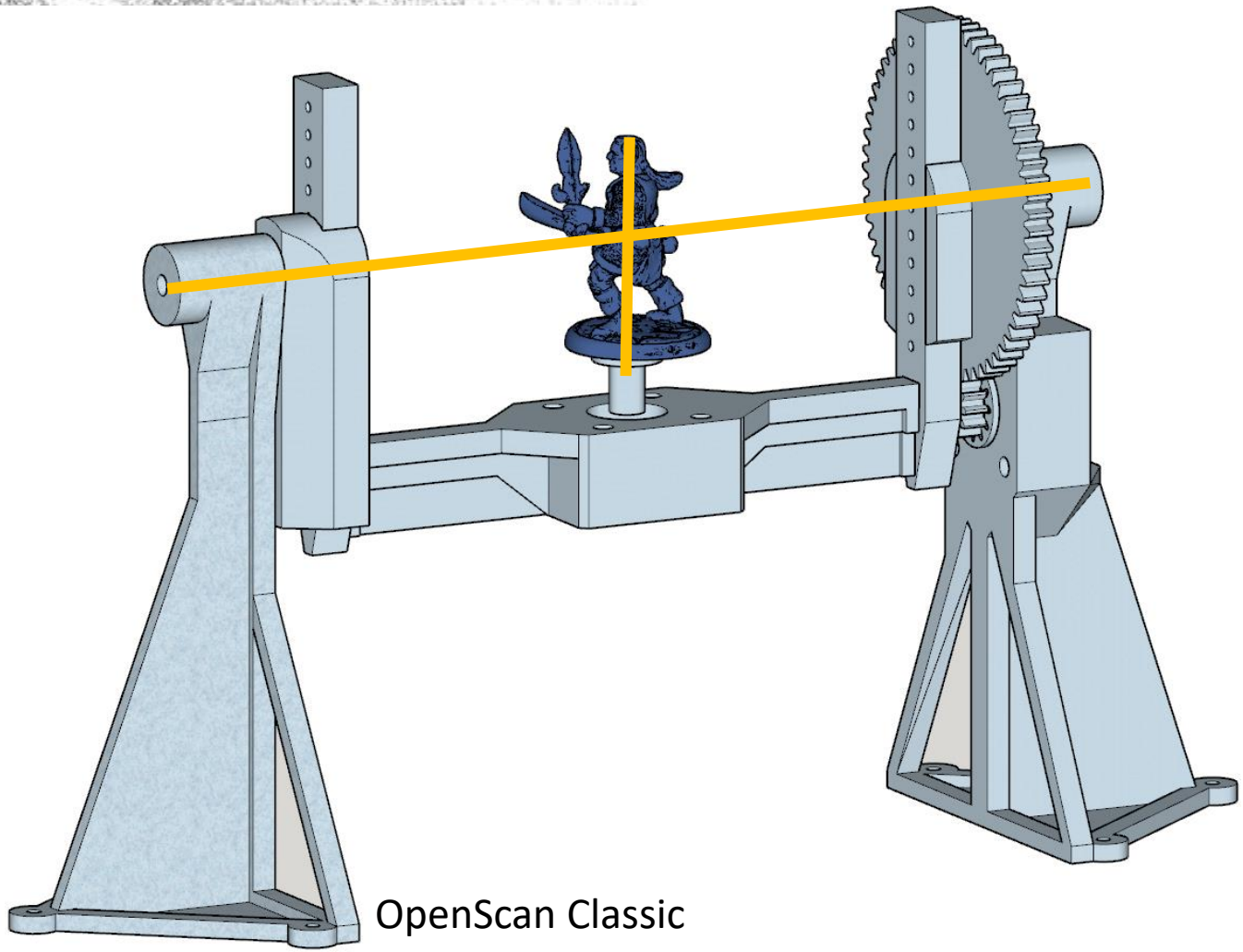




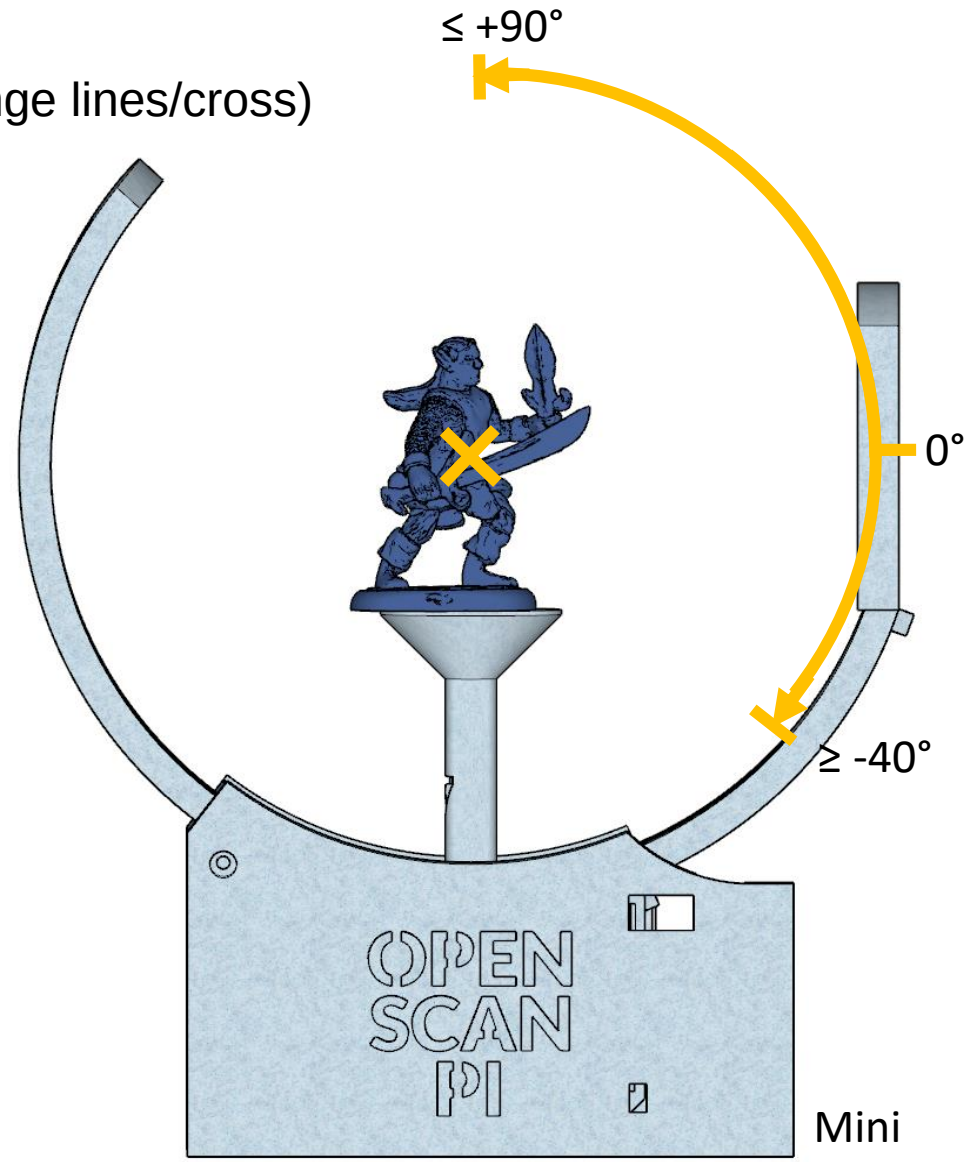
WORKFLOW – SCAN PROCEDURE

(1) move the rotor to the shown position

(2) align the object center with the center of the two rotation axis (orange lines/cross)

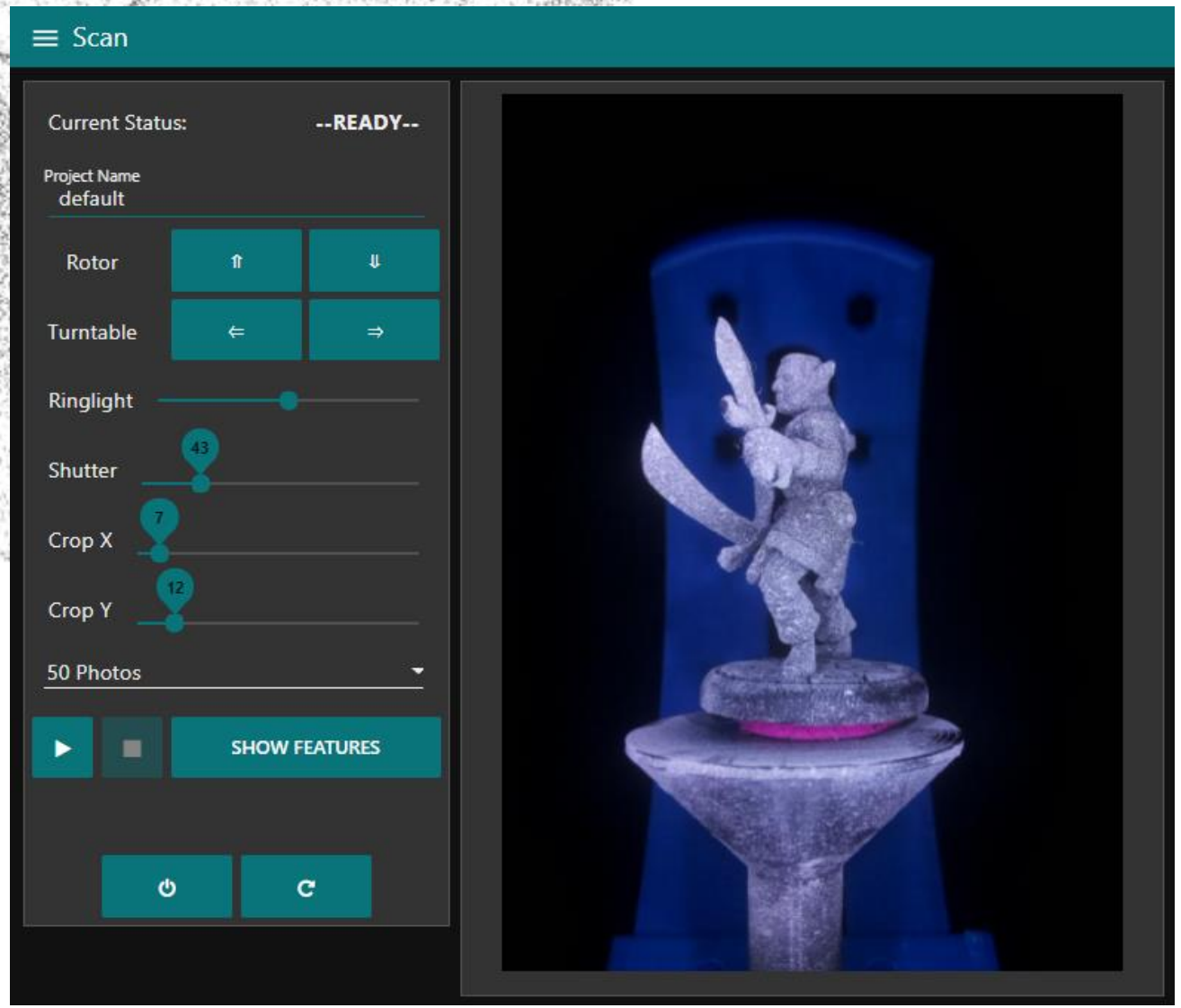


OpenScan Classic



Mini

WORKFLOW – SCAN PROCEDURE



(3) set the project name

(4) ringlight on

(5) adjust the shutter speed so that the object is well exposed.

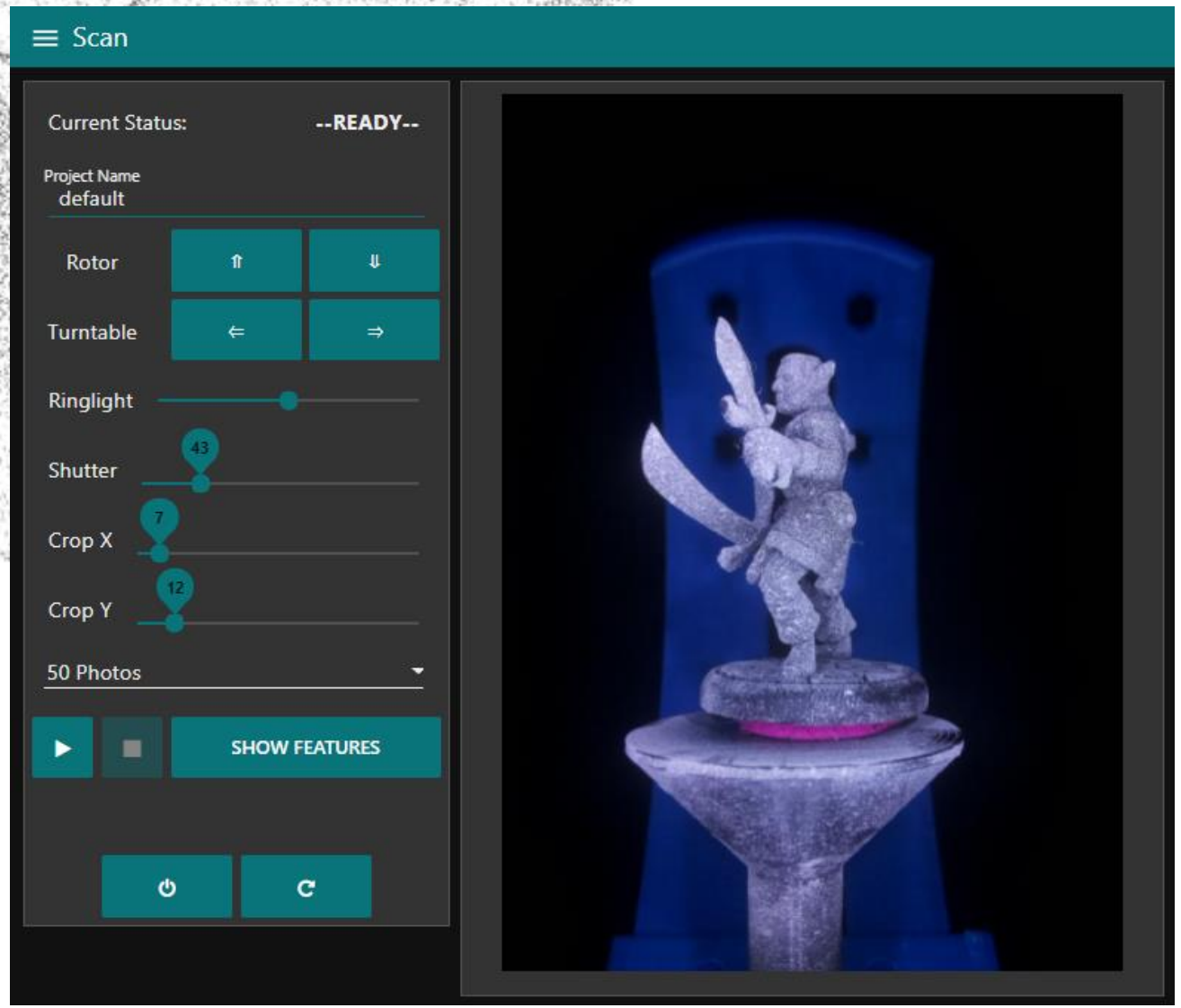
(6) crop the image to avoid unnecessary file size and reconstruction time

(7) Use *Show Features* to identify critical areas

(8) Choose the number of photos:

- 30-50 is ok for simple objects or testing, when the object has a lot of features
- 70-150 should be enough for most objects
- >150 if the object is very detailed or has only few features (note, that "the more, the better" is not true here and that there is a sweet spot after which the quality does not increase)

WORKFLOW – SCAN PROCEDURE



(9) Press start

(10) after the routine is done, you can download the image set (.zip) in the *Files* Tab and start processing in a photogrammetry software of your choice.

Some tips:

- You can adjust the minimal and max angle of the rotor in *Settings* - the camera will only cover the given area.
- Especially at the beginnen, less is more :) Take only 30-50 photos between -20° and +20° to see, whether the reconstruction will succeed. As long as there are enough surface features on the object, any photogrammetry software should work.
- A "dirty" turntable/objectholder will help the software to find more features