

Focus Stacking Tutorial (Rev. 1.)

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Focus stacking is a method used to dramatically increase the depth of field (DOF) by incrementally changing the focus distance while taking multiple exposures of the subject.

The focus stacking software will select the part of your subject which is in focus from each exposure and combine them to make one image where the entire subject is in focus.

Focus stacking is usually applied to macro photography but can be used for any situation where increased depth of field is desired.

Equipment required for macro focus stacking -

- Focusing rail, camera and a sturdy tripod;
- macro lens (or close-up filters, or extension tubes, or bellows or reverse lens adapter etc.);
- some type of tape which can be used to mark the scale on your focusing rail;
- remote shutter release;
- auxiliary lighting, (optional) soft boxes, flood lights, electronic flash etc.
- Post-processing software which is capable of focus stacking.

The next picture shows a typical macro focus stacking setup.
A camera with a macro lens on a focusing rail on a tripod



Set-up -

Choose a subject which will remain very still as the process will take some time and any movement must be avoided. Indoors is best as there is no wind.

If you prefer natural light, set up your subject near a window in daylight.

Mount your focusing rail on your tripod and mount your camera on the focusing rail.

Because you are using a tripod and have a stationary subject you can carefully compose the picture so you will not have to crop much. Adjust the lighting and get everything right because once you start you will not be able to make further adjustments.

Live insects are a huge challenge because they will probably move before you are finished. If you choose an old dead insect it will probably show some signs of deterioration.

Some people capture insects and slow their metabolism by cooling them in a refrigerator and thereby keep them immobile while carrying out the photo session.

Flowers make a great subject for focus stacking.

Once you have the picture composed you will notice that your depth of field is very shallow.

Select manual focus and start by focusing on the nearest part of the subject using the manual focusing ring on the lens.

Do not touch the manual focusing ring again.

Procedure -

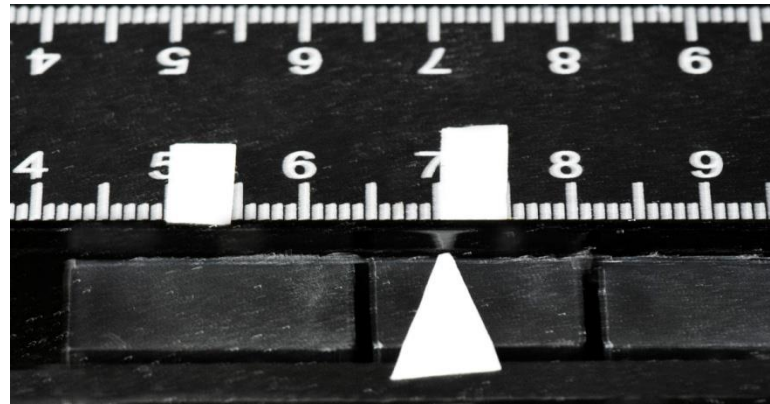
Cut a piece of tape in the form of an triangle and attach it to the frame of the focusing rail pointing at the distance scale.

Cut another piece of tape and place it on the distance scale aligned with the arrow. The arrow is now pointing at the location where the focus is on the nearest part of the subject.

Move the distance adjusting knob on the focusing rail (not the manual focusing ring on the lens) while observing the subject through the viewfinder or the LCD screen until the furthest part of your subject is in focus.

Cut another piece of tape and attach it to the distance scale opposite where the arrow is now pointing.

You now have the starting point and finish point for your stack of exposures.



You must decide how many exposures you want to include in the stack. Very high magnification will require the exposures to be taken more closely together than lower magnification.

You will learn from experience how closely to take the exposures for different magnifications.

If you take too few exposures your subject will have out-of-focus bands along its length. The objective is to get your subject in focus from front to back.

A good place to start will be to use each increment on the scale. Each increment on the rail shown is one millimeter or approximately 0.040 inches. It is better to take too many exposures than too few. Most good focus stacking software programmes will handle hundreds of exposures.

So, let's say for example that the distance between the two pieces of tape on the distance scale of the focusing rail is 1.5 cm as shown above, then there will be fifteen increments between the two tapes. However, it is always wise to take one closer and one farther as a factor of safety.

In this case, your stack will consist of $15+2 = 17$ exposures.

Double check to make sure the you are still focused on the nearest part of your subject using the distance knob on the rail.

You should have your camera set to either Manual exposure or Aperture priority and use a low ISO for best image quality.

Now would be a good time to take a test shot to verify your composition and exposure. You will also have to decide what aperture to use.

Since you are working under very controlled conditions where camera shake or subject movement is not likely, the shutter speed is of little concern and you can choose the sweet spot aperture of your lens for the sharpest picture.

Don't be surprised if your shutter speed is several seconds.

The sweet spot of your lens will be somewhere around f/5.6.

Larger apertures may result in minor aberrations and smaller apertures may result in a little diffraction. Of course, this depends on the quality of your lens.

Usually there is no problem a couple of stops over or under the sweet spot so I would choose f/11 just to get a little more DOF.

This next step is optional - take the test shot, remove the SD card, put it in the computer and take a very close look. Not only to check the exposure but verify the focus.

If you can't easily remove the memory card while the camera is on the tripod you can skip this step.

Don't be afraid to add more exposures either in front or behind the subject if you think you have set the distance tapes too close together. The software can handle lots more.

Once you have replaced the SD card the only thing you want to touch during the process is the knob on the focusing rail which advances the distance.

It would be best to start with an empty SD card because you will have to identify the first and last exposures later. If you have other images on the card hold a piece of white paper in front of the lens and snap a shot before your first exposure. You can do this again after your sequence just to make sure that you have positively identified the first and last exposures of your stack when you select them on your computer.

Shoot the stack -

Back off one increment from the taped start position and take your first exposure using your remote shutter release.

Advance the rail one increment and take another exposure.

Continue until you reach the far piece of tape then advance one more increment and take the last (seventeenth) exposure.

Remove the SD card, install it in your computer and copy your seventeen exposures to an appropriate place on your harddrive as you are now ready to have your software stack the exposures.

Software -

It will be necessary to investigate the focus stacking procedure for the post processing software that you are using.

You can start by looking in your manual or by clicking on the HELP tab or Googling it to find the procedure for your specific post processing software. Not all post processing software supports focus stacking. Focus stacking became a feature of Photoshop starting with CS-4.

If your software does not support focus stacking there are stand-alone software packages which will do it for you. Here are three: [CombineZP](#); [Zerene Stacker](#) and [Helicon Soft](#). Combine ZP is a free programme and the other two have to be purchased. I only know that they are available. Zerene is reported to be the best.

I use Photoshop CS-5 so I will go through the steps for Photoshop.

- Download the stacked exposures onto a separate picture folder on the harddrive of your computer and open Photoshop;
- FILE > Open > Look in (Browse your picture folders, select (highlight) all the pictures in your stack) and click Open;
- FILE > Automate > Photomerge;
- Uncheck the 'Blend Images Together' box;
- Click the 'Auto' Layout radio button on the top left of the page;
- Click 'Add Open Files';
- At the top of the Photoshop home page click SELECT > All Layers;

- At the top of the Photoshop home page click EDIT > Autoblend Layers;
- Check the 'Seamless Tones and Colors' box, click OK and wait until it finishes;
- At the top of the Photoshop home page click LAYER > Flatten Image and wait until it finishes;
- FILE > Save As > (name your picture and specify it to a saved as a JPEG) > click Open;
- FILE > Save

Your stacked image is now ready for any required post-processing.

Note: If you have a very large number of exposures and you get a message that your stack exceeds the maximum size, you will have to reduce the size of each exposure. Try reducing by about 20%.

In Photoshop you can batch reduce pictures as follows:

- Ensure that you have put your exposure stack in a separate folder;
- File > Scripts > Image Processor;
- In section 1, click "Select Folder", browse your picture file, select the folder with your stack and click OK;
- In section 3, enter the desired reduced size of your exposures in both boxes W and H (for example 4000) and click RUN.

Note: This procedure for batch reducing pictures can also be used for reducing your month-end submissions to 1024 pixels. Just put 1024 in both the W and H boxes and the long side will always be 1024 pixels.

Macro focus stacking without a focusing rail -

Theoretically it is possible to carry out a macro focus stack without using a focusing rail.

As with the focusing rail procedure, cut a small arrow of tape and stick it on the lens barrel pointing at the manual focusing ring.

Arrange your setup and compose your picture.

Select Manual focus and focus on the nearest part of your subject.

Carefully place a small strip of tape on the focusing ring so that the arrow is pointing along one edge.

Now manually focus on the farthest point of your subject and stick another small piece of tape on the focusing ring aligning one edge with the arrow.

The distance between the two pieces of tape on the manual focusing ring is the range that you will have to incrementally adjust in order for your subject to be entirely in focus.

Some lenses have a very short throw for manually focusing. If your lens is one of these the two pieces of tape will be very close to each other and it will be difficult to make many incremental adjustments.

If this is the case, select a larger subject so you can be further away then the two pieces of tape should be further apart.

However if the two pieces of tape are some distance apart on your lens it will be easier to carry out the procedure.

As with the focusing rail, take one exposure a little before the first tape mark then carefully rotate the manual focusing ring a very minute amount at a time and take as many exposures as you think necessary, plus one more at the end.

Very high magnification macro stacks will require more exposures than lower magnification ones.

It will not be as convenient or as precise as using a focusing rail but you should be able to make it work.

You can also use another method which I have called Procedure 2 in the next section.

Non-macro focus stacking -

If you are a landscape photographer and have always yearned to have the flowers which are only a few feet in front of you in perfect focus while also having the rolling hills in the background in perfect focus I have a solution for you. Focus stacking.

Just make sure that there is nothing in the scene which is moving.

Your equipment and procedure will be the same as for macro focus stacking but you will not use a focusing rail and you can use your normal lens.

Since your magnification is not large your depth of field will be greater, and the number of exposures to make your stack can be fewer. There are two ways that you can carry this out.

Procedure 1 -

Set your camera on manual focus, place it on a tripod and compose your picture.

Identify an object which is in the extreme foreground of the frame and focus on it using the manual focusing ring on your lens. Take notice which way to turn the focusing ring to reach infinity and identify where the focusing ring is when you do reach infinity.

Take an exposure and advance the focus ring a little. Repeat this, taking several exposures until you have reached infinity.

Focus stacking can be used on any type of picture, not only macro and landscapes. Use it whenever you want more depth of field.

Process the exposures as you would doing a macro focus stack.

Procedure 2 -

Manually focus on the nearest part of the foreground and take an exposure.

Notice where the focus starts to fall off then manually refocus on something a little nearer than the place where you saw the focus fall off and take another exposure.

Repeat this procedure until the most distant object in your picture (or subject) is in focus and you have taken an exposure.

You can use either the viewfinder or live view but because you will be manhandling the camera more with this procedure you must make sure that you don't move the camera.

Additional information -

Do not compose your picture too tightly, leave a little room for a slight crop because your software might not give you a good edge. You may also want to crop out a distracting item near the edge that is not in focus.

Your stacked picture can be post processed to your liking (brightness, contrast, clone out unwanted features etc.).

Some PP software packages will allow you to carry out your edits on one exposure then apply them to all the exposures before you stack them. This would probably be best if you shoot RAW.

In all of the methods mentioned in this article the use of a focusing rail gives the best results.

The focusing rail that I have shown is the least expensive available. It can be bought on Amazon for about \$35. but it does have its limitations.

It uses a rack and pinion to advance the rail.

It is not rock solid but if you are careful not to move it while making your exposures it should be fine.

If you are shooting down at a steep angle the rail may creep if your camera and lens are heavy.

There is a tension knob which will help but do not over-tighten it or other problems will occur. (If you rotate the advance knob when the tension knob is over tightened the rack may become loose on the frame.)

With this rail it is best to keep the camera angle fairly shallow. You can experiment to see how steep you can go without creeping.

There are better focusing rails on the market which use a screw thread instead of a rack and pinion but they will be more expensive.