Sill OPTICS

Laser Optics

F-Theta Lenses - Beam Expanders
Aspheric Lenses - Trapped Ion Lenses

2022

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 then 60% of laser optic orders as development projects based on individual inquiries and participation in public research projects. Most of these developments 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.

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

Customized Laser Optics

Benefit from our expertise

Sill OPTICS

- Requirement analysis with our customer
- Detailed in-house specification
- In-House design & development
- In-House optics prototyping
- In-House mechanics prototyping
- System integration
- In-House test & measurement
- F-Theta lenses
- Beam Expanders
- Aspheric lenses
- Trapped Ion lenses

F-Theta Lenses

Benefit from our 40 years of 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	Wave-length [nm]	Focal Length [mm]	Scan Area [mm x mm]	Focus Size (1/e²)	Max. Beam-Ø [mm]	Max. Tele-centricity Error [°]	Working Distance [mm]	SP/USP*	Achro-matic	Data-sheet
S4LFT7010/450	1000-1100	100	35 x 35	18.3	10	1.5	115.0	yes	yes	PDF
S4LFT0350/126	1064	350	212 x 212	56.3	12	16	412.2	no	no	PDF
S4LFT1254/126	1064	254	160 x 160	41.4	12	14.9	306.5	no	no	PDF
S4LFT0163/126	1064	163	107 x 107	26.4	12	15	181.2	no	no	PDF
S4LFT0253/126	1064	254	160 x 160	35.2	14	16.7	284.9	no	no	PDF
S4LFT0508/126	1064	508	325 x 325	55.6	20	16.3	651.4	no	no	PDF
S4LFT0635/126	1064	635	370 x 370	51.3	25	16.3	732.8	no	no	PDF
S4LFT0080/126	1064	80	39 x 39	6.5	25	3.8	79.4	no	no	PDF
S4LFT0420/126	1064	420	242 x 242	27.7	30	14.8	480.9	no	no	PDF
S4LFT3254/126	1064	254	115 x 115	16.6	30	8.5	297.0	no	no	PDF
S4LFT1163/081	532+1064	163	102 x 102	13.3 / 20.0	12	12.7	159.0	no	yes	PDF
S4LFT8254/081	532+1064	254	180 x 180	16.6 / 33.0	15	19.7	211.6	no	yes	PDF
S4LFT7012/292	515-589	100	35 x 35	9.4	10	1.3	101.4	yes	yes	PDF
S4LFT5100/121	532	100	69 x 69	9.8	10	2.4	126.7	no	no	PDF
S4LFT0300/121	532	300	200 x 200	19.4	14	15.8	324.1	no	no	PDF

Besides our standard 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

The STEP files are available upon request.
In case of deviations from the standard portfolio and delivery times, please contact our Customer Care Team.

F-Theta Lenses

Benefit from our 40 years of experience

Sill OPTICS

Fused Silica Optics

Part Number	Wavelength [nm]	Focal Length [mm]	Scan Area [mm x mm]	Focus Size (1/e²)	Max. Beam-Ø [mm]	Max. Telecentricity Error [°]	Working Distance [mm]	SP/USP*	Datasheet
S4LFT0710/328	1064	100	60 x 60	39.1	5	11.5	120.7	yes	
S4LFT0763/328	1064	163	100 x 100	45.6	7	14.6	194.1	yes	
S4LFT0725/328	1064	254	140 x 140	61.5	8	16.2	282.8	yes	
S4LFT3167/328	1064	163	100 x 100	32.6	10	11.6	200.7	yes	
S4LFT4010/328	1064	100	35 x 35	19.5	10	1.3	129.8	yes	
S4LFT1420/328	1064	420	280 x 280	58.5	14	17.3	499.2	yes	
S4LFT3250/328	1064	254	160 x 160	33.2	15	10.7	321.3	yes	
S4LFT3162/328	1064	163	90 x 90	21.2	15	5.6	201.5	yes	
S4LFT4127/328	1064	125	50 x 50	13.6	15	1.5	157.6	yes	
S4LFT4065/328	1064	65	15 x 15	9.4	15	2	83.1	yes	
S4LFT4147/328	1064	48	7 x 7	6.3	15	2.1	61.1	yes	
S4LFT1655/328	1064	650	410 x 410	63.3	20	22.5	581.6	yes	
S4LFT1330/328	1064	330	215 x 215	33.3	20	23.5	203.4	yes	
S4LFT0910/328	1064	910	500 x 500	65.8	30	16.2	1048.8	yes	
S4LFT3161/292	532	163	90 x 90	15.4	10	4.8	219	yes	
S4LFT4126/292	532	125	53 x 53	12	10	1.6	167	yes	
S4LFT4010/292	532	100	35 x 35	9.8	10	1.5	130.2	yes	
S4LFT4262/292	532	163	65 x 65	12.7	12	1.7	195.4	yes	
S4LFT1330/292	532	330	212 x 212	24.3	14	20.3	279	yes	
S4LFT4066/292	532	65	15 x 15	4.8	15	1.5	85.8	yes	
S4LFT4148/292	532	48	6 x 6	3.2	15	1.8	60	yes	
S4LFT1330/373	450	330	180 x 180	10.7	20	11.1	268.2	yes	
S4LFT3250/373	450	241	115 x 115	10	20	7.4	304.8	yes	
S4LFT3170/373	450	168	75 x 75	7.6	20	3.2	228.3	yes	
S4LFT4125/373	450	125	45 x 45	6.1	20	1.6	160.2	yes	
S4LFT3170/075	355	163	90 x 90	11.4	10	4.3	221.7	yes	
S4LFT4262/075	355	163	65 x 65	10.5	10	2	193.7	yes	
S4LFT4125/075	355	125	53 x 53	8	10	1.1	156.9	yes	
S4LFT4010/075	355	100	35 x 35	6.5	10	1.2	132	yes	
S4LFT1330/075	355	330	210 x 210	15.4	14	21	260.5	yes	
S4LFT4067/075	355	65	15 x 15	3.1	15	1.8	81.7	yes	
S4LFT4149/075	355	48	6 x 6	2.1	15	2.1	69.3	yes	
S4LFT4263/199	266	163	70 x 70	9.2	10	2.6	218.4	yes	
S4LFT3170/199	266	154	85 x 85	7.7	10	3.8	208.1	yes	

*usable for SP=Short Pulse, USP=Ultra Short Pulse

The STEP files are available upon request.
In case of deviations from the standard portfolio and delivery times, please contact our Customer Care Team.

Beam Expanders

Benefit from our 40 years of 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	Wavelength [nm]	Magnification	Clear Input Aperture [mm]	Clear Output Aperture [mm]	Length [mm]	Thread	Data-sheet
S6EXZ5310/328	1064	1-3x	10.5	20.0	85.2	C-Mount	
S6EXZ5311/328	1064	1-3x	10.5	20.0	85.2	M30x1	
S6EXZ5076/328	1064	1-8x	10.3	31.0	162.0	C-Mount	
S6EXZ5310/292	532	1-3x	10.5	20.0	85.2	C-Mount	
S6EXZ5311/292	532	1-3x	10.5	20.0	85.2	M30x1	
S6EXZ5076/292	532	1-8x	10.3	31.0	162.0	C-Mount	
S6EXZ5310/075	355	1-3x	10.5	20.0	85.2	C-Mount	
S6EXZ5311/075	355	1-3x	10.5	20.0	85.2	M30x1	
S6EXZ5075/075	355	1-8x	10.3	31.0	162.0	C-Mount	
S6EXZ0940/574	343-355	0.9-4x	16.0	28.0	191.0	M30x1	
S6EXZ5310/574	343-355	1-3x	10.5	20.0	85.2	C-Mount	
S6EXZ5311/574	343-355	1-3x	10.5	20.0	85.2	M30x1	
S6EXZ5075/574	343-355	1-8x	10.3	31.0	162.0	C-Mount	
S6EXZ5075/199	266	1-8x	10.3	31.0	162.0	C-Mount	

Fix Magnification Beam Expanders

Part Number	Wavelength [nm]	Magnification	Clear Input Aperture [mm]	Clear Output Aperture [mm]	Length [mm]	Thread	Data-sheet
S6EXK0005/328	1064	0.5	12.0	12.0	44.7	M30x1	
S6EXK0008/328	1064	0.8	12.0	12.0	44.7	M30x1	
S6EXK0010/328	1064	1.0	12.0	14.0	44.7	M30x1	
S6EXK0012/328	1064	1.2	12.0	26.0	44.7	M30x1	
S6EXK0015/328	1064	1.5	12.0	26.0	44.7	M30x1	
S6EXK0020/328	1064	2.0	12.0	26.0	44.7	M30x1	
S6EXK0025/328	1064	2.5	11.0	26.0	44.7	M30x1	
S6EXK0030/328	1064	3.0	8.0	26.0	44.7	M30x1	
S6EXK0035/328	1064	3.5	8.0	20.0	44.7	M30x1	
S6EXK0040/328	1064	4.0	8.0	20.0	44.7	M30x1	
S6EXK0005/292	532	0.5	12.0	12.0	44.7	M30x1	
S6EXK0008/292	532	0.8	12.0	12.0	44.7	M30x1	
S6EXK0010/292	532	1.0	12.0	14.0	44.7	M30x1	
S6EXK0012/292	532	1.2	12.0	26.0	44.7	M30x1	
S6EXK0015/292	532	1.5	12.0	26.0	44.7	M30x1	
S6EXK0020/292	532	2.0	12.0	26.0	44.7	M30x1	
S6EXK0025/292	532	2.5	11.0	26.0	44.7	M30x1	
S6EXK0030/292	532	3.0	8.0	26.0	44.7	M30x1	
S6EXK0035/292	532	3.5	8.0	20.0	44.7	M30x1	
S6EXK0040/292	532	4.0	8.0	20.0	44.7	M30x1	

The STEP files are available upon request.
In case of deviations from the standard portfolio and delivery times, please contact our Customer Care Team.

Beam Expanders

Benefit from our 40 years of experience

Fix Magnification Beam Expanders

Part Number	Wavelength [nm]	Magnification	Clear Input Aperture [mm]	Clear Output Aperture [mm]	Length [mm]	Thread	Data-sheet
S6EXK0008/075	355	0.8	12.0	12.0	44.7	M30x1	
S6EXK0012/075	355	1.2	12.0	26.0	44.7	M30x1	
S6EXK0015/075	355	1.5	12.0	26.0	44.7	M30x1	
S6EXK0020/075	355	2.0	12.0	26.0	44.7	M30x1	
S6EXK0025/075	355	2.5	11.0	26.0	44.7	M30x1	
S6EXK0030/075	355	3.0	8.0	26.0	44.7	M30x1	
S6EXK0035/075	355	3.5	8.0	20.0	44.7	M30x1	
S6EXK0040/075	355	4.0	8.0	20.0	44.7	M30x1	
S6EXK0008/574	343-355	0.8	12.0	12.0	44.7	M30x1	
S6EXK0010/574	343-355	1.0	12.0	14.0	44.7	M30x1	
S6EXK0012/574	343-355	1.2	12.0	26.0	44.7	M30x1	
S6EXK0015/574	343-355	1.5	12.0	26.0	44.7	M30x1	
S6EXK0020/574	343-355	2.0	12.0	26.0	44.7	M30x1	
S6EXK0025/574	343-355	2.5	11.0	26.0	44.7	M30x1	
S6EXK0030/574	343-355	3.0	8.0	26.0	44.7	M30x1	
S6EXK0035/574	343-355	3.5	8.0	20.0	44.7	M30x1	
S6EXK0040/574	343-355	4.0	8.0	20.0	44.7	M30x1	
S6EXP0005/328	1064	0.5	14.0	31.0	85.0	M30x1	
S6EXP0008/328	1064	0.8	14.0	20.0	85.0	M30x1	
S6EXP0012/328	1064	1.2	14.0	28.0	85.0	M30x1	
S6EXP0015/328	1064	1.5	8.0	31.0	85.0	M30x1	
S6EXP0020/328	1064	2.0	8.0	31.0	85.0	M30x1	
S6EXP0025/328	1064	2.5	8.0	31.0	85.0	M30x1	
S6EXP0030/328	1064	3.0	8.0	31.0	85.0	M30x1	
S6EXP0040/328	1064	4.0	8.0	31.0	85.0	M30x1	
S6EXP0050/328	1064	5.0	8.0	31.0	85.0	M30x1	
S6EXP0005/292	532	0.5	14.0	31.0	85.0	M30x1	
S6EXP0008/292	532	0.8	14.0	20.0	85.0	M30x1	
S6EXP0015/292	532	1.5	8.0	31.0	85.0	M30x1	
S6EXP0020/292	532	2.0	8.0	31.0	85.0	M30x1	
S6EXP0025/292	532	2.5	8.0	31.0	85.0	M30x1	
S6EXP0030/292	532	3.0	8.0	31.0	85.0	M30x1	
S6EXP0040/292	532	4.0	8.0	31.0	85.0	M30x1	
S6EXP0050/292	532	5.0	8.0	31.0	85.0	M30x1	
S6EXP0015/075	355	1.5	8.0	31.0	85.0	M30x1	
S6EXP0020/075	355	2.0	8.0	31.0	85.0	M30x1	
S6EXP0025/075	355	2.5	8.0	31.0	85.0	M30x1	
S6EXP0030/075	355	3.0	8.0	31.0	85.0	M30x1	
S6EXP0040/075	355	4.0	8.0	31.0	85.0	M30x1	
S6EXP0050/075	355	5.0	8.0	31.0	85.0	M30x1	
S6EXP0015/574	343-355	1.5	8.0	31.0	85.0	M30x1	
S6EXP0020/574	343-355	2.0	8.0	31.0	85.0	M30x1	
S6EXP0025/574	343-355	2.5	8.0	31.0	85.0	M30x1	
S6EXP0030/574	343-355	3.0	8.0	31.0	85.0	M30x1	
S6EXP0040/574	343-355	4.0	8.0	31.0	85.0	M30x1	
S6EXP0050/574	343-355	5.0	8.0	31.0	85.0	M30x1	
S6EXP0015/199	266	1.5	8.0	31.0	85.0	M30x1	
S6EXP0020/199	266	2.0	8.0	31.0	85.0	M30x1	
S6EXP0030/199	266	3.0	8.0	31.0	85.0	M30x1	
S6EXP0040/199	266	4.0	8.0	31.0	85.0	M30x1	
S6EXP0050/199	266	5.0	8.0	31.0	85.0	M30x1	

The STEP files are available upon request.
In case of deviations from the standard portfolio and delivery times, please contact our Customer Care Team.

Sill OPTICS

Aspheres
Benefit from our capabilities

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.

Multi-element Lens Systems

Part Number	Wavelength [nm]	Focal Length [mm]	Lens-Ø [mm]	Center Thickness [mm]	Working Distance [mm]
S1ADX0540/328	1064	400	52.0	8.0	395.2
S1ADX0330/328	1064	300	30.0	9.0	294.7
S1ADX0325/328	1064	250	38.1	8.9	245.2
S1ADX0320/328	1064	200	38.1	8.9	194.8
S1ADX0316/328	1064	150	30.0	9.6	144.4
S1ADX0312/328	1064	120	38.1	10.3	114.0
S1ADX0310/328	1064	100	38.1	11.0	93.7
S1ADX0380/328	1064	80	38.1	12.0	73.1
S1ADX0370/328	1064	72	38.1	11.0	63.6
S1ADX0260/328	1064	60	30.0	11.3	53.5
S1ADX0250/328	1064	50	30.0	13.7	42.1
S1ADX0240/328	1064	40	30.0	15.0	31.3
S1ADX0230/328	1064	30	30.0	16.0	20.9
S1ADX0220/328	1064	20	25.0	13.2	13.3

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	Wavelength [nm]	Focal Length [mm]	Focus Size 1/e² [µm]	Housing-Ø [mm]	Length [mm]	Working Distance [mm]	Data-sheet
S6ASS2020/292	532	25	2.4	25.0	13.5	19.3	
S6ASS2060/292	532	62	3.0	40.0	32.0	47.9	
S6ASS5300/292	532	100	5.4	41.0	16.0	86.7	
S6ASS6151/292	532	150	7.2	56.0	20.0	135.0	
S6ASS6200/292	532	200	6.6	54.0	15.0	188.5	
S6ASS2020/075	355	25	1.6	25.0	17.0	17.9	
S6ASS2060/075	355	60	2.8	40.0	30.0	46.5	
S6ASS5120/075	355	114	5.6	48.0	20.0	104.4	
S6ASS2020/199	266	24	1.4	25.0	17.0	17.1	
S6ASS2060/199	266	57	2.2	40.0	30.0	43.9	
S6ASS5120/199	266	109	4.6	48.0	20.0	99.1	

The STEP files are available upon request.
In case of deviations from the standard portfolio and delivery times, please contact our Customer Care Team.

Trapped Ion Lenses

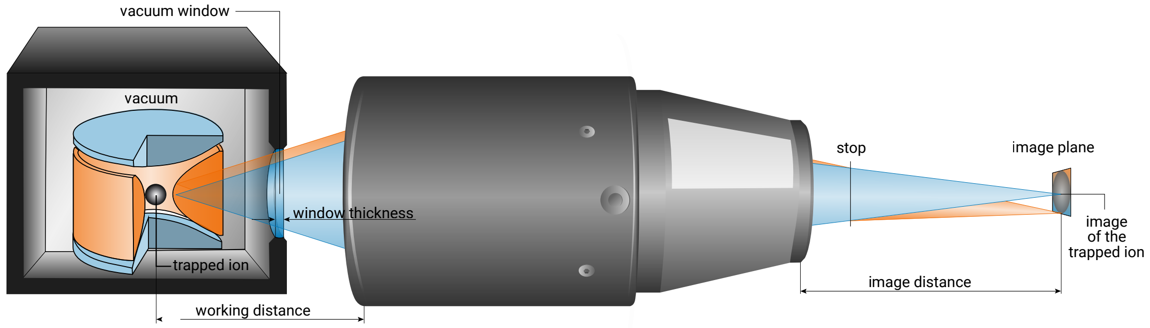
Benefit from our capabilities

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	Wavelength 1 [nm]	Wavelength 2 [nm]	Material	Focus Length [mm]	NA	f#	Max. FOV [mm]	Magnification @ wavelength 1	Magnification @ wavelength 2	Thickness Window	Material Window	Working Distance [mm]
S6ASS2243/126	1064	-	optical glass	40.5	0.4	1.4	0.71	infinity	-	6.0	fused silica	50.7
S6ASS2242/081	590	1064	optical glass	40.0	0.4	1.4	0.71	infinity	infinity	6.0	fused silica	50.7
S6ASS2224	494	671	optical glass	22.0	0.5	1.0	0.08	infinity	infinity	-	-	11.6
S6ASS2255	422	-	fused silica	45.0	0.4	1.2	0.27	10.0	-	19.1	fused silica	63.4
S6ASS2256	422	-	fused silica	44.9	0.4	1.2	0.27	10.0	-	19.1	N-BK7	63.8
S6ASS2258	397	422	optical glass	44.8	0.4	1.1	0.28	10.0	10.0	19.1	N-BK7	62.3
S6ASS2258/006	397	422	optical glass	45.5	0.4	1.2	0.29	10.0	10.0	6.3	fused silica	60.5
S6ASS2241	395	729	optical glass	66.9	0.3	1.7	0.2	20.0	20.0	6.0	fused silica	55.7
S6ASS2241/045	395	729	optical glass	66.9	0.3	1.8	0.19	20.0	20.0	6.0	fused silica	55.7
S6ASS2341	370	-	optical glass	82.1	0.2	2.1	0.2	6.0	-	6.0	fused silica	55.7
S6ASS2245	369	-	fused silica	40.0	0.4	1.3	0.35	infinity	-	8.0	fused silica	39.3
S6ASS2246	369	-	fused silica	41.2	0.4	1.3	0.36	infinity	-	4.3	fused silica	38.7
S6ASS2247	369	493	fused silica	50.1	0.2	2.5	0.95	8.0	78.0	2.0	sapphire	49.4
S6ASS2247/389	313	397	fused silica	49.0	0.2	2.5	0.95	8.2	79.0	2.0	sapphire	48.2
S6ASS2248	313	397	fused silica	49.0	0.3	1.6	0.27	15.0	145.0	3.0	fused silica	46.5



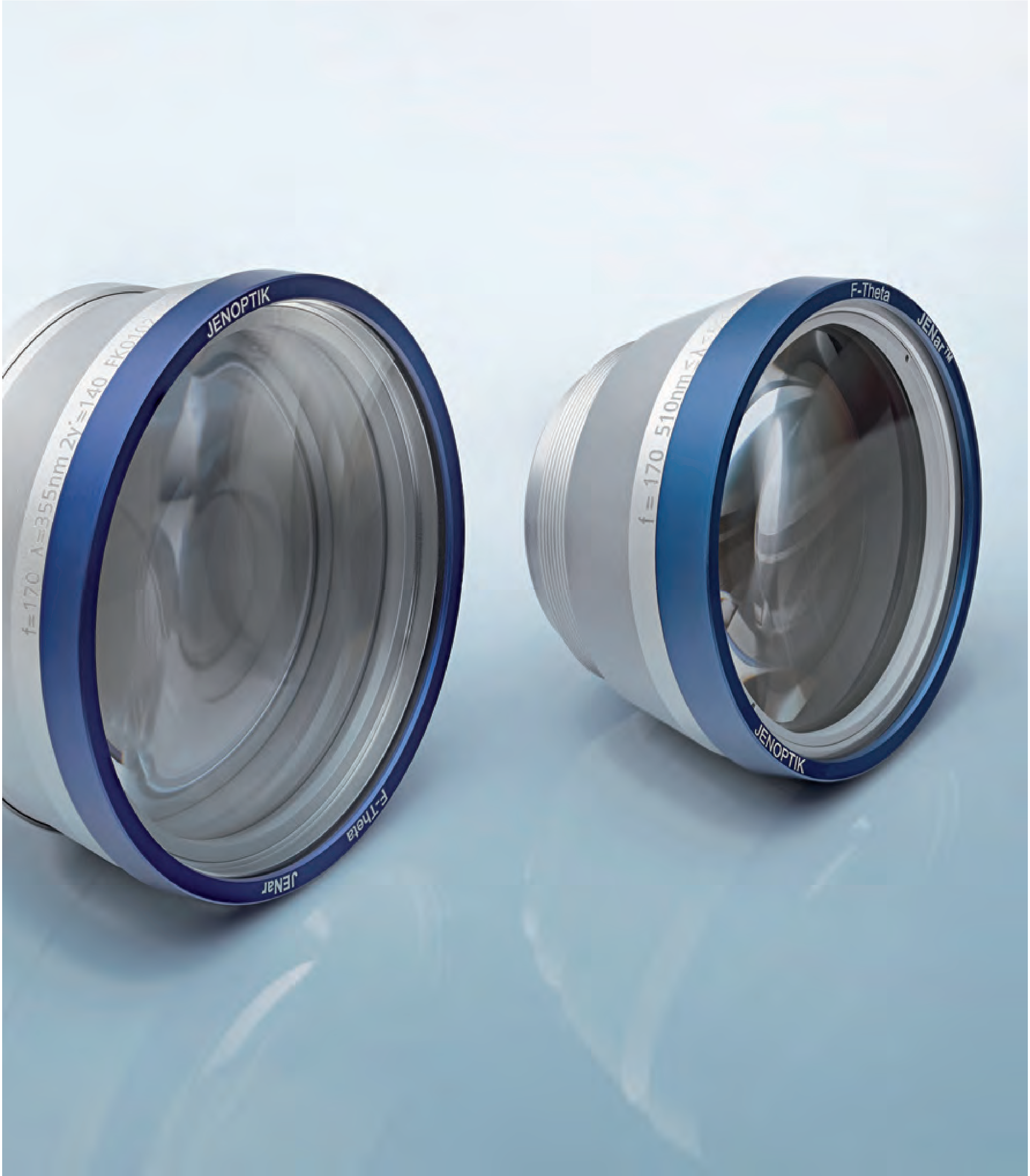
The STEP files are available upon request.
In case of deviations from the standard portfolio and delivery times, please contact our Customer Care Team.

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)]

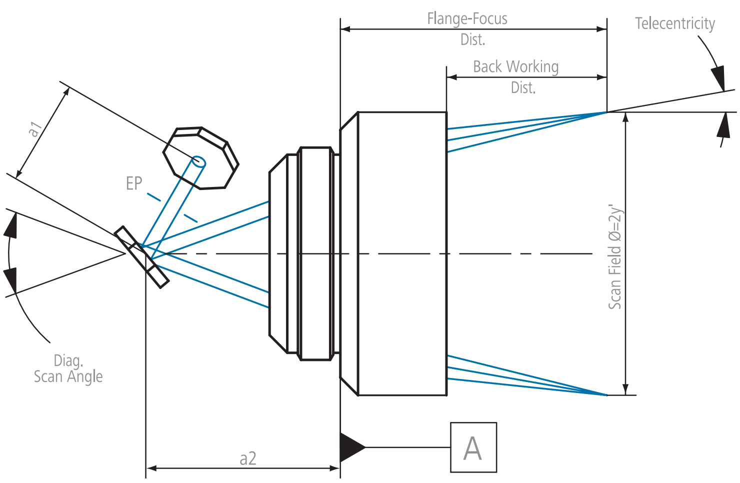
Wavelength	Lens Order Number	Focal Length	Scan Field Diagonal	Max. Full Diagonal Scan Angle	Max. Input Beam Diameter Truncated at $1/e^2$ for 2-axis-scan	Focus Size at $1/e^2$ Intensity Level
[nm]		[mm]	[mm]	[°]	[mm]	[µm]
1030…1080	017700-025-26**	160	110	40	14	22
	017700-026-26**	255	160	36	20	25
	609120 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

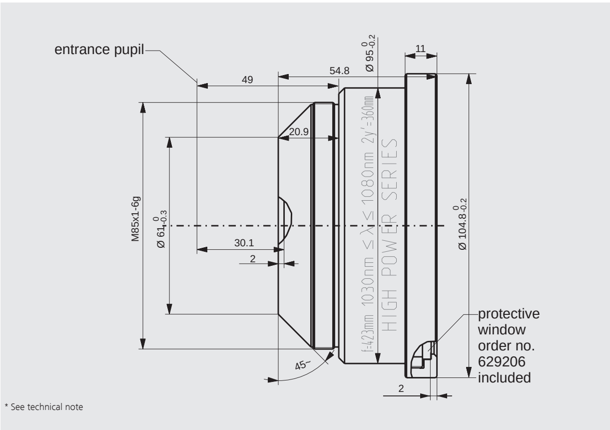
NEW**

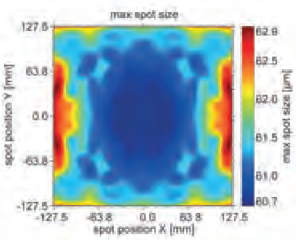
Laser Material Processing

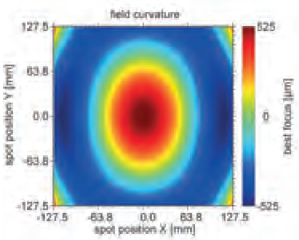
Parameters	JENar™ 423-1030…1080-360 Fused silica lens for large scan fields**	JENar™ 160-1030…1080-110 Fused silica lens
Focal length:	423 mm	160 mm
Wavelength:	1030…1080 nm	1030…1080 nm
Scan field (X x Y); Ø:	(255 mm x 255 mm); 360 mm	(78 mm x 78 mm); 110 mm
Diagonal scan angle:	± 24.4°	± 20°
X/Y mirror 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

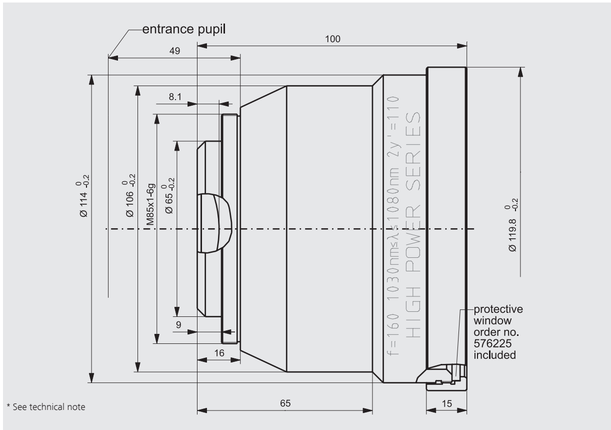
JENar™ 423-1030…1080-360

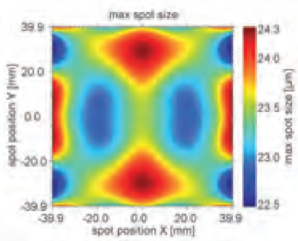


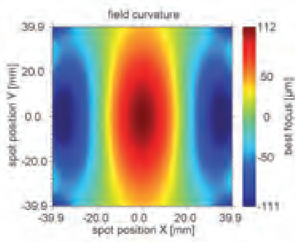




JENar™ 160-1030…1080-110







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

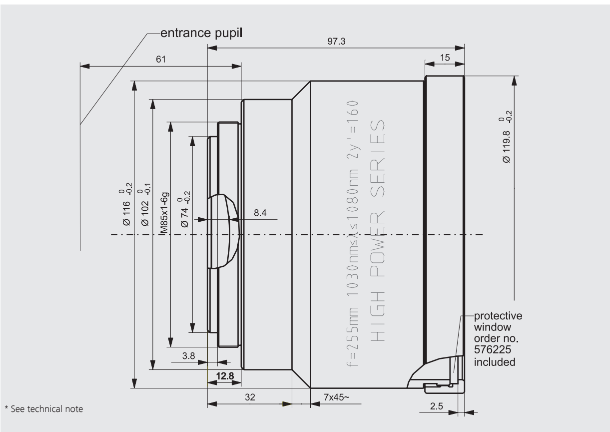
F-Theta JENar™ Silverline™ Lenses

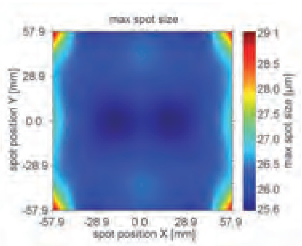
High Power Lenses

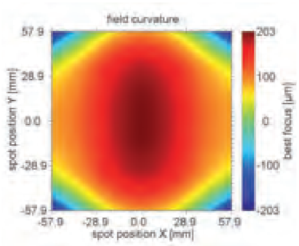
Parameters	JENar™ 255-1030…1080-160 Fused silica lens	JENar™ 160-900…1100-110 Fused silica lens
Focal length:	255 mm	160 mm
Wavelength:	1030…1080 nm	900…1100 nm
Scan field (X x Y); Ø:	(114 mm x 114 mm); 160 mm	(78 mm x 78 mm); 110 mm
Diagonal scan angle:	± 18°	± 20°
X/Y mirror angle:	± 6.4°	± 7.1°
Back 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

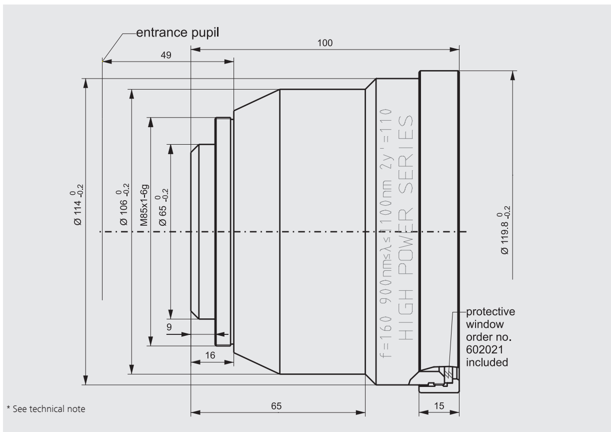
JENar™ 255-1030…1080-160

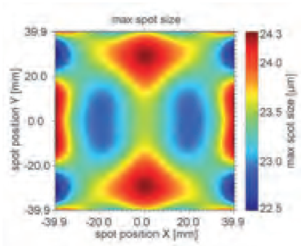


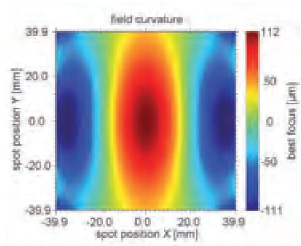




JENar™ 160-900…1100-110







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

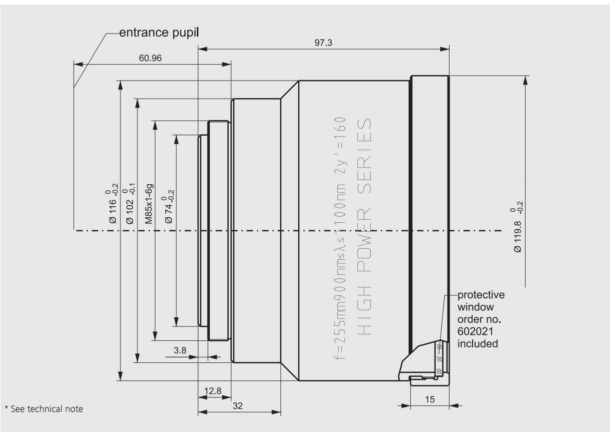
F-Theta JENar™ Silverline™ Lenses

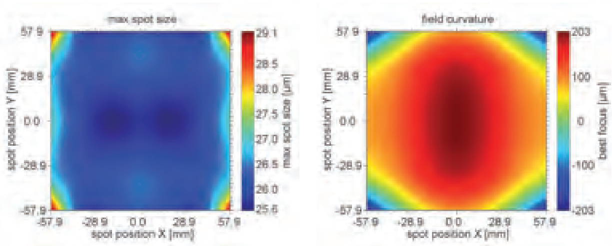
High Power Lenses

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

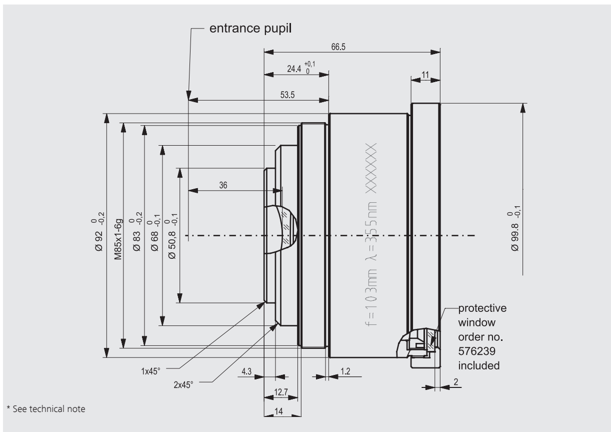
Specifications

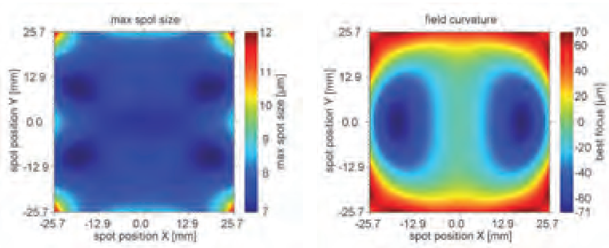
JENar™ 255-900…1100-161





JENar™ 103-355-71





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

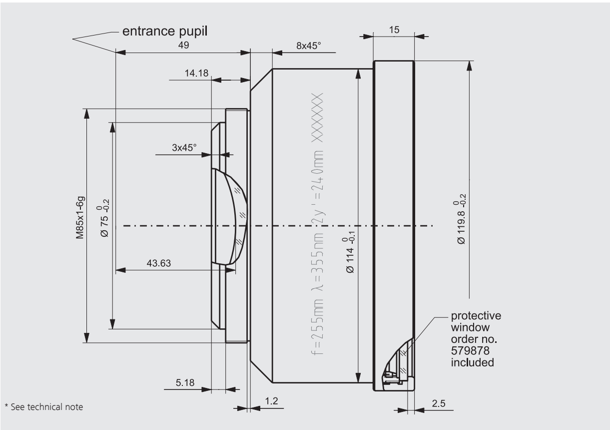
F-Theta JENar™ Silverline™ Lenses

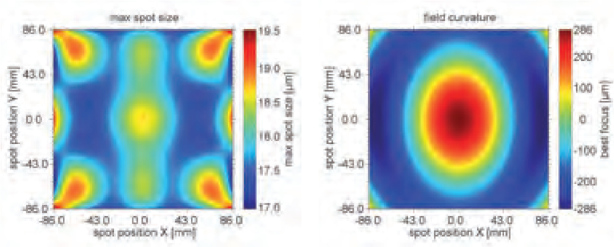
High Power Lenses

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

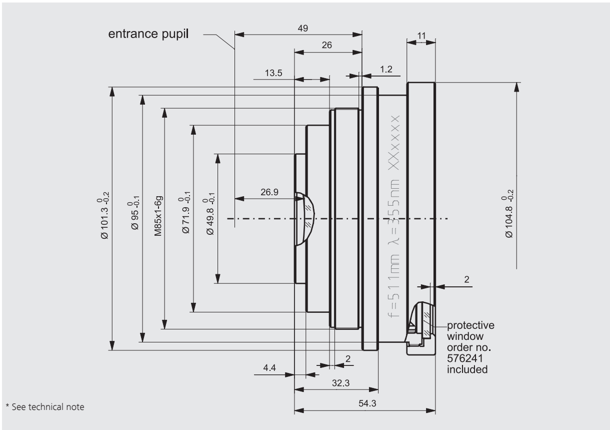
Specifications

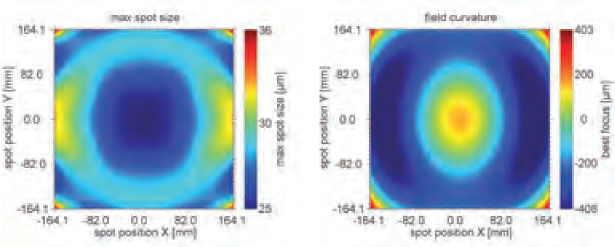
JENar™ 255-355-240





JENar™ 510-355-431





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

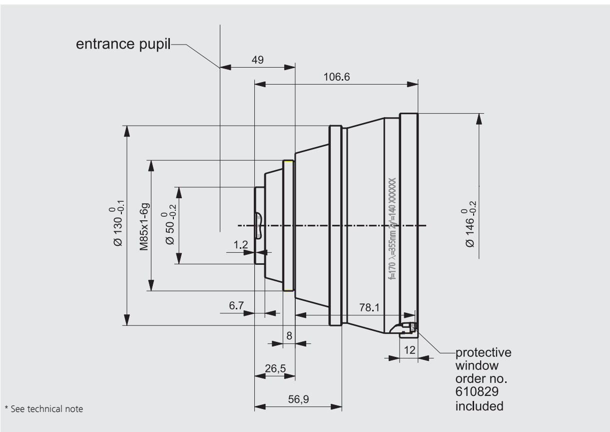
F-Theta JENar™ Silverline™ Lenses

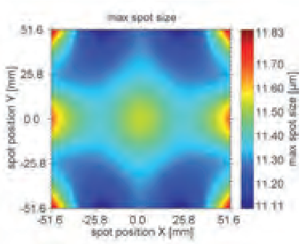
High Power Lenses

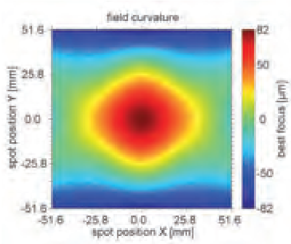
Parameters	JENar™ 170-355-140 Telecentric fused silica lens for large scan fields	JENar™ 103-266-71 Telecentric fused silica lens
Focal length:	170 mm	103 mm
Wavelength:	355 nm	266 nm
Scan field (X x Y); Ø:	(100 mm x 100 mm); 140 mm	(50 mm x 50 mm); 71 mm
Diagonal scan angle:	± 25°	± 20.1°
X/Y mirror 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

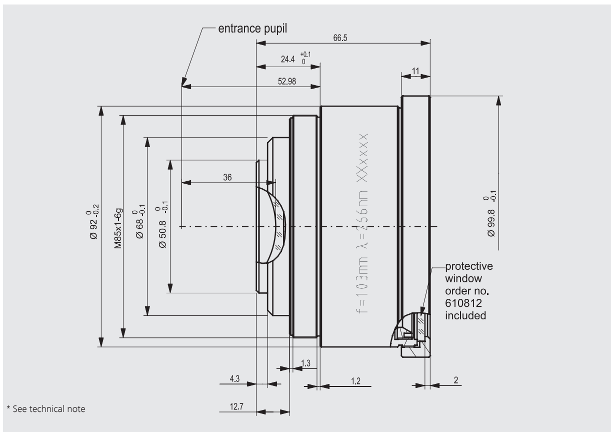
JENar™ 170-355-140

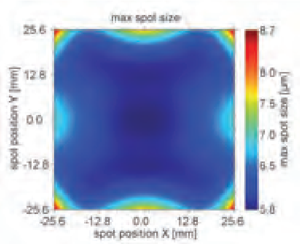


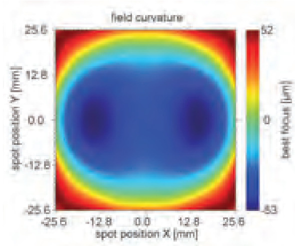




JENar™ 103-266-71







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)

Laser Material Processing

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.

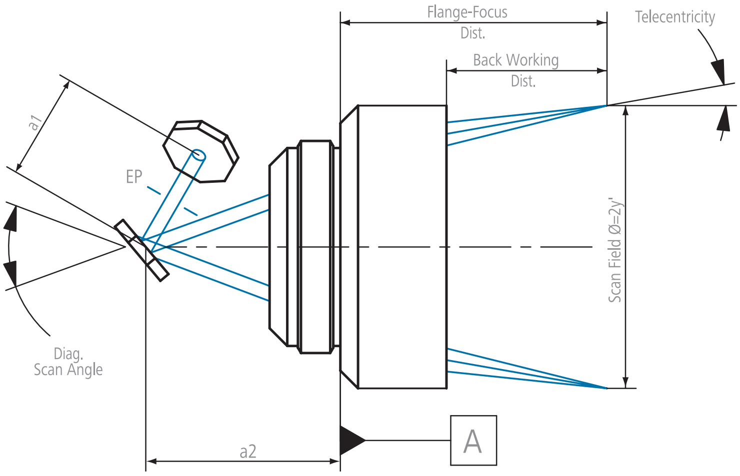
Type: F-Theta Lenses

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.

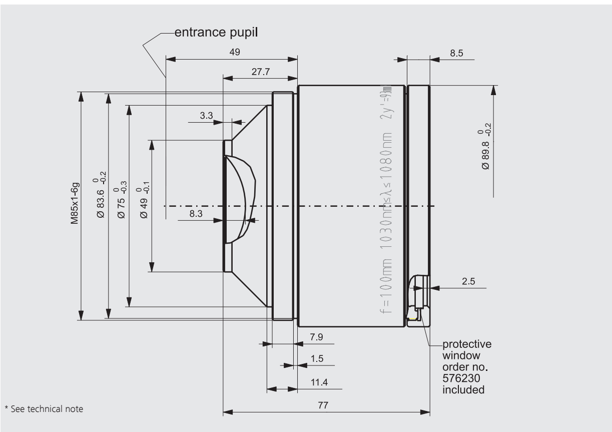
F-Theta JENar™ Lens Series

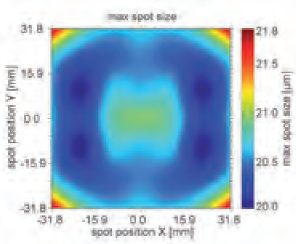
High Image Quality | Telecentric Lens

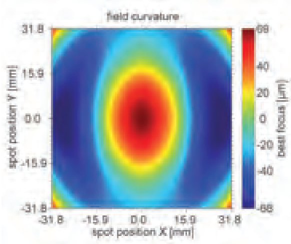
Parameters	JENar™ 100-1030…1080-93 F-Theta lens for high image quality	JENar™ 125-1030…1080-80 Telecentric lens
Focal length:	100 mm	125 mm
Wavelength:	1030…1080 nm	1030…1080 nm
Scan field (X x Y); Ø:	(66 mm x 66 mm); 93 mm	(57 mm x 57 mm); 80 mm
Diagonal scan angle:	± 27°	± 18.6°
X/Y mirror angle:	± 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

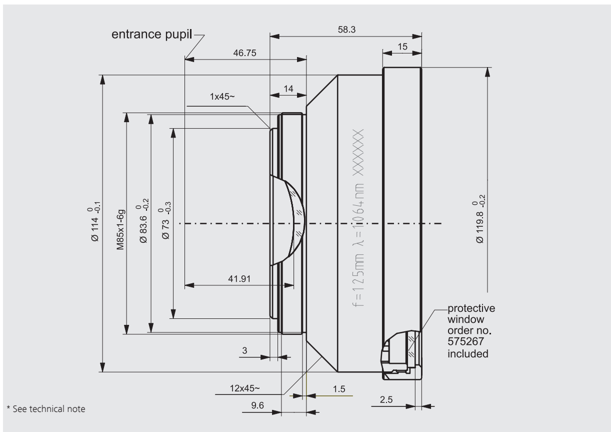
JENar™ 100-1030…1080-93

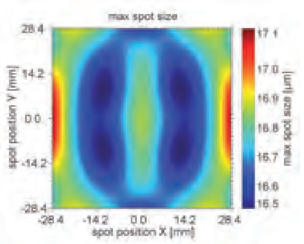


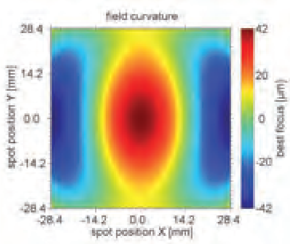




JENar™ 125-1030…1080-80







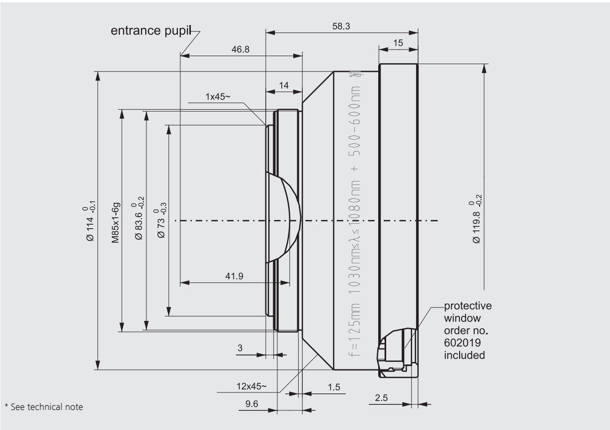
JENar®: Registered in EU, CN, JP, SG, US
F-Theta: Registered Design in EU, CN, KR, IN, SG, JP, HK, TW

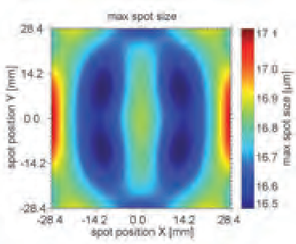
F-Theta JENar™ Lens Series

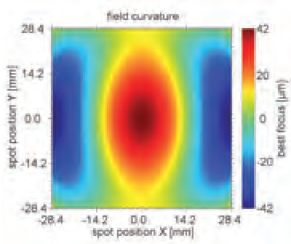
Telecentric Lens | Large Scan Fields

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

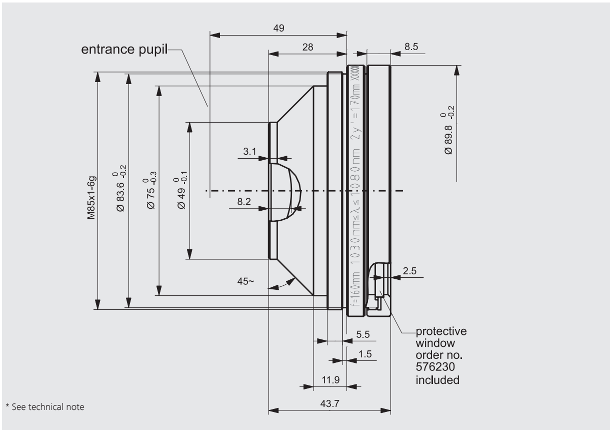
Specifications
JENar™ 125-1030…1080-80 + VIS

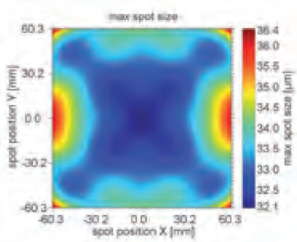


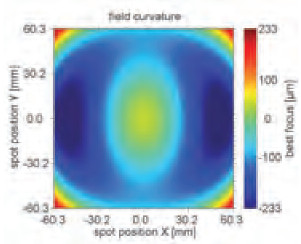




JENar™ 160-1030…1080-170







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

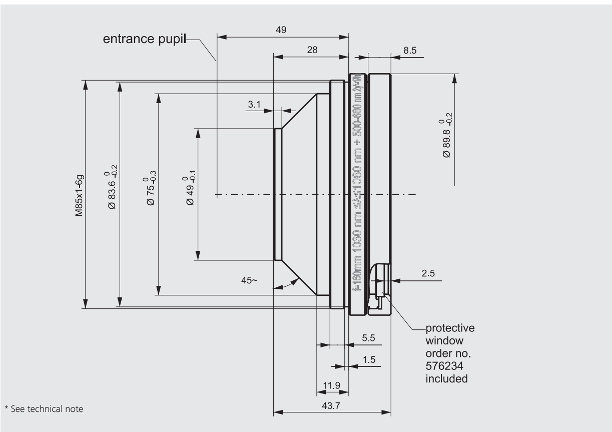
F-Theta JENar™ Lens Series

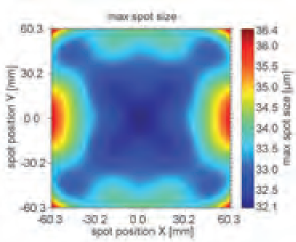
Large Scan Fields | High Image Quality

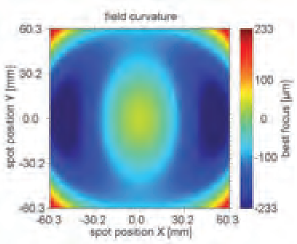
Parameters	JENar™ 160-1030…1080-170 + VIS Compact F-Theta lens for large scan fields	JENar™ 170-1030…1080-170 F-Theta lens for high image quality
Focal length:	160 mm	170 mm
Wavelength:	1030…1080 nm; T@500…680 nm > 85 %	1030…1080 nm
Scan field (X x Y); Ø:	(120 mm x 120 mm); 170 mm	(120 mm x 120 mm); 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

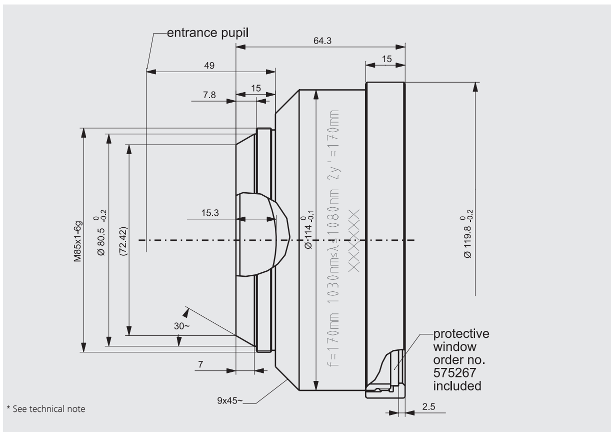
JENar™ 160-1030…1080-170 + VIS

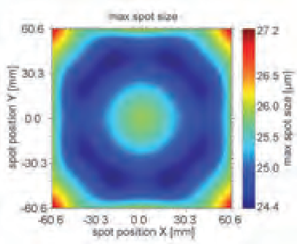


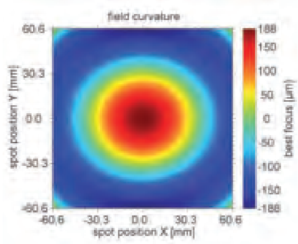




JENar™ 170-1030…1080-170







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

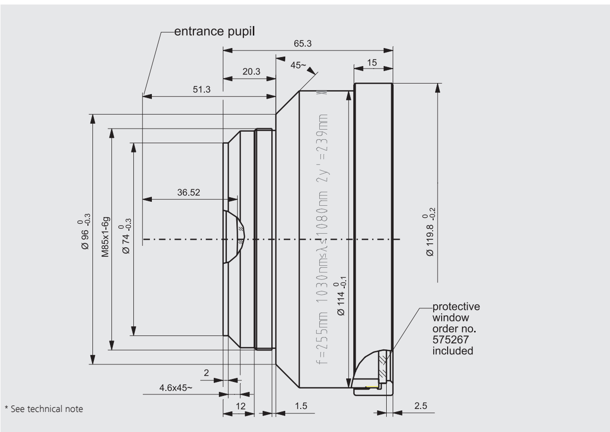
F-Theta JENar™ Lens Series

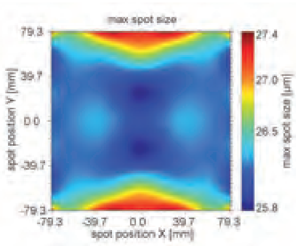
Larger Beam Diameters and Scan Fields

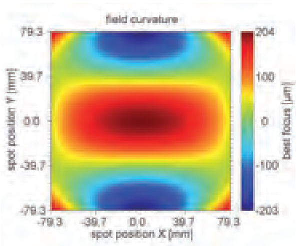
Parameters	JENar™ 255-1030…1080-239 Lens for larger beam diameters and scan fields	JENar™ 255-1030…1080-239 + VIS Lens for larger beam diameters and scan fields
Focal length:	255 mm	255 mm
Wavelength:	1030…1080 nm	1030…1080 nm; T@500…680 nm > 85 %
Scan field (X x Y); Ø:	(169 mm x 169 mm); 239 mm	(169 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

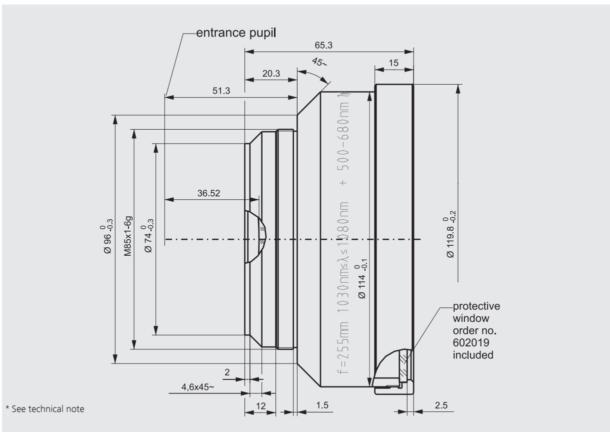
JENar™ 255-1030…1080-239

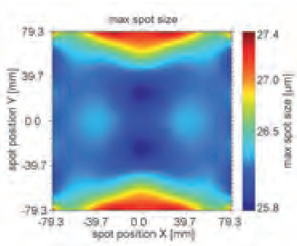


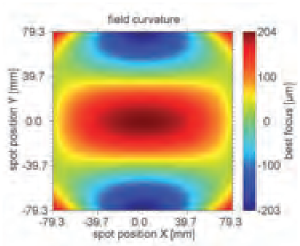




JENar™ 255-1030…1080-239 + VIS







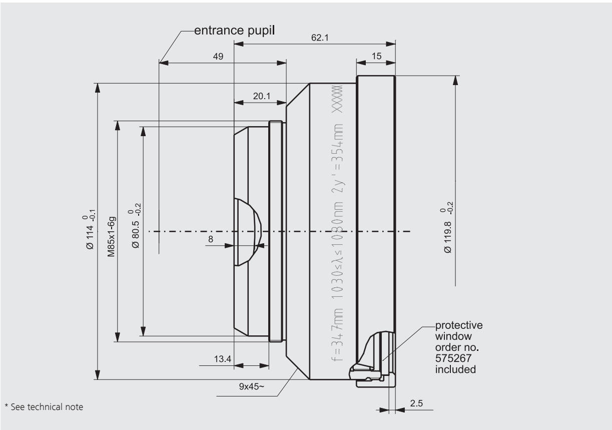
JENar®: Registered in EU, CN, JP, SG, US
F-Theta: Registered Design in EU, CN, KR, IN, SG, JP, HK, TW

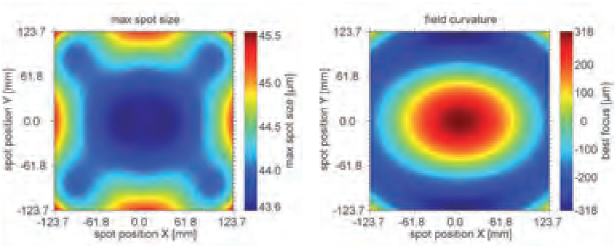
F-Theta JENar™ Lens Series
Large Scan Fields

Parameters	JENar™ 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

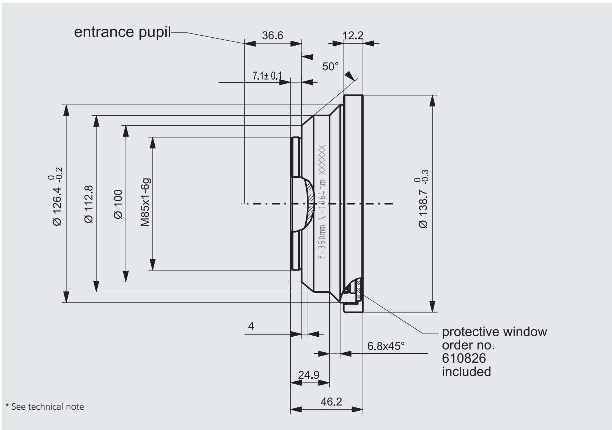
Specifications

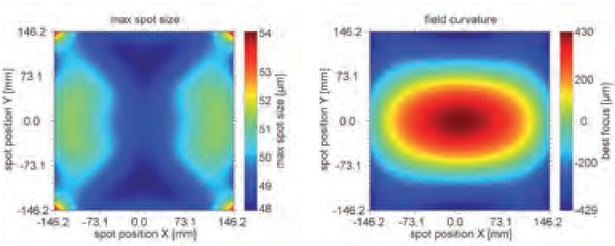
JENar™ 347-1030…1080-354





JENar™ 350-1030…1080-452





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

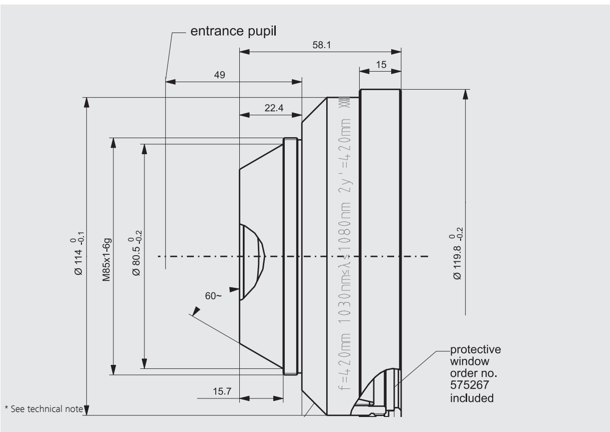
F-Theta JENar™ Lens Series

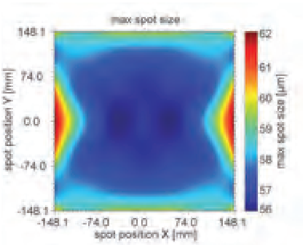
Large Scan Fields | High Image Quality

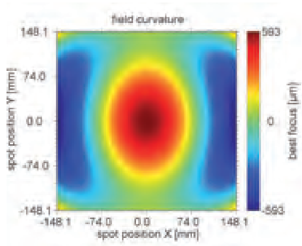
Parameters	JENar™ 420-1030…1080-420 F-Theta lens for large scan fields	JENar™ 100-515…540-90 F-Theta lens for high image quality
Focal length:	420 mm	100 mm
Wavelength:	1030…1080 nm	515…540 nm
Scan field (X x Y); Ø:	(297 mm x 297 mm); 420 mm	(64 mm x 64 mm); 90 mm
Diagonal scan angle:	± 28.5°	± 26.5°
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

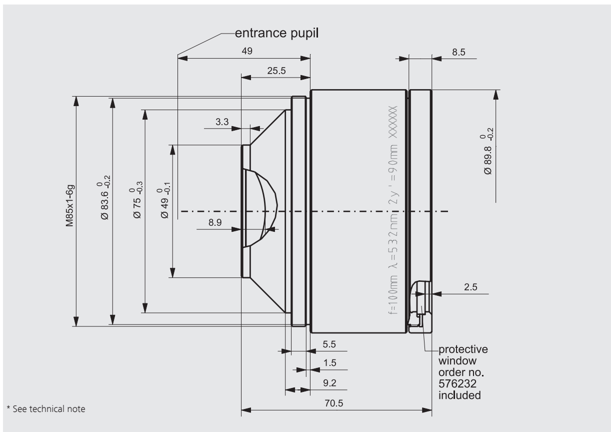
JENar™ 420-1030…1080-420

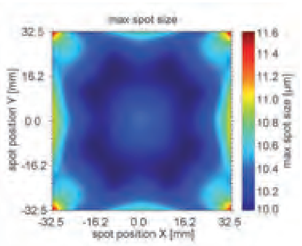


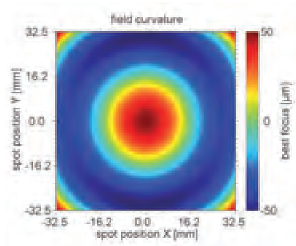




JENar™ 100-515…540-90





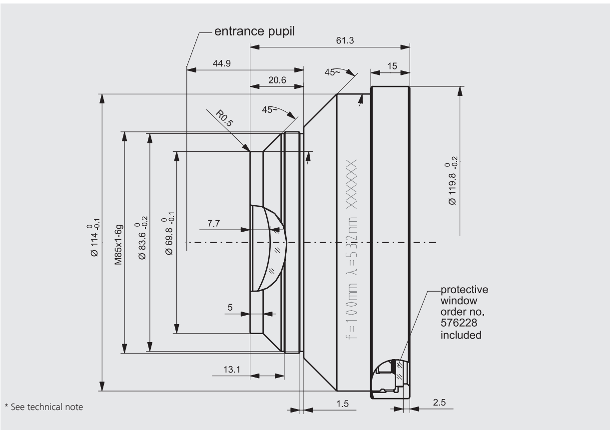


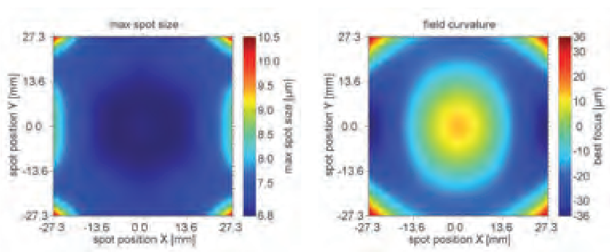
JENar®: Registered in EU, CN, JP, SG, US
F-Theta: Registered Design in EU, CN, KR, IN, SG, JP, HK, TW

F-Theta JENar™ Lens Series
Telecentric Lenses

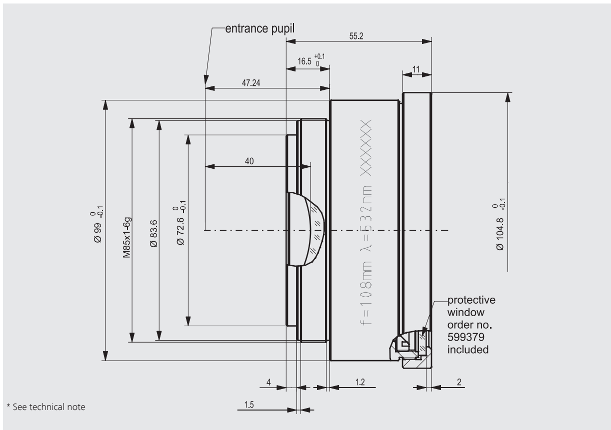
Parameters	JENar™ 102-515…540-75 Telecentric lens	JENar™ 108-515…540-75 Telecentric lens
Focal length:	102 mm	108 mm
Wavelength:	515…540 nm	515…540 nm
Scan field (X x Y); Ø:	(53 mm x 53 mm); 75 mm	(53 mm x 53 mm); 75 mm
Diagonal scan angle:	± 21.5°	± 20°
X/Y mirror angle:	± 7.7°	± 7.1°
Back working distance:	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

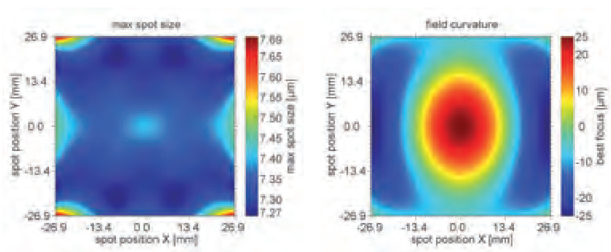
Specifications
JENar™ 102-515…540-75





JENar™ 108-515…540-75





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

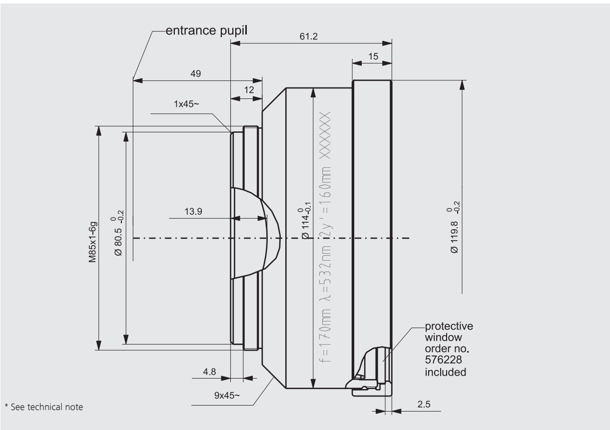
F-Theta JENar™ Lens Series

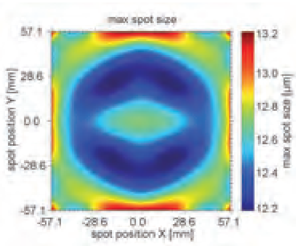
High Image Quality | Larger Beam Diameters and Scan Fields

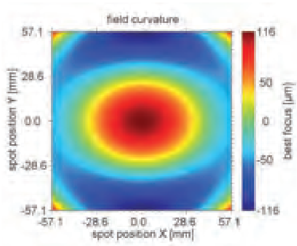
Parameters	JENar™ 170-515…540-160 F-Theta lens for high image quality	JENar™ 255-515…540-233 Lens for larger beam diameters and scan fields
Focal length:	170 mm	255 mm
Wavelength:	515…540 nm	515…540 nm
Scan field (X x Y); Ø:	(113 mm x 113 mm); 160 mm	(165 mm x 165 mm); 233 mm
Diagonal scan angle:	± 27°	± 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

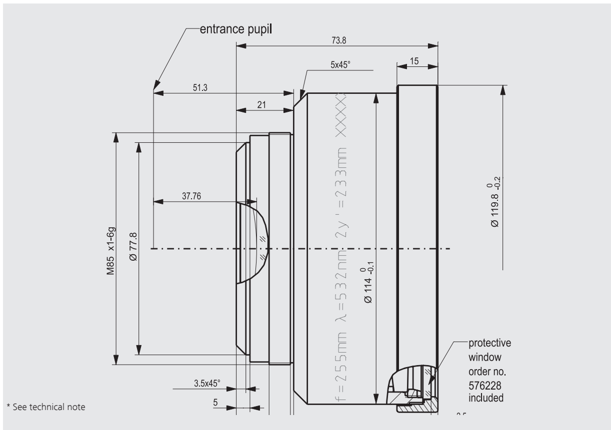
JENar™ 170-515…540-160

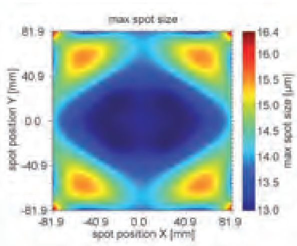


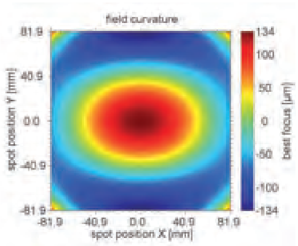




JENar™ 255-515…540-233





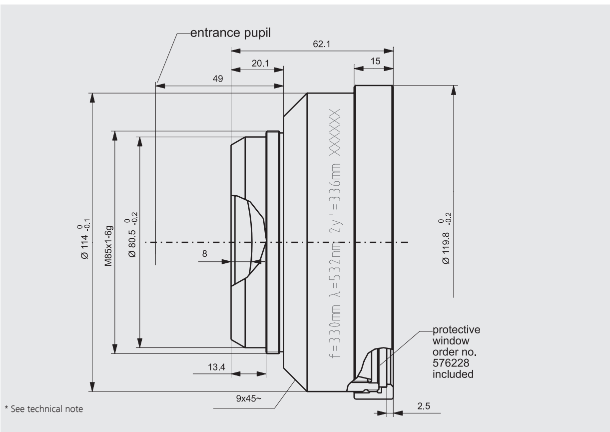


JENar®: Registered in EU, CN, JP, SG, US
F-Theta: Registered Design in EU, CN, KR, IN, SG, JP, HK, TW

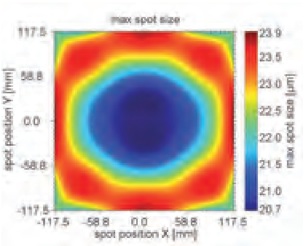
F-Theta JENar™ Lens Series
Large Scan Fields

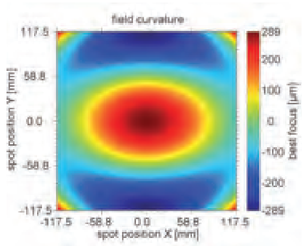
Parameters	JENar™ 330-515…540-347 F-Theta lens for large scan fields	JENar™ 420-515…540-420 F-Theta lens for large scan fields
Focal length:	330 mm	420 mm
Wavelength:	515…540 nm	515…540 nm
Scan field (X x Y); Ø:	(245 mm x 245 mm); 347 mm	(297 mm x 297 mm); 420 mm
Diagonal scan angle:	± 28.8°	± 28.55°
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

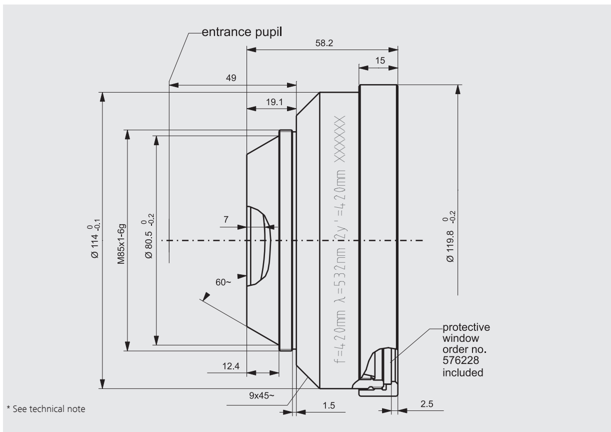


* See technical note

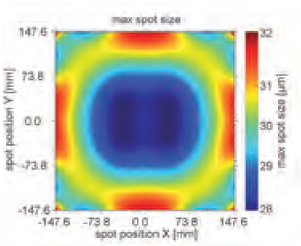


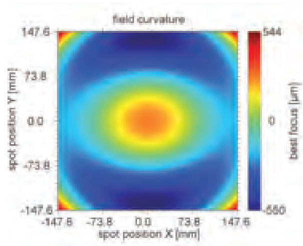


JENar™ 420-515…540-420



* See technical note





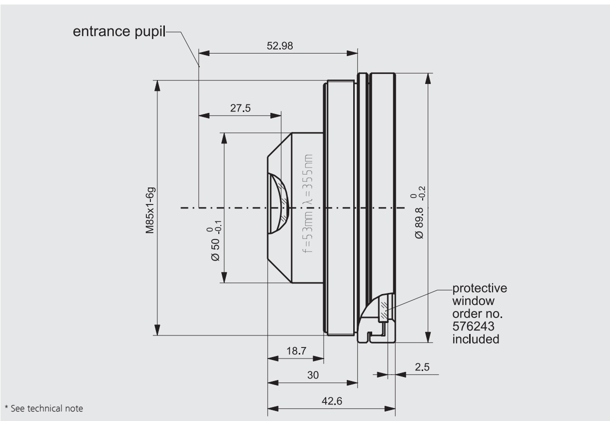
JENar®: Registered in EU, CN, JP, SG, US
F-Theta: Registered Design in EU, CN, KR, IN, SG, JP, HK, TW

F-Theta JENar™ Lens Series

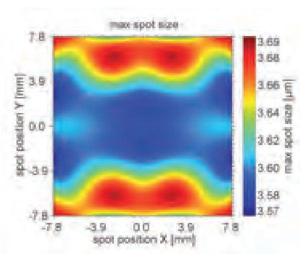
Short Focal Length

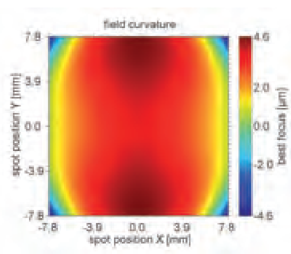
Parameters	JENar™ 53-355-24 Telecentric lens with short focal length
Focal length:	53 mm
Wavelength:	355 nm
Scan field (X x Y); Ø:	(17 mm x 17 mm); 24 mm
Diagonal scan angle:	± 12.1°
X/Y mirror angle:	± 4.3°
Back working distance:	64.9 mm
Flange focus distance:	77.48 mm
Input beam Ø 1/e²:	10 mm
Focus 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





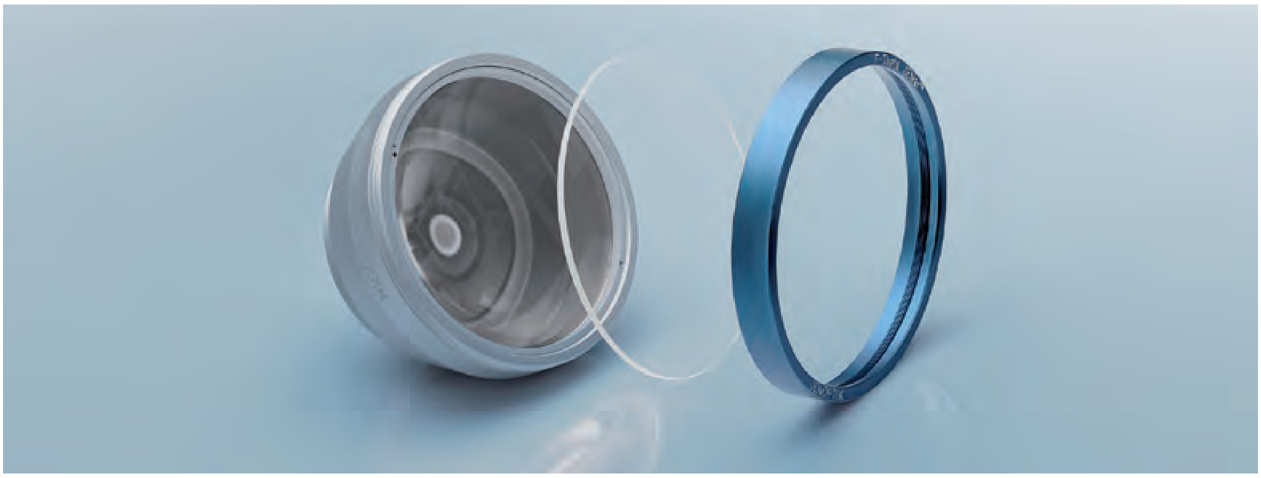
JENar®: Registered in EU, CN, JP, SG, US
F-Theta: Registered Design in EU, CN, KR, IN, SG, JP, HK, TW

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

Type: Protective Windows

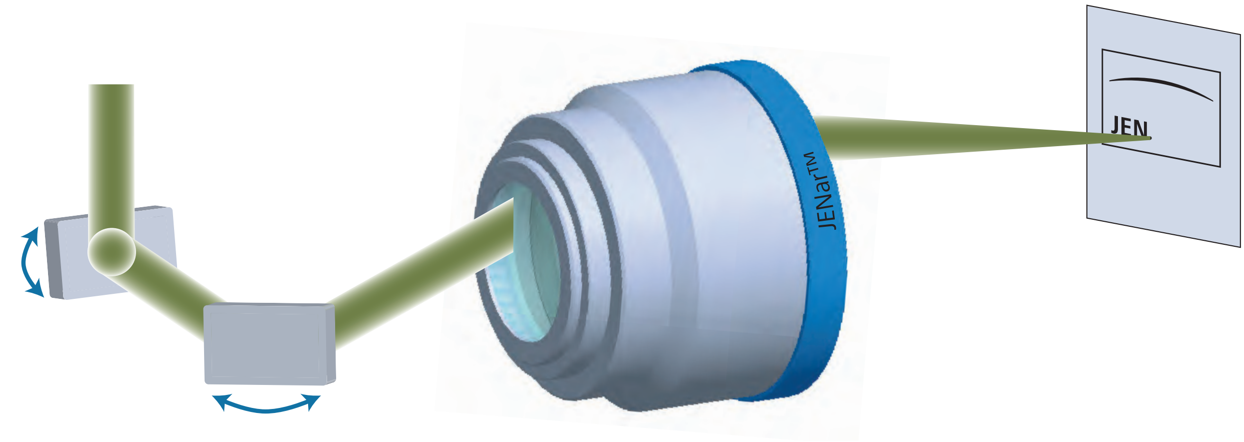
		Drawing Number (017700 = *)	*-004-31	*-004-32	*-049-31	*-049-32	*-049-33	*-410-31	*-410-32
		Order Number Window	575267	576228	576230	576232	576234	576239	610812
	Wavelength [nm]	F-Theta Lens							
Silverline™ High Power Lenses	1030…1080	017700-025-26							
		017700-026-26							
		609120 NEW							
	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									
	X									
									X	
		X								
		X								
										X
			X							
X										
						X				
							X			
					X					
					X					
								X		
			X							

Basic Principles



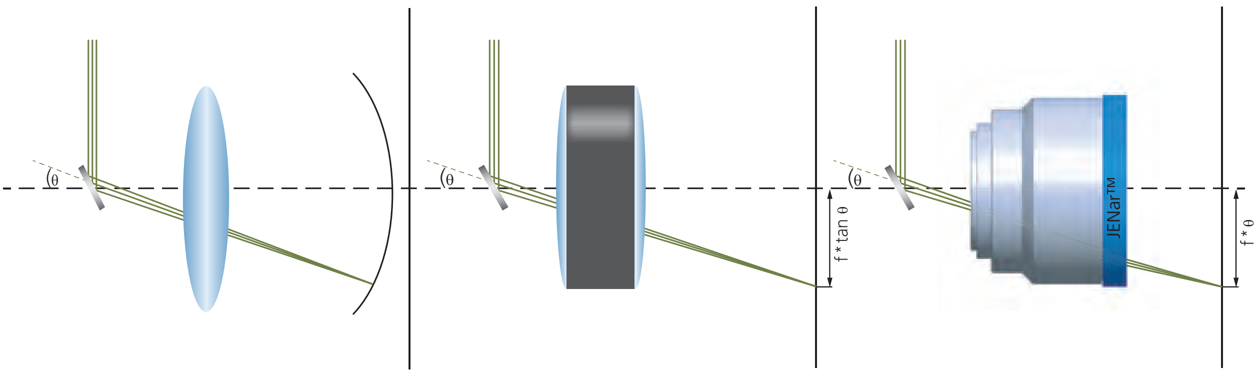
F-Theta objective lenses

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).

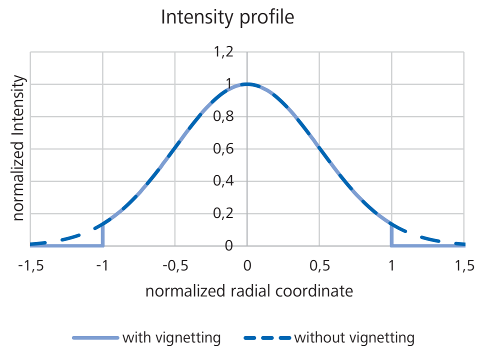
Scan angle

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

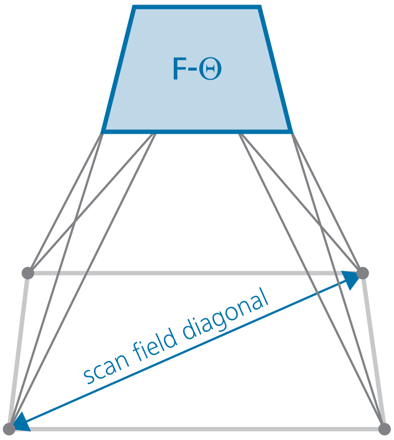
Whereas the focal length is a rather theoretical construct, the back working distance describes the real distance between the end of the objective (the edge closest to the workpiece) and the workpiece.

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.

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

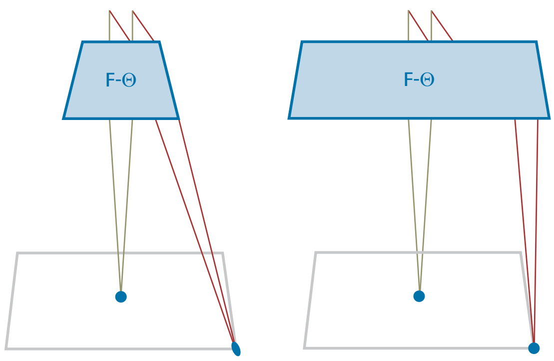
The parameters c and p of this law are wavelength-dependent. Furthermore, the real damage threshold of the system critically depends several exterior influences, like adequate storage, handling, and cleaning. Inappropriate care of the optical systems reduces the damage threshold and renders the guarantee 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

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

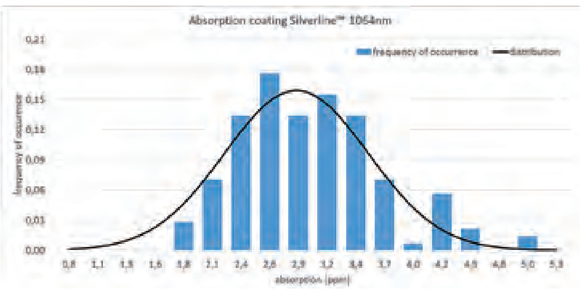
$$\Delta z_G = \ln(4)\Delta z_T$$

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

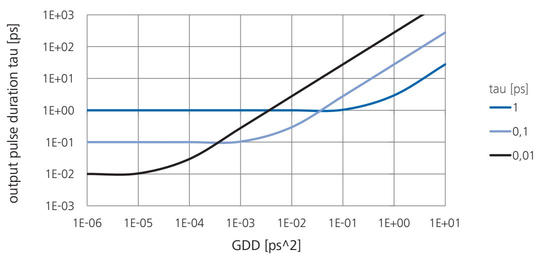
When light passes through an optical material of non-vanishing dispersion it accumulates a wavelength dependent optical phase. For laser pulses, which are effectively a linear superposition of harmonic oscillations of different wavelengths, this influences the pulse shape. In a second order approximation 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

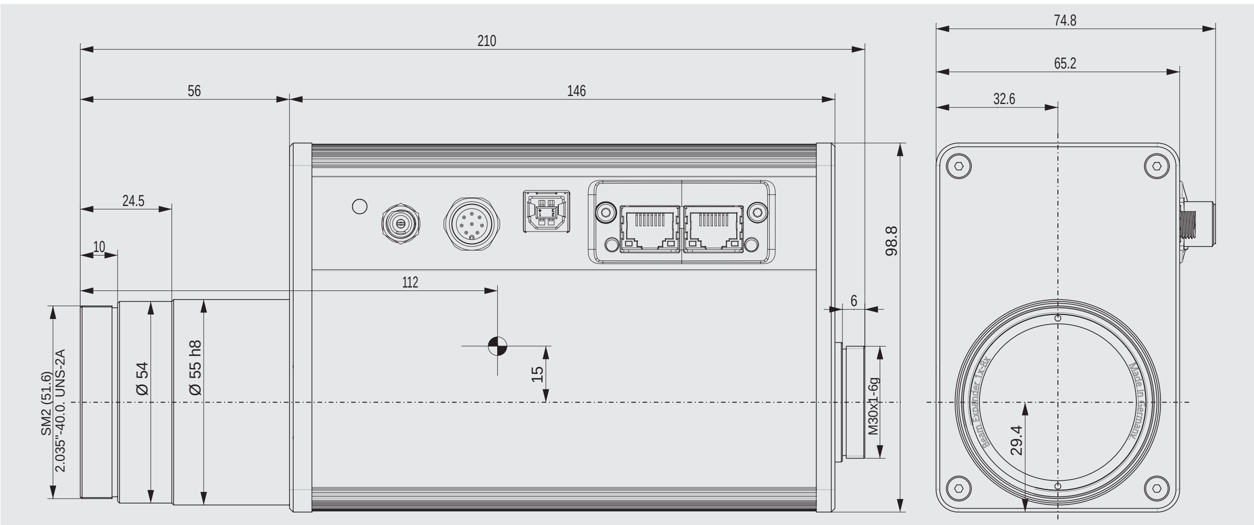
Specification

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 fs^2 [1030-1080 nm] | 1580 fs^2 [515-540 nm] | 2810 fs^2 [355 nm]
	LIDT coating pulsed; CW[4]:	5.0 J/cm^2 * (τ/[ns]) ^ 0.30; 5.0 MW/cm^2 [1030-1080 nm] 2.5 J/cm^2 * (τ/[ns]) ^ 0.35; 2.5 MW/cm^2 [515-540 nm] 1.0 J/cm^2 * (τ/[ns]) ^ 0.40; 1.0 MW/cm^2 [355 nm]
	LIDT system pulsed; CW[4]:	0.35 J/cm^2 * (τ/[ns]) ^ 0.30; 0.35 MW/cm^2 [1030-1080 nm] 0.20 J/cm^2 * (τ/[ns]) ^ 0.35; 0.20 MW/cm^2 [515-540 nm] 0.10 J/cm^2 * (τ/[ns]) ^ 0.40; 0.10 MW/cm^2 [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

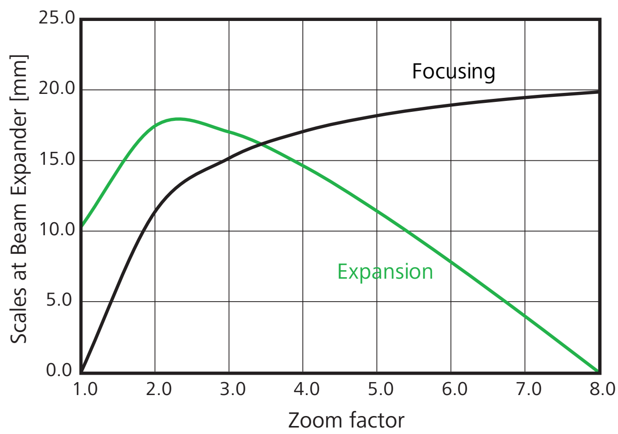
Zoom factor		Ø entrance pupil[3]	
	1030-1080 nm	515-540 nm	355 nm
1x	9.0 mm	9.0 mm	9.0 mm
2x	9.0 mm	9.0 mm	9.0 mm
3x	9.0 mm	9.0 mm	9.0 mm
4x	7.5 mm	7.5 mm	7.5 mm
5x	6.0 mm	6.0 mm	6.0 mm
6x	5.0 mm	5.0 mm	5.0 mm
7x	4.5 mm	4.5 mm	4.5 mm
8x	4.0 mm	4.0 mm	4.0 mm
Order Number:	606997	627443	586117

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

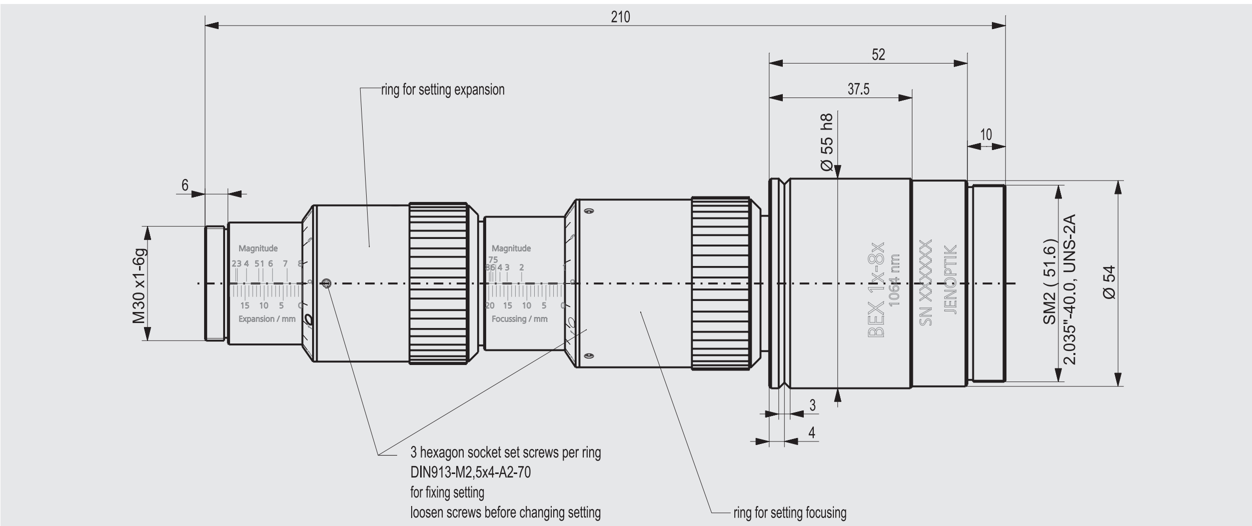
Specification

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

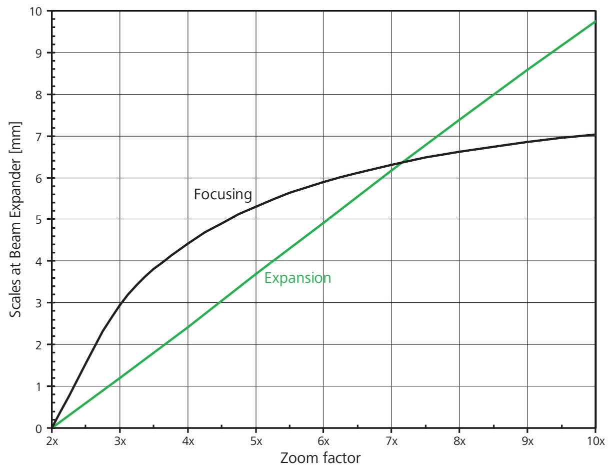
Zoom factor	Ø entrance pupil[3]		
	1030-1080 nm	515-540 nm	355 nm
2x	8.0 mm	8.0 mm	6.0 mm
3x	8.0 mm	7.0 mm	6.0 mm
4x	7.0 mm	6.0 mm	5.0 mm
5x	6.0 mm	5.0 mm	4.5 mm
6x	5.0 mm	4.0 mm	4.0 mm
7x	4.0 mm	4.0 mm	3.5 mm
8x	3.5 mm	3.5 mm	3.0 mm
9x	3.2 mm	3.2 mm	2.7 mm
10x	3.0 mm	3.0 mm	2.2 mm
Order Number:	017052-001-26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

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

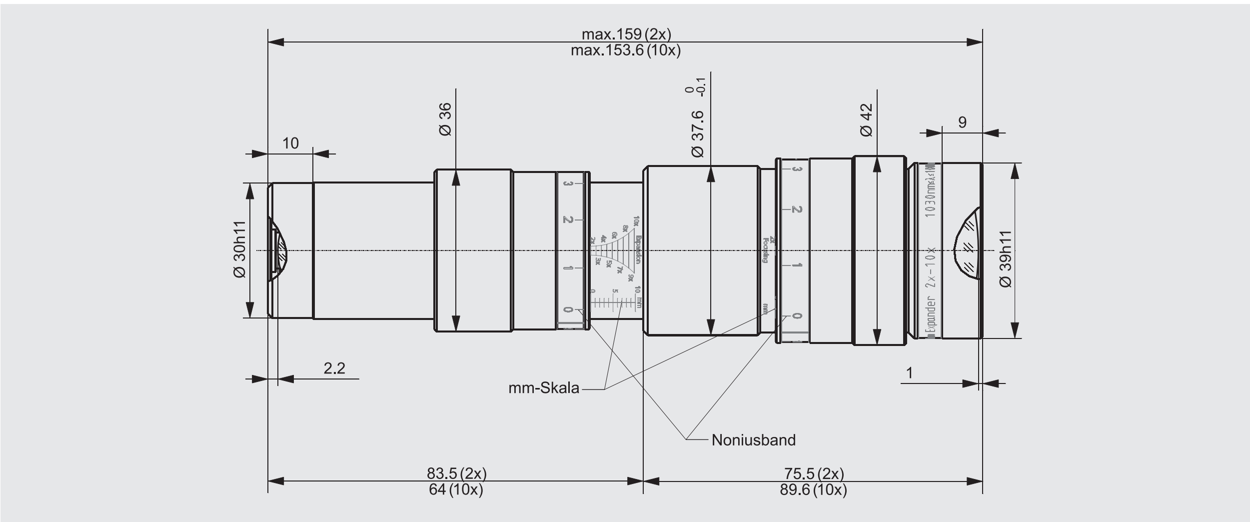
Specification

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 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

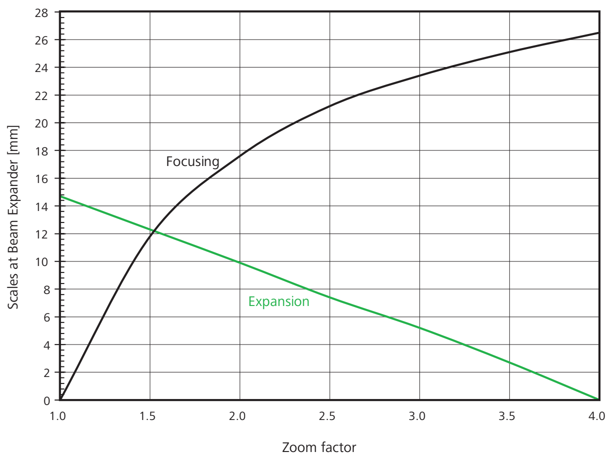
Zoom factor	Ø entrance pupil[3]		
	1030-1080 nm	515-540 nm	355 nm
1x	4.0 mm	4.0 mm	4.0 mm
2x	4.0 mm	4.0 mm	4.0 mm
3x	4.0 mm	4.0 mm	4.0 mm
4x	4.0 mm	4.0 mm	4.0 mm
Order Number:	582823	593355	593354

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

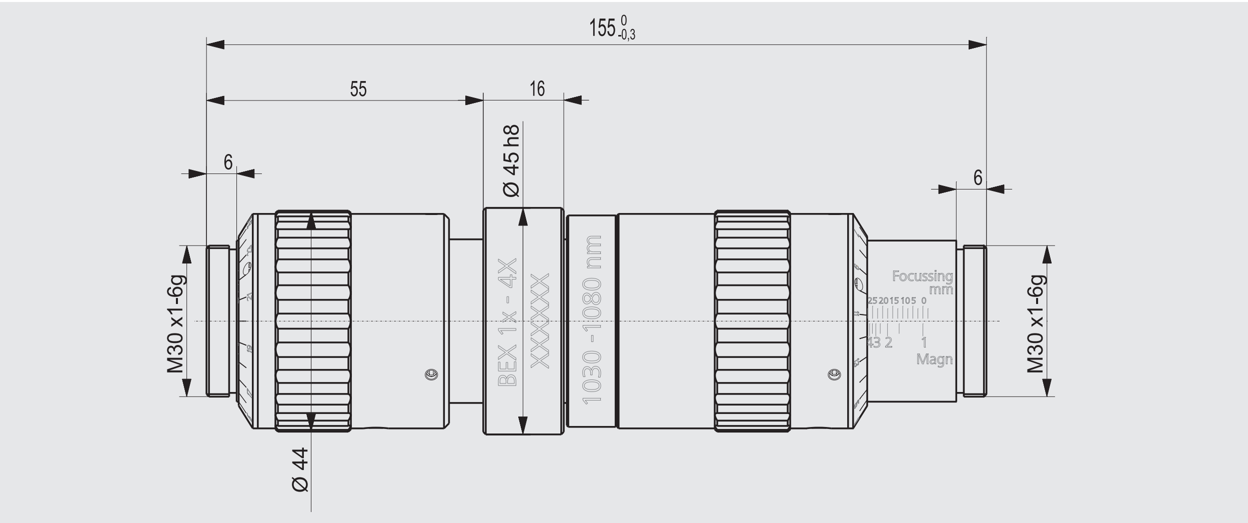
Specification

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

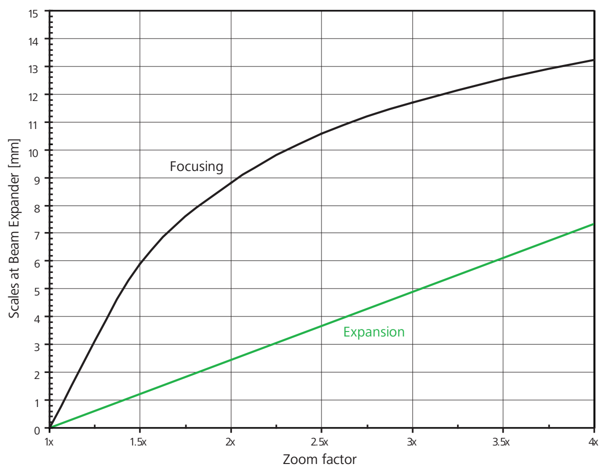
Zoom factor		Ø entrance pupil[3]	
	1030-1080 nm	515-540 nm	355 nm
1x	4.0 mm	4.0 mm	4.0 mm
2x	4.0 mm	4.0 mm	4.0 mm
3x	4.0 mm	4.0 mm	4.0 mm
4x	4.0 mm	4.0 mm	4.0 mm
Order Number:	017052-012-26	017052-202-26	017052-402-26

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

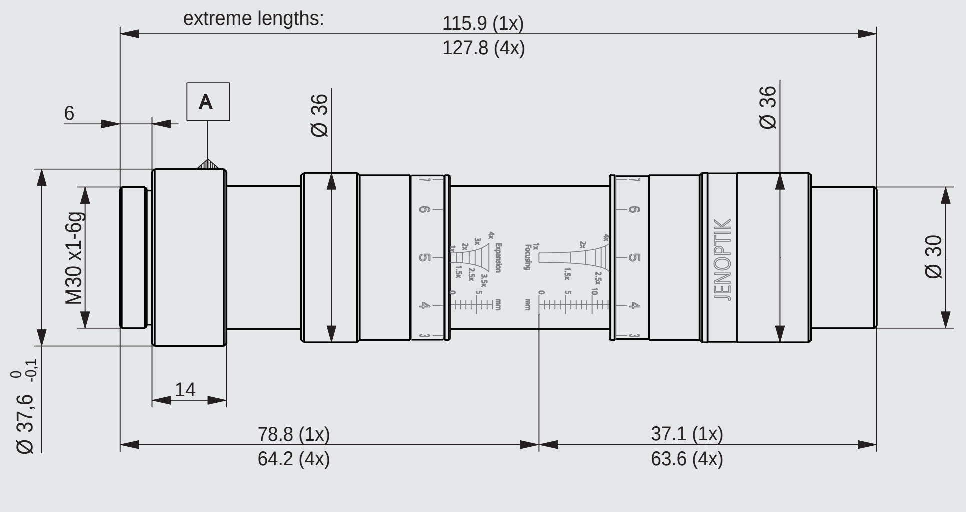
Specification

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