Voigtländer Large Format Lenses from 1949-1972

The Voigtländer companies - a short historic overview

Although it has been more than 40 years since the last LF lenses left the Voigtländer plant in Braunschweig (Brunswick), Germany, the company name is still well known. Many of the lenses, especially those made after WWII, are still in use and are highly regarded. One reason is certainly that the Voigtländer company was one of the oldest manufacturers in the field, having made large format (LF) lenses for 132 years, but there is also a certain mystique about the lenses – as an old German advertisement slogan for the company's cameras said: "A Voigtländer, because the lens is so good!".

The company name Voigtländer[1] is much older than photography. In 1756, Johann Christoph Voigtländer founded a mechanical shop in Vienna, Austria, making compasses and other mechanical instruments. In 1807, his youngest son Johann Friedrich Voigtländer founded his own optical and mechanical shop, also in Vienna, adding eyeglasses and other optical instruments to the line. The company was famous for their opera glasses, introduced in 1823. Johann Friedrich retired in 1837 and the company was headed next by his son Peter Wilhelm Friedrich Voigtländer. Shortly after the Daguerreotype process was announced in 1839, he started to cooperate with the Viennese mathematician Joseph Petzval, resulting in the first lens designed purely through mathematical calculations, the famous f/3.7 Petzval portrait lens. In 1849 Peter Wilhelm Friedrich Voigtländer founded a second shop in Braunschweig, Germany, the home of his forefathers, which subsequently became the company headquarters. The Viennese shop was closed in 1868, while the factory in Braunschweig remained for more than 100 years. In 1876, Peter Wilhelm Friedrich Voigtländer was succeeded by his son, Friedrich Ritter von Voigtländer, who converted Voigtländer into a stock company in 1898. After the death of Friedrich Ritter von Voigtländer in 1924, the family sold the stock to Schering, a manufacturer of chemicals and photographic papers. Voigtländer survived the WW II years without major damage and came under British control in 1945. From 1945 until the introduction of the D-Mark in 1949, their production went mostly to the Allies as reparations. In 1956, Schering sold Voigtländer to the West-German Carl Zeiss foundation in Heidenheim, although manufacturing and sales remained separate from Zeiss until the founding of the joint "Zeiss-Ikon – Voigtländer" sales organization in 1966. In 1970, the Voigtländer company was dissolved and merged into Zeiss-Ikon, although LF lenses still carried the Voigtländer name. In 1972, Zeiss-Ikon stopped the production of all product lines, including the Voigtländer LF lens production; existing stock

[1] A remark on the spelling: The name is spelled Voigtländer, with the umlaut "ä" – the correct transcription into English is "Voigtlaender", although "Voigtlander" is close. Note that there was *never* an "h" in the name, as in the commonly seen "Voightlander"!

was sold for a few more years afterwards. The Braunschweig factory was sold to Rollei (also in Braunschweig) and renamed "Optische Werke Voigtländer". Lens production continued with the Zeiss-licensed Rollei medium format and 35mm lenses, using a much smaller number of employees. The factory was finally closed 3 years later in 1975. Rollei continued to sell products under the Voigtländer brand name until they got into financial trouble in 1981. The Voigtländer name was then sold to Plusfoto, a German photo retail chain. In the 1980's, cheap 35mm cameras and lenses from Japan (made by Tokina, Maginon, Kiron, etc.) and Taiwan were branded with the Voigtländer name and distributed through Plusfoto. In 1997, Plusfoto merged with Ringfoto, another German retailer. A recent 20-year agreement on the use of the Voigtländer name between Ringfoto and the Japanese Cosina company lead to the present "Bessa" line of 35mm and medium format rangefinder cameras and lenses. However, from the LF point of view, the history of Voigtländer ended in 1972.

LF lenses from 1840 to 1945

The first photographic lens built by Voigtländer was the Petzval portrait lens in 1840. It was followed by the Orthoskop landscape lens, another development by Joseph Petzval. Later well-known lenses were the Euryskop (an Aplanat/Rapid-Rectilinear type), and the anastigmatic Collinear, which was built from 1894 until the 1940's. The Collinear lens was also sold as Orthostigmat by Steinheil in Munich (Steinheil and Voigtländer shared the patents), and was a direct competitor of the Goerz Dagor. The best-known Voigtländer lens was the Heliar, originally invented by Dr. Hans Harting for Voigtländer in 1902 [17]. It was a derivative of the Cooke triplet with cemented doublets replacing the first and third lenses. These consisted of an outer negative meniscus made from flint glass and an inner biconvex lens made from crown glass. Harting's first design was symmetric [17], but he soon followed it with a much better corrected asymmetric one, shown in fig. 1a [18]. Later he designed a related lens [19] that turned the outer doublets around, shown in fig. 1b. This lens was called the "Dynar". After World War I, Voigtländer continued mostly with the Dynar design, but renamed it Heliar from then on. Therefore the term "Heliar-type" often refers to Harting's 3rd design (fig. 1b). Note that Voigtländers literature often showed the old design (fig. 1a), even in catalogs after WW II [11], although the actual lenses used the design shown in fig. 1b. Which design is used can easily be checked by observing the reflection of a light source in the lens, especially the weak reflection of the cemented interfaces: for type 1a the cemented interfaces are convex towards the viewer, when seen from the outside, for type 1b they are concave. All post-WWII regular Heliars I have seen are of the second type.

In 1921, the Heliar was improved, and an f/9 process lens version [20] as well as a portrait version with a maximum aperture of 3.5 [21] were designed by Robert Richter, who later became a designer for Goerz and subsequently for Zeiss. Other well-known LF lenses in addition to the Heliar and the Collinear were the Skopar, a well-regarded Tessar-type design, the fast (f/2.5) and somewhat soft Heliostigmat (a reversed Tessar design), the Voigtar (a simple Triplet), the Radiar (a Dialyte), and the Tele-Dynar, a 5/3 telephoto lens. Table 1 lists most

lenses available for large format in the years from about 1928 to the early 1940's; all in all more than 60 different lenses were offered.

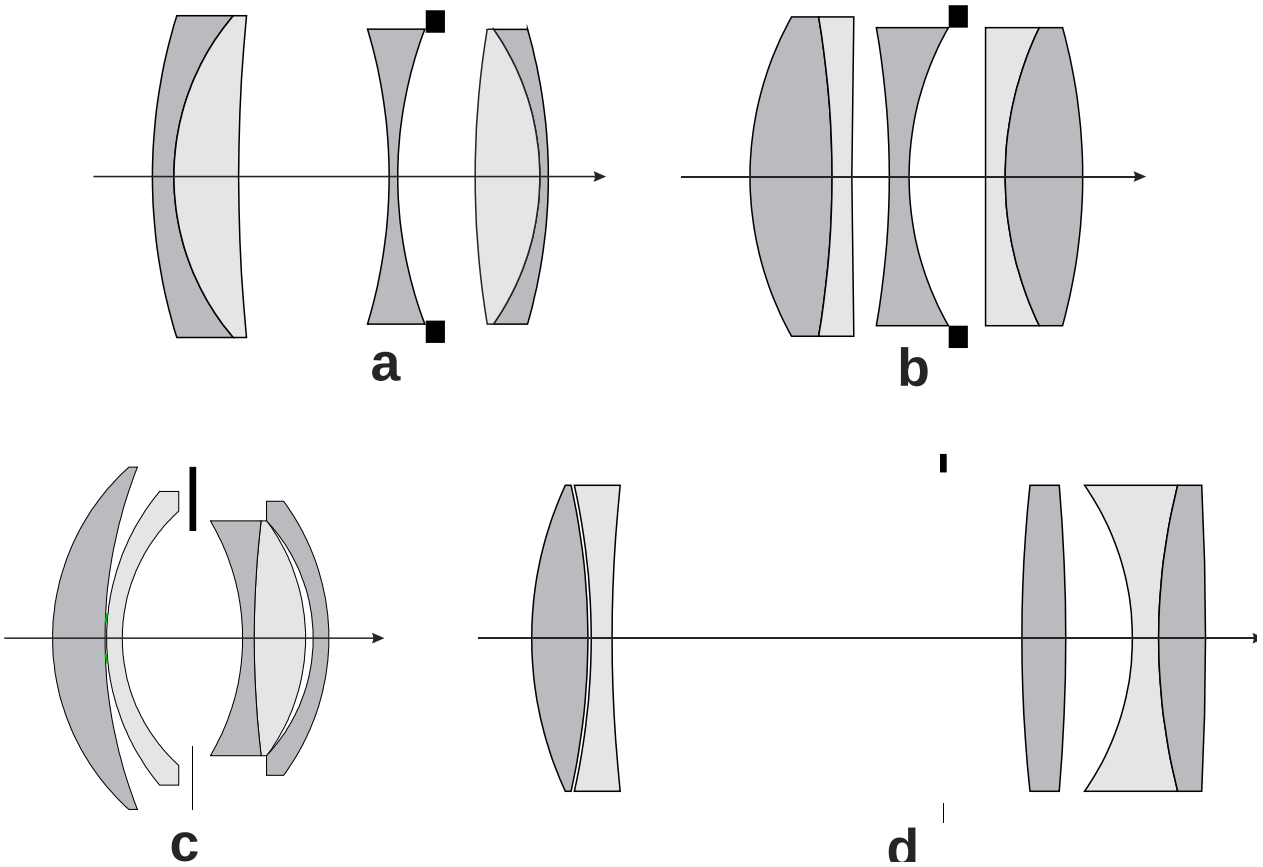

Fig. 1: Schematic lens diagrams (not to scale) for a)the original asymmetric Heliar [18]; b)the original Dynar [19], later Heliars [19,20,22], the Apo-Lanthar [22], and Apo-Skopar have the same basic arrangement; c)the Ultragon [24]; d)the Telomar [25], note that the elements of the front group of the Telomar are not cemented, but separated by a small airspace.

Post-WWII lenses

Directly after the war, Voigtländer continued parts of the prewar program as the plant had not suffered major war damage, and introduced lens coatings soon after the war's end. A list of serial numbers for the postwar production is given in table 2. Thus coated lenses of some prewar models that were later discontinued do exist (e.g. f/3.5 Heliar, Skopar, etc.). Those are usually above the 2,700,000 serial number, marking the end of WWII, but not much above 3,000,000 (Nov. 1947). The inscription font of the lenses also changed to a cleaner, more modern one without serifs. From about 1949 on, Voigtländer discontinued many older LF lenses and introduced several new models, specifically the Apo-Lanthar, Apo-Skopar, Ultragon, and Telomar series. The only older LF lens lines to be continued were the f/4.5 Heliars and Universal-Heliars, although with a reduced number of focal lengths. Most new lenses were designed by Albrecht Wilhelm Tronnier (1902 - 1982), who had been a lens designer for Schnei-

Table 1 (right): Voigtländer LF lenses offered in the 1930's. For the Collinears the coverage is for the stopped down lens, for all other lenses the coverage is for the open lens. In addition to these lenses, there existed some budget triplets (Voigtar f/6.3) and Dialytes (Radiar f/6.8) fitted to simple plate cameras.

The Collinear was also sold as a convertible set:

set B (single elements 136-225-282mm, combinations 99-107-147mm) for 9x12cm,

set C (single elements 205-256-307mm, combinations 133-144-164mm) for 10x15cm,

set D (single elements 225-282-340mm, combinations 147-159-181mm) for 13x18cm,

set E (single elements 340-416-516mm, combinations 223-244-277mm) for 18x24cm.

Name	Max. aperture	Focal length [mm]	Max. Format [cm^2]
Collinear	6.3	105	9x14
		120	10x15
		132	13x18
		150	15x20
		165	16x21
		180	18x24
		200	21x27
		250	21x27
		310	27x35
		370	30x40
		440	30x40
		520	45x55
Weitwinkel-Collinear	12.5	105	13x18
		120	15x20
		150	21x26
		180	24x30
		200	26x31
		250	30x40
		320	45x55
Apochromat-Collinear	9	200	21x27 (1:1)
		300	30x40 (1:1)
		420	45x55 (1:1)
	10	500	55x65 (1:1)
		600	70x80 (1:1)
	11	700	75x85 (1:1)
		800	85x100 (1:1)
	12.5	1000	100x130 (1:1)
Skopar	4.5	180	12x16
		210	13x18
		240	13x21
		300	18x24
		360	24x30
Heliostigmat	2.5	210	9x12
		335	12x16.5
Heliar	3.5	135	9x12
		150	9x12
		165	9x14
		180	9x14
		210	13x18
		240	13x21
		300	16x21
Heliar	4.5	135	9x12
		150	9x14
		165	10x15
		180	12x16
		210	13x18
		240	13x21
		300	16x21
		360	18x24
		420	21x27
		480	26x31
		600	30x40
Universal-Heliar	4.5	300	16x21
		360	18x24
		420	21x27
		480	26x31
Tele-Dynar	6.3	255	9x12
		290	9x12
		320	10x15

der-Kreuznach and ISCO before and during the war. At Schneider he had been responsible for several well-known lenses, including the Angulon, Xenar, and Xenon. He had his own optics design bureau in Göttingen and became a consultant to Voigtländer in 1944. He was responsible for most of their famous post-WWII lenses, including the 35mm Ultron and Nokton.

After the initial flurry of new designs in the LF field, Tronnier and Voigtländer concentrated on 35mm cameras and lenses until the demise of the company in 1972. However, LF lenses were manufactured and sold until the end – the last 1000 LF lenses were manufactured in April 1972 [4]. The prewar Voigtländer LF cameras (e.g. the famous "Bergheil") were all discontinued after WWII, but one new 13x18cm (5x7") monorail "studio camera" model was produced from 1950-1954 [26]. It is rare, but easily recognized by its use of large circular lensboards.

Table 2 (right): Serial numbers of Voigtländer lenses after WW II, based on the production lists [4]. Note that there are slight differences with the table in the "Vademecum" [5] for the early years.

July 1945	2,700,000
November 1947	3,000,000
1952	3,500,000
January 1956	4,000,000
December 1959	5,000,000
March 1962	6,000,000
December 1966	7,000,000
March 1970	7,300,000
September 1972	7,449,000

There are a few peculiarities of Voigtländer LF lenses. One is the unit for the focal length inscription. Before the early 1900's, German lens companies, including Voigtländer, marked the focal length in millimeters. After that time, centimeters were generally used as a unit. After WWII, most lens companies switched back to using millimeters. Voigtländer also used mm designations for their 35mm and medium format lenses from that time on, but for unknown reasons continued the cm designation for their large format lenses.

Due to their construction (i.e. the Heliar type), most Voigtländer lenses need a rather large shutter opening in relation to the focal length, especially compared to Plasmat-type lenses like the Schneider Symmar from the same time period. Many of their shuttered lenses therefore use Compound shutters (sizes III, IV, and V), or a Compur 2. The latter is often a dial-set version, although the later rim-set version (introduced by Deckel in 1953) was also used. Only the short focal lengths (105 and 150mm Heliar/Apo-Lanthar) used rim-set Synchro-Compurs exclusively. Towards the end of production, Voigtländer offered an alternative to the Compounds, the Compur electronic shutters (nos. 3 and 5 FS)[2], and the very last lenses used the new mechanical Compur versions. This peculiar lineup of shutters means that only the short focal lengths in Compur 1 and the late lenses in a Compur 3 can easily be transferred to current modern shutters. The Compur 2 was discontinued in the mid-late 1960's and has unfortunately no modern equivalent. An adapter to Copal 3 is necessary to transfer lens cells to a modern shutter. The Compound III is different from a modern size 3 in the thread diameter and thread pitch as well as the spacing of the lens cells and thus adapters are needed for mounting in a modern no. 3 shutter. Compounds IV and V as well as the Compur 5 FS have no modern equivalent, although the lens cells of the latter two are interchangeable. Fortunately, Compur and Compound shutters are usually pretty robust and when slow or stuck can be brought back to life with a good CLA. A few lenses have also been seen in Ilex shutters. Note that Voigtländer

[2] Note that the Compur electronic 5 FS, which replaced both the Compound IV and V, is very heavy (even compared to a Compound V) and can only be used with a battery-powered external command unit to set the aperture and trip the shutter.

LF lenses *do not* have filter threads - they only take slip-on filters. Visible threads in the front mount are for the retaining rings of lens elements.

Voigtländer coatings were quite hard, even early ones, and are therefore usually in good shape if the lens was not abused. Only single coatings exist, as the advent of multicoating coincided with the end of production at Voigtländer. A common ailment of the lenses, however, is the separation of the cemented interfaces and it is worthwhile to check for it in a used lens. The Apo-Skopar, Apo-Lanthar, and the Telomar are especially prone to element separation. Separation shows up as colorful Newton's rings in the lens, almost always starting at the rim. The 300mm and 450mm Apo-Skopar in the front row, and the 600mm in the back row in Fig. 7 show this. The optical correction is not really affected by this, since the separation is only a few hundred nanometers, but flare will be increased. In most cases only a few mm in the periphery are affected. Although this should not influence performance at all, it does affect the used market price.

Heliar and Universal-Heliar

Of the two prewar Heliar lines, Voigtländer continued mostly the "slower" f/4.5 versions (table 3), with a slightly reduced number of focal lengths, based on the design in fig. 1b. One source [2] claims a redesign in the early 1950's, but this is hard to verify. The new postwar "Color-Heliar" [23] was only made in a 105mm f/3.5 version for 6x9cm, mostly for the "Bessa II" folder, although a version of it in a "Linhof"-labeled Synchro-Compur 0 shutter has been seen. It is certainly useable on a 6x9cm view camera (as is the 105mm f/3.5 Color-Skopar, a Tessar type, which was also used on the Bessa II). Made until 1972, the Heliar was one of the lenses with the longest production cycle, 70 years. Due to the design and the wide opening, Heliars have a considerable size and weight in the longer focal lengths – they are at least as big and heavier than Tessars with the same specifications. Fig. 2 shows the Heliar lineup. The coverage of most Heliars is around 58°, except for the 300mm with 45°.

Both barrel and shutter versions of the Heliar were sold. There was also a third possibility: One could buy the cheaper barrel version and mount a "Zettor" external shutter on the front (figs. 3 and 4). The Zettors were made by the Zett company, owned by Erich Zillmer, also located in Braunschweig. He sold his company to Voigtländer in 1960. Zettors were offered for the 210, 240, and 300mm barrel Heliars. For the 300mm Heliar, the 1950 prices in Germany were [1]: in barrel DM 560.00; in barrel with Zettor shutter DM 630.00; in Compound V shutter DM 670.00. The Zettor shutters had only 4 settings: Closed, Open, B, and Instantaneous time. The latter time depends on how fast the cable released is pressed; in my experience about 1/8s is the fastest for the largest Zettor fitting the 300mm Heliar, but this is obviously operator dependent. With a little practice it is possible to achieve slower times like ¼ or ½ s repeatedly, but the accuracy is certainly not good enough for the controlled exposure of color slides. The Zettor shutters can of course be used with other lenses having a similar front diameter.

Table 3: Post-WWII Heliar lenses; coverage is for open aperture.

Focal length [mm]	Max./ Min. Aperture	Coverage [°]	Image circle at infinity [mm]	Mount/ Shutter	Filter size slip-on [mm]	Weight [g]	Remarks
150	4.5/32	58	166	Synchro-Compur 1	42	261	
				Barrel			
180			200	Compur 2	47	358	
				Barrel			
210			233	Compound III	57 or 60 (Linhof version)	500	
				Compur electronic 3			
				Barrel		627	Available with "Zettor" front-mounted shutter
240			266	Compound IV	70	817	
				Compur electronic 5			Separate control unit for shutter
				Barrel			Available with "Zettor" front-mounted shutter
300		45	250	Compound V	85	1472	Also available in Ilex 5 (in the US)
				Compur electronic 5		1840	Separate control unit for shutter (additional 1166g with cable and batteries)
				Barrel			Available with "Zettor" front-mounted shutter
360			300	Barrel	98		Discontinued in the 1960's
420			350		116		
480			400		128		

The main use of the Heliar was (and is) as a portrait lens. Used wide open the lens shows a slightly reduced contrast and resolution (by today's standards), without being a soft focus lens like the Universal Heliar or Rodenstocks Imagon. It has always been praised for its pleasing rendering of out of focus areas ("bokeh"). Both features contribute to the "Heliar look". The Heliar becomes gradually sharper and achieves high resolution when stopped down, and at f/16-f/22 it is indistinguishable from a modern lens.

The Universal-Heliar (table 4) was a real soft focus lens, where the biconcave center element was moveable with a ring at the front of the lens to adjust the soft focus effect (fig. 5). In the 0 position, the lens is fully corrected, without soft focus effect, for the other settings the softening effect increases with the number. It was only available in barrel mount. It is usually said that it is the same design as the Heliar, just adding the lens movement, but in this case it actually does use the design of Hartings original Heliar (fig. 1a) and has a smaller angle of coverage (50°). After WWII, the Universal-Heliar was produced in 3 focal lengths (300, 360, 420mm).

Fig. 2: Post-WW II Heliar lenses, all are f/4.5. Front row from left to right: 150mm in a Press-Compur 1, 180mm in a Compur 2, 210mm in Compound III, and 240mm in a Compound IV. Back row from left to right: 210mm in barrel, 300mm in Compound V, and 300mm in Compur 5FS electronic. Scale is in cm.

Fig. 3: Zettor shutters for use with the 210mm Heliar (left) and the 300mm Heliar (right).Scale is in cm.

Fig. 4: Zettor shutter mounted on a 300mm Heliar. Scale is in cm.

Table 4: Universal Heliar lenses; coverage is for open aperture. The 1st number in the "focal length" and "coverage" columns refers to the "sharp" normal setting ("0"), the 2nd one to the maximum soft focus setting ("5").

Focal length [mm]	Max./Min. Aperture	Coverage [°]	Image circle at infinity [mm]	Mount/ Shutter	Filter size slip-on [mm]	Weight [g]	Remarks
300-250	4.5/32	45-54	250	Barrel	85		Adjustable center lens for soft-focus effect
360-300			300		98		
420-350			350		116	4200	

Fig. 5: Post-WW II Universal Heliar 420mm f/4.5. Apart from the coating and the inscription font, prewar and postwar versions can be distinguished by the shape of the "handles" for the aperture and the soft focus effect. Prewar handles are knurled, cylindrical, and nickel-plated, the postwar handles are smooth with a small ball at the end and chrome-plated, as shown above. The lower handle set changes the aperture, the one near the lens front changes the position of the central biconcave lens. The "0" setting shown above is without soft focus, the highest soft setting is "5". Scale is in cm.

Pricewise, regular Heliars used to be bargains, especially compared to the other Voigtländer lenses, but since a few years prices have picked up. A 210mm lens in a Compound III that is in reasonably good condition used to be in the $200-300 range in the late 1990's, but now often goes for twice as much. The coated postwar Universal-Heliar on the other hand, is quite scarce (even scarcer than an Apo-Lanthar, see below) and therefore commands much higher prices, even though it only comes in a barrel mount.

Apo-Lanthar

Fig. 6: Apo-Lanthar lenses, all are f/4.5. Front row from left to right: 210mm prototype in barrel, still named "Color-Heliar"(see table 8); 210mm in Compound III, and 210mm Linhof "Technika"-version in Compound III. Note the slightly larger outside diameter of the front barrel of the Technika version. Back row from left to right: 150mm in Synchro-Compur 1 and 300mm in Compound V. Scale is in cm.

The Apo-Lanthar (fig. 6), available in 4 focal lengths from 105-300mm (table 5), was designed and patented by A.W. Tronnier [22]. It is of the same basic construction as the Heliar, 5 lenses in 3 groups (fig. 1b), with similar coverage, but improved performance. Apparently, Voigtländer originally planned to name it "Color-Heliar", as shown in the prototype in fig. 6. This is proven by the fact that that prototype lens has the exact same lens radii as a regular Apo-Lanthar. The Color-Heliar name, however, was given to a different design that was not apochromatically corrected, as mentioned above.

Apo-Lanthars were introduced in 1954 and made until 1972. Most Apo-Lanthars were sold in shutters; barrel mounts are rare, but do exist. The Apo-Lanthars are marked by three colored stripes around the outside chrome surface of the front cell, in red, green, and blue. This designates the apochromatic correction referred to in the "Apo" part of the name, with a considerably reduced secondary spectrum. As Voigtländer wrote in a brochure from 1967 [11]:

"… -a high-performance five-element anastigmat with the remarkable speed of 4.5, fully corrected for the three main colour bands of the spectrum. Its design is based on the principles used in the apochromatic correction of process lenses. In view of its high speed the Apo-Lanthar is thus eminently suitable for shots of live subjects at fast shutter speeds. It is a universal lens in the true sense of the word, guaranteeing perfect sharpness all over the image field, maximum brilliance and contrast, as well as purity of colour rendition."

The second part of the lens name is due to the fact that the front lens is made from lanthanum crown glass. Glasses using rare earth oxides were investigated by George W. Morey in the late 1920's at the US Geophysical Laboratory, and from 1931on he developed them further for Eastman Kodak. They were initially made and used by Kodak for their Aero-Ektar aerial lenses in WWII [7, 8]. After the war, these glasses were adopted by all major glass manufacturers. Some of those glasses intentionally contained thorium oxide in addition to lanthanum oxide and are therefore slightly radioactive. This is the case for the Apo-Lanthar (other "hot" LF lenses are some Repro-Clarons, the 135mm f/3.5 Xenotar, both from Schneider, and the Tessar-type process lenses from TTH, such as the Apotal, and others). Over a long period of time, the radio-

Table 5: Apo-Lanthar lenses; coverage is for open aperture.

Focal length [mm]	Max./Min. Aperture	Coverage [°]	Image circle at infinity [mm]	Mount/ Shutter	Filter size slip-on [mm]	Weight [g]	Remarks
105	4.5/32	58	116	Synchro-Compur 0	42		For 6x9cm. A late version designated as 4.5/100mm (!) focal length exists
150			166	Synchro-Compur 1	42	269	
210			233	Compound III	57 or 60 (Linhof version)	585	Barrel mount version exists
				Compur electronic 3			
				Compur 3			
300		50	280	Compound V	90	1554	Ilex 5 version exists
				Compur electronic 5			Separate control unit for electronic shutter

activity leads to radiation damage of the glass in the form of so-called "color centers". This damage is seen as a yellow-brown discoloration of the glass; other glass parameters like refractive index and dispersion will not be measurably affected. The claimed exceptional color fidelity of the Apo-Lanthar is of course made obsolete by this discoloration, giving color slides a warm cast; however, it may be advantageous for black and white, acting as a light yellow filter. Note that the

discoloration can be bleached by exposure to UV for several weeks, e.g. from a "black light" bulb. When doing this, one should remember that *UV is harmful for the eyes and take the necessary precautions*. The radioactivity of the lens is not high, but measurable: I measured 16μSv/h (Micro-Sievert per hour) a few mm from the front lens of a 15cm Apo-Lanthar, 27 μSv/h for the 21cm version, and 35μS/h for the 30cm one. For comparison, the natural background radiation at sea level is of the order of 0.1-0.2μSv/h, the radiation level in a plane at 30,000ft between 2 and 5μSv/h. It is probably not a good idea to carry an Apo-Lanthar in the pocket for a prolonged time, store it under the bed, or on top of a box of film for several weeks, but otherwise no harm will be done. Note that possession of such lenses is legal in the US - and in most other parts of the world too, I assume (compare [14]). The "Lens Collectors Vademecum" [5] claims that Voigtländer changed the formulation to a non-radioactive glass around 1956, but this is not true. An Apo-Lanthar from January 1964 (serial number 6442XXX) that I measured is still radioactive. A lens made in August 1966 (serial no. 6939XXX) did not show any radioactivity [15], so they apparently switched the production in those two years. Since the production numbers were much lower in their last years, most Apo-Lanthars will be radioactive, and only a few are not.

With respect to performance, my personal experience is that in terms of resolution and contrast the Apo-Lanthar is in general one stop better than the Heliar at large apertures; that is, an Apo-Lanthar at f/5.6 is as good as a Heliar of the same focal length at f/8. The difference is reduced when stopping down, and at f/22 both lenses perform about the same. For out of focus areas it has the same pleasing characteristics as the Heliar, which means that is well suited for pictures with selective focus at wide apertures.

Based on their exceptional performance (in the 1950's) and their original high price, as well as their rareness, Apo-Lanthars have unfortunately become something of a cult item for collectors. Used prices are often as high or higher than a new modern lens of the same focal length, or a factor of 4-5 higher than a comparable Heliar. Whether or not the performance of an Apo-Lanthar is worth the asking price, can only be decided individually.

Apo-Skopar

The Apo-Skopars (fig. 7) are process lenses with a maximum opening of f/8 or f/9, depending on the focal length (table 6). They were a new design, made from about 1954 to 1972, and replaced the symmetric prewar Apo-Collinear process lenses. The Apo-Skopar is also based on the Heliar/Dynar design shown in fig. 1b. Therefore the lens name is somewhat misleading, as "Skopar" without the "Apo" prefix was Voigtländers name for Tessar-type lenses before and after the war. In general the Heliar type is unusual for a process lens[3], but this was nevertheless a very highly regarded design with 45° coverage at f/22. Note that although the very first Heliar design [17] as well as a later one [20] were symmetric with respect to the center lens, the Apo-

[3] In addition to the Apo-Skopar and the earlier process Heliar by Richter, there was a series of Boyer Apo-Saphir process lenses that used the Heliar/Dynar design.

Skopar is not symmetric – the cemented outer cells have different focal lengths. Apparently a few Apo-Skopars from the 1950's did not cement the front and back groups, but used a very small airgap by separating the elements with small aluminum strips. This is similar to the approach used by Zeiss Jena in their last generation of Apo-Tessars, see [29].

The Apo-Skopar was made in seven focal lengths and came in a barrel mount for process applications, but the more common focal lengths were also sold in a shutter (table 6). Voigtländers choice of shutter sizes for some of the Apo-Skopars is somewhat baffling – for instance, the size of the 210mm or 300mm Apo-Skopar lens elements would have easily allowed the use of a Compur 1, but it came in a Compound III (fig. 7), or later a Compur 3. Size and weight of a lens were certainly not a criterion back then. Barrel and shutter versions use different mounts and are not compatible, with the exception of the 150mm f/8 Apo-Skopar, where the barrel cells fit a size 0 shutter. Apo-Skopar lenses do not show any discoloration and are not radioactive. Note that despite the process lens designation Apo-Skopars can be used at infinity with excellent results and Voigtländer actually recommended them for landscapes in their literature. A quote from [11]:

"The correction is of such a high order that the greatest possible resolution is already reached at full aperture (f/8 or f/9). This is especially useful in landscape photography calling for great detail."

The fact that they deliver excellent results already wide open, although with a reduced coverage, distinguishes them from other process lenses, e.g. the dialyte types. Apo-Skopars are therefore a good but often overlooked choice for slightly longer focal lengths, e.g. at 210 or 300mm for 4x5".

Table 6: Apo-Skopar lenses; coverage is for infinity at f/22. Coverage at 1:1 would be twice that value.

Focal length [mm]	Max./Min. Aperture	Coverage [°]	Image circle at infinty [mm]	Mount/ Shutter	Filter size slip-on [mm]	Weight [g]	Remarks
75	8/45	45	62	Barrel	32		Does not cover 4x5 even at 1:1
150	8/32		124	Synchro-Compur 0			Covers 4x5 at 1:1
	8/45			Barrel		152	Cells fit size 0 shutter
210	9/32		174	Compound III	50	325	
	9/90			Barrel	55		
300	9/32		249	Compound III	50	465	
	9/90			Barrel	55		
450	9/32		373	Compound IV	68	960	
	9/90			Barrel	75	1195	
600	9/90		497	Barrel	94	2200	
750	9/90		621	Barrel			

Fig. 7: Apo-Skopar lenses. Front row from left to right: 150mm f/8 in Synchro-Compur 1, 210mm f/9 in Compound III, 300mm f/9 in Compound III, 450mm f/9 in Compound IV. Top row from left to right: 150mm f/8 in barrel, 600mm f/9 in barrel, 210mm f/9 in barrel and 450mm f/9 in barrel. Scale is in cm.

Ultragon

The 115mm f/5.5 Ultragon wide angle was another new design by Tronnier introduced in 1950 [24]. It has about 85-90° coverage (literature values vary between 80° and 100°; it officially covers 13x18cm/5x7") and came in a Compur 2 shutter. It is seen in both the dial-set and the rim-set version of the Compur 2 (fig. 8). It was quite fast for a wide angle: the competing lenses in 1950 were the Schneider Angulon 120mm f/6.8 (an earlier design by Tronnier), the 4 3/8" f/8 Goerz W.A. Dagor, the Rodenstock Perigon 110mm f/12 (a Protar V-type design), or the 4/4 double Gauss lenses like the Meyer-Görlitz Aristostigmat or the Kodak Wide-Field Ektar (f/6.3). The design of the Ultragon was unusual in that it was completely asymmetric, the powers of the groups are + - I + -. It combines the strongly curved front cell of a double Gauss Topogon/WF-Ektar-type wide angle with an anastigmatic back cell of 3 lenses in 2 groups. The back cell geometry closely resembles a convertible Protar VII cell with the lowest index glass element replaced by air. According to the patent, the glass of the 4th lens element of the Ultragon (the inner lens in the back cell) was the same as the glass Tronnier used for the front lens of the Apo-Lanthar. Consequently, the back cell is slightly radioactive (1.5μSv/h) and shows the characteristic yellowish color.

The performance of the Ultragon is quite good and it can be used at wider apertures than the Angulon which needs to be stopped down to at least f/16. Although slightly larger than an Angulon, it does fit into most field cameras when closed – the overall length is only 35mm. A very interesting and unknown feature of the Ultragon is that it can be used as a convertible lens with a very attractive combination of focal lengths [13]. The back cell gives close to 2 times the combined focal length, it is a 225mm f/11. In my experience, the back cell can be used at f/16 and has good sharpness over a field of 70° at f/22, similar to the performance of a single Protar VII cell. Note that in principle the back cell of Tronnier's older wide angle construction, the Schneider Angulon, can also be used on its own. The performance, however, is definitely inferior to the Ultragon back cell. This is not too surprising, since the Angulon back cell is a derived from the (reverse) Dagor construction with 3 cemented lenses and the Ultragon back cell is derived from the Protar VII with one additional lens or airspace.

Fig. 8: Voigtländer Ultragon 115mm f/5.5. Left: in dial-set Compur 2, right: in rim-set Compur 2. Scale is in cm.

The front cell on its own has about 1.5 times the combined focal length, it is a 175mm f/8. Being one half of a double Gauss lens, it is not as well corrected as the back and is quite soft wide open. It needs to be stopped down at least 3-4 stops, unless it is used as a soft-focus lens. In addition, the front cell covers 4x5 only barely, with a field of about 46° at f/32. However, mounting it on the back side of the lens with the concave side towards the object improves the image circle to approximately 56°. In my opinion, this makes the Ultragon a very interesting lens for 4x5 or 5x7 backpacking, combining a compact, coated wide angle lens with better

performance than an Angulon with a longer landscape length (225mm) and a portrait lens (175mm) in one small package.

Other focal lengths were apparently planned for the Ultragon (65mm, 90-95mm, and 150mm, for 6x9cm, 9x12cm/4x5", and 18x24cm/8x10", respectively) [13], as well as f/4.5 versions [2,5]. A prototype version of a 60mm f/4.5 Ultragon covering 6x9cm has been described by Mechelhoff [27], it appears to be a 6/4 construction related to a later Tronnier patent [28]. Another f/4.5 Ultragon, an 80mm fitted to a 6x9cm Bessa II was auctioned off in 2014 [30]. It was likely also a prototype. The 115mm f/5.5 (table 7), however, seems to be the sole example of this type that has been in regular production. The lens was discontinued early, around 1961, which makes it even rarer than the Apo-Lanthar.

Note that there is *no* relation between the Voigtländer Ultragon and the later process lenses of the same name made by the Staeble company in Munich. Those Staeble Ultragons are symmetric Plasmat constructions like Schneiders G-Claron. The Staeble Ultragon was also sold as "Eskofot Ultragon" and "Agfa Repromaster" (Agfa owned Staeble since 1969).

Table 7: Ultragon and Telomar lenses; coverage is for f/22.

Name	Focal length [mm]	Max./Min. Aperture	Coverage [°]	Image circle at infinity [mm]	Mount/ Shutter	Filter size slip-on [mm]	Weight [g]	Remarks
Ultragon	115	5.5/32	90	230	Compur 2 (dial-set)	60	313	Convertible: front cell is 175mm f/8, back cell 225mm f/11
					Compur 2 (rim-set)		337 (374 with original brass flange ring instead of aluminum)	
Telomar	180	5.5/32	33	107	Synchro-Compur 1	42		For 6x9cm press cameras
	240			142		51	417	
	360			213	Compound III	70	995	Covers 4x5

Telomar

The last new LF lens introduced by Voigtländer was the Telomar telephoto in 1956. It was again a new Tronnier design [25], with 5 lenses in 4 groups. There is no measurable radioactivity present. The Telomar has 33° coverage, and a maximum opening of f/5.5. It was manufactured in three focal lengths of 180mm, 240mm, and 360mm (table 7) and remained in production until 1972. Of those, only the 360mm model (fig. 9) can be used for 4x5". Of the telephoto constructions of the time it was highly regarded, with improved sharpness compared to older constructions like Schneider-Kreuznach's Tele-Xenar. The other major competitors at the time were the Tele-Arton, also from Schneider, and Rodenstock's Rotelar. If the patent data are to be trusted, the Telomar shows an exceptionally high MTF curve with best performance over 2/3rd of the field at f/11 (fig. 10). Typical for a telephoto construction, the image circle is rather small. In

addition, some mechanical vignetting by the front mount can be seen in the corners down to f/22, even without movements. This is caused by the large distance between the front and the back groups (fig. 1d).

Fig. 9: 240mm Telomar (left) in Synchro-Compur 1 and 360mm Telomar (right) in Compound III, both f/5.5. Scale is in cm.

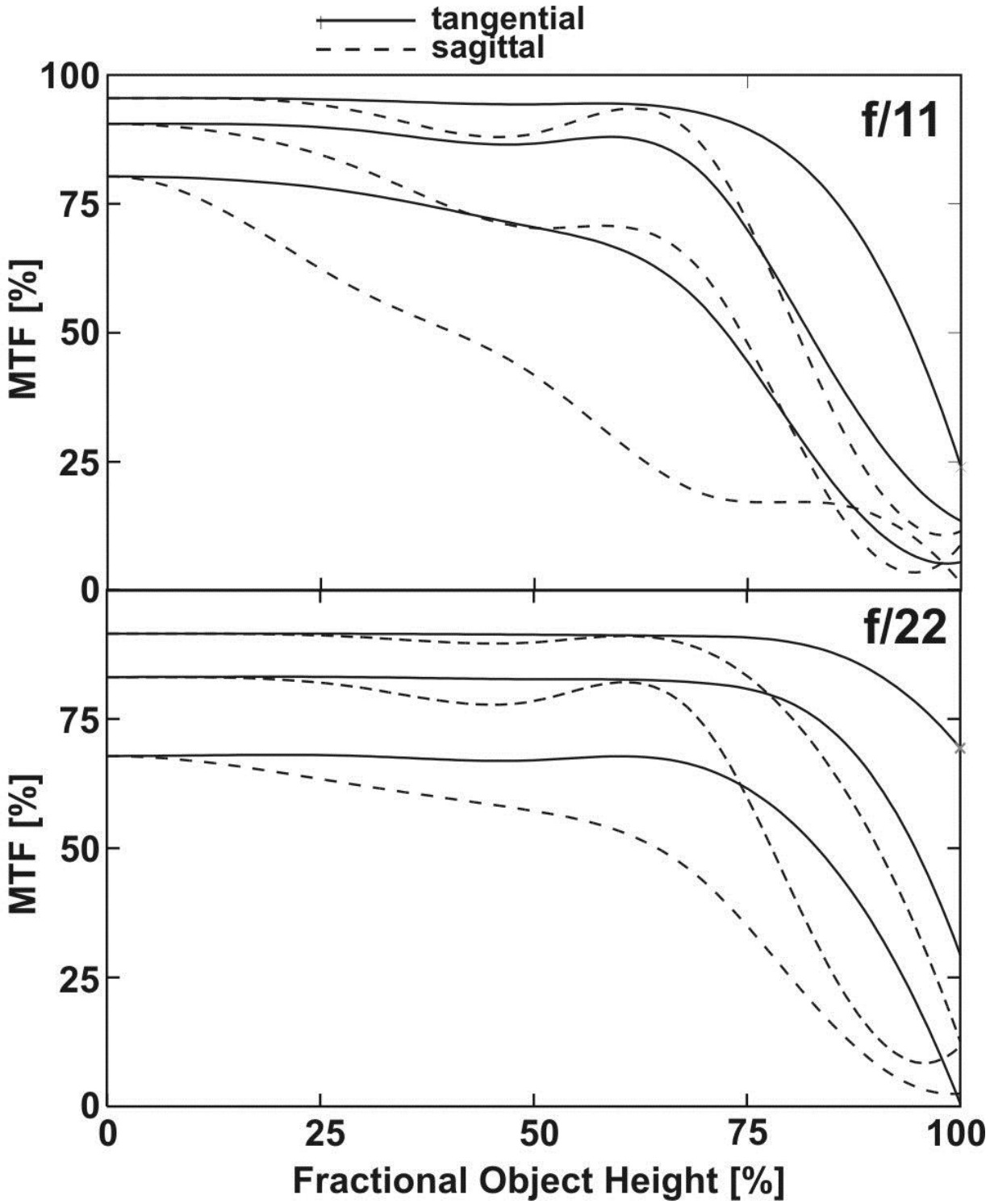

Fig.10: Calculated MTF curves (using the OSLO® lens design software and the patent data from [25]) of the 360mm Telomar at f/11 (top) and f/22 (bottom). The curve sets are for 5, 10, and 20lp/mm. 100% object height is 16.5° or 106.5mm (33°coverage/213mm image circle).

Other Lenses

Voigtländer also produced prototypes of other lenses that may show up on the used market occasionally. One example is shown in fig. 11, the "Neu-Oxyn 1:5.4 20cm", i.e. it was a 200mm f/5.4 lens. The solid brass front lens mount clearly designates it as a prototype, as does the "VK2" inscription, standing for "Versuchskörper 2 – experimental mount 2". "Neu" means new in German, whereas the "Oxyn" was an old lens name used by Voigtländer. The original Oxyn was a 1903 design of an f/9 lens by Hans Harting that was a cross of the original Heliar (fig. 1a) and the Dynar (fig. 1b); the front group was the Heliar version, and the back group was the Dynar version [7]. This new "Oxyn" prototype, however, was completely different, it was a Plasmat design with 6 lenses in 4 groups, similar to the contemporary Schneider Symmar. The mount inscription lists an image circle of 72°, so the nominal design values of f/5.4 and 72° were better than the Schneider Symmar ones of f/5.6 and 70°. Since there is no serial number, a production date is hard to pinpoint, but judging from the shutter and the coating color, it was probably made in the late 1950's to early 1960's. Why they did not offer this lens is hard to judge; possibly the strong market position of Schneider in this segment was thought to be too strong.

Fig. 11: "Neu-Oxyn" 200mm f/5.4 prototype lens by Voigtländer, a Plasmat type similar to the Symmar from Schneider-Kreuznach. Scale is in cm.

*Table 8: Some Voigtländer prototype LF lenses. *values: calculated*

Name	Focal length [mm]	Max/Min. aperture	Cover age [°]	Image circle at infinity [mm]	Mount/ Shutter	Filter size slip-on [mm]	Weight [g]	Remarks
"Color-Heliar"	210	4.5/32	58	233*	barrel	57	547	Apo-Lanthar prototype
"Neu-Oxyn"	200	5.4/45	72	291*	Synchro-Compur 1	62	585	Plasmat type

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