Leica R-Lenses

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Chapter 5: 19 mm and 24 mm lenses

__ LEICA ELMARIT-R 19 mm f/2.8
__ LEICA ELMARIT-R 24 mm f/2.8

Introduction

The story of the 18/19mm and 24/25mm focal length is quite interesting. For a long time the range of focal lengths in the wide angle section progressed with steps of 7mm: 21mm, 28mm and 35mm and then the standard lens of nominally 42 to 43mm, but in practice 52mm. This was the normal line-up for the classical rangefinder cameras, but occasionally one could find a 25mm lens in the program. When the major rangefinder companies switched to the single lens reflex cameras, they adopted the same line. That is natural and logical because the photographers were used to these focal lengths and the companies could use the optical expertise to change the classical designs to retrofocus lenses. The big advantage of the reflex viewing system is the freedom of auxiliary finders and fixed framelines in rangefinders. The optical designers had more scope for new design types and focal lengths. The limiting factor was the required optical performance in combination with the retrofocus requirement. It is not a big problem to create a high quality 15mm lens in a non-retrofocus design, although one should not assume that such a design is a piece of cake. On the other hand, the requirements for a retrofocus lens in the range from 18mm to 25mm are in fact quite demanding. These lenses will be used with a focusing screen and then a distortion-free, full frame coverage without darkening of the corners is necessary. In addition one expects good sharpness from corner to corner, as these lenses are employed in assignments where a corner to corner coverage of the scene is required.

If we look at the specifications of a high speed retrofocus wide angle lens, we are ready to understand the considerable difficulties. The current LEICA ELMARIT-R 19mm f/2.8 has a length from bayonet flange to front lens of 60mm and a front lens diameter of 62mm. The retrofocus design requires a much larger front lens diameter than would be necessary if we had a non-retrofocus design. If we had a 'normal' lens with a focal length of 19mm, this aperture of f/2.8 would ask for a front lens diameter of a mere 6.8mm. The actual diameter is nine times larger! The normal calculation for the aperture stop is the diameter of the front lens divided by the focal length. For a 50mm f/2 lens, the front lens diameter is 50mm divided by 2= 25mm. For a 19mm f/2.8 lens we have a front lens diameter of 19/2.8=6.8mm. We can approach the problem from the other side too. If we had a 'normal' 19mm lens with a front lens of 62mm diameter, the aperture would be an unbelievable f/0.3, if that were possible. Assume we would design a normal 19mm with a f/1 aperture, like the Noctlilux. Then the front lens diameter would be 19mm (19/19=1!). But the actual diameter is even larger! It is 62mm. According to the same calculation, the aperture would be 19/62=0,3. An aperture of f/0.3 is physically impossible, as the maximum aperture is f/0.5. As we know, the retrofocus principle asks for a negative front lens with a positive second group. The large front element helps to give an even illumination over the whole negative area. It can also be used to give a flat field and thus reduces astigmatism. Distortion, however, is a problem. The construction of the lens is totally asymmetric, and that means that the correction of the chromatic aberrations and of coma is very difficult. If we wish to have a smaller front lens diameter, we need to use glass with a high refractive index or glass with greater curvatures. In both cases the incoming rays will be strongly bent to be pushed through the small diameter of the aperture stop. But great curvatures of the glass elements are difficult to coat with anti-reflection (multi) layers to reduce flare caused by the large angle of view of the lens. And when the speed of the lens increases, we need more elements to create a complex design. With many elements it will not be easy to assure the centring of every element during assembly. As these lenses will require floating elements to deliver good performance in the close focusing range, the opto-mechanical complexity becomes of a very high order.

The movement of the floating element, as example, is often between 0.5 and 1mm and that is quite small a distance. To add to the optical complexity, we should draw attention to the filter turret, that is often part of the lens and thus part of the design. The glass of the filters must be made with very high precision, as they will immediately reduce the image quality when there are defects. Reflecting on this long list of problems and conflicting demands, we should perhaps admire that the current Leica lenses of this specification deliver such excellent performance.

It was Angenieux who designed the very first retrofocus lens for 35mm still cameras in 1950. The retrofocus idea was well-known in the movie industry where many lenses were of this design, but for 35mm photographic cameras the idea was quite new. This was a 2.5/35mm, shortly followed by a 3.5/24mm.

One of the very first 24mm lenses for SLR-cameras in Germany was the Ennalyt 4/24mm from the Enna-Werke. It was introduced already in 1960, together with the Zeiss Jena Flektogon 4/25mm. The probably first lens in Germany was the prototype Ultragon 5.8/24mm from Voigtlander in 1950. The Zeiss Jena company crossed the 21mm barrier in 1963 with the Flektogon 4/20mm. In that same year Carl Zeiss Oberkochen introduced the 2.8/25mm and set a new aperture record for this focal length at that time. Carl Zeiss Oberkochen pushed the frontier in 1967 to 18mm with a 4/18mm lens for the Contarex. Given the complexity of the design, only a few companies offered this type of lenses. Another factor was the high image quality demanded by critical users. The quality provided by the Ennalyt 24 from 1950 would be unacceptable for a photographer working in the seventies.

It took, in those days, several years to calculate a lens with such demanding specifications, even with the help of computer power and optical design software.
Between 1965 and 1975 the major Japanese companies also introduced lenses with focal lengths from 17/18/19 to 24/25mm with apertures from 2.8 to 4.

In Germany most companies, with the exception of Zeiss, did not offer lenses in this 19-25mm range. And for some time, we might have designated the 17/19mm and 24/25mm focal lengths a typical Japanese wide angle. This is, with hindsight, a bit strange because of the excellent pictorial possibilities with these angles of view. One would have assumed that most users would have demanded such lenses for their photography.

The retrofocus design has now evolved to a design type of its own, shedding its origins as a normal lens with a negative front element attached in front of the system.

Leitz introduced its own Elmarit-R 19mm f/2.8 lens in 1975. It was a Midland design and offered quite good specifications. The distortion with 4% was a bit on the high side and it was also prone to flare, which is not surprising, given the very large front lens. It was an improvement on the Super-Angulon-R 21mm f/4, a retrofocus design too. With a maximum aperture of f/2.8, it was one full stop ahead of the previous lens. A year earlier, in 1974, Leitz made a new Elmarit-R 24mm f/2.8 available for the R-system. The origin and development of this lens will be traced below in the lens section. This lens has had no major design changes, but the 19mm was completely redesigned in 1991.

__The nanometer scale

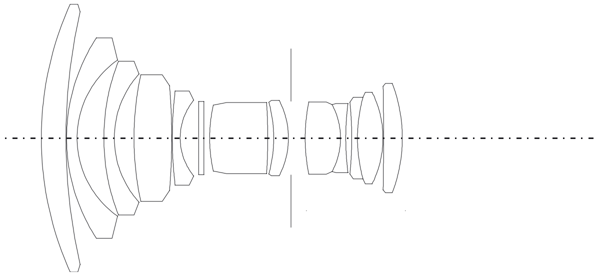
In optical design, the unit of measurement is the micrometer ('micron' is another name for the same magnitude) for the lens element and the nanometer for the wavelengths and the coating layers. In mounting and mechanical construction the unit is the micrometer too and the millimeter. We use these units of measurement quite casually without having a good idea what they mean in real dimensions. The millimeter is one thousandth of a meter, a micron is one thousandth of a millimeter and the nanometer is one thousandth of a micron or in other words one billionth of a meter. The smallness of this cannot be imagined without some help. The smallest dimension we can see in normal life is the width of a hair. The average thickness for thin hair is 0.06mm or 60 micron. Now we go for a mental experiment. Put the hair under a microscope and put next to it the nanometer. This is so small we cannot see it all.If we e could magnify to such a scale that the width of the hair becomes as high as the height of the Eiffeltower in Paris. Then the nanometer would have the thickness of a Eurocent. To repeat this: the ratio of the height of the Eiffeltower to the width of a Eurocent would be the same as the ratio of the width of a human hair to a nanometer.

Why do we want to know this? We do assume that the surface of a glass lens is perfectly smooth. In reality the glass surface is quite irregular. On the nanometer scale of course! This surface roughness reduces the brilliance and contrast of the image. When the path of lens rays is calculated, the assumption is a completely perfect surface. With irregularities the true path of a ray is disturbed as it is when aberrations would act on the ray. In addition small errors in the shape of the lens will lead to decentring and tilting of the lens and that is the source of another bunch of errors. And the microscopically thin layers of coating in a multi-coating layer should have the same thickness over the whole surface. Small errors in the thickness will again produce deviations in the calculated ray path.

The exceptional clarity and brilliance of the current Leica lenses is the result of the optical calculations, but also of the mastery of the nanometer scale. To study the deviations on such a small scale in the manufacture of lenses, one needs measurement instruments that are even more accurate than the manufacturing machines. Laser interferometers are the basic instruments to accomplish these measurements. The secret of Leica lens performance is the combination of optical expertise and manufacturing technology. And for a 12 element 19mm with large lens diameters this is more important than for a three element 50mm.

__ LEICA ELMARIT-R 19 mm f/2.8

The current LEICA ELMARIT-R 19mm f/2.8 has a floating element and 12 elements in 10 groups. It is an example of the modern design approach at Solms to use mainly single lenses in a system to correct the aberrations. A single lens has one refractive index, two curvatures, one thickness and one distance to the next lens element.
Any of these parameters can be used to adjust or correct an aberration. If you select a group of lenses hat are cemented together, you loose some parameters (curvatures and distances). More possibilities for correction are quite interesting for the designer, but the number of combinations grows exponentially. Without a clear insight into the basic principles of a design, you are quickly lost in an embarrassing array of options. Comparing the older design to the current one, the main difference can be found in the middle section, which is most sensitive to design changes (see previous chapter). The lens is composed of 12 elements and has a floating element to improve close focus performance.



The result is a lens with exceptionally good quality. We should realize that wide aperture-wide angle lenses cannot be corrected to the same level as let us say a well tuned 180mm. As long as we expect the lens to be affordable and useable, there have to be some compromises. Optical aberrations operate at several levels. We have the classical third order aberrations (coma, spherical aberration, astigmatism and more) and we have the next higher level of aberrations, called fifth-order aberrations. If you could correct the full range of third-order aberrations, you still are facing the fifth-order ones. In most lenses the designer tries to leave some third-order errors in the design to compensate for the fifth-order ones. In wide angle designs, you will accept some loss of quality in the outer zones to balance the quality in the centre area, where the main subject will be located. But to fulfil the important requirement that the whole image area must be covered with good definition, the balance should be quite subtle.

At full aperture the Elmarit-R 19mm f/2.8 has a high contrast image with crisp definition of very fine detail over a large part of the image area. The extreme corners are a bit soft, but when using slides this edge area will be covered by the slide mounts. The sagittal and tangential lines are very close, indicating absence of coma and astigmatism. Very fine detail is being represented by the 20 Lp/mm line and we can see that even at 2.8 the contrast of 60% is held till an image height of 15mm, giving an image circle of 30mm diameter ***(see image 1)***.

Flare and secondary reflections are very well controlled and in most situations, even with the sun in the scene, the brilliance of the image is well preserved. Without a shade and with very bright light sources shining obliquely on the front lens, we may expect to see secondary reflections. At f/5.6 the 20 Lp/mm are now above 80% contrast from centre to corner and the 5 Lp/mm are close to 100%. This performance is of a very high order indeed. We may appreciate the quality if we reflect on the fact that the previous 19mm at aperture 5.6 was as good as the current one at 2.8. At aperture f/8, the usual drop in contrast can be seen ***(see image 2 and 3)***.

Vignetting at full aperture is more than two stops at the extreme corners and can be visible. We should be practical here, when evaluating these results.

When you use the lens wide open, you need this light gathering power and most often you are then in action or reportage photography ***(see image 4).*** In these cases the darkening of corners may be not important. If you need very high quality from corner to corner, you must stop down and then the problem of vignetting is gone. There is often the tendency to want the best of everything when evaluating lens designs. But a lens is a carefully crafted compromise to its intended job as best as possible. In the area of cars we all accept that a sports engine has lower torque but can make

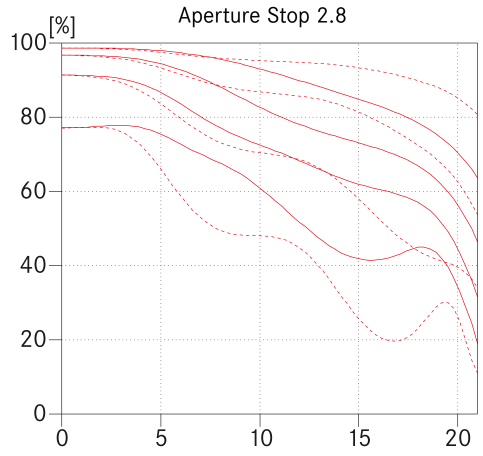


image 1

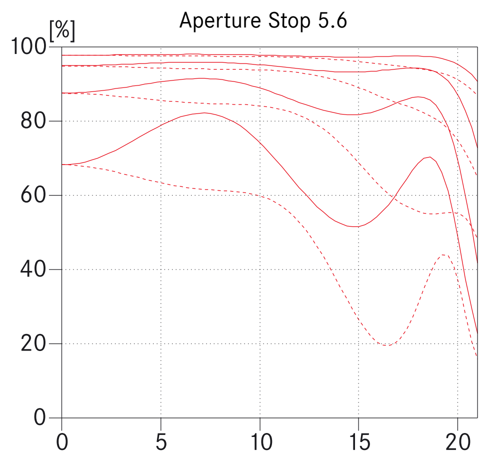


image 2

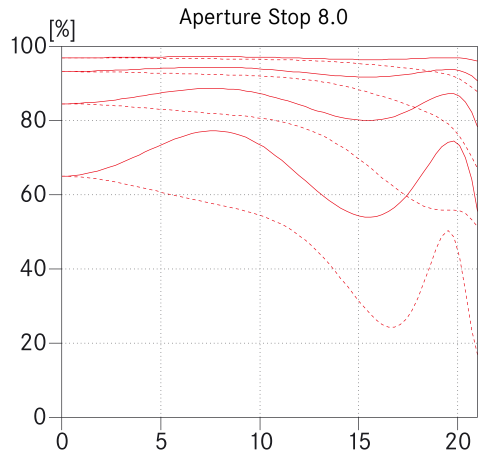


image 3

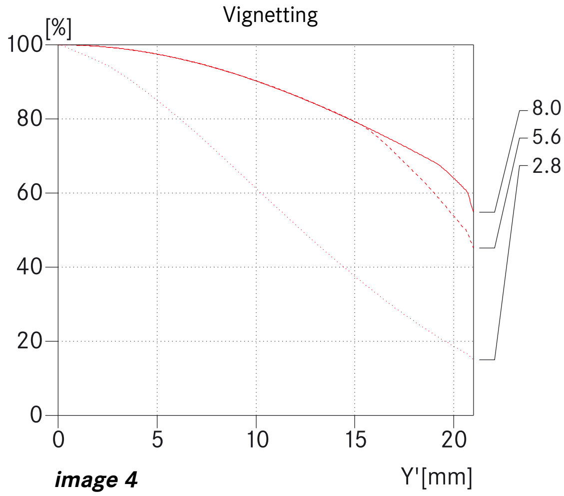


image 4

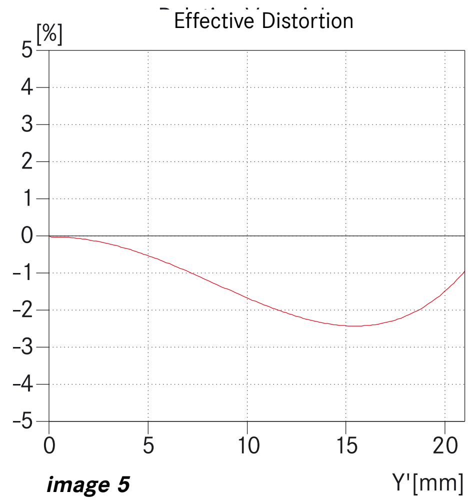


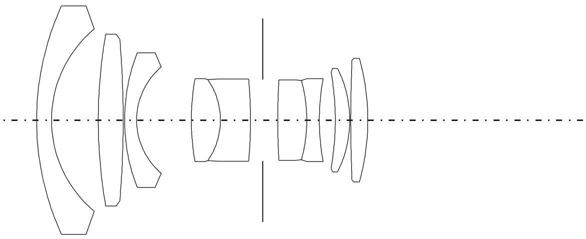
image 5

more revolutions and will burn more gasoline. In the optical area we expect a lens that has super quality from corner to corner at all apertures and distances and with small physical dimensions. As with car engines and in politics, we must compromise. The distortion curve is very interesting. Maximum distortion is 2.5% but it occurs not at the extreme corner, but at the image height of 15mm, and drops to 1% at the edge of the frame.

This behaviour is intentional and will help to reduce the visual effects of a type of distortion that becomes worse and worse in a linear pattern ***(see image 5)***.

__ LEICA ELMARIT-R 24 mm f/2.8

The LEICA ELMARIT-R 24mm f/2.8 is a 9 element lens in 7 groups. It also has a floating element.



The lens dates from 1974, which is reflected in the relative performance. At full aperture overall contrast is medium high and definition of fine detail in the centre portion of the image is excellent. The outer zones reproduce textural details with some softness, but the outlines of major subject areas are quite crisp and this fact gives the images a high impact. Flare is hardly visible, but there is a trace of coma. While the lens at full aperture does not have the clarity and crispness of the 19mm, it brings imagery of a high order ***(see image 6)***.

Stopping down to 1:5.6 improves contrast substantially and the coverage over the image area is very even. This performance stays till 1:11, where the usual drop in contrast can be detected ***(see image 7 and 8)***. The distortion pattern is the same as with the 19mm and helps to reduce the visual impact of linear distortion ***(see image 9)***. Vignetting is two stops at the edges at full aperture and is gone at 5.6 ***(see image 10)***.

Compared to lenses from other companies, the Elmarit-R 24mm is an excellent lens with a fully competitive performance. The intended use of the lens is the reportage and the capture of dynamic scenes in confined spaces. For this typeof photography the Elmarit is eminently suited, thanks

__Artistic considerations

These wide angles from 19mm and 24mm offer many artistic and pictorial possibilities, that need exploring for a longer period of time. The LEICA ELMARIT-R 19mm f/2.8 needs to be aligned very carefully to avoid inaccurate verticals, because of tilting of the camera. The slight distortion of the 19mm may be limiting its use for accurate architectural drawing, but one should be surprised how often the distortion goes unnoticed. And the wide angle effect, reported in the previous chapter, may even enhance the picture by drawing visual attention to the wide scene that can be covered. The large foreground often included in the vertical format image, will make a certain amount of perspective distortion difficult to avoid. Knowing these characteristics, one can put them to good effect to create pictures with added visual power. And when you use the middle apertures from 4 to 8, the extended depth of field, combined with the high contrast and excellent definition of really fine detail, can convey an atmosphere of heightened reality. The horizontal angle of view of the 19mm focal length is 87 degrees, which is very close to a 90 degree angle to cover a full frame picture.

The LEICA ELMARIT-R 24mm f/2.8 has a horizontal angle of view of 74 degrees. It is less sensitive to the perspective distortion and can be used with good effect even in situations where the camera needs to be tilted. Of course you will notice this distortion, but the drawing of the lens seems to be more lenient to the effect. The 24mm (and this is also true for the 24mm in the M-range), especially when used in the 1 to 3 meter range of distances, brings additional imaginative possibilities. It seems that even ordinary objects when seen at close range with this angle of view become interesting in themselves. The specific pushing forward of the main subject and pulling out of the background create a balance in composition that is visually quite interesting. Where the 19mm lens records the scene, the 24mm lens can create a dream.

__Conclusion

The choice between these two lenses should be primarily based on the intended use and pictorial capabilities and possibilities. The more recent 19mm is optically more advanced, but the 24mm is a capable performer and at the middle apertures it delivers an image quality that most film emulsions can hardly match. While most photographers have a good idea what a 35mm wide angle can do, it is quite difficult to imagine what a very wide angle lens can deliver in terms of pictorial (not technical) quality. The 24mm angle is more versatile and more stimulating in the creative process. The 19mm angle of view is more exacting and demands a higher level of visual discipline. But one should study the famous distorted nude pictures by Kertész (made in 1933!) or the pictures by Sieff to get an idea how far one can push the limits of acceptable vision when distortion with the extreme wide angle lenses is used with an open mind.