Large Format Lens Tests

Below are the results of some tests of large format lenses I did over the years. The best way to test a lens would be to use an MTF measurement setup like the Zeiss K8, but since this is not an option for me, I made test chart images and evaluated negatives, similar to the tests by Chris Perez and Kerry Thalmann (http://www.hevanet.com/cperez/testing.html), but with a different target and setup. Of course, one has to keep in mind that all these tests test the whole system, from film holder to development procedures. To get any meaningful data on one component of this system like the lens, one needs to be very diligent in keeping everything else as constant as possible. Possible error sources range from film holder problems to ground glass alignment, parallelism of the object, lens, and film planes, to development temperature and agitation. In addition, numbers from different test setups should not be compared!

My present setup is the following*: As test object I chose the Norman Koren lens test chart (http://www.normankoren.com/Tutorials/MTF5.html) which allows a judgement of performance at two contrast levels, 50% MTF, and 10% MTF. It is different from a pure bar chart, and gives slightly worse results in lp/mm for the 10% MTF than a standard USAF bar chart. The text at the linked web site is worth reading to understand the concept. I printed out seven of these charts, and mounted them on a flat door indoors, one in the center, and the remaining six in three pairs for sagittal and tangential orientation in two corners and at one intermediate position. Note that in the “upper” corner the tangential structures are on the outside, whereas in the “lower” corner they are inside, and vice versa for the sagittal structures. For the intermediate position, the tangential structures are on the inside, i.e. closer to the center (see. Fig.1).

Lighting is by 2000W of halogen video lighting. I photograph these on 4x5 Kodak TMAX 100 (TMX) at a magnification of 1:20 and at an EI of 80, resulting in the following exposures: f/2.8: 1/250s, f/4: 1/125s, f/5.6:1/60s, f/8: 1/30s, f/11: 1/15s, f16: 1/8s, f/22: ¼s, f/32: ½s. The numbers on Koren’s charts are calibrated for 1:50, but 1:20 works for the distances I can achieve, so I have to divide the numbers by 2.5. This means the maximum resolution I can detect is 80lp/mm, but that is already above what most LF lenses can do, and above the diffraction-limited resolution at f/22. So far, I have only encountered a few LF lenses that reached that number (at f/11-16) in the center for 10% MTF. Also, 1:20 is the magnification that is used for the MTF charts

of many LF lenses like Rodenstock's Apo-Sironar N and W. The charts are located in the left half of the image, so the center position, two out of the four corners, and one of the four intermediate positions are evaluated.

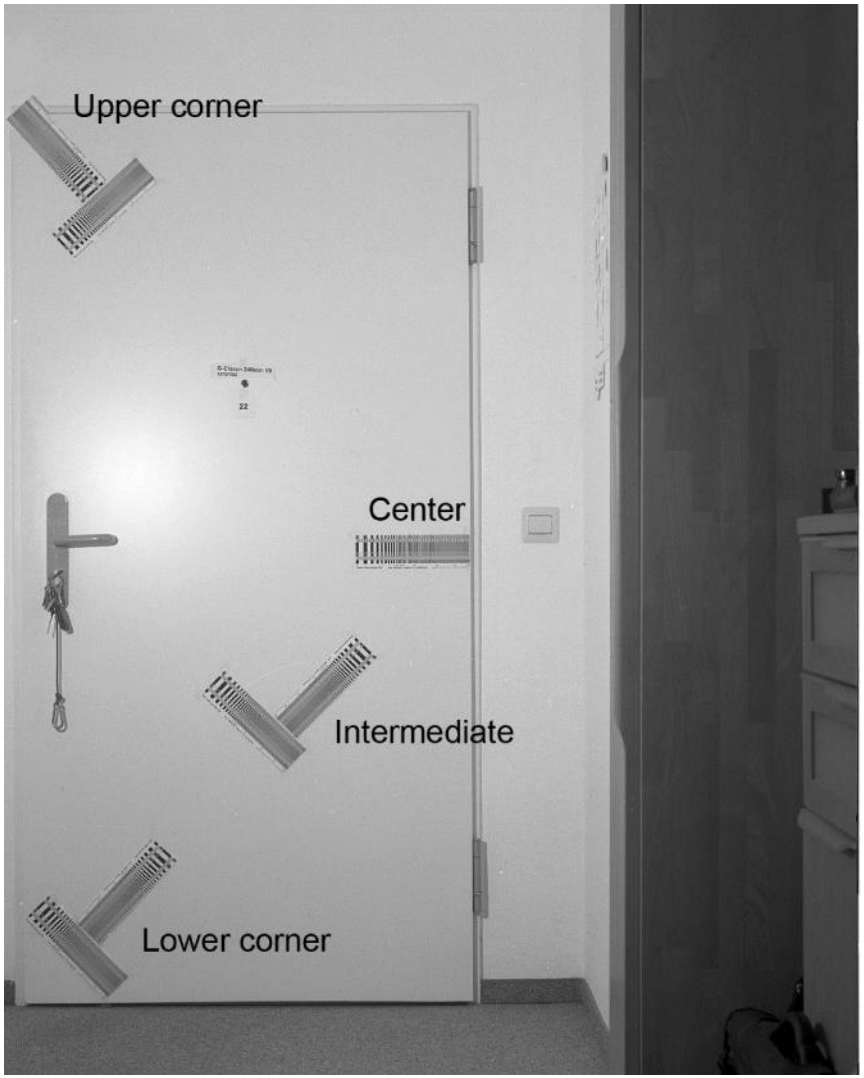

Fig. 1: Scan of one of the 4x5 test negatives showing the setup.

The film holders I use for the tests are the Sinar Precision 4x5 *single* sheet holders employing a pressure plate and full metal construction; the camera is a Linhof Super Color, which is a very stable monorail, on a Gitzo 1325 tripod (not extended, no center post) with a Linhof 3663 three-way head. To ensure parallelism, I use a combination of the Zig-Align ZV1 setup (http://www.zig-align.com/zig-align/View_Cameras.html) and the Versalab parallel laser alignment tool: (http://www.versalab.com/server/photo/products/parallel.htm) . In the beginning, I measure the approximate distance between the lens and object planes for the 1:20 magnification. Then I check the size of the individual test chart images on the ground glass with a caliper and adjust the distance until I have the right value, then I center the image. Then I remove the lens, put the Zig-Align 4x5 main mirror in the camera back and hold the Versalab Laser module onto the door surface at the image center, pointing to the mirror. I adjust the lateral tripod position and angle and the back standard until the laser reflects straight back onto the module. Now the film and object planes are parallel. If necessary, I re-center the image using the horizontal and vertical shift, and then recheck the parallelism of the film and object planes. In the next step, I mount the Zig-Align secondary mirror onto the lens standard and adjust the lens

standard until it is parallel to the film plane. I focus on the ground glass using loupes between 6x and 15x (I have a Bosscreen ground glass which allows the use of such high magnifications) and take images from wide open to f/22 in full stop increments. I use a "rubber ball" release with a long tube to reduce vibrations to a minimum. I do not refocus at other openings, so any focus difference from stopping down will show. The focus shift is usually detectable by a resolution drop from wide open to one or two stops down, and is more common with older lenses optimized for wider openings such as f/3.5 or f/4.5 lenses. It can also show by spurious resolution at higher lp/mm values in the “defocussed” image. The maximum focal length I can test at 1:20 is 360mm.

I develop the TMX negatives in Kodak TMAX RS 1+9 (from concentrate) to N contrast (11:30min) in a Jobo CPP-2 at 75F/24°C and 50rpm. After drying, the negatives are examined in a microscope at 50-200x magnification, and the lp/mm cutoff values for 50% and 10% MTF are noted for each individual chart. As an example, these are 70 numbers for an f/5.6 lens (14x5 different apertures). Occasionally, I tested a lens only at 1 or 2 apertures.

The values in the tables below show the resolution in lp/mm at the stated MTF’s, 50% and 10%. A regular bar graph is also part of the test pattern; as a rule of thumb, the lp/mm resolution numbers for the bar graph are about 10% higher than the 10%MTF values.

For interpreting the results it is useful to have some knowledge about the general characteristics of a lens type. As an example, Tessar and Dagor types, and to a lesser extent also Plasmats, tend to have a slump in their MTF curve at about ½ to ¾ of the image height, with a subsequent increase in performance. For longer focal length, like 240mm, this would be close to the corner of the 4x5 format tested here and one could be tempted to extrapolate the falloff from the center through the intermediate position to the corner, whereas in reality the performance would increase again before the final drop. Dialytes tend to have a little less contrast in the center, but keep their performance pretty even over most of the image circle; 4/4 double Gauss lenses tend to have a continuous falloff towards the edges of the image circle. A comparison with published MTF data, where available, is helpful in assessing the characteristics.

* I realize that this method has some remaining problems, e.g. focusing errors, variability of different shutter speeds, shutter vibrations at different speeds, the use of a Bosscreen, the subjective assessment of the contrast cutoff values (that’s why having lots of numbers for one lens helps, improves the statistics).

65mm lenses

Lens	f stop		Open		4		5.6		8		11		16		22		Remarks
	MTF		50%	10%	50%	10%	50%	10%	50%	10%	50%	10%	50%	10%	50%	10%	
Carl Zeiss Jena Lamegon 65mm f/4.5 682XXXX 1964 single coated Prestor 1	Center		12	30			14	32	12	30	10	18	20	48	20	48	Prototype for the “Grandina” camera Super-Angulon type
	Upper corner	sagittal	10	16			10	16	10	16	8	12	10	18	12	22	
		tangential	10	18			10	16	10	18	10	26	12	24	10	24	
	Lower corner	sagittal	8	12			7	9	7	10	5	8	7	10	10	14	
		tangential	9	14			8	10	7	10	6	9	8	12	10	18	
	Intermediate	sagittal	11	18			10	16	8	14	8	12	14	22	14	28	
		tangential	10	18			8	14	8	14	8	12	16	24	16	32	
Rodenstock Grandagon-N 65mm f/4.5 1101XXXX ca. 1992 multicoated Copal 0	Center		10	16			12	20	16	26	14	26	16	28	16	36	Super-Angulon type
	Upper corner	sagittal	10	18			10	18	11	20	10	14	11	18	12	26	
		tangential	10	16			10	18	10	18	10	18	10	18	12	24	
	Lower corner	sagittal	10	14			10	16	12	18	10	14	10	16	11	24	
		tangential	10	16			10	18	10	22	10	16	12	20	12	26	
	Intermediate	sagittal	14	26			22	30	16	26	14	20	14	24	16	36	
		tangential	16	26			22	32	16	28	16	24	16	26	16	36	
Nikon Nikkor-SW 65mm f/4 700XXX post-1981 multicoated Copal 0	Center		8	20	8	20	7	16	14	36	20	52	20	56	20	52	Super-Angulon type
	Upper corner	sagittal	10	16	10	16	8	16	8	14	10	14	10	18	12	24	
		tangential	8	14	8	14	10	16	10	20	8	20	10	20	10	22	
	Lower corner	sagittal	10	14	10	14	10	16	8	14	8	14	10	16	12	20	
		tangential	10	18	10	18	8	18	12	22	12	22	12	26	12	24	
	Intermediate	sagittal	14	32	14	32	10	18	12	24	14	32	16	48	16	44	
		tangential	10	22	10	22	9	16	10	20	14	28	16	36	16	40	

90-100mm lenses (a)

Lens	f stop		Open		4		5.6		8		11		16		22		Remarks
	MTF		50%	10%	50%	10%	50%	10%	50%	10%	50%	10%	50%	10%	50%	10%	
Nikon Nikkor-SW 90mm f/8 693XXX Post-1981 multicoated Copal 0	Center		36	>80					36	>80	40	>80	50	>80	32	64	Super-Angulon type
	Upper corner	sagittal	16	36					16	36	20	36	22	40	24	44	
		tangential	16	24					16	24	16	24	16	28	20	36	
	Lower corner	sagittal	10	12					10	12	10	14	10	14	12	28	
		tangential	12	16					12	16	10	14	10	14	16	24	
	Intermediate	sagittal	20	28					20	28	20	28	20	32	24	48	
		tangential	20	30					20	30	20	28	20	36	28	52	
Schneider-Kreuznach Angulon 90mm f/6.8 485XXXX 1956-1957 single coated Synchro-Compur 0	Center		24	48					20	46	24	56	24	52	20	48	Reverse Dagor type
	Upper corner	sagittal	6	16					7	18	8	16	10	24	14	36	
		tangential	8	24					8	24	8	24	12	26	12	26	
	Lower corner	sagittal	16	36					12	36	16	42	18	44	20	42	
		tangential	12	24					10	24	14	24	14	28	14	28	
	Intermediate	sagittal	8	22					8	16	16	34	16	28	20	42	
		tangential	12	28					14	30	16	32	20	32	20	40	
Schneider-Kreuznach Angulon 90mm f/6.8 757XXXX 1962 single coated Copal 0 Sinar select Copal 0	Center		16	32					24	60	28	56	24	56	24	48	Reverse Dagor type
	Upper corner	sagittal	8	14					10	16	16	22	16	28	16	40	
		tangential	3	6					4	7	4	8	6	12	7	12	
	Lower corner	sagittal	4	8					6	24	12	26	20	32	16	36	
		tangential	8	16					8	20	10	22	12	22	12	22	
	Intermediate	sagittal	8	14					10	14	12	18	16	28	16	44	
		tangential	10	24					12	28	12	26	16	28	20	36	
Schneider-Kreuznach Angulon 90mm f/5.6 311XXXX 1952 single coated Copal 1	Center		24	48			24	48	28	64	40	>80	32	64	28	52	NOT the regular Angulon (above) or Super-Angulon, a prototype lens, Topogon-type
	Upper corner	sagittal	4	6			4	6	7	10	8	20	16	36	20	40	
		tangential	4	8			4	8	6	10	10	16	10	22	10	16	
	Lower corner	sagittal	4	6			4	6	10	22	16	32	20	36	20	36	
		tangential	4	8			4	8	8	10	10	20	10	24	12	20	
	Intermediate	sagittal	8	10			8	10	22	40	32	48	32	52	24	40	
		tangential	8	14			8	14	10	28	24	40	24	40	24	36	

90-100mm lenses (b)

Lens	f stop		Open		4		5.6		8		11		16		22		Remarks
	MTF		50%	10%	50%	10%	50%	10%	50%	10%	50%	10%	50%	10%	50%	10%	
Schneider-Kreuznach Super-Angulon XL 90mm f/5.6 1492XXXX 2005-2008 multicoated Copal 0	Center		20	48			20	48	28	80	28	80	32	72	28	56	Super-Angulon type
	Upper corner	sagittal	12	28			12	28	12	36	20	52	28	52	24	52	
		tangential	8	20			8	20	8	24	16	28	20	36	18	36	
	Lower corner	sagittal	10	16			10	16	10	22	16	32	24	40	24	44	
		tangential	8	20			8	20	10	24	16	28	24	40	20	40	
	Intermediate	sagittal	20	32			20	32	28	48	28	56	32	56	28	48	
		tangential	20	40			20	40	24	48	28	52	32	56	24	44	
Carl Zeiss Jena Lamegon 90mm f/4.5 6682XXXX 1964 single coated Prestor 1	Center		20	48			20	40	28	48	28	48	24	48	20	44	Prototype lens for “Meopta Grandina” camera Super-Angulon type
	Upper corner	sagittal	12	16			12	20	10	20	12	28	16	32	16	36	
		tangential	8	18			12	22	12	24	14	28	14	28	14	30	
	Lower corner	sagittal	8	12			8	12	8	14	12	18	16	26	16	32	
		tangential	8	16			10	16	10	18	14	24	16	30	16	30	
	Intermediate	sagittal	16	32			20	44	28	56	24	52	24	48	24	48	
		tangential	20	36			24	48	24	52	24	52	24	52	24	44	
Carl Zeiss Jena Lamegon 90mm f/4.5 1009XXXX 1971 single coated Copal electric 1	Center		12	44			28	60	32	68	28	68	28	56	24	44	Super-Angulon type
	Upper corner	sagittal	7	16			9	16	12	18	14	30	16	36	16	36	
		tangential	10	20			12	24	14	24	14	32	14	32	14	28	
	Lower corner	sagittal	10	22			16	24	16	22	16	28	18	40	18	36	
		tangential	14	28			20	44	24	44	22	44	20	40	16	34	
	Intermediate	sagittal	14	24			28	76	32	80	36	76	32	56	24	44	
		tangential	16	30			28	64	32	68	32	64	26	52	24	40	
Rodenstock Geronar WA 90mm f/8 1058XXXX 1984-1985 multicoated Copal 1	Center		20	44					20	44	32	80	30	80	28	56	4/4 Double Gauss
	Upper corner	sagittal	6	14					6	14	8	22	12	36	16	48	
		tangential	5	7					5	7	5	7	6	11	10	20	
	Lower corner	sagittal	16	32					16	32	24	44	24	52	20	46	
		tangential	8	14					8	14	10	16	10	24	16	32	
	Intermediate	sagittal	24	56					24	56	28	64	32	64	24	52	
		tangential	14	28					14	28	20	40	20	40	20	44	

90-100mm lenses (c)

Lens	f stop		Open		4		5.6		8		11		16		22		Remarks
	MTF		50%	10%	50%	10%	50%	10%	50%	10%	50%	10%	50%	10%	50%	10%	
Roeschlein-Kreuznach Rexagon 90mm f/6.8 C64XXX 1950's – 1960's single coated Synchro-Compur 0	Center		20	40					20	44	24	44	24	56	24	48	Reverse Dagor type
	Upper corner	sagittal	2	4					2	4	4	7	6	10	7	16	
		tangential	4	8					4	8	5	10	6	14	8	16	
	Lower corner	sagittal	12	32					12	28	14	36	16	36	20	40	
		tangential	7	10					7	10	7	14	8	16	10	24	
	Intermediate	sagittal	8	18					10	20	16	28	16	28	20	40	
		tangential	10	24					12	26	14	28	16	26	20	36	
Leitmeyr WW Anastigmat 90mm f/6.8 10XXX 1950's – 1960's single coated Prontor 0	Center		12	44					14	44	20	48	24	52	24	52	4/4 double Gauss type
	Upper corner	sagittal	2	4					2	4	3	4	4	6	4	7	
		tangential	2	3					2	4	3	5	4	8	4	8	
	Lower corner	sagittal	2	4					2	4	4	5	4	6	6	8	
		tangential	4	6					4	8	5	8	6	14	8	16	
	Intermediate	sagittal	7	24					10	28	10	32	16	36	20	40	
		tangential	12	36					12	44	16	48	20	52	24	56	
Wray WA Anastigmat 89mm f/6.3 147XXX 1950's – 1960's single coated	Center		16	44					16	40	24	56	24	46	24	46	4/4 double Gauss type
	Upper corner	sagittal	2	3					2	3	2	3	2	3	3	7	
		tangential	1	2					1	2	1	2	1	2	2	3	
	Lower corner	sagittal	2	2					2	2	2	2	2	3	3	4	
		tangential	2	2					2	2	2	2	2	2	3	5	
	Intermediate	sagittal	8	16					8	16	10	16	12	24	16	36	
		tangential	10	20					12	18	12	18	14	26	16	36	
Meyer Optik Weitwinkel Aristostigmat 100mm f/6.3 121XXXX 1950's single coated Synchro-Compur 0	Center		12	28					12	32	20	48	24	48	22	52	4/4 double Gauss type
	Upper corner	sagittal	6	16					6	14	8	16	10	18	10	20	
		tangential	4	10					4	8	5	12	4	12	4	12	
	Lower corner	sagittal	10	20					7	16	8	20	12	24	10	24	
		tangential	6	10					6	12	8	18	8	18	8	18	
	Intermediate	sagittal	10	24					8	16	12	24	18	36	16	40	
		tangential	12	20					10	24	16	32	20	42	20	40	

90-100mm lenses (d)

Lens	f stop		Open		4		5.6		8		11		16		22		Remarks
	MTF		50%	10%	50%	10%	50%	10%	50%	10%	50%	10%	50%	10%	50%	10%	
Eastman Kodak Wide Field Ektar 100mm f/6.3 EI 12XX 1948 Single coated Kodak Supermatic	Center		16	32					20	44	28	80	28	60	24	52	4/4 double Gauss type
	Upper corner	sagittal	5	10					6	10	6	10	7	12	7	16	
		tangential	4	6					4	6	5	16	5	12	5	12	
	Lower corner	sagittal	7	12					7	10	7	10	8	14	8	16	
		tangential	6	8					5	8	6	16	7	10	7	11	
	Intermediate	sagittal	10	16					12	20	14	32	16	40	16	44	
		tangential	8	18					10	18	14	26	16	36	16	40	
	Center																
	Upper corner	sagittal															
		tangential															
	Lower corner	sagittal															
		tangential															
	Intermediate	sagittal															
		tangential															
	Center																
	Upper corner	sagittal															
		tangential															
	Lower corner	sagittal															
		tangential															
	Intermediate	sagittal															
		tangential															
	Center																
	Upper corner	sagittal															
		tangential															
	Lower corner	sagittal															
		tangential															
	Intermediate	sagittal															
		tangential															

110-120mm lenses (a)

Lens	f stop		Open		4		5.6		8		11		16		22		Remarks
	MTF		50%	10%	50%	10%	50%	10%	50%	10%	50%	10%	50%	10%	50%	10%	
Schneider-Kreuznach Super-Symmar XL 110mm f/5.6 1462XXXX 1997 multicoated Copal 1	Center		16	40			16	40	24	52	24	60	28	56	28	52	Aspheric element Proprietary type
	Upper corner	sagittal	10	20			10	20	14	28	20	32	24	40	20	40	
		tangential	6	8			6	8	8	12	8	14	14	24	14	>28	
	Lower corner	sagittal	12	28			12	28	28	36	20	40	20	48	20	44	
		tangential	6	12			6	12	8	16	10	22	16	28	20	36	
	Intermediate	sagittal	16	32			16	32	20	44	16	40	20	48	20	48	
		tangential	12	20			12	20	16	36	14	40	20	40	24	48	
Rodenstock Perigon 110mm f/12 313XXXX 1954 single coated Synchro-Compur 0 Protar V type	Center		24	48									24	52	16	48	f/32: 16 - 40
	Upper corner	sagittal	4	8									8	20	8	20	f/32: 9 - 22
		tangential	3	6									4	8	10	14	f/32: 10 - 18
	Lower corner	sagittal	?	?									6	10	6	20	f/32: 10 - 20
		tangential	3	6									4	8	8	16	f/32: 10 - 16
	Intermediate	sagittal	10	28									8	32	12	28	f/32: 14 - 32
		tangential	10	20									10	24	14	32	f/32: 16 - 36
Voigtländer Ultragon 115mm f/5.5 334XXXX 1952 single coated Compur 2	Center		16	36													Proprietary type developed by A. Tronnier
	Upper corner	sagittal	5	7													
		tangential	6	12													
	Lower corner	sagittal	4	8													
		tangential	8	16													
	Intermediate	sagittal	7	12													
		tangential	7	20													
Voigtländer Ultragon 115mm f/5.5 356XXXX 1953 single coated Compur 2	Center		18	36					24	56	28	64	32	56	24	50	Proprietary type developed by A. Tronnier
	Upper corner	sagittal	4	7					6	8	6	9	10	14	14	24	
		tangential	7	16					10	20	10	24	14	20	12	20	
	Lower corner	sagittal	4	8					4	7	6	10	9	16	12	28	
		tangential	10	18					10	22	14	32	14	28	16	26	
	Intermediate	sagittal	8	12					7	20	9	18	12	24	18	44	
		tangential	10	20					12	36	14	36	16	32	20	44	

110-120mm lenses (b)

Lens	f stop		Open		4		5.6		8		11		16		22		Remarks
	MTF		50%	10%	50%	10%	50%	10%	50%	10%	50%	10%	50%	10%	50%	10%	
Schneider-Kreuznach Super-Symmar HM 120mmf/5.6 1451XXXX 1994 multicoated Copal 0	Center		14	24			14	24	36	>80	40	>80	36	64	24	50	Proprietary type
	Upper corner	sagittal	12	18			12	18	12	16	12	20	16	28	20	40	
		tangential	12	40			12	40	20	>24	16	36	>16	>28	>16	>28	
	Lower corner	sagittal	16	32			16	32	16	24	16	24	24	40	24	44	
		tangential	16	48			16	48	24	48	24	48	28	48	24	40	
	Intermediate	sagittal	14	24			14	24	24	44	24	52	32	60	28	48	
		tangential	20	36			20	36	36	80	40	72	32	60	28	48	
Schneider-Kreuznach Angulon 120mmf/6.8 778XXXX 1962-1963 single coated Synchro-Compur 0	Center		16	48													Reverse Dagor type
	Upper corner	sagittal	5	18													
		tangential	6	12													
	Lower corner	sagittal	4	14													
		tangential	8	16													
	Intermediate	sagittal	10	32													
		tangential	14	36													
Schneider-Kreuznach Super-Angulon 120mmf/8 1430XXXX 1989 multicoated Copal 0	Center										20	56	24	72	24	56	Super-Angulon type
	Upper corner	sagittal									20	76	20	68	20	52	
		tangential									20	56	20	48	16	36	
	Lower corner	sagittal									20	44	22	56	24	48	
		tangential									16	28	16	44	20	40	
	Intermediate	sagittal									20	52	28	68	28	56	
		tangential									20	40	24	60	24	52	
	Center																
	Upper corner	sagittal															
		tangential															
	Lower corner	sagittal															
		tangential															
	Intermediate	sagittal															
		tangential															

135mm lenses (a)

Lens	f stop		Open		4		5.6		8		11		16		22		Remarks
	MTF		50%	10%	50%	10%	50%	10%	50%	10%	50%	10%	50%	10%	50%	10%	
Carl Zeiss Planar 135mm f/3.5 228XXXX 1957-1959 single coated Synchro-Compur 1	Center		14	28	10	24	12	18	16	24	18	26	20	30	20	32	focus shift
	Upper corner	sagittal	12	20	6	10	6	12	6	9	8	14	12	22	16	32	5-element Planar type
		tangential	14	28	14	26	9	24	9	18	12	24	12	24	14	24	
	Lower corner	sagittal	11	16	8	15	9	16	7	13	10	18	14	24	16	32	
		tangential	14	28	12	20	8	22	8	16	10	18	12	24	14	26	
	Intermediate	sagittal	7	10	8	10	7	12	9	14	14	20	20	32	20	34	
		tangential	9	20	7	14	7	18	10	18	12	22	16	28	20	32	
Carl Zeiss Planar 135mm f/3.5 349XXXX 1963 single coated Synchro-Compur 1	Center		12	24	8	22	8	14	10	24	16	28	14	22	20	32	focus shift
	Upper corner	sagittal	5	14	5	6	4	6	6	8	7	12	9	17	12	26	5-element Planar type
		tangential	8	16	6	16	8	14	7	10	8	14	8	18	10	24	
	Lower corner	sagittal	5	14	5	8	5	7	6	8	8	13	8	16	11	24	
		tangential	6	12	8	14	5	16	6	12	8	12	9	18	12	24	
	Intermediate	sagittal	6	8	6	8	6	8	7	11	10	18	12	20	16	32	
		tangential	7	12	7	10	7	14	8	16	12	24	20	28	18	34	
Carl Zeiss Planar T* 135mm f/3.5 657XXXX 1983-1986 multicoated Compur 1	Center		12	20	20	40	16	36	36	80	36	80	36	72	32	56	5-element Planar type
	Upper corner	sagittal	9	12	12	14	10	14	12	18	16	26	20	36	20	36	
		tangential	12	28	16	36	20	40	20	40	20	40	20	36	14	28	
	Lower corner	sagittal	10	16	16	32	20	34	18	30	24	40	20	44	20	40	
		tangential	12	20	16	28	16	32	16	40	16	36	16	36	14	32	
	Intermediate	sagittal	7	12	14	22	12	18	18	26	20	40	24	48	22	44	
		tangential	12	16	18	36	16	24	20	44	24	48	24	44	22	36	
Schneider-Kreuznach Xenotar 135mm f/3.5 512XXXX 1957 single coated Th-glass Synchro-Compur 1	Center		12	28	10	24	10	20	12	22	16	26	16	24	16	32	focus shift
	Upper corner	sagittal	12	16	12	14	11	14	12	16	14	22	14	26	14	36	5-element Planar type
		tangential	12	18	8	20	10	20	9	16	10	22	10	20	12	24	
	Lower corner	sagittal	12	24	10	18	12	20	10	20	12	20	10	18	14	26	
		tangential	8	14	8	12	9	12	10	14	10	16	12	16	12	24	
	Intermediate	sagittal	6	8	6	8	7	10	10	16	12	22	12	22	16	32	
		tangential	7	18	7	16	8	16	14	20	16	26	18	30	20	36	

135mm lenses (b)

Lens	f stop		Open		4		5.6		8		11		16		22		Remarks
	MTF		50%	10%	50%	10%	50%	10%	50%	10%	50%	10%	50%	10%	50%	10%	
Schneider-Kreuznach Xenotar 135mm f/3.5 1146XXXX 1970 single coated Synchro-Compur 1	Center		6	8	7	9	8	12	12	20	14	24	14	24	16	34	5-element Planar type
	Upper corner	sagittal	8	10	8	10	8	11	8	11	10	14	12	20	14	24	
		tangential	7	14	7	14	9	14	7	16	8	18	10	18	10	20	
	Lower corner	sagittal	10	22	10	20	-	-	10	18	12	20	12	18	14	24	
		tangential	9	14	8	14	-	-	9	14	10	20	12	22	12	22	
	Intermediate	sagittal	6	7	6	7	6	8	8	16	12	20	12	20	14	28	
		tangential	6	10	7	12	8	16	12	18	16	26	20	28	20	32	
Rodenstock Apo-Sironar S 135mm f/5.6 1151XXXX ca. 1999 multicoated Copal 0	Center		14	24			14	24	16	48	20	44	32	56	28	52	Plasmat type
	Upper corner	sagittal	16	26			16	26	16	28	16	24	20	38	24	40	
		tangential	20	36			20	36	18	32	20	40	24	44	20	40	
	Lower corner	sagittal	8	12			8	12	9	12	10	16	12	22	16	32	
		tangential	10	18			10	18	12	18	14	22	20	36	22	40	
	Intermediate	sagittal	8	14			8	14	12	20	12	22	28	52	32	48	
		tangential	14	20			14	20	20	32	16	26	28	52	28	46	
Schneider-Kreuznach Apo-Symmar 135mm f/5.6 1443XXXX 1991 multicoated Copal 0	Center		10	16			10	16	14	28	24	60	28	60	24	50	Plasmat type
	Upper corner	sagittal	12	15			12	15	9	12	9	16	14	28	16	38	
		tangential	10	20			10	20	9	20	10	24	16	32	16	32	
	Lower corner	sagittal	10	14			10	14	7	11	10	14	14	24	16	36	
		tangential	12	20			12	20	8	16	10	16	16	30	20	38	
	Intermediate	sagittal	8	14			8	14	10	16	16	32	24	52	24	48	
		tangential	12	22			12	22	12	28	24	44	28	56	24	44	
Schneider-Kreuznach Componon-S 135mm f/5.6 1227XXXX 1973 single coated Compur electronic 3	Center		12	20			12	20	10	16	18	44	28	52	20	44	Plasmat type
	Upper corner	sagittal	16	26			16	26	16	26	20	36	20	44	18	40	
		tangential	16	40			16	40	16	40	20	48	24	40	18	36	
	Lower corner	sagittal	14	28			14	28	14	28	16	32	20	40	20	40	
		tangential	16	22			16	22	14	26	20	34	24	42	20	38	
	Intermediate	sagittal	8	14			8	14	10	13	14	26	20	36	18	40	
		tangential	12	28			12	28	10	22	20	32	24	44	20	42	

135mm lenses (c)

Lens	f stop		Open		4		5.6		8		11		16		22		Remarks
	MTF		50%	10%	50%	10%	50%	10%	50%	10%	50%	10%	50%	10%	50%	10%	
Carl Zeiss Jena Tessar 13,5cm f/4.5 340XXXX 1953 single coated Synchro-Compur	Center		10	32	-	-	11	32	12	26	20	50	28	60	28	52	Tessar type
	Upper corner	sagittal	3	7	-	-	4	5	5	6	6	7	8	12	10	18	
		tangential	6	10	-	-	6	9	6	12	8	14	10	20	10	22	
	Lower corner	sagittal	5	9	-	-	6	9	6	10	7	10	10	20	14	28	
		tangential	9	17	-	-	8	18	10	20	16	32	20	32	16	30	
	Intermediate	sagittal	5	6	-	-	6	7	6	8	8	12	16	28	20	40	
		tangential	8	19	-	-	8	20	9	20	12	22	20	40	18	36	
Meopta Largor 135mm f/6.8 205XXXX 1949-1955 single coated Prontor	Center		10	24					8	36	24	48	20	44	16	28	4/4 double Gauss type
	Upper corner	sagittal	4	5					4	5	4	4	6	8	6	12	
		tangential	4	4					4	4	6	7	7	12	8	16	
	Lower corner	sagittal	0	0					4	4	4	5	6	7	7	9	
		tangential	4	4					6	8	6	8	8	22	8	12	
	Intermediate	sagittal	10	14					8	24	12	28	16	30	20	44	
		tangential	12	24					16	32	20	36	20	40	14	20	
Carl Zeiss Jena Tessar 135mm f/6.3 622XXXX 1961 single coated Synchro-Compur 0	Center		7	12					12	24	14	32	24	48	24	44	Tessar type
	Upper corner	sagittal	4	5					4	5	6	7	7	9	9	14	
		tangential	4	7					4	7	6	12	10	18	10	16	
	Lower corner	sagittal	4	4					4	5	6	7	8	14	12	24	
		tangential	6	8					8	10	6	8	16	32	16	26	
	Intermediate	sagittal	6	7					6	9	10	16	14	36	20	44	
		tangential	7	10					10	14	12	20	24	40	24	40	

150mm lenses

Lens	f stop		Open		4		5.6		8		11		16		22		Remarks
	MTF		50%	10%	50%	10%	50%	10%	50%	10%	50%	10%	50%	10%	50%	10%	
Docter Optic Apo-Germinar W 150mm f/8 10XX 1991-1995 multicoated Copal 1	Center		20	48					20	48	24	60					Proprietary 8/8 construction, process lens corrected for 1:1
	Upper corner	sagittal	12	30					12	30	16	40					
		tangential	10	24					10	24	14	30					
	Lower corner	sagittal	12	28					12	28	14	32					
		tangential	12	24					12	24	14	28					
	Intermediate	sagittal	14	32					14	32	16	40					
		tangential	14	28					14	28	20	48					
	Center																
	Upper corner	sagittal															
		tangential															
	Lower corner	sagittal															
		tangential															
	Intermediate	sagittal															
		tangential															
	Center																
	Upper corner	sagittal															
		tangential															
	Lower corner	sagittal															
		tangential															
	Intermediate	sagittal															
		tangential															
	Center																
	Upper corner	sagittal															
		tangential															
	Lower corner	sagittal															
		tangential															
	Intermediate	sagittal															
		tangential															

180mm lenses (a)

Lens	f stop		Open		4		5.6		8		11		16		22		Remarks
	MTF		50%	10%	50%	10%	50%	10%	50%	10%	50%	10%	50%	10%	50%	10%	
Carl Zeiss Jena Tessar 180mm f/4.5 397XXXX 1954 single coated Compur 2	Center		14	32			14	24	16	36	16	32	20	48			Tessar type
	Upper corner	sagittal	6	12			6	10	6	10	8	16	10	24			
		tangential	8	16			7	16	12	20	12	22	12	24			
	Lower corner	sagittal	4	6			4	6	4	6	5	8	8	12			
		tangential	12	24			14	24	6	18	12	24	16	30			
	Intermediate	sagittal	7	14			10	20	7	14	16	30	20	44			
		tangential	14	32			16	32	12	28	20	36	20	44			
Carl Zeiss Jena Tessar 180mm f/4.5 490XXXX 1958 single coated Compur 2	Center		20	48			16	30	24	64	24	64	26	60	20	46	Tessar type
	Upper corner	sagittal	4	6			4	6	4	6	6	10	10	18	12	36	
		tangential	10	24			12	26	14	32	16	36	14	28	12	24	
	Lower corner	sagittal	6	8			6	8	6	8	8	12	12	20	14	32	
		tangential	16	30			16	32	16	40	16	42	16	42	16	32	
	Intermediate	sagittal	12	44			16	48	12	32	24	52	20	42	20	40	
		tangential	20	40			20	42	18	44	28	60	28	56	22	42	
Voigtländer Heliar 180mm f/4.5 665XXXX ca. 1965 single coated Compur 2	Center		8	32			10	32	8	30	10	32	20	42	20	42	Dynar/Heliar type
	Upper corner	sagittal	4	16			4	20	4	12	5	9	7	14	8	20	
		tangential	5	10			7	14	6	12	6	16	8	22	8	16	
	Lower corner	sagittal	4	7			4	12	3	5	4	6	7	10	9	14	
		tangential	8	14			8	20	4	14	6	12	8	16	8	16	
	Intermediate	sagittal	6	24			7	24	7	12	8	14	14	30	14	32	
		tangential	12	28			8	28	8	22	10	20	16	36	16	34	
Tamron Color-Tamron 180mm f/6.8 71XXX 1970's single coated Copal 1	Center		16	40					18	44	20	68	20	40	20	48	Dagor or reverse Dagor type
	Upper corner	sagittal	3	6					3	12	6	14	12	24	16	40	
		tangential	6	24					6	24	12	40	14	42	18	42	
	Lower corner	sagittal	4	6					3	12	6	16	12	24	16	44	
		tangential	8	24					10	20	14	36	18	44	20	42	
	Intermediate	sagittal	12	40					10	44	18	48	24	60	24	52	
		tangential	14	40					16	46	20	56	20	56	20	48	

180mm lenses (b)

Lens	f stop		Open		4		5.6		8		11		16		22		Remarks
	MTF		50%	10%	50%	10%	50%	10%	50%	10%	50%	10%	50%	10%	50%	10%	
Fujifilm Fujinon A 180mm f/9 282XXX 1980's-1990's multicoated Copal 0	Center		28	68							28	72	28	72	24	52	Plasmat type Optimized for 1:5
	Upper corner	sagittal	12	26							14	36	18	52	16	44	
		tangential	8	20							10	24	14	40	16	40	
	Lower corner	sagittal	14	32							14	36	18	44	20	44	
		tangential	10	22							12	28	16	36	16	40	
	Intermediate	sagittal	16	40							20	48	24	60	20	48	
		tangential	18	40							20	46	24	52	22	48	
Schneider-Kreuznach Apo-Symmar L 180mm f/5.6 1483XXXX 2003 multicoated Copal 1	Center		20	52			20	52	24	60	28	76	24	64	24	56	Plasmat type
	Upper corner	sagittal	10	20			10	20	14	32	20	56	24	60	20	52	
		tangential	16	44			16	44	20	56	20	60	20	56	20	46	
	Lower corner	sagittal	14	24			14	24	16	28	20	52	24	56	24	48	
		tangential	20	44			20	44	22	56	28	64	24	52	22	44	
	Intermediate	sagittal	20	56			20	56	28	76	32	76	28	64	24	52	
		tangential	16	56			16	56	24	76	28	76	24	56	24	48	
	Center																
	Upper corner	sagittal															
		tangential															
	Lower corner	sagittal															
		tangential															
	Intermediate	sagittal															
		tangential															
	Center																
	Upper corner	sagittal															
		tangential															
	Lower corner	sagittal															
		tangential															
	Intermediate	sagittal															
		tangential															

200-210mm lenses

Lens	f stop		Open		4		5.6		8		11		16		22		Remarks
	MTF		50%	10%	50%	10%	50%	10%	50%	10%	50%	10%	50%	10%	50%	10%	
Nikon Nikkor-M 200mm f/8 201XXX post-1981 multicoated Copal 0	Center		24	64					24	64	24	60	28	64	24	52	Tessar type
	Upper corner	sagittal	10	18					10	18	12	20	14	30	16	48	
		tangential	12	>32					12	>32	12	>32	14	>32	16	>32	
	Lower corner	sagittal	16	32					16	32	18	32	20	40	20	48	
		tangential	16	36					16	36	16	28	18	34	16	44	
	Intermediate	sagittal	24	56					24	56	20	36	24	60	24	52	
		tangential	24	60					24	60	24	36	24	62	24	52	
Rodenstock Apo-Sironar S 210mm f/5.6 11466XXX 1997 multicoated Copal 1	Center												24	64			Plasmat type
	Upper corner	sagittal											16	44			
		tangential											24	56			
	Lower corner	sagittal											20	40			
		tangential											26	56			
	Intermediate	sagittal											28	64			
		tangential											28	60			
Docter Optic Germinar W 210mm f/9 10XX 1995-1996 multicoated Copal 1	Center		12	36							12	52	24	64	24	52	Plasmat type
	Upper corner	sagittal	10	40							10	52	16	56	16	52	
		tangential	8	28							10	32	16	56	20	52	
	Lower corner	sagittal	10	32							10	40	18	44	24	52	
		tangential	8	24							10	28	18	52	24	48	
	Intermediate	sagittal	10	40							12	48	28	68	24	56	
		tangential	16	44							20	56	24	64	22	52	

240-250mm lenses (a)

Lens	f stop		Open		4		5.6		8		11		16		22		Remarks
	MTF		50%	10%	50%	10%	50%	10%	50%	10%	50%	10%	50%	10%	50%	10%	
Rodenstock Apo-Ronar 240mm f/9 1164XXXX ca. 2000-2001 multicoated Copal 1	Center		20	44							20	48	28	72	24	56	Last “blue ring” version Dialyte type
	Upper corner	sagittal	8	12							8	20	10	20	14	32	
		tangential	10	18							12	24	16	36	16	40	
	Lower corner	sagittal	8	14							10	20	14	28	16	32	
		tangential	12	20							12	28	20	40	20	42	
	Intermediate	sagittal	16	30							16	40	28	60	28	52	
		tangential	16	36							20	48	28	56	24	52	
Docter Optic Apo-Germinar 240mm f/9 10XX 1991-1995 single coated w/o washer Copal 1	Center		28	76							28	80	32	76	28	56	4/4Dialyte type
	Upper corner	sagittal	8	30							10	28	12	28	14	32	
		tangential	8	14							12	22	12	30	14	28	
	Lower corner	sagittal	12	24							14	24	20	36	20	40	
		tangential	14	22							14	26	18	44	20	42	
	Intermediate	sagittal	24	48							28	52	28	68	24	56	
		tangential	24	48							24	52	28	60	24	52	
Docter Optic Apo-Germinar 240mm f/9 10XX 1991-1995 single coated with 0.4mm washer Copal 1	Center		28	80							28	80	32	76	28	56	4/4Dialyte type
	Upper corner	sagittal	8	24							10	28	16	28	14	36	
		tangential	10	16							12	18	14	32	14	32	
	Lower corner	sagittal	12	22							12	26	16	36	20	44	
		tangential	12	22							16	26	20	42	24	44	
	Intermediate	sagittal	20	44							24	52	28	60	28	56	
		tangential	20	40							24	48	28	60	24	56	
Docter Optic Apo-Germinar W 240mm f/8 10XX 1991-1995 single coated Copal 3	Center		28	64					28	64	28	76	28	68			Proprietory 8/8 type
	Upper corner	sagittal	10	18					10	18	16	32	18	44			
		tangential	10	16					10	16	16	28	20	44			
	Lower corner	sagittal	12	20					12	20	18	32	24	52			
		tangential	10	16					10	16	16	32	20	48			
	Intermediate	sagittal	16	40					16	40	28	60	28	68			
		tangential	16	32					16	32	24	52	24	60			

240-250mm lenses (b)

Lens	f stop		Open		4		5.6		8		11		16		22		Remarks
	MTF		50%	10%	50%	10%	50%	10%	50%	10%	50%	10%	50%	10%	50%	10%	
Docter Optic Germinar W 240mm f/9 10XX 1995 multicoated Copal 1	Center		24	64							32	76	32	64	28	56	Plasmat type
	Upper corner	sagittal	8	16							10	18	12	20	20	32	
		tangential	8	16							10	20	10	26	12	28	
	Lower corner	sagittal	10	20							14	24	16	28	20	44	
		tangential	12	18							14	24	20	32	20	34	
	Intermediate	sagittal	20	48							32	60	30	60	28	56	
		tangential	20	44							28	56	32	56	30	56	
Schneider-Kreuznach G-Claron 240mm f/9 1379XXXX 1980 single coated Copal 1	Center		20	40							20	48	28	56	24	56	Plasmat type
	Upper corner	sagittal	8	14							10	20	8	16	12	24	
		tangential	8	10							10	16	8	22	10	24	
	Lower corner	sagittal	8	12							8	20	10	18	14	28	
		tangential	8	12							10	20	10	32	16	36	
	Intermediate	sagittal	16	32							20	48	18	40	20	48	
		tangential	16	32							20	52	20	52	24	52	
Voigtländer Heliar 240mm f/4.5 415XXXX ca. 1956 single coated Compound IV	Center		10	28			16	28	18	36	18	34	20	40	20	44	Dynar/Heliar type
	Upper corner	sagittal	5	8			6	24	6	20	8	20	10	28	14	40	
		tangential	8	20			10	16	10	24	12	28	14	32	14	32	
	Lower corner	sagittal	6	9			8	24	8	24	12	24	14	28	14	36	
		tangential	12	26			10	18	12	26	14	28	16	36	16	32	
	Intermediate	sagittal	10	30			16	32	14	40	20	40	24	46	20	46	
		tangential	14	32			16	32	16	40	18	38	20	40	18	42	
Voigtländer Heliar 240mm f/4.5 470XXXX ca. 1958 single coated Compound IV	Center		16	28			12	24	24	36	20	36	24	40	24	44	Dynar/Heliar type
	Upper corner	sagittal	5	8			6	14	8	20	10	24	12	28	16	36	
		tangential	6	20			8	20	12	24	14	28	14	32	14	32	
	Lower corner	sagittal	6	12			6	8	8	22	10	22	20	32	22	40	
		tangential	12	24			8	28	12	24	14	28	16	32	18	32	
	Intermediate	sagittal	14	32			10	28	16	40	20	40	24	48	24	48	
		tangential	14	30			12	28	20	40	20	36	24	36	24	40	

240-250mm lenses (c)

Lens	f stop		Open		4		5.6		8		11		16		22		Remarks
	MTF		50%	10%	50%	10%	50%	10%	50%	10%	50%	10%	50%	10%	50%	10%	
Schneider-Kreuznach Xenar 240mm f/4.5 503XXXX 1957 single coated Compound IV	Center		12	20			10	28	16	36	20	38	20	48	20	44	Tessar type
	Upper corner	sagittal	4	16			4	16	4	16	7	20	10	24	12	36	
		tangential	6	20			4	20	8	28	8	32	14	36	16	40	
	Lower corner	sagittal	6	18			5	24	6	24	10	24	10	22	14	36	
		tangential	8	16			10	20	10	22	14	28	16	40	16	44	
	Intermediate	sagittal	10	22			10	32	14	40	20	44	24	48	24	46	
		tangential	12	22			14	26	16	30	18	36	24	48	20	46	
Carl Zeiss Jena Tessar 250mm f/3.5 355XXXX 1954 Single coated Compound V	Center		6	20	8	18	10	32	16	36	16	38	20	52	16	44	Tessar type
	Upper corner	sagittal	3	10	3	12	3	10	6	16	8	22	12	24	14	34	
		tangential	4	7	3	6	6	12	8	14	8	18	12	24	12	24	
	Lower corner	sagittal	1	2	1	2	2	3	3	5	5	7	8	12	10	18	
		tangential	2	4	2	8	3	8	5	16	7	20	8	22	12	24	
	Intermediate	sagittal	4	20	5	24	5	28	12	40	20	48	24	56	24	52	
		tangential	4	22	6	22	8	28	14	40	18	44	22	48	20	46	
Carl Zeiss Oberkochen Sonnar 250mm f/5.6 228XXXX 1958-1959 single coated Synchro-Compur 1	Center		32	64			32	64	32	60	32	64	36	60	32	52	For Linhof Technika Sonnar type
	Upper corner	sagittal	10	24			10	24	14	28	14	24	16	36	20	40	
		tangential	10	16			10	16	10	14	12	16	16	32	20	44	
	Lower corner	sagittal	10	28			10	28	10	16	12	16	14	24	20	32	
		tangential	10	22			10	22	12	28	12	24	16	24	16	24	
	Intermediate	sagittal	20	56			20	56	20	56	24	52	28	56	20	52	
		tangential	20	36			20	36	24	48	28	44	28	48	24	44	
	Center																
	Upper corner	sagittal															
		tangential															
	Lower corner	sagittal															
		tangential															
	Intermediate	sagittal															
		tangential															

270-305mm lenses (a)

Lens	f stop		Open		4		5.6		8		11		16		22		Remarks
	MTF		50%	10%	50%	10%	50%	10%	50%	10%	50%	10%	50%	10%	50%	10%	
Goerz Apo-Artar 10¾"-270mm f/9.5 802XXX post-1955 single coated Synchro-Compur 1	Center		20	44							24	48	24	40	24	44	4/4 Dialyte type
	Upper corner	sagittal	12	24							12	28	16	40	18	44	
		tangential	12	20							10	22	12	28	14	32	
	Lower corner	sagittal	8	20							12	24	14	32	16	40	
		tangential	10	16							10	18	12	32	16	32	
	Intermediate	sagittal	14	32							20	48	20	40	24	44	
		tangential	16	40							20	48	24	40	24	44	
Carl Zeiss Jena Tessar 270mm f/8 682XXXX 1964 single coated Prestor 1	Center		16	32					16	32	20	40	20	44	20	42	Prototype for the "Grandina" camera Tessar type
	Upper corner	sagittal	8	16					8	16	10	24	14	36	18	42	
		tangential	8	20					8	20	10	22	12	32	16	36	
	Lower corner	sagittal	10	18					10	18	12	24	16	32	18	40	
		tangential	16	28					16	28	16	32	20	42	20	40	
	Intermediate	sagittal	16	32					16	32	16	36	20	48	20	44	
		tangential	20	36					20	36	16	40	20	52	20	46	
Docter Optic Apo-Germinar 300mm f/9 with washer 10XX 1994 single coated Copal 1	Center		24	40							28	60	32	60	28	48	4/4 Dialyte type
	Upper corner	sagittal	8	20							10	28	14	28	20	44	
		tangential	10	20							10	24	20	40	20	44	
	Lower corner	sagittal	10	24							10	24	16	36	20	40	
		tangential	8	16							12	24	18	32	20	36	
	Intermediate	sagittal	14	36							16	40	24	48	24	48	
		tangential	14	28							16	40	24	40	24	44	
Rodenstock Apo-Ronar MC 300mm f/9 Linhof Select 1088XXXX ca. 1990 multicoated Compur 1	Center		20	72							-	64	20	60	24	48	4/4 Dialyte type
	Upper corner	sagittal	14	20							12	24	12	32	16	44	
		tangential	8	18							10	26	>16	>28	16	>28	
	Lower corner	sagittal	10	20							10	28	12	28	20	42	
		tangential	12	20							12	28	24	48	24	44	
	Intermediate	sagittal	20	32							20	40	26	56	24	48	
		tangential	20	32							24	48	24	56	24	52	

270-305mm lenses (b)

Lens	f stop		Open		4		5.6		8		11		16		22		Remarks
	MTF		50%	10%	50%	10%	50%	10%	50%	10%	50%	10%	50%	10%	50%	10%	
Nikon Nikkor-M 300mm f/9 750XXX post-1981 multicoated Copal 1	Center		20	40							>36	48	36	56	28	52	Tessar type
	Upper corner	sagittal	8	16							10	18	16	28	20	40	
		tangential	8	16							6	16	10	18	20	24	
	Lower corner	sagittal	7	9							12	16	16	24	16	32	
		tangential	7	10							8	16	12	18	16	32	
	Intermediate	sagittal	10	18							16	36	24	48	24	52	
		tangential	12	18							20	36	24	48	24	52	
Fuji Fujinon-C 300mm f/8.5 633XXX 1990's? multicoated Copal 1	Center		22	64								54	20	60	28	48	Asymmetric 4/4 dialyte derivative
	Upper corner	sagittal	10	20							12	20	12	28	14	40	
		tangential	12	28							12	30	16	32	18	40	
	Lower corner	sagittal	10	20							12	24	14	36	18	40	
		tangential	12	32							14	36	16	40	24	40	
	Intermediate	sagittal	16	40							20	44	20	60	24	48	
		tangential	18	40							20	48	24	56	24	44	
Fuji Fujinon-A 300mm f/9 780XXX 1980's? multicoated Copal 1	Center		20	40							24	44	24	60	24	52	Plasmat type
	Upper corner	sagittal	10	24							10	28	12	28	20	44	
		tangential	8	18							10	32	12	32	>12	>32	
	Lower corner	sagittal	10	20							16	28	20	48	20	44	
		tangential	10	20							12	24	16	36	20	36	
	Intermediate	sagittal	16	32							20	44	24	64	20	52	
		tangential	18	36							20	40	24	52	20	48	
Schneider-Kreuznach G-Claron 305mm f/9 1439XXXX 1990 single coated Copal 1	Center		14	32							16	40	16	32	14	36	Plasmat type
	Upper corner	sagittal	6	13							8	14	8	18	12	28	
		tangential	6	16							8	20	8	>20	>8	>20	
	Lower corner	sagittal	7	10							8	14	8	16	10	24	
		tangential	7	14							8	19	12	28	16	32	
	Intermediate	sagittal	10	18							12	24	12	24	14	28	
		tangential	12	22							16	28	16	32	18	36	

270-305mm lenses (c)

Lens	f stop		Open		4		5.6		8		11		16		22		Remarks
	MTF		50%	10%	50%	10%	50%	10%	50%	10%	50%	10%	50%	10%	50%	10%	
Docter Optic Tessar 300mm f/5.6 10XX 1992-1995 single coated Copal 3	Center		8	32			8	32	16	44	20	50	24	56	28	46	Tessar type
	Upper corner	sagittal	4	12			4	12	6	20	10	20	10	24	16	40	
		tangential	4	24			4	24	12	>30	16	>30	16	>30	16	>30	
	Lower corner	sagittal	4	8			4	8	6	12	8	14	12	20	16	36	
		tangential	6	28			6	28	12	40	16	40	16	36	16	32	
	Intermediate	sagittal	6	28			6	28	10	32	24	48	24	52	24	48	
		tangential	8	32			8	32	16	44	24	52	28	44	24	40	

350-360mm lenses (a)

Lens	f stop		Open		4		5.6		8		11		16		22		Remarks
	MTF		50%	10%	50%	10%	50%	10%	50%	10%	50%	10%	50%	10%	50%	10%	
Schneider-Kreuznach Apo-Tele-Xenar 350mm f/11 1504XXXX 2010 multicoated Copal 1 4/4 dialyte type	Center		24	56							24	56	32	60	32	52	f/32: 28 44
	Upper corner	sagittal	12	28							12	28	24	36	24	44	f/32: 24 36
		tangential	20	32							20	32	24	36	24	36	f/32: 20 36
	Lower corner	sagittal	20	32							20	32	28	40	28	40	f/32: 24 36
		tangential	20	34							20	34	28	40	32	48	f/32: 28 36
	Intermediate	sagittal	32	48							32	48	40	52	32	44	f/32: 28 36
		tangential	28	44							28	44	40	56	36	52	f/32: 28 36
Rodenstock Apo-Ronar 360mm f/9 448XXXX 1960 single coated Compur 2	Center		24	48							28	56	32	60	28	52	4/4 Dialyte type
	Upper corner	sagittal	10	32							12	28	14	28	20	40	
		tangential	12	32							12	24	18	36	20	40	
	Lower corner	sagittal	10	28							16	32	16	26	20	40	
		tangential	12	24							14	30	20	40	24	44	
	Intermediate	sagittal	16	36							28	56	32	56	28	52	
		tangential	18	40							28	56	26	56	26	50	
Rodenstock Apo-Ronar 360mm f/9 556XXXX 1964 single coated Compur 2	Center		20	40							20	36	18	24	16	24	4/4 Dialyte type
	Upper corner	sagittal	9	24							10	24	10	20	12	24	
		tangential	12	20							12	24	16	30	20	28	
	Lower corner	sagittal	10	24							10	24	14	24	16	32	
		tangential	12	24							14	28	20	28	20	28	
	Intermediate	sagittal	20	40							20	36	20	32	20	32	
		tangential	22	44							24	48	20	30	20	32	
Rodenstock Apo-Ronar 360mm f/9 629XXXX 1969 single coated Compur 2	Center		28	56							18	40	24	48	24	48	4/4 Dialyte type
	Upper corner	sagittal	10	32							10	26	14	32	20	44	
		tangential	12	18							12	24	14	36	16	36	
	Lower corner	sagittal	10	28							10	24	14	28	20	40	
		tangential	12	20							14	24	20	36	22	44	
	Intermediate	sagittal	18	38							20	36	24	48	28	48	
		tangential	20	40							20	32	24	48	28	48	

350-360mm lenses (b)

Lens	f stop		Open		4		5.6		8		11		16		22		Remarks
	MTF		50%	10%	50%	10%	50%	10%	50%	10%	50%	10%	50%	10%	50%	10%	
Fuji Fujinon-A 360mm f/10 521XXX 1980's? multicoated Copal 1	Center		26	56							28	68	32	64	28	52	Plasmat type
	Upper corner	sagittal	14	46							18	52	24	56	24	52	
		tangential	12	28							14	30	16	32	20	36	
	Lower corner	sagittal	20	36							24	40	28	48	28	48	
		tangential	14	28							16	32	24	40	20	40	
	Intermediate	sagittal	28	56							32	58	28	56	28	48	
		tangential	24	52							24	56	24	56	28	52	
Schneider-Kreuznach Apo-Artar 360mm f/9 1442XXXX 1991 single coated Prontor 3	Center		24	48							24	48	28	56	28	52	4/4 Dialyte type
	Upper corner	sagittal	10	28							10	32	14	40	20	42	
		tangential	10	24							10	28	16	36	24	44	
	Lower corner	sagittal	12	32							14	36	18	44	24	46	
		tangential	12	28							12	32	16	42	22	42	
	Intermediate	sagittal	24	52							28	56	28	52	28	52	
		tangential	20	48							24	56	28	56	28	48	
Docter Optic Apo-Germinar 360mm f/9 w/o washer 10XX 1992-1995 single coated Copal 3	Center		28	52							24	48	28	52	28	52	4/4 Dialyte type
	Upper corner	sagittal	10	20							12	32	16	30	24	40	
		tangential	8	16							10	24	16	28	18	32	
	Lower corner	sagittal	12	20							16	28	20	32	24	38	
		tangential	12	24							14	28	20	40	24	40	
	Intermediate	sagittal	24	40							26	36	28	52	28	52	
		tangential	20	36							24	44	24	52	24	50	
Docter Optic Apo-Germinar 360mm f/9 with washer 10XX 1992-1995 single coated Copal 3	Center		20	32							24	40	24	48	28	52	4/4 Dialyte type
	Upper corner	sagittal	10	20							12	36	16	34	18	46	
		tangential	12	18							12	28	18	44	24	44	
	Lower corner	sagittal	12	20							14	24	16	36	20	44	
		tangential	12	22							16	28	20	44	24	46	
	Intermediate	sagittal	16	26							20	36	24	44	24	48	
		tangential	16	36							20	44	28	52	28	52	

350-360mm lenses (c)

Lens	f stop		Open		4		5.6		8		11		16		22		Remarks
	MTF		50%	10%	50%	10%	50%	10%	50%	10%	50%	10%	50%	10%	50%	10%	
Schneider-Kreuznach Repro-Claron 355mm f/9 859XXXX 1964 Th-glass single coated Compur 2	Center		12	24							10	20	10	14	7	10	Defective!? 4/4 Dialyte type
	Upper corner	sagittal	6	20							6	20	6	12	6	8	
		tangential	6	12							8	12	10	18	12	20	
	Lower corner	sagittal	6	12							6	10	7	12	6	9	
		tangential	6	20							8	12	10	16	8	22	
	Intermediate	sagittal	12	18							10	14	10	13	7	9	
		tangential	10	20							10	14	8	20	7	18	
Schneider-Kreuznach Repro-Claron 355mm f/9 1163XXXX 1970 single coated Compound III	Center		10	24							16	28	16	32	20	40	4/4 Dialyte type
	Upper corner	sagittal	6	12							8	14	10	16	10	24	
		tangential	8	18							8	20	10	20	12	24	
	Lower corner	sagittal	10	16							10	18	14	24	12	30	
		tangential	8	18							10	18	10	22	12	24	
	Intermediate	sagittal	16	28							14	30	16	36	20	40	
		tangential	12	18							12	20	16	24	16	32	
Voigtänder Telomar 360mm f/5.5 663XXXX 1964-1965 single coated Compound III	Center		12	48					20	48	20	52	24	48	24	50	Telephoto type
	Upper corner	sagittal	12	30					16	30	12	32	16	40	14	44	
		tangential	10	14					8	20	12	24	10	22	12	28	
	Lower corner	sagittal	20	40					16	30	18	40	20	36	20	44	
		tangential	14	22					10	16	14	22	20	24	16	32	
	Intermediate	sagittal	18	48					16	40	20	50	20	36	22	52	
		tangential	16	34					16	32	16	36	16	28	16	30	
Schneider-Kreuznach Tele-Xenar 360mm f/5.5 649XXXX 1960-1961 single coated Compound III	Center		16	40					16	40	20	48	24	48	24	48	Linhof select Telephoto type
	Upper corner	sagittal	14	32					16	40	16	44	24	48	24	46	
		tangential	10	24					10	>24	12	>24	>12	>24	>12	>24	
	Lower corner	sagittal	16	28					16	28	16	32	20	40	24	40	
		tangential	10	24					8	24	10	14	10	16	12	20	
	Intermediate	sagittal	14	32					16	36	22	44	24	52	24	48	
		tangential	14	28					14	32	16	40	20	36	18	34	

350-360mm lenses (d)

Lens	f stop		Open		4		5.6		8		11		16		22		Remarks
	MTF		50%	10%	50%	10%	50%	10%	50%	10%	50%	10%	50%	10%	50%	10%	
Schneider-Kreuznach Tele-Arton 360mm f/5.5 870XXXX 1964 single coated Compound III	Center		6	28					7	28	16	42	20	48	24	48	Telephoto type Linhof Technika select
	Upper corner	sagittal	6	24					6	24	8	32	16	40	20	40	
		tangential	4	6					4	6	5	8	6	8	6	9	
	Lower corner	sagittal	4	8					4	8	6	12	10	18	16	32	
		tangential	4	6					4	6	5	14	6	14	7	14	
	Intermediate	sagittal	6	20					7	24	14	40	20	46	20	46	
		tangential	6	18					8	20	12	32	16	32	16	30	
Schneider-Kreuznach Tele-Arton 360mm f/5.5 1099XXXX 1968 single coated Compound III	Center		8	28					12	36	16	46	24	52	24	48	Telephoto type Linhof Technika select
	Upper corner	sagittal	8	18					8	28	10	32	16	42	16	44	
		tangential	5	6					6	7	6	8	7	12	6	10	
	Lower corner	sagittal	4	7					6	10	7	16	12	22	12	32	
		tangential	4	8					6	14	7	14	7	12	7	10	
	Intermediate	sagittal	6	24					8	36	14	44	24	56	24	48	
		tangential	10	20					14	32	14	34	14	34	14	30	
	Center																
	Upper corner	sagittal															
		tangential															
	Lower corner	sagittal															
		tangential															
	Intermediate	sagittal															
		tangential															
	Center																
	Upper corner	sagittal															
		tangential															
	Lower corner	sagittal															
		tangential															
	Intermediate	sagittal															
		tangential															