Center Filters For Large Format Lenses

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Introduction

While trying to understand how Horseman exposure meters would perform with wide angle lenses, (please see http://www.galerie-photo.com/horseman-4x5-exposure-meter.html, English; http://www.galerie-photo.com/posemetre-calculateur-horseman-pour-chambre.html, Français) I had to think about optical vignetting, the natural fall in illumination off-axis that afflicts all lenses. For most LF lenses illumination falls off with $\cos^4$ of the angle off axis. Some modern wide angle lenses have somewhat less falloff but even for them $\cos^4$ is a reasonable approximation.

I realized that my 58/5.6 Grandagon and 65/8 Fujinon, both usable, to my taste, on 2x3 without center filters, would need them when used on 6x12. I found much confusion and error in discussions on the 'net about which center filter to use. The problem is especially acute for Fujinon and Nikon wide angle lenses; Fuji and Nikon didn't make center filters or suggest which to use on their w/a lenses. There's also no information about CFs for early Grandagons such as my 58/5.6.

Figure 1: An example of a center filter, Rodenstock 4X filter for the Apo Grandagon Series

1 Schneider, Rodenstock and Heliopan center filters

To find out which CFs might do for my lenses I made a list of Schneider and Rodenstock wide angle lenses and CFs. Schneider and Rodenstock agree that lenses which cover 100° to 105° should use + 1.5 center filters. They also agree that lenses which cover more than 110° need + 2. They disagree about 110° lenses. Schneider recommends + 1.5 for them, Rodenstock recommends + 2. The table below (table 1) summarizes what I found and puts Fujinon and Nikon wide angle lenses in the Schneider/Rodenstock context.

Table 1: **$\cos^4$ loss of illumination, center to corner, for modern extreme w/a lenses**

coverage	90°	100°	102°	105°	106°	110°	115°	120°
stops down	-2.0	-2.6	-2.7	-2.9	-2.9	-3.2	-3.6	-4.0
recommended CF	none	+1.5, Rodenstock recommends + 2.0 for 110°					+2.0	
Fujinon		f/8 SW, N SW		f/5.6 SWD				
Nikon				SW				
Schneider		f/6.8 SA		f/5.6 SA		58/5.6 SA XL	72/5.6 SA XL	38/5.6 SA XL
		f/8 SA		f/5.6 SS A		90/5.6 SA XL		47/5.6 SA XL
		210 SSA XL		80, 110, 150 SSA XL				
Rodenstock			f/6.8 G-N			45, 55 AG		35/4.5 AG

The tables below (tables 2, 3 and 4) list Schneider, Rodenstock and Heliopan CFs by the manufacturers' designations, can be used to a find CF that will fit a lens and has the right exposure correction.

Table 2: **Schneider center filters**

Schneider				
Designation	Exposure correction (stops)	Rear thread	Front thread	Recommended focal lengths
I	1.5	M49x0.75	M58x0.75	65
II	1.5	M49x0.75	M67x0.75	47
II	1.5	M52x0.75	M67x0.75	47, 75
IIa	2.0	M72x0.75	M82x0.75	38
IIb	2.0	M67x0.75	M72x0.75	24
IId	2.0	M52x0.75	M72x0.75	24
IIf	2.0	M52x0.75	M72x0.75	35
IIg	2.0	M67x0.75	M72x0.75	35
IIh	1.5	M62x0.75	M72x0.75	60
IIi	1.5	M58x0.75	M72x0.75	43
III	1.5	M67x0.75	M86x1	65, 75
IIIa	1.5	M67x0.75	M86x1	90
IIIb	1.5	M67x0.75	M86x1	47
IIIc	2.0	M67x0.75	M86x1	47
IIId	1.5	M82x0.75	M105x1	90
IV	1.5	M77x0.75	M105x1	121
IV	1.5	M82x0.75	M105x1	90, 120
IVa	1.5	M95x1	M112x1.5	72, 90
IVb	2.0	M95x1	M112x1.5	72
VI	1.5	M135x1	M152x1	210
VId	2.0	M86x0.75	no front threads	28

Table 3: **Rodenstock center filters**

Rodenstock				
Designation	Exposure correction (stops)	Rear thread	Front thread	Recommended focal lengths
E58/77	1.5	M58x0.75	M77x0.75	65, 75
E67/86	1.5	M67x0.75	M86x1	75, 90
E67/86	2.0	M67x0.75	M86x1	35, 45, 55
E67/86	2.5	M67x0.75	M86x1	35, 45, 55
E82/112	1.5	M82x0.75	M112x1.5	90, 115
E105/127	1.5	M105x1	M127x?	155
E135/-	2.0	M135x1		200

Schneider and Rodenstock center filters aren't particularly lens-specific, their makers' propaganda notwithstanding.

Table 4: **Heliopan center filters**

Heliopan ND Center Filters			
Designation (as many as two types in each row; 3X, 8X)	Exposure Correction (stops)	Front Thread	Rear Thread
49mm ND Center Filter 3X, 8X	1.5, 3	M49x0.75	M67x0.75
52mm ND Center Filter 3X, 8X	1.5, 3	M52x0.75	M67x0.75
58mm ND Center Filter 3X	1.5	M58x0.75	M77x0.75
67mm ND Center Filter 3X, 8X	1.5, 3	M67x0.75	M86x1
77mm ND Center Filter 3X, 8X	1.5, 3	M77x0.75	M105x1
82mm ND Center Filter 3X	1.5	M82x0.75	M105x1
95mm ND Center Filter 3X, 8X	1.5, 3	M95x1	M105x1

I've seen comments about center filters' +1.5 and +2 markings to the effect that these are adjustments to exposure times. Schneider and Rodenstock literature on center filters make it very clear that the markings refer to f/stop adjustments to be made when using a center filter. The corresponding adjustments to exposure times are 3x (1.5 stops) and 4x (2 stops).

Some filters are marked ND 0.45 instead of + 1.5 or 2x. They're equivalent. Similarly, ND 0.6 is the same as +2 and 4x and ND 0.9 is equivalent to +3 and 8x.

2 Suggestions for Nikon and Fuji wide-angle lenses

Here are my suggestions for Nikon (table 5) and Fuji (table 6) wide angle lenses that follow Schneider and Rodenstock recommendations for similar lenses:

Table 5: **Suggestions for Nikon wide angle lenses**

Nikkor SW[1]		Likely Center Filter		
lens	filter threads	Schneider	Rodenstock	Heliopan
65/4	M67x0.75	III	+1.5 E67/86	67mm ND Center Filter 3X
75/4.5	M67x0.75	III	+1.5 E67/86	67mm ND Center Filter 3X
90/4.5	M82x0.75	IV	+1.5 E82/112	82mm ND Center Filter 3X
90/8	M67x0.75	IIIa (III?)	+1.5 E67/86	67mm ND Center Filter 3X
120/8	M77x0.75	IV (with step ring to 77 mm)[2]	+1.5 E82/112 (with step ring to 77 mm) [2]	77mm ND Center Filter 3X
150/8	M95x1	IVa	--	95mm ND Center Filter 3X
[1] none of these lenses covers more than 106°				
[2] this follows Schneider's recommendation for using CF IV with step ring on the 121/8 SA				

Table 6: **Suggestions for Fuji wide angle lenses**

Fujinon SW[1] & SWD[1]		Likely Center Filter		
lens	filter threads	Schneider	Rodenstock	Heliopan
65/8	M52x0.75	II	--	52mm ND Center Filter 3X
65/5.6	M62x0.75	III with step ring	+1.5 E67/86 with step ring	--
65/5.6	M67x0.75	III	+1.5 E67/86	67mm ND Center Filter 3X
75/8	M58x0.75	--	+1.5 E58/77	58mm ND Center Filter 3X
75/5.6	M67x0.75	III	+1.5 E67/86	67mm ND Center Filter 3X
90/8	M67x0.75	IIIa (III?)	+1.5 E67/86	67mm ND Center Filter 3X
90/5.6	M82x0.75	IV	+1.5 E82/112	82mm ND Center Filter 3X
105/8	M67x0.75	IIIa (III?)	+1.5 E67/86	67mm ND Center Filter 3X
105/8	M77x0.75	IV (with step ring to 77 mm)[2]	+1.5 E82/112 (with step ring to 77 mm) [2]	77mm ND Center Filter 3X
120/8	M77x0.75	IV (with step ring to 77 mm)[2]	+1.5 E82/112 (with step ring to 77 mm) [2]	77mm ND Center Filter 3X
125/8	M82x0.75	IV	+1.5 E82/112	82mm ND Center Filter 3X
300/9	M145	--	--	--
[1] none of these lenses covers more than 106°				
[2] this follows Schneider's recommendation for using CF IV with step ring on the 121/8 SA				

My 58/5.6 Grandagon has 67 mm filter threads. It is reported to cover 135 mm, 140 mm and perhaps even 4x5 (150 mm) with absolutely no movements, i.e., no more than 105°, so should have a 1.5 stop center filter. Schneider's Center Filter III, Rodenstock's + 1.5 E67/86 Center filter and Heliopan's 67mm ND Center Filter 3X should all work properly on it.

When I started this exercise I had none of these, did have a Rodenstock AR Center Filter + 2.5 E67/86. This is an early center filter for Apo Grandagons, is functionally equivalent to the more recent +2 E67/86. Some users say it performs worse than the newer + 2.

It fits my 58 Grandagon but the Schneider/Rodenstock rule suggests that it won't give the best results. With a 58 mm lens 6x12's corners are 2.2 stops down from the center. My +2.5 should give slight overexposure in the corners, the newer +2 should give slight underexposure.

My 65/8 Fujinon has 52 mm filter threads. It covers 105° so a 1.5 stop center filter is right for it. Schneider's 52 mm Center Filter II and Heliopan's 52 mm ND Center Filter 3X should work. My 47/5.6 Super Angulon's 49 mm CF II would work too if it could be attached. Unfortunately off-the-shelf step-down rings are too long. SKGrimes advised me that a short custom threaded bushing is at best marginally possible, suggested that I get a 52 mm CF II. So I did. Mounting aside, it seems to be identical to the 49 mm CF II.

3 Historical note

That extreme wide angle lenses need center filters to even out exposure across the field has been known almost since the first such lens was made.

The best known early center filter is probably the "star," also called spinner, supplied with f/18 Goerz Hypergons, which cover as much as 140°. The star is a mechanical center filter that is denser towards the center than at the edges.

For a fuller explanation of the Hypergon, see
http://web.archive.org/web/20161204154713/http://www.cameraquest.com/hyper.htm

http://web.archive.org/web/20160506045622/http://matmarrash.com/blog/2015/5/12/just-one-more-lens-i-promise
has a clearer image of the star in place, ready to be spun.

Rodenstock made an optical center filter "Enixantos" for their Pantogonal extreme wide angle lenses, which cover 125 - 130°.

A 1912 catalog (see www.pacificrimcamera.com/rl/00718/00718.pdf) says:

For time exposures, when the full angle is used, it is advisable to use the Enixantos Compensator which is furnished with the lens. This consists of a plano-convex lens of yellowish green glass which absorbs very strongly blue and violet light, and a plano-concave lens of a colorless, very transparent material. The optical constants of both these lenses is exactly equal so that the cemented lenses act as a plane parallel plate which is dark in the center and transparent at the sides. The effect of this is that the marginal rays which pass through the lens at great angle undergo only a slight absorption, and therefore any marked decrease of light toward the edges of the plate is prevented. Thus the necessity of bunglesome and complicated appliances usually found on extreme angle lenses is obviated. With orthochromatic plates the Compensator has the added advantage of giving excellent color values.

"Bunglesome and complicated appliances" refers to the Hypergon's star.

Appendix: Rodenstock and Schneider Wide Angle Large Format Lenses With Recommended Center Filters

Table 7: **Rodenstock Wide Angle Large Format Lenses With Recommended Center Filters**

Lens	Angle (f/22)	Exposure Correction (stops)	Filter Thread	CF Recommended, Manufacturer's article number
35/4.5 Apo-Grandagon	120°	2	M67x0.75	E67/86 - 1094.2403.143
45/4.5 Apo-Grandagon	110°	2	M67x0.75	E67/86 - 1094.2403.143
55/4.5 Apo-Grandagon	110°	2	M67x0.75	E67/86 - 1094.2403.143
65/4.5 Grandagon-N	105°	1.5	M58x0.75	E58/77 - 1094.2403.138
75/4.5 Grandagon-N	105°	1.5	M67x0.75	E67/86 - 1094.2403.139
75/6.8 Grandagon-N	102°	1.5	M58x0.75	E58/77 - 1094.2403.138
90/4.5 Grandagon-N	105°	1.5	M82x0.75	E82/112 - 1094.2403.140
90/6.8 Grandagon-N	102°	1.5	M67x0.75	E67/86 - 1094.2403.139
115/4.5 Grandagon-N	104°	1.5	M82x0.75	E82/112 - 1094.2403.140
155/4.5 Grandagon-N	102°	1.5	M105x1	E105/127 - 1094.2403.141
200/4.5 Grandagon-N	102°	2	M135x1	E135/- - 1094.2403.134

Table 8: **Schneider Wide Angle Large Format Lenses With Recommended Center Filters**

Lens	Angle (f/22)	Exposure Correction (stops)	Filter Thread	CF Recommended, Manufacturer's article number
38/5.6 Super Angulon XL	120°	2	M72x0.75	IIa - 45385
47/5.6 Super Angulon XL	120°	2	M67x0.75	IIIc, also IIIb – 25637, 10590
58/5.6 Super Angulon XL	110°	1.5	M67x0.75	IIIb - 10590
72/5.6 Super Angulon XL	115°	2	M95x1	IVb, also IVa – 25638, 10591 (w/less correction)
90/5.6 Super Angulon XL	110°	1.5	M95x1	IVa - 10591
47/5.6 Super Angulon	105°	1.5	M49x0.75	II – 10476, later 39286
47/5.6 Super Angulon	105°	1.5	M52x0.75	II - 16190
65/5.6 Super Angulon	105°	1.5	M67x0.75	III – 11580, later 10598
75/5.6 Super Angulon	105°	1.5	M67x0.75	III – 11580, later 10598
90/5.6 Super Angulon	105°	1.5	M82x0.75	IV – 11581, later 10599
90/6.8 Super Angulon	100°	1.5	M82x0.75	IIId - 28300
47/8 Super Angulon	100°	1.5	M40.5x0.75	None offered
65/8 Super Angulon	100°	1.5	M49x0.75	I - 10745
75/8 Super Angulon	100°	1.5	M49x0.75	II - 10746
90/8 Super Angulon	100°	1.5	M67x0.75	IIIa , later IIIB – 12796, 10590
120/8 Super Angulon	100°	1.5	M82x0.75	IV - 11581
121/8 Super Angulon	100°	1.5	M77x0.75	IV (with step ring) - 12767
165/8 Super Angulon	100°	1.5	M110x1	V - 10592
210/8 Super Angulon	100°	1.5	M135x1	VI - 10593
80/4.5 Super Symmar XL	105°	1.5	M67x0.75	IIIb - 10590
110/5.6 Super Symmar XL	105°	1.5	M67x0.75	IIIb - 10590
150/5.6 Super Symmar XL	105°	1.5	M95x1	IVa - 10591
210/5.6 Super Symmar XL	100°	1.5	M135x1	VI - 10593
24/5.6 Apo Digitar XL	n/a	2[1]	M52x0.75	IId
35/5.6 Apo Digitar XL	102°	2[1]	M52x0.75	IIf - 19786
43/5.6 Apo Digitar XL	102°	1.5	M58x0.75	IIi - 1069162
47/5.6 Apo Digitar XL	100°	1.5	M52x0.75	IIh - 1069161

[1]these may be errors in Schneider's center filter list. They're inconsistent with recommendations for all other lenses with similar coverage. Documentation of CFs for Apo Digitars is sparse. The information I present on them is certainly incomplete, may be incorrect.

Steve Goldstein pointed out to me that in addition to the CFs listed above (table 8) Schneider made two marked, respectively, 8/65 and 8/90. He believes that they are denser, probably +3, than the newer CF III and IV, both +1.5, for 65/8 and 90/8 Super Angulons.

Thanks to Steve Goldstein for bringing the existence of a 52/77 1.5x center filter to my attention. My source for information on Heliopan's center filters,

https://static.bhphotovideo.com/FrameWork/Product_Resources/SourceBookProPhoto/Section04LgFormatLenses.pdf

may be incomplete or incorrect.