Leica R-Lenses

by Erwin Puts

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Introduction

__The R-System

The first lenses for the Leicaflex have been introduced in 1965 in the then classical focal lengths of 35,50, 90 and 135mm. The Summicron 50mm had a maximum aperture of 1:2, all the others were Elmarit-versions with an aperture of 1:2.8. The quality of the mount was immediately recognized as the best in the world. These characteristics: sufficiently wide apertures and all metal mounts with excellent ergonomics are still true today for all lenses within the R-system. I could myself convince of the longevity and sustained accuracy over many years when I was able to test and check several scores of older lenses, often very heavy used. Every lens, even the most worn out ones, were within the originally specified tolerances and there was not a sign of decentring, one of the earliest signs of degraded performance. The optical performance was as expected from a new lens just out of the box.

The R-system has been developed and evolved over the years from 4 lenses with focal lengths from 35mm to 135mm to 26 lenses with focal lengths from 15mm to 800mm. The average age of all lenses is 11.5 years. Six lenses are less than 5 years old, eleven lenses are less than 10 years old and nine lenses have an average age of about 20 years. This last group of lenses has focal lengths from 24 to 100mm and the optical layout is mostly a Double-Gauss variant. This lens type is based on a very mature design and it is not easy to improve on the performance within acceptable financial and ergonomic constraints. The Summicron-R 1:2/50mm as example is still the best standard lens for reflex cameras. This range of lenses between 24 and 100mm has been complemented in the last decade with a series of high performance zoomlenses.

If we look carefully at the introductions in the last decade we can see where the development efforts will be focused on and what a possible road map could be. Actual and future mainstay of the range will be the zoomlenses and those fixed focal lengths that are eminently suited to manual focusing, like the very wide angle lenses (15mm to 19mm), telelenses with superb performance that can be used handheld (!80mm to 300mm) and specialized lenses with very wide apertures like the Summicron-R 1:2/180mm. The image quality of the R-lenses should enable the photographer to exploit to the full extent the potential of the imaging chain and to implement creative imagery with great clarity of vision.

__The construction

Several limitations are imposed on the design and construction of R-lenses. The most important are the back focal length, that is the distance from bayonet flange to the front of the film plane (in this case also free space for the mirror movement), the manual focusing mechanism and the the mechanical aperture control. You can not create an arbitrary small lens because you need space for the mechanical functions and the mounts. And the aperture and focal length have some influence too. A 180mm lens with a maximum aperture of 1:2 will have a front lens diameter of at least 90mm. Size and weight are important limiting parameters when designing a lens. If you are able to create small lenses, as with the Minox camera, you will encounter less problems with the correction of optical aberrations. That is one of the reasons why the Minox lenses are so good. If you can design a lens without any consideration to weight and size, you can compute a system with many lenses and so reach a very high level of quality. In practical terms, one will have to find a smart middle course and one has to balance the conflicting demands to reach a delicate and individual equilibrium. Every optical designer will set his/her own emphasis and will accentuate certain characteristics.

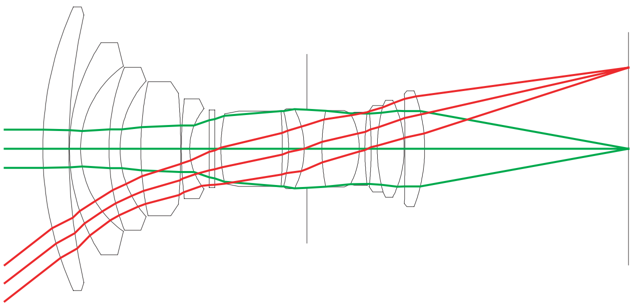
When designing long focus lenses and high speed retrofocus designs, the back focal length and the bayonet diameter will influence the location of the exit pupil, and this must be chosen carefully. It is really not a simple matter to create a design that will satisfy all demands without some reduction.

__Retrofocus lenses

A retrofocus lens is characterized by a back focal length that is longer than the true focal length. The Leica R mirror box asks for some space and the back focal length is 47mm. A lens with a focal length of 15mm will only fit if you can lock the mirror in its upward position. This was indeed the only solution in the past. The designer created so called symmetrical lenses, consisting of two identical groups of lenses, that were mirrored around the aperture stop. A simple and brilliant solution: several optical aberrations generated by the fist group, could be compensated fully by the second group. But the disadvantage of the blocked viewfinder path was too great and so the retrofocus lens was developed. At the beginning the image quality of the retrofocus design was less than what could be expected from the symmetrical design. The first generation of retrofocus designs were simply normal lenses wit a negative lens put in front. In the course of time this type has been evolved to a new type of design with very promising possibilities. Today one can calculate retrofocus designs that are as good or even better than symmetrical lenses (see illustration below). The necessary effort is however much higher and the lenses will not be as small. It is extremely difficult to design a compact retrofocus lens without compromising the image quality. On the other hand the location of the exit pupil can be used to reduce the amount of vignetting.
Without floating elements a good performance in the near focus range at wider apertures is quite a task. Leica will use the method of floating elements whenever needed. But then the opto-mechanical complexity increases and the Leica photographer may find him/her self lucky that the Leica company has this almost fanatical aspiration to reduce the mechanical tolerances to the level that production machinery nowadays can consistently deliver.

__Telelenses

There are some aberrations that become a downright nuisance when the focal length increases. A longer focal length implies a higher magnification of the subject and also an enlargement of chromatic aberrations.You need special glass types to correct these errors. The use of new glass types from among others Schott, Hoya and Ohara, the so called glass with anomalous dispersion, is required to correct the optical errors to a high degree. But these glasses are difficult to manipulate and also very expensive. And it makes no sense to employ this glass if you can not mount and check the manufacture with very narrow tolerances. With the help of these glasses, you can design lenses with excellent performance (if you have understood the optical system) and there are some superb lenses in the Leica program that are a serious challenge for the capabilities of the user. If you have understood the the performance profile of such a lens, you can create astonishingly good pictures.
If you correct the chromatic aberrations to a particular high degree, the lens is called an apochromatic design. Such designation is however not an objective criterion and so the transitions are fleeting. Where an apochromat starts and an achromat ends is not easy to define in practice. The Apo designs from Leica have a vanishingly small amount of residual chromatic errors and can be called apochromats. There are some photographic situations where the subjects will exhibit some small color fringes at the edges, specifically when the dark subject is positioned against a very light background.
The second characteristic of modern telelenses is the use of internal focusing. Here a lens group will be moved over a small distance in order to improve the image quality over a wider focusing range. In addition the focusing movement can be much smoother as smaller masses will have to be moved over a shorter distance.
The small movement must be controlled quite accurately, otherwise the result will be worse than without this method.



An example for a modern retrofocus wideangle lens (19mm f/2.8)

__Zoomlenses

Zoomlenses and Single Lens Reflex cameras form a natural and harmonious unit. The focal length can be changed continuously and you can see the changes in the viewfinder in order to select the appropriate framing of the subject. The Leitz company has for a long time expressed their hesitancy with respect to the optical excellence of zoomlenses compared to the fixed focal lengths. The first zoomlenses (Zoomar 36-82 or Nikkor 43-86) were indeed not revolutionary, but they ofefred an additional added value to practical picture taking that exceeded their limited performances. From the moment that one could improve the quality substantially (with improved understanding of the lens type, new optical design programs, effective coating of the many lens elements) all major lens manufacturers have concentrated on this type of lens. Even leitz had a special department for the analysis and design of zoomlenses, but limited to the systems for the Leicina, a movie camera that was quite important in those days. The knowledge that was acquired was not transferred to the photo department, even though the famous Dr. Walther Mandler, head of the optical department at Leitz Canada wrote in an article in 1980 hat according to his studies, zoomlenses could deliver image quality as good as that as that of the corresponding fixed focal lengths.
From 1992 (about ten tears later) new zoomlenses have been designed by Leica. It new start had to be made as the previous experience and knowledge was of limited value. It is the great accomplishment of Lothar Kölsch, then head of the optical department of Leica, to redefine the performance level of zoomlenses to an all time height. The first original Leica zoom is the Vario-APO-Elmarit-R 1:2.8/70-180mm.

__The idea of moving lens elements

A zoomlens is basically an optical system that has a changeable magnification ratio while maintaining the focus position. A zoomlens has two requirements: (1) the focal length must be continuously variable and (2) the distance setting (focus position) must not change so that the object stays focused correctly. Generally one can accomplish this with an optical system with two moving lenses (or lens groups). If you look at the very complicated lens diagrams of current zoomlenses, you may feel surprised that the basic idea is so simple.
Let us start with the basics. Assume we have only two lens elements. One element is needed for the change of focal length and the other one for the distance setting. It does not matter which lens is used for what function. When you move one lens over a small distance, the focal length will change or what is the same the magnification ratio. Now you must move the second lens over a certain distance to compensate the focus position. Both lenses can be coupled mechanically so that a change by one element automatically will move the other element over the required distance. You could imagine the following construction: both lenses are mounted in one tube, that has two grooves with a certain length and angle of inclination. Both elements will move at the same time within these grooves. Now we can start to understand the basic problem of zoomlenses. One of the elements can be moved in a linear fashion, that is a straight line. The other one must move in a nonlinear fashion. The optical explanation is quite daunting and will be skipped here. The resulting shape of the nonlinear curve can be very elaborate and is very laborious to construct with the required accuracy. Even more difficult is a shape where the movement of the lens has to be reversed and one must provide a twist in the curve. As the movement of all elements has to be accomplished with one turning movement of the lens mount, one needs a quite complicated shape of the curve that is very expensive to manufacture. This method of lens coupling is called the mechanical zoom compensation.

The second method of compensation is called the optical compensation. This one has the advantage that all movements are linear. Biggest drawback is the fact that the focusing is only accurately compensated for a few positions of focal length. At all other positions the image is slightly unsharp. The user has to adjust the focus manually. With autofocus systems there is no problem as the AF sensor will detect this unsharpness and can refocus. Systems with optical compensation are quite elaborate as one needs more lens elements and groups (up to 5 moving groups). Then we may expect problems with the accuracy of

mounting, the transparency and flare.
Leica has basically chosen to only employ the method of mechanical compensation. This construction has definite advantages. On which more later.

__From principle to construction

The basic design with two moving elements is just theory. The optical designer wants to create a very good overall level of error correction and to secure this performance over the whole magnification range of the zoomlens. In this case the two elements are hopelessly inadequate. In addition one needs two fixed lens groups, a front group for manual focusing and a master group at the rear part. This master group is known from normal photographic lenses and defines the angle of view and the maximum aperture of the system. Between these two groups you will find the linked moving elements. The overall complexity is dependent on the required level of optical correction.
You can also change the fixed front group (for focusing) to a moving element and it this case there are three moving groups and has the front group a double task. Leica has zoomlenses with different designs in the program. The first design by Leica was the Vario-Apo-Elmarit-R 1:2.8/70-180mm and has 13 elements with a very high performance profile. The Apo-Elmarit-R 1:2.8/180mm has 7 elements and delivers an even higher performance. This comparison is not entirely honest, but it does indicate the higher level of effort that is needed for complex zoomlenses. On the other hand can you use these additional elements to improve the quality if you understand the optical system. There is a rule of thumb in optical design that says that it is better to distribute the total power of the system evenly over the lens elements. With more elements this is somewhat simpler. In addition the designer will pay attention to the fact that the contribution of every lens surface to the total optical error of the system has to be minimized. This is only feasible if you understand the shapes of the curvatures very well in their error contribution. The creative mind is the most important asset in lens design and superior to any computer program when really good solutions are requited.

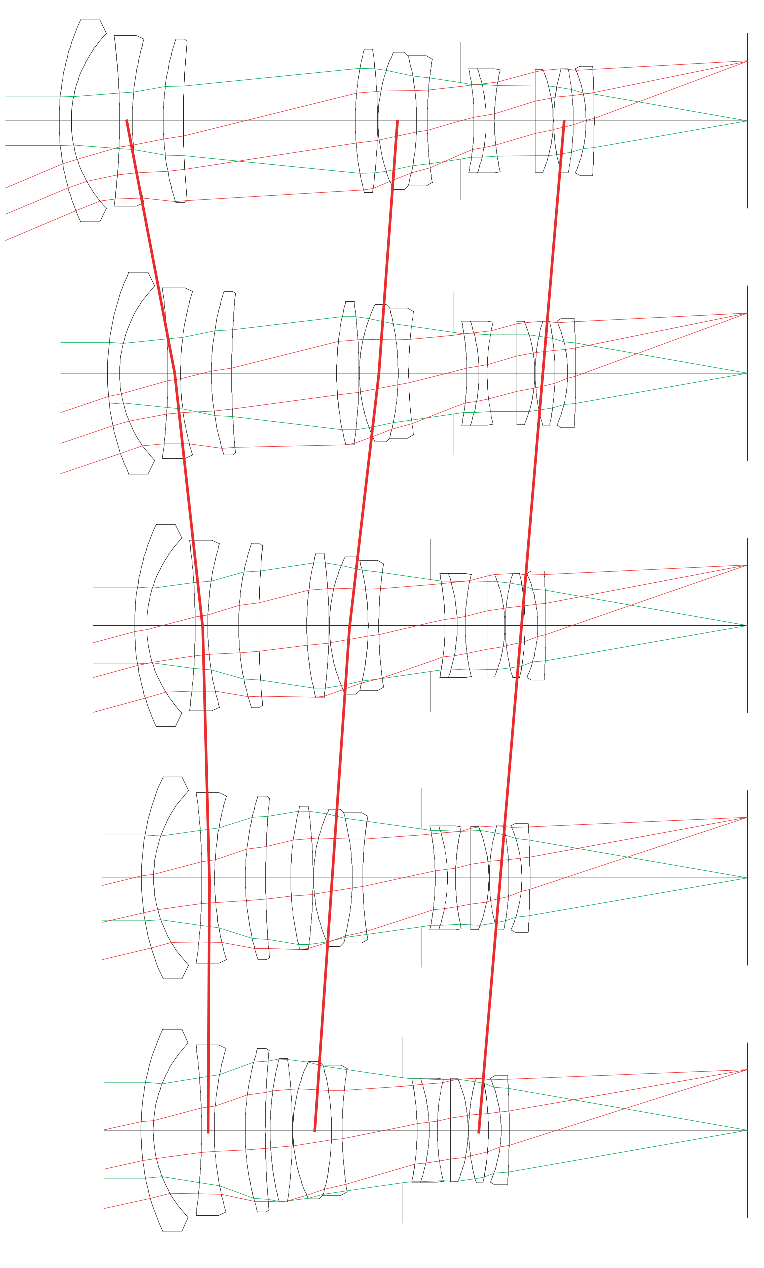
The optical designer has more degrees of freedom when he/she has control over more elements that can be moved within limits and the possible error correction can be of a very high order indeed. But to make a high quality zoomlens that will deliver at all focal lengths within the zoom range the movement of the sliding groups should be as small as possible. The two-group design with mechanical coupling is the preferred solution within the current range of Leica zooms. The Vario-Elmar-R 1:4/35-70 and the Vario-Elmar-R ASPH 1:3,5-4/21-35 have this design. The Vario-Elmarit-R ASPH 2,8/35-70 has two moving groups and in addition a "floating element" to add error correction. Here three groups are moving in concert.
These two-group moving systems are excellent solutions for zoomlenses with a zoom range between 1:2 and 1:3. Examples are : 21-35 makes 1:1.66, 35-70 makes 1:2.0, 70-180 makes 1:2.5.
With this system, one can get outstandingly good results, but the manufacturing process has to work with narrow tolerances.

__Metal mounts

The meal mounts of Leica lenses make it possible to work within these tolerances, that are below 0.01mm in many cases. The Leica mounts are produced nowadays with CNC machines and every part will be carefully and painstakingly finished manually by experienced workers. The mechanical control of the movement of the lens groups functions within minute tolerances and that is indeed required. After having found the correct framing of the motive by changing the magnification of the lens, you do not want to have to refocus, which is a nuisance and will disturb the act of photography. When using AF cameras, the requirements are less precise, as a small unsharpness will be corrected by the AF system. In a general sense, one should know the limitations of the AF system. AF is extremely fast, much faster than what one can accomplish manually with eye-hand coordination. AF systems are not very exact in their focusing. I have noticed this personally when testing systems from several well known manufacturers.

The complex barrel construction of the Vario-Apo-Elmarit-R 70-180 mm f/2.8

Movements of the optical groups when changing the focal lenght (Vario-Elmar-R 35-70 mm f/4)



In many instances I had to refocus after changing the focal length to get a sharp image of the subject. And many photographers switch off the AF function when they need really accurate focus. It is without any doubt that AF is a great help and often necessary when you want to capture fast and unpredictably moving subjects. But there are many motives where accurate focusing is more important than fast focusing. Here one enters the domain of Leica-R photography.

Metal mounts are an important characteristic of Leica lenses. But one should keep a sensible eye on the matter. There are opinions that claim that synthetic materials are inferior to metal parts. This is not true. Synthetic materials has many characteristics that are quite valuable in precision engineering mechanics. A negative attitude is a thing of the past. But synthetic materials are best suited in mass production situations, because the individual parts can be made by dedicated machinery that are custom made and must be depreciated in a short period. Metal mounts are always slightly larger than comparable synthetic components, but the size should be kept in reasonable dimensions. If one could built without restrictions, the optical designer can create aberration free lenses. One can then use as many lenses as needed and can create many degrees of freedom, including lens diameters. This can be seen in the field of micro-lithography where lenses are used for the chip manufacture and were 30 lens elements for one system are not an exception.

__Ergonomics and size

A lens needs a very good ergonomic shape, especially if it is used manually. The size of a lens depends on a few parameters. The most important are the focal length, and the front and rear lens opening (the maximum aperture and the bayonet diameter). R-lenses are also constrained by the back focal length (mirror box and space for moving mirror). Not only the focusing is manual, but the diaphragm mechanism is mechanically actuated too. This fact is important as you need room for the mechanical linkages. Actually this linkage is a challenge for the engineers, as there is force involved. And the transmission of forces by mechanical means is not that simple. The time parallax between the moment the shutter is tripped and the closing of the diaphragm should be small and work without resistances. The position of the diagram is not really free with telelenses as it cannot be placed to far in the front part of the lens. Mechanical constraints, optical demands and ergonomic criteria together define the construction, shape, handling and weight of a lens.

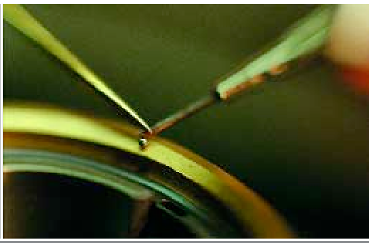
__Focusing

The focusing movement is accomplished with parallel threads and the movement must be very precise, tight and smooth at the same time. And backlash may not be detectable after decades of use. The choice and tooling of the materials is very critical. To enhance the smoothness of operation it now customary to employ internal focusing groups. While smoothness is improved, the demands on accuracy increase. But leica often uses constructions that are not mentioned in the literature. The Apo-Elmarit-R :2.8/180mm not only offers a superb performance profile, but also a patented focusing construction and a new form of the aperture blades. The customary discretion of the Leica engineers not to disclose their accomplishments, has its virtues, but many fascinating details are kept in the dark.

__Performance profile and lens personality

Leica R-lenses are characterized by a very homogeneous performance profile: the optical quality is very high, but the performance peak is not an isolated value. You could design a lens with excellent values at a certain distance and aperture, but and lower values at all other positions. With Leica lenses one can expect the same high quality at all apertures and object distances, and for zoomlenses over all focal lengths. This optical performance is accompanied by a very good ergonomic design. These goals can be attained because the metal mounts allow for the accuracy and precision that is needed.

Mechanical precision down to the finest details



And we need this accuracy as there is no AF system that can smooth out small errors in mechanical accuracy. Here the circle is closed: because there is no AF, a higher level of precision is required and that can be delivered only when using metal parts that are individually and manually finished. And the current requirements can only be met when the zoomranges are not too extended.
Every lens for a photographic purpose is a compromise between many often conflicting demands. Size and weight and correction of optical errors are interlinked parameters. The word 'compromise' is probably not the right designation as it could give the impression that we are talking about a less desirable solution. It would be better to talk about an equilibrium condition. The optical designer searches for an optimum solution within the allowable space conditions and will balance third order aberrations with fifth order aberrations. This balance will be different for a standardlens, a wide aperture wide angle retrofocus lens or a zoomlens. You can not characterize the profile of a lens along a unidimensional scale. A wide angle lens has requirements that are different from a tlelens and what is acceptable for a wide angle lens, may be anathema for a telelens. In this area individual and personal views play some role and the definition of the image quality is a bit personal. Optical designers are very creative people who will select one specific design out of many possible solutions, that they accept as the best possible design, but there are no objective standards.
That is why every Leica lens has an individual personality within a family likeness. A Summicron-R 1:2/50mm is a classical six element Double-Gauss design, of which hundreds of variants exist. There are bigger and finer differences between the many design forms and the individual aberration correction. Precisely these smaller differences do define the final image quality and the fingerprint of the Leica lenses. One needs a bit of time and discipline to discover these finer characteristics and use them to good effect during picture making.
The lens reports that follow, will expand on these issues.

See you soon!
Erwin Puts

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Chapter 1: 50 mm and 60 mm lenses

__ LEICA SUMMICRON-R 50 mm f/2
__ LEICA MACRO-ELMARIT-R 60 mm f/2.8
__ LEICA SUMMILUX-R 50 mm f/1.4

From 1925 to 1950, the lens with a focal length of 50mm was the most used standard lens. Much has been written about the diagonal of the film format being the dsetermining value for its definition as the 'standard lens'. The length of the diagonal of the 35mm-format is 43mm (to be precise: 43.27mm) and therefore this should actually be its focal length. In fact any focal length from 43 to 58mm has been used for the standard lens. More importnat from my point of view are the perspective and angle of view that one gets with a 50mm lens. When Prof. Berek was calculating the first 50mm lens for the new Leica format as it was known in those days, he was without doubt searching for a balanced compromise between useability, speed, depth-of-field, and optical performance. In addition, the lens should exploit all capabilities of the somewhat unorthodox image size that Barnack had chosen. The aspect ratio of 2:3 (1: 1.5) was known from the then ubiquitous 6x9cm print size, but most paper sizes had an aspect ratio between 1:1.25 und 1:1.38. The "golden section", i.e. the ideal proportion as used by painters, had an aspect ratio of 1:1.62, slightly more than Barnack's format.

__Artistic considerations

The Leica was intentionally designed as a camera to be used in an upright posiion and in front of the eye. The maximum viewing angle of humans is limited to 140 degrees in the vertical direction and 200 degrees in the horizontal position. And this ratio (1:1.43) is quite close to the ratio of the Barnack negative size. What you can intuitively observe with your eyes, can be captured almost identically on the negative. A small trick: when you observe the scene with squinted eyes you will see a blurred picture, but the outlines of subjects and their distribution over the image area can be detected with ease. This helps to find a good or interesting composition. The viewing angle of 47 degrees and the perspective (meaning the relationship between the size of the depicted objects at the different distances) of the 50mm lens supports the correct reproduction of the intuitive observations on the final print. The first generation of Leica photographers almost exclusively employed the 50mm lens, evan after the introduction of interchangeable lenses. And with this lens, often stopped down to 1:8, photographic masterpieces have been created. A picture originates between the ears, but one needs an instrument that can capture the scene on film exactly as it was experienced. The '50mm' has much more potential than is often believed.

In recent times it has gotten a bit quiet around the normal lens. You will quite often hear that the focal length 35mm represents the natural perspective in a more pleasing way. In part this is just a matter of taste or opinion. Every picture has a main motive and some environment surrounding the subject. Or in other words: a foreground and a background. In photographic composition the size relation between main subject and background is quite important. If you look closely at pictures, you will often find that the picture taken with a 35mm lens is a bit tense and intrusive, because of the prominent position of the main subject in the focus of attention.

The '50mm' is a bit more balanced in its representaion of bakground and foreground and the size relations are often harmoniously proportioned. Both perspectives are valid and one needs to understand the subtle visual differences, as this helps you to make the right decision for the selection of a lens.

__Optical considerations

The optical evolution normally proceeds in a smooth and orderly way, but sometimes we note an unexpected jump. The first theories about aberrations were developed by mathematicians and practical experience was gathered by makers of telescopes and microscopes. It is therefore logical that maximum resolution is a very important quality criterion. You will not be happy when the distinct spot in the sky is not a star but a double star! The optical designers tried to correct the aberrations in such a way that the resulting image point (the spot) was as small as possible. Often this meant that the small spot was surrounded by a larger area of halo or flare that reduced contrast. In those days that was the least of problems. Already in 1936, Dr. Fricke, Leitz Wetzlar, argued that edge sharpness was more important than resolution. MTF measurements were not yet invented, but his discourse pointed in that direction. In the fifties, TV became a commodity. There was considerable research to match the quality of the TV image to that of the 8mm movie format. The TV image however is restricted to 625 lines in the vertical direction and more resolution cannot be realized than is possible with these TV screen limitations.(this is identical to the current dicussion about pixel size and number in comparison to film emulsions. History repeats itself!).

Dr. Schade was the first person who discovered that an improvement in contrast was the cause of a visually enhanced sharpness impression, even with identical or lower resolution. This knowledge, first employed in the TV design in America, has been adopted by Dr. Mandler, Leitz-Midland, when he designed the first Summicron-R 50mm f/2, introduced in 1964 together with the new Leicaflex. This lens had a very high contrast and image quality judged by the then accepted standards. The high level of contrast was coupled in a smart way to a high level of resolution and for a long period, because of its excellence in terms of the micro-contrast at the limit of useable resolution, this lens served as the reference lens for tests of film emulsions. If you are engaged in collecting Leica lenses, this one should be in your collection as a significant milestone in lens design. Since then, Leica designers have always been engaged in optimizing, which is not the same as maximizing, contrast and resolution at full aperture.

__Aberrations

You can imagine that a scene is made up of many small patches with different brightness. Their distribution is the basis for a good composition and may be used to find an interesting composition. At the moment we are only interested in the fact that the lens should reproduce these brightness spots faithfully. Even the smallest image point must have some extension and therefore a certain amount of energy as the light quanta are themselves energy particles. The light rays of on object point fall on the surface of a lens and are refracted by the spherical form of the surface to form an image point as small as possible. These image points on the negative are very small (typically 0.005mm in diameter). If you look at such a point very closely, you will note that it consists of a very small bright core where most of the light rays are focused, and a larger circle around the core where the rest of the rays will fall. This is a rim caused by flare. If we have a very small core and a large area around the core, we have maximum resolution but contrast will be very low. You can reduce the circle of flare around the core, with the effect that more rays will be concentrated in that core, but we now need a larger area for more rays. Now contrast is at optimum, but resolution is slightly less (see illustration below).

The designer has clearly some influence on the shape and composition of this image point. He/she can try to find a certain compromise between between both extremes and nudge the design in a certain direction. The residual aberrations that are always present, because of the fact that the optical errors cannot be reduced to zero, will influence the final image quality. Object points that are on or close to the optical axis will be represented as circular image points and are relatively easy to correct. That is why a good image quality in the center of the image field is not so difficult to achieve provided you restrict yourself to small apertures. When the maximum aperture is quite large, say f/2 or f/1.4, it is no longer a simple task to get good quality in the center. If you go to positions away from the axis, the distance from image point to optical axis (image height) will increase and the rays will fall obliquely on the image plane (angle of entrance). Now we will encounter new types of aberrations like astigmatism and coma that are quite difficult to correct. And some of these aberrations will, depending on image height and entrance angle, increase disproportionally in magnitude. As an example we may use spherical aberration. If we increase the aperture from f/2.8 to f/1.4, the magnitude of error increases ninefold.

To complicate matters, we know that we can only correct a lens optimally for a certain distance or magification. Mostly we use the infinity distance as the reference, but for macro lenses another distance should be selected. The image quality cannot be evenly distributed over all distances, over the whole image field and at all apertures. And the wider the aperture, the more difficult it will be to find a satisfactory balance of error correction. And finally we have to face the chromatic aberrations. It is well-known that every color is refracted in an optical system by a different amount (dispersion). This means that every color (red, blue, green and so on) will have its own optimal sharpness plane and that all colors will be seen with differences in sharpness. This so called longitudinal chromatic aberration must be taken into consideration when you are searching for a compromise between highest contrast and resolution of small textural details.

These facts may illustrate that any lens is always a compromise solution between many and often conflicting characteristics decided upon by humans. Even the best computer program can produce only numerical indications for this balancing. At the end of the day the optical designer has to make the final decisions. The three standard lenses in the Leica R-system therefore offer a different set of capabilities and performances.

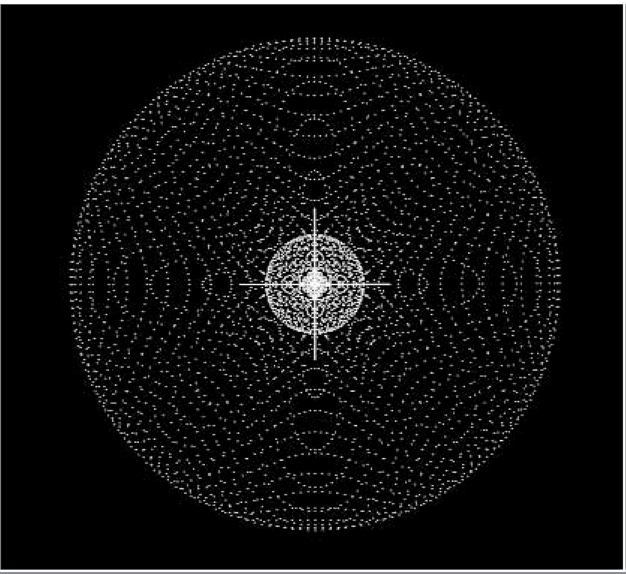


Image point A

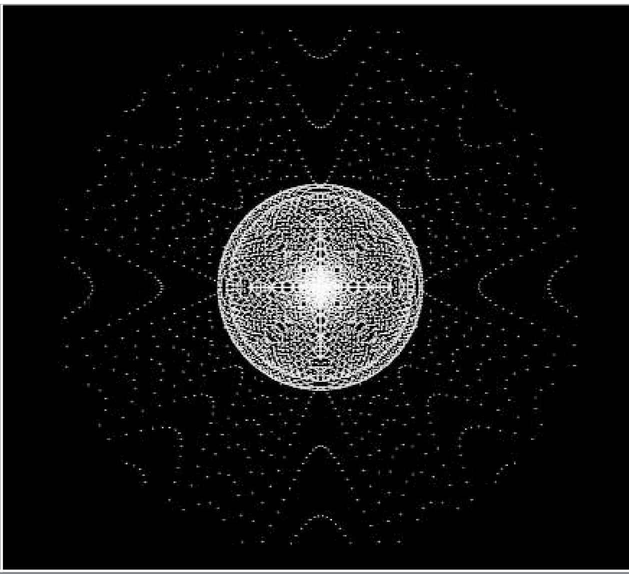


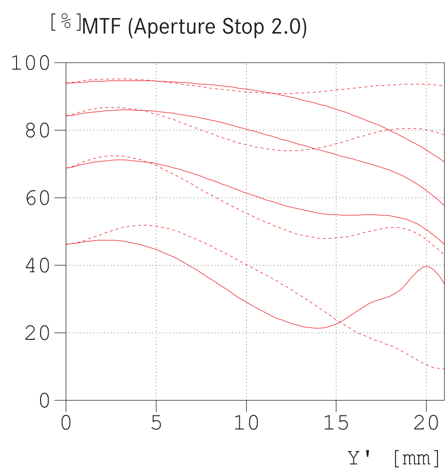
Image point B

__Three standard lenses

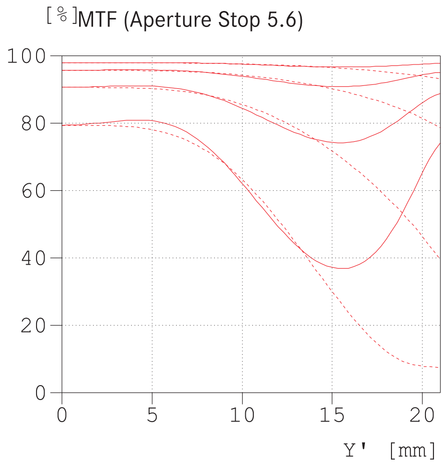
At this moment there are three lenses in the lens line-up that may be designated as standard or normal lenses:the Summilux-R 50mm f/1.4 (1998), the Summicron-R 50mm f/2 (1976) and the Macro-Elmarit-R 60mm f/2.8 (1972). There are good reasons to classify this last lens as a special lens for macro purposes. I would rather see this one as a very interesting standard lens with some remarkable properties.

__ LEICA SUMMICRON-R 50 mm f/2

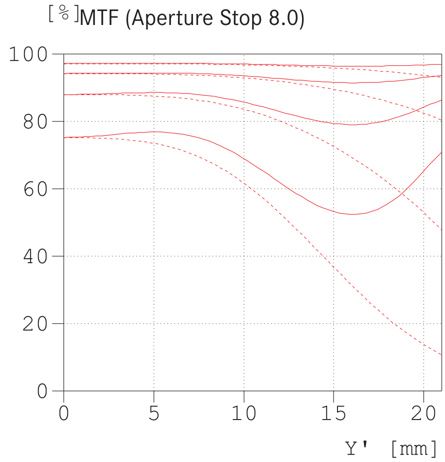
The current Summicron-R is almost identical in optical construction with its counterpart in the M-system. It is one of the two or three best standard lenses in the world. The predecessor from 1964 was balanced for high contrast at wide openings. The disadvantage of the design was a slight shift of focus when stopping down, that resulted in the best sharpness zone shifting from center to a zone outside of the center. The current version is a bit less contrasty at full aperture, but performs better when stopping down, and its image quality is more evenly distributed over the whole image area. Stopped down to f/4 the lens already delivers its best performance. Over an image area with a diameter of 24mm excellent quality can be seen. Brilliance, edge sharpness and resolution smoothly work together to create images with crisp rendition and almost a 3-dimensional effect. Most objects are 3-dimensional and should, when projected onto a flat plane (paper or screen), keep these properties.
Image quality falls off towards the corners, i.e. if the image quality across the whole negative area is really crucial, one should consider the Macro-Elmarit-R 60mm f/2.8.
Wide open the 5 Lp/mm are not yet at optimum position. This can be detected in the slight softness of delineations of main subject outlines. The curve itself is a bit wavy. At an image height of 12mm the line is split in two different lines for the tangential and sagital image plane. This behaviour often indicates the presence of astigmatism (horizonatal and vertical lines are sharp in different positions of the image plane) and coma.



The fact that the curve turns upwards in the corners indicates the influence of vignetting. Especially the curve for 20 Lp/mm (third group of lines in the diagram) is responsible for the somewhat soft definition of the finer image details in the outer areas of the negative.



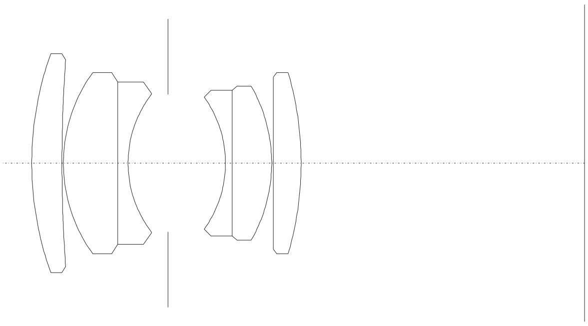
At f/5.6 the performance is outstanding. The line for 40 Lp/mm is now as good as that for10 Lp/mm wide open. The higher the contrast at 40 Lp/mm, the higher the clarity of the fine image details. The line for 5 Lp/mm is completely level now. The fact that the outer zones do not improve in the same way at the higher frequencies indicates the presence of residual aberrations.



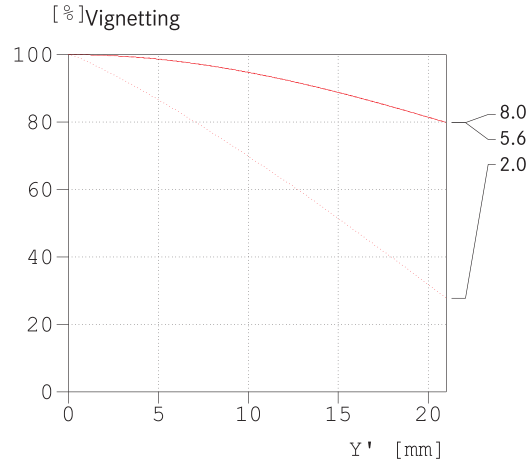
At f/8 you will detect a slight drop in the curve for 5 Lp/mm, as can be seen in the other curves too. This small loss of contrast indicates the influence of diffraction that starts to have effect at this small diamter of the aperture opening. Small differences should not be over-emphasized. Every lens has a tolerance range of 5% in the values of the curves. This is true for all MTF-graphs.

The Summicron-R 50mm f/2 offers outstanding image quality that can hardly be improved as long as one sticks to the six elements normally employed.

In complicated light conditions (contre-jour or backlighting,

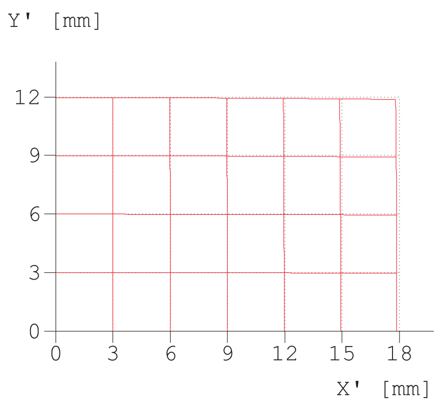


strong light sources that fall obliquely on the lens surface, extreme differences in subject contrast, that produce flare in the shadowy parts and specular highlights) this excellent performance is preserved. Flare and secondary reflections are minimal. Specifically with slides that can render a larger contrast range, this performance shows in really deep black shadow areas. A bit typical for the Summicron design is the occurrence of a hazy patch of light in the center of the image in situations where a large and bright backgound is part of the scene and can act as a light box. In this situation a small change of position can correct this phenomenon.



Vignetting at the edges is visible with almost two stops at full aperture. Vignetting is not so easy to analyse as seems to be the case.With a motive that has a uniform and medium bright illumination, you will see the vignetting quite clearly. With a very bright or dark background or when there are many details in the picture, it is not so easy to detect.

Effective Distortion



Distortion is visible with 1% at the dges of the image area. At an image height of 12mm (the top border of the negative in normal horizontal position) the distortion is hardly detectable. The general rule says that distortion above 1 to 2% will be seen, as straight lines then visibly become slightly curved.

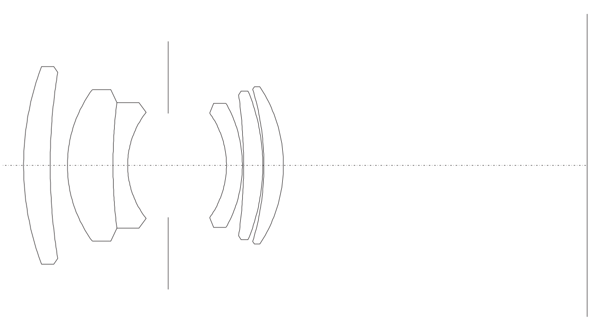
Leica lenses are always calculated according Barnack's famous motto: small negatives, large pictures. It is in fact a pity to to restrict yourself to color pictures on a small print. Leica images should be printed at least on A4 (24x30cm) or projected with larger magnifications. It is only then that the performance of Leica lenses can be appreciated. It is clear that fine detail is only visible when the magnification is above the threshold of human perception. Small details with a size of 0.01mm or 0.005mm on the negative need a resolution of 50 to 100 Lp/mm with good micro-contrast. In normal conditions and at a distance of 25cm the eye can discern about 3 to 6 Lp/mm. This means we need an enlargement between 8x and 32x to see the detail in the negative.

	Eye 3 Lp/mm	Eye 6 Lp/mm
Negative 50 Lp/mm	16x	8x
Negative 100 Lp/mm	32x	16x

At smaller print magnifications and print sizes we are unable to see the many details present in the subject and captured by our Leica lenses. The joy and pleasure in using Leica lenses could be enhanced when we exploit the quality to the full. The 50mm lens with an aperture of f/2 can be employed universally and its full aperture can be used without restrictions. You should always strive to use the highest possible shutter speed. The old rule of thumb that the reciprocal of the focal length is the speed limit for handheld photogrpahy is not a very smart one. With a 50mm lens that would imply 1/60 of a second, which is evidently too slow to counter the self-excited vibration of the body (heart beat). The smaller details and especially the edge sharpness will be disturbed. The overall impression of the image is soft.
There is hardly a subject that cannot be photographed with good effect with a 50mm lens. The palette of possibilties runs from landscape to portrait, from still life to reportage. And in photographic style there are no restrictions: dynamical or constructed, spontaneous or reflective, every approch is possible. You can do more with a 50mm than is often assumed. And as noted in the introduction, the perspective is natural and relaxed. Artistically the 50mm is a challenge to use. The 35mm format with its 1:1.5 aspect ratio is a bit to wide for most compositions. You need to carefully position the main subjects and secondary subjects in a good foreground-background realtion to get a fine composition.

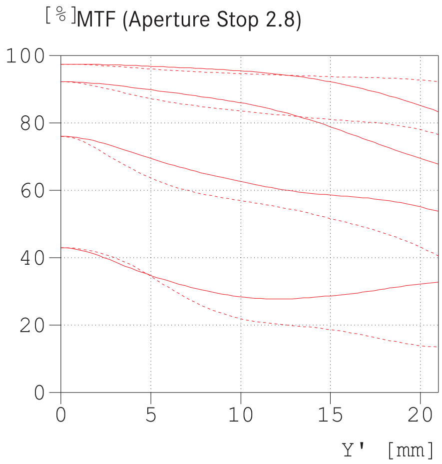
__ LEICA MACRO-ELMARIT-R 60 mm f/2.8

It is often an advantage to use a lens with an aperture that is as large as possible, as with the Summilux-R. The added value of such a lens should be carefully considered. Depth-of-field is very small and when you enlarge, the depth-of-field is reduced again. The tables for the depth-of-field are based on a circle of confusion of 0.033mm, which is too large in many situations for critical work.

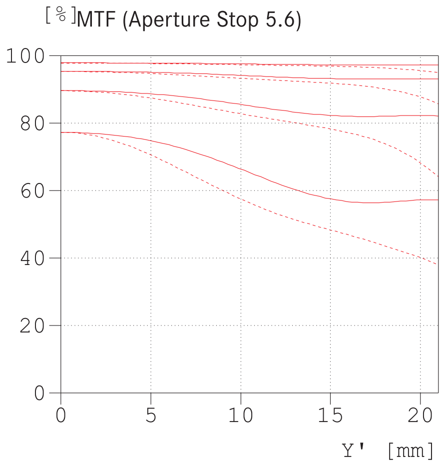


Here a trick can help: if you wish to enlarge or project substantially larger, you can find the real depth-of-field according to this rule: Aperture on the lens used is f/8. The depth-of-field is now read off the table at the f/4 line for big enlargements and at the f/5.6 linefor smaller enlargements. This rule works also for the close-up capabilities of the Macro-Elmarit-R 60mm f/2.8.

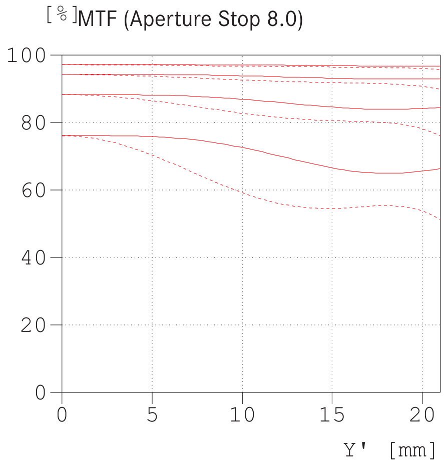
This lens is often characterized as a true macro lens. You should see this designation in a wider perspective. The 'Macro' in the designation does not imply that the lens is calculated for very close distances and high magnifications. The macro range is normally described as the magnification range from 1:1.0 to 1:50.0 or with distances from 1000mm to 10mm. Actually, the Macro-Elmarit should be designated as a close-range Elmarit. Normally a lens is calculated for optical infinity, that is a distance equal to 500 to 1000 x the focal length. It is logical that at closer distances the optical performance will drop a bit, as the aberrations are not corrected fully in this range. Partly you can compensate by stopping down. And you will often read the recommendation to stop down the lens when you are at close range with your lens to improve the image quality. True macroscopic lenses are designed for one optimum (small) magnification or distance range. The Macro-Elmarit-R has been designed and corrected for the medium distances in order to provide for excellent performance at infinity. The diagrams show quite good MTF values at the infinity position and especially at medium apertures the performance is better than with the Summicron-R.



At aperture f/2.8 the line for 5 Lp/mm is already located quite high and straight. The 10 and 20 Lp/mm are on the low side and you will note that medium fine detail will be outlined with faintly soft edges.



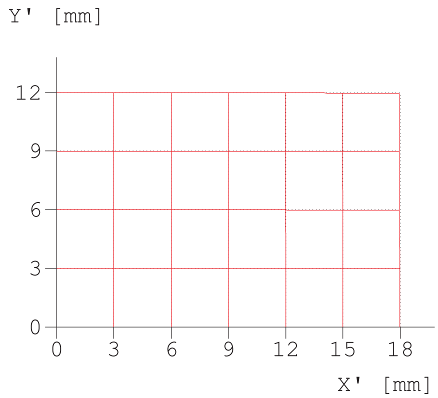
At aperture f/5.6 the correction of the aberrations is excellent. The 5 and 10 Lp/mm are very high and indicate very high contrast and good resolution. The 40 Lp/mm curve drops a bit from center to corner. But one should be careful here. These very small image details are not so sensitive to small differences in contrast as the subject outlines.



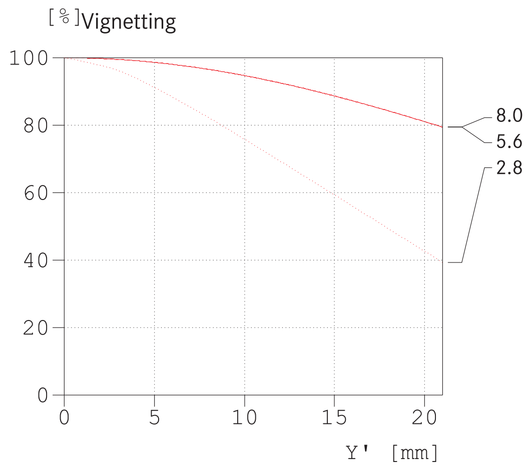
At aperture f/8 you will see (as with the Summicron-R 50mm f/2) the effect of diffraction. The contrast drops a bit. Again a remark: these effects can be calculated and shown in a diagram: it is not so easy to detect this in real photographic practice.

The Macro-Elmarit-R 60mm f/2.8 has no distortion and the performance is equally good from center to edge.

Effective Distortion



easily recognized. Flare cannot be detected and vignetting is quite small .



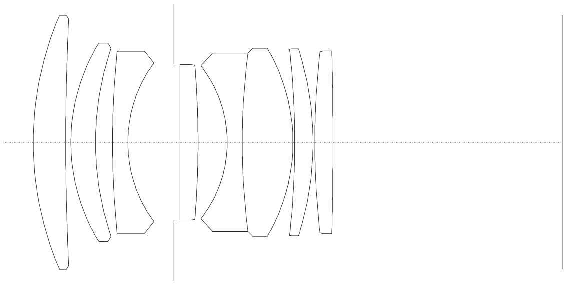
If you are looking for a standard lens that delivers superior performance at medium apertures and distances, then the Macro-Elmarit-R is frst choice. This quality can be exploited best when using a tripod or working with high shutter speeds. And (often overlooked) the subject matter must have those fine textural details, after all, the lens cannot capture what is not available. In the close-up range, between 70cm and 20cm, there is a fascinating world to explore, if you are open-eyed and wish to see new patterns in ordinary subjects. In this range the optical quality is outstandingly good. A small drop in contrast cannot be avoided, but can be accepted as the textural details are already captured quite clearly. Objects with a considerable depth should be photographed with quite small apertures and whenever possible with some backlighting to preserve the sense of depth. At a magnification of 1:10 the depth-of-field at f/5.6 is a mere 4cm. It is advantageous that the unsharpness gradient is quite smooth: unsharp detail will retain its shape and can be

The diagram shows a smooth curve, which helps to lessen the effect of vignetting. If absolutely even illumination is required, an aperture of smaller than f/5.6 should be used where the limit of natural vignetting is reached.

The big advantage of this type of lens is the possibility to change quickly and smoothly from close-up to medium distances. Detail pictures and overviews can be made in one sweep from infinity to magnification 1:2. The slightly smaller angle of view of 39 degrees (compared to 47 degrees with the 50mm) assists in isolating the main subject. The Macro-Elmarit-R is a general purpose lens and can be used with all subjects and most photographic conditions. It is not a true reportage lens, as the long focusing movement is a bit slow when you need to go from close-up to long distance. But in all situations where the documentary and meditative style of photography is selected, this lens is the best choice.

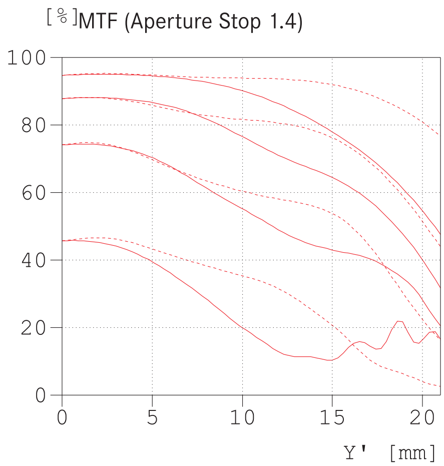
__ LEICA SUMMILUX-R 50 mm f/ 1.4

The jump from 2.8 to 1.4 brings a fourfold increase in the amount of light energy that travels through the optical system. And some aberrations grow in magnitude by a factor of nine. Specifically the spherical aberration and the chromatic variation of spherical aberration and coma are nasty funspoilers. You can not eliminate these errors, only compensate them with other aberrations. That is why a truly outstanding 1.4-lens is so difficult to design.



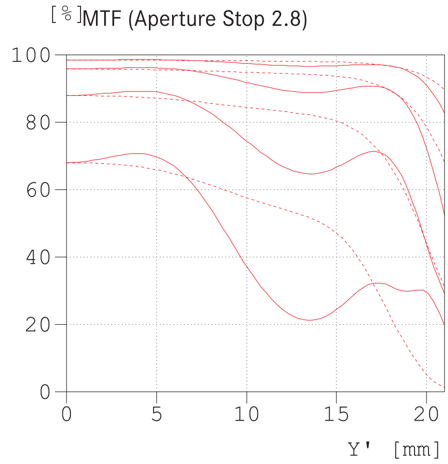
The first version of the Summilux-R 50mm f/ 1.4 from 1970 had commendable performance and was as good as the rest of the competition. It was not better though, and one should reflect on the fact that in those days a 1.4-lens was a must for every manufacturer in the front rank of optical design. Wide open the image was soft and with low contrast. Stopped down the quality improved, but the lens never reached the performance level of the Summicron-R. Specifically the quality in the outer zonal areas was not very good even at f/4.

The new design from 1998 with 8 elements solved these problems and more! At aperture f/ 1.4 the performance is very close to that of the Summicron-R at f/2. I write 'almost' as the lens shows a very faint softness under critical inspection and large magnifications. The curves for 5 and 10 Lp/mm are located a bit low and this signifies a lower overall contrast and a softness at the edges of subject outlines. The maximum resolution is not yet at its best at this aperture. You can discover this under test conditions, but generally it makes no sense to test a 1.4 lens wide open for best resolution. You will not use this lens at maximum aperture to make high resolution pictures. A more relevant practical comparison is the one I made when, during a two week holiday, I used both the Summicron-R at aperture f/2 and the Summilux-R at aperture f/ 1.4 and f/2. During the projection of the slides it was often impossible to identify which lens was used for the pictures. We may state that for most picture taking situations the Summilux-R performs as well as the Summicron-R at when both are set at aperture f/2 the Summilux is a tad better. At aperture f/ 1.4 the vignetting is identical to that of the Summicron-R at f/2.

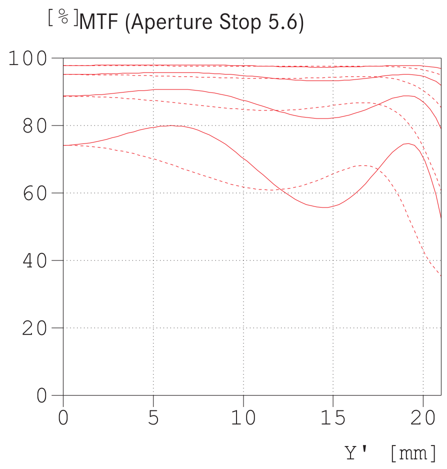


It is really fun to use this lens at aprture f/1.4. The bright image on the finder screen allows for fast and secure focusing and the resulting pictures have a special charm and character. With aperture f/1.4 under-exposure is not so very critical as the light gathering power allows the main subject detail in the shadows to have clean outlines and the specular highlights to be cleanly delineated. The fine textural details in the main subject (where the sharpness plane is located) show clarity, the colors are saturated without being on the dark side. The sum of all these characteristics creates pictures with the famous Leica look.

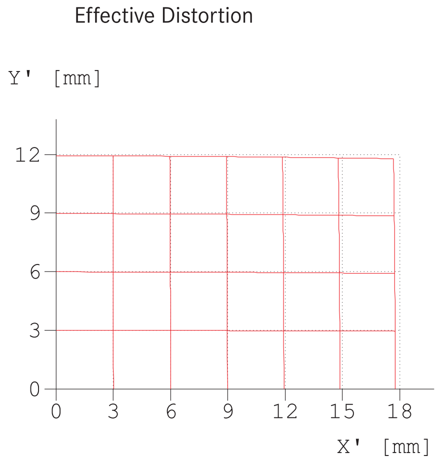
Flare in high contrast situations is very minor, but whenever possible, the built-in lens hood is a must. Tricky lighting can spoil the day. The big surprise with the Summilux-R is the remarkably high image quality when stopping down. This is not an obvious result. You buy a lens not only for its wide open performance, but want to use it also at smaller apertures with equally good or better results. Especially the improvement of the performance in the area outside the center of the image is very high.



At aperture f/2.8 the Summilux-R equals the Summicron at aperture f/5.6. Especially the location of the curve for 5 Lp/mm indicates a very high image contrast. Very fine details in the edges are still weak and blurred. Look at the curve for 40 Lp/mm beyond an image height of 15mm. The rapid increase in performance when stopping down indicates a low level of residual aberrations, specifically the chromatic aberrations.
At f/5.6 the Summilux is so good that you need the best films to realize the image potential.



The curves for 5, 10 and 20 Lp/mm are almost flat, close together, and high in the diagram. The small undulation in the curve for 40 Lp/mm is not so important in this case. You can be very happy with this performance potential. An ideal lens is not (yet) possible. The excellent performance wide open is accompanied by some distortion.



Close to 2% is still an impressive value, but one will see this clearly as straight lines as the edges become a bit curved. You should reflect on this behaviour when selecting your subject matter. I am not aware of a better 50mm f/1.4 lens than this one, within and without the Leica domain. There are very few lenses in the same performance league, but the Leica lens has the advantages of better mechanical engineering and precision in manufacture. Especially here, where you expect and demand top quality, the accuracy of manufacture may be quite significant. Stopped down this lens delivers outstandingly good image quality and wide open the performance is excellent, even in absolute terms. If you are aware of the great challenges that have to be taken up by the designers to create a lens with such high performance, you feel impressed by the result.

__Summary

The Summilux-R 50mm f/1.4most versatile and offers the best allround performance and improves upon the Summicron-R 50mm f/2 at smaller apertures. Ana dditional advantage of the Summilux is its good performance at the wider apertures. If you want accurate reproduction of a wide range of subjects, also in the close focusing range, the Macro-Elmarit-R 60mm f/2.8 is the best choice. The Summicron-R 50mm f/2 offers many of the characteristics of both these lenses in a compact and well-handling shape, but has to take second place in the specialized disciplines of its companions.

Leica R-Lenses

by Erwin Puts

August 2003
Chapter 2: 80 mm and 100 mm lenses

__ LEICA SUMMILUX-R 80 mm f/ 1.4
__ LEICA APO-SUMMICRON-R 90 mm f/ 2 ASPH.
__ LEICA APO-MACRO-ELMARIT 100 mm f/ 2.8

In older textbooks about photographic techniques there is much space devoted to the choice of a lens. At first one should buy a 50mm lens and use it for an extended period of time. Having learned the language of photography, one is prepared, and only then, to buy a second lens. The 90mm lens, or as it was called when focal lengths were measured in centimeters, the 9cm lens, was the next step. Having bought this lens and after studying the laws of perspective, one was ready for a wide angle lens. And finally a 135mm telelens could be considered. The first Leicaflex was introduced was only four focal lengths (35-50-90-135) and this was done on purpose. Much of what was known in the past, is still valid today. Lenses are like persons. Only after a long period of companionship, the true character can be seen and appreciated. A 90mm lens is a more versatile tool than can be gleaned from the usual catalog description (useful for landscapes, architecture, snapshots, animals). The 'ninety' is a lens that enables you to really investigate the Leica style of photography. If you look at many pictures, you will discover that often the image works overloaded as so many parts of the image ask for attention. A ninety millimeter lens forces the photographer to a selective choice of subject matter and thus to exploit the space provided by the quite small negative format to its best. Selective enlargement should be avoided as much as possible, as any additional magnification will degrade the optimum image quality. In this sense the 90mm is an excellent teacher

__Artistic reflections

The natural perspective is one where the viewing angle in natural space is identical to the angle of view when looking at the picture. The eye has a viewing angle that is close that of a fisheye lens, but in practice the field of vision is much narrower. Fundamental requirement for the correct perspective demands that the eye should be positioned at the same location as the entrance pupil of the lens. There is a simple equation that tells you that the viewing distance (e) for the correct perspective should be the focal length of the lens (f) times the negative enlargement (v). As a formula: e = f times v. If you make a picture with a 50mm lens and wish to look at the negative directly, your eye should also be 50mm from the negative. But the minimum distance of distinct vision is 250mm and so the negative must be enlarged 5 times. We need a 5x magnifying glass to see the picture with the correct perspective. Or you should enlarge the negative 5 times to a print to a size of 13x18cm. The well known picture format of 10x15cm requires a 4 x enlargement and is too small. It implies that you will look at the picture with an extended space perception. You look at the picture with a wide angle perspective so to speak. When a format of 13x18cm is used and the picture is made with a 50mm lens, then this 5 times enlargement will provide for a correct and natural perspective. The picture format of 13x18cm has a diagonal with a length of 222mm and that is quite close to the minimum distance of distinct vision of 250mm. The angle of view is now about 50 degrees and this corresponds to the angle of view of a 50mm lens (45 - 47 degrees). But this minimum distance is very often quite uncomfortable in many situations. You may not be able to view the whole picture at once without moving your eyes and the distance of 250mm is quite short, if you are above 20 years old. Many studies have found that he most comfortable viewing distance is twice the value of the minimum distance. If you want to keep the natural perspective, you need a lens with a focal length that is twice the value of the diagonal of the negative format, thus 2 x 43mm. A focal length of 86mm, then would be the ideal lens. This somewhat surprising conclusion can be supported by the following observations. The focal length of 90mm is often described as the best for portraiture. This is true, but why? Let us make a head and shoulder portrait at a distance of 2 meter with a 100mm lens, and enlarge this negative to a print size of 13x18cm. The formula tells us that we need to look at the picture from a distance of 5 x 100mm, or 50cm. If we now take the same picture with a 50mm lens at one meter distance, the viewing distance should be 25cm. But we look at the portrait often at a distance from 50cm as this is more comfortable. Then we look at the portrait with a wide angle perspective and the impact of the image will be different from that taken with the 100mm lens.

Perspective is independent from the focal length. If we photograph a subject from the same position with a 28mm lens and a 300mm lens, the perspective is not changed, only the rate of magnification. We can verify this, when we enlarge the 28mm picture ten times. Let us now compare both pictures and we see that they are both identical in size and perspective (depth cues). The vertical angle of view of the 28mm lens is 46 degrees and that of the 300mm lens is 4.6 degrees. The viewing distance for the enlargement of the negative with the 28mm lens is 28cm (10 times 2,8cm) and for the (not enlarged) picture with the 300mm lens it is 30cm (1 times 30cm).
If we take pictures with lenses of different focal lengths at different distances to keep the size of the main subject at equal size, the perspective will change of course. The perspective formula tells that the perspective impression is only then a natural one, if the viewing angle of the camera in space is the same as the viewing angle of the eye at the picture. You can ensure this when you carefully adjust these three important aspects: enlargement factor, viewing distance and focal length. This is true also when you project slides. The choice of the focal length should always take into consideration the expected enlargement factor and the normal viewing distance. It cannot be a coincidence that the 90mm lens was very popular with experienced photographers. And Leica has always offered a wide selection of 90mm lenses, carefully tuned to different tasks. It might be a fine exercise to use the 90mm exclusively for one month and enlarge all pictures to a size of 13x18cm. The viewing distance should be about 50cm. Then you really get used to the correct perspective. A portrait taking with a 90mm has a 'flatter' perspective that is 'flattering' for the sitter.

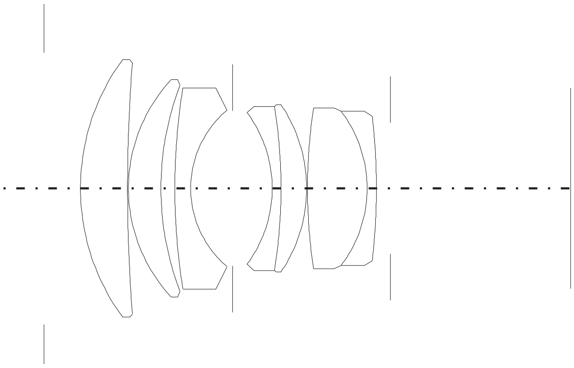
__Optical considerations

Within the R-System we have three lenses with a focal length between 80 and 100mm. Every lens has its special use and character. We will look at first at the optical properties. Almost every high speed lens with focal lengths from 35 to 100mm are derived from either the Sonnar or Biotar basic form. The number of lens elements ranges from 5 to 8. With this amoint of options the optical designer has an abundance of choices.

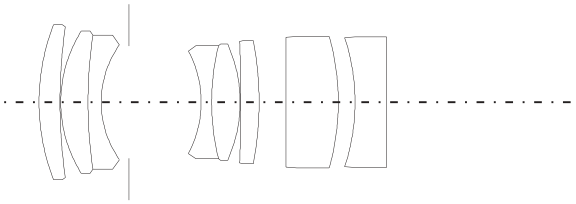
Basically the following options exist:

- split a lens in two single lenses (distribution of refractive powers)
- create a single lens as a compound of two lenses
- change the refractive index of the glass types
- use aspherical surfaces
- split a compound element in two separate elements
- use glass types with anomalous dispersion

The optical designer can use all of these options in any combination to design a lens that delivers optimum performance according to his set of standards.



The Summilux-R 1:1.4/ 80mm (from 1980) has the construction we already know from the Summilux-M 1.4/ 50 from 1961. Three single lenses before the aperture and two compound lens groups behind the aperture. Leitz used two versions of this design: the last group is constructed as a compound doublet or as two separate single elements. For high speed lenses the compound version is better suited, if this group is designed as a new achromat. It is in fact remarkable how well this design has served the demands of generations of users. Even from todays elevated demands we can evaluate the performance as outstandingly good. With some effort you may detect in the design the vestiges of a Double-Gauss lens.

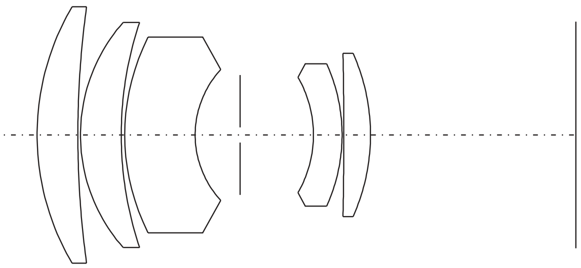


A true Double-Gauss design we find in the Apo-Macro-Elmarit-R 1:2.8/ 100mm. Here we have a six element construction with two separate thick elements at the rear end. As with the 60mm macro lens, the computation is designed for universal usage. When focusing the lens, the whole front lens with six elements moves and the rear group is stationary. The apochromatic correction is very important when slides or negatives need to be magnified substantially. The disturbing color fringes are eliminated, because of the reduction of the secondary spectrum. The apochromatic correction is often restricted to the long focus lenses as the chromatic errors grow proportionally with the focal length. It was a remarkable decision by Leitz to employ this correction type in a lens with a focal length of 100mm. The optical qualities have not been surpassed to this date, although we have some others who are quite close in performance. With the 100mm lens, you can take pictures at a magnification of 1:2 without supplementary tools and still keep some distance from the subject. The image quality is equally high at close ups and at infinity. The special construction with the two thick rear lenses is partly responsible for this behavior. The use of special glasses with anomalous dispersion helped the apochromatic correction substantially. The optical design gas been optimized for the specified task, especially the homogeneous quality level over the whole distance range. The first version of the Apo-Macro-Elmarit-R 1:2.8/ 100mm used a mount with a double thread, later changed to a single thread, as the previous mechanism created a less smooth movement. (from serial number 3469285)

The first Summicron-R 1:2/ 90mm has been introduced in 1970 and has held the flag for this classical focal length during 30 years. It is a five element design from the Midland optical construction department. It has some reminiscence to the Sonnar design. The system is nose heavy as most elements are in front of the aperture. The performance is good, but the Summilux-R is as good and has twice the speed to illuminate the negative area.

The Summicron-R 1:2/ 90mm displays the typical veil of soft flare over the whole image at full aperture, that is the characteristic of almost every high speed lens of the older generation. The typical use of the 90mm as a portrait lens could serve as an explanation and defense of this behavior. The soft reproduction of image details and subject outlines created a more friendly image of most faces of the sitters. But one did the 90mm lens an injustice as it restricted its potential universal use.

The current Apo-Summicron-R 1:2/ 90mm ASPH (2002) raised the level of optical quality substantially. The size is very compact and almost equal to that of the current Summilux-R 1:1.4/ 50mm. Based on size it can be classified as a standard lens. The optical quality is superb and a revelation. The aspherical surface is grinded by CNC-equipment in a lengthy and elaborate way. Grinding and finishing takes many hours per element and is so time consuming because of the many inspections and checks during the manufacture. If a lens is manufactured with such accuracy, you need a very careful assembly. The Leica-typical construction with metal parts of exact dimensionality is a necessary condition for a high quality product. This aspherical surface with a large diameter and complex shape has to be assembled with utmost care to ensure that the theoretical capabilities can be practically available. The optical construction shows a five single elements, and the first surface of the third lens has the aspherical shape. True mastery can be seen in this elegant design. Some time ago one needed seven or eight lens elements and could not get this high performance. The low number of elements, the choice of glasses for transparency and color transmission, the effective type of coating, all work together to provide the remarkably clear and crisp rendition. The image quality is very, even at full aperture and veiling glare and secondary reflections are absent. If you take pictures with the sun, directly shining into the front lens, some aperture reflections can not be avoided.



This layout may be indicative for new designs from Solms. The classical design with seven or eight elements may be in its final stage. The current demands have become too high, especially in relation to the new method of digital capture.

__Three lenses of medium focal length

These three lenses do not only differ in their effect on perspective but also in their performance at full aperture. Everyone of these lenses could be described as a general purpose lens, with exception of the special macro facilities of the Apo-Macro-Elmarit. The angles of view are close together with 30, 27 and 25 degrees. In reality the differences are bigger. If we take a picture of a person and a face in vertical format, the subject distances are as seen in the table below.

	Person 1.76 Meter	Face 50 cm
Summilux-R 80 mm f/ 1.4	6.57 Meter	1.86 Meter
Apo-Summicron-R 90 mm f/ 2 ASPH.	7.33 Meter	2.08 Meter
Apo-Macro-Elmarit-R 100 mm f/ 2.8	7.93 Meter	2.25 Meter

At these distances the image size of the person is always the same, but the background is clearly different and has its pictorial effect on the subject. For formatfilling figure photography, the 100mm is a bit uncomfortable as the distance to the person is quite large and here the 80 or 90 are better suited. The most important selection criterion is the performance wide open. In the next table I have compared the three lenses in this respect.

	Aperture 1,4	**Aperture 2,0**	**Aperture 2,8**
Summilux-R 80 mm f/ 1.4	Medium contrast, some flare. In the center good resolution, in the outer zones medium resolution, some astigmatism is visible.	Medium contrast, low flare. In the center very good resolution, in the outer zones good resolution, some astigmatism is visible.	High contrast. In the center very good resolution, in the outer zones good resolution with some softness, astigmatism is very faint.
Apo-Summicron-R 90 mm f/ 2 ASPH.		High contrast, very high edge sharpness, high resolution from center to edge.	Very high contrast, very high edge sharpness, very high resolution from center to edge.
Apo-Macro-Elmarit-R 100 mm f/ 2.8			Very high contrast, high edge sharpness, very high resolution from center to edge.

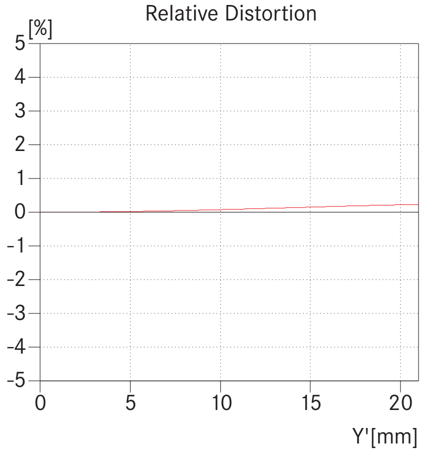
This evaluation is based on very severe conditions. The testslides were enlarged to a size 0f 2.40 meter, that is a magnification of 66 times. Under these conditions, even the minutest error can be seen, especially as the observer is close to the screen, where he should not be to be honest! The Summilux-R shows some characteristics, that are not visible at all at smaller magnifications. From aperture 2.8 all three may be considered equal in image quality. The performance of the Summilux is in absolute terms excellent and should be related to the very high speed. It is not always the case that a very high speed lens can be compared favorably to a dedicated macro lens of stunning performance.The MTF graphs are very informative for the appreciation of optical performance. These graphs show the maximum resolution of 40 Lp/ mm. That is more than needed for most picture assignments. The new Digital Back for the R8/ 9 has a theoretical resolution of 75 Lp/ mm. It is interesting to know if these lenses meet the requirements.

The Summilux-R reaches at full aperture a value of 100 Lp/ mm in the center of the image and 40 to 50 Lp/ mm in the outer zones. The edge is weak with 16-25 Lp/ mm. At aperture 2 these values may be raised by +10 Lp/ mm and at 2.8 we have a center resolution of above 100 Lp/ mm and in the outer zones above 70 Lp/ mm. The Apo-Summicron-R ASPH at full aperure has a value of above 100 Lp/ mm over the full image area, excepting the corners where we still have a stunning 50 Lp/ mm. On the optical axis we even see more than 150 Lp/ mm. From 2.8 we have a uniform resolution of more than 100 Lp/ mm with the edge now at 80 Lp/ mm. The Apo-Macro-Elmarit-R has the same values as the 90mm lens at aperture 2.8.

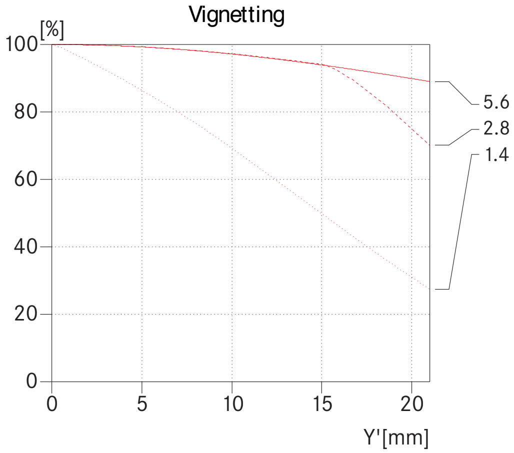
Overall we may declare that all three lenses can exploit the high resolution of the future digital back and they even have some reserve capacity.

__ LEICA SUMMILUX-R 80 mm f/ 1.4

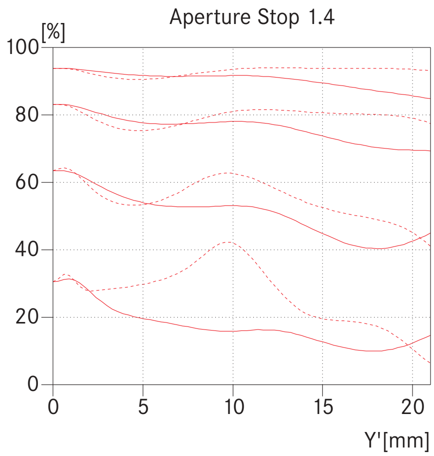
With 700 grams the Summilux-R has somewhat less weight than the Apo-Macro-Elmarit-R. The discussion whether mass does support the stability of the lens will presumably never end. But a high mass also asks energy from the photographer to support the weight and this may counteract the stabilizing effect of mass. You need to hold the lens immobile for a longer period. The Summilux-R has been classified as a ultra-high speed reportage lens. The brightness of the focusing screen is very high, indeed and the focusing is fast and accurate. The speed of focusing can be improved when you pre-focus at the anticipated distance and move the camera slightly to and from the subject for fine tuning,without larger focusing movements. The true focus snaps into position on the bright screen.

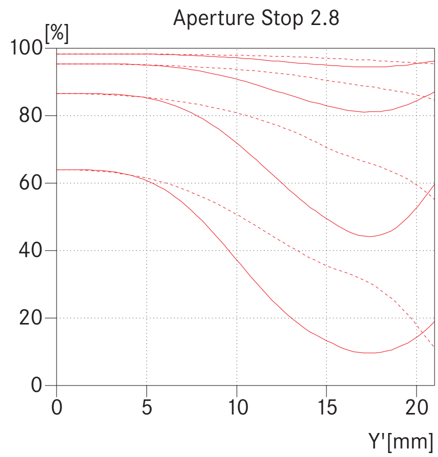


Distortion is surprisingly low with only 0.2%and is even suitable for architectural photography.



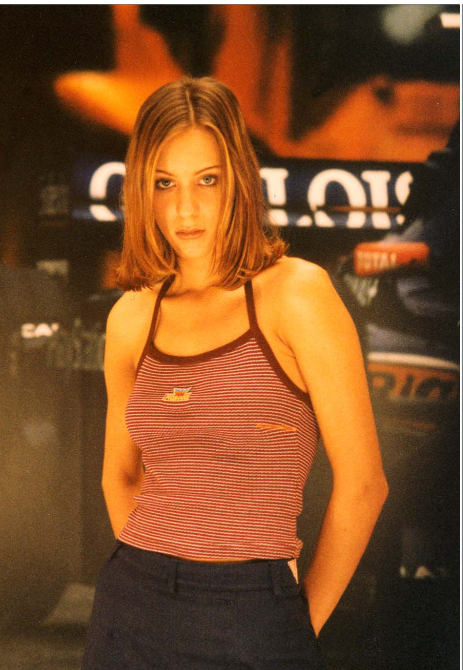
Vignetting is relativley high with 2.5 stops as a measured value. In practical use, these values should be treated with some caution. Even landscape pictures with clear sky show only a slight darkening in the corners.

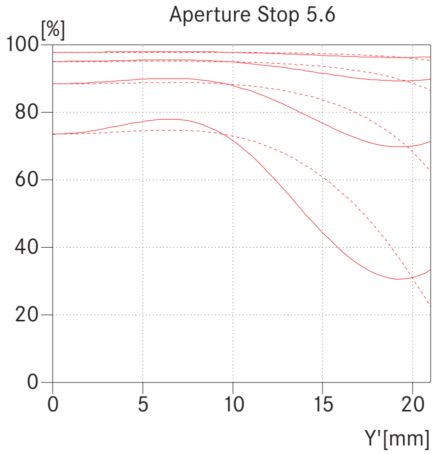




At aperture 1.4 the overall contrast is medium, as can be seen from the graph, where the low frequencies are below 95% The important 20 Lp/ mm are clearly defined with 60%in the center and 40%in the outer zones. The edge sharpness is a bit soft as can be seen from the low position of the line for the 40Lp/ mm. High contrast scenes with many light sources and deep shadow areas are reproduced with a slight veil of softness, but quite low halo around bright spots. You will use the wide aperture of 1.4 to capture scenes in low light situations that are interesting, moving or informative-documentary in character. For this kind of photography, the Summilux is eminently suited. The performance wide open is better than can be captured on modern high speed emulsions . Stopped down to 1:2 the overall contrast improves visibly, as internal reflections are effectively reduced.

Aperture 2.8 again improves contrast and now performance in the center is very high. In the outer zones the quality lags a bit behind, but for this type of photography that is not so important. Here you should look at the 20 Lp/ mm as the guiding line.





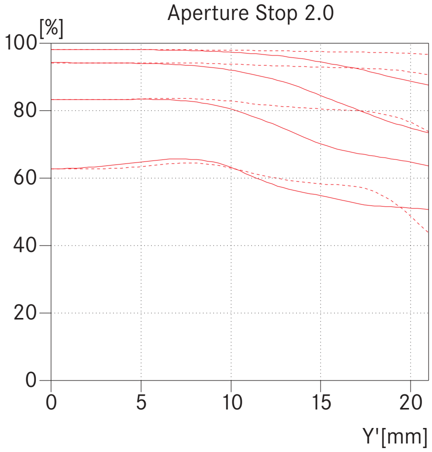
Aperture 5.6 can be regarded as the optimum. The edges stay a bit soft in the definition, but you need a high magnification to discern this. In the center of the image where the main subject or action is being located, very fine textures are reproduced with crispness.

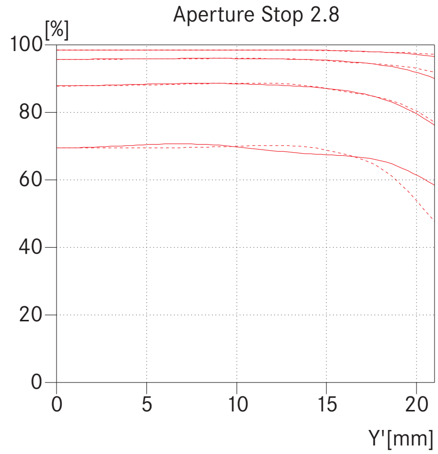
The MTF graphs should be studied with some caution. You can overrate the values that are displayed. I have made comparison pictures with all three lenses at all apertures on ISO100 slide film. The distinctive differences as described above, can be seen only when the magnification is 20 times or more. You should also take care of your photographic technique. Wrong focusing distance and a slight movement of the camera create more loss in the picture quality than the inherent optical characteristics. The unsharpness gradient is quite pleasing and adds to the impression of depth and space. Specular highlights are reproduced with finely nuanced hues and that again improves the plasticity of the image.

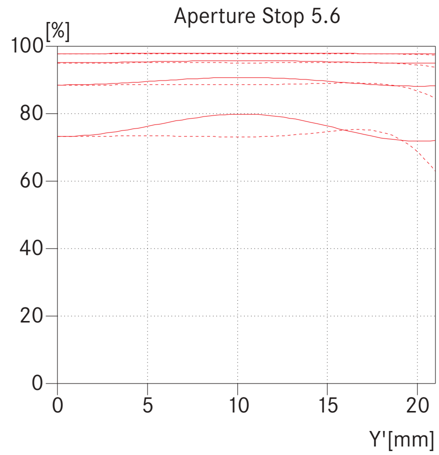
__ LEICA APO-SUMMICRON-R 90 mm f/ 2 ASPH.

Since Photokina 2002 the R-photographer can deploy an optical crown juwel. Every lens line from every manufacture is built up from lenses with differing characteristics, performance levels and deployment possibilities. There is not one manufacturer where all lenses exhibit identically high performance. The rule is still valid that a lens has to be designed with a large set of requirements that are often conflicting an every designer has his own ideas about what should be the best solution for a given task. Anyway, sometimes we have a lens that is very difficult to fault and seems to show a very happy synthesis of requirements. The Apo-Summicron-R 1:2/ 90mm ASPH is such a lens. It is really difficult to criticize this lens.

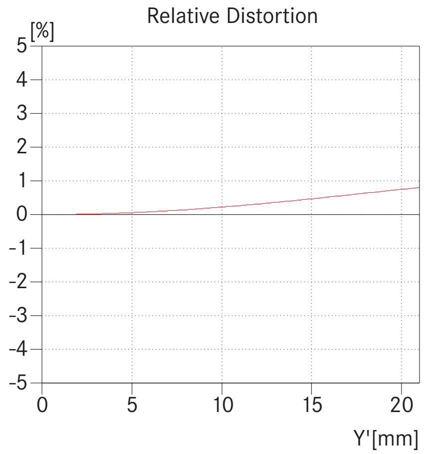
At full aperture the performance is already as good as that of the Apo-Macro-Elmarit-R 1:2.8/ 100mm at aperture 2.8. For an aperture of 1:2 this is a most remarkable feat. More important perhaps is the transparency of the colors and the clarity of the details. Extremely fine details are reproduced with very good crispness from center to edge. The 40 Lp/ mm have an average contrast value of 60%, and there is no race of astigmatism of coma in the outer zones. The previous version of the Summicron 90mm had a contrast of 30%for the same 40 Lp/ mm. A doubling of the contrast of the fine textural details is more than just visible: it is a new experience for high speed lenses. Stopped down the performance improves only slightly.



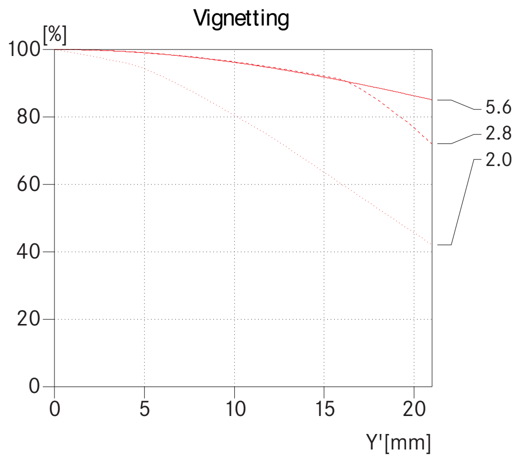




The graphs for 2.8 and 5.6 indicate an improvement for the 20Lp/ m and the 40Lp/ mm, but the jumps are quite small. Compare the jumps in performance of the Summilux. The residual aberrations of the Apo-Summicron are already so low at full aperture that stopping down only improves the depth of field. At smaller apertures the internal reflections are reduced and the extreme edge rays are blocked. If you look carefully, you may see the result of the diffraction at aperture 5.6: the overall contrast for the 5Lp/ mm is slightly reduced compared to the values at 2.8.



Distortion is low with 1%but may be visible on critical inspection and suitable subjects. The Summilux is better here.

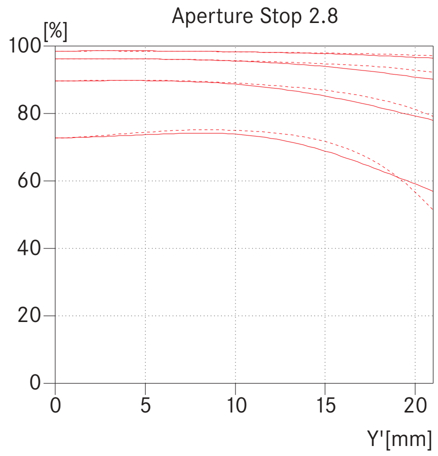


Vignetting amounts to 2 stops wide open, but can already be neglected at 2.8, and is even lower than that of the Apo-Macro-Elamrit at 2.8. The apochromatic correction is effective from aperture 1:2 and can be seen from the non existant color fringes at high contrast edges. Still the correction is not perfect. At very steep black-white borders (and color-white or color/ black borders) a very small color fringe can be detected, but only just and in high magnification. The unsharpness gradient is not as smooth as can be seen with the Summilux 80mm. Some veiling glare can be detected in strong back light and large areas of sky that work as a light box. At distances below 1.5 meter the definition of very fine structures softens a bit at the wider apertures. Stopping down to 5.6 will save the day. Using the Apo-Extender-R 2x, you get a very fine 4/ 180mm lens, that should be stopped down to smaller apertures at distances below 2.5 meter for best quality.

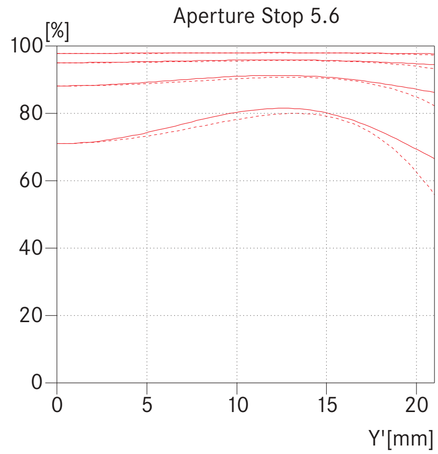
These remarks should not be interpreted as nitpicking. As tester you simply stumble across some limits, how far off they may be, and these should be noted. The Apo-Summicron-R 1:2/ 90mm ASPH is a superb lens in any sense of objectivity, that beraks all previous limitations. With a weight of 520 grams and a small size it may be sen as the ideal standard lens.

__ LEICA APO-MACRO-ELMARIT-R 100 mm f/ 2.8

There are persons who always seem to operate at maximum efficiency, show a uniform performance, never get angry and never say never. Such persons you meet only once in a lifetime. You may jealous of such a person. Some lenses have this character too. The Apo-Macro-Elmarit-R 1:2.8/ 100mm is such a lens. In direct comparison to the Apo-Summicron-R 1:2/ 90mm ASPH, the maximum aperture is slower by a stop, the performance over the entire distance range uniformly high. These parameters define the choice. If the near focusing range (1 meter to 20cm) is not important, the Apo-Summicron-R is the better choice (better ergonomics, less weight and more speed).

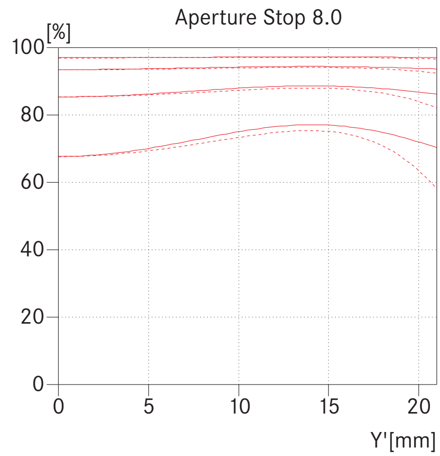


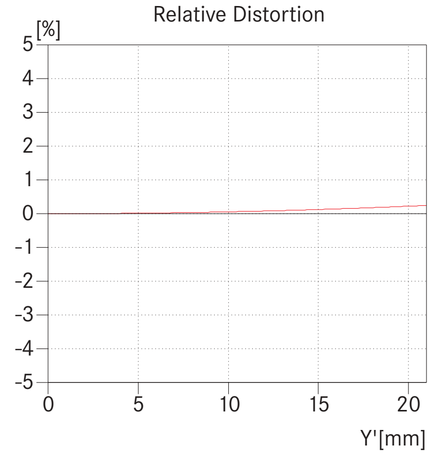
At aperture 2.8 the performance is uniformly high: high contrast and clarity of details are even better than what you expect from medium format systems and this verdict indicates the preferred domain of the 100mm. On tripod and with carefully selected emulsions, the R-System reaches distinctive studio quality. The MTF graphs indicate the performance potential. The 5,10 and 20 Lp/ mm are at all apertures equally high. At 5.6 you note the unavoidable effect of diffraction. Only the best lenses can 'suffer' from diffraction at this aperture. The 40 Lp/ mm, responsible for the reproduction of the fine details and the crispness of the subject outlines, show an interesting shape of the curve. At apertures of 5.6 and 8 the shape bulges out a bit. This is the result of some focus shift. When you stop down a lens, the rays at the edges are blocked and the plane of best focus shifts a little bit. Often this shift will be compensated with a correction state that plays out third and fifth degree spherical aberration. But then contrast drops a bit too at full aperture.



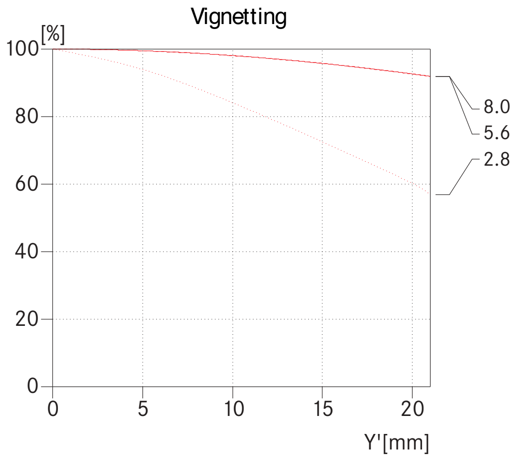
The Apo-Macro-Elmarit-R has hardly any spherical aberration and already a high contrast at full aperture. Then you will see a slight focus shift more easily. You should also look at the design with the two thick single lenses at the rear. The front group (six elements) moves in relation to the rear group (two elements). Tis is not the same mechanism as with zoomlenses, but a kind of internal focus mechanism. This is also responsible for a slight reduction of focal length at the 1:1 macro position: the focal length is here 92mm. You will hardly notice it.

The Apo-Macro-Elmarit-R is one of the very few lenses that performs at its best already at full aperture and does not improve on stopping down.





The distortion is close to zero, and the lens can be used with good effect for architecture and reproduction.



Vignetting is low with a drop of 0.7 stops. My comparison pictures indicate that in practical use the difference in light fall off between one and two stops is less important visually than the numbers seem to indicate. The apochromatic correction has been described in the Summicrons ection and the same applies here too. Without supplementary equipment the Apo-Macro-Elmarit-R reaches a magnification of 1:2. With the Elpro lens it is possible to get to 1:1. This lens has been calculated specifically for the Apo-Macro-Emarit-R. Still one will see a slight drop in contrast at the wider apertures and when maximum magnification is required you could stop down to the middle and smaller apertures.

The Apo-Extender-2 creates a focal length of 200mm and an aperture of 5.6. This is fine for emergency situations, but the relatively small aperture will not give much pleasure.
You sometimes can read the statement that the Apo-Macro-Elmarit-R is too sharp for portraiture. I do not share this view. The superb image quality already at 2.8 allows for a clear definition of the finest modulation of color hues and brightness differences on film. This aperture has limited depth of field and both effects work together to create images with high realism and good depth impression. Paul Wolff and Renger-Patch would love to use this lens!

__To summarize

These three lenses are on the one hand very similar and on the other hand represent very different worlds, optically and in practicaluse. The best optical performance we find with the Apo-Summicron-R 1:2/ 90mm ASPH. If the close focusing ability is not important, this should be the first choice, as the 90mm focal length gives the most natural perspective and forces one to concentrate on the photographic language. The performance at 1:2 boosts the available-light photography with current high speed films. The photographer who needs or wants to make documentary and emotional pictures at very wide apertures and expects excellent quality in all lighting situations and at smaller apertures should look at the Summilux-R 1:1.4/ 80mm. Versatile usability, outstanding performance at all apertures and distances till 1:1 are the specifics of the Apo-Macro-Elmarit-R 1:2.8/ 100mm. It has not the best ergonomics, but has excellent built-quality and is capable of amazingly good pictures when using a tripod and medium speed films.

Leica R-Lenses

by Erwin Puts

September 2003
Chapter 3: 180 mm and 280 mm lenses

__ LEICA APO-ELMARIT-R 180 mm f/2.8
__ LEICA APO-TELYT-R 280 mm f/4

Telephoto lenses have a long tradition at Leica. The first 20 cm f/4.5 Telyt lens was introduced as long ago as 1935 for the Leica rangefinder camera. An additional mirror reflex housing was required for the accurate determination of the field of view and the focus. This 200 mm lens was designed for landscape work, animal photography and sports photography. It is interesting to read that sports photography in modern large stadiums was only possible at longer distances, and this required the long lengths. The lens was also quite suitable for portrait studies, the classical head-and-shoulders type.

The Telyt was three times as expensive as the standard 50 mm f/3.5 Elmar lens, and with the mirror reflex housing it was five times as expensive.

The design was a true telephoto design: the total length was about 0.8x the focal length. A long focus lens is simply a lens with a longer focus than a standard lens (more than 2x). Examples: 90 mm Elmar, 105 mm Elmar, 135 mm Elmar lenses.
There are also lenses with a telescopic construction:
example: 800 mm f/6.3 Telyt-S. This type of lenses has been in use since 1700. The very first telephoto lens was introduced in 1891 by the English firm of Dallmeyer. By now this design is 112 years old, and it was only recently upgraded to a very high optical performance, not in the least by the efforts of Leitz.

The first 180 mm f/2.8 Elmarit-R lens for the Leica R-System was introduced in 1967 as a counterpoint to the 180 mm f/2.8 Zeiss Sonnar lens that was introduced in 1966 for the Zeiss Contarex system. With five elements in four groups, it was a state-of-the art design, but the Elmarit lens weighed 300 grams (10.6 ounces) more than the Sonnar lens. The price-ratio to the standard lens was now 2:1. The second version (of 1980) weighed only 750 grams (26.5 ounces) and it had a somewhat better performance. Gradually, 180mm lenses were beginning to be used for hand held dynamic photography when a tripod would be a hindrance in following rapid movements of the subjects.

The Achilles heels with telephoto lenses are the chromatic errors and the size of the secondary spectrum or chromatic difference (typically 0.002 times the focal length [F]).
Visible light is composed of wavelengths with frequencies from short waves of about 380 nm (nanometers) to long waves of about 780 nm. Lenses are generally corrected for two specific wavelengths: 643 nm (red) and 479 nm (blue), so that both these wavelengths will focus on the same image plane.
This plane is located behind the plane where the third important wavelength (green, 546 nm) is focused. The longitudinal difference between these two locations is called the chromatic difference. If only two wavelengths are focused in the same plane, all the others will focus somewhere else on the optical axis. The sum of these aberrations is called the secondary spectrum. 'Secondary' may also be read as 'residual chromatic errors'.

A 180 mm telephoto lens has a magnification factor of 3.6x compared to the standard lens and this means that the residual chromatic errors will also be enlarged 3.6 times. At the start of the seventies it became clear that the performance of these long focus lenses lagged behind that of wide-angle and normal lenses and therefore needed improvement. New glass types with high refractive indices and anomalous (non-linear) dispersion were needed.

Light waves are refracted by different amounts depending on their wavelengths. The power of the lens depends on the wavelength. This is called dispersion. Normally the power will increase continuously with decreasing wavelength. If the power changes abruptly, this is not normal or non-linear or anomalous.

New glasses with these characteristics were developed in the former Leitz glass laboratory and later produced by Schott, Corning and others. By means of an appropriate optical design, the secondary spectrum could be reduced to so small an amount that for all intents and purposes an image free of color defects could be created. This state of correction is known as apochromatic correction.

Erwin Puts
Leica Camera AG

__ LEICA APO-ELMARIT-R 180 mm f/2.8

In 1975 Leitz Canada designers computed the 180 mm f/3.4 Apo-Telyt-R lens for scientific purposes that required a very high information content. It is a seven-element system with four groups, corrected for the infrared region and it performs best at infinity. At the same time Canon introduced a new 300 mm f/2.8 lens with synthetically grown fluorite crystals, a solution that Leitz did not wish to use.
With the 180 mm f/3.4 Apo-Telyt-R, Leitz offered a high performance lens that undoubtedly inspired a friendly competition with other prominent companies. Reduction of the weight of lenses was the primary concern and goal as such lenses grew in popularity for hand-held photography in available light. Subsequently, new lenses were introduced: in 1977 (180 mm f/4 Elmar-R) and in 1980 a new computation was made for the 180 mm f/2.8 lens.
For a short period there was a choice of three 180mm lenses (f/4, f/3.4 and f/2.8) that were close in price: in relation to the standard 50 mm f/2 Summicron-R lens the ratio was: 2.4:1, 2.9:1 and 3:1.

The second version of the 180 mm f/2.8 Elmarit-R lens could not outperform the 180 mm f/3.4 Apo-Telyt-R lens. And the shortest focusing distance of 2.5 meters (8.2 feet) was unremarkable. In addition, the ergonomics were no longer state-of-the-art as more and more companies introduced internal focusing.

In 1998 Leica introduced the new 180 mm f/2.8 Apo-Elmarit-R, a system that can be described as "Return of the Empire".
The price ratio to the 50 mm Summicron now became 3.5:1, just as it was in the thirties.
A lens with the focal length of 280 mm for the Visoflex system was introduced in 1961, and in 1970 a 250 mm lens was introduced for the Leica R-system.
Both versions offered commendable but not top performances. The same challenge of optimal weight, high performance and short near focusing distance existed here as it did with the 180 mm focal length, and the first computations by leitz were not entirely convincing.

This changed abruptly with the introduction in 1984 of the 280 mm f/2.8 Apo-Elmarit-R, an outstandingly good performer with internal focusing and a weight of almost three kilograms (6.6 pounds). These characteristics required the use of a tripod and they restricted the lens to static photography. With a price ratio of 10.6:1, it was not a lens for the normal Leica user.

__ LEICA APO-TELYT-R 280 mm f/4

In 1993 the 280 mm f/4 Apo-Telyt-R was introduced. Performance was improved, especially in the outer zones; the weight was reduced to 1875 grams (66.1 ounces) and the price ratio of 4.8:1 was much better.

In terms of performance, both new lenses, the 180 mm f/2.8 Apo-Elmarit-R and the 280 mm f/4 Apo-Telyt-R, are world-class lenses and they represent the finest examples of the outstanding excellence of the current quality of optical design at Leica Camera AG.

__ Artistic considerations

Both lenses share essentially the same characteristics, but the strongest visual effects can clearly be seen with the 280 mm lens. Pictures with these lenses show the classical compressed image: two cars in a row look as if they collided and many cars acquire a new wedge shape. Pictures of groups of people look like the paintings of people by Rembrandt.

We can explain this with a small experiment:

Let us photograph two objects of the same size that are located one meter (3.28 feet) from each other at a distance from one meter (3.28 feet) from the first object.
The second object is then twice as far away from the lens as the first object. Therefore the second object will be seen and reproduced at half the viewing angle of the first object.
It will be halved in linear size.

Now we move the camera to a distance of three meters (9.8 feet) from the first object. Now the viewing angle of the second object is 3/4 of that of the first object.
The linear magnification is thus 3/4 of that of the first object.
Our brain assumes that large objects are always close to us.
As the second object has 'grown' from 1/2 to 3/4 the size of the first object, we assume that it must now be closer to that object.

This effect explains why telephoto lenses produce a compressed or foreshortened perspective.

With these considerations it is possible to create and define the image effects that you want.
If the main subject is encircled by objects in the fore- and bakkground, you can visually emphasize the relationship between the subjects and even make it appear as threatening, as is the case with cars that seem to collide. If the photographer needs the impression of masses, the selection of subject matter becomes important. Pictures at the beach show the piling up of beach guests and pictures in shopping centers show the masses of stacked-up buyers.

On the other hand, it is also possible to isolate the subject completely from the surroundings. Wide open, the depth of field is quite shallow and by adding light and shapes to the composition we can create very interesting images. The shallow depth of field is enhanced by the following phenomenon:
A 180 mm lens has a lateral magnification of 3.6x compared to a standard lens. The subject is enlarged 3.6 times in its height and width dimensions. But what happens to the third dimension: depth? The optical laws tell us that the axial magnification (the depth) is the square of the lateral magnification. The depth magnification is now 12.96x. In photographic practice we see this as an abrupt change in the unsharpness gradient. The circles of confusion are also enlarged! This effect is not related to the so-called 'bo-ke' effect. Both lenses (180 and 280 mm) have a somewhat granular unsharpness plane, without destroying the subject outlines in the out-of-focus areas.

An image point always has a certain extension or radius that looks like a small circle or disc of light. If the radius is small enough, the eye will interpret it as a point. The largest circle that is seen as a point is called the circle of confusion and its diameter is 0.03 mm on the negative.

The superb performance of the 180 mm f/2.8 Apo-Elmarit-R permits the unrestricted use of the Macro-Adapter-R. We can obtain a reproduction ratio of 1:3 with excellent quality. At these distances there is a reduction of 1.8x in the luminance of the negative. The automatic exposure programs of Leica R cameras compensate for this effect, but when you make a manual exposure, it is wise to take this into account. The occasionally expressed wish for a true macro lens with a focal length of 200 mm is practically fulfilled with this combination. A bit outmoded nowadays, but still useful is the Bellows Attachment BR-2 that allows reproduction ratios of 1:3.3 to 1.2:1.

The focal length of the 180 mm f/2.8 Apo-Elmarit-R lens has more interesting possibilities than is sometimes assumed. The subject area runs from portrait and children photography to landscape photography and from theatre- to fashion photography and reportage. The ergonomics are excellent, its functions are very smooth because of internal focusing and a new mount with ball-bearing rotation.
With an Apo-Extender-R 2x the focal length becomes 360mm. This is within the range of the 280 mm f/4 Apo-Telyt-R that was introduced in 1993 and that to this day still delivers the best image quality of all Leica R lenses, with the possible exception of the 400 mm f/4 module lens.
This lens has somewhat higher contrast in the center of the image, but it is not so good at the comers and in the outer zonal areas. The 280 mm lens however, is usable as a hand-held lens. You should not be misled by the old rule of thumb that tells you that the slowest speed for handheld photography is the reciprocal of the focal length. When taking pictures with the 280 mm lens, a shutter speed of 1/250 will often suffice for good quality images and sometimes even for sharp pictures. If the highest quality is required, a tripod is a must. With the 280 mm lens, extremely fine texture details can be captured at longer distances. A person can be photographed filling the entire negative area at a distance of 14 meters (46 feet). Perhaps the following is a more impressive example: with the 280 mm lens you can capture a 5x7 mm section of a full negative photographed with a 50 mm lens. This is a very small segment and it is an indication of the many possibilities of this lens.

LEICA APO-ELMARIT-R 180 mm f/2.8 Picture: Erwin Puts

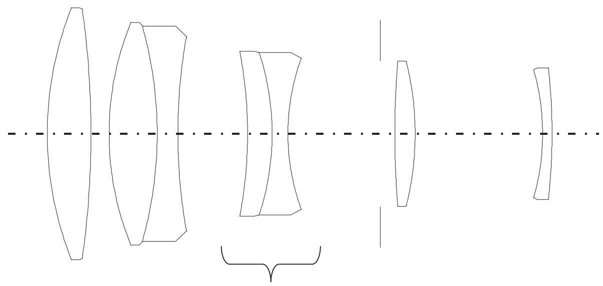
Atmospheric turbulence and heat waves can destroy the image quality at these large magnifications and one needs a skylight filter with color film and a medium orange filter with black-and-white film.

The discussion often arises as to whether a lens can be too sharp, a question that is certainly relevant for both of these lenses. In many discussions, sharpness and contrast are seen as the destroyers of subtle tonal values.
This idea is associated with the effects of gradation of films and papers. A steep gradation of a film or a paper with a high contrast will accentuate small differences in brightness and also reduce the number of tonal shades of the overall tonal range. But these properties cannot be transferred to the optical sharpness or modulation transfer.
Any lens should generate an accurate image of the subject. Every detail (subject outline, textural detail, tonal value) is a composition of very small point images of different brightness. If we have a lens that is free from aberrations, every point will be reproduced on film exactly as it is in the real world.
A lens with optical aberrations will reproduce these points with some blur and the small differences in brightness will also be diffused. The better the lens, the more accurate the image reproduction and the finer the brightness differences that we can discern.

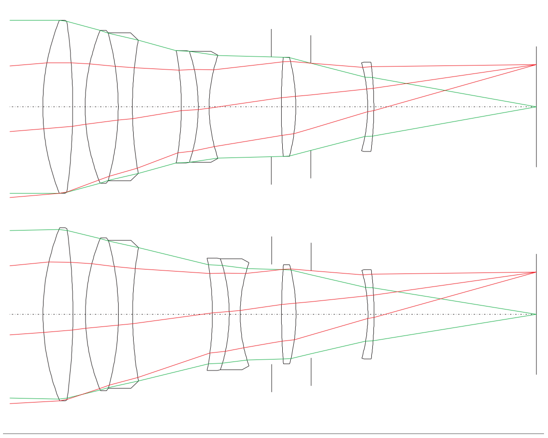
The 280 mm f/4 Apo-Telyt-R lens can be combined quite effectively with the Macro-Adapter-R. Then you can take pictures at a distance of one meter (3’ 3 3/8”) from small animals that do not let you approach too closely, like frogs. You may even combine the Macro-Adapter-R and the Apo-Extender-R. This is also true for the 180 mm f/2.8 Apo-Elmarit-R lens.
You might even use two Macro-Adapters together.
The only recommendation I can give is to be willing to experiment and investigate which combination best suits your needs.

Optical considerations

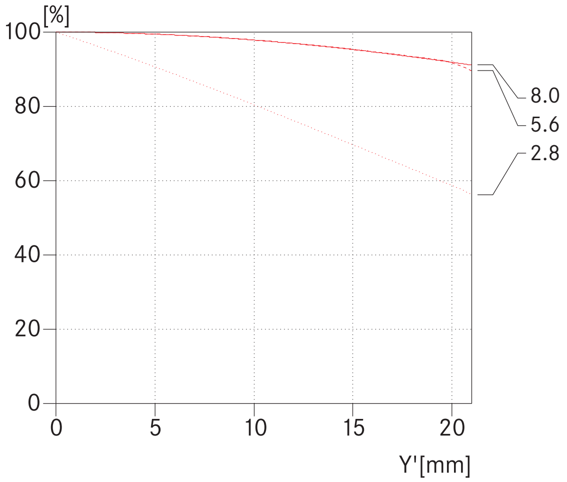
The basic design of a telephoto lens consists of a converging front lens with a positive focal length and a diverging second lens with a negative focal length. The main optical problems with telephoto lenses are distortion (solved quite early), secondary spectrum and the longitudinal chromatic errors.
The first 180 mm lenses from Leitz had five elements in four groups. Their design was derived from the 135 mm lenses. A low number of elements reduced flare, but it also limited the optical correction a bit. Chromatic correction was not optimal and overall contrast was on the low side. Image quality was quite good, especially because now one needed a lower magnification of the negative. The breakthrough came with the 180 mm f/3.4 Apo-Telyt-R lens, a design that used new types of optical glass.
For the first time, chromatic aberrations (color fringes) could be reduced to negligible amounts. Multi-layer coating was used sparingly, as these layers often create more problems than they solve. Especially with strongly curved surfaces and with glasses with high refractive indices, a uniform thickness over the entire surface could not be guaranteed.
It seemed impossible, but with the 180 mm f/2.8 Apo-Elmarit-R lens, image quality was improved significantly. With seven elements in five groups, its design is totally different from that of the 180 mm f/3.4 lens, also with seven elements in four groups.



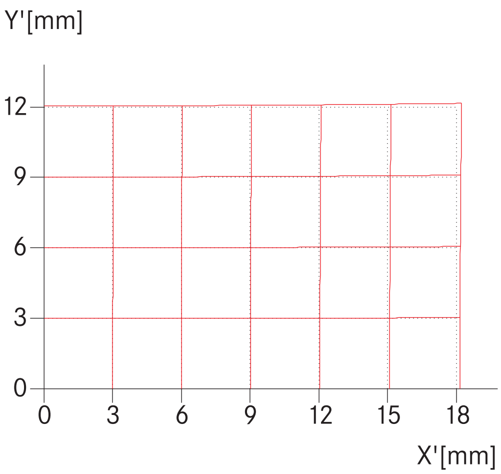
Maximum quality is already reached at full aperture. From the center to the edge of the image, a resolution of extremely fine details with high micro-contrast is ensured. Especially with fashion- and beauty photography, where hyper-realistic images are required, these lenses are ideal. From a lens tester’s point of view, the 180 mm f/2.8 Apo-Elmarit-R lens is not a challenging lens: there is hardly a point to criticize! Thanks to its floating element design, performance in the close-up range is excellent.



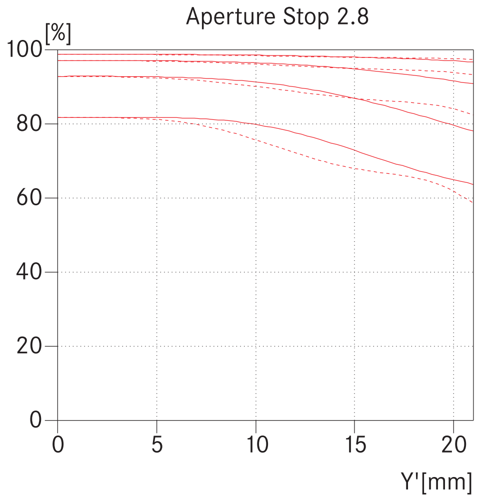
Flare and secondary images are absent and specular highlights in the blazing sun are free from halo effects.
Vignetting may be visible under critical circumstances (wide open), but it is eliminated at f/5.6.

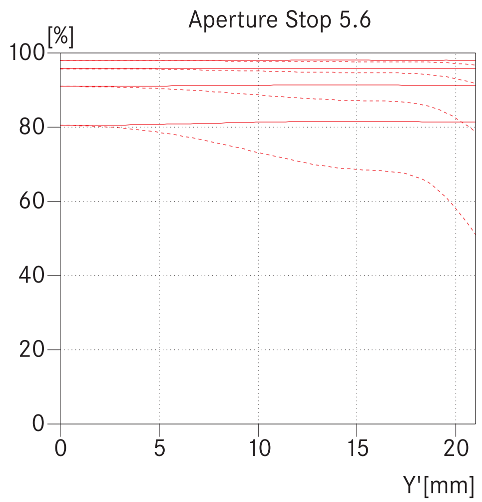


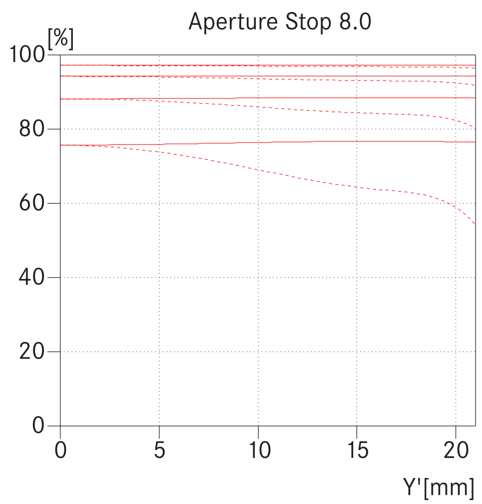
Distortion amounts to 1% in the comers and may be visible when one photographs geometric figures (architectural details) near the edges of the negative.



The high level of correction of the current 180 mm lens can be seen in the MTF graphs. The f/2.8 aperture delivers the best performance, it might be improved a bit at f/4, but at f/5.6 you already see a small reduction in contrast, which is even more pronounced at f/8.

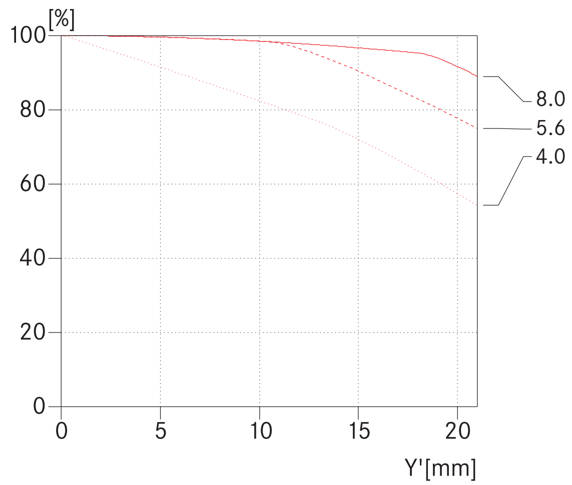


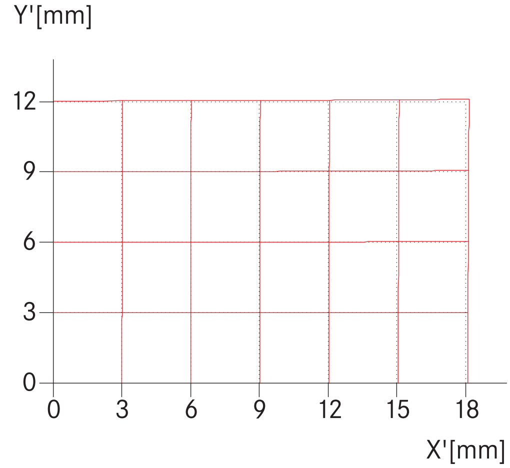




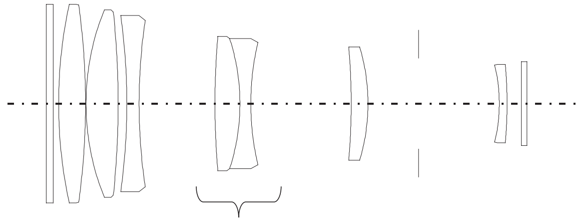
The diverging curves at 40 Lp/mm for sagittal and tangential lines is of no relevance in practical photography. This reduction in contrast can only be computed; it is not visible in real life. This behavior indicates that the lens earns highest scores for color correction. The 'APO' designation is well deserved. We should explain this once again: there is no universally accepted definition for apochromatic correction.
When the secondary spectrum is small and/or when three wavelengths focus (almost) on one plane, the 'APO' designation is appropriate. The question now is: How do the other wavelengths behave and how does the shape of the secondary spectrum look as a whole.

The 180 mm f/3.4 Apo-Telyt-R lens is at its optimum at f/5.6, implying that there are some residual aberrations that disappear when the lens is stopped down. The often asked question as to which of these lenses is the best has an easy answer: up to an aperture of f/4, the Apo-Elmarit-R is the best and more so at the close-focus range. From f/5.6 both lenses are equal at infinity. But the higher overall correction of the Apo-Elmarit-R yields images with a crisper and tighter effect.



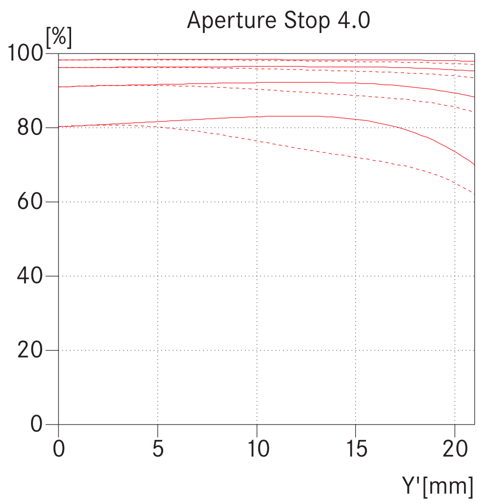


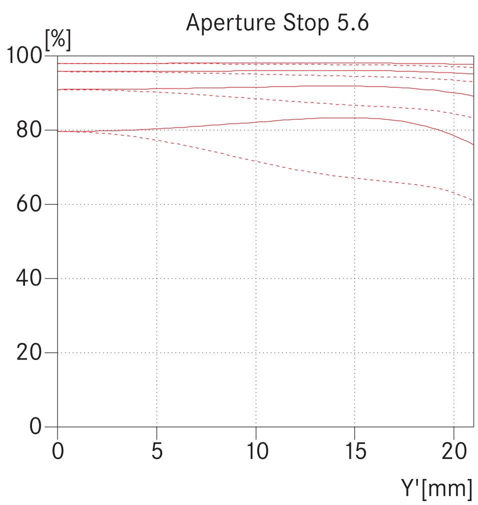
The 180 mm f/2.8 Apo-Elmarit-R lens can be focused beyond the infinity mark (as the 280 mm lens can as well). This is intentional in order to accommodate heat expansion and it is not designed for searching the best infinity position. There is nothing beyond infinity and the true infinity mark is optically and mechanically fixed by the factory.

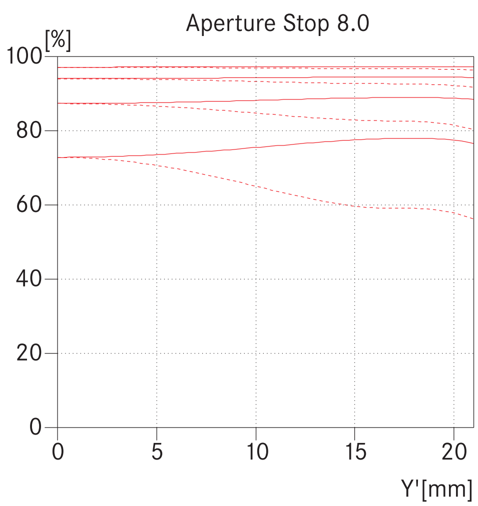


The 280 mm f/4 Apo-Telyt-R lens has a strong family resemblance to the 180 mm lens. Here too, seven elements are used, now in six groups (the first cemented group is separated). Distortion and vignetting of the two lenses are almost identical.

The telephoto ratio is 0.74 (Focal length/physical length) and close to that of the 180 mm lens:
A protective filter, positioned in front of the lens, is part of the optical design and computation.
The possible fear that the filter might reduce the optical performance is not justified. As with the 180 mm lens, optimum optical performance is already reached at full aperture. Microfine textural details are reproduced with high edge sharpness and micro contrast, the clarity of the colors and tonal gradation are exemplary and give the image a special depth impression.
The MTF graphs show superb results and are hardly distinguishable from those of the 180 mm lens.







Even so, the optical quality of the 280 mm lens is higher. Here we can detect the limit of the MTF graphs when we restrict ourselves to 40 Lp/mm as the highest frequency. There are sound arguments for this limit, but when dealing with very high performance lenses, the information may not be as we want it to be.
The 280 mm f/4 Apo-Telyt-R lens is one of the every few lenses that is truly diffraction-limited. This means that the optical aberrations are so small that the size and shape of the image point is governed solely by physical laws. The absolute limit can be found at 450 Lp/mm. The most amazing feature is the following: a contrast value of 50% for 50 Lp/mm is the normal limit for high quality 35 mm photography.
The 280 mm f/4 Apo-Telyt-R lens delivers a resolution of 150 Lp/mm with 50% contrast. Often the lower limit for usable contrast is set at 20%. At this value this lens still delivers an outstanding 300 Lp/mm.

The big question is: how do we obtain this performance on the negative?

__ High-resolution photography

Let us make it clear from the start. Under practical circumstances, we can achieve a visible and usable resolution of more than 150 Lp/mm on microfilm (Agfa Copex and Kodak Technical Pan).
At first sight this may appear to be a bit disappointing. But 150 Lp/mm are 300 separate lines in one millimeter and that means that every single line has a width of 0.003 mm – an exceedingly small number!
Between two black lines there is a single white separation of a mere 0.003 mm in width. The smallest halo caused by the lens or by the grain in the emulsion, will reduce that separation line to a dark gray one, making the difference between black and white disappear. The same holds for the slightest movement of camera or subject.

Occasionally you will read about film emulsions that are capable of resolving 700 Lp/mm or more in normal photographic situations (film-lens combination). In this case we have a line width of less than 0.0007 mm and that is minute in the extreme. But these theoretical claims are not so important because the results have never been seen or documented.

The 280 mm f/4 Apo-Telyt-R, which has a theoretical (i.e. computed) resolving power of 450 Lp/mm (depending on the wavelength that is being used), can resolve 250 Lp/mm with a contrast of 50%, of which approximately 150 Lp/mm can actually be recorded on film. The 180 mm f/2.8 Apo-Elmarit-R has values that are a bit lower.

You will have to find subjects that have extremely fine details to start with, and then you must take pictures at quite a large distance, because you need a high value of negative magnification, and then you must enlarge the tiny negative to big proportions. This places the imaging chain under heavy strain.

For example: I use a subject that consists of a black-and-white line pattern with line widths of 0.25 mm. The pattern has a resolution of 2 Lp/mm. I need a negative magnification of 100x to get a resolution of 200x on the negative. Using my 280 mm lens, the distance to the subject will be 28 meters (92 feet).

But that positions me so far away from the subject that I cannot even see the pattern! To achieve an accurate focus I affixed the pattern to a large piece of white cardboard with a big black line on it for easy focusing. It is too optimistic to assume that all my problems have now been solved.
The focusing on the viewfinder screen is performed visually, with the eye being the final judge, but the eye is easily fooled! Therefore you have to bracket your focus by making several exposures with a slightly shifted focus in both directions from the original focus. The amount of that shift is a matter of experience: I would suggest that you begin with one or two millimeters at a time. The accuracy of Leica R8 or R9 cameras can be taken for granted! If errors occur, they will be human errors. Cable release, mirror lock-up and fast shutter speeds are fundamental requirements. A shutter speed of 1/30 second, even on a heavy tripod, is not the best solution, it may even be hopeless.

The lens mount of the 280 mm lens has a built-in tripod socket, which is a necessity. But camera- and lens-induced vibration frequencies cannot be avoided (this involves thousandths of a millimeter). Experienced wildlife photographers use everything from sandbags to bricks attached to the tripod in order to reduce vibrations. I used weights placed on the body and on the front part of the lens in order to eliminate the tremors.
This may sound very elaborate. It may be partly so, but with some experience it becomes a natural habit in high-resolution photography. Without specific experiments, you will never master the imaging chain. I wish to dispel the impression that this type of photography is as easy as shooting from the hip. But it is not a big problem either. Leica camera bodies and lenses are not the weakest links in the chain. And it is very gratifying to discover details in projected images or in big prints that you never knew were there in the first place!

You will get the best performance of around 150 Lp/mm with Agfa Copex exposed at a film speed of ISO 12 to 16 and processed in Spur Nanospeed developer, or Kodak Technical Pan exposed at a film speed of ISO 20 to 25 and processed in Spur Dokuspeed developer. There are no secret tricks here: just develop according to normal practice. With Agfa Rodinal developer you will have to experiment: at a dilution of 1:50, you will get quite a steep gradation. And users have reported very good results at dilutions of 1:100 and even 1:300 (this maybe a secret tip!).
Up to 110/120 Lp/mm can be achieved with ISO 100 slide films from Fuji (Velvia, Velvia 100F, Astia 100F) and Kodak (E100G/GX). The advantage here is the higher film speed.

Current ISO 100 black-and-white films can deliver up to 100 Lp/mm and slightly more with dedicated developers and speed settings (often ISO 64 and 50). Recommendations are not easy, because every worker has his or her own methods and developer solutions. You need a developer that has a low amount of sulfite. The formulas from noted experts like Beutler, Windisch, Cyril Blood or Crawley (FXI) are good starting points.

LEICA APO-TELYT-R 280 mm f/4 Picture: Martin Trippen

Summary

In the roaring twenties there was a 540 SSK Mercedes Benz sports car with a turbo-charged engine.
The turbo charger could only be used for a few minutes, otherwise it would overheat the engine. But the driving experience was breathtakingly exilarating.
Both the 180 mm f/2.8 Apo-Elmarit-R and the 280 mm f/4 Apo-Telyt-R Leica lenses offer superior image quality plus that special turbo-feeling and sensation, not for just a few minutes, but always and everywhere!

These lenses are eminently suited for the type of photography where you need to capture every possible detail and when you wish to explore the limits of analog emulsions. As with the aforementioned sports car, you do not always have to use the turbo. The optical performance is superb even with high-speed films (the grain will be tight and compact because the small image points will not cause flare or halo in the grain pattern). Hand-held pictures will preserve the high overall contrast and the reproduction of finely graded colors and tonal values. You may compare it with music with a final sound that is composed of many frequencies and a wide dynamic range.
There are some very high and some very low frequencies that you cannot hear, but they are required for the character of the sound. This is comparable to what happens in optical phenomena. Good MTF values at the very high frequencies are a must for a high contour sharpness at the lower frequencies.
If you have not yet experienced image-making with current slide films and these superb Leica lenses, you should really do so.

Photography with a 'turbo' effect will open up a whole new world for you!

LEICA APO-TELYT-R 280 mm f/4 Picture: Martin Trippen

Leica R-Lenses

by Erwin Puts

September 2003

Chapter 4: 28 mm and 35 mm lenses

__ LEICA SUMMILUX-R 35 mm f/1.4
__ LEICA SUMMICRON-R 35 mm f/2
__ LEICA ELMARIT-R 28 mm f/2.8

Introduction

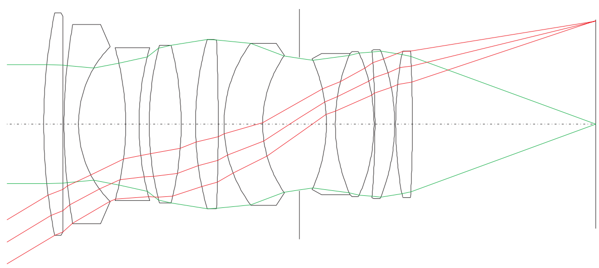
It is well known that the thirties and the fifties were the great classical periods of the Leica rangefinder camera. The next period of 1965 to 1985 was the era of the mechanical SLR, forever immortalized in the famous movie "Blow Up" by Antonioni. In those days it was generally believed that the 35mm SLR could evolve into the most universal photographic instrument ever designed. Mechanical functions were replaced by electro-mechanical and electronic ones, more and more functions were added and the lens range covered lenses from extreme fish-eye to very long telephoto lenses with focal lengths of 2000mm and more. And every company wanted to cover as wide a spectrum as possible. Leica started the SLR-era with the Leicaflex-series. This was an attempt to translate the best principles of the rangefinder camera into the world of the single lens reflex. The first Leicaflex cameraswere totally mechanical designswith a great deal of innovative details that filled their bodies to the brim and did not leave enough free space for additional electro-mechanical components. The next camera, the R3, developed in cooperation with Minolta had a radically different construction, was built in Portugal and is in fact much better than its reputation. The professional market was a bit disappointed by the size of the R3 and Leica reacted a few years later with a new camera series beginning with several versions of the R4 and later the R5. With these models, Leitz tried to compete head on with the Japanese professional camera systems. Optically there was no problem, but the versatility of the R-system was impaired by some important gaps, especially it lacked fish-eye lenses and long focal length zoom lenses.. About 150.000 cameras of the R4/5 series were sold. The camera was perfectly capable of withstanding the heavy-duty demands of the working professional, but it was not bakked by a universal system like themain manufacturers' models, i.e. the Canon F1 or Nikon F2. The main German manufacturers, Zeiss and Leitz, could not support these camera systems with the universal appeal of a very versatile system and concentrated on the optical side of the system. This approach was quite understandable as German optical designers had a certain view of the level of performance a high quality lens should have. There was a long tradition of optical design theories and correction of the aberrations and an abundance of knowledge about the practical and theoretical limits of design, optically as well as mechanically had been acquired. And there was naturally a strong sense of pride about the high level that had been reached by generations of designers. That is why there was an unwillingness to lower the high standards. The German lenses of the seventies were masterpieces of engineering, mechanical construction, glass manufacture and optical calculations.
The Japanese, on the other hand, knowing they could not compete with the German designs in terms of quality, chose a different approach. They tried to provide the photographer with a range of lenses that expanded the photographic possibilities into realms that were not explored in the past. An example is the Nikkor 43-86mm zoom lens that was optically very bad, but offered the user a new way of visual expression.
One would be tempted to think that the lenses of Zeiss and Leitz were made with the goal to provide the photographer with the best possible image quality and not with the goal to deliver tools that were needed to do the required job. In this respect the Japanese companies were far ahead.
The Japanese lenses did not deliver the ultimate in optical and mechanical performance, but the practical characteristics (weight and compactness, or very wide angle or very wide zoom range or very long telephoto lenses with high speeds) could impress the working photographer in his daily applications. Zeiss and Leitz used the same strategy. They would not compromise the ultimate in image quality for a lens with more exciting specifications. It was not a lack of innovative capabilities that restricted the Leitz designers, but a conscious decision to deliver only the best lenses they could design. In the archives of the old Leitz optical department one can find quite exciting designs, but they did not pass the critical requirements that Leitz had set for themselves. In retrospect, we may be very happy that Leitz invested that much energy in advancing the state of the art of lens design. We can admire the results in our current photographic experience, picture for picture.
Leitz's optical experience did not include the retrofocus design initially, and they had some difficulties mastering the principles and intricacies. The first Summicron-R35mm f/2 from 1970 (Zeiss introduced a 2/35 in 1963) had a performance level about equal to that of the then current M-lens 2/35mm. But the construction was very complicated with nine lens elements in seven groups. Fifteen years later they succeeded in creating a 1.4/35 design with the same effort. The first version of the 2.0/35 had a length of 61mm and was specifically designed for the photo-reportage. Contrast in the center of the image was quite high, but dropped significantly in the outer zones. In those days, the SLR was used for every photographic assignment and also for the reportage style of photography. For this type of photography the outer zones are of less importance for the impact of the image. The second and current version of the Summicron-R 35mm f/2 features a more even performance at full stop and a significantly improved handling .

The Summilux-R 35mm f/1.4 is an excellent design, introduced in 1984 and still state of the art in terms of performance. A high speed lens for an SLR has two goals: More light for the film plane and for the focusing screen. Specifically when objects are moving fast and in situations with scarce illumination a bright image on the screen with good contrast is necessary. In many situations the 35mm's angle of view (64 degrees) is a bit too narrow, especially if you want to relate your subject to the surrounding environment. Then the 28mm (76 degrees) will be of interest and Leitz already offered such a lens in 1970 with the "standard" speed of 2.8. It was a very

lightweight lens in the R-range with only 300 grams. The optical performance was very good with medium overall contrast and commendably good definition of fine structural details in the outer zones. It stayed in production for almost 25 years, an indication of its popularity. As a side thought I might say that this lens has a hint of Japanese design philosophy: quite sufficient performance in a lightweight mount.
SLR-cameras are well suited for the near-focus range, as there is no parallax to take care of. But a lens can only be optimized for one distance or magnification. Normally one has to accept that the near-focus range is always of lesser quality than the infinity position. In the past this was acceptable. But what was an acceptable image quality in the past, may not be tolerable in later times. That is the course of evolution. Not only optical designers, but also users set the standards higher every time. The solution was to introduce a lens element that was moved independently from the other parts of the optics during focusing. Designated as 'floating elements', they help to improve the optical system. With a floating element you can change the space between certain lens elements when you focus into the close range. The mechanism of 'floating elements' is not the same as the mechanism of 'internal focusing'. With 'internal focusing" a whole lens group will move over the full distance range. The practical advantages of internal focusing are less bulky lenses whose weight balance hardly changes and whose front mountsdo not rotate during focusing, which is an advantage when using polarizing filters. With the normal focusing method the complete optics are moved back and forth, which usually results in the lenses' whole front barrel is moving in and out and rotating when you focus. In most cases internal focusing and floating elements are used to accomplish different goals. But Leica designers found a way to combine both methods. Internal focusing can also be utilized to improve the performance in the near-focus range. In 1994, Leica introduced a new Elmarit-R 28mm f/2.8 with a floating element, much improved image quality and optimized ergonomics.
In the area of ergonomics, Leica has progressed quite substantially, compared to was the norm in the past.
In one area however, Leica has not changed the old traditions: the mechanical quality of the lens mounts is still unsurpassed.

__Optical considerations

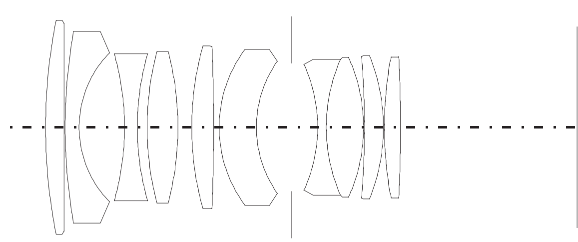
The main topics in optical discussions may be the glass types, the number of elements and the type of lens (retrofocus, telephoto lens or Gauss-design), the really decisive parameters are to be found elsewhere. An optical designer can create the best lens in the world, but when it is too big, too expensive or too complex it will not go into production. And to be quite honest: a lens is made to generate a profit. With retrofocus lenses the volume is a big problem. A retrofocus lens has a large size from the start because of the long back focus. You cannot build a shorter lens, and when the speed is to be increased the volume grows beyond what is acceptable for handling. A wide angle lens with a very wide diameter cannot be handled and in the past there was no other solution but to settle for a lens whose size could be tolerated and to accept a higher level of distortion or vignetting. The solution is simple: you must design a longer lens with a smaller diameter. When you need to transport the light photons through a long pipe, you must use more lens elements. We know that aberrations are caused by the steep angle of the rays incident on the lens surface. In the center of a lens the rays pass through without being refracted. Without refraction, there are no aberrations to take care of.. This is a lesson for the design in general. If you can design a lens with minimal changes in direction from lens surface to surface, the total amount of aberrations will be minimized.

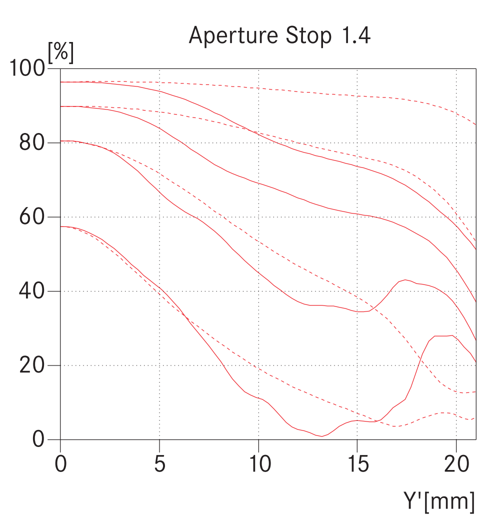


The drawing of the Summilux-R 35mm f/1.4 shows the path of the rays through the lens elements. You see that the angles of refraction at the surfaces are quite small. But the price is a higher number of elements. A higher number of elements should normally be avoided as much as possible, but with the current methods of anti-reflection coatings, the loss of contrast can be minimized. And this high number of elements allows the designer to manipulate the central section of the lens in such a way that the front lens diameter can be reduced. Note that in the drawing all lens elements have the same diameter, which also helps to smoothly guide the rays through the lens. The classical retrofocus designs have a much larger front lens than is being used with the Summilux. As comparison: the Summicron-R 35 f/2 has a front lens diameter of 63mm and a length of 54mm. That is a proportion of 1:1,17. The Summilux-R 35mm f/1.4 has 75mm, resp. 76mm, thus 1:0,99. The older Summicron 2/35mm had 68mm, resp. 61mm, therefore 1:1.11.
Often the question is asked why the wide angle lenses of the R-system do not have aspherical elements. A part of the explanation lies in the fact that in the past only the so-called blank-pressed versions were available, and this production method restricted the possible diameters as well as the glass selection. Another part of the explanation can be found in the gains achieved by using aspherics: They are commonly needed to realize a high quality design in a small volume (as with the M-lenses). The R-lenses with their on average somewhat larger volume cannot profit as much in this respect by the use of aspherics as is the case with smaller lenses (like the M-series).

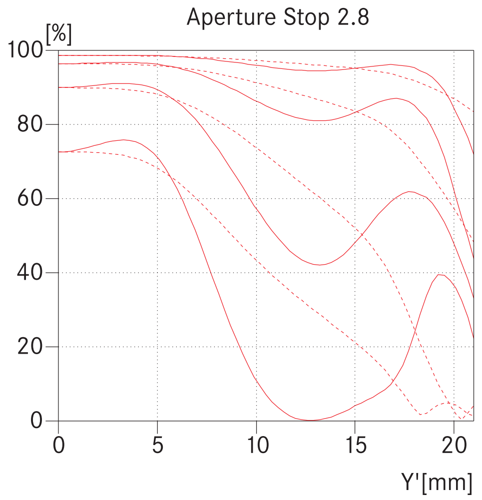
__ LEICA SUMMILUX-R 35 mm f/1.4

Together with the Summilux 80mm and Summilux 50mm this Summilux belongs to the class of very high speed lenses for the R-system. The performance wide open (f/1.4) is much better than that of the first Summilux-M from 1961, as can be expected. There is a twenty year span between both designs. But also compared to the current Summilux-M 35mm f/1.4 ASPH. the performance attainable in practise is almost equal. The M-version shows somewhat better definition and the very fine structural details only at the outer zones . The overall contrast is high, but the major subject outlines have softer edges.

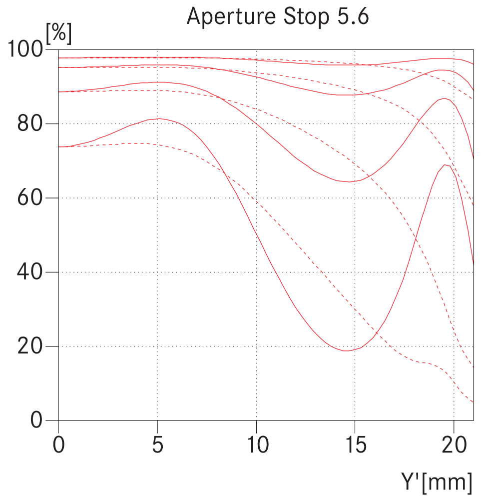




The MTF graph at 1.4 shows a relative low set of lines for the 40 lp/mm. And even the 20 lp/mm seem to be on the low side at first sight. However, one should not overrate the MTF graphs and try to evaluate all lenses according to the same criteria. With a 180mm lens the 40 lp/mm are very important. With a high speed wide angle lens the situation is different. In this case the performance at 40 lp/mm usually has less influence on the final and overall image appearance and lower values are of less importance. It is of more practical value to note that secondary reflections and veiling glare are very well reduced, but may be visible when light sources point directly into the front lens. Coma is only existent at a very low level as can be seen from the sagittal and tangential lines that are close together.

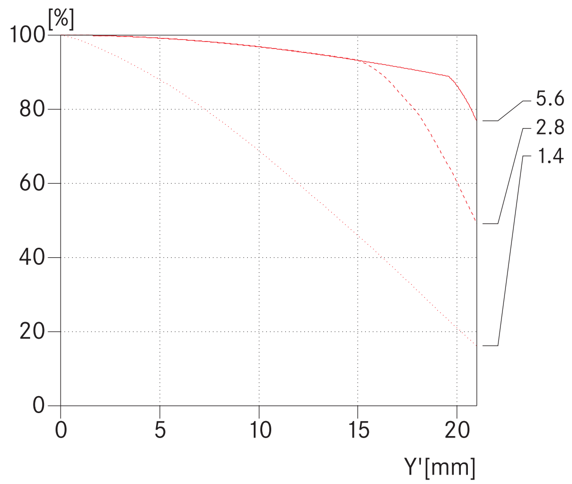


At aperture 2.8 the overall contrast is visibly improved as is the quality in the outer zones of the image. The very fine detail however has a softer definition.

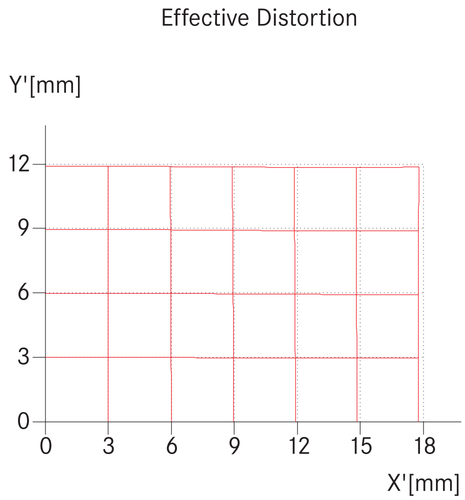


At aperture 4 the optimum is reached and we can expect an excellent overall quality. Especially in the important main center part of the image the performance is outstanding. This quality is also available at smaller apertures.

The maximum amount of vignetting at full aperture is 2.4 stops and this is rather high. But again, this figure must be interpreted in the correct way. Partly it is system related (the length of the lens) and often the type of pictures you will make at full stop are not negatively influenced by the vignetting.

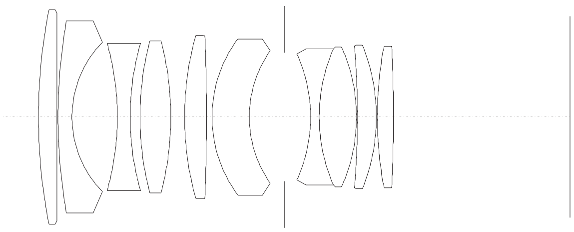


One should evaluate a lens according to sensible criteria and not compared to a theoretical ideal. Wide angle lenses have their own set of characteristics.



The distortion of the Summilux-R is visible with 2%.

There is an additional phenomenon that I will discuss later on in the next paragraph. The Summilux-R has a floating element and the performance in the near focus range is excellent, especially after stopping down several stops. Very close to the object one cannot evade some distortion, but this is not a lens for reproduction stands.



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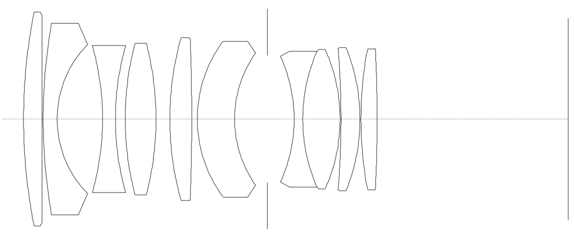

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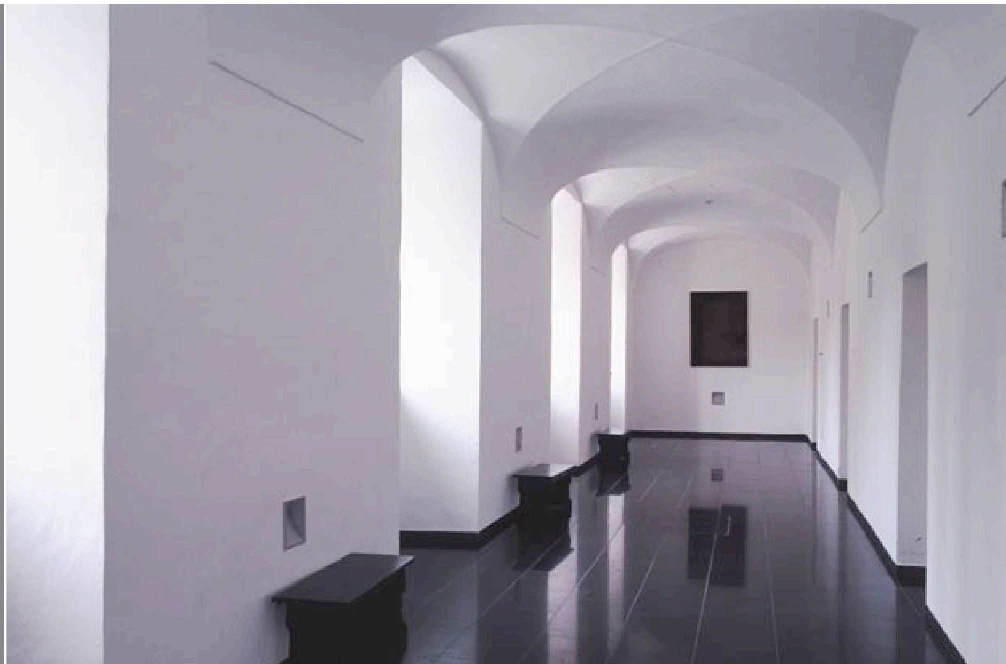
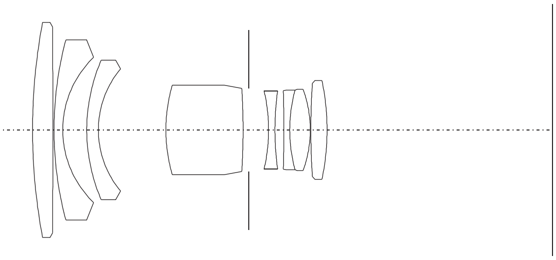
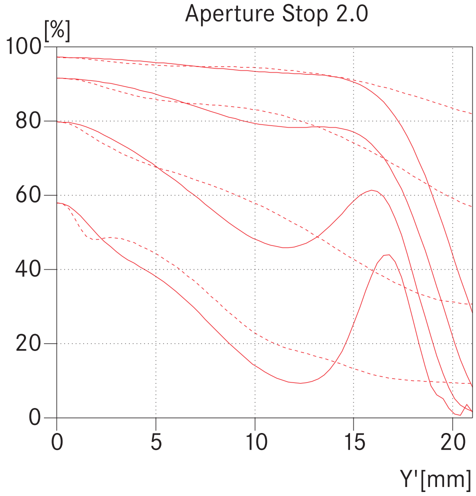


__ LEICA SUMMICRON-R 35 mm f/2

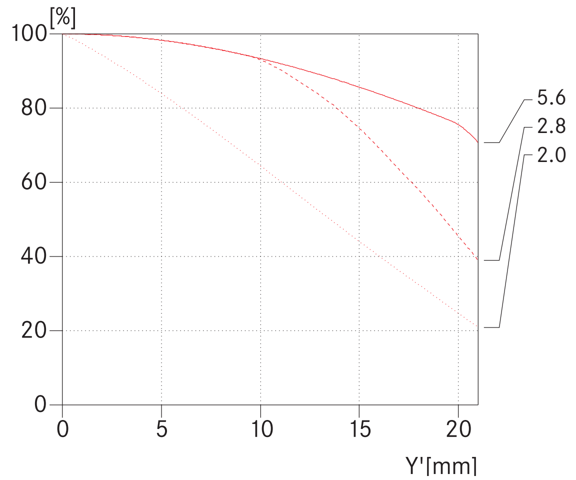
The Summicron-R is a design from Midland, Canada and was introduced in 1977. It is a six element lens with a characteristic thick central element as field flattener (flattening of the image plane). The first element is a negative lens with a plane first surface. As with the Summilux-R the central section of the lens elements are important for the design concept. Wide open the contrast is medium-high and in the central part of the image fine details can be recorded with some softness at the outlines. Stopping down to f/2.8 delivers good contrast and lets the small amount of stray light in the lens disappear altogether, and the image quality is competitive.



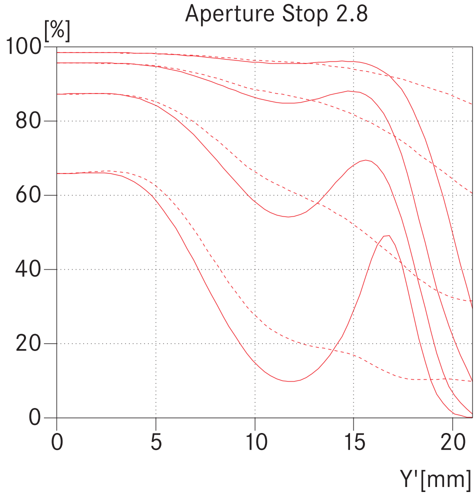
Aperture Stop 2.0



At apertures 4 and 5.6 the optimum is reached. The graphs of the 20 lp/mm and the 40 lp/mm are a bit wavy. At an image height of 12mm there is a weaker zone, the result of aberration compensation. The improvement beyond an image height of 18mm is the influence of the vignetting. The vignetting is acceptable with two stops and will only be detected at the edge of the negative when larger areas with the same brightness are recorded.

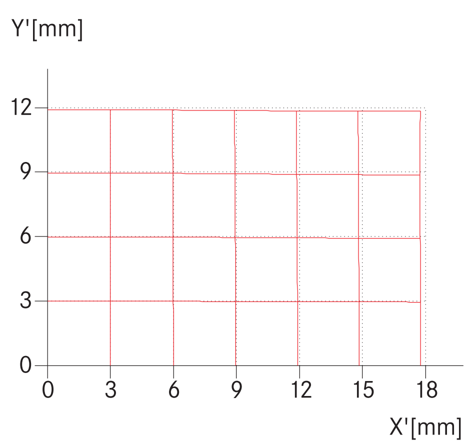


Aperture Stop 2.8

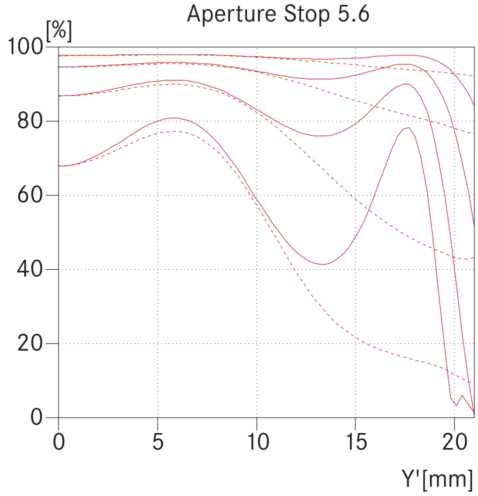


As with the Summilux-R the design goal was to achieve a very good performance in the central part of the image as this will benefit the intended type of pictures with this lens.

Effective Distortion



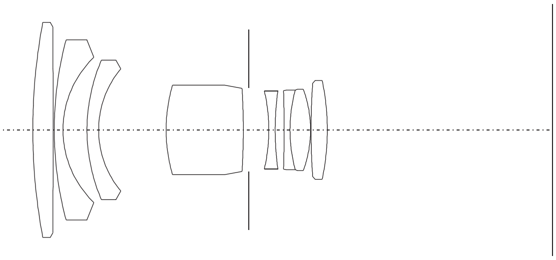
Aperture Stop 5.6

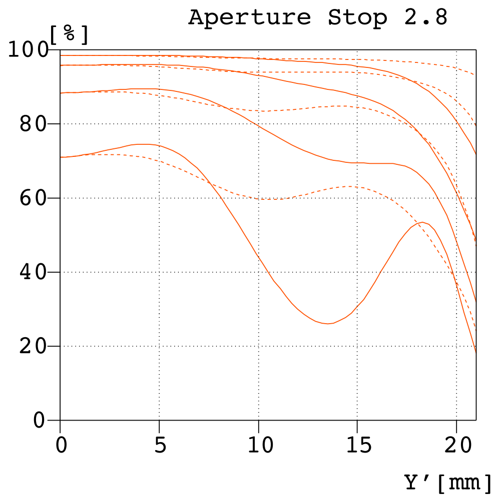


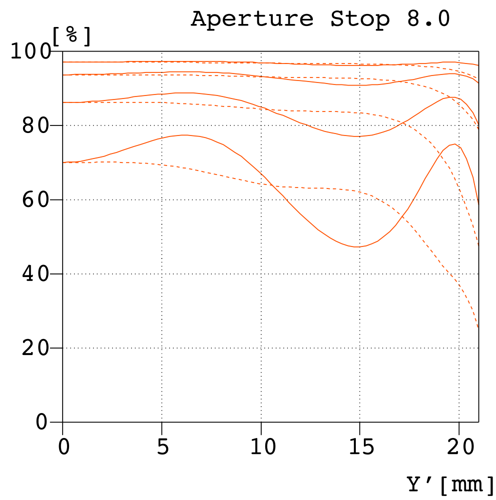
Distortion is on the same level as the Summilux-R with 2% .

__ LEICA ELMARIT-R 28 mm f/2.8

This Elmarit-R lens from 1994 is an improvement over the predecessor from 1970 by two stops. That is a quantum leap. The design is clearly retrofocus with a negative front element and the thick central element. When you want to study the design it is best to compare it with a symmetrical wide angle lens and note that the central group has the same role and function.

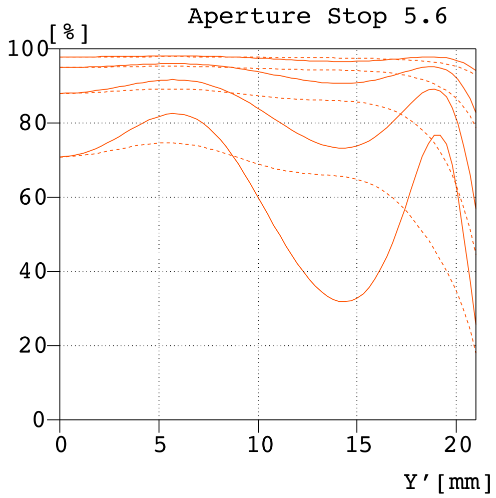


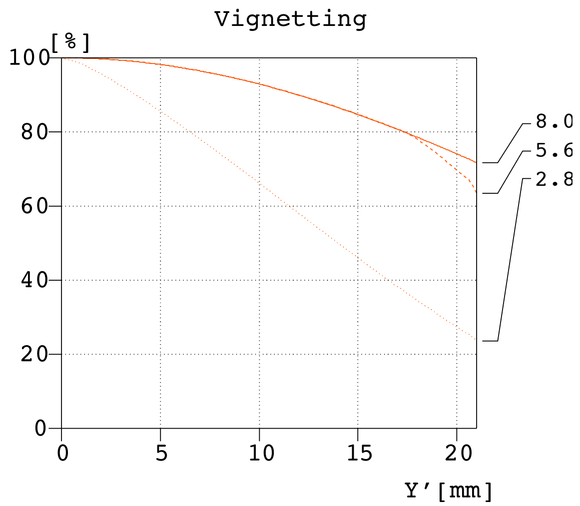




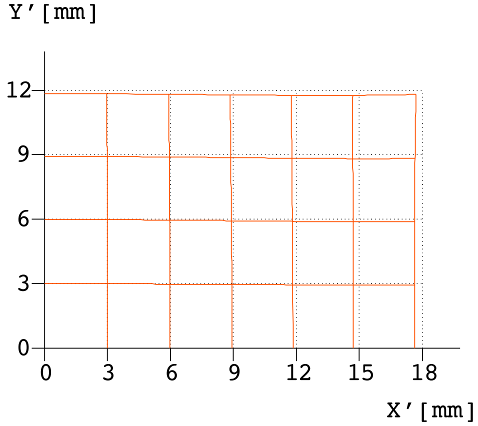
At aperture 2.8 the overall contrast is high and the image quality very even from center to edge. The sagittal and tangential lines in the MTF are close together and very fine differences in gradation in small subject areas will be clearly recorded. The Leica-typical dip in the zonal performance at image height of 12mm can be seen in the curves. It can be case that the well-known smoothness of the unsharpness gradient for which many Leica lenses are famous can be attributed to this characteristic.

Stopped down to 5.6 and especially to 8 the Elmarit-R improves to a very high level of definition of very fine detail and a even performance over the whole image area. At aperture 8 there is already a small loss in contrast due to the influence of the diffraction effects. This lens is in the very front rank of the worlds best lenses of this specification.



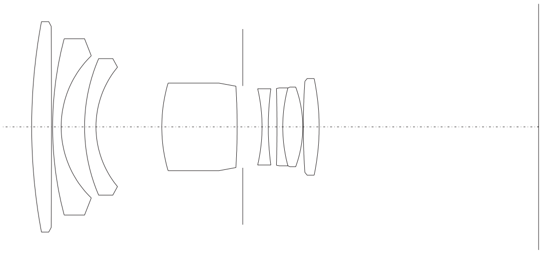


Vignetting is acceptable with 1.8 stops and will not be disturbing in most cases.



The distortion is 2% and visible in critical situations, but one should not confuse distortion with converging perspective lines.

The Elmarit-R 28mm f/2.8 features the floating element which has become a standard nowadays to significantly enhance the quality in the near-focus range.



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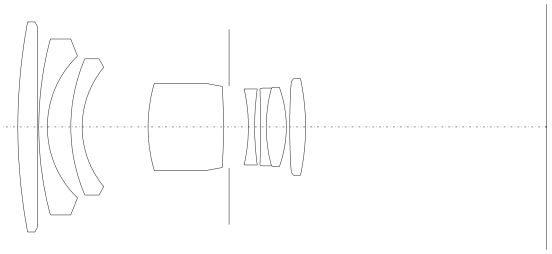


__distance setting 0.3m

__Artistic considerations

For the 28mm and for the 35mm lens the well-known phrase by Robert Capa is valid: "If your picture isn't good enough, you weren't close enough. Often a wide angle lens is used just to get more information on the negative. But the problems with composition grow disproportionally. If you cram too much into the frame, it is difficult to get a clear and simple composition. And the subjects will become small details behind an empty foreground. The 35mm perspective is only efficient if the subject is almost touchable. With the 28mm this effect is even more pronounced. Here one should literally be close to the skin. Wide angle lenses are often employed for landscapes, interiors, and buildings. In these cases one should stop down to get very sharp pictures as it is the crispness of the details that tells the story. The true domain of the moderate wide angles is the reportage or documentary snapshot at closer distances. The large depth of field will help to cover up slight unsharpness due to errors in focusing. The photographic challenge is the figure-ground relationship and the size relation between back- and foreground subjects. The details in the background are very small and because there are so many details (due to the field angle) the background can be very distracting. It is simpler to take a good picture with a 90mm than with a 28mm. Therefore you should be close to the main subject and let the surroundings support your statement with good choice of detail and structure.

There are some additional considerations. If you take a picture from a distance of 20 to 30 meters from a row of houses (as example), the houses in the center of the image will appear much more prominent than intended for the eye of the observer. This is not distortion in the technical optical sense, but an effect of the wide angle view, where houses at the edges are at a larger distance from the camera than the houses in the middle of the picture and aretherefore recorded with a lower reproduction ratio, i.e. smaller. You can observe the same effect when makeing a picture of a group of people: You will note that the faces of the persons at the edge of the image are a bit distorted. If you take a picture of a series of circles with a very wide angle lens you will notice that the circles at the edges are horizontally elongated. This is the wide angle perspective that you should study. The phenomenon of widening and converging lines (as with rail road tracks) is not distortion in the technical sense but a visual effect. And converging street poles at the edge of the image are not an optical distortion, but simply the result of a camera that had not been held correctly. When composing a picture you should be aware of the several types of wide angle effects that can enhance your message.

__Conclusion

These 28 and 35mm lenses are eminently suited for the spontaneous snapshot and for the more formal artistic pictures. In any case one should start with pictures of subjects not farther away from the camera than 3m. Close range photography is the best approach to start with. In this range you can learn to see and study the wide angle effects. In fact you can photograph almost everything with these lenses. The most important thing is the style of language of your photography. The play with the depth of field and the size relationships in fore- and bakkground are the decisive factors here for a good or bad image. The lenses can only be the means to an end. The Summicron-R 35mm f/2 is a fine compromise between all demands. The Summilux-R 35mm f/1.4 would be the first choice in this group. With a floating element and outstandingly good quality already at f/1.4 it is best suited for available light photography and stopped down it has all sharpness needed for the reproduction of fine detail in wider viewing angles. The Elmarit-R 28mm f/2.8 is a challenge for photographers who need the best possible definition in their style of photography. The lenses with focal lengths of 28mm and 35mm belong to the group of classical focal lengths of the 35mm-format's tradition. The Leica R photographer does not need to select subject matter. Every thing can be photographed in every style. The range extends from landscape pictures that are composed like a poem with carefully selected image elements to dramatic reportages about the human condition. Specifically with the new generation of ISO100 and ISO400 slide films the optical potential can be exploited with spectacular results.

LEICA SUMMICRON-R 35 mm f/2

Leica R-Lenses

by Erwin Puts

October 2003

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

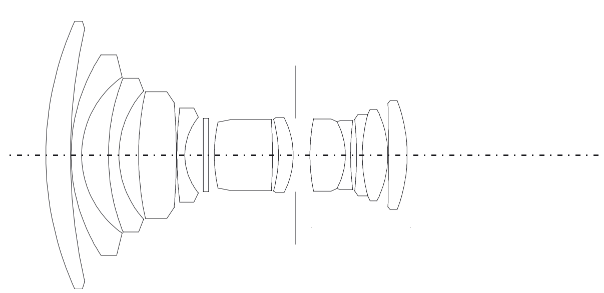
In optical design, the unit of measurement is the micrometer ('micron' is another name for the same magnitude) for the lens element and the nanometer for the wavelengths and the coating layers. In mounting and mechanical construction the unit is the micrometer too and the millimeter. We use these units 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

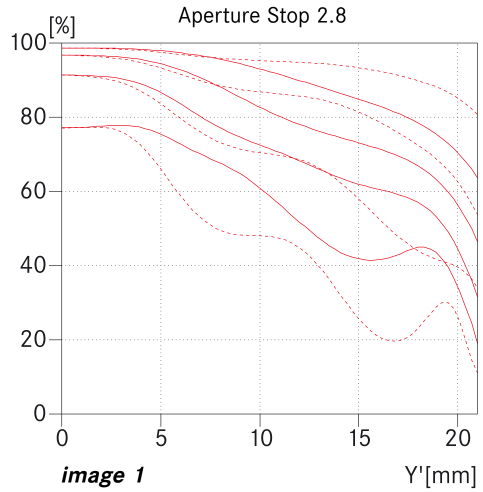


image 1

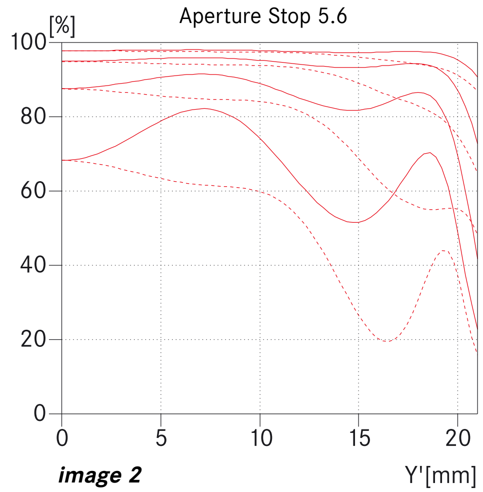


image 2

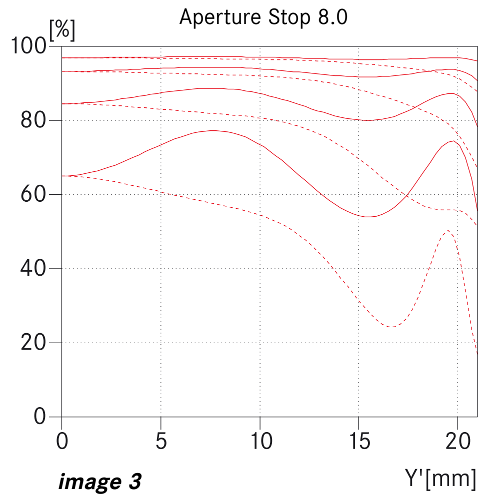


image 3

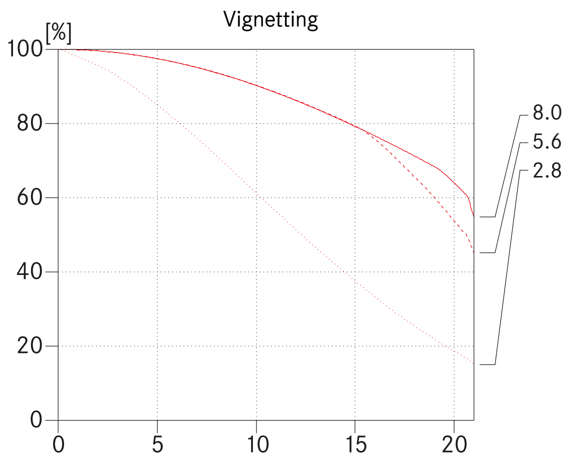


image 4

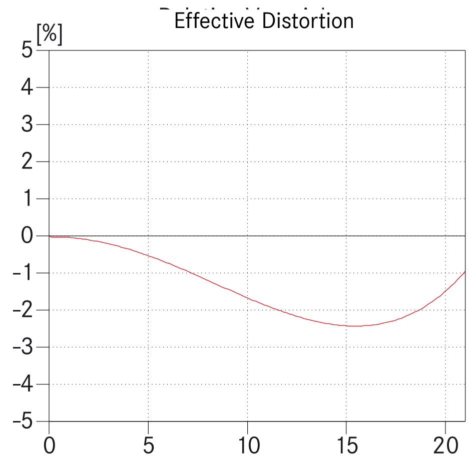


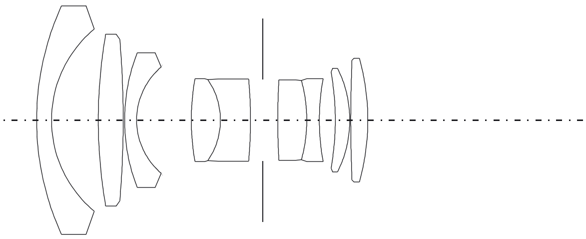
image 5

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

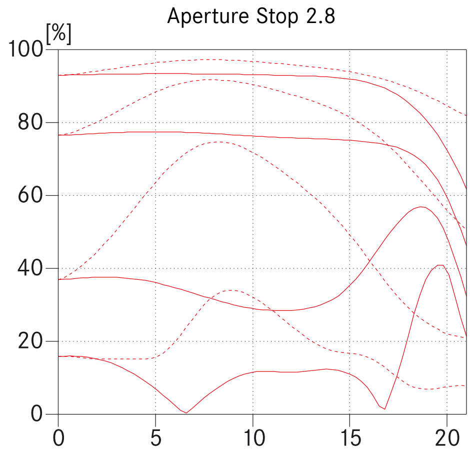


image 6

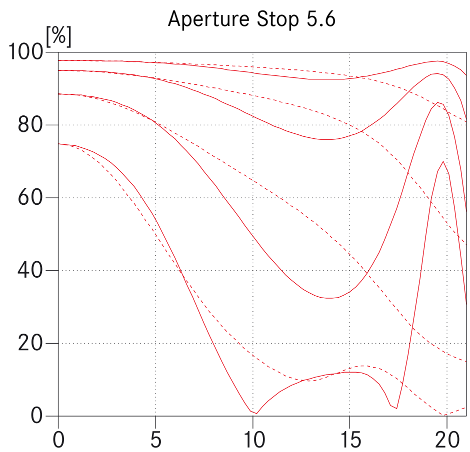


image 7

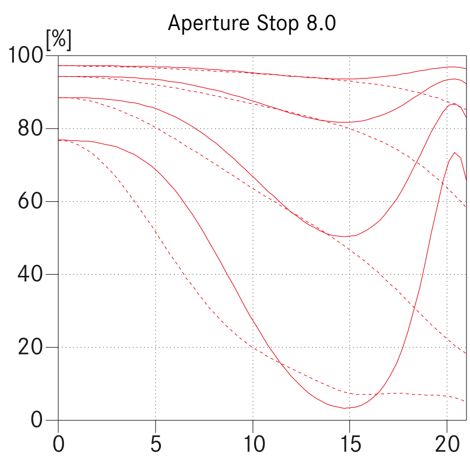


image 8

to the 24mm angle. The LEICA ELMARIT-R 24mm f/2.8 has a long history. In the period of the cooperation with Minolta this lens was adopted from a Minolta design and packaged

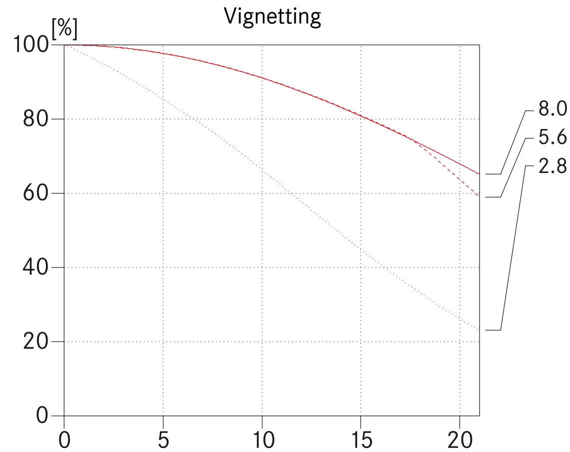


image 9

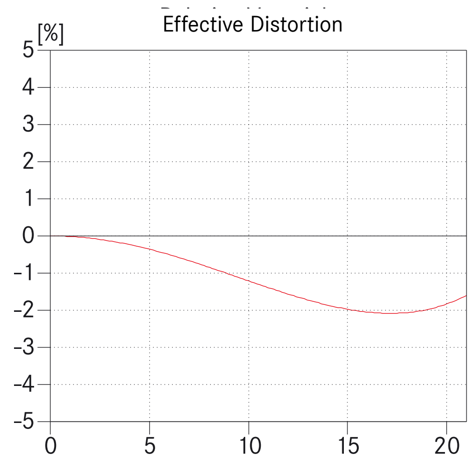


image 10

in a Leitz mount.The glass elements were from Minolta and other manufacturers. In a later stage Minolta stopped producing the lens and Leitz had to adapt the lens design to the use of different glass types from different glass manufacturers.

The question often posed is whether this lens is a Leica lens or not. Let me rephrase the question: is an Elmar 50mm a true Leica lens, even when it looks identical to a Zeiss Tessar lens? Obviously the answer is a yes. Most lenses from the major companies show similarities in design and performance. Designers all over the world know what users expect and all can use the same basic approach and materials.
The differences are nowadays more subtle than in the past when one could more easily identify a lens by its fingerprint. In the past the designer needed to make more either-or choices in balancing the aberrations and physical requirements. Now the balancing act is more comprehensive and therefore the result more pleasing.

__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.

Leica R-Lenses

by Erwin Puts

November 2003

Chapter 6: 15 mm lens

__ LEICA ELMARIT-R 15 mm f/2.8

Introduction

The 15mm focal length offers an angle of view of 100 degrees in the horizontal direction. I prefer to use the horizontal angle and not the diagonal angle of 111 degrees. We look through the viewfinder and holding the camera in the normal position, we usually assess the scene from left to right. That is how we compose the picture and then the horizontal angle of view determines our choices. Some years ago, a lens with a 17mm focal length would be the limit for high quality photography. Beyond this limit we could find the so-called fish-eye lenses. If we push the retrofocus wide angle design to its extreme, we can cover a field of 180 degrees and more. The front element must be very strongly bent and we must create very heavily overcorrected spherical aberration to let the oblique rays pass through the aperture stop. Doing this, we also introduce a large amount of barrel distortion.

What is acceptable or even necessary for a fish-eye lens with a circular image, is not possible for a lens that needs to cover a rectilinear field with accurate proportions.
The designer has a very difficult job to control the aberrations and it is here that the use of aspherical surfaces can be highly effective. The first serious discussion about the principles of aspherical (non spherical) surfaces can be found in the work of Descartes in 1638. The first calculations of aspherical surfaces are proposed by Huygens in 1678. In the beginning, the research was focussed on the correction of spherical aberration, but nowadays aspherical surfaces are employed for the correction of all kinds of aberrations and for the reduction of physical size of a lens.

Useful as they are, the production of aspherical lenses requires a very high level of accuracy. It is normal in optics to use the value of a quarter of a wavelength as the tolerance level for the accuracy of the shape of a lens. A quarter wavelength is about 1/1000th of the thickness of a human hair. The demands on the quality and precision of manufacturing are very high.

With the use of aspherical surfaces and better techniques for the correction of aberrations, the focal length of 15mm is not a technical limit anymore. Looking at the world market we discover lenses with focal lengths from 12mm to 14mm, some of them very good. These designs have to be admired for their generally high image quality.

The question here is not that such an extreme wide angle is feasible, but where the limit of usability lies. The wide angle perspective, as noted in earlier chapters, becomes quite strong. With a 12mm lens the central push of the image and the horizontal elongation of subjects at the outer zones of the lens are quite visible. This effect may be so strong that persons, located at the edge of the frame become victims of apparent obesity.

With a focal length of 15mm, the photographer enters the realm of specialist lenses. Its special characteristics support eye-catching pictures and compositions, but the lens cannot be used for every type of picture and object. In the past, specialist lenses often had a lower image quality and could be excused because of these characteristics. Today this is not possible. No photographer would accept that some pictures in a show would be clearly distinguished by a much lower performance.

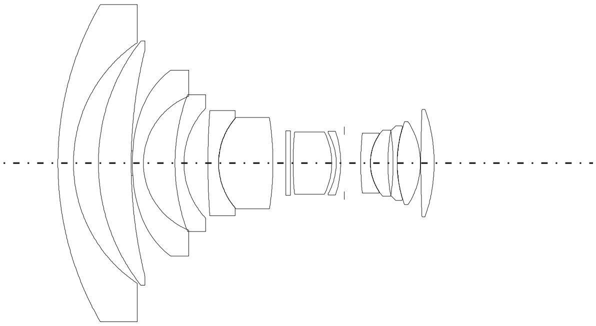
It might be interesting to compare the image quality and information gathering capability of a few lenses to see where we stand in the optical landscape. The following values have been calculated by a very complex formula. The base of the calculation is the optical transfer function (OTF). This is the overall measure for the image quality. The MTF (modulation transfer function) is part of the OTF. The OTF is more complex and can only be grasped by optical designers. Based on OTF values, the spatial frequencies at which the modulation falls to 50% (excellent value) and 20% (limit of normal visual perception) are noted at five positions in the picture area (from centre to corner). Then the picture field is divided in four circular zones.

The area of each zone is computed. We now assign the spatial frequency values at 50% and 20% to each of the zones. Then we calculate by a complex formula the number of pixels at both modulation levels. The resulting single figure is a measure of the information gathering capacity of a lens. The higher the number, the better the lens is in this respect. The comparison is done for lenses to be used with the 35mm format.

The 15mm lens has a value of 3.39, an excellent 1.2/55 aspherical has a value of 4.22, and an excellent 28mm f/2.8 has a value of 7.28. The first lens is the original Schneider design, the second and third ones are from a major Japanese manufacturer.We should not read too much in these figures, but as a base for comparison we can note that the current 15mm lens captures the same amount of information as a high quality standard lens with a very large aperture. The 28mm lens can collect more details, but does this at half the angle of field. The trade off between angle of field and aperture can be clearly identified.

__LEICA SUPER-ELMARIT-R 15 mm f/2.8 ASPH

The Super-Elmarit-R 15mm f/2.8 ASPH is a state of the art design with 13 elements in ten groups, one aspherical surface and a floating element/internal focusing to improve performance in the close-focus range. The true focal length is 15.6mm (compared to 15.4mm for the predecessor, the Super-Elmar-R 15mm f/3.5).



Distortion is surprisingly low with a maximum of 2%. You may compare this value with the other wide-angle lenses, discussed in previous chapters ***(see image 1)***.

The maximum value is of less importance than the shape of the distortion curve. In the case of the Super-Elmarit-R 15mm the distortion is already visible from image height 4mm, where the Elmarit-R 19mm starts at 6 mm. But the bulging shape of the 19mm delivers a different distortion character than that of the 15mm.

Distortion is in general very well corrected and even persons at the edges of the image retain their normal body contours. (Ever looked at the elongated faces and bodies of persons when using a 12 mm or some other 15mm lenses?). Architectural straight lines are straight lines with a just visible distortion in the outer zones of the image.

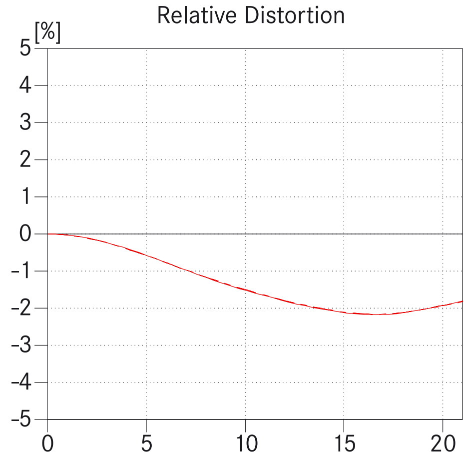


image 1

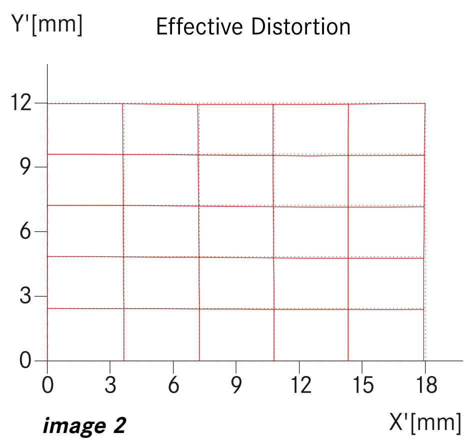


image 2

The fish-eye lenses are lucky with the high distortion, as this offsets the vignetting. But in a normal 15mm lens, the distortion is quite well controlled and now the vignetting is more difficult to control ***(see image 2)***. The Super-Elmarit-R 15mm has a maximum vignetting of 2.5 stops, which is below the figure of the Noctilux 50mm. This comparison is again an indication that high performance lenses (high speed or wide angle) are still a compromise, but also that the general level of performance is very high. In the case of the Super-Elmarit, the illumination fall-off at aperture 1:11 is still one full stop. But we need some additional information to understand these figures As with plain resolution figures, it is easy to be misled by quantification. The human eye is very insensitive to very small changes when they occur smoothly. The eye is trained to focus on abrupt changes and will neglect small differences. Of course one will see a darkening in the corner at full aperture where the vignetting is more than 2 stops. I have made many pictures just to find out the effect of illumination fall-off and discovered that in many situations you do not see the darkening in the corners, even if you know it should be there. If we study the vignetting curves, you will se that the graphs for the smaller apertures are very smooth, a fact that helps to suppress the impression of vignetting. In darker grey areas it is not visible, but white areas or clear blue sky do show light fall-off. You can often hear and read about claims that an illumination fall-off of a half stop is already severe and unacceptable.

The behaviour of this Super-Elmarit-R indicates that such claims are not based on real life situations.
In extreme wide angle lenses, some aberrations are not really problematic. Longitudinal chromatic aberration and secondary colour are for the most part only dependent on focal length and with this short length of 15mm, these chromatic errors are not important. The secondary spectrum of the lateral chromatic aberration is a problem as is the chromatic error in distortion. In short all chromatic aberrations that are dependent on focal length (the longitudinal direction or along the optical axis) are small, but all aberrations, depending on the angle of view or the height of the image (the lateral direction) can be quite severe. The remarkable performance of the Super-Elmarit-R can be attributed to the control of both types of aberrations. At full aperture we have a medium to high contrast image with excellent definition of fine detail over an image circle of 12mm radius (24mm image circle in diameter) ***(see image 3)***.

The outer zones and the corners loose their bite progressively, but even in the extreme corners coarse detail is well visible. The curves, representing the 5 to 20 lp/mm are in excellent shape and even the curve for the 40 lp/mm is quite good, but levels off to zero percent at the edges. The curve for the 10 lp/mm has a value of about 20% at the edge of the image, which is just visible. When reading this one should reflect on the extreme angle of field. For this angle the definition over the whole image field outstandingly good. A slight fuzziness at the edges of fine detail delineation softens the overall crispness of the image a bit.

Astigmatism and colour fringing are for all practical purposes non existent. If you are doing really demanding work (above 50 times enlargements of slides), expect some colour fringing beyond the 9mm radius.

Flare is commendably low: secondary images can not be detected and the veiling glare in back-lit shots is confined to very small areas around the bright spots themselves. A good example is a picture of very fine telegraph or electricity lines against a light grey or white sky: if the lines are clearly differentiated and keep their own colour (no greying)

then the lens is OK. There is absolutely no decentring, which gives credit to manufacture and quality control given the large diameter of the lens elements.
At 1:4 the lens visibly crispens and the circle of best performance grows to 30mm (15mm image height) , that is close to covering the whole format. Edges of fine detail now are clean-cut and overall contrast is high.

The typical Leica sparkle in the highlights and bright spots is evident and the fine differentiation of the whitish hues (on modern slide films) adds to the impact of the image. Further stopping down is not necessary, neither to optimise image quality, nor to increase the depth of field. Till 1:16 the lens can be used, but at apertures from 1:11 the overall image is softer.

At 1:5,6 and 1:8. the lens is at its optimum and has that well-known Leica fingerprint of crisp and clean details with excellent clarity of shadow and highlight hues and outstanding colour reproduction, with a high fidelity reproduction of fine gradation of hues in small subject areas ***(see image 4 and 5)***.

The MTF graphs for these smaller apertures show a remarkable semblance to the one for aperture 1;2.8. You see a crispening at the higher frequencies and over a larger image area. But generally speaking the lens performs quite evenly over a large range of apertures.

At closer distances the contrast drops in the zonal areas outside a small centre circle. But stopping down to 1:8 brings the quality you need over the whole image area and you can expect the same performance as you will get at larger distances.

The Super-Elmarit-R is an original Schneider design. It is worth stressing that Leica did not accept the design as Schneider provided initially but commented on the quality and wanted a performance that is in line with the Leica philosophy. I have studied the original design and the major change is in the shape and curvature of the second lens element. Whoever designed and manufactures the lens is of minor importance, compared to the required performance parameters. The imagery is as Leica wants it to be, given their own goals and aspirations.

One cannot help to compare the new lens with its predecessor: the Super-Elmar-R 15mm f/3.5. This Zeiss design has less overall contrast at all apertures and especially the definition of very fine detail is much lower. The new Super-Elmarit-R design is quite crisp and clean in its detail rendition, which is the result of a better mastery of the higher frequencies.

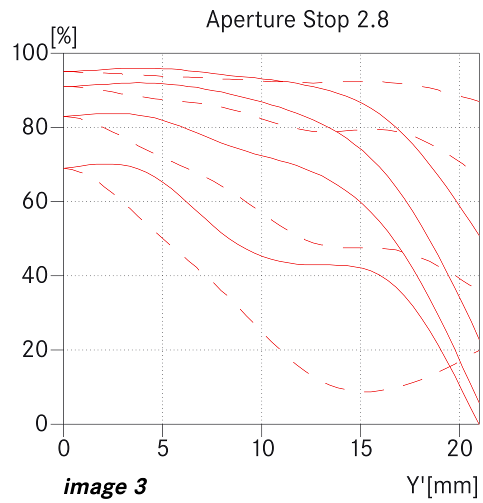


image 3

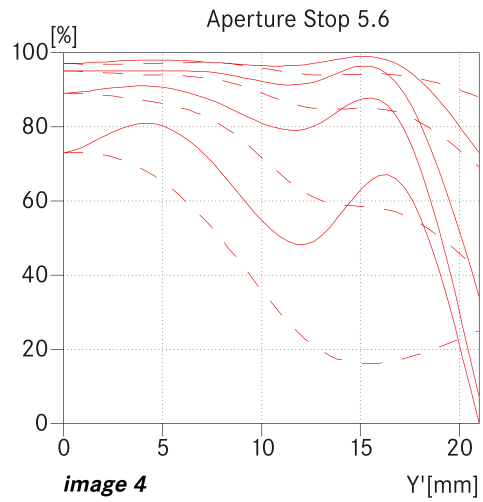


image 4

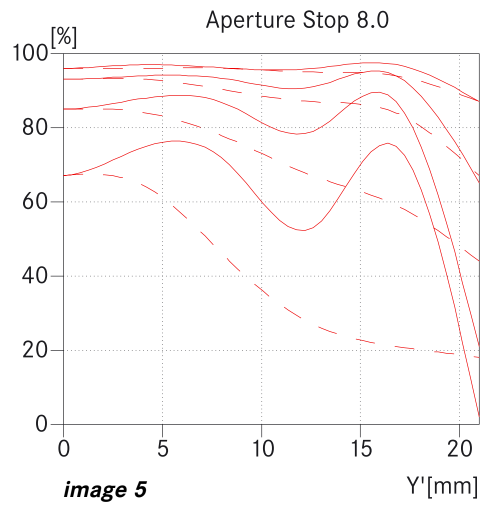


image 5

As example: At 1:8 the older Elmar design has about 90% contrast in the centre for the 10 lp/mm. The newer Super Elmarit has above 95%, a difference that is clearly visible. Even more important is the 40 lp/mm: Elmar in the centre: 40% at 1:3.5 and 55% at 1:8 versus Super-Elmarit 65% at 1:2,8 and 70% at 1:8. This optical progress is quite visible in normal photography.

__Artistic considerations

The very wide angle of this lens and its short focal length bring advantages and restrictions. At normal distances the lens captures a large visual area in breadth and depth. At the shortest distance of 18cm, we can create a very interesting close focus view and perspective of an object engulfed by its environment. The extended depth of field makes the concept of 'boke' (unpleasant or fragmented representation of unsharpness) obsolete for this lens.

At aperture 1:8 and focus at 1 meter the depth of field extends from 0,5 meter to infinity. Even unsharp areas in front of and beyond the sharpness field ('plane' would be the wrong word here) retain shapes and details. The transition from sharp to unsharp is very smooth. The assumption that this focal length is an easy one for pictorial representation is wrong. This is definitely not a convenient landscape lens. The large and extended foreground push main subject areas into the vanishing background. So you need to be careful how and where to deploy the lens. It is at its best when the sense of depth and shape needs to be defined in space. It is also needed when the overwhelming impressions of magnificently decorated rooms, long corridors, interior buildings or narrow alleys must be captured.

The lens can be used with good effect when photographing groups of persons that are engaged in a common activity. Photographed from a close position and centre location, the picture gets a strong sense of visual dynamics and the spectator feels to be in the middle of the action. Almost tactile closeness to the subject, combined with the sense of extended depth give pictures with a 15mm lens an almost picturesque perspective.

The reference to painting is intentional. When you look closely at landscape paintings and paintings of groups of persons, you will notice that there is at the same time a sense of vastness because of depth illusion and wide angle perspective, but also a sense of intimacy as the major objects are positioned very close to the viewer. A visually sensitive photographer with a keen and empathic eye can do wonders with the lens.

(S)he can even create a new visual language with the 15mm. There is, in my view, no other lens in the R-stable that offers such exciting opportunities for novel imagery, based on careful composition and layout of objects and the play with perspective and sense of depth.

It is quite natural that with this lens the camera must be held level to avoid slanting lines. The accurate viewfinder masking on the R8/9 can be used very effectively to avoid tilting the camera. Just find a horizontal and vertical line in your motive and align the finder frame in one corner as close as possible as if you were using a straight edge. On the other hand, the oblique lines that appear when holding the camera in a tilted position can heighten the visual effect. When you are using the 15mm a lot, it is advisable to acquaint yourself with the rules of graphical perspective.

Conclusion

The Super-Elmarit-R delivers outstandingly good image quality at all apertures. The best proof of the capabilities of the Super-Elmarit-R 15 is a close look at slides taken with this lens. You would not expect that these slides can be made with a 15mm lens. this They are natural looking in their perspective and clarity. Fine details radiate when enlarging, projecting or looking closer at the picture. The colour reproduction is very natural and pictures with the Super-Elmarit-R show a distinguished colour palette that invites you to step into the picture and marvel at the quality of reproduction and the depth of perspective.

The mechanical quality is superb: the mechanism of internal focusing is indeed incredibly smooth in its movement. Accurate focusing with the normal screen is not so easy as the sharpness plane does not jump into focus as with the Summilux-R 35mm f/1.4. You have to rely on the split image mechanism, which only works with vertical lines. The internal filter revolver is the same as can be found in the previous Super-Elmar-R 15mm. A filter must be used as the filter element is part of the optical design.

The Super-Elmarit-R is a very fine tool for the photographer who wants to create pictures with a very strong visual impact and a wide dimensional scope.

Leica R-Lenses

by Erwin Puts

January 2004
Chapter 7: 28-90 mm lens

__ LEICA VARIO-ELMARIT-R 28-90 MM F/2.8-4.5 ASPH

__Introduction

The zoomlens as a species of lens design has had a strange evolution. The first design seems to be the Vario-Glaukar 1:2.8/25-80 mm for 16 mm cine cameras, created by Siemens around 1936. Especially in movies, the idea of a smoothly changing rate of magnification is very valuable as it can dispense of the stationary camera, moving on a trolley over rails. The first patent for a zoomlens is from 1902 by a USA company. The idea of a zoomlens is now more than a hundred years old. The first zoomlenses for 35 mm cameras were regarded as toys and even during the eighties of the previous century the Leica company declared that zoomlenses would never surpass the image quality of fixed focal lengths. It is Mr Kölsch who deserves the credit for two major breakthroughs in Leica lens design: the aspherical surface and the high quality zoomlens. The seminal LEICA VARIO-ELMARIT-R 35-70 MM F/2.8 ASPH and the Vario-Apo-Elmarit-R 70-180 mm F/2.8 are the proof in the pudding: zoomlenses can be as good as fixed focal lengths.
Nowadays the situation is reversed: it are the fixed focal lengths that must prove their superiority against the challenge of the zoomlens. There is no doubt: the zoomlens does not lend itself to high apertures (in the world of the digital camera this statement is not true!) and the maximum aperture is F/2.8. But with current film technology the best ISO 200 and ISO 400 slide films (and 400 ISO BW films) can compensate for the one or two stops difference between fixed focal lengths and zoomlenses.

The zoomlens has a higher number of lens elements that can all be used to correct the optical aberrations and the designer has more tools to optimize his design. We know that with fixed focal lengths there is one optimum distance (or magnification) for which the lens can be corrected. In zoomlens design the same principle holds: there is only one focal length for which the design can be optimized. The choice is obvious: one can select the medium position, the wide angle side or the tele side. For the new LEICA VARIO-ELMARIT-R 28-90 MM F/2.8-4.5 ASPH, Leica has opted for an optimization of the 50 to 90 mm range.

The designer of a zoomlens has more tools to correct the lens, but the mechanical design and engineering are more demanding. There is clearly a difference between assembling a lens with 6 elements in a stationary mount and a lens with 11 elements in a moving mount. It is already a hefty task to manufacture and assemble components with a precision within 0.01 mm consistently. The additional requirement for a zoomlens is that this same level of accuracy must be maintained with moving components. Leica does check the precision of the lens with a testcycle of 50.000 movements of the lens mount.
This new Leica zoomlens has a number of innovative features that elevates zoomlens design to a new level.

It is the first Leica zoomlens that has a zoom range above a ratio of 1:3, to be exact it is 1:3.214, very close to the magic mathematical number pi (3.14…).

The second innovation is a new and very elaborate mechanical design for the movement of the lens groups.

The third innovation is the ergonomics: the LEICA VARIO-ELMARIT-R 28-90 MM F/2.8-4.5 ASPH has one of the smoothest lensmounts I have touched, considering the fact that the lens has been made for manual focusing with a fully mechanical mechanism. The size of the lens is relatively small and fits in between the smaller Vario-Elmar-R 28-70 mm f/3.5-4.5 and the larger Vario-Elmarit-R 35-70 mm f/2.8 ASPH. That is quite good, given the additional focal length of 20 mm. The diameter of the lensmount could be held down by employing quite thin but very stable aluminium tubes. If you press very hard on the distance ring, you will increase the friction and this phenomenon has caused some users to question the mechanical stability of the new generation of zoomlenses. This is not the case, and one needs to get used to the idea that modern lenses have a different feel compared to previous generations.

The fourth area where innovations can be detected is the cosmetics: the lens has a beautiful shape and very impressive black finish.

We may add that the lens has its share of electronics with the electronic exposure compensation, useable with R8/9. No news here, but one should see it as a fifth area.
The ROM (electronic data and signal relay) contact ledge transfers information from the lens (focal length, aperture compensation and vignetting data) to the camera for correct exposure determination and flash settings (zoom reflector).

__ LEICA VARIO-ELMARIT-R 28-90 MM F/2.8-4.5 ASPH

__Zoomrange

The choice of focal lengths is very practical. Many years ago Canon has analysed thousands of photographs and concluded that the most often used apertures and speeds are 1:8 and 1/125 and that the most used focal lengths were within the 28 mm and 90 mm range. If we believe these studies, the new Leica lens would cover the most used range of focal lengths with one zoom movement.

This Leica lens is a fine addition to the expanding range of Vario-lenses, but it cannot be a jack of all trades.

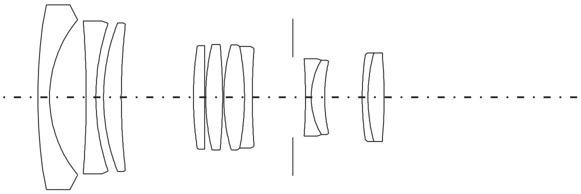
A macro facility is not available, but can be found in the companion lens Vario-Elmar-R 35-70 mm f/4 . And for most applications, the near focus limit of 0.6 meter on the 90 mm position may suffice. The aperture range from 1:2.8 to 1:4.5 has enough speed for current high quality medium speed films. One would have hoped for a slightly wider aperture at the telephoto side of the zoomrange. But that wish would have clashed with the desire for a compact lens. Remember that the famous Vario-Elmarit-R 35-70 mm f/2.8 had a front diameter of 88 mm and extrapolating this to the 90 mm position, one would have to live with a lens with a diameter in the neighbourhood of 120 mm and a much higher weight due to the proportionally heavier glass lenses.

The aperture ring has numbers from 2.8 to 22 and one should be aware that this range only holds for the focal lengths from 28 to35 mm.
The 50 mm aperture starts at 3.4 and the 90 mm at 4.5.
If you are at the 90 mm position, the aperture setting of 2.8 corresponds to 4,5 and the 22 is in fact 36.

One should be careful when using a handheld meter or when one uses the A-setting and wants to select a specific aperture. It is easiest to use the aperture indication in the finder.

__Optical demands and mechanical construction

The design has 11 elements in 8 groups and employs two aspherical surfaces, one at the first surface of the front element and one at the second surface of the last element, incidentally the same as in the original Noctilux 50 mm f/1.2.
The lens has three moving groups that are being guided in milled slots with a precision of 0.010 to 0.005 mm.



The challenge for the Leica engineers was to design a lens that had to fit into three dimensions of requirements: performance, haptics and cosmetics. These dimensions are partly at conflict with each other. And we have to add another dimension, that is the manufacture of the lens. In this area Leica has learned a lot from the previous designs. The main problem area is the narrow tolerance band for the manufacture and assembly. The lens consists of eleven lens elements, that are precision grinded and have a surface treatment to reduce surface irregularities to a sub micron level, in fact here we are talking about tolerances at the nanometer scale (0.001 micron). To deliver the required and calculated performance, the lens element must be fitted into the mount without any stress, as the slightest strain on the lens will deform the surface and produce unwanted optical aberrations. One should be aware that the accurate and strain free mounting of the lens elements is a big challenge. There are additional challenges too: a lens element needs to be blackened at the sides to reduce the possibility of flare. This is accomplished by painting the sides of the lens with a black paint, still done by hand by experienced workers. But a thick (relatively speaking!) elastic layer implies that the lens could move ever so slightly within the mount. One solution might be to press the glass element into its mount, but too much pressure is not good at all. So one has to carefully balance the thickness of the layer of paint with the requirement of a strain free fitting.

In the area of lens grinding and shaping we are operating on a nanometer dimension. The jump from this optical dimension to the mechanical dimension of the mount and the accuracy of assembly is a jump from nanometer scale to micrometer scale (0.001 mm), but this micrometer scale is still incredibly small. And the designer must be aware of this jump to assure that his calculations can be met in the realm of manual assembly, even when using sophisticated instruments to check the precision of the assembly. The new zoomlens has more than 40 main mechanical parts (excluding the elements and electronics and the aperture mechanism) that have to be assembled with a precision of 0.010 to 0.005 mm.

One of the biggest problem areas in lens assembly is the possible decentring of lens elements. Decentring of lens elements can be a tilt or a lateral displacement (relative to the optical axis) and will occur almost always during lens assembly unless one can work with very narrow tolerances. Most optical programs have a special module to study the effects of decentring and can indicate how much decentring is allowable before one sees a deterioration of the image quality.

Decentring in general brings loss of contrast and more astigmatism. A special construction is required to ensure that the very tight tolerances that this lens demand (due to the mechanical and optical constraints of a 1:3 zoomrange). The manufacture of parts can never be done in a zero-tolerance environment. Therefore a certain amount of tolerance in the system must be accepted. In general one can approach this problem in three ways: one can allow for adjustments during the assembly process and try to pair plus/minus parts to get the correct fit (old Leitz method), one can do a Monte Carlo statistical analysis to investigate where the most sensitive problem areas are and distribute the problematic aspect through the system by relaxing the constraint (Zeiss method of relaxation) and now Leica uses a third method. This is the method of mechanical compensators that are part of the mechanical construction and are already taken into account at the stage of optical design and calculation. This is the novel idea. Compensators themselves are not new as a technique. In this case the lens element can be displaced by a small amount by a mechanical movement before being fixed in place. The displacement is controlled by a MTF measurement at a very high scale of magnification

New too is the approach to design the lens optically and mechanically at the same time and in full interaction. The designer must be aware what is possible at the assembly stage as he cannot demand the impossible from the people during their work. The optical calculations are optimized to allow the people at the assembly line to hand adjust the compensator mechanism in such a way that the lens is always at optimum performance. Every single lens is being checked to perform as designed and especially the aspherical elements are very carefully adjusted. The result is a much lower tolerance band than would normally be possible. The care that is being lavished on the quality of the assembly can be read off from the time needed: it takes a worker more than two hours to assemble the lens. This close cooperation between design and assembly is one of the main causes for the consistently high quality of the Leica lenses and has now been brought to a new level. The assembly and adjustment instructions are part of the final lens design and the design is adapted to what is the best assembly practice.

No two lenses that leave the factory are absolutely identical. There is always some tolerance during manufacture.

The factory must set the lower limits of the performance that they can accept as being within the requirements as specified by the designers. A long as these requirements are met, a lens will be accepted by quality assurance. With the construction of the LEICA VARIO-ELMARIT-R 28-90 MM F/2.8-4.5 ASPH the statistical distribution within the tolerance range is significantly reduced.

Zoomlenses are difficult to manufacture to narrow tolerances because of the lens groups that have to move in a complicated path. Normally one uses a mount with guiding slots that govern the movements of the lens groups in relation to each other.

In most cases there are two or three slits and they are milled in the mount as open holes, in which the guiding rollers move. With open slits, however, the structural integrity of the mount can suffer, but with two slits and sufficiently thick walls, there is no problem. The price you have to pay is a heavy lens. One of the requirements for the new lens was its low weight. In this LEICA VARIO-ELMARIT-R 28-90 MM F/2.8-4.5 ASPH we have three moving groups and therefore three guiding grooves. Now we cannot use the normal construction. (too heavy and/or too fragile). To ensure the necessary stability, one cannot use the open slit method, but must use internal grooves that can only be cut by special CNC machinery that Leica developed in cooperation with Weller, the leading manufacturer of this type of CNC tools. The milling movement creates a surface roughness that has to be smoothed to a tolerance depth of 0.01 mm to ensure that the guiding rollers move with the same resistance over the whole range. The mount of the new lens is made of quite thin and very high-grade aluminium that is specially selected to have the required stability. It is also selected because the surface reacts quite well to the black anodizing process ***(see image 1)***.

(image 1)

The result of all this effort is a lens with a very smooth movement of the focusing ring and focal length selection. With quite sensitive fingers one can feel some instances of friction when you go from 90 mm to 28 mm, so perfection is always relative.

__Optical considerations

The general image quality of this lens is of a very high order. Leica characterizes the lens as a travel and general purpose lens. This is undoubtedly true, but I would add that the performance of the LEICA VARIO-ELMARIT-R 28-90 MM F/2.8-4.5 ASPH does support professional photography of a very high calibre.

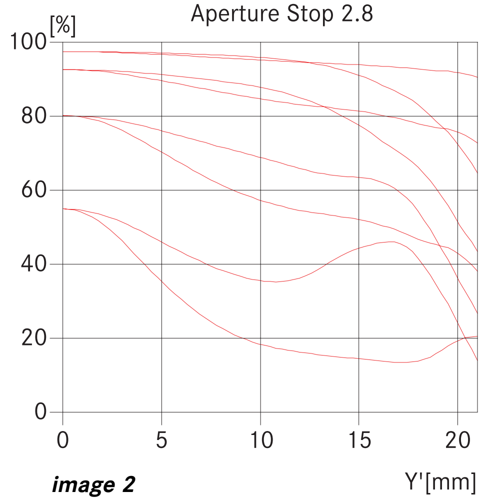
At 28 mm and full aperture (2.8) we have a high contrast image that can record above 150 Lp/mm in the centre of the image and more than 80 lp/mm in the outer zones ***(see image 2)***. Only the corners are weak with a soft recording of fine detail. Stopping down to 5.6 the performance of the centre now extends over an image circle of 12 mm diameter ***(see image 3)***. There is no trace of astigmatism and a slight field curvature. Some colour fringing is visible at very high magnifications. Distortion is visible with -3% (barrel distortion) and so is vignetting at 2.5 stops ***(see image 4)***.

At 35 mm and full aperture (2.8) there is a small improvement in the outer zones where the lens now records 100 lp/mm with good micro-contrast ***(see image 5)***. Distortion now is about -1%. At 5.6 we have optimum performance with a crisp rendition of very fine detail over most of the image area ***(see image 6)***. Vignetting is practically gone ***(see image 7)***.

At 50 mm and full aperture (3.4) we see a very high contrast and an exceptionally high resolving power of more than 150 lp/mm over a large section of the negative. There is still some faint colour fringing, but in practice one would be very hard pressed to note it ***(see image 8 and 10)***. At 5.6 we have impeccable performance that easily surpasses the quality of the Summicron 50 mm lens, especially in the outer zones of the field ***(see image 9)***.

At 70 mm and full aperture (4) the image quality becomes superb and we have an extremely high contrast and a very crisp definition of the finest details ***(see image 11)***. Stopping down to 5.6 does improve edge contrast and now the corners are quite good too ***(see image 12)***. Distortion is 1% (pincushion) and vignetting negligible ***(see image 13)***.

At 90 mm and full aperture (4.5) the best performance is reached and compared to the 70 mm position the outer zones and corners are now as good as the centre of the image ***(see image 14)***. Vignetting is gone and distortion is very low with 1%. The low distortion at the tele side of the zoomrange is quite remarkable. Often the behaviour of zoomlenses can be characterized as good in the middle range and weaker at both extremes ***(see image 15 and 16)***.



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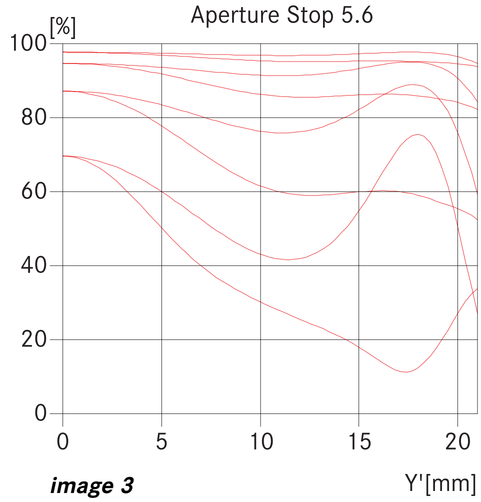

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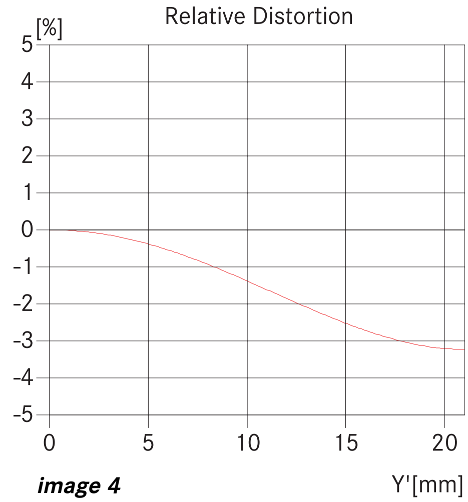

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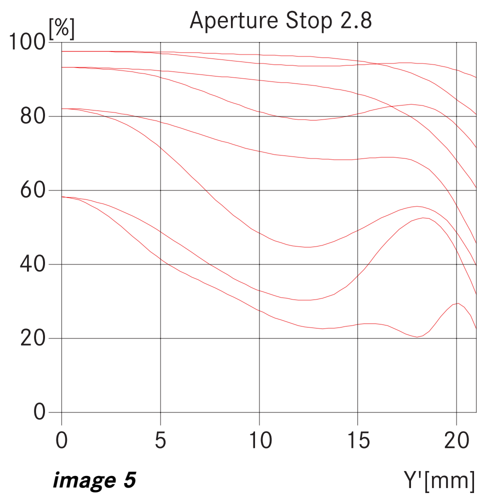

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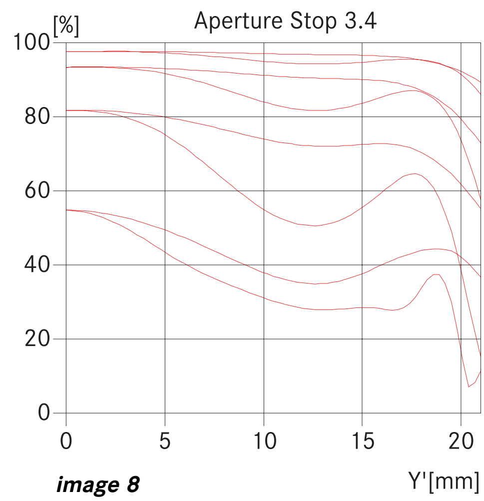

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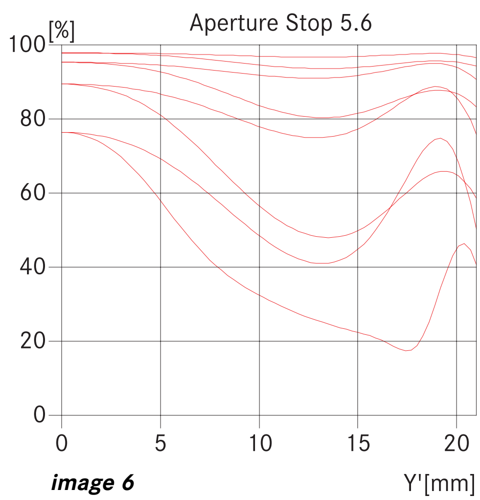

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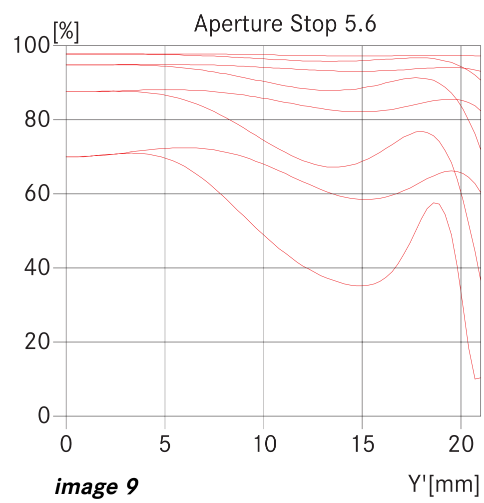

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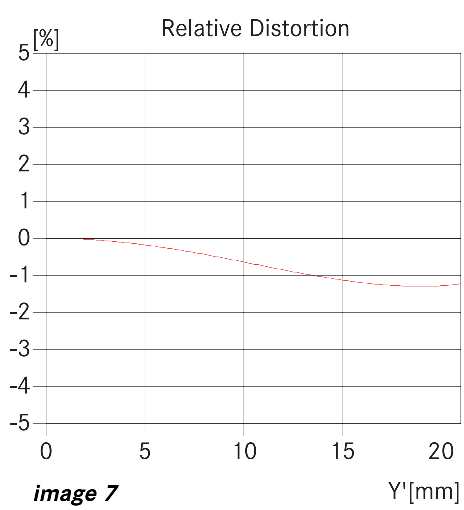

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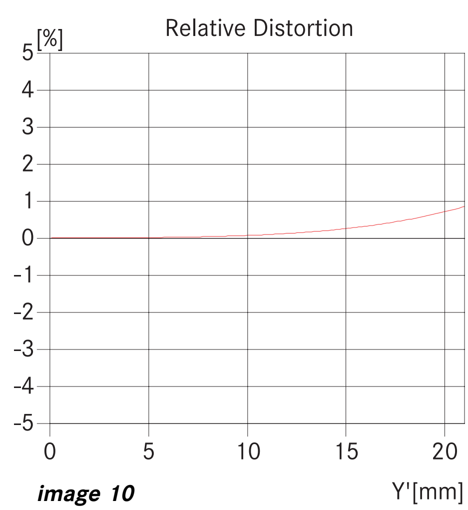

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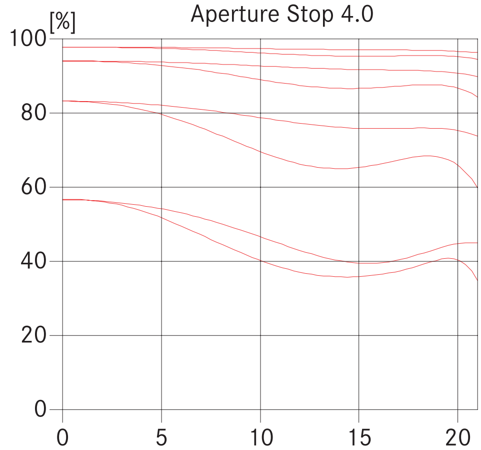
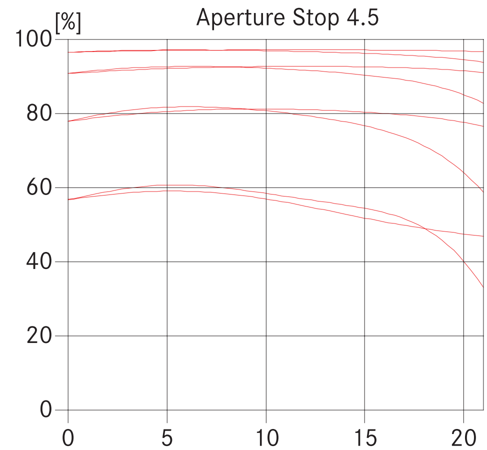


image 11



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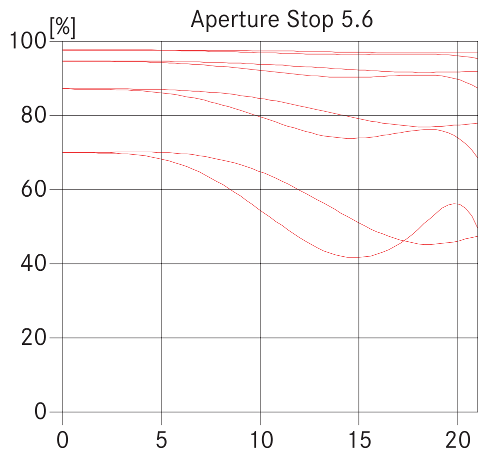

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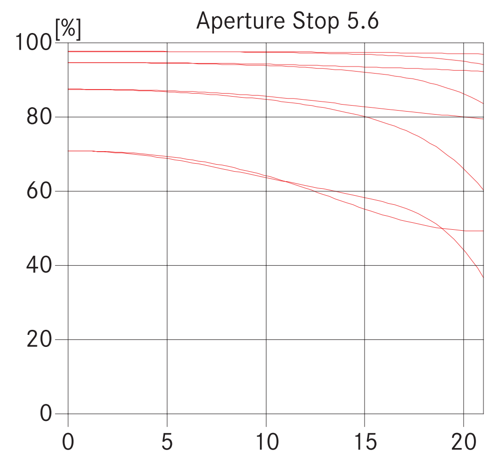

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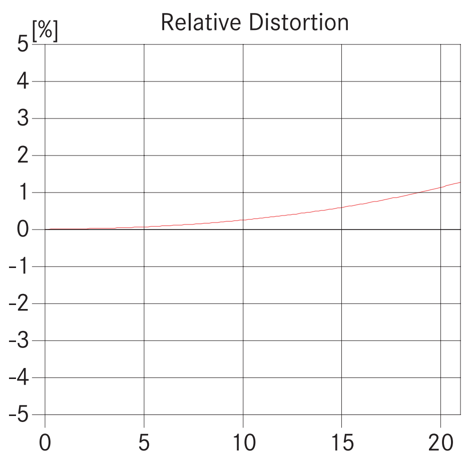


image 13

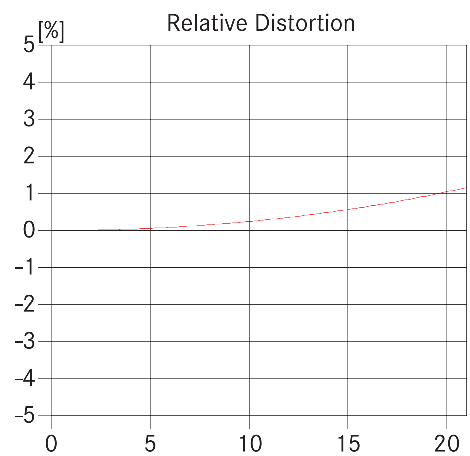


image 16

This is a lens with amazing characteristics. It offers outstanding quality and can be compared very favourably to the fixed focal lengths. A detailed comparison with the equivalent fixed focal lengths is possible based on the published graphs in earlier chapters and in the lens data sheets, available separately. The reader can do this him/herself.

The comparison with the Apo-Summicron-R 90 mm f/2 ASPH is interesting and does indicate where the advantages of fixed focal lengths may be found. A careful study of the properties of the individual lenses does help making the correct selection. The Apo-Summicron-R delivers at full aperture (1:2) the same performance as the Vario-Elmarit-R at the 90 mm focal length at f/4.5.
The Apo lens has a two stop advantage here. The greater depth of field and the more effective reduction of internal reflections (smaller lens diameters!) give the pictures with the Vario lens a smoother quality. With the Apo lens the sharpness plane is clearly isolated from the rest of the image and the unsharpess gradient is steeper. Stopping down the Apo-Summicron-R to 1:4 will make the differences disappear of course.

In general the fixed focal lengths will be more compact and offer a higher speed per focal length. Stopped down there is no longer a big difference and compared to older lens generations, the zoomlens often has better imagery in the outer zones of the image.

The images made with the LEICA VARIO-ELMARIT-R 28-90 MM F/2.8-4.5 ASPH have a very good colour fidelity, a very fine pictorial depth and realism. This is a lens for slide film and if you have not yet tried slide film, the acquisition of this lens might be a good incentive to try these films.

The wide zoomrange from 28 to 90 mm highlights another property of the reflex system: the normal finder screen of the R8/9 is a bit too dark at the 90 mm position and it is difficult to focus accurately at the 28 mm position. Here lies a new job for the engineers at Solms! Focussing at the wide angle range is often not very critical as depth of field will cover slight errors. If accurate focus is required, it is best to focus at 70 mm and zoom to 28 mm (or 90 mm and zoom to 35 mm).

In this range, focus constancy is abolutely spot on. Current Leica lenses score high marks in the areas of contrast and definition and reproduction of very fine detail. These characteristics can be inferred from the published MTF graphs, as long as you try not to read too much out of these graphs. One very critical area where the MTF can not provide information is the propensity to flare in its several aspects.

LEICA VARIO-ELMARIT-R 28-90 MM F/2.8-4.5 ASPH image: Oliver Richter

__Flare properties

I made a special study of the flare properties of the lens, as this is the one area where lenses have to go 'a bout de souffle'. Veiling glare is hardly visible at all focal lengths, implying there is no loss of contrast when the background is much brighter than the subject itself. When the sun is obliquely shining into the lens, and is behind the subject, one can see some secondary reflections of small extent in the picture, but the well-known diaphragm blade reflections are not visible. With the sun flooding the image, there is of course a bleaching out of the picture details, but in such a situation one would change the position slightly to evade this direct confrontation with the sun.

In general I would say that for veiling glare the lens is better than the average Leica lens, and for secondary reflections it is slightly better.

__Conclusion

The new lens is an outstanding performer at all focal lengths. The compact size, the ergonomics and the performance are all balanced into what economists call a Pareto optimum. Any change in one of the parameters will degrade the quality of the whole. This actual image quality can only be guaranteed during production and assembly where the very tight tolerances and adjustment methods demand workmanship of the highest level.

The image quality of the LEICA VARIO-ELMARIT-R 28-90 MM F/2.8-4.5 ASPH is generally above what one expects from high grade fixed focal lengths and the focal length range secures it a premium role in the Leica R lens range.

LEICA VARIO-ELMARIT-R 28-90 MM F/2.8-4.5 ASPH

image: Oliver Richter

Leica R-Lenses

by Erwin Puts

March 2004

Chapter 8: 28 mm lens

__ LEICA PC-SUPER-ANGULON-R 28 mm f/2.8

Introduction

The main differences between the film-based photography and the photography based on electronic image capture is the division of labour and the status of the analogue negative and digital image file. In film-based photography the negative (or slide) is the final result, which can be changed only slightly by darkroom processes. The digital image file on the other hand is the basic raw material for extensive digital manipulation with the computer. This fact forces the photographer to adopt different working methods.

In analogue photography (s)he must visualize and think about the final image before making the picture. Then the scene must be arranged and composed, the lighting set up and manipulated and all other technical and artistic details considered at length before the shutter is tripped. With the method of electronic image capture there are many more degrees of freedom at the picture taking stage, as the software for manipulating the image has an almost unlimited potential for correction and change.

It is evident that the result may be identical in both worlds, but the approach is fundamentally different. With film, the creative process is activated and finished before making the picture and can be extended at best till the moment of exposure. The potential for manipulation after the picture has been made is limited. For slides there is hardly any possibility. Here the picture is the final result. In the darkroom, we are able to influence the printing process and change the quality of the negative. With dodging and burning, split grading and choice of gradation and chemicals, there are numerous and important ways of changing the basic negative. But the digital manipulation is easier (not faster!) and has a larger range of image transformations.With electronic image capture, the creative control extends beyond the capture stage (often it begins just here) and is even unlimited in time after the picture has been made.

There is a growing trend in the world of film-based photography to choose the large format camera as an antidote to the hurried style of taking pictures that is often the mark of 35mm photography. The careful consideration of a scene and theme and the planning of a picture, technically and artistically, add a new dimension to the style of the photographer. As with many works of art, the way of making the work is often as important as the content for the final result.

The large format camera is the ultimate in flexibility and can be used to manipulate depth of field, perspective and to control the plane of picture sharpness. In film-based photography the studio camera (or technical camera) is a necessary tool, when you need to control and manipulate these aspects before taking the picture. The mastery of the large format camera is not easy and it is a clear token of craftsmanship to be able to use such a tool to good effect.

Outside the studio, the large format can be very effective as a documentary tool. No one who has seen the moving pictures by Walker Evans of the period of the Great Depression can dismiss the large format camera as a static tool, suitable only for studio work.

The versatility of the 35 mm system is greatly enhanced when the possibilities of the large format camera can be added to its capabilities. In 1969 Leitz offered the PA-Curtagon-R 35 mm f/4 to its range of lenses. Where the Japanese competition offered shift and tilt options to emulate the movements of the large format camera, Leitz/Schneider limited the lens to the shift movement. The range of the movement was less than could be realized with some of the competition and the image quality of the PA-Curtagon was decent, but not impressive. PA stands for the German words "Perspektivischer Ausgleich" or Perpective Control (PC), the designation of the current lens. The LEICA PC-SUPER-ANGULON-R 28 mm f/2.8 (introduced in 1988) can be shifted in all directions and has an extension horizontally and vertically from 11mm and diagonally from 9.5 mm. The normal image circle for a 35 mm camera lens has a diameter of 43.2 mm and with the PC lens it is 62 mm. The maximum displacement is 19 mm, which explains the maker's recommendation to limit the useable shift to 9.5 mm in either direction (19 mm divided by 2 equals 9.5 mm). It is interesting to reflect on the fact that the 28 mm PC lens has almost the same image coverage as a 15 mm lens.

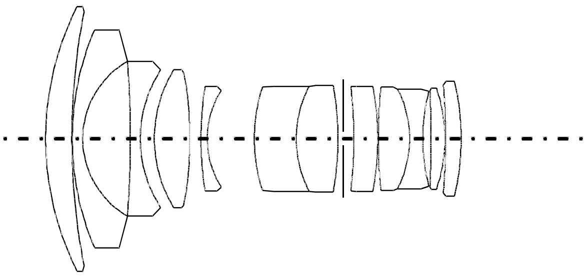
The obvious question is why the PC lens has only shift and no tilt possibilities. The tilt options in a studio camera are mostly used for close focus shots and in these situation the short focal length of 28 mm can offer only very limited support. A long focus lens would be needed in these situations. The tilt function is mostly used to extend the depth of field, but in a wide angle design, the depth of field is already quite large. Adding the tilt function to a wide angle lens, complicates design and has limited value.

The diaphragm is not automatic and must be stopped down manually by a lever that is convenient to use.
Sometimes the PC lens is seen as a gimmick. It is not: it is very potent lens for serious photography where the image and the perspective must be controlled in a tight way. Simply looking through the finder and turning the milled knob of the shift mechanism may generate amazingly intersting and inspiring viewpoints.

__ LEICA PC-SUPER-ANGULON-R 28 mm f/2.8

__Optical considerations

The LEICA PC-SUPER-ANGULON-R 28 mm f/2.8 has a complex design of 12 elements in ten groups, with a floating group in the front section to improve the image quality at close distances.



An evaluation of this lens should be based on the PC characteristics, as one would not buy this lens only as a normal 28 mm lens. In this case, the LEICA ELMARIT-R 28 mm f/2.8 is clearly the better choice. The PC-Super-Angulon-R lens, however, should be useable as a normal 28 mm lens and a comparison of the capabilities is of some interest. At full aperture the PC lens delivers a medium contrast image with good centre sharpness and a visible softening of the fine image details at the outer zones. The extreme corners are quite soft, but can handle about 20 lp/mm with good visibility ***(see image 1)***. There is a visible tendency to flare in strong back-lit situations.

Stopping down to 5.6 gradually improves the overall quality and now contrast has improved significantly and the outer zones can reproduce very fine detail (up to 100 lp/mm) with good edge contrast ***(see image 2 and 3)***. Optimum aperture is f/11where the image quality may be described

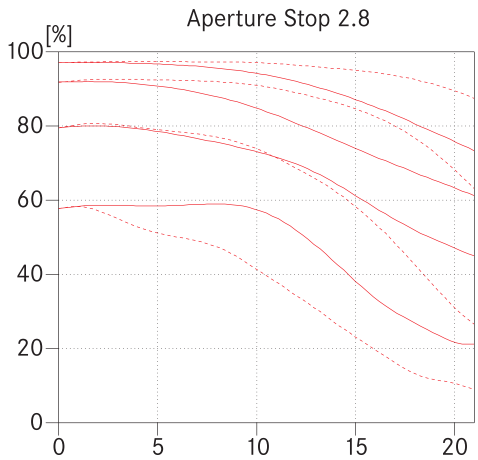


image 1

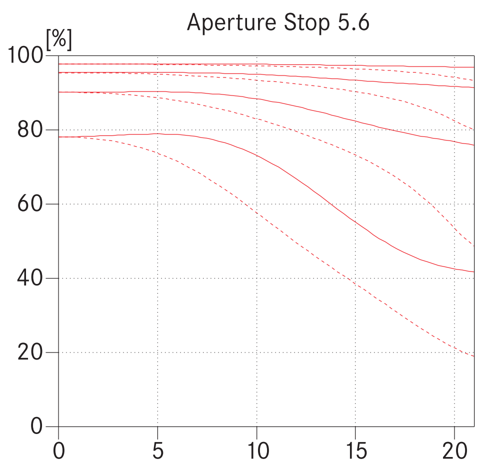


image 2

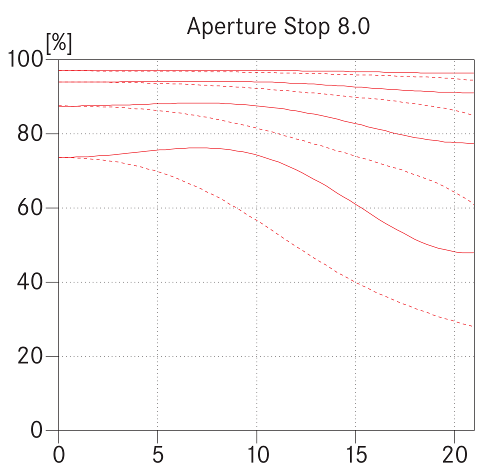


image 3

as outstandingly good. The edge of the image is still a bit weak, but can be used with full confidence.

Compared to the Elmarit-R 28 mm, the most noticeable difference is the higher contrast of the Elmarit and the crisper definition of really fine detail in the outer zones of the image, aperture for aperture. The differences are greatest at the wider apertures, and become very small at the optimum diaphragms.

It is at maximum extension that the PC-Super-Angulon-R delivers amazing performance. At f/2.8 (wide open) overall contrast is medium high with good edge sharpness at the lower frequencies. The image quality at the outer zones is very good with crisp rendition of fine detail over most of the image area. The corners, however, are not good, even close to unacceptable ***(see image 4)***. The MTF graphs are representative of the maximum quality you can expect. There is a tendency within the world of Leica photography to consider only the maximum figures and the maximum performance. If some lens has a resolution of 150 lp/mm and an MTF value of 80% for the reproduction of the fine frequencies around 40 lp/mm, this performance then is seen as the norm or every lens. In fact we are talking here of a lens with a quality of a very high order, that can not be realized with every design. We should realize that the MTF analysis for the 20 lp/m and the 40 lp/mm is at the limit of useable image quality and for most pictures we use only the lower frequencies, even when we want large-size pictures. If you would carefully analyse your own pictures in large format prints, or projected as slides, you would be surprised to find that the fine detail you see at these magnifications can be related to the 10 to 20 lp/mm in the MTF graphs.

The wide open performance of the PC-Super-Angulon-R is quite good. The major outlines of subject detail is well defined and allows pictures with high visual impact.

Stopping down brings the usual improvements and again at f/11 the best quality can be expected ***(see image 5 and 6)***.

Given the intended use of the lens, we may assume that in most cases small apertures will be used. The performance at these diaphragms and at moderate shifts is the real yardstick for this lens. When using low-speed film, a tripod and small apertures, we may indeed approach the impeccable image quality we expect from large format cameras.

Vignetting at the normal position is very low (1.5 stops) at maximum aperture and disappears quickly when stopping down ***(see image 7)***. In the maximum position the numerical value of 3.4 stops seems rather high. But my test pictures at aperture f/2.8 and maximum extension of 11 mm show a visually quite acceptable loss of luminance in the corners. As so often, we should not rely fully on the measured values, but translate them to the practical situations and the style of photography we want to implement. There are many pictorial situations where a slight darkening in the corners may be an advantage, as the effect will direct the main focus to the centre of the picture ***(see image 8)***.

Distortion is another matter. For a lens that will be used to photograph architectural structures and buildings, especially in the maximum shift position, excessive distortion will be unacceptable. The PC-Super-Angulon-R has a 3% distortion, both in normal and in extended positions. The shape of the distortion is however quite different. In normal position the distortion is not objectionable and often will not be detected at all ***(see image 9)***. In the position of maximum extension the distortion has a different shape (pin-cushion type of distortion) and may be quite visible in a number of occasions. Of course one must be very careful to align the camera to the subject plane very carefully and then it depends on the scene whether the distortion is acceptable. The maximum extension for best distortion control is 6 to 9 mm ***(see image 10)***.

The interesting question would be what is the better approach: a section enlargement of a picture, taken with the Elmarit-R 28 mm or a full enlargement of a picture taken with the PC-Super-Angulon-R at maximum shift. The main difference would be the higher contrast of the Elmarit-R and the improved definition of quite fine detail over the image area. The higher magnification would of course show slight distortions, camera movements and will also lower the overall contrast a bit. The additional possibilities of the PC lens give it the edge in this comparison and anyone who needs the shift capabilities of a view camera, should think of acquiring the PC-Super-Angulon-R.

__Artistic considerations

The PC-Super-Angulon-R is a lens designed with a special purpose. In the normal position it operates as a standard 28mm lens. The use of this focal length has been discussed in a previous chapter. The shift capability is the raison d'etre of this lens and we should focus on this aspect in our report. It is customary to approach the R8/9 camera as the reflex version of the M-camera. This is however a too narrow view. The rangefinder camera is eminently suited for the dynamic style of photography where a strong emotional relation exists between photographer and subject, but the M-camera can also be used in the studio as many outstanding photographers have demonstrated. To make the best use of the capabilities of the R-system, one is inevitably

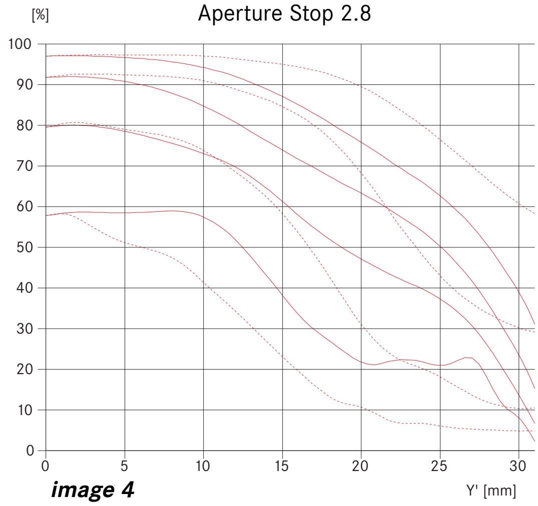


image 4

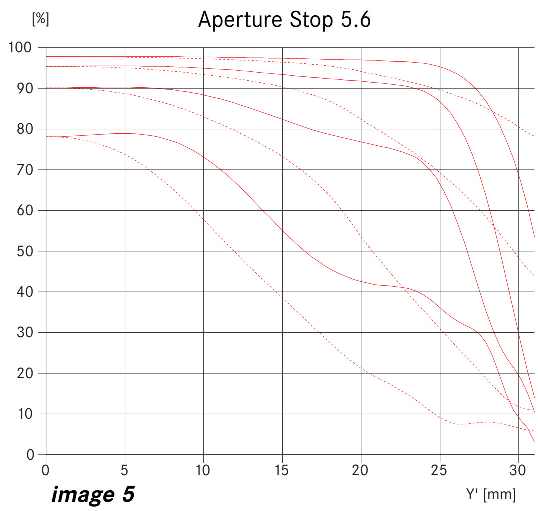


image 5

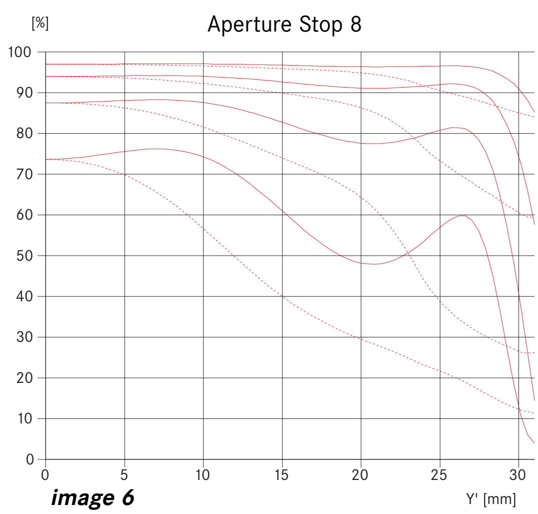


image 6

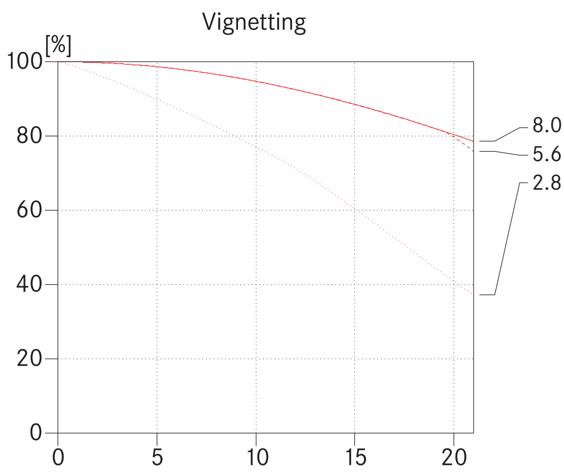


image 7

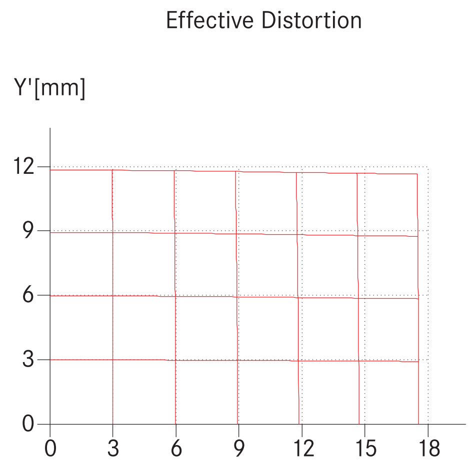


image 9

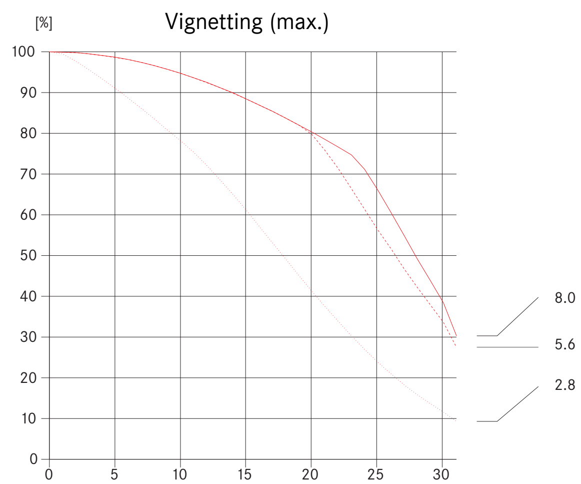


image 8

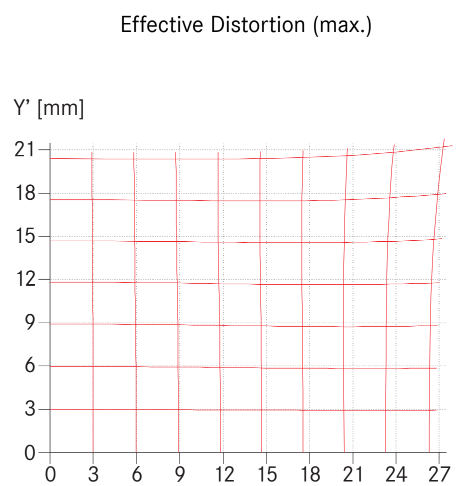


image 10

drawn to the comparison with the large format field and studio camera. As noted in the introduction, we can produce impressive documentary work (Walker Evans) when using the field camera. It is not a question of equipment, but of intention and emotion. The R-system is an excellent tool for documentary photography in all its incarnations and lends itself to the so-called considered approach to subject matter. The functional capabilities and the very high level of optical and mechanical precision of the R8/9, combined with the array of dedicated lenses, direct the R-user to the considered style of photography.

The PC-Super-Angulon-R adds substance to this approach. I used the lens handheld when doing street scenes and landscapes and industrial architecture. The lack of an automatic diaphragm and the sequence of focusing at wider apertures, manually stopping down the lens, exposure metering and tripping the shutter force you to take your time.

The most obvious use of the shift capability is the removal of unwanted foreground and the correction of camera tilt when photographing tall buildings. It is amazing how often a picture improves pictorially when employing a moderate shift. The shift movement of the lens is extremely smooth and gives a very solid feeling and thus a strong confidence in the quality of the picture. As discussed in the optical section, the lens is best used for images with visual impact, as exemplified by the great Dutch landscape painters. At moderate and close distances, the shift movement has additional and very interesting additional possibilities.

The lens movement is continuous in every direction and this can be used to photograph detailed objects, where angling of the camera would produce unwanted distortion. A simple example is the photography of a square box in close up.

With normal lenses, the perspective of the lens will show the box as a distorted shape with one corner pointing prominently into the lens. With the right movement of the PC-Super-Angulon-R one can find an angle that reproduces the box with a normal perspective. The horizontal shift movement can be used to remove unwanted reflections from a scene (pictures of shop windows as example). It can also be used to make panoramic pictures by overlapping exposures.

With the PC-Super-Angulon-R, the 35 mm photographer acquires the possibilities of technical movements that were reserved for users of large format cameras. When using the lens in normal photography, one becomes aware how often a picture can be improved by a moderate shift to correct falling lines, or small distortions by the fine control of perspective. It is also a lens that teaches you to observe the scene intensely and intentionally as you become more and more aware of the shapes and distortions of subjects. You can see it quite visually when using he shift movement and observing at the screen what happens. The lens can be used handheld, but the fine tuning of the perspective control can be better analyzed when the camera is on a tripod.

The additional advantage is the use of very small apertures and the extended depth of field. The lens stops down to f/22 and focuses till 30cm. At closer distances the maximum depth of field is required and the PC-Super-Angulon-R can be used without reservation at the smallest apertures, where crisp imagery is delivered.

The extended use of the lens allows for a gentle learning curve in a course for the study of technical movements. It may be an eye opener for any photographer who often takes pictures in a subconscious way. The shift capabilities of the lens bring a growing awareness of the subtle changes in shape and perspective and the impact of these changes on the final image.

__Conclusion

The LEICA PC-SUPER-ANGULON-R 28 mm f/2.8 is a very versatile and flexible tool. It can add to the R-camera some important technical movements of a large format camera and transform the R-camera into a 35 mm studio or field camera. The full implementation of all possibilities is of course impossible in a 35 mm camera system, as the design and construction of this type of equipment is quite elaborate. The PC-Super-Angulon-R is very sturdily built to support the optical qualities of the lens, even at its extreme positions.

The optical performance of the lens must be evaluated with the shift capabilities as major focus, as the lens is not

LEICA PC-SUPER-ANGULON-R 28 mm f/2.8 image: Sven Sturm designed as competition for a normal 28 mm lens. Indeed, compared to the current LEICA ELMARIT-R 28 mm f/2.8, the PC used as a normal 28 mm lens, needs to be stopped down to f/5.6 to become competitive. But this direct comparison is a bit unfair. You would not want to seriously test a sports car on its all-terrain performance.

Where the PC-Super-Angulon-R gets very high marks is in the area of perspective control. Here the additional visual impact of a picture is in many cases quite stunning. The versatility of the R-system is greatly enhanced by this lens. The image quality at the smaller apertures and in the moderate shift position is excellent and can be favourably compared with the quality you get form larger format field cameras. The lens can be used for technical and artistic purposes and is a great learning tool for training the visual awareness of the photographer.

Once you have learned to see with an eye to the differences in shapes and perspective that are available with small shift and tilt movements, the lens offers ever-expanding possibilities to improve the visual impact of your pictures.

Whetherthese possibilities in the technical and artistic sense justify the use of the lens, is the decision of each individual photographer.

LEICA PC-SUPER-ANGULON-R 28 mm f/2.8 image: Sven Sturm

Leica R-Lenses

by Erwin Puts

January 2005

Chapter 9: 180 mm lens

__ LEICA APO-SUMMICRON-R 180 mm f/2

__ LEICA APO-SUMMICRON-R 180 mm f/2

__General considerations

This lens was introduced in 1994 and was generally recognized as a lens with superior qualities. It is indeed a lens that redefines the famous Summicron quality and places it on a much higher level than had been seen before. The focal length of 180mm has been the acid test for optical manufacturers since the days of the Berlin Olympiad of 1936 when Zeiss showed the impressive Olympia-Sonnar 180 mm f/2.8. Since that day the performance of lenses has improved significantly, not gradually, but with period jumps. The LEICA APO-TELYT-R180 mm f/3.4 set the pace in 1975 with an, for that time, excellent image quality. The task to reduce the chromatic aberrations in telephoto-lenses to very slight proportions is a never ending story. It is well known that the major problem for this type of lenses is the presence of chromatic aberrations (longitudinal, that is, along the optical axis and lateral, that is, vertically across the image plane). The phenomenon of chromatic or colour aberrations has been explained in previous chapters. These optical errors are best seen at the edges of dark subject details against a bright background as coloured bands or fringes. Most often this halo is purplish, but other colours are possible. With a telephoto-lens the object is enlarged, but these aberrations are magnified as well. The classical approach is to correct the lens by making the focus points of two different wavelengths to coincide. Such a lens is called an 'achromat'. If we accomplish this feat for three different wavelengths, then the lens is claimed to be apochromatically corrected. Such a lens is close to the ideal state of correction. We must accept however that for the other wavelengths there is still a different focus and the sum of these aberrations is called the residual aberration or the secondary spectrum.

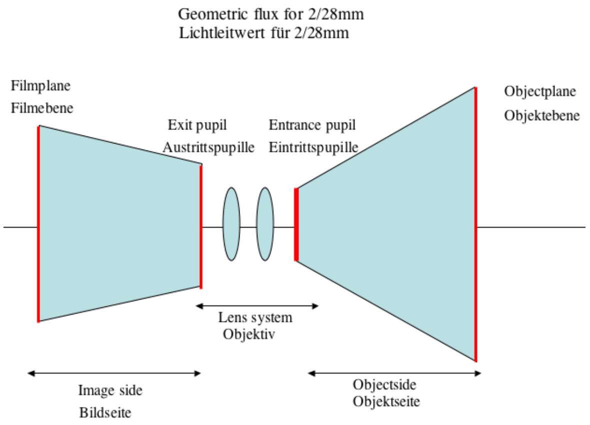
What we do not often realise is the fact that this correction is exact only for one specific zonal area of the lens. Let us return for a moment to the spherical aberration: we know that rays that fall on the lens at the outer zones of the lens are bent more strongly than the rays entering the lens in the centre. The rays from the outer zones are in focus in front of the image plane, and the rays from the centre (the axis) are in focus in the image plane itself. You may see the problem: if we want rays with two or three wavelengths to focus on the same location, we must choose one of several possible locations and by implication one specific zone of the lens (or image height). In other words: we have the 'simple' spherical aberration for monochromatic light, but the same phenomenon occurs for every wavelength. This more troublesome chromatic aberration is never discussed in the popular literature, but is very bad. It is called spherochromatism, but is also known as the variation of chromatic aberration with ray height and as the variation of chromatic aberration with wavelength. All three descriptions refer to the same phenomenon. Every wavelength corresponds to a different colour sensation. It is customary however to use seven well defined wavelengths (or colours) as the base for optical design and error correction.
The wider the aperture, the more troublesome the correction of spherochromatism becomes. The designer of the LEICA APO-SUMMICRON-R 180 mm f/2 had to face these challenges and needed to reduce the secondary spectrum to a small amount over the whole range of wavelengths in the visual band and for a very wide aperture.
The result is very impressive: at the widest aperture of f/2, the LEICA APO-SUMMICRON-R 180 mm f/2 is better than the LEICA APO-TELYT-R at f/3.4. The LEICA APO-SUMMICRON-R 180 mm f/2 does not improve on stopping down: the MTF values for the 5 to 20 lp/mm range do hardly change from aperture f/2 to f/8. At smaller apertures we see the usual drop in quality due to diffraction effects.

__Size of the lens

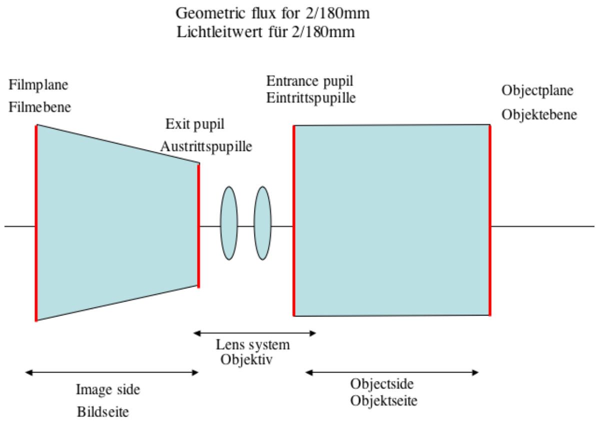
The optical performance is indeed quite impressive, but so is the size of the lens. The lens can certainly be used without a tripod and the ergonomically design does support this use. With 2500 grams the lens is not suited for prolonged handheld use. The lens is 176 mm long and has a diameter of 116 mm. That is only slightly wider than the diameter of the front lens. This diameter is 90 mm, that is focal length divided by aperture or 180/2.
In comparison to others with the same specifications, the lens is not a large one. The Canon EF 200 mm f/1.8 weights 3000 grams and has dimensions of 208 mm (length) and 130 mm (diameter). The slightly larger aperture explains the bigger dimensions. Note the shorter length of the Summicron, indicating a true telephoto design. We may note here that a physically shorter lens is more difficult to correct than a physically longer lens with the same focal length.

Would it be possible to design a more compact lens? To answer this question I have to introduce another new concept: the geometrical flux or in German; 'Lichtleitwert'. Photography is physically speaking nothing more than capturing the light energy that is radiating from the object. The lens has a certain angle of view with which the object is seen and isolated. The object radiates energy in all directions and the lens does capture a small part of this total energy flux, restricted to the angle of view of the lens. From the object to the camera lens we may imagine a cone of light or a light pipe through which the light energy streams from the object to the camera lens and through this one to the film. We can calculate the amount of energy by finding the size of the cone: the formula is quite complicated, and involves the length of the cone, the solid angle (the three dimensional version of the angle of view), the size of the entrance pupil and much more.
An optical system is among others characterized by its entrance and exit pupils. The entrance pupil accepts the light that is coming from the object and the exit pupil is the pupil where the light energy leaves the lens to be captured on the film plane. From the exit pupil to the film plane we see another cone of light with dimensions equal to the diameter of the film plane and the size of the exit pupil.
These relationships are graphically represented in figure 1 for a hypothetical 28 mm lens.

The shaded area on the image ***(see image 1 on next page)*** side represents the light pipe (geometric flux) from the film plane to the exit pupil of the lens. The shaded area on the object side represents the light pipe from object plane to the entrance pupil of the lens. These areas are almost equal in size, but that is only for purposes of clarity. If we were to calculate the exact amount of light energy we would note that the amount of light energy in both light pipes is the same. Here we disregard the effect of vignetting and transmission losses.



(image 1)



(image 2)

The important point is to understand that this relationship of equal energy holds for all lenses with the same aperture but of different focal length.
A moment's thought will show that we are here saying that a lens with the same aperture transmits the same amount of light whatever the focal length.
The size of the cone of light on the image side is always the same. The diameter of the film plane is always the same too. On the object side we must have the same amount of light energy, but now we can have different shapes of the light pipe. Size of the entrance pupil (or maximum aperture of the lens) and angle of view may be changed in relation to each other. For a 2/28 mm lens we have a small entrance pupil diameter (2.8 mm in fact) and a large angle of view (76). For a 2/180 mm lens we have a smaller angle of view (14), and must have a larger entrance pupil, in this case 90 mm.
(see image 2).

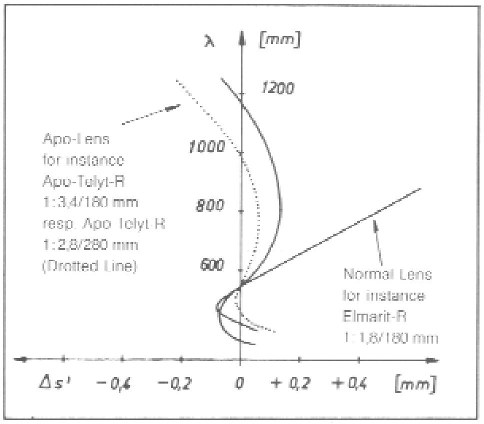
It is not possible to design a 2/180 mm lens with a smaller entrance pupil to reduce the physical dimensions. The upshot is this: if you need a large aperture telephoto-lens, you have to accept the physical dimensions that are required by the geometric flux equation.

__Diffraction limited

The LEICA APO-SUMMICRON-R 180 mm f/2 has an exceptionally good performance and is quite close to being diffraction limited. There is much misunderstanding when interpreting this claim. Officially a diffraction limited lens is a lens where the optical aberrations are reduced to zero and the image of a point has the diameter of the calculated Airy-disk diameter. The formula is R= 2.44 x wavelength x f/number (in radians). For the standard wavelength (yellow) and an aperture of f/2 the diameter is 2.68 micron or 375 linepairs/mm. Note that the diameter of the spot size depends on the wavelength. With other wavelengths (colours) the size of the spot is different. We should distinguish between a monochromatically diffraction limit and a limit that is composed of all colours.
Theoretically the use of colour filters in black and white photography can boost the resolution of the lens as we can block the colours that are spoiling the resolution. Most optical errors are reduced when stopping down the lens and performance of the lens improves simply by using a smaller aperture. If a lens has optical errors, we see the classical pattern : the lens improves when stopping down to the optimum aperture and then the image quality is degraded again but now as the result of diffraction: the bending of light at the edges of the diaphragm blades. A lens that is diffraction limited hardly improves on stopping down

The LEICA APO-SUMMICRON-R 180 mm f/2 can be classified as being monochromatically diffraction limited at aperture 5.6. At this aperture 270 lp/mm can be resolved, if we have a film that can handle this. Such a film does not exist and my own experiments indicate that a practical resolution of about 150 lp/mm is the best we can expect. In the case that some readers may be disappointed, I wish to note that this resolution implies a spot size of 0.0033 mm on the film!

You will have to enlarge the negative by a factor of at least 30 times to be able to detect this spot size.
But resolution is not all there is: contrast is evenmore important and here we can say that at 5.6 contrast is very high for the 40 lp/mm: around 80%! Stopping down from this aperture to 1:16 will reduce the resolution to 90 lp/mm and the contrast for the 40 lp/mm to about 55%.
The negative effects of stopping down too much can be clearly seen in these figures. The upshot is that you should adapt the choice of your film to the situation in order to avoid having to select too small an aperture! With the R8/9 and shutter speeds to 1/8000 you have ample choices!



(image 3)

__MTF values

Resolution is dependent on wavelength, but the MTF curves too are related to wavelength. Most manufacturers and several magazines now publish MTF graphs. It is hardly possible to compare these graphs in a direct manner.
There is a difference between calculated and measured graphs and between graphs based on a different spectral composition of white light. And you must know the optimum value of the linepairs used to calibrate the equipment. When calculating the MTF values you can use the geometrical or the diffraction limited MTF.

The first ones allow for larger spot sizes and give more favourable results. The spectral composition of the white light is also very important: if your lens is very good in the yellow region of the spectrum and bad in the deep blue part of the spectrum, you might use an MTF that disregards the deep blue section of the spectrum and you get better results than when you use the whole spectrum.
In most cases this information is not known and then the direct comparison is very tricky. It is best to compare only lens ranges within themselves to get a feeling for the relative performance within a range and avoid making comparisons across lens lines of other manufacturers.

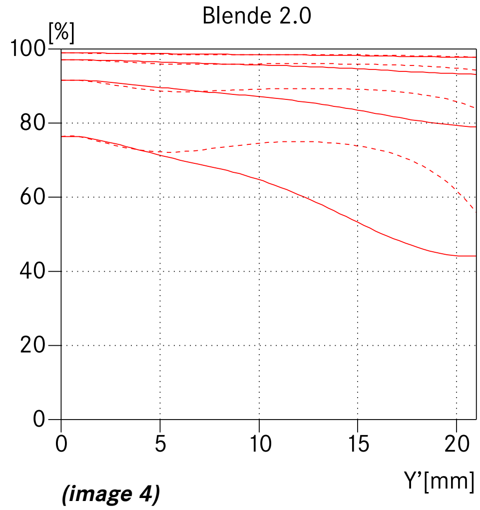
__Apochromatic correction.

What has been discussed above about the wavelength dependence of diffraction limits and MTF values, can be transferred to the notion of apochromatically corrected lenses too. The official statement tells you that an apochromatically corrected lens is a lens where three colours have been brought to a common focus. There is no discussion of the level of correction of all the other colours, or the secondary spectrum.

In the picture ***(see image 3)*** we see on the vertical line the different colours from infrared (top) to deep blue (bottom) and on the horizontal line the amount of residual colour aberration.
While it is important that the three colours focus to the common line, we see also that the rest of the colours are diverging from the line. The area under the curve (the dotted line) indicates the amount of residual aberrations or the secondary spectrum.
That is why some lenses, designated as being apo-corrected show a disappointing performance: the residuals are still too large! It is best to reduce the total residual aberrations to a minimum, even if this implies that we have to distract a little from the official definition.

A lens that is corrected for the smallest possible residual chromatic aberration needs very special glass of anomalous dispersion, carefully selected to cancel out all colour errors.

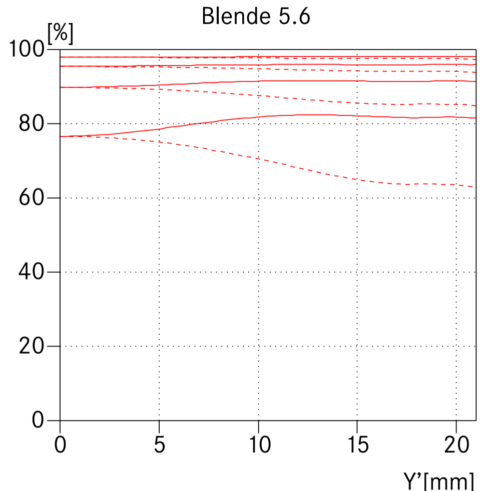
Often these glasses are quite sensitive to environmental influences. In the case of the LEICA APO-SUMMICRON-R 180 mm f/2 the front lens element is a bit sensitive and therefore the filter in front of the lens is really needed. Glasses needed for the apochromatic correction are sometimes sensitive to environmental conditions, but the special characteristics of the selected glass are needed for the high level of correction of this lens. They also add considerably to the weight. The total weight of the glass elements is more than 850 grams or about a third of the total weight of the lens.



(image 4)

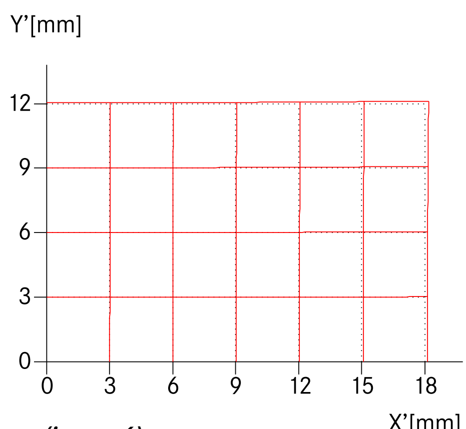
__Optical considerations

If we accept the Summicron designation as the embodiment of optical performance, we may safely state that this LEICA APO-SUMMICRON-R 180 mm f/2 is the best Summicron ever designed as of this date. Period. It really is the benchmark lens for all Summicron designs and even surpasses the already famous LEICA APO-SUMMICRON-M 90 mm f/2 ASPH. You may with some reason argue that a 180mm has a narrower angle of field, and is therefore easier to design. But on the other hand the enlargement of the chromatic errors more than offsets this 'advantage'. The size of the lens elements requires a very high level of accuracy in machining, quality control and assembly.
At full aperture the image quality is superb as can be seen from the MTF ***(see image 4)***.



(image 5)

The graph for the 40 linepairs/mm indicates a very crisp rendition of very fine detail over the whole image field. The contrast values seem to drop when going from centre to corner. This is a bit deceptive as in the extreme corner the values is as high as that of the Summicron 50 mm in the centre of the image! This comparison gives a clue as to what quality you can expect in the central portion of the Summicron 180 mm lens. At full aperture there is some tendency to secondary reflections, even if the light source is not directly shining into the lens. Here the use of the shade is very important. From f/2.8 the corners improve and are on the same level as the centre and a very uniform image quality can be expected. A careful comparison with the MTF graph for aperture 5.6 ***(see image 5)*** indicates the drop in contrast that is a characteristic of the influence of the diffraction effects.



(image 6)

The distortion is acceptably low with 1%, but for very critical work and big enlargements, it may be visible, depending on the subject matter. ***(see image 6)***

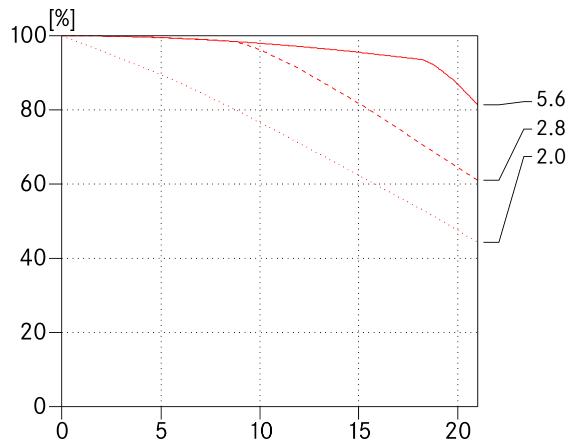
Vignetting is wide open visible with about one stop. Here we must carefully differentiate between the natural vignetting and the mechanical vignetting. The combined effects of the shape of the film gate and the bayonet mount add some vignetting at the upper and under sides of the film area. From 2.8 we see only the natural vignetting. The amount of vignetting is less when one focuses in the near range. At infinity the darkening in the corners is a bit more pronounced. Some stopping down will help.
(see image 7)

The 2x Extender can be used with full confidence at full aperture (but there is more vignetting), and the 1.4 Extender should be stopped down two stops for best performance. Imagine the use of the Summicron 180 lens with 2x Extender and the forthcoming Digiback, with a 1.4 focal length extension. Then we should have a high quality f/2/500mm, ideal for many subjects and purposes.

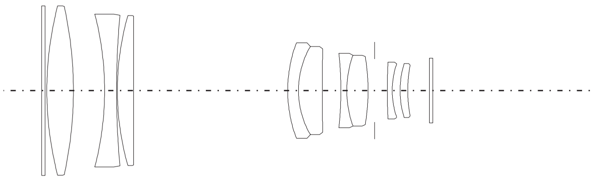
It goes without saying that it is not simple to extract the inherent optical performance from this lens. Only careful focussing, vibration free exposure and the best possible film technique will allow to exploit the quality. A stable tripod, additional weights on the camera body and lens are all helpful. There are no ready-made receipts here. You must and should experiment. Try to avoid the shutterspeed range from 1/60 to 1/125 with the non-R8/9 bodies as at these speeds the camera body has high frequency vibrations.

With 9 elements, the lens has a clean design. The use of special glass not only adds to the weight ***(see image 8)***, but also has a larger amount of thermal expansion. In big temperature changes the bigger glass elements expand and cemented elements are not possible. The second and third elements seem to be cemented in the drawing, but that is not true. There is an air space of about 0.10 mm that cannot be drawn on this scale. The thermal expansion is the argument for the fact that the focus ring can be set beyond infinity. This is not provided to help find the infinity focus, as sometimes is suggested, but to accommodate the thermal expansion. When we talk about substantial temperature differences, we are thinking of a difference of 40 degrees Celsius, which occurs when the lens was in the heavy sun in the car (about 60 degrees) and then is used in open space (20 degrees).

The lens diagram also indicates the mechanism of internal focusing. It makes a big difference if we have to provide internal focussing for a small sized lens or for a big one like the Summicron 180 mm. The movement of the lens group is about 15 mm and this has to be done with great accuracy and smoothness. The focussing movement of the lens is indeed butter smooth. And that is a real mechanical accomplishment.



(image 7)


(image 8)

__Artistic considerations.

A look at the depth of field table shows that at full aperture and at close focus the depth of field is less than 1 cm! The sharpness gradient is very smooth and the excellent quality of the sharpness plane provide for a very intriguing representation of the subject matter. The focal length of 180 mm is an outstanding choice for portraiture and spontaneous shoulder length shots. It has been rumoured that the lens was specifically designed to provide fashion photographers with a very creative tool for capturing atmosphere and beauty on the catwalk. The focal length of 180mm is much more useable and versatile than is often assumed. The high contrast wide open and the shallow depth of field do visually guide the eye to the major subject outlines and the excellent reproduction of details adds depth and clarity to the picture. The pictures made with this lens at full aperture show a rarely seen combination of image quality that one expects from a lens stopped down to 5.6 and the depth of field of a lens at aperture 2. With this lens one can play with the depth of field zone and by carefully placing the unsharpness zones in the correct subject planes, one can create startling compositions with great visual impact.
The gradient from sharpness to unsharpness is of course quite abrupt at the wider apertures, as the depth of field is quite limited. With a telelens all subjects are enlarged and the unsharpness blur is also enlarged. Pictures made with the LEICA APO-SUMMICRON-R f/2/180 mm benefit from this characteristic: the unsharpness planes are quite diffuse, and lack the harshness, sometimes associated with highly corrected lenses.
This behaviour produces images that focus the attention of the viewer very forcefully on the main subject without a distracting background or foreground. Especially enchanting are fashion style reportages in urban environments in early evening when the ambient light is mixed with street lights and the fast speed of the lens can be exploited without reserve. The carefully selected distribution of colourful light spots in the background can add immensely to the 'couleur locale' of the scene.

At medium distances the very high resolution and the compressed space add to the impression of being very close to the scene of action and almost being drawn into the scene.

The focal length of 180 mm is often associated with sports photography and landscape photography. In reality this lens is at its best as a portrait and human interest lens in the studio and on location, hand held or on tripod. With the suitable choice of focusing screen, the focus action is very fast and secure and here one does not have any disadvantage compared to the autofocus systems. In fact one is often more accurate!

image: Oliver Richter

__Conclusion

This is one of the best lenses in the R-system and arguably one of the very best lenses of comparable specification in the world. The very smooth handling, outstandingly good optical performance and mechanical stability provide the platform for photographic images of great quality and impact. The focal length is more versatile than is often assumed and the handling is much more convenient than the physical size suggests. This is typically a lens that should be used and experienced. The proof of the pudding is in the eating! It is one the few lenses that can deliver superior imagery wide open. The lens should not be used at very small apertures (beyond 1:8) unless the depth of field requirement asks for this aperture. At apertures from 2 to 5.6 the quality is impeccable and gives the discerning photographer a new tool for creative and high quality images, which go beyond the usual representational photographs. The lens needs some learning, as do all high quality tools and instruments, but the result is worth the effort.

image: Michael Agel

Leica R lenses

by Erwin Puts

March 2005

Chapter 10: Leica APO-Telyt-R Module System

LEICA FOCUS MODULE
280/400 mm f/2.8

LEICA FOCUS MODULE
400/560 mm f/4

LEICA FOCUS MODULE
560/800 mm f/5.6

LEICA APO-TELYT-R
280/400/560 mm

LEICA APO-TELYT-R
280 mm f/2.8

LEICA APO-TELYT-R
400 mm f/4

LEICA APO-TELYT-R
560 mm f/5.6

LEICA APO-TELYT-R
400/560/800 mm

LEICA APO-TELYT-R
400 mm f/2.8

LEICA APO-TELYT-R
560 mm f/4

LEICA APO-TELYT-R
800 mm f/5.6

__General considerations

Long focus lenses have contributed considerably to the fame and universal importance of the Leica system. The Telyt 400 mm f/5 was introduced in 1936 and captured the imagination of photographers by its ability to magnify the objects by a factor of 8, compared to the standard lens. You should understand that this ratio is related to the inherent magnification of the 50mm lens, and so is different from the 8x magnification you get with a 8 times binocular system: as example the LEICA TRINOVID 8 x 42 BN. With this focal length, the Leica system could cover an unparalleled range of subjects and photographic tasks. This Telyt was a very slow seller, but the Leica system as a universal photographic tool was firmly established. It is an ingrained feature of human nature to try to push the limits of the system a notch farther. During the growth of the Leica system, the maximum focal length climbed from 400mm to 560mm and in 1978 to 800mm.

The image quality of the first generation of long focus lenses is barely acceptable when we relate the performance to current demands, But this is not fair. We have adapted ourselves to the very high quality of modern Leica lens designs and accept as normal what is in fact exceptional. In those days the sheer excitement of being able to use a lens with these specifications far outweighed the lower level of image quality. When designing long focus lenses, several problems became evident. The optical limits (especially the chromatic errors), the handling, the focusing speed and the accuracy of the assembly all put a heavy load on the design specifications. Long lens barrels may introduce flare. The strong pumping action of the focusing mount may draw dust and moisture into the lens system. Atmospheric haze may degrade the image and a lens system with exceptional clarity and penetrating power is required. The bigger size of the lens can obstruct the speed of the focussing action. Several types of sliding focusing mount were introduced and the optical design changed from a telescope type of design (cemented doublets and triplets) to the highly developed eight-element-system of the Apo-Telyt-R 280 mm f/2.8 from 1984 and the eleven-element-system of the Apo-Telyt-R 400 mm f/2.8 from 1992.

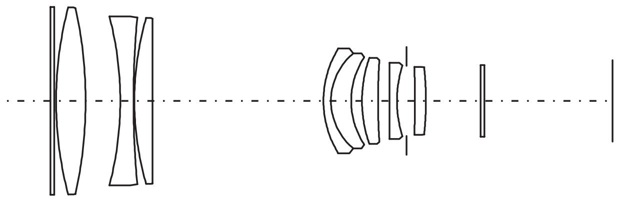
These lenses solved many of the problems mentioned earlier. But in one area there was no easy solution.
The photographer who is active in the areas of sport, nature, reportage or fashion, however will not limit his equipment to one single long focus lens. In many situations different lenses are required. The recording characteristics of these lenses (perspective, angle of view, near focus limit) will match with a specific range of photographic tasks, but they have to be seen as specialist lenses as compared to standard or wide angle lenses. The Apo-Extender solution gives already the possibility to change the focal length with a factor of 1.4 and 2.0, but a certain loss of contrast and therefore image quality has to be accepted, especially at the shorter distances.

If a photographer needs more than one lens in the range from 300 to 800mm, cost and weight may become quite high. The Apo-Telyt-R module system has been designed to reduce cost when investing in a selection of long focus lenses.
This range of focal lengths allows for really exciting and

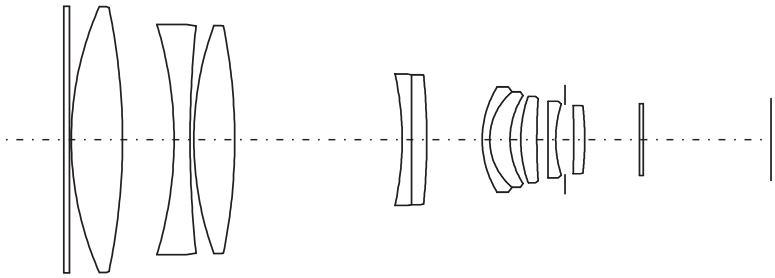
and fascinating photography. Anyone who has used binoculars with a magnification of eight or ten times, will recognize the pleasant chock of surprise when being able to see subjects at a larger distance with great clarity and full of intriguing details. "Impossible" pictures are within reach of the photographer using the module system. As with binoculars, one learns to search for subject details and image composition with a very narrow angle of view, which is a kind of visual discipline one has to appreciate and get accustomed to.

__Optical considerations

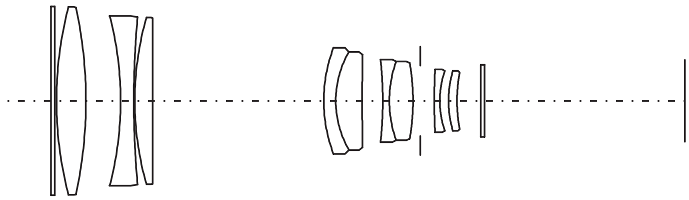
The normal optical system (the lens with a fixed focal length) has a fixed number of lens elements, and all of them have a fixed distance between them. A zoom lens has a fixed number of lens elements, but here the distances between elements can change. A third category of designs is the multi-configuration design. Here the number of lens elements do change, but the distances between them are fixed. The Apo-Telyt-R module system belongs to this last category. The multi-configuration design has nothing to do with the so-called convertible lenses (Satz Objektive). In this latter design we encounter two lens elements or doublets (A and B) with almost identical specification, but different power of magnification, that can be used together or separately, delivering three possible configurations (A, B and AB) and therefore three different focal lengths.
The starting point of the Module system was the layout of the Apo-Telyt-R 280 mm f/2.8 and Apo-Telyt-R 400 mm f/2.8. The former has a front group of three elements and a second group of 5 elements. The 400mm system has a front group of four elements, a middle group of two and a third group of 5 elements, including the lens group for the internal focusing. If we cut both lenses in two segments and regroup the front and middle section of the 400 lens, we see the contours of the module system. The three element front group of the 280mm lens becomes the smaller module head with 125mm diameter. The rearranged first and second group of the 400mm become the larger module head with 157mm diameter. The focus module 2.8/280/400 is derived from the last group of the 280mm lens. And the focus modules 4/400/560 and 5.6/560/800 are derived from the rear group of the 400mm lens.



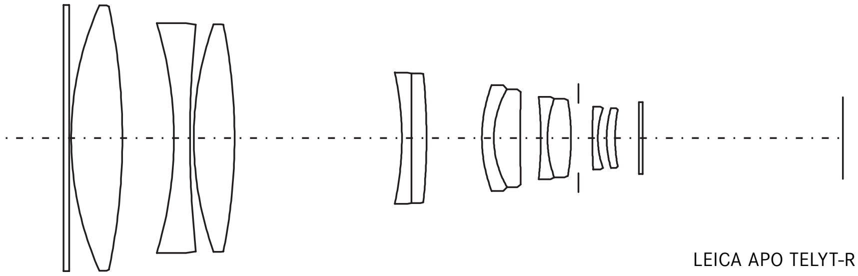
LEICA APO TELYT-R 280 mm f/2.8



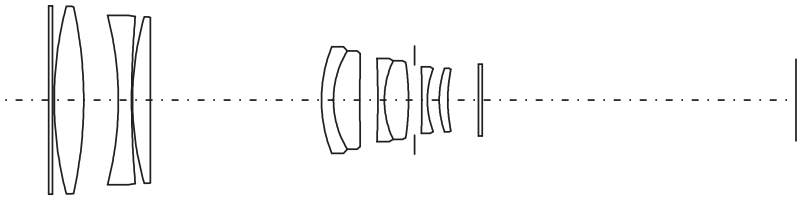
LEICA APO TELYT-R 400 mm f/2.8



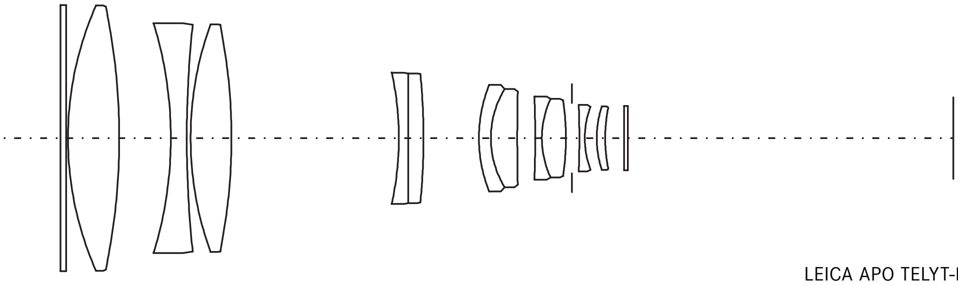
LEICA APO TELYT-R 400 mm f/4



LEICA APO TELYT-R 560 mm f/4



LEICA APO TELYT-R 560 mm f/5.6



LEICA APO TELYT-R 800 mm f/5.6

LEICA APO TELYT-R 560 mm f/5.6 / Photography: Oliver Richter

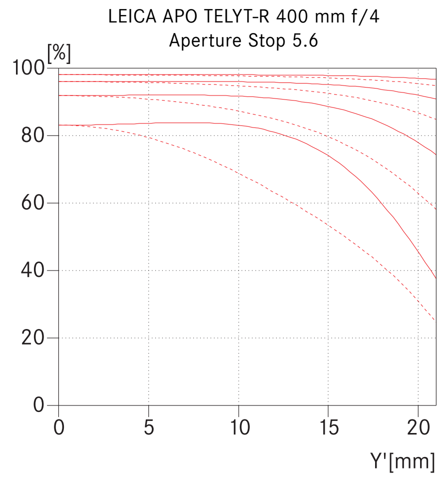
Compare the module versions of the Apo-Telyt-R 280 mm f/2.8 and Apo-Telyt-R 400 mm f/2.8 with the original 280 and 400 designs and you will discover the close resemblance. The three focus modules have relative magnification factors of 1, 1.4 and 2, a progression that is identical to a lens with fixed focal length and the two Apo-Extenders.

All combinations of the module system can be used with the Apo-Extenders and in theory you could create a 1:11/1600mm lens. But this combination is beyond the usability limit. Most photographers accept a 1200mm lens as the most extreme focal length for photographic purposes. Up till now I have used the generic term of long focus lenses to describe all lens designs with a focal length above 300mm. To be more precise, I have to add that the Module system is a telephoto design and falls in the category of super-telephoto lenses. All lenses with telephoto design have a physical length that is less than the focal length. But in the case of the Module system the lens units are really compact. The 800mm as example has a length of only 442mm. The small size helps making pictures in severe weather conditions as the low wind resistance profile reduces shake and vibrations. The design of a multi-configuration system has been described above as a kind a simple task. In reality this design is exceedingly difficult and must be done for a large part by hand. In this case the computer plays a relatively minor role in optimizing the system. The designer of the Module system had to study and experiment to find the best solution that had to searched for in a long and laborious process.

When studying the MTF graphs, we note an exceptionally high overall quality. You will discover that as a general rule the fine and the very fine tangential structures or lines show a lower contrast than the sagittal structures or lines. If we imagine a bicycle wheel as object, the sagittal orientation corresponds to the spokes of the wheel (also called the radial orientation). The tangential orientation corresponds to the rim of the wheel (also called the meridional orientation). The result of these different orientations implies that if the spokes are sharp, the rim is not and when the rim is sharp, the spokes are not.
Several lens configurations of the Module System show this phenomenon of a lower contrast of the fine subject detail in the tangential orientation or direction. This lower contrast is the result of some small residual aberrations: we see at very large magnifications in projection or prints a trace of lateral chromatic aberration. We are familiar with the fact that the colours of the spectrum do not focus at the same image plane: the familiar chromatic error. If this error is corrected, we may designate such a lens as apochromatically corrected. But we have a related error: when the several colours do not focus at the same image plane, every colour has its own focal length. This is logical. Focal length is defined as the distance from the lens (in fact the nodal point) to the focal plane or image plane. But we also know that focal length defines the magnification power of the lens. If several colours have different focal lengths, they also have different magnifications. The focal length distance is measured along the optical axis (the axial direction). The magnification is measured along the height of the image plane (the lateral direction). The apochromatic correction implies that three different colours are focused at the same image plane (axial direction). There are always some residual errors in the system, the so called secondary spectrum. These may manifest themselves as very small colour fringes in the lateral direction.

A very detailed description of the lens performance of all module combinations at every aperture is beyond the scope of this chapter. It is not necessary to do this. A glance at the MTF diagrams does indicate that at aperture 5.6 all combinations perform at an optimum level. Especially noteworthy is the excellent contrast at the 5,10 and 20 linepairs/mm. In most cases, the values are between 90 and 98% over the whole image frame. This performance will translate into extremely sharp pictures, with very clean and crisp definition of the small subject details. The high contrast at all frequencies and the apochromatic correction can cut through atmospheric haze and heat turbulence of the air in long distance shots. Excellent and neutral colour rendition is guaranteed by the high level of transparency at all colours of the spectrum.

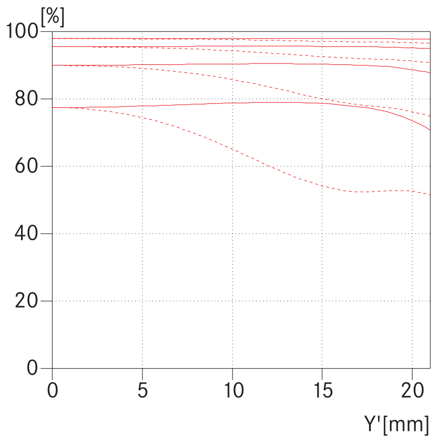
As exemplary we may describe the performance of the Apo-Telyt-R 400 mm f/4. In this case even the contrast of the 40 linepairs/mm is close to 90% over a large part of the image plane at full aperture. At 1:5.6 the outer ones improve and an exemplary performance is delivered.



The drop at the outer zones is hardly significant for most type of photographs. As a comparison, we may refer to the original 400mm f/5 lens from 1936. In this case we have a contrast of less than 90% for the 5 linepairs/mm and 20% for the 40 linepairs/mm.

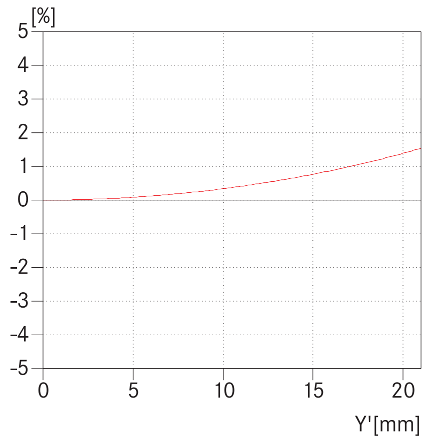
The Apo-Telyt-R 280 mm f/2.8 at aperture 5.6 shows slightly lower contrast values when reproducing the finer subject details compared to the Apo-Telyt-R 400 mm f/4.

LEICA APO TELYT-R 280 mm f/2.8
Aperture Stop 5.6

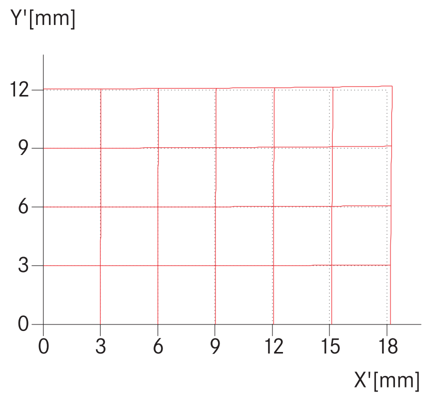


At aperture 2.8 there is hardly a visual difference, indicating the high quality of the lens system. The positive aspect of the provision of MTF graphs is the ability to study the performance one can expect from a lens. But the negative aspect is the possibility of laying too much significance on certain numerical values. A drop of contrast from 80% in the centre of the image to 50% in the corners seems a big drop. Numerically this is true. But a contrast of 50% at the edge of the image is undoubtedly an excellent, if not outstanding result. Lenses with narrow angles of view do not suffer from the usual optical aberrations as coma or distortion. You will search in vain for these errors. The exceptional clarity of the image details over most of the picture frame may be in part attributed to the absence of these aberrations. The module system of lenses in general have hardly vignetting and distortion: the Apo-Telyt-R 400 mm f/2.8 has respectively less than one stop and 1.5%. Identical values we see at the Apo-Telyt-R 280 mm f/2.8.

LEICA APO TELYT-R 400 mm f/2.8
Relative Distortion

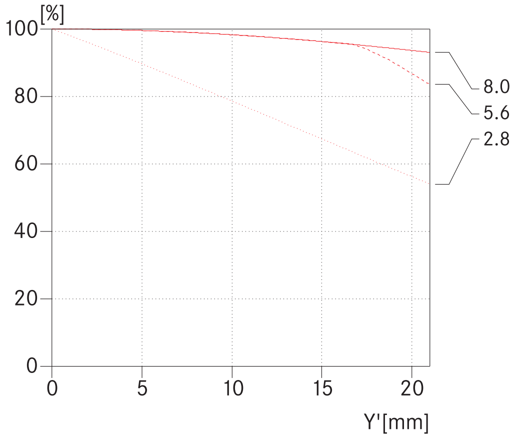


LEICA APO TELYT-R 400 mm f/2.8
Effective Distortion

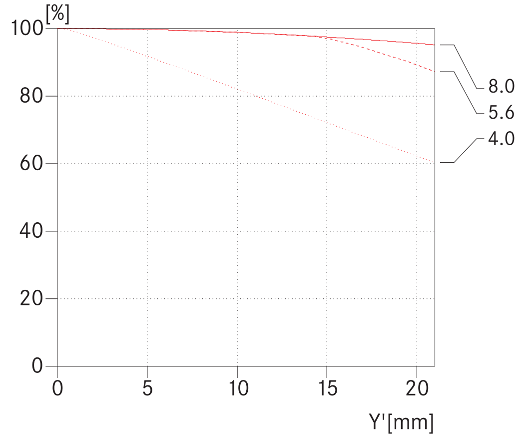


Photos: LEICA APO TELYT-R 280 mm f/2.8
Photography: Oliver Richter

LEICA APO TELYT-R 400 mm f/2.8
Vignetting



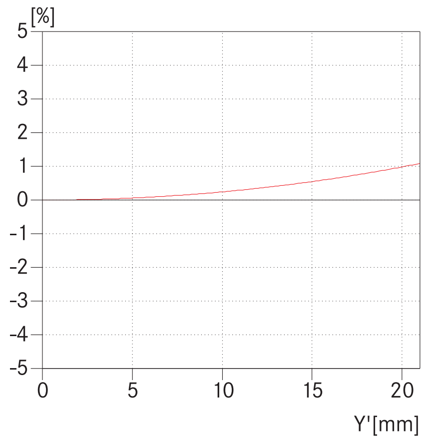
LEICA APO TELYT-R 400 mm f/4
Vignetting



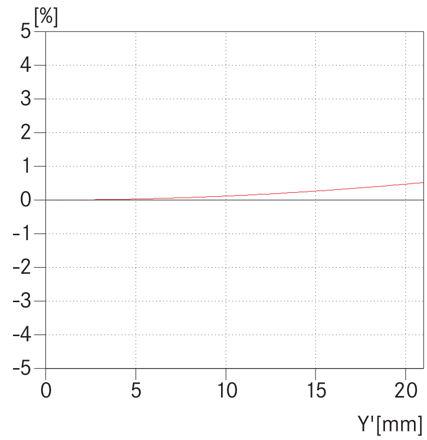
The Apo-Telyt-R 400 mm f/4, Apo-Telyt-R 560 mm f/4 have vignetting of much less than a stop and a distortion of 1%.

The best values are presented by the Apo-Telyt-R 560 mm f/5.6 and Apo-Telyt-R 800 mm f/5.6, Insignificant vignetting and distortion below 0.5%.

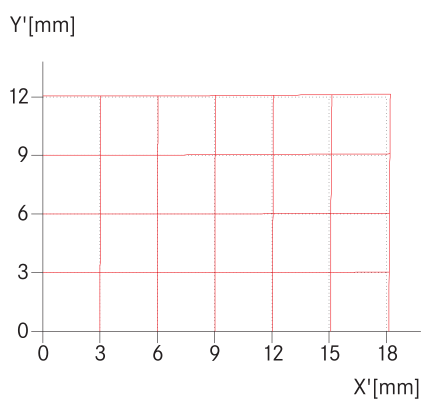
LEICA APO TELYT-R 400 mm f/4
Relative Distortion



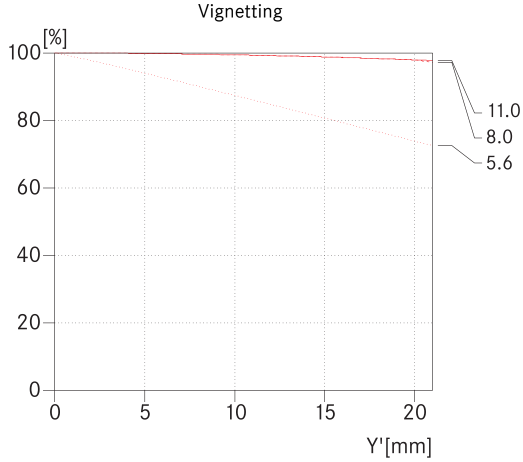
LEICA APO TELYT-R 800 mm f/5.6
Relative Distortion



LEICA APO TELYT-R 400 mm f/4
Effective Distortion



LEICA APO TELYT-R 800 mm f/5.6
Vignetting



Compared to the earlier lenses, the Module system delivers superior performance, especially at the longer end of the scale (the 560 and 800mm). If you only need one single focal length and restrict yourself to the 280 or 400mm, you have the choice to select the current 4/280mm with even better image quality at a reduced aperture or the older Apo-Telyt-R 280 mm f/2.8 does deliver equal performance as the module version. The older Apo-Telyt-R 400 mm f/2.8 has a slightly less crisp image at the wider apertures and here the module system shows a slight advantage.

Leica aficionados will undoubtedly have the original brochure of the Module system, in which the MTF graphs are displayed. If you compare these graphs with the ones now available on the Leica site, you will note that the older diagrams seem to indicate better results. Has the performance changed? Not at all: what has happened is a change in the calculation of the MTF diagrams. Previously Leica calculated the MTF values based on geometrical optics, which is somewhat simpler and will approximate the MTF that can be expected in the case of larger aberrations. Now Leica uses the more exacting diffraction limited MTF, which is better suited to the small residual errors that are left in the lens systems.

__Haptic considerations

Three observations are paramount when using the lenses of the Module system: they feel and operate with the utmost of sturdiness, they exhibit the smoothest focussing that I have ever encountered and they are extremely practical to use. Both aspects support the great precision that is needed when using the system. The depth of focus is very limited at the wider apertures, the ones that will be used most often. As example: the Apo-Telyt-R 400 mm f/2.8 has a depth of focus of 4cm at a distance of 5 meter and aperture f/2.8.

Even at a distance of 20 meters you have a bandwidth of 50cm, that is 25cm at either side of the exact focusing point. These values are of course calculated with the standard circle of confusion, which is simply too wide for the large sizes of the Leica pictures. In reality then he Do must be interpreted more strictly. For best results, the optical and mechanical requirements must match and support each other. Optically the lenses perform at optimum quality. Mechanically, the ability to interchange the module components freely puts a heavy load on the quality and finish of the mating surfaces of the components and the accuracy of the assembly. The price level of the module system

LEICA APO TELYT-R 400 mm f/2.8 / Photography: Oliver Richter reflects the engineering and optical quality you may expect to get. The internal focusing is superbly smooth. The sharpness plane snaps into focus on the screen and there is no insecurity during the focus movement. The many small details of the system show the experience of Leica with this type of lenses. You can set the shortest focusing distance anywhere between the available focusing distance and infinity. You can preselect the shortest distance where you want to focus as a minimum range. During picture shooting you can use the whole range of distances, but when something of interest happens at that particular distance you can jump to that distance setting with the near-focus stop. These lenses will often been used in extreme conditions where they meet more dirt and rain than photons. For these conditions, the lenses are prepared. Protection measures at all sensitive locations are provided. The Module system lenses feel as rugged as a Landrover, with which they will often be transported and they are capable of withstanding every abuse. When the photographer needs to make good pictures in extreme conditions, care for the equipment is the least of his worries.

It is possible to use the 280mm /400mm lenses handheld. It did it with the Apo-Telyt-R 400 mm f/4 system. I was prepared to see only fuzzy pictures. With about 4 kilograms, the lens is no featherweight. I was however amazed at the sharpness of the pictures when used at the more usual enlargements. Handheld shooting is not the best method to get the full quality of the lens, but it is possible. Prefocusing is necessary as you cannot focus and hold the lens stable at the same time.

It is evident that all precautions must be made to ensure a vibrationless operation. A high shutter speed, mirror lock-up and preferably a cable release are basic tools. For the rest (which tripod system, how to balance the system, etc) every one needs and will find his/her preferable solution. There is much conflicting advice in the handbooks and also in practical situations. My advice would be: experiment with several solutions and stop as soon the level of image quality that you want has been reached. Some photographers are always on the search to find an even better mousetrap, but it is the result you want that finally counts. The Module system lenses can deliver whatever quality you aspire to reach.

Leica R lenses

by Erwin Puts

March 2005
Chapter 11: 21-35 mm lens

LEICA VARIO-ELMAR-R 21-35 mm f/3.5-4 ASPH.

__ LEICA VARIO-ELMAR-R 21-35mm f/3.5-4 ASPH.

__General considerations

The zoomlens may be considered as the standard type of lens construction since a decade or two.

Photographers and cinematographers have always wanted to change focal lengths quickly and easily. The step from the thread mount to the bayonet mount was the first method in this direction. The turret with two or three different focal lengths was the next step and this was even offered for the Leica M camera. But a smooth change of focal lengths became only a possibility with the zoomlens. This type of lens is now the norm. The lens line up of one of the best known names in 35 mm camera production consists for over 50% of zoom lens designs. The Leica R lens catalogue shows that about 20% of the current lenses is of zoom lens design.

In cinematography and video cameras the zoomlens with large focal length ratio is ubiquietous. And the current crop of digital cameras is almost invariably equipped with a zoomlens with a ratio above 1:10. The optical performance of the first zoomlenses in the late fifties and early sixties of the previous century was quite mediocre. For a long time it was widely assumed that this design could never challenge the image quality of the prime lenses with fixed focal length. When you study the current lens designs, you may indeed wonder how it is possible that a single lens with 9 elements can cover the range of focal lengths between 21 and 35 mm, where the prime lenses need from 6 to 9 elements to cover one single focal length.

The answer is not so difficult to provide: better knowledge of the design problems, new glasses with special properties and/or with high refractive indices and the insight into the possibilities of aspherical surfaces allow the designer to create zoomlenses with great performance. The major factor for the good quality of the zoomlens is of course the relatively low speed of the lens. Doubling the speed of a lens implies a hefty increase in the impact of the optical aberrations. And any lens designer will tell you that it is not possible to reduce all these aberrations to a level that they are inconsequential in normal photography. You may comment that the new generation of digital cameras have zoomlenses that combine high speed and a large zoomratio. That is true, but to paraphrase a famous remark by Bill Clinton: it is the format, stupid! When the image area is small (16 mm movie film, APS format, 6x8 mm sensors), a high speed lens is less difficult to create, compared to the relatively large 35 mm picture size. Designing really high quality zoomlenses for the 35 mm format is not easy and when you add the requirement for high speed, it becomes quite a daunting challenge. Not only optically, but also mechanically. Increase the speed and the zoom range simultaneously and you are stuck with a very big lens that is not convenient to handle.

When you look at the lens diagrams of modern zoomlenses, you may feel impressed: many lenses have a very high number of lens elements, from 15 to over 20. And if you care to glance into other areas, the zoomlenses for videocameras may have more than 30 elements. The basic zoomlens however can be designed with only two elements. The focal length is changed by increasing or decreasing the variable air space between the elements. Then you shift the whole system to keep it in focus.That is not convenient and a second moveable element was added.

One element moves to provide the shift in magnification (focal length) and the second element moves to hold the focus. The relative movement of both elements is very non-linear and that causes he elaborate mechanical linkage of the moving elements. This is the basic principle of he mechanically compensated zoomlens. In a real lens, you do want not only to change the focal length and hold the focus, but also to correct the aberrations. The basic layout consists of a primary lens group that corrects the aberrations and a zoom group that is responsible for the other actions. The zoomgroup is often designed in the classical plus-minus-plus configuration. The original Cooke triplet is indeed a seminal design. The front lens element is used for focusing, the middle element for changing the focal length and the third element is the mechanically linked compensator for the focus position during the zooming action. This layout can be seen very clearly in the LEICA APO-ELMARIT-R 70-180 mm f/2.8. But in the more recent designs the construction is more elaborate and the relative movements of the lens groups are more interlinked. Here we see a natural evolution of knowledge and experience. It is not too difficult to create a lens with the current optical design programs. The optimization algorithms are very powerful and the manufacture of lenses is often highly automated. But the number of lens elements does increase often beyond necessity. The prime directive of the current generation of Leica designers is simplicity of design, based on a true understanding of the problems involved in a lens design. It is the basic principle of Lothar Kölsch, the former head of the optical department, that it does not make sense to try to optimize a lens, without a very good grasp of the inherent problem areas of a design. Pencil and paper are still the starting tools of the Leica designers as is creative understanding of the optical configurations. The quest for a design with minimal elements also supports that other goal of the Solms designs: every lens element must be mounted without any deviation from the intended location. The drive to assemble a lens without the slightest amount of decentring may be seen sometimes as obsessive, but it is this seamless integration of optical perfection and mechanical excellence that provide the fingerprint of current Leica lenses. The other side of the coin is a lens, that offers less features than can be found with the competition.

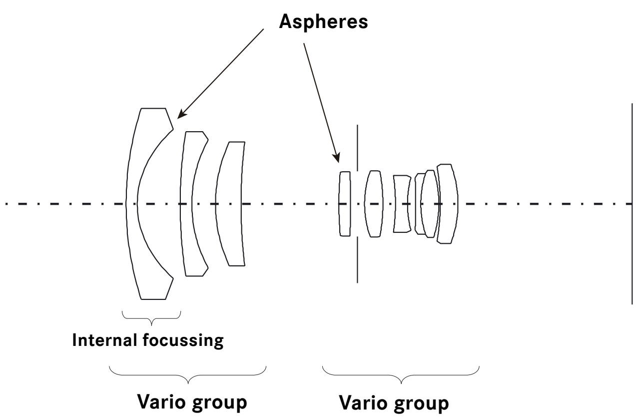
These considerations may be read as background information when discussing in general the philosophy of the Leica R zoomlenses. Compared to other well-known manufacturers and certainly when compared to the independent makers of zoomlenses, the specifications of the Leica zoomlenses seem quite modest. A lens however is the result of a series of conflicting demands: specifically a small size is very difficult to combine with excellent optical performance. And a compromise is then unavoidable.

Leica will never soften their focus on optical excellence, even if this implies that a lens may have specifications that are not up to what the competition does offer.

And the Leica users will have to accept this fact. One of the very charming consequences of this approach is the fact that every lens will perform in identical fashion.

__Optical considerations

The LEICA VARIO-ELMAR-R 21-35 mm f/3.5-4 ASPH. is a good example of this philosophy.

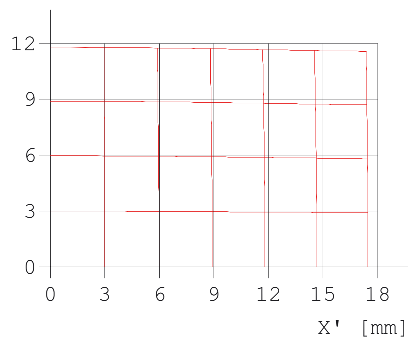


The lens has nine elements in eight groups and has two aspherical surfaces, both located before the aperture stop. The LEICA ELMARIT-R 24 mm f/2.8 has nine elements too, but is much less versatile and does not offer more image quality.

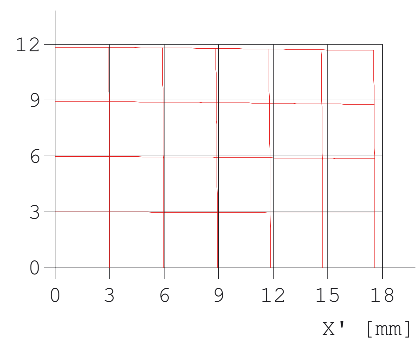
The design goal of the LEICA VARIO-ELMAR-R 21-35 mm f/3.5-4 was to provide a very compact lens with excellent performance over the whole focal range. One of the most pressing problems in a zoomlens is the distortion, which cannot be eliminated, but only distributed over the whole system. Here we have a part of the argument why Leica did not extend the zoomrange to 17 or 18mm on the wide angle side.

If we look at the distortion figures, we see that at 21mm the distortion is -3.5%, which is quite visible in architectural work and when there are straight lines at the outer zones and the horizontal edges of the picture. The distortion diminishes when changing the focal length to 35mm, where it is -1% (at 28mm it is -2%).

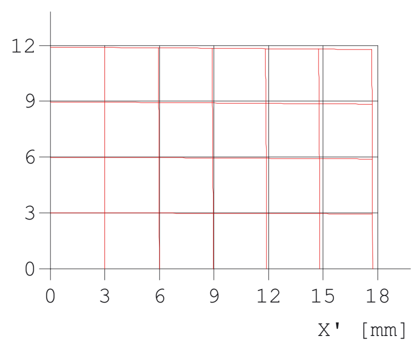
Effective Distortion
21 mm



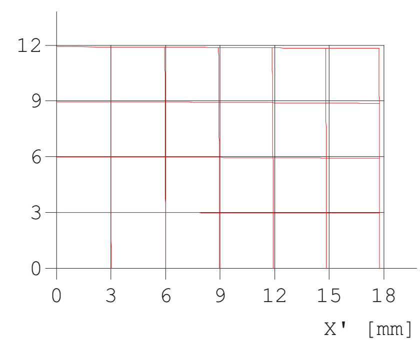
Effective Distortion
24 mm



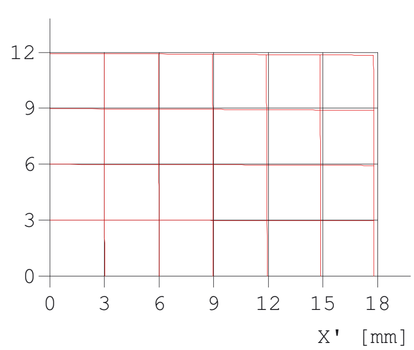
Effective Distortion
28 mm



Effective Distortion
31 mm

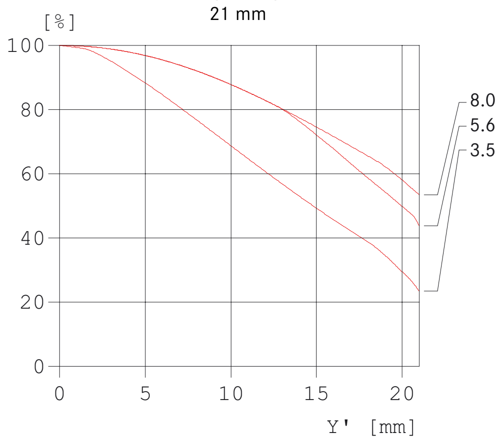


Effective Distortion
35 mm

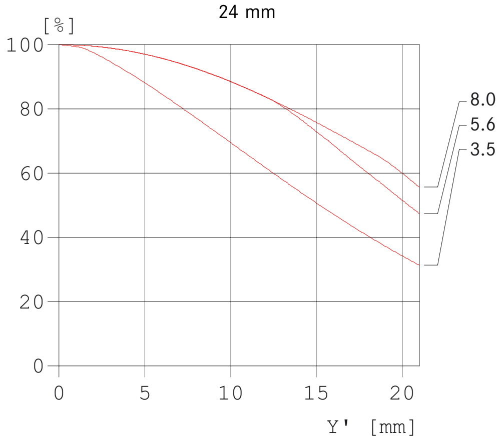


Vignetting varies from two stops at 21 mm to about one stop at the 35 mm position. Many persons are a bit amazed that the values for vignetting should be so high. In fact they are not. We may study current and older lens designs form Leica and note that in most cases the wide angle lenses have vignetting form around one to two stops at the wider apertures. This is not a typical defect in Leica lenses, but is the consequence of the cosine-to-the-fourth law. Total vignetting is the sum of artificial (mechanical) vignetting and natural (physical) vignetting. The mechanical vignetting can be reduced by using large lens diameters, but the natural vignetting is based on a physical law. It can be explained as follows. When we have a pocket torch and point it directly (with a straight angle) to a wall, we see a circular patch of light that uniformly illuminates that part of the wall. When we point at the wall from the same position, but with an oblique angle, the illuminated area is much bigger, but the illumination itself is less, because the distance has increased. Vignetting with wide angle lenses is a fact of life. It is at times very annoying and can spoil your picture, but you cannot eliminate the effect, only take care of the consequences.

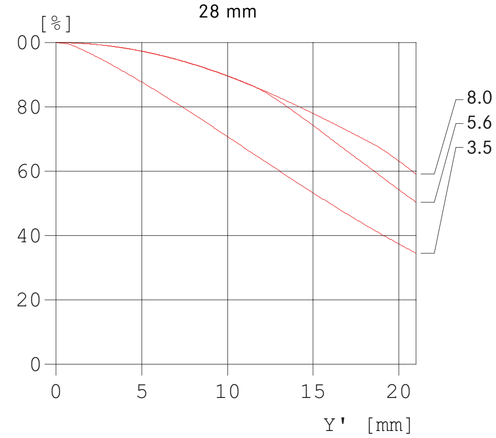
Vignetting
21 mm



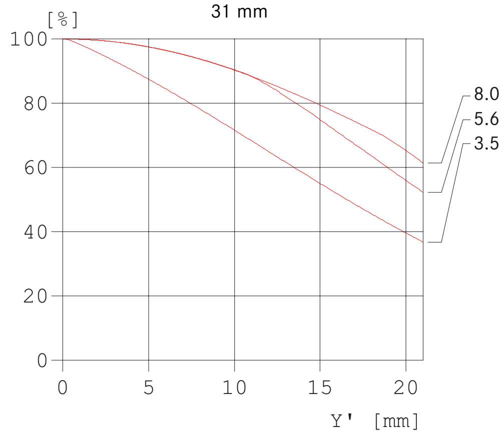
Vignetting
24 mm



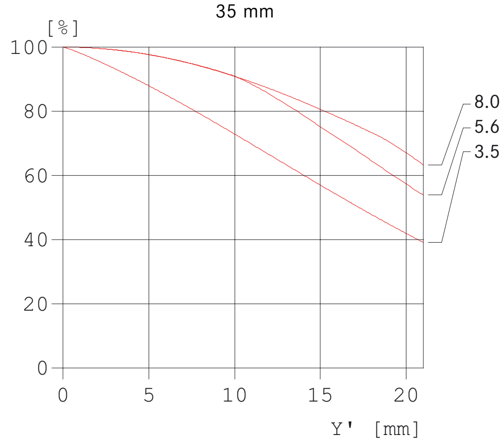
Vignetting
28 mm



Vignetting
31 mm

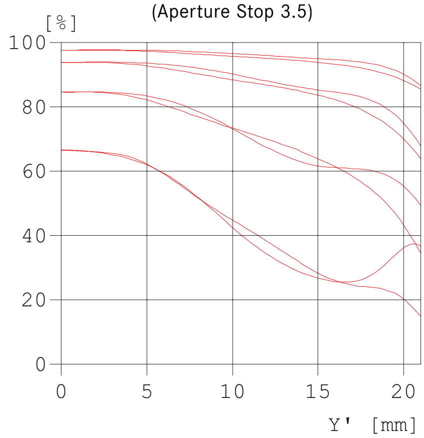


Vignetting
35 mm



The relatively low number of nine glass elements are one of the reasons for the excellent clarity of the pictures at full aperture. Careful treatment of the glass surfaces and very effective coating techniques are other reasons for a picture quality that surpasses the comparable fixed focal length lenses. Of course you cannot compare directly a 4/35 mm lens with a 1.4/35 mm. The design parameters are too different. But at comparable apertures the zoomlens has definitely the edge, especially in the outer zones of the picture. This is a general characteristic of the LEICA VARIO-ELMAR-R 21-35 mm f/3.5-4 ASPH. in comparison with the fixed focal lengths: the improved quality in the outer zones of the image. When you study the MTF graphs, you may notice two characteristics of the newer zoomlens: the tangential and sagittal curves are close together and the drop in quality at the edges is quite limited. Astigmatism and curvature of field are very well controlled and this should please most users, as they can use the full picture area without expecting a loss of quality. The Leica users who like smooth unsharpness gradients and picturesque background shapes (the bo-ke effects) may be slightly disappointed: the new LEICA VARIO-ELMAR-R 21-35 mm f/3.5-4 ASPH. does not produce harsh and brittle shapes in the unsharpness zones, but is does produce somewhat rough shapes.

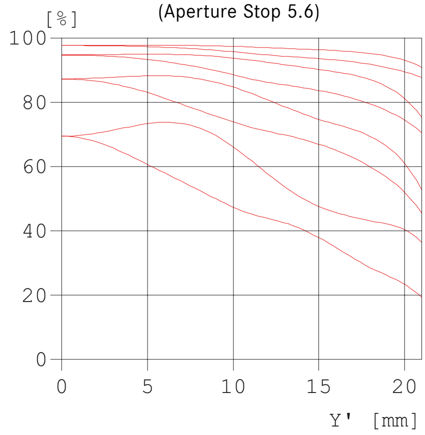
MTF - 31 mm
(Aperture Stop 3.5)



Colour fidelity is very good and colours are reproduced with natural hues. Even when using slide films with a warm balance, the colours are very pleasing.

Flare and secondary reflections are hardly visible, as is coma. With this lens, you can stop worrying about unpleasant surprises when shooting in demanding conditions and the choice of aperture and focal length is purely a matter of artistic consideration.

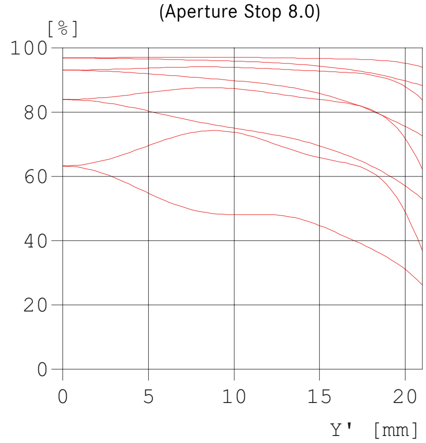
MTF - 31 mm
(Aperture Stop 5.6)



The high level of optical correction has pushed the residual errors to the margin as can be seen from the behaviour of the MTF graphs. There is a tendency in the internet user groups to diminish the information value of the MTF curves as being irrelevant to real picture taking, drawing a parallel to the resolution figures as a yardstick for image quality. It would be a pity if this approach to MTF graphs would become wide spread. Studying these curves is very informative: it will tell you at once that at all focal lengths, stopping down the lens has hardly any effect on the quality of the image. As example one may care to analyse the graphs of the 31 mm position.

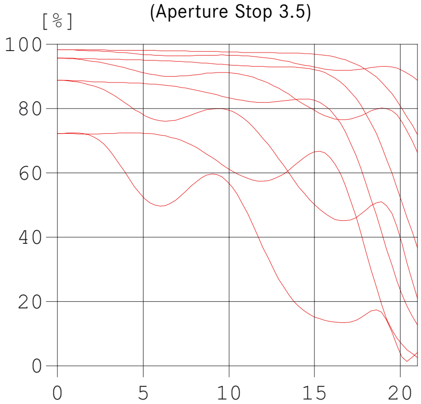
There is a high contrast image at full aperture, as can be seen in the closeness of the graphs for the 5, 10 and 20 lp/mm and the fact that all three graphs are above 9% contrast transfer. Micro contrast is excellent too as can be seen from the shape and location of the graph for the 40 lp/mm. At 5.6 very fine detail in the outer zones becomes quite crisp and edge contrast is very good too. There is no colour fringing at the edge of black-white borders. At 8.0 we note a slight reduction in overall contrast and some residual colour errors.

MTF - 31 mm
(Aperture Stop 8.0)

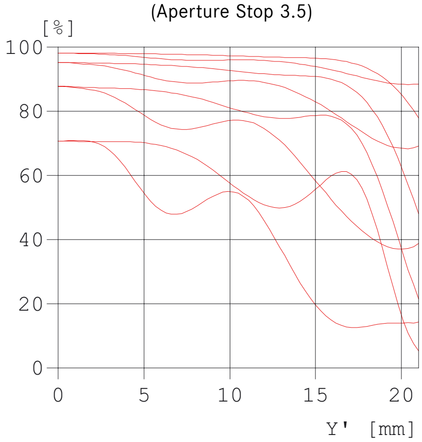


The best performance can be found at the focal positions from 28 to 31 mm. The 21 mm focal length is slightly softer overall and should be stopped down to 5.6 for best quality. This is especially true when making pictures in the near focus range.
A comparison of the MTF graphs at the various focal lengths and at full aperture indicate the evenness of image quality. The Leica broschure has a value of 1:3.5 attached to the full aperture at every focal length: in reality there is a progression from 21 mm (1:3.5) to 28 mm (1:3.7) and to 31 and 35 mm (1:4). The half stop difference is however not a problem in normal situations.

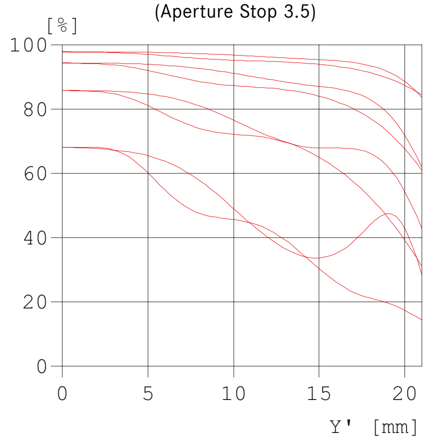
MTF - 21 mm
(Aperture Stop 3.5)



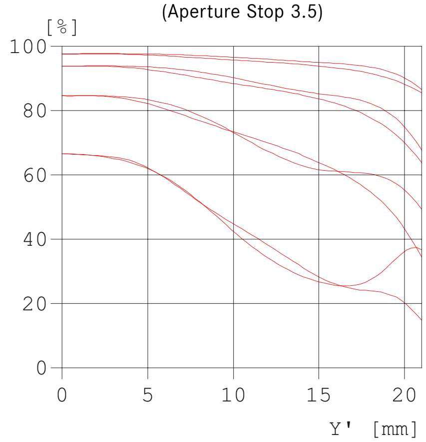
MTF - 24 mm
(Aperture Stop 3.5)



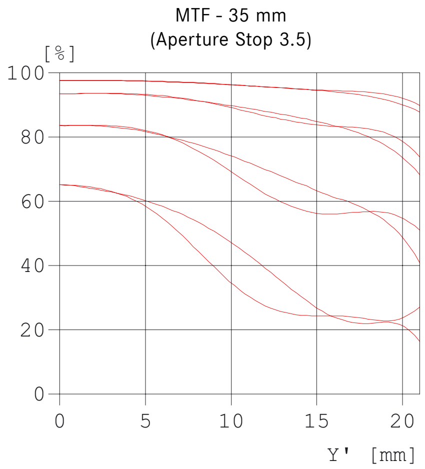
MTF - 28 mm
(Aperture Stop 3.5)



MTF - 31 mm
(Aperture Stop 3.5)



LEICA VARIO-ELMAR-R 21-35 mm f/3.5-4 ASPH.
Photography: Oliver Richter



Resolution figures, for whom it may concern, do vary from 70 lp/mm to 150 lp/mm, with the exception of the far corners, where we find values around 20 to 40 lp/mm.

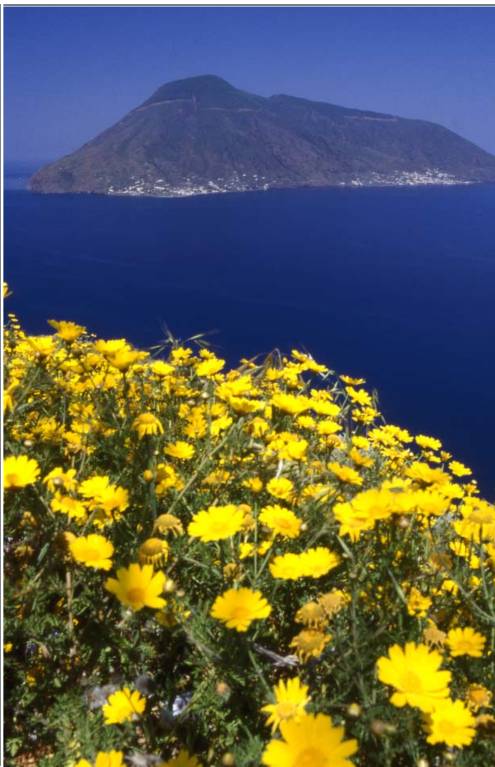
__Handling considerations

A compact lens with very smooth handling characteristics and relatively low weight, can not be constructed without the use of thin aluminium tubes for the focusing mount. A thick metal wall would increase the lens diameter and make the focusing less smooth. Compare the ease of handling of this 21-35 mm with the 70-180 mm vario lens.

Sometimes you may hear a complaint that the focusing mount can be distorted when putting a strong pressure on it, as when you lift the lens out of the camera bag with a strong grip on the front part of the lens. The mount cannot be distorted, it is too strong for that, but you can change the smooth movement by pressing hard on the mount and so increasing the friction. Some see this behaviour as a lowering of the manufacturing quality of the Solms products when compared with the rock solid mounts of the older Leica lenses with fixed focal length. This conclusion would be wrong: it is not a question of manufacturing quality, but of ergonomics and a more complicated combination of demands. The focusing movement of a zoomlens is very different from that of a fixed focal length lens. And the handling requirements of a zoomlens must be taken into consideration.

This said, we might notice that the LEICA VARIO-ELMAR-R 21-35 mm f/3.5-4 ASPH. is a delightful lens to use, with the solid smoothness of movement and positive clickstops we expect from Leica. When using the lens at the 21 mm position during street photography and group photography, you should try to avoid having persons at the edge of the filed, as they will be stretched horizontally to inelegant proportions. This is not the effect of the distortion mentioned above, but the result of the wide angle characteristics as explained in the chapters on the 15 mm and 19 mm lenses.
The comments made in the earlier chapters from 19 to 35 mm about the artistic considerations (perspective, relative size, and depth of field) apply for this lens too and should not be rehearsed here.

LEICA VARIO-ELMAR-R 21-35 mm f/3.5-4 ASPH.
Photography: Oliver Richter



__Conclusion

The LEICA VARIO-ELMAR-R 21-35 mm f/3.5-4 ASPH. has an optical performance that equals and in many cases surpasses the comparable fixed focal lengths and delivers very punchy images.

The 19 mm and the 28mm fixed focal lengths have an aperture of 2.8 and somewhat better performance and indicate that there is room for dedicated lenses. The LEICA SUMMILUX-R 35 mm f/1.4 is obviously the champion in low ambient light, but in other areas shows its age, as does the LEICA SUMMICRON-R 35 mm f/2. The older 21 design is of significantly lower contrast and the 24mm design can only compete on axis with the performance of the 21 position of the Vario-Elmar-R.

The focal range of 1:1.7 seems a bit on the low side and looks more limited on paper than it is in daily use. The range from 21 mm to 35 mm covers a very interesting range and should be able to help you create very potent pictures in the wider angle range from 90 degrees to 63 degrees. Especially if you are looking for close contact pictures with a sense of tightness and immediacy, this lens is very versatile and useful. You need to adjust to the lens characteristics in real photography and do not judge solely from first experiences or from paper specs.

The maximum aperture of 1:3.5 does seem to limit the deployment possibilities a bit, especially when using slow speed slide film. I am not so impressed with this type of argumentation. If you choose a film and a lens carefully, you do so with a specific goal in mind. And then the speed limitations are obvious, but can be countered by flash and/or a tripod.

Only when scrolling around on the search for a suitable subject, you may find yourself in a position where the speed of the lens and the speed of the film are at a mismatch. But then the human quality of improvising may be honed.

My only problem with the aperture of 1:3.5 is the brightness of the focusing screen, which makes accurate focusing sometimes difficult. In this respect Leica has to reconsider their technique of the focusing screens.

It is customary to designate this lens for landscape or reportage photography as the preferred areas, but this is too limited a view. Situational portraits, human interest scenes in close and tight quarters and everything that can be imagined by the photographer to benefit from a wider perspective at close distances can be captured with this lens. It is the photographer not the lens that defines the subject.

The LEICA VARIO-ELMAR-R 21-35 mm f/3.5-4 ASPH. is very pleasant to use, compares favourably to companion lenses of fixed focal length, has excellent to outstanding overall performance and gives the user a new range of creative possibilities. It is one the few lenses that has no weak points in performance or handling.

LEICA VARIO-ELMAR-R 21-35 mm f/3.5-4 ASPH.
Photography: Oliver Richter

Leica R-Lenses

by Erwin Puts

April 2005
Chapter 12: 35-70 mm lens

_ LEICA VARIO-ELMAR-R 35-70 mm f/4

_ LEICA VARIO-ELMAR-R 35-70 mm f/4

Background

The first zoomlens for 35mm cameras was introduced by Voigtländer around 1960 and named Zoomar with a focal length range from 36 to 82mm. The Zoomar was an American invention (USA Patent 2 454 686) and Voigtländer was quick to see its potential. In Germany the system was designated as Gummilinse (rubber lens) to focus on its primary characteristic as a lens with continuously variable focal length or variable magnification, which is the same idea. The design possibilities of a lens system with moveable elements were already known in 1902, when the first American patent was filed. The optical and mechanical complications are quite complex and it took a full generation before the first workable systems were introduced. Siemens was one of the first in Germany to create a zoomlens for 16mm cine cameras already before 1939, but the war made a large-scale commercialisation impossible.
The correction for optical aberrations has to very good over the whole range of focal lengths, but strictly speaking, this is only possible for one specific focal length, most often the middle position of the total range. All other positions will present some aberrations. It was necessary in the early period of zoomlens design to restrict oneself to the shorter focal lengths. The image quality will be negatively influenced when the focal lengths of the individual lens elements are short in relation to the overall focal length. The individual lens elements will have longer focal lengths if you build the lens as long as possible.
The large size of the early zoomlenses may be explained by this restriction.
Early zoomlenses had commendable performance, but could not approach the level of quality, one could get with fixed focal lengths.
The Zoom-Nikkor 1:3.5/43-86 mm initiated the breakthrough of the zoomlens as a standard lens and quickly became the favourite of the fashion photographers of the sixties. This lens displayed two remarkable characteristics: it was a high contrast lens with limited resolution and it had a high level of distortion. For optical designers it was a nightmare, but for the photographers it could unleash a new amount of creative freedom.
Leitz was quite reluctant to get involved in this area of zoomlens design. As an historical aside one may note that Leitz did have a large department for zoomlens design, but the results were limited to studies and prototypes.
The demand for zoomlenses was high and Leitz offered third-party products from Angenieux and Schneider as an alternative. Later Leitz cooperated with Minolta and offered from 1983 the LEICA VARIO-ELMAR-R 35-70 mm f/3.5 as a Leica branded lens. In 1990 Leica added the LEICA VARIO-ELMAR-R 28-70 mm f/3.5-4.5 to it lens range. This Sigma design displayed the same performance profile as the earlier Nikkor lens and as the Minolta design: medium to high contrast, limited definition of fine detail and fairly large distortion at the extreme positions of the focal range.

The Leica design team had a higher level of ambition and wanted to create zoomlenses at least as good as the Leica lenses with fixed focal lengths. To set such an ambitious goal is a formidable task, but in 1998 Leica introduced the superb LEICA VARIO-ELMAR-R 35-70 mm f/2.8 ASPH. (The first Leica designed zoomlens was the LEICA VARIO-ELMAR-R 70-180 mm f/2.8 from 1995).

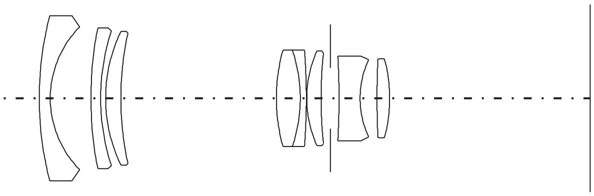
This lens demonstrated without any doubt that zoomlenses have the potential to provide image quality that is better than what can be accomplished with lenses with fixed focal lengths at comparable apertures. This is an important addition and for very high-speed lens designs, a fixed focal length is still the best solution. At least in a practical sense: it might be theoretically possible to design a very high-speed zoomlens with excellent quality, but the size and weight would be too large. The trend to digital cameras with smaller sensor sizes will present great opportunities for high-speed zoomlenses with excellent image quality.

The LEICA VARIO-ELMAR-R 35-70 mm f/2.8 ASPH. was the first lens that could substitute a range of lenses with focal lengths from wide angle lens and the standard lens to the moderate telelens without loss of performance. A very elaborate manufacturing and assembly process was required to ensure that the actual performance of the lens matched the design specifications. By now this lens has achieved a cult status within the Leica community and with reason.

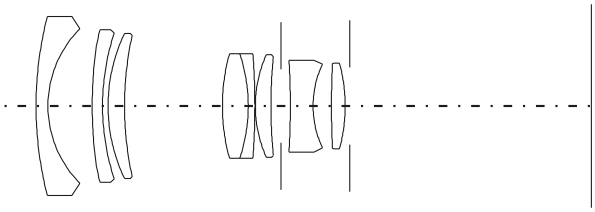
A year earlier, in 1997, Leica had introduced a lens with a maximum aperture of 1:4 and the same range (35-70 mm) that offered almost identical image quality in a more convenient package: the LEICA VARIO-ELMAR-R 35-70 mm f/4. For some reason Leica omitted the designation 'ASPH' for this lens, although it has an aspherical surface.

Optical considerations

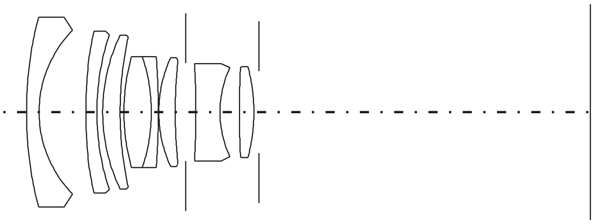
The LEICA VARIO-ELMAR-R 35-70 mm f/4 has 8 elements, arranged in seven groups. One lens element has an aspherically pressed surface. The lens diagram indicates the two main groups and one can see that the front group has a close resemblance to the front group of the LEICA VARIO-ELMAR-R 35-70 mm f/ 2.8 ASPH. and the second group is adapted from the previous LEICA VARIO-ELMAR-R 35-70 mm f/3.5. Casual inspection shows that the LEICA TRI-ELMAR-M 28-50 mm f/4 ASPH. is also closely related to the Leica Vario-Elmar-R, with the big difference that the M version has two aspherical surfaces.



Lens shape 35 mm



Lens shape 50 mm



Lens shape 70 mm

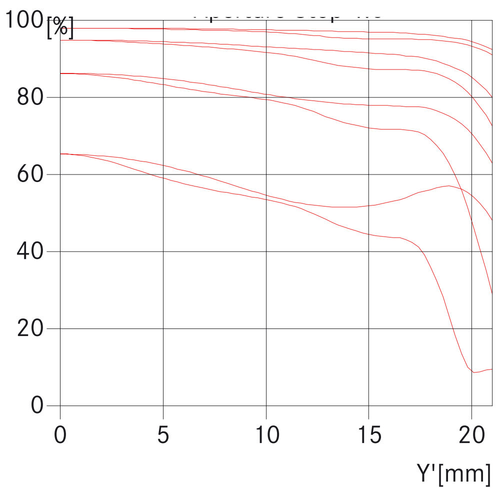
The comparison of lens diagrams should not be taken too far. A lens diagram gives a family resemblance and might even be seen as a lens genealogy. The most important aspects of a lens design, like the choice of glass and the employment of aspherical surfaces and the true shape of the surfaces, cannot be derived from the diagram as such.
In my report of the LEICA VARIO-ELMAR-R 21-35 mm f/3.5-4 ASPH. I have explained why current vario designs can deliver improved quality, compared to fixed focal length designs. To repeat the main points: better knowledge of the design problems, new glasses with special properties and/or with high refractive indices and the insight into the possibilities of aspherical surfaces allow the designer to create zoomlenses with great performance.

The first impression when looking at the pictures taken with the LEICA VARIO-ELMAR-R 35-70 mm f/4 with slide films or the current crop of colour negative films, is one of image clarity and pure colours. There is a hint of Matisse here with his use of clean shapes and refreshingly pure colours. The colour rendition of the Leica Vario-Elmar is subtle and powerful at the same time, and offers a good balance of saturation and finely shaded hues.

The background blur at wider apertures is quite smooth and retains its main outlines and the gradient from sharp to unsharp has a gentle curve and is not too steep.
Large scale enlargements are needed to inspect the rendition of very fine detail and here the combination of really crisp outlines of main subject shapes and the clear reproduction of small changes in highlight detail and shadow detail supports the impression of a picture made with a larger format camera.

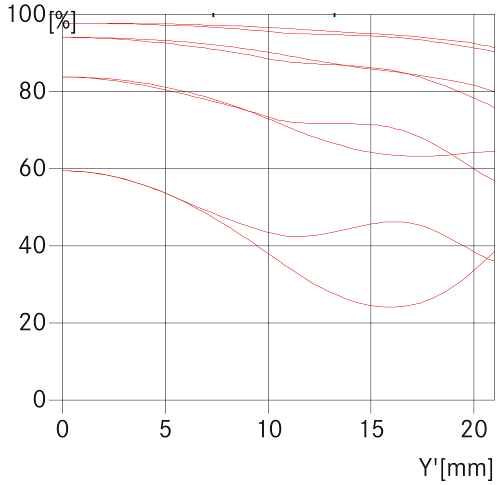
Ghost images and secondary reflections hardly occur and can only be seen in strong back light situations. Effective coating, good internal blackening of the mount and of course the smaller diameter of the lens elements contributes to this excellent behaviour.
The description above is based on a visual inspection of pictures made with this lens. These aspects cannot be inferred from the analysis of MTF graphs, but these graphs are needed to provide a backup for the more personal impressions.
The difference in performance between the 35, 50 and 70 mm position at the wider apertures is quite small, as can be seen from the diagrams.

MTF - 35 mm
(Aperture Stop 4.0)



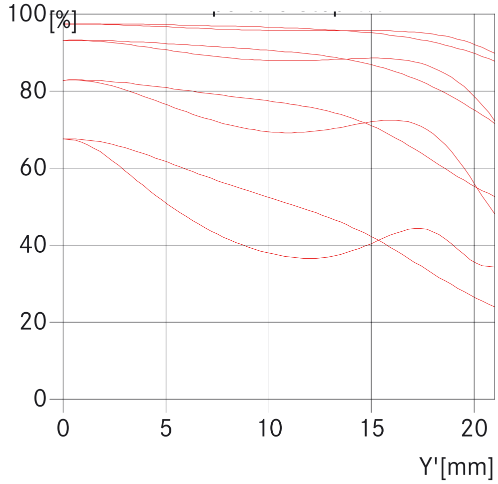
LEICA VARIO-ELMAR-R 35-70 mm f/4 (35 mm)

MTF - 50 mm
(Aperture Stop 4.0)



LEICA VARIO-ELMAR-R 35-70 mm f/4 (50 mm)

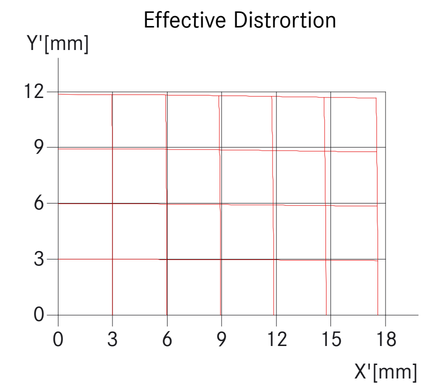
MTF - 70 mm
(Aperture Stop 4.0)



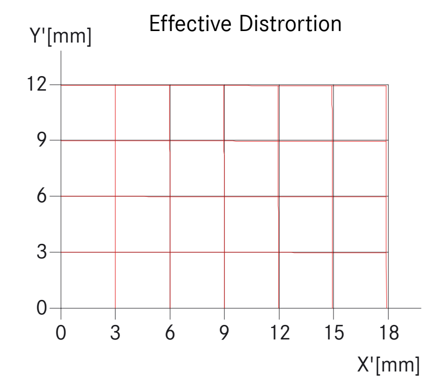
LEICA VARIO-ELMAR-R 35-70 mm f/4 (70mm)

A verbal description would run like this: at maximum aperture the overall contrast is high with excellent definition of very fine detail over a large part of the image frame. There is some softening of edge contrast of small detail due to some colour fringing at white-black gradients. At the edges and in the corners of the image there is a visible softening in the reproduction of fine detail, which becomes blurred.

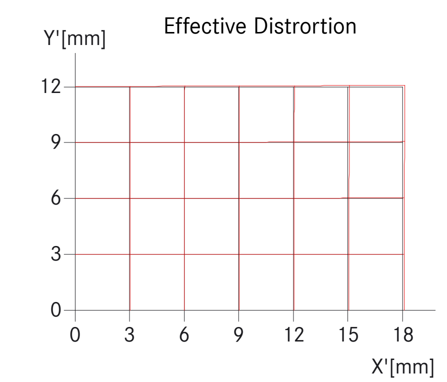
The 35 mm and the 50 mm positions offer the best image quality and the 70mm is slightly behind with a faintly softer rendition of details and somewhat lower overall contrast.
The main differences between the three focal length positions are the amount of distortion. The 35 mm has a 3% barrel distortion that is visible when straight lines are reproduced at the edge of the frame. At the 50 mm and the 70 mm position distortion is not a problem.



LEICA VARIO-ELMAR-R 35-70 mm f/4 (35 mm)



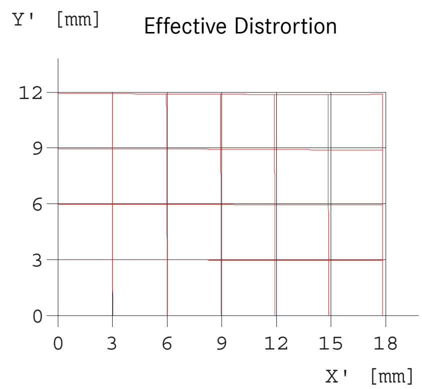
LEICA VARIO-ELMAR-R 35-70 mm f/4 (50 mm)



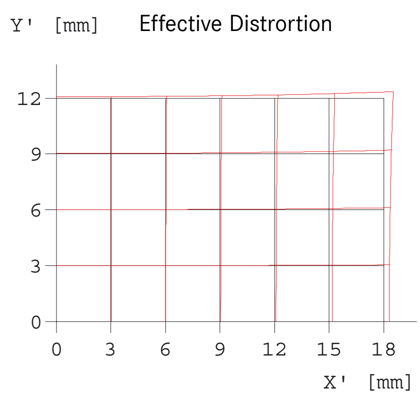
LEICA VARIO-ELMAR-R 35-70 mm f/4 (70 mm)

The now discontinued LEICA VARIO-ELMAR-R 28-70 mm f/3.5-4.5 showed a more pronounced distortion at the 28 mm and 70 mm position with -6% and 3% distortion.

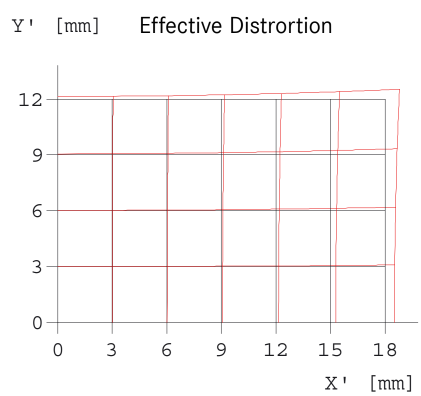
The improvement in distortion values is quite visible, but the overall performance is enhanced too. When you compare the MTF graphs, you will notice that at the wider apertures the main difference is a better definition in the outer zonal areas of the frame and especially the corners.



LEICA VARIO-ELMAR-R 28-70 mm f/3,5-4,5 (35 mm)



LEICA VARIO-ELMAR-R 28-70 mm f/3,5-4,5 (50 mm)



LEICA VARIO-ELMAR-R 28-70 mm f/3,5-4,5 (70 mm)

A comparison of the behaviour of the lens, when closing the aperture is more revealing. The LEICA VARIO-ELMAR-R 28-70 mm f/3.5-4.5 does not improve significantly upon stopping down, whereas the newer LEICA VARIO-ELMAR-R 35-70 mm f/4 produces a tighter image and a much crisper reproduction of fine detail.

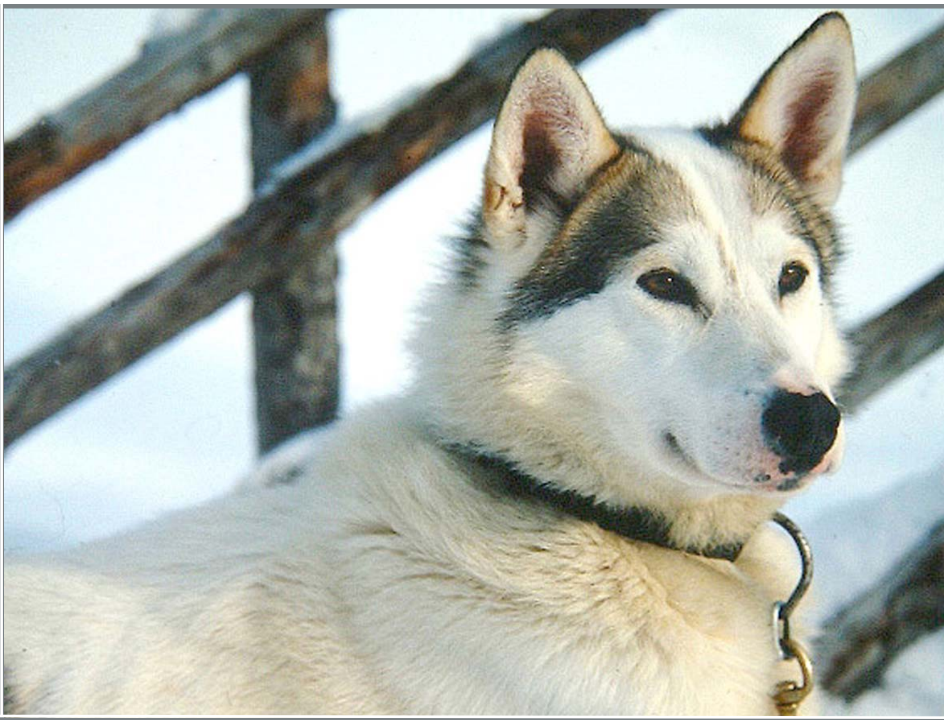
The restriction to the range of 35 to 70 mm helps to deliver this excellent performance, but the overall reduction of the residual aberrations is the real cause of the image quality.
The macro capability of the Leica Vario-Elmar-R is quite useful for normal subjects with extended depth. It is not suited for the reproduction of flat documents or paintings as the flatness of field at close range is not at its optimum.

Summary

The LEICA VARIO-ELMAR-R 35-70 mm f/4 is the first choice for a versatile standard lens for the Leica R system. In addition it covers three important focal lengths, the 35 mm, the 50 mm and the 70 mm. Its performance is as good, if not better than that of the comparable lenses with fixed focal length at the same apertures, the LEICA SUMMICRON-R 35 mm f/2, the LEICA SUMMILUX-R 35 mm f/1.4, the LEICA SUMMICRON-R 50 mm f/2 and the LEICA SUMMILUX-R 80 mm f/1.4. The topic of the maximum apertures has already been touched upon in this review and should be discussed at some length here. Leica offers lenses in the R range with maximum apertures from 1:1.4 to 1:5.6. Not so long ago, there was a tendency to buy the lens with the widest aperture, as this would give the photographer some margin in low light situations and in creative possibilities to use the shallow depth of field as an element in composition.

Today we have excellent high-speed films that are more than capable to compensate the wider apertures of the lenses. In addition the quality of the films have been improved. The image equation of a high-speed lens and a lower quality film is now less favourable than the combination of a lower-speed lens with a high quality film.
With a few exceptions most higher speed lenses offer less performance than the current slower-speed versions. In the past, the slower speed lens was often seen as an entry-level lens with a cost/performance compromise. This is not true anymore and the current 1:4 and 1:2.8 lenses in the Leica R (zoom)range are outstandingly good examples of the current state of the art of optical design.

We should also realise that lenses do deliver their optimum performance in situations where all variables can be controlled, especially vibration and focus accuracy.
The R system is more prone to vibration (mirror movement) and accurate focussing is more demanding because of the properties of the focusing screens.
For best performance a tripod is often required and in such a situation the lens may be stopped down without adverse effects. One can select slower speeds and operate at optimum apertures for the chosen depth of field without fear of blurring or vibration due to the slow speeds.



LEICA VARIO-ELMAR-R 35-70 mm f/4 image: Oliver Richter

There is a good case to make for the use of a wide aperture to reduce the visual impact of the background. But there is an equally good case to make that the background should be a valuable part of the overall composition of a scene. A study of many paintings in museums will reveal that the bakkground blur is less common than often assumed.

Current digital imagery is often criticized for its extended depth of field, picturing a scene with back- and foreground as sharp as the main subject. The truth is that this way of reproducing is the same as the human way of seeing a scene or a subject.

It may be the time for a recalibration of our notions of the language of photography and of the photographic technique.

The LEICA VARIO-ELMAR-R 35-70 mm f/4 may be the right tool to stimulate one's reflection about the state of the art of Leica R photography.

It offers excellent image quality, the range from 35 mm to 70 mm is just wide enough to stimulate the visual exploration of a scene of interest and the photographer can restrict him/herself to one lens.

LEICA VARIO-ELMAR-R 35-70 mm f/4 image: Oliver Richter

Leica R lenses

by Erwin Puts

May 2005
Chapter 13:
LEICA VARIO-APO-ELMARIT-R 70-180 mm f/2.8

LEICA VARIO-APO-ELMARIT-R 70-180 mm f/2.8

General considerations

Leica products are characterised by a fine balance between innovation and solid engineering with the most emphasis on engineering qualities and performance. Leica is at its best in the perfection of novel ideas and the elegant integration of proven parts. The classical M3 camera was an excellent example of the integration of available ideas and components, brilliantly executed. Zoomlenses are a second example where Leica does improve on the work of others. The Leitz company had for a long period resisted the demands of working photographers to introduce zoom lenses.

The official statement during that period was quite firm, but a bit short-sighted. Zoomlenses could never provide the image quality of the fixed focal length lenses and certainly could not operate at the wider apertures that Leica users were habitually using. This second part of the statement is still true, but the first part is not. Modern zoomlenses are mostly based on the two-component mechanically compensated variable-power system. The designation 'zoom' for this type of lenses is now universally adopted, but technically the optical system with a variable magnification is better designated as a variable power lens. The focal length of a lens gives a certain magnification of the object and optically speaking we can interchange focal length with the power of the lens. Leica is therefore correct, if a bit strict, to use the word 'vario' to indicate a zoomlens.

As said above, most vario systems are derivations of or improvements of the two-component mechanically compensated zoomlens. Let us recall briefly the main problem of zoomlenses: With two components (lens groups) we can only achieve exact focus and magnification (or focal length) for two positions. At all other magnifications (powers) the image will be defocused. In the past it was thought impossible to get the engineering precision to compensate the defocus by mechanical means.

The second type of compensation, the optical compensation, is much simpler to achieve, but has as big disadvantage its size, which is significantly larger than with a mechanical compensated system. The original first generation zoomlenses were optically compensated, as can be derived form the large size of the lens. Once the engineering problem of the mechanical coupling of the movement of the two lens groups was solved, designers all over the world could focus on the improvement of the image quality. This type of design, because of its promising performance, was extensively studied and optimum solutions were offered in patent documents and during the many optical competitions all over the world. In many cases a third moving group has been introduced to optimise performance, but the basic design still stands.

Given the large amount of research into this single type of design, it is no surprise that the performance generally is quite good. The first lens that Leica introduced in the longer focal length vario systems was the Minolta designed LEICA VARIO-ELMAR-R 80-200 mm f/4.5 from 1974, quickly followed by the Minolta designed LEICA VARIO-ELMAR-R 75-200 mm f/4.5 and later by the LEICA VARIO- ELMAR-R 70-210 mm f/4 in 1984. The range of focal lengths is untypically Leica, and indicates its foreign heritage, but optically the lens has a stronger injection of Leica knowledge. This lens has a medium-high contrast and a good delineation of fine detail, but distortion is quite visible and the critical medium frequencies (15 to 25 linepairs//mm) responsible for smooth gradation and crisp detail are weak. To improve on these aspects we had to wait for the availability of new glass types and new knowledge. The arrival of Lothar Kölsch as head of the optical design deparment gave the impetus to create the breakthroughs in design and engineering to catapult Leica out of the fishbowl there were swimming in till that moment. Mr. Kölsch assembled a small group of very talented young people around him and a new generation of Leica lenses was about to se the daylight.

The first truly Leica designed vario lens was the LEICA VARIO-APO-ELMARIT-R 70-180 mm f/2.8 and it was and it is still the lens that defied the claim that single focal length lenses could never be equalled by vario lenses. It is quite unique in its wide aperture of 1:2.8 that does not change during the full rage of focal lengths. This is quite an achievement for mechanically compensated zoomlenses. This new zoomlens could not be designed overnight. Mr. Kölsch explained to me, when I asked him about the secrets of this design, that the optical calculations were secondary in designing a lens, but that the designer needs to understand the fundamental properties of a design type before it is possible to make significant progress. Once you understand the character of a lens type and its possibilities and impossibilities, you can exploit its potential. The making of the LEICA VARIO-APO-ELMARIT-R 70-180 mm f/2.8 took about one and a half year. But the result is a stunning lens.

The qualification of what is better optical performance must be seen always in context. Let us be more specific. Take the image quality of the LEICA VARIO-APO-ELMARIT-R 70-180 mm f/2.8 at its extreme position of 180 mm and compare this to the fixed focal length lenses of Leica. The vario lens is significantly better at all apertures than the LEICA ELMARIT-R 180 mm f/2.8, but not as good as the superb LEICA APO-ELMARIT-R 180 mm f/2.8. The same relation holds for the 4/100mm and the 2.8/100mm, but again this last lens can be trimmed to a very high level. Even the LEICA ELMARIT-R 135 mm f/2.8 is surpassed by the vario lens.

LEICA VARIO-APO-ELMARIT-R
70-180 mm f/2.8
Photographer: Oliver Richter

__Size and handling of the lens

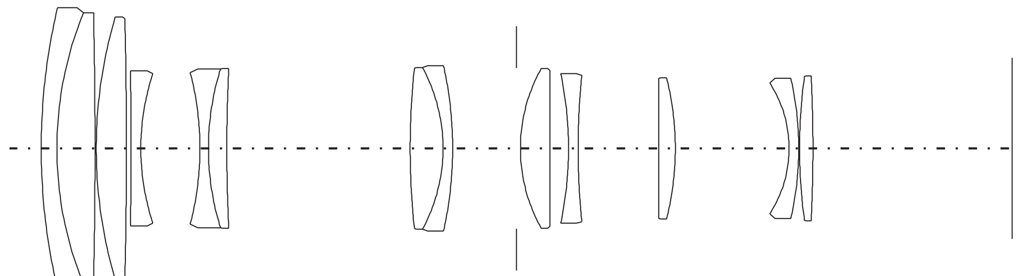
The optical performance is indeed quite impressive, and the size of the lens has to be taken into consideration. There is no question that it is possible to stretch the focal length to 200 mm, but then the front diameter will be excessively large. For the 180 mm focal length the diameter is now 88mm and the extension to 200 mm would enlarge the diameter proportionally and this increase is not worth the limited gain in focal length. It is really imperative to understand that a lens design starts and ends not with the optical internals, but with the given physical dimensions. Leica's choice for an all-metal focusing and compensation mechanism implied weight and size. This is the strong side of the Leica competence. They have the expertise and knowledge to match mechanical engineering to optical performance.It is by the way not necessarily the case that metals are always superior in manufacturing. The modern plastics or polymers (this name is to be preferred as 'plastics' bears a cheap annotation) can be of very good quality. The choice between metal and polymers is a matter of batch size and cost. The cost of moulding tools to create the shape of a polymer component is extremely high and only economically justified with large production runs. There is no need to be negative about a product that has some plastic components incorporated into its assembly.

It is evident that a lens with a complicated mount needs to be assembled with the utmost care to ensure a smooth movement of all moving parts. The LEICA VARIO-APO-ELMARIT-R 70-180 mm f/2.8 has a weight of about 1900 grams a size of roughly 20 cm long by 10 cm thick. This is just the limit for handheld photography. The aperture of 2.8 is quite helpful as it is fully useable and allows for higher shutter speeds. When testing the lens, one of the aspects was to analyse its potential for handheld shooting. I used the lens constantly for three hours with ISO200 slide film (to get some extra speed) and have to say that the shots at the end of the day were as crisp as at the beginning, an indication that physical fatigue does not reduce the quality of the pictures. Current styles and trends in photography favour the wide angle lens and wide angle zoomlens, and the longer focal lengths are put in the cinderalla-corner. Use of this zoomlens with its very interesting range from 70mm to 180mm shows the creative possibilities of this range in every-day shooting. Many subjects and objects will be enhanced visually by a selective focus and a selective composition. Wide open the LEICA VARIO-APO-ELMARIT-R 70-180 mm f/2.8 brings very crisp images and tight composition that visually draws the viewer into the picture. And for whom it is interesting, the bo-ke of this lens is very smooth and subdued. Personally I am more interested in the solidity and plasticity of the drawing of round subjects, a topic that can be discussed more objectively. The LEICA VARIO-APO-ELMARIT-R 70-180 mm f/2.8 is an excellent choice if you need pictures with punch, crispness, clean colours and visually pleasing definition of round subjects. My favourite film for this lens is the Kodachrome 200 whose characteristics match the lens in a nice artistic way. But pictures with any good quality slide film will benefit from the capabilities of this lens. I cannot wait to test this lens with the new LEICA DIGITAL-MODUL-R for the R8/9 system.
The closest focus of the lens is 170 cm. Good enough for the range from 135 mm to 180 mm, but a bit limited when using the 70mm to 100mm. The throw of the focusing ring is quite large and a bit of pre-focussing will help to catch the correct focus with a short movement. Otherwise the focussing movement will destabilise the handholding.

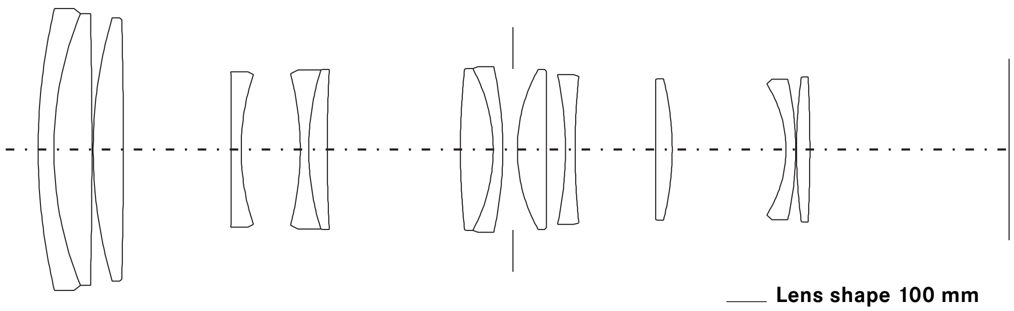
The performance of the lens is at its optimum when used on tripod and the lens mount can be easily turned for horizontal and vertical pictures. It goes without saying that a heavy tripod and careful focussing and mirror lock up is necessary to extract every ounce of performance from this lens. When you are able to use shutter speeds above 1/500, however, handheld shooting will bring exquisite results.

LEICA VARIO-APO-ELMARIT-R 70-180 mm f/2.8
Photographer: Oliver Richter

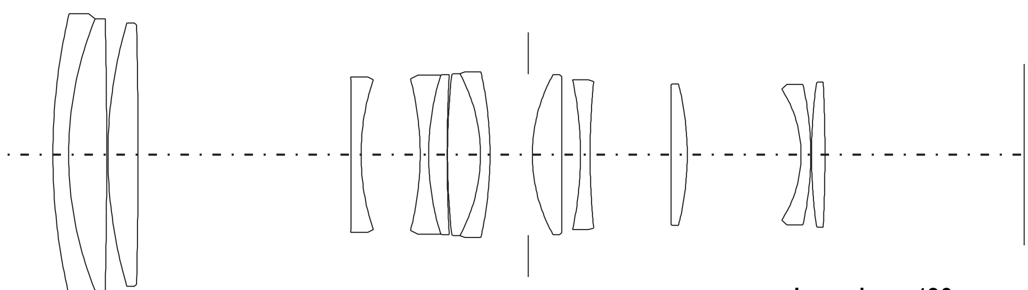
__Optical considerations



Lens shape 70 mm



Lens shape 100 mm



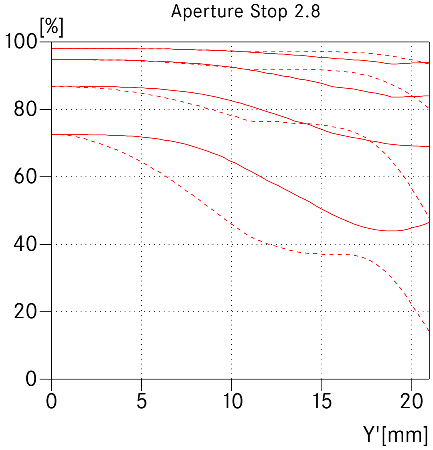
Lens shape 180 mm

The design with 13 elements in 10 groups is a bit complicated to analyse, but the drawing can be divided in two main groups: the stationary group behind the aperture location and the moving group before the aperture. Here we see the classical two-component design, with the first component (Vario Gruppe 1) also functioning as an internal focussing movement.
It is not necessary (nor is it possible) to discuss every possible focal length position and the behaviour at every aperture. It is possible however to draw a larger picture.

Generally the lens is already outstandingly good at the wider apertures over the whole range of focal lengths. The MTF graphs are quite clear in this respect.

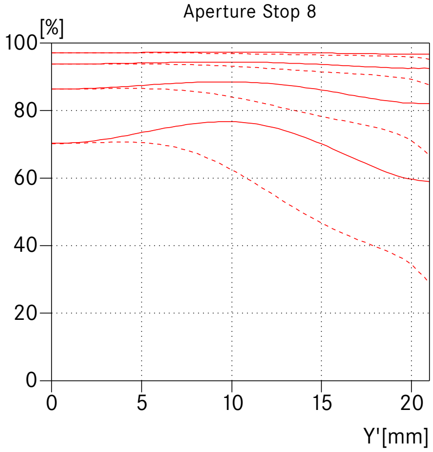
MTF graph 70 mm

Aperture Stop 2.8



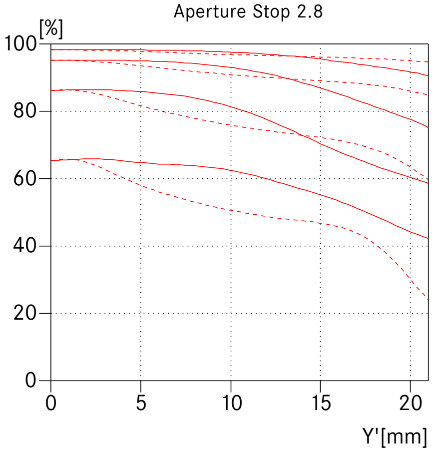
MTF graph 70 mm

Aperture Stop 8



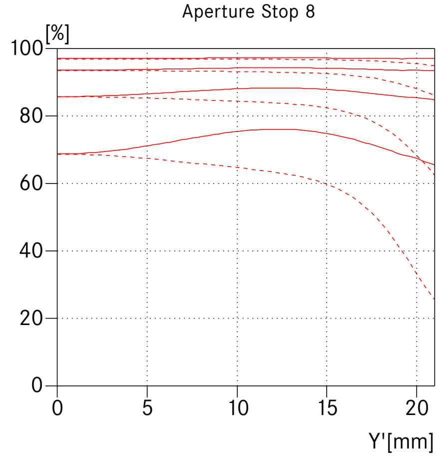
MTF graph 180 mm

Aperture Stop 2.8



MTF graph 180 mm

Aperture Stop 8



Note that there is hardly a difference in performance between the apertures and the focal lengths. The general behaviour on stopping down is a crispening of the detail definition at the corners of the image and an improvement of micro contrast at the rendition of very small detail. The 40 lp/mm are important for stationary and tripod based photography. For most situations it is best to look at the performance of the 20-30 lp/mm. This is around 90% overall at all apertures and focal lengths.

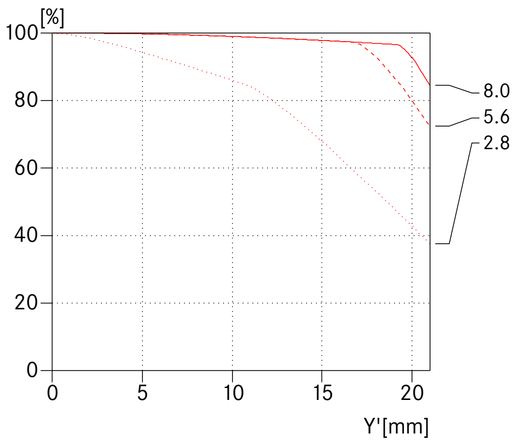
If you wish to be very critical one can note that the range from 80mm to 110mm delivers optimum performance at a level only equalled by the LEICA APO-MACRO-ELMARIT-R 100 mm f/2.8. A verbal description of the performance would be as follows: at full aperture overall contrast is very high with an even performance over the whole image area, with the exception of the extreme corners where contrast drops slightly. Very fine detail is rendered with excellent micro contrast and is defined with crisp edges and smooth gradation of subtle differences in hue and light intensity. Exceedingly fine structural elements are captured till the limits of the recording capacity of the film emulsions, where detail is mashed with the grain structure and becomes invisible.

For most intents and purposes the LEICA VARIO-APO-ELMARIT-R 70-180 mm f/2.8 is free from flare and exhibits excellent internal flare reduction. At the maximum extension (180mm) we can detect some flare when strong light sources are obliquely entering the front surface of the lens.

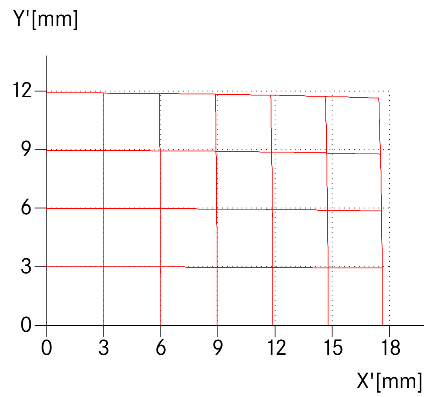
Vignetting is acceptably low with a maximum of 1.5 aperture stops. In most situations a one stop difference is hardly visible as long as the darkening in the corners is smoothly progressing. For really critical work and with very evenly lit backgrounds it may become visible.

Distortion in the medium positions (focal lengths from 90 to 135mm) is very low, but inevitably in a zoomlens, the extreme positions show the familiar barrel and pincushion distortion figures. The photographer should be aware of these characteristics and act as needed or intended.

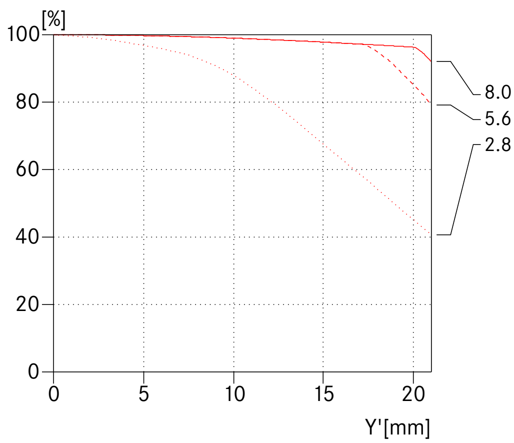
Vignetting 70 mm



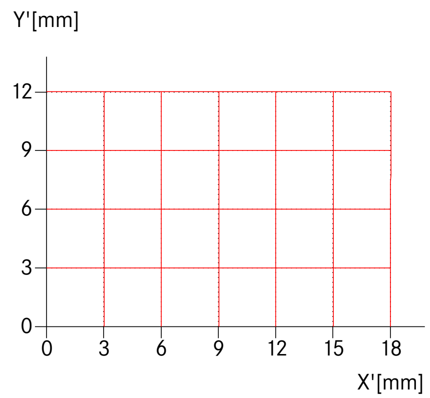
Effective Distortion 70 mm



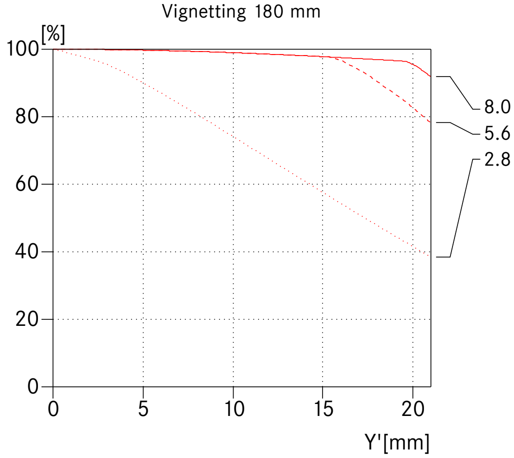
Vignetting 135 mm



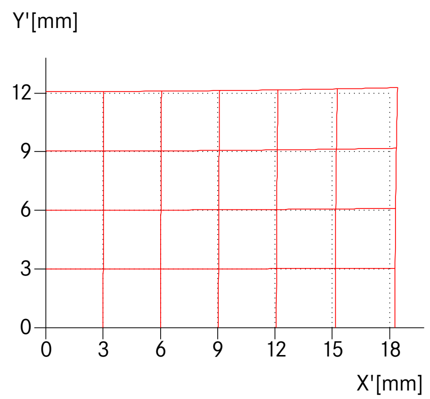
Effective Distortion 100 mm



Vignetting 180 mm



Effective Distortion 180 mm



__Artistic considerations

The great danger of the zoomlens is its flexibility in changing focal lengths. The selected focal length does not only define the magnification, but also the depth of field, the relative sizes of background and foreground objects and the depth impression of the scene. These aspects are different for every scene and should be defined and considered before you start with the actual shooting. The zoomlens allows for the fine-tuning of the composition and the framing of the scene. The zoomlens should not be used to try to improve a bad composition by varying the focal length over the whole range in the vain hope of finding a good composition.

The functional advantage of the zoomlens is the provision of a range of focal lengths in one package, thus reducing the need to travel with a number of individual lenses. In the case of single focal lengths, the photographer would decide on using only one or two lenses that are appropriate for the shooting session he has in mind. The same approach is best when employing a zoomlens.

The focal range from 70 to 180mm predestines the Vario LEICA VARIO-APO-ELMARIT-R 70-180 mm f/2.8 for a large range of assignments in the world of nature, reportage and fashion/portrait photography. You can still hear the claim that a lens may be too sharp for portrait photography and the LEICA VARIO-APO-ELMARIT-R 70-180 mm f/2.8 is indeed very exacting in its reproduction behaviour. One should however not forget that it is the photographer who makes the picture, not the lens as is. High definition is always accompanied by a very smooth gradation of subtle hues and illumination differences, characteristics that give a portrait a very good depth perspective. Photography is drawing with light and sketching with the shadows and it is the direction and quality of the light that will define the impact of the photograph. Here we can still learn much from studying the paintings of old and current masters.

LEICA VARIO-APO-ELMARIT-R 70-180 mm f/2.8
Photographer: Oliver Richter

__Conclusion

The LEICA VARIO-APO-ELMARIT-R 70-180 mm f/2.8 is the first zoom lens that can challenge the best single focal length lenses in its zoom range and even today is still state of the art. It is a fine example of the capabilities of the design team at Leica, Solms. It delivers outstandingly good imagery when commanding its performance profile and with knowledge of the photographic processes involved. The current Leica signature of accurate colour rendition on the verge of creamy saturation, clean and crisp definition of fine detail, a visible depth impression of solid objects and subtle gradation in highlights and shadow areas is fully preserved in this lens. Slides and large-scale prints in black and white and colour exhibit sparkle in highlights, forceful details in the shadows and extended tonality in the mid range of luminance values or grey areas.

LEICA VARIO-APO-ELMARIT-R 70-180 mm f/2.8
Photographer: Oliver Richter

Leica R lenses

by Erwin Puts

June 2005
Chapter 14:
LEICA VARIO-ELMAR-R 80-200 mm f/4.0

LEICA VARIO-ELMAR-R 80-200 mm f/4.0

Background

Around 1960 the first generation of vario lenses hit the market and offered good performance. As a start many manufacturers had a standard zoom (from about 40 mm to 80 mm) and a long tele zoom (from about 70 mm to 250 mm) in the program. The long zoom lens was mostly seen in combination with a motor drive unit to make clear that this type of lens had been designed for photographic applications where a quick change of magnification and picture angle was essential, in combination with a rapid sequence of pictures at different angles of view and moments.
It was clearly intended for scientific photography and event' photography in a wide sense of the word. Sports, reportage, wild-life and nature photographers were the first buyers. It is an interesting observation, that the traditional type of static photography (select a focal length, decide on the location and wait for the right moment to happen) was changing to a dynamic type, were the aim was to take as many pictures as you can and select the right shot after the event. The adoption of the cinematographic attitude and the post-selecting of the images is now the mainstream approach in the current digital scene, but was a revelation in those days.

The maturing of the telezoom reduced the market for fixed focal length lenses and at the same time increased the wish for quite extended vario ranges. The original Japanese vario ranges comprised the range form 85 mm to 250 mm and 85 mm to 300 mm. Since then we have seen a reduction to 70 mm to 210 mm and 80 mm to 200mm and an expansion to 28 mm to 200 mm and even 18 mm to 200 mm. These two trends (narrow range and extended range) are the result of two different design approaches.

It was Bill Clinton, who noted: "it is the economy, stupid!" when campaigning. In optical design, one could exclaim: "it is the size, stupid!" It is not often appreciated that the two prime parameters that limit the possible image quality of an optical system are the size and the weight. A wide aperture telephoto lens by necessity has a large front diameter and a big mount, both responsible for weight and size. Add demands like even illumination, excellent performance, durability and you end up with a mount that cannot be reduced in size without compromising these demands.

The choice by Leica for the range from 80 mm to 200 mm is a bit staid, but becomes understandable when we look at the performance figures.

To give you some perspective, let us take a look at the very compact current wide range vario lenses, like a 28 mm to 200 mm zoom lens. These designs cannot be constructed, using the classical zoom designs with four or two main moving groups (the focusing and the compensation groups). The new designs consist of up to five independently moving groups, including that of the diaphragm. Autofocus systems are really needed to adjust the internal zooming groups for reasonably accurate focus of the lens. Lens design, autofocus design and miniature electromechanical components are all integrated into one very complex system.

With more lens groups that can move in combination, the designer has the option to create a large zoom range that can be subdivided by the movements of all the groups, such that every group has only a small movement to make. The lens can be designed without any motion becoming excessively long. An additional feature is the independent movement of the diaphragm. Normally the aperture position is fixed and therefore the exit pupil is fixed too, not only in location, but also in size. The exit pupil has to illuminate and cover the whole negative area. When the location of the diaphragm can move according to the zooming motion, the designer can try to locate the diaphragm at a position that is as close to the film plane as possible when the lens is zoomed to its maximum focal length. When the diaphragm is very close to the film plane, the exit pupil is also very close to the film gate and can be made smaller in diameter. This approach helps to keep the size of the lens down.

The reduction in image quality that is initiated by the compromises in weight and size in combination with a long zoom range would be unacceptable for the Leica designers. It is maybe a sign of the times, that many photographers are quite happy with the results. Leica users will and can demand an optical performance that is situated at a much higher platform.

The first vario lens in the telephoto range for the Leica R system was the LEICA VARIO-ELMAR-R 80-200 mm f/4.5, introduced in 1974. It was followed by a LEICA VARIO-ELMAR-R 75-200 mm f/4.5 in 1978, a LEICA VARIO-ELMAR-R 70-210 mm f/4.0 in 1984 to be replaced in 1996 by the current LEICA VARIO-ELMAR-R 180-200 mm f/4.0 with specifications close to those of the original version. If we look at the lens layout of the current version and compare it with the previous versions, there is quite strong family resemblance. But we know that we cannot judge a lens on its layout, but need to incorporate information about the glass types that are used, as this selection is often more important than the physical shape of the lens element.

It is no secret that the first two designs were adopted from Minolta, the third incorporated more Leica thinking and the current one is an original Leica design, derived from the LEICA VARIO-APO-ELMARIT-R 70-180 mm f/2.8. It took the Solms designers 18 months to complete the LEICA VARIO-APO-ELMARIT-R 70-180 mm f/2.8, but the LEICA VARIO-ELMAR-R 80-200 mm f/4.0 was finished in about six months. This state of affairs begs the question when is a design a true Leica design.

We all have the romantic impression of that famous Leica designer, Dr. Berek who is known to have been sitting in the evenings at his desk at home, sketching with pencils on squared paper, making calculations while exploring uncharted optical properties. Berek was responsible for the main calculations and the overall concept, but the laborious raytracing, that took many years to complete had to be done by his team of assistants. But Berek was not working in a vacuum. The basic designs he used where well known in the optical community of which he was a member. Articles and books were available, exploring all aspects of design and performance. The same basic six element design could deliver

LEICA VARIO-ELMAR-R 80-200mm f/4.0
Photographer: Oliver Richter

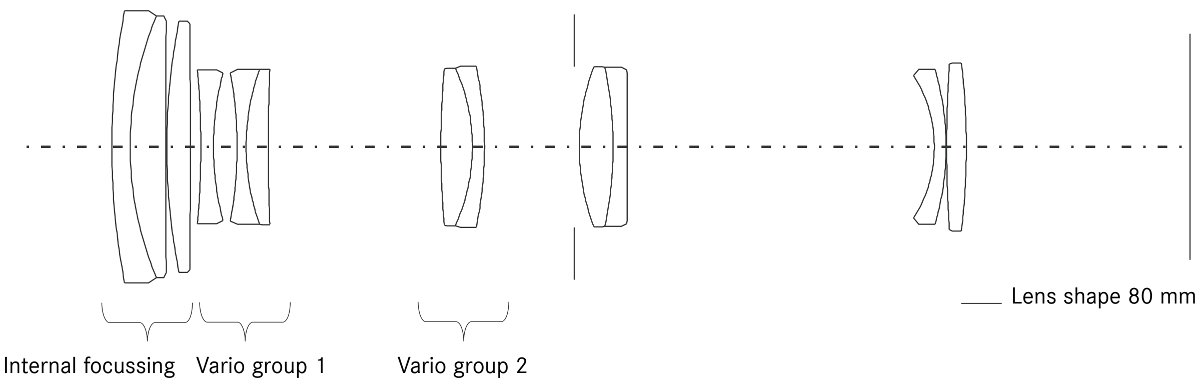
excellent results and sometimes just good results depending on design effort, creative hunches as well as on manufacturing quality.

Today we have a fundamentally different situation. The optical design community is a global affair, with tens of thousands of patents and examples on which to base a new optical system. The powerful optical design programs that are used by every company can create designs within a day or two, when an experienced designer manipulates the program. And these designs are really light years ahead of what Berek could do in his time. All serious optical manufacturers use the same (American) design program and Leica is no exception. Every design program however uses algorithms for optimization and glass selection that reflect the bias of the design team of the program. The mathematical background for aberration correction is common knowledge, but not the way to balance the errors and the approach to reduce the errors to some small numerical value. That is the reason why Leica also uses a proprietary design programs, originally created by Prof. Marx (of Noctilux fame). Quite often in the design process, the program has no solution to offer and then the Leica programs have to add the finishing touches to create a design that satisfies the goals of the Leica design teams. The hallmark of a Leica lens are the careful selection of glass types, the rigorous correction of the aberrations of a high degree to the smallest possible values, the meticulous surface treatment of the glass elements and the narrowest possible mechanical tolerances when manufacturing the mount and fitting the glass elements.

The origin of a design is less important than the changes that the Leica designers make to the design to fit their own specifications. Leica has changed the original Minolta design in the third version with the introduction of different glass types to improve the performance and to create the typical optical fingerprint that is characteristic of all Leica lenses. There is no reason to keep a parochial stand here. Leica offers outstandingly good designs, but they are not alone in this field.
Unique for Leica is the tight coupling of optical design and manufacturing tolerances to ensure that every lens performs durably to the design specifications.

LEICA VARIO-ELMAR-R 80-200 mm f/4.0
Photographer: Oliver Richter

__Optical considerations

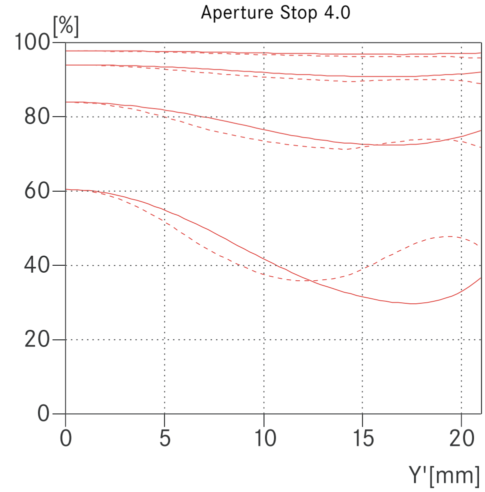


The LEICA VARIO-ELMAR-R 80-200 mm f/4.0 has 12 elements, arranged in eight groups (the original brochure counts nine groups). Six elements have glass with anomalous dispersion and/or high refractive index. In total eleven different glass types are employed. Compare these figures with the LEICA VARIO-APO-ELMARIT-R 70-180 mm f/2.8: 13 elements in ten groups, 5 special glasses and in total 12 different glass types. The large amount of different glass types is typical and probably unique for current Leica designs: this large selection allows the designer to improve image quality substantially, as every glass type adds two degrees of freedom to the design possibilities (any glass can be characterized by two numbers: dispersion and index of refraction). But the number of permutations and combinations increases exponentially and computer programs do not like this as there are too many solution directions. Here we note another special Leica characteristic: the special knowledge about glass types (related to the period when Leitz had their own experimental glass lab) and the experience with the treatment of 'difficult' glass surfaces. Leica designers are able to choose and treat glasses that offer exciting possibilities but are too problematic for large-scale series production.

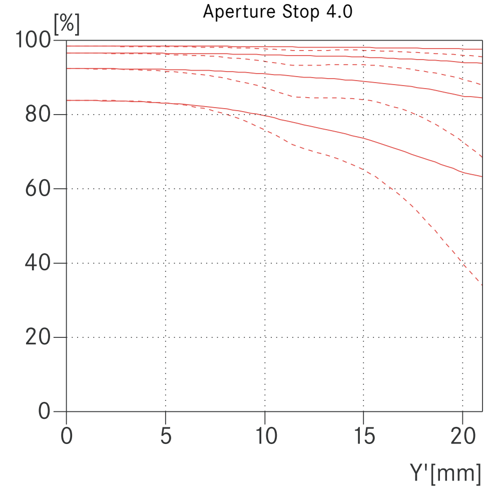
The optical performance wide open is excellent. At the shortest focal length the quality is a bit less than at the longer focal lengths, where really good imagery can be expected. In fact the quality profile favours the midrange (around 140 mm) with the short and long focal lengths a bit less good. This choice of the way of correcting the lens is a sensible one. Leica lenses at the fixed focal length of 135 mm have vanished for a long time, but it still is a very interesting focal length where exacting performance may be required. And around 200 mm current prime lenses are outstandingly good and it is reasonable that the photographer expects the same type of performance of the vario lens at this focal length of 180 mm to 200 mm.

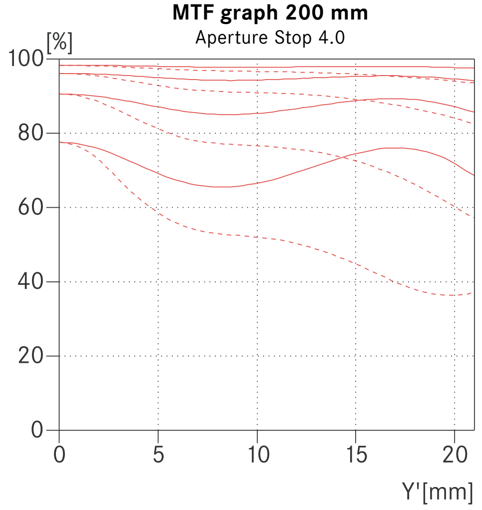
Stopping down to 1:5.6 brings a visible improvement at the 80 mm setting and a slight improvement at the other settings (140 mm and 200 mm). Overall the image quality is now quite even at all apertures and focal lengths. Pictures made with the LEICA VARIO-ELMAR-R 80-200 mm f/4.0 offer a high contrast, crisp definition of very fine detail and the clarity of colours and gradation that are the hallmarks of a well corrected design. You will notice, when studying the MTF graphs that there is a widening of the gap between the sagittal and tangential lines at the higher frequencies.

MTF graph 80 mm
Aperture Stop 4.0

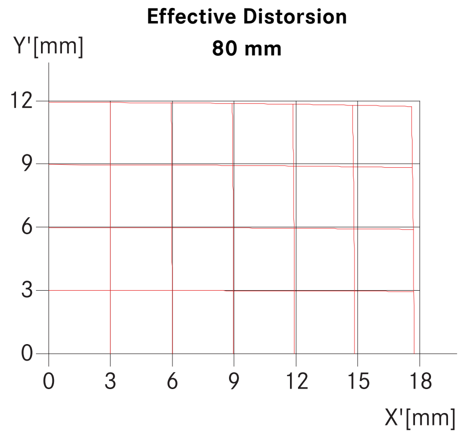


MTF graph 135 mm
Aperture Stop 4.0

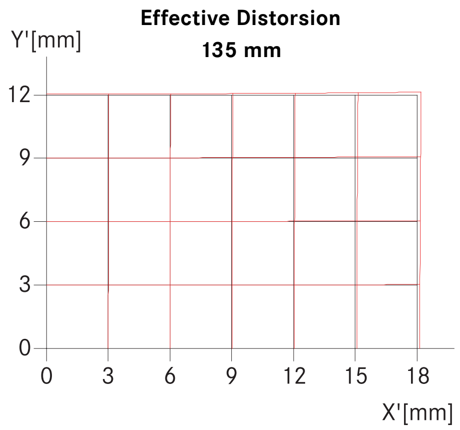




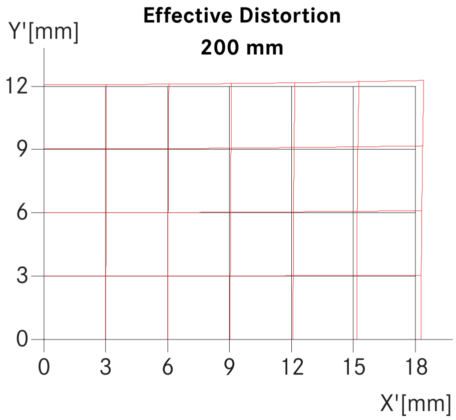
The main differences between the three focal length positions are the amount of distortion. The 80 mm has a -3% barrel distortion that is visible when straight lines are reproduced at the edge of the frame. At the 140 mm and the 200 mm position there is pincushion distortion of 1.5% and 2.5% respectively.

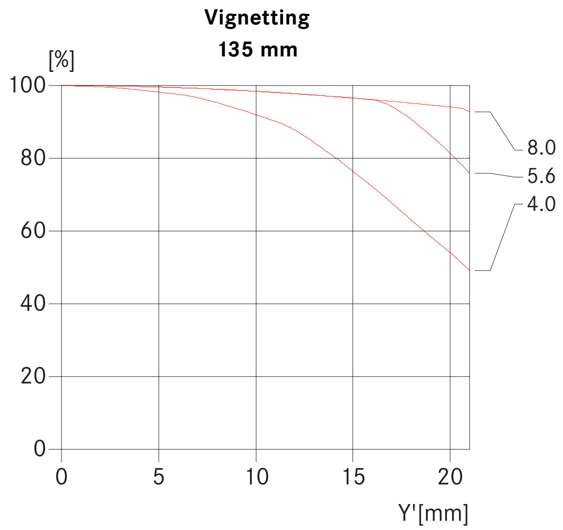


This implies that the correction of the secondary spectrum and astigmatism is not perfect. In practice you will be able to notice this contrast drop at high magnifications on very small textural details, but most often the occurrence of the grain pattern and the blur effects of hand held shooting will be more pronounced. It is interesting to compare this performance to the previous version (the LEICA VARIO-ELMAR-R 70-210 mm f/4.0). The gain in performance is most pronounced at the 80mm setting where the current lens produces an image with much higher contrast. At the longer focal lengths the improvements are subtler and can be found in a more crisp definition of fine detail and a more even performance over the whole film area. The older lens has a stronger drop of performance at the edges of the image.
The LEICA VARIO-ELMAR-R 80-200 mm f/4.0 can be used with confidence at all settings and apertures without fearing that there will be a big variation in image quality.



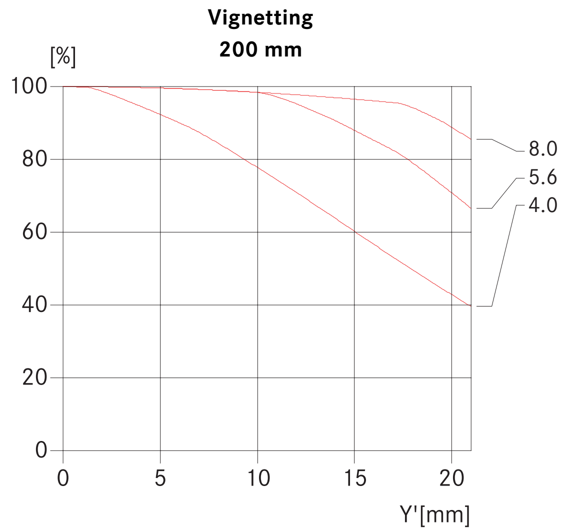
The background blur at wider apertures and longer focal lengths is typical for telephoto designs and a bit harsh, and main outlines become quite blurred. Veiling glare and secondary reflections hardly occur and only when the rays of the light source are directly hitting the front surface. You can always deliberately provoke secondary reflections, caused by the reflections by the aperture blades. High class images have an extended tonal range and it is killing for a picture when the highlights and especially the specular highlights in reflective surfaces, like gleaming metal, are washed out or when the small spots of light are diffused by flare effects. In this respect the LEICA VARIO-ELMAR-R 80-200 mm f/4.0 behaves commendably, especially when using slides, where highlight rendition is very important.

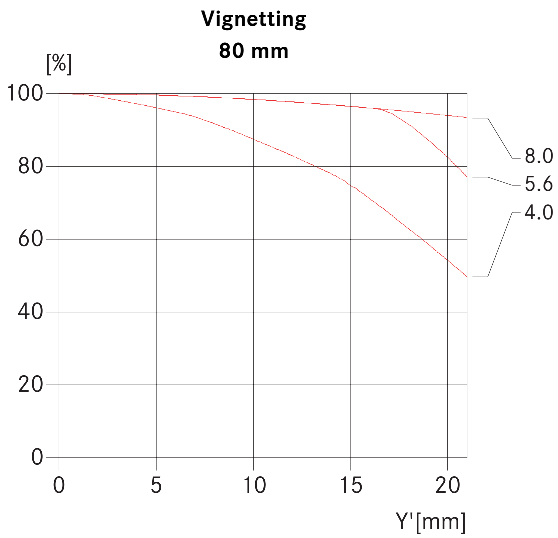




The previous version has -4%, 2% and 3% distortion.

Vignetting is low at all settings with a value of 1stop, where the previous version had 1.5 stop and more. A loss of light at the corners of 1 stop sounds severe, but you see from the graphs that the change in value is very gradual and the human eye is very tolerant for this type of gradual changes. When you really want or need absolutely even light distribution, you can stop down to 1:8, as you would have to do anyway when photographing scenes that require the best of image quality. Working at wide apertures often implies photography where the main motive is located in the centre of the image.





__Summary

The LEICA VARIO-ELMAR-R 80-200 mm f/4.0 is a worthy complement to the VARIO-ELMAR-R 35-70 mm f/4.0. With these two lenses you can cover a focal range from 1:5.7. The quality of the VARIO-ELMAR-R 80-200 mm f/4.0 is excellent over the whole range of focal lengths and apertures and distances. The lens can be used in a wide range of situations and subjects, but if you are looking for more limited but dedicated imagery of a very high order, the fixed focal lengths of 100 mm and 180 mm might be the first choice. The near focus limit of 1.1 meter is a big improvement over the 1.7 meter limit that the VARIO-APO-ELMARIT-R 70-180 mm f/2.8 offers. As usual it is best to stop down to 1:8 or smaller when working that close. This is advisable not only for the performance improvement, but mainly for the increased depth of field. As the little brother of the redoubtable LEICA VARIO-APO-ELMARIT-R 70-180 mm f/2.8, the lens stands a bit in its shadow, but the reduction in aperture brings a welcome reduction in weight from 1.87 kg to 1.02 kg.

As noted at the start of this review, the lens is very suitable for 'event' photography, but can be used very favourably as a portrait lens in studio and on location shoots. Common sense will advise you to use the 90 mm or the 100 mm focal length for portrait work. The 150 mm to 200 mm settings bring a very pleasant perspective and a very natural looking representation of a humans face. With an Apo-Extender-R 2x we get a 160 mm to 400 mm lens at aperture 1:8. This combination is not the best there is for handheld shooting, but on tripod and stopped down to 1:11 it helps you to bring home exciting pictures at long range. Photography is a demanding profession and hobby and we are all inclined to stay into well-confined paths that evade surprises and unexpected views in order to get the required results. The nice aspect of the Leica system is that you can experiment with different combinations and settings and in doing so will support your creative potential and can expand your visual horizon and experiences. The LEICA VARIO-ELMaR-R 80-200 mm f/4.0 covers a very potent range of focal lengths including the classical 90 mm, 135 mm and 200 mm. The focal length range from 80 to 200 mm offers a world of possibilities in one package. It is the photographer who chooses what focal length to use in a given situation, not traditional prescriptions.

LEICA VARIO-ELMAR-R
80-200 mm f/4.0
Photographer: Oliver Richter