Jan Röpenack

Focus stacking in product and advertising photography

- Requirements for a good product photo
- Photographic challenges
- What is depth of field?
- Three ways to increase depth of field
- Tilt/Shift explained using examples
- Advantages and disadvantages of focus stacking
- Three types of focusing when stacking
- Introducing the STACKPRO 1 set
- The complete stacking workflow
- Rendering with Helicon Focus
- Dealing with blurred edges, “halos”
- Description of an outdoor stacking project
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NOVOFLEX

eBook

Foreword

Dear readers,

You are probably wondering what this document is: an electronic textbook, a photo magazine, an instruction manual, or perhaps an advertising brochure? It encompasses all of those things. However, having said that, this publication is primarily about focus stacking. A technique that can be used to increase the depth of field in a photograph, which is mainly used in extreme macro photography to make spatially extended objects visible. Extreme macro photography is fascinating, and how to explore it photographically is the subject of many publications. But this eBook is about something different – product photography. Products whose sizes aren't in the millimetre range, but in the centimetre range, which can be photographed quite well without focus stacking. The main message of this publication is that focus stacking can be particularly useful in this area as well. This eBook should therefore be of particular interest to professional photographers who earn their living with product and advertising photography and rely on delivering better, more consistent results than the masses. The primary competitive advantage here is maintaining controlled sharpness across all of your shots. Sharpness that begins where the product starts and ends where it finishes, literally putting the advertised item in complete focus.

When I wrote the user manual for the CASTEL-MICRO stepper motor-controlled focusing rail for NOVOFLEX in 2018, I considered the device an essential tool for exploring the extreme macro range using the focus-stacking technique. Several years have passed since then, and many people have extensively experimented with this device and the stacking technique during that time. It is therefore not uncommon during the evolutionary process that a new method for using focus stacking in product and advertising photography was discovered purely by chance. This involves shifting the bellows' rear standard backwards with the focusing rail. Sounds complicated, actually it's not. I have tried and tested this approach and, on the following pages, I will describe my own experiences employing this technique. The method is ingenious and relatively simple to use! That's the topic of this eBook.

Jan Röpenack, September 2025

Contents

Let‘s start from the very beginning!

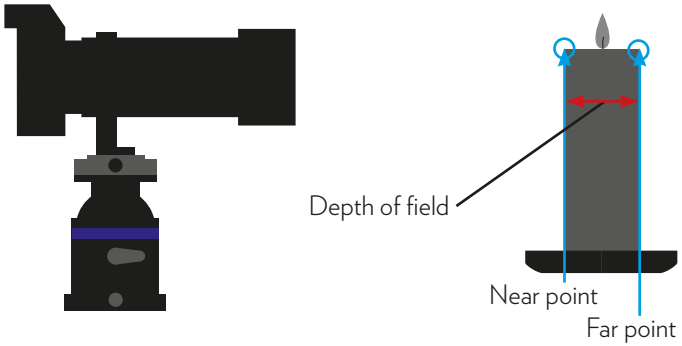
Before we delve into the topic, I would like to briefly explain what is expected of a good product shot and why it is often challenging to achieve. I would also like to define some important terms related to sharpness. See for yourself how sharp the images in this PDF are. Feel free to use the magnifying glass function on your reader.

Requirements for a good product photo

- The product should be completely in focus and well-lit so that the viewer can recognise it within seconds.
- Details and excerpts are permitted as additions, for example, to visually explain product functions.
- The product can be presented either as a cutout or in its typical environment or application. This should be discussed with the customer. Often, both are required.
- The images should have the highest possible resolution so that they are also suitable for large-format printing if required.

Photographic challenges

In addition to ensuring good lighting with artificial continuous light, flash, or natural light, one of the most difficult challenges is precisely adjusting the focus range to the product. This range should extend between the near and far points of the product, that is, the focus point closest to the camera and the focus point farthest from it.



Of course, in the final image, you will not see points of focus but planes of focus. When focusing with a camera and lens, however, the photographer will tend to concentrate on prominent points in the subject that represent the beginning and end of the focus range. With focus stacking, this range can be set precisely, but more on that later.

When photographing smaller objects, you quickly encounter the problem of limited depth of field. The focus range between the near and far points is physically limited and cannot be extended arbitrarily in a single shot. This is a real challenge in classic photography.

What is depth of field, and how do you assess the sharpness of a digital image?

If you look at a photo that has a limited depth of field, i.e. it shows blur in both the foreground and background. The first question that arises is how to define area of sharpness. At what point does an area become sharp, and at what point does it become blurred again?

To answer this question, there are mathematical and physical considerations that are rarely applied in practice. First, it is important to recognise that the visual sharpness of an image produced by a lens is a combination of its resolving power and contrast reproduction. The more details we see and the higher the contrast, the sharper the image appears to us.

However, the closer we get to the image, i.e., the further we "zoom in," the fewer details we can see, until ultimately, we only see individual pixels.

The impression of sharpness is therefore also a question of distance or, when viewing digitally on a screen, the zoom factor.

It has therefore proven useful to view a digital image in the software's "100%" view. This means that one pixel of a digital image corresponds to one pixel on the monitor. With a high-resolution camera that has many pixels, you therefore need to zoom in further to achieve this 1:1 ratio. The demands on the optics that enable high-contrast details to be captured on such a tiny surface become even greater.

To answer the question in the title about how to assess sharpness in a digital image: I evaluate sharpness purely visually, using the software's 100% view. This method considers the camera's resolution (number of pixels), the quality of the optics, and possible diffraction blur caused by stopping down the lens too much.

The depth of field, i.e., the spatial extension of the sharpness, therefore depends on the aforementioned resolution of the camera lens combination (camera sensor resolution and optics quality), the image scale, and the aperture used. Mathematical formulas and tables exist for the last two points, which you can find, among other places, in the instruction manual for the NOVOFLEX CASTEL-MICRO focusing rail.

It's important to note that stopping down too much increases depth of field but reduces sharpness due to diffraction. Therefore, in practice, it's recommended to shoot with the so-called "critical aperture" or "optimal aperture" to avoid quality loss due to stopping down too much. The optimal aperture is the best compromise between depth of field and diffraction blur, while the "critical aperture" enables the best resolution.

The sharpness range begins at the wick of the front candle and ends at the wick of the rear candle.

In Adobe Photoshop, select the Loupe tool, right-click, and then click 100%:

Alternatively, and this works with any tool, press the Ctrl or Command key and the + or - key simultaneously. This zooms in or out of the image. The zoom factor is displayed in % at the top left of the window.

In the 100% view you can see that the label of the front candle is still in the blur area.

Diffraction blur

Bread basket photographed in the classic style: top left at f/8, bottom right at f/32 to maximise depth of field. At the 100% view, it's clearly visible that stopping down too much leads to diffraction blur, which reduces resolution and micro contrast.

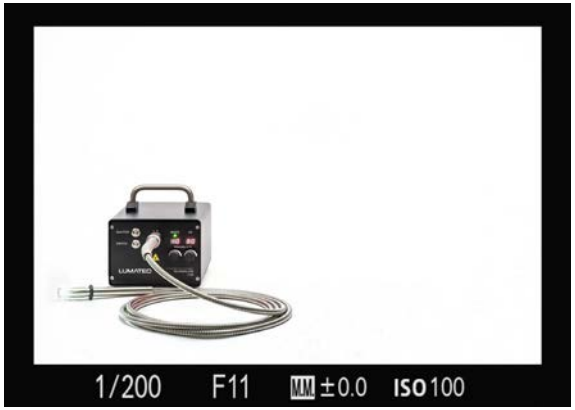
How to increase the depth of field?

Simple approach: Reduce the magnification and stop down the aperture

Compared to 35mm, medium, or large format films of previous generations, smaller sensors result in smaller image scales and thus greater depth of field at the same aperture. High-resolution sensors also allow for cropping when the maximum number of pixels don't need to be used in the final result.

A proven method for depicting, for example, a three-dimensional, rectangular object in a slightly above-ground perspective, without distortion, would be to place it on a table, position the camera slightly higher (aligned exactly horizontally), and place the object in one of the lower corners in the viewfinder. Lateral lines of the object are thus aligned exactly parallel to the sides of the image or viewfinder, and perspective distortion is therefore avoided.

The necessary depth of field is achieved by increasing the distance (smaller reproduction scale) and closing the aperture. The image section is then determined by cropping using software. This kind of "reframing" involves cutting away approximately 3/4 of the recorded pixels.



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Disadvantages of this method:

- The achievable resolutions (number of pixels) are not particularly high by today's standards, but are generally sufficient for online publications.
- The depth of field cannot be expanded arbitrarily, if you don't want to stop down too much for quality reasons, you quickly reach your limits depending on the object's size.

Shift so that vertical lines remain vertical and do not tilt

Incidentally, this kind of perspective can also be created by "shifting." With the lens aligned horizontally, the camera is moved up, down, or sideways using the bellows for moving parallel to the lens plane. The image circle remains in the same position, while the camera or sensor moves accordingly. It's important that the lens's image circle is significantly larger than the sensor.

In this example, you would place the camera slightly higher than the product and shift the camera upwards.

Alternatively, you could fix the camera and shift the lens downward. However, this is disadvantageous for some multi-shot procedures, such as panoramic photography, as the perspective changes when shifting.

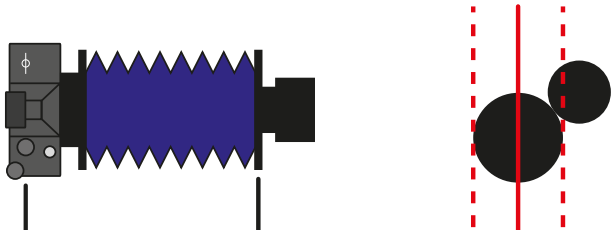
In contrast to this example, in architectural photography, you usually shift in the other direction, mostly to capture a building from the horizon to the roof without having to tilt the camera.

NOVOFLEX PROSHIFT+
Adapter on universal bellows

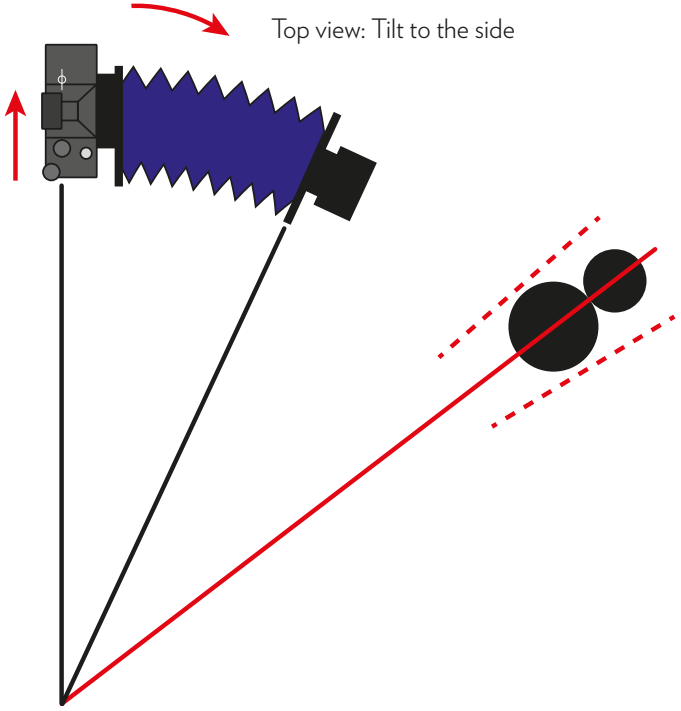
Classic approach: Tilt and shift

Scheimpflug's rule, named to honour the Austrian officer and cartographer Theodor Scheimpflug states that the focal plane, lens plane and image plane intersect in a common straight line.

In a conventional camera setup, the sensor, lens, and focal plane are aligned parallel to each other. The three planes intersect at infinity. Objects are sharply focused on a plane that is parallel to the sensor plane. The depth of field can be extended by stopping down the aperture (dashed lines).



If the lens plane is tilted, the focal plane also tilts. This can be used to sharply depict objects that are not parallel to the sensor plane.



Strictly speaking, tilting the lens according to Scheimpflug doesn't increase the depth of field, but merely rotates or tilts the plane of focus in space. Only when this position of the lens plane is adjusted to the subject does it cause an apparent extension of the depth of field, compared to the usual parallel alignment of the sensor and lens planes.

Tilt to the side

It makes sense to tilt the lens standard, for example, when viewing a flat object at an angle or tilting downwards for spatially extended objects. It should be noted that this focal plane runs wedge-shaped from back to front. The subject must be arranged accordingly. Since both the image section and the angle between the axes change when tilting, it is essential to readjust the focus afterwards, ideally with the aid of a large monitor. This should be done with the aperture open if possible, which can be stopped down for the actual shot in order to increase the extension of the newly positioned focal plane and thus adapt it to the shape of the subject.

Simultaneous "shifting," which means a parallel movement of the sensor up or down or sideways is necessary in order not to crop the subject at the edge, and to move the sensor as close as possible to the centre of the image circle, where the image quality is highest. This prevents the need to tilt the sensor plane, which would cause unattractive "falling lines".

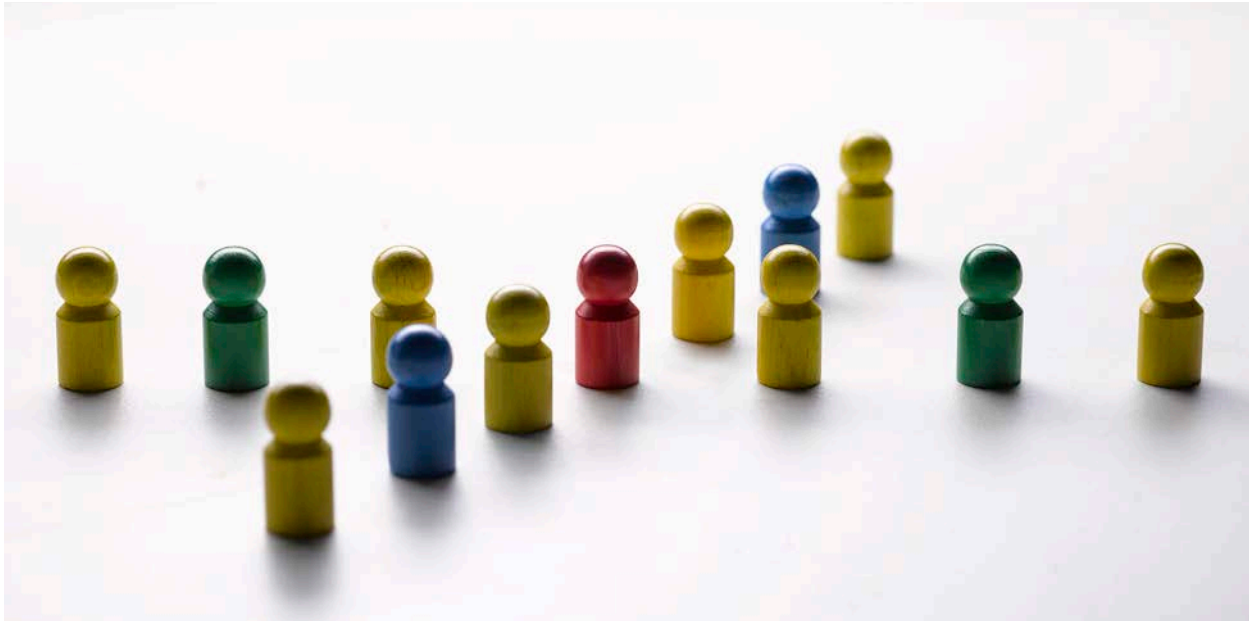
Tilt down

NOVOFLEX offers the Universal Bellows Tilt/Shift (BALPRO T/S) for this classic approach.

For an additional (second) shift direction, the PRO-SHIFT+ adapter can be used, which is mounted between the bellows and the camera.

Disadvantages of this method:

- Long setup and adjustment times. The technique requires a lot of experience. Flat objects are ideal; objects that extend in all three degrees of freedom also require stopping down the aperture.



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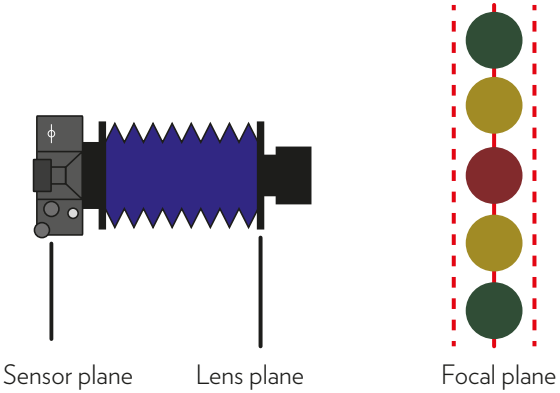
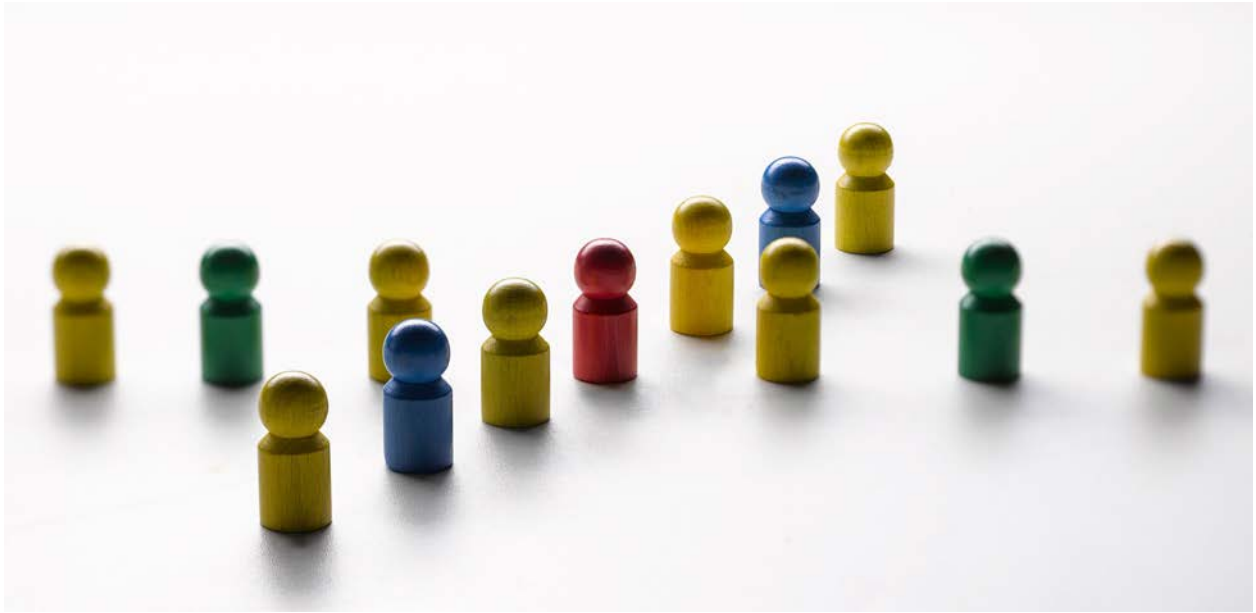
Top view:
Conventional camera setup





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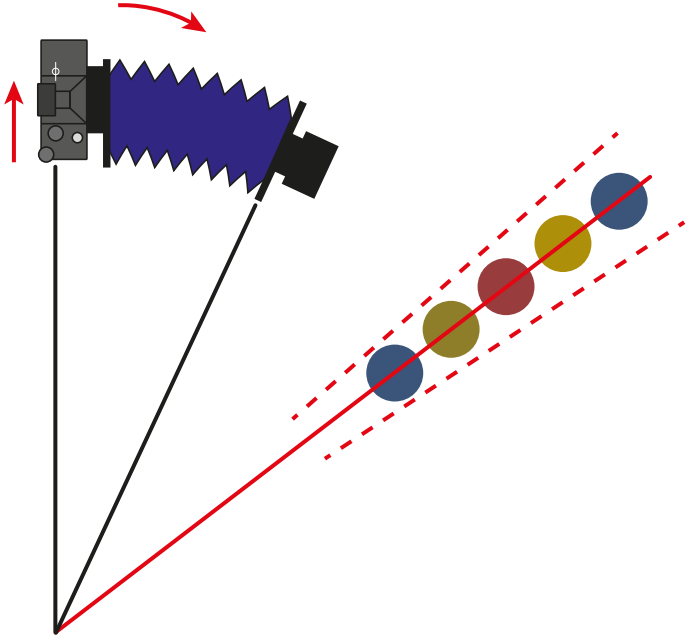
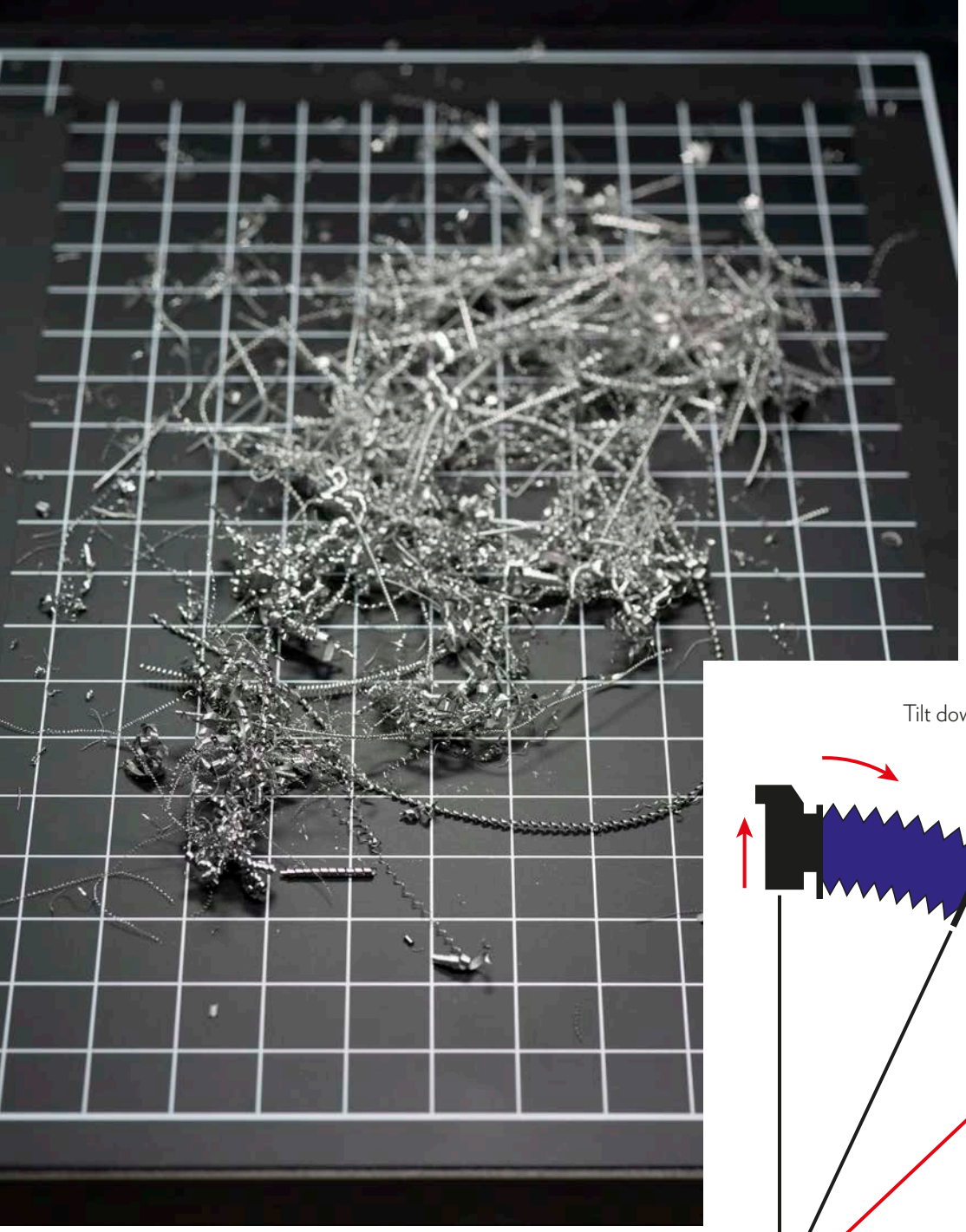
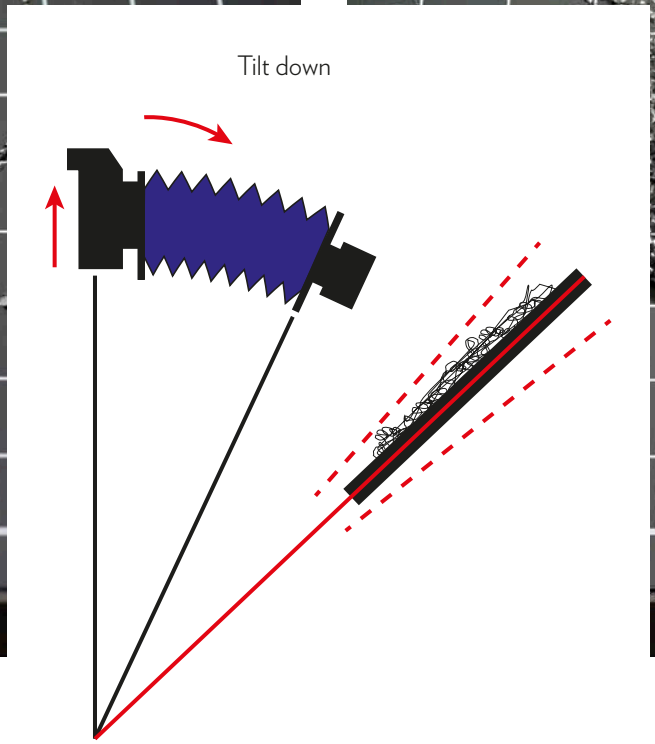
Tilt to the side







Modern approach: Focus stacking

Focus stacking is an ingenious solution for increasing depth of field, using a medium aperture or the so-called optimal aperture. This involves taking a large number of shots with different focus settings. The short focus range thus moves through the image from shot to shot. Software then combines the individual shots with shallow depth of field into a single image with a large depth of field.

For focus stacking in the macro and micro range, NOVOFEX offers the CASTEL-MICRO stepper motor-controlled focusing rail and the manually operated CASTEL-M focusing rail with the focus wheel and detents in its product range.

© Jan Röpenack

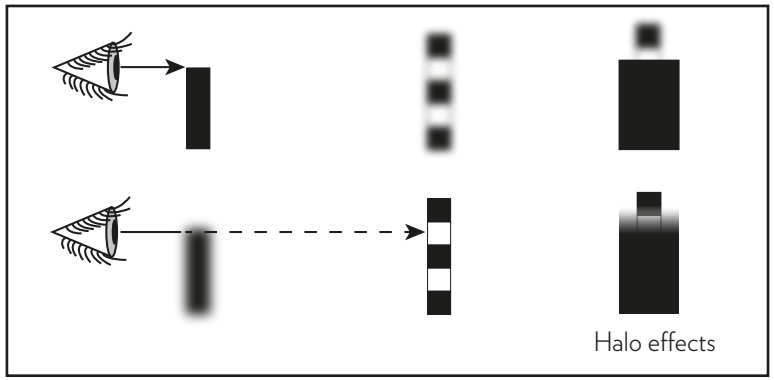
Advantages of focus stacking

- Virtually “any depth of field” without having to stop down significantly, i.e., the highest possible quality by working with the optimal aperture.
- Subjects can be rendered completely sharp, or a specific blur gradient can be created; the sharpness gradient from the last individual shot to the background is determined by the aperture setting and can be controlled individually. Nevertheless, the main subject is sharp and does not look cut out or pasted in, but is naturally integrated into the composition. The focus range can be adjusted precisely. Setting the near and far points is quick and easy.

Examples

Disadvantages of focus stacking

- The subject must not move while the stack is being captured. However, certain motion blur effects, such as flickering candles, can be easily removed using software such as the Helicon Focus retouching function.
- If flash is to be used, the flash system must be capable of emitting all flashes in a series with the same brightness and colour temperature. In most cases, it is more advantageous to use continuous light, e.g., a HEDLER LED light set.
- Blurring, known as halo effects, at edges with large distances, is a common problem with focus stacking. This effect is caused by physics and cannot be prevented. If the focus is in the distance, the edge in front of it will appear blurred. This blurring in the foreground obscures the sharp background. This effect can be minimised using software (Helicon Focus method C). To remove it completely, retouching is necessary, e.g., with Photoshop. In most cases, it is easier to avoid large distance jumps when arranging the object, to blur the background, or to use a structureless, single-colour background.

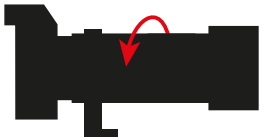


HEDLER continuous light „Content Creators Kit Profilux“: Profilux LED 1000 and Profilux LED 650 (dimmable, flicker-free), MaxiSoft 45 x 45 cm, 360° flap frame, two light stands 2.37 m and LightBag.

Focusing when stacking

In principle, there are three methods for shifting the focal plane between shots when using focus stacking:

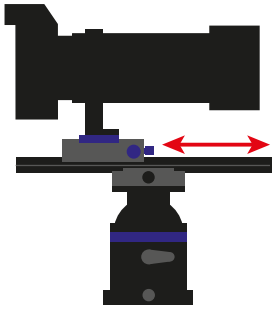
Focusing on the lens, manually or controlled by the camera



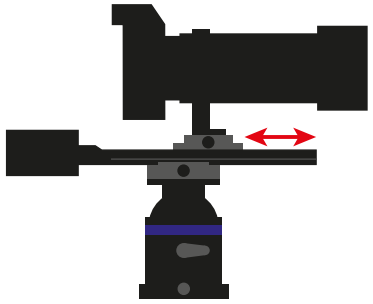
Some cameras have a special feature that, in combination with certain AF lenses, allows automatic "focus bracketing" to be performed. If this function is not available, you will have to focus manually, step by step, i.e. by hand.

Focusing by changing the distance with the aid of a focusing rail

With the classic method of focusing in the macro range, the distance to the subject is increased or decreased using a focusing rail. To ensure a consistent distances between single shots, a conventional focusing rail requires the same number of turns of the drive knob between shots. This is easier with the NOVOFLEX CASTEL-M. Here, the focus wheel is turned to the next detent point. Detent steps are available for magnifications of 2:1, 3:1, 4:1, and 5:1.

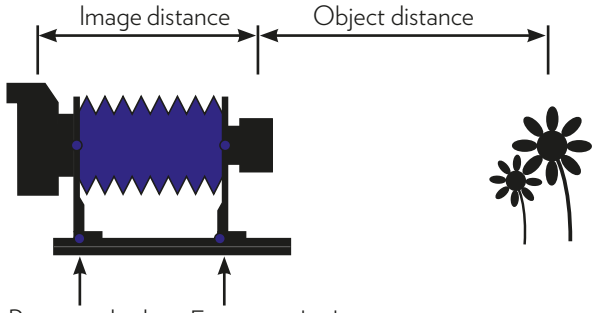


With the CASTEL-MICRO stepper motor-controlled focusing rail, the step size is entered on the control unit. The optics used in the close-up and micro range are a macro or magnifying lens, a standard or wide-angle lens in retro position, a microscope lens with special tube, or a bellows equipped with a lens head in normal or retro position. The entire assembly (camera and optics) is moved forward or backward on the rail for focusing.



Focusing by varying the extension length on the bellows

In macro photography, a bellows allows the image distance to be increased significantly, thereby reducing the object distance and increasing the magnification ratio.

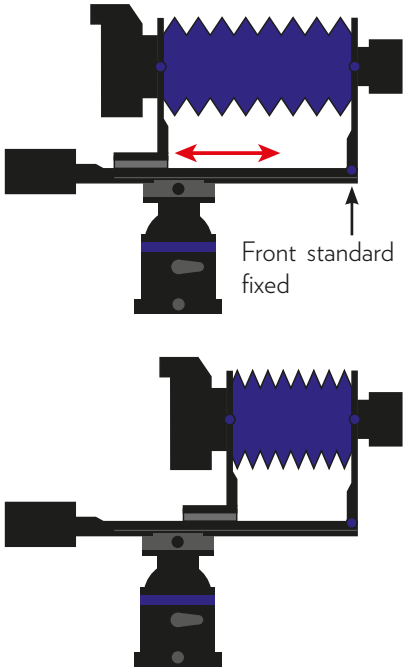


With the STACKPRO 1, a combination of the CASTBAL-PRO bellows attachment and the CASTEL-MICRO stepper motor-controlled focusing rail, and the use of medium or large format lenses, it is also possible to focus at long distances and infinity, just like with a view camera. The use of medium or large format lenses is important because they have a large flange focal distance (image distance), i.e., they were designed for bellows or a view camera. Wide-angle lenses and those for smaller formats (e.g., for 35 mm, APS-C, etc.) usually do not work because the image distance and/or image circle are too small.

The bellows of the STACKPRO 1 is the central component of the setup, allowing flexible adjustment of the magnification over an extremely wide range. The maximum extension length of 100mm is designed so that magnifications from 1:2 to 0 (focus at infinity) can be set with the NOVOFLEX PRO-PYRITE 90, a 90mm lens head from Schneider Kreuznach. This flexibility makes the system an ideal tool for product photography. Larger magnifications, even beyond 1:1, are possible by inserting one or more extension tubes between the camera and the bellows.

Another important point is that, unlike with an attached bellows, focusing is achieved not by changing the distance between the lens and the object, but by changing the bellows extension.

In this case, the front standard is fixed, while the rear standard can move forward or backwards. NOVOFLEX calls this method "stacking camera." Here, the camera or sensor plane is moved, but not the optics or the overall structure! This not only ensures an unchanged perspective for all images in the stack, but also allows for a relatively small step size, which can be used to cover much greater object depths than would be possible with an attached bellows or camera/lens combination. A single step size of 0.3 mm is sufficient for standard focal lengths from 80 mm. This step size is permanently set in the control unit's software, which greatly simplifies the recording process.



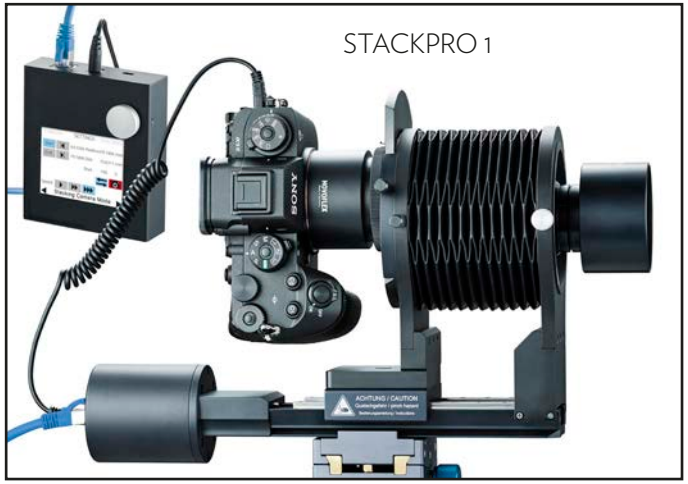
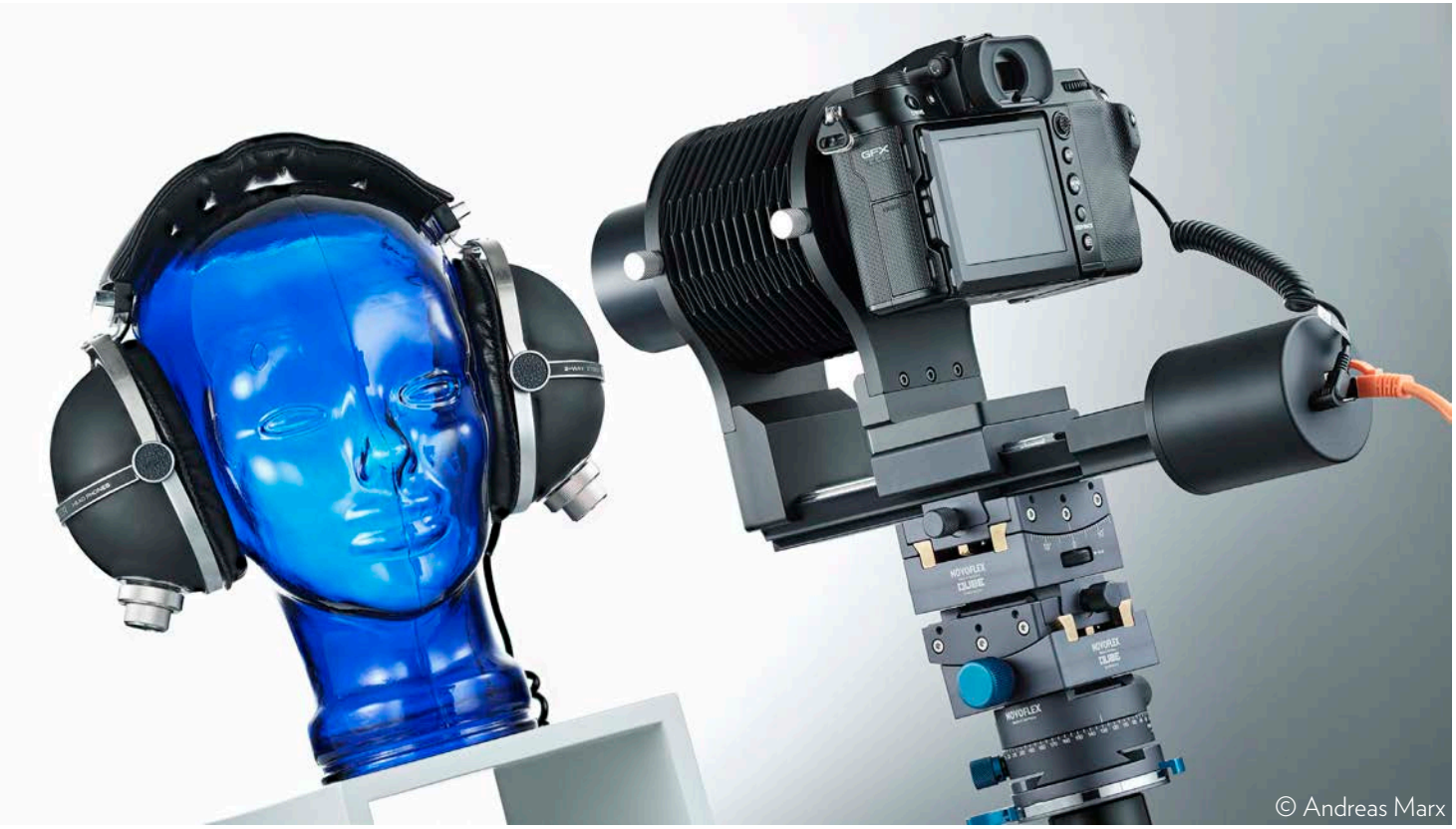


Image above: STACKPRO 1 mounted on camera in combination with PRO-PYRITE 90 lens, PROSHIFT+ shift adapter, and PRO 50 extension tube.

Advantages of the STACKPRO 1 set

- Great flexibility in terms of reproduction scale and subject size. Objects ranging in size from a matchbox to entire houses can be photographed in full format and with a precisely defined depth of field.
- No change in perspective between individual shots, making it easy to use even with shiny objects or reflective image components.
- Existing enlargement and large-format lenses from the past are perfectly suited and can still be used today. These include, for example, Mamiya RB / RZ lenses, various Sironare, Nikon and Schneider large-format lenses with Copal 0 mount (flat or recessed) as well as Leica 39mm thread and others. Many mounts can be easily converted. However, Sinar pressure aperture lenses cannot be adapted.
- For shift adjustment in order to avoid perspective distortion in product photography with rectangular objects, the PRO-SHIFT+ adapter can be combined with the bellows on the rear standard.
- A wide range of adapters are available for 35mm and medium format cameras, including Canon EF and RF mounts, Fujifilm X and GFX mounts, Hasselblad X and L mounts, Nikon F and Z mounts, Phase One IQ3 and IQ4 mounts, and Sony E mounts. Extension tubes with 15, 25, and 50 mm are available for use with longer focal lengths.



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The image on the top left was created from a stack of 13 shots at f/5.6. On the right a 100% view cutout is shown: Details are sharp and perfectly rendered.

Both images were taken in the studio with a Fujifilm GFX Medium Format Camera and the PRO-PYRITE 90. The depth of field extends completely across the object.

The image at the bottom right was created using tilt/shift technique. Since the object is not flat, the aperture had to be reduced to f/32 in order to achieve the necessary depth of field. Diffraction blurring can be seen in the details.

In this comparison, an aperture of f/8 was used in both cases. Using tilt/shift technique, it is possible to capture both bears' faces in focus, but not the writing on the box and the camera at the bottom left.

When stacking 14 images, the focus range can be adjusted perfectly. All important image components are rendered sharply.

The excerpts on the right-hand side, top and bottom, are screenshots of the 100% view.

Image examples

Tin toy, 32 cm x 27 cm x 14 cm (12.5” x 10.5” x 5.5”), stack of 8 shots, © Jan Röpenack

Tin toy, 37 cm x 24 cm x 15 cm (14.5” x 9.5” x 6”), stack of 8 shots, © Jan Röpenack

Universal cutter, 24 cm x 20 cm x 34 cm (9.5” x 8” x 13.5”), © Andreas Marx

Siana bowl from 40-50 BC, Antiquities Collection, University of Tübingen, stack of 35 shots, © Michael Rogosch

Bronze ram from the Roman Empire, approximately 200 AD, Antiquities Collection, University of Tübingen, stack of 80 shots, © Michael Rogosch

Summary and classification: Which method for which application?

How product photos are taken is, of course, up to each photographer. However, when it comes to balancing effort and benefit, I would classify the methods and equipment mentioned as follows:

For simple product photos that serve only as documentation and are intended exclusively for online distribution, **stopping down at a small magnification ratio** is certainly sufficient.

In former days, I used only a flash setup, a 100mm macro lens at f/11, and a DSLR for all my photos for online auctions of used items. For this type of mass production, it's a proven and quick method.

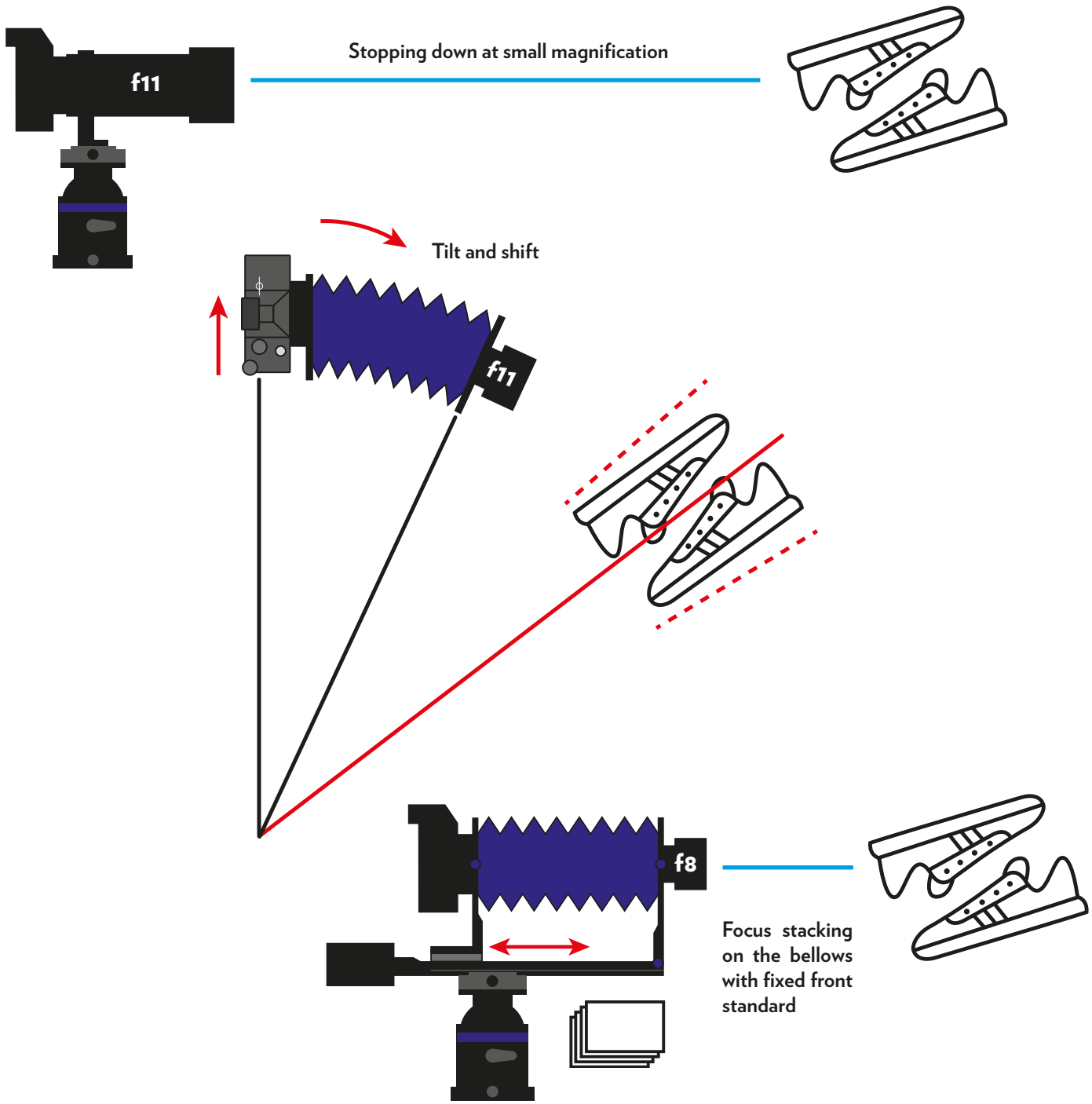
The situation is different when high-quality products are to be presented for advertising purposes. A good photograph can play an important role in the product's market success or in a brand's reputation, so significantly more effort is required here.

The classic approach of adjusting the focal plane to the subject by **tilting and shifting** using a view camera and digital back is complex, time-consuming, and requires considerable experience. Furthermore, this method fails with complex, non-flat objects or arrangements, requiring additional, significant stopping down, which reduces image quality through diffraction blur.

However, for those who limit themselves to "feasible" subjects, have considerable experience, and already have the necessary equipment, this method can certainly be considered for practical reasons and can lead to impressive results.

In contrast, **focus stacking** works with any subject, whether flat or extended in all three dimensions. The only problem is large focus distance jumps behind high-contrast edges, which causes blurring, known as halo effects. However, with a little experience, such situations can be avoided in most of the cases, and if not, halo effects can be retouched using image editing software. Apart from that, focus stacking is a simple and quick method for creating product photos of the highest possible quality. I would particularly recommend this modern approach of adjusting depth of field to beginners.

When stacking in product photography, moving the rear standard of a bellows while keeping the front standard fixed is the ideal method, as this preserves the perspective to be shifted with every shot and enables extreme subject depths. Therefore, the STACKPRO 1 set, which works in this way, will be described in detail in the following chapters.

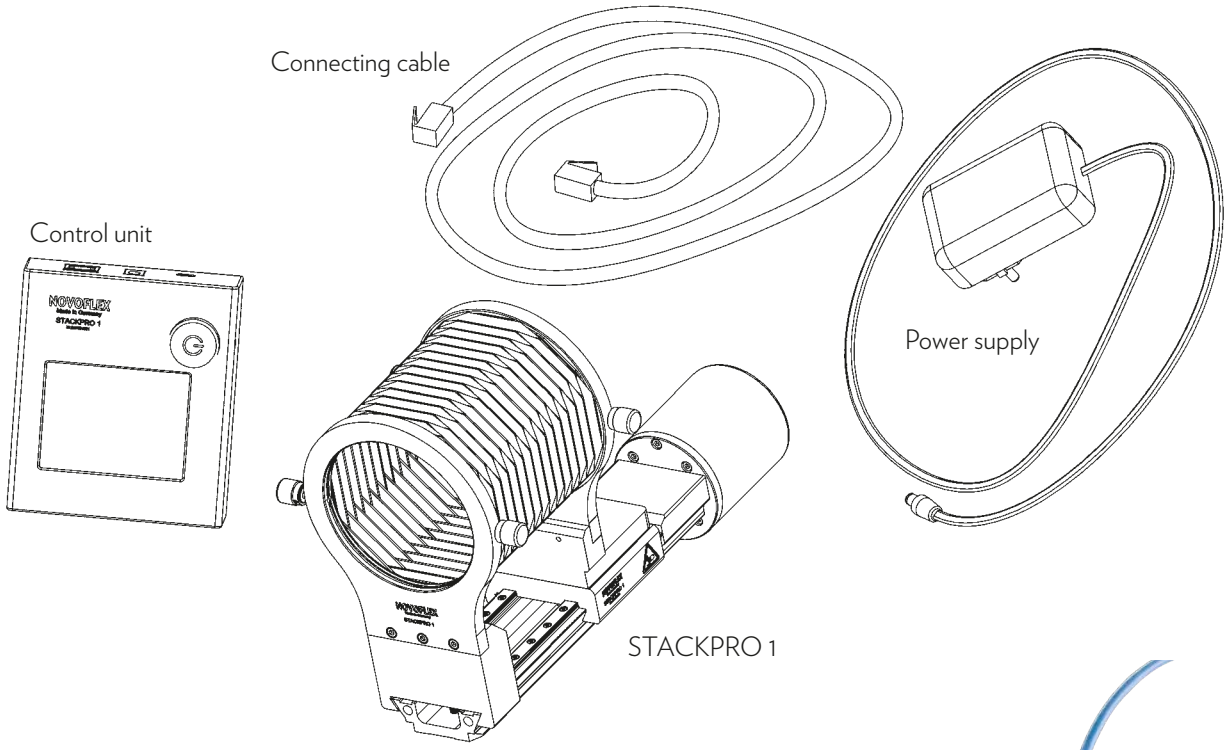


The STACKPRO 1 Set in detail

Components

The set consists of a stepper motor-driven focusing rail, including a control unit with software adapted for bellows operation, and a mounted universal bellows attachment.

Additional adapters for connecting the bellows to the camera and lens, as well as a camera release cable, are required for the unit to operate successfully. The combination with the PRO-PYRITE 90, a 90mm lens head from Schneider Kreuznach, is also available as a special “ready-to-use” set for various cameras (including the necessary adapters).



Camera connection rings

Bayonet	**| Adapter**
Canon EOS RF-Mount:	| EOSRA-K and APRO or PROshift+
Fujifilm G-Mount*:	| FUGPRO
Hasselblad X-SYSTEM:	| HAXPRO
Leica M (Live View):	| LEMA-K and APRO or PROshift+
Leica S:	| LESPRO
L-Mount (Leica, Panasonic, Sigma):	| LETA-K and APRO or PROshift+
Phaseone IQ3 und IQ4 Digital Backs:	| PHASEIQPRO
Sony E-Mount:	| NEXA-K and APRO or PROshift+
Extension tubes:	| PRO15, PRO25 and PRO50

Adapters for SLR cameras are available on request

* Due to its body shape, the Fujifilm GFX 100 also requires a PRO25 extension tube.

Lens mount rings

Bayonet	**| Adapter**
COPAL-0 flat	| PROCOPAL-0F
COPAL-0 recessed:	| PROCOPAL-0
Leica M39:	| PROLEI
Mamiya RB und RZ67:	| PROMAM 67

Lens recommendations

Again, it's important to use medium- or large-format lenses, as they have a large flange focal distance (image distance), meaning they're designed for bellows or a view camera. Wide-angle lenses and lenses for smaller formats (e.g., 35mm, APS-C, etc.) generally don't work, because their focal distance and/or image circle are too small.

When asked about particularly suitable lenses for the STACKPRO 1 set, Andreas Marx, master photographer and head of photo technology at NOVOFLEX, gave me the following recommendations:

- Schneider PRO-PYRITE 1:4,5 F=90mm
- Schneider APO-Digitar 1:4,5 F=90mm
- Rodenstock APO-RODAGON N 1:4 F=105mm
- Rodenstock APO-RODAGON N 1:4 F=150mm
- Rodenstock RODAGON N 1:5.6 F=210mm
- Mamiya Sekor Z 1:4.5 F=250mm
- Many Mamiya lenses for RB and RZ cameras can be adapted and work very well!

Extension tubes are required for the following lenses; they work very well for special perspectives and are very sharp! They come from my SINAR system:

- Rodenstock APO-RONAR 1:9 F=300 mm
- Rodenstock APO-RONAR 1:9 F=360 mm
- Rodenstock APO-RONAR 1:9 F=480 mm

Mamiya lenses and large-format lenses with focal lengths between approximately 80mm and 125mm usually works (depending on the image scale) with the bellows extension alone. For longer focal lengths of the classic design, starting at 150mm, the extension length must be increased. For this purpose, we offer the PRO15, PRO25, and PRO50 extension tubes. For some cameras with a large handle, other (smaller) clamping screws and/or the small extension tube may be necessary. I have a 50mm tube permanently mounted on the 150mm. That usually works well for me. When combining multiple tubes, you should support the extension somewhat if possible. I use a combination of a QPL rail with an L-bracket and a quick-release coupling (Q=MOUNT D).

PRO 50

PRO 25

Essential accessories

A stable setup is essential for focus stacking. A suitably sized tripod and a solid tripod head form the foundation for shake-free shots and are a long-term investment!

A three-way geared head is extremely beneficial as a tripod head, as each axis can be adjusted independently of the others via a fine adjustment mechanism. Alternatively, a goniometer head kit can be used, with each module responsible for a separate axis.

Here are some product recommendations:

Modular Geared Head KOPF^2 Pro Kit with QR-coupling, panorama base-Q and 2x fine adjustment handles

The KOPF^2 is a compact, highly precise three-way geared head. Developed for demanding photographic genres such as architecture, studio, macro, repro, and astrophotography. This innovative head allows independent adjustments across all three axes. With the ability for precise tilting up and down as well as lateral tilting, the KOPF^2 offers unparalleled flexibility. The load capacity is 5 kg. The weight is 1273 g.

Modular Goniometer Head Pro-Kit with panorama base and QR-coupling

This modular goniometer head stands out with its versatile structure, offering unprecedented flexibility to photographers and nature observers. The ARCA-compatible quick-release clamp on the top allows for easy attachment of various devices, while the ARCA-compatible square base on the bottom ensures secure and stable anchoring. The movements can be parallel to each other or offset by 90° to meet a wide variety of photographic requirements. The load capacity is 10 kg. The weight is 1150 g.

TrioPod PRO75 with carbon legs

The TrioPod series is an excellent choice for tripods, allowing for easy interchangeability of legs of different lengths, allowing for optimal adaptation to the respective shooting situation. The upper support plate is secured with 3x set screws. It can be replaced with either the MagicBalance PRO75 levelling ball, the TRIO-CC PRO75 geared centre column or a half bowl to enable the use of 75mm half ball heads. Compatible accessories from other manufacturers can also be used. Three interchangeable mini legs, the QP-MONO monopod adapter, spikes for outdoor use, and a tripod bag are included.

TRIOPROC3940

Max. working height: 154 cm / 60.6”
Min. working height: ~5,5 cm / 2.2”
Folded Length: 57 cm / 22”
Load Capacity: 65 kg / 143 lbs
Weight: 3175 g / 7 lbs

Stacking Workflow

Once the subject and camera equipment are set up, you can start the shooting process.

Shooting

Check the electrical connections:

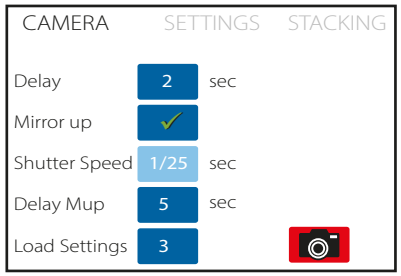
The control unit should be connected to the stepper motor-driven focusing rail via the patch cable (cat 6 or higher). The focusing rail should be connected to the camera via the camera release cable. The control unit should be powered, either via an attached AC power supply or a 12V DC power bank.

Start the system:

Press and hold the big silver knob on the control unit to start the STACKPRO 1 system.

To calibrate, you will now be prompted on the control unit's touchscreen to press and hold the "START" button. During this process, the sliding block moves all the way back to the start position.

In the main menu, select "Stacking Camera Mode", which was developed specifically for the STACKPRO 1 camera set. This opens the "CAMERA" menu, where you can set a delay after the sliding block stops (recommendation: 2 seconds) and the camera's shutter speed under "Delay." A longer shutter speed than set on the camera can be used, but not a shorter one!



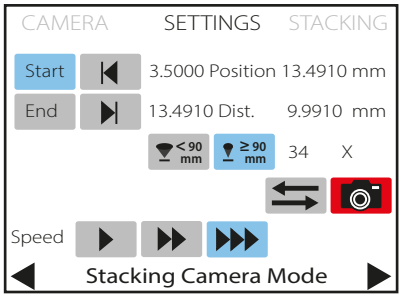
"Mirror up" should only be selected if you're using an SLR camera with mirror lock-up function. Then, under "Delay Mup," enter the time until the vibrations caused by the mirror slap have subsided (typically, several seconds). However, most users will be using a mirrorless camera or a digital back.

Note: The value of the light blue "Shutter Speed" button can only be set using the silver dial, not via the touchscreen. This setting is not automatically transferred to the camera! It only serves as information for the control unit of the sliding block so that it does not continue moving during longer exposure times. **The exposure time must be set separately on the camera!**

With "Load Settings", you can load settings that were previously saved in the STACKING menu.

Now go to the "SETTINGS" menu. Here you can adjust the focus (bellows extension) and the near and far points (start and end points) of the rear standard's movement.

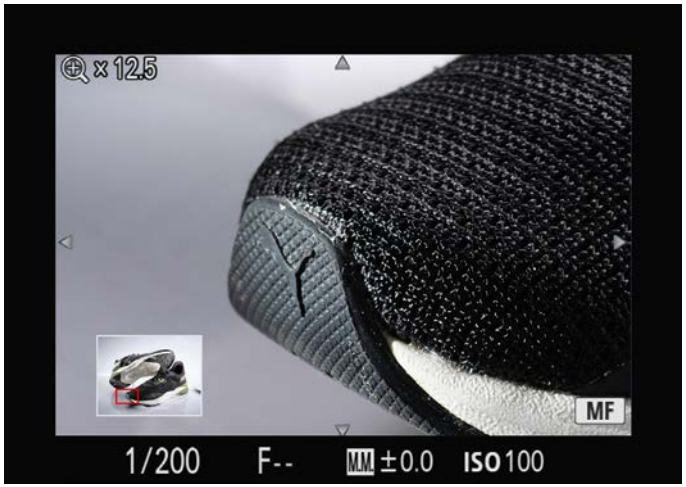
Adjust depth of field:



Now turn on the camera and select a suitable shutter speed in manual mode so that your shots are neither over- nor underexposed. Set a medium aperture (max. f/8 or f/11 to avoid diffraction blur) on the lens. Use the display on your camera or your computer monitor if you are working in tethered mode to frame the image and the tripod head under the STACKPRO 1 setup to move the image section to the desired position.

Please note that the magnification and thus the image section change with each shot when stacking. It's proven effective to start with the closest focus point and then shift the focus back with each shot. The first shot in the stack thus has the largest magnification. It's the largest image in the stack.

Now press the "Start" button (this will change the background colour to light blue and is thus marked as active) to move the sliding block forward to set the near point (which will become the starting point). It is recommended to set the speed to ▶▶▶ for this. Use the ▶ button to move forward. Alternatively, you can turn the silver knob clockwise. The numerical display of the current position in mm will increase as you do so.

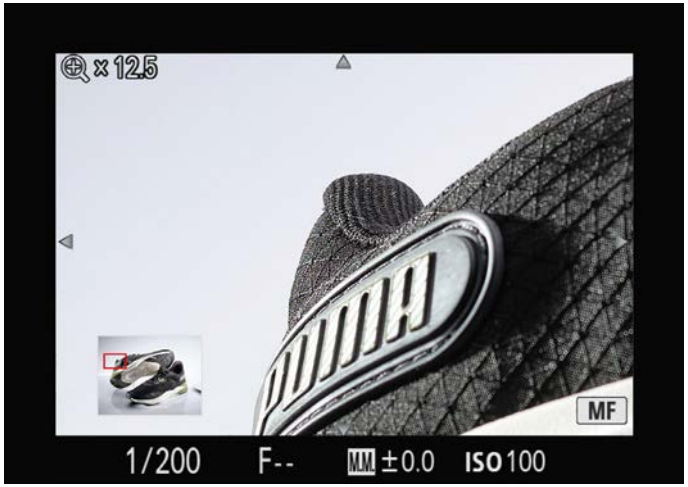


If you want to move the sliding block back a little, e.g. because you have moved beyond the near point, use the ◀ button or turn the silver knob counterclockwise.

If you are assessing the sharpness using the camera display, use your camera's magnifying glass function and zoom in on the image as far as possible. If you are working in tethered mode and assessing the live image on your computer monitor, use the zoom factor of the live view in your software, which allows you to assess the sharpness most effectively.

Once you have found the starting point, press the "End" button, which will be highlighted in light blue. At the same time, the "Start" button will turn grey again and be deactivated. Now use the ▶ button or the rotary knob (clockwise) to move forward to the end of the desired focus range. Once you have reached it, press the "End" button again. It will then turn grey again, i.e., it will be deactivated.

The near and far points, or start and end points, are now defined. The numerical values of the two positions of the rear standard and the distance calculated between these points are shown on the touch display.



Testing sharpness range settings:

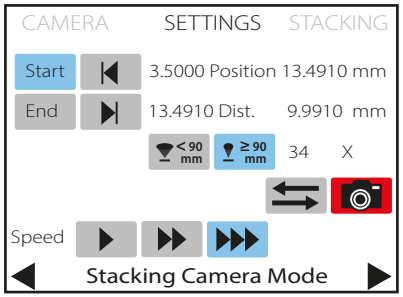
To test the two saved positions, press the I◀ button for the start position and the ▶I button for the end position.

Number of shots and increment:

Now that you have set the distance of the sliding block movement with the start and end points, the control unit has calculated the number of shots and shows the result on the touchscreen next to "Shots".

By using the "**<90mm**" and "**≥90mm**" buttons, you tell the system whether you're using a focal length shorter or longer than 90mm. The increment and the resulting number of shots are then automatically calculated and readjusted if needed.

Other displays on the screen:



The **start and end positions**, as well as the **current position** and **distance**, are now displayed in the upper area of the touchscreen. The button with the two arrows can be used to change the direction of movement of the sliding block or rear standard of the bellows. The red "Camera" button can be used to take a test shot.

Camera settings:

It goes without saying that individual shots in the stack should vary in focus only, not in exposure. Therefore, use a fixed shutter speed and a fixed ISO setting on your camera.

For maximum image quality, you should work with a medium aperture or the so-called optimal aperture. The aperture is set at the front of the lens and usually cannot be controlled by the camera.

If you are using a flash, make sure that it is ready for the next shot within the "delay" time set on the control unit after firing.

For maximum image quality, select the RAW file format on your camera.

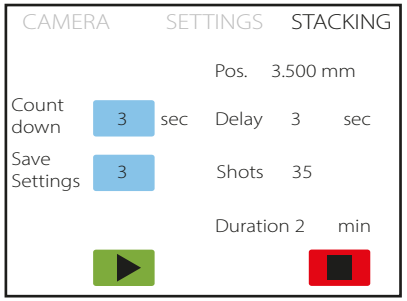
To suppress image noise as much as possible, a low ISO setting is recommended.

If your camera has a mechanical and electronic shutter, it is advantageous to activate the electronic shutter, as this does not cause any vibrations and protects the mechanics of your camera. Rolling shutter distortion is not to be expected, as your subject is not moving. However, you should take a few test shots to check for "banding". This negative effect is caused by the flickering of certain light sources.

The function of the camera and the release cable can be checked by taking a test shot. To do this, press the red camera icon on the touchscreen.

It is recommended to create a separate folder for each stack on the memory card or hard drive. Alternatively, when tethering, the first and last shots of the stack can be marked via the software.

Start shooting:



Switch to the STACKING menu in the upper right corner.

Here, under "**Countdown**" you can set a delay for the first shot if, for example, you want to start shooting only after you have left the room to avoid vibrations.

Under "**Save Settings**", you can save the settings you have made if you want to use them frequently. There are three memory spaces available.

Press the green ▶ button to start the stacking process.

After the countdown, the sliding block moves to the start position and begins the series of shots.

You can cancel the current stacking process by pressing the red ■ button. The settings will be retained. Pressing the green ▶ button again starts a new stacking session. The sliding block then returns to the starting position and begins the new series of images.

The right part of the display shows the current position, the current delay in seconds ("Delay"), the remaining number of shots ("Shots") and the approximate remaining time ("Duration") in minutes.

Stacking is complete when the total number of shots for the stack is displayed again under "Shots." The device is then ready for the next stacking session.

Tethered shooting or camera display and focus peaking?

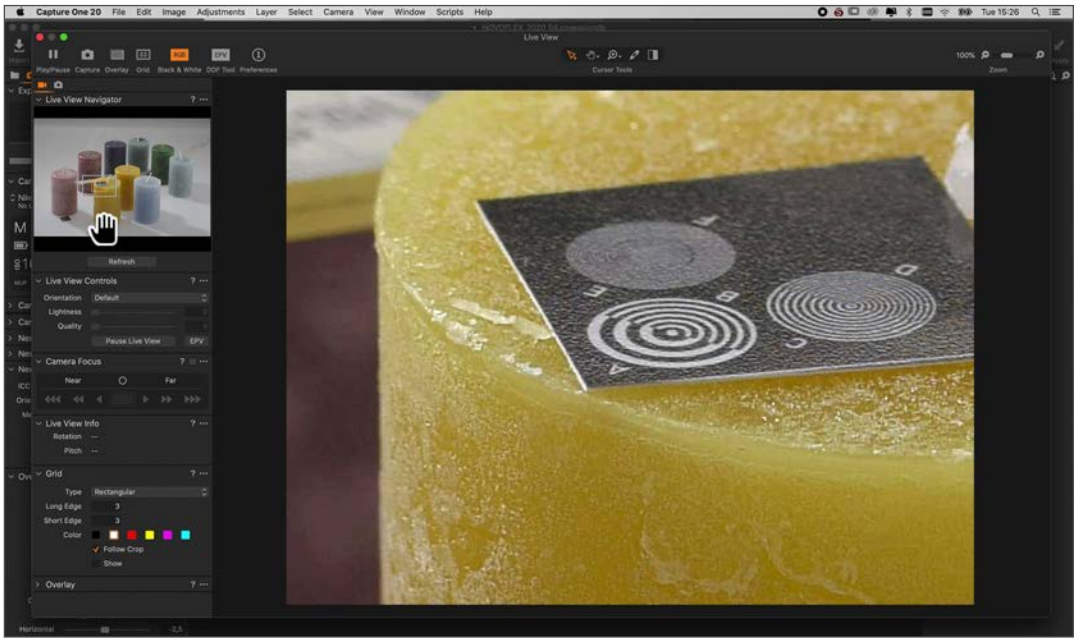
In the previous sections, I described how to assess focus using the camera display or viewfinder. Alternatively, a large screen can also be used for this: With "tethered shooting," the camera is connected directly to a computer, tablet, or smartphone, usually via USB cable or Wi-Fi. From here, the camera can be controlled remotely, and the captured images can be saved directly on the device for subsequent processing.

This method is extremely advantageous in studio photography: The composition and focus can be conveniently checked on a large monitor. When stacking and setting the near and far points, the focus can be checked precisely and usually better than on the camera's display. How well this works naturally also depends on the tethering software used. Almost every camera manufacturer includes a corresponding software. Besides this, common RAW converters like Lightroom Classic or Capture One usually also include a remote module. And this is also the case with the stacking software I use, which is Helicon Focus. Personally, I prefer the Sony Remote because it supports all of my camera's functions. I recommend trying out all available remote programs for your camera to find out which one is best for you.

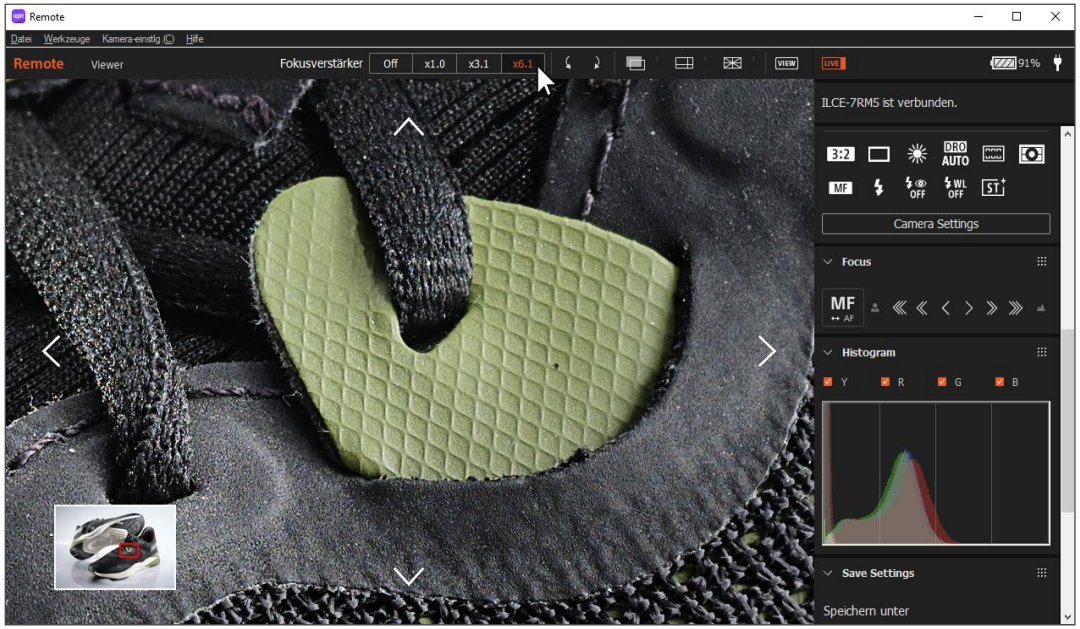
One deciding factor might be whether and how far you can zoom into the live image, which is important for manually adjusting the focus at the near and far points. Regardless of the software used, you should also consider the relatively high power consumption in tethered mode; an external power bank or AC power supply for your camera is a good option here.

Of course, stacking it is also possible without tethering, especially if you are using a high-quality camera with a good display or viewfinder.

With my Sony A7RV, for example, I flip the display toward me and zoom in as far as possible on the viewfinder's image. This allows me to quickly and accurately assess the sharpness at both the near and the far points. Since no cable or Wi-Fi connection is required, I mainly use this simple and energy-efficient method especially for outdoor shootings.



Shooting in tethered mode and optimizing the images taken with Capture One



Shooting in tethering mode using the camera manufacturer's software, in this case Sony Remote

Focus peaking, a camera function that displays sharp areas in false colours in the viewfinder, can be helpful in difficult situations. However, the "false colour" should be clearly different from the colour of the subject.

Frequent changes to the false colour are unavoidable, which can also be annoying. In addition, focus peaking can be quite inaccurate in some situations or at some cameras, so it is essential to check the results immediately after exposure to ensure you have an accurate result. For this reason, I personally don't use this function.

Post-production: Processing the stack

In the following, I would like to describe my workflow for processing the stack as an example. This description should only be understood as a recommendation. Many things can also be done differently or with other software.

My workflow essentially consists of two steps: optimising the individual images with Adobe Lightroom Classic and then rendering the stack with Helicon Focus. Both programs are currently leading in their applications and have proven themselves in many of my projects. Of course, other programs can also be used. Andreas Marx, master photographer and head of photo technology at NOVOFLEX, for example, works with Capture One only in tethered mode when taking the shots and then optimises the images with this software as well. In the final step, he exports the results to Helicon Focus for stacking.

In addition to Helicon Focus, there are many other programs that can be used to process and optimise the individual images in the stack to create a single composite image with a large depth of field. These include e.g. Zerne Stacker, Affinity Photo, and Adobe Photoshop.

Back to my workflow:

Lightroom Classic

To keep the organisational effort to a minimum afterwards, it has proven useful to create a separate folder for each stack on the memory card before shooting, which then only needs to be dragged and dropped into the Lightroom library. Lightroom will then import the entire folder.

Let's continue in the Lightroom "Develop" section. Here, I select a shot that represents the entire stack, in which, for example, an important detail of the subject is sharply focused. I adust this shot as usual in Lightroom in terms of colour, tonal values, details, etc.

When I am satisfied with the result, I select all other shots in the current folder in the bottom row with Ctrl + A and click on the "Synchronize" button at the bottom right to process them in the same way.

Then I export all images as 16-bit TIFFs to a new folder. Alternatively, if you have installed Helicon Focus as a Lightroom plug-in, you can right-click on the bottom image row and click on "Export > Helicon Focus (TIFF)".

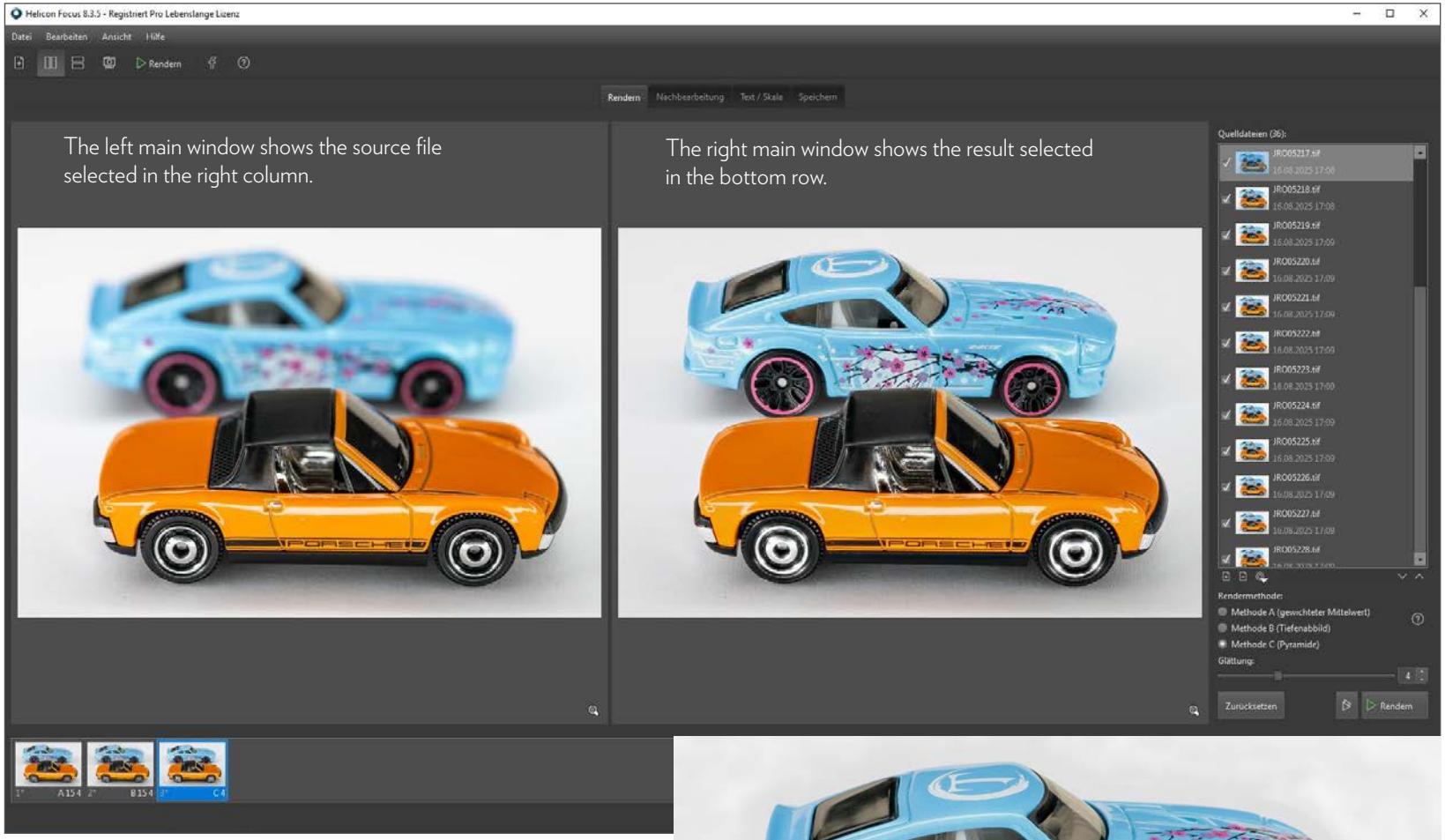
Helicon Focus

Now, continue in Helicon Focus: If you have not exported the files yet; you must now import the previously optimised source files into the software. To do this, simply drag the entire folder containing the adjusted TIFF images into the Helicon Focus window. The files will now appear as thumbnails in the right-hand column of Helicon Focus.

Overview

Helicon Focus is very easy to use and combines individual shots faster than comparable programs. Using the default parameters, the software delivers impressive results just after a few clicks. Adjustments are only necessary for difficult subjects. I'll explain what to do in such cases starting on the next page.

First, the user interface: Helicon Focus is divided into four areas: The source files are displayed as thumbnails on the right side. The current source file is highlighted in grey and is also displayed in large format in the left main window. You can zoom in on this area using the mouse wheel, and you can pan the view in all four directions by holding down the spacebar and moving the mouse.



After clicking "Render," a result is generated, which is displayed in the right-hand main window. A thumbnail of the result is also generated in the lower row. After re-rendering with different parameters or a different rendering method, another result is generated and displayed, also as a thumbnail in the lower row and in large detail in the right-hand main window.

Individual images with different results can now be compared in the two main windows. The views are synchronised. To switch between views, click on the corresponding thumbnail in the bottom row or right column.

Once the best result has been selected, it can be enhanced in detail using the brush tool in the next step, if necessary. More on this later in the section "Problems and solutions."

In the last step, the result is saved.

Right: Result of the stack of 36 individual images, magnification approx. 1:2, NOVOFLEX STACKPRO 1 with PRO-PYRITE 90.

There are three rendering methods to choose from at the bottom right:

Method A (weighted average)

This method is used the least and is well-suited for re-rendering results that have already been generated.

The strengths of method A are smooth transitions and a beautiful bokeh, that means the representation of blur in the background looks best with this method.

The disadvantage of this method is that the sharpness usually decreases slightly and, like method B, halo effects can occur at the edges with large focus jumps (see figure on the next page).

Method B (Depth Map)

This method is the all-rounder and almost always delivers good results. The source images must be captured in sequential order, which is the case with the STACKPRO 1 anyway. Sharp areas in the source images are detected by the software and combined. This creates a relief map, which can later be exported as a 3D model, animation, or depth map. This "depth map" can later be used as a layer mask in Photoshop, for example, if you want to specifically edit only areas in the foreground or background to enhance the spatial impression.

The strength of method B is the preservation of details in shadows and highlights, making it ideal for shiny objects with a high contrast range.

A disadvantage of method B is blur, so-called halo effects, on intersecting lines or on edges with large focus jumps. To minimise these, the manufacturer recommends gradually increasing the radius parameter. The optimal value can only be determined through trial and error. The "Smoothing" parameter determines how sharp areas are combined. A value that is too low leads to artefacts in the transition area of the source images, while a value that is too high leads to a loss of detail. In most cases, the default values already produce very acceptable results. I recommend adjusting them experimentally only if there are visible problems.

Method C (Pyramid)

Method C (Pyramid) increases the image contrast, which can be advantageous depending on the subject, but is undesirable in most cases because details in the highlights and shadows are lost. Bright areas slightly overexpose the dark areas, resulting in a kind of glamour glow look.

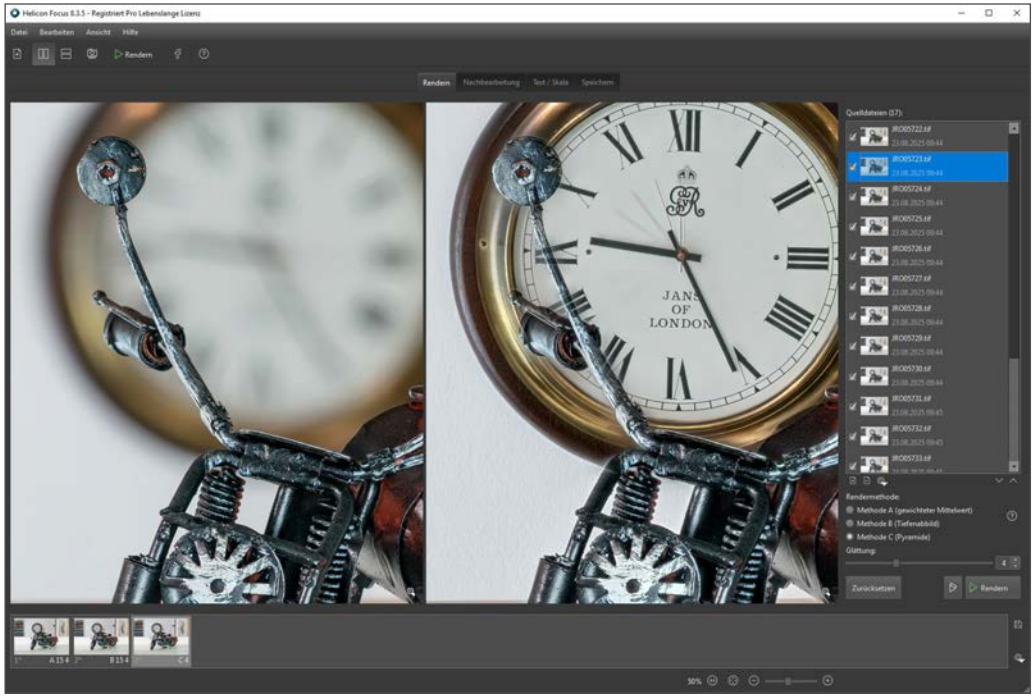
Difficult subject with a 5m distance jump

The strength of this method is reduced halo effects on edges with large focus jumps, which is a big advantage for subjects with complex structures. At such edges, you sometimes have to accept a kind of transparency effect if the software can't decide at certain points or edges whether the foreground or background should be sharply displayed in the result. To resolf this, a brush tool is available in the "Post-Processing" section, which you can use to easily transfer parts of the image from a source image into the resulting image. More about this in a moment.

Comparing sharpness and detail — Method A — Method B — Method C

Rendering

To generate a result, select one of the three rendering methods using the options box and click the “Render” button at the bottom. Don’t worry too much about which method is best suited for your subject. Helicon Focus encourages you to experiment. Therefore, select the three rendering methods one after the other and click the “Render” button after each one. Helicon will then display all previously rendered results as thumbnails in the bottom row. Clicking on the corresponding thumbnail will display the image above it in the right main window. For comparison, the individual image selected on the right is displayed in the left main window.



Checking the results

Now look for errors in order to edit them in the next step: Use the mouse wheel for step-less zooming in the right-hand main window showing the result; the left-hand main window shows the individual shot in comparison and zooms in or out parallel with the window on the right. Use the Ctrl. +1 keys to zoom to the 100% view. To move the section, press the space bar and move the mouse while holding down the left mouse button, just like in Lightroom. Now look at all the results one after the other. They are shown as thumbnails in the bottom row and larger in the right-hand main window, both in the full view (Ctrl. +0) and in the 100% view (Ctrl. +1). In the full view, pay attention to the blurred background and the shadows and highlights. In the 100% view, look for broken edges or transparent areas that allow a background structure to show through. As mentioned at the beginning, the individual images in the stack are shown as thumbnails in the right-hand column. The selected thumbnail with a grey background in the right column is displayed large in the left main window, next to it, for comparison, the result whose thumbnail is currently selected in the column below.

Problems and solutions

Blurring, also known as halos

Halos occur at high-contrast edges where the background is relatively far away. While this is comparatively rare in practice, it’s still important to know how to deal with it. Halos occur with all three methods. Halos are least pronounced with method C.

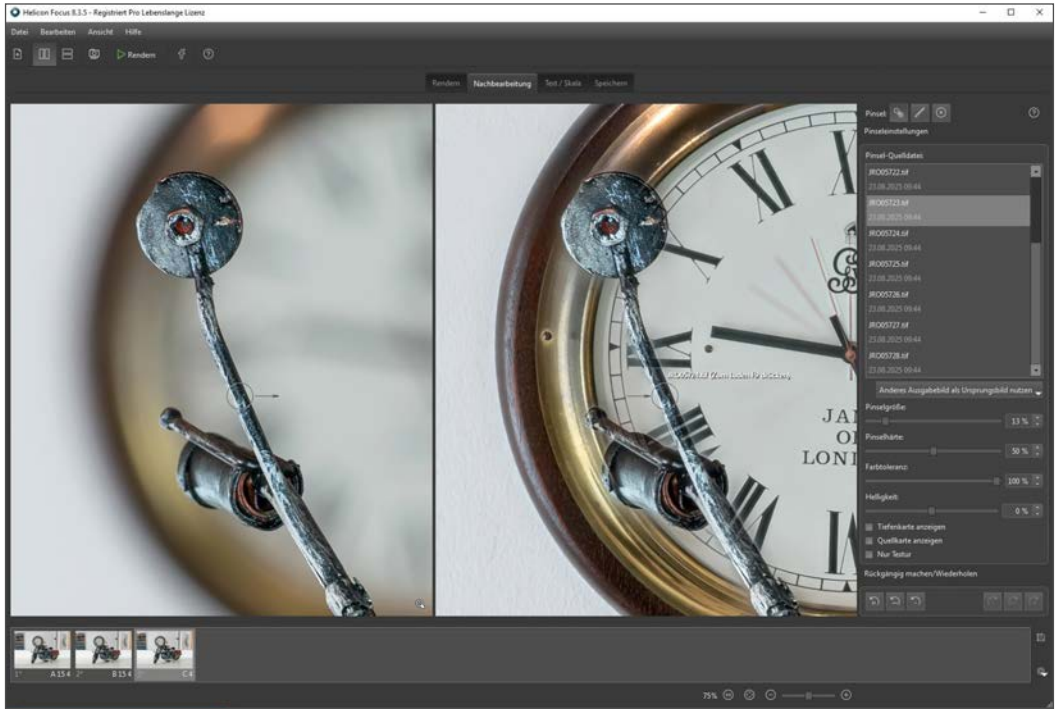
Transparency effect

This “show-through” of the sharp background only occurs with method C and can be easily retouched with the Brush tool in Helicon Focus. When working with method C, you should always check the resulting image for this transparency effect. This effect, like blur, only occurs at edges where the background is relatively far away.

Comparison of behavior at distance jumps: Method A

Method B

Method C



My optimisation strategy: Correcting result C

Now I'd like to briefly explain how I deal with the problems mentioned: First, I render all three methods A, B, and C. For method B, I try different radii. I keep the best result B and delete the poor ones. What remains is A, the best B, and C. Now I first correct result C with regard to the transparency effect:

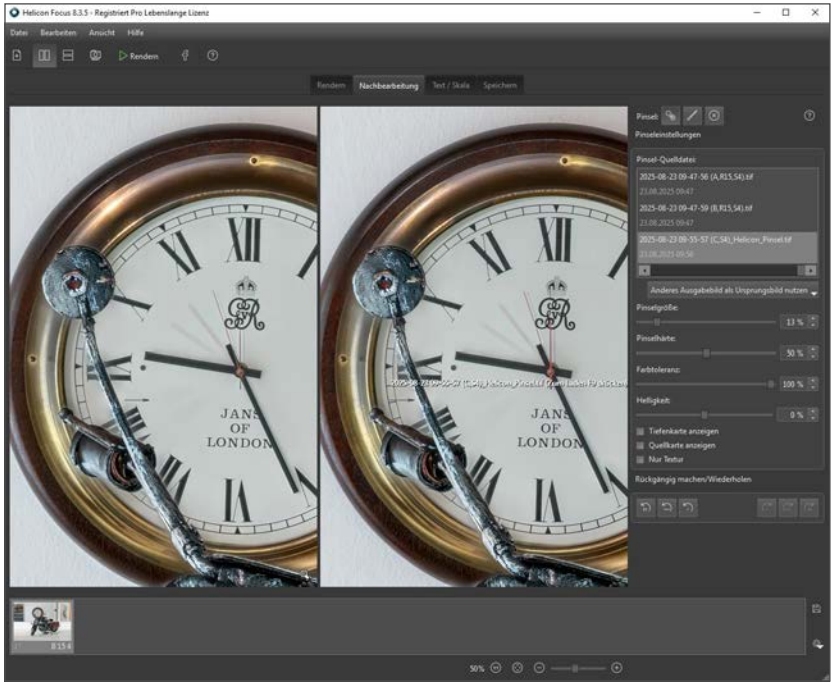
To do this, I look at all edges in result C where there are large focus jumps in distance. I use the mouse wheel to zoom and the spacebar in combination with the mouse to move the view.

Once I've found a transparent area, I switch to Post-Process mode at the top, zoom in deeply into the main view, and set a small brush size (10% or less) in the bottom right corner.

To copy, I now need to find the appropriate individual image that shows the edge sharply but without transparency. To do this, I try out various "brush source files" by clicking in the right column. The corresponding file is then displayed in the left main view.

Once I find a file that shows the required area sharply, I copy the corresponding areas from the left to the right main view by clicking or by hovering over them with the mouse button pressed (see screenshot on the left).

After correcting all transparent areas or edges in result C, I save all three results (A, B, and C). To do this, select "Save All..." from the File menu in the top left corner. I select TIFF as the file format and the same folder as the source files as the output folder. Helicon Focus names the files according to the date, time, method used, and parameters, which is particularly convenient.



Combination of rendering methods

Now I close Helicon Focus, since this software doesn't have a "close project, new project" option.

Then I restart Helicon Focus and import the three previous results, which means A, B, and the corrected C. These files are displayed in the right column. This time I choose method B as the rendering method. After rendering, the result appears as a thumbnail in the bottom left and large in the right main window.

Now I check whether the previously corrected edges have been transferred. To do this, I switch back to post-processing and select result C in the top right as the "Brush Source File." By zooming and panning, I check whether the corrections I previously made in source file C have been transferred to the new result B. If my corrections have not been transferred, I use the brush tool to copy them from source file C to the new result B, that means from the left main view to the right main view.

You'll notice that in most cases, Helicon Focus combines all the strengths of the different methods in the new result. This means the software uses the areas from result A for the unstructured surfaces, the particularly well-defined shadows and highlights from result B, and the best edges without halo effects from result C. This is usually the case! However, you should always double-check this. The three source files can be selected in the top right corner and directly compared with the result in the two main windows. If necessary, use the Brush tool to make adjustments.

By the way, in addition to the Brush tool, which allows you to transfer elements of the source files into the resulting image, Helicon Focus also offers a Clone Brush. This works similarly to Photoshop's Stamp tool. Unlike the Brush tool, it only moves pixels within the resulting image.

And that's it. After saving, I optimise the result with Adobe Photoshop if necessary, e.g., to remove dust or adjust the image section.

Result

I would like to emphasise again that large focus distance jumps (5m in this example) are extremely rare in product photography, and "normal" subjects require significantly less effort in post-production, especially if you isolate the product or blur the background, which is required in the vast majority of cases anyway. My subject, the 37 cm x 24 cm x 15 cm (14.5" x 9.5" x 5.9") tin toy, would certainly not be placed in front of a wall clock in practice. However, this setup was extremely helpful for me to understand the behaviour of the software and develop a workflow that allows me to achieve impressive results even with difficult subjects.

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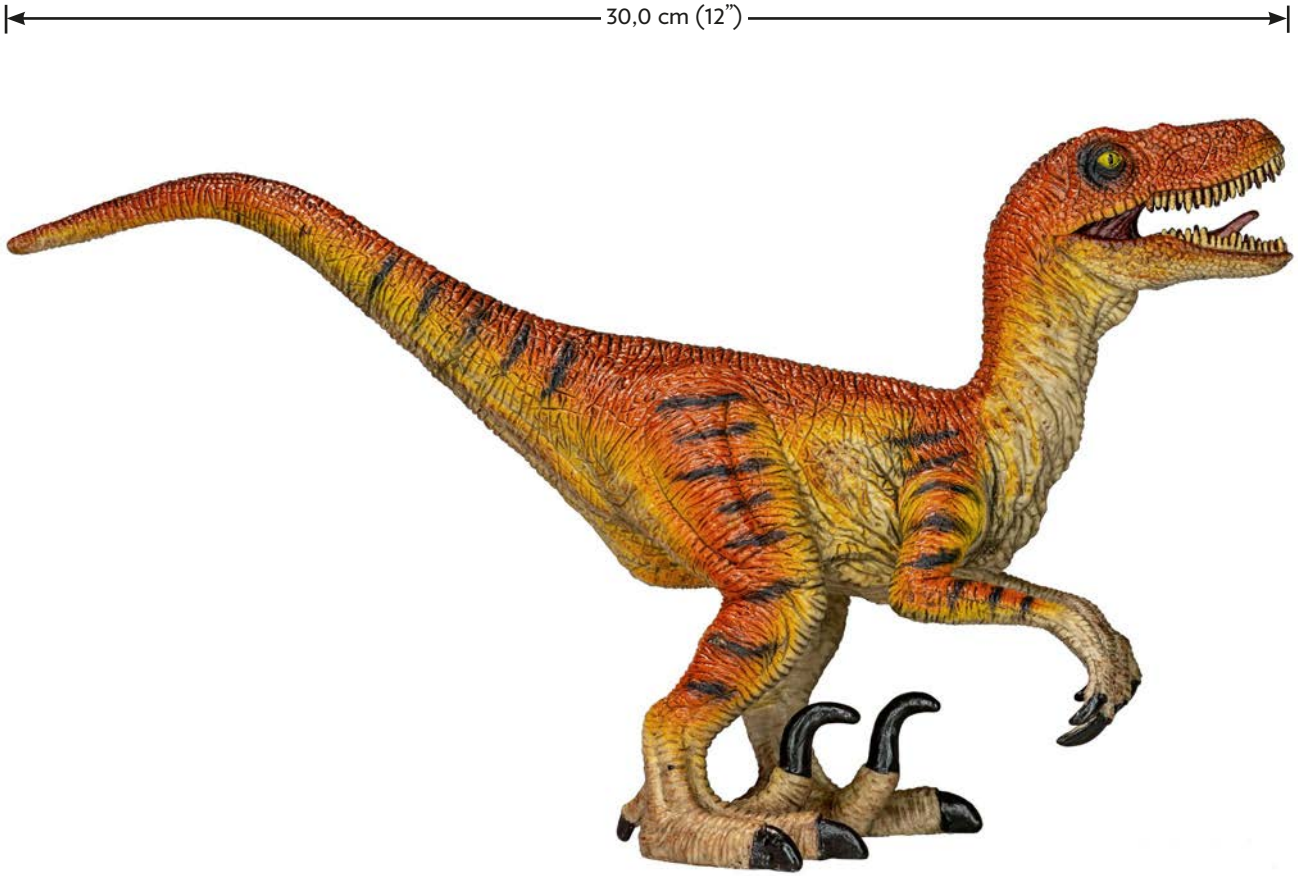
A "normal" subject as a cutout, which requires significantly less post-processing. © Andreas Marx

The background fades into blur. © Andreas Marx

The Velociraptor in the Isar's floodplains – an outdoor stacking project

When NOVOFLEX provided me with a pre-production model of the STACKPRO 1 to test, I naturally thought about which subjects would be best suited to try out the device. I decided that objects that are difficult to photograph in classic photography due to limited depth of field would be a good choice. So I decided on Matchbox cars, tomatoes, and tin toys, which I photographed in the studio in the classic way, as potential customers are used to and expect. With Red, however, I also wanted to test the system's suitability for outdoor use in natural light.

Red is Blue's little brother and a replica of a Velociraptor; this species lived about 80 million years ago and grew to about the size of a human. My specimen, however, is still a baby, measuring about 30 cm (12") long, 16.5 cm (6.5") high, and 9.5 cm (4") wide, so it fits perfectly in my camera backpack. I bought it in the toy department of a drugstore. Not only does he look good, but he's also ideal for stacking projects, as his surface features numerous folds and textures that make it very easy to adjust the focus point using the camera viewfinder.



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First, I set up Red in the studio to take the usual catalogue photos. The dinosaur was to be photographed in a documentary style so that it could be compared with others, for example. I ensured even lighting against a white background. For the stack of the side views, I only needed four individual shots at f/8, and nine for the front view due to the greater depth. The results were easily rendered with Helicon Focus and then cropped with Photoshop - all routine, nothing special.

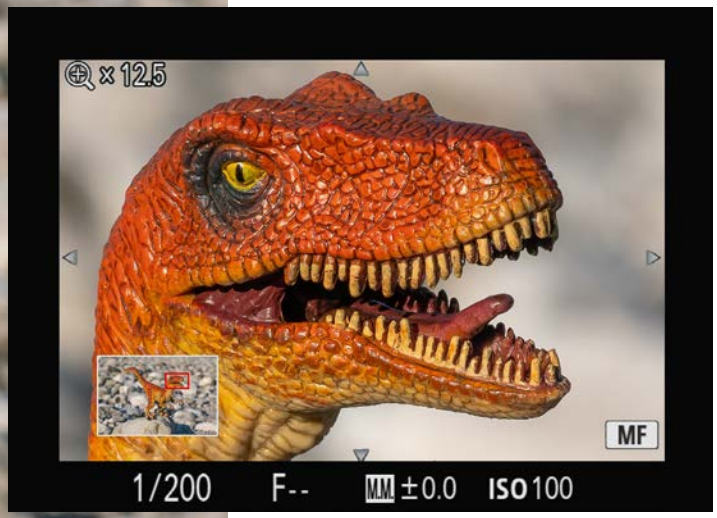
Then we went into the garden. I let him run around a bit in the tall grass and photographed him as he stalked a bird. This stack consisted of 9 individual shots. I was quite pleased with the result: the raptor in its natural environment.

Now I wanted to show a bit more of the landscape in the background and planned a detour to the Isar's floodplains near Lenggries, as the pristine river landscape there might look similar today to what it did in the late Cretaceous period.

Since the STACKPRO 1 is easy to disassemble, the entire equipment, including the KOPF^2 geared head and Red, fit into my medium-sized thinkTANK Street Walker Pro photo backpack.

Since I wanted to work as close to the ground as possible, I used only the short QLEG Mini stubby legs for the TrioPod tripod, which also fit in the backpack.

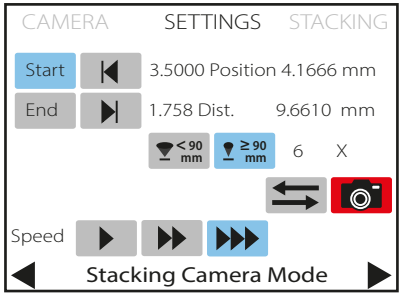
Early in the morning, I positioned Red in the natural river landscape and set up my equipment about 1.5 meters (60") in front of it. The tripod's short legs were spread at a 90° angle, allowing for a low camera position. I powered the control unit with a 12V power bank. After the system was started, I first roughly adjusted the focus on Red by moving the back standard forward with the control unit while simultaneously viewing the camera display. Then I adjusted the final image composition using the KOPF^2 geared head: I used the lower rotary plate to adjust the angle position around the vertical axis (panning), and the fine adjustment screws to adjust the angle positions around the transverse and longitudinal axes (tilting and tipping over). Of course, the electronic spirit level on my Sony camera was also helpful.



Next, I adjusted the exposure: I set the aperture to f/8 on the front of the PRO-PYRITE 90 lens and, in manual mode on the camera, an exposure time so that the light meter in the viewfinder showed +-0.0. The histogram did not show any peaks on the right or left edge. I found the correct value within a few seconds by trial and error.

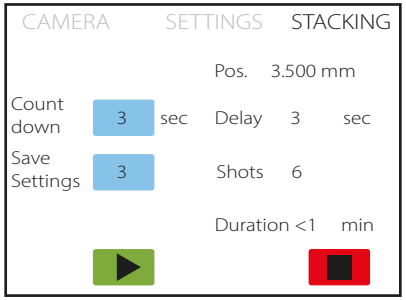
Now I turned my attention to the depth of field: I wanted to focus on the raptor, which I had previously placed at a slight angle to the sensor plane in order to create spatial depth. Consequently, I set the near point on his snout and the far point on the end of its tail. To do this, I zoomed in on Red's snout as far as possible using the camera display and moved the rear standard forward using the control unit until the camera display showed a sharp, detailed image. I saved this position by tapping the "Start" button on the control unit in the "SETTINGS" menu.

Next, I had to set the far point. For this, I pressed the "End" button on the control unit. On the camera display, I zoomed in as far as possible on the end of Red's tail and moved the rear standard further forward using the control unit until the camera display showed a sharp, detailed image of the end of his tail. By touching the "End" button again, this position value was accepted.



With my pre-production model, I had to reconfirm the 0.3 mm increment, which NOVOFLEX later stated will no longer necessary in the future. The control unit display now showed 6 exposures under "Shots" and less than one minute under "Duration." I then switched to the "STACKING" menu, checked the cable connection to the camera again, and started the stacking process by touching the green ▶ button.

Once this was complete, I immediately created a new folder on the camera's memory card in order to be ready for the next stack.



In the next attempt, I set the far point all the way back on the river and was curious to see how this would affect the result later on. I then tried out different camera positions. The entire equipment could be easily carried under my arm and moved to another location. Changing locations is therefore no problem for short distances.

After the light became too bright and therefore unpleasant, I ended the shooting and then devoted myself to my sporting activities. In the evening, I worked on post-production as described in the previous chapter. I discovered that the stacks that blend behind the subject into a blurred background were absolutely easy to process, without any issues. I used Helicon Focus with method B, and that was it - no errors to correct!

Things were different with the stack that also included a sharp, distant background. Depending on the distance between the dinosaur's contours and the background, the inevitable halos are sometimes clearly visible, sometimes less so. This is nothing that can't be fixed with Helicon or Photoshop retouching. In my opinion, however, the sharp background detracts far too much from the subject. Nobody is interested in the distant rocks when there's a dinosaur in the foreground. So I skipped the retouching and stuck with the perfect version with the blurred background.

Result above: Stack of 6 shots, with the near point placed on the snout and the far point on the end of the tail. In contrast, in the result on the right, the far point was placed on the river. This stack consists of 30 shots. The "all-over sharpness" is very distracting from the subject.

My conclusion: Focus stacking with the STACKPRO 1 is a simple technique that works amazingly well, solves a fundamental photographic problem, and quickly leads to the desired result.

Velociraptor, 30 cm x 16,5 cm x 9,5 cm (12” x 6.5” x 4”), stack from 7 shots, © Jan Röpenack

Imprint

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Status: 12/25