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

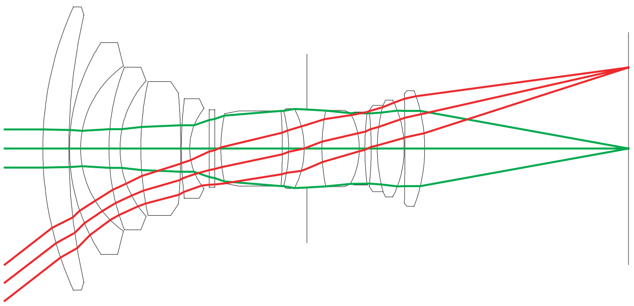
Several limitations are imposed on the design and construction of R-lenses. The most important are the back focal length, that is the distance from bayonet flange to the front of the film plane (in this case also free space for the mirror movement), the manual focusing mechanism and the the mechanical 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.

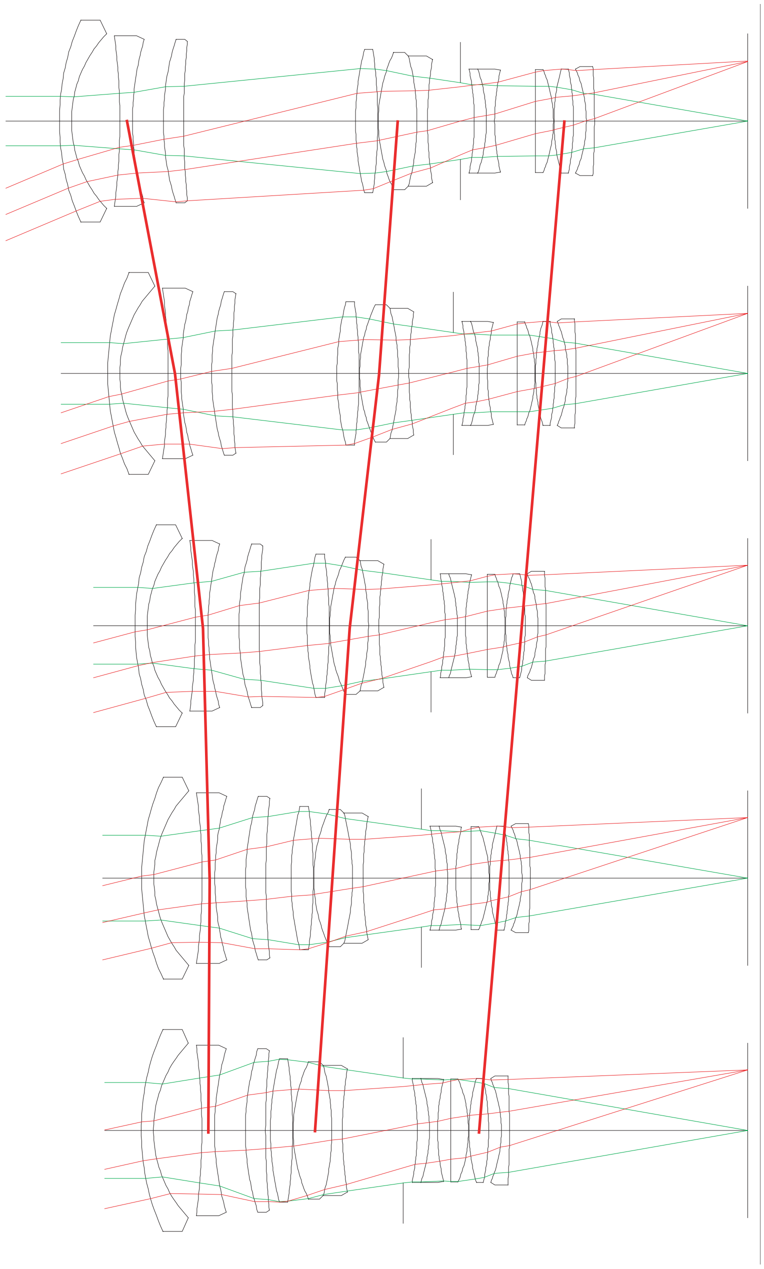
The optical designer has more degrees of freedom when he/she has control over more elements that can be moved within limits and the possible error correction can be of a very high order indeed. But to make a high quality zoomlens that will deliver at all focal lengths within the zoom range the movement 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.

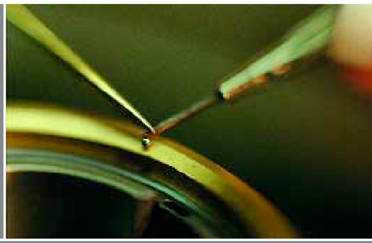
__Focusing

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.

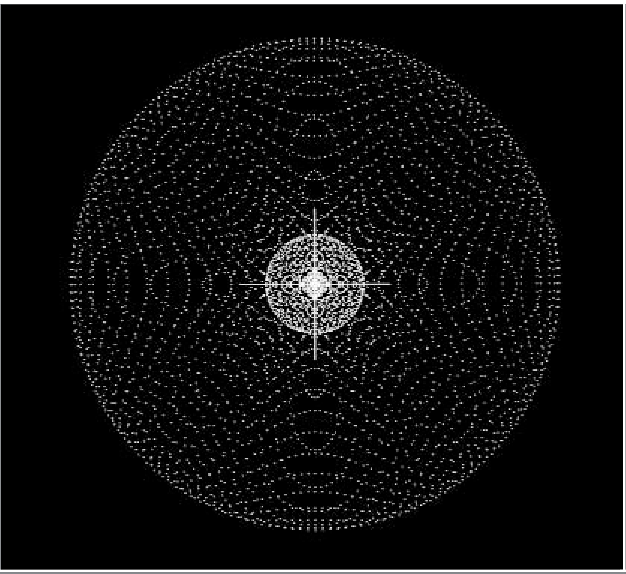


Image point A

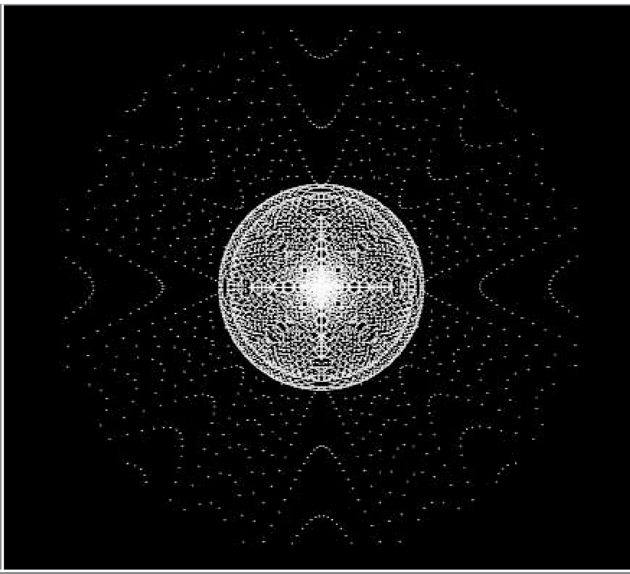


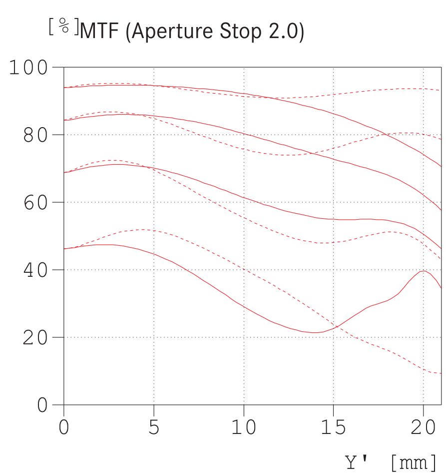
Image point B

__Three standard lenses

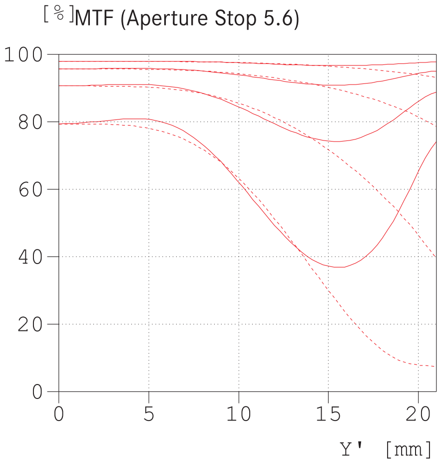
At this moment there are three lenses in the lens line-up that may be designated as standard or normal lenses:the Summilux-R 50mm f/1.4 (1998), the Summicron-R 50mm f/2 (1976) and the Macro-Elmarit-R 60mm f/2.8 (1972). There are good reasons to classify this last lens as a special lens for macro purposes.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

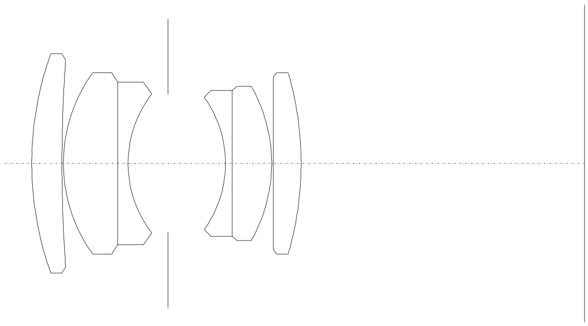


The fact that the curve turns upwards in the corners indicates the influence of vignetting. Especially the curve for 20 Lp/mm (third group of lines in the diagram) is responsible for the somewhat soft definition of the finer image details in the outer areas of the negative.

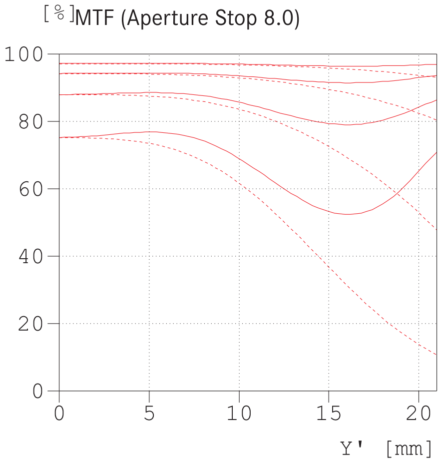


At f/5.6 the performance is outstanding. The line for 40 Lp/mm is now as good as that for10 Lp/mm wide open. The higher the contrast at 40 Lp/mm, the higher the clarity of the fine image details. The line for 5 Lp/mm is completely level now. The fact that the outer zones do not improve in the same way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

In complicated light conditions (contre-jour or backlighting,

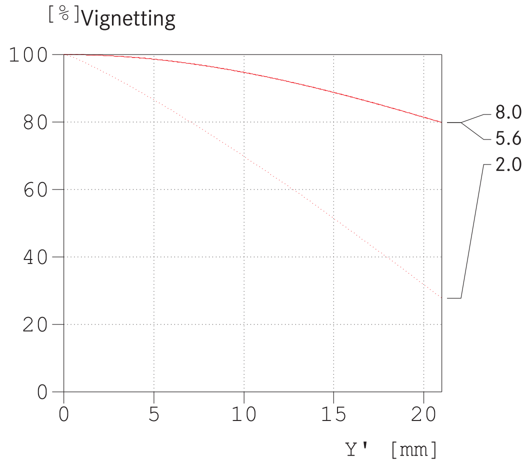


strong light sources that fall obliquely on the lens surface, extreme differences in subject contrast, that produce flare in the shadowy parts and specular highlights) this excellent performance is preserved. Flare and secondary reflections are minimal. Specifically with slides that can render a larger 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.



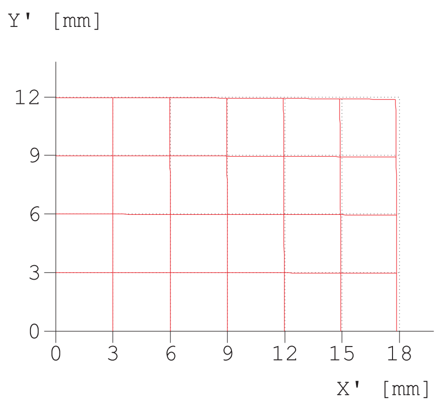
At f/8 you will detect a slight drop in the curve for 5 Lp/mm, as can be seen in the other curves too. This small loss of contrast indicates the influence of diffraction that starts to have effect at this small diamter of the aperture opening. Small differences should not be over-emphasized. Every lens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



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.

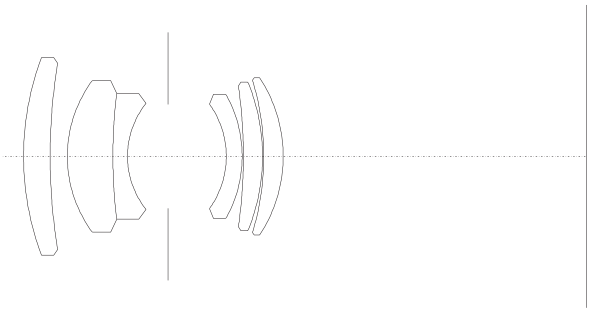
Leica lenses are always calculated according Barnack's famous motto: small negatives, large pictures. It is in fact a pity to to restrict yourself to color pictures on a small print. Leica images should be printed at least on A4 (24x30cm) or projected with larger magnifications. It is only then that 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.

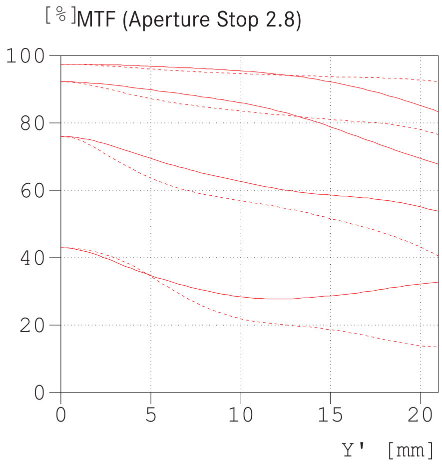
__ LEICA MACRO-ELMARIT-R 60 mm f/2.8

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.

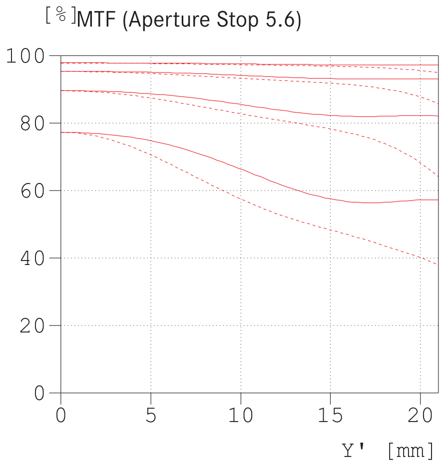


Here a trick can help: if you wish to enlarge or project substantially larger, you can find the real depth-of-field according to this rule: Aperture on the lens used is f/8. The depth-of-field is now read off the table at the f/4 line for big enlargements and at the f/5.6 linefor smaller enlargements.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

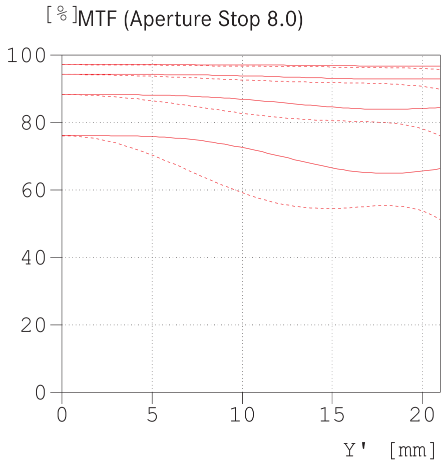
This lens is often characterized as a true macro lens. You should see this designation in a wider perspective. The ‘Macro’ in the designation does not imply that the lens is calculated for very close distances and high magnifications. The macro range is normally described as the magnification range from 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.

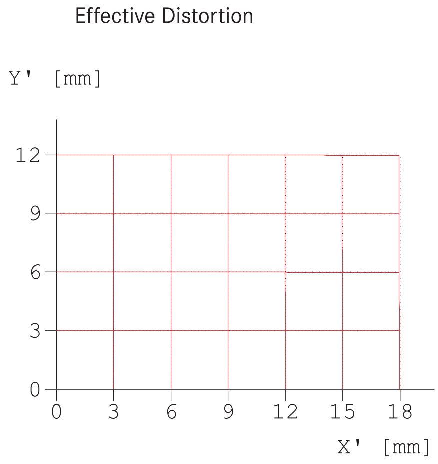


At aperture f/5.6 the correction of the aberrations is excellent. The 5 and 10 Lp/mm are very high and indicate very high contrast and good resolution. The 40 Lp/mm curve drops a bit from center to corner. But one should be careful here. These very small image details are not so sensitive to small differences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

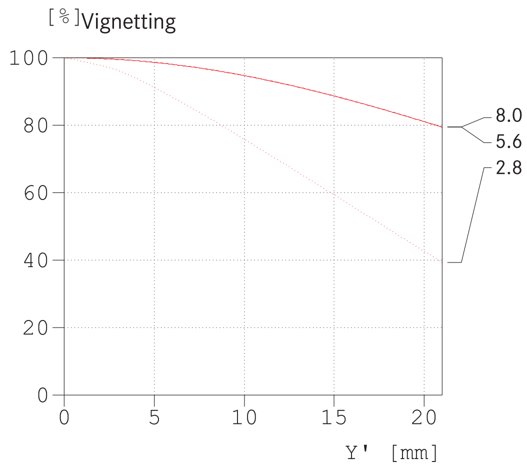


At aperture f/8 you will see (as with the Summicron-R 50mm f/2) the effect of diffraction. The contrast drops a bit. Again a remark: these effects can be calculated and shown in a diagram: it is not so easy to detect this in real photographic practice.

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



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



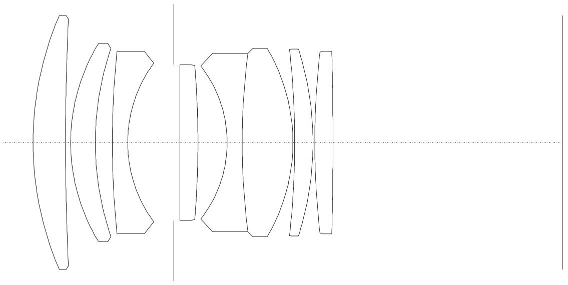
If you are looking for a standard lens that delivers superior performance at medium apertures and distances, then the Macro-Elmarit-R is frst choice. This quality can be exploited best when using a tripod or working with high shutter speeds. And (often overlooked) the subject matter must have those fine 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.

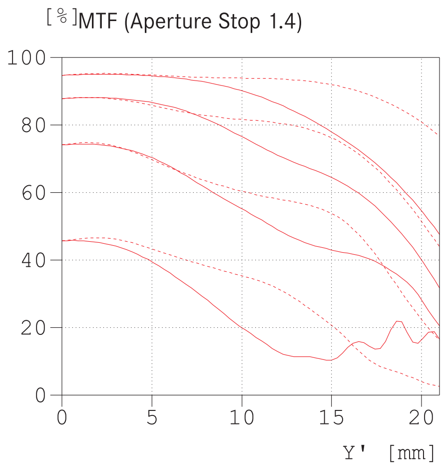
__ LEICA SUMMILUX-R 50 mm f/ 1.4

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.



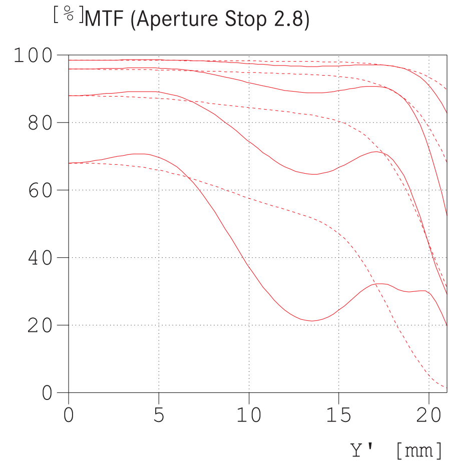
The first version of the Summilux-R 50mm f/ 1.4 from 1970 had commendable performance and was as good as the rest of the competition. It was not better though, and one should reflect on the fact that in those days a 1.4-lens was a must for every manufacturer in the front rank of optical design. Wide 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.

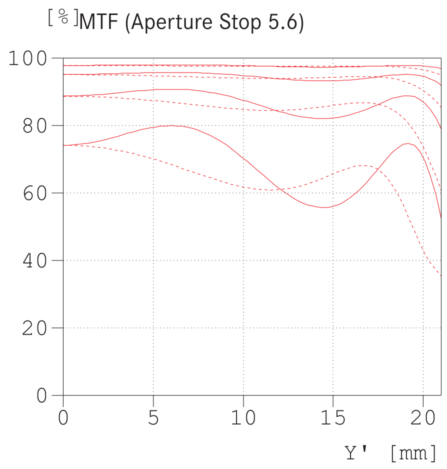


It is really fun to use this lens at aprture f/1.4. The bright image on the finder screen allows for fast and secure focusing and the resulting pictures have a special charm and character. With aperture f/1.4 under-exposure is not so very critical as the light gathering power allows the main subject 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.

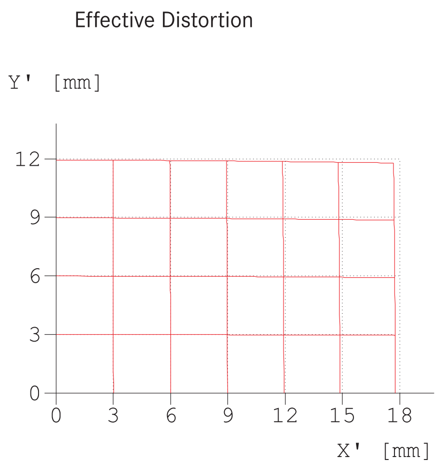
Flare in high contrast situations is very minor, but whenever possible, the built-in lens hood is a must. Tricky lighting can spoil the day. The big surprise with the Summilux-R is the remarkably high image quality when stopping down. This is not an obvious result. You buy a lens not only for its wide 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.

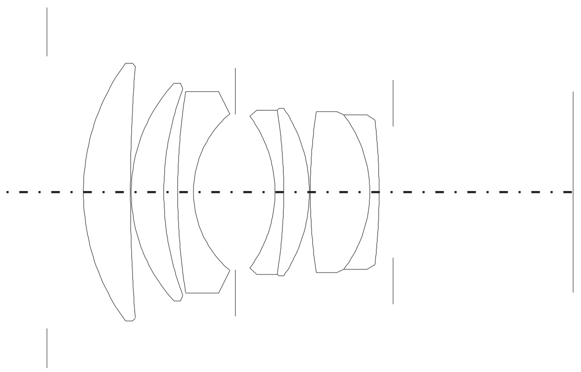
__Optical considerations

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.

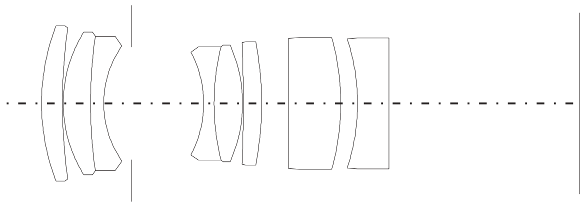
Basically the following options exist:

- 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.

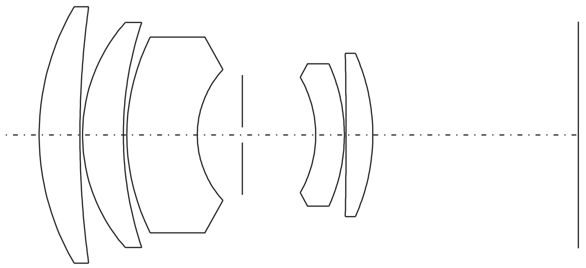


A true Double-Gauss design we find in the Apo-Macro-Elmarit-R 1:2.8/ 100mm. Here we have a six element construction with two separate thick elements at the rear end. As with the 60mm macro lens, the computation is designed for universal usage. When focusing the lens, the whole front lens with six elements 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.

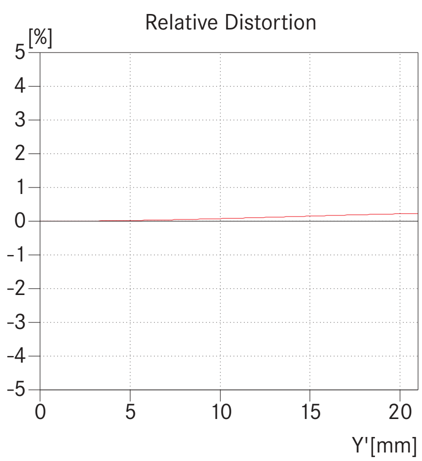
	Aperture 1,4	Aperture 2,0	Aperture 2,8
Summilux-R 80 mm f/ 1.4	Medium contrast, some flare. In the center good resolution, in the outer zones medium resolution, some astigmatism is visible.	Medium contrast, low flare. In the center very good resolution, in the outer zones good resolution, some astigmatism 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.

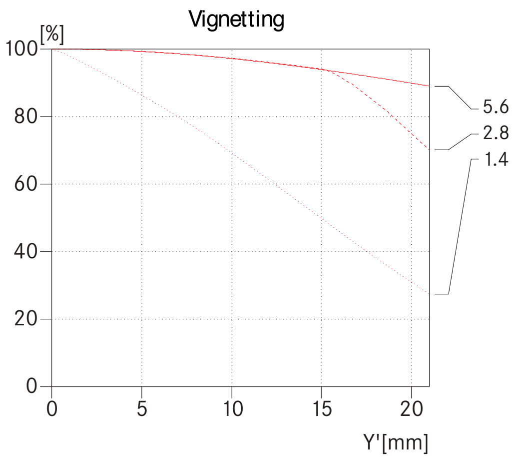
Overall we may declare that all three lenses can exploit the high resolution of the future digital back and they even have some reserve capacity.

__ LEICA SUMMILUX-R 80 mm f/ 1.4

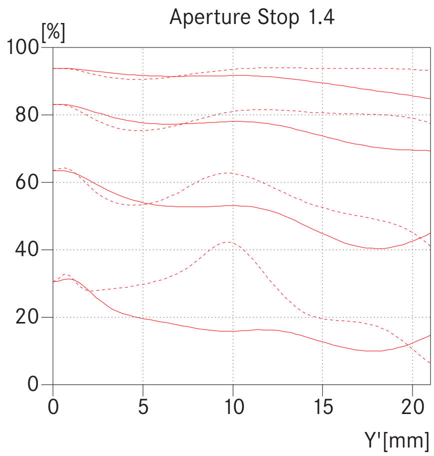
With 700 grams the Summilux-R has somewhat less weight than the Apo-Macro-Elmarit-R. The discussion whether mass does support the stability of the lens will presumably never end. But a high mass also asks energy from the photographer to support the weight and this may counteract the stabilizing effect 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.

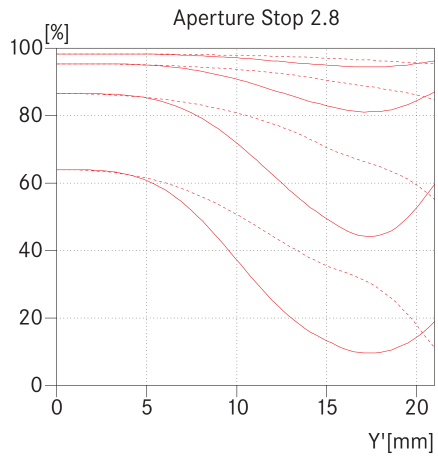


Distortion is surprisingly low with only 0.2%and is even suitable for architectural photography.



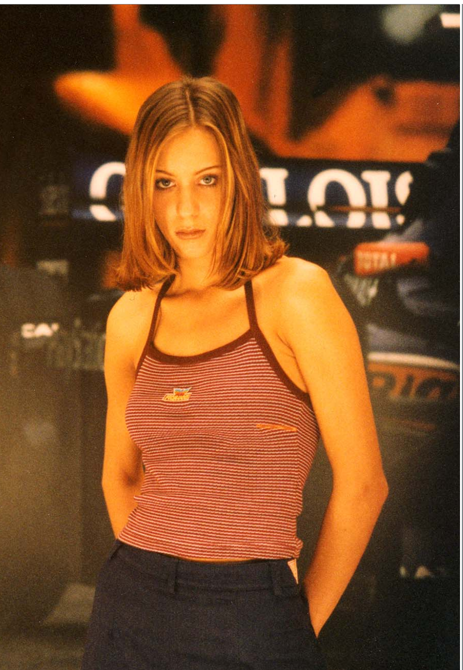
Vignetting is relativley high with 2.5 stops as a measured value. In practical use, these values should be treated with some caution. Even landscape pictures with clear sky show only a slight darkening in the corners.

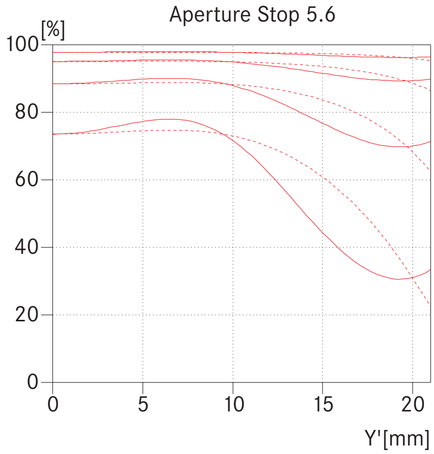




At aperture 1.4 the overall contrast is medium, as can be seen from the graph, where the low frequencies are below 95% The important 20 Lp/ mm are clearly defined with 60%in the center and 40%in the outer zones. The edge sharpness is a bit soft as can be seen from the low position of the line for the 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.





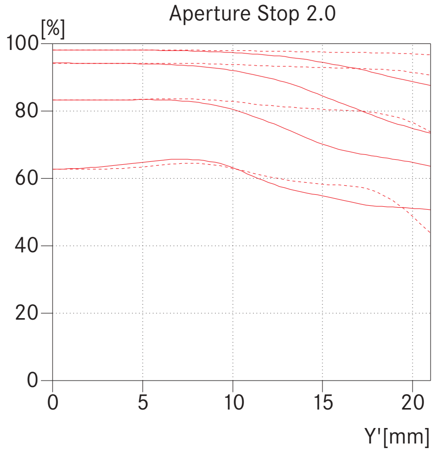
Aperture 5.6 can be regarded as the optimum. The edges stay a bit soft in the definition, but you need a high magnification to discern this. In the center of the image where the main subject or action is being located, very fine textures are reproduced with crispness.

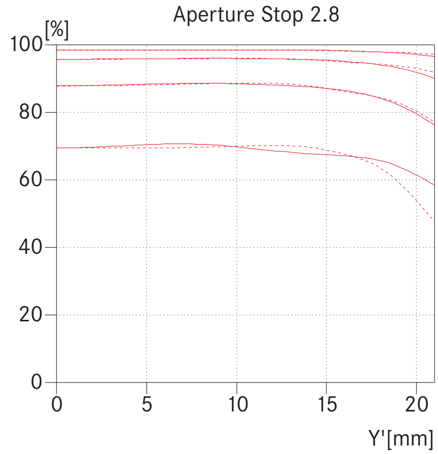
The MTF graphs should be studied with some caution. You can overrate the values that are displayed. I have made comparison pictures with all three lenses at all apertures on ISO100 slide film. The distinctive differences as described above, can be seen only when the magnification is 20 times or more. 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.

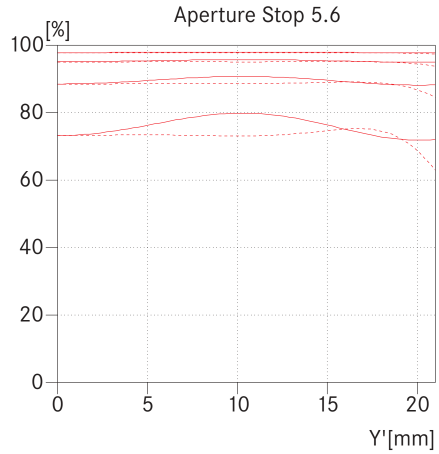
__ LEICA APO-SUMMICRON-R 90 mm f/ 2 ASPH.

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.

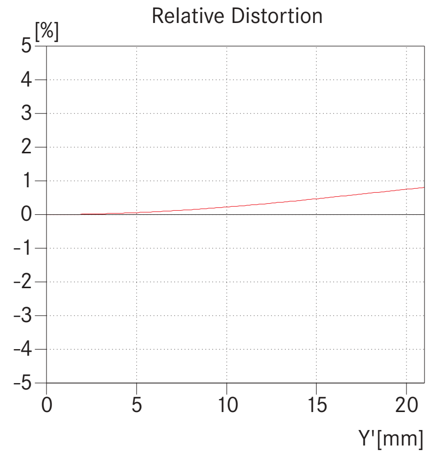
At full aperture the performance is already as good as that of the Apo-Macro-Elmarit-R 1:2.8/ 100mm at aperture 2.8. For an aperture of 1:2 this is a most remarkable feat. More important perhaps is the transparency of the colors and the clarity of the details. Extremely fine details are reproduced with 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.



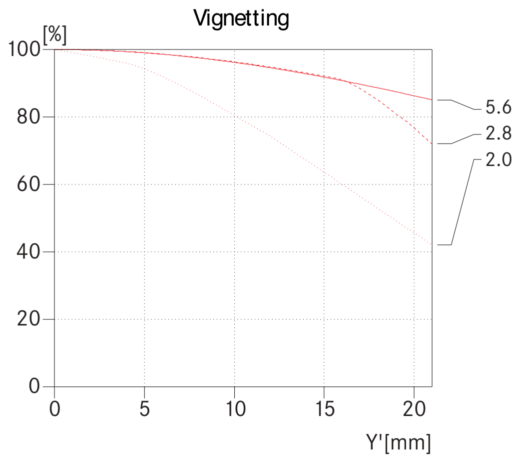




The graphs for 2.8 and 5.6 indicate an improvement for the 20Lp/ m and the 40Lp/ mm, but the jumps are quite small. Compare the jumps in performance of the Summilux. The residual aberrations of the Apo-Summicron are already so low at full aperture that stopping down only improves the depth of field. 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.

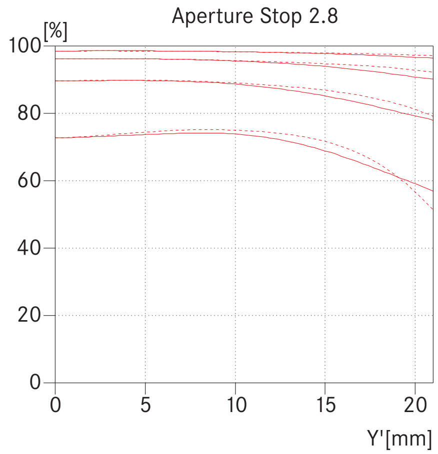


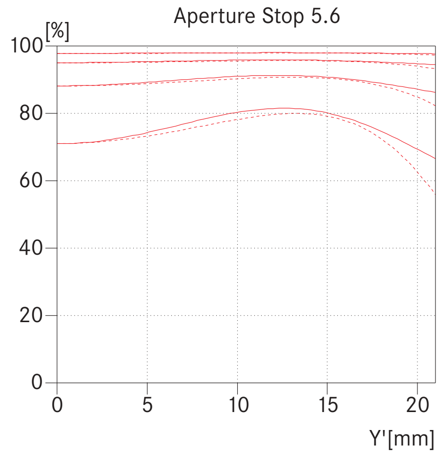
Vignetting amounts to 2 stops wide open, but can already be neglected at 2.8, and is even lower than that of the Apo-Macro-Elamrit at 2.8. The apochromatic correction is effective from aperture 1:2 and can be seen from the non existant color fringes at high contrast edges. Still the correction is not 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.

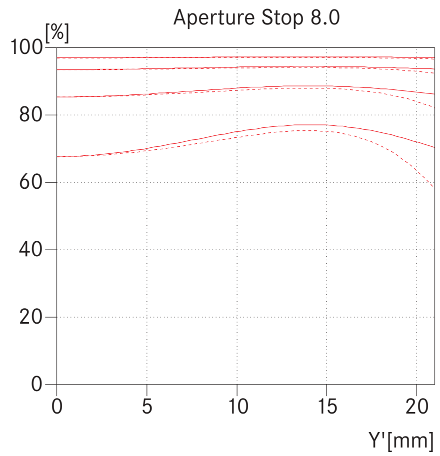
These remarks should not be interpreted as nitpicking. As tester you simply stumble across some limits, how far off they may be, and these should be noted. The Apo-Summicron-R 1:2/ 90mm ASPH is a superb lens in any sense of objectivity, that beraks all previous limitations. With a weight of 520 grams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



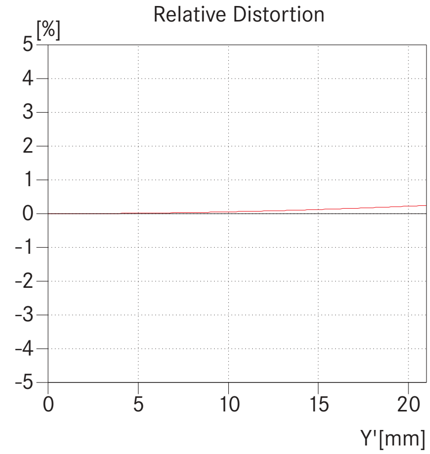




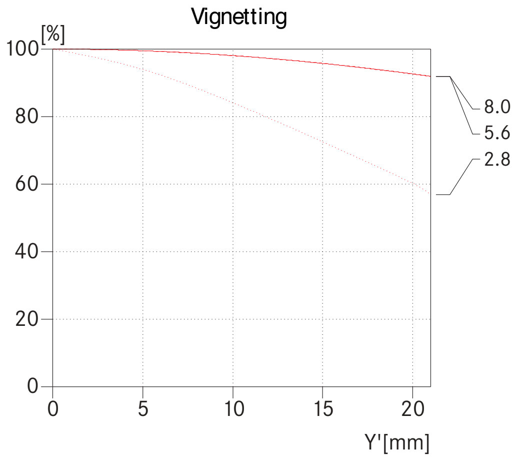
At aperture 2.8 the performance is uniformly high: high contrast and clarity of details are even better than what you expect from medium format systems and this verdict indicates the preferred domain of the 100mm. On tripod and with carefully selected emulsions, the R-System reaches distinctive studio 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-Elmarit-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.