Leica R-Lenses

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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.

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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.

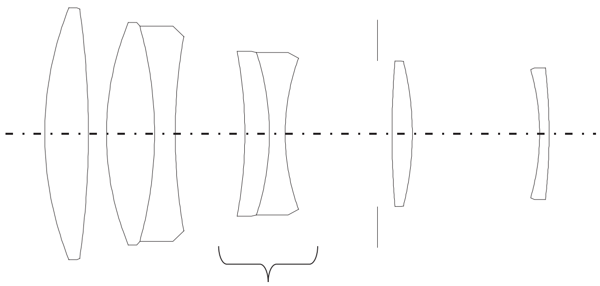
The discussion often arises as to whether a lens can be too sharp, a question that is certainly relevant for both of these lenses. In many discussions, sharpness and contrast are seen as the destroyers of subtle tonal values.
This idea is associated with the effects of gradation of films and papers. 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.

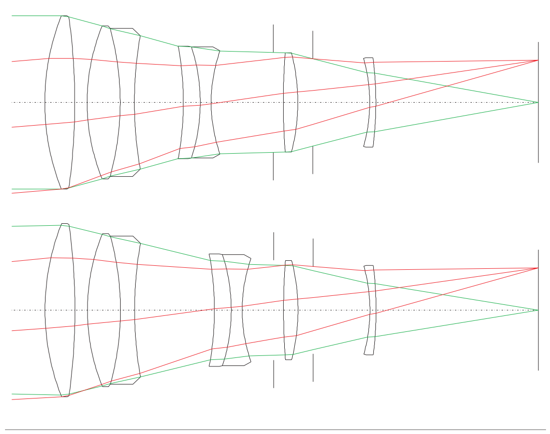
Optical considerations

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.

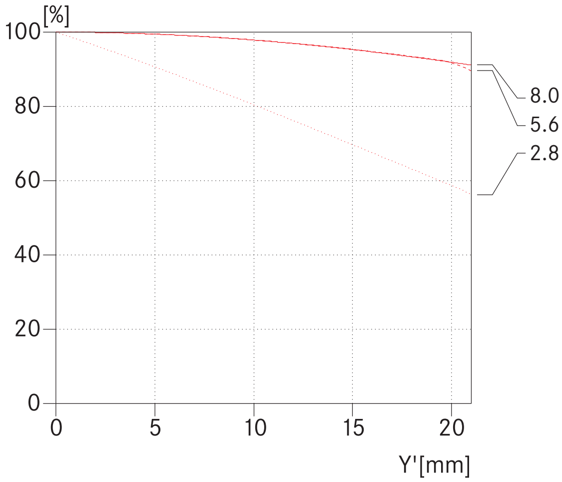
For the first time, chromatic aberrations (color fringes) could be reduced to negligible amounts. Multi-layer coating was used sparingly, as these layers often create more problems than they solve. Especially with strongly curved surfaces and with glasses with high refractive indices, a uniform thickness 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.



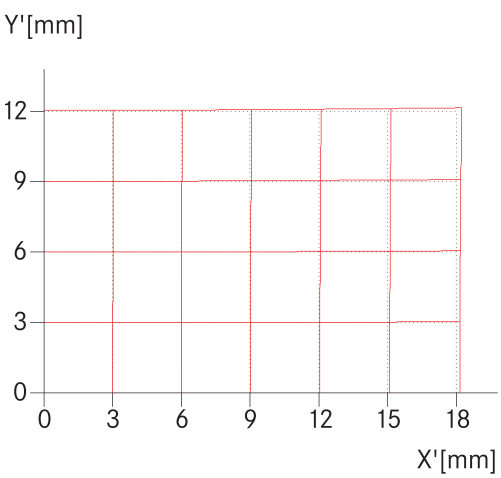
Maximum quality is already reached at full aperture. From the center to the edge of the image, a resolution of extremely fine details with high micro-contrast is ensured. Especially with fashion- and beauty photography, where hyper-realistic images are required, these lenses are ideal. From a lens tester’s 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.



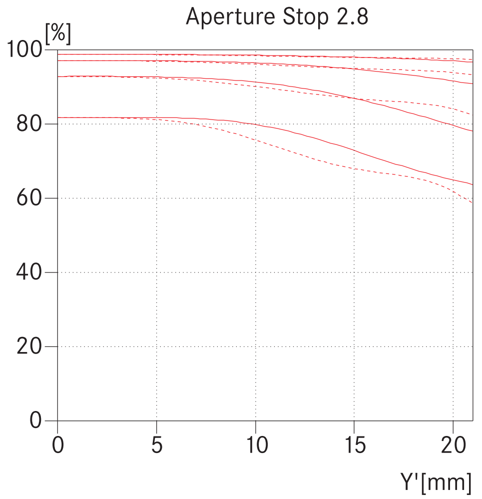
Flare and secondary images are absent and specular highlights in the blazing sun are free from halo effects.
Vignetting may be visible under critical circumstances (wide open), but it is eliminated at f/5.6.

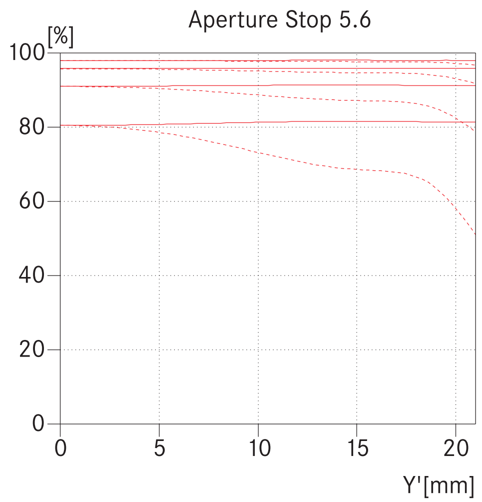


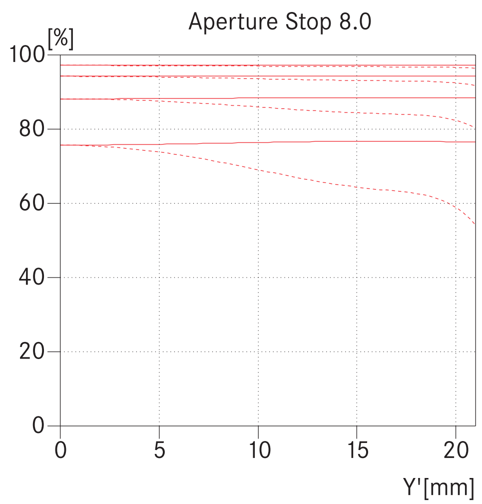
Distortion amounts to 1% in the comers and may be visible when one photographs geometric figures (architectural details) near the edges of the negative.



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.

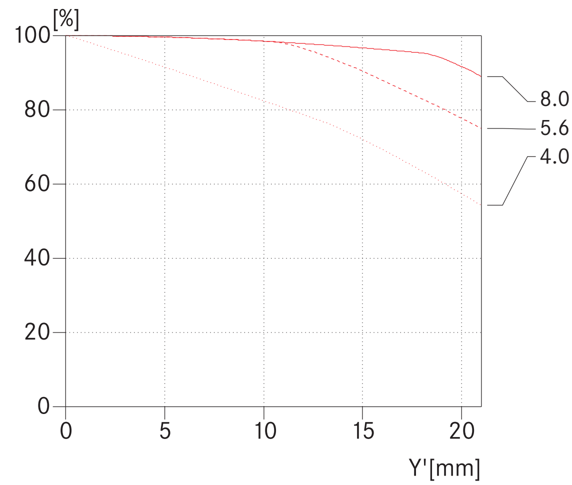




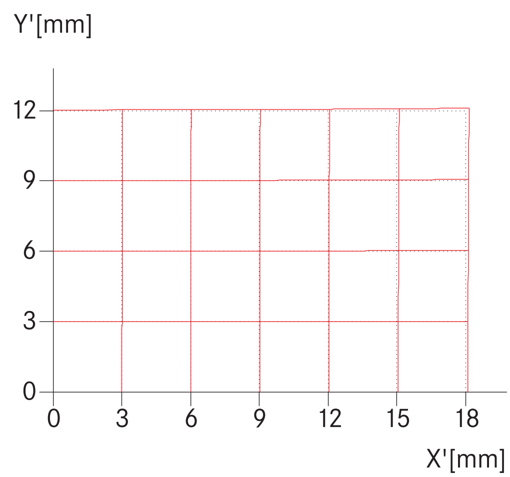


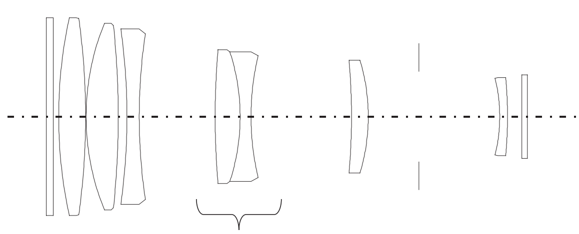
The diverging curves at 40 Lp/mm for sagittal and tangential lines is of no relevance in practical photography. This reduction in contrast can only be computed; it is not visible in real life. This behavior indicates that the lens earns highest scores for color correction. The 'APO' designation is well 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.



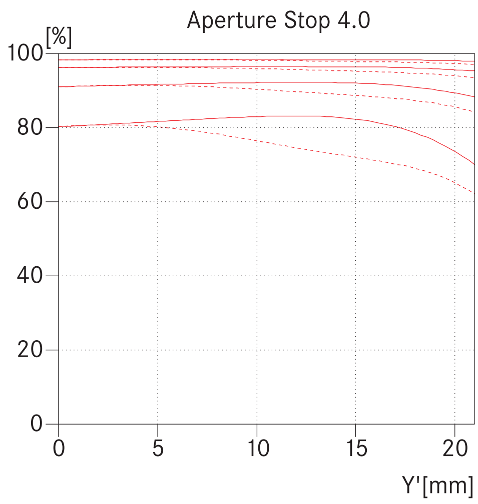
The 180 mm f/2.8 Apo-Elmarit-R lens can be focused beyond the infinity mark (as the 280 mm lens can as well). This is intentional in order to accommodate heat expansion and it is not designed for searching the best infinity position. There is nothing beyond infinity and the true infinity mark is optically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

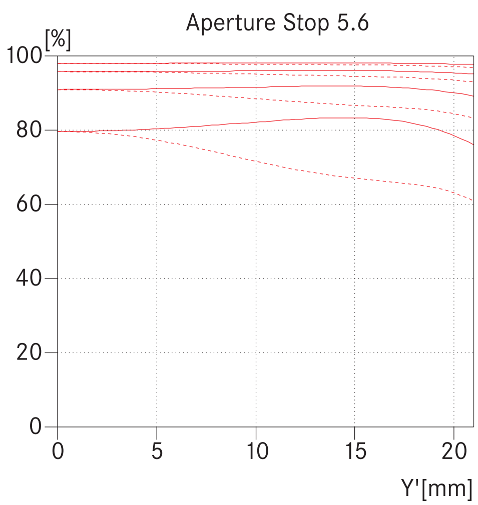


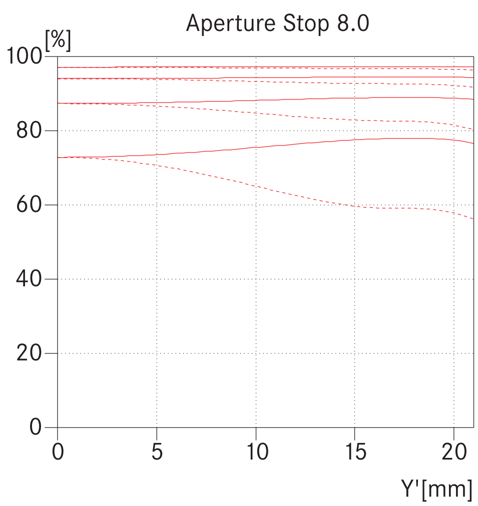


The 280 mm f/4 Apo-Telyt-R lens has a strong family resemblance to the 180 mm lens. Here too, seven elements are used, now in six groups (the first cemented group is separated). Distortion and vignetting of the two lenses are almost identical.

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 130 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