Macro and Micro Cinematography

Cinematography, Lenses

Introduction

We all love to see images of extreme magnification to show a world which we can't experience with our own eyes but just like all cinematography, this is hard to do well.

The choice right lens for the specific shot is key and this article aims to explain the differences between Close Up, Macro and Micro photography/cinematography and in particular, to introduce the cinematographer to a relatively recent new type of lens for motion-picture, made by Infinity Photo-Optical and which use microscope techniques to create unique images, using a 2 path optical process which increases magnification , producing shots not possible using traditional optics and which require different shooting techniques to achieve the best results.

This article seeks to give the cinematographer a better understanding of these concepts and to improve their close-up macro and micro photography/cinematography and is broken up into 5 distinct sections:

PART 1 – The fundamentals of Macro/Micro imaging

20p piece captured with 100mm Canon 100mm macro T2.8

For regular imaging, the size of the image formed on the sensor is much smaller than the subject itself, so the image of a 10-metre tree might only produce an image 1 cm tall on the sensor. That is a ratio of 1:1000 and is what we are used to seeing with **regular lenses**.

However, as we move closer to small objects, the image size on the sensor increases in size to become much closer to the real-life size of the subject.

Eventually, if we are close enough to the subject whilst still keeping it in focus, we can produce an image that's the same size as the subject and as we approach this point, the ratio becomes 1:1, or life-size or X1 magnification. This is the range where we discern that a shot can be described to be a **close-focus** image.

- Leitz 90mm PL macro is a dedicated macro lens capable of 1:1.5 magnification.

The distinction for a lens to be classified as a **true macro** requires it to produce an image size that is as big or bigger than the subject and up to a factor of ten-to-one (X10 or 10:1).

However, if you require images with a greater magnification than x10, then we must enter the realms of **micro images**, which use microscope imaging techniques to produce both higher image quality and levels of magnification too.

Insect head captured with InfiniProbe TS-160 Robusto Nelsonian lens.
Image courtesy of Clay Bolt

The basic problems to solve to make a choice of lens

We have six problems to solve if you have a given shot to create and this article aims to help you to decide which lenses and accessories to use to create your desired shot and what factors ought to be considered.

Firstly, we need to be able to be very close to the subject and not many lenses allow you to shoot sufficiently close to a subject in order to shoot macro images.

All cinema lenses have a Close Focus measurement, which is the minimum focus distance at which a lens can focus from the focal plane mark on the camera body.

Macro lenses are designed to permit objects to be focussed much closer to the focal plane than regular lenses.

- *Image is Cooke 65mm Anamorphic/i 2x anamorphic macro lens*

Second is lighting. If your lens is very close to the subject, then lighting it effectively becomes quite difficult, especially if you want to shoot with a small iris because you want to maximise your depth of field…

Also, the nature of lighting for macro differs from that of regular photography, since the subject needs to be 'bathed' in light from different directions to maximise resolution and avoid strong shadows.

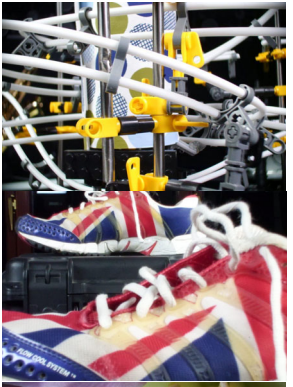
- *Image is Leitz 90mm PL mount macro lens*

Third is depth of field. Generally, shooting

moment) but you can manipulate the depth of field using a number of techniques. Practically speaking, an extremely shallow depth of field makes shooting anything but flat images quite challenging.

- *Image taken with Laowa 24mm EF macro probe lens*

Specialist lenses such as the Infinity Photo-Optical InfiniProbe TS-160 Robusto Micro HM lens, will give an unsurpassed depth of ield not possible with regular macro lenses.

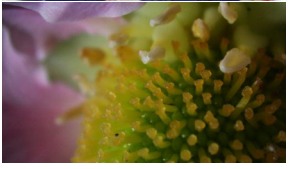


- *Image taken with InfiniProbe TS-160 Robusto Micro HM Nelsonian™ lens*

Using the HM Micro lens mounted to the Infinity Photo-Optical InfiniProbe TS-160 Robusto, allow an unsurpassed depth of field for shots which are not macro.

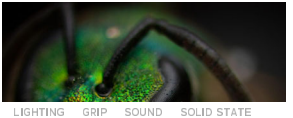
- *Image taken with TS-160 InfiniProbe with Micro HM optic*

Fourth is magnification. A small degree of magnification is possible with regular lenses using dioptres or extension tubes but higher levels of magnification require you to use specific macro or micro lenses.

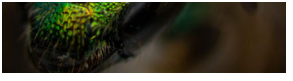


- *Image is MikroMak 125mm Nelsonian™ lens*

Fifth is image quality. Any cinematographer will tell you that not all lenses are made equally and neither are the images that they produce. At very high levels of magnification, image quality varies enormously depending on the build quality of the optic being used and it is safe to assume that dedicated macro lenses will achieve better results than regular lenses in conjunction with dioptres.



In this same vein, Micro lenses will generally achieve better results than macro lenses and especially at extreme magnification, micro lenses outperform macro lenses substantially.

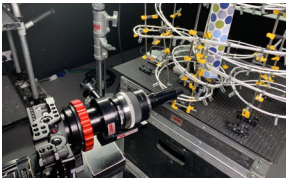


- *Image taken with Infiniprobe TS-160 with HM Micro optic.* Credit: Clay Bolt

Lastly is method. This wasn't in my original

It is therefore imperative for the cinematographer to learn the concept of setting iris at the *Nelsonian point* in order to maximise the image quality of micro lenses, such as the Infiniprobe TS-160 Robusto or MikroMak. The explanation of this point is explained later.

- *Image is InfiniProbe TS-160 Robusto Micro HM Nelsonian lens* (image is 3 above).



Using regular lenses to shoot Close Focus

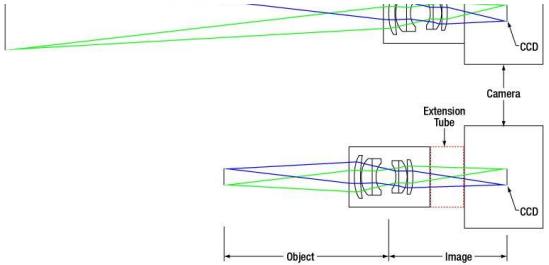
Some film lenses have a macro capability but if a given film lens is unable to shoot macro images, then two common methods can be used to reduce the minimum focus of a given lens and thus increase the object size. This involves using either *Extension Tubes* or *Dioptres*.

Using Extension Tubes

An extension tube is simply a hollow cylinder that fits in between your camera and lens, causing the lens to move further from the sensor. This additional distance allows your lens to focus more closely, which in turn provides more magnification capability.

Unlike most lens accessories, extension tubes don't add any extra optics, and are therefore the most inexpensive, simple devices to achieve close-up photography/cinematography.

- Duclos PL Extension Tube Kit



Extension Tube shortens minimum object distance

- Choose a Magnification: 1:2 (0.5X) 1:1 (1.0X)
- Note: Diagram assumes that the lens is symmetric (pupil magnification = 1).

An extension tube increases lens magnification by an amount equal to the extension distance divicied by the lens focal length.

For example, adding a 25mm extension tube to a 50mm lens will give a magnification gain of 0.5X.

Therefore, if the lens's original magnification was 0.15X, then the new magnification will be 0.15X+0.5X=0.65X.

The closest focusing distance will also decrease to ~210 mm.

Using Dioptres

The second method is to introduce an external lens to the front of the lens called a dioptre, which shortens the close-focusing distance. This allows the camera to focus closer to the subject and achieve a larger image size. If you use good film lenses, then you can achieve very good results and very sharp details shooting small subjects.

Dioptres are another simple and inexpensive method to achieve close-up photography/cinematography and can be considered as placing a magnifying glass in front of your camera's lens, so the quality

A +1 close-up lens will allow you to focus your lens somewhat closer than it already does; A +2 close-up lens will allow you to focus closer than the +1; A +4 lens will allow you to focus even closer than a +2

- Image is of a 138mm full dioptre fitted into PV filter tray

focus even closer to your subject.

A +1 combined with a +2 will equal a +3, while a +2 combined with a +4 will equal a +6, and so on.

The usual way of using dioptres for video is to use 138mm circular dioptres and mount them into 138mm donut holders in matte boxes like ARRI MB19, LMB4x5 etc. Alternatively, they can be mounted into a PV tray (4"x5.65") to use as a slide-in PV filter in a clip-on matte box, such as an ARRI LMB 15/25 or equivalent.

Both methods work equally well.

Dioptres are commonly available in full or split sets (split is a half lens, so that half of the lens works normally and half becomes a close focus lens for specialist shots) and sets include the strengths of +1/2, +1, +2 and +3.

Using split dioptres is an effective way to create two separate fields of view in the same image.

- Schneider 138mm full Dioptre Kit
- Schneider 138mm split Dioptre Kit

Macro Lenses

Lenses don't need to be sophisticated or indeed expensive to give Macro images.

Here are some comparison images of a plate of coffee beans with various macro lenses and all look very alike.

Tokina 100mm Macro, T16, 18" from subject (8.5" to front element)

Leitz 90mm Macro, F20, 17" from subject (8.5" to front element)

Laowa 24mm Probe Lens, T16, 20" from subject (2" to front element)

InfiniProbe TS-160 with Macro optic, 17" to subject (9" to front element)

MikroMak 125mm, 8" to subject (9" to front element)

InfiniProbe TS-160 with SFX-1, 19.5" to subject (8" to front element)

Tokina 100mm Macro.
11" to subject (4" to front element)

Laowa 24" Probe Lens.
19" to subject (less than 1" to front element).
The short distance to front element is partly due to the wide 24mm focal length of the lens.

InfiniProbe TS-160 with HM Micro Optic.
13.5" to subject (3" to front element)

Whilst all of the above shots have a similar field of view and need to be shot close to the subject, it is clear that a narrow 'snorkle' type lens arrangement allows the operator to shoot closer to the subject for a more 'immersive' shot.

Using Tokina 100mm Macro

Using InfiniProbe TS-160 with HM Micro Optic

Macro Lenses vs Micro Lenses.

Not all lenses are created equal...

A 50mm macro lens will give the same images as a 50mm regular lens at the same iris.

However, the construction of the 50mm macro lens will allow a much closer focus to the subject than a regular 50mm lens and can thus produce a larger magnification and produce images which are larger than the subject.

The image to the right is of my herb bed as shot with an iPhone XR, so that you can appreciate just how small the delicate, beautiful flowers are.

To demonstrate the difference between Micro and Macro lenses, I have shot this initially with a 100mm Canon Macro lens

Chive flower shot with
100mm Canon EOS macro lens

Chive flower shot with
125mm MikroMak probe lens

Head of an Oak Hawkmoth taken with a 90mm MikroMak and Olympus twin flash on a Panasonic DCH G9 body
Image courtesy of Paul Harcourt Davies

Snail image taken with MikroMak 40mm Aspheric, 1600ISO Red Gemini
Image courtesy of Mark Payne Gill

Image magnification and focal length all play their part in influencing depth of field

Put simply, the best macro lenses shoot excellent image quality at low levels of magnification which can compare with micro lenses. However micro lenses also allow much higher levels of magnification with extremely high image quality.

However, depth of field is also a consideration, since as you can see from the 125mm MikroMak image of the flower above, high magnification at high focal lengths can create a shallow depth of field which makes focussing very challenging but there is a great technique to allow the cinematographer to both shoot high magnification images AND do so with a high depth of field.

This will be explored in greater detail later.

However, this article is aimed at cinematographers, so let's look at some beautiful examples of video shot with Nelsonian^{tm} micro lenses.

TS-160 Robusto images shot by Roberto Laguna Ditleff Director and DOP
Lens Used: TS-160 w/ Micro HM Objective

Macro lenses vs Probe lenses

A relatively uncommon type of macro lens design is the probe lens which has found much recent popularity.

Designed to maximise the distance between the lens and the imaging plane, higher levels of magnification are achievable with a dedicated probe lens like the Laowa 24mm Probe.

Key advantages are that they are easy to use and relatively low cost but like with other macro lenses, though they do not achieve the same level of quality or magnification afforded by micro lenses.

Another advantage is that they have a wide focal length of 24mm, which allows the viewer to have an 'immersive' experience created by the perspective of the wide angle lens and the closeness afforded by the extension tube design.

- Laowa 24mm Probe lens PL mount
- Laowa 24mm Probe lens EF mount

Chive flower shot with Laowa 24mm Probe lens

Two similar shots of a chive plant taken by a Laowa Probe 24mm lens (above) vs the MikroMak 25mm lens (below).

Whilst the Laowa lens makes a beautiful images, in my opinion the Nelsonian[tm] optics of the MikroMak probe lens below is visibly sharper.

Chive flower shot with 25mm MikroMak Micro lens

- Infinity Photo-Optical 125mm MikroMak Nelsonian Lens with PL or EF mount

Macro and these lenses can ONLY be used for very specific shots. Whilst this is a very powerful macro lens, its small construction lacks an extension tube, which severely limits its use, as it is only able to achieve sharp focus in extreme close focus work.

- Laowa 25mm dedicated Macro lens

Optical laws of physics necessarily dictate that a very close object distance achieves high levels of magnification and an extremely shallow depth of field, as can be seen by the shot inside a daisy flower below, though his also means that available levels of magnification are very limited too, since only subjects of a few centimetres from the front of the lens are focusable.

Unless the object is at precisely 90 degrees, much of the image will be out of focus. From the examples below, a critical setup by Paul Harcourt Davies shoots the eggs of the large white moth perfectly

Laowa 25mm Macro shot inside a daisy. The depth of field is so shallow that focussing is very challenging

Eggs of large white taken with 25mm Laowa. Credit Paul Harcourt Davies

Aperture and Numerical Aperture

As cinematographers, we like to use /f stops so that depth of field is predictable and whilst those rules apply with regular macro lenses and borescope probe macro lenses (like the Laowa 24mm probe lens), Nelsonian[tm] lenses seem to work differently, as you can see from the images produced.

My experience was that I compared shots taken with a 100mm macro and the InfinProbe/HM micro (also 100mm equvalent) and found that the same field of view, allowed a wider depth of field with the InfiniProbe. I used as much light as I could to ensure that the macro worked at the smallest iris setting possible (F22), yet the InfiniProbe combination consistently made images with more DoF. The images tell the story.

Infinprobe TS-160 InfiniProbe with HM Micro optic.

Leitz 90mm PL Macro at F22

Lighting for Macro

During lock-down, I took a number of Nelsonian[tm], macro and probe lenses home to play in the garden and lit the images by sunlight, believing that this would be an excellent natural light source and avoid the need for external lights to help me to learn about macro photography in order to write this paper.

Whilst initial results were perfectly acceptable, I later learned that what I really needed to do was to fully bathe the subject in from of the front lens in light to achieve the very best results, which is why I undertook several further shoots in order to show all lenses at their very best.

It is necessary to bathe the subject in angular light for optimal results.
My temporary studio set up in my home-office!

As a physicist by training, the reason for this seemed difficult for me to understand, so I was referred to a 100 year old book on microscopy by Edmund J Spitta, who explained that a large number of isolated beams are required to form a regular pattern in order to show a complete range of prismatic colours, which become known as diffraction-spectra…

In English, this means that if you bathe the object in angular light, then the results are noticeably sharper. The 'angular' adjective is key here.

> *You need to bathe the object in angular light and the results are noticeably sharper!*
>
> *— Flarsp,hrssed Edmund J Spitta, Microscopy, 1920.*

Dramatic lighting with shadows does not work for optimal macro images.

Probe lens manufacturers know this and both Infinity Photo-Optical MikroMak and TS-160 Robusto allow lighting to be mounted on their shafts using a standard 30mm diameter probe and Laowa probe lenses include a USB powered LED ring light built-into its front housing.

Just how much light do you need?

I know that my colleagues will answer with the rhetorical question of how long is a piece of string but if you choose to use Nelsonian^{tm} optics, then be prepared that they need a lot of light.

For reference, all of the images shot of the running shoes and coffee beans required 2 x Gemini 2×1 and 2 x Gemini 1×1 light panels to expose correctly images using the InfiniProbe and MikroMak lenses.

However be aware that I was shooting at 1/250s shutter speed to avoid blur and would instead have chosen a much slower 1/50s shutter for video which would have needed 1/2.5 of the light level used.

Because I was shooting stills and wanted to avoid shutter shake, I increased the ISO to compensate from 2,000 (at 1/50s) to 10,000 (at 1/250s).

Conclusion: Light from 2 angles and bathe the object in light and if you are using Nelsonian^{tm} optics, then increase the light provision considerably but it will be worth it!

Conclusion Part 1

- So, we have established that for close-subject cinematography, all lenses can be used when used in conjunction with dioptres to reduce their minimum focus distance and increase magnification and this is a very simple solution.
- Macro lenses generally give better results than regular lenses used with dioptres because they are optimised to achieve close focus images.
- Probe macro lenses are more versatile than regular macros, as they increase distance between the lens and imaging plane and provide immersive perspectives.
- Specific macro lenses (short non-probe) can give highly magnified images but offer little versatility.
- Micro lenses give the optimum image quality possible and the highest levels of magnification.

PART 2: Using Nelsonian^{tm} Micro Lenses

Micro lenses are likely to be a completely new type of lens to the cinematographer.

Nelsonian^{tm} Micro lenses do not look like regular lenses and it is important to spend some time to understand them in order to optimise their results, so even experienced cinematographers need to take note here!

Micro lenses use a different method for producing images than regular film and macro lenses, since they rely on microscope optical techniques. As a result, they need a LOT of light to work and haven't really been practical to use until the wide availability of extremely sensitive camera sensors.

I asked Jay Margolis, the president and inventor of the Nelsonian lenses which are discussed at length here, to present me with an optical diagram of how his lenses worked and he was coy about sharing his secret sauce for patent reasons. However, what is most important is understanding how to optimise the images under different conditions.

- Infinity Photo-Optical Infiniprobe TS-160 Robusto Nelsonian lens. Shown mounted with SFX-2 lens optic

Firstly, they have a compound design with interchangeable mount and various optics which screw into the front of the main lens tube to offer maximum versatility.

Practically, once you have screwed the lens mount to the body and mounted this to the camera, all you need to worry about is using the correct optic.

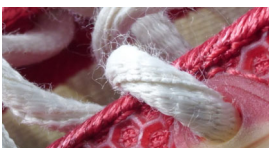
The 5 optics provided with the Infiniprobe TS-160 Robusto effectively give the cinematographer 5 x different lenses in one package.

The Macro optic is the easiest to use for macro, since it makes the TS-160 into a regular macro lens (NON-Nelsonian[tm]) and uses only its secondary optics, focussing directly from infinity to 32mm at 4x magnification. As such, it is very similar in operation to the Laowa 24mm probe lens and even shoots images the right way up. like all regular macros and film lenses.

The Micro HM Objective converts TS-160 into a **Nelsonian dual system** and is best used from 3m (9') to 18mm (3/4") at 16x magnification. At 18mm working distance, it has resolution equal to objectives on a laboratory microscope.

The other three optics, called SFX-1, SFX-2 & SFX-3 are prime lenses designed to work for image 9' (3m) away (see below), which makes them of very limited use.

The images below tell this story better though.



All above images are taken with InfiniProbe TS-160 with macro lens which is perhaps the most useful optic. This tiny optic fits to the front of the Infiniprobe TS-160 Robusto and allows a surprisingly high level of magnification (4x). The best part is that the image is shot the correct way up in common with other borescopes like the Laowa 24mm.

The HM Micro is to be used for close-up work (front optic less than 9'/3m from the subject. These images are of the laces shown above in extreme magnification.

Remember that shooting with the HM Micro means that the images shot are upside down because of the two-stage optical path of aerial imaging.



When shooting up to 3m from a subject, you can still use the HM Micro optic.
They achieve a surprisingly high depth of field as can be seen in the shots above.
Everything sufficiently far away from then lens is in focus.

The other three optics, called SFX-1, SFX-2 & SFX-3 are prime lenses designed to work for image 9' (3m) away. Whilst they do work for close-up images, they are not optimised for this purpose and this use ought to be discouraged, though my experience is that they can be used for close up work to a limited degree.

The SFX-1 is equivalent to a 100mm; SFX-2 equivalent to a 50mm and SFX-3 equivalent to a 33mm. The apparent reason that they are not called 100mm, 50mm & 33mm is that their equivalent focal length changes if the rear extension tubes are reduced in length. The idea is that everything from 3m onwards is focussed to infinity, though I found them of limited use. Some cinematographers have used them effectively though for close-up work, so the choice of how you use them is up to you, as all 5 optics are included in the TS-160 standard package.

What is clear however is that the projection nature of the Nelsonian[tm] lenses means that the image size can be increased indefinitely which makes them sensor independent. I am told that they can cover B4, 16mm, S35 and even FF (36mm x 24mm).

Technically, by adding tubes, the MikroMak or TS-160 Robusto InfiniProbe can project to 67mm sensors or 8x10in. plates if this was demanded.

In fact, the Infiniprobe TS-160 is supplied with 2 x 24mm extension tubes to allow it to cover Full Frame. By loosening a very small screw, you can remove one 24mm rear tubes which doubles the lens's sensitivity and in doing so, it fully covers a S-35 area, so removing one extension tube is a very efficient way to shoot on S-35 format.

Further experimentation allowed me to add further tubes and this effectively zoom into the shot but is impractical, since it increases the level of light required enormously.

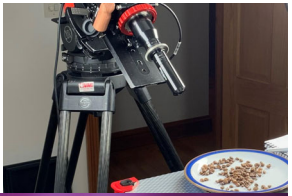
VMI MikroMak Lens Package

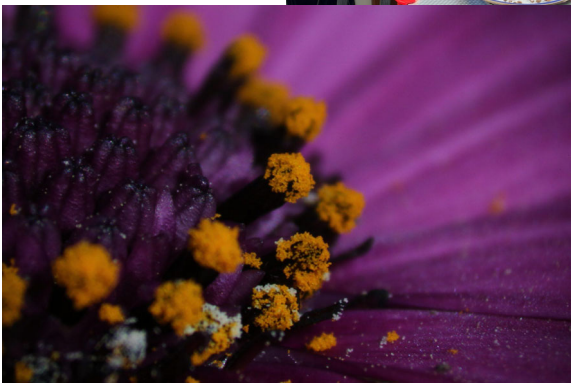
The Infinity Photo-Optical MikroMak lens is a simplified design to the full InfiniProbe TS-160 Robusto.

VMI's package includes 2 x separate lenses which are complete with optic, both designed for close-up work. It includes a

to the 40mm lens in order to convert it to a 25mm Nelsonian lens.

Image is of a 125mm MikroMak lens filming coffee beans.





MikroMak 125mm lens of same pink daisy. The MikroMak is capable of 5.5x magnification and the InfiniProbe TS-160 Robusto is capable of 16x magnification

Upside Down Alert!

One implication of this design is that, with the exception of the Infiniprobe TS-160/macro optic combination, the image is captured ***upside down*** and will need to be inverted to correct it in post. Most quality cameras and indeed many monitors provide an image inversion facility to help whilst shooting but it is important to consider this so that you are not surprised when you use one for the first time.

Since the capability to flip the viewfinder is now commonly available and so too can the majority solid state recorders (Atomos etc), so this capability makes acquisition of inverted images easy.

It is worth mentioning that since lab scopes already invert their images and capture software automatically corrects this, so you can use micro accessories with Nelsonian optics, such as Zeiss lab scope cameras and let the software correct your images too.

PART 3 – Magnification, iris and working distance

Another fundamental lesson that I learned was the trade-off between magnification, distance to object and depth of field. All are connected and a complete understanding will help the cinematographer to achieve better results.

Firstly, the closer the object distance to the lens is, the higher is the magnification. This is a fundamental truism and is pretty obvious to the experienced operator. However if you consider that the angle of light in a highly magnified image is extremely narrow. This means that when shooting, the aperture adjustment (or Numerical Aperture for microscope lenses) becomes crucial to ensuring that the focus remains crisp as highly magnified images produce an extremely shallow depth of field.

It is worth mentioning at this point that the InfiniProbe TS-160 Robusto has specific lenses which are optimised to work at different objective distances from the subject. The cinematographer can use this to their advantage when they discover that they can shoot high resolution, high magnification images at some distance from the object. This is a very useful technique which I shall describe in detail in Part 3.

Conclusion: the closer the object distance to the lens, the higher is the magnification, unless you are using lenses which are optimised to work at a specific distance. In such an example, the above does not apply.

Aperture, Resolution and lens front diameter

Just like in regular cinematography, a smaller aperture achieves a higher DOF.

However, the quality of the image will be ultimately governed by the quality of the lens and in particular, the size of the front diameter, since this will ultimately give the full range of light rays in order to create the sharpest image.

What it means in practice is that macro lenses with the largest front diameter will outperform those with narrow front diameters however this requires a rider if you are using microscope optics, since the necessary requirement to achieving high quality is to be able to accept diffracted rays from the subject.

The practical conclusion of this is that the Infinity Photo-Optical MikroMak which has a front element of 12mm diameter, manages to achieve higher resolution than the 24mm Laowa probe, which only has a 1.7mm front diameter.

The famous microscopist, Edward Milles Nelson is famous for creating the critical illumination of a microscope by setting the iris to the 'Nelsonian point'.

Infinity Photo-Optical InfiniProbe TS-160 Robusto with Micro HM optic

For us non-microscopists, I can simplify this principle to inform you that lenses which are based on 'Nelsonian optics' have a single iris at which point the images are optimised. For the InfiniProbe TS-160, this iris point is shown very clearly with a white dot on the iris ring. The reason why the user is able to

For other lenses which don't have the Nelsonian point marked, it is a fundamental truism that a smaller iris will give a better image quality to a wide-open image. This is a mathematical calculation, which is set for a given lens.

Also, a smaller iris will give a larger depth of field to a smaller iris, a concept which the cinematographer will be extremely familiar with and this is our next subject.

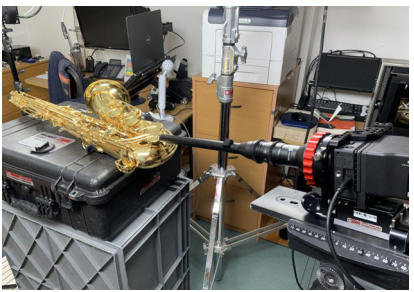
Conclusion: Ensure that you set your iris to the Nelsonian point or a reasonably closed iris for best results.

Magnification, Focal Length and object distance

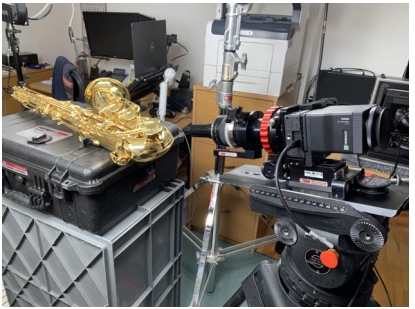
Magnification is magnification. The focal length in macro only means that a traditional lens must work closer than one of greater focal length to achieve the same magnification.

This means that a 24mm macro can achieve the same magnification as a 100mm macro but the object will need to be closer the front of the lens and this will necessarily change the perspective of the image.

Tokina 100mm Macro lens exposed at F22 for maximum DoF.
6" to front element and 14" to image plane. Shallowest DoF of 3 examples.



28". Exposed at F22 for max DoF.
DoF is increased on 100mm but front element is really close to subject.

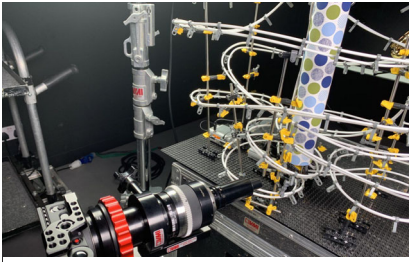


InfiniProbe TS-160 Robusto Lens with HM Micro optic. Front element to subject is 5". Distance to image plane: 16". Exposed at Nelsonian point for optimal results. DoF is increased on 100mm but relative distance to subject gives cinematographer more options

InfiniProbe TS-160 with HM Micro Optic.
Front element is 17" from subject and depth of field increases enormously.

Clearly, a wider lens will have some inherent wide-angle barrel distortion, so a longer macro lens may be preferable.

However, regular macro lenses may be too large to physically bring as close to the object as one may like and for this, probe lenses offer some advantage over conventional macros.



TS-160 Robusto shooting close-up with Micro HM lens for immersive experience

InfiniProbe TS-160 shooting close-up with Micro HM lens for immersive experience.

Conclusion: probe lenses allow an immersive shot.

Focal Length and Distortion

The fundamental truism that the wider the lens, the greater is the degree of distortion applies for macro and micro lenses, as it does for regular photo and cine lenses.

For this reason, the MikroMak and InfiniProbe TS-160 Nelsonian[tm] lenses include a selection of focal lengths in the package and a 125mm will give a perfectly flat image with imperceptible perspective and distortion. The nature of the material being shot may influence the focal length of lens selected, so for example, a circuit board will show a near perfect grid with this lens, whereas a 25mm will be far less forgiving.

The same is true when using the 24mm Laowa Probe lens. Being only 24mm, it will need to be brought very close to the subject in order to cover the same field of view as a 65mm or 100mm macro.

Conclusion: wide macro lenses will give more distortion than longer lenses.

Full Frame and S-35

The Laowa probe, Nelsonian InfiniProbe TS-160 Robusto and MikroMak lenses all cover both S-35 and Full Frame (36mm x 24mm), as they are projection-style optics and could cover larger sensors if used with longer expansion tubes.

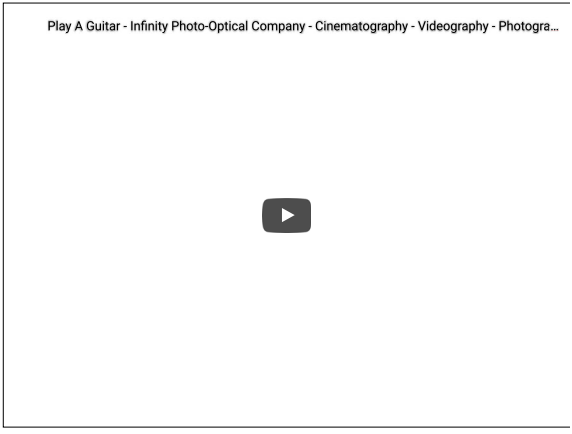
Conclusion Part 3

- There is a trade-off between working distance and magnification
- the closer the object distance to the lens, the higher is the magnification, unless you are using lenses which are optimised to work at a specific distance.
- The quality of the image will be ultimately governed by the quality of the lens and in particular, the size of the front diameter.

- Wide macro lenses will give more distortion than longer lenses.
- Probe lenses can provide a convenient way to help to produce an 'immersive' shot for the viewer.
- Laowa Probe lenses cover S-35 only and Nelsonian MikroMak and InfiniProbe TS-160 Robusto lenses can cover both S-35 and Full Frame and larger formats if required (needs additional extension tubes to be fitted).

PART 4 – Manipulating Perspective and Depth of Field using Nelsonian Optics

Pictures save many words – these great examples of depth of field manipulation illustrate how these lenses can be used to very great effect.



A great example of perspective manipulation, shot and starring Rob Stiff
TS-160 w/ HM Micro

Here are some examples which I shot in order to help to explain the principles.

Two shoes setup to achieve a high depth of field.

Infinprobe TS-160 InfiniProbe with HM Micro optic.
Subject is 37" to image plane.
Shoes are 34" apart.

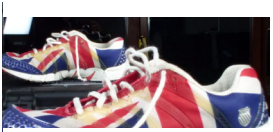
Leitz 90mm PL Macro at F22.
Subject is 38" from image plane
Shoes are 34" apart.

With the iris at F22 for the maximum possible depth of field, it is clear that it is not possible just 38" from the subject to keep both shoes in focus using the 90mm Leitz macro.

It is fair to mention that the image on the left has slightly soft focus which was a user error, for which I apologise.

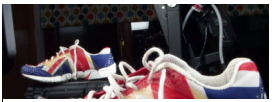
However, using the InfiniProbe with the Micro HM optic and exposed at the Nelsonian point, it achieves just this.

Comparing this with a wider focal length achieves the same result but with a different perspective. Here the 24mm Laowa probe lens almost keeps both shoes in focus but the InfiProbe with HM Micro achieves this with ease. However, note that the InfiniProbe with SFX-2 optic achieves a similar look to the 24mm



Infinprobe TS-160 with HM Micro optic.
Subject is 45" to image plane.
Shoes are 39" apart.

Laowa 24mm Probe Lens at F22.
Subject is 27" from image plane
Shoes are 34" apart.



Infinprobe TS-160 with SFX-2 optic.
Subject is 35" to image plane, which is sub-optimal for this lens.
Shoes are 39" apart.

The important thing to mention here is that this and other Nelsonian[tm] lenses do not work like regular lenses, so you have to unlearn everything that you are used to doing in order to achieve the best results. I must confess here that it took me a couple of attempts to do this, as some habits are deeply engrained but I am glad that I did and can explain my experiences and tips for shooting to great effect and with spectacular results.

The InfinProbe TS-160 Robusto is not a zoom lens but it might be helpful to consider a continually-focusable microscope, where you can position your camera to achieve the best results.

To ensure that the cinematographer does not compromise the optics, three sets of optics are supplied, to enable either working close-up, really close-up or for working at a distance.

If you need more depth of field, then move further away from the subject and refocus – don't worry about image quality suffering – providing you set the iris to its critical point (the Nelsonian point) and ensuring that your focus is pin-sharp, then the quality will be there.

Here I made another magical discovery – whilst optical laws dictate that the closer you are to an object, the shallower the depth of field is, the converse means that by moving away from the subject, both the depth of field increases and the need to focus reduces too, since pretty much everything appears sharp.

I am told by Jay Margolis, the President of Infinity Photo-Optical and inventor of the InfiniProbe TS-160 Robusto that if used correctly, that the cinematographer just need only to focus to infinity and **only** adjust the focus adjustment if needed, such is the large depth of field created by the TS-160 Robusto.

This will definitely come as an anathema to the cinematographer, as it took me some attempts to trust it but I am glad that I did, as the results are greatly improved as a result.

I have explained that the SFX optics are used with the InfiniProbe TS-160 for when the subject is more than 9'/3m from the front element, as this type of lens requires converging light rays.

IF you use them incorrectly, then the results will be poor and I have included such an example below to explain.

Poor shot with InfiniProbe with incorrect optic for close-up work.

Manipulating Perspective

Using the above technique allows the cinematographer to manipulate both depth of field and also perspective, as a consequence of using different lens elements together.

Trees & Pinwheels. Shot and starring Rob Stiff
Lens Used: TS-160 w/Micro HM Objective

Part 4 Conclusion

- If using a InfiniProbe TS-160 Robusto lens, then use a Macro Optic when working close to the subject (less than 3m). You can focus to a couple of cm for really effective results and high magnification and the image will not be upside down.
- When working close to the subject (less than 3m from front element), you can also use the Micro HM Optic. This will offer greater levels of magnification than the macro optic and will also achieve a larger depth of field than regular macro lenses too. Note that images shot with the Micro HM optic will be upside down.
- Use SFX-1, SFX-2 or SFX-3 if front element is more than 3m to the subject for perspective distortion effects. These are not macro lenses but special effects lenses and should never be used very close to the subject, as the images will be not be optimum. The SFX lenses focus at infinity and the focus adjustment will not need to be touched. Note that images shot with SFX optics will be upside down.
- Working with very high-resolution sensors and the very high lens quality of microscope optics in combination with the Micro HM optic will allow images to be cropped after shooting, providing the focus is sharp. This is a useful technique for increasing the perceived depth of field of images.
- Increasing the distance to the object will widen the depth of field achieved and in doing so, also reduce the degree of focus adjustment required (since the focus latitude will be higher).

Part 5 – Popular Macro lenses and adapters

Here are some of our most popular macro lenses and adapters for your convenience.

Top of the range Nelsonian lens set capable of unparalled quality for extreme macro cinematography. This system also has the capability of focussing from infinity to only millimeters from an object. Supplied with PL & EF mounts and includes a variety of lenses for maximum versatility and covers S-35 and FF too.

MIKROMAK PROBE LENS KIT PL/EF/NIKON MOUNT

Like the TS-160 system, the Mikromak works on Nelsonian designs based on Microscope principles, in order to achieve extraordinary clarity and quality. Both EF and PL mount options are included in the kit as standard.

VMI's package includes 2 x separate lenses, both designed for close-up work. It includes a 125mm MikroMak and 40mm MicroMak lens and both are full Nelsonian lenses, which shoot upside down. A maximum magnification of 5.5x is possible and the 25mm wide-angle optic supplied attaches to the 40mm lens in order to convert it to a 25mm Nelsonian lens.

The MikroMak lenses fully cover S-35 and FF too.

LAOWA 24MM F/14 PROBE LENS PL MOUNT

24mm probe lens with PL mount which shoots excellent macro images but with a large depth of field. The USB-powered light on the end of the lens makes lighting easy too.

Unlike the Nelsonian lenses, images are not captured upside down.

LAOWA 24MM F/14 PROBE LENS EF MOUNT

24mm probe lens with EF mount which shoots excellent macro images but with a large depth of field. The USB-powered light on the end of the lens makes lighting easy too.

LAOWA 25MM/F2.8 MACRO PRIME (EF MOUNT)

Specialist 25mm Ultra Macro lens lens is optimized for macro shooting between 2.5X – 5X life-size. EF mount only (Full Frame).

CANON 100MM/F2.8 L MACRO IS USM PRIME (EF MOUNT)

Popular low-cost Canon L USM L mid-telephoto macro lens with stabilisation. EF mount only (Full Frame).

TOKINA MACRO PRIME 100MM/F2.8 (PL & EF MOUNT)

Macro Prime 100mm/F2.8 rehoused Tokina lens offered in PL and EF mount.

Cooke 65mm Panchro Classic Macro (PL Mount)

Spherical 65mm macro with 'Cooke look'.

Cooke 65mm x2 anamorphic macro prime

65mm macro anamorphic lens available in either regular or with SF(special flare) coatings.

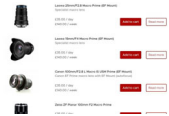
DUCLOS EXTENSION TUBE SET

Duclos Macro PL Extension Tube Set including all three lengths, 15mm, 20mm, and 35mm, stack-able up to 70mm of extension.

CANON EOS EXTENSION TUBE EF25II

FULL RANGE OF MACRO LENSES IN EF, PL AND NIKON MOUNTS

A full range of spherical and anamorphic lenses in all mounts available to hire from VMI.



FULL AND HALF DIOPTRES

Full and half dioptres and 138mm trays for using in matte boxes.

Conclusion

The popular aphorism “The right tools for the job” is entirely appropriate when shooting micro or macro images.

Sometimes, simpler is better, so using extension tubes or dioptres with your usual lenses may be able to give you the shot that you need without using specialist optics.

Whereas a macro can be extremely effective for an extreme close-up shot, probe lenses are unequalled for being able to provide the full immersive shot experience, though Nelsonian lenses offer an entirely different approach again and can provide some beautiful and unique images.

Whatever happens, understanding the principles of lighting for macro, magnification and its effect on distance to subject and depth of field are crucial for optimising image quality.

I hope that the wide range of tools presented in this article help to widen your repertoire of creating better close-up cinematography and photography

Barry Bassett assisted by Ian Jackson; January 2021