LASER OPTICS
IMAGING OPTICS

2025


Sill
OPTICS
S4LFT0260/159

Sill OPTICS

LASER OPTICS

IMAGING OPTICS

CUSTOMIZED LASER OPTICS
BENEFIT FROM OUR EXPERTISE

OUR HIGHLIGHTS 2025

Sill Optics sells customized lenses for CO_2 lasers. Scan lenses, beam expanders, focusing lenses and other customized optics for lasers with wavelengths above 9 µm can be calculated, designed, constructed, assembled and distributed thanks to our new materials (zinc selenide, zinc sulfide and germanium).

ZINC SELENIDE

Zinc selenide is particularly suitable for the design of high-performance lenses. This is mainly due to its high transmission (approx. 70 %) in the range of 550 nm to 20 µm and its low absorption. This means that little power remains in the lenses, which could otherwise lead to damage. The low hardness and therefore low mechanical strength as well as the toxicity of the dust during processing (due to the selenium content) are disadvantages of the material. However, due to its excellent optical properties, it is usually gladly accepted.

The 1-3x zoom beam expander S6EXZ9313-684 made of zinc selenide was developed for the use of high-power CO_2 lasers. For the first time, you can order a lens for lasers in the LWIR (long wave infrared) range from our catalog. Many other lenses can be requested as customized designs at any time.

GERMANIUM

Due to its high refractive power, germanium is particularly suitable for the color correction of lenses. Highly refractive materials are also advantageous for lenses that are only designed for one wavelength and therefore usually consist of one glass, as this saves single lens elements. The very high Knoop hardness of approx. 800 kg/mm² makes germanium insensitive to mechanical stress. Germanium is particularly suitable for low-power applications in the LWIR (long wave infrared) range. The medium transmission of 50 % between 1.8 µm and 18 µm and the high absorption make it less suitable in combination with high-power lasers. In addition, there is a strongly temperature-dependent refractive index, which leads to an enormous thermal focus shift.

The material is opaque in the visible range and therefore poses challenges during testing.

Nevertheless, it is often used for color-corrected applications in the low-power range due to its high refractive power and good machinability (non-toxic and hard).

CUSTOMIZED LASER OPTICS

BENEFIT FROM OUR EXPERTISE

OUR HIGHLIGHTS 2025

ZINC SULPHIDE

Zinc sulphide is a cost-effective alternative to zinc selenide. It is non-toxic during processing and slightly harder than zinc selenide, which makes it easier to manufacture lenses from this material. The high transmission of 70 % (clear grade) in the range of 500 nm to 12 µm makes the material interesting for medium power applications.

Zinc sulphide is less suitable for high-performance applications due to its higher absorption. In addition, the compound is not resistant to water, which causes problems for certain applications.

However, the temperature-stable refractive index and the low coefficient of thermal expansion ensure a low thermal color shift and suitability for use at high or strongly fluctuating temperatures. In addition, zinc sulphide as an alternative to zinc selenide allows a wider choice of glasses for the long-wave infrared range. This simplifies the color correction of lenses for this area of application.

NEW ZINC SELENIDE BEAM EXPANDERS FOR HIGH POWER LASERS

With the two zoom beam expanders S6EXZ9313-684 and S6EXZ9313-681, Sill Optics is launching lenses for CO_2 lasers with wavelengths of 9.3 µm and 10.6 µm as a standard product for the first time.

Both beam expanders are manually adjustable in an **expansion range from 1x to 3x**. All magnification levels in between can be set manually. As with all Sill Optics beam expanders, the divergence can also be set manually.

Both zoom beam expanders contain lenses made exclusively from **high-performance zinc selenide**. The material is characterized by very high transmission and low absorption for this spectrum. State-of-the-art coatings and a special optical design with particularly few individual lenses allow very high overall transmission through the lens. S6EXZ9313-684 and S6EXZ9313-681 are both suitable for usage with high-power lasers due to their material and optical design. A free entry aperture of 28.5 mm (mechanical limitation) can be widened to a maximum of 45 mm.

The difference between the two beam expanders lies in the correction for the wavelengths of 9.3 µm (S6EXZ9313-584) and 10.6 µm (S6EXZ9313-581). These are the two most common wavelengths for standard CO_2 lasers.

If you require a beam expander with other specifications (magnification, aperture, etc.) for your setup in the LWIR range (long wave infrared), you are welcome to contact us with your request at any time.

Since Sill Optics offers lenses made of materials for this range (zinc selenide, zinc sulphide, germanium), our engineers have experience in the design of such optics. In addition to beam expanders, this also applies to scan lenses, focusing optics and many other lenses. We design, manufacture and sell customer-specific prototypes and small series that are specially adapted to your requirements and wishes.

OUR HIGHLIGHTS 2025

MOTORIZED BEAM EXPANDER FOR HIGH-POWER LASERS

The success of the Sill Optics beam expanders made of high-quality fused silica and coatings over the past decades invited Sill Optics to start a new project, which resulted in the newly developed motorized beam expander S6EZM0940-574.

This new motorized beam expander S6EZM0940-574 features the identical optical design as the manually adjustable S6EXZ0940-574. By using the highest quality coatings and fused silica, Sill Optics also ensures that this new beam expander achieves a particularly high resistance, when used by modern high-power lasers. The beam diameter does not fall below the minimum value on all inside lens surfaces of the lens. As a result, the energy input even on the usually critical second lens is so low, even when using high-power lasers, that damage to the material and the coating is avoided.

While zoom beam expanders score with an adjustable range of the magnification factor, beam expanders with a fixed magnification are often interesting because of their suitability for extremely short-pulsed high-power lasers. The new high-power motorized beam expander S6EZM0940-574 combines both advantages as its manually adjustable counterpart.

In contrast to the S6EXZ0940-574, the inside lenses of the S6EZM0940-574 are moved motorized. This allows both the magnification factor in the range of 0.9x – 4x and the divergence to be set with high precision and fully automatically. Since no components are touched during the magnification and divergence setting and the lenses are positioned with an accuracy of up to 30 µm, a pointing error of ≤0.2 mrad can be realized.

Our wide range of products in the field of beam expanders is large and includes many different models. The spectrum ranges from compact or natural anodized beam expanders with fixed magnification to manual, partially motorized or fully motorized zoom beam expanders. If you need a specific magnification or have other special requirements that cannot be realized by our portfolio lenses, we are happy to adapt existing products to your needs or develop a customer-specific new design. Please feel free to contact us and experience the performance of our high-quality beam expanders.

OUR HIGHLIGHTS 2025

NEW LENSES FOR HIGH POWER LASERS

Sill Optics is expanding its laser range with a telecentric lens that combines two advantages: telecentricity and an extremely large scanning field.

Common LC display formats are usually very cheap. However, in some industries, such as aviation or modern trains, other formats are required. As a new development with special aspect ratios would be enormously expensive, especially for small and medium quantities, standard formats are preferred for cutting. In fact, this approach is possible without any loss of function, as LC displays consist of several individual components connected in series. If these are completed in advance, special formats can be produced cost-effectively by that.

Laser cutting is the method of choice for cutting the displays. It is particularly important that the cut is made perpendicular to the surface of the display. A minimal cutting depth results in minimal heat input so that neighbouring assemblies are not affected. In addition, a vertical cut is required to fit the extremely narrow space between the individual assemblies.

Telecentric f-theta lenses **enable a vertical beam incidence and therefore a vertical section in the entire working plane due to their low telecentric error**. This is most important for the field corners, where the input beam is deflected to the maximum by the upstream galvanometer scanner. Telecentric lenses are also characterized by a particularly homogeneous spot shape and size in the entire scan field area, especially when it comes to a diffraction-limited optical design.

Nevertheless, the advantages of telecentricity also come at a price, especially for applications which need a large scan field size. The scan field is mechanically limited by the diameter of the last lens. Therefore, the rear lenses of telecentric lenses must be significantly larger than those of non-telecentric versions to cover extended scan fields. The larger the scan field of the f-theta lens, the higher the maximum section length.

S4LFT3340-075 fulfils both criteria at a laser wavelength of 343 nm - 355 nm and has a low **telecentric error of less than 1° and a large scan field of 205 mm x 205 mm**. Due to its properties, the lens is particularly suitable for extremely fine cutting tasks such as cutting LC displays. Telecentric f-theta lenses are also available for other fields and wavelengths. Sill Optics also specializes in customized solutions for complicated applications with high quality requirements. This means that customized lens designs can be developed and manufactured. Existing designs can modified and adapted according to your wishes. Please contact us to find out more about the possibilities of our telecentric high-performance optics.

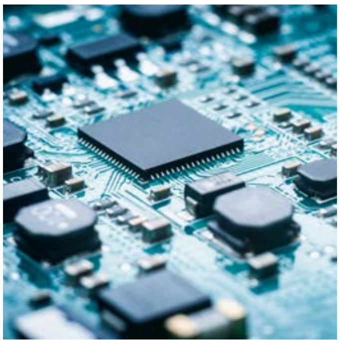
CUSTOMIZED LASER OPTICS

BENEFIT FROM OUR EXPERTISE

Sill Optics has been a trusted partner for customized laser optic solutions for years. Our specialties lie in many different areas of application and a wide variety of designs. Sill Optics also has many years of experience with various projects for customized optical designs and individual mechanical layouts.

The close coordination between various internal departments, our large range of manufacturing capabilities and our high quality series production are the reasons why we are able to build your prototype in the shortest time possible.

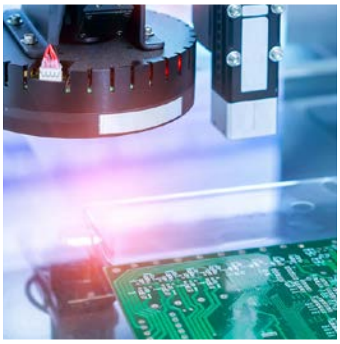
In recent years, we have successfully completed more than 60% of laser optic orders as development projects based on individual inquiries and participation in public research projects. Most of these develop-ments took part in the field of high-power solutions in solar systems, consumer electronics, eMobility or additive manufacturing applications for mechanical engineering processing.



SEMICONDUCTOR & DISPLAY MANUFACTURING

AUTOMOTIVE INDUSTRY, E.G. BATTERY PRODUCTION BODY WELDING ETC.

DEFENCE APPLICATIONS



CONSUMER ELECTRONICS

SOLARCELL PRODUCTION

ADDITIVE MANUFACTURING

YOUR BENEFITS FROM A SILL OPTICS DEVELOPMENT

- development of specification sheet close to design and production possibilities
- direct contact to optical designer and project manager
- short distances between design, development and production
- prototypes at short notice
- high quality of series production
- quality assurance according to individual needs

YOUR BENEFITS FROM SILL OPTICS DEVELOPMENT

WHY SILL OPTICS?

- Development of specification sheets closely aligned with design and production capabilities
- Direct contact with optical designers and project managers
- Short distances between design, development and production
- Quick turnaround for prototypes
- High quality in series production
- Customized quality assurance based on individual needs

WHICH SPECIFICATIONS?

- Scan lens: laser data (wavelength, pulse duration, pulse energy, M^2), scanner data (beam diameter, mirror distances, scanner type), Lens data (telecentricity, scan field size, spot diameter, focal length)
- Beam expander: wavelength, magnification (region), motorization, entrance beam diameter
- Focussing system: wavelength, focal length, spot diameter
- Trapped Ion lens: wavelengths, NA, vacuum window data (thickness, material, position), scan field

WHEN STARTING A PROJECT?

A typical starting point for a customized design, considering the overall benefit in terms of the price-performance ratio, is around 50-100 lenses per year. Sill Optics' production capacity is well-suited for up to 500 pieces per year.

However, the ideal number of lenses will vary depending on the size, number of elements, and complexity of the system. For highly complex designs with large elements, special glass types, high alignment demands and end test requirements, even as few as 5 pieces can be beneficial. Other designs may start with quantities of 20 or 50 pieces.

WORKFLOW THROUGH OUR CUSTOM DESIGN PROCESS

1. PROJECT DESCRIPTION AND SPECIFICATION
2. OPTICAL PREDESIGN AND FEASIBILITY ANALYSIS
3. QUOTE FOR DEVELOPMENT, TOOLING, PROTOTYPES AND SERIES CONDITIONS
4. PROTOTYPE AND TOOLING ORDER
5. PROTOTYPE PRODUCTION
6. PROTOTYPE FINAL TEST AND SHIPMENT

F-THETA LENSES

BENEFIT FROM OUR EXPERIENCE

Sill Optics has been manufacturing high-quality laser optics for almost 40 years. These lenses are specifically designed for laser material processing applications for industrial mechanical engineering.

They are specially designed for applications in CE, automotive, semiconductor, additive or solar cell manufacturing. In addition to medical and biotech applications (confocal microscopy, ophthalmology) and science and research. The design and the quality of the optical components play a key role in the lens performance.

GLASS OPTICS

PART NUMBER	FOCAL LENGTH [mm]	SCAN AREA [mm x mm]	FOCUS SIZE (1/e²) [µm]	MAX. BEAM-Ø [mm]	MAX. TELE-CENTRICITY ERROR [°]	WORKING DISTANCE [mm]	SP/USP*	ACHROMATIC
1064 nm								
S4LFT0080-126	80	39 x 39	6.5	25	3.8	79.4	no	no
S4LFT0163-126	163	107 x 107	26.4	12	15	181.2	no	no
S4LFT0253-126	254	160 x 160	35.2	14	16.7	284.9	no	no
S4LFT1254-126	254	160 x 160	41.4	12	14.9	306.5	no	no
S4LFT3254-126	254	115 x 115	16.6	30	8.5	297.0	no	no
S4LFT0350-126	350	212 x 212	56.3	12	16	412.2	no	no
S4LFT0420-126	420	242 x 242	27.7	30	14.8	480.9	no	no
S4LFT0508-126	508	325 x 325	55.6	20	16.3	651.4	no	no
S4LFT0635-126	635	370 x 370	51.3	25	16.3	732.8	no	no
532+1064 nm								
S4LFT1163-081	163	102 x 102	13.3 / 20.0	12	12.7	159.0	no	yes
S4LFT8254-081	254	180 x 180	16.6 / 33.0	15	19.7	211.6	no	yes
515-589 nm								
S4LFT7012-292	100	35 x 35	9.4	10	1.3	101.4	yes	yes
532 nm								
S4LFT5100-121	100	69 x 69	9.8	10	2.4	126.7	no	no
S4LFT0300-121	300	200 x 200	19.4	14	15.8	324.1	no	no

Besides our portfolio and customized optics, we also offer a variety of F-Theta lenses and Beam Expanders from our former portfolio with outstanding specifications upon request. This also includes lenses for different lens markets, applications and specifications.

- **MORE WAVELENGTHS**
- **MORE FOCAL LENGTHS**
- **MORE MAGNIFICATIONS**

*usable for SP=Short Pulse, USP=Ultra Short Pulse
In case of deviations from the portfolio and delivery times, please contact our Customer Care Team.

F-THETA LENSES

BENEFIT FROM OUR EXPERIENCE

Sill OPTICS

FUSED SILICA OPTICS

PART NUMBER	FOCAL LENGTH [mm]	SCAN AREA [mm x mm]	FOCUS SIZE (1/e²) [µm]	MAX. BEAM-Ø [mm]	MAX. TELECEN-TRICITY ERROR [°]	WORKING DISTANCE [mm]	SP/USP*
1030-1080 nm							
S4LFT4147-328	48	7 x 7	6.3	15	2.1	61.1	yes
S4LFT4065-328	65	15 x 15	9.4	15	2	83.1	yes
S4LFT0710-328	100	60 x 60	39.1	5	11.5	120.7	yes
S4LFT4010-328	100	35 x 35	19.5	10	1.3	129.8	yes
S4LFT4127-328	125	50 x 50	13.6	15	1.5	157.6	yes
S4LFT0763-328	163	100 x 100	45.6	7	14.6	194.1	yes
S4LFT3162-328	163	90 x 90	21.2	15	5.6	201.5	yes
S4LFT3167-328	163	100 x 100	32.6	10	11.6	200.7	yes
S4LFT0725-328	254	140 x 140	61.5	8	16.2	282.8	yes
S4LFT3250-328	254	160 x 160	33.2	15	10.7	321.3	yes
S4LFT1330-328	330	215 x 215	33.3	20	23.5	203.4	yes
S4LFT1420-328	420	280 x 280	58.5	14	17.3	499.2	yes
S4LFT5430-328	430	250 x 250	30.0	30	11.6	538	yes
S4LFT1655-328	650	410 x 410	63.3	20	22.5	581.6	yes
S4LFT0910-328	910	500 x 500	65.8	30	16.2	1048.8	yes
515-532 nm							
S4LFT4148-292	48	6 x 6	3.2	15	1.8	60	yes
S4LFT4066-292	65	15 x 15	4.8	15	1.5	85.8	yes
S4LFT4010-292	100	35 x 35	9.8	10	1.5	130.2	yes
S4LFT4126-292	125	53 x 53	12	10	1.6	167	yes
S4LFT3161-292	163	90 x 90	15.4	10	4.8	219	yes
S4LFT4262-292	163	65 x 65	12.7	12	1.7	195.4	yes
S4LFT1330-292	330	212 x 212	24.3	14	20.3	279	yes
HIGHLIGHT S4LFT5650-292	650	410 x 410	31.8	20	22.7	569.9	yes
420-480 nm							
S4LFT4125-373	125	45 x 45	6.1	20	1.6	160.2	yes
S4LFT3170-373	168	75 x 75	7.6	20	3.2	228.3	yes
S4LFT3250-373	241	115 x 115	10	20	7.4	304.8	yes
S4LFT1330-373	330	180 x 180	10.7	20	11.1	268.2	yes
343-355 nm							
S4LFT4149-075	48	6 x 6	2.1	15	2.1	69.3	yes
S4LFT4067-075	65	15 x 15	3.1	15	1.8	81.7	yes
S4LFT4010-075	100	35 x 35	6.5	10	1.2	132	yes
S4LFT4125-075	125	53 x 53	8	10	1.1	156.9	yes
S4LFT3170-075	163	90 x 90	11.4	10	4.3	221.7	yes
S4LFT4262-075	163	65 x 65	10.5	10	2	193.7	yes
S4LFT1330-075	330	210 x 210	15.4	14	21	260.5	yes
HIGHLIGHT S4LFT3340-075	340	205 x 205	17.0	14	0.85	479.5	yes
257-266 nm							
S4LFT4068-199	65	20 x 20	2.5	15	1.3	85.6	yes
S4LFT3170-199	154	85 x 85	7.7	10	3.8	208.1	yes
S4LFT4263-199	163	70 x 70	9.2	10	2.6	218.4	yes

BEAM EXPANDERS

BENEFIT FROM OUR EXPERIENCE

Sill Optics has been manufacturing high-quality laser optics for almost 40 years. These lenses are specifically designed for laser material processing applications of industrial mechanical engineering.

They are specially designed for applications in CE, automotive, semiconductor, additive or solar cell manufacturing. In addition to medical and biotech applications (confocal microscopy, ophthalmology) and science and research. The design and the quality of the optical components play a key role in the lens performance.

Many of our Beam Expanders can also be used in reverse direction. Using a Beam Expander reverse may the result in increased divergence and possibly other disadvantages as the Beam Expanders are usually designed to magnify beams. Therefore, please feel free to contact our technical support if you have any questions.

ZOOM BEAM EXPANDERS

	PART NUMBER	MAGNIFICATION	CLEAR INPUT APERTURE [mm]	CLEAR OUTPUT APERTURE [mm]	LENGTH [mm]	THREAD
	9300-10600 nm					
HIGHLIGHT	S6EXZ9313-684	1-3x	28.5	45.0	150.0	M55x1
HIGHLIGHT	S6EXZ9313-681	1-3x	28.5	45.0	150.0	M55x1
	1030-1080 nm					
	S6EXZ5310-328	1-3x	10.5	20.0	85.2	C-Mount
	S6EXZ5311-328	1-3x	10.5	20.0	85.2	M30x1
	S6EXZ5076-328	1-8x	10.3	31.0	162.0	C-Mount
	515-532 nm					
	S6EXZ5310-292	1-3x	10.5	20.0	85.2	C-Mount
	S6EXZ5311-292	1-3x	10.5	20.0	85.2	M30x1
	S6EXZ5076-292	1-8x	10.3	31.0	162.0	C-Mount
	355 nm					
	S6EXZ5310-075	1-3x	10.5	20.0	85.2	C-Mount
	S6EXZ5311-075	1-3x	10.5	20.0	85.2	M30x1
	S6EXZ5075-075	1-8x	10.3	31.0	162.0	C-Mount
	343-355 nm					
	S6EXZ0940-574	0.9-4x	16.0	28.0	191.0	M30x1
	S6EXZ5310-574	1-3x	10.5	20.0	85.2	C-Mount
	S6EXZ5311-574	1-3x	10.5	20.0	85.2	M30x1
	S6EXZ5075-574	1-8x	10.3	31.0	162.0	C-Mount
	257-266 nm					
	S6EXZ5075-199	1-8x	10.3	31.0	162.0	C-Mount

MOTORIZED BEAM EXPANDER

	PART NUMBER	MAGNIFICATION	CLEAR INPUT APERTURE [mm]	CLEAR OUTPUT APERTURE [mm]	LENGTH [mm]	THREAD
	343-355 nm					
HIGHLIGHT	S6EZM0940-574	0.9-4x	12.0	28.0	200.0	M30x1

In case of deviations from the portfolio and delivery times, please contact our Customer Care Team.

FIX MAGNIFICATION BEAM EXPANDERS

PART NUMBER	MAGNIFICATION	CLEAR INPUT APERTURE [mm]	CLEAR OUTPUT APERTURE [mm]	LENGTH [mm]	THREAD
1030-1080 nm					
S6EXK0005-328	0.5	12.0	12.0	44.7	M30x1
S6EXK0008-328	0.8	12.0	12.0	44.7	M30x1
S6EXK0010-328	1.0	12.0	14.0	44.7	M30x1
S6EXK0012-328	1.2	12.0	26.0	44.7	M30x1
S6EXK0015-328	1.5	12.0	26.0	44.7	M30x1
S6EXK0020-328	2.0	12.0	26.0	44.7	M30x1
S6EXK0025-328	2.5	11.0	26.0	44.7	M30x1
S6EXK0030-328	3.0	8.0	26.0	44.7	M30x1
S6EXK0035-328	3.5	8.0	20.0	44.7	M30x1
S6EXK0040-328	4.0	8.0	20.0	44.7	M30x1
515-532 nm					
S6EXK0005-292	0.5	12.0	12.0	44.7	M30x1
S6EXK0008-292	0.8	12.0	12.0	44.7	M30x1
S6EXK0010-292	1.0	12.0	14.0	44.7	M30x1
S6EXK0012-292	1.2	12.0	26.0	44.7	M30x1
S6EXK0015-292	1.5	12.0	26.0	44.7	M30x1
S6EXK0020-292	2.0	12.0	26.0	44.7	M30x1
S6EXK0025-292	2.5	11.0	26.0	44.7	M30x1
S6EXK0030-292	3.0	8.0	26.0	44.7	M30x1
S6EXK0035-292	3.5	8.0	20.0	44.7	M30x1
S6EXK0040-292	4.0	8.0	20.0	44.7	M30x1
355 nm					
S6EXK0008-075	0.8	12.0	12.0	44.7	M30x1
S6EXK0012-075	1.2	12.0	26.0	44.7	M30x1
S6EXK0015-075	1.5	12.0	26.0	44.7	M30x1
S6EXK0020-075	2.0	12.0	26.0	44.7	M30x1
S6EXK0025-075	2.5	11.0	26.0	44.7	M30x1
S6EXK0030-075	3.0	8.0	26.0	44.7	M30x1
S6EXK0035-075	3.5	8.0	20.0	44.7	M30x1
S6EXK0040-075	4.0	8.0	20.0	44.7	M30x1
343-355 nm					
S6EXK0008-574	0.8	12.0	12.0	44.7	M30x1
S6EXK0010-574	1.0	12.0	14.0	44.7	M30x1
S6EXK0012-574	1.2	12.0	26.0	44.7	M30x1
S6EXK0015-574	1.5	12.0	26.0	44.7	M30x1
S6EXK0020-574	2.0	12.0	26.0	44.7	M30x1
S6EXK0025-574	2.5	11.0	26.0	44.7	M30x1
S6EXK0030-574	3.0	8.0	26.0	44.7	M30x1
S6EXK0035-574	3.5	8.0	20.0	44.7	M30x1
S6EXK0040-574	4.0	8.0	20.0	44.7	M30x1

FIX MAGNIFICATION BEAM EXPANDERS

PART NUMBER	MAGNIFICATION	CLEAR INPUT APERTURE [mm]	CLEAR OUTPUT APERTURE [mm]	LENGTH [mm]	THREAD
1030-1080 nm					
S6EXP0005-328	0.5	14.0	31.0	85.0	M30x1
S6EXP0008-328	0.8	14.0	20.0	85.0	M30x1
S6EXP0012-328	1.2	14.0	28.0	85.0	M30x1
S6EXP0015-328	1.5	8.0	31.0	85.0	M30x1
S6EXP0020-328	2.0	8.0	31.0	85.0	M30x1
S6EXP0025-328	2.5	8.0	31.0	85.0	M30x1
S6EXP0030-328	3.0	8.0	31.0	85.0	M30x1
S6EXP0040-328	4.0	8.0	31.0	85.0	M30x1
S6EXP0050-328	5.0	8.0	31.0	85.0	M30x1
515-532 nm					
S6EXP0005-292	0.5	14.0	31.0	85.0	M30x1
S6EXP0008-292	0.8	14.0	20.0	85.0	M30x1
S6EXP0015-292	1.5	8.0	31.0	85.0	M30x1
S6EXP0020-292	2.0	8.0	31.0	85.0	M30x1
S6EXP0025-292	2.5	8.0	31.0	85.0	M30x1
S6EXP0030-292	3.0	8.0	31.0	85.0	M30x1
S6EXP0040-292	4.0	8.0	31.0	85.0	M30x1
S6EXP0050-292	5.0	8.0	31.0	85.0	M30x1
355 nm					
S6EXP0015-075	1.5	8.0	31.0	85.0	M30x1
S6EXP0020-075	2.0	8.0	31.0	85.0	M30x1
S6EXP0025-075	2.5	8.0	31.0	85.0	M30x1
S6EXP0030-075	3.0	8.0	31.0	85.0	M30x1
S6EXP0040-075	4.0	8.0	31.0	85.0	M30x1
S6EXP0050-075	5.0	8.0	31.0	85.0	M30x1
343-355 nm					
S6EXP0015-574	1.5	8.0	31.0	85.0	M30x1
S6EXP0020-574	2.0	8.0	31.0	85.0	M30x1
S6EXP0025-574	2.5	8.0	31.0	85.0	M30x1
S6EXP0030-574	3.0	8.0	31.0	85.0	M30x1
S6EXP0040-574	4.0	8.0	31.0	85.0	M30x1
S6EXP0050-574	5.0	8.0	31.0	85.0	M30x1
257-266 nm					
S6EXP0015-199	1.5	8.0	31.0	85.0	M30x1
S6EXP0020-199	2.0	8.0	31.0	85.0	M30x1
S6EXP0030-199	3.0	8.0	31.0	85.0	M30x1
S6EXP0040-199	4.0	8.0	31.0	85.0	M30x1
S6EXP0050-199	5.0	8.0	31.0	85.0	M30x1

ASPHERES

The use of aspheric lenses in optical systems is increasing. Aspheric lenses enable an enhancement of resolution especially for optical systems with a high numerical aperture. The aspheric deviation of the high end series is smaller than 0.05 µm RMSi.

Aspheres offer the great advantage to accomplish monochromatic imaging tasks with one optical element where multiple lens elements would otherwise be needed. Main advantages of aspheres are less spherical aberrations, less weight, increased transmission and no internal ghosts.

PART NUMBER	FOCAL LENGTH [mm]	LENS-Ø [mm]	CENTER THICKNESS [mm]	WORKING DISTANCE [mm]
1064 nm				
S1ADX0220-328	20	25.0	13.2	13.3
S1ADX0230-328	30	30.0	16.0	20.9
S1ADX0240-328	40	30.0	15.0	31.3
S1ADX0250-328	50	30.0	13.7	42.1
S1ADX0260-328	60	30.0	11.3	53.5
S1ADX0370-328	72	38.1	11.0	63.6
S1ADX0380-328	80	38.1	12.0	73.1
S1ADX0310-328	100	38.1	11.0	93.7
S1ADX0312-328	120	38.1	10.3	114.0
S1ADX0316-328	150	30.0	9.6	144.4
S1ADX0320-328	200	38.1	8.9	194.8
S1ADX0325-328	250	38.1	8.9	245.2
S1ADX0330-328	300	30.0	9.0	294.7
S1ADX0540-328	400	52.0	8.0	395.2

Besides our portfolio and customized optics, we also offer a variety of F-Theta lenses and Beam Expanders from our former portfolio with outstanding specifications upon request. This also includes lenses for different lens markets, applications and specifications.

- **MORE WAVELENGTHS**
- **MORE FOCAL LENGTHS**
- **MORE MAGNIFICATIONS**

In case of deviations from the portfolio and delivery times, please contact our Customer Care Team.

FOCUSING ELEMENTS
BENEFIT FROM OUR CAPABILITIES

LENS SYSTEMS
Multi-element lens systems minimize the imaging errors of single lenses and provide precision focusing for non-scanning applications.

MULTI-ELEMENT LENS SYSTEMS

PART NUMBER	FOCAL LENGTH [mm]	FOCUS SIZE 1/e² [µm]	HOUSING-Ø [mm]	LENGTH [mm]	WORKING DISTANCE [mm]
532 nm					
S6ASS2020-292	25	2.4	25.0	13.5	19.3
S6ASS2060-292	62	3.0	40.0	32.0	47.9
S6ASS5300-292	100	5.4	41.0	16.0	86.7
S6ASS6151-292	150	7.2	56.0	20.0	135.0
S6ASS6200-292	200	6.6	54.0	15.0	188.5
355 nm					
S6ASS2020-075	25	1.6	25.0	17.0	17.9
S6ASS2060-075	60	2.8	40.0	30.0	46.5
S6ASS5120-075	114	5.6	48.0	20.0	104.4
266 nm					
S6ASS2020-199	24	1.4	25.0	17.0	17.1
S6ASS2060-199	57	2.2	40.0	30.0	43.9
S6ASS5120-199	109	4.6	48.0	20.0	99.1

Besides our portfolio and customized optics, we also offer a variety of F-Theta lenses and Beam Expanders from our former portfolio with outstanding specifications upon request. This also includes lenses for different lens markets, applications and specifications.

- **MORE WAVELENGTHS**
- **MORE FOCAL LENGTHS**
- **MORE MAGNIFICATIONS**

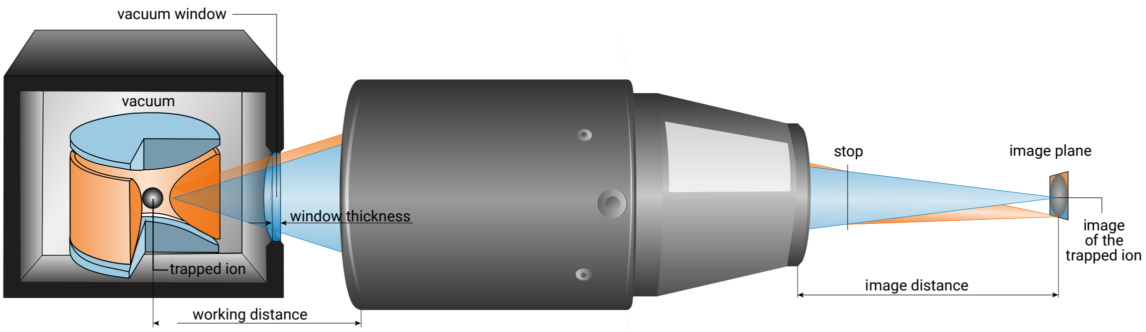
In case of deviations from the portfolio and delivery times, please contact our Customer Care Team.

TRAPPED ION LENSES
BENEFIT FROM OUR CAPABILITIES

TRAPPED ION LENSES
Trapped (cold) ions are a research topic with increasing interest over the last few years because of their possibility to store Qubits (quantum bits) and the related use for quantum computers. To make the qubits usable under certain conditions, we must observe and study their behaviour in detailed experiments first.

Sill Optics has designed lenses both, for just observation and observation combined with laser focusing for these experiments. Those lenses are exceptional for their high NA and adjustment to specific wavelengths (UV to IR). As the vacuum cryostats differ in dimension (e.g. the window thickness) every lens has to be designed specifically for the existing conditions.

PART NUMBER	WAVE-LENGTH 1 [nm]	WAVE-LENGTH 2 [nm]	MATERIAL	FOCUS LENGTH [mm]	NA	MAX. FOV [mm]	MAGNIFI-CATION @ WAVE-LENGTH 1	MAGNIFI-CATION @ WAVE-LENGTH 2	THICK-NESS WINDOW	MATERIAL WINDOW	WORKING DISTANCE [mm]
S6ASS2243-126	1064	-	optical glass	40.5	0.4	0.71	infinity	-	6.0	fused silica	50.7
S6ASS2242-081	590	1064	optical glass	40.0	0.4	0.71	infinity	infinity	6.0	fused silica	50.7
S6ASS2224	494	671	optical glass	22.0	0.5	0.08	infinity	infinity	-	-	11.6
S6ASS2255	422	-	fused silica	45.0	0.4	0.27	10.0	-	19.1	fused silica	63.4
S6ASS2256	422	-	fused silica	44.9	0.4	0.27	10.0	-	19.1	N-BK7	63.8
S6ASS2258	397	422	optical glass	44.8	0.4	0.28	10.0	10.0	19.1	N-BK7	62.3
S6ASS2258-006	397	422	optical glass	45.5	0.4	0.29	10.0	10.0	6.3	fused silica	60.5
S6ASS2241	395	729	optical glass	66.9	0.3	0.2	20.0	20.0	6.0	fused silica	55.7
S6ASS2241-045	395	729	optical glass	66.9	0.3	0.19	20.0	20.0	6.0	fused silica	55.7
S6ASS2341	370	-	optical glass	82.1	0.2	0.2	6.0	-	6.0	fused silica	55.7
S6ASS2245	369	-	fused silica	40.0	0.4	0.35	infinity	-	8.0	fused silica	39.3
S6ASS2246	369	-	fused silica	41.2	0.4	0.36	infinity	-	4.3	fused silica	38.7
S6ASS2247	369	493	fused silica	50.1	0.2	0.95	8.0	7.8	2.0	sapphire	49.4
S6ASS2247-389	313	397	fused silica	49.0	0.2	0.95	8.2	7.9	2.0	sapphire	48.2
S6ASS2248	313	397	fused silica	49.0	0.3	0.27	15.0	14.5	3.0	fused silica	46.5



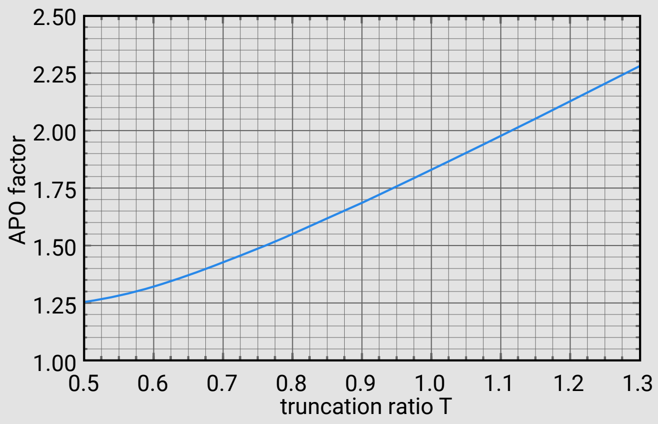
In case of deviations from the portfolio and delivery times, please contact our Customer Care Team.

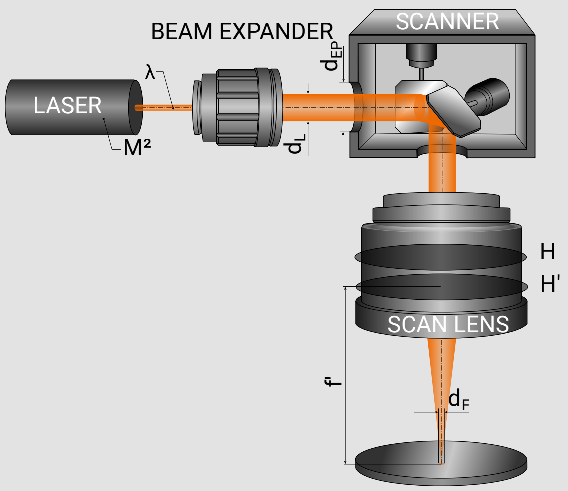
1. FOCUSSING LENSES

1.1 CALCULATION OF THE MINIMUM FOCAL DIAMETER

$$d_F = \frac{\lambda \cdot f' \cdot APO \cdot M^2}{d_L}$$

$$T = \frac{d_L}{d_{EP}}$$





d_F: focal spot diameter
d_{EP}: entrance pupil of the scanner
d_L: entrance beam diameter ($1/e^2$)
f‘: focal length
λ: wavelength
APO: apodisation factor
M^2: diffraction value of the laser
T: truncation ratio

1.2 CALCULATION OF THE RAYLEIGH LENGTH

$$z_R = \pi \cdot \left(\frac{d_F}{2}\right)^2 \cdot \frac{\left(APO/1.27\right)^2}{\lambda \cdot M^2}$$

zR: rayleigh length

1.3 CALCULATION OF THE FOCAL DIAMETER FOR FIBER IMAGING

$$d_F = M \cdot d_{fc} \approx \frac{f_2}{f_1} \cdot d_{fc}$$

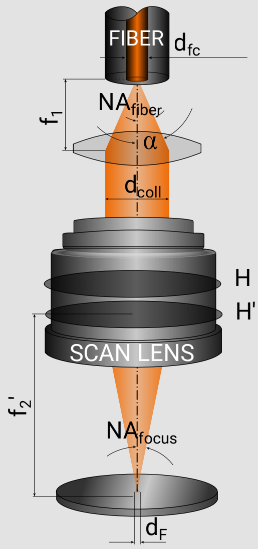
$$d_{coll} = 2 \cdot f_1 \cdot \tan(\alpha)$$

$$M = \frac{NA_{fiber}}{NA_{focus}}$$

$$\alpha = \sin^{-1}(NA_{fiber})$$

$$NA_{focus} = \sin[\tan^{-1}(\frac{d_{coll}/2}{f_2})]$$

$$\alpha = \tan^{-1}(\frac{d_{coll}}{2 \cdot f_1})$$



d_{fc}:	fiber core diameter
NA_{fiber}:	numerical aperture of the fiber
α:	half beam cone angle
M:	magnification by NA calculation
d_F:	focal spot diameter
f_1:	focal length of the collimating lens
f_2:	focal length of the focussing lens

2. LASER INDUCED DAMAGE THRESHOLD (LIDT)

2.1 ENERGY- AND POWER DENSITY

$$F[J/cm^2] = \frac{E[J]}{1/4 \cdot (d_F[cm])^2 \cdot \pi}$$

$$I[W/cm^2] = \frac{P_{peak}[W]}{1/4 \cdot (d_F[cm])^2 \cdot \pi}$$

F:	energy density / fluence
E:	pulse energy
F:	focal spot diameter
I:	power density / irradiance
P_{peak}:	peak power of the laser

2.2 ESTIMATE OF THE LIDT

$$\frac{E[J]}{1/4 \cdot (d_F[cm])^2 \cdot \pi} << LIDT \approx \approx \frac{\lambda}{\lambda_{spec}} \cdot \sqrt{\frac{\tau}{\tau_{spec}}} \cdot LIDT_{spec}$$

E: pulse energy
d_F: focal spot diameter
λ: used wavelength
λ_{spec}: specified wavelength
τ: pulse duration of the used laser
τ_{spec}: specified pulse duration
LIDT: real LIDT
$LIDT_{spec}$: specified LIDT

$$\frac{P_{peak}[W]}{1/4 \cdot (d_F[cm])^2 \cdot \pi} << LIDT \approx \approx \frac{\lambda}{\lambda_{spec}} \cdot \sqrt{\frac{\tau}{\tau_{spec}}} \cdot LIDT_{spec}$$

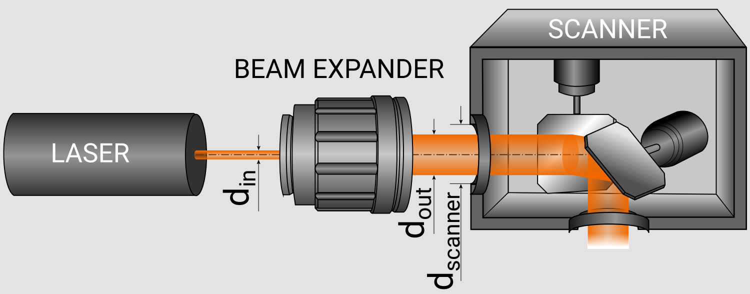
3. BEAM EXPANDERS

3.1 CALCULATION OF THE MAGNIFICATION

$$\beta' = \frac{d_{out}}{d_{in}}$$

$$\beta'_{max} = \frac{d_{scanner}}{d_{in}}$$

β‘: magnification
β'_{max}: maximum magnification
d_{in}: entrance beam diameter
d_{out}: outgoing beam diameter
$d_{scanner}$: aperture of the scanner

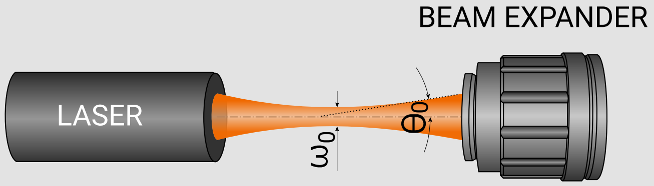


The outgoing beam diameter d_{out} is limited by the beam expander or by the aperture of the scanner.

3.2 DIVERGENCE ANGLE

$$\Theta_0 = \frac{\lambda}{\pi \cdot {}^{\omega_0}/_2} \rightarrow \Theta_0 \cdot \omega_0 = \text{const}$$

Θ_0: divergence angle
λ: wavelength
ω_0: beam diameter at the waist



The higher the beam diameter the lower is the divergence!

NOTES
FOR YOUR INDIVIDUAL PROJECT

Laser specifications
(pulse duration, wavelength, $1/e^2$ beam diameter, pulse energy, M^2)

Scanner data
(free aperture, mirror positions, distance to scan lens)

Scan lens requirements
(telecentricity, scan field, focal length, spot diameter, entrance beam diamater)

Beam expander requirements
(magnification (region), wavelength, motorized, entrance beam diameter)

Trapped Ion lens data
NA, vacuum window data (thickness, material, position), wavelengths, magnification, scan field)

IMAGING OPTICS

PORTFOLIO IMAGING LENSES

BENEFIT FROM OUR EXPERIENCE

HIGH PERFORMANCE TELECENTRIC LENSES

- LOW F# AND HIGH RESOLUTION
- LOW DISTORTION <1%
- LOW TELECENTRIC ERROR <0.2°
- CUSTOM MODIFICATIONS

NEW FOCUS TUNABLE LENS WITH 2X MAGNIFICATION

Sill Optics has developed a telecentric lens with a 2 x magnification, large aperture, and integrated liquid lens for focus adjustment.

The increasing demand for magnifying telecentric lenses, particularly with large apertures that accommodate a 2.74 µm pixel size and a 1.1-inch sensor diagonal while maintaining stable imaging performance across various wavelengths, has posed significant challenges. However, through collaboration between Sill Optics and Optotune, these requirements have been met.

The lens, named EL16-40, achieves a resolution of 90 lp/mm across the entire field of view, exhibiting the best wavefront specification in vertical alignment. This outstanding performance enables the lens to deliver exceptional results as a 2x magnification telecentric lens for sensors with 12-20 megapixels, along with an additional automated focus adjustment capability of at least 6 mm.

This groundbreaking product opens up new possibilities for the fields of semiconductor inspection and precision metrology, enabling them to achieve sinificant milestones.

PORTFOLIO IMAGING LENSES

BENEFIT FROM OUR EXPERIENCE

Sill OPTICS

OUR HIGHLIGHTS 2025

SILL OPTICS LAUNCHES FIRST RGB-NIR LENS FOR 8K LINE SCAN CAMERA

The S5LPJ4465 lens enables imaging with four color channels (RGB-NIR) for 8k resolution (pixel size up to 5 µm).

The ongoing development of camera technologies also requires modern lens designs. Different camera manufactures offer new line scan cameras that are sensitive to four color channels. While the chips of conventional cameras only detected light in the visible range, this new camera not only **has a red, blue and green channel, but also a color channel in the near infrared range**.

Conventional entocentric and telecentric lens designs are often unable to compensate the axial color shift. This results in at least one of the channels at the edge of the spectrum being blurred. Especially blue and NIR channel are affected.

In this context, Sill Optics has developed an innovative lens with a **focal length of 65 mm** for 8k resolution with a **pixel size of 5 µm (with a line length of 40 mm)**. This new development marks the beginning of a small series of lenses that meet customer requirements for color correction for all four wavelengths.

Until beginning of 2025, f'28 mm and f'40 mm will be available, too. In addition to the new series of color corrected lenses, Sill Optics also offers custom lens designs that are perfectly tailored to the individual requirements of a specific application. Furthermore, lenses from the series can be easily adapted to customized setup requirements by making small modifications, such as adjusting the camera mount.

NEW LENS SERIES FOR APS-C FORMAT SENSORS

In addition to the S5LPJ2607-M42, Sill Optics offers four other lenses for use with cameras with APS-C format sensors.

High End Resolution in telecentric imaging is our main motivation in development of our product portfolio. After introducing lenses with C-Mount and imaging diagonal up to 22.0 mm in the last years, we now go a step ahead and offer five different lenses for **APS format sensors with Pixel size down to 2.74 µm**.

The lenses cover a **sensor diagonal up to 32.6 mm** and can be used with line and area sensors. **Magnification range covers 0.2 x to 1.0 x**. Additionally to standard imaging in visible range with small bandwidth, most of the lenses are color corrected for bayer pattern sensors and have a high transmission as well in near infrared (800- 900 nm). We offer two standard threads: M42x1 with BFD 12 mm and F-Mount. Other threads are available upon request.

CUSTOMIZED IMAGING LENSES

BENEFIT FROM OUR EXPERTISE

Sill Optics has been a trusted partner for customized imaging lens solutions for many years. We specialize in various areas of application and offer a wide range of design types. With our extensive experience, we have successfully completed numerous projects involving customized optical designs and unique mechanical layouts.

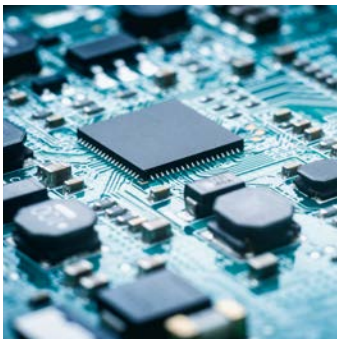
The key to our success lies in the close cooperation between our different internal departments, our vast manufacturing capabilities, and our commitment to high-quality production. These factors enable us to build your prototype in the shortest possible time.

In recent years, we have focused on developing nearly 80% of our imaging lens orders as individual development projects. We actively participate in public research projects and respond to specific inquiries from our customers. Our expertise has been particularly applied in high-precision measurement applications for mechanical engineering, as well as in biomedical applications and material processing.

We take pride in our ability to deliver tailored solutions to meet your specific requirements. By choosing Sill Optics, you benefit from our experience, expertise, and dedication to providing top-notch imaging lens solutions.

MACHINE VISION

BIOMEDICAL IMAGING



SEMICONDUCTOR INSPECTION

OPTICAL METROLOGY

YOUR BENEFITS FROM SILL OPTICS DEVELOPMENT

WHY SILL OPTICS?

- Development of specification sheets closely aligned with design and production capabilities
- Direct contact with optical designers and project managers
- Short distances between design, development, and production
- Quick turnaround for prototypes
- High quality in series production
- Customized quality assurance based on individual needs

WHICH SPECIFICATIONS?

- Aperture
- Field size (FOV, sensor size)
- Waveband (UV, VIS, IR, bandwidth)
- Space constraints (total track, working distance, maximum length, maximum diameter, mounting)
- Camera specifications (sensor dimensions, pixel size, resolution, camera thread, back flange distance, maximum chief ray angle, color)
- Performance requirements (Strehl ratio, MTF, edge spread function, distortion, color correction)

WHEN STARTING A PROJECT?

A typical starting point for a customized design, considering the overall benefit in terms of the price-performance ratio, is around 50-100 lenses per year. Sill Optics' production capacity is well-suited for up to 500 pieces per year.

However, the ideal number of lenses will vary depending on the size, number of elements, and complexity of the system. For highly complex designs with large elements, special glass types, high alignment demands and end test requirements, even as few as 5 pieces can be beneficial. Other designs may start with quantities of 20 or 50 pieces.

WORKFLOW THROUGH OUR CUSTOM DESIGN PROCESS

PROJECT DESCRIPTION AND SPECIFICATION

OPTICAL PREDESIGN AND FEASIBILITY ANALYSIS

QUOTE FOR DEVELOPMENT, TOOLING, PROTOTYPES AND SERIES CONDITIONS

PROTOTYPE AND TOOLING ORDER

PROTOTYPE PRODUCTION

PROTOTYPE FINAL TEST AND SHIPMENT

TELECENTRIC IMAGING LENSES

For nearly 40 years, Sill Optics has been manufacturing **high-end telecentric imaging lenses**. These lenses are specifically designed for measurement applications in industrial machine vision, aiming to eliminate magnification changes and measurement deviations caused by depth of field or defocus.

With the increasing data rates and sensor sizes, there is a clear trend towards larger sensor diagonals and smaller pixel sizes. As a result, our lens portfolio focuses on lenses optimized for small pixel sizes, supporting sensors up to APS format (with sensor diagonal of 32.6 mm).

- Telecentric FOV up to Ø150 mm
- Lens design for R,G,B illumination and monochrome sensor
- Variable iris for improved DOF (depth of focus)
- Available with integrated coaxial illumination upon request

Benefit from our extensive experience and expertise in telecentric imaging lenses. Contact Sill Optics today to discuss your specific requirements and discover the right lens solution for your measurement applications.

PART NUMBER	MAGNIFICATION	RECOMMENDED SENSOR DIAGONAL [mm]	WORKING DISTANCE [mm]	WAVELENGTH BAND MONO (RED, GREEN, BLUE) WHITE (COLOR/BAYER) NIR (800-900 nm)	RECOMMENDED PIXEL SIZE [µm]	THREAD	PART NUMBER FOR VERSION WITH INTEGR. COAXIAL ILLUMINATION
LENSES FOR 1/3“ AND 1/2” SENSORS							
S5LPJ1823	0.044	6.0	300.0	R,G,B,NIR	2.20	C	S5LPL1823-LED
S5LPJ1514	0.054	6.0	284.0	R,G,B	2.20	C	S5LPL1514-LED
S5LPJ1824	0.056	8.0	300.0	R,G,B	2.20	C	S5LPL1824-LED
S5LPJ1522	0.068	8.0	284.0	R,G,B	2.20	C	S5LPL1522-LED
S5LPJ6014	0.079	6.0	180.0	R,G,B	2.00	C	S5LPL6014-LED
S5LPJ1523	0.082	8.0	284.0	R,G,B	3.45	C	S5LPL1523-LED
S5LPJ6022	0.100	8.0	180.0	R,G,B	2.20	C	S5LPL6022-LED
S5LPJ1224	0.110	6.0	190.0	R,G,B,W,NIR	2.20	C	S5LPL1224-LED
S5LPJ1201	0.132	6.0	190.0	R,G,B,W	2.20	C	S5LPL1201-LED
S5LPJ1223	0.158	8.0	190.0	R,G,B,NIR	2.00	C	S5LPL1223-LED
LENSES FOR 1/1.8“ AND 2/3” SENSORS							
S5LPJ1832	0.065	8.9	300.0	R,G,B,NIR	2.00	C	S5LPL1832-LED
S5LPJ1533	0.098	11.0	284.0	R,G,B	2.00	C	S5LPL1533-LED
S5LPJ6024	0.121	8.9	180.0	R,G,B	2.20	C	S5LPL6024-LED
S5LPJ6033	0.145	11.0	180.0	R,G,B	2.50	C	S5LPL6033-LED
S5LPJ5015	0.160	8.9	88.0	R,G,B	2.80	C	S5LPL5015-LED
S5LPJ1299	0.200	11.0	92.0	R,G,B,NIR	2.80	C	S5LPL1299-LED
S5LPJ2298	0.244	11.0	92.0	R,G,B,W	4.60	C	S5LPL2298-LED
S5LPJ1252	0.265	11.0	190.0	R,G,B,W	2.50	C	S5LPL1252-LED
S5LPJ2893	0.292	11.0	92.0	R,G,B,W,NIR	2.50	C	S5LPL2893-LED
LENSES FOR 1“ AND 1.1” SENSORS							
S5LPJ1852	0.112	16.0	300.0	R,G,B	2.20	C	S5LPL1852-LED
S5LPJ1860	0.134	17.6	300.0	R,G,B	3.45	C	S5LPL1860-LED
S5LPJ1551	0.165	16.0	284.0	R,G,B	3.45	C	S5LPL1551-LED
S5LPJ1565	0.195	16.0	284.0	R,G,B	4.20	C	S5LPL1565-LED
S5LPJ6050	0.246	16.0	180.0	R,G,B	3.45	C	S5LPL6050-LED
S5LPJ6060	0.292	16.0	180.0	R,G,B	3.45	C	S5LPL6060-LED
S5LPJ1260	0.313	16.0	190.0	R,G,B	4.60	C	S5LPL1260-LED
S5LPJ2499	0.492	17.6	92.0	R,G,B,W,NIR	3.45	C	S5LPL2499-LED
S5LPJ2898	0.581	17.6	92.0	R,G,B,W,NIR	4.60	C	S5LPL2898-LED

PORTFOLIO IMAGING LENSES

BENEFIT FROM OUR EXPERIENCE

TELECENTRIC IMAGING LENSES FOR SMALLER FOV

- Low cost alternatives for pixel size 3.45 µm
- Lens design for R,G,B illumination and monochrome sensor

PART NUMBER	MAGNIFICATION	RECOMMENDED SENSOR DIAGONAL [mm]	WORKING DISTANCE [mm]	WAVELENGTH BAND MONO (RED, GREEN, BLUE) WHITE (COLOR/BAYER) NIR (800-900 nm)	RECOMMENDED PIXEL SIZE [µm]	THREAD
LENSES FOR 1/3“ AND 1/2” SENSORS						
S5LPJ4425	1.000	8.0	107.5	R,G,B	3.45	C
LENSES FOR 1“ AND 1.1” SENSORS						
S5LPJ4061-216	0.600	16.0	121.0	R,G,B,W	3.45	C
S5LPJ3208	0.770	16.0	119.5	R,G,B,W	3.45	C

TELECENTRIC IMAGING LENSES WITH COLOR CORRECTION AND NIR USABILITY

- Telecentric FOV up to Ø120 mm
- Lens designs for white illumination with Bayer pattern color sensor
- Lens designs for NIR illumination with monochrome sensor
- Variable iris for improved DOF (depth of focus)

PART NUMBER	MAGNIFICATION	RECOMMENDED SENSOR DIAGONAL [mm]	WORKING DISTANCE [mm]	WAVELENGTH BAND MONO (RED, GREEN, BLUE) WHITE (COLOR/BAYER) NIR (800-900 nm)	RECOMMENDED PIXEL SIZE [µm]	THREAD
LENSES FOR 1/3“ AND 1/2” SENSORS						
S5LPJ6122	0.100	8.0	180.0	R,G,B,W,NIR	2.00	C
S5LPJ1722	0.068	8.0	284.0	R,G,B,W,NIR	2.00	C
LENSES FOR 1/1.8“ AND 2/3” SENSORS						
S5LPJ1733	0.098	11.0	284.0	R,G,B,W,NIR	2.00	C
S5LPJ6133	0.145	11.0	180.0	R,G,B,W,NIR	2.50	C
LENSES FOR 1“ AND 1.1” SENSORS						
S5LPJ6150	0.246	17.6	180.0	R,G,B,W,NIR	3.45	C
S5LPJ1750	0.165	17.6	284.0	R,G,B,W,NIR	3.45	C

TELECENTRIC IMAGING LENSES FOR SENSOR SIZE UP TO APS FORMAT

- High performance telecentric lenses for pixel size <3.45 µm
- Large sensor diagonal for high resolution C-Mount cameras up to 25 MPx
- Large sensor diagonal for high resolution APS format cameras up to 60 MPx
- Excellent color correction for Bayer pattern color sensors with white illumination
- Excellent performance in NIR with small working distance adjustment

	PART NUMBER	MAGNIFICATION	RECOMMENDED SENSOR DIAGONAL [mm]	WORKING DISTANCE [mm]	WAVELENGTH BAND MONO (RED, GREEN, BLUE) WHITE (COLOR/BAYER) NIR (800-900 nm)	RECOMMENDED PIXEL SIZE [µm]	THREAD
	LENSES FOR 1.2" AND 1.5" SENSORS						
	S5LPJ1862	0.130	19.2	300.0	R,G,B,W,NIR	2.74	C
	S5LPJ1762	0.200	19.2	284.0	R,G,B,W,NIR	2.74	C
	S5LPJ1762-M42	0.200	24.0	284.0	R,G,B,W,NIR	2.74	M42x1
	S5LPJ6162	0.300	19.2	180.0	R,G,B,W,NIR	2.74	C
	S5LPJ6162-M42	0.300	24.0	180.0	R,G,B,W,NIR	2.74	M42x1
NEW	S5LPJ6405	0.500	19.2	176.0	R,G,B,W,NIR	2.74	C
	S5LPJ6406	0.600	22.0	155.0	R,G,B,W,NIR	2.74	C
	S5LPJ6407	0.700	22.0	140.0	R,G,B,W,NIR	2.74	C
	S5LPJ6408	0.800	22.0	131.0	R,G,B,W,NIR	2.74	C
NEW	S5LPJ6409	0.900	19.2	127.0	R,G,B,W,NIR	2.74	C
	S5LPJ7201	1.000	21.4	81.0	R,G,B,W,NIR	2.74	C
	S5LPJ6415	1.500	21.4	80.2	R,G,B,W	2.40	C
	S5LPJ6420	2.000	21.4	68.1	R,G,B,W	2.74	C
	S5LPJ6425	2.500	19.2	61.4	R,G,B,W	3.10	C
	S5LPJ6430	3.000	19.2	57.0	R,G,B,W	3.45	C
	LENSES FOR APS FORMAT SENSORS						
HIGHLIGHT	S5LPJ1894-FMO	0.200	28.2	300.0	R,G,B,W,NIR	2.74	F
HIGHLIGHT	S5LPJ1894-M42	0.200	28.2	300.0	R,G,B,W,NIR	2.74	M42x1
HIGHLIGHT	S5LPJ1794-FMO	0.310	32.6	284.0	R,G,B,W,NIR	2.74	F
HIGHLIGHT	S5LPJ1794-M42	0.310	32.6	284.0	R,G,B,W,NIR	2.74	M42x1
HIGHLIGHT	S5LPJ6194-FMO	0.450	32.6	180.0	R,G,B,W,NIR	2.74	F
HIGHLIGHT	S5LPJ6194-M42	0.450	32.6	180.0	R,G,B,W,NIR	2.74	M42x1
HIGHLIGHT	S5LPJ2607-FMO	0.710	35.0	140.0	R,G,B,W,NIR	2.74	F
HIGHLIGHT	S5LPJ2607-M42	0.710	35.0	140.0	R,G,B,W,NIR	2.74	M42x1
HIGHLIGHT	S5LPJ7201-FMO	1.000	32.6	81.0	R,G,B,W,NIR	2.74	F
HIGHLIGHT	S5LPJ7201-M42	1.000	32.6	81.0	R,G,B,W,NIR	2.74	M42x1

TELECENTRIC LENSES WITH INTEGRATED TUNABLE LIQUID LENS

- High performance stability within specified tuning range.
- Constant telecentricity, small linear magnification change within tuning
- Good color correction and performance stability for 1.2" magnifying lenses in vertical orientation (gravity influence on liquid reduces performance in horizontal orientation)
- Good performance stability in both vertical and horizontal orientation for 1" demagnifying lenses.

PART NUMBER	MAGNIFICATION	RECOMMENDED SENSOR DIAGONAL [mm]	WORKING DISTANCE [mm]	TUNING RANGE [mm]	WAVELENGTH BAND MONO (RED, GREEN, BLUE) WHITE (COLOR/BAYER) NIR (800-900 nm)	RECOMMENDED PIXEL SIZE [µm]	THREAD	PART NUMBER FOR VERSION WITH INTEGR. COAXIAL ILLUMINATION
S5VPJ1565	0.193	16.0	284.0	+/-70.0	R,G,B	2.74	C	-
S5VPJ6060	0.289	16.0	180.0	+/-32.5	R,G,B	2.74	C	S5VPL6060-LED
S5VPJ1260	0.311	16.0	190.0	+/-27.5	R,G,B	3.10	C	-
S5VPJ2898	0.578	16.0	92.0	+/-8.5	R,G,B	3.10	C	S5VPL2898-LED
S5VPJ6415	1.500	19.2	80.2	+/-5	R,G,B,W	2.74	C	-
S5VPJ6420	2.000	19.2	68.2	+/-5	R,G,B,W	2.74	C	-
S5VPJ6425	2.500	19.2	61.4	+/-5	R,G,B,W	3.10	C	-

SPECIAL IMAGING LENSES

BENEFIT FROM OUR CAPABILITIES

Besides our portfolio telecentric lenses, we also offer a variety of **telecentric and entocentric designs upon request.**
These special lenses are not manufactured regularly. We kindly ask you to send us your inquiry to check availability, lead time and price according your required quantity.

To enable a short lead-time for your test setup, we are going to build up a demo lens stock.

PART NUMBER	MAGNIFICATION	RECOMMENDED SENSOR DIAGONAL [mm]	WORKING DISTANCE [mm]	WAVELENGTH BAND MONO (RED, GREEN, BLUE) WHITE (COLOR/BAYER) NIR (800-900nm) SWIR (900-1700nm)	RECOMMENDED PIXEL SIZE [µm]	THREAD
TELECENTRIC LENSES FOR APS FORMAT SENSORS						
S5LPJ0492-M42	2.00	35.0	96.5	R,G,B,W	4.60	M42x1
TELECENTRIC LENSES FOR FULL FORMAT AND LARGER SENSORS						
S5LPJ3025-M58	0.25	43.3	310.0	R,G,B,W	3.45	M58x0.75
S5LPJ3005-M72	0.33	60.0	310.0	R,G,B	3.45	M72x0.75
S5LPJ1556-M58	0.46	43.3	332.3	R,G,B,W,NIR	3.30	M58x0.75
S5LPJ7207-M72	0.66	43.3	180.0	R,G,B	5.50	M72x0.75
S5LPJ7209-M72	0.80	43.3	180.0	R,G,B	4.00	M72x0.75
S5LPJ7255-M72	1.00	56.0	120.0	R,G,B	4.60	M72x0.75
S5LPJ7211-M90	1.00	70.0	180.0	R,G,B	5.00	M90x1
S5LPJ7212-M90	1.25	70.0	141.0	R,G,B	4.20	M90x1
S5LPJ7215-M90	1.51	70.0	111.0	R,G,B	6.00	M90x1
HIGH-MAGNIFICATION TELECENTRIC LENSES						
S5LPJ2533	3.00	16.0	100.4	R	3.45	C
S5LPJ2555	5.00	16.0	100.5	R	4.50	C
TELECENTRIC SWIR LENSES						
S5LPJ6835	0.33	16.0	147.0	SWIR	10.00	C
S5LPJ6837	0.50	24.0	147.0	SWIR	10.00	M42x1

	PART NUMBER	FOCAL LENGTH [mm]	RECOMMENDED SENSOR DIAGONAL [mm]	MINIMUM F#	WORKING DISTANCE RANGE [mm]	WAVELENGTH BAND MONO (RED, GREEN, BLUE) WHITE (COLOR/BAYER) NIR (800-900nm) SWIR (900-1700nm)	RECOMMENDED PIXEL SIZE [µm]	THREAD
	ENTOCENTRIC LENSES FOR MULTILINE CAMERAS RGB-NIR							
HIGHLIGHT	S5LPJ4429	28.0	40.96	4.0	450 - 1200	R,G,B,W,NIR	5.00	M58, optional M42
HIGHLIGHT	S5LPJ4440	40.0	40.96	4.0	350 - 1200	R,G,B,W,NIR	5.00	M58, optional M42
HIGHLIGHT	S5LPJ4465	65.0	40.96	4.0	500 - 1500	R,G,B,W,NIR	5.00	M58, optional M42
	ENTOCENTRIC SWIR LENSES							
	S5LPJ6805-216	50.0	16.0	1.8	400 - inf	SWIR	10.00	C
	S5LPJ6807-M42	75.0	25.6	2.0	500 - inf	SWIR	10.00	M42x1
	ENTOCENTRIC TELE LENSES FOR LASER PROCESS IMAGING							
	S5LPJ0305	150.3	8.0	8.0	infinity	R	5.60	C
	S5LPJ0303	305.3	11.0	16.0	infinity	R	5.00	C
	ENTOCENTRIC TELE LENSES FOR LASER PROCESS IMAGING WITH INTEGRATED LIQUID LENS							
	S5VPJ0305	150.0	11.0	8.0	infinity	R	5.60	C
	S5VPJ0303	304.3	11.0	11.0	infinity	R	5.00	C

PORTFOLIO LED CONDENSERS

BENEFIT FROM OUR EXPERIENCE

Within our telecentric imaging lens portfolio, we have also developed LED condensers that complement our offerings. These condensers serve as collimated backlights for high-precision measurements in machine vision applications. Our main expertise lies in optical subassemblies that ensure the emitted light exhibits high homogeneity and parallelism.

In addition to the condensers available in our portfolio, we can provide other sizes (up to an illumination diameter of Ø150) and offer modifications or custom developments upon request. We are committed to meet your specific requirements and providing tailored solutions for your imaging needs.

PART NUMBER	CLEAR APERTURE/ ILLUMINATION DIAMETER [mm]	FOCAL LENGTH [mm]	LED	WAVELENGTH [nm]	MAX. CURRENT [mA]	CONNECTOR
IR CONDENSER						
S6IRI4530	30.0	30.0	SFH4770S	850	1000	M8 / 4-pin
S6IRI4540	55.0	76.0	SFH4770S	850	1000	M8 / 4-pin
S6IRI4550	73.0	100.0	SFH4770S	850	1000	M8 / 4-pin
RED CONDENSER						
S6IRI4531	30.0	30.0	GR QSSPA1.13	623	1000	M8 / 4-pin
S6IRI4541	55.0	76.0	GR QSSPA1.13	623	1000	M8 / 4-pin
S6IRI4551	73.0	100.0	GR QSSPA1.13	623	1000	M8 / 4-pin
BLUE CONDENSER						
S6IRI4532	30.0	30.0	GB QSSPA1.13	470	1000	M8 / 4-pin
S6IRI4542	55.0	76.0	GB QSSPA1.13	470	1000	M8 / 4-pin
S6IRI4552	73.0	100.0	GB QSSPA1.13	470	1000	M8 / 4-pin
GREEN CONDENSER						
S6IRI4533	30.0	30.0	GT QSSPA1.13	528	1000	M8 / 4-pin
S6IRI4543	55.0	76.0	GT QSSPA1.13	528	1000	M8 / 4-pin
S6IRI4553	73.0	100.0	GT QSSPA1.13	528	1000	M8 / 4-pin

ACCESSORY FOR TELECENTRIC IMAGING LENSES AND LED CONDENSERS

PART NUMBER	DESCRIPTION
LENS MOUNT SET	
S5SET0020	Clamping Ø60/Ø75 for many telecentric lenses
S5SET0022	Clamping Ø47 for all LED condensers
BEAMS SPLITTER CUBES FOR INTEGRATED COAXIAL ILLUMINATION	
S0SET9125-000	Polarized beam splitter (standard condition)
S0SET9125-017	Non-polarized beam splitter
RETARDATION PLATES FOR INTEGRATED COAXIAL ILLUMINATION	
S5SET1150	half wave plate for 630nm, slide-in unit
S5SET8325-040	half wave plate for 630nm, add-on unit
USB DRIVER FOR FOCUS TUNABLE OPTOTUNE LENSES	
S5ZUB1640	Optotune USB Driver EL-E-4i
S5ZUB1641	Hirose 6-pin connection cable for USB Driver EL-E-4i

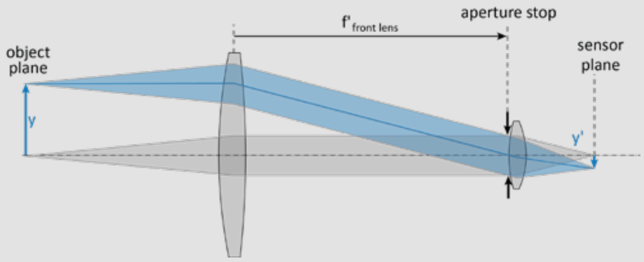
Other accessory upon request.
In case of demands on modifications, please contact our Customer Care Team.

LENS DESIGNS – TELECENTRIC LENSES

OBJECT-SIDED TELECENTRIC LENS

Object-sided telecentric lenses offer the highest measurement precision because the chief rays in the object space are parallel, and there is no magnification change with variations in working distance within the depth of field.

In addition to our portfolio of telecentric lenses, Sill Optics has successfully developed numerous customized telecentric designs for series production.



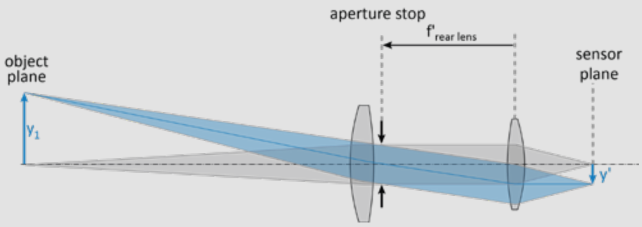


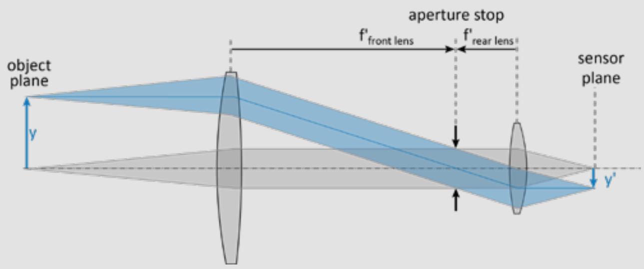
IMAGE-SIDED TELECENTRIC LENS

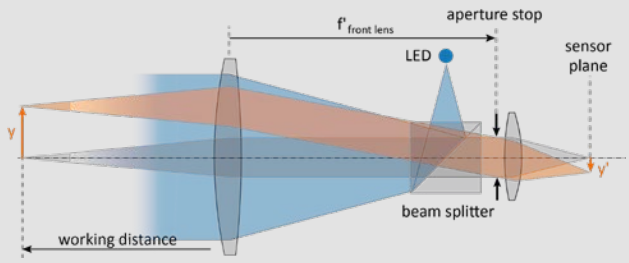
Image-sided telecentric lenses are essential for various specialized imaging purposes or specific camera types. These lenses are specifically designed for applications where intermediate images are required for follow-up systems (e.g., spectrometers) or for prism-based three-chip sensors.

In many applications with CMOS sensors, a small angle of incidence at the sensor side is adequate for optimal performance.

BI-TELECENTRIC LENS

Bi-telecentric lenses integrate both object-sided and image-sided telecentric beam paths into a single lens. These lenses offer significant advantages for high-spec imaging applications and provide minimal distortion.





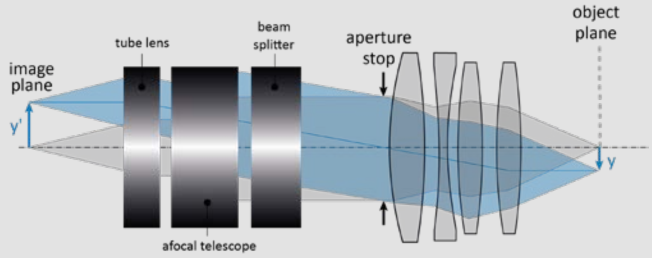
TELECENTRIC LENS WITH INTEGRATED COAXIAL ILLUMINATION

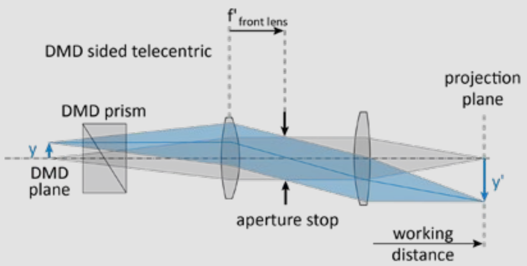
Telecentric lenses with integrated coaxial illumination offer a unique combination of telecentric imaging and coaxial collimated front illumination. This design incorporates a beam splitter to introduce the illumination path, while the front part of the telecentric lens collimates the light.

LENS DESIGNS – TELECENTRIC LENSES

MICROSCOPE LENSES

Sill Optics is no typical microscope lens manufacturer for standards with small field of view (FOV) and high NA.
Nevertheless, we have the manufacturing expertise to realize microscope lenses for applications with larger working distance (≥ 5 mm) and NA ≤ 0.5 that require larger FOV or special waveband correction.
We are your trusted partner in finding customized solutions to meet your individual requirements.





DMD LENSES

DMD lenses are specifically designed for the projection of a digital micromirror device. These lenses feature a telecentric design on the DMD side. When working with DMDs, it is essential to consider the prism material and internal distances to prevent axial color shift.

At Sill Optics, we are your trusted partner, especially when it comes to lenses for DMD manufacturing and precision measurement pattern projection. Our expertise in this area ensures that we can provide you with the optimal lens solutions tailored to your specific needs.

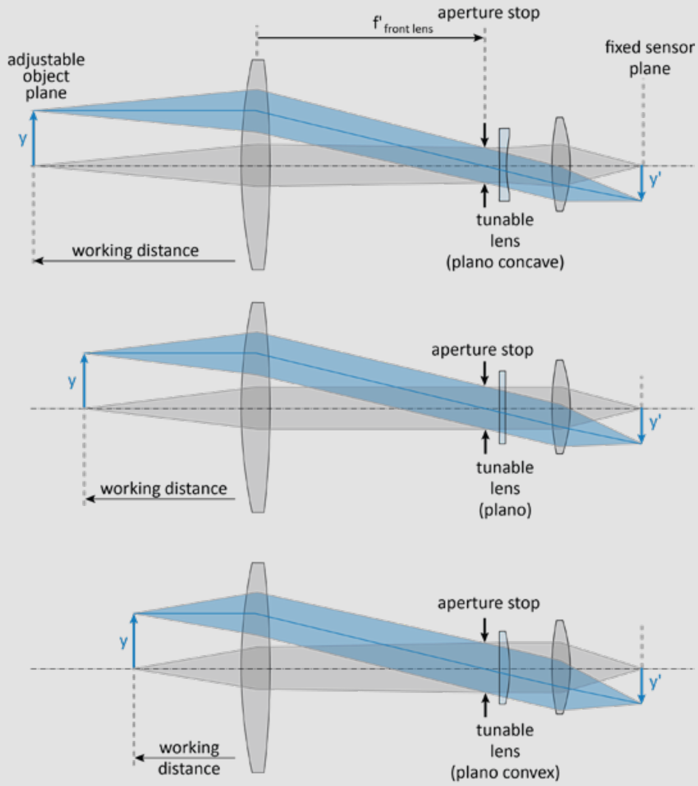
TELECENTRIC LENSES WITH INTEGRATED TUNABLE LIQUID LENS

Telecentric lenses with integrated tunable liquid lenses provide the capability for fast focus changes without the need for moving elements. While we offer a range of telecentric lenses in our portfolio, our true strength lies in designing custom lenses with integrated liquid lenses.

In our projects, we typically incorporate liquid lenses from Optotune, as we have had positive experiences with their reliable products.

However, it is worth noting that we can also develop entocentric designs with integrated liquid lenses if needed.

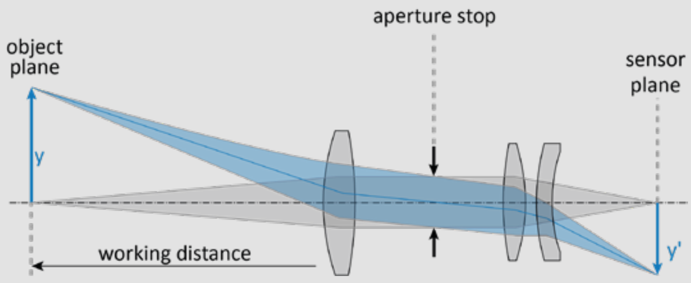
Count on Sill Optics to deliver the precise lens solution with integrated tunable liquid lenses that meets your specific requirements.

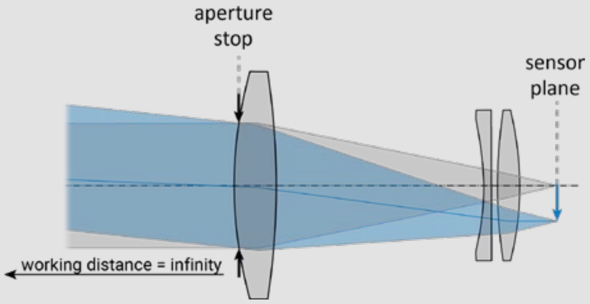


LENS DESIGNS - ENTOCENTRIC LENSES

LARGE FIELD ENTOCENTRIC LENS

Sill Optics defines "large field" as referring to lenses designed for use with sensors of a large diagonal size. When dealing with line scan cameras or large format area sensors with a length or diagonal size exceeding 43.3mm (full format), the complexity of entocentric lens design increases. These scenarios create a demand for custom development, particularly when high aperture, high resolution, and/or large bandwidth are required.





TELEPHOTO LENS

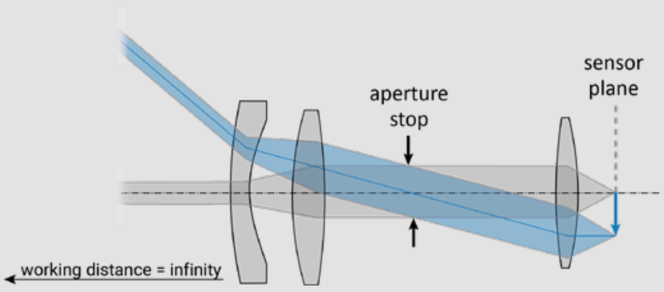
Telephoto lenses are characterized by their long focal length, which is typically greater than their physical length. These lenses are designed to capture images of distant objects with a specific magnification factor.

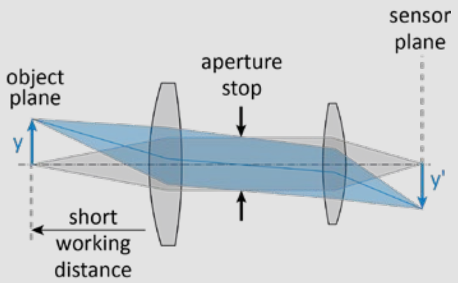
In telephoto lenses, the aperture stop is typically positioned at the front surface of the lens. When a larger aperture is desired, a correspondingly large front lens element is necessary to accommodate it.

WIDE-ANGLE LENS

Wide-angle lenses are commonly used for observation applications or imaging tasks that require capturing a large field of view at significant distances.

These lenses can be designed in two main configurations: fisheye lenses, which feature concave lens elements at the front, as shown; or pinhole lenses, where the aperture is positioned outside the lens assembly.





MACRO LENS

Macro lenses are entocentric lenses designed for capturing close-up shots with magnifications ranging from approximately 0.5x to 1.5x. These lenses feature a small optical transfer length and typically have a large aperture.

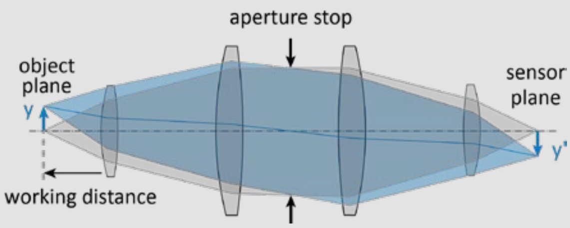
Due to the short transfer length, macro lenses require a short focal length and must be carefully designed to fit within the available space without compromising performance.

LENS DESIGNS - ENTOCENTRIC LENSES

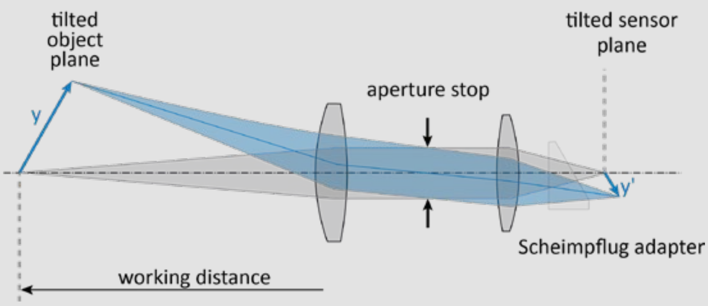
RELAY LENS

Relay lenses are integral components of optical systems used to transfer an intermediate image plane to the pupil plane (Fourier plane) and/or back to a final image plane. They play a crucial role in various applications, such as refractive spectrometers.

Relay systems can be designed in a symmetric configuration, where the magnification is 1:1, or in an asymmetric configuration with a magnification ratio of 1:X. The choice of configuration depends on the specific requirements of the optical system.



Furthermore, relay lenses can also be utilized for pupil relays in specialized scanning setups. These setups allow for precise scanning and control of the beam path.



SCHEIMPFLUG LENS FOR TILTED OBJECT PLANE

Scheimpflug lenses are designed to image a tilted object plane onto a tilted image plane while minimizing critical blur. This allows for capturing accurate measurements even when dealing with non-planar objects. The distortion can also be optimized for specific measurement purposes.

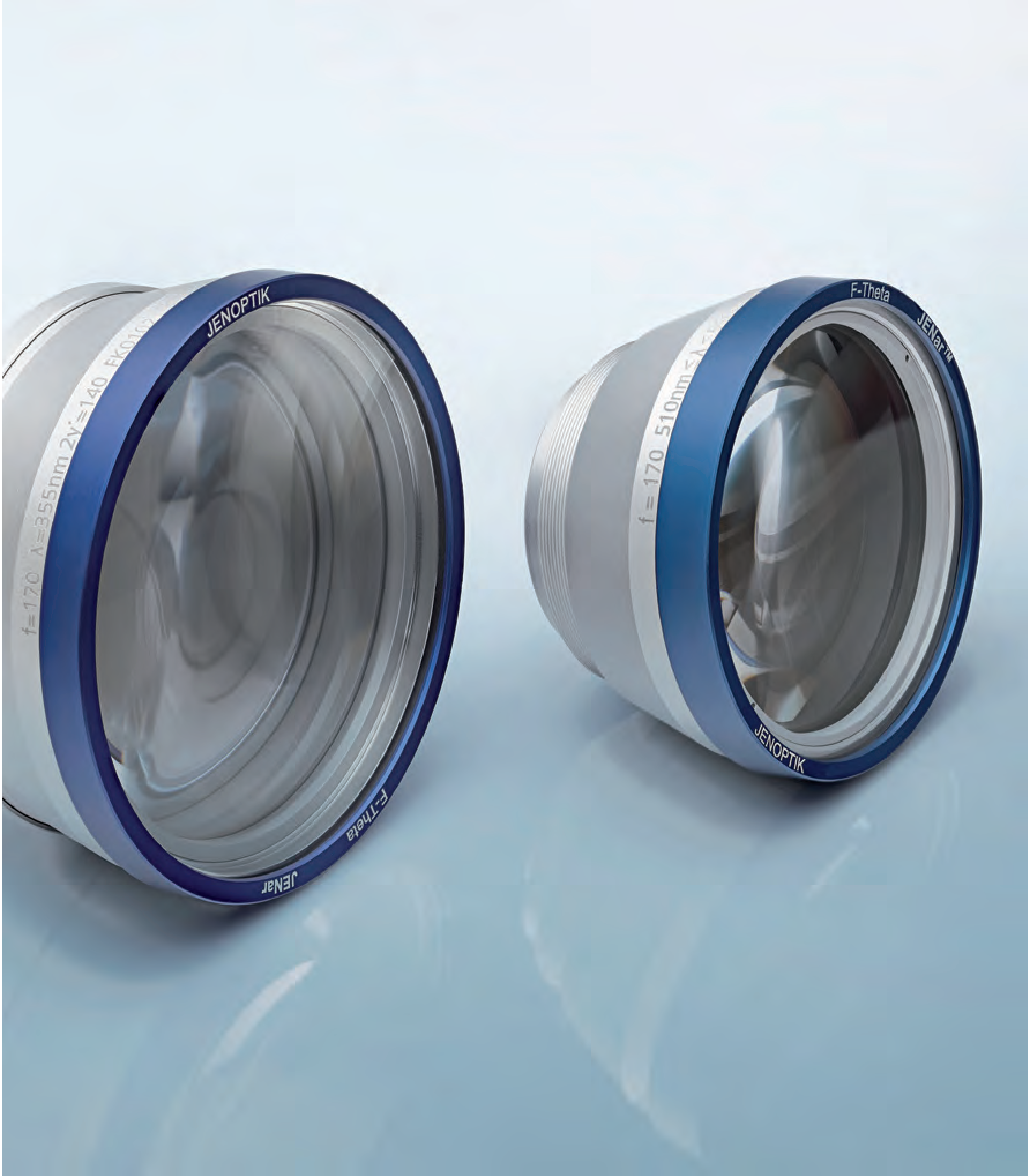
To accommodate standard imaging cameras, a tilting adapter can be used to meet the imaging performance requirements. This adapter ensures that the Scheimpflug imaging setup is compatible with the camera system being used.

JENOPTIK

MORE LIGHT

Featured optic products 2019

Realize your success with products from Jenoptik.



F-Theta JENar™ Silverline™

High Power Scan Lenses "Made in Germany"

Minimal absorption for high power and short pulse applications.

The use of high power lasers allows remarkably higher productivity of laser material processing.
However, also the requirements of concerned optical processing solutions increase. The F-Theta JENar™ Silverline™ series of high power scan lenses is designed to meet today's laser material processing requirements.

Low-absorbing fused silica elements and coatings ensure very high damage thresholds and minimal thermal influences resulting in outstanding process performance. Challenge our expertise!

USP

- Extremely durable: Due to special, low contamination mounting technology, avoidance of adhesives and lubricants; assembly in a certified cleanroom
- Efficient: Despite possible beam power of up to four kilowatts no active cooling required
- Customized: Available as a standard selection or adapted to your individual requirements

Fields of Application

- Automotive industry:
  E.g. industrial production of components
- Semiconductor and display manufacturing:
  E.g. marking of semiconductor chips
- Solar cell manufacturing:
  E.g. optics for edge removal and P1, P2 and P3 structuring
- General applications:
  E.g. battery welding, metal cutting, marking
- Medical technology:
  E.g. lenses for redirecting laser beams in ophthalmology instruments

Looking for an easy way to integrate our F-Theta in your laser material application? → please see page 98

Contact

Contact worldwide → please see page 7

Find your way into our optics …

Technical Parameters & Properties
F-Theta JENar™ Silverline™ High Power Scan Lens Series.

Type: Silverline™ [1)]/ High Power Scan Lens Series[1)]

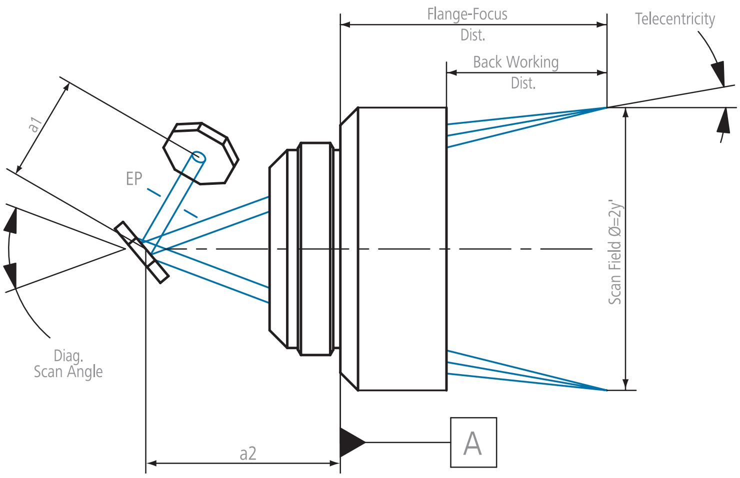
Wavelength	Lens Order Number	Focal Length	Scan Field Diagonal	Max. Full Diagonal Scan Angle	Max. Input Beam Diameter Truncated at 1/e² for 2-axis-scan	Focus Size at 1/e² Intensity Level
[nm]		[mm]	[mm]	[°]	[mm]	[µm]
1030…1080	017700-025-26**	160	110	40	14	22
	017700-026-26**	255	160	36	20	25
	609120 NEW***	423	360	48	14	59
900…1100	601787	160	110	40	14	19
	601804	255	161	36	20	21
	628951 NEW***	423	360	48	14	50
355	017700-402-26	103	71	40	9	8
	017700-406-26	255	240	54	10	17
	017700-405-26	510	431	51	14	24
	586840*	170	140	50	10	11
266	017700-601-26	103	71	40	9	6

[1)] fused silica

The data given are nominal values for the specified application parameters. Jenoptik provides Zemax® BlackBox files for simulating application results for customized parameters (e.g. wavelength, scanner geometry, beam diameter, …).
Back working distance, Flange focus distance, and focal length vary by ± 1.5 % due to manufacturing variances.

JENar®: Registered in EU, CN, JP, SG, US | Silverline®: Registered in DE, JP, SG, IN
* two-part lens - F-Theta 170-355-140: Registered Design in DE, 40 2016 000 911.4 | Design appl. for CN, EU, JP, KR, SG, HK, IN, TW
Patent pending CN, JP, HK, KR, SG | Utility patent DE, CN (DE 20 2016 004 165.8, ZL 201720751058)
** Registered / pending - Utility patents - in DE, CN
*** Utility patent DE 20 2018 100 128 U1 | Utility patent pending CN, JP, KR

It is our policy to constantly improve the design and specifications. Accordingly, the details represented herein cannot be regarded as final and binding.



a1 Recommended Mirror Separation	a2 2nd Mirror to Flange	Telecentricity (only F-Theta | with scanner)	Back Working Distance from last mechanical surface (incl. window)	Mounting Thread	Window Order Number for Spare Part
[mm]	[mm]	[°]	[mm]		
17	40	5.2 | 5.4	184	M85x1	576225
25	48	7.2 | 7.4	303	M85x1	576225
17	40	16.4 | 16.4	500	M85x1	629206
17	40	5.2 | 5.4	182	M85x1	602021
25	48	7.2 | 7.4	302	M85x1	602021
17	40	16.4 | 16.4	500	M85x1	628981
14	47	2.4 | 2.8	135	M85x1	576239
13	42	12.7 | 12.7	314	M85x1	579878
14	42	18.2 | 18.2	609	M85x1	576241
13	42	4.8 | 4.8	236	M85x1	610829
14	46	2.6 | 2.9	133	M85x1	610812

Correct lens storage, cleaning, and handling
Lifetime and performance of optical elements depend critically on the cleanliness and intactness of the optical surfaces. Proper storage, cleaning, and handling are therefore essential. Optical systems should be stored only in their respective original packaging and opened only in a clean environment by trained operators. Disassembly of optical systems on one's own responsibility leads to expiration of warranty. Return of optical systems should only be done using the original packaging.

Highlight in 2019
High Power F-Theta Lenses for Additive Manufacturing

New Silverline™ high power F-Theta Lenses for additive manufacturing
- New fused silica lenses optimized for 3D-metal-sintering
- Designed for multi kW fiber or diode laser applications
- They feature lowest absorption
- Minimal focus shift and highest damage threshold

Also available as diodes version with wavelength 900…1100 nm
- Order Number: 628951

JENar®: Registered in EU, CN, JP, SG, US | Silverline®: Registered in DE, JP, SG, IN
Utility patent DE 20 2018 100 128 U1| Utility patent pending CN, JP, KR

F-Theta JENar™ Silverline™ Lenses

Lens for Large Scan Fields | High Power Lenses

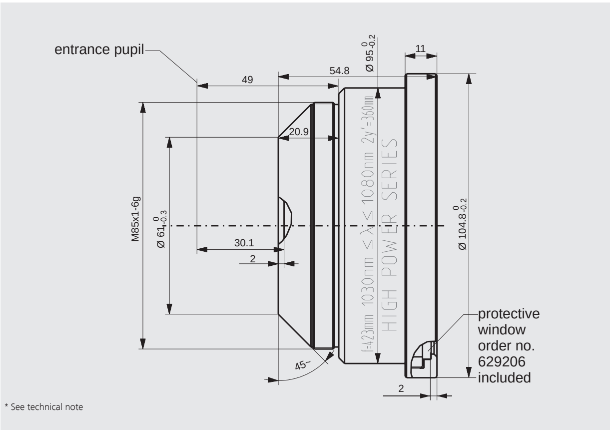
NEW**

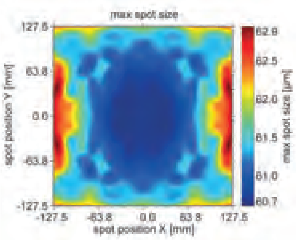
Laser Material Processing

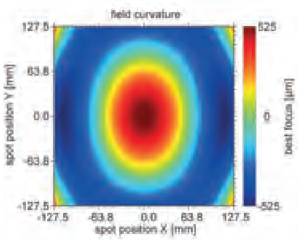
Parameters	JENar™ 423-1030…1080-360 Fused silica lens for large scan fields**	JENar™ 160-1030…1080-110 Fused silica lens
Focal length:	423 mm	160 mm
Wavelength:	1030…1080 nm	1030…1080 nm
Scan field (X x Y); Ø:	(255 mm x 255 mm); 360 mm	(78 mm x 78 mm); 110 mm
Diagonal scan angle:	± 24.4°	± 20°
X/Y mirror angle:	± 8.7°	± 7.1°
Back working distance:	500.2 mm	183.6 mm
Flange focus distance:	534.1 mm	267.6 mm
Input beam Ø 1/e²:	14 mm	14 mm
Focus size Ø 1/e²:	59 µm	22 µm
a1 | a2:	17 mm | 40.5 mm	17 mm | 40.5 mm
Telecentricity (only F-Theta | with scanner):	16.4° | 16.4°	5.2° | 5.4°
Absorption:	fused silica: < 15 ppm/cm coating: < 5 ppm (mean = 3 ppm)	fused silica: < 15 ppm/cm coating: < 5 ppm (mean = 3 ppm)
Group delay dispersion (GDD)*:	621 fs²	759 fs²
LIDT coating pulsed; CW*:	5.0 J/cm² * (τ/[ns]) ^ 0.30; 5.0 MW/cm²	5.0 J/cm² * (τ/[ns]) ^ 0.30; 5.0 MW/cm²
LIDT system pulsed; CW*:	5.0 J/cm² * (τ/[ns]) ^ 0.30; 5.0 MW/cm²	5.0 J/cm² * (τ/[ns]) ^ 0.30; 5.0 MW/cm²
Weight:	0.66 kg	1.08 kg
Order Number:	609120	017700-025-26

Specifications

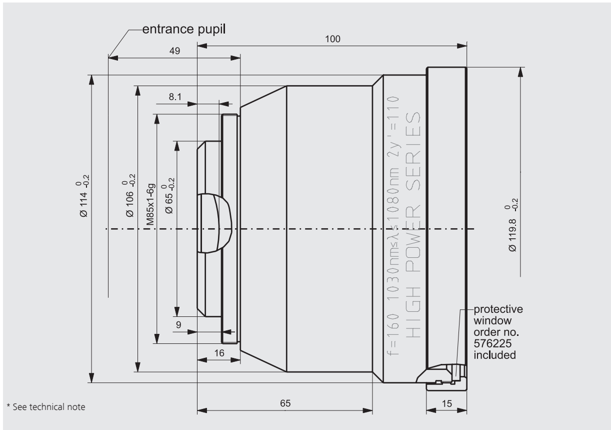
JENar™ 423-1030…1080-360

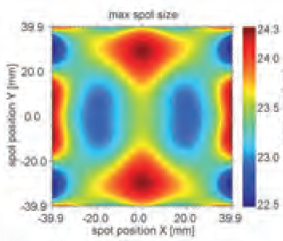


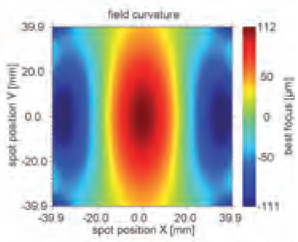




JENar™ 160-1030…1080-110







JENar®: Registered in EU, CN, JP, SG, US | Silverline®: Registered in DE, JP, SG, IN
Registered / pending - Utility patents - in DE, CN

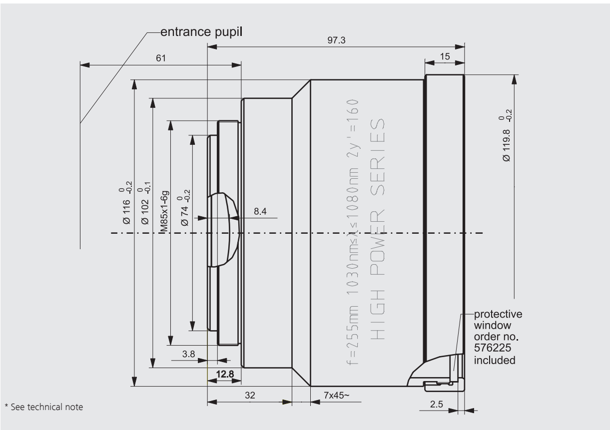
F-Theta JENar™ Silverline™ Lenses

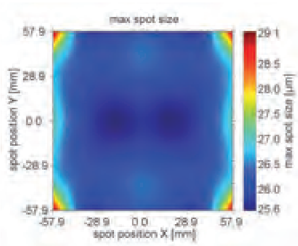
High Power Lenses

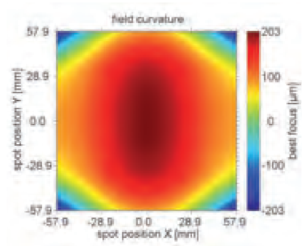
Parameters	JENar™ 255-1030…1080-160 Fused silica lens	JENar™ 160-900…1100-110 Fused silica lens
Focal length:	255 mm	160 mm
Wavelength:	1030…1080 nm	900…1100 nm
Scan field (X x Y); Ø:	(114 mm x 114 mm); 160 mm	(78 mm x 78 mm); 110 mm
Diagonal scan angle:	± 18°	± 20°
X/Y mirror angle:	± 6.4°	± 7.1°
Back working distance:	303.3 mm	182.0 mm @ 900 nm; 183.9 mm @ 1100 nm
Flange focus distance:	387.8 mm	266.0 mm @ 900 nm; 267.9 mm @ 1100 nm
Input beam Ø 1/e²:	20 mm	14 mm
Focus size Ø 1/e²:	25 µm	19 µm @ 900 nm; 23 µm @ 1100 nm
a1 | a2:	25 mm | 48.46 mm	17 mm | 40.5 mm
Telecentricity (only F-Theta | with scanner):	7.2° | 7.4°	5.2° | 5.4°
Absorption:	fused silica: < 15 ppm/cm coating: < 5 ppm (mean = 3 ppm)	–
Group delay dispersion (GDD)*:	904 fs²	759 fs²
LIDT coating pulsed; CW*:	5.0 J/cm² * (τ/[ns]) ^ 0.30; 5.0 MW/cm²	not available yet
LIDT system pulsed; CW*:	5.0 J/cm² * (τ/[ns]) ^ 0.30; 5.0 MW/cm²	not available yet
Weight:	1.2 kg	1.08 kg
Order Number:	017700-026-26	601787

Specifications

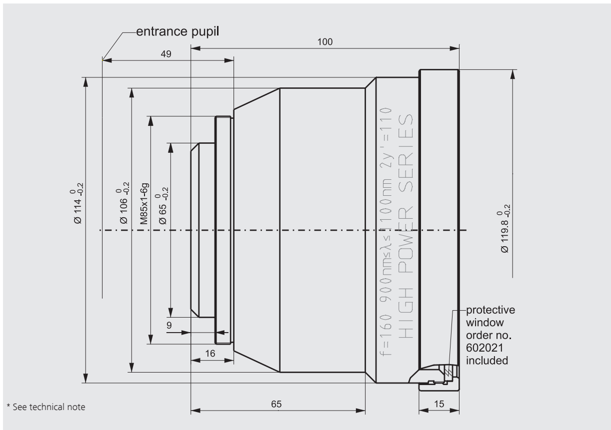
JENar™ 255-1030…1080-160

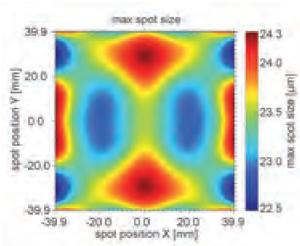


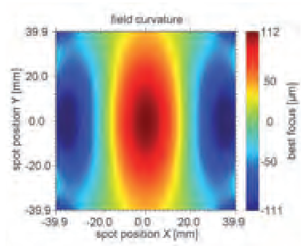




JENar™ 160-900…1100-110







JENar®: Registered in EU, CN, JP, SG, US | Silverline®: Registered in DE, JP, SG, IN

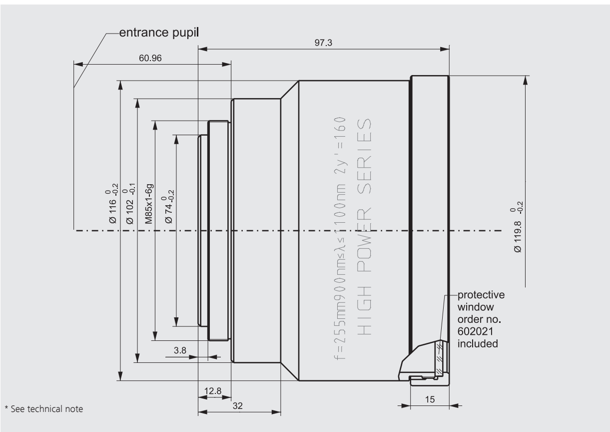
F-Theta JENar™ Silverline™ Lenses

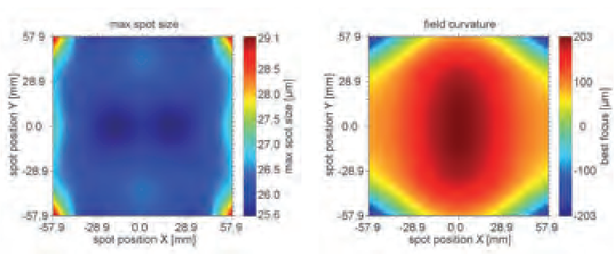
High Power Lenses

Parameters	JENar™ 255-900…1100-161 Fused silica lens	JENar™ 103-355-71 Telecentric fused silica lens
Focal length:	255 mm	103 mm
Wavelength:	900…1100 nm	355 nm
Scan field (X x Y); Ø:	(114 mm x 114 mm); 161 mm	(50 mm x 50 mm); 71 mm
Diagonal scan angle:	± 18°	± 20.1°
X/Y mirror angle:	± 6.4°	± 7.2°
Back working distance:	301.5 mm @ 900 nm; 304.2 mm @ 1100 nm	134.85 mm
Flange focus distance:	386.1 mm @ 900 nm; 388.8 mm @ 1100 nm	176.95 mm
Input beam Ø 1/e²:	20 mm	9 mm
Focus size Ø 1/e²:	21 µm @ 900 nm; 26 µm @ 1100 nm	8 µm
a1 | a2:	25 mm | 48.46 mm	14 mm | 46.5 mm
Telecentricity (only F-Theta | with scanner):	7.2° | 7.4°	2.4° | 2.8°
Group delay dispersion (GDD)*:	904 fs²	5670 fs²
LIDT coating pulsed; CW*:	not available yet	1.0 J/cm² * (τ/[ns]) ^ 0.40; 1.0 MW/cm²
LIDT system pulsed; CW*:	not available yet	not available yet
Weight:	1.2 kg	0.7 kg
Order Number:	601804	017700-402-26

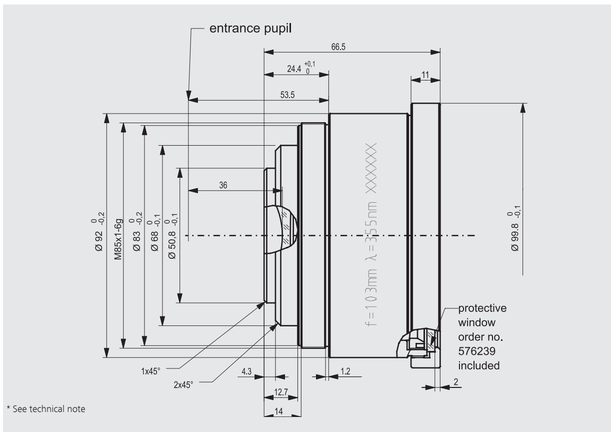
Specifications

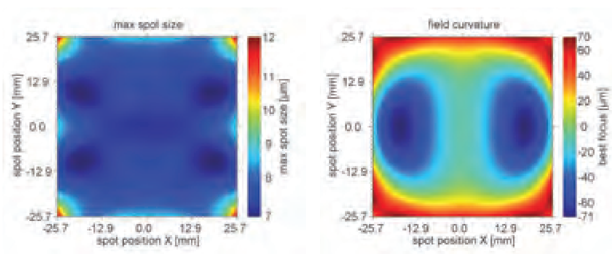
JENar™ 255-900…1100-161





JENar™ 103-355-71





JENar®: Registered in EU, CN, JP, SG, US | Silverline®: Registered in DE, JP, SG, IN

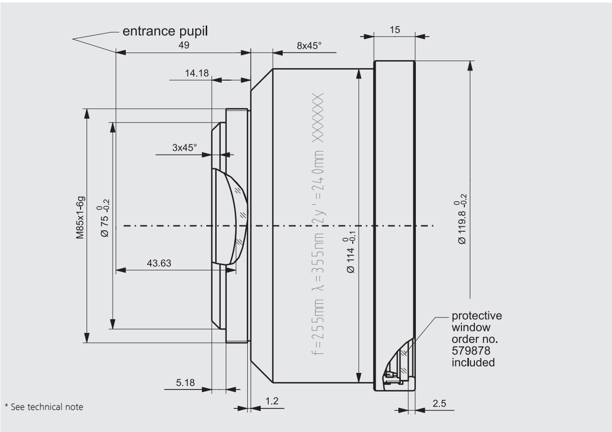
F-Theta JENar™ Silverline™ Lenses

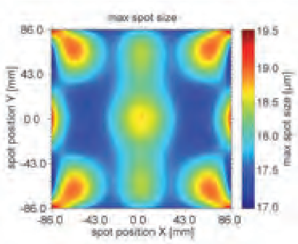
High Power Lenses

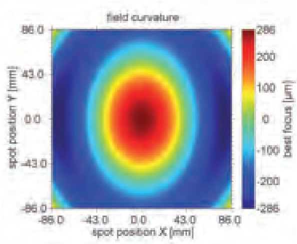
Parameters	JENar™ 255-355-240 Fused silica lens	JENar™ 510-355-431 Fused silica lens for large scan fields
Focal length:	255 mm	510 mm
Wavelength:	355 nm	355 nm
Scan field (X x Y); Ø:	(170 mm x 170 mm); 240 mm	(328 mm x 328 mm); 431 mm
Diagonal scan angle:	± 27.1°	± 25.7°
X/Y mirror angle:	± 9.7°	± 9.2°
Back working distance:	313.6 mm	609 mm
Flange focus distance:	373.3 mm	637 mm
Input beam Ø 1/e²:	10 mm	14 mm
Focus size Ø 1/e²:	17 µm	24 µm
a1 | a2:	13 mm | 42.5 mm	14 mm | 42 mm
Telecentricity (only F-Theta | with scanner):	12.7° | 12.7°	18.2° | 18.2°
Group delay dispersion (GDD)*:	6530 fs²	5260 fs²
LIDT coating pulsed; CW*:	1.0 J/cm² * (τ/[ns]) ^ 0.40; 1.0 MW/cm²	1.0 J/cm² * (τ/[ns]) ^ 0.40; 1.0 MW/cm²
LIDT system pulsed; CW*:	1.0 J/cm² * (τ/[ns]) ^ 0.40; 1.0 MW/cm²	1.0 J/cm² * (τ/[ns]) ^ 0.40; 1.0 MW/cm²
Weight:	1.2 kg	0.70 kg
Order Number:	017700-406-26	017700-405-26

Specifications

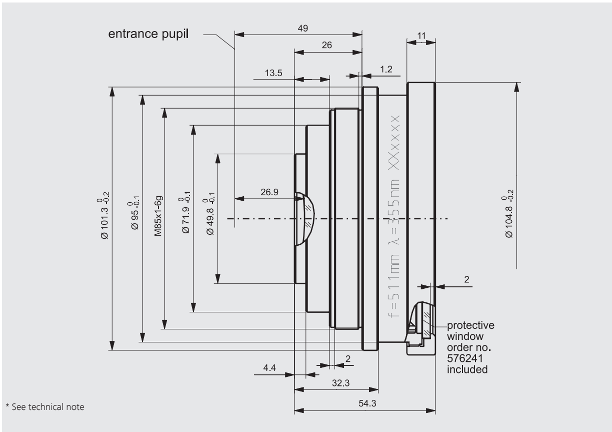
JENar™ 255-355-240

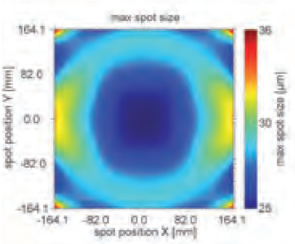


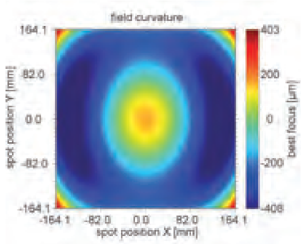




JENar™ 510-355-431







JENar®: Registered in EU, CN, JP, SG, US | Silverline®: Registered in DE, JP, SG, IN

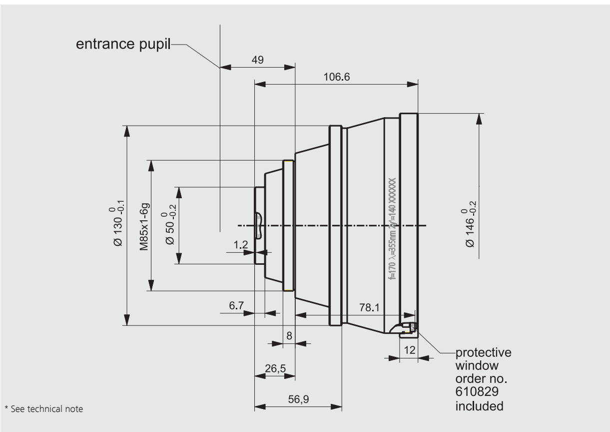
F-Theta JENar™ Silverline™ Lenses

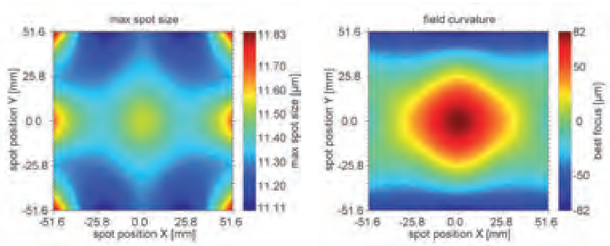
High Power Lenses

Parameters	JENar™ 170-355-140 Telecentric fused silica lens for large scan fields	JENar™ 103-266-71 Telecentric fused silica lens
Focal length:	170 mm	103 mm
Wavelength:	355 nm	266 nm
Scan field (X x Y); Ø:	(100 mm x 100 mm); 140 mm	(50 mm x 50 mm); 71 mm
Diagonal scan angle:	± 25°	± 20.1°
X/Y mirror angle:	± 8.9°	± 7.2°
Back working distance:	235.8 mm	133 mm
Flange focus distance:	315.8 mm	175.1 mm
Input beam Ø 1/e²:	10 mm	9 mm
Focus size Ø 1/e²:	11 µm	6 µm
a1 | a2:	13 mm | 42.5 mm	14 mm | 46 mm
Telecentricity (only F-Theta | with scanner):	4.8° | 4.8°	2.6° | 2.9°
Group delay dispersion (GDD)*:	8490 fs²	9350 fs²
LIDT coating pulsed; CW*:	1.0 J/cm² * (τ/[ns]) ^ 0.40; 1.0 MW/cm²	not available yet
LIDT system pulsed; CW*:	0.5 J/cm² * (τ/[ns]) ^ 0.40; 0.5 MW/cm²	not available yet
Weight:	1.85 kg	0.7 kg
Order Number:	586840	017700-601-26

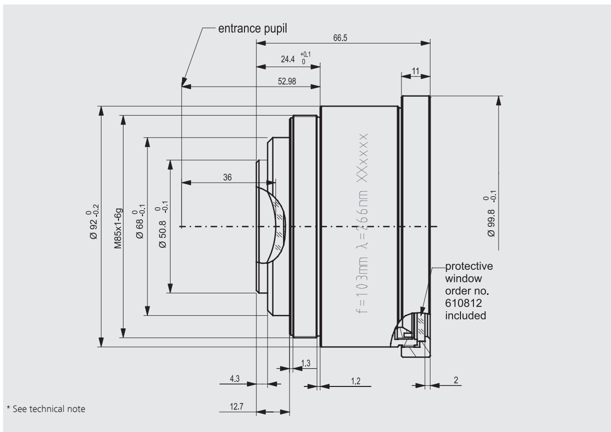
Specifications

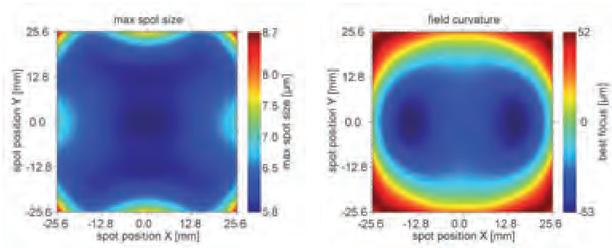
JENar™ 170-355-140





JENar™ 103-266-71





JENar™ 170-355-140: Registered Design in DE, 40 2016 000 911.4 | Design appl. for CN, EU, JP, KR, SG, HK, IN, TW
Patent pending CN, JP, HK, KR, SG | Utility patent DE, CN (DE 20 2016 004 165.8, ZL 201720751058)

F-Theta JENar™

Scan Lenses "Made in Germany"

Scan lenses can be used for high precision microstructuring, marking and labeling of a wide range of materials.

Jenoptik's JENar™ F-Theta scan lenses are exceptionally well suited to meet the requirements of highly sophisticated micro and macro machining processes in a wide variety of industries.
Our comprehensive product range includes F-Theta scan lenses for almost all common wavelengths and geometries and we are constantly striving to enlarge our product portfolio. Rely on our substantial know-how in optical and mechanical design as well as our latest optical test capabilities - challenge our expertise!

USP

- Extremely durable: In consequence of specific, low contamination mounting technology, avoidance of adhesion as well as lubricant and assembly in a certified cleanroom
- High precision: Suitable for microstructuring, marking and labeling of a wide range of materials
- Flexible: Quick and easy to integrate into any existing system
- Customized: Available as standard lenses or tailored to your individual requirements

Fields of Application

- Microelectronics:
  E.g. microstructuring of glass and metal
- Semiconductor industry:
  E.g. micro machining
- Automotive industry:
  E.g. cutting and structuring of composites and metal
- Medicine:
  E.g. blister packaging
- General applications:
  E.g. glass machining, battery welding

Looking for an easy way to integrate our F-Theta in your laser material application? → please see page 98

Contact

Contact worldwide → please see page 7

Find your way into our optics …

Technical Parameters & Properties F-Theta JENar™ Lens Series.

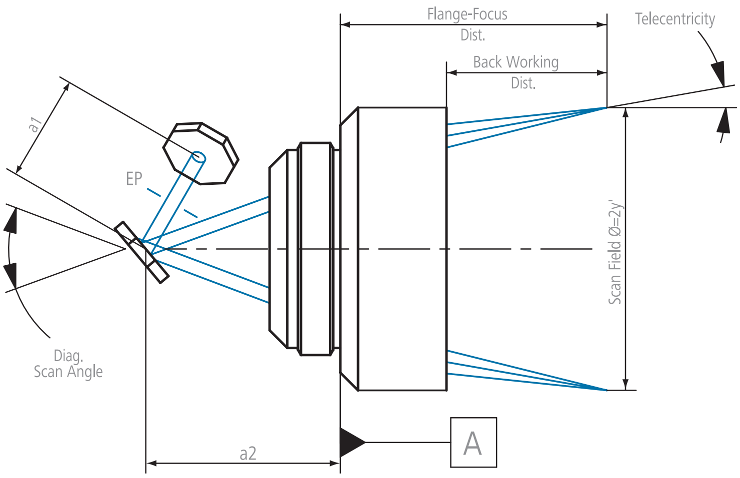
Type: F-Theta Lenses

Wavelength	Lens Order Number	Focal Length	Scan Field Diagonal	Max. Full Diagonal Scan Angle	Max. Input Beam Diameter Truncated at 1/e² for 2-axis-scan	Focus Size at 1/e² Intensity Level
[nm]		[mm]	[mm]	[°]	[mm]	[µm]
1030…1080	017700-024-26	100	93	54	10	19
	017700-003-26	125 125	80 93	37 43	15 15	16 16
	601926	125 125	80 93	37 43	15 15	16 16
	017700-019-26	160	170	60	10	31
	601914	160	170	60	10	31
	017700-018-26	170	170	57	14	24
	017700-017-26	255	239	53	20	24
	601948	255	239	53	20	24
	017700-022-26	347	354	58	16	46
	017700-009-26	350	452	71	15	45
	017700-021-26	420	420	57	15	55
515…540	017700-209-26	100	90	53	10	10
	017700-202-26	102	75	43	15	7
	017700-203-26	108 108	75 86	40 46	15 15	7 7
	017700-206-26	170	160	54	14	12
	017700-205-26	255	233	52	20	12
	017700-208-26	330	347	58	16	23
	017700-207-26	420	420	57	15	27
355	017700-401-26	53	24	24	10	3.5

The data given are nominal values for the specified application parameters. Jenoptik provides Zemax® BlackBox files for simulating application results for customized parameters (e.g. wavelength, scanner geometry, beam diameter, …).
Back working distance, Flange focus distance, and focal length vary by ± 1.5 % due to manufacturing variances.

JENar®: Registered in EU, CN, JP, SG, US
F-Theta: Registered Design in EU, CN, KR, IN, SG, JP, HK, TW

It is our policy to constantly improve the design and specifications. Accordingly, the details represented herein cannot be regarded as final and binding.



a1 Recommended Mirror Separation	a2 2nd Mirror to Flange	Telecentricity (only F-Theta | with scanner)	Back Working Distance from last mechanical surface (incl. window)	Mounting Thread	Window Order Number for Spare Part
[mm]	[mm]	[°]	[mm]		
13	43	8.7 | 9.1	87	M85x1	576230
18 18	38 28	4.9 | 5.1 7.2 | 7.4	155 155	M85x1	575267
18 18	38 28	4.9 | 5.1 7.2 | 7.4	155 155	M85x1	602019
13	43	17.1 | 17.2	178	M85x1	576230
13	43	17.1 | 17.2	178	M85x1	576234
17	41	11.6 | 11.7	194	M85x1	575267
25	39	14.3 | 15.0	291	M85x1	575267
25	39	14.3 | 15.0	291	M85x1	602019
17	41	18.7 | 18.7	404	M85x1	575267
23	25	23.7 | 24.0	395	M85x1	610826
17	41	18.7 | 18.8	501	M85x1	575267
13	43	7.7 | 7.8	95	M85x1	576232
18	36	4.1 | 4.9	133	M85x1	576228
16 16	39 31	4.9 | 5.1 7.1 | 7.3	130 130	M85x1	599379
17	41	10.9 | 11.0	195	M85x1	576228
25	39	14.2 | 14.3	294	M85x1	576228
17	41	18.4 | 18.4	384	M85x1	576228
17	41	19.3 | 19.3	485	M85x1	576228
13	46	0.4 | 1.5	65	M85x1	576243

Correct lens storage, cleaning, and handling
Lifetime and performance of optical elements depend critically on the cleanliness and intactness of the optical surfaces. Proper storage, cleaning, and handling are therefore essential. Optical systems should be stored only in their respective original packaging and opened only in a clean environment by trained operators. Disassembly of optical systems on one's own responsibility leads to expiration of warranty. Return of optical systems should only be done using the original packaging.

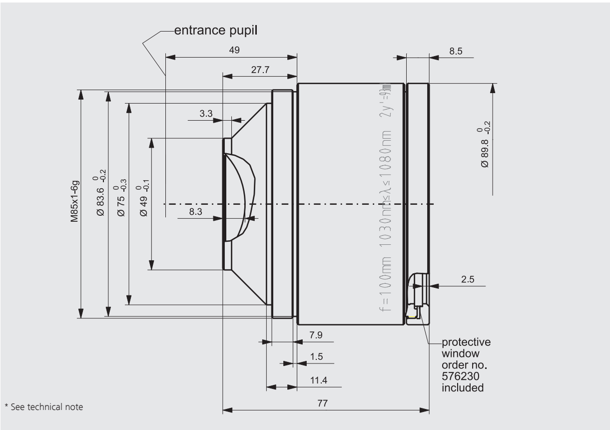
F-Theta JENar™ Lens Series

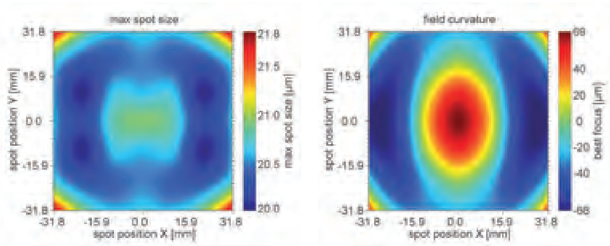
High Image Quality | Telecentric Lens

Parameters	JENar™ 100-1030…1080-93 F-Theta lens for high image quality	JENar™ 125-1030…1080-80 Telecentric lens
Focal length:	100 mm	125 mm
Wavelength:	1030…1080 nm	1030…1080 nm
Scan field (X x Y); Ø:	(66 mm x 66 mm); 93 mm	(57 mm x 57 mm); 80 mm
Diagonal scan angle:	± 27°	± 18.6°
X/Y mirror angle:	± 9.6°	± 6.6°
Back working distance:	87 mm	154.6 mm
Flange focus distance:	136.3 mm	196.9 mm
Input beam Ø 1/e²:	10 mm	15 mm
Focus size Ø 1/e²:	19 µm	16 µm
a1 | a2:	13 mm | 42.5 mm	18.2 mm | 37.65 mm
Telecentricity (only F-Theta | with scanner):	8.7° | 9.1°	4.9° | 5.1°
Group delay dispersion (GDD)*:	1710 fs²	3670 fs²
LIDT coating pulsed; CW*:	5.0 J/cm² * (τ/[ns]) ^ 0.30; 5.0 MW/cm²	5.0 J/cm² * (τ/[ns]) ^ 0.30; 5.0 MW/cm²
LIDT system pulsed; CW*:	5.0 J/cm² * (τ/[ns]) ^ 0.30; 5.0 MW/cm²	not available yet
Weight:	0.7 kg	0.86 kg
Order Number:	017700-024-26	017700-003-26

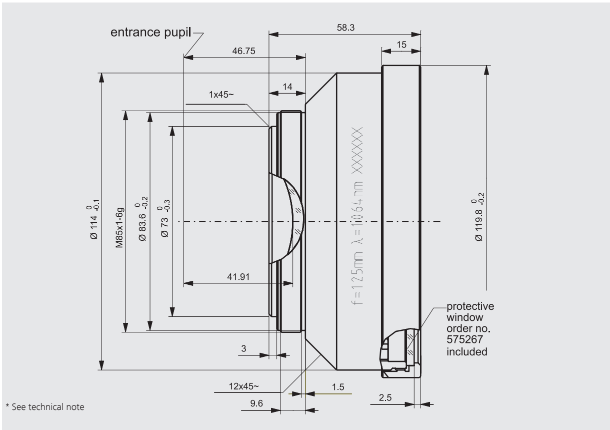
Specifications

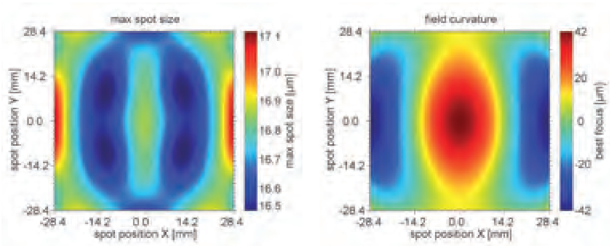
JENar™ 100-1030…1080-93





JENar™ 125-1030…1080-80





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F-Theta: Registered Design in EU, CN, KR, IN, SG, JP, HK, TW

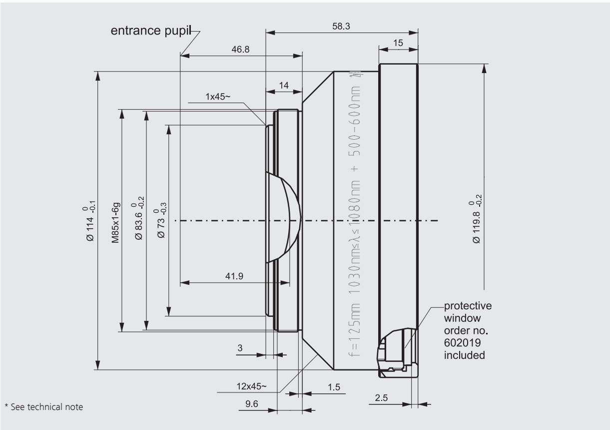
F-Theta JENar™ Lens Series

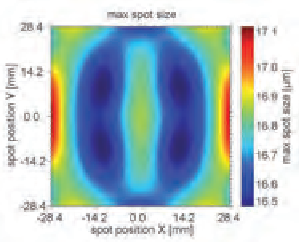
Telecentric Lens | Large Scan Fields

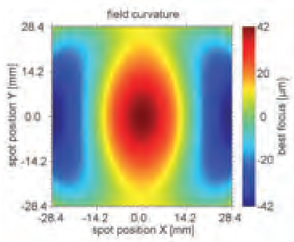
Parameters	JENar™ 125-1030…1080-80 + VIS Telecentric lens	JENar™ 160-1030…1080-170 Compact F-Theta lens for large scan fields
Focal length:	125 mm	160 mm
Wavelength:	1030…1080 nm; T@500…680 nm > 85 %	1030…1080 nm
Scan field (X x Y); Ø:	(57 mm x 57 mm); 80 mm	(120 mm x 120 mm); 170 mm
Diagonal scan angle:	± 18.6°	± 30°
X/Y mirror angle:	± 6.6°	± 10.7°
Back working distance:	154.6 mm	178.4 mm
Flange focus distance:	196.9 mm	194.1 mm
Input beam Ø 1/e²:	15 mm	10 mm
Focus size Ø 1/e²:	16 µm	31 µm
a1 | a2:	18.2 mm | 37.65 mm	13 mm | 42.5 mm
Telecentricity (only F-Theta | with scanner):	4.9° | 5.1°	17.1° | 17.2°
Group delay dispersion (GDD)*:	3670 fs²	934 fs²
LIDT coating pulsed; CW*:	not available yet	5.0 J/cm² * (τ/[ns]) ^ 0.30; 5.0 MW/cm²
LIDT system pulsed; CW*:	not available yet	5.0 J/cm² * (τ/[ns]) ^ 0.30; 5.0 MW/cm²
Weight:	0.86 kg	0.38 kg
Order Number:	601926	017700-019-26

Specifications

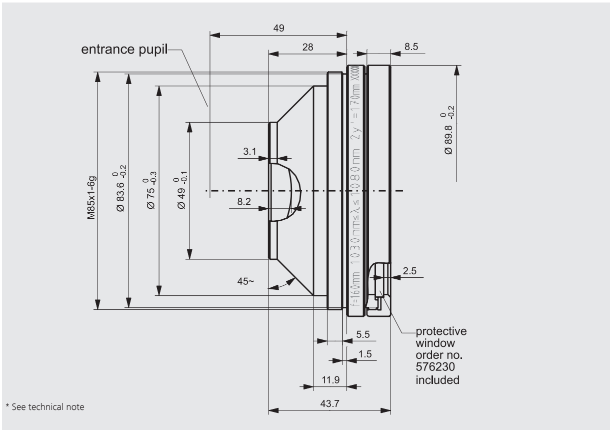
JENar™ 125-1030…1080-80 + VIS

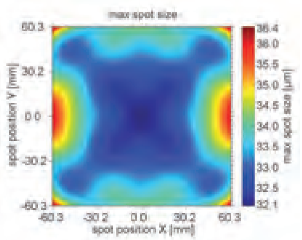


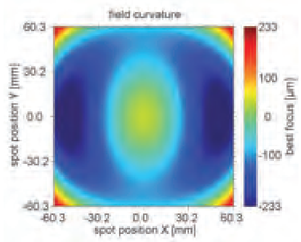




JENar™ 160-1030…1080-170







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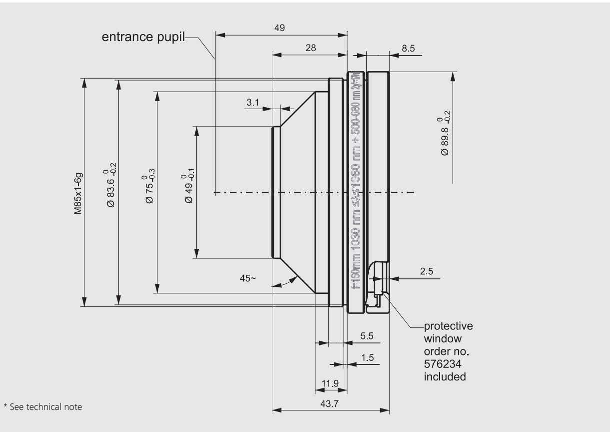
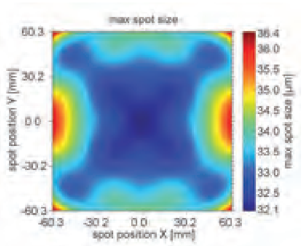
F-Theta: Registered Design in EU, CN, KR, IN, SG, JP, HK, TW

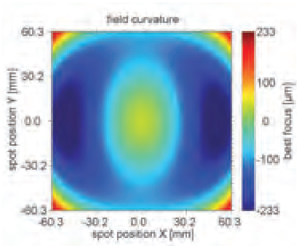
F-Theta JENar™ Lens Series
Large Scan Fields | High Image Quality

Parameters	JENar™ 160-1030…1080-170 + VIS Compact F-Theta lens for large scan fields	JENar™ 170-1030…1080-170 F-Theta lens for high image quality
Focal length:	160 mm	170 mm
Wavelength:	1030…1080 nm; T@500…680 nm > 85 %	1030…1080 nm
Scan field (X x Y); Ø:	(120 mm x 120 mm); 170 mm	(120 mm x 120 mm); 170 mm
Diagonal scan angle:	± 30°	± 28.7°
X/Y mirror angle:	± 10.7°	± 10.2°
Back working distance:	178.4 mm	194 mm
Flange focus distance:	194.1 mm	243.2 mm
Input beam Ø 1/e²:	10 mm	14 mm
Focus size Ø 1/e²:	31 µm	24 µm
a1 | a2:	13 mm | 42.5 mm	17 mm | 40.5 mm
Telecentricity (only F-Theta | with scanner):	17.1° | 17.2°	11.6° | 11.7°
Group delay dispersion (GDD)*:	934 fs²	1870 fs²
LIDT coating pulsed; CW*:	not available yet	5.0 J/cm² * (τ/[ns]) ^ 0.30; 5.0 MW/cm²
LIDT system pulsed; CW*:	not available yet	5.0 J/cm² * (τ/[ns]) ^ 0.30; 5.0 MW/cm²
Weight:	0.38 kg	1.23 kg
Order Number:	**601914**	**017700-018-26**

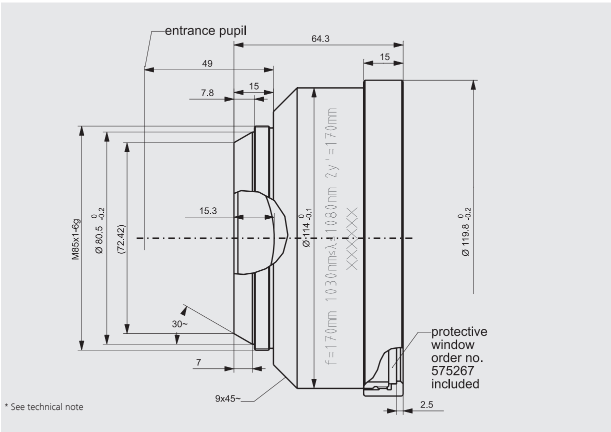
Specifications
JENar™ 160-1030…1080-170 + VIS

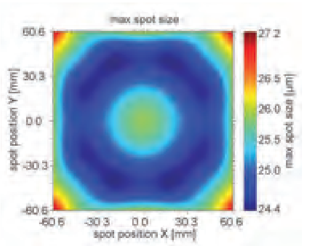


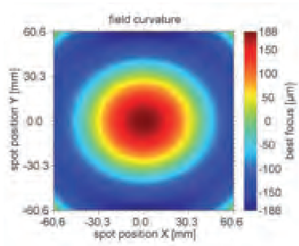




JENar™ 170-1030…1080-170







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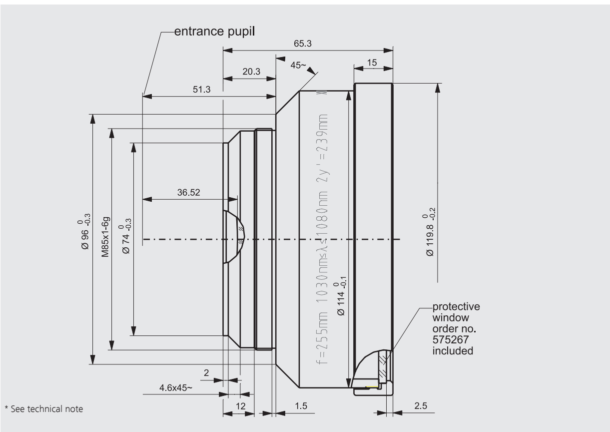
F-Theta: Registered Design in EU, CN, KR, IN, SG, JP, HK, TW

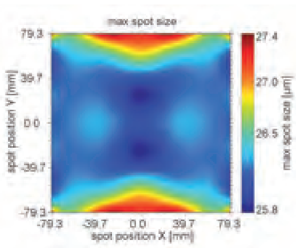
F-Theta JENar™ Lens Series
Larger Beam Diameters and Scan Fields

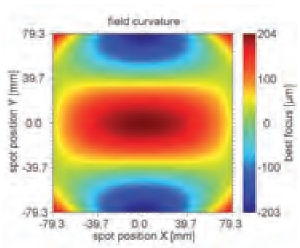
Parameters	JENar™ 255-1030…1080-239 Lens for larger beam diameters and scan fields	JENar™ 255-1030…1080-239 + VIS Lens for larger beam diameters and scan fields
Focal length:	255 mm	255 mm
Wavelength:	1030…1080 nm	1030…1080 nm; T@500…680 nm > 85 %
Scan field (X x Y); Ø:	(169 mm x 169 mm); 239 mm	(169 mm x 169 mm); 239 mm
Diagonal scan angle:	± 26.6°	± 26.6°
X/Y mirror angle:	± 9.5°	± 9.5°
Back working distance:	291 mm	291 mm
Flange focus distance:	336 mm	336 mm
Input beam Ø 1/e²:	20 mm	20 mm
Focus size Ø 1/e²:	24 µm	24 µm
a1 | a2:	25 mm | 39 mm	25 mm | 39 mm
Telecentricity (only F-Theta | with scanner):	14.3° | 15°	14.3° | 15°
Group delay dispersion (GDD)*:	3670 fs²	3670 fs²
LIDT coating pulsed; CW*:	5.0 J/cm² * (τ/[ns]) ^ 0.30; 5.0 MW/cm²	not available yet
LIDT system pulsed; CW*:	2.5 J/cm² * (τ/[ns]) ^ 0.30; 2.5 MW/cm²	not available yet
Weight:	1.4 kg	1.4 kg
Order Number:	017700-017-26	601948

Specifications

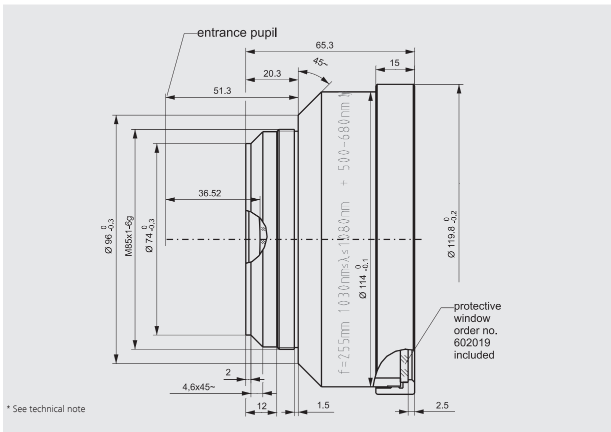
JENar™ 255-1030…1080-239

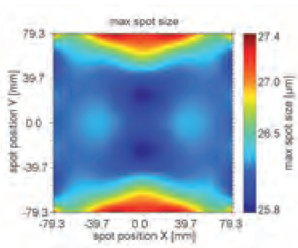


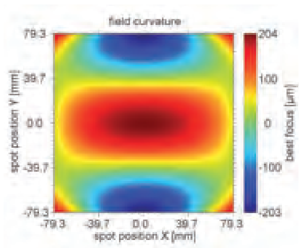




JENar™ 255-1030…1080-239 + VIS







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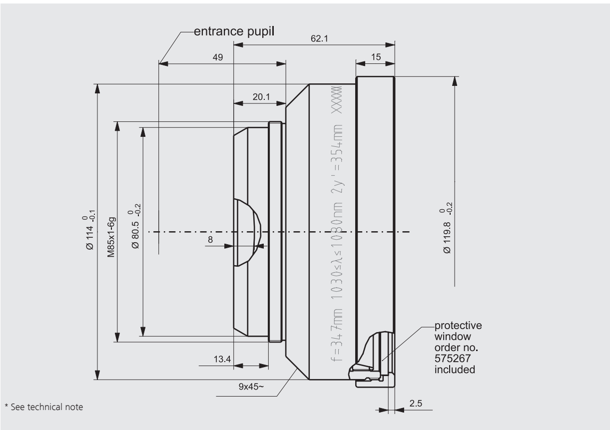
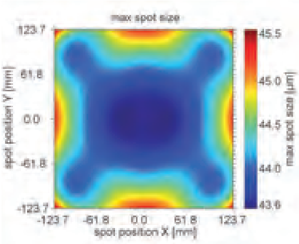
F-Theta JENar™ Lens Series
Large Scan Fields

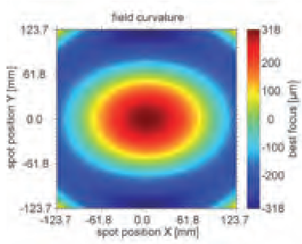
Parameters	JENar™ 347-1030…1080-354 F-Theta lens for large scan fields	JENar™ 350-1030…1080-452 F-Theta lens for large scan fields
Focal length:	347 mm	350 mm
Wavelength:	1030…1080 nm	1030…1080 nm
Scan field (X x Y); Ø:	(250 mm x 250 mm); 354 mm	(320 mm x 320 mm); 452 mm
Diagonal scan angle:	± 28.8°	± 35.5°
X/Y mirror angle:	± 10.3°	± 12.7°
Back working distance:	403.8 mm	395.4 mm
Flange focus distance:	445.8 mm	434.5 mm
Input beam Ø 1/e²:	16 mm	15 mm
Focus size Ø 1/e²:	46 µm	46 µm
a1 | a2:	17 mm | 40.5 mm	23.2 mm | 25 mm
Telecentricity (only F-Theta | with scanner):	18.7° | 18.7°	23.7° | 24°
Group delay dispersion (GDD)*:	2140 fs²	2850 fs²
LIDT coating pulsed; CW*:	5.0 J/cm² * (τ/[ns]) ^ 0.30; 5.0 MW/cm²	5.0 J/cm² * (τ/[ns]) ^ 0.30; 5.0 MW/cm²
LIDT system pulsed; CW*:	5.0 J/cm² * (τ/[ns]) ^ 0.30; 5.0 MW/cm²	5.0 J/cm² * (τ/[ns]) ^ 0.30; 5.0 MW/cm²
Weight:	1.3 kg	1.14 kg
Order Number:	017700-022-26	017700-009-26

Specifications

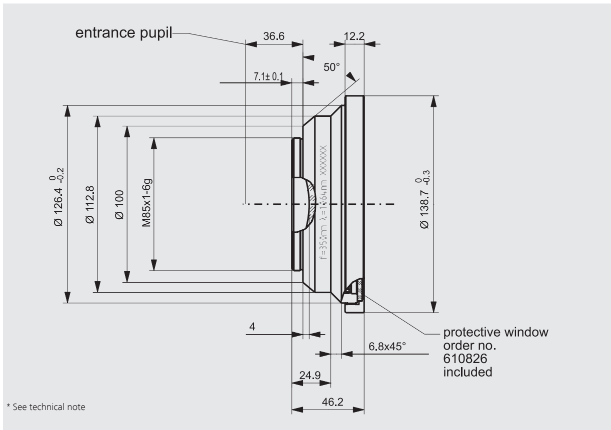
JENar™ 347-1030…1080-354

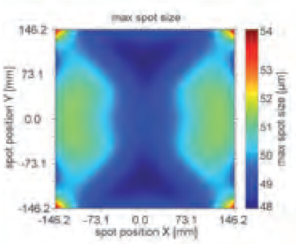


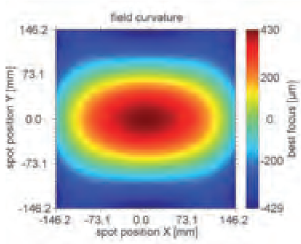




JENar™ 350-1030…1080-452







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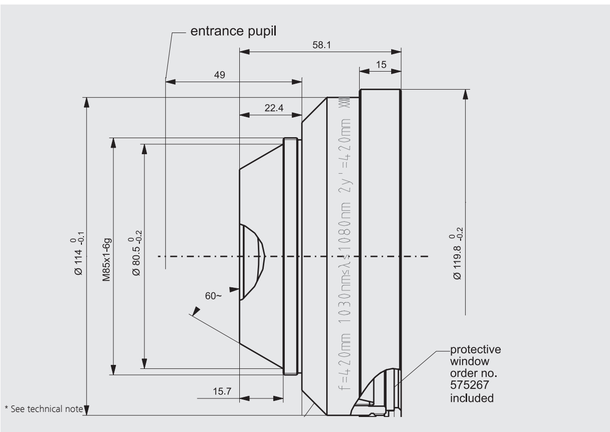
F-Theta JENar™ Lens Series

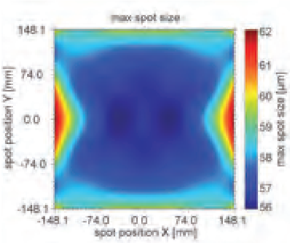
Large Scan Fields | High Image Quality

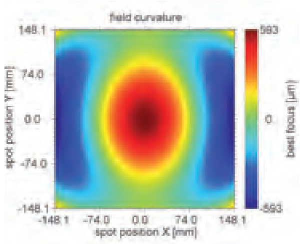
Parameters	JENar™ 420-1030…1080-420 F-Theta lens for large scan fields	JENar™ 100-515…540-90 F-Theta lens for high image quality
Focal length:	420 mm	100 mm
Wavelength:	1030…1080 nm	515…540 nm
Scan field (X x Y); Ø:	(297 mm x 297 mm); 420 mm	(64 mm x 64 mm); 90 mm
Diagonal scan angle:	± 28.5°	± 26.5°
X/Y mirror angle:	± 10.2°	± 9.5°
Back working distance:	500.6 mm	95 mm
Flange focus distance:	536.3 mm	140 mm
Input beam Ø 1/e²:	15 mm	10 mm
Focus size Ø 1/e²:	55 µm	10 µm
a1 | a2:	17 mm | 40.5 mm	13 mm | 42.5 mm
Telecentricity (only F-Theta | with scanner):	18.7° | 18.8°	7.7° | 7.8°
Group delay dispersion (GDD)*:	1020 fs²	4940 fs²
LIDT coating pulsed; CW*:	5.0 J/cm² * (τ/[ns]) ^ 0.30; 5.0 MW/cm²	2.5 J/cm² * (τ/[ns]) ^ 0.35; 2.5 MW/cm²
LIDT system pulsed; CW*:	5.0 J/cm² * (τ/[ns]) ^ 0.30; 5.0 MW/cm²	The system LIDT depends strongly on used laser parameters. Please be advised to test.
Weight:	0.84 kg	0.7 kg
Order Number:	017700-021-26	017700-209-26

Specifications

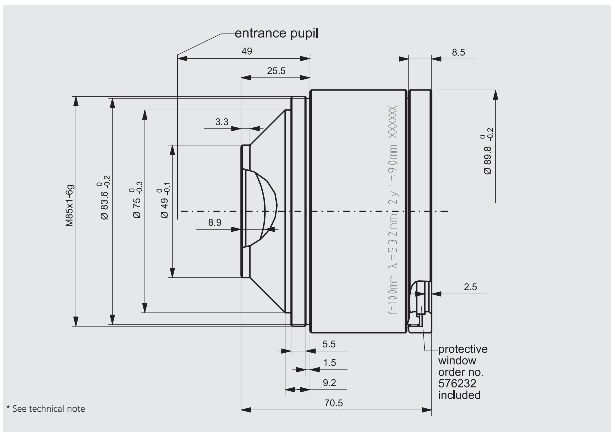
JENar™ 420-1030…1080-420

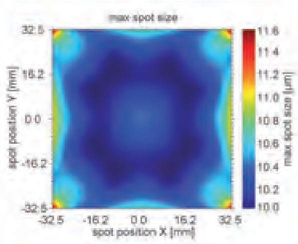


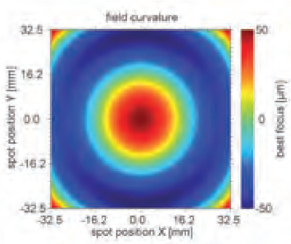




JENar™ 100-515…540-90







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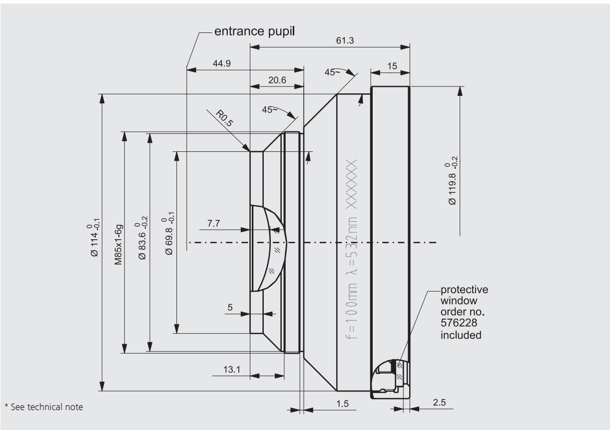
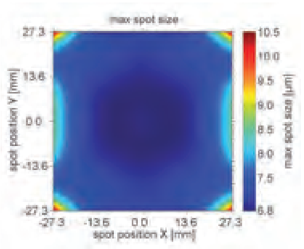
F-Theta JENar™ Lens Series

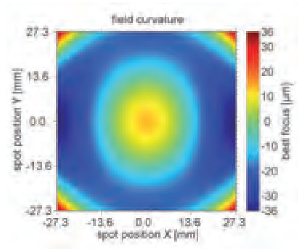
Telecentric Lenses

Parameters	JENar™ 102-515…540-75 Telecentric lens	JENar™ 108-515…540-75 Telecentric lens
Focal length:	102 mm	108 mm
Wavelength:	515…540 nm	515…540 nm
Scan field (X x Y); Ø:	(53 mm x 53 mm); 75 mm	(53 mm x 53 mm); 75 mm
Diagonal scan angle:	± 21.5°	± 20°
X/Y mirror angle:	± 7.7°	± 7.1°
Back working distance:	132.9 mm	130.2 mm
Flange focus distance:	173.6 mm	168.9 mm
Input beam Ø 1/e²:	15 mm	15 mm
Focus size Ø 1/e²:	7 µm	7 µm
a1 | a2:	18 mm | 36 mm	16 mm | 39.2 mm
Telecentricity (only F-Theta | with scanner):	4.1° | 4.9°	4.9° | 5.1°
Group delay dispersion (GDD)*:	15700 fs²	14700 fs²
LIDT coating pulsed; CW*:	2.5 J/cm² * (τ/[ns]) ^ 0.35; 2.5 MW/cm²	2.5 J/cm² * (τ/[ns]) ^ 0.35; 2.5 MW/cm²
LIDT system pulsed; CW*:	The system LIDT depends strongly on used laser parameters. Please be advised to test.	The system LIDT depends strongly on used laser parameters. Please be advised to test.
Weight:	0.7 kg	0.9 kg
Order Number:	017700-202-26	017700-203-26

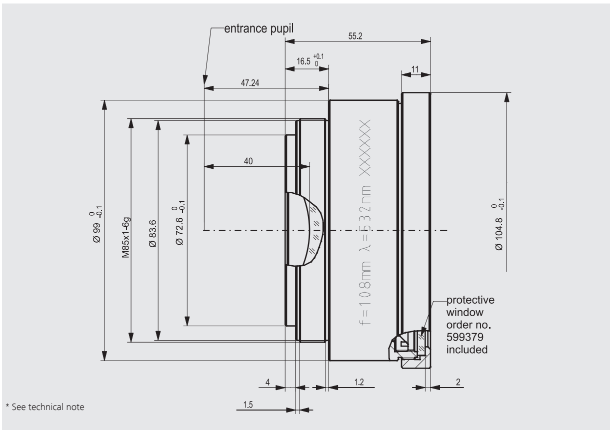
Specifications
JENar™ 102-515…540-75

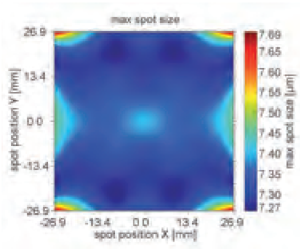


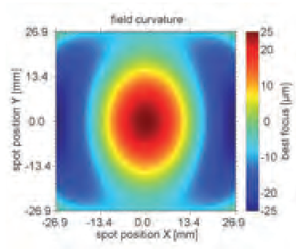




JENar™ 108-515…540-75







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F-Theta: Registered Design in EU, CN, KR, IN, SG, JP, HK, TW

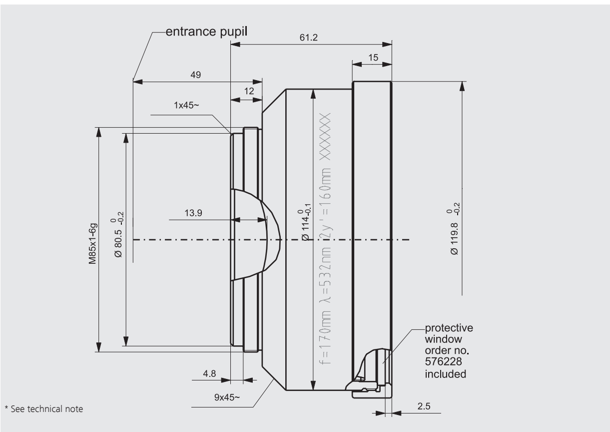
F-Theta JENar™ Lens Series

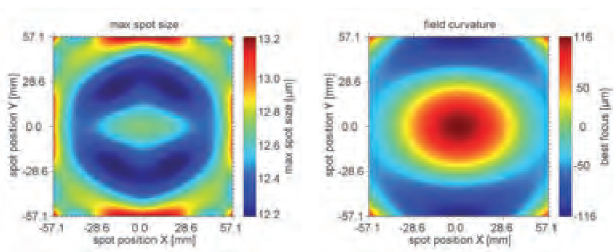
High Image Quality | Larger Beam Diameters and Scan Fields

Parameters	JENar™ 170-515…540-160 F-Theta lens for high image quality	JENar™ 255-515…540-233 Lens for larger beam diameters and scan fields
Focal length:	170 mm	255 mm
Wavelength:	515…540 nm	515…540 nm
Scan field (X x Y); Ø:	(113 mm x 113 mm); 160 mm	(165 mm x 165 mm); 233 mm
Diagonal scan angle:	± 27°	± 26.05°
X/Y mirror angle:	± 9.6°	± 9.3°
Back working distance:	195 mm	294 mm
Flange focus distance:	244 mm	347 mm
Input beam Ø 1/e²:	14 mm	20 mm
Focus size Ø 1/e²:	12 µm	12 µm
a1 | a2:	17 mm | 40.5 mm	25 mm | 39 mm
Telecentricity (only F-Theta | with scanner):	10.9° | 11°	14.2° | 14.3°
Group delay dispersion (GDD)*:	7100 fs²	7690 fs²
LIDT coating pulsed; CW*:	2.5 J/cm² * (τ/[ns]) ^ 0.35; 2.5 MW/cm²	2.5 J/cm² * (τ/[ns]) ^ 0.35; 2.5 MW/cm²
LIDT system pulsed; CW*:	The system LIDT depends strongly on used laser parameters. Please be advised to test.	The system LIDT depends strongly on used laser parameters. Please be advised to test.
Weight:	1.21 kg	1.5 kg
Order Number:	017700-206-26	017700-205-26

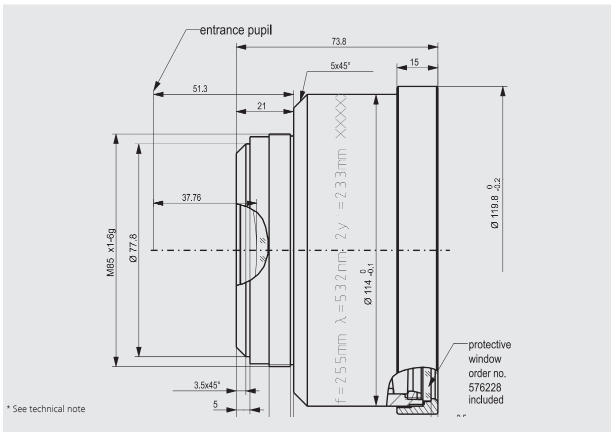
Specifications

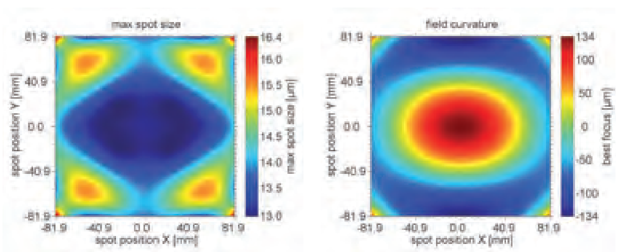
JENar™ 170-515…540-160





JENar™ 255-515…540-233





JENar®: Registered in EU, CN, JP, SG, US
F-Theta: Registered Design in EU, CN, KR, IN, SG, JP, HK, TW

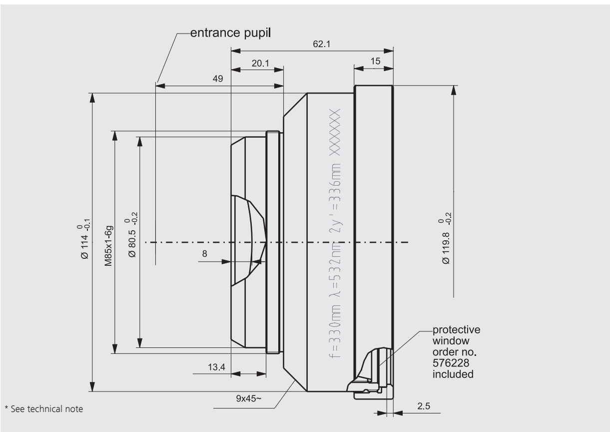
F-Theta JENar™ Lens Series

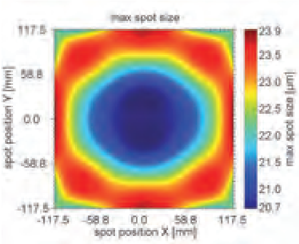
Large Scan Fields

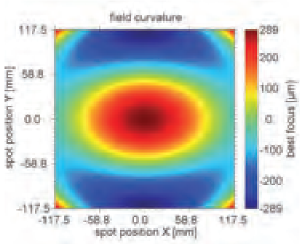
Parameters	JENar™ 330-515…540-347 F-Theta lens for large scan fields	JENar™ 420-515…540-420 F-Theta lens for large scan fields
Focal length:	330 mm	420 mm
Wavelength:	515…540 nm	515…540 nm
Scan field (X x Y); Ø:	(245 mm x 245 mm); 347 mm	(297 mm x 297 mm); 420 mm
Diagonal scan angle:	± 28.8°	± 28.55°
X/Y mirror angle:	± 10.3°	± 10.2°
Back working distance:	384.1 mm	485.2 mm
Flange focus distance:	426.1 mm	524.3 mm
Input beam Ø 1/e²:	16 mm	15 mm
Focus size Ø 1/e²:	23 µm	27 µm
a1 | a2:	17 mm | 40.5 mm	17 mm | 40.5 mm
Telecentricity (only F-Theta | with scanner):	18.4° | 18.4°	19.3° | 19.3°
Group delay dispersion (GDD)*:	6810 fs²	4860 fs²
LIDT coating pulsed; CW*:	2.5 J/cm² * (τ/[ns]) ^ 0.35; 2.5 MW/cm²	2.5 J/cm² * (τ/[ns]) ^ 0.35; 2.5 MW/cm²
LIDT system pulsed; CW*:	The system LIDT depends strongly on used laser parameters. Please be advised to test.	The system LIDT depends strongly on used laser parameters. Please be advised to test.
Weight:	1.3 kg	0.98 kg
Order Number:	017700-208-26	017700-207-26

Specifications

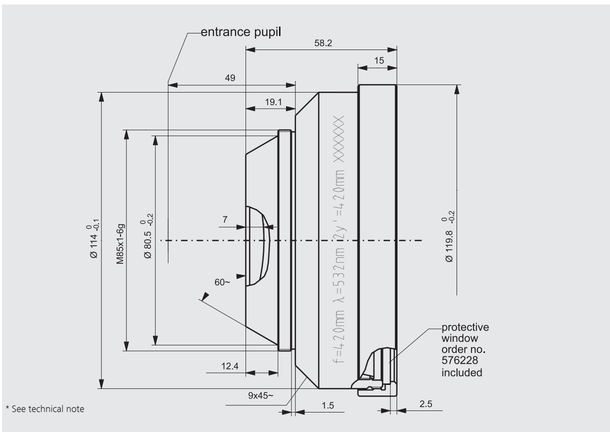
JENar™ 330-515…540-347

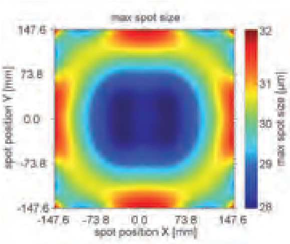


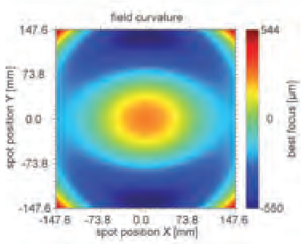




JENar™ 420-515…540-420





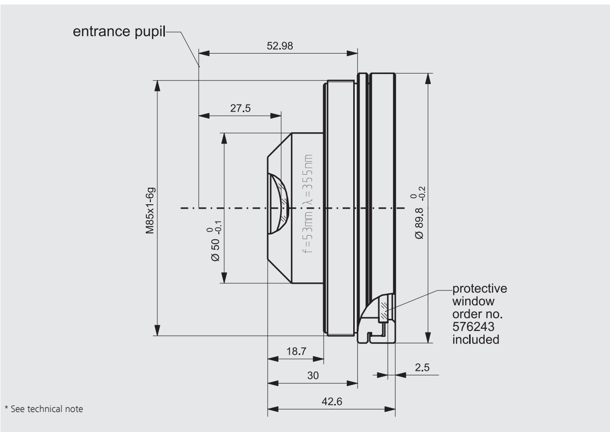


JENar®: Registered in EU, CN, JP, SG, US
F-Theta: Registered Design in EU, CN, KR, IN, SG, JP, HK, TW

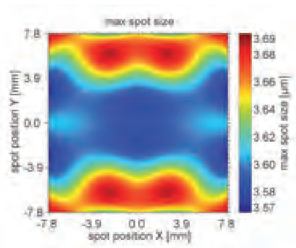
F-Theta JENar™ Lens Series
Short Focal Length

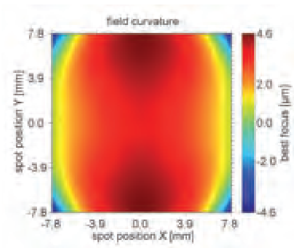
Parameters	JENar™ 53-355-24 Telecentric lens with short focal length
Focal length:	53 mm
Wavelength:	355 nm
Scan field (X x Y); Ø:	(17 mm x 17 mm); 24 mm
Diagonal scan angle:	± 12.1°
X/Y mirror angle:	± 4.3°
Back working distance:	64.9 mm
Flange focus distance:	77.48 mm
Input beam Ø 1/e²:	10 mm
Focus size Ø 1/e²:	3.5 µm
a1 | a2:	13 mm | 46.48 mm
Telecentricity (only F-Theta | with scanner):	0.4° | 1.5°
Group delay dispersion (GDD)*:	10800 fs²
LIDT coating pulsed; CW*:	1.0 J/cm² * (τ/[ns]) ^ 0.40; 1.0 MW/cm²
LIDT system pulsed; CW*:	1.0 J/cm² * (τ/[ns]) ^ 0.40; 1.0 MW/cm²
Weight:	0.7 kg
Order Number:	017700-401-26

Specifications
JENar™ 53-355-24



* See technical note





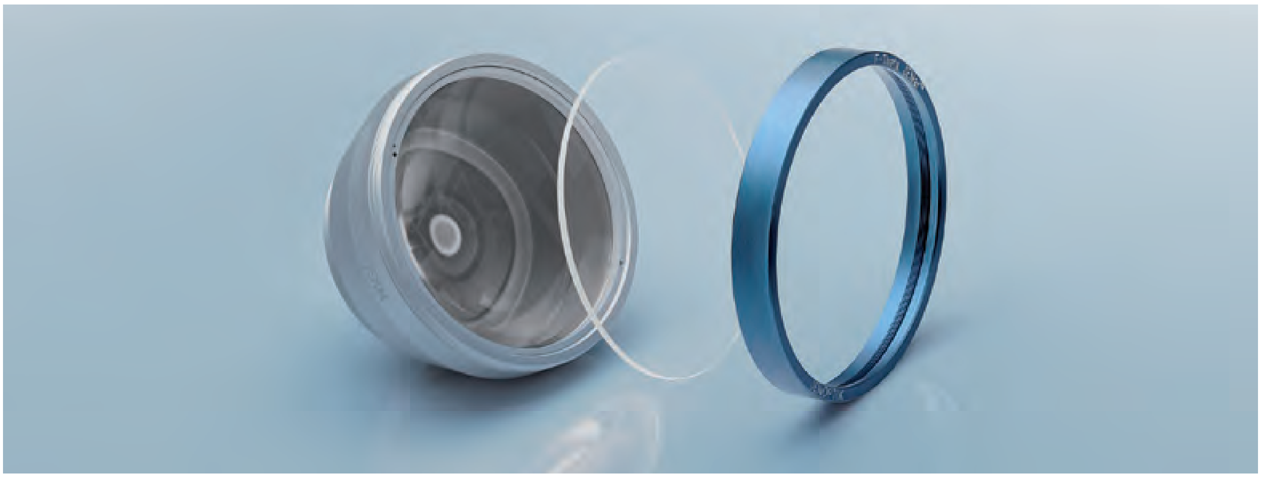
JENar®: Registered in EU, CN, JP, SG, US
F-Theta: Registered Design in EU, CN, KR, IN, SG, JP, HK, TW

Replaceable Protective Windows for JENar™ Silverline™ High Power Lenses & F-Theta Lenses.

Type: Protective Windows

		Drawing Number (017700 = *)	*-004-31	*-004-32	*-049-31	*-049-32	*-049-33	*-410-31	*-410-32
		Order Number Window	575267	576228	576230	576232	576234	576239	610812
	Wavelength [nm]	F-Theta Lens							
Silverline™ High Power Lenses	1030…1080	017700-025-26							
		017700-026-26							
		609120 NEW							
	900…1100	601787							
		601804							
		628951 NEW							
	515…540	017700-402-26						X	
		017700-405-26							
		017700-406-26							
		586840							
	266	017700-601-26							X
JENar™ F-Theta Lenses	1030…1080	017700-003-26	X						
		017700-009-26							
		017700-017-26	X						
		017700-018-26	X						
		017700-019-26			X				
		017700-021-26	X						
		017700-022-26	X						
		017700-024-26			X				
		601914					X		
		601926							
		601948							
	515…540	017700-202-26		X					
		017700-203-26							
		017700-205-26		X					
		017700-206-26		X					
		017700-207-26		X					
		017700-208-26		X					
		017700-209-26				X			
	355	017700-401-26							

The stated data are approximate values and can deviate under different conditions during customer's use.
All data are subject to generally accepted manufacturing tolerances.



*-415-31	*-415-32	*-415-34	*-442-31	*-475-31	601936	586855	*-024-31	*-221-31	*-442-33	628961
579878	576225	602021	576241	576243	602019	610829	610826	599379	629206	628981
	X									
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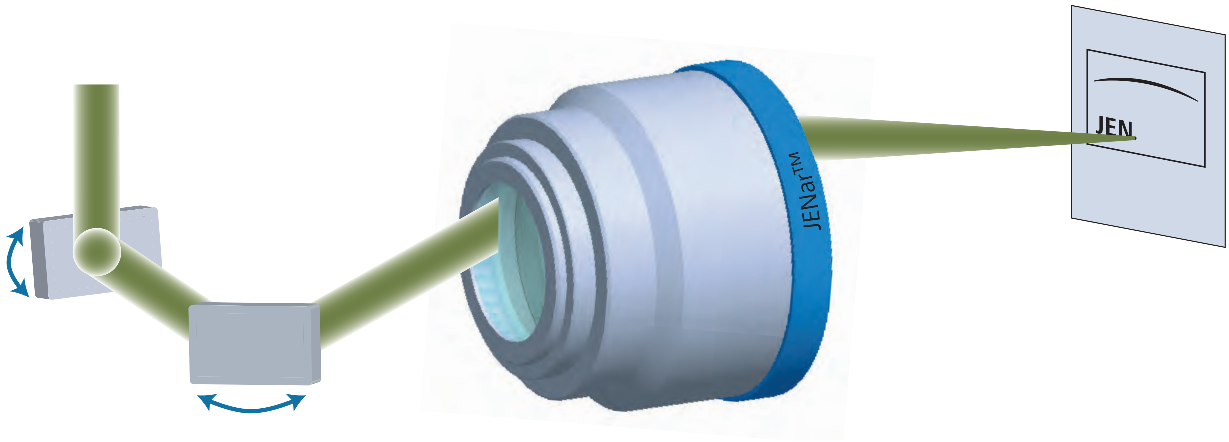
Basic Principles



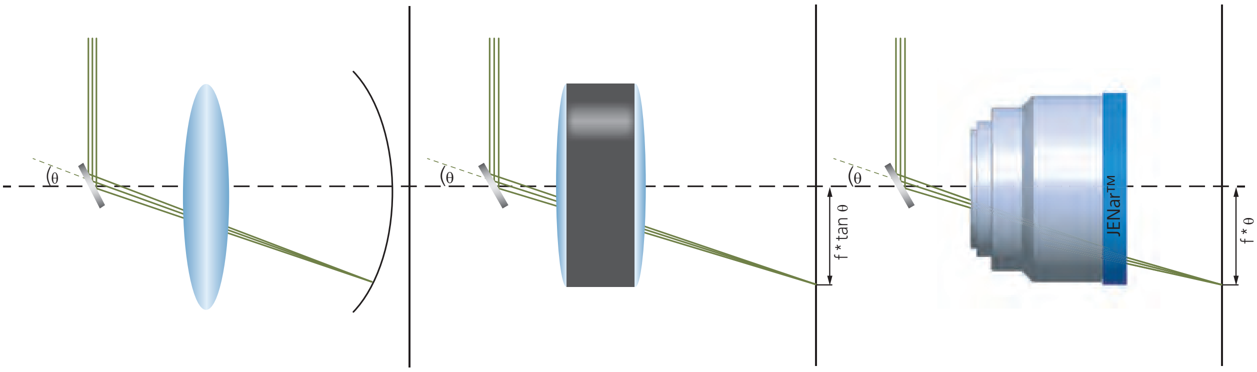
F-Theta objective lenses

Jenoptik's F-Theta objectives are optimized for the requirements of laser material processing. On the one hand, they are designed to yield excellent optical performance, manifesting itself in small field curvature, small distortion and diffraction limited focus sizes.
On the other hand, F-Theta lenses realize a linear dependence between the angle Θ of the incoming laser beam and the image height h of the focussed spot on the workpiece. The proportionality factor is the focal length f. This relation is mathematically expressed as

$$h = f\,\Theta$$

which gives those special lenses their name F-Theta.

Application-relevance – Whereas the merits of good optical performance are easy to see, the advantages of the F-Theta relation are more subtle and best understood considering polygon scanners. Those scanners rotate with a constant angular velocity. If, for example, the image height would be proportional to the tangens of Θ, then the speed of the spot on the workpiece would increase for higher angles, and therefore, the energy deposited in the material would decrease, possibly resulting in inhomogeneous application performance. Since the F-Theta objective translates the constant angular velocity of the polygon to a constant velocity of the spot on the workpiece, this problem disappears.



ideal paraxial lens | field flattening lens | F-Theta lens

Focal length

In theoretical nomenclature, the focal length is the distance from the second cardinal plane to the paraxial focus point of the objective. That means, if one would represent the objective as having vanishing length, then the distance from this ideal lens to the focus would be the focal length.

Application-relevance – From the F-Theta relation h = f * theta, the image height is proportional to the focal length, i.e. if one wants to increase the area of application then one can use lenses with bigger focal length. However, if one wants to retain the same spot size, then, according to the focus size definition, one would also have to increase the laser input beam size. Another property is the distance between lens and workpiece. If this has to be increased, usually an increase in focal length is required (→ see also back working distance).

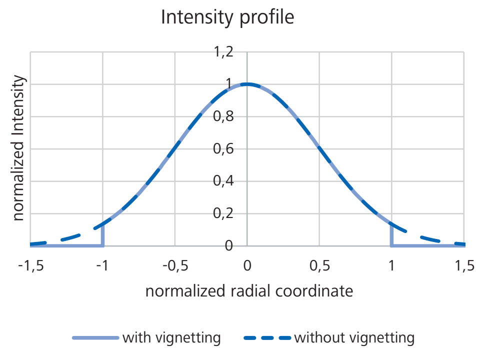
Scan angle

The max full diagonal scan angle corresponds to the scan field diagonal, i.e. using the objective with angles above this maximum angle will lead to clipping of the beam.

Application-relevance – From the F-Theta relation one sees that an increase of the field size can also be achieved by using bigger scan angles. This would have the advantage that the beam size would stay the same. However, big scan angles pose a considerable complication for the design of cost effective F-Theta lenses.

Input beam diameter

To control stray light, and also reduce the required size of optical elements in laser material processing applications, the incoming Gaussian laser beam will usually be clipped at the diameter where the intensity has fallen to $1/e^2$ of the maximum value. The objectives are designed such that those beams will pass through the objective without being clipped anywhere.



Application-relevance – The input beam diameter immediately affects the spot size via the spot size relation antiproportionally. Bigger beam diameters result in smaller spot sizes and vice versa. Using beams with diameters above the maximum allowed beam size will lead to clipping of the beam at the edges of the field (→ see beam-clipping).

Focus size

When focusing light, the spot size σ can not surpass the limit of diffraction, i.e. the spot size does not depend on the aberrations of the lens anymore but only on the physical properties wavelength λ, the input beam diameter Ø, and the focal length f. As for the laser input beam diameter, it is common to define the focus size as the diameter at which the intensity is dropped to $1/e^2$ of the maximum intensity at the spot center. For input beams defined as in „input beam diameter“, the focus size is given as

$$\sigma = 1.83\ \lambda\ f / Ø$$

Application-relevance – Decreasing the focus size immediately decreases the structure sizes of the patterns written. It also increases the maximum intensity in the center of the spot, therefore lifting it above the application threshold of a particular material. If, however, the intensity is way above the application threshold, the energy not needed for the application processed is deposited in the material leading to varying non-controllable side effects, possibly reducing the application performance.
Therefore, the user has to find the optimal focus size for the application under question.

Beam-clipping

If the beam diameter of the incoming laser beam is too big or the scan angle is above the maximum allowed angle, parts of the laser beam might hit mechanical parts when passing through the objective. This is referred to as clipping of the laser beam.

Application-relevance – A laser beam being clipped inside the objective will generate unwanted stray light and might also heat up the objective leading to thermal focus shift and even destruction of the lens. All JENar™ Standard and Silverline™ lenses are designed to show no beam clipping when used with the scanner setup described on the datasheets.

Back working distance

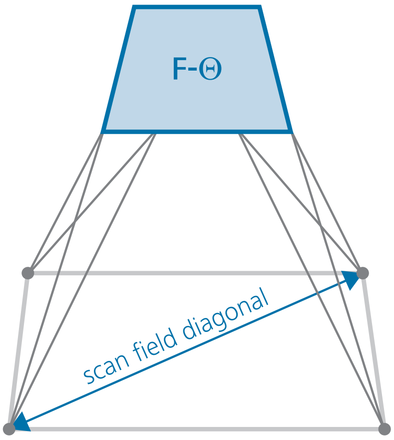
Whereas the focal length is a rather theoretical construct, the back working distance describes the real distance between the end of the objective (the edge closest to the workpiece) and the workpiece.

Application-relevance – The back working distance describes how much free space there is between workpiece and lens. Since focal length and back working distance are closely related, the need for a bigger free space between workpiece and objective usually results in the requirement of using lenses with bigger focal lengths.

Scan field

When using a galvanometric 2D-scanner, changing the mirror angles moves the laser spot over the workpiece. The Jenoptik's F-Theta lenses are then optimized for a quadratic scan field where the diagonal of this square is denoted as the scan field diagonal.

Application-relevance – If the galvanometer mirrors are tilted more than the angles corresponding to the quadratic scan field area two major effects appear. Firstly, the optical performance will degrade above diffraction limit, and secondly the laser beam might be clipped inside the objective
→ see beam-clipping.



Definition of scan field

Scanner geometry

The geometry of a 2D galvanometric scanner is very important for the design of an efficient lens. Since the two scan mirrors have to have a certain distance to prevent collision, the application performance will not be rotationally symmetric, instead they will exhibit a twofold mirror-symmetry in X and Y.
The distance between the mirrors is given by the parameter a1. The distance from the second mirror to the flange of the objective is described by parameter a2.
The separation of mirrors makes the physical concept of a pupil inadmissable. One therefore defines an effective pupil as being positioned in the middle between the two mirrors.

The non-existence of a real pupil also has the consequence that a 2D-galvanometric scan system can not be perfectly telecentric.

Application-relevance – Different optical properties of an existing F-Theta lens can be modified by modifying the scanner geometry. But care must be taken not to create clipping of the laser beam somewhere in the objective. For example, increasing the distance between objective and effective pupil changes the telecentricity angle (usually it decreases it). But to prevent clipping the maximum scan angle, and therefore the maximum field size, must be reduced as well.

Damage threshold LIDT

The laser induced damage threshold (LIDT) describes the laser intensity (or fluence) above which damage of the lenses occurs. This threshold depends on several parameters like wavelength and pulse duration and involves different physical phenomena. For CW and long pulses (> 10 ns) the main problem is the accumulation of energy inside the material and subsequent melting and evaporation. For ultra-short pulses (< 10 ps), on the other hand, non-thermal processes like avalanche ionization and coulomb explosion are dominant reasons for damage. This variety of different processes makes an analytical description very difficult and for industrial purposes it seems to be advisable to test coatings and materials and derive phenomenological descriptions.

Jenoptik tested its standard coatings and materials for the most common application parameters and expressed the pulse-duration dependent damage threshold fluence Φ in terms of a power law of the pulse duration τ.

$$\Phi = c * \tau \wedge p$$

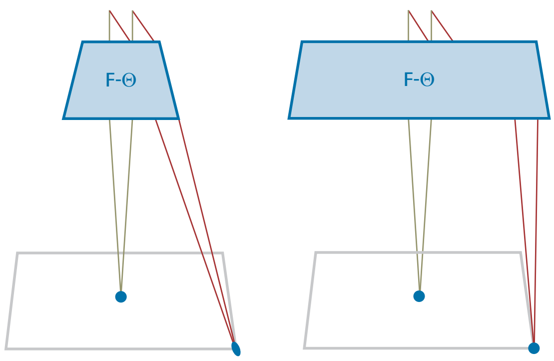
The parameters c and p of this law are wavelength-dependent. Furthermore, the real damage threshold of the system critically depends several exterior influences, like adequate storage, handling, and cleaning. Inappropriate care of the optical systems reduces the damage threshold and renders the guarantee obsolete.
Due to varying intensities inside of the optical system, the system damage threshold might vary from the single element coating damage threshold.

Application-relevance – Being able to pass more energy per time through an optical system allows a faster scanning and therefore a higher throughput.

Telecentricity

Telecentricity describes the angle of the centroid of the laser beam at the edge of the scan field, for example how much the entire beam is tilted with respect to the optical axis.

Application-relevance – Telecentric lenses usually show a more homogeneous focus size distribution over the full field. Furthermore, telecentric lenses are more „scale preserving" when the workpiece is defocussed. For example, if the workpiece is moved away from the lens, but the tilt of the laser beam is vanishing, the spot position will not change. This is important for example in drilling applications. An immediate consequence of a small telecentricity angle is that the lenses have approximately the same diameter as the field diagonal. Therefore, telecentric lenses are usually more expensive than non-telecentric ones.



Concept of telecentricity

Thermal focus shift

When the temperature of an optical material changes, the corresponding shape and index of refraction change. These two effects alter the optical properties of the system, mainly the focus position.
This change in position is called the thermal focus shift. An objective can be optimized to withstand a global homogeneous temperature change (due to variations of room temperature and sufficient time of relaxation), for example by employing temperature dependent spacers. However, when used with a high power laser, the temperature distribution over the lens elements becomes non-homogeneous and also scan-pattern dependent. The only way to make objectives insensitive towards these effects is to reduce the change in temperature, for example reduce absorption in lens and coating material:

The induced thermal focus shifts for top-hat (Δz_T) and Gaussian (Δz_G) intensity distributions can be calculated analytically as

$$\Delta z_T = -P_0 f^2 \sum_i \left(\frac{dn_i}{dT} + (n_i - 1)\alpha_i\right)\left(\frac{2A_i + B_i d_i}{\pi \lambda_i}\right)\left(\frac{2}{\o_i^2}\right)$$

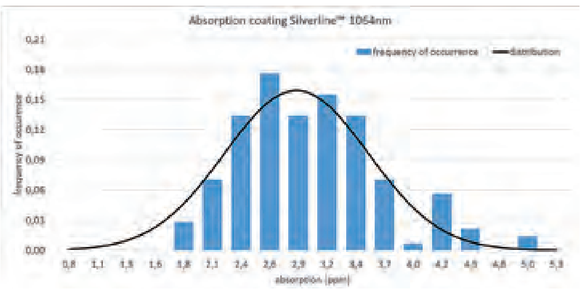
$$\Delta z_G = \ln(4)\Delta z_T$$

P_0 is the input power of the laser. f is the focal length of the lens. The sum is then over all optical elements in the system, indicated by the index i. n_i and dn/dT_i describe the index of refraction and its thermal derivative. alpha_i is the thermal expansion coefficient, lambda_i is the heat conduction coefficient, A_i and B_i describe the absorption coefficients of coating and material respectively. d_i is the thickness of the element, and phi_i is the diameter of the laser beam on element i.
For high power applications, the range of usable materials is small (fused silica or CaF_2) which fixes most of the material coefficients (dn/dT, n, alpha, lambda). Furthermore, the application requirements determine the parameters input power (P_0) and focal length (f) and the beam sizes (phi) on and thickness (d) of the elements in an F-Theta lens usually constitute no powerful optimization parameters. In essence, optical designs which fulfill the optical specification usually do not differ very much in their respective lens shapes. Therefore, the most promising strategy to reduce the thermal focus shift of a system is to reduce the amount of energy being absorbed. This can be achieved by choosing low absorbing materials and coatings.

Application-relevance – A thermal focus shift, when uncompensated, changes the application performance over time. A workpiece being in perfect focus at the beginning of the process might be considerably out of focus after some process-time and the application result will look very different.

Silverline™

Fused silica exhibits extremely small material absorption and is therefore very well suited for being used for high power applications. For their NIR (1064 nm) Silverline™ F-Theta lenses, Jenoptik chooses low-absorbing fused silica material and an optimized lowest-absorbing high performance coating. The maximum absorption of 5 ppm of the coating is guaranteed by a standardized absorption measurement procedure for every coating batch. The manufacturing statistics is shown in the following graph:



Application-relevance – → see thermal focus shift

Therefore, the following absorption values are specified:

NIR Silverline™ F-Theta	Absorption specification
Material:	< 15 ppm/cm
Coating:	< 5 ppm (mean = 3 ppm)

Pulse stretching GDD

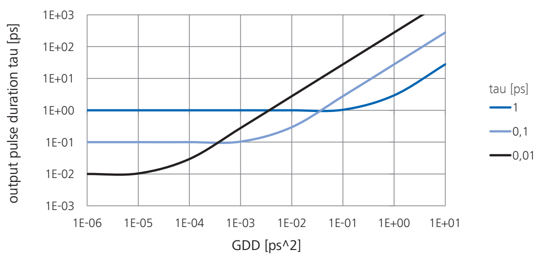
When light passes through an optical material of non-vanishing dispersion it accumulates a wavelength dependent optical phase. For laser pulses, which are effectively a linear superposition of harmonic oscillations of different wavelengths, this influences the pulse shape. In a second order approximation for gaussian pulses, the temporal stretching of the laser pulse is determined only by the second derivative of the phase change with respect to the light frequency, also called the group delay dispersion (GDD).

$$\mathrm{GDD} = \frac{d^2\phi(\omega)}{d\omega^2}$$

The shape of the laser pulse stays gaussian, but its width, expressed as its standard deviation, is scaled as

$$\sigma_{\mathrm{out}} = \sigma_{\mathrm{in}}\sqrt{1 + \frac{\mathrm{GDD}^2}{4\sigma_{\mathrm{in}}^4}}$$

Application-relevance – A temporal stretching of the laser pulse reduces its maximal intensity. This might have severe impact on the application performance. To remedy the problem of too long pulses at the workpiece due to pulse stretching one could use lasers with even shorter output pulses. This might increase the intensity above the damage threshold of the involved optical system. Another way would be a precompensation of the induced GDD by gratings, prisms, and microoptical elements.



Beam Expanders

Variable Beam Expanders "Made in Germany"

Manual and motorized continuously adjustable beam expanders deliver a high level of precision as required in high-end laser material processing.

Beam expanders increase or decrease the diameter of a laser beam, allowing various elements of an optical system to be calibrated to one another.
The laser beam´s diameter at the output of the laser is adapted to the required diameter at the input of the lens. Moreover, the independently adjustable divergence of the beam allows the optimization of the working plane position.

Beam expanders are primarily used in laser material processing. The latest product enables a parameter setting via industrial control interfaces and a motorized adjustment of the laser beam.

All beam expanders can be integrated with F-Theta lenses from Jenoptik in a wide range of beam guidance systems.

USP

- High precision:
  Optimized to deliver the level of precision required in laser material processing
- Robust and compact:
  No rotation of lens elements during a setup modification
- Flexible:
  Expansion and divergence can be adjusted separately
- Continuously adjustable:
  From single to tenfold expansion factor
- Quick manual adjustments:
  With engraved zoom and focus gauge
- Motorized version for remote adjustment

Fields of Application

- Microelectronics:
  E.g. micro structuring of glass and metal
- Semiconductor industry:
  E.g. micro machining
- Automotive industry:
  E.g. cutting and structuring composites
- Medicine:
  E.g. removing gauze in therapeutic applications

Contact

Contact worldwide → please see page 7

Find your way into our optics ...

Highlight in 2019
Beam Expander 1x-8x Motorized

Perfect for
- Magnification and focus setting via machine control
- Integration into class 1 machines for laser material processing
- Data exchange for e.g. predictive maintenance

- Motorized magnification and focus change
- Focus compensation in closed loop mode
- Temperature measurement
- Easy integration due to broad coverage of digital interfaces

Registered Design in DE 40 2016 001 282.4 | Registered in EU

Beam Expander 1x-8x Motorized

Automated Configuration Setting with Smart BEX

NEW

- Motorized magnification and focus change
- Focus compensation in closed loop mode
- Temperature measurement
- Easy integration due to broad coverage of digital interfaces

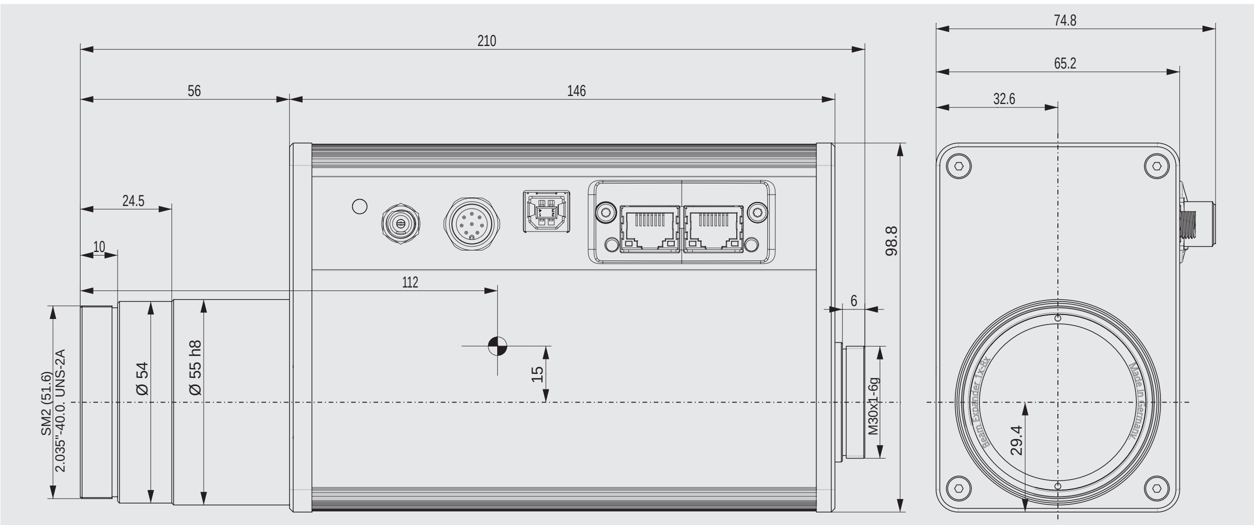
Specification

Please take the technical specifications of the optical values from our Beam Expander 1x-8x on the following page.

	1030-1080 nm[1]	515-540 nm	355 nm
Order Number:	611842	627445	613266

Mechanical	Increments for step-less adjustment of magnification:	< 0.01
	Time for configuation change:	< 3 s (from 1x to 8x)
	Weight:	< 1.2 kg
	Outer dimensions:	210 x 74.8 x 98.2 mm
Optical	Lens material:	Fused silica
	Max. residual divergence of collimated beam:	< 1 mrad (input side) at 6 mm beam diameter at input side [2]
	GDD[3]:	339 fs² [1030-1080 nm] | 1580 fs² [515-540 nm] | 2810 fs² [355 nm]
	LIDT coating pulsed; CW[4]:	5.0 J/cm² * (τ/[ns]) ^ 0.30; 5.0 MW/cm² [1030-1080 nm] 2.5 J/cm² * (τ/[ns]) ^ 0.35; 2.5 MW/cm² [515-540 nm] 1.0 J/cm² * (τ/[ns]) ^ 0.40; 1.0 MW/cm² [355 nm]
	LIDT system pulsed; CW[4]:	0.35 J/cm² * (τ/[ns]) ^ 0.30; 0.35 MW/cm² [1030-1080 nm] 0.20 J/cm² * (τ/[ns]) ^ 0.35; 0.20 MW/cm² [515-540 nm] 0.10 J/cm² * (τ/[ns]) ^ 0.40; 0.10 MW/cm² [355 nm]
	Transmittance:	≥ 97 %
	Beam pointing stability[5]:	≤ 0.3 mrad
Electrical	Supply voltage[6]:	24 ± 3 V
	Max. current consumption:	< 1.5 A
	Standard control interface: [Optional]:	USB, digital interface (5V TTL, high-level 3.7…7 V, configurable) [EtherCAT, EtherNet, ProfiNet, RS485, RS232]
	Software interface:	C, C++, C#, Labview, Excel
	Software protocols:	Text protocol, binary protocol
Ambient conditions	Operation temperature (measured inside the device):	5°C - 40°C (non-condensing conditions)
	Storage temperature:	0°C - 70°C (non-condensing conditions)

[1] Other IR wavelengths (e.g. 980 nm) upon request. | [2] Compensable residual divergence at input side depends on beam diameter | [3] Group delay dispersion | [4] See technical note | [5] At minimal adjustment error | [6] Power supply unit for 0-264 V single phase and 50/60 Hz is included | Additional options like mounting brackets, adjusting possibilities, adaptable fiber coupling add-on, adaptable beam deflection units e.g. upon request.



Registered Design in DE 40 2016 001 282.4 | Registered in EU | Registered pending in CN, HK, IN, TW, IR (JP, KR, SG, US)
Granted Patent DE 10 2015 009 124 | Patent pending CN-, CZ-, KR-, US-Appl.

Beam Expander 1x-8x
High Power Systems

NEW

- Diffraction-limited performance for all magnifications
- No internal foci & no internal reflections in elements for all magnifications
- Highest beam pointing stability (≤ 0.3 mrad)

	1030-1080 nm	515-540 nm	355 nm
GDD[1]:	339 fs²	1580 fs²	2810 fs²
LIDT coating pulsed; CW[2]:	5.0 J/cm² * (τ/[ns]) ^ 0.30; 5.0 MW/cm²	2.5 J/cm² * (τ/[ns]) ^ 0.35; 2.5 MW/cm²	1.0 J/cm² * (τ/[ns]) ^ 0.40; 1.0 MW/cm²
LIDT system pulsed; CW[2]:	0.35 J/cm² * (τ/[ns]) ^ 0.30; 0.35 MW/cm²	0.20 J/cm² * (τ/[ns]) ^ 0.35; 0.20 MW/cm²	0.10 J/cm² * (τ/[ns]) ^ 0.40; 0.10 MW/cm²

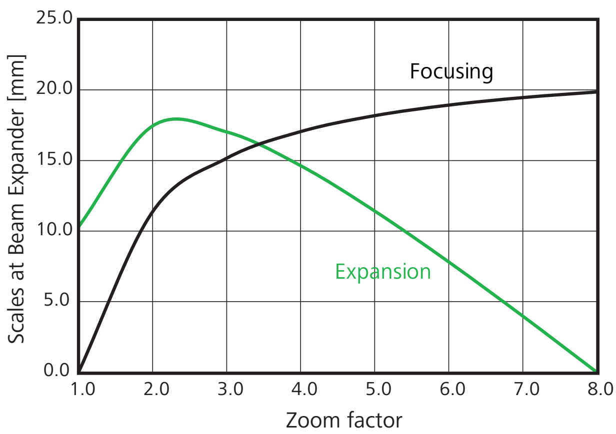
Zoom factor		Ø entrance pupil[3]	
	1030-1080 nm	515-540 nm	355 nm
1x	9.0 mm	9.0 mm	9.0 mm
2x	9.0 mm	9.0 mm	9.0 mm
3x	9.0 mm	9.0 mm	9.0 mm
4x	7.5 mm	7.5 mm	7.5 mm
5x	6.0 mm	6.0 mm	6.0 mm
6x	5.0 mm	5.0 mm	5.0 mm
7x	4.5 mm	4.5 mm	4.5 mm
8x	4.0 mm	4.0 mm	4.0 mm
Order Number:	606997	627443	586117

[1] Group delay dispersion | [2] See technical note
[3] Recommended maximum diameter of entrance pupil

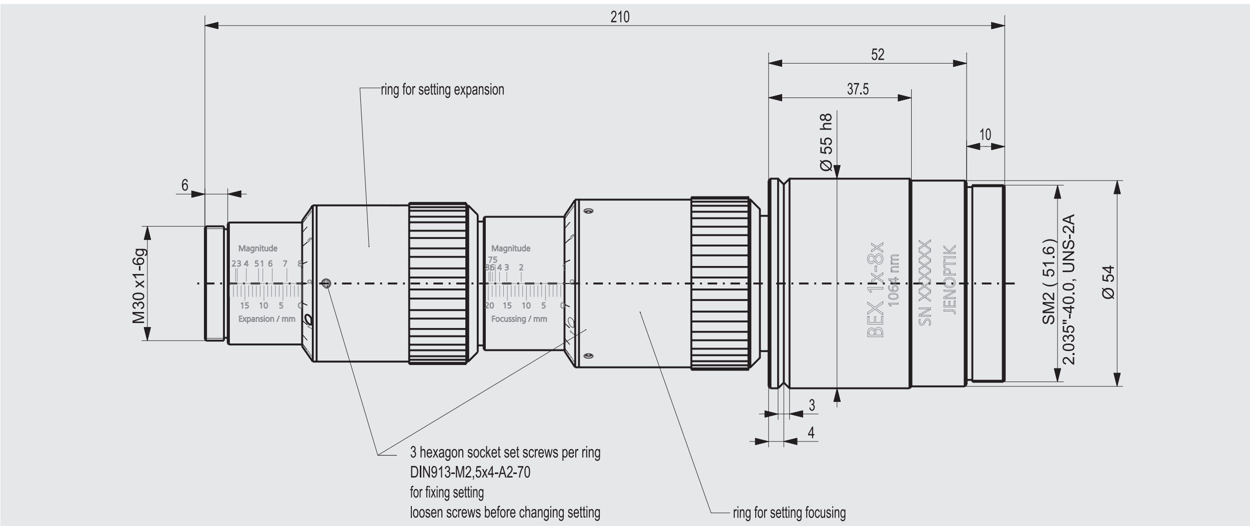
Specification

Materials	
Entrance elements:	Fused silica
Exit elements:	Fused silica
Transmission:	≥ 97 %
Beam pointing stability:	≤ 0.3 mrad
Mounting Ø:	55.0 (+0.0/-0.05) mm or mounting threads M30x1
Weight:	0.54 kg

Magnification	Expansion scale	Focusing scale
1x	10.3 mm	0.0 mm
8x	0.0 mm	19.9 mm



Fine adjustment of the zooming and focusing scale by the combination of mm scales and vernier scales.



Same dimensions for all wavelength versions.

Registered Design in DE 40 2016 001 282.4 | Registered in CN, EU, HK, IN, JP, KR
Pending in TW | Granted Patent DE 10 2015 009 124 | Patent pending CN-, CZ-, KR-, US-Appl.

Beam Expander 2x-10x
Large Magnification Range

- Diffraction-limited performance for all magnifications
- No internal foci
- No internal reflections in elements for all magnifications

	1030-1080 nm	515-540 nm	355 nm
GDD[1]:	288 fs²	1070 fs²	1640 fs²
LIDT coating pulsed; CW[2]:	5.0 J/cm² * (τ/[ns]) ^ 0.30; 5.0 MW/cm²	2.5 J/cm² * (τ/[ns]) ^ 0.35; 2.5 MW/cm²	1.0 J/cm² * (τ/[ns]) ^ 0.40; 1.0 MW/cm²
LIDT system pulsed; CW[2]:	0.50 J/cm² * (τ/[ns]) ^ 0.30; 0.50 MW/cm²	0.25 J/cm² * (τ/[ns]) ^ 0.35; 0.25 MW/cm²	0.10 J/cm² * (τ/[ns]) ^ 0.40; 0.10 MW/cm²

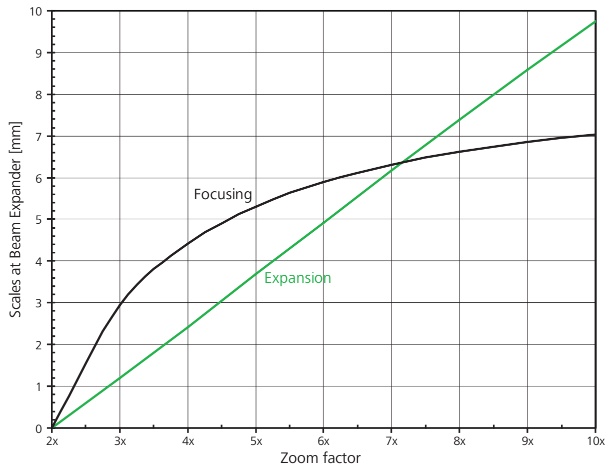
Zoom factor	Ø entrance pupil[3]		
	1030-1080 nm	515-540 nm	355 nm
2x	8.0 mm	8.0 mm	6.0 mm
3x	8.0 mm	7.0 mm	6.0 mm
4x	7.0 mm	6.0 mm	5.0 mm
5x	6.0 mm	5.0 mm	4.5 mm
6x	5.0 mm	4.0 mm	4.0 mm
7x	4.0 mm	4.0 mm	3.5 mm
8x	3.5 mm	3.5 mm	3.0 mm
9x	3.2 mm	3.2 mm	2.7 mm
10x	3.0 mm	3.0 mm	2.2 mm
Order Number:	017052-001-26	017052-201-26	017052-401-26

[1] Group delay dispersion | [2] See technical note
[3] Recommended maximum diameter of entrance pupil

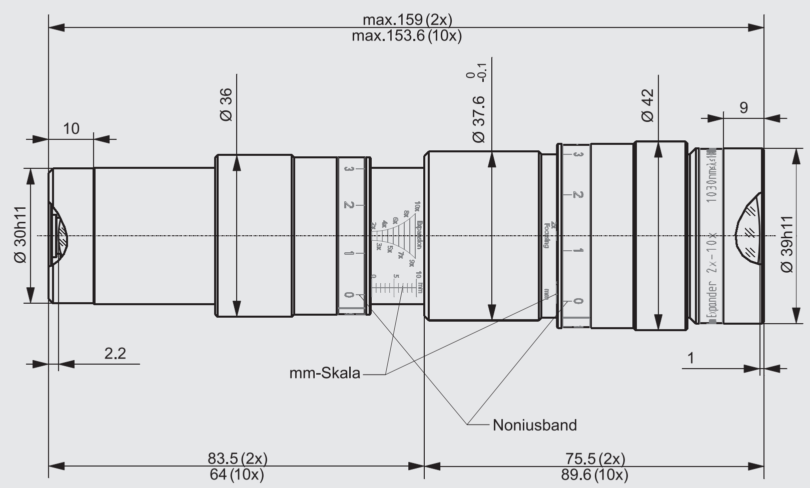
Specification

Materials	
Entrance elements:	Fused silica
Exit elements:	Highly laser-resistant materials (532 nm and 1030...1080 nm) or fused silica (355 nm)
Transmission:	≥ 96 %
Mounting Ø:	37.6 (0/-0.1) mm
Weight:	0.23 kg

Magnification	Expansion scale	Focusing scale
2x	0.0 mm	0.0 mm
10x	9.7 mm	7.1 mm



Fine adjustment of the zooming and focusing scale by the combination of mm scales and vernier scales.



Same dimensions for all wavelength versions.

Registered Design in EU 000952049 | Granted Patent DE 10 2009 025 182

Beam Expander 1x-4x Steadfast

Very Robust Fused Silica Systems

- Lockable optical elements
- High beam pointing stability (< 1 mrad)
- Diffraction-limited performance over the whole range of magnifications
- Novel mechanical design

	1030-1080 nm	515-540 nm	355 nm
GDD[1]:	134 fs^2	547 fs^2	972 fs^2
LIDT coating pulsed; CW[2]:	5.0 J/cm^2 * (τ/[ns]) ^ 0.30; 5.0 MW/cm^2	2.5 J/cm^2 * (τ/[ns]) ^ 0.35; 2.5 MW/cm^2	1.0 J/cm^2 * (τ/[ns]) ^ 0.40; 1.0 MW/cm^2
LIDT system pulsed; CW[2]:	1.00 J/cm^2 * (τ/[ns]) ^ 0.30; 1.00 MW/cm^2	0.50 J/cm^2 * (τ/[ns]) ^ 0.35; 0.50 MW/cm^2	0.20 J/cm^2 * (τ/[ns]) ^ 0.40; 0.20 MW/cm^2

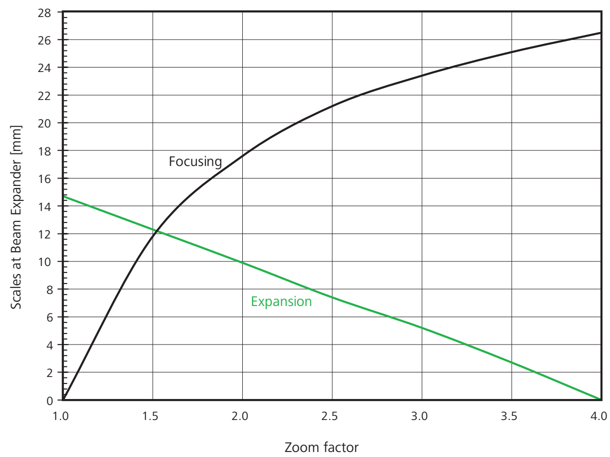
Zoom factor	Ø entrance pupil[3]		
	1030-1080 nm	515-540 nm	355 nm
1x	4.0 mm	4.0 mm	4.0 mm
2x	4.0 mm	4.0 mm	4.0 mm
3x	4.0 mm	4.0 mm	4.0 mm
4x	4.0 mm	4.0 mm	4.0 mm
Order Number:	582823	593355	593354

[1] Group delay dispersion | [2] See technical note
[3] Recommended maximum diameter of entrance pupil

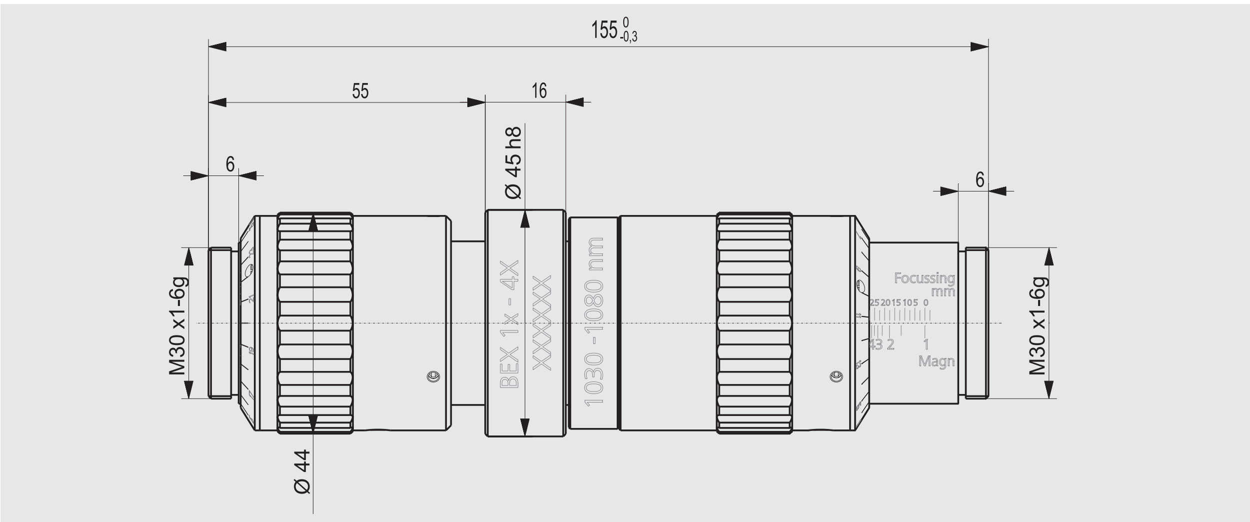
Specification

Materials	
Entrance elements:	Fused silica
Exit elements:	Fused silica
Transmission:	≥ 97 %
Beam pointing stability:	≤ 1 mrad
Mounting Ø:	45.0 (+0.0/-0.04) mm or M30x1 mounting threads at both entrance and exit
Weight:	0.37 kg

Magnification	Expansion scale	Focusing scale
1x	14.8 mm	0.0 mm
4x	0.0 mm	26.5 mm



Fine adjustment of the zooming and focusing scale by the combination of mm scales and vernier scales.



Same dimensions for all wavelength versions.

Pending Design in DE 40 2016 001 282.4 | Patent DE 10 2015 009 124.7
Granted Patent DE 10 2015 009 124 | Patent pending CN-, CZ-, KR-, US-Appl.

Beam Expander 1x-4x

Fused Silica Systems

– Diffraction-limited performance for all magnifications
– No internal foci
– No internal reflections in elements for all magnifications

	1030-1080 nm	515-540 nm	355 nm
GDD[1]:	134 fs²	547 fs²	972 fs²
LIDT coating pulsed; CW[2]:	5.0 J/cm² * (τ/[ns]) ^ 0.30; 5.0 MW/cm²	2.5 J/cm² * (τ/[ns]) ^ 0.35; 2.5 MW/cm²	1.0 J/cm² * (τ/[ns]) ^ 0.40; 1.0 MW/cm²
LIDT system pulsed; CW[2]:	1.00 J/cm² * (τ/[ns]) ^ 0.30; 1.00 MW/cm²	0.50 J/cm² * (τ/[ns]) ^ 0.35; 0.50 MW/cm²	0.20 J/cm² * (τ/[ns]) ^ 0.40; 0.20 MW/cm²

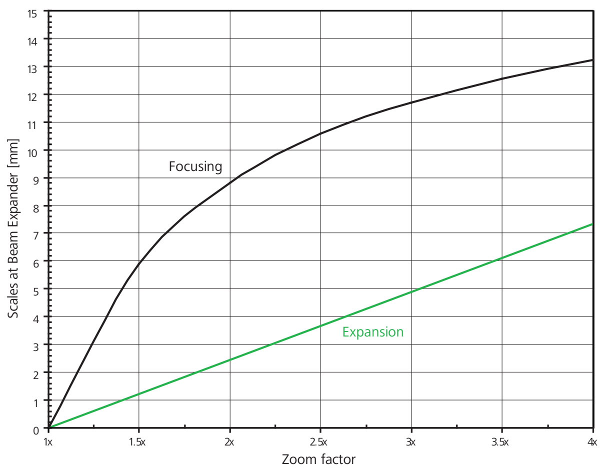
Zoom factor		Ø entrance pupil[3]	
	1030-1080 nm	515-540 nm	355 nm
1x	4.0 mm	4.0 mm	4.0 mm
2x	4.0 mm	4.0 mm	4.0 mm
3x	4.0 mm	4.0 mm	4.0 mm
4x	4.0 mm	4.0 mm	4.0 mm
Order Number:	017052-012-26	017052-202-26	017052-402-26

[1] Group delay dispersion | [2] See technical note
[3] Recommended maximum diameter of entrance pupil

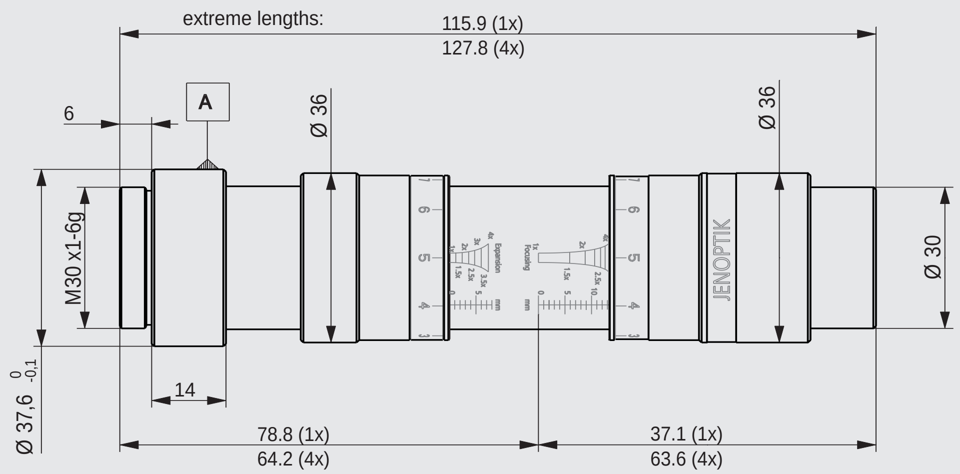
Specification

Materials	
Entrance elements:	Fused silica
Exit elements:	Fused silica
Transmission:	≥ 97 %
Mounting Ø:	37.6 (0/-0.1) mm or mounting thread M30x1
Weight:	0.19 kg

Magnification	Expansion scale	Focusing scale
1x	0.0 mm	0.0 mm
4x	7.4 mm	13.3 mm



Fine adjustment of the zooming and focusing scale by the combination of mm scales and vernier scales.



Same dimensions for all wavelength versions.

Registered Design in EU 000952049 | Granted Patent DE 10 2009 025 182