JENOPTIK

Featured optic products

Realize your success with products from Jenoptik.

SHARING EXCELLENCE

Closer to You

Key Locations

North America

Canada
Toronto

Mexico
Saltillo

USA
El Paso (TX)
Huntsville (AL)
Jupiter (FL)
Rochester Hills (MI)
Fremont (CA)

Europe

Austria
Vienna

Czech Republic
Teplice

France
Bayeux

Israel
Nes Ziona

Netherlands
Riel

Switzerland
Peseux
Uster

United Kingdom
Frimley
Saltash

South America

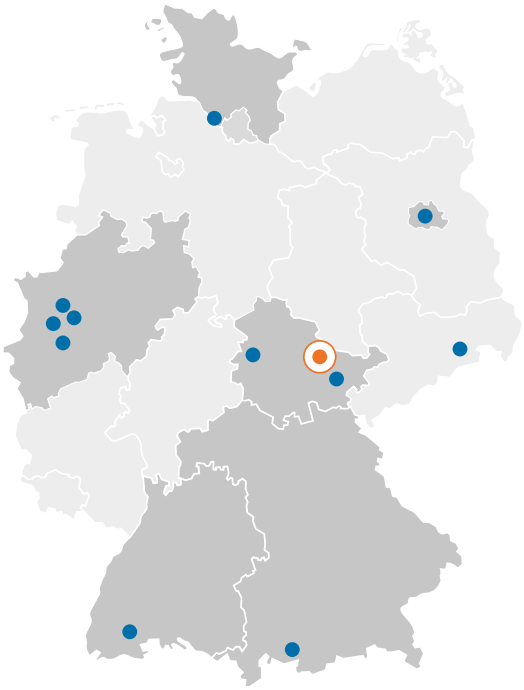
Brazil
São Bernardo
do Campo

Africa

Algeria
Algiers

Germany

Altenstadt
Berlin
Dresden
Eisenach
Essen
Jena (HQ)
Monheim on the Rhine
Muehlhausen
Ratingen
Triptis
Villingen-Schwenningen
Wedel



Asia/Pacific

Australia
Sydney

China
Shanghai

India
Bangalore

Japan
Yokohama

Malaysia
Kuala Lumpur

Singapore
Singapore

South Korea
Pyeongtaek

Jenoptik

A Globally Operating Photonics Group

In 2016 our 3,600 employees generated more than 684 million Euros revenue.

Jenoptik is a leading photonics supplier of premium, innovative capital goods and active in the three segments of Optics & Life Science, Mobility and Defense & Civil Systems.

The structure of the Jenoptik group

Corporate Center

Segment	Optics & Life Science		Mobility		Defense & Civil Systems
					
Division	Optical Systems	Healthcare & Industry	Automotive	Traffic Solutions	Defense & Civil Systems

Shared Service Center

Our brand for your success

SHARING

Your satisfaction is our mission. By sharing our experience and profound know-how, our innovative ideas and creativity with you and all our partners globally, we realize your product+ – your outstanding solution.

EXCELLENCE

Your product+ is our mission. Our passionate employees and technological readiness are the foundation for our excellence, ensuring best quality solutions, speed and innovation, sustainable responsibility and direct customer care, serving your success.

It’s time for SHARING EXCELLENCE

Dear valued customer,

Jenoptik shares excellence by combining experience and knowledge, by putting the focus on working closely together, by thinking ahead to transcend boundaries and by being ready to pave out new paths for our customers, their partners and us.

With the other divisions and subsidiaries of the Jenoptik group, the division Optical Systems assures that our customers enjoy an excellent performance.

We invite you to find your way into our optics and immerse yourself in a selection of our featured products and core competencies. Together we will find the best solution for your challenge!

Jenoptik is looking forward to Sharing Excellence with you.

Enjoy the tour!

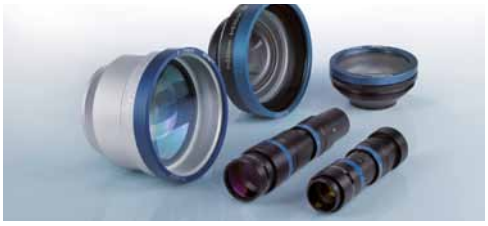
Dr. Ralf Kuschnereit
Executive Vice President Optical Systems

Stefan Trippe and his Team
Vice President Business Unit Optics

Find your way into our optics ...

Content

Featured Optic Products




Technologiezentrum
B 14

JENOPTIK | Optical Systems

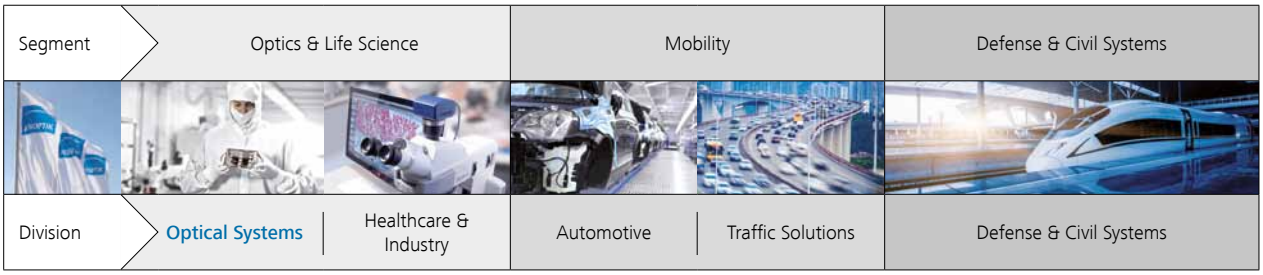
Optical Technologies for Specialized Applications

Your partner for optical and micro-optical systems, opto-electronical subsystems, modules as well as components – made of optical glass, infrared materials and polymers.

The Optical Systems division of Jenoptik is one of the few research, development and production partners worldwide for optical, micro-optical and opto-electronical systems and subsystems as well as precision components designed to meet your highest quality standards.

From the initial concept development to the optimized supply chain: We support you throughout the entire project and respond to your requirements with utmost flexibility, thereby, contributing to your economic success.

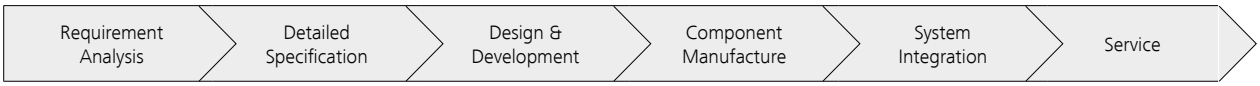
The structure of the Jenoptik group



Optical Systems

A holistic solution provider

From an Idea to your Solution



Supply Chain Management

Clear process steps for repeatable and sustainable performance in technology, quality and logistics.

Our Markets

- Semiconductor equipment industry
- Optical information & communication technologies
- Laser material processing
- Security & defense technology
- Healthcare & entertainment
- Digital world


JENOPTIK
F-Theta
JENar
f=170 λ=355nm 2y'=140
F-Theta
JENar™
f = 170 510nm
JENOPTIK

F-Theta JENar™ Silverline™

High Power Scan Lenses Made in Germany

Minimal absorption for high-power and short-pulse applications.

JENar™ Silverline™ scan lenses are designed to yield highest quality for applications using high power lasers. Low-absorbing fused silica elements and coatings ensure very high damage thresholds and minimal thermal influence resulting in best performance even under demanding conditions.

USP:

- Extremely durable: Due to special, low-contamination mounting technology, avoidance of adhesive and lubricants and 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

Contact:

Contact worldwide → please see page 10

Find your way into our optics ...

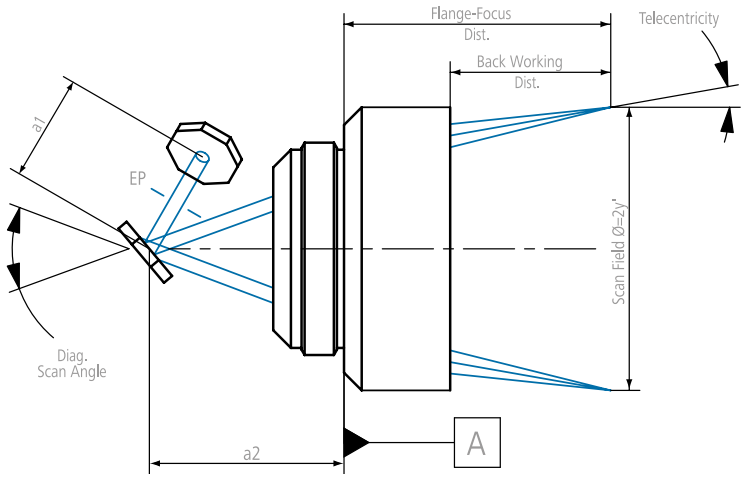
Technical Parameters & Properties
F-Theta JENar™ Silverline™ High Power Scan Lens Series.

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	161	36	20	25
900...1100	601787 NEW	160	110	40	14	19
	601804 NEW	255	161	36	20	21
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* NEW	170	140	50	10	11
266	017700-601-26	103	71	40	9	6

[1] fused silica

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.



	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	5.2 | 5.4	182	M85x1	602021
	25	48	7.2 | 7.4	302	M85x1	602021
	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	610826
	14	46	2.6 | 2.9	133	M85x1	610812

Contact Worldwide
for Laser Material Processing

Europe & Germany

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Phone +65 6774 0479-115

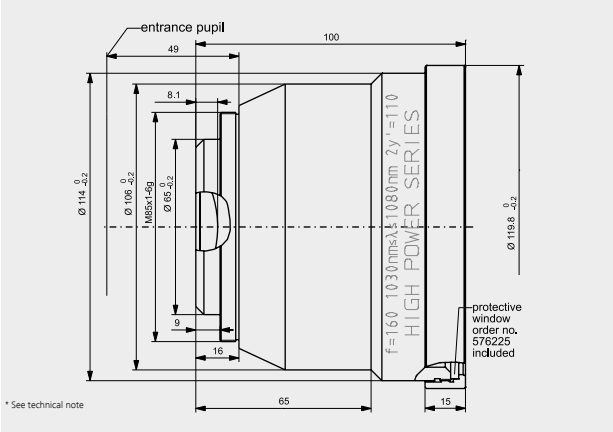
F-Theta JENar™ Silverline™ Lenses

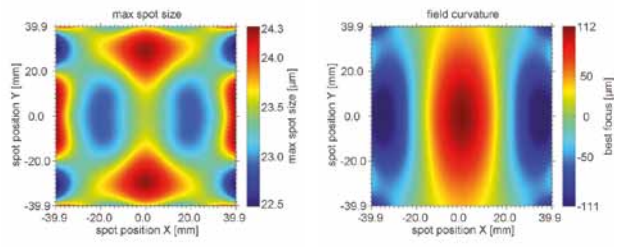
High Power Lenses

Parameters	JENar™ 160-1030...1080-110 Fused silica lens	JENar™ 255-1030...1080-160 Fused silica lens
Focal length:	160 mm	255 mm
Wavelength:	1030...1080 nm	1030...1080 nm
Scan field (X x Y); Ø:	(78 mm x 78 mm); 110 mm	(114 mm x 114 mm); 161 mm
Diagonal scan angle:	40°	36°
Back working distance:	183.6 mm	303.3 mm
Flange focus distance:	267.6 mm	387.8 mm
Entrance pupil Ø:	18 mm	25 mm
Input beam Ø 1/e²:	14 mm	20 mm
Focus size Ø 1/e²:	22 µm	25 µm
a1:	17 mm	25 mm
a2:	40.5 mm	48.46 mm
Telecentricity (only F-Theta | with scanner):	5.2° | 5.4°	7.2° | 7.4°
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)*:	759 fs²	904 fs²
LIDT 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:	1.08 kg	1.2 kg
Order Number::	017700-025-26	017700-026-26

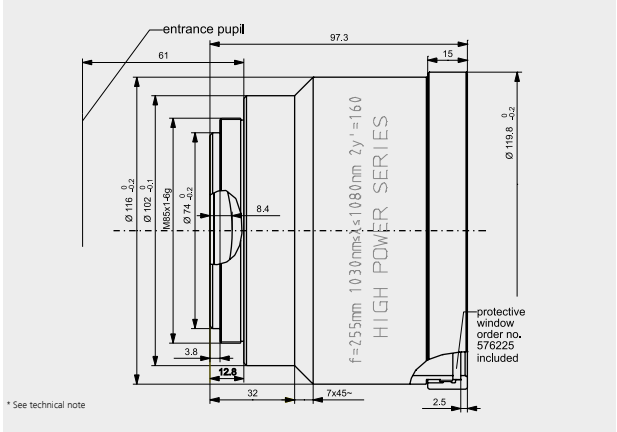
Specifications

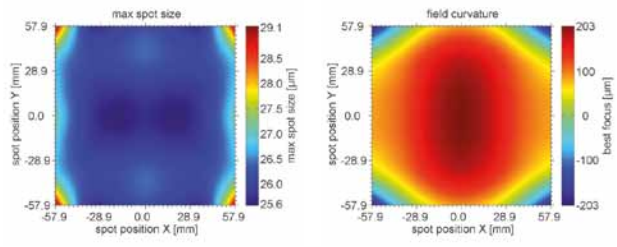
JENar™ 160-1030...1080-110





JENar™ 255-1030...1080-160





F-Theta JENar™ Silverline™ Lenses

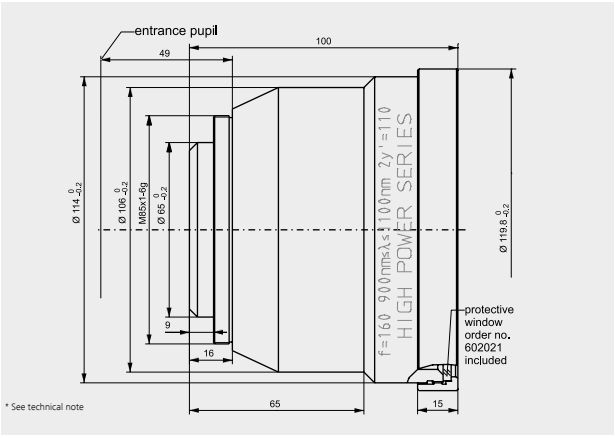
High Power Lenses

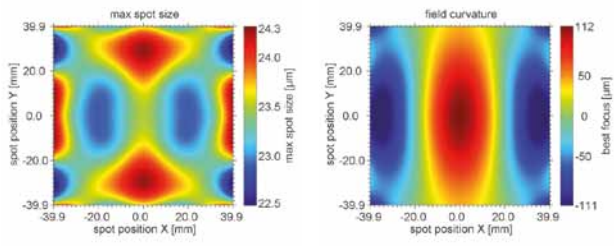
NEW

Parameters	JENar™ 160-900...1100-110 Fused silica lens	JENar™ 255-900...1100-160 Fused silica lens
Focal length:	160 mm	255 mm
Wavelength:	900…1100 nm	900…1100 nm
Scan field (X x Y); Ø:	(78 mm x 78 mm); 110 mm	(114 mm x 114 mm); 161 mm
Diagonal scan angle:	40°	36°
Back working distance:	182.0 mm @ 900 nm; 183.9 mm @ 1100 nm	301.5 mm @ 900 nm; 304.2 mm @ 1100 nm
Flange focus distance:	182.0 mm @ 900 nm; 183.9 mm @ 1100 nm	386.1 mm @ 900 nm; 388.8 mm @ 1100 nm
Entrance pupil Ø:	18 mm	25 mm
Input beam Ø 1/e²:	14 mm	20 mm
Focus size Ø 1/e²:	19 µm @ 900 nm; 23 µm @ 1100 nm	21 µm @ 900 nm; 26 µm @ 1100 nm
a1:	17 mm	25 mm
a2:	40.5 mm	48.46 mm
Telecentricity (only F-Theta | with scanner):	5.2° | 5.4°	7.2° | 7.4°
Group delay dispersion (GDD)*:	759 fs²	904 fs²
LIDT pulsed; CW*:	not available yet	not available yet
Weight:	1.08 kg	1.2 kg
Order Number::	601787	601804

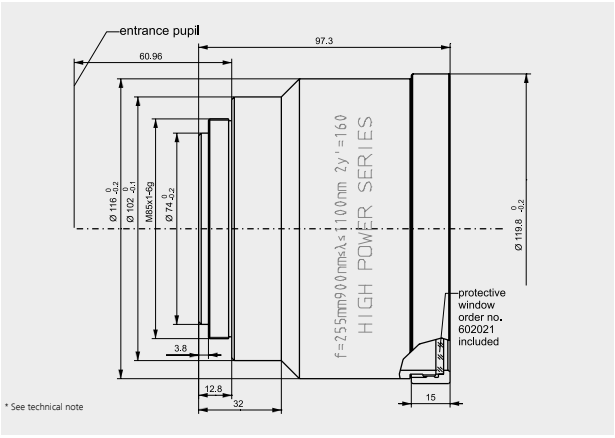
Specifications

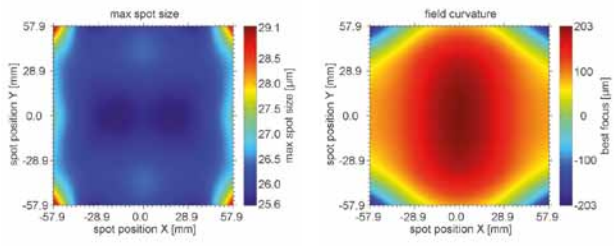
JENar™ 160-900...1100-110





JENar™ 255-900…1100-160





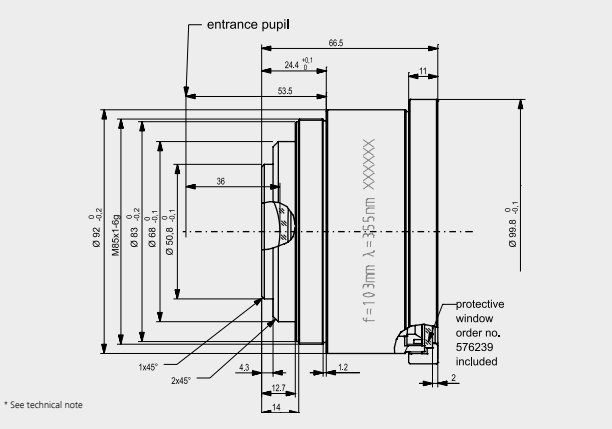
F-Theta JENar™ Silverline™ Lenses

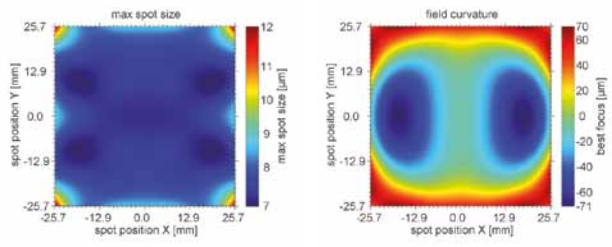
High Power Lenses

Parameters	JENar™ 03-70FT-100-355 Telecentric fused silica lens	JENar™ 255-355-240 Fused silica lens
Focal length:	103 mm	255 mm
Wavelength:	355 nm	355 nm
Scan field (X x Y); Ø:	(50 mm x 50 mm); 71 mm	(170 mm x 170 mm); 240 mm
Diagonal scan angle:	40.2°	54.2°
Back working distance:	134.85 mm	313.6 mm
Flange focus distance:	176.95 mm	373.3 mm
Entrance pupil Ø:	12.7 mm	15 mm
Input beam Ø 1/e²:	9 mm	10 mm
Focus size Ø 1/e²:	8 µm	17 µm
a1:	14 mm	13 mm
a2:	46.5 mm	42.5 mm
Telecentricity (only F-Theta | with scanner):	2.4° | 2.8°	12.7° | 12.7°
Group delay dispersion (GDD)*:	5670 fs²	6530 fs²
LIDT pulsed; CW*:	not available yet	1 J/cm² * (τ/[ns]) ^ 0.40; 1 MW/cm²
Weight:	0.7 kg	1.2 kg
Order Number::	017700-402-26	017700-406-26

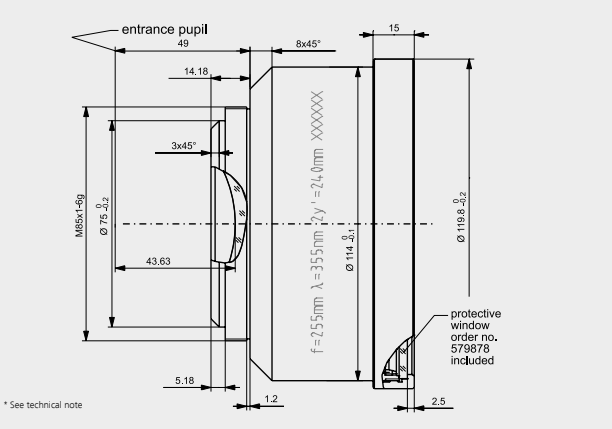
Specifications

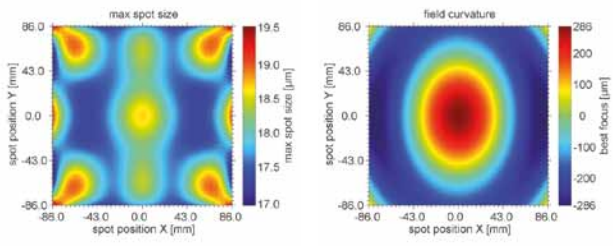
JENar™ 03-70FT-100-355





JENar™ 255-355-240





JENar™: Trademark registered in EU, CN, JP, SG | Silverline™: Trademark registered in DE, JP, SG, IN
F-Theta: Registered Design in EU, CN, KR, IN, SG, JP

F-Theta JENar™ Silverline™ Lenses

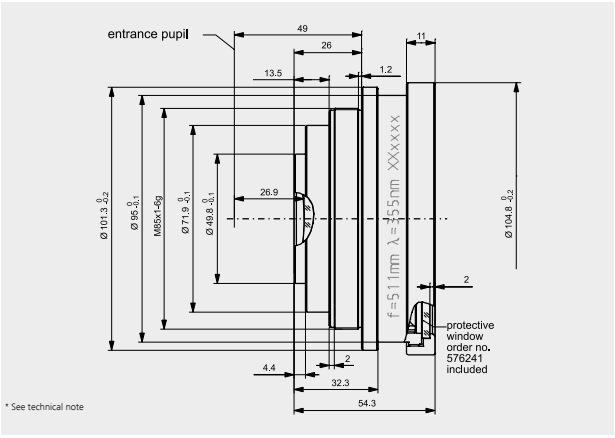
High Power Lenses

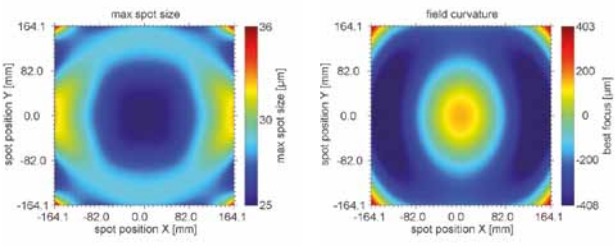
NEW**

Parameters	JENar™ 03-431FT-511-355 Fused silica lens for large scan fields	JENar™ 170-355-140** Telecentric fused silica lens for large scan fields
Focal length:	510 mm	170 mm
Wavelength:	355 nm	355 nm
Scan field (X x Y); Ø:	(328 mm x 328 mm); 431 mm	(100 mm x 100 mm); 140 mm
Diagonal scan angle:	51.4°	50°
Back working distance:	609 mm	235.8 mm
Flange focus distance:	637 mm	315.8 mm
Entrance pupil Ø:	20 mm	15 mm
Input beam Ø 1/e²:	14 mm	10 mm
Focus size Ø 1/e²:	24 µm	11 µm
a1:	14 mm	13 mm
a2:	42 mm	42.5 mm
Telecentricity (only F-Theta | with scanner):	18.2° | 18.2°	4.8° | 4.8°
Group delay dispersion (GDD)*:	5260 fs²	8490 fs²
LIDT pulsed; CW*:	1 J/cm² * (τ/[ns]) ^ 0.40; 1 MW/cm²	0.5 J/cm² * (τ/[ns]) ^ 0.40 ; 0.5 MW/cm²
Weight:	0.70 kg	1.85 kg
Order Number::	017700-405-26	586840

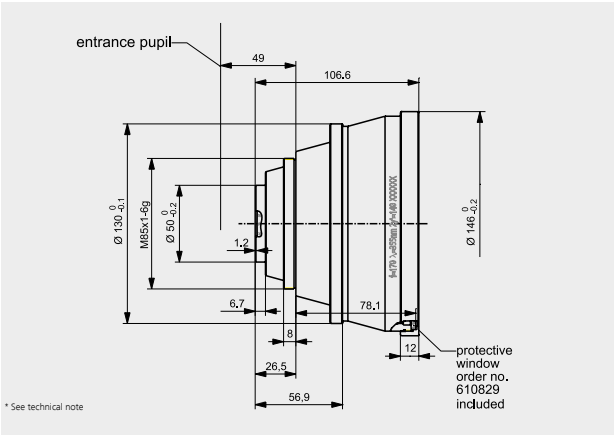
Specifications

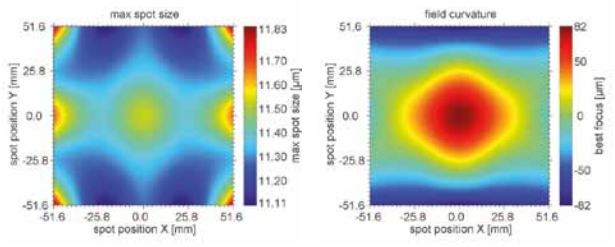
JENar™ 03-431FT-511-355





JENar™ 170-355-140





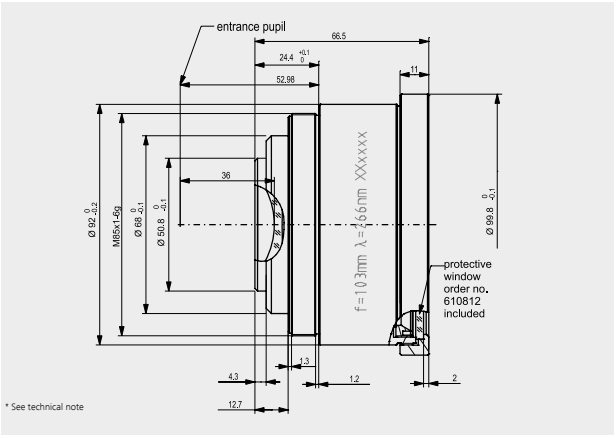
JENar™ 170-355-140: Registered Design in DE, 40 2016 000 911.4, CN, EU, JP, HK | Design appl. pending for KR, SG, IN, TW
Patent pending DE 10 2017 209 325 | Utility patent DE 20 2016 004 165.8 | Utility patent pending CN, KR

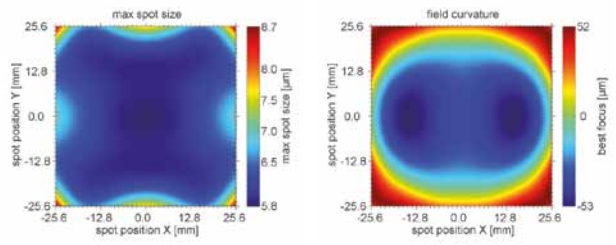
F-Theta JENar™ Silverline™ Lenses

High Power Lenses

Parameters	JENar™ 03-71FT-103-266 Telecentric fused silica lens
Focal length:	103 mm
Wavelength:	266 nm
Scan field (X x Y); Ø:	(50 mm x 50 mm); 71 mm
Diagonal scan angle:	40.2°
Back working distance:	133 mm
Flange focus distance:	175.1 mm
Entrance pupil Ø:	12.7 mm
Input beam Ø 1/e²:	9 mm
Focus size Ø 1/e²:	6 µm
a1:	14 mm
a2:	46 mm
Telecentricity (only F-Theta | with scanner):	2.6° | 2.9°
Group delay dispersion (GDD)*:	9350 fs²
LIDT pulsed; CW*:	not available yet
Weight:	0.7 kg
Order Number::	017700-601-26

Specifications
JENar™ 03-71FT-103-266






F-Theta
JENOPTIK GERMANY
F-theta
JENOPTIK GERMANY
F-Theta

F-Theta JENar™

Scan Lenses Made in Germany

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

Jenoptik's JENar™ F-Theta scan lenses are exceptionally well-suited for use in micro- and macromachining applications.

Comprehensive acceptance tests ensure highest quality and production stability.

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 micro structuring, 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. micro structuring of glass and metal
- Semiconductor industry:
  E.g. micromachining
- Automotive industry:
  E.g. cutting and structuring of composites and metal
- Medicine:
  E.g. removing gauze in therapeutic applications
- General applications:
  E.g. glass machining, battery welding

Contact:

Contact worldwide → please see page 10

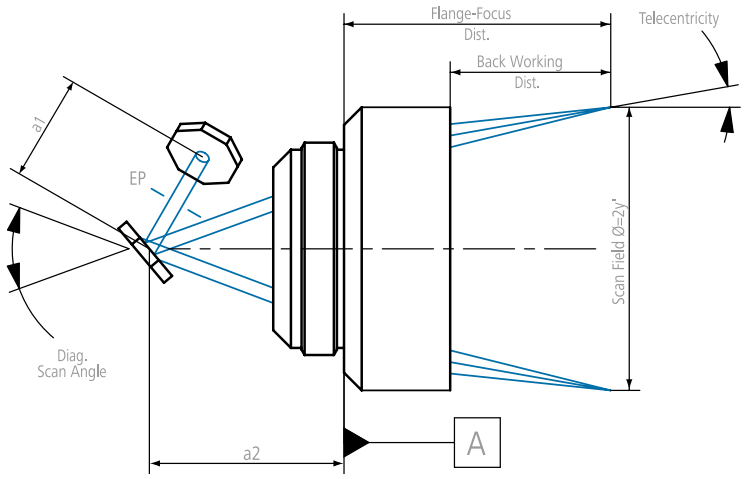
Find your way into our optics ...

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 NEW	125	80	37	15	16
	017700-019-26	160	170	60	10	31
	601914 NEW	160	170	60	10	31
	017700-018-26	170	170	57	14	24
	017700-017-26	255	239	53	20	24
	601948 NEW	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
532	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 stated data are approximate values and can deviate under different conditions during customer's use.
All data are subject to generally accepted manufacturing tolerances.



	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	38	4.9 | 5.1	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	132 132	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

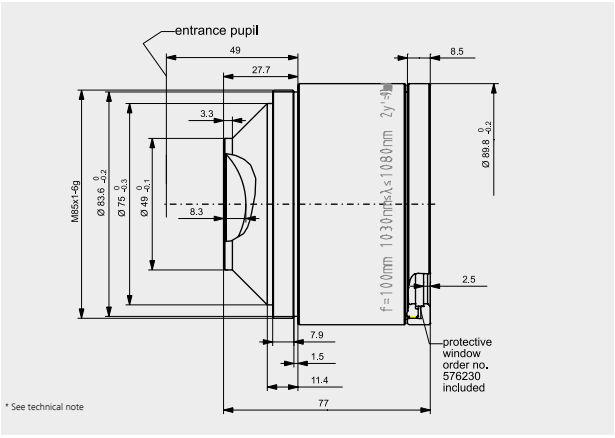
F-Theta JENar™ Lens Series

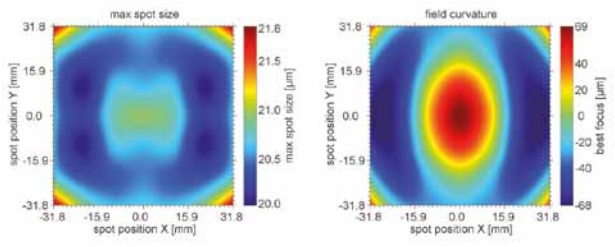
High Image Quality | Telecentric Lens

Parameters	JENar™ 100-1030...1080-93 F-Theta lens for high image quality	JENar™ 03-90FT-125-1030...1080 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:	54°	37.2°
Back working distance:	87 mm	154.6 mm
Flange focus distance:	136.3 mm	196.9 mm
Entrance pupil Ø:	15 mm	22 mm
Input beam Ø 1/e²:	10 mm	15 mm
Focus size Ø 1/e²:	19 µm	16 µm
a1:	13 mm	18.2 mm
a2:	42.5 mm	47.7 mm
Telecentricity (only F-Theta | with scanner):	8.7° | 9.1°	4.8° | 5.7°
Group delay dispersion (GDD)*:	1710 fs²	3670 fs²
LIDT 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

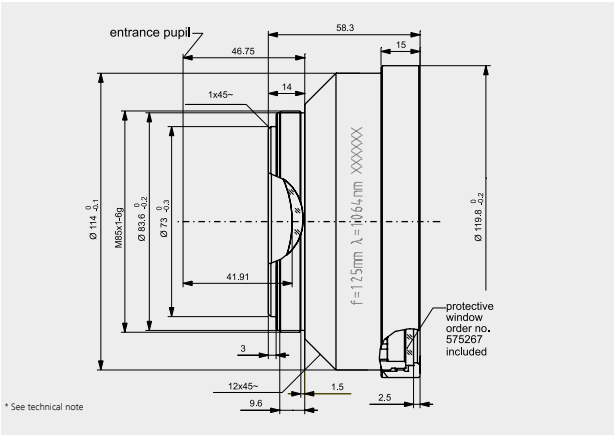
Specifications

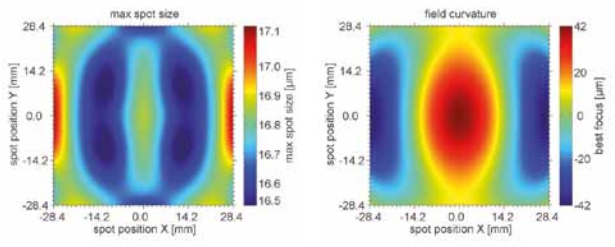
JENar™ 100-1030...1080-93





JENar™ 03-90FT-125-1030...1080





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

F-Theta JENar™ Lens Series

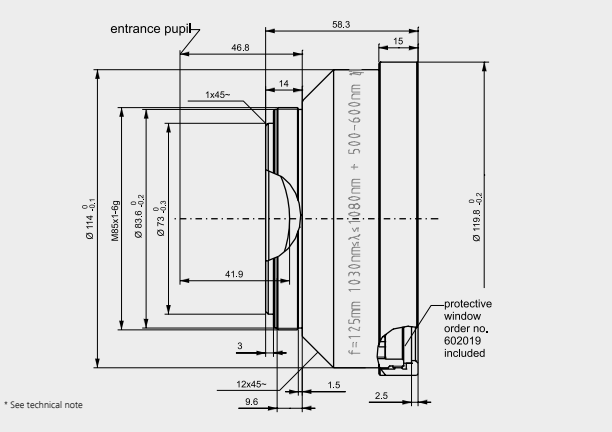
Telecentric Lens | Large Scan Fields

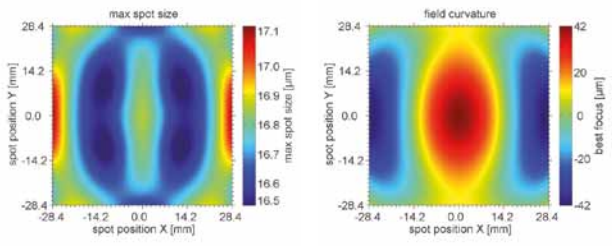
NEW**

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:	37.2°	60°
Back working distance:	154.6 mm	178.4 mm
Flange focus distance:	196.9 mm	194.1 mm
Entrance pupil Ø:	22 mm	15 mm
Input beam Ø 1/e²:	15 mm	10 mm
Focus size Ø 1/e²:	16 µm	31 µm
a1:	18.2 mm	13 mm
a2:	37.65 mm	42.5 mm
Telecentricity (only F-Theta | with scanner):	4.8° | 5.7°	17.1° | 17.2°
Group delay dispersion (GDD)*:	3670 fs²	934 fs²
LIDT pulsed; CW*:	not available yet	5.0 J/cm² * (τ/[ns]) ^ 0.30; 5.0 MW/cm²
Weight:	0.86 kg	0.383 kg
Order Number::	601926	017700-019-26

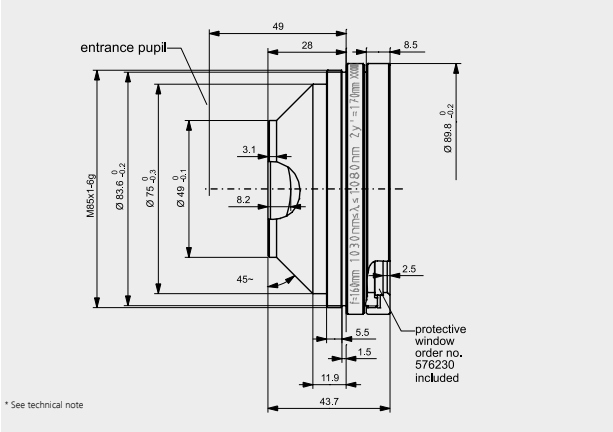
Specifications

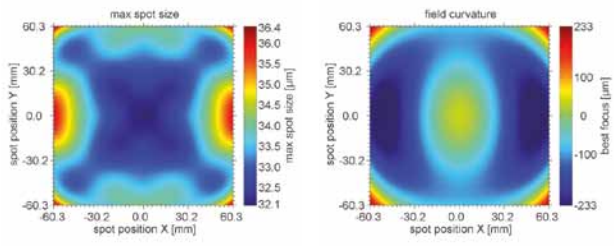
JENar™ 125-1030...1080-80 + VIS





JENar™ 160-1030...1080-170





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

F-Theta JENar™ Lens Series

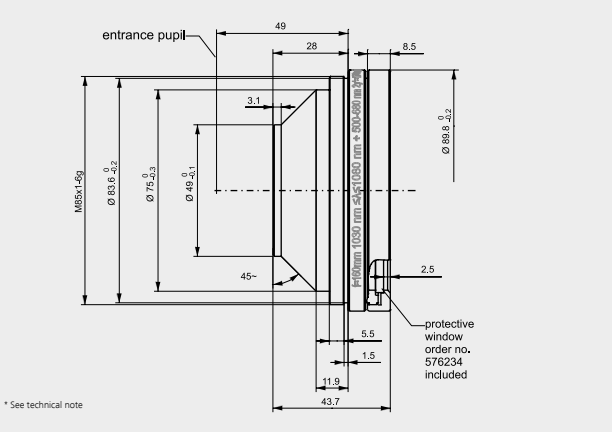
Large Scan Fields | High Image Quality

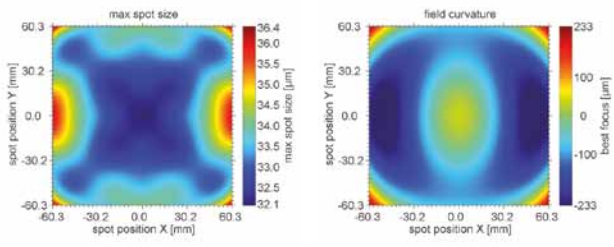
NEW**

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:	60°	57.4°
Back working distance:	178.4 mm	194 mm
Flange focus distance:	194.1 mm	243.2 mm
Entrance pupil Ø:	15 mm	21 mm
Input beam Ø 1/e²:	10 mm	14 mm
Focus size Ø 1/e²:	31 µm	24 µm
a1:	13 mm	17 mm
a2:	42.5 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 pulsed; CW*:	not available yet	5.0 J/cm² * (τ/[ns]) ^ 0.30; 5.0 MW/cm²
Weight:	0.383 kg	1.232 kg
Order Number::	601914	017700-018-26

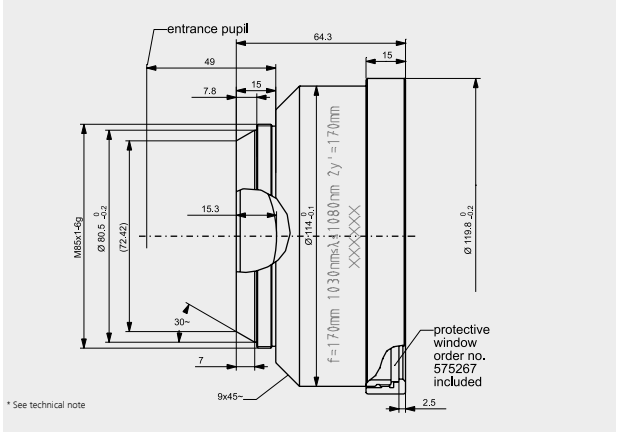
Specifications

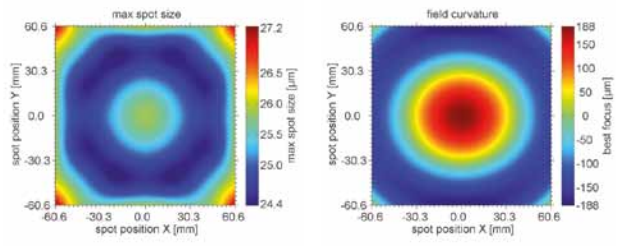
JENar™ 160-1030...1080-170 + VIS





JENar™ 170-1030...1080-170





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

F-Theta JENar™ Lens Series

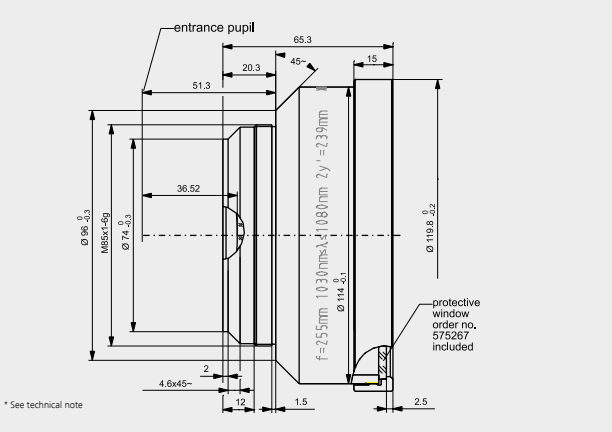
Larger Beam Diameters and Scan Fields

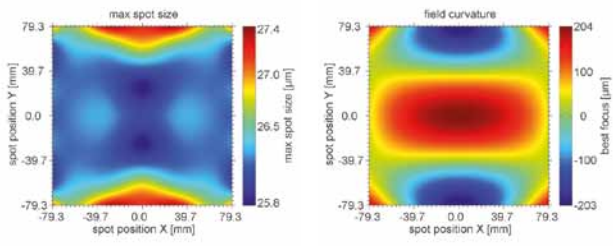
NEW**

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:	125 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:	53.2°	53.2°
Back working distance:	291 mm	291 mm
Flange focus distance:	336 mm	336 mm
Entrance pupil Ø:	30 mm	30 mm
Input beam Ø 1/e²:	20 mm	20 mm
Focus size Ø 1/e²:	24 µm	24 µm
a1:	25 mm	25 mm
a2:	39 mm	39 mm
Telecentricity (only F-Theta | with scanner):	14.3° | 15°	14.3° | 15°
Group delay dispersion (GDD)*:	3670 fs²	3670 fs²
LIDT 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

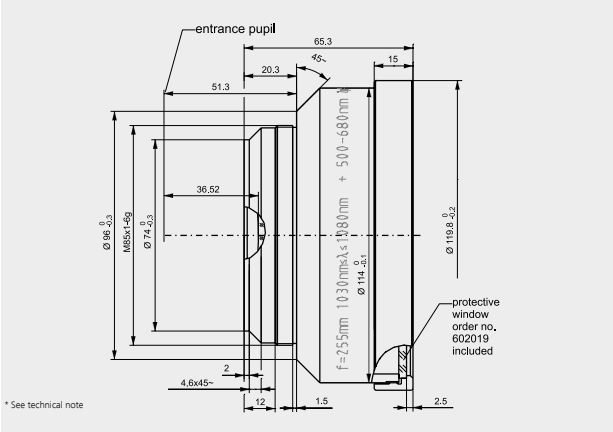
Specifications

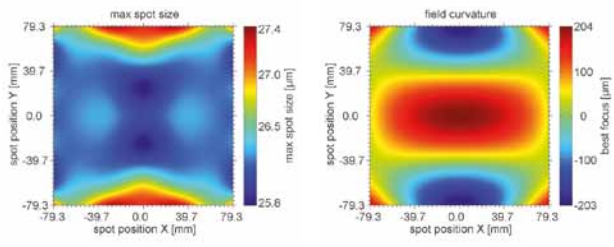
JENar™ 255-1030...1080-239





JENar™ 255-1030...1080-239 + VIS





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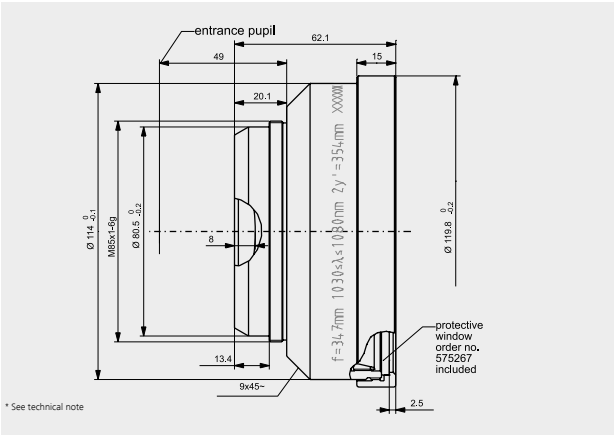
F-Theta: Registered Design in EU, CN, KR, IN, SG, JP

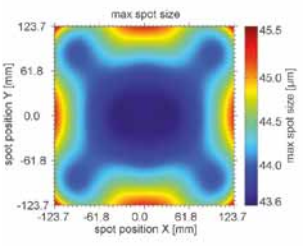
F-Theta JENar™ Lens Series
Large Scan Fields

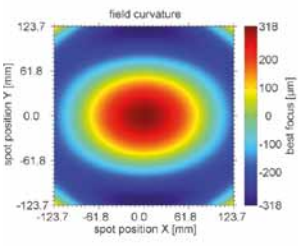
Parameters	JENar™ 347-1030...1080-354 F-Theta lens for large scan fields	JENar™ 03-424FT-350-1030...1080 F-Theta lens for large scan fields
Focal length:	347 mm	350 mm
Wavelength:	1030...1080 nm	1030...1080 nm
Scan field (X x Y); Ø:	(250 mm x 250 mm); 354 mm	(320 mm x 320 mm); 452 mm
Diagonal scan angle:	57.6°	71°
Back working distance:	403.8 mm	395.4 mm
Flange focus distance:	445.8 mm	434.5 mm
Entrance pupil Ø:	23 mm	21 mm
Input beam Ø 1/e²:	16 mm	15 mm
Focus size Ø 1/e²:	46 µm	46 µm
a1:	17 mm	23.2 mm
a2:	40.5 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 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

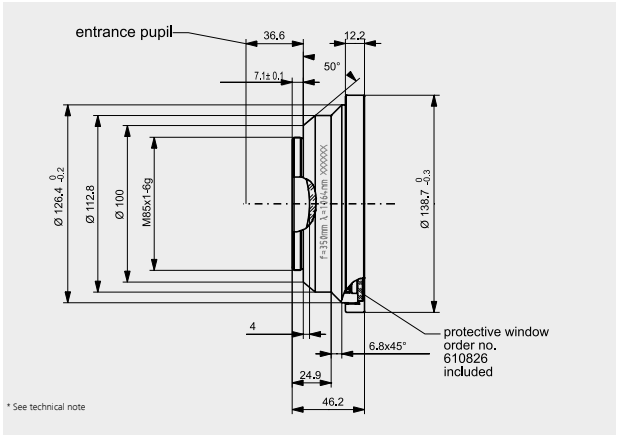
JENar™ 347-1030...1080-354

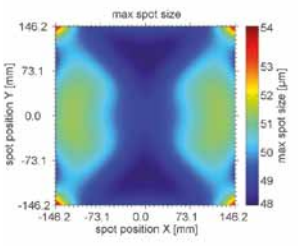


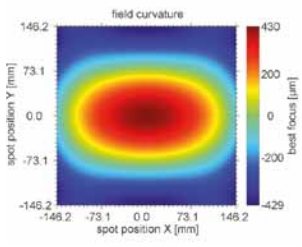




JENar™ 03-424FT-350-1030...1080







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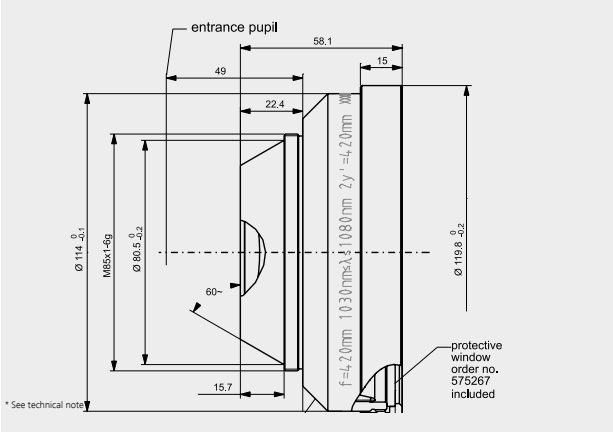
F-Theta JENar™ Lens Series

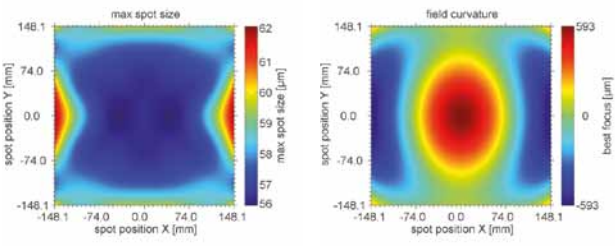
Large Scan Fields | High Image Quality

Parameters	JENar™ 420-1030...1080-420 F-Theta lens for large scan fields	JENar™ 100-532-90 F-Theta lens for high image quality
Focal length:	420 mm	100 mm
Wavelength:	1030...1080 nm	532 nm
Scan field (X x Y); Ø:	(297 mm x 297 mm); 420 mm	(64 mm x 64 mm); 90 mm
Diagonal scan angle:	57.1°	53°
Back working distance:	500.6 mm	95 mm
Flange focus distance:	536.3 mm	140 mm
Entrance pupil Ø:	21 mm	15 mm
Input beam Ø 1/e²:	15 mm	10 mm
Focus size Ø 1/e²:	55 µm	10 µm
a1:	17 mm	13 mm
a2:	40.5 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 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
Weight:	0.841 kg	0.7 kg
Order Number::	017700-021-26	017700-209-26

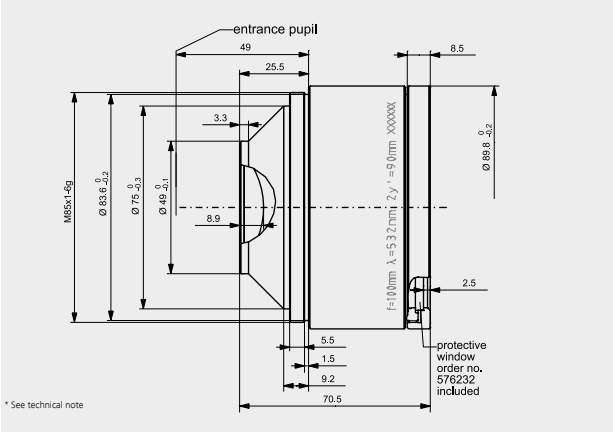
Specifications

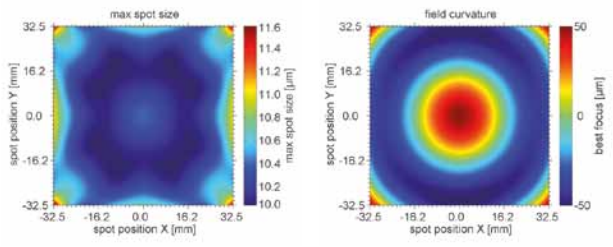
JENar™ 420-1030...1080-420





JENar™ 100-532-90





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

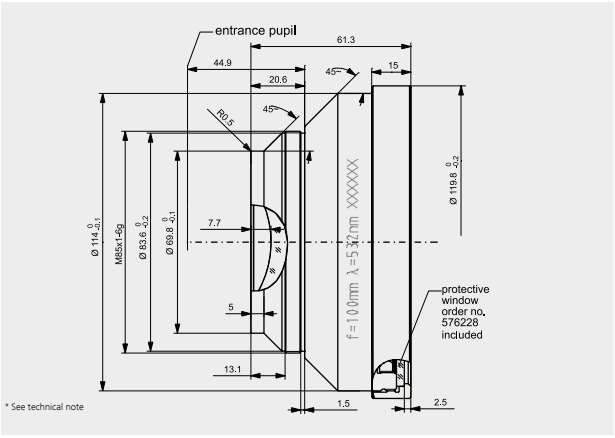
F-Theta JENar™ Lens Series

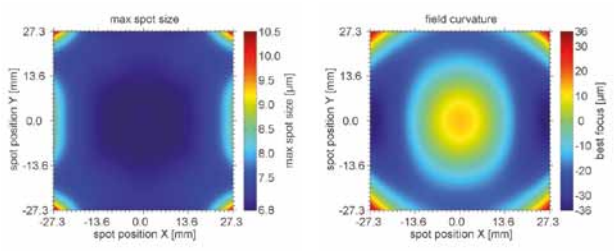
Telecentric Lenses

Parameters	JENar™ 03-75FT-100-532 Telecentric lens	JENar™ 03-75FT-108-532 Telecentric lens
Focal length:	102 mm	108 mm
Wavelength:	532 nm	532 nm
Scan field (X x Y); Ø:	(53 mm x 53 mm); 75 mm	(53 mm x 53 mm); 75 mm
Diagonal scan angle:	43°	40°
Back working distance:	132.9 mm	132.2 mm
Flange focus distance:	173.6 mm	170.9 mm
Entrance pupil Ø:	20 mm	22 mm
Input beam Ø 1/e²:	15 mm	15 mm
Focus size Ø 1/e²:	7 µm	7 µm
a1:	18 mm	16 mm
a2:	36 mm	39.2 mm
Telecentricity (only F-Theta | with scanner):	4.1° | 4.9°	4.8° | 5.6°
Group delay dispersion (GDD)*:	15700 fs²	14700 fs²
LIDT 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
Weight:	0.7 kg	0.9 kg
Order Number::	017700-202-26	017700-203-26

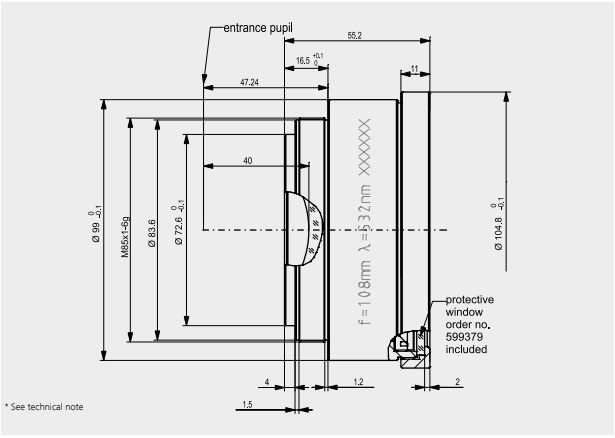
Specifications

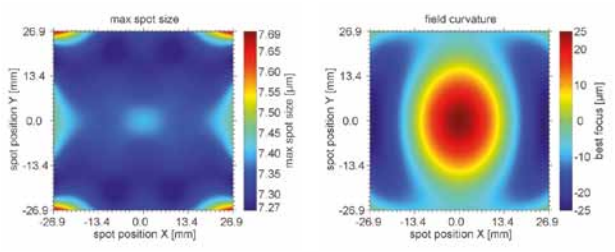
JENar™ 03-75FT-100-532





JENar™ 03-75FT-108-532





JENar™: Trademark registered in EU, CN, JP, SG
F-Theta: Registered Design in EU, CN, KR, IN, SG, JP

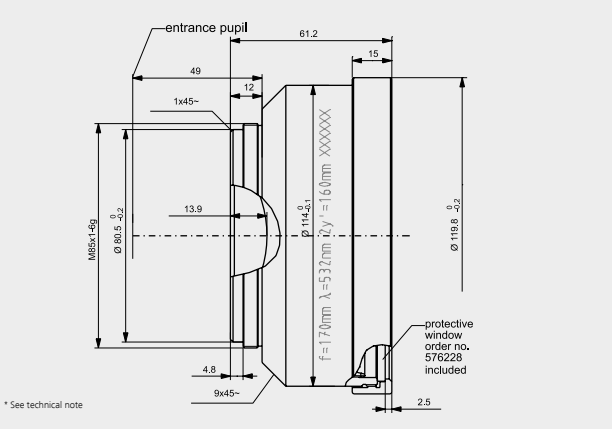
F-Theta JENar™ Lens Series

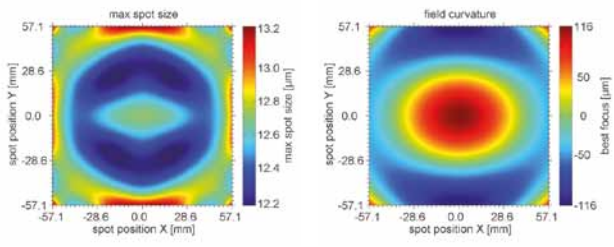
High Image Quality | Larger Beam Diameters and Scan Fields

Parameters	JENar™ 170-532-160 F-Theta lens for high image quality	JENar™ 255-532-233 Lens for larger beam diameters and scan fields
Focal length:	170 mm	255 mm
Wavelength:	532 nm	532 nm
Scan field (X x Y); Ø:	(113 mm x 113 mm); 160 mm	(165 mm x 165 mm); 233 mm
Diagonal scan angle:	54°	52.1°
Back working distance:	195 mm	294 mm
Flange focus distance:	244 mm	347 mm
Entrance pupil Ø:	21 mm	30 mm
Input beam Ø 1/e²:	14 mm	20 mm
Focus size Ø 1/e²:	12 µm	12 µm
a1:	17 mm	25 mm
a2:	40.5 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 pulsed; CW*:	2.5 J/cm² * (τ/[ns]) ^ 0.35; 2.5 MW/cm²	1.3 J/cm² * (τ/[ns]) ^ 0.35 ; 1.3 MW/cm²
Weight:	1.213 kg	1.5 kg
Order Number::	017700-206-26	017700-205-26

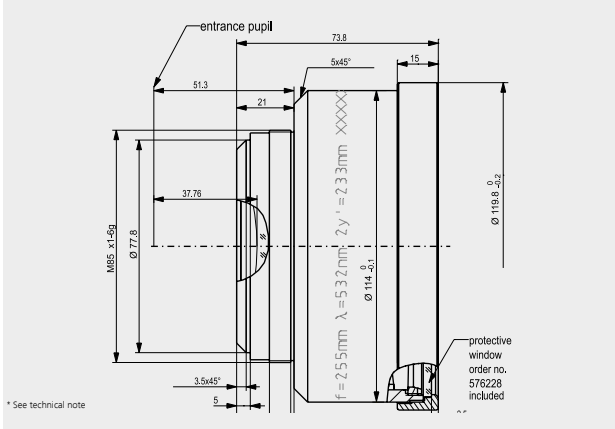
Specifications

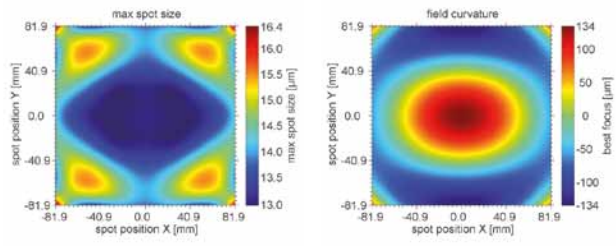
JENar™ 170-532-160





JENar™ 255-532-233



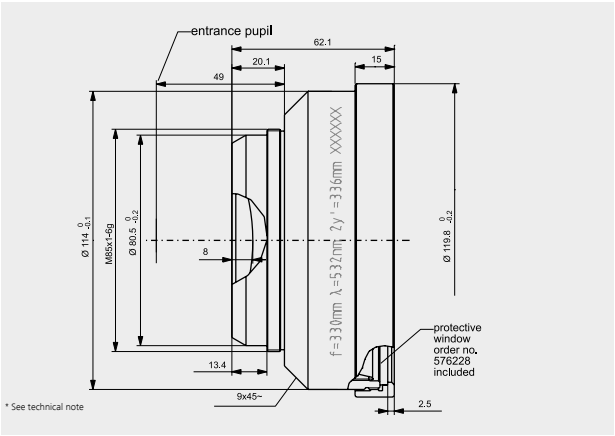


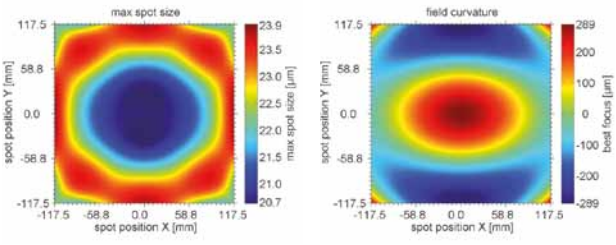
JENar™: Trademark registered in EU, CN, JP, SG
F-Theta: Registered Design in EU, CN, KR, IN, SG, JP

F-Theta JENar™ Lens Series
Large Scan Fields

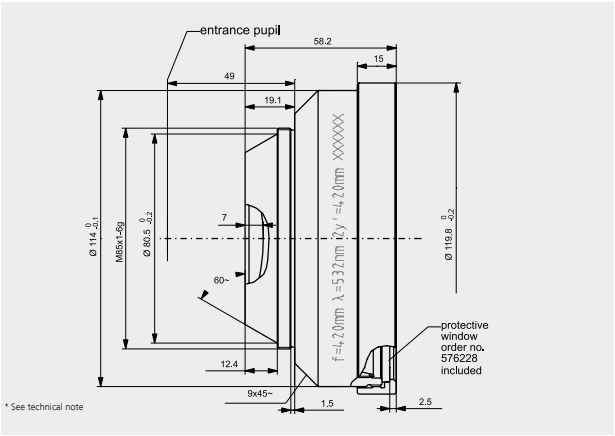
Parameters	JENar™ 330-532-336 F-Theta lens for large scan fields	JENar™ 420-532-420 F-Theta lens for large scan fields
Focal length:	330 mm	420 mm
Wavelength:	532 nm	532 nm
Scan field (X x Y); Ø:	(245 mm x 245 mm); 347 mm	(297 mm x 297 mm); 420 mm
Diagonal scan angle:	57.6°	57.1°
Back working distance:	384.1 mm	485.2 mm
Flange focus distance:	426.1 mm	524.3 mm
Entrance pupil Ø:	23 mm	21 mm
Input beam Ø 1/e²:	16 mm	15 mm
Focus size Ø 1/e²:	23 µm	27 µm
a1:	17 mm	17 mm
a2:	40.5 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 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
Weight:	1.3 kg	0.978 kg
Order Number::	017700-208-26	017700-207-26

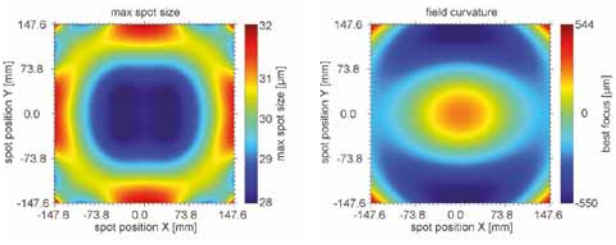
Specifications
JENar™ 330-532-336





JENar™ 420-532-420



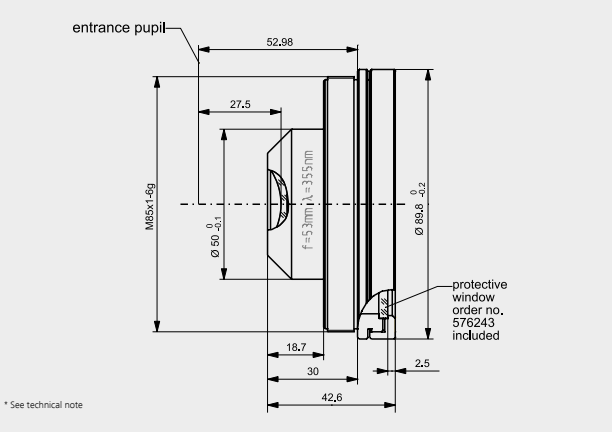


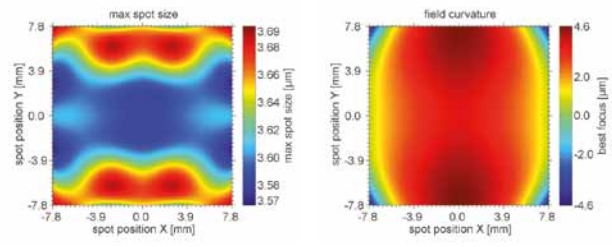
JENar™: Trademark registered in EU, CN, JP, SG
F-Theta: Registered Design in EU, CN, KR, IN, SG, JP

F-Theta JENar™ Lens Series
Short Focal Length

Parameters	JENar™ 53-355-22 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:	24.2°
Back working distance:	64.9 mm
Flange focus distance:	77.48 mm
Entrance pupil Ø:	13 mm
Input beam Ø 1/e²:	10 mm
Focus size Ø 1/e²:	3.5 µm
a1:	13 mm
a2:	46.48 mm
Telecentricity (only F-Theta | with scanner):	0.4° | 1.5°
Group delay dispersion (GDD)*:	10800 fs²
LIDT pulsed; CW*:	1 J/cm² * (τ/[ns]) ^ 0.40; 1 MW/cm²
Weight:	0.7 kg
Order Number::	017700-401-26

Specifications
JENar™ 53-355-22





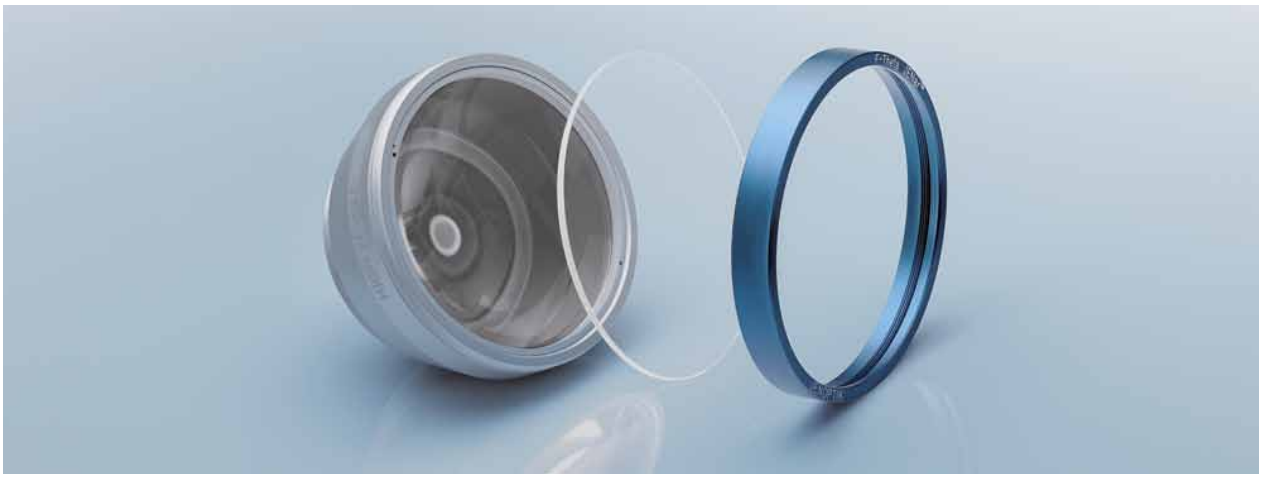
JENar™: Trademark registered in EU, CN, JP, SG
F-Theta: Registered Design in EU, CN, KR, IN, SG, JP

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

Type: Protective Windows

		Drawing Number	017700-004-31	017700-004-32	017700-049-31	017700-049-32	017700-049-33	017700-410-31
		Order Number Window	575267	576228	576230	576232	576234	576239
	Wavelength [nm]	F-Theta Lens						
Silverline™ High Power Lenses	1030...1080	017700-025-26						
		017700-026-26						
	900...1100	601787 NEW						
		601804 NEW						
	355	017700-402-26						X
		017700-406-26						
		017700-405-26						
		586840 NEW						
	266	017700-601-26						
JENar™ F-Theta Lenses	1030...1080	017700-024-26			X			
		017700-003-26	X					
		601926 NEW						
		017700-019-26			X			
		601914 NEW					X	
		017700-018-26	X					
		017700-017-26	X					
		601948 NEW						
		017700-022-26	X					
		017700-009-26						
		017700-021-26	X					
	532	017700-209-26				X		
		017700-202-26		X				
		017700-203-26						
		017700-206-26		X				
		017700-205-26		X				
		017700-208-26		X				
		017700-207-26		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.



017700-410-32	017700-415-31	017700-415-32	017700-415-34	017700-442-31	017700-475-31	601936	586855	017700-024-31	017700-221-31
610812	579878	576225	602021	576241	576243	602019	610829	610826	599379
		X							
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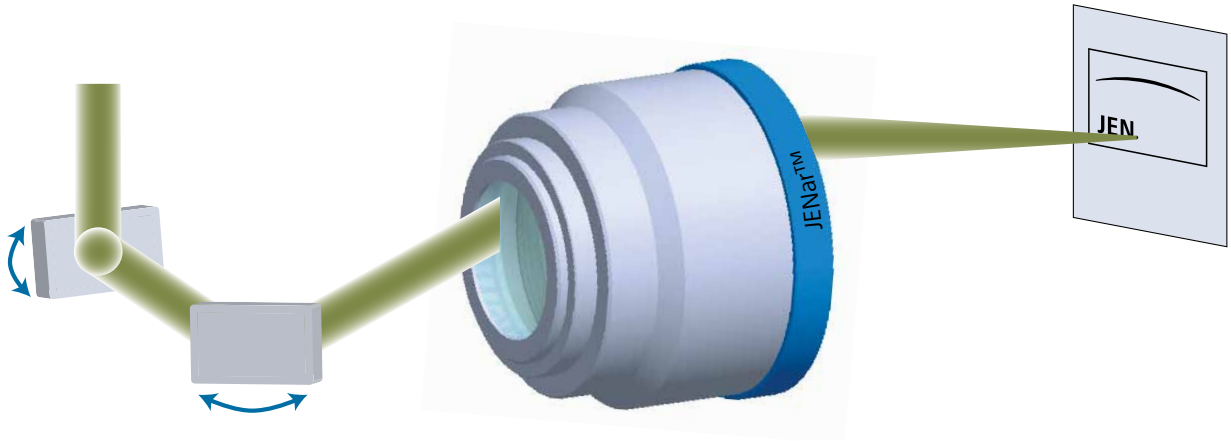
Basic Principles



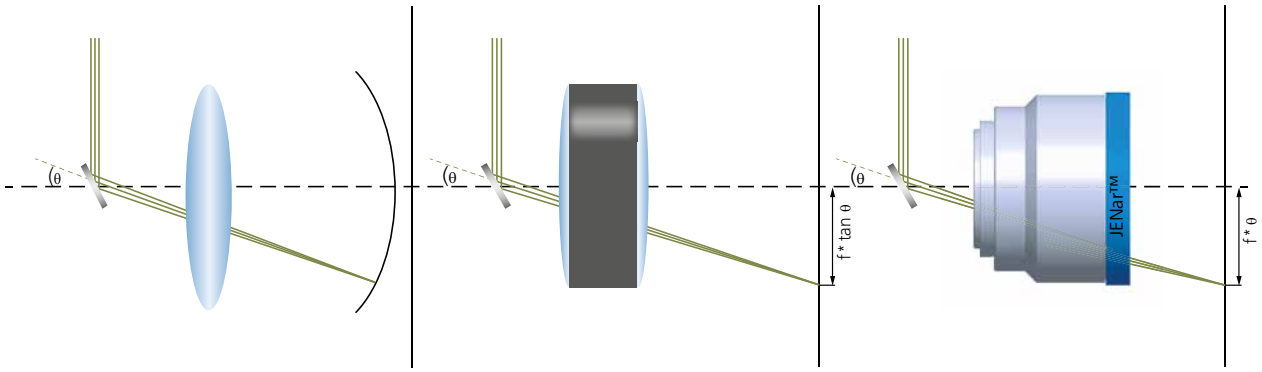
F-Theta objective lenses

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).

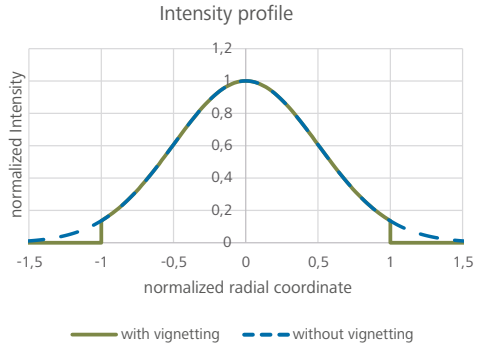
Scan angle

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 focussing 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 to 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

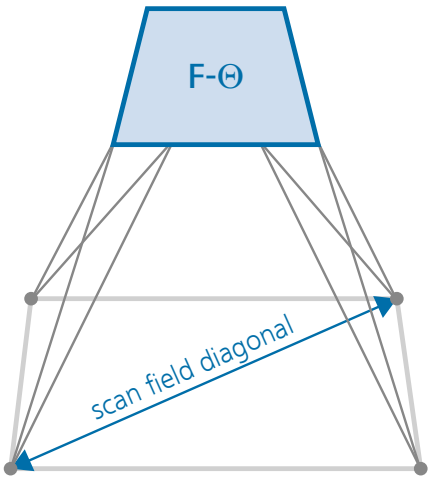
Whereas the focal length is a rather theoretical construct, the back working distance describes the real distance between the end of the objective (the edge closest to the workpiece) and the workpiece.

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.

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

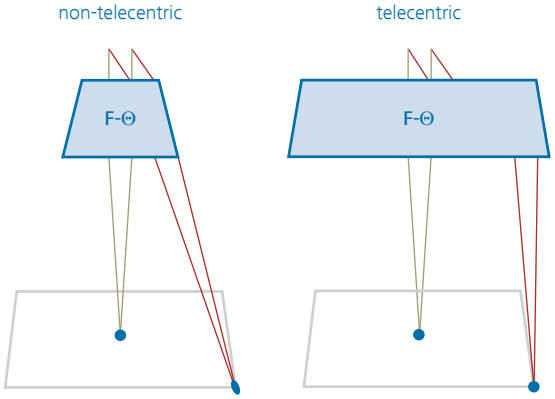
The parameters c and p of this law are wavelength dependent.

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

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

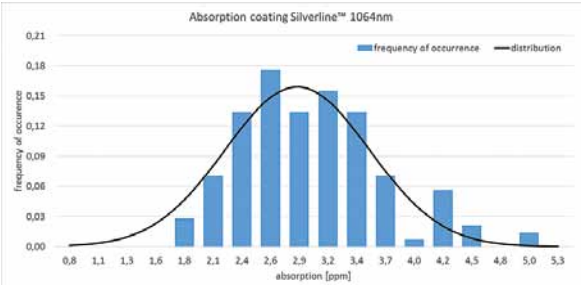
$$\Delta z_G = \ln(4) \Delta z_T$$

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/affordable 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. I.e. 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

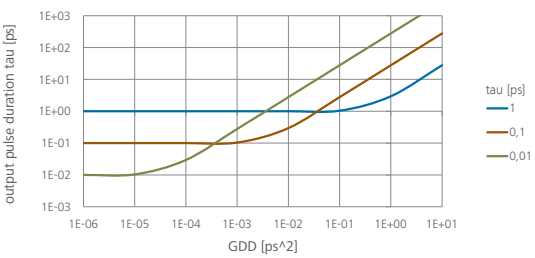
When light passes through an optical material of non-vanishing dispersion it accumulates a wavelength dependent optical phase. For laser pulses, which are effectively a linear superposition of harmonic oscillations of different wavelengths, this influences the pulse shape. In a second order approximation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




BEX 1x - 8x
355 nm
SN KA0004
JENOPTIK
Focussing / mm
Magnitude
BEX 1x - 4X
PA0002
JENOPTIK
JENOPTIK

Beam Expander

Variable Beam Expanders Made in Germany

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 diameter of the laser beam at the output of the laser is adapted to the required diameter at the input of the objective lens.

Furthermore, the indepently adjustable divergence of the beam allows the optimization of the working plane position. Beam expanders are primarily used in laser material processing.
All beam expanders can be integrated with F-theta objective 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

Fields of Application:

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

Contact:

Contact worldwide → please see page 10

Find your way into our optics ...

Highlight in 2018

- High power Beam Expander
- Fused silica
- High beam pointing stability (< 1 mrad)
- Large input diameter (9 mm)
- Diffraction-limited performance over the whole range of magnifications
- Adjustable magnification and divergence
- Perfect for Silverline™ F-Theta lens series

Registered Design in DE, 40 2016 001 282.4
Registered in CN, EU, HK, IN

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 (< 1 mrad)
- Lockable elements

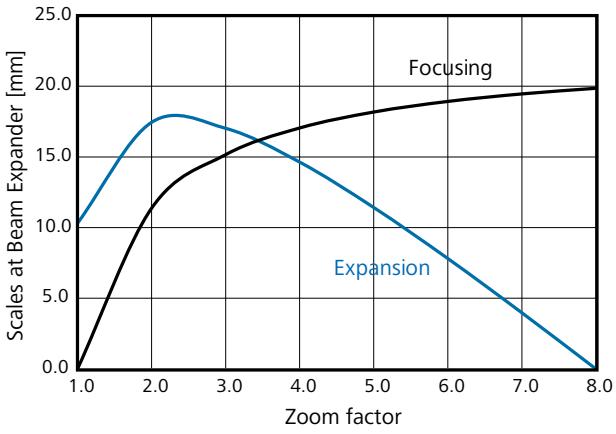
	1030-1080 nm	355 nm
GDD*:	339 fs²	2810 fs²
LIDT pulsed;	0.35 J/cm² * (τ/[ns]) ^ 0.30;	0.10 J/cm² * (τ/[ns]) ^ 0.40;
CW:	0.35 MW/cm²	0.10 MW/cm²

Specification

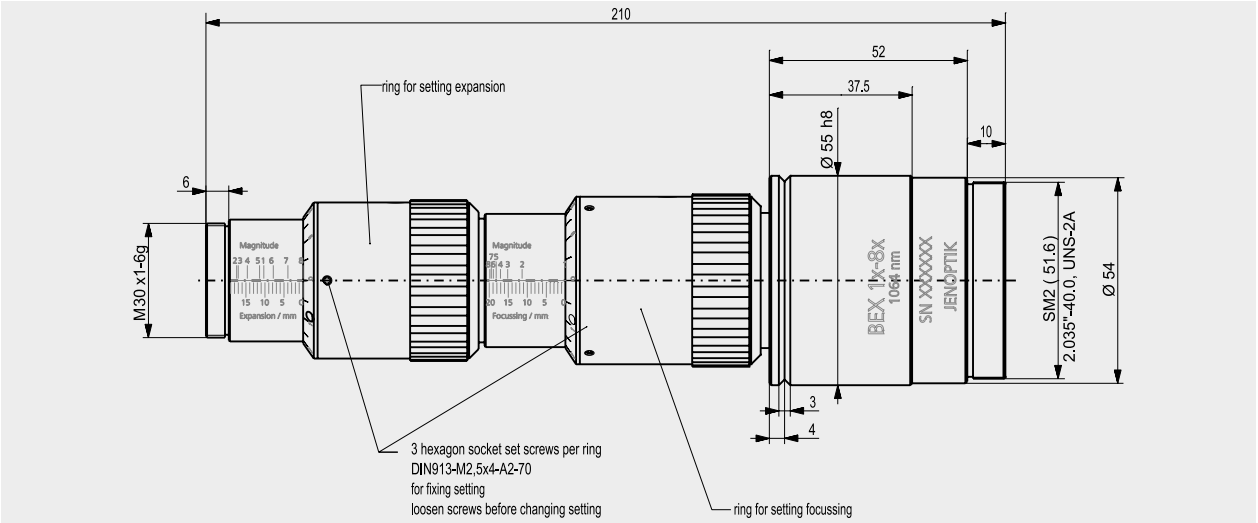
Magnification	Max. entrance diameter	Expansion scale	Focussing scale
1x	9.0 mm	10.3 mm	0.0 mm
2x	9.0 mm	17.4 mm	11.4 mm
3x	9.0 mm	17.0 mm	15.2 mm
4x	7.5 mm	14.6 mm	17.0 mm
5x	6.0 mm	11.4 mm	18.2 mm
6x	5.0 mm	7.8 mm	18.9 mm
7x	4.5 mm	4.0 mm	19.5 mm
8x	4.0 mm	0.0 mm	19.9 mm

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

* Group delay dispersion
** Recommended maximum diameter of entrance pupil



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
Pending in JP, KR, TW | Grant Patent DE, 10 2015 009 124 | Patent pending WO-Appl.

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

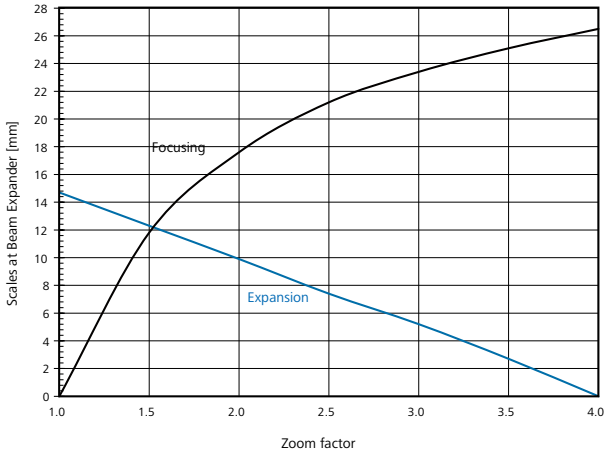
	1030-1080 nm	515-540 nm	355 nm
GDD*:	134 fs²	547 fs²	972 fs²
LIDT pulsed;	1.00 J/cm² * (τ/[ns]) ^ 0.30;	0.50 J/cm² * (τ/[ns]) ^ 0.35;	0.20 J/cm² * (τ/[ns]) ^ 0.40;
CW:	1.00 MW/cm²	0.50 MW/cm²	0.20 MW/cm²

Specification

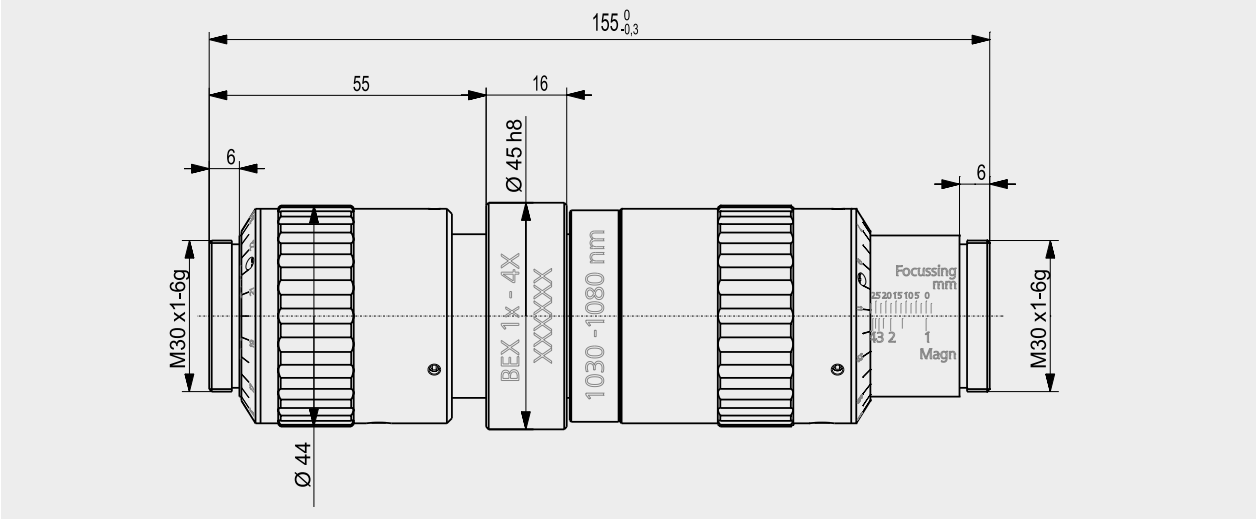
Materials	
Entrance elements:	Fused silica
Exit elements:	Fused silica
Transmission:	≥ 97 %
Beam pointing stability:	≤ 1 mrad
Mounting Ø:	45.0 (+0.0/-0.1) mm or M30x1 mounting threads at both entrance and exit
Weight:	0.37 kg

Zoom factor	Ø entrance pupil**		
	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

* Group delay dispersion
** Recommended maximum diameter of entrance pupil



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 pending DE 10 2015 009 124.7 and PCT/EP2016/064345

Beam Expander 1x-4x

Fused Silica Systems

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

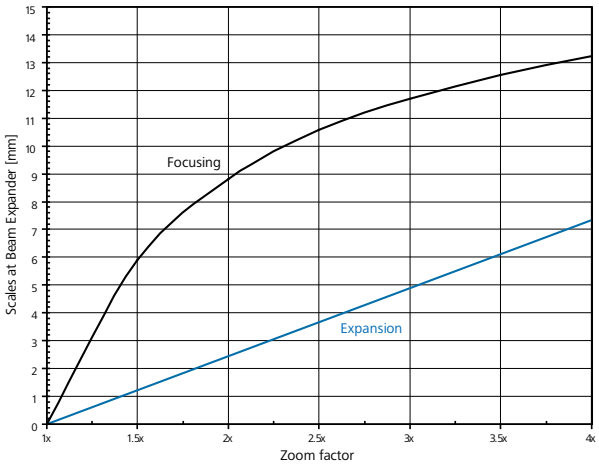
	1030-1080 nm	515-540 nm	355 nm
GDD*:	134 fs²	547 fs²	972 fs²
LIDT pulsed;	1.00 J/cm² * (τ/[ns]) ^ 0.30 ;	0.50 J/cm² * (τ/[ns]) ^ 0.35;	0.20 J/cm² * (τ/[ns]) ^ 0.40;
CW:	1.00 MW/cm²	0.50 MW/cm²	0.20 MW/cm²

Specification

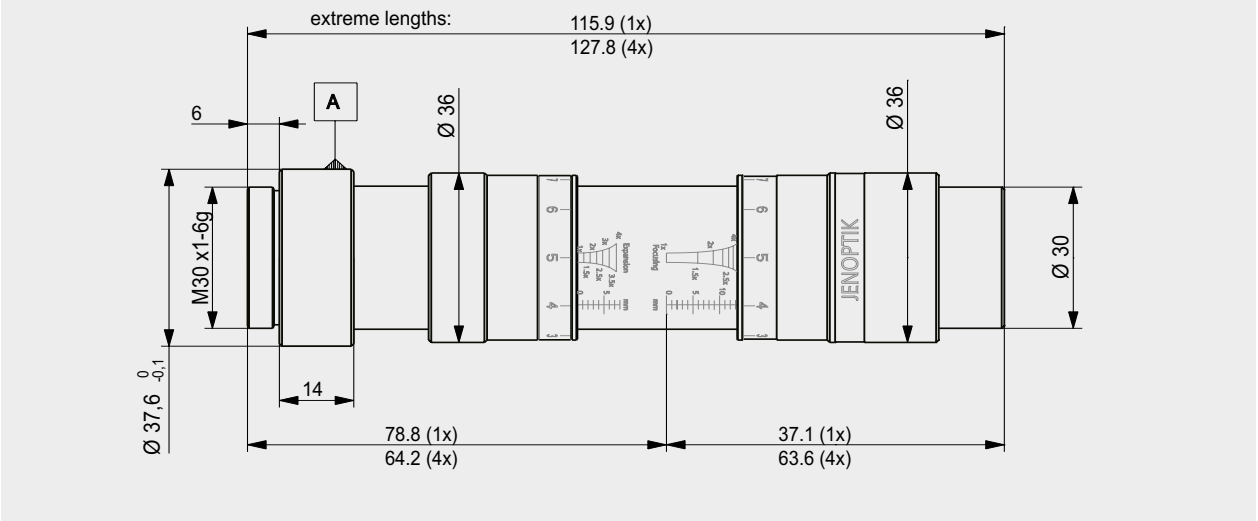
Materials	
Entrance elements:	Fused silica
Exit elements:	Fused silica
Transmission:	≥ 97 %
Mounting Ø:	37.6 (0/-0.1) mm or mounting thread M30x1
Weight:	0.19 kg

Zoom factor	Ø entrance pupil**		
	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

* Group delay dispersion
** Recommended maximum diameter of entrance pupil



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

Beam Expander 2x-10x
Large Magnification Range

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

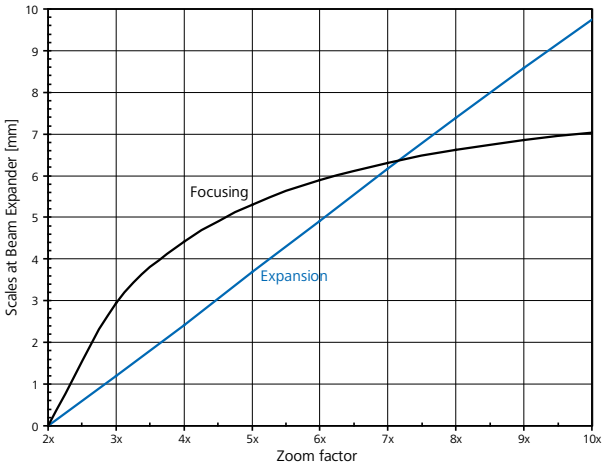
	1030-1080 nm	515-540 nm	355 nm
GDD*:	288 fs²	1070 fs²	1640 fs²
LIDT pulsed;	0.50 J/cm² * (τ/[ns]) ^ 0.30;	0.25 J/cm² * (τ/[ns]) ^ 0.35;	0.10 J/cm² * (τ/[ns]) ^ 0.40;
CW:	0.50 MW/cm²	0.25 MW/cm²	0.10 MW/cm²

Specification

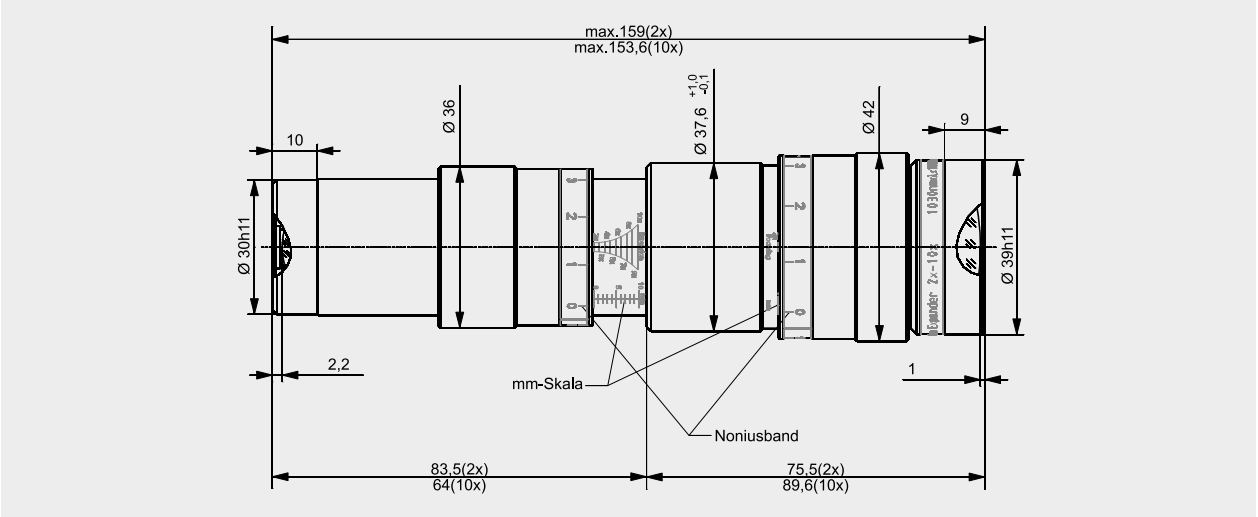
Materials	
Entrance elements:	Fused silica
Exit elements:	Highly laser resistant materials (532 nm and 1030...1080 nm) or fused silica (355 nm)
Transmission:	≥ 96 %
Mounting Ø:	37.6 (0/-0.1) mm
Weight:	0.23 kg

Zoom factor	Ø entrance pupil**		
	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

* Group delay dispersion
** Recommended maximum diameter of entrance pupil



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

Beam Expander 1x-8x Motorized

Automated Configuration Setting with Smart Beam Expander

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

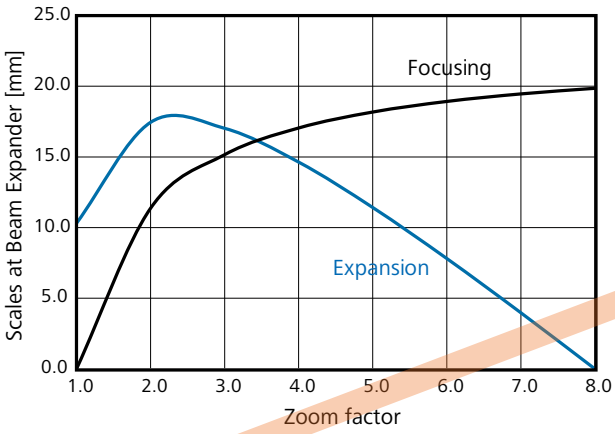
	1030-1080 nm	355 nm
GDD*:	339 fs²	2810 fs²
LIDT pulsed;	0.35 J/cm² * (τ/[ns]) ^ 0.30;	0.10 J/cm² * (τ/[ns]) ^ 0.40;
CW:	0.35 MW/cm²	0.10 MW/cm²

Zoom factor	Ø entrance pupil**	
	1030-1080 nm	355 nm
1x	9.0 mm	9.0 mm
2x	9.0 mm	9.0 mm
3x	9.0 mm	9.0 mm
4x	7.5 mm	7.5 mm
5x	6.0 mm	6.0 mm
6x	5.0 mm	5.0 mm
7x	4.5 mm	4.5 mm
8x	4.0 mm	4.0 mm
Order Number:	611842	613266

* Group delay dispersion
** Recommended maximum diameter of entrance pupil

Basic facts

Magnification	Max. entrance diameter	Expansion scale	Focussing scale
1x	9.0 mm	10.3 mm	0.0 mm
2x	9.0 mm	17.4 mm	11.4 mm
3x	9.0 mm	17.0 mm	15.2 mm
4x	7.5 mm	14.6 mm	17.0 mm
5x	6.0 mm	11.4 mm	18.2 mm
6x	5.0 mm	7.8 mm	18.9 mm
7x	4.5 mm	4.0 mm	19.5 mm
8x	4.0 mm	0.0 mm	19.9 mm



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

The different versions of these Beam Expanders offer a variable expansion at wavelengths of 355 nm or 1030-1080 nm. Its zoom range allows a continuously variable setting of an expansion factor between 1x and 8x set by a control unit. By expanding the laser beam the size of the generated structures will be decreased. A motorized focusing allows deliberate changes in the divergence of laser radiation, thus matching the tolerances on focal length relationships throughout the entire system. Similarly, the image plane position after the scanning unit can be changed. Due to an optimized mechanical design concept, these beam expanders are very compact and robust.

When changing magnification of focusing settings, the lenses do not rotate and move in a linear guide, which yields extremely high beam pointing stability.

Each beam expander is designed to achieve a diffraction limited imaging quality and has a specific AR coating for operation at 355 nm or 1030-1080 nm. The expansion and focusing can be controlled using a variety of digital interfaces. All beam expanders can be used perfectly with F-Theta lenses from Jenoptik as integral parts of a wide variety of beam delivery systems.

Excellent Optical Components

For Your Demanding Application

Customized high-precision optical components made from a wide range of optical materials with various shapes and high-end coatings tailored to our customer's applications.

If you are looking for a partner who has the ability to provide you with the complete solution – special high quality optical components from DUV to FIR including all different types of geometric shapes due to 5-axis counturing and optical parameters as well as their integration into a demanding optical system – Jenoptik is looking forward to successfully taking up this challenge together with you.

Responsible employees with considerable experience in developing and manufacturing optical components and systems, modern equipment and a globally acting well-established supply chain management ensure Jenoptik's remarkable performance as your holistic solution provider.

USP:

- Your whole customized solution from one hand, from prototypes to serial production
- Use of diverse optical glasses for the whole spectral range and various polymer materials
- Synergy effects due to intense cooperation between Jenoptik's business units
- Non-destructive testing of materials, components and systems

Fields of Application:

- Semiconductor inspection equipment
- F-Theta Lenses for laser material processing
- Thermography cameras for defense and security
- Optical components for medical technology
- Lenses for entertainment

Contact:

JENOPTIK | Optical Systems

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Optical Components

Excellent Optical Components and Customized Coatings

Plano Optics

- Extremely good cleanliness and irregularity
- Angular accuracy to 2'', for prisms special geometries realizable
- Rq < 0.2 nm for components made of CaF_2, Rq < 0.3 nm for components made of SiO_2
- Surface shape accuracy to 1 nm RMSi
- Customized demanding optical contact bonding components

Spheres

- Centering accuracy to 10 µm and customized on request
- Tolerance of center thickness to ± 0.01 mm and customized on request
- IRR by MRF < 2 nm RMSi; IRR by ion beam technology < 1 nm RMSi
- Rotationally symmetric or stripe formed spherical components with all possible combinations of curvatures (e.g. plano-convex, plano-concave)
- Large optics up to Ø 300 mm

Aspheres

- High-precision aspheres with IRR < 3 nm RMSi and Rq < 0.5 nm
- Double-sided aspherical components
- From rotational symmetric asphere to freeform
- Even sensitive materials (e.g. CaF_2)

Cylinders

- Spherical cylinder: IRR < 2nm RMS
- Double-sided cylindrical surfaces
- Cylindrical lenses made of CaF_2
- Rq 0.5 nm (CaF_2)
- Aspherical cylinders with IRR < 5 nm RMS, up to 200 mm length
- Position of cylindrical axis ± 0.01 mm
- Parallelism reference edge towards axis 0.01 mm

Mirrors

- Plano, spherical, aspherical, cylindrical and toric mirrors

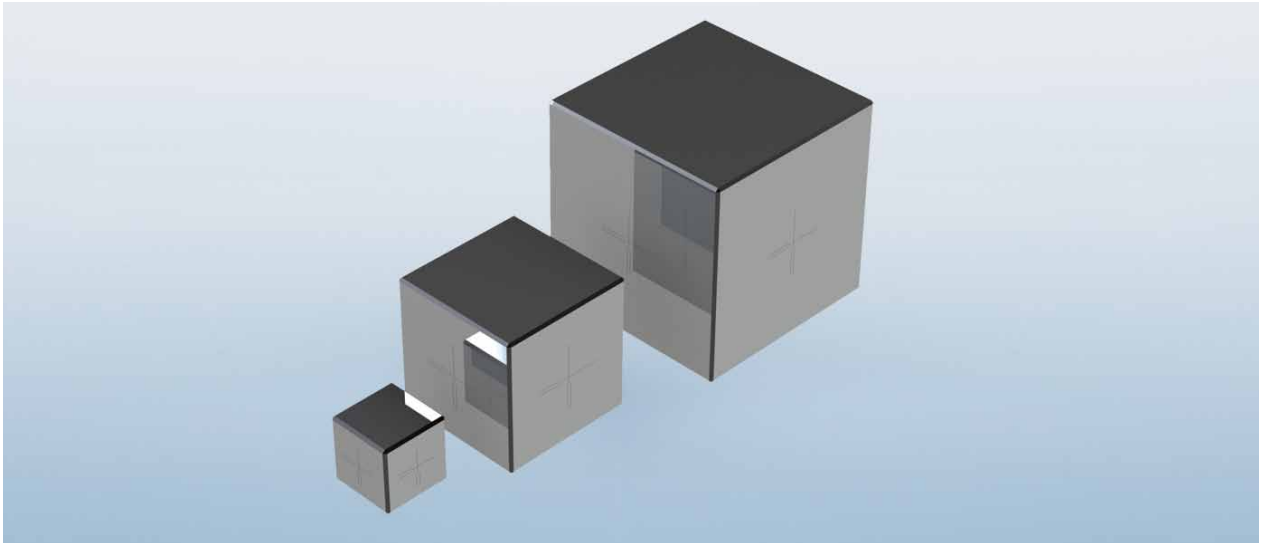
OrthoLine Optical Alignment Cubes

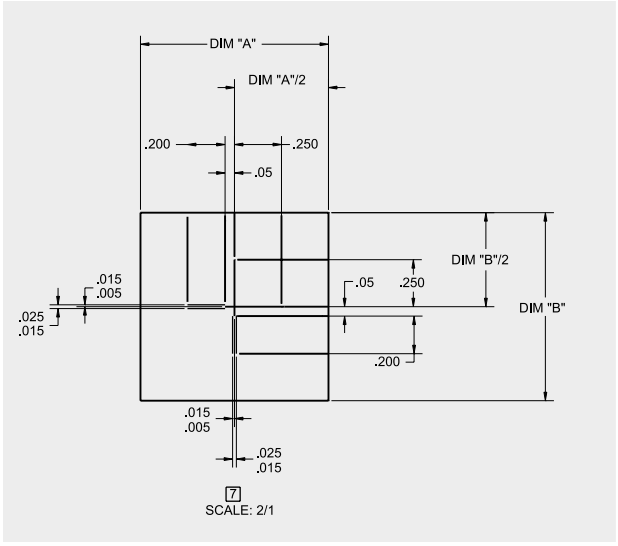
The Standard for High Precision Alignment Tooling

Jenoptik´s OrthoLine optical alignment cubes are designed primarily for processes that require precision datum registration - including applications in the life and health sciences, metrology and defense.
These durable high-reflective, chrome-coated standards are made from high quality fused silica substrates.

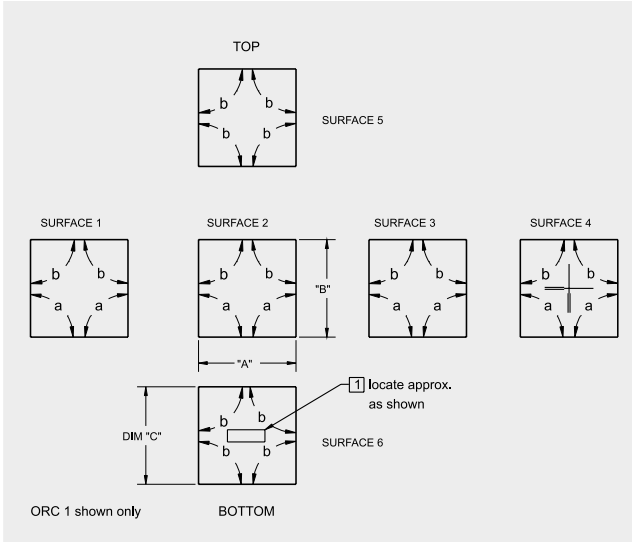
The alignment cubes feature a surface flatter than λ/10 and have five sides polished perpendicular to < 2 arc-seconds for critical alignments of up to eight orthogonal angles in five directions.

Size	Unpatterned P/N	Patterned P/N	Dimensions (DIM) „A", „B", „C"
0.50" Cube:	99129ORC0.50	99129ORC0.50P	0.50 inch
0.75" Cube:	99129ORC0.75	99129ORC0.75P	0.75 inch
1.00" Cube:	99129ORC1.00	99129ORC1.00P	1.00 inch





Reticle Dimensions



Cube Dimensions

Entertainment

Creating Stunning Moments for your Customers

From digital customer desktops to the largest stage and movie theater projectors in the world, Jenoptik develops 2D and 3D projection objective lenses for a wide range of systems.

Transforming light into fun. When talking about entertainment our eyes want to experience unexpected visual sensations. An ideal picture can only be produced by an outstanding projector; an outstanding projector can only perform through an excellent objective lens used to project the enlarged, perfect image our senses ask for.

To create such moments for your customers you need custom technology solutions built by a partner who speaks your language. Jenoptik has the experience and dependable expertise that is needed for a customized, reliable and on-time build. We would be pleased to provide you with projection optics offering the highest quality images in the market.

USP:

- Works with many projectors
- All pixels of 4K projectors can be used due to very high contrast levels
- Decreased number of channels used to cover a dome or simulator surface
- Reduces costs and improves return on investment

Fields of Application:

- Entertainment: soaring and dark rides
- Simulation and training
- Giant screen cinema
- 3D movie theaters
- Planetarium

Contact:

JENOPTIK | Optical Systems

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Video

F-Theta Projection Lenses
4K Single Projector Solution

From digital customer desktops to the largest stage and movie theater projectors in the world – Jenoptik develops 2D and 3D projection objective lenses for a wide range of systems. They can be used for innovative wide-angle and high-aperture projection units for soaring rides, 3D movie theaters, dark rides and simulators.

Advantages of laser projection:
- Lower cost of total ownership
- Lower power consumption
- Expanded color gamut
- Brighter picture
- Longer life-time

JL4K-1 (top), JL4K-2 and JL4K-4

Jenoptik has designed, manufactured and delivered more than 1000 projection lenses for 3 to 20 meter domes. Whether you are looking for a single or multi-projector solution, Jenoptik has lenses ready for your application – from stock or tailored to your ideas.

By working closely with the leading laser projector manufacturers Jenoptik ensures to meet all application specifications. With high lumens (45 k to 60 k) today's projectors become more prevalent. Hence, selecting the right projection optics is more important than ever before.

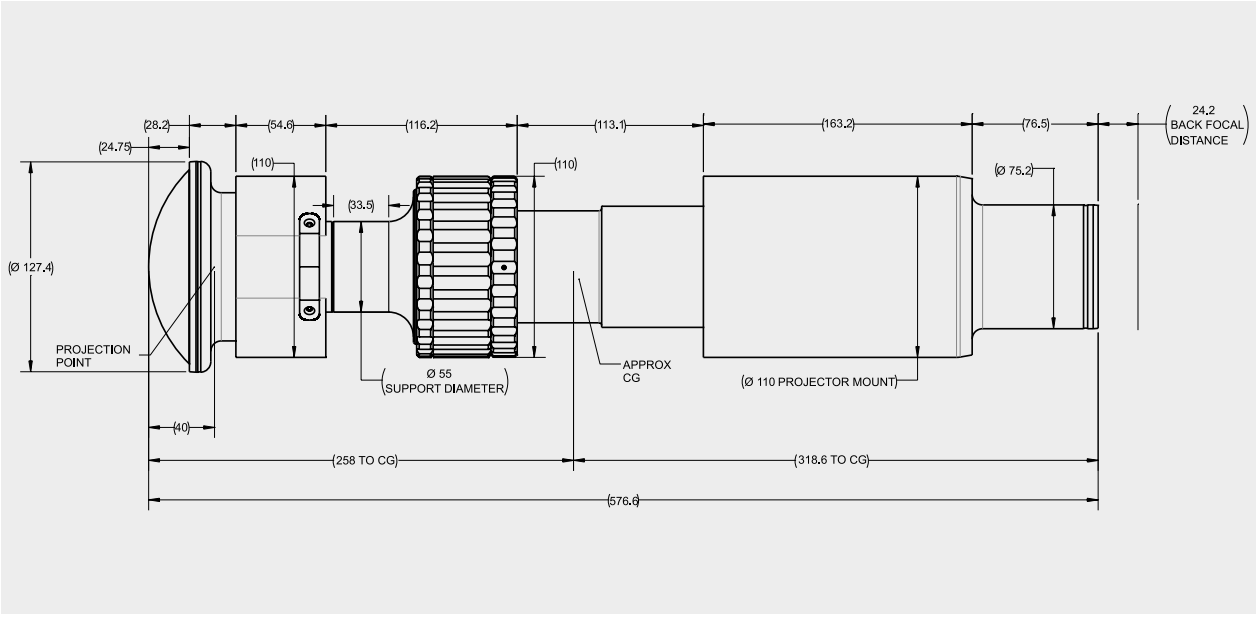
F-Theta Projection Lenses

4K Single Projector Solution

Suitable for following projectors:

- Christie D4K60LH
- Christie D4K3560
- Christie Roadie HD+35K
- Christie Boxer 4K30
- Barco DP4K-32B
- Barco HDQ-4K35
- DP INSIGHT 4K QUAD
- DP INSIGHT LASER 4K

Parameters	
Horizontal field of view:	180°
Vertical field of view:	125°
Diagonal field of view:	–
Effective focal length:	7.5 mm
f#:	2.85
MTF @ 66 lp/mm:	0.68
Lateral color B-R:	< 3.5 µm
F-Theta distortion:	< 0.2 %
Transmission:	> 77 %
Digital light procession (DLP):	1.38" 3 Chip
Resolution:	4096 x 2160 pixel
DLP dimension:	30.96 mm x 16.33 mm
Pixel pitch:	7.56 µm
Max lumens:	45 k
Order Number:	JOS4K-1



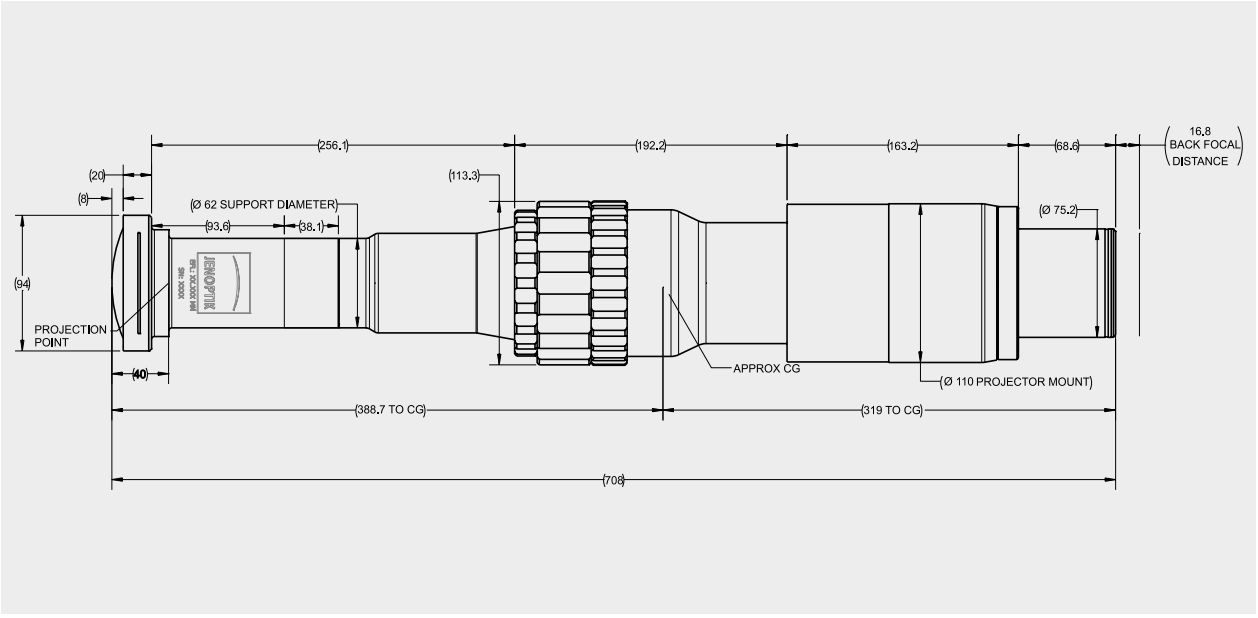
F-Theta Projection Lenses

8K Laser Planetarium Lenses

Suitable for following projectors:

- Christie D4K60LH
- Christie D4K3560
- Christie Roadie HD+35K
- Christie Boxer 4K30
- Barco DP4K-32B
- Barco HDQ-4K35
- DP INSIGHT 4K QUAD
- DP INSIGHT LASER 4K

Parameters	
Horizontal field of view:	101°
Vertical field of view:	53°
Diagonal field of view:	114°
Effective focal length:	17.5 mm
f#:	2.85
MTF @ 66 lp/mm:	0.78
Lateral color B-R:	< 1 µm
F-Theta distortion:	< 0.8 %
Transmission:	> 77 %
Digital light procession (DLP):	1.38“ 3 Chip
Resolution:	4096 x 2160 pixel
DLP dimension:	30.96 mm x 16.33 mm
Pixel pitch:	7.56 µm
Max lumens:	45 k
Order Number:	JOS4K-2



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

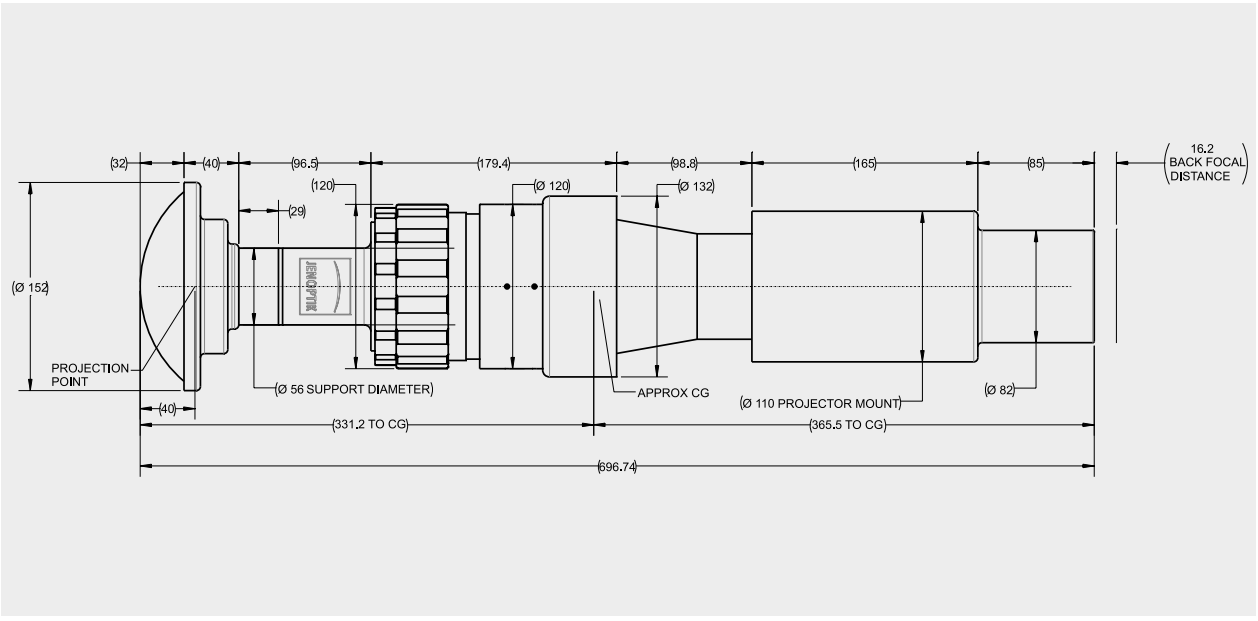
F-Theta Projection Lenses

8K Laser Planetarium Lenses

Suitable for following projectors:

- Christie D4K60LH
- Christie D4K3560
- Christie Roadie HD+35K
- Christie Boxer 4K30
- Barco DP4K-32B
- Barco HDQ-4K35
- DP INSIGHT 4K QUAD
- DP INSIGHT LASER 4K

Parameters	
Horizontal field of view:	170°
Vertical field of view:	90°
Diagonal field of view:	192°
Effective focal length:	10.35 mm
f#:	2.85
MTF @ 66 lp/mm:	0.55
Lateral color B-R:	< 3.5 µm
F-Theta distortion:	< 1 %
Transmission:	> 85 %
Digital light procession (DLP):	1.38“ 3 Chip
Resolution:	4096 x 2160 pixel
DLP dimension:	30.96 mm x 16.33 mm
Pixel pitch:	7.56 µm
Max lumens:	60 k
Order Number:	JOS4K-4



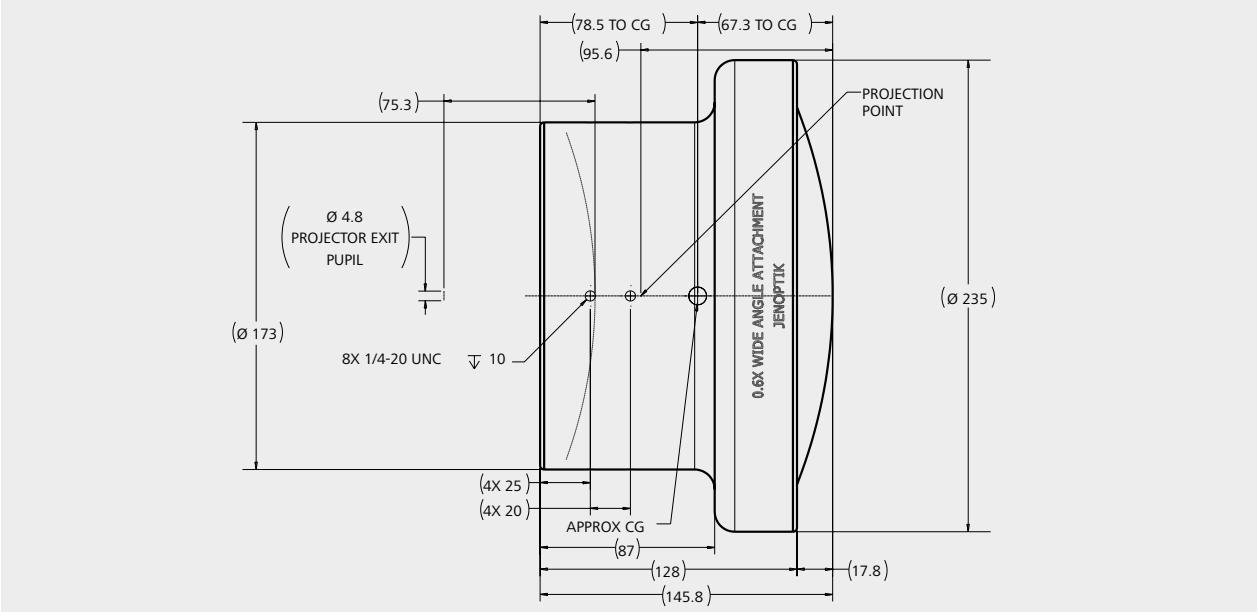
0.6x Lens Attachment
Wide Angle Conversion Lens

Jenoptik's portfolio of projection lenses is complemented by the 0.6x lens attachment.
The wide angle conversion lens which is optionally offered works in conjunction with the projector prime lens.

It allows to increase the image size while maintaining a static projection distance.
Reverse, it also facilitates to decrease projection throw distance while maintaining the image size.

Suitable for following projector:
SONY VPL-GTZ 270/280 w/Lens VPLL-Z7008
(EFL 13.46 mm - 18 mm)

Parameters	
Effective focal length:	- 2201 mm
MTF @ 66 lp/mm:	Depends on zoom postion of prime lens
Transmission:	> 92 %
Magnification:	0.6x
Order Number:	JOSI4K-5CL



Jenoptik Dome Theater

In-house testing and demonstration of Jenoptik projection lenses

The Jenoptik Dome Theater enables testing and demonstrating new laser projection lenses for digital cinemas, planetariums and theme park attractions in-house at Jenoptik site.

The screen is 24 feet in diameter with 12 feet dome radius. The hemispherical screen is elevated five feet above the audience which is perfect for testing digital planetarium lenses. The screen is coated with a proprietary high performance surface treatment to match our customer's preferred 3D projection screens.

The Jenoptik Theater also has a 30 x 16 feet flat screen for testing digital cinema lenses especially produced for flat screens.


IR 1.0/120 LW JENOPTIK
IR 1.0/15 LW JENOPTIK
IR 1.0/60 LW JENOPTIK

Thermal Imaging

Infrared at its Best

Across-the-board expertise in visualizing the invisible light.

With a wide range of competencies on a very high level of vertical integration within the infrared spectrum, Jenoptik is a reliable development and system partner for optics and modules applied with our high-performance coatings.

The presented products not only demostrate Jenoptik´s outstanding performance in manufacturing standard products but also show its proficiency in developing highly complex optics and components tailored to our customers' requirements in a vast range of markets.

The Jenoptik IR sales team supports its customers with all product-specific questions and looks forward to a close and successful relationship.

USP:

- Stable: Performance remains unaffected by temperature fluctuations
- Tough: Resistant to mechanical and thermal stresses
- Standard-compliant: Compliant with the DIN ISO or MIL standards
- Comprehensive service: Support from conception and planning to production and system integration
- Customer-specific: Adapted to individual needs and system requirements
- Testing: High competency in optical metrology and environmental and durability tests

The items may be subject to the German and European Union Export Control Regulations / Laws.

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Infrared Objective Lenses

Uncooled Precision Infrared Thermography

The infrared objective lenses from Jenoptik operate with great security and reliability in the spectral range from 8 to 13 µm.
Jenoptik offers both: Simple fixed-focus objective lenses as well as complex opto-electro-mechanical modules and also provides infrared objective lenses adapted to its customers individual requirements, specifically aligned to their existing systems. Thus, the infrared lenses are able to withstand mechanical and thermal stresses and survive under harsh environmental conditions.
Customers will benefit from Jenoptik's long-year experience and its comprehensive service.

Fields of Application:

- Electronics and automotive industry: Quality control and assurance in industrial operations, process control, optimization and monitoring to prevent production stops
- Research and development: Non-destructive testing of materials and components
- Process monitoring in the raw materials industry: Plant monitoring and plant safety
- Automation technology: Thermal test benches, process monitoring, optimization and control
- Thermography: Building insulation testing
- Fire fighting: Hand-held thermal imaging devices
- Security: Thermal night-vision and target recognition

Specifications & Technical Parameters

Parameters	1/7.5	1/15	1/30	1/60	1/120
Spectral range:	8 to 13 µm	8 to 13 µm	8 to 13 µm	8 to 13 µm	8 to 13 µm
Field of view HFOV x VFOV (diagonal):	135.8° x 101.3° (174.1°)	67.8° x 50.6° (86.0°)	32.4° x 24.6° (42.3°)	16.4° x 12.3° (20.1°)	8.1° x 6.1° (10.0°)
Object distance:	0.2 m … ∞	0.2 m … ∞	0.5 m … ∞	2 m … ∞	10 m … ∞
Supported sensors:	1024 x 768 Pixel; 17 µm pitch 640 x 480 Pixel; 25 µm pitch				
F#:	< 1.07	< 1.07	< 1.07	< 1.07	< 1.07
Focal length:	7.5 mm	15 mm	30 mm	60 mm	120 mm
Transmission:	> 80 %	> 85 %	> 85 %	> 85 %	> 75 %
Vignette:	0	0	0	0	0
Focus:	fix focus lens				
Diameter:	126 mm	74 mm	74 mm	89 mm	148 mm
Length:	97 mm	70 mm	41 mm	43 mm	209 mm
Mechanical interfaces:	pin connection to camera thermometer				
Weight:	1300 g	308 g	229 g	294 g	1850 g
Shock:	25 g / 6 ms	25 g / 6 ms	25 g / 6 ms	25 g / 6 ms	25 g / 6 ms
Vibration:	2 g	2 g	2 g	2 g	2 g
Temperatures:	working temperature: -20°C … + 50°C storage temperature: -40°C … + 70°C				
Leadtime:	on request				

Patent pending DE 10 2015 005 779 | Grant patent DE 10 2012 100 311 | Grant patents US 8,154,733; DE 10 2008 049 159

Measurement:

Optical Tests
- Interferometrical Measurement
- CGHs
- Wavefront
- Transmission
- MTF

Environmental Tests
- DIN EN 60068-2-14 (Change of Temperature)
- DIN EN 60068-2-27 (Shock, Ea and guidance)
- DIN EN 60068-2-6 (Vibration, sinusoidal)
- DIN EN 60068-2-64 (Vibration, broad-band random)

Durability Tests
- MIL-C-675C P 4.5.8 (Humidity)
- MIL-M-13508 P 4.4.4 (Temperature Influence)
- MIL-C-675C P 4.5.10 (Severe Abrasion)
- MIL-C-675C P 4.5.12 (Adhesion)
- MIL-C-675C P 4.5.7 (Salt Solubility)
- MIL-C-675C P 4.5.9 (Salt Spray)
- DIN 58196-2 P 5.2 (Boiling Test)
- Durable in hydrochloric acid (pH=1)
- TS 1888 P5.4.3 (Windscreen Wiper Test)*

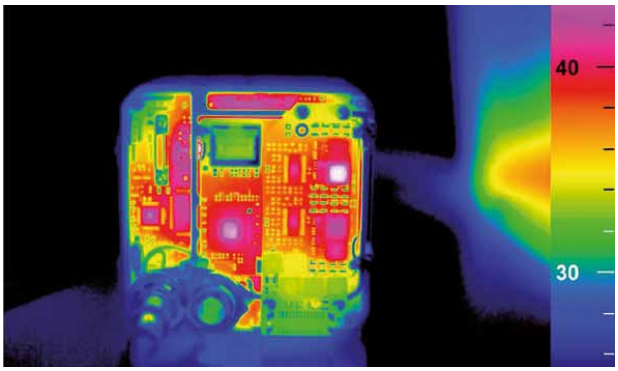
* Performed on IR lens 1/120 (front lens coated with DLC coating)

Uncooled handheld and stationary infrared cameras

If demanding thermal imaging is your assignment, the Jenoptik uncooled LWIR Infrared Cameras is your first choice. They deliver high quality thermograms fast and in real-time allowing to record radiometric image series and videos.

Versatile industry-proof standard interface option allow for easy integration into individual system solutions.

Video



Electronics – sample thermogram, 1024 x 768 pixel thermogram recorded with IR-TCM HD

The Jenoptik IR-TCM HD: Thermography camera for stationary use

Freeform Optics *fo*$^{+}$

A Success Story to be Continued

Monolithic optical element

Fire fighting IR camera

USP:

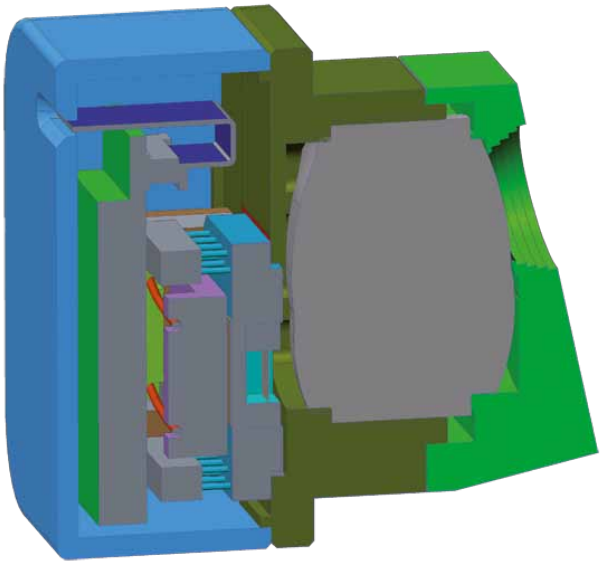
- Reduced size and weight compared to conventional systems
- High mobility of user
- Simple thermal management
- Easy snap-in assembly
- Tolerances comparable to those of rotationally symmetric systems

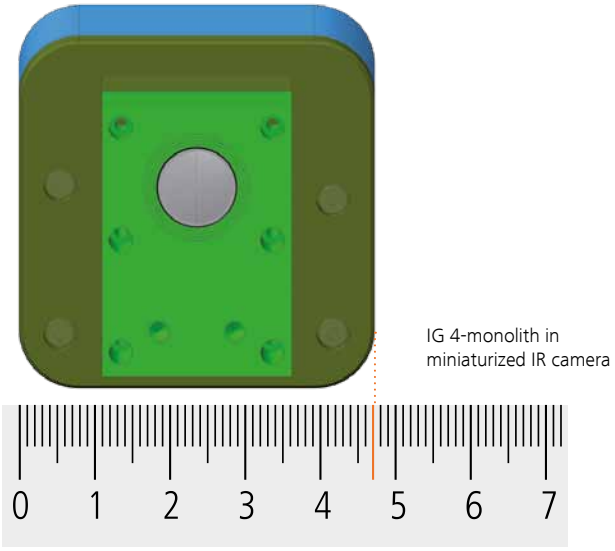
Fields of Application:

- Automotive: IR driver assistance
- Thermography camera for system integration
- IR camera lens (remote sensing, public safety, night vision)
- LIDAR

Supported by the German Federal Ministry of Education and Research (BMBF), together with nine alliance partners, Jenoptik has made an important advance toward miniaturized systems for infrared image processing and has developed a complete production chain for freeform optics.

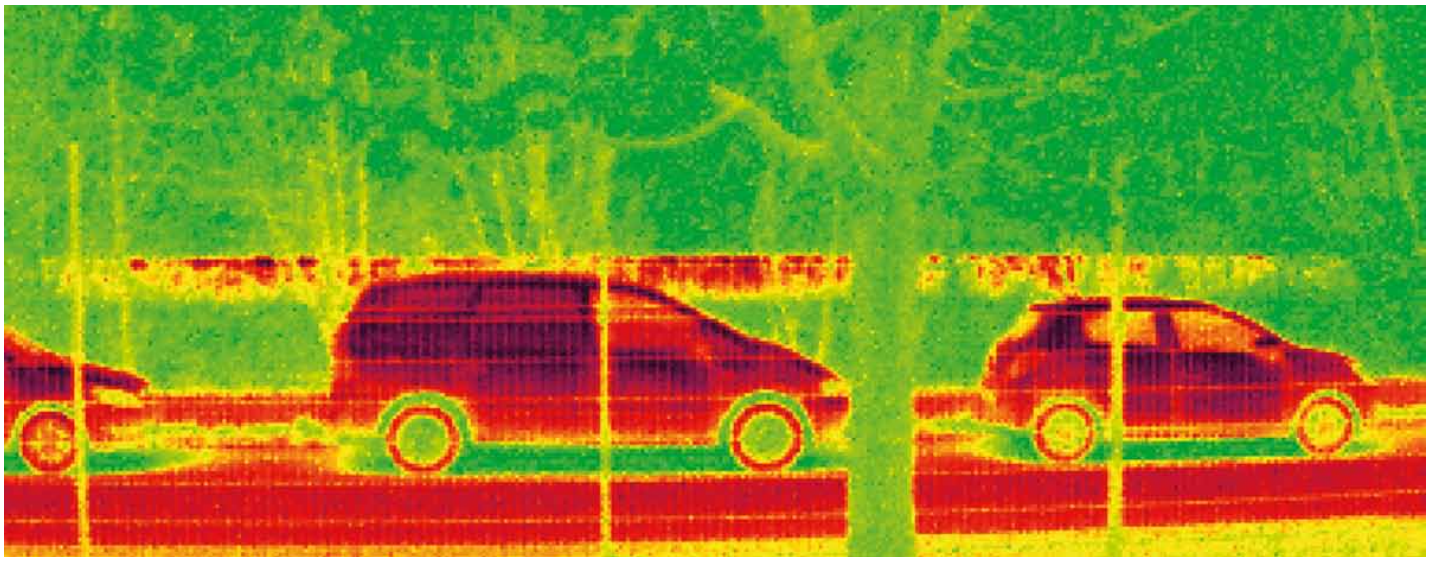
Miniaturized image processing systems such as the one developed and the ability to produce and establish them, are a core aim of this joint project.
Underlying those tailored freeform optics, optical systems are process-technological principles of design, materials, processing, coating, and structure, together with system integration.





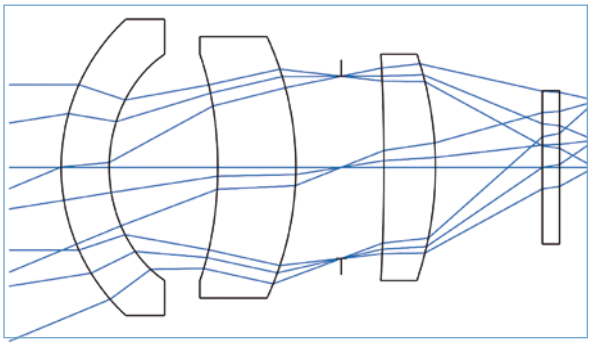
IG 4-monolith in miniaturized IR camera

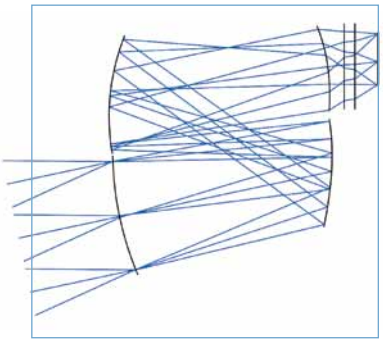
Patent pending DE 10 2015 110 004



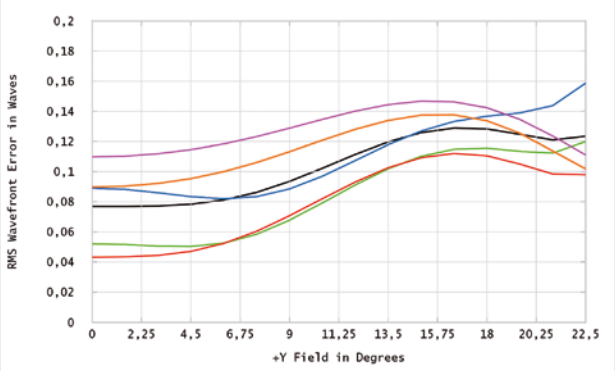
Conventional Optic

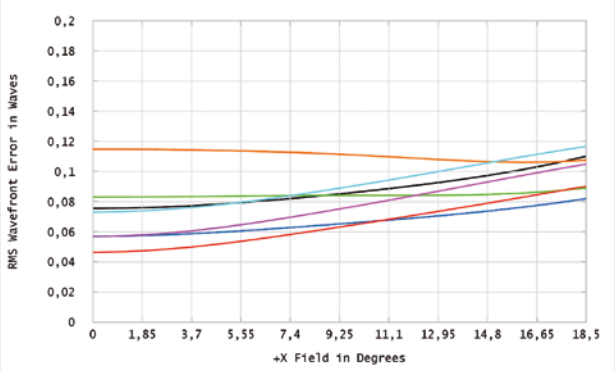
Multi-surface Freeform Optic





Volume reduction from 10 to 2.6 cubic cm





The freeform demonstrator reduced the volume of the optics by approximately 75 % while preserving excellent imaging qualities.

Next step is to produce the IG freeform optics by molding to reduce the manufacturing costs.


macro
ft
m
JENOPTIK
UV-VIS-IR Apo Macro
Made in USA
45 32 22 16 11 8 5.6 4
105mm f/4 UV-MICRO-APO
JENOPTIK
25 mm f/2 | 400-1700 nm

Hyper- & Multispectral Imaging

Discover what is Beyond the Visible

Hyper- and multispectral objective lenses from Jenoptik are characterized by their outstanding focus correction, from the UV range to infrared.

Our eyes – perfect sensors of visible radiation and excellent for our daily life.
However, today's continuous development in all areas of life, especially the rapid technology growth and our rising claim to see more than only the visible, requires technological advances that enable your cameras providing best outputs by delivering outstanding image quality over the whole spectral range. Jenoptik's multispectral lenses are the outcome of considerable experience and expertise and cover a broad field of application. We ensure a high level of flexibility for delivery as our lenses are off the shelf for our customers available.

USP:

- The Nikon and C-mount lens was developed to use with the increasingly ultraviolet sensitive CCDs offered in the marketplace
- Broad spectral range coupled with an adjustable iris
- Designed to maximize the performance across the UV-IR spectrum
- Advanced floating element design and sophisticated ultra broadband AR coatings make this lens a stunning performer in all conditions

Fields of Application:

- Machine vision
- Metrology
- Digital imaging
- Forensic and professional photography

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201315 Shanghai | Phone +86 21 3825-2380

25 mm f/2 400-1700 nm

Hyperspectral Objective Lens with Adjustable Iris

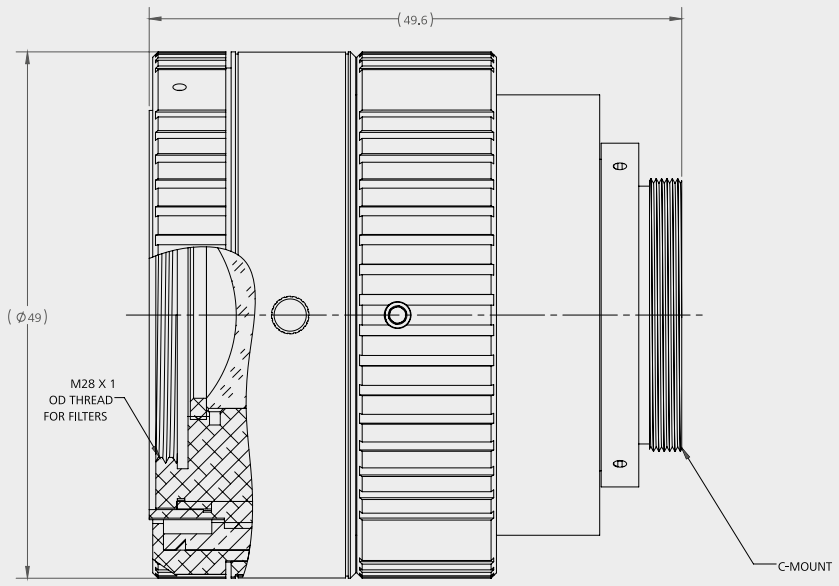
The Jenoptik 25 mm f/2, 400-1700 nm lens is a commercial off-the-shelf (COTS) objective lens designed to maximize the performance of many popular SWIR and hyperspectral cameras.

The broad spectral range coupled with an adjustable iris makes this lens well-suited for a variety of applications in the fields of imaging, medical, machine vision, industrial inspection, surveillance and law enforcement.

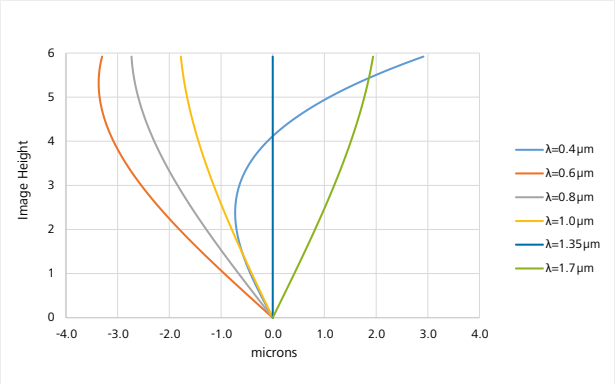
Features:

- FLIR® A6260sc, A6261sc (InGaAs) & A6262sc (VisGaAs)
- FLIR Tau SWIR™
- Quantum Imaging QI-SCD15-M1
- Raptor Photonics OWL 640 Analog SWIR
- Xenics Bobcat-640-CL

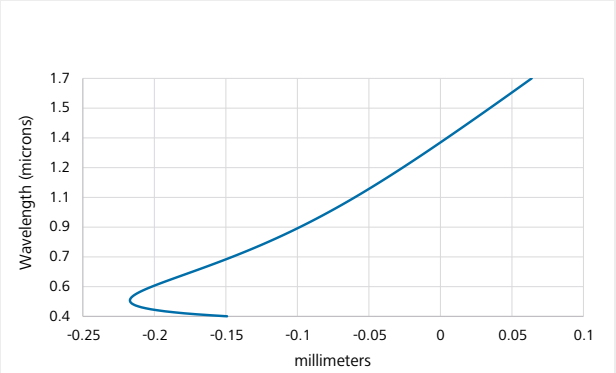
Spectral Range:	400 - 1700 nm
Focal Length:	25 mm
Focal Ratio:	f/2
Image Format:	9.6 mm x 7.68 mm
Aperture:	Adjustable Iris
Field of View:	22.1° H x 17.6° V
Transmission:	85 % Average
Diagonal Field of View:	27.6°
Distortion:	< 3.5 %
Image Circle:	12.29 mm
Focus Range:	Fixed
Minimum Object Distance:	200 mm
Filter Mount:	28 x 1 mm Thread
Mount:	C-Mount Locking
Dimensions:	49.6 L x 48.5 Ø
Weight:	195 g
Order Number:	10-03188100



Lateral Color and Chromatic Focal Shift

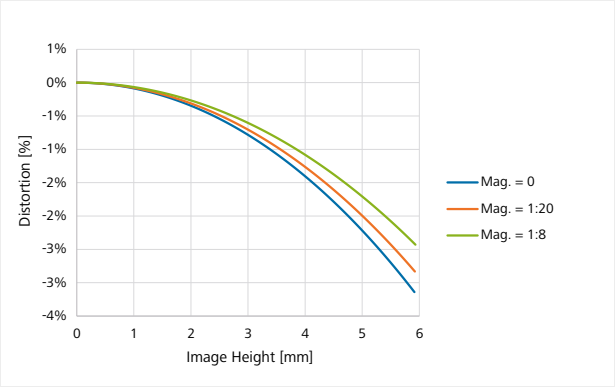


Lateral Color

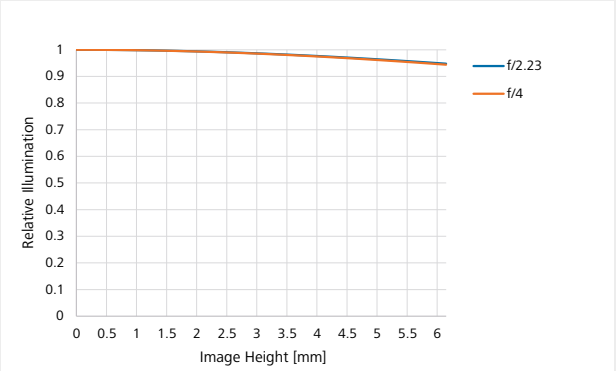


Chromatic Focal Shift

Distortion and Relative Illumination

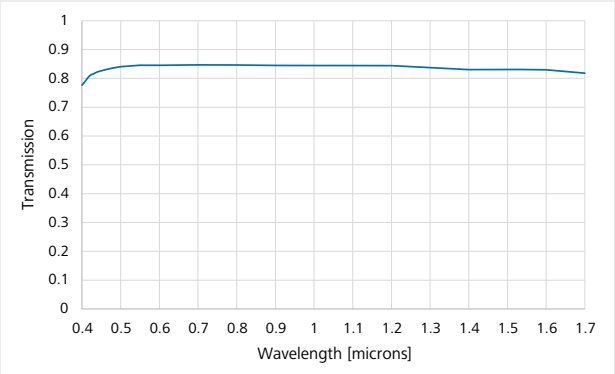


Distortion

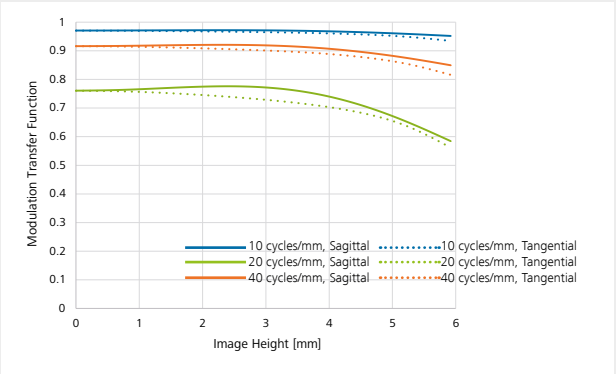


Relative Illumination

Transmission and MTF



Transmission



Hyperspectral MTF (400 nm-1700 nm), f/2.2, Mag.= 0

UV-VIS-IR 60 mm 1:4 APO Macro

Multispectral High Performance Lens

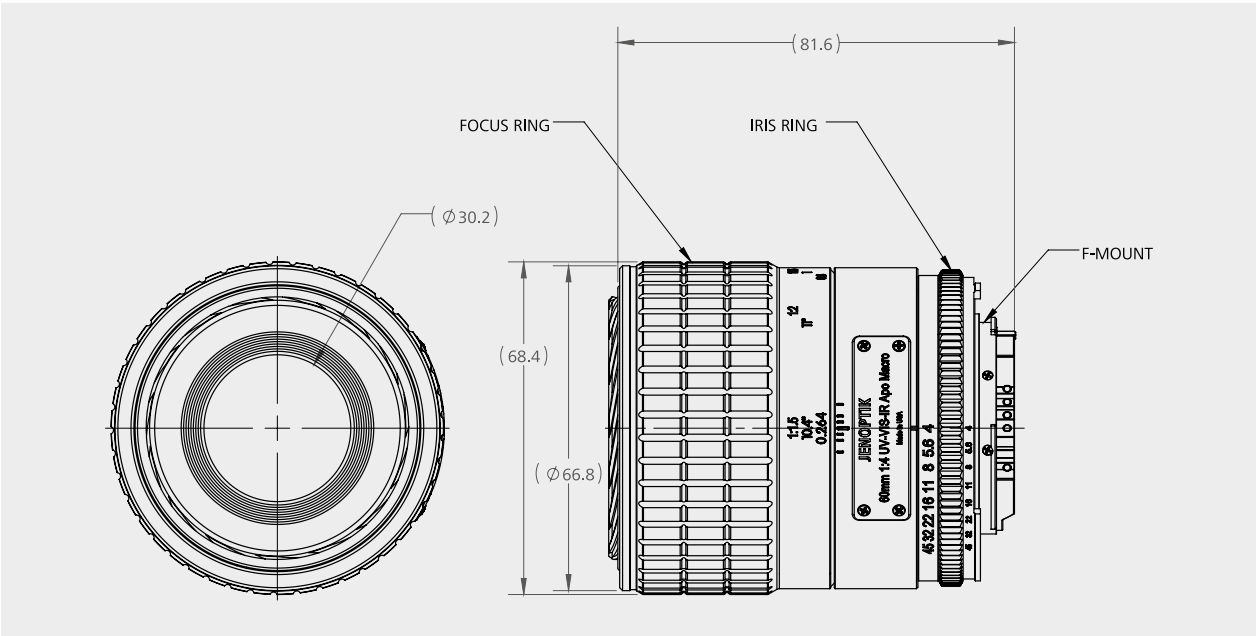
The Jenoptik UV-VIS-IR 60 mm 1:4 lens is a APO macro lens designed to maximize the performance across the UV-IR spectrum. The advanced floating element design and advanced ultra broadband AR coating make this lens a stunning performer in all conditions.

This lens is well-suited for a variety of applications in the fields of forensics, science, fine arts and law enforcement.

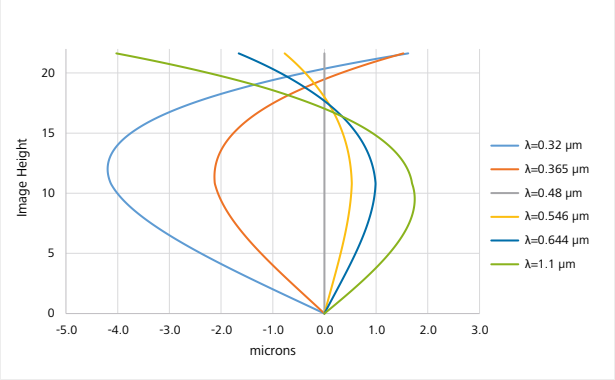
Features:

- No focus shift from UV-IR
- Excellent UV transmission
- Automatic diaphragm for maximum viewfinder brightness
- Perfect lens for Fuji IS Pro DSLR

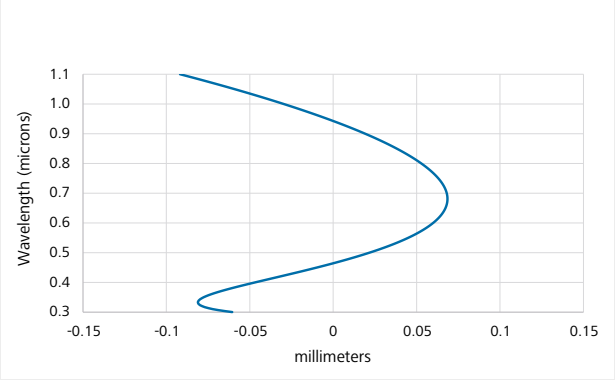
Transmission Waveband:	290 - 1500 nm
Apochromatic Waveband:	315 - 1100 nm
Focal Length:	60 mm
Focal Ratio:	f/4 - f/45
Image Format:	24 mm x 36 mm
No. of Elements/Groups:	10/9
Focus Range:	264 mm to infinity
Maximum Magnification:	1:1.5
Mounting Flange:	Nikon F-Mount
Filter:	52 mm Thread (M 52 x 0.75)
Weight:	535 g
Length:	73.4 mm (2.7 in)
Order Number	10-07109000



Lateral Color and Chromatic Focal Shift

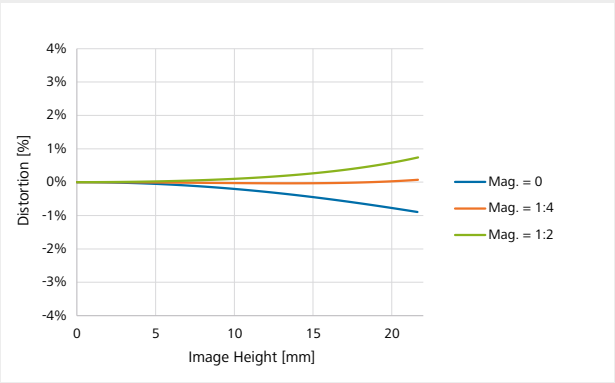


Lateral Color

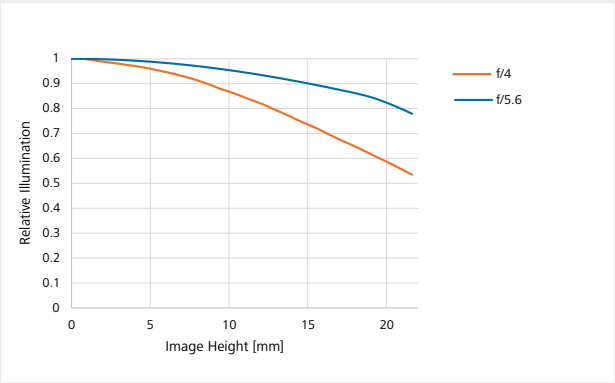


Chromatic Focal Shift

Distortion and Relative Illumination

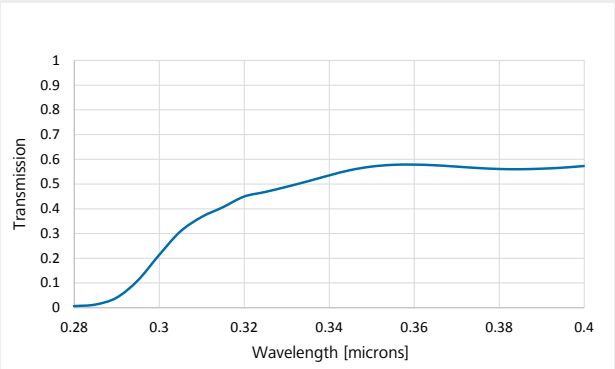


Distortion

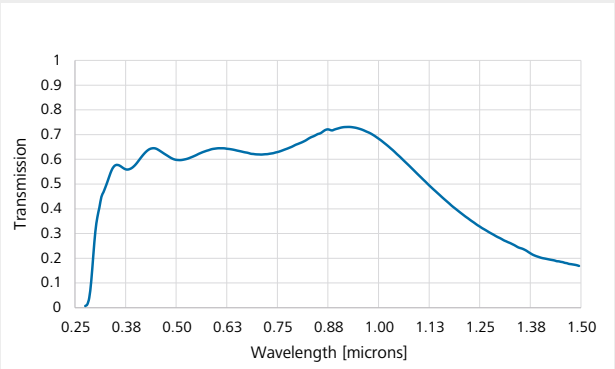


Relative Illumination

Transmission

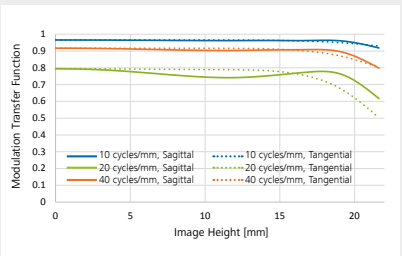


Transmission (280-400 nm)

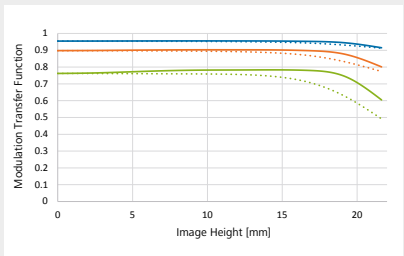


Transmission (280-1500 nm)

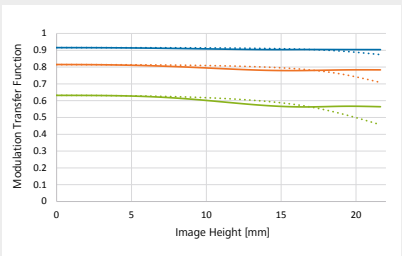
MTF - UV, VIS, IR



UV MTF (320-400 nm), f/5.6, Mag.= 0



VIS MTF (400-700 nm), f/5.6, Mag.= 0



IR MTF (700-1100 nm), f/5.6, Mag.= 0

105 mm f/4.5 250-650 nm
Multispectral UV SLR Lens

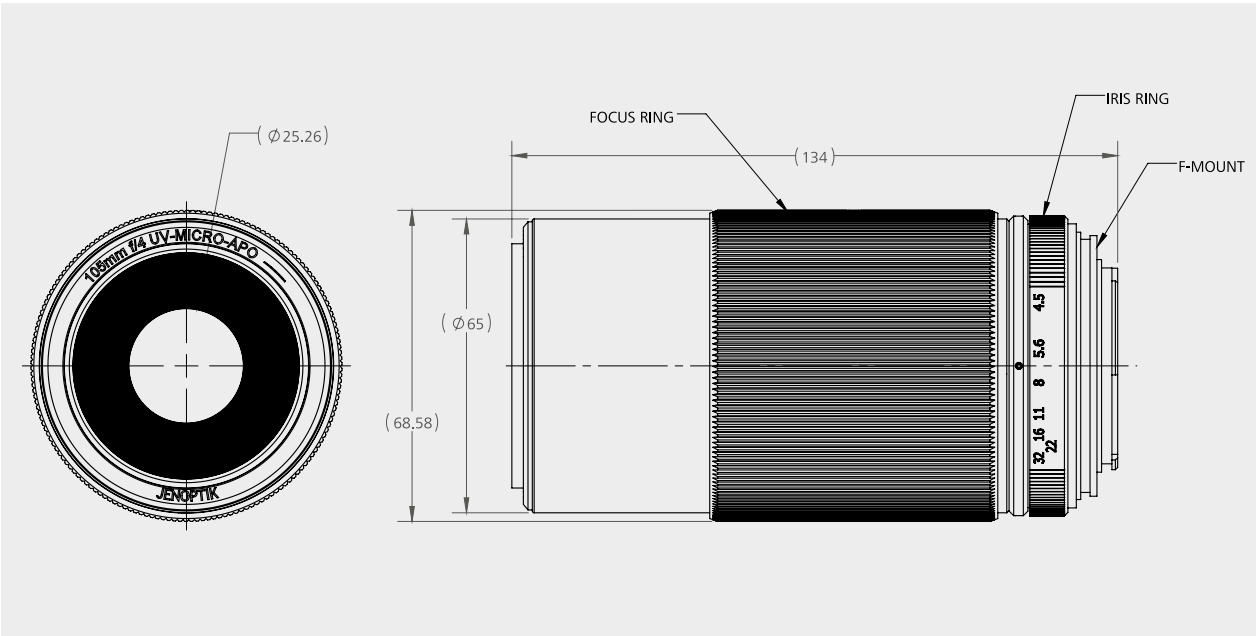
The Jenoptik UV SLR Lens allows capturing both UV and visible images without a focus adjustment for the color shift. The lens can be used for applications below 250 nm with narrow band filters. The Nikon and C-mount lens was developed to use with the increasingly ultraviolet sensitive CCDs offered in the marketplace.

This lens is well-suited for a variety of applications in the fields of security, biological characterization, combustion analysis, forensics and professional photography.

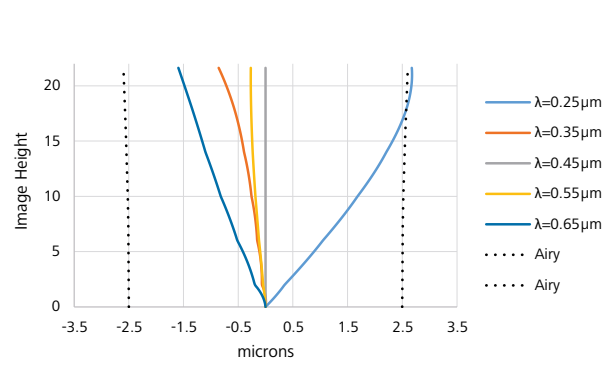
Features:

- Apochromatic
- Macro lens
- Manual focus (0.5 m-infinity)
- 52 mm filter mount
- Aperture (4.5-32)

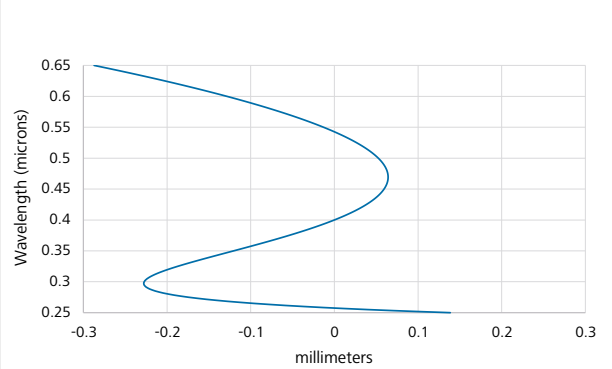
Spectral Range:	250 nm – 650 nm
Focal Length:	105 mm
Focal Ratio:	f/4.5 to f/32
Image Format:	24 mm x 36 mm
Field of View:	26.56° H x 16.68° V
Diagonal Field of View:	29.78°
Distortion:	Less than 1 % over the full image format
Image Circle:	43.27 mm
Minimum Object Distance:	300 mm
Filter Mount:	52 mm
Lens Mount:	Nikon F-mount
Dimensions:	5.26" L x 2.70" Ø
Weight:	620 g
Order Number:	10-02315000



Lateral Color and Chromatic Focal Shift

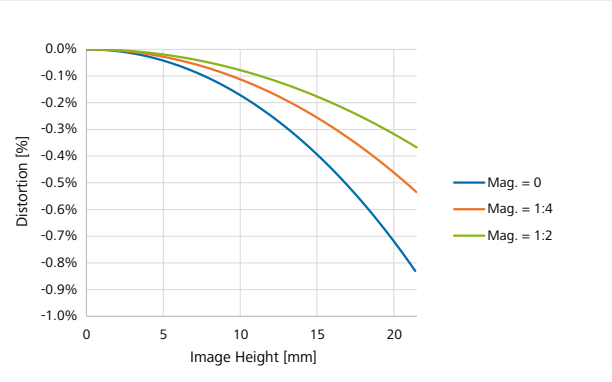


Lateral Color

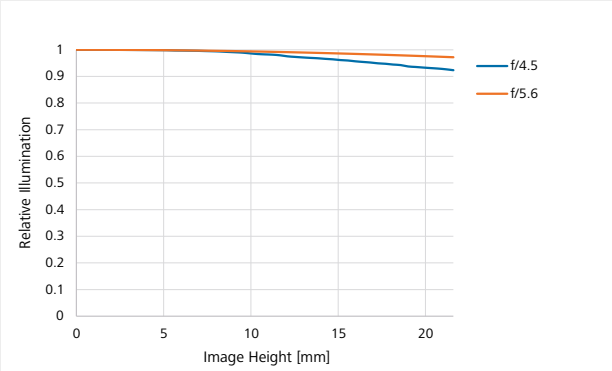


Chromatic Focal Shift

Distortion and Relative Illumination

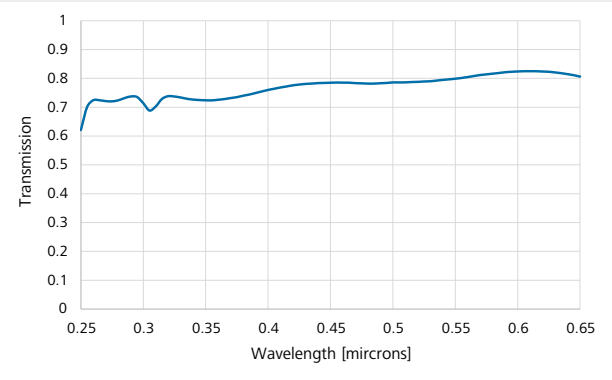


Distortion

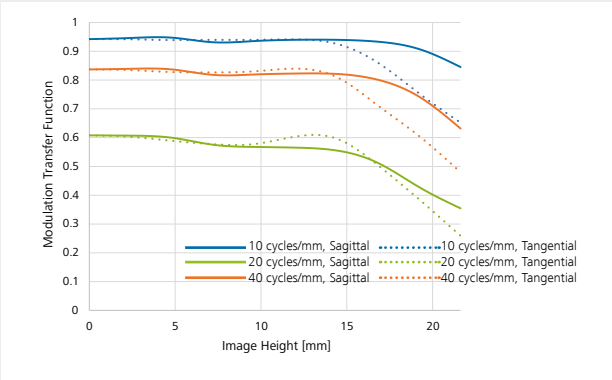


Relative Illumination

Transmission and MTF



Transmission



MTF (250 nm-650 nm), f/4.5, Mag.= 0

Thermal Analysis

The Entire Experience from One Source

High-performance optical filters and coatings for your complex applications.

More than 40 years experience combined with the entire technical knowledge in design, development and a state-of-the-art machinery in operation and technology, enables Jenoptik to realize reliable standard and customized high-end solutions for the infrared range from 1 to 16 µm. Jenoptik coats every known IR material from small to large-scale quantities in diverse geometries and shapes.

Apart from the expertise in the IR spectral range, Jenoptik´s competency also covers coating technologies within the deep ultraviolet and visual wavelength range. Those coatings enable the application of optics in highly sophisticated systems.

USP:

- Benefit from Jenoptik´s most sophisticated IR coating technology
- Jenoptik´s in-house R&D team ensures state-of the art products with an expertise of more than 40 years
- Jenoptik accompanies its customers from component to module – from standard to customized solutions

The items may be subject to the German and European Union Export Control Regulations / Laws.

Fields of Application:

- NDIR gas analysis:
  E.g. Security technology (alcohol measurement, mining, building technology)
- Thermography:
  E.g. Handheld fire fighting thermography camera
- Smart Home:
  E.g. Fire alarming systems
- Automotive:
  E.g. Night vision (pedestrian recognition, warning systems, sight improvement)

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DLC and Hybrid-DLC Coatings

Extremely Durable DLC Coatings with Low Reflection

Jenoptik´s DLC (diamond-like carbon) coatings are well-known for their excellent mechanical properties under harsh environmental conditions, whereas the optical performance of DLC coatings is limited.

Hybrid-DLC coatings combine the conventional mechanical properties of DLC coatings with multispectral characteristics of high-efficiency coatings.
This technology offers the possibility to produce extremely resistant coatings with significantly reduced reflection.

USP: Hybrid-DLC coatings

- More efficient but stable as DLC
- Also available on exotic materials, e.g. Chalcogenide Glasses and Zinc Sulfide
- Multichannel applications are realizable
- Extremely robust and certified according to DIN ISO or MIL with CoC
- Free of any radioactive materials

Fields of Application:

- Lenses for thermal imaging cameras (night vision)
- Windows for military applications
- Protective windows in gas sensors

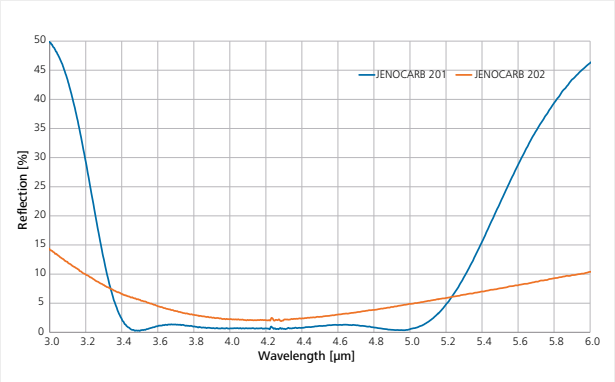
Specifications & Technical Parameters

Coating Type	Description	Substrate	Wavelength	R_{ave} per surface	R_{min}
JENOCARB 101	DLC AR Coating for 3 - 5 µm	Ge	3.0 - 5.0 µm	< 3.2 %	< 0.7 %
JENOCARB 102	DLC AR Coating for 8 - 12 µm	Ge	8.0 - 11.5 µm	< 2.4 %	< 0.9 %
JENOCARB 201	DLC AR Coating for 3 - 5 µm	Si	3.0 - 5.0 µm	< 4.5 %	< 2.5 %
JENOCARB 103	Hybrid-DLC Coating for 3 - 5 µm	Ge	3.4 - 5.1 µm	< 1.0 %	< 0.5 %
JENOCARB 104	Hybrid-DLC Coating for 8 - 13 µm	Ge	8.0 - 13.0 µm	< 1.5 %	< 0.5 %
JENOCARB 202	Hybrid-DLC Coating for 3 - 5 µm	Si	3.4 - 5.1 µm	< 1.0 %	< 0.5 %
JENOCARB 301	Hybrid-DLC Coating for 7.5 - 10 µm	ZnS	7.5 - 10.0 µm	< 1.0 %	< 0.3 %
JENOCARB 105	Dual Band Hybrid-DLC Coating for 3 - 5 µm and 8 - 11.5 µm	Ge	3.1 - 5.0 µm 8.0 - 11.5 µm	< 4.0 % < 3.0 %	< 2.5 % < 1.5 %
JENOCARB 302	Dual Band Hybrid-DLC Coating for 4 - 5 µm and 7 - 10 µm	ZnS	4.0 - 5.0 µm 7.5 - 10.0 µm	< 6.0 % < 1.5 %	< 2.0 % < 0.5 %

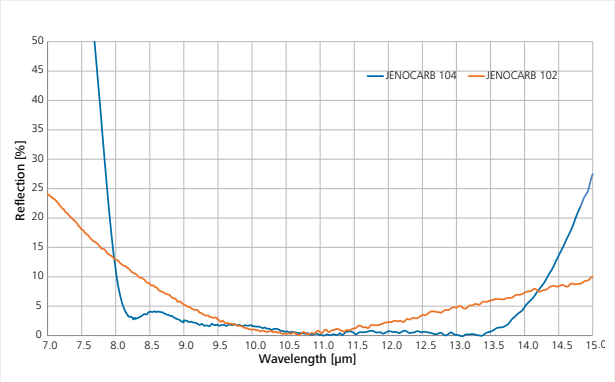
Patent pending EP2850469; US20150109663 and in CA, IL, JP | Grant patent CN 104303078 B

Durability:

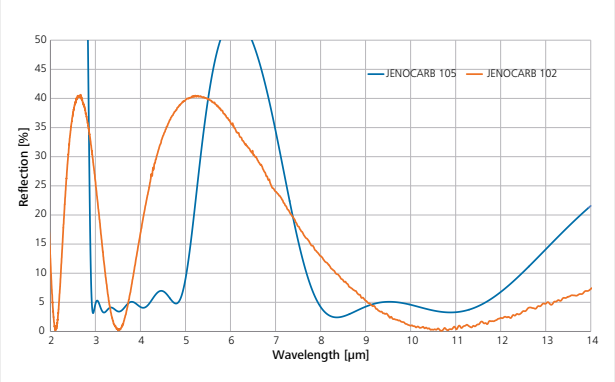
- Windscreen Wiper Test TS1888 / P 5.4.3
- Adhesion MIL-C-675 P4.5.12
- Humidity MIL-C-675 P4.5.8
- Severe Abrasion MIL-C-675C P4.5.10
- Temperature MIL-M-13508 P4.4.4
- Salt Solubility MIL-C-675C P4.5.7
- Salt Spray MIL-C-675C P4.5.9
- Boiling Test DIN 58196-2 P5.2
- Durability in hydrochlorid acid (pH=1)



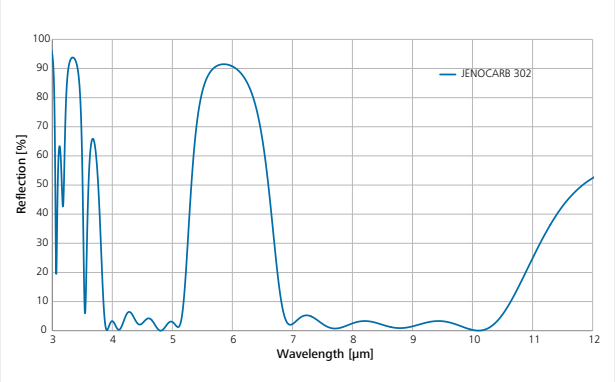
DLC and Hybrid-DLC for 3.0 - 5.0 µm on Si



DLC and Hybrid-DLC for 8.0 - 12.0 µm on Ge



DLC and Dual Band Hybrid-DLC for 3.0 - 5.0 µm and 8.0 - 12.0 µm on Ge



Dual Band Hybrid-DLC for 4.0 - 5.0 µm and 7.0 - 10.0 µm on ZnS

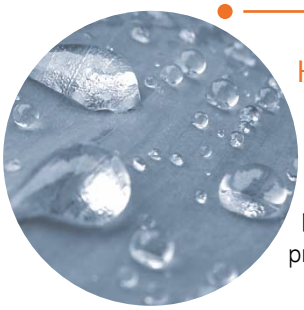
High Efficiency AR Coatings
Durable Coatings with Low Reflection

With more than 40 years of experience in designing, developing and manufacturing highly efficient and durable coatings, Jenoptik is a competent supplier for a large number of standard anti-reflective coatings, which belong to Jenoptik´s standard coating line JENODUR. A selection of the most common standard AR coatings are shown below.

Jenoptik coats all usual IR materials like Germanium, Silicon, Zinc Sulfide, Zinc Selenide, Chalcogenide Glasses, Sapphire and Calcium Fluoride within the scope of customized single-piece or high volume production. Jenoptik guarantees that its products are RoHs compliant and free of any radioactive materials.

USP:

- Experts in understanding coating structures and their related characteristics
- Perfect combination of high efficiency by guaranteeing high durability
- Certified according to DIN ISO or MIL with CoC
- Free of any radioactive materials



Hydrophobic Coating

On request a hydrophobic coating could be offered to protect the IR surfaces and provide an easy-to-clean effect.

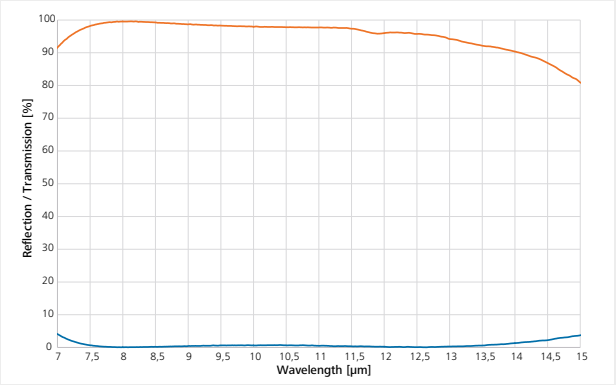
Specifications & Technical Parameters

Coating Type	Description	Substrate	Wavelength	R_{ave} per surface	T_{ave} backside coated
JENODUR 411	Broadband AR Coating for 8 - 11.5 µm	Ge	8.0 - 11.5 µm	< 0.5 %	98.5 %
JENODUR 411 - 002	Broadband AR Coating for 8 - 13 µm	Ge	8.0 - 13.0 µm 13.0 - 14.0 µm	< 0.7 % < 2.0 %	> 97.5 %
JENODUR 406 - 002	Broadband AR Coating for 3.4 - 5.1 µm	Ge	3.4 - 5.1 µm	< 0.5 %	> 98.0 % / T_{abs} > 95.0 %
JENODUR 404 - 003	Broadband AR Coating for 3.4 - 5.1 µm	Si	3.4 - 5.1 µm	< 1.0 %	> 98.0 % / T_{abs} > 95.0 %
JENODUR 404 - 006	Broadband AR Coating for 3.0 - 5.8 µm	Si	3.0 - 5.8 µm	< 1.0 %	> 97.5 %
JENODUR 416 - 001	Broadband AR Coating for 3.0 - 5.0 µm	Si	3.0 - 5.0 µm	< 0.6 %	> 98.0 %
JENODUR 416 - 002	Broadband AR Coating for 2.0 - 5.0 µm	Si	2.0 - 5.0 µm	< 1.5 %	> 95.5 %
JENODUR 417 - 001	Broadband AR Coating for 3.3 - 5.8 µm	ZnS	3.3 - 5.4 µm 5.4 - 5.8 µm	< 0.8 % < 1.5 %	> 99.0 %
JENODUR 418 - 001	Broadband AR Coating for 2.8 - 3.9 µm	CaF_2	2.8 - 3.9 µm	< 0.3 %	> 98.5 %
JENODUR 419 - 001	Broadband AR Coating for 3.0 - 5.0 µm	Sapphire	3.0 - 5.0 µm	< 1.5 %	> 97.5 %
JENODUR 424	Broadband AR Coating for 7.0 - 11.8 µm	ZnS	7.0 - 9.5 µm 9.5 - 11.0 µm 11.0 - 11.8 µm	< 0.9 % (R_{abs}) < 1.0 % (R_{abs}) < 1.3 % (R_{abs})	> 97.0 % > 93.0 % > 92.0 %
JENODUR 414	Broadband AR Coating for 8 - 12 µm	Chalcogenide IG4	8.0 - 12.0 µm 12.0 - 14.0 µm	< 0.5 % < 1.0 %	> 96.5 %
JENODUR 426	Broadband AR Coating for 8 - 12 µm	Chalcogenide IG5	8.0 - 12.0 µm	< 0.5 %	> 95.5 %
JENODUR 427	Broadband AR Coating for 8 - 12 µm	Chalcogenide IG6	8.0 - 12.0 µm	< 0.5 %	> 97.0 %

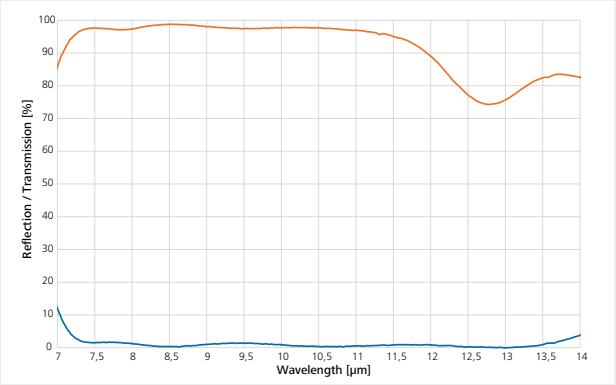
Grant patent EP 1749222 B1

Durability:

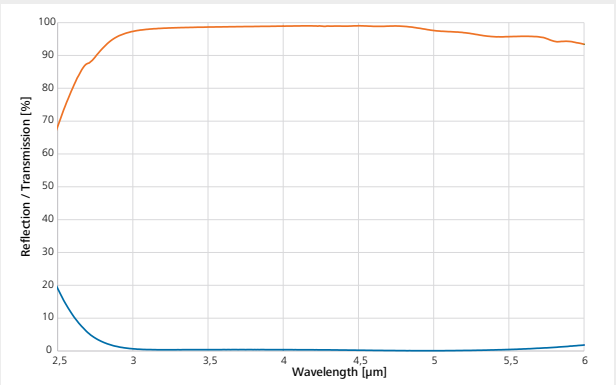
- Adhesion: MIL-C-48497A / section 4.5.3.1
- Humidity: MIL-C-48497A / section 4.5.3.2
- Abrasion Resistance: MIL-C-48497A / section 4.5.3.3
- Temperature: MIL-C-48497A / section 4.5.4.1
- Solvent Resistance: MIL-C-48497A / section 4.5.4.2



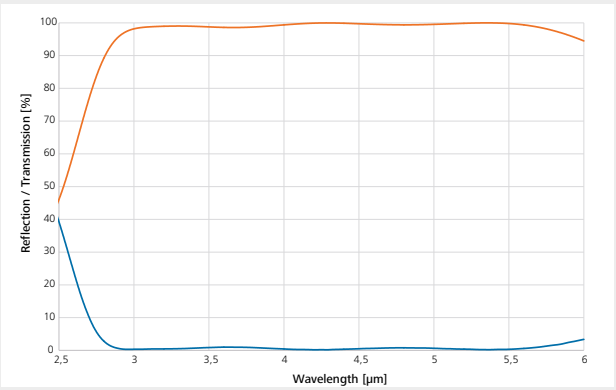
JENODUR 411 - 002 Broadband AR Coating for 8 - 13 µm on Ge



JENODUR 414 Broadband AR Coating for 8 - 12 µm on IG4



Jenodur 404 - 003 Broadband AR coating for 3.4 - 5.1µm on Si



Jenodur 417 - 001 Broadband AR coating for 3.3 - 5.8µm on ZnS

Multi- & Wideband AR Coatings

Broadband Durable Coatings with Low Reflection

The development of dual band IR optics requires high performance optical coatings in multiple spectral bands. Jenoptik offers anti-reflection coatings on diverse IR materials which combine a high reduction of reflection within different bands with high durability. Besides the IR materials Germanium, Silicon and Chalcogenide Glasses, Zinc Sulfide is a prime example due to its transmission from VIS to LWIR.

Jenoptik is a competent partner with long-year experience in developing customized solutions and offers a comprehensive range of standard AR coatings that belong to the coating line JENODUR.

USP:

- Long-year experience in developing complex and challenging customized solutions
- High transmission in multiple spectral bands
- High durability and stability
- Certified according to DIN ISO or MIL with CoC
- Free of any radioactive materials

Fields of Application:

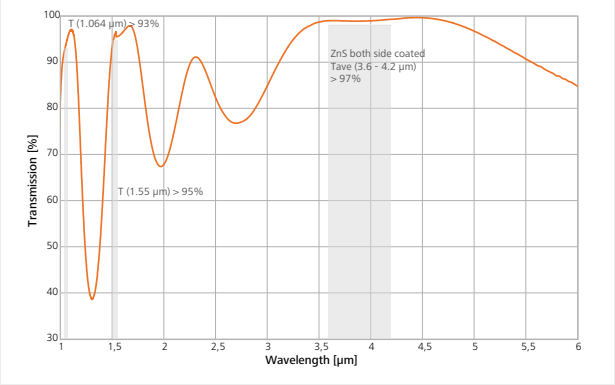
- Multi-color IR cameras
- Multiband infrared spectrometers

Specifications & Technical Parameters

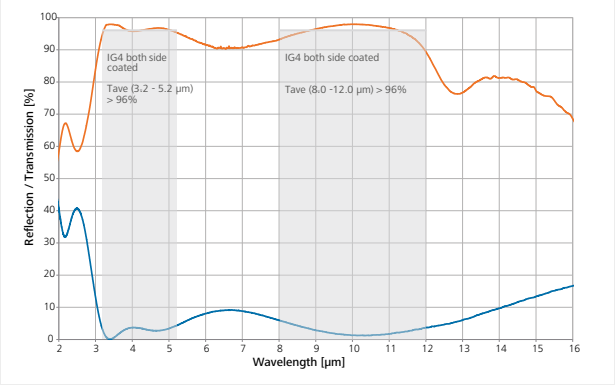
Coating Type	Description	Substrate	Wavelength	T_{ave}
JENODUR 420	Tripleband AR Coating for VIS - SWIR - MWIR	ZnS	420 - 500 nm 500 - 700 nm 700 - 900 nm / 1550 nm 3.8 - 5.5 µm	> 85.0 % > 88.0 % > 90.0 % > 96.0 %
JENODUR 421	Tripleband AR Coating for SWIR - MWIR	ZnS	1064 nm 1550 nm 3.6 - 4.2 µm	> 93.0 % > 95.0 % > 97.0 %
JENODUR 425	Dualband AR Coating for MWIR - LWIR	Ge	3.0 - 5.5 µm 7.5 - 10 µm	> 93.0 % > 92.0 %
JENODUR 428	Dualband AR Coating for MWIR - LWIR	IG4	3.2 - 5.2 µm / 8.0 - 12.0 µm	> 96.0 %
JENODUR 429	Wideband AR Coating for MWIR - LWIR	Ge	3.5 - 12.0 µm	> 91.5 %
JENODUR 430	Wideband AR Coating for MWIR - LWIR	Si	3.0 - 7.0 µm	> 93.0 %
JENODUR 431	Wideband AR Coating for MWIR - LWIR	Si	2.0 - 12.0 µm	> 92.0 %

Durability:

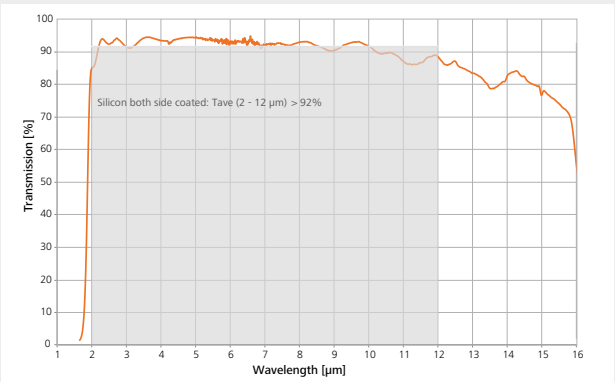
- Adhesion: MIL-C-48497A / section 4.5.3.1
- Humidity: MIL-C-48497A / section 4.5.3.2
- Abrasion Resistance: MIL-C-48497A / section 4.5.3.3
- Temperature: MIL-C-48497A / section 4.5.4.1
- Solvent Resistance: MIL-C-48497A / section 4.5.4.2



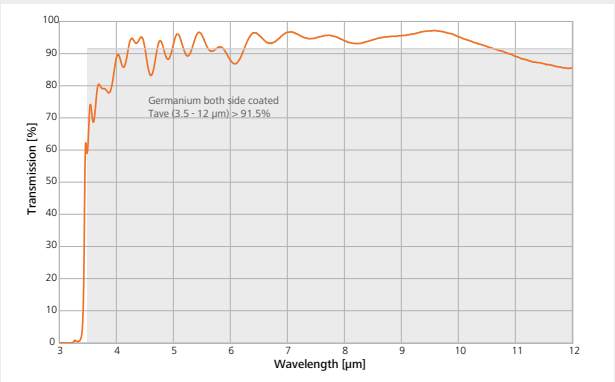
JENODUR 421 Tripleband AR Coating for SWIR - MWIR on ZnS



JENODUR 428 Dualband AR Coating for MWIR - LWIR on IG4



JENODUR 431 Wideband AR Coating for MWIR - LWIR on Si



JENODUR 429 Wideband AR Coating for MWIR - LWIR on Ge

Multifunctional IR Filters

Filters & Detector Windows at a High Level of Precision

Optical filters and windows are key elements of modern radiation detectors which contribute substantially to their overall performance.
The filter characteristics directly impact on the response sensitiveness and the signal-to-noise ratio of the detector.
Jenoptik offers filters and windows which provide additional system functionality for a higher level of integration.
Filters can be fitted with structured aperture blades, stray-light-suppressing elements, absorbing patterns or with solderable border strips.
According to the application highly efficient solutions can be realized for high-volume quantities.

USP:

- Multifunctional: Filters are versatile
- Flexible: Additional functions can be integrated
- Stable: Protected against environmental impacts
- Environmentally sound: Coating contains no radioactive substances
- Compliant with standards: Comply with DIN ISO or MIL with CoC

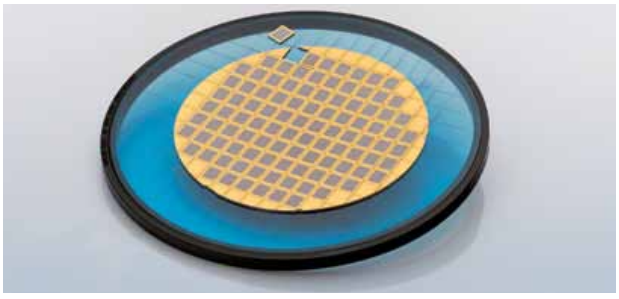
Fields of Application:

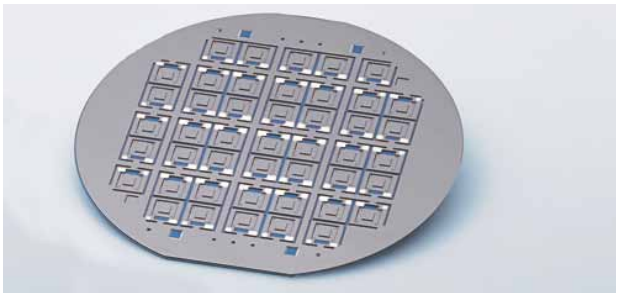
- Automotive industry: Filters for gas analysis
- Digital imaging: Filters for image capture and target detection
- Semiconductor equipment: Filters for IR sensor technology

Multifunctional IR Filters and Detector Windows

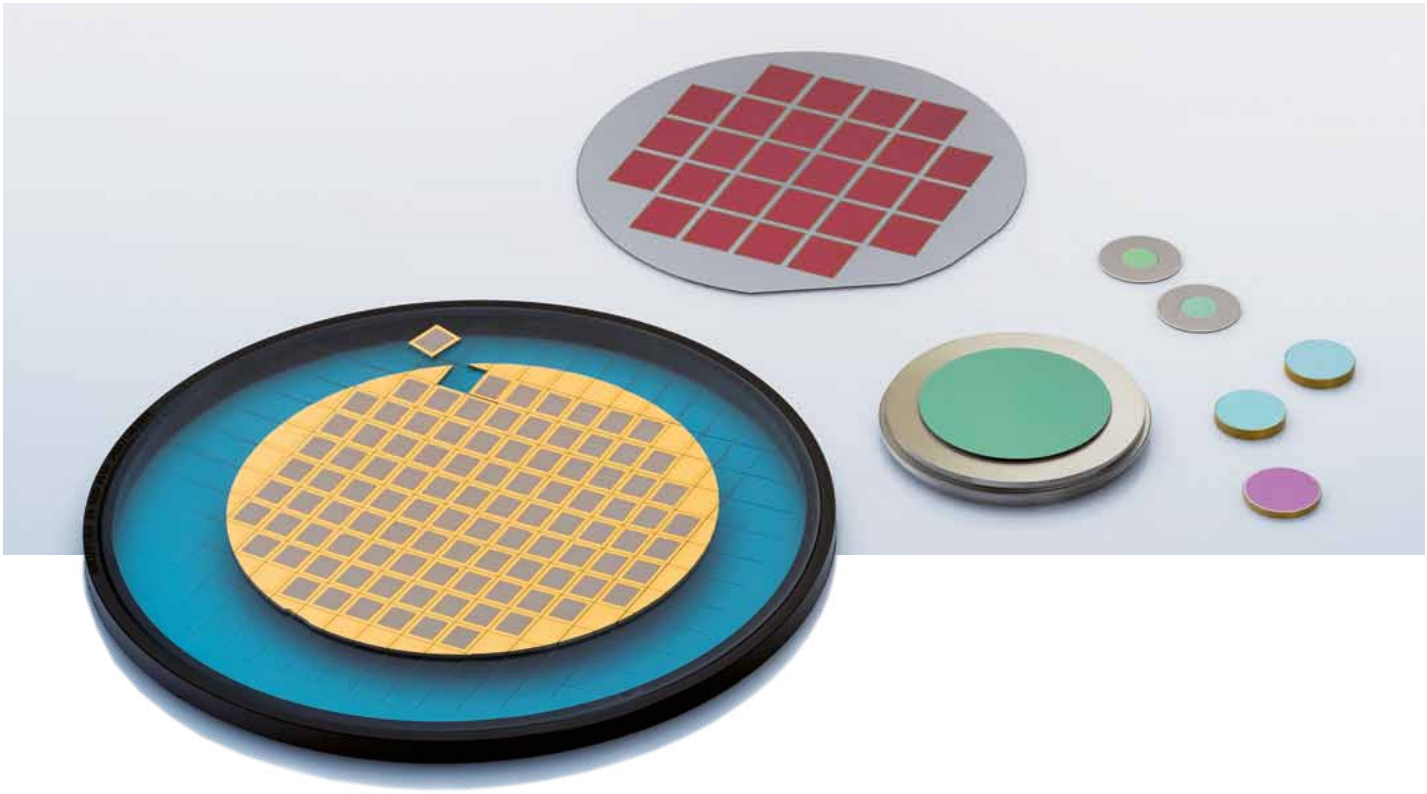
Following trend markets like ‚Smart Factory' and ‚Smart Home', the increasing IR detector market for civil applications needs new technologies. The machine solution Wafer-Level-Packaging (WLP) realizes a wafer fab manufacturing and, thus, a cost-optimized mass production. The priority is to ensure the entire processes like optical coating, mechanical protection and soldering on wafer level.
Jenoptik designs and manufactures optical coatings which are compatible with respective process conditions of the entire technology chain. In cooperation with its customers, Jenoptik develops coatings which exactly meet specific requirements for temperature and environmental stability.
For example, rectangular windows with IR bandpass filter and metal deposition (e.g. gold frame) up to 200 mm can be realized on wafer level.

While the wafer manufacturing based on MEMS technology is quite matured, developments for optical coatings, however, are limited in SWIR. For the spectral areas MWIR and LWIR Jenoptik developed a specific technology for coating Silicon MEMS-based wafers. Within joint projects Jenoptik succesfully cooperated with universities and industry partners.
With a very high depth of integration within the process chain Jenoptik is able to evaporate optical coatings on highly complex, structured MEMS Silicon wafers. To protect those micro-mechanics, Jenoptik further developed its coating systems and processes with special focus on the mechanical stress within the layer systems which survive the respective following process steps without any destruction.



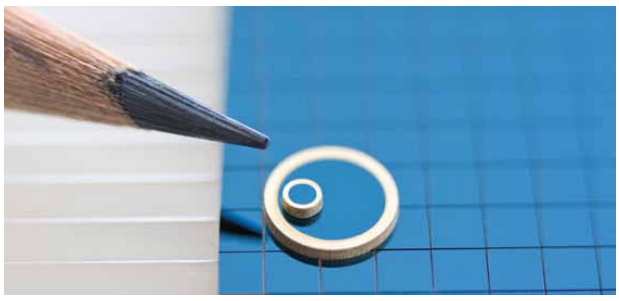


Patent pending EP 2758826, EP 2997406, US 20160062127, CN 105209949 A, JP 2016526290 A |
Granted patents DE 102010018052, EP 2381280, CN 103814326 B, EP 1727210, US 7,468,293



For detectors with minimized clear apertures, round shaped windows are advantageous. Single manufacturing of such windows leads to unreasonable high efforts in handling and when in addition minimized diameters are needed, an efficient serial production is nearly impossible. Jenoptik has wide-reaching know-how and provides the entire supply chain to manufacture wafers with specific optical coatings and to generate for example, round window elements afterwards. On request Jenoptik also offers hermetically soldered window elements and thus is providing the entire technology chain from one source. This patented technology not only allows individual shapes like round, oval, polygonal or any other form.
Also miniaturized diameters of 1 mm can be realized at reasonable costs.

Increasing demands for window elements are not only towards their multi-functionality – following the trend of miniaturization – they are also becoming steadily smaller. In addition, more and more required is the necessity of different optical coatings on one single window element. Jenoptik provides the technology which, for example, realizes the coating of the window's center that offers the first functionality and, in addition, the window's outer zone which offers the second.
Thereby, filters for different wavelengths or anti-reflective coatings for specific spectral ranges on one single window can be realized with accuracies in geometry up to 50 µm.



Standard Narrow Bandpass Filters

Highest Standards of Filters for Gas Analysis

Filters that show a half-power bandwidth up to 10 % with regards to their center wavelength are defined as Narrow Bandpass Filters (NBP).

To produce dielectrical optical NBP filters both surfaces of the substrates need to be coated respectively with a filter layer system and a blocking layer system (→ see Fig. 1) which are very complex. One filter layer system consists of approximately 10 ... 30 individual layers.
Up to 100 layers are necessary for one blocking system.

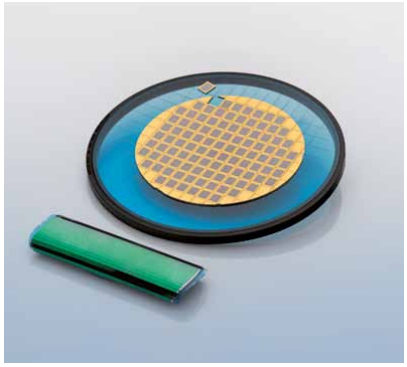
Jenoptik is able to design both systems in such a way that they best suit its customers' application.

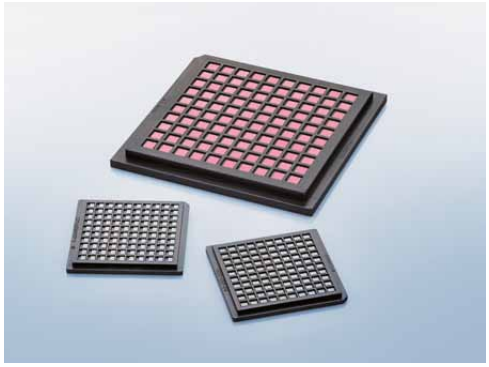
The filter design affects the bandwidth, the edge steepness as well as temperature and angle shift. The blocking system's design is decisive for the achievable attenuation that could be reached outside the passband (→ see Fig. 2).

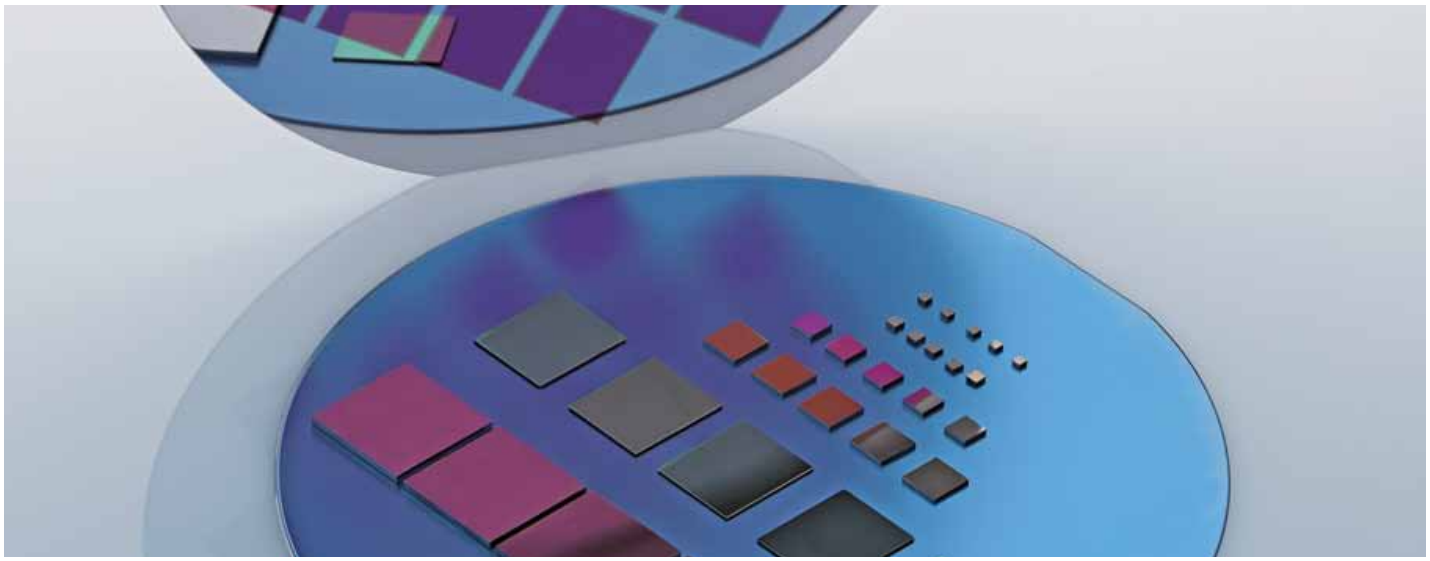
The number of single layers has an essential impact on the production costs.
In cooperation with its customers Jenoptik always focuses on an optimal cost-benefit-ratio solution.

Specifications & Technical Parameters

Filter	Application	CWL	CWL Tolerance	HPBW	HPBW Tolerance
JENOGAS 3.33	CH_4	3.330 µm	± 20 nm	160 nm	± 20 nm
JENOGAS 3.40	HC	3.400 µm	± 30 nm	120 nm	± 20 nm
JENOGAS 3.95	Reference	3.950 µm	± 35 nm	90 nm	± 10 nm
JENOGAS 4.26 - 001	CO_2 Narrow	4.260 µm	± 20 nm	90 nm	± 20 nm
JENOGAS 4.26 - 002	CO_2 Standard	4.260 µm	± 20 nm	180 nm	± 20 nm
JENOGAS 4.27	CO_2 Standard	4.270 µm	± 30 nm	170 nm	± 20 nm
JENOGAS 4.30	Flame	4.300 µm	± 30 nm	600 nm	± 30 nm
JENOGAS 4.45	CO_2 long path	4.450 µm	± 20 nm	60 nm	± 20 nm
JENOGAS 4.66	CO centered	4.660 µm	± 30 nm	180 nm	± 20 nm
JENOGAS 4.74	CO flank	4.740 µm	± 20 nm	140 nm	± 20 nm
JENOGAS 5.30	Nox	5.300 µm	± 40 nm	180 nm	± 20 nm
JENOGAS 7.30	SO_2	7.300 µm	± 40 nm	200 nm	± 30 nm







Deliverables:

- Production of standard filters with typical tolerances ± 1% on Si Wafers 4 inch
- Wafers cut to dimensions down to 1.0 x 1.0 mm on blue tape or separated in waffle packs
- On request – round or any freeform surfaces
- Additional solder metallization is possible
- Different substrates (Sapphire, Ge) and geometries can be provided

Durability:

- Adhesion: MIL-C-48497A / section 4.5.3.1
- Humidity: MIL-C-48497A / section 4.5.3.2
- Moderate Abrasion: MIL-C-48497A / section 4.5.3.3
- Temperature: MIL-C-48497A / section 4.5.4.1
- Solvent Resistance: MIL-C-48497A / section 4.5.4.2

Details for your RFQ:

Parameters:	Examplarily:
Center wavelength (CWL) with tolerance	CWL = 3.900 µm ± 30 nm
Half-power bandwith (HPBW) with tolerance	HPBW = 90 nm ± 10 nm
Peak transmission Tpeak	Tpeak > 80 %
Blocking range	from UV to 10 µm
Average transmission in the blocking range	Tave < 0.1 %
Angle of incidence (AOI)	AOI: 0° ± 10°
Filter dimension (diameter thickness)	Ø 100 mm ± 0.5 mm; Thickness 0.5 mm ± 0.5 mm
Operating temperature, slope or environmetal requirements	Tbd

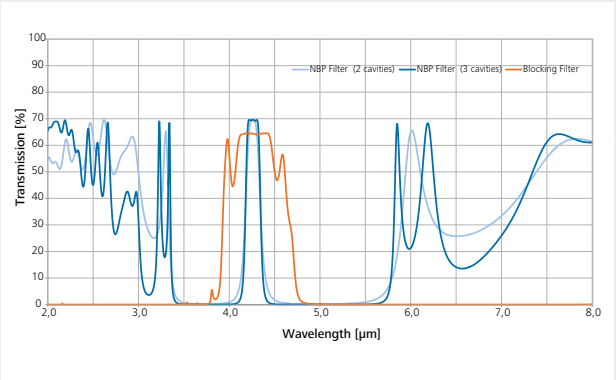


Fig. 1 shows the design principle of a NBP

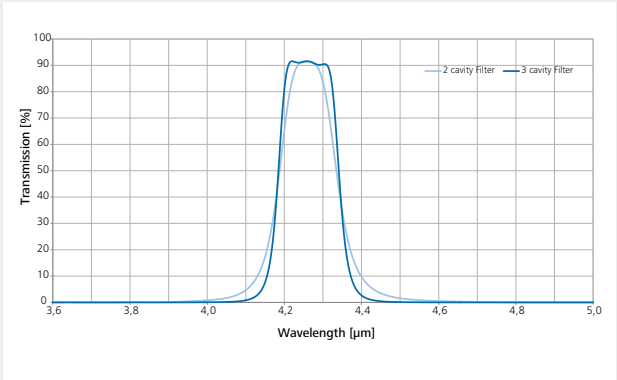


Fig. 2 shows different slopes related to the respective design

Bandpass Filters

Bandpass Filters are Applicable for a Wide Range of Functions

The use of bandpass filters realizes the transmission of light in one defined spectral range. By combining absorption through the substrate with the reflection of systems of intereference layers the blocking of light outside the requested transmission band can be reached.
The filter's passband can be designed very flexible by combining a longpass with a shortpass. Those complex layer systems are evaporated on each side of the substrate. The coating designs are customer-specific and optimized regarding the transmission within the bandpass. Jenoptik processes materials and technologies which guarantee a long lifetime.

USP:

- Durable: Ion-assisted coating technology guarantees long lifetime
- Customized: Individual designs possible
- Flexible: Suitable for a wide range of applications

Fields of Application:

Filters for cooled and uncooled IR detectors for:

- Military applications
- Homeland security
- IR gas analysis

Specification and Technical Information

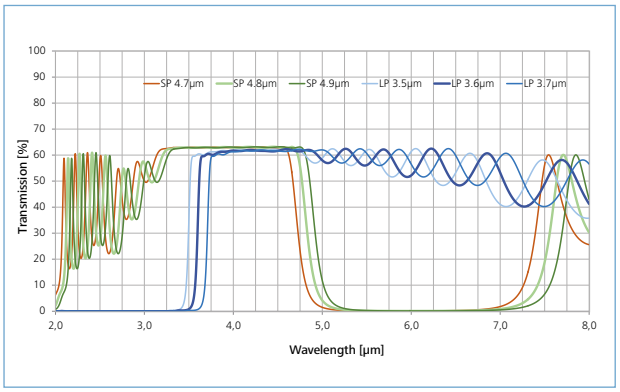


Fig. 1 shows the design principle of a BP filter generated by a short- and longpass filter design

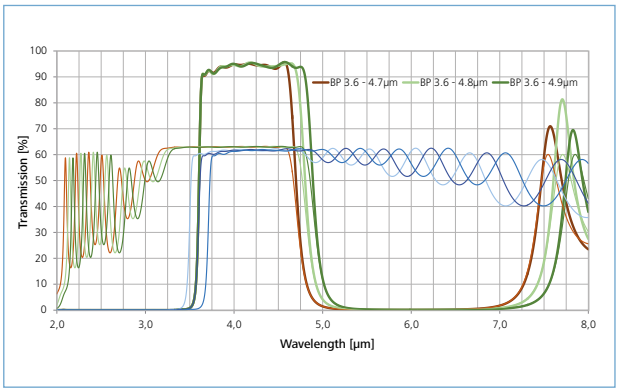
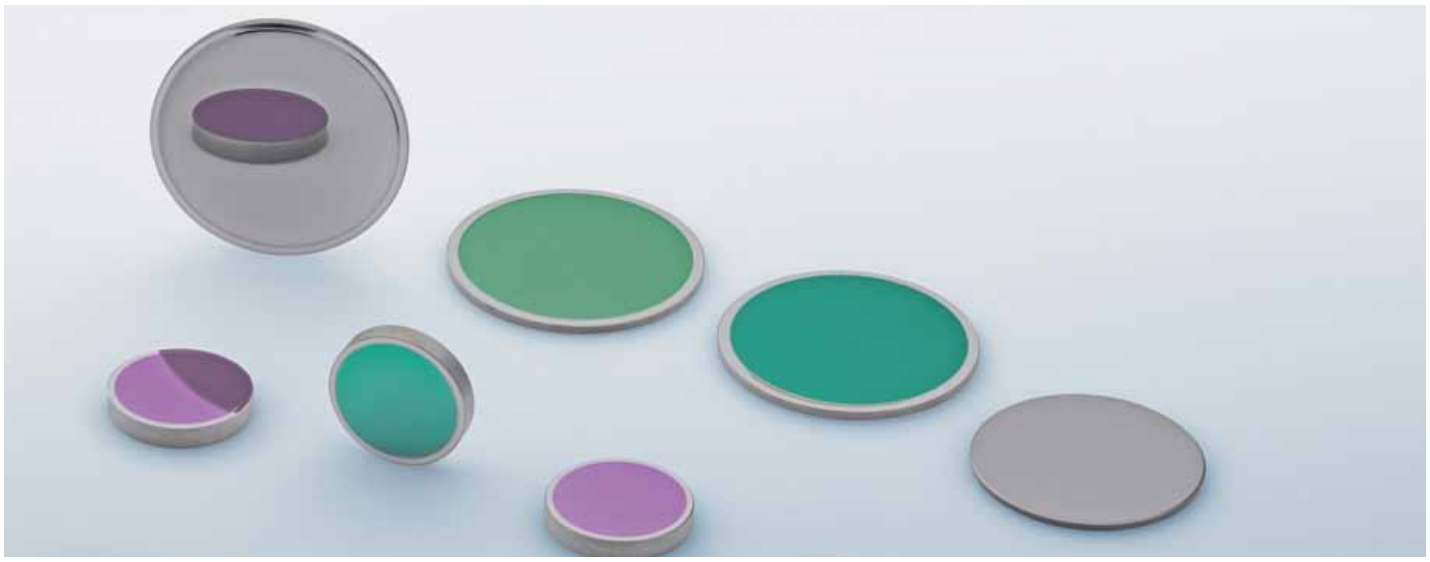


Fig. 2 shows different options of a BP filter. The bandwidth can be determined by the cut-on and cuf-off wavelengths

Details for your RFQ:

Parameters:	Examplarily:
Cut on 50 % with tolerance	Cut on 50 % = 3.60 µm ± 30 nm
Cut off 50 % with tolerance	Cut off 50 % = 4.80 µm ± 30 nm
Transmission in defined spectral range	Tave > 80 % from 3.65 to 4.75 µm
Blocking range	from UV to 8 µm
Average transmission in the blocking range	Tave < 0.1 %
Angle of incidence (AOI)	AOI: 0° ± 10°
Filter dimension (diameter thickness)	Ø 100 mm ± 0.5 mm; Thickness 0.5 mm ± 0.5 mm
Operating temperature, slope or environmetal requirements	Tbd

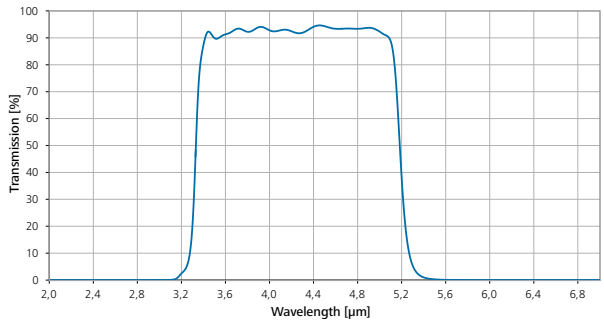


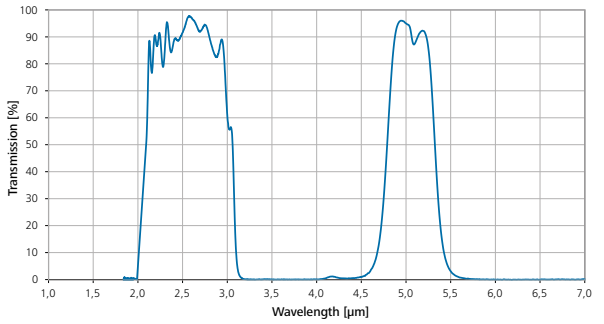
Deliverables:

- Manufacturing on single filter or wafer-level base according to customer specification
- All IR substrates adjusted to respective specification (e. g. Ge, Si, Sapphire, Fluorides)
- Adaption to respective operating temperature is possible (measurement at Cryo temperature down to 95 K)
- Filter geometries: Round or any individual size
- Hermetical soldering on request

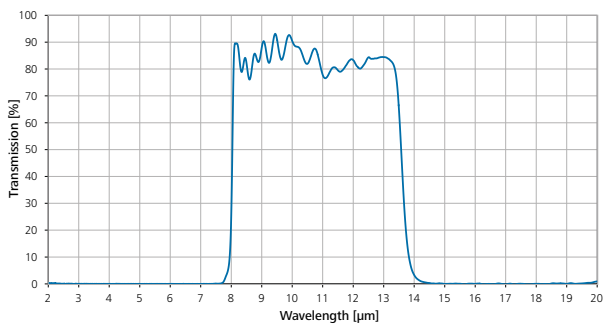
Durability:

- Adhesion: MIL-C-48497A / section 4.5.3.1
- Humidity: MIL-C-48497A / section 4.5.3.2
- Moderate Abrasion: MIL-C-48497A / section 4.5.3.3
- Temperature: MIL-C-48497A / section 4.5.4.1
- Solvent Resistance: MIL-C-48497A / section 4.5.4.2

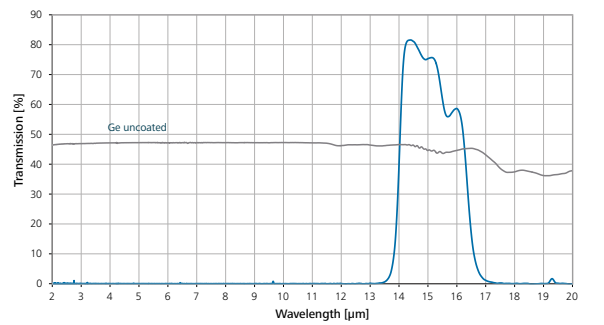




Dualband Bandpass Filter 1.9 - 2.5 µm and 4.8 - 5.3 µm on Ge



Bandpass Filter 8.0 - 14.0 µm on Si



Bandpass Filter 14.0 - 16.5 µm on Ge

Germanium & Silicon Blanks

Enabling Infrared Optics

Photonic Sense offers the complete value-added chain for infrared optics.

Photonic Sense, a Jenoptik company, is one of the distinctive companies in the world exclusively dedicated to manufacturing precision optical components for infrared applications made from Germanium and Silicon.

The company's 3,600 square meter, high-tech facility offers state-of-the-art capabilities for growing large monocrystals and CNC-driven manufacturing processes for prototype and high volume infrared optics.

Our advanced technology and equipment in production and inspection as well as the proven excellence of our employees guarantee consistent and cost-effective processes and high quality product.

USP:

- Photonic Sense Inc. is ITAR registered and compliant. The company works under the terms of an approved TAA
- All manufacturing processes are conform to ISO, ANSI and DIN
- Top of the notch Czochralski type crystal growing up to diameter 450 mm
- Fine ground, ready to polish surface option
- Refractive index measurements
- Complete value-added chain of infrared optics components

Fields of Application:

- Defense & security
- Thermography
- Industrial monitoring systems
- Laser systems
- Sensor systems

Europe & Asia

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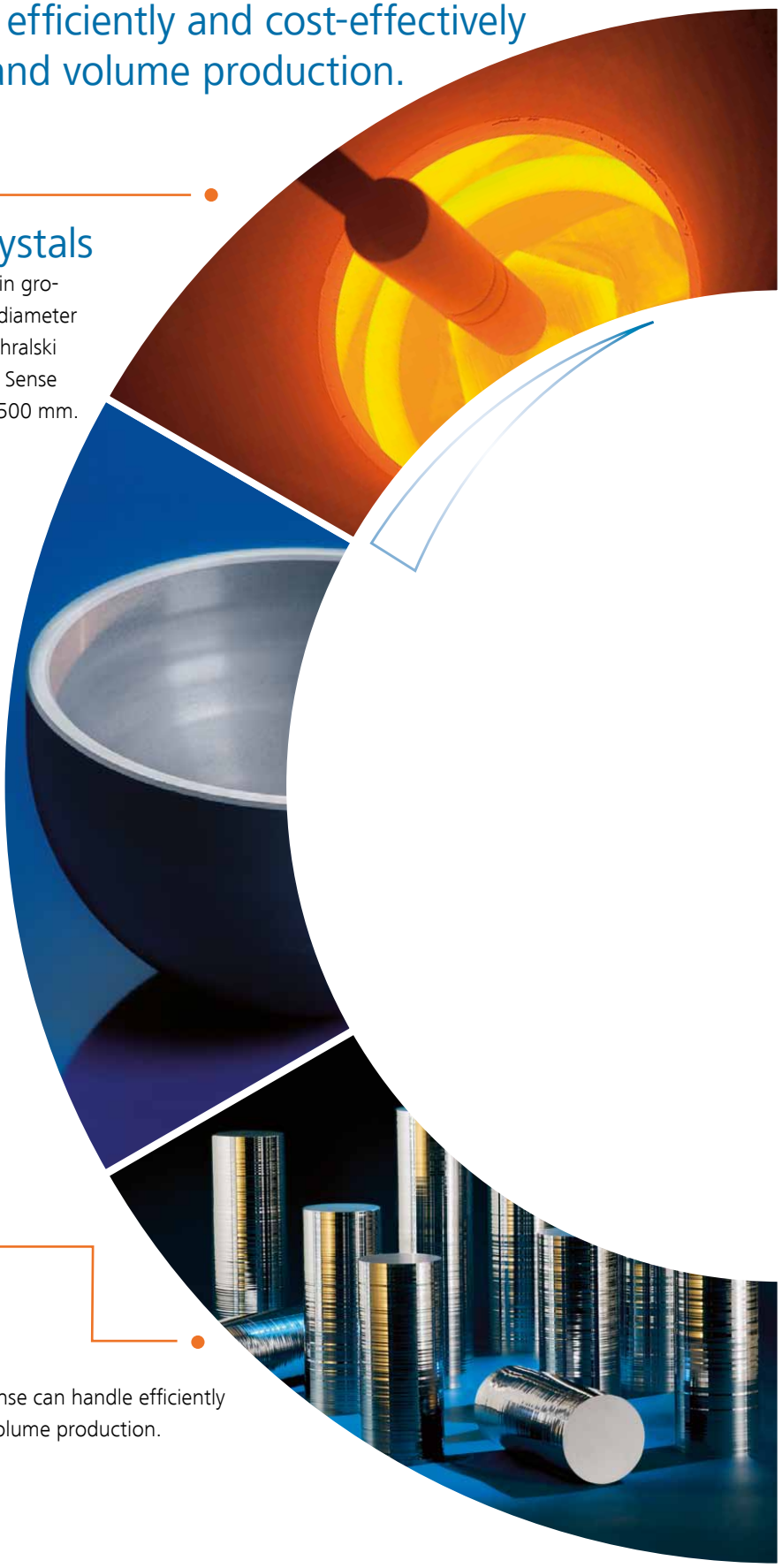
Complete Value-added Chain
of Infrared Optic Components

Photonic Sense can handle efficiently and cost-effectively both prototype quantities and volume production.



Grow Large Germanium Crystals

Photonic Sense has developed world class expertise in growing large Germanium crystals. Mono-crystals with diameter from 10 to 350 mm are routinely grown in our Czochralski type crystal pullers. For special applications Photonic Sense can provide Germanium crystals with diameter of > 500 mm.

Products and Scraps

Besides domes, windows and various blankets, Photonics Sense offers as well to buy your scrap.

Prototype Quantities and Volume Production

With its flexible structure and processes Photonic Sense can handle efficiently and cost effectively both prototype quantities and volume production.

CNC Driven Manufacturing Processes

Our-state-of-the art machine park and advanced CNC driven manufacturing processes guarantee tight near-net shape specifications of even the most complex blanks, like domes or windows and sputtering targets. Shape and tolerances according to customer drawing respectively our standard tolerances are +/- 0.025 mm.

Ready to Polish

Photonics Sense offers surface finish from Ra_{max} 0.2 µm to 4.0 µm (D7 to D46). Polishing or diamond turning upon request.

Measurement & Quality Control

Our advanced measuring technologies and equipments like refractice index measurement guarantee consistent and outstanding product quality.

"We are proud to help realizing tomorrow's solutions. Let us discuss your impediments that stop you from reaching the next level."

Digital Business Team

Digital Business

Smart Optical Solutions Enabling Digital Services

Transforming digitalization into sensation.

Digitalization is transforming everybody's life. It influences the way we live, we work, we cooperate, we play with increasing acceleration. This change provides significant business opportunities – new business models, new products are generated every day.
Within our group Digital Business we are analyzing these opportunities to understand the emerging technical requirements and the impact on production equipment. Our mission is to build smart solutions enabling our customers to engage in these opportunities.

Our smart optical solutions combine tailored optics with sensors and software applications to successfully shape your way into the digital world.

USP:

- Reliable partner for digital services
- Competitive high performance solutions
- Digital enabling products
- One-stop solutions

Fields of Application:

- Smart phone production: automated optical inspection
- Electronic manufacturing of Internet of Things devices: marking, cutting and drilling
- Production of medical devices: Unique Device Identification (UDI) solution
- Automotive battery: ablation and cutting
- Smart farming and optical sorting
- Imaging based process control
- Particle counting for process industry

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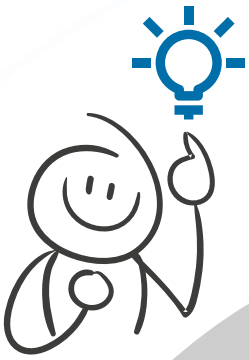
Micro Machining Tool

Laser Processing and Optical Inspection – Build in One Device

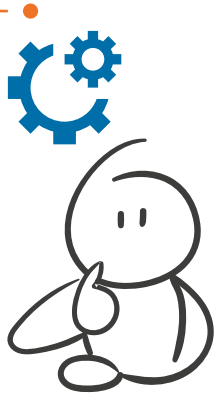
Smart Idea

The Micro Machining Tool is a smart solution combining laser processing and optical inspection in one device.
It is designed for machine manufacturers and companies looking for an easy way to integrate laser processes in their existing equipment.



One-stop Solution

The optical system is completely aligned and calibrated.
It offers a flexible configuration according to the applications it is used for. Basic setup includes beam expander, galvo scanner, F-Theta lens and an integrated camera channel. The Micro Machining Tool is available for different wavelengths and a suitable laser source can be added on demand.



Special Features

The integrated coaxial camera channel offers the opportunity for automatic position detection of the workpiece, which eliminates the complicated alignment and referencing of the setup. Moreover, it is possible to perform optical inspections task such as QR- or Data Matrix recognition, the localization of relevant details and automated assessment based on various defined criteria. The coaxial vision and laser system is enabling new high precision processes in automotive, consumer electronics, medical technology and many more.

Video

Find your way into our optics ...

We are looking forward to providing you with our Smart Digital Services.

Applications
for Micro Machining Tool

Black Marking / UDI

Traceable and non-corrosive marking (using USP laser)

- Surgical instruments and medical equipment
- Safety related components
- Natural anodized aluminum
- Front panels and smartphones

Glass Processing

Damage free manufacturing due to cold ablation

- Smartphone glass processing
- Gorilla Glass
- Laser bonding of two glasses
- Edge quality inspection “on-the-fly”

Consumer Electronics and PCB Processing

Versatile application possibility

- Encapsulation of electronic devices
- Precision marking, drilling, cutting
- High precision positioning
- Optical inspection of quality parameters

Looking forward
to Meeting You in 2018!

Exhibition	Location	Country	Date
SPIE BiOS	San Francisco, CA	USA	January 27 - 28
SPIE Photonics West	San Francisco, CA	USA	January 30 - February 01
SEMICON Korea	Seoul	South Korea	January 31 - February 02
ISE (Integrated Systems Europe)	Amsterdam	Netherlands	February 07 - 09
SPIE Advanced Lithography	San Jose, CA	USA	February 27 - 28
OFC	San Diego, CA	USA	March 13 - 15
Laser World of Photonics China	Shanghai	China	March 14 - 16
FOE (Fiber Optics Expo)	Tokyo	Japan	April 04 - 06
infoComm -ASIA	Beijing	China	April 11- 13
SPIE Defense + Commercial Sensing Conference	Orlando, FL	USA	April 15- 19
Waste Expo	Las Vegas, NV	USA	April 24- 26
32nd Control	Stuttgart	Germany	April 24- 27
LASER EXPO	Pacifico Yokohama	Japan	April 25- 27
AKL (Aachener Kolloquium für Lasertechnik)	Aachen	Germany	May 02 - 04
New Tech Israel	Tel Aviv	Israel	May 29 - 30
LASYS	Stuttgart	Germany	June 05 - 07
InfoComm	Orlando, FL	USA	June 06 - 08
SENSOR + TEST	Nuremberg	Germany	June 26 - 28
SEMICON West	San Francisco, CA	USA	July 10 - 12
Laser Korea	Seoul	South Korea	July 11 - 13
SPIE Optics + Photonics	San Diego, CA	USA	August 21 - 23
CIOE (China International Optoelectronic Exhibiton)	Shenzhen	China	September 05 - 08
ECOC Conference and Exhibiton	Rome	Italy	September 24 - 26
Laser World of Photonics India	Bangalore	India	September 26 - 28
InterOpto	Tokyo	Japan	October 17 - 19
Euroblech	Hannover	Germany	October 25 - 29
FabTech	Atlanta, GA	USA	November 06 - 08
Jenaer Lasertagung	Jena	Germany	November 22 - 23
Photonix Japan Expo and Conference	Chiba	Japan	December 05 - 07
SEMICON Japan	Tokyo	Japan	December 12 - 14

Imprint:

Editor:
JENOPTIK Optical Systems GmbH
Layout:
JENOPTIK Optical Systems GmbH
Print:
Druckhaus Gera GmbH
Images:
lochtephoto - Kurt Lochte (page titel, 3, 6, 31, 36, 38, 60, 70, 73, 75, 77-83)
JENOPTIK Optical Systems GmbH (page 3-5, 15, 46, 60-61, 74, 88, 91)
JENOPTIK Optical Systems, LLC (page 3, 47-50, 54-55, 62-63)
JENOPTIK Advanced Systems GmbH (page 59)
Fotolia (page 5, 90)
Wolfgang Oberle Fotograf (page 3, 16, 44, 46)
Jeibmann Photographik - Torsten Proß (page U4, 3, 5, 56, 59)
NARCISS & TAURUS cross media store gmbh (page 5)
Augenwerke Fotografie - Nadine Grimm (page 1, 10, 45, 57, 71, 89)
Art-Kon-Tor - Peter Eichler (page 59)
Drägerwerk AG & Co. KGaA (page 60)
Photonic Sense GmbH (page 84-87)
FUSE Integrierte Kommunikation und Neue Medien GmbH (page 90-91)

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000000-100-99-11-en-002-210-1801