JENOPTIK

MORE LIGHT

Featured optic products 2019

Realize your success with products from Jenoptik.

Closer to You
Key Locations

North America

Canada
Barrie
Toronto

Mexico
Saltillo

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

Europe

Austria
Vienna

Czech Republic
Teplice

France
Bayeux

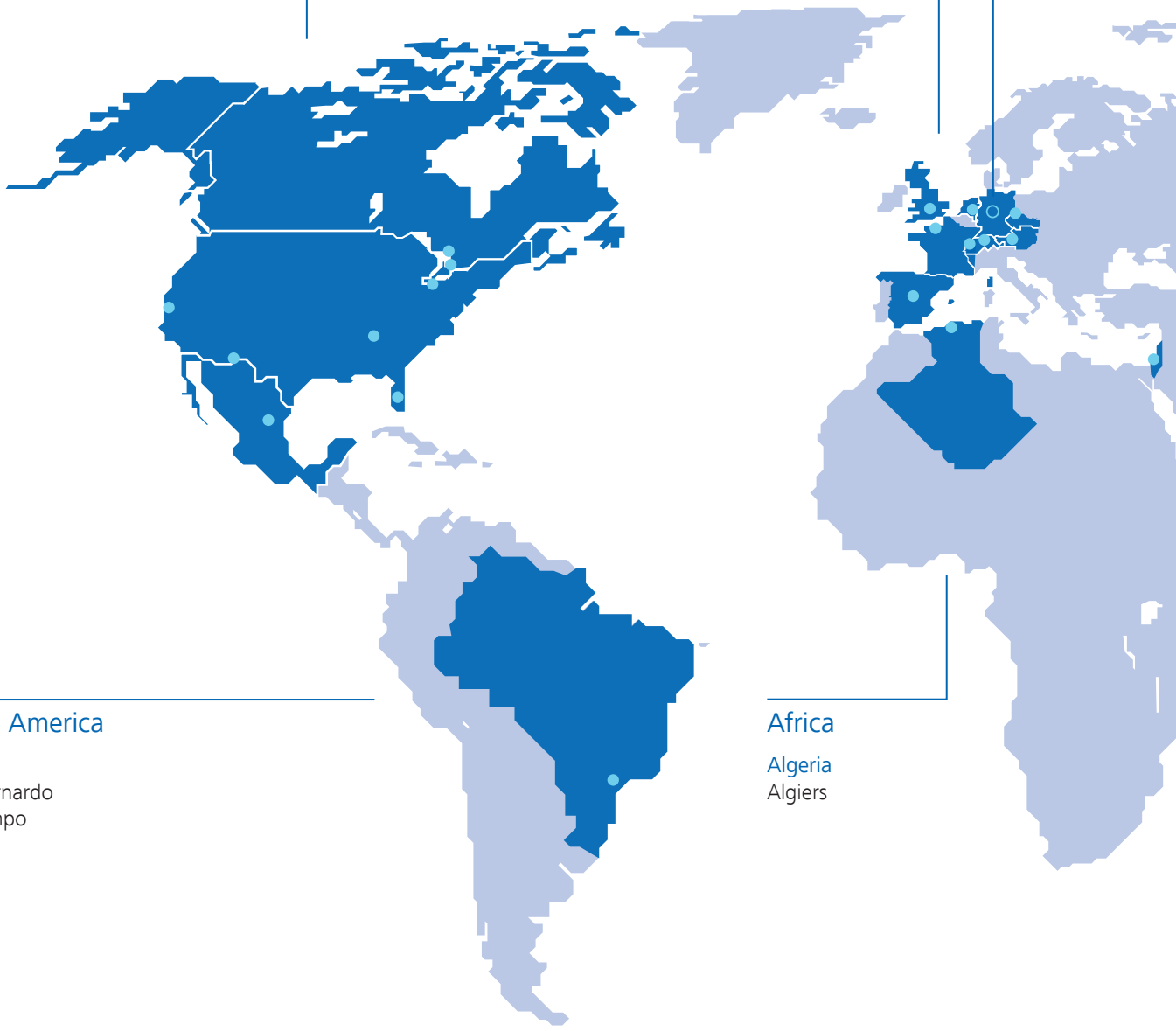
Israel
Nes Ziona

Netherlands
Riel

Spain
Madrid

Switzerland
Peseux
Uster

United Kingdom
Camberley



South America

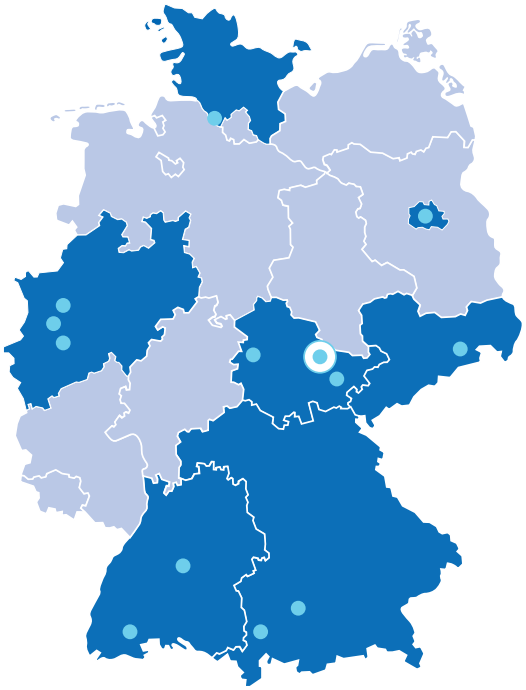
Brazil
São Bernardo
do Campo

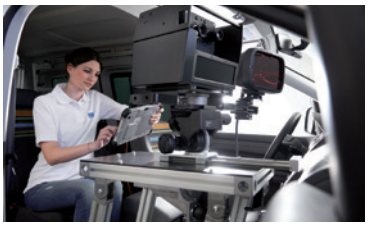
Africa

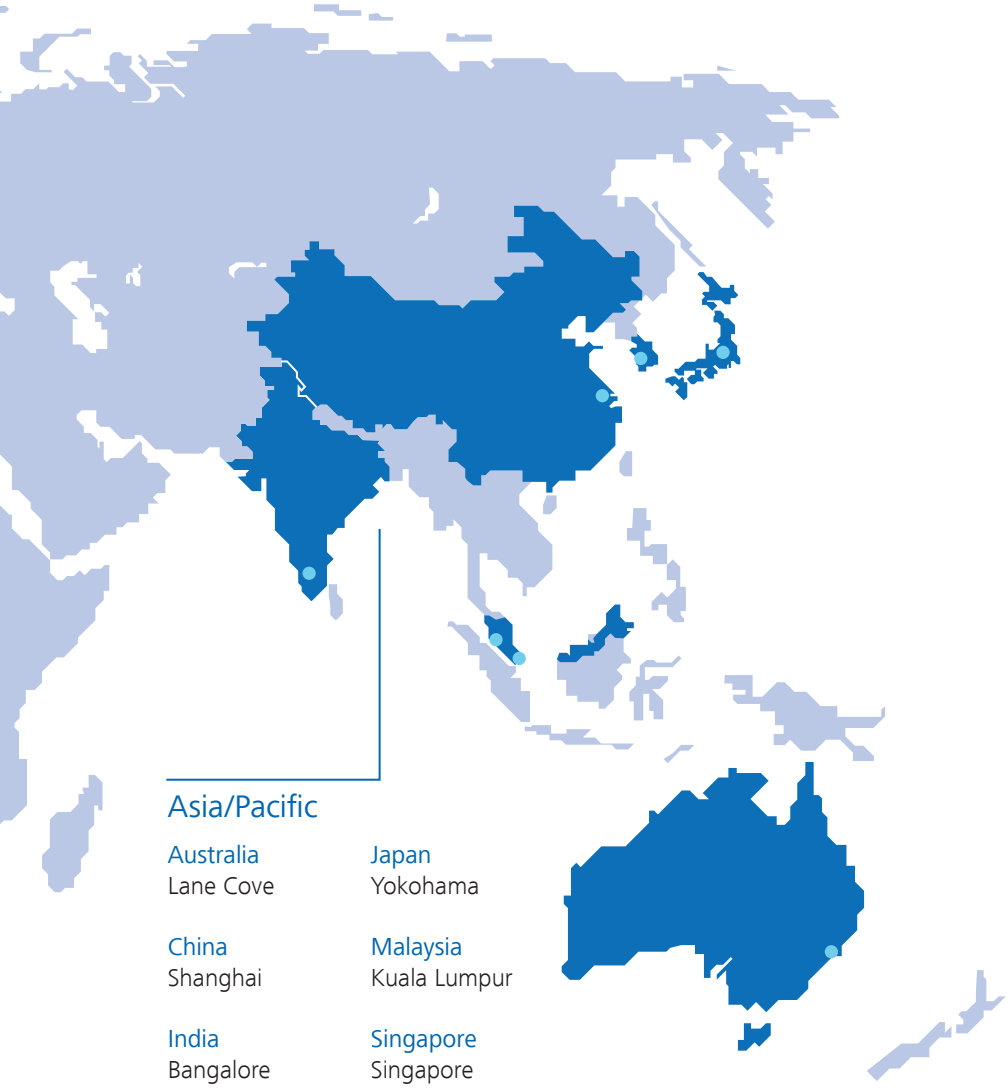
Algeria
Algiers

Germany

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







Asia/Pacific

Australia
Lane Cove

China
Shanghai

India
Bangalore

Japan
Yokohama

Malaysia
Kuala Lumpur

Singapore
Singapore

South Korea
Pyeongtaek

Jenoptik
A Globally Operating Photonics Group

In 2018 our 4,043 valued employees generated revenue of approximately 834 million Euros.

Photonics is one of the foundations of our core strengths. Our mission is to concentrate our successful path on applications for attractive and promising photonics markets and thus, on topics such as information processing, intelligent manufacturing processes, sensors and measurement technology as well as biophotonics.

The structure of the Jenoptik Group

LIGHT & OPTICS OEM-Business	LIGHT & PRODUCTION B2B-Business	LIGHT & SAFETY B2G-Business	VINCORION A member of Jenoptik Group
Your OEM design and manufacturing partner for optical components, modules and systems for the semiconductor industry, communication and biophotonics.	Your engineering partner for industrial application with a focus on smart manufacturing and process automation.	Your supplier of imaging based solutions for public safety offering full range service around the globe.	Your provider of electro-mechanical solutions for the aviations and securtiy industry and a member of Jenoptik Group that offers service and solutions under its own brand.




MORE LIGHT …

… Is the headline for all our initiatives to develop Jenoptik further. Based on the three pillars, we will move to the next level and will support you to be one step ahead!

More Focus

We leverage our core competencies in optics and photonics.

More Innovation

We will step up our R&D activities.

More International

We will build truly global enterprise.

Shaping, directing and detecting light with products from Jenoptik

Dear valued customer,

We look forward to shaping the future with you!

For more than 25 years, Jenoptik's core competencies have been enabled by our expertise in emitting, shaping and directing light. We offer sophisticated technologies and a combination of broad knowledge and deep experience in the fields of optics, image processing, lasers, and sensor technologies to produce customer-specific and intelligent optical solutions for industry, medicine and research, and for all aspects of digital communication.

Jenoptik strategically invests in R&D and partners with well-established research institutes to ensure that we remain on the cutting edge of photonics technologies.

Jenoptik successfully collaborates with system integrating OEM companies in a diverse set of industries such as semiconductor equipment, laser material processing, safety & security, and medical technology around the globe. Early engagement with our customers at the very beginning of a project enables us to contribute at a very high level and facilitate the development of more highly-integrated optical solutions.

Working closely with you and by leveraging our expertise, innovations, and close collaboration, we will develop the perfect solution for your demanding projects.
You can rely on Jenoptik to ensure that your critical developments are a success!

It's time for Light & Optics. Find your way into our optics!

Dr. Ralf Kuschnereit
Executive Vice President Light & Optics

Find your way into our optics …

Video

Content

Featured Optic Products 2019

JENOPTIK | Light & Optics

Optical Technologies for Specialized Applications

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

The Light & Optics division of Jenoptik is one of the few research, development and production partners worldwide for optical, micro optical and opto-electronic 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 | Division Light & Optics

Semiconductor & Advanced Manufacturing

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
- Laser material processing
- Digital world & entertainment
- Healthcare
- Safety & security
- Optical information & communication technologies

Laser Material Processing

Contact Worldwide

Global

JENOPTIK · Light & Optics

JENOPTIK Optical Systems GmbH
Goeschwitzer Strasse 25
07745 Jena · Germany
www.jenoptik.com/optics

Mr. Bernhard Westerhoff
bernhard.westerhoff@jenoptik.com
Phone +49 3641 65-3327

North America

Mr. Jim Volek
jim.volek@jenoptik-inc.com

JENOPTIK Optical Systems, LLC.
39300 Civic Center Drive, Suite 240
Fremont · CA 94538 · USA
Phone: +1 561 881 7400

China

Mr. Robin Bai
robin.bai@jenoptik.com

JENOPTIK (Shanghai) Precision
Instrument and Equipment Co.,Ltd.
Building 15, No. 3999 Xiupu Road
201315 Shanghai
Phone +86 21 3825-2380

Israel

Mr. Vladislav Gvardiyan
vladislav.gvardiyan@jenoptik.com

Branch Office Israel
Einstein Street 16
76470 Nes Ziona
Phone +972 8 930 3501

Japan

Ms. Yuko Tanaka
yuko.tanaka@jenoptik.com

JENOPTIK Japan Co., Ltd.
4666 Ikebe-cho Tsuzuki-ku
224-0053 Yokohama-City, Kanagawa
Phone +81 45 345 0003

Korea

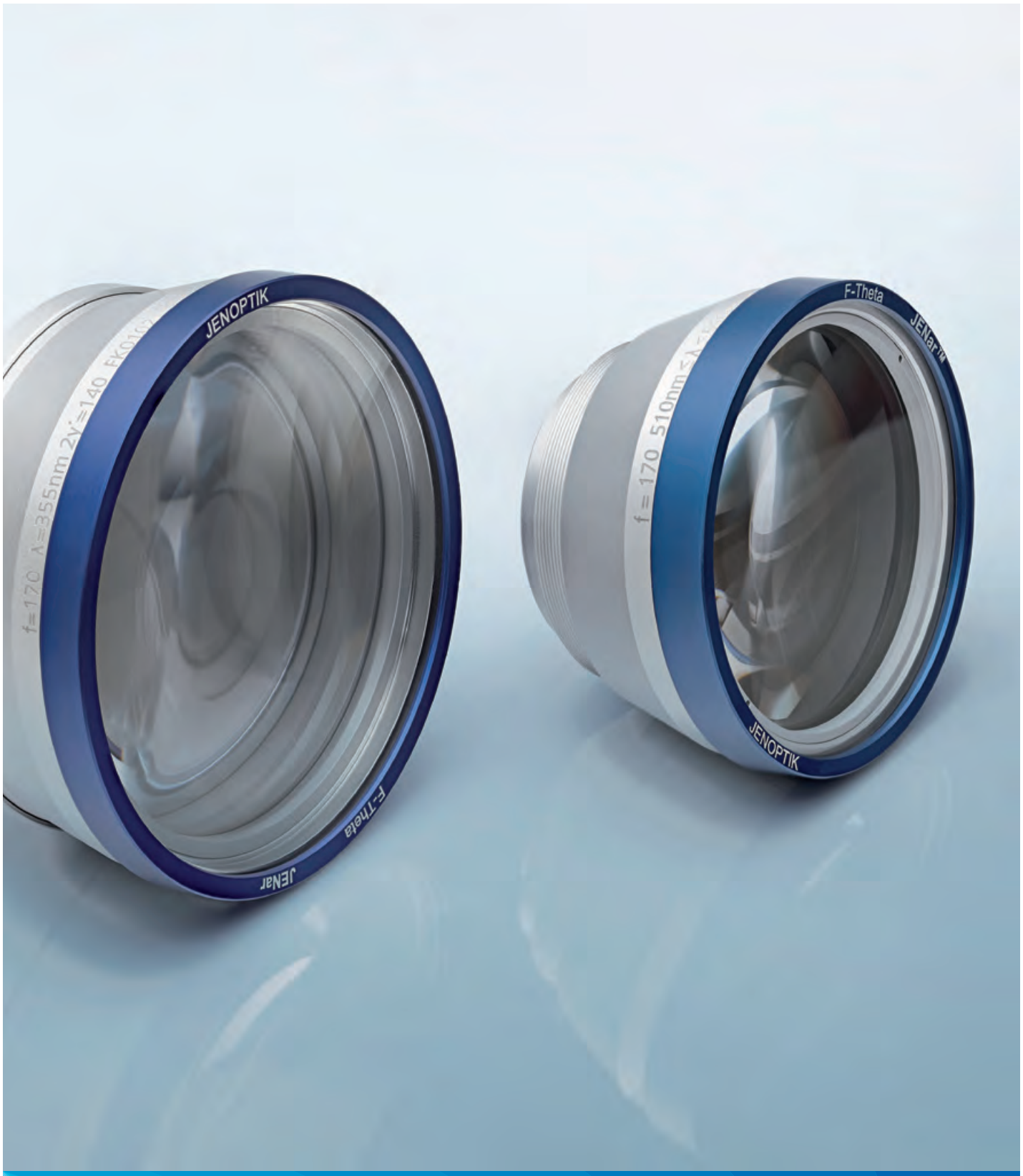
Mr. Cavin Kim
cavin.kim@jenoptik.com

JENOPTIK Korea Corporation, Ltd.
91, Hyeongoksandan-ro 93 beon-gil,
Cheongbuk-myeon, Pyeongtaek-si,
Gyeonggi-do, 17812 Pyeongtaek City
Phone +82 10 3753-2503

South East Asia

Mr. Dennis Yeh
dennis.yeh@jenoptik.com

JENOPTIK Asia Pacific Pte. Ltd.
20 Harbour Drive PSA Vista #05-06A
Singapore 117612
Phone +65 6774 0479-115



F-Theta JENar™ Silverline™

High Power Scan Lenses "Made in Germany"

Minimal absorption for high power and short pulse applications.

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

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

USP

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

Fields of Application

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

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

Contact

Contact worldwide → please see page 7

Find your way into our optics …

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

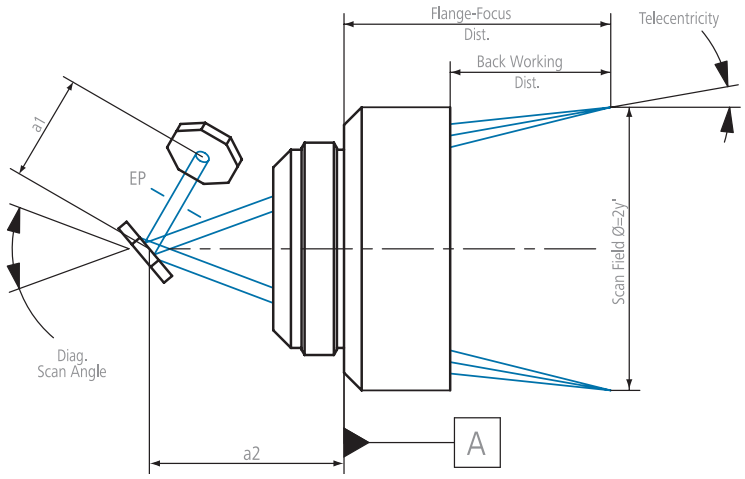
Type: Silverline™ [1]/ High Power Scan Lens Series[1]

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

[1] fused silica

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

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



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

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

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

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

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

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

F-Theta JENar™ Silverline™ Lenses

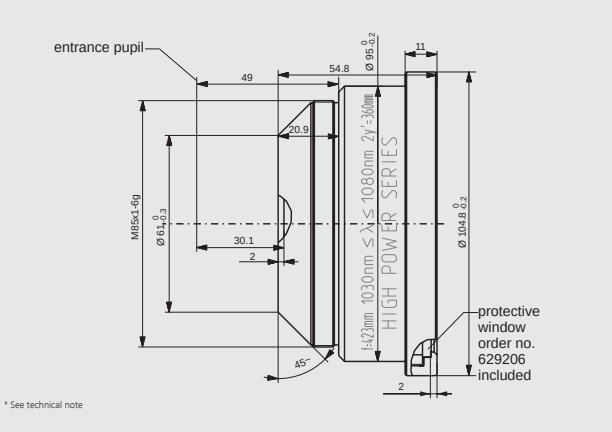
Lens for Large Scan Fields | High Power Lenses

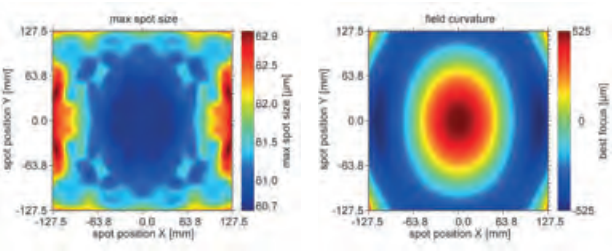
NEW**

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

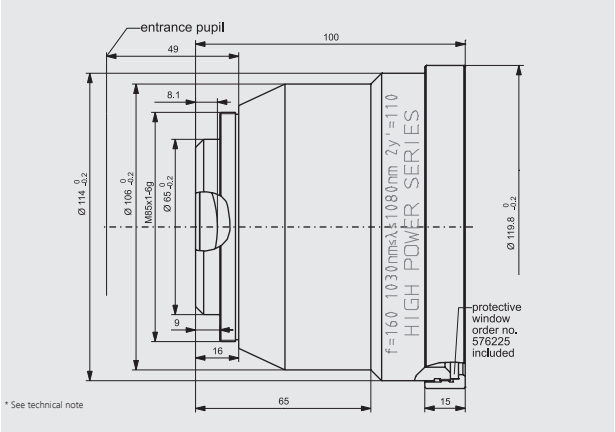
Specifications

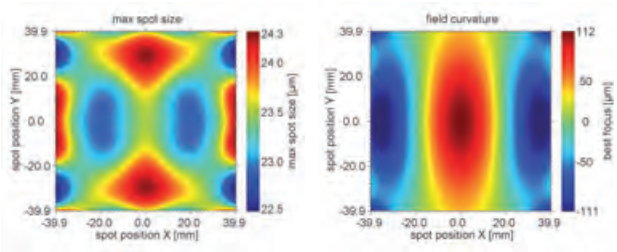
JENar™ 423-1030…1080-360





JENar™ 160-1030…1080-110





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

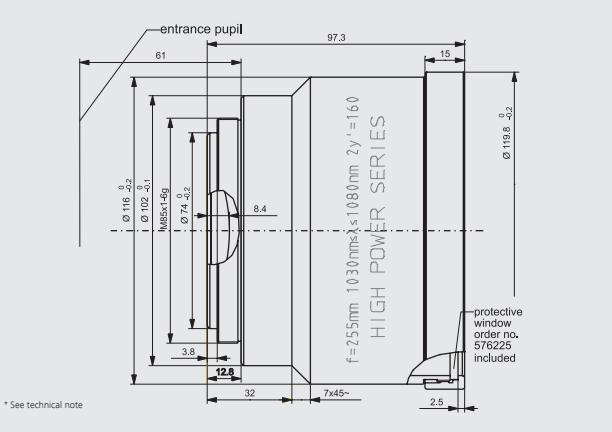
F-Theta JENar™ Silverline™ Lenses

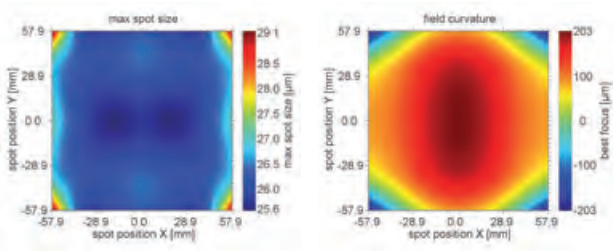
High Power Lenses

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

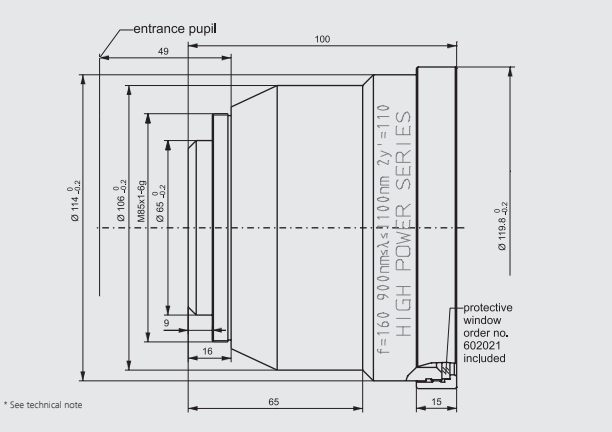
Specifications

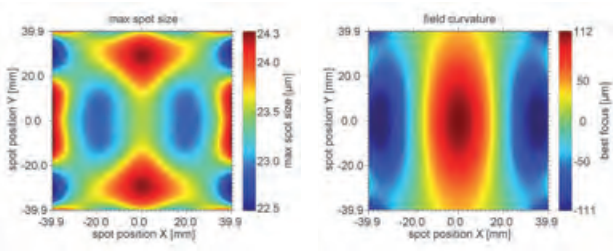
JENar™ 255-1030…1080-160





JENar™ 160-900…1100-110





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

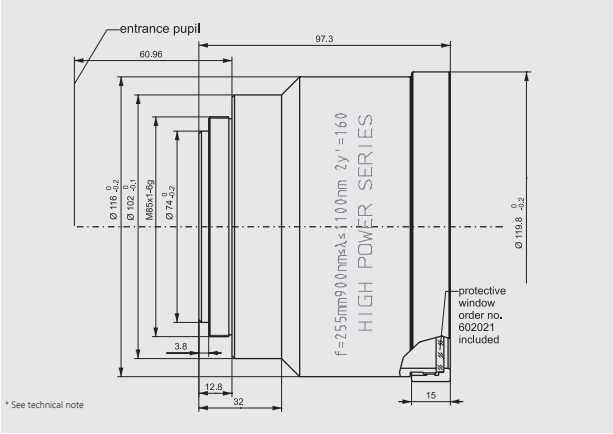
F-Theta JENar™ Silverline™ Lenses

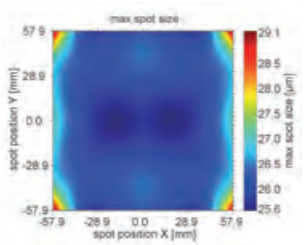
High Power Lenses

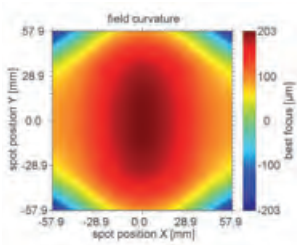
Parameters	JENar™ 255-900…1100-161 Fused silica lens	JENar™ 103-355-71 Telecentric fused silica lens
Focal length:	255 mm	103 mm
Wavelength:	900…1100 nm	355 nm
Scan field (X x Y); Ø:	(114 mm x 114 mm); 161 mm	(50 mm x 50 mm); 71 mm
Diagonal scan angle:	± 18°	± 20.1°
X/Y mirror angle:	± 6.4°	± 7.2°
Back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

Specifications

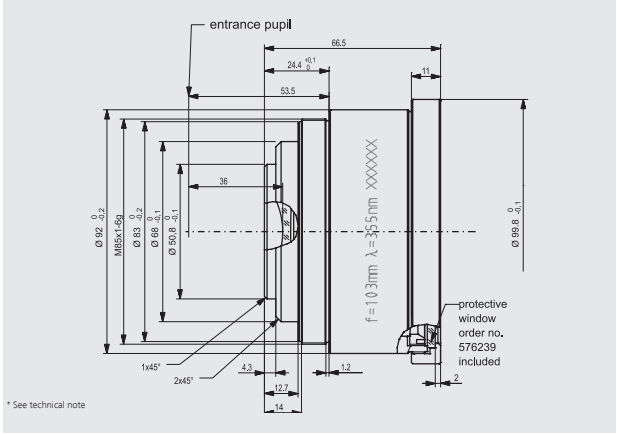
JENar™ 255-900…1100-161

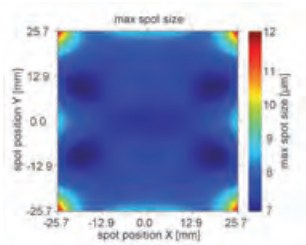


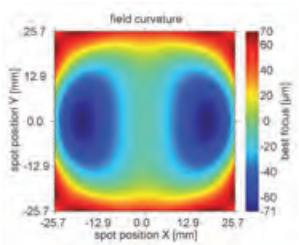




JENar™ 103-355-71







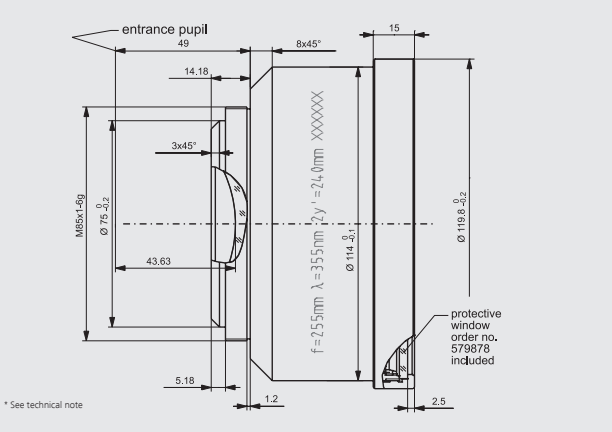
JENar®: Registered in EU, CN, JP, SG, US | Silverline®: Registered in DE, JP, SG, IN

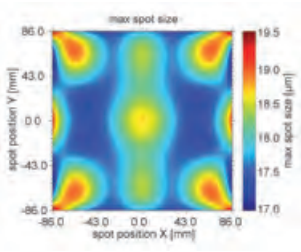
F-Theta JENar™ Silverline™ Lenses

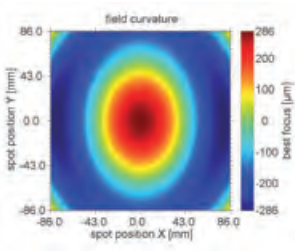
High Power Lenses

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

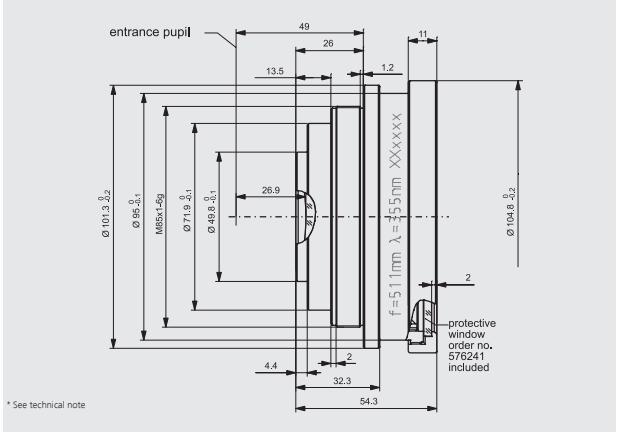
Specifications
JENar™ 255-355-240

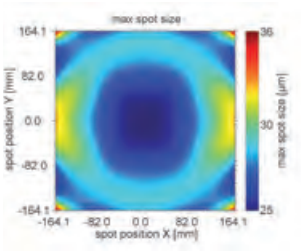


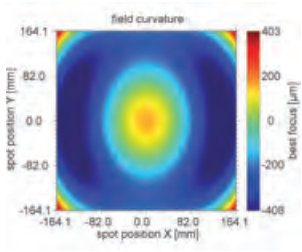




JENar™ 510-355-431







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

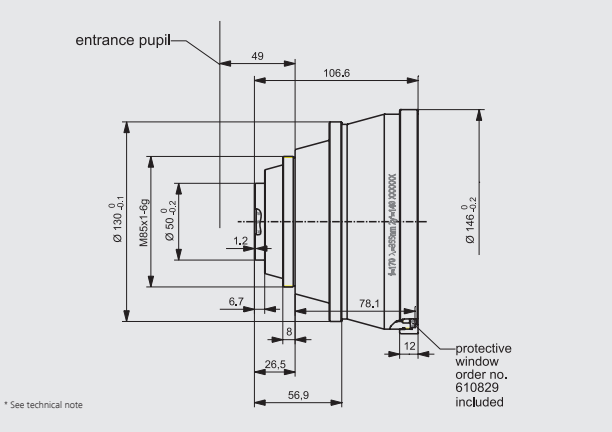
F-Theta JENar™ Silverline™ Lenses

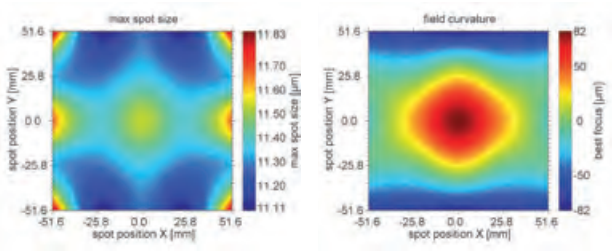
High Power Lenses

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

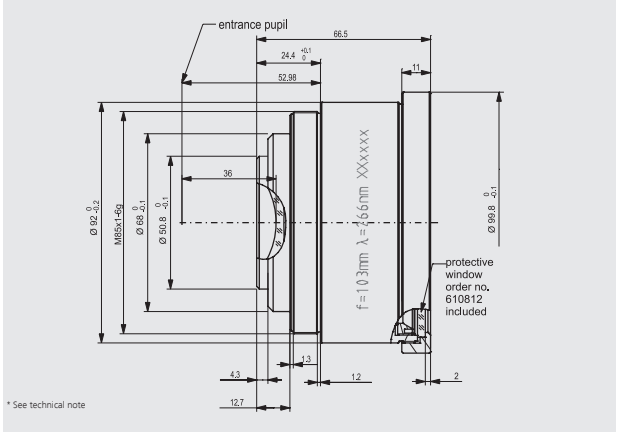
Specifications

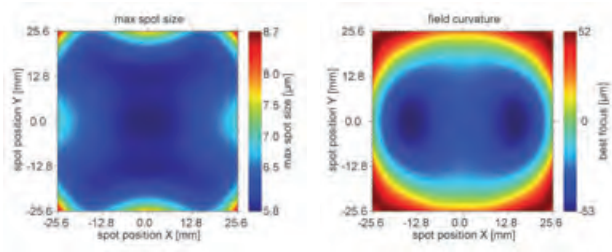
JENar™ 170-355-140





JENar™ 103-266-71





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

F-Theta JENar™

Scan Lenses "Made in Germany"

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

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

USP

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

Fields of Application

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

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

Contact

Contact worldwide → please see page 7

Find your way into our optics …

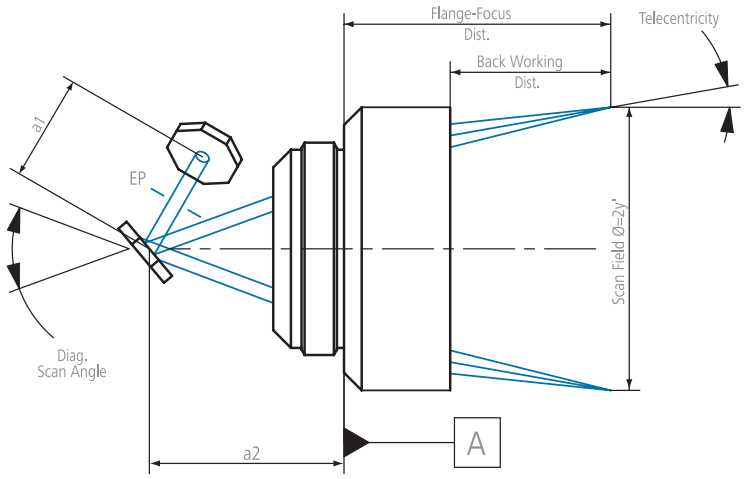
Technical Parameters & Properties F-Theta JENar™ Lens Series.

Type: F-Theta Lenses

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

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

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



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

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

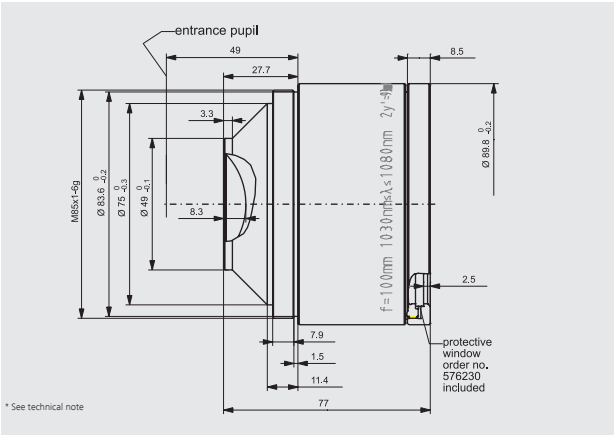
F-Theta JENar™ Lens Series

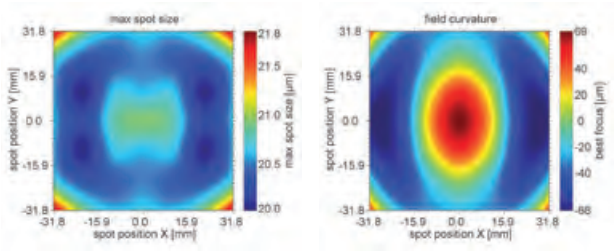
High Image Quality | Telecentric Lens

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

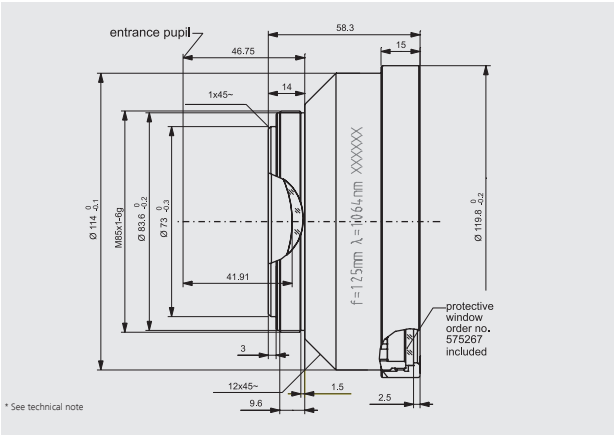
Specifications

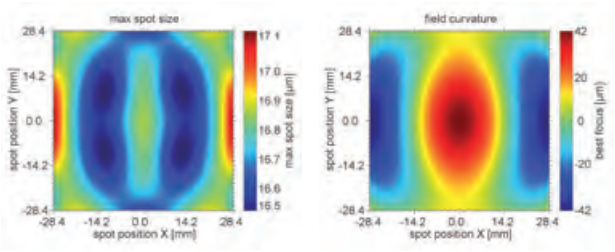
JENar™ 100-1030…1080-93





JENar™ 125-1030…1080-80





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

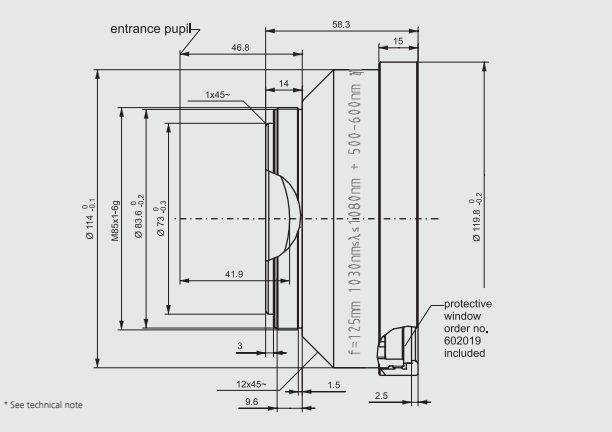
F-Theta JENar™ Lens Series

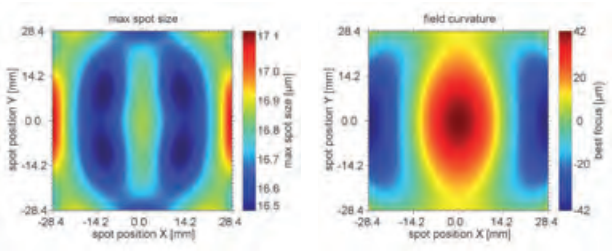
Telecentric Lens | Large Scan Fields

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

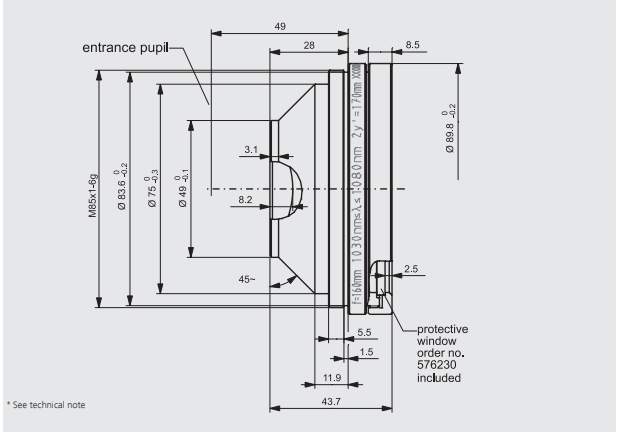
Specifications

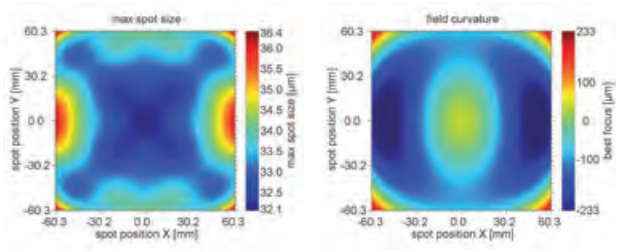
JENar™ 125-1030…1080-80 + VIS





JENar™ 160-1030…1080-170





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

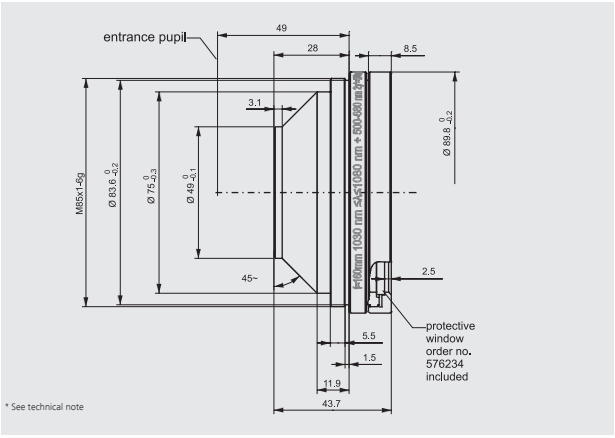
F-Theta JENar™ Lens Series

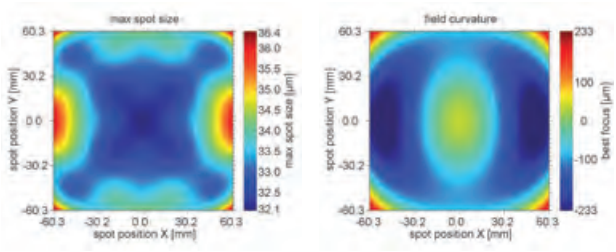
Large Scan Fields | High Image Quality

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

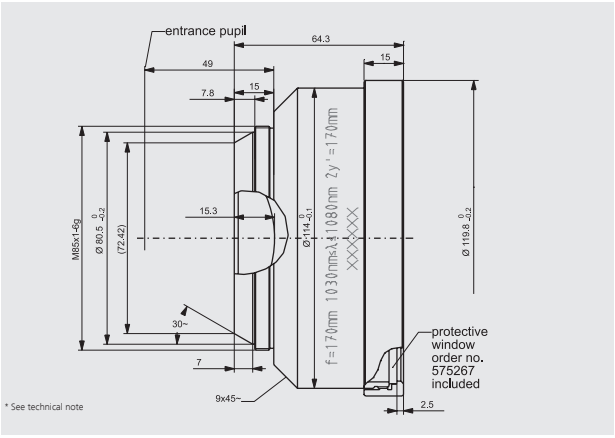
Specifications

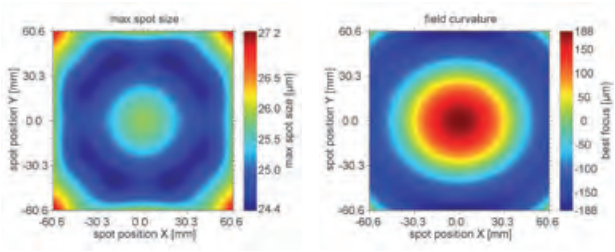
JENar™ 160-1030…1080-170 + VIS





JENar™ 170-1030…1080-170





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

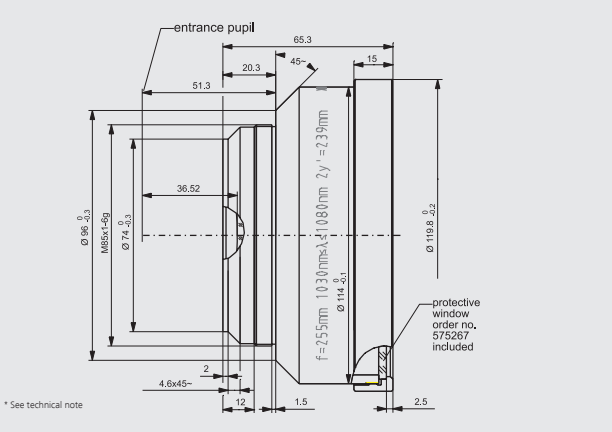
F-Theta JENar™ Lens Series

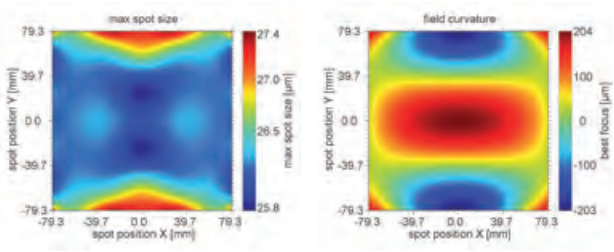
Larger Beam Diameters and Scan Fields

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

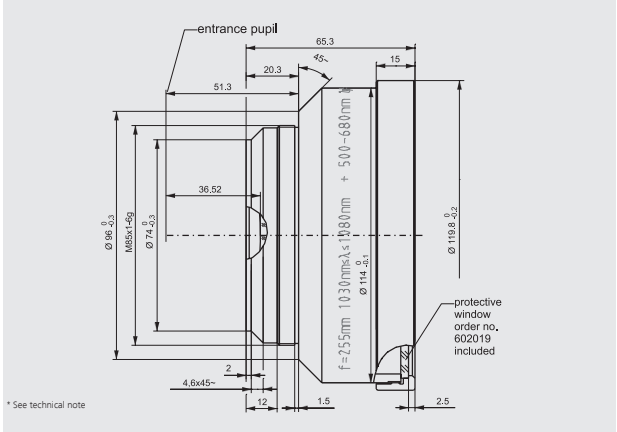
Specifications

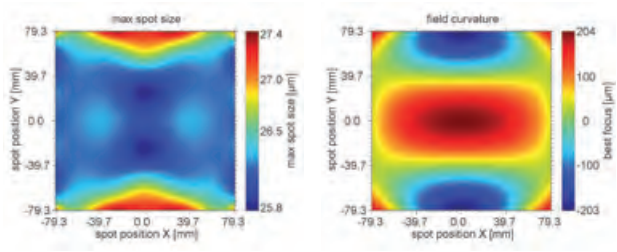
JENar™ 255-1030…1080-239





JENar™ 255-1030…1080-239 + VIS



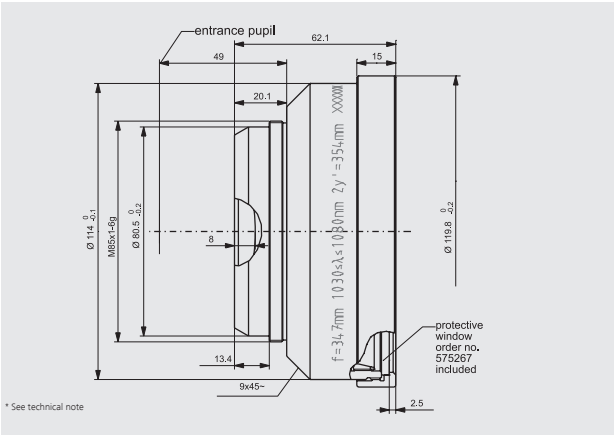


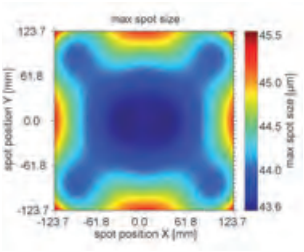
JENar®: Registered in EU, CN, JP, SG, US
F-Theta: Registered Design in EU, CN, KR, IN, SG, JP, HK, TW

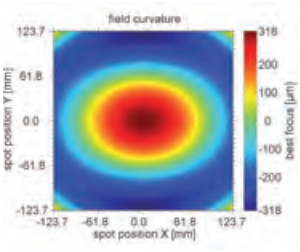
F-Theta JENar™ Lens Series
Large Scan Fields

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

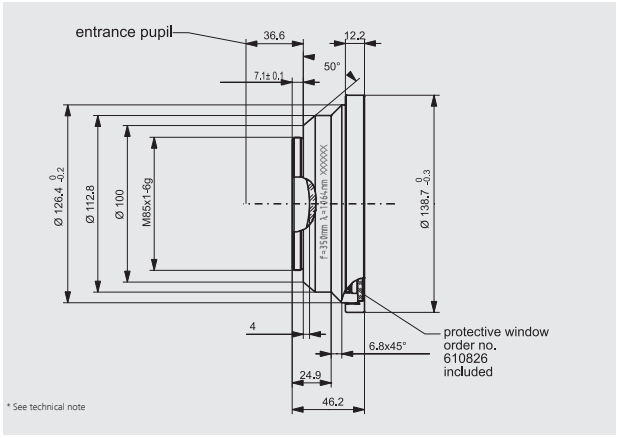
Specifications
JENar™ 347-1030…1080-354

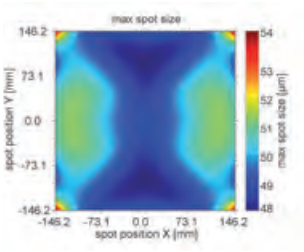


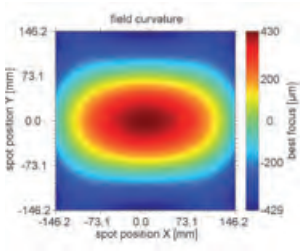




JENar™ 350-1030…1080-452







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

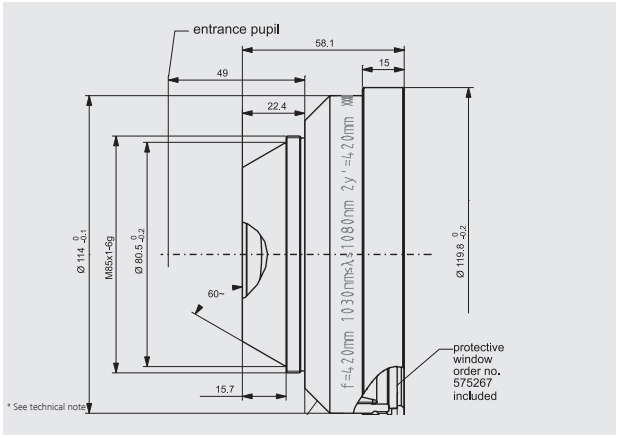
F-Theta JENar™ Lens Series

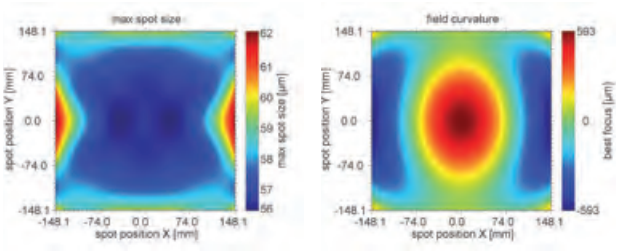
Large Scan Fields | High Image Quality

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

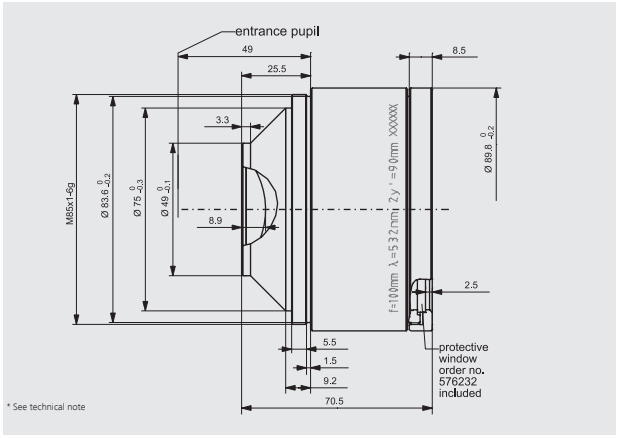
Specifications

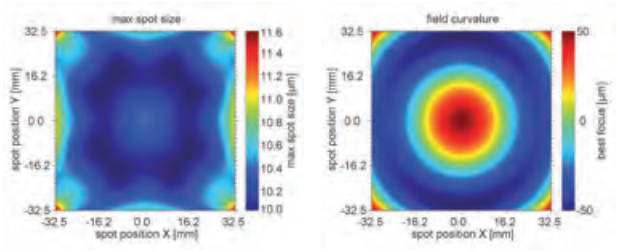
JENar™ 420-1030…1080-420





JENar™ 100-515…540-90



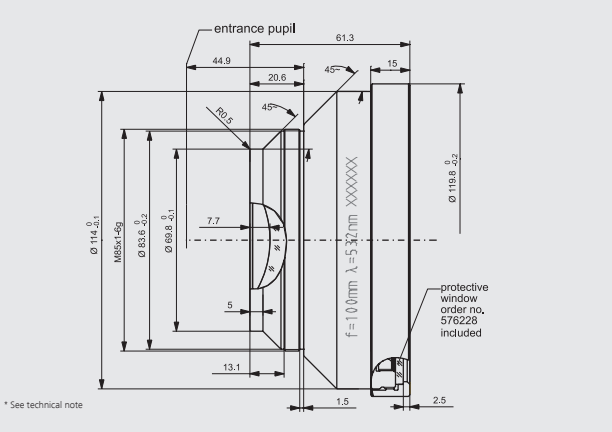


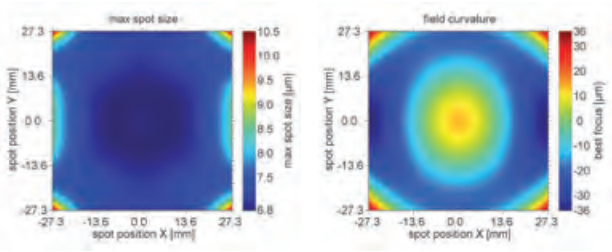
JENar®: Registered in EU, CN, JP, SG, US
F-Theta: Registered Design in EU, CN, KR, IN, SG, JP, HK, TW

F-Theta JENar™ Lens Series
Telecentric Lenses

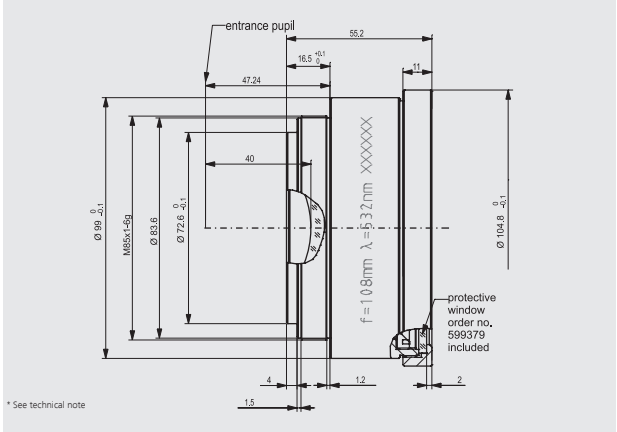
Parameters	JENar™ 102-515…540-75 Telecentric lens	JENar™ 108-515…540-75 Telecentric lens
Focal length:	102 mm	108 mm
Wavelength:	515…540 nm	515…540 nm
Scan field (X x Y); Ø:	(53 mm x 53 mm); 75 mm	(53 mm x 53 mm); 75 mm
Diagonal scan angle:	± 21.5°	± 20°
X/Y mirror angle:	± 7.7°	± 7.1°
Back working distance: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

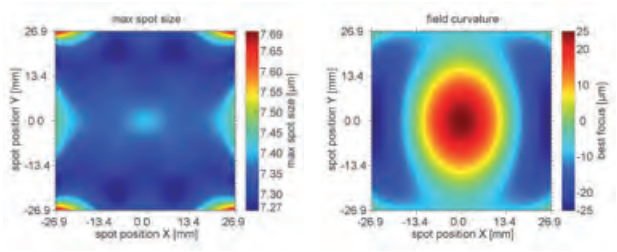
Specifications
JENar™ 102-515…540-75





JENar™ 108-515…540-75





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

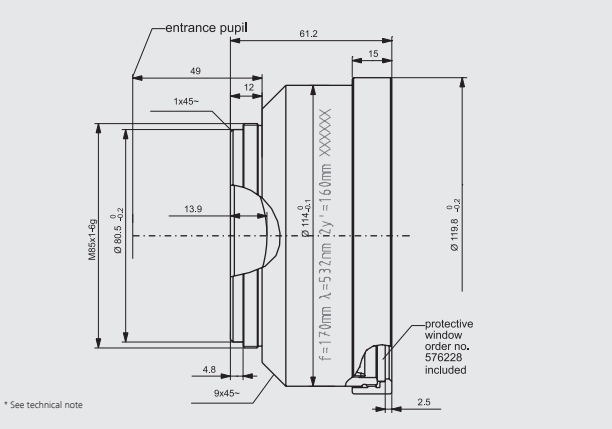
F-Theta JENar™ Lens Series

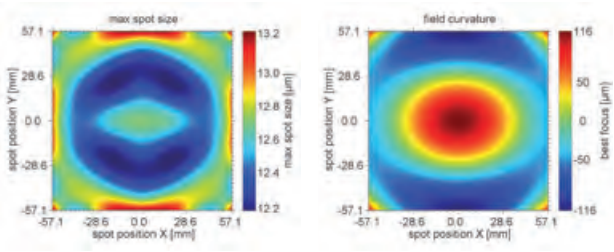
High Image Quality | Larger Beam Diameters and Scan Fields

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

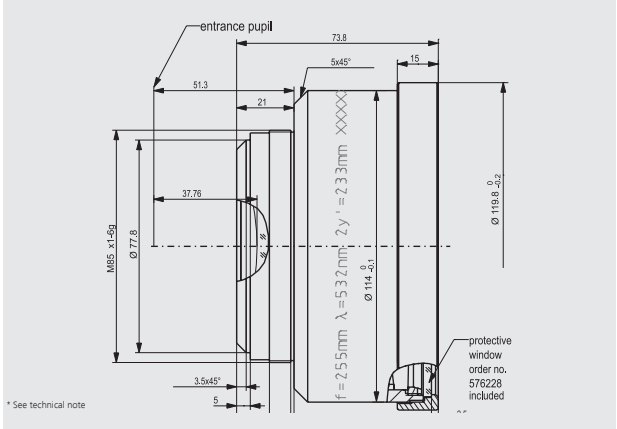
Specifications

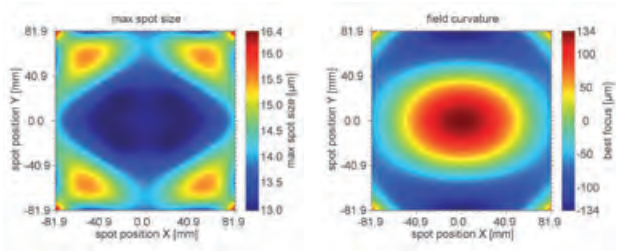
JENar™ 170-515…540-160





JENar™ 255-515…540-233



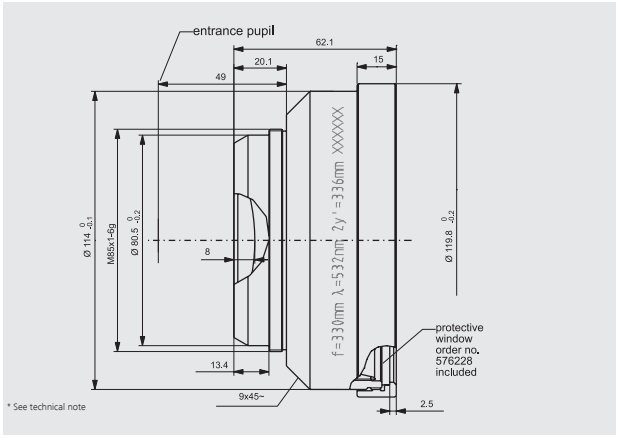


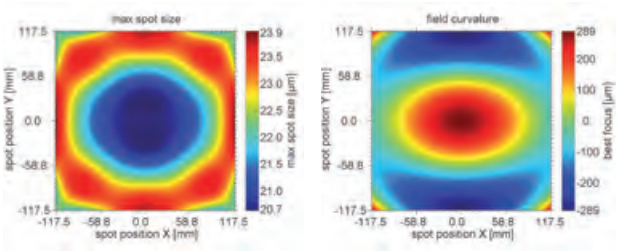
JENar®: Registered in EU, CN, JP, SG, US
F-Theta: Registered Design in EU, CN, KR, IN, SG, JP, HK, TW

F-Theta JENar™ Lens Series
Large Scan Fields

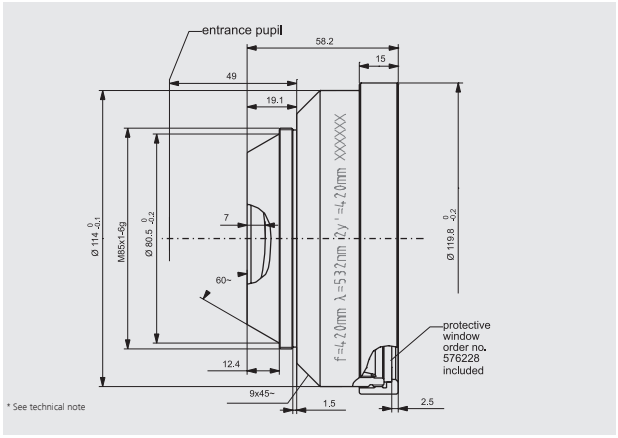
Parameters	JENar™ 330-515…540-347 F-Theta lens for large scan fields	JENar™ 420-515…540-420 F-Theta lens for large scan fields
Focal length:	330 mm	420 mm
Wavelength:	515…540 nm	515…540 nm
Scan field (X x Y); Ø:	(245 mm x 245 mm); 347 mm	(297 mm x 297 mm); 420 mm
Diagonal scan angle:	± 28.8°	± 28.55°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

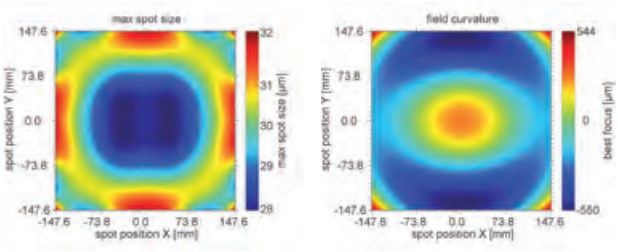
Specifications
JENar™ 330-515…540-347





JENar™ 420-515…540-420



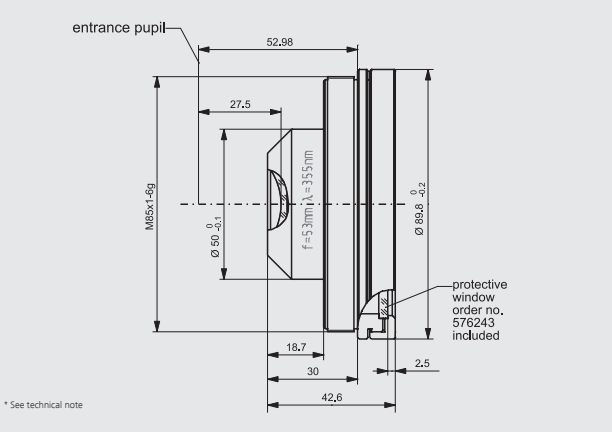


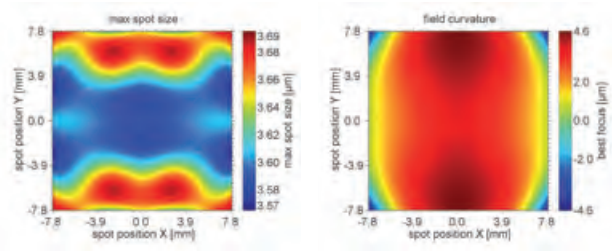
JENar®: Registered in EU, CN, JP, SG, US
F-Theta: Registered Design in EU, CN, KR, IN, SG, JP, HK, TW

F-Theta JENar™ Lens Series
Short Focal Length

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

Specifications
JENar™ 53-355-24





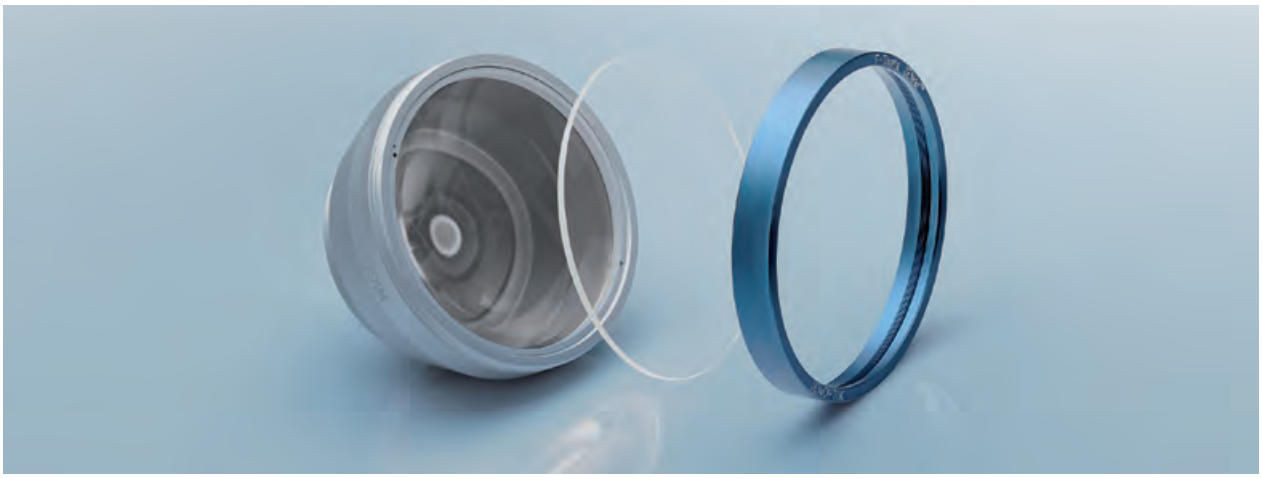
JENar®: Registered in EU, CN, JP, SG, US
F-Theta: Registered Design in EU, CN, KR, IN, SG, JP, HK, TW

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

Type: Protective Windows

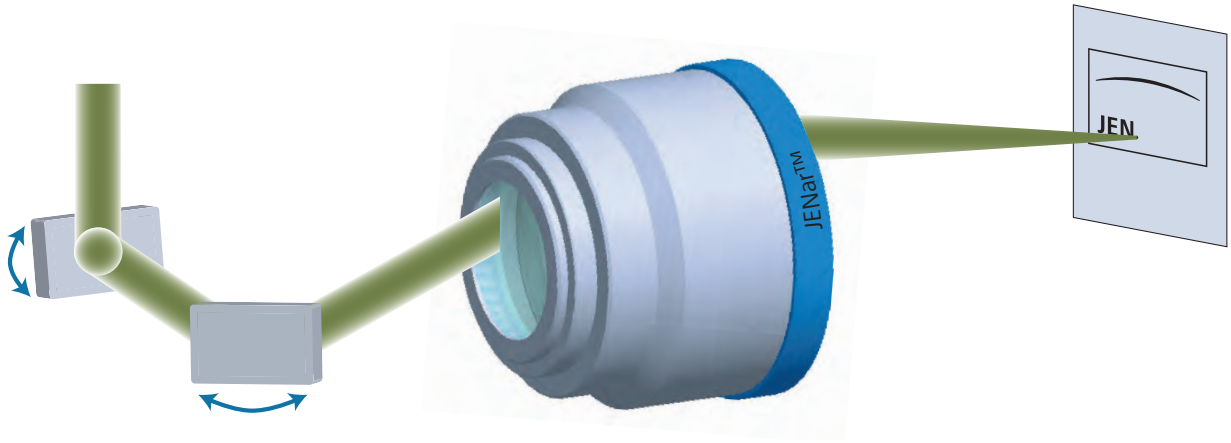
		Drawing Number (017700 = *)	*-004-31	*-004-32	*-049-31	*-049-32	*-049-33	*-410-31	*-410-32
		Order Number Window	575267	576228	576230	576232	576234	576239	610812
	Wavelength [nm]	F-Theta Lens							
Silverline™ High Power Lenses	1030…1080	017700-025-26							
		017700-026-26							
		609120 NEW					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

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



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

Basic Principles



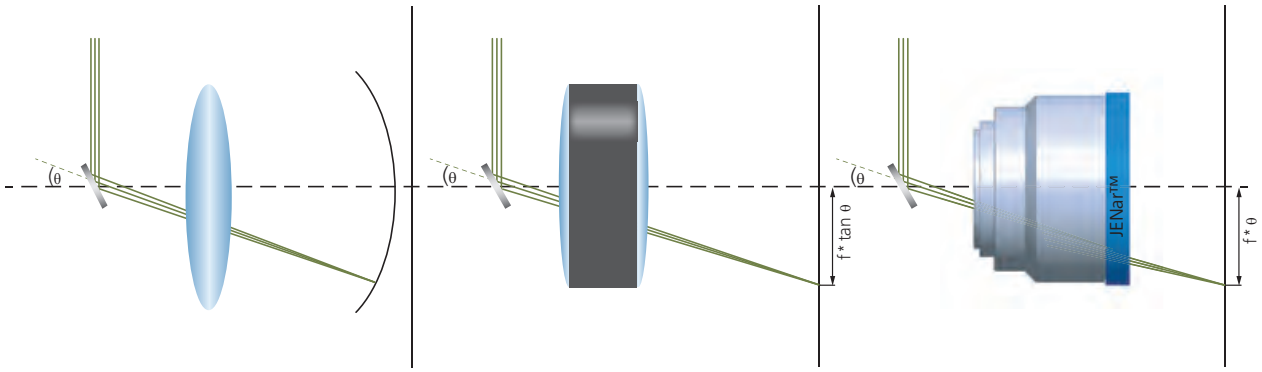
F-Theta objective lenses

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

$$h = f \Theta$$

which gives those special lenses their name F-Theta.

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



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

Focal length

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

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

Scan angle

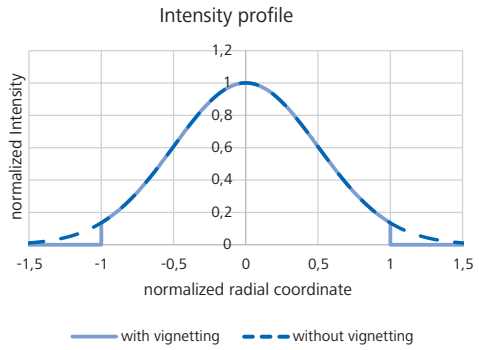
The max full diagonal scan angle corresponds to the scan field diagonal, i.e. using the objective with angles above this maximum angle will lead to clipping of the beam.

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

Input beam diameter

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

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



Focus size

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

$$\sigma = 1.83\ \lambda\ f / Ø$$

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

Beam-clipping

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

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

Back working distance

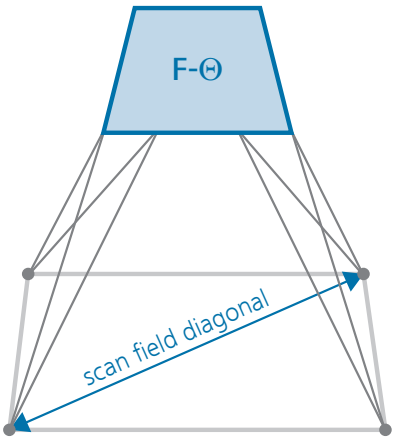
Whereas the focal length is a rather theoretical construct, the back working distance describes the real distance between the end of the objective (the edge closest to the workpiece) and the workpiece.

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

Scan field

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

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



Definition of scan field

Scanner geometry

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

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

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

Damage threshold LIDT

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

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

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

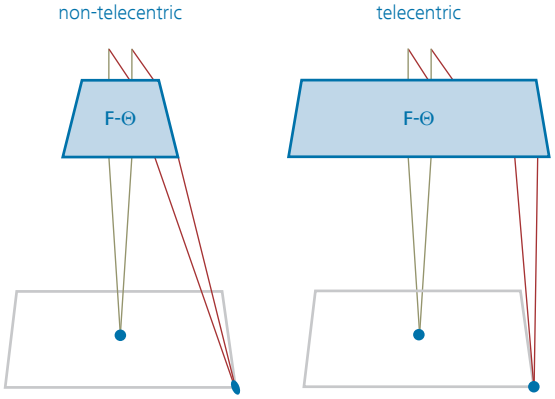
The parameters c and p of this law are wavelength-dependent. Furthermore, the real damage threshold of the system critically depends several exterior influences, like adequate storage, handling, and cleaning. Inappropriate care of the optical systems reduces the damage threshold and renders the guarantee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

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

Telecentricity

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

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



Concept of telecentricity

Thermal focus shift

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

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

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

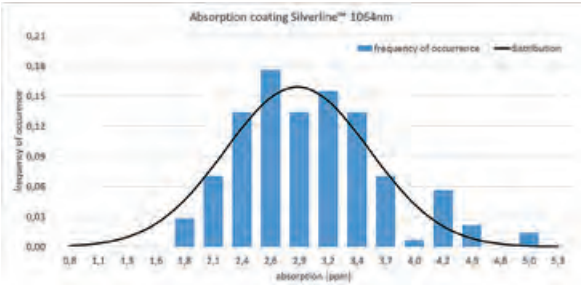
$$\Delta z_G = \ln(4)\Delta z_T$$

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 materials is small (fused silica or CaF_2) which fixes most of the material coefficients (dn/dT, n, alpha, lambda). Furthermore, the application requirements determine the parameters input power (P_0) and focal length (f) and the beam sizes (phi) on and thickness (d) of the elements in an F-Theta lens usually constitute no powerful optimization parameters. In essence, optical designs which fulfill the optical specification usually do not differ very much in their respective lens shapes. Therefore, the most promising strategy to reduce the thermal focus shift of a system is to reduce the amount of energy being absorbed. This can be achieved by choosing low absorbing materials and coatings.

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

Silverline™

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



Application-relevance – → see thermal focus shift

Therefore, the following absorption values are specified:

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

Pulse stretching GDD

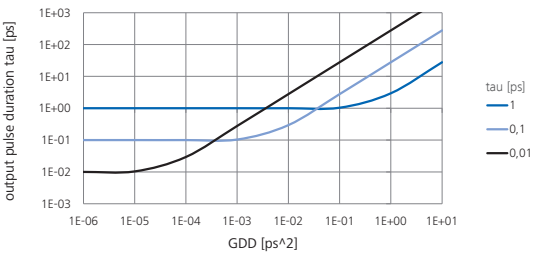
When light passes through an optical material of non-vanishing dispersion it accumulates a wavelength dependent optical phase. For laser pulses, which are effectively a linear superposition of harmonic oscillations of different wavelengths, this influences the pulse shape. In a second order approximation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

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

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

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

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



Beam Expanders

Variable Beam Expanders "Made in Germany"

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

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

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

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

USP

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

Fields of Application

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

Contact

Contact worldwide → please see page 7

Find your way into our optics ...

Highlight in 2019
Beam Expander 1x-8x Motorized

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

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

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

Beam Expander 1x-8x Motorized

Automated Configuration Setting with Smart BEX

NEW

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

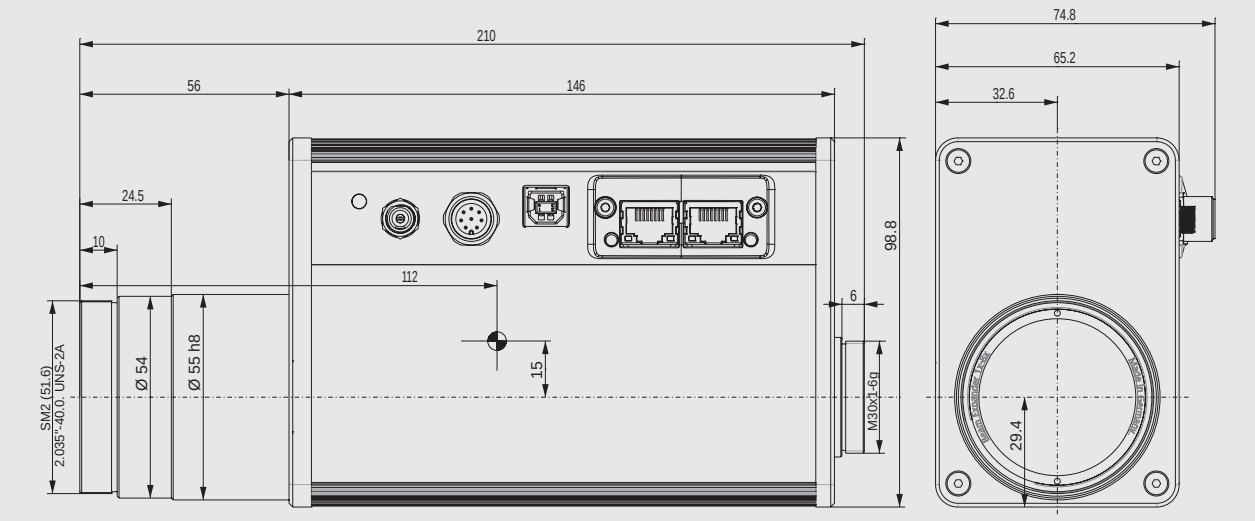
Specification

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

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

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

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



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

Beam Expander 1x-8x

High Power Systems

NEW

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

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

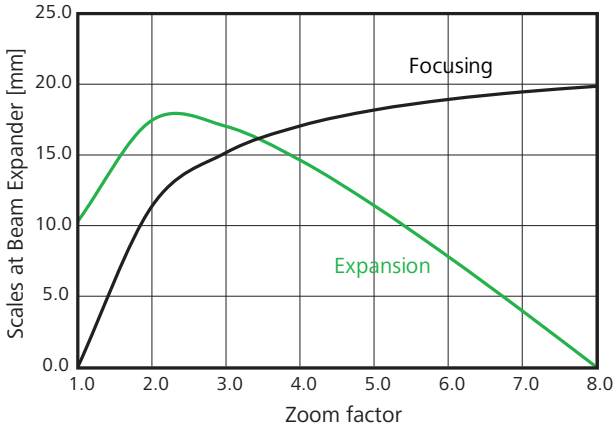
Zoom factor	Ø entrance pupil[3]		
	1030-1080 nm	515-540 nm	355 nm
1x	9.0 mm	9.0 mm	9.0 mm
2x	9.0 mm	9.0 mm	9.0 mm
3x	9.0 mm	9.0 mm	9.0 mm
4x	7.5 mm	7.5 mm	7.5 mm
5x	6.0 mm	6.0 mm	6.0 mm
6x	5.0 mm	5.0 mm	5.0 mm
7x	4.5 mm	4.5 mm	4.5 mm
8x	4.0 mm	4.0 mm	4.0 mm
Order Number:	606997	627443	586117

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

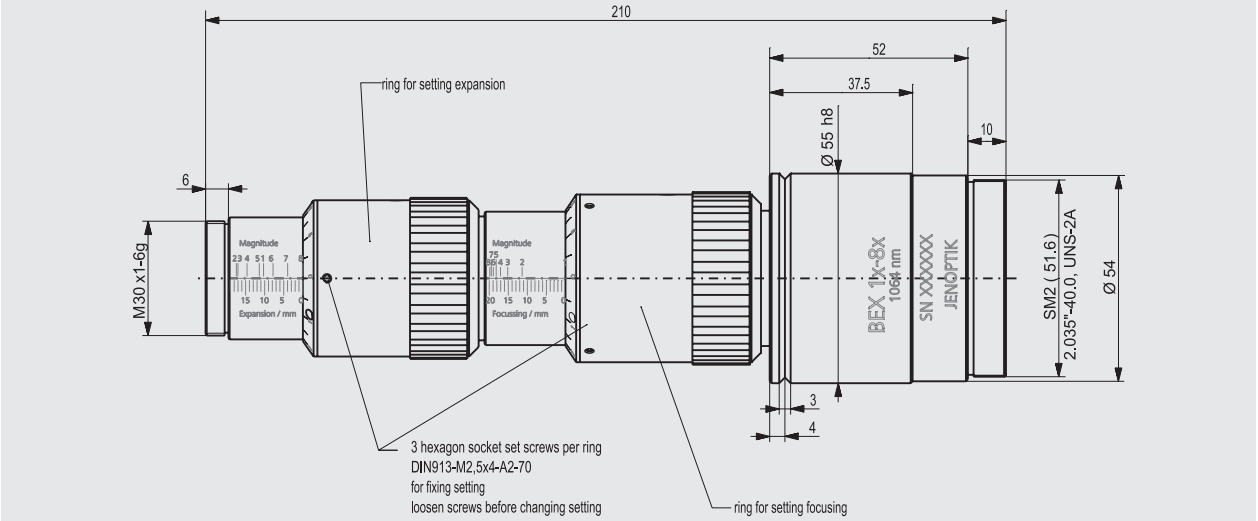
Specification

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

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



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



Same dimensions for all wavelength versions.

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

Beam Expander 2x-10x

Large Magnification Range

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

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

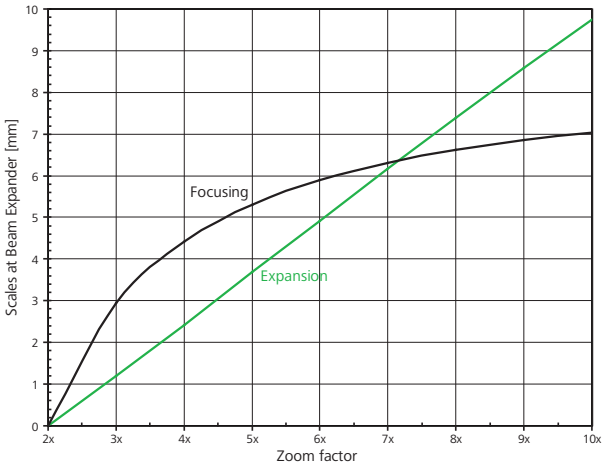
Zoom factor	Ø entrance pupil[3]		
	1030-1080 nm	515-540 nm	355 nm
2x	8.0 mm	8.0 mm	6.0 mm
3x	8.0 mm	7.0 mm	6.0 mm
4x	7.0 mm	6.0 mm	5.0 mm
5x	6.0 mm	5.0 mm	4.5 mm
6x	5.0 mm	4.0 mm	4.0 mm
7x	4.0 mm	4.0 mm	3.5 mm
8x	3.5 mm	3.5 mm	3.0 mm
9x	3.2 mm	3.2 mm	2.7 mm
10x	3.0 mm	3.0 mm	2.2 mm
Order Number:	017052-001-26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

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

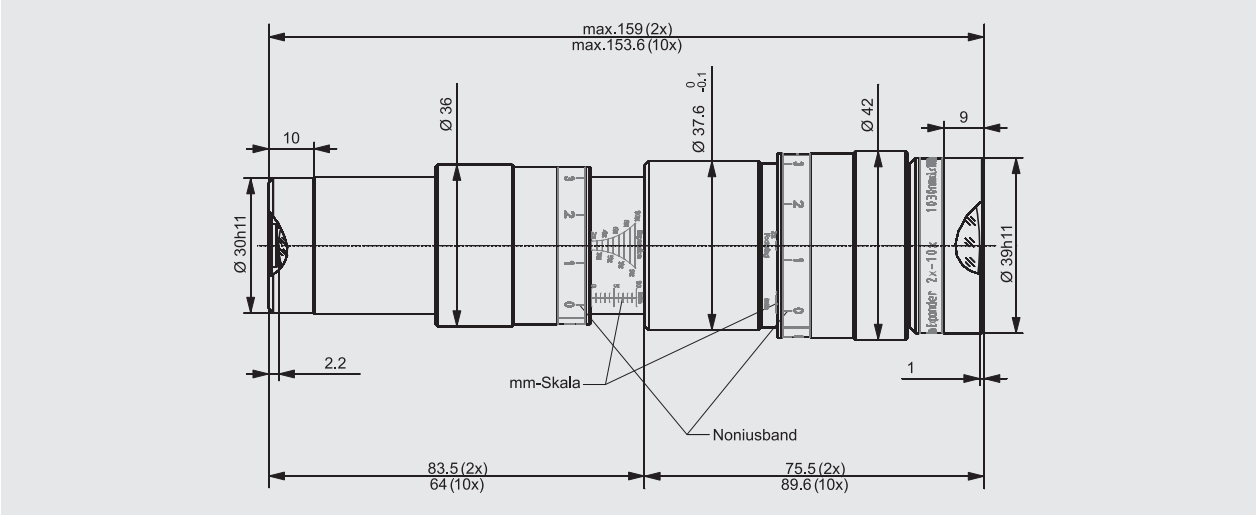
Specification

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

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



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



Same dimensions for all wavelength versions.

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

Beam Expander 1x-4x Steadfast

Very Robust Fused Silica Systems

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

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

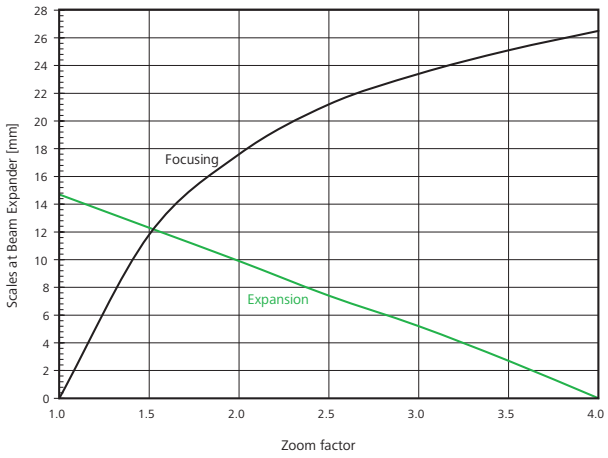
Zoom factor	Ø entrance pupil[3]		
	1030-1080 nm	515-540 nm	355 nm
1x	4.0 mm	4.0 mm	4.0 mm
2x	4.0 mm	4.0 mm	4.0 mm
3x	4.0 mm	4.0 mm	4.0 mm
4x	4.0 mm	4.0 mm	4.0 mm
Order Number:	582823	593355	593354

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

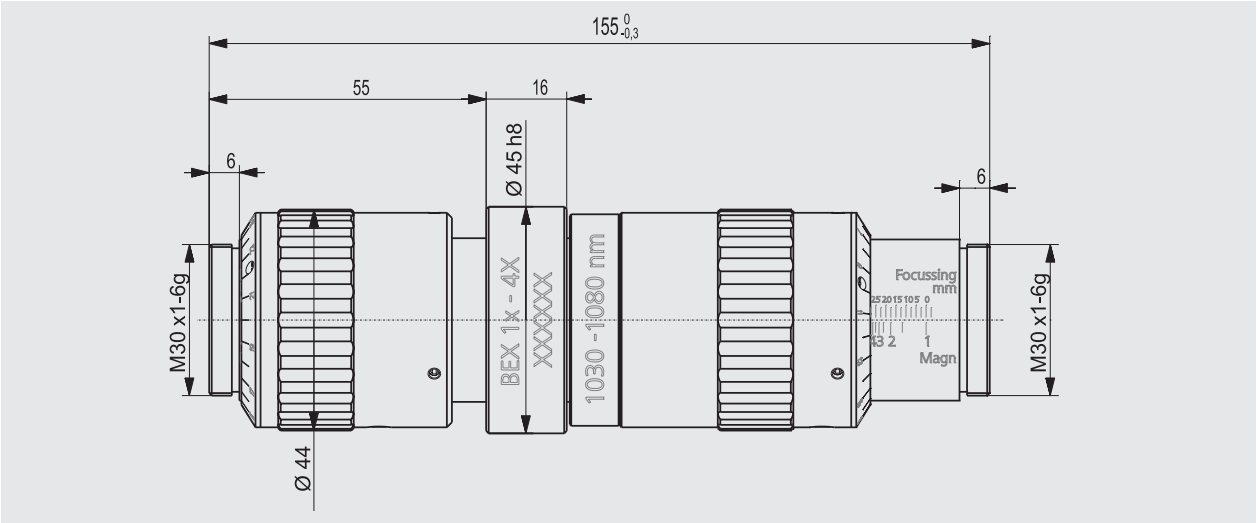
Specification

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

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



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



Same dimensions for all wavelength versions.

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

Beam Expander 1x-4x

Fused Silica Systems

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

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

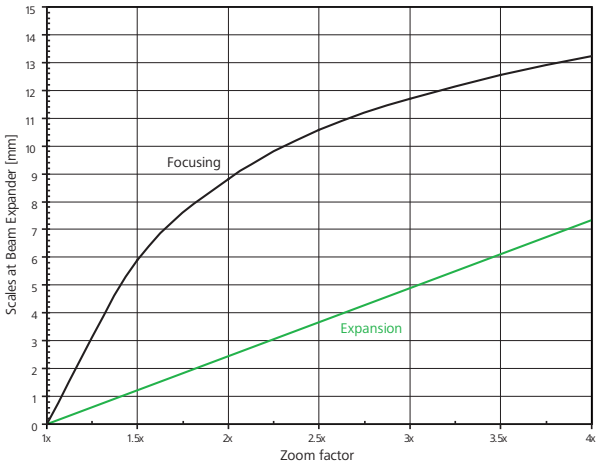
Zoom factor	Ø entrance pupil[3]		
	1030-1080 nm	515-540 nm	355 nm
1x	4.0 mm	4.0 mm	4.0 mm
2x	4.0 mm	4.0 mm	4.0 mm
3x	4.0 mm	4.0 mm	4.0 mm
4x	4.0 mm	4.0 mm	4.0 mm
Order Number:	017052-012-26	017052-202-26	017052-402-26

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

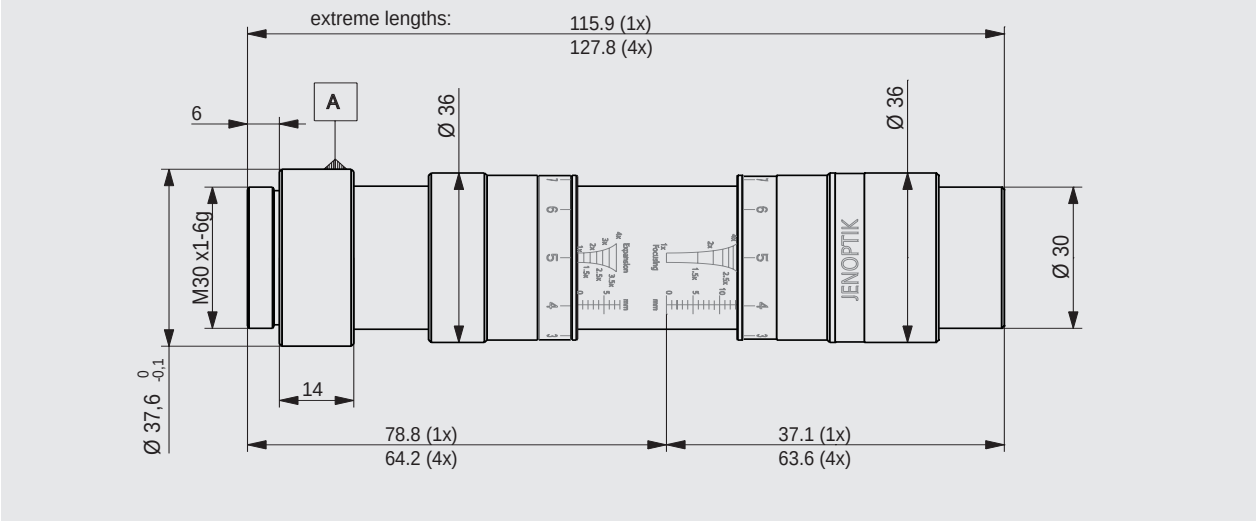
Specification

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

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



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



Same dimensions for all wavelength versions.

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

Optical Systems & Components

Know-How Combined in High-End Systems

From customized high precision optical components to high-end tailored optical systems for your success.

If you are looking for a partner with the ability to provide you with a complete solution – from manufacturing precision optical components with high-quality coatings from DUV to FIR as well as integrating them into a demanding optical system – Jenoptik is looking forward to successfully partnering with you.

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

USP

- One-stop customized solution from prototypes to serial production
- Proven experience over 25 years
- Stress-free mounting techniques for high numerical aperture DUV lenses
- High precision optical components made from virtually any optical material
- All different types of geometric shapes through 5-axis contouring

Fields of Application

- Semiconductor wafer and mask inspection
- Flat panel display industry
- High-quality optical components for precise measurement, analysis and assembly of optical modules
- Material processing

Europe

JENOPTIK · Light & Optics

JENOPTIK Optical Systems GmbH
Goeschwitzer Strasse 25
07745 Jena · Germany
www.jenoptik.com/optics

Dr. Thomas Ganz
thomas.ganz@jenoptik.com
Phone +49 3641 65-3154

North America

Mr. Ray Malcom
ray.malcom@jenoptik-inc.com

JENOPTIK Optical Systems, LLC.
16490 Innovation Drive
Jupiter · FL 33478 · USA
Phone +1 561 881 7400 x-1116

High Numerical Aperture DUV Lens Systems
for Wafer and Mask Inspection

Partnership

We are passionate. We are experienced. We are innovative.
And we are excited to work with you!

Measurement

- High numerical aperture wavefront measurement NA = 0.97
- Field curvature measurement with accuracy up to ~ 5 nm
- Performable at a wavelength between 193 nm - 1064 nm
- Transmission mapping
- Life time test

Assembly

- Patented stress-free mounting
- Minimal stress induced birefringence
- Exact adjustment with a stability < 100 nm

Granted Pat. US 6,560,045; US 8,154,733; US 7,903,353; US 9,097,899; US 9,151,926; US 9,442,269; US 9,488,830; US 9,971,149; US 9,400,367; US 9,482,842; US 9,645,348; US 9,964,730; US 9,829,702; US 9,513,457; US 9,891,402; US 9,823,437; US 10036869

Video

Optical and Mechanical Design

- Lens systems also for uncommon wavelengths
- Low-contamination mounting
- Stacked mounting technology
- Excellent polarization extinction ratio 1:1000
- Nitrogen purged design
- Clean room compatible

Lenses

- High precision aspheres with IRR < 3 nm RMSi
- Ion beam and MRF technologies
- Large optics up to 700 mm
- From rotational symmetric aspheres to freeform optics
- Sensitive materials like CaF_2
- Jenoptik expertise from design stage to system integration

Coatings

- Coatings on extreme curved surfaces
- Low loss coatings
- Broadband coatings
- Long-term stability

Pending Pat. US 16/049,443; US 16/049,383 and equivalent Granted or Pending Patents in CN, DE, FR, GB, JP, KR and/or TW.
Pending Pat. DE 102017117464 | PCT/DE2018/100907

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 fused silica
- 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 < 2 nm 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

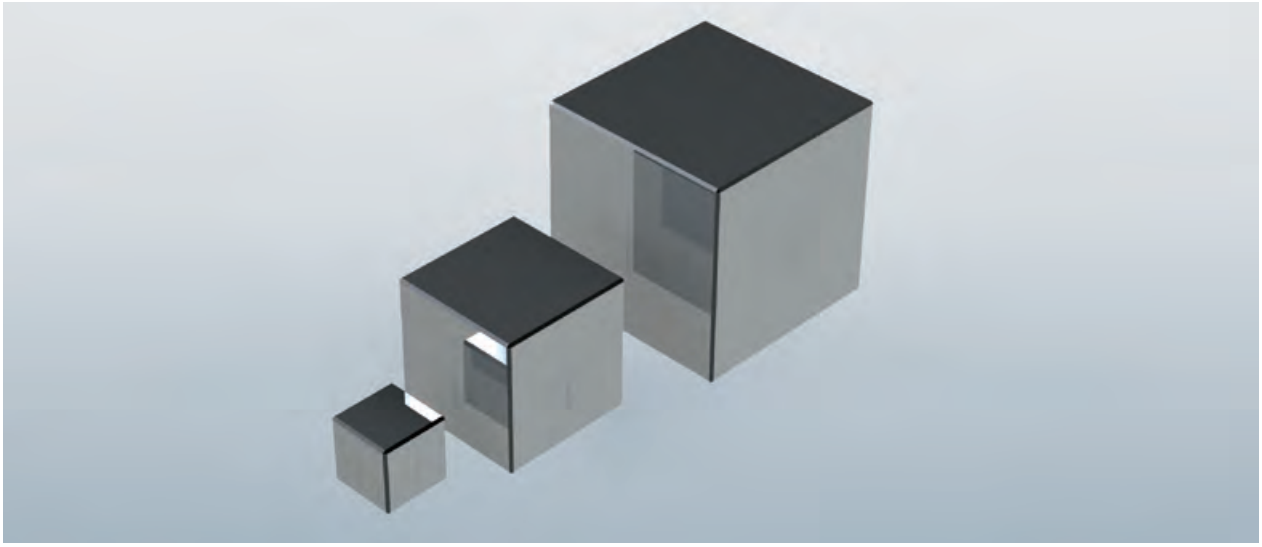
OrthoLine Optical Alignment Cubes

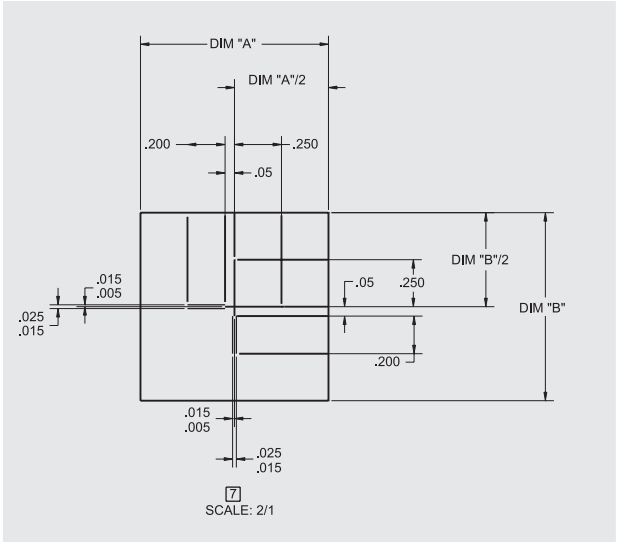
The Standard for High Precision Alignment Tooling

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.

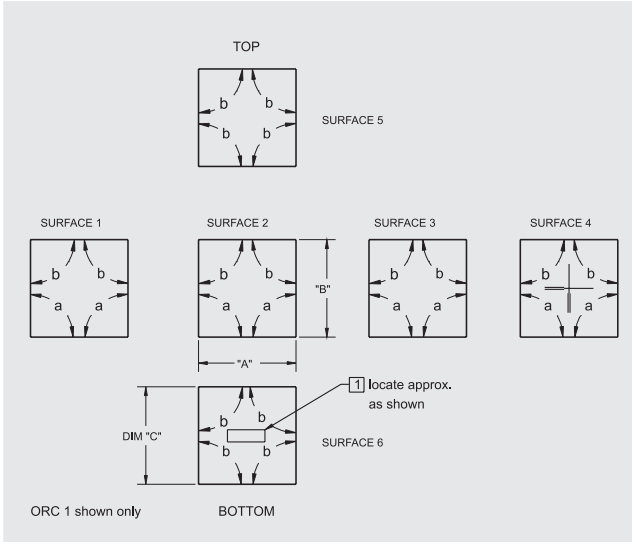
The alignment cubes feature a surface flatter than λ/10 and have five sides polished perpendicular to < 2 arc-seconds for critical alignments of up to eight orthogonal angles in five directions.

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

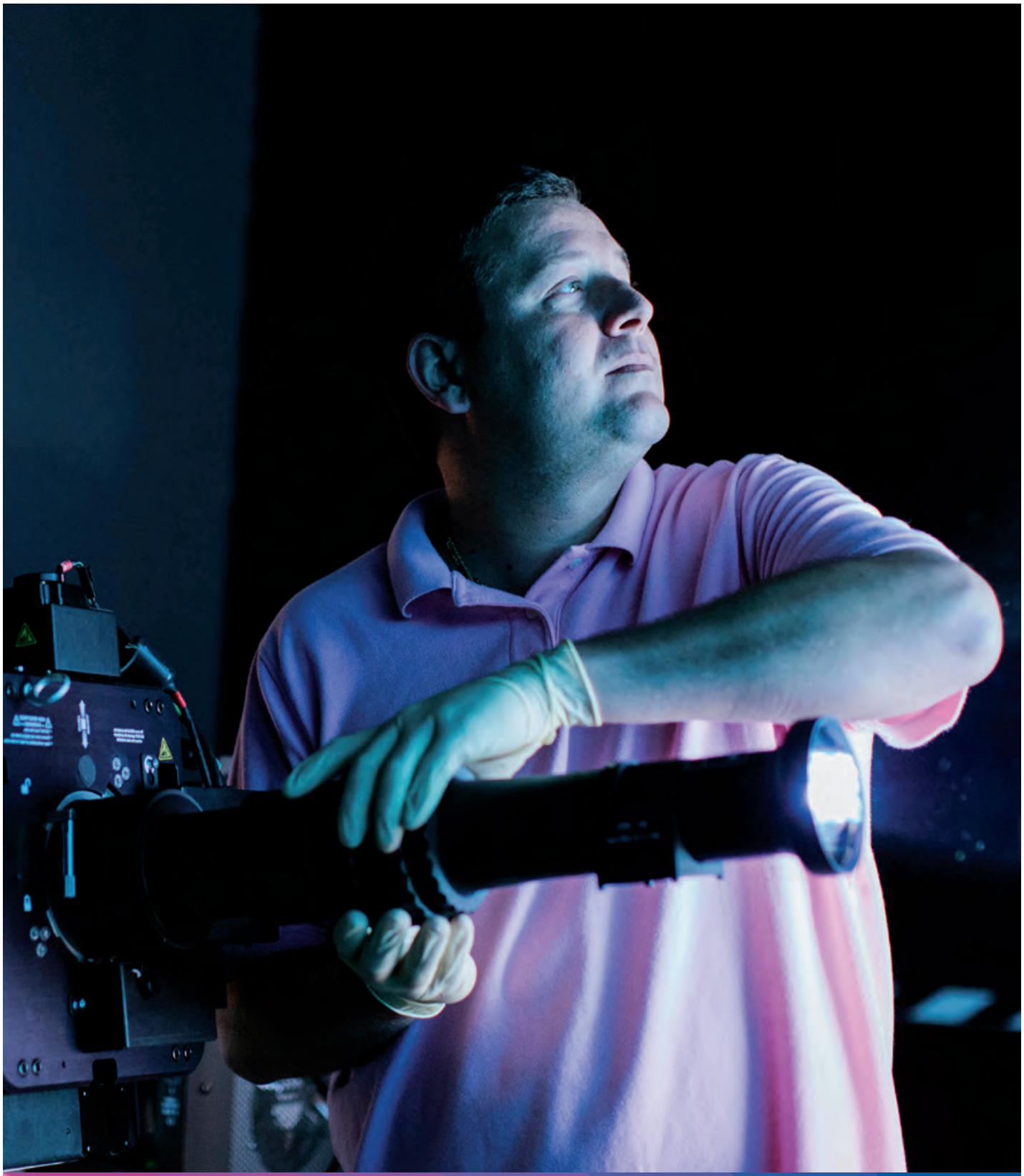




Reticle Dimensions



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 crave.

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
- Able to achieve high contrast levels for deeper blacks
- Decreased number of channels used to cover a dome or simulator screen
- Reduces costs and improves return on investment
- Folded design possible
- In-house testing with Jenoptik Dome Theater

Fields of Application

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

Contact

JENOPTIK · Light & Optics

JENOPTIK Optical Systems, LLC
16490 Innovation Drive
Jupiter · FL 33478-6428 · USA
www.jenoptik.us

Mr. Kurt Van Hout
kurt.vanhout@jenoptik-inc.com
Phone +1 561 339-9811

Europe

Ms. Maxi Seifert
maxi.seifert@jenoptik.com

JENOPTIK Optical Systems GmbH
Goeschwitzer Strasse 25
07745 Jena · Germany
Phone +49 3641 65-3323

China

Mr. Robin Bai
robin.bai@jenoptik.com

JENOPTIK (Shanghai) Precision
Instrument and Equipment Co.,Ltd.
Building 15, No. 3999 Xiupu Road
201315 Shanghai · Phone +86 21 3825-2380

Video

F-Theta High Power Projection Lenses

Planetarium and Giant Screen Solutions

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

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 2K and 4K capable lenses ready for your application – from stock or tailored to your ideas.

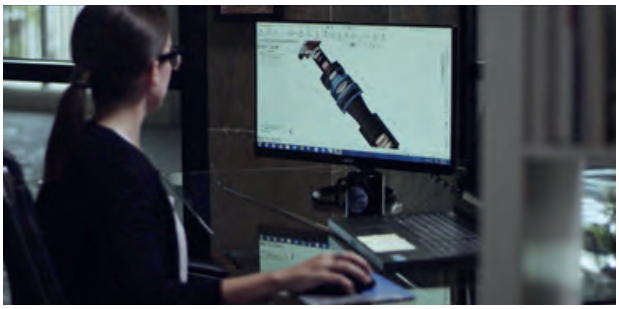
By working closely with the leading laser projector manufacturers, Jenoptik ensures to meet all application specifications. With high lumen projector becoming more prevalent in the market, selecting the right projection optics is more important than ever before.

All our Projection Lenses are suitable for following projectors

Christie
- Roadie 4K45
- Boxer Series
- D4K2560
- D4K3560
- D4KLH
- Mirage Series

Barco
- XDL-4K75
- XDL-4K60
- XDL-4K30
- DP4K-60L
- DP4K-32B

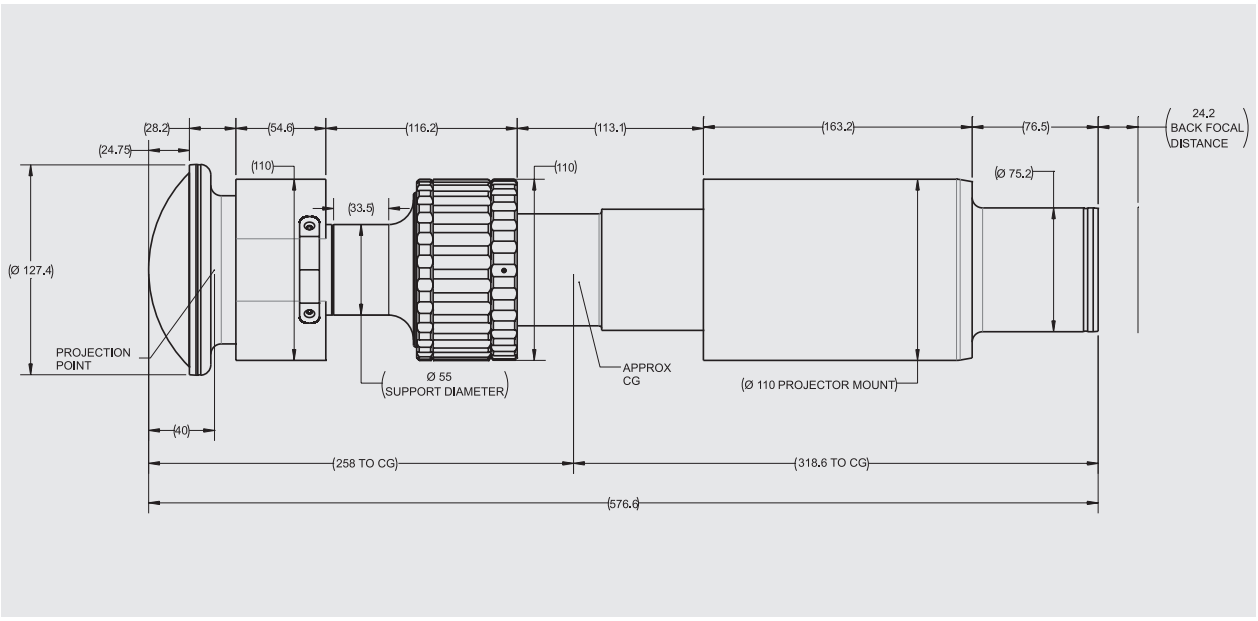
Digital Projection
- Insight Laser 8K
- Insight Dual Laser 4K



F-Theta High Power Projection Lenses

Planetarium and Giant Screen Solutions | JOS4K-1

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

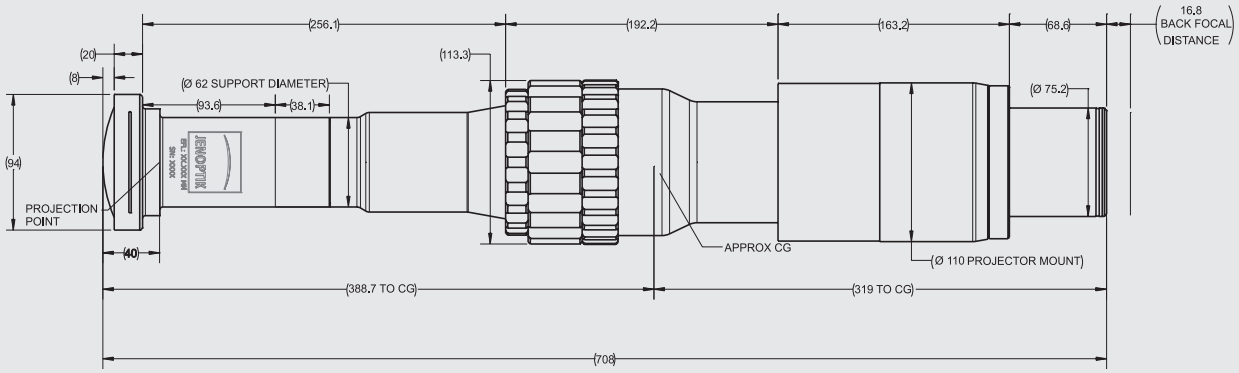


It is our policy to constantly improve the design and specifications. Accordingly, the details represented herein cannot be regarded as final and binding.

F-Theta High Power Projection Lenses

Planetarium and Giant Screen Solutions | JOS4K-2

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

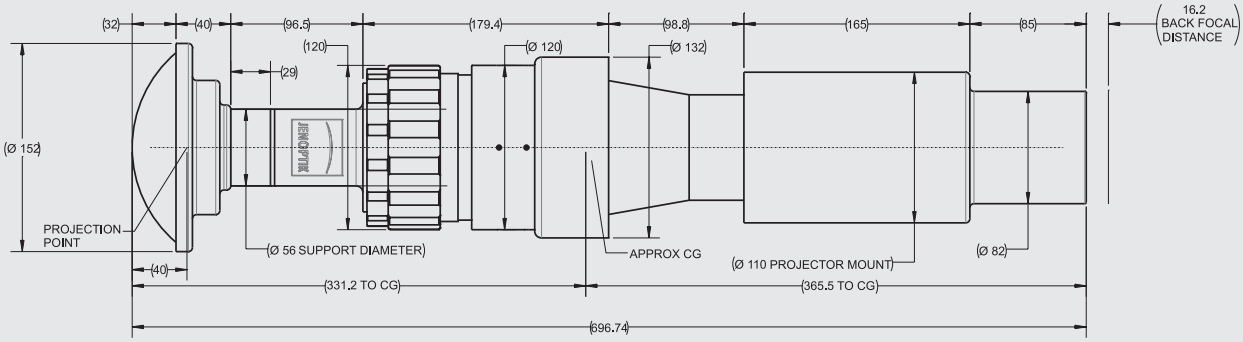


It is our policy to constantly improve the design and specifications. Accordingly, the details represented herein cannot be regarded as final and binding.

F-Theta High Power Projection Lenses

Planetarium and Giant Screen Solutions | JOS4K-4

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**



Highlight in 2019
The new 4K F-Theta Planetarium Prime Lens

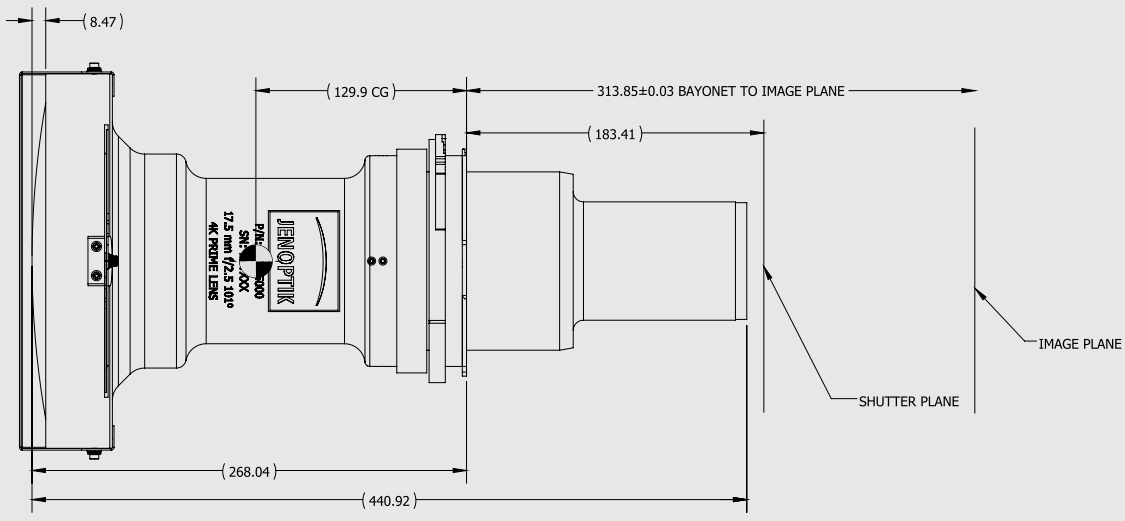
USP:
- More compact
- Shorter design
- Reduced number of projectors
- Lower costs

F-Theta High Power Projection Lenses

Planetarium and Giant Screen Solutions | JOS4K-5

NEW

Parameters	
Horizontal field of view:	101°
Vertical field of view:	53°
Diagonal field of view:	114°
Effective focal length:	7.56 mm
f#:	2.5
MTF @ 66 lp/mm:	0.8
Lateral color B-R:	< 5.0 µm
F-Theta distortion:	< 0.6 %
Transmission:	80 %
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-5

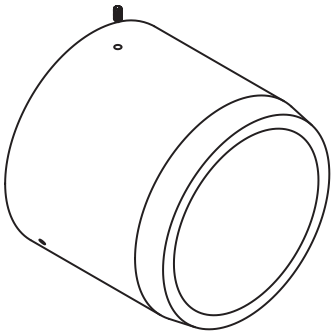


Adapters for F-Theta High Power Projection Lenses

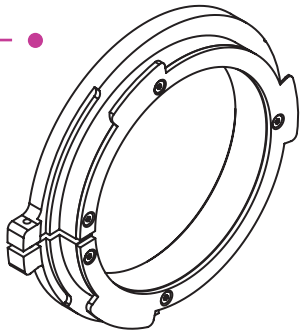
Making Your Projects More Flexible!

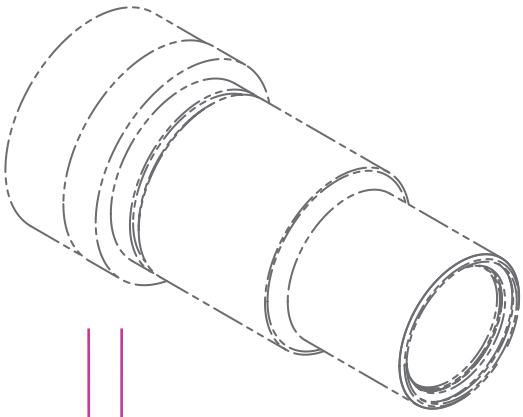
Each projection manufacturer has a specific mounting configuration. This could lead to limitations when it comes to a practical equipment of your project. To compensate for this disadvantage Jenoptik extended its portfolio for the entertainment industry with projection lens adapters. With a simple installation, the new adapters allow use of all of our projection lenses on various 3-chip DLP projectors.

Christie/Roadie Adapter
P/N: 500-210

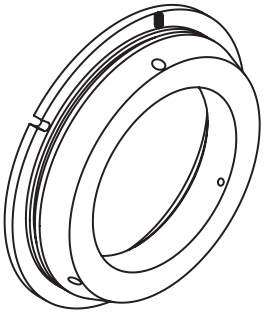


Christie Boxer Adapter
P/N: 500-163

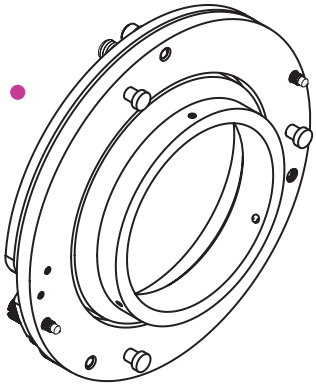


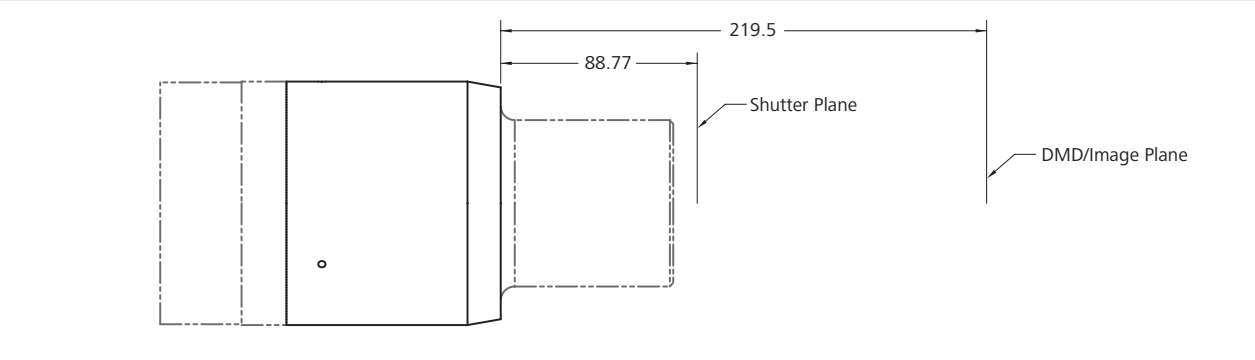


Barco Adapter
P/N: 500-211

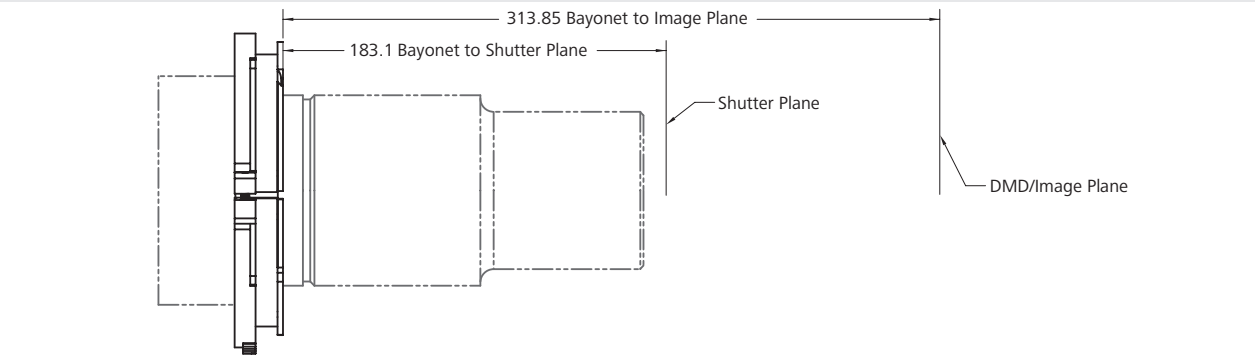


Digital Projection Adapter
P/N: 500-225

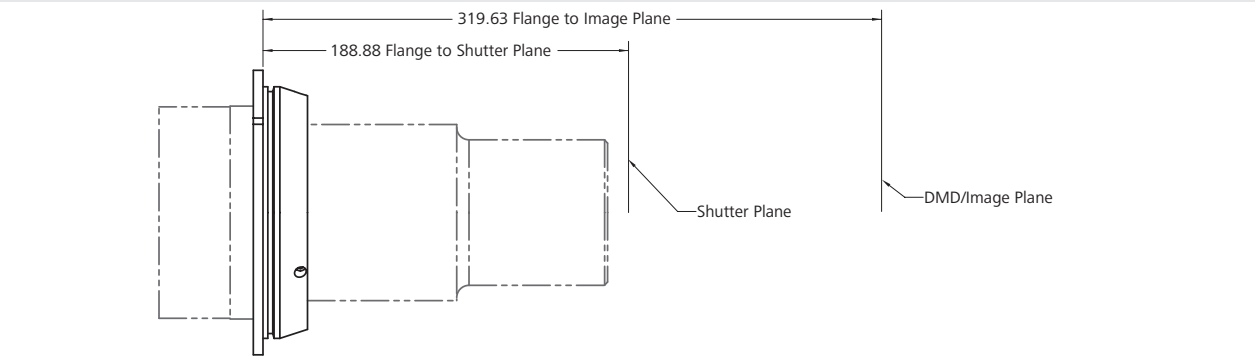




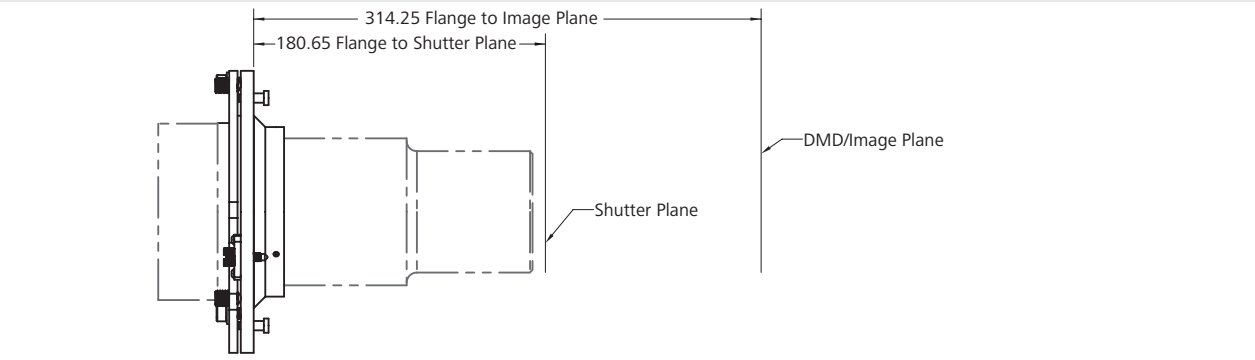
500-210 Christie/Roadie Adapter



500-163 Christie Boxer Adapter



500-211 Barco Adapter



500-225 Digital Projection Adapter

0.6x Lens Attachment

Wide Angle Conversion Lens

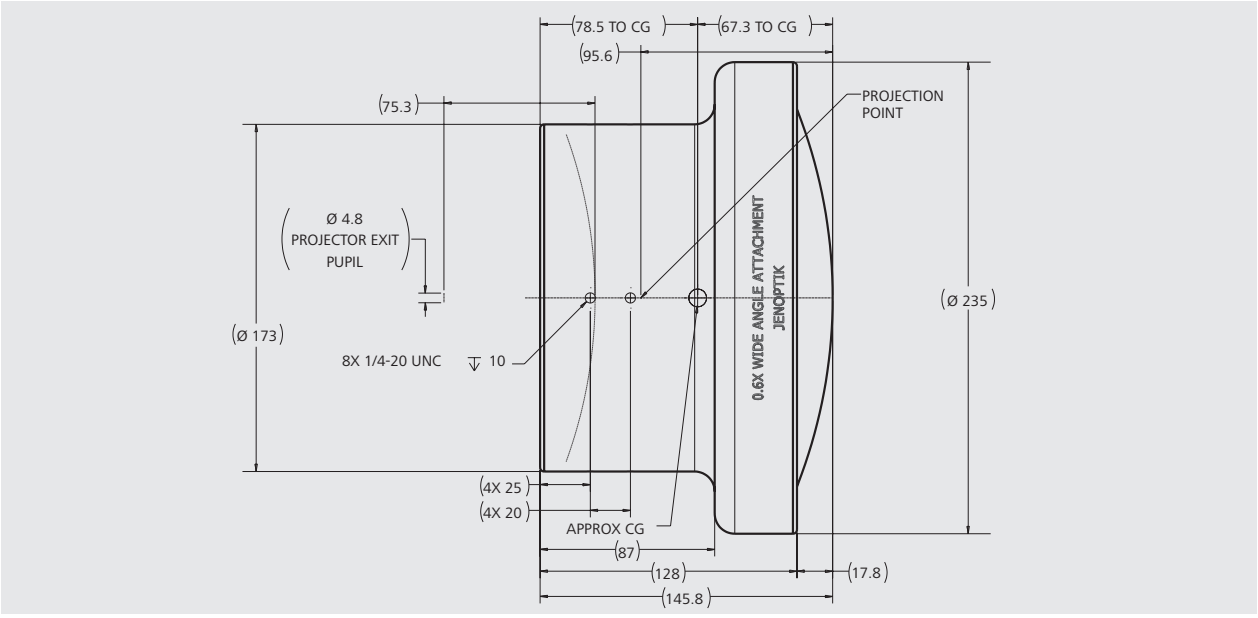
Jenoptik's portfolio of projection lenses is complemented by the 0.6x lens attachment.
The wide angle conversion lens, which is optionally offered, works in conjunction with the projector prime lens.

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)

Please consult us for information on further projectors.

Parameters	
Effective focal length:	- 2201 mm
MTF @ 66 lp/mm:	Depends on zoom position 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 a Jenoptik facility.

The screen is 24 feet in diameter with a 12 foot 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 Dome Theater also has a 30 x 16 feet flat screen for testing digital cinema lenses especially produced for flat screens.

Thermal Imaging

High-performance Infrared Technology

25 years of expertise in visualizing the invisible light with camera technology and infrared optics.

With a wide range of competencies on a high level of vertical integration within the infrared spectrum, we are a reliable development and system partner for optics and modules.

Our high-end thermography cameras and infrared camera modules, for example, impress with their outstanding performance in visualizing even the smallest differences in temperature and pin-sharp thermal images. However, if you are looking for IR cameras and modules that meet your particular specifications we provide in-depth knowledge for the planning, development and manufacturing of your own high-performance solution based on Jenoptik technology.

USP

- Stable performance over a wide operating temperature range
- Resistant to mechanical and thermal stresses
- Compliant with the DIN ISO or MIL standards
- Support from design to production and system integration
- High-performance IR coatings

Fields of Application

- Electronics industry and automotive industry: Quality control and assurance in industrial operations, process control, optimization and monitoring
- Automation technology: Thermal test benches, process monitoring, optimization and control
- Research and development: Non-destructive testing of materials and components
- Construction: Building insulation testing

Europe & Germany

JENOPTIK · Light & Optics

JENOPTIK Optical Systems GmbH
Goeschwitzer Strasse 25
07745 Jena · Germany
www.jenoptik.com/optics

Ms. Tina Bräutigam
tina.braeutigam@jenoptik.com
Phone +49 3641 65-2934

Israel

Mr. Vladislav Gvardiyan
vladislav.gvardiyan@jenoptik.com

Branch Office Israel
Einstein Street 16
76470 Nes Ziona · Israel
Phone +972 8 930 3501

North America

Mr. Joel Murphy
joel.murphy@jenoptik-inc.com

JENOPTIK Optical Systems, LLC.
16490 Innovation Drive
Jupiter · FL 33478 · USA
Phone +1 561 881 7400 x-1248

Video

Infrared Cameras and Camera Modules

Ultra-high-resolution Uncooled Thermography Cameras

Thermography cameras and infrared camera modules made by Jenoptik measure two-dimensional temperature distributions in a fast and non-contact process. Due to the high spatial and temperature resolution, the cameras are characterized by their exceptionally high and reliable level of measuring accuracy.

They are built with a robust, ergonomic housing which makes them very durable, even under harsh environmental conditions. As uncooled Jenoptik thermal imaging technology requires very little maintenance, follow-up costs are practically non-existent.

Our stationary infrared cameras from the IR-TCM HD range

The IR-TCM HD 1024 & 640 series cameras measure surface temperatures in real time. The data is then used, for example, to monitor or control industrial processes. Even minimal changes in temperature can be detected thanks to the best in class image resolution of up to 3.1 IR megapixels.
This high resolution is achieved by combining high-resolution microbolometer arrays with optomechanical resolution enhancement technology. The IR-TCM HD Basic thermography camera is the entry-level model from Jenoptik for professional use in stationary or mobile applications.
The thermal imager is based on state-of-the-art sensitive sensor technology with 17 µm pitch and optimized lenses.

For all cameras we offer a broad choice of lenses and converters suitable for various thermal imaging applications.

Technical Specifications (Excerpt)

Parameters	IR-TCM HD 1024	IR-TCM HD 640	IR-TCM HD Basic
IR detector type:	Uncooled microbolometer array (FPA)	Uncooled microbolometer array (FPA)	Uncooled microbolometer array (FPA), 17 µm pixel pitch
Detector size:	1024 x 768 pixels	640 x 480 pixels	640 x 480 pixels
Image resolution (max.):	2014 x 1536 IR pixels (RE mode)	1280 x 960 IR pixels (RE mode)	640 x 480 IR pixels
Frame rate:	30 Hz (@ 1024 x 768 pixels)	60 Hz (@ 640 x 480 pixels)	30 Hz (@ 640 x 480 pixels)
Sub-framing:	640 x 480 pixels (@ 60 Hz) 384 x 288 pixels (@ 120 Hz) 1024 x 96 pixels (@ 240 Hz)	384 x 288 pixels (@ 120 Hz) 1024 x 96 pixels (@ 240 Hz)	384 x 288 pixels (@ 60 Hz)
Spectral range:	7.5 µm … 14 µm	7.5 µm … 14 µm	7.5 µm … 14 µm
Temperature measurement range:	-40 °C … +1,200 °C (optional: up to + 2,000 °C)	-40 °C … +1,200 °C (optional: up to +2,000 °C)	-40 °C … +600 °C
Thermal resolution:	< 50 mK	< 30 mK	< 40 mK
Accuracy:	1.5 K or 1.5 %	1.5 K or 1.5 %	2.0 K or 2.0 %
Interfaces:	GigE-Vision, DVI-D, C-Video, WLAN (optional)	GigE-Vision, DVI-D, C-Video, WLAN (optional)	GigE-Vision, DVI-D, C-Video, WLAN (optional)
Interfaces for remote control:	–	–	GigE-Vision, RS232, Trigger, Bluetooth (optional)
Dimensions (L x W x H):	190 mm x 90 mm x 94 mm (incl. 30 mm standard lens)	190 mm x 90 mm x 94 mm (incl. 30 mm standard lens)	approx. 190 mm x 90 mm x 94 mm (incl. 20 mm standard lens)
Weight:	1.15 kg (incl. 30 mm standard lens)	1.15 kg (incl. 30 mm standard lens)	approx. 1.2 kg (incl. 20 mm standard lens)
Operating conditions:	Environmental temperature: -25 °C … +50 °C (operational) Shock: 25G (IEC 68-2-29) | Vibration: 2 G (IEC 68-2-6) | Protection class: IP54		

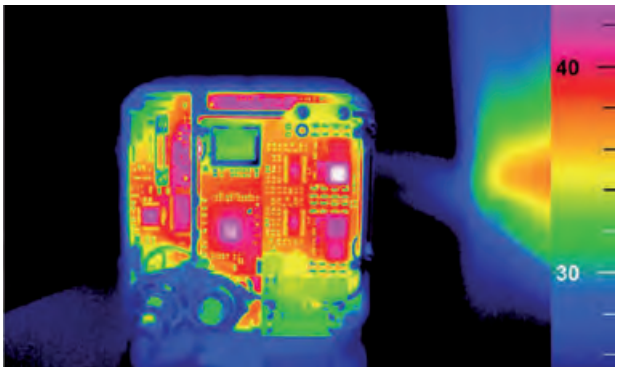
Make your choice!

We offer infrared cameras or camera modules that are especially designed, developed and precisely manufactured based on our high experience and in-depth knowledge in industrial and thermal imaging technology.

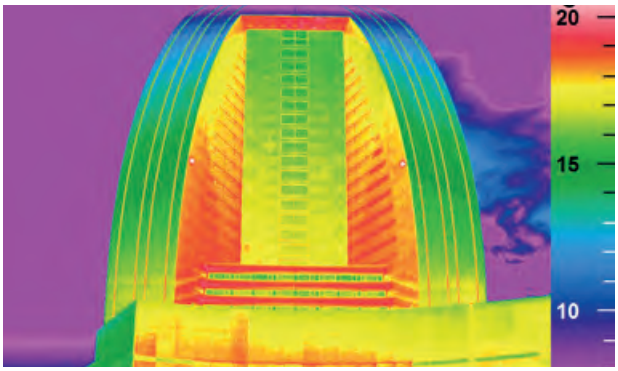
Our portfolio includes handheld infrared cameras for mobile use to stationary models that can be used in field as well as camera modules for OEM integration into your own system or products.

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

Our technological expertise enables us to plan, develop and manufacture IR cameras and modules to meet customer specifications.



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



Building – sample thermogram, Hotel Intercontinental Yokohama Grand,
1024 x 768 pixel recorded with VarioCAM® HD

Freeform Optics

From Components to Next Generation Systems

Due to enhanced design and tooling, improved manufacturing processes and top-accuracy measuring systems, it is now possible to produce freeform optics - a constantly recurring term that is changing the world of optics. In contrast to conventional symmetrical optics, freeform optics have no rotational symmetry and, thus, a high degree of geometrical freedom.

Freeform optics can combine different optical functions which can also be found in standard multi lens assemblies. Therefore, these multi lens assemblies can be replaced by a single tailor-made optical component while achieving the same results. Benefits are, among others, reduced weight and a compact system that allow the installation at positions with highly limited space.

USP

- Reduced size due to more compact design
- Easy handling e.g. snap-in assembly
- Easy thermal and mechanical management
- Similar tolerances to rotationally symmetric systems
- Molded optics possible

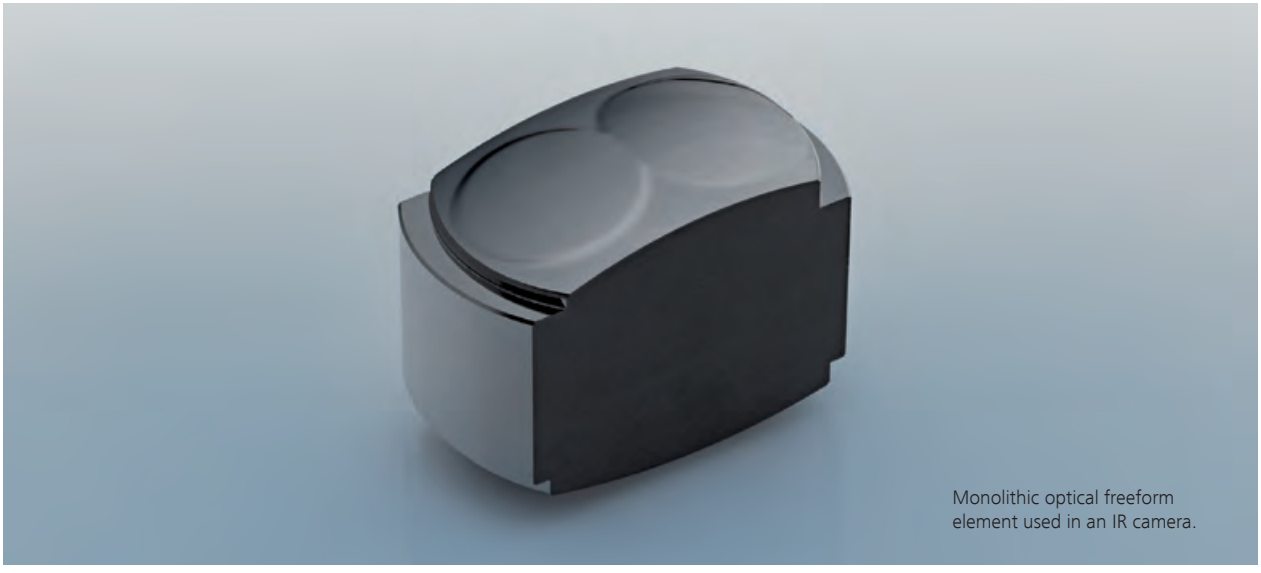
Fields of Application

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

The *fo*⁺ Project at a Glance

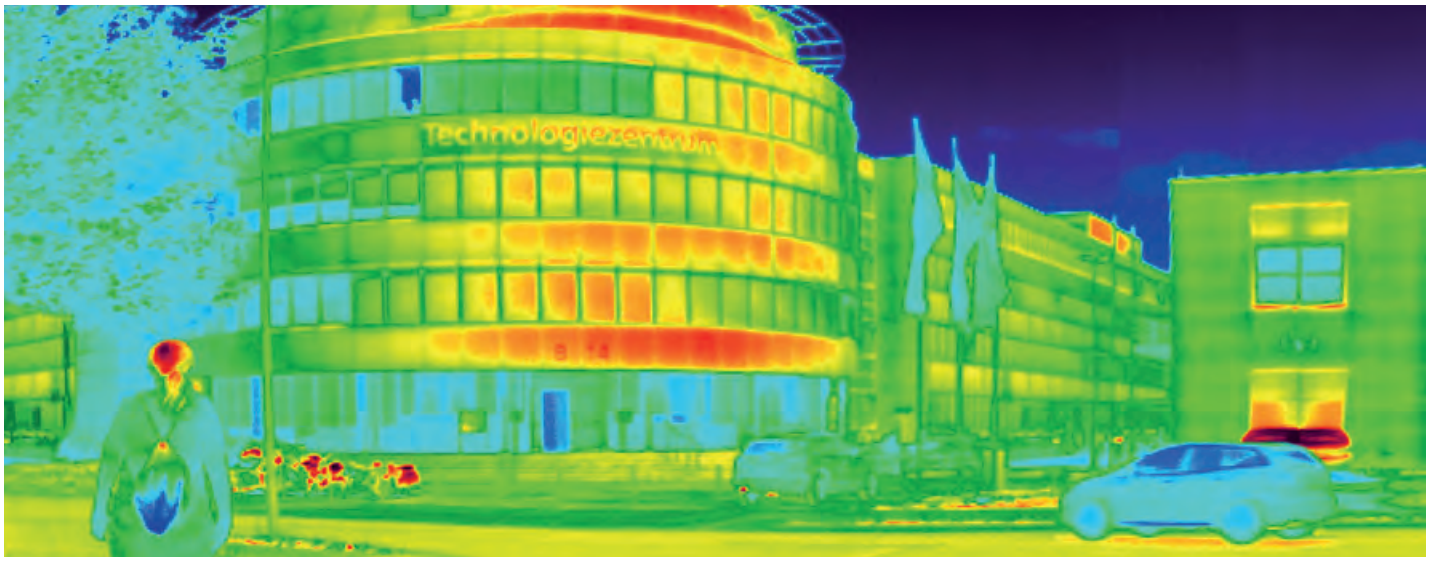
Together with nine alliance partners and the support of the German Federal Ministry of Education and Research (BMBF), Jenoptik started the project "Innovative regional growth core *fo*⁺". Jointly Jenoptik was able to make considerable progress towards miniaturized systems for infrared image processing with the development of monolithic freeform optics.

During the *fo*⁺ project, not only the product development has been completed, also a complete technology chain for freeform optics has been established – from design to system integration. Moreover, the technology also offers cost-efficient solutions like molded optical elements which address price sensitive markets as, for instance, the automotive industry.



Monolithic optical freeform element used in an IR camera.

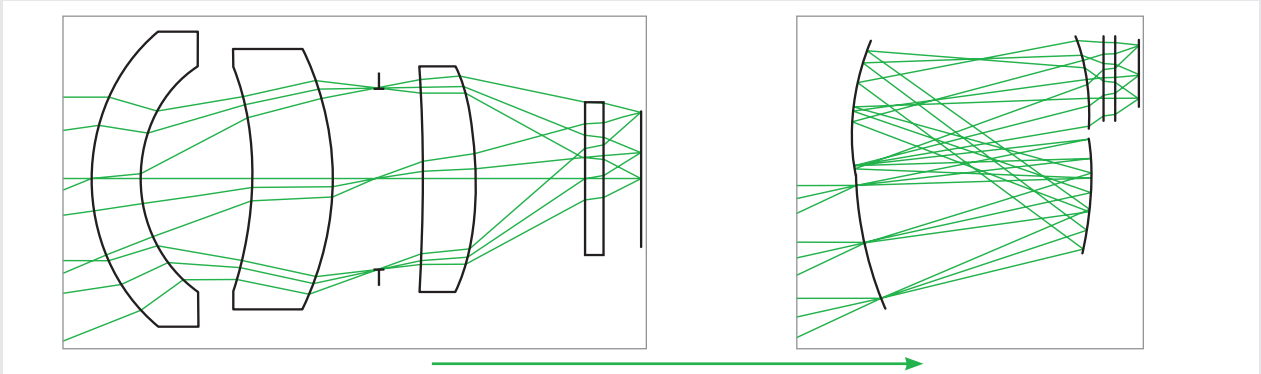
Patent DE 10 2015 110 004 | Patent pending DE 10 2018 115 045, 10 2018 127 689



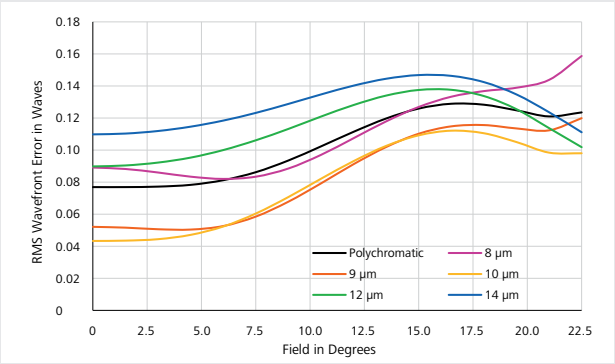
Infrared picture made with an IR camera. The complete optical system is a Germanium monolith with a freeform that uses internal total reflections for the imaging.

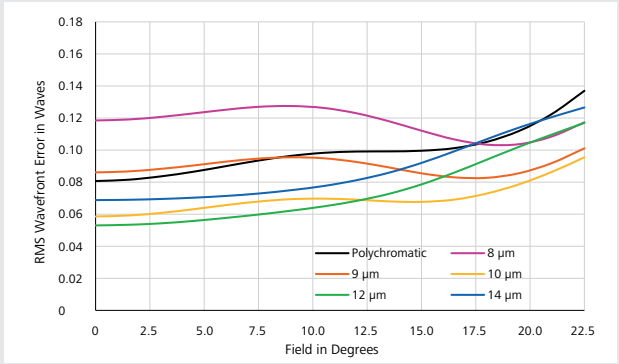
Conventional Optics

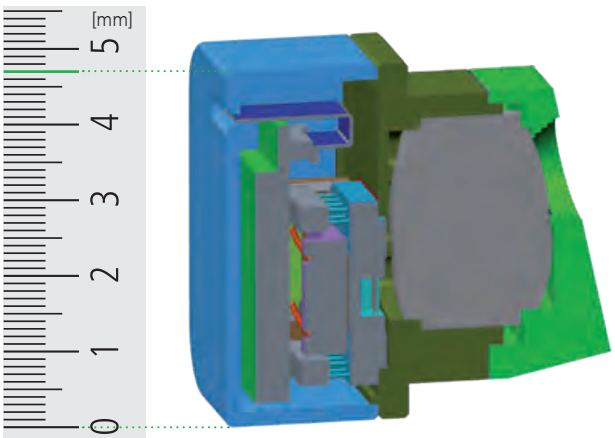
Multi-surface Freeform Optics



Volume reduction from 10 to 2.6 cubic cm







Thanks to the monolitic freeform optics developed in the *fo*+ project the overall volume of the previously used optics has been reduced by approximately 75 %.
The excellent image quality was not compromized.

The next step is the production of molded IG freeform optics to significantly cut manufacturing costs.

IG 4-monolith in miniaturized IR camera

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

Contact

JENOPTIK · Light & Optics

JENOPTIK Optical Systems, LLC
16490 Innovation Drive
Jupiter · FL 33478-6428 · USA
www.jenoptik.us

Mr. Kurt Van Hout
kurt.vanhout@jenoptik-inc.com
Phone +1 561 339-9811

Europe

Ms. Maxi Seifert
maxi.seifert@jenoptik.com

JENOPTIK Optical Systems GmbH
Goeschwitzer Strasse 25
07745 Jena · Germany
Phone +49 3641 65-3323

China

Mr. Robin Bai
robin.bai@jenoptik.com

JENOPTIK (Shanghai) Precision
Instrument and Equipment Co.,Ltd.
Building 15, No. 3999 Xiupu Road
201315 Shanghai · Phone +86 21 3825-2380

25 mm f/2 400 - 1700 nm

Hyperspectral Objective Lens with Adjustable Iris

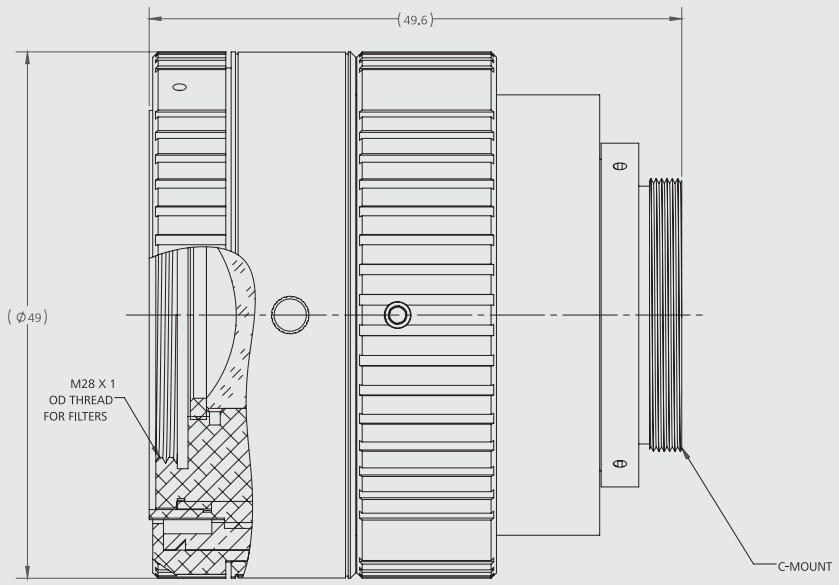
The Jenoptik 25 mm f/2, 400 - 1700 nm lens is a commercial off-the-shelf (COTS) objective lens designed to maximize the performance of many popular SWIR and hyperspectral cameras.

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.

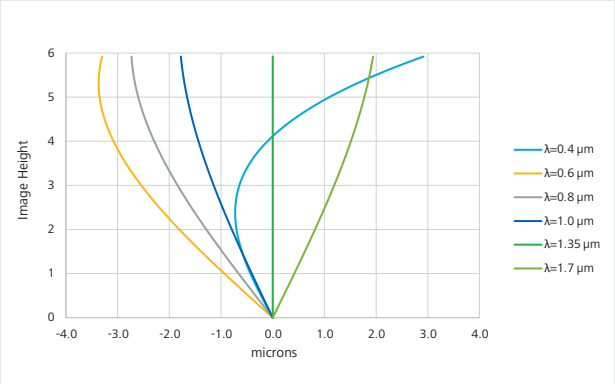
Features

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

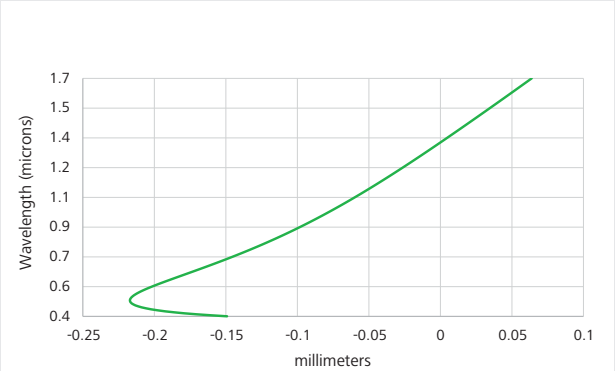
Spectral Range:	400 - 1700 nm
Focal Length:	25 mm
Focal Ratio:	f/2
Image Format:	9.6 mm x 7.68 mm
Aperture:	Adjustable Iris
Field of View:	22.1° H x 17.6° V
Transmission:	85 % Average
Diagonal Field of View:	27.6°
Distortion:	< 3.5 %
Image Circle:	12.29 mm
Focus Range:	Fixed
Minimum Object Distance:	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

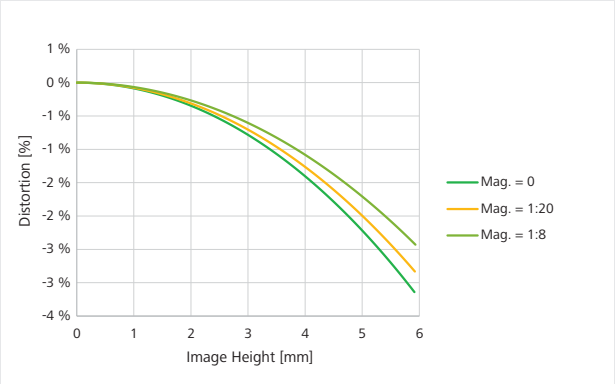


Lateral Color

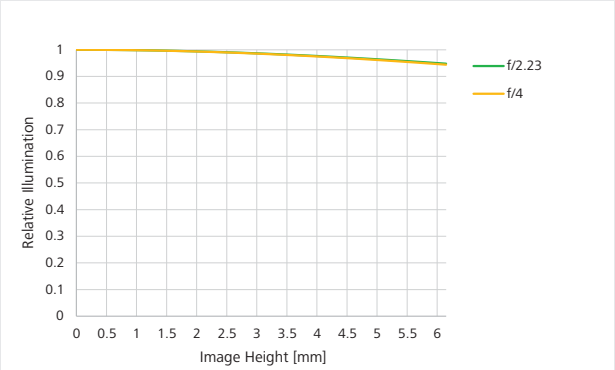


Chromatic Focal Shift

Distortion and Relative Illumination

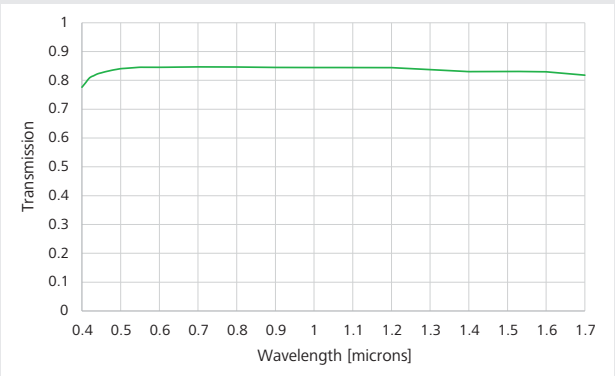


Distortion

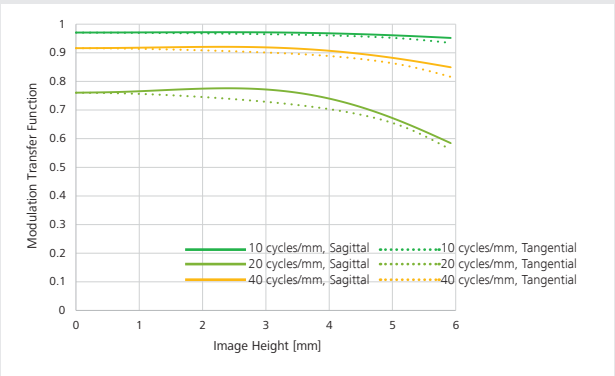


Relative Illumination

Transmission and MTF



Transmission



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

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

Multispectral High Performance Lens

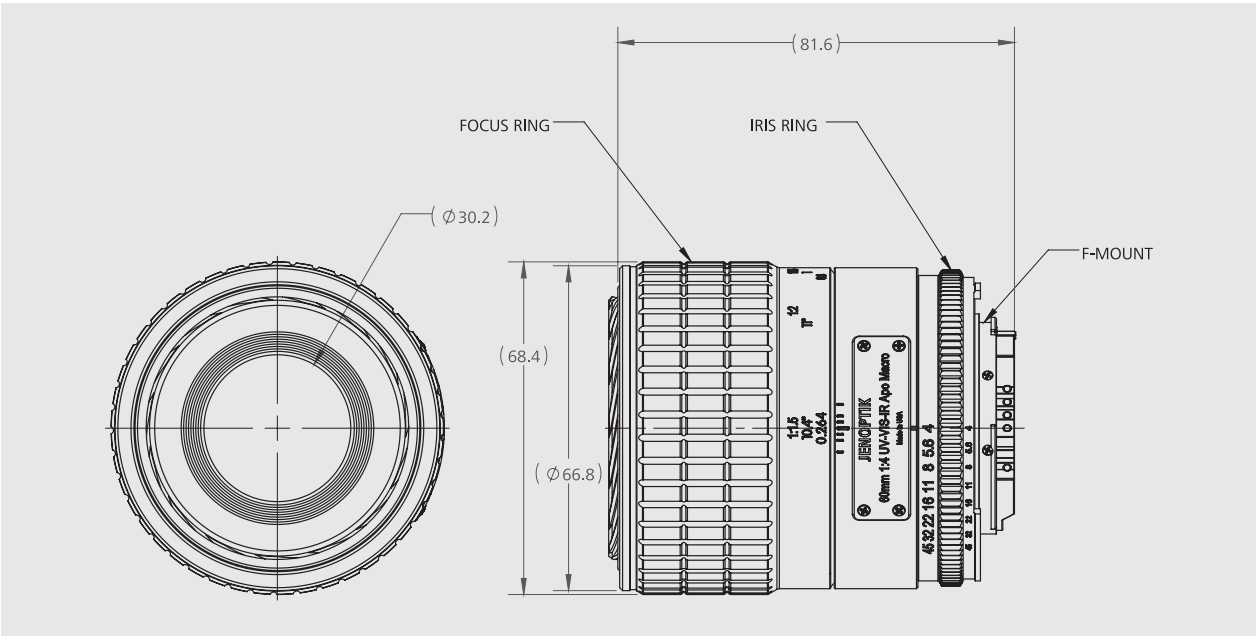
The Jenoptik UV-VIS-IR 60 mm 1:4 lens is a APO macro lens designed to maximize the performance across the UV-IR spectrum. The advanced floating element design and advanced ultra broadband AR coating make this lens a stunning performer in all conditions.

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

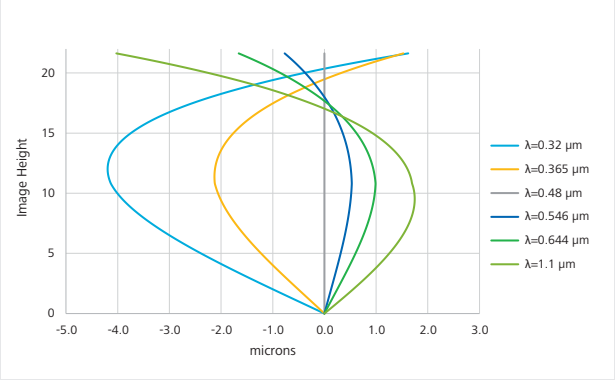
Features

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

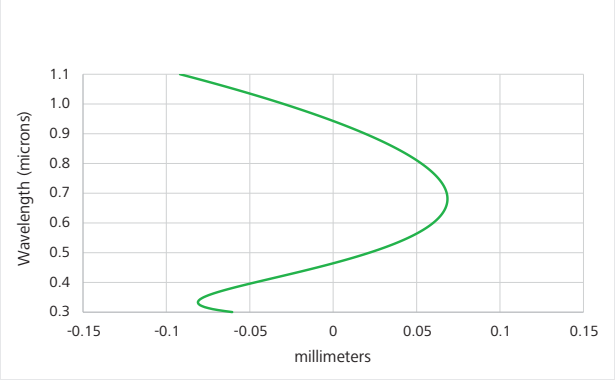
Transmission Waveband:	290 - 1500 nm
Apochromatic Waveband:	315 - 1100 nm
Focal Length:	60 mm
Focal Ratio:	f/4 - f/45
Image Format:	24 mm x 36 mm
No. of Elements/Groups:	10/9
Focus Range:	264 mm to infinity
Maximum Magnification:	1:1.5
Mounting Flange:	Nikon F-Mount
Filter:	52 mm Thread (M 52 x 0.75)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



Lateral Color and Chromatic Focal Shift

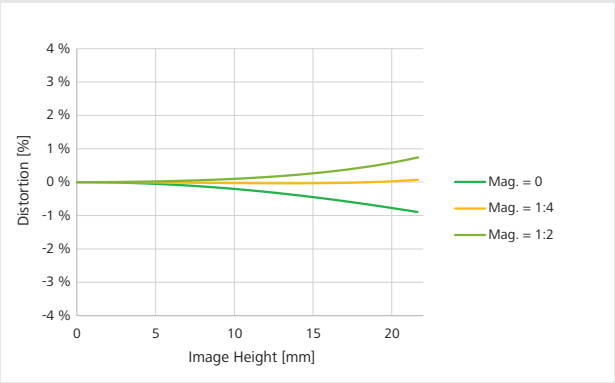


Lateral Color

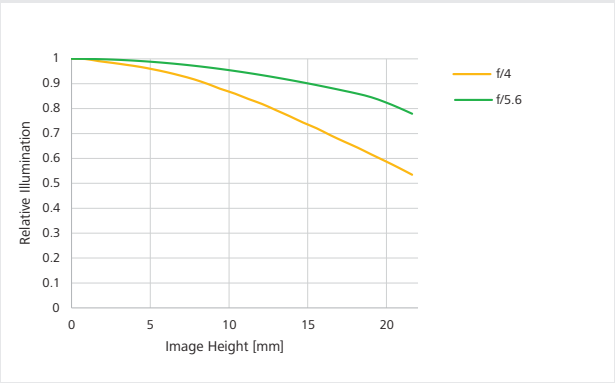


Chromatic Focal Shift

Distortion and Relative Illumination

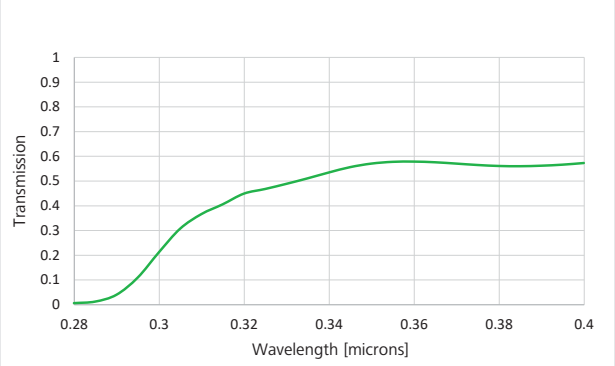


Distortion

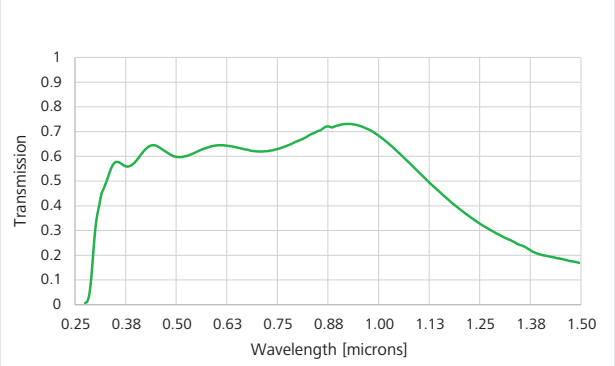


Relative Illumination

Transmission

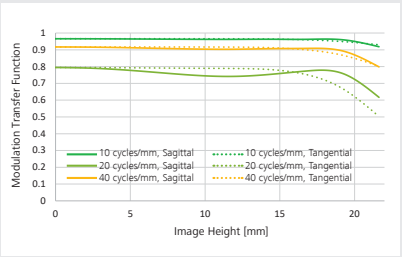


Transmission (280 - 400 nm)

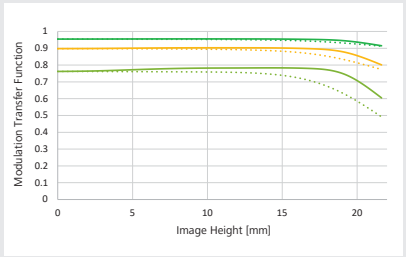


Transmission (280 - 1500 nm)

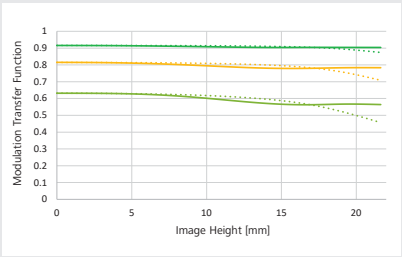
MTF - UV, VIS, IR



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

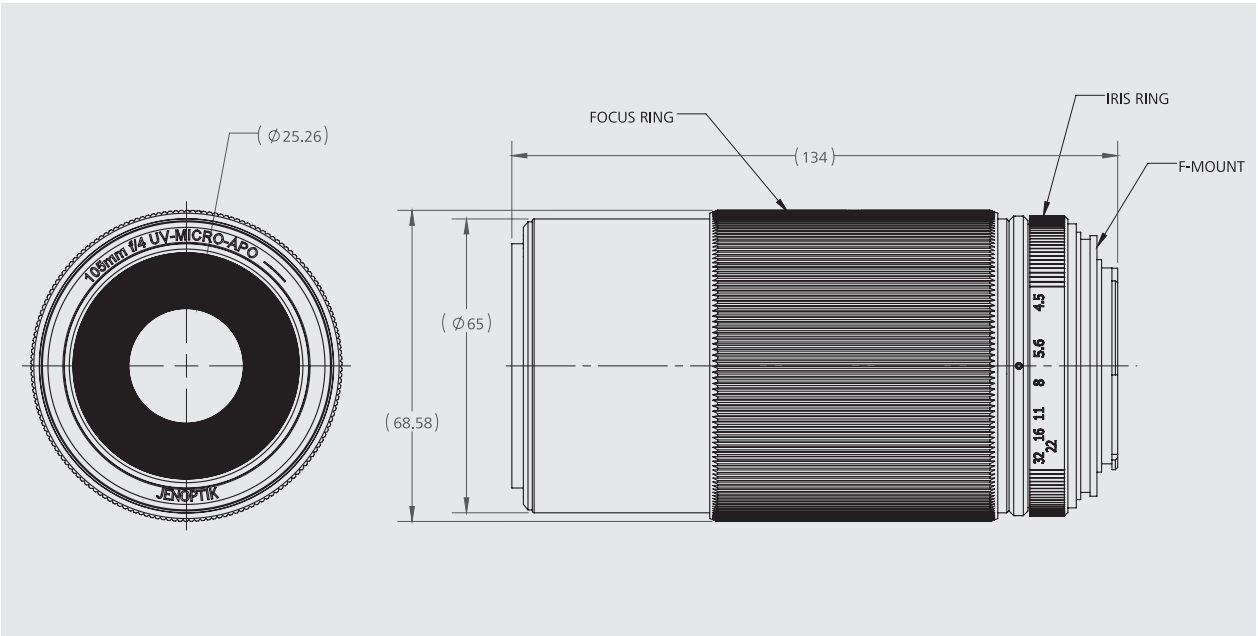
The Jenoptik UV SLR Lens allows capturing both UV and visible images without a focus adjustment for the color shift. The lens can be used for applications below 250 nm with narrow band filters. The Nikon and C-mount lens was developed to use with the increasingly ultraviolet sensitive CCDs offered in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

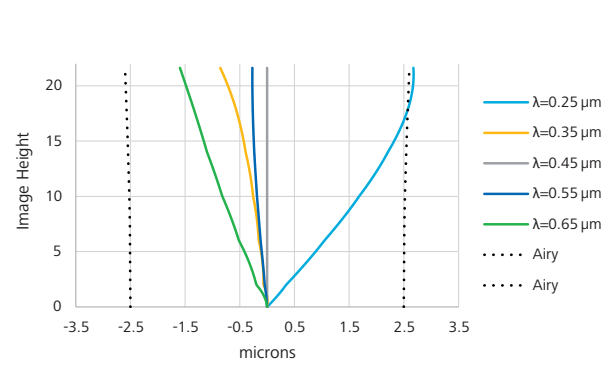
Features

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

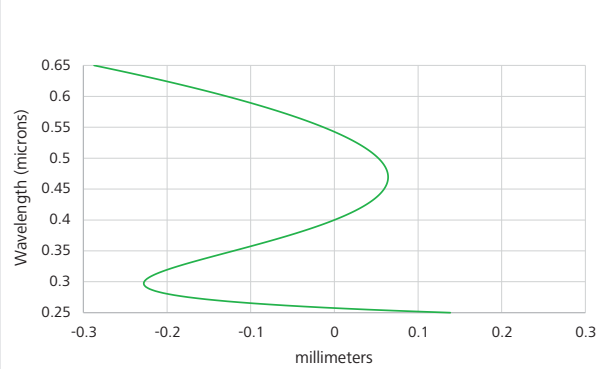
Spectral Range:	250 - 650 nm
Focal Length:	105 mm
Focal Ratio:	f/4.5 to f/32
Image Format:	24 mm x 36 mm
Field of View:	26.56° H x 16.68° V
Diagonal Field of View:	29.78°
Distortion:	Less than 1 % over the full image format
Image Circle:	43.27 mm
Minimum Object Distance:	300 mm
Filter Mount:	52 mm
Lens 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

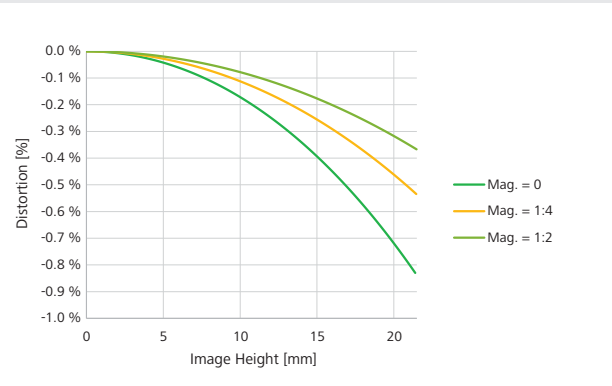


Lateral Color

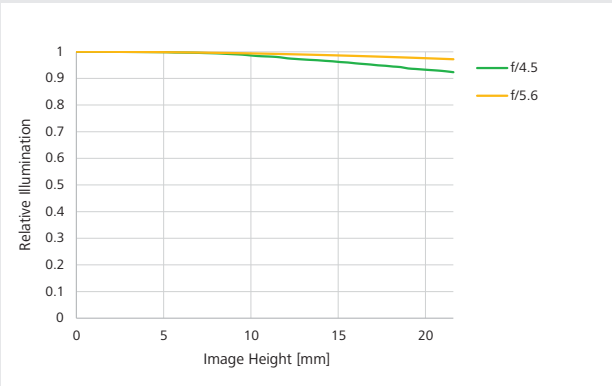


Chromatic Focal Shift

Distortion and Relative Illumination

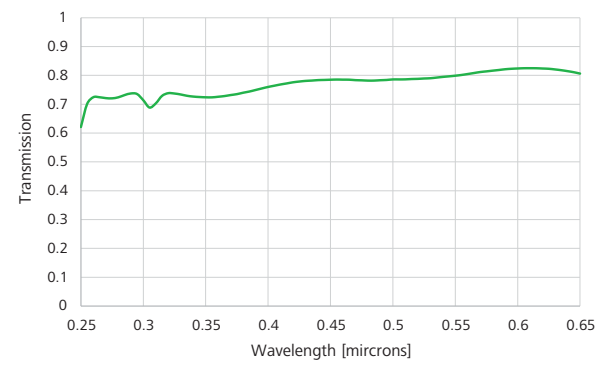


Distortion

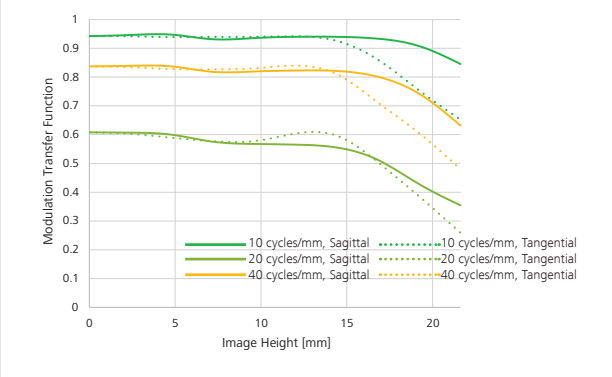


Relative Illumination

Transmission and MTF



Transmission



MTF (250 - 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)

Europe

JENOPTIK · Light & Optics

JENOPTIK Optical Systems GmbH
Goeschwitzer Strasse 25
07745 Jena · Germany
www.jenoptik.com/optics

Ms. Maxi Seifert
maxi.seifert@jenoptik.com
Phone +49 3641 65-3323

Germany

Ms. Tina Bräutigam
tina.braeutigam@jenoptik.com

JENOPTIK Optical Systems GmbH
Goeschwitzer Strasse 25
07745 Jena · Germany
Phone +49 3641 65-2934

Israel

Mr. Vladislav Gvardiyan
vladislav.gvardiyan@jenoptik.com

Branch Office Israel
Einstein Street 16
76470 Nes Ziona · Israel
Phone +972 8 930 3501

North America

Mr. Joel Murphy
joel.murphy@jenoptik-inc.com

JENOPTIK Optical Systems, LLC.
16490 Innovation Drive
Jupiter · FL 33478 · USA
Phone +1 561 881 7400 x-1248

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

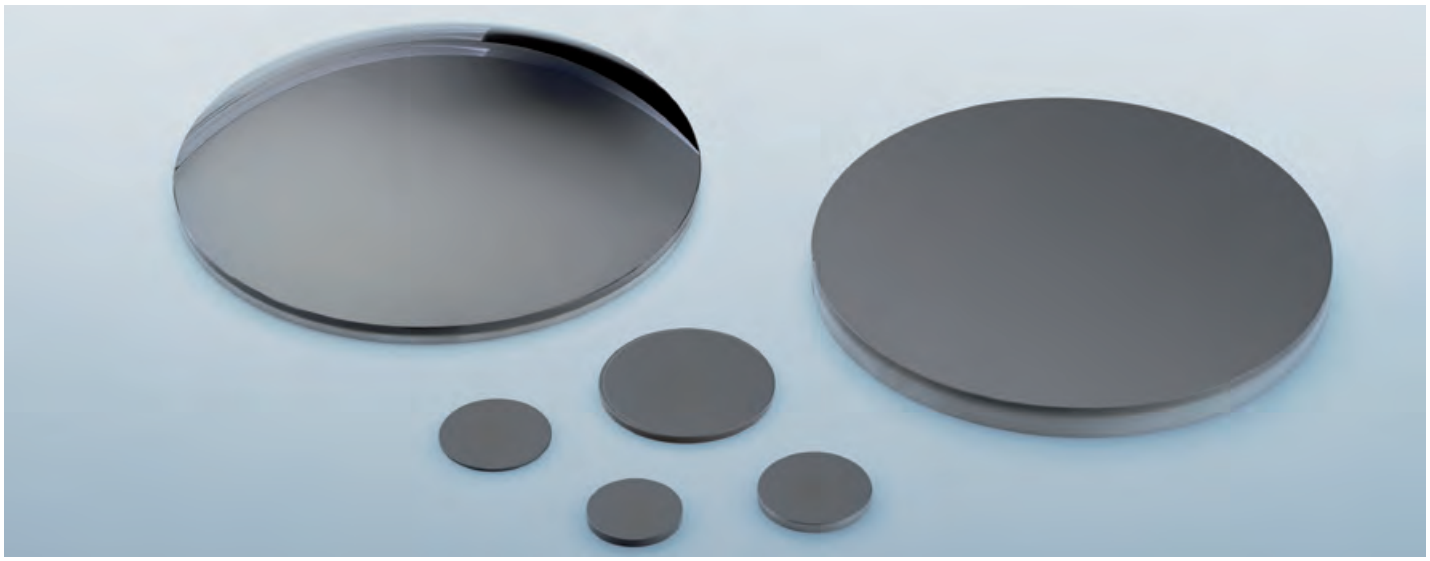
Fields of Application

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

Specifications & Technical Parameters

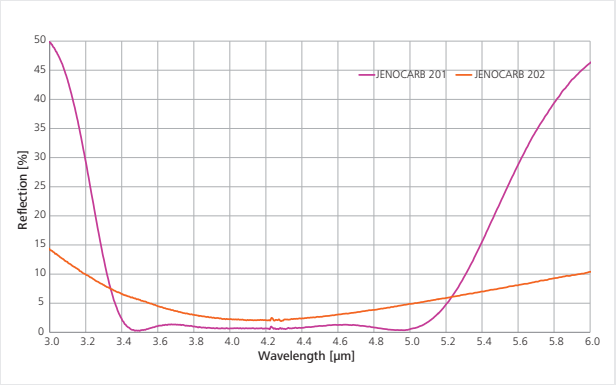
Coating Type	Description	Substrate	Wavelength	R_{ave} per surface	R_{min}
JENOCARB 101	DLC AR Coating for 3 - 5 µm	Ge	3.0 - 5.0 µm	< 3.2 %	< 0.7 %
JENOCARB 102	DLC AR Coating for 8 - 12 µm	Ge	8.0 - 11.5 µm	< 2.4 %	< 0.9 %
JENOCARB 201	DLC AR Coating for 3 - 5 µm	Si	3.0 - 5.0 µm	< 4.5 %	< 2.5 %
JENOCARB 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 | Granted patent CN 104303078 B

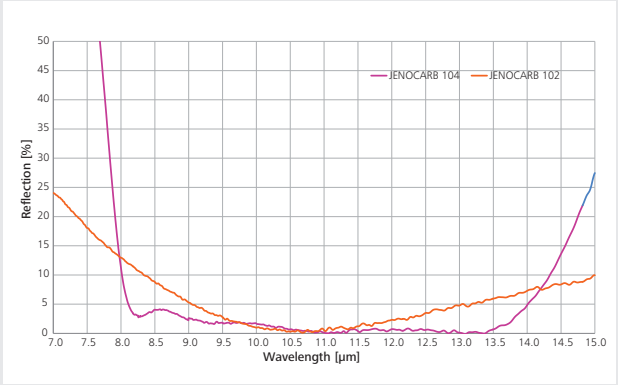


Durability:

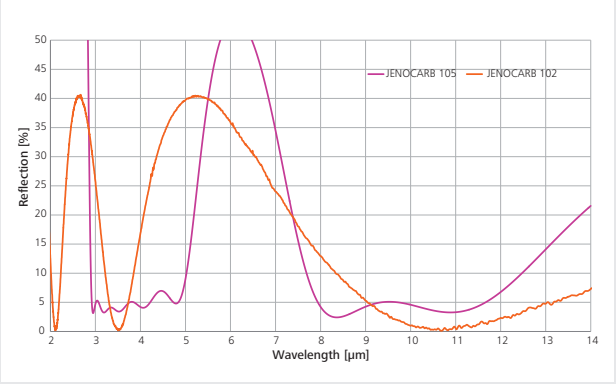
- Windscreen Wiper Test TS1888 / P 5.4.3
- Adhesion MIL-C-675 P4.5.12
- Humidity MIL-C-675 P4.5.8
- Severe Abrasion MIL-C-675C P4.5.10
- Temperature MIL-M-13508 P4.4.4
- Salt Solubility MIL-C-675C P4.5.7
- Salt Spray MIL-C-675C P4.5.9
- Boiling Test DIN 58196-2 P5.2
- Durability in hydrochlorid acid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



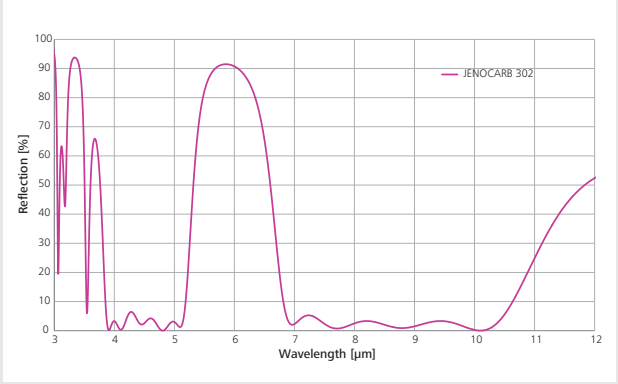
DLC and Hybrid-DLC for 3.0 - 5.0 µm on Si



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 - 5.8 µm	Si	3.0 - 5.8 µm	< 1.0 %	> 97.5 %
JENODUR 416 - 001	Broadband AR Coating for 3 - 5 µm	Si	3.0 - 5.0 µm	< 0.6 %	> 98.0 %
JENODUR 416 - 002	Broadband AR Coating for 2 - 5 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 - 5 µm	Sapphire	3.0 - 5.0 µm	< 1.5 %	> 97.5 %
JENODUR 424	Broadband AR Coating for 7 - 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 %

Granted patent EP 1749222 B1 | Granted patent US 10,139,539 and equivalent Granted or Pending patents in CN, EP, JP

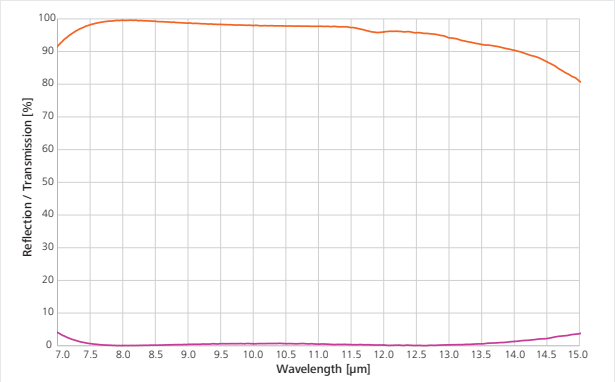
Applications

Evaporation, wet chemical (dipping spraying, spinning…),

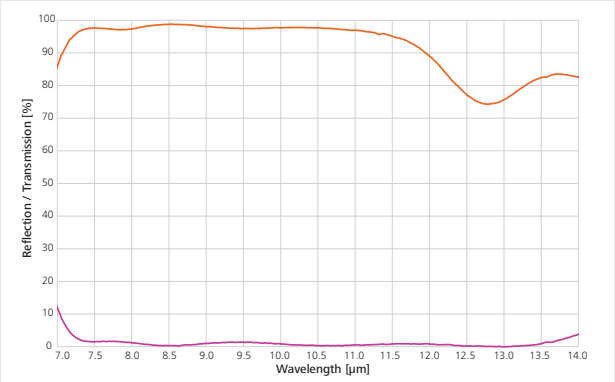
- Covaltent bonding on oxides, metals
- Contact angle initial 115°/ H_2O
- Reduction of the roughness up to 80 %
- Surface energy < 20 mN/m

Durability

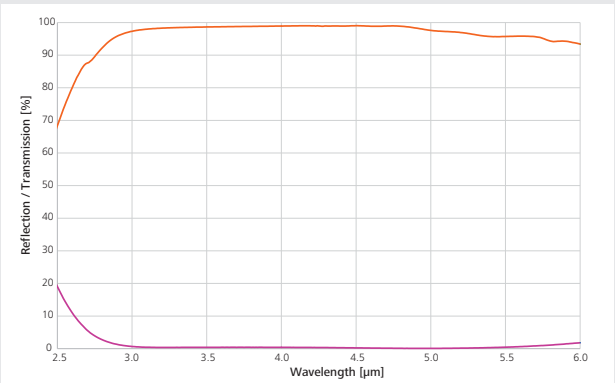
- Adhesion: MIL-C-48497A / section 4.5.3.1
- Humidity: MIL-C-48497A / section 4.5.3.2
- Abrasion Resistance: MIL-C-48497A / section 4.5.3.3
- Temperature: MIL-C-48497A / section 4.5.4.1
- Solvent Resistance: MIL-C-48497A / section 4.5.4.2



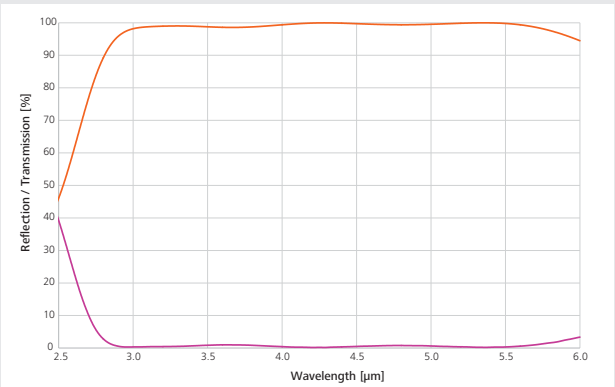
JENODUR 411 - 002 Broadband AR Coating for 8 - 13 µm on Ge



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



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



Jenodur 417 - 001 Broadband AR coating for 3.3 - 5.8 µm 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. In addition to 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

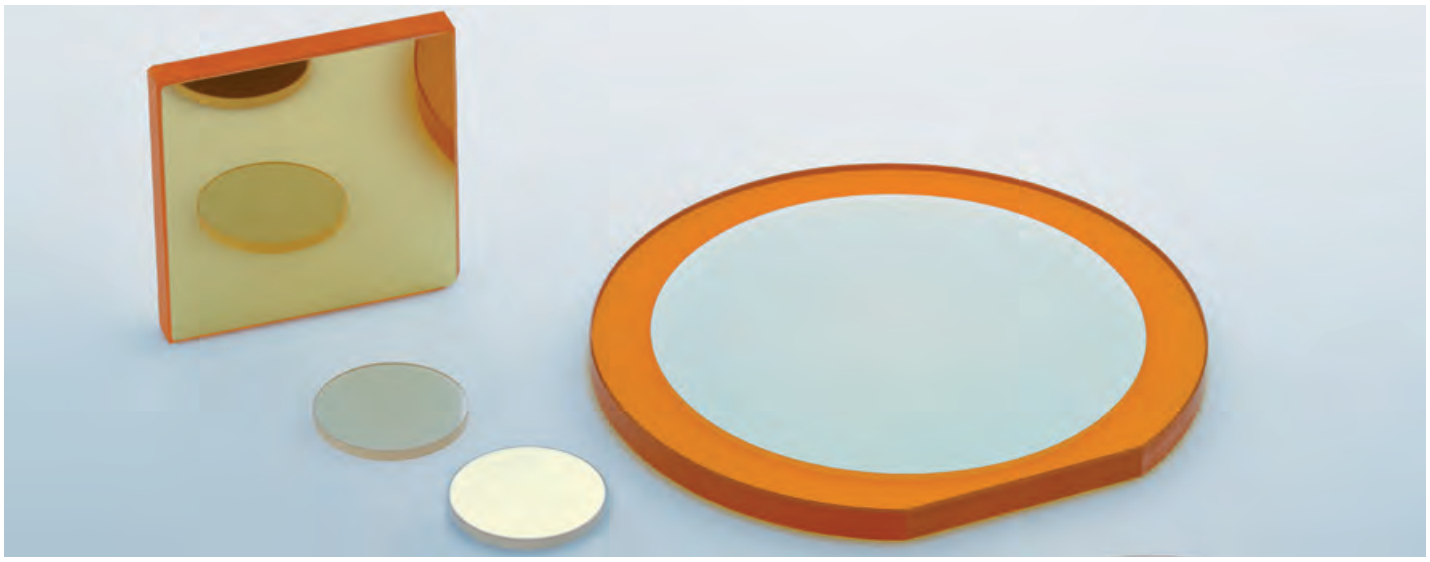
- Long-year experience in developing complex and challenging customized solutions
- High transmission in multiple spectral bands
- High durability and stability
- Certified according to DIN ISO or MIL with CoC
- Free of any radioactive materials

Fields of Application

- Multi-color IR cameras
- Multiband infrared spectrometers

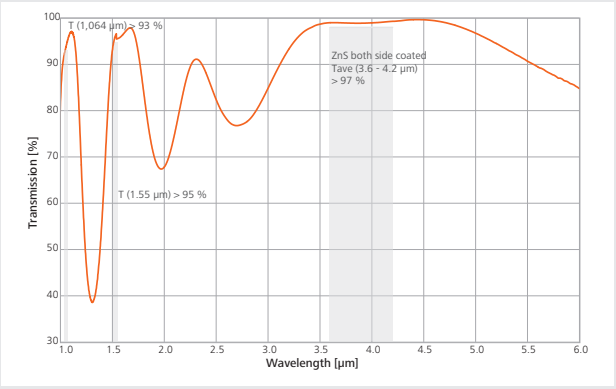
Specifications & Technical Parameters

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 %

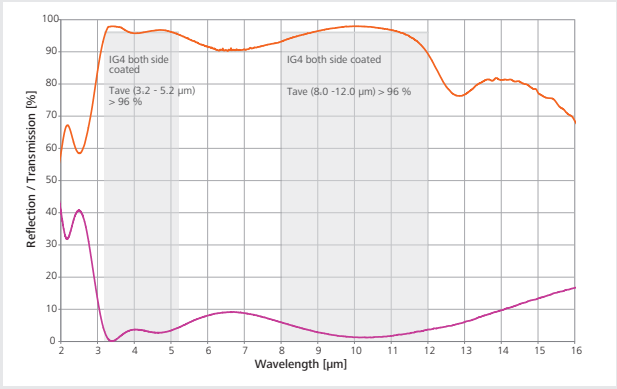


Durability

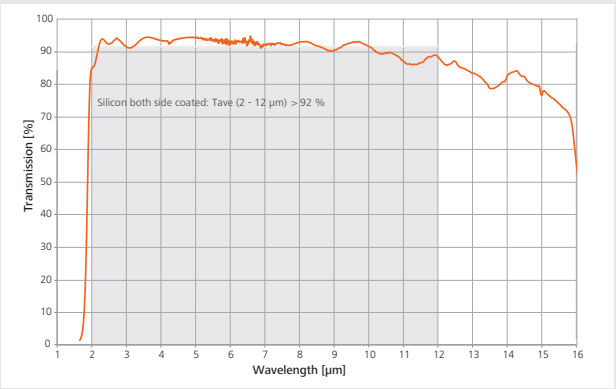
- Adhesion: MIL-C-48497A / section 4.5.3.1
- Humidity: MIL-C-48497A / section 4.5.3.2
- Abrasion Resistance: MIL-C-48497A / section 4.5.3.3
- Temperature: MIL-C-48497A / section 4.5.4.1
- Solvent Resistance: MIL-C-48497A / section 4.5.4.2



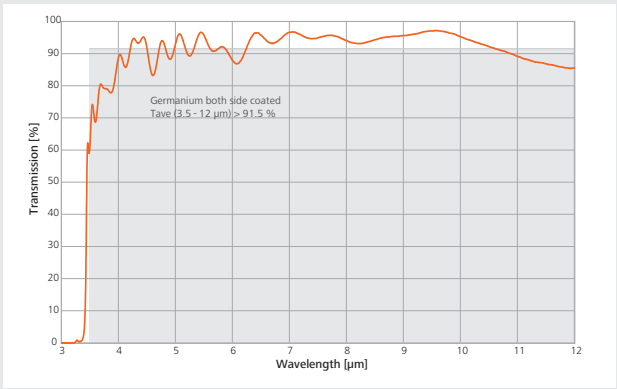
JENODUR 421 Tripleband AR Coating for SWIR - MWIR on ZnS



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

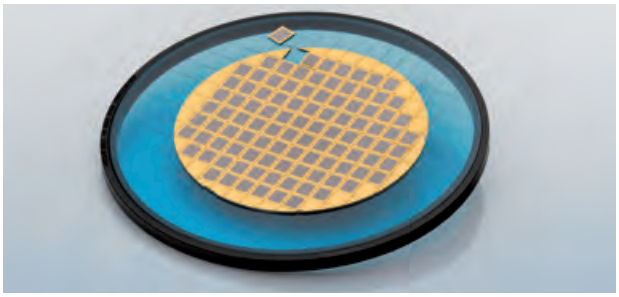
Fields of Application

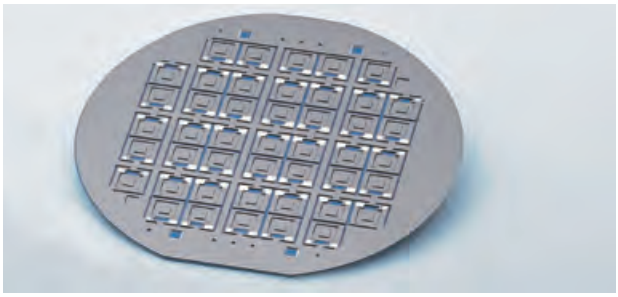
- Automotive industry: Filters for gas analysis
- Digital imaging: Filters for image capture and target detection
- Semiconductor equipment: Filters for IR sensor technology

Multifunctional IR Filters and Detector Windows

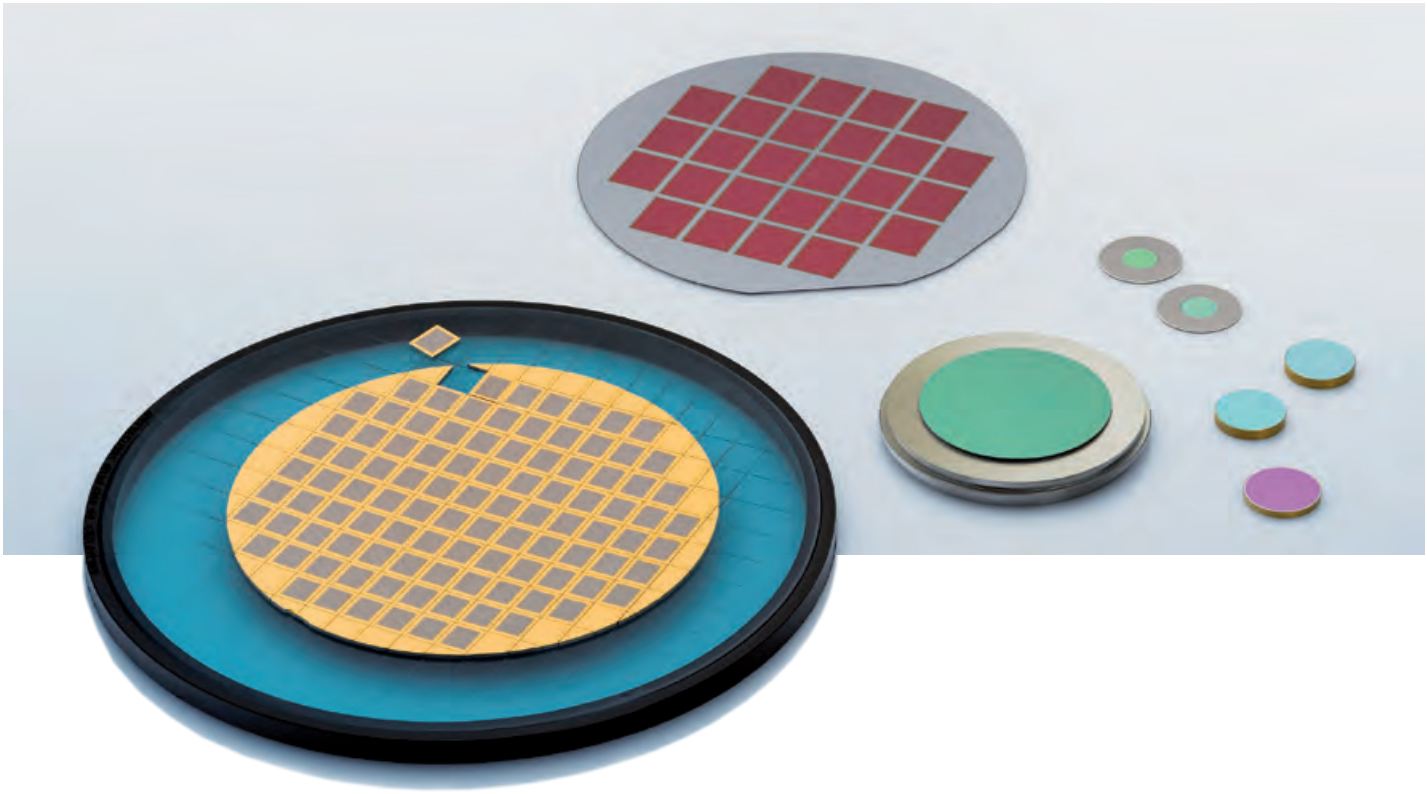
Following trend markets like ‚Smart Factory' and ‚Smart Home', the increasing IR detector market for civil applications needs new technologies. The machine solution Wafer-Level-Packaging (WLP) realizes a wafer fab manufacturing and, thus, a cost-optimized mass production.
The priority is to ensure the 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.



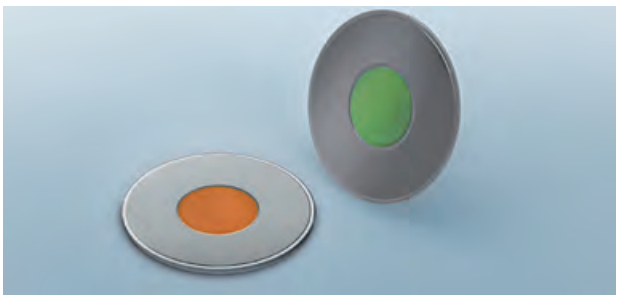


Pending Pat. US 20160062127 and equivalent granted or Pending Patents in CN, EP, JP



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.

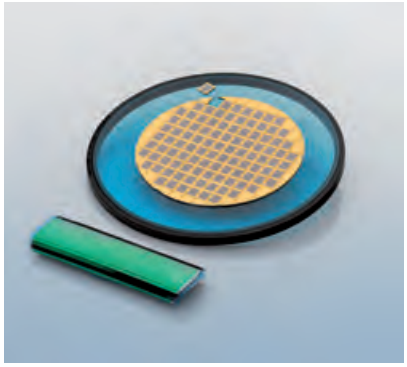
Jenoptik is able to design both systems in such a way that they best suit its customers' application.

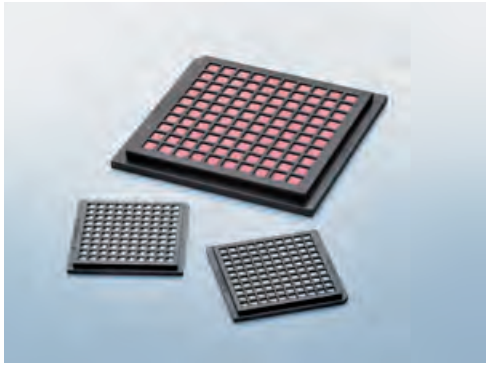
The filter design affects the bandwidth, the edge steepness as well as temperature and angle shift. The blocking system's design is decisive for the achievable attenuation that could be reached outside the passband (→ see Fig. 2).

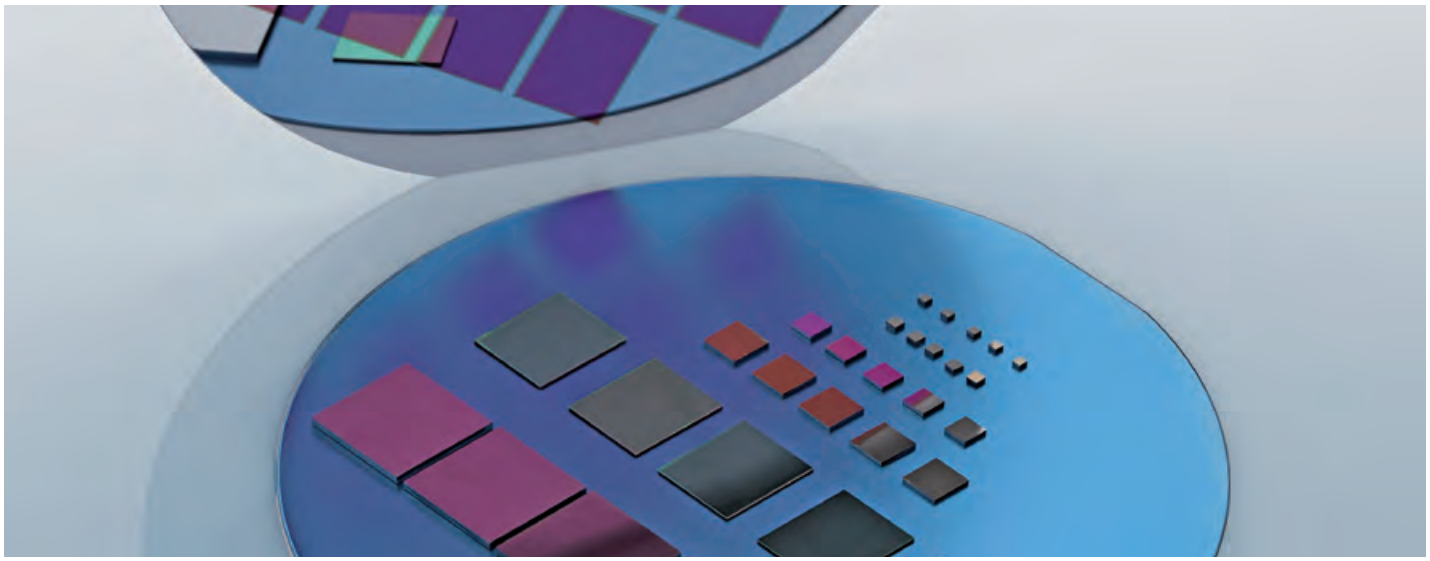
The number of single layers has an essential impact on the production costs.
In cooperation with its customers Jenoptik always focuses on an optimal cost-benefit-ratio solution.

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

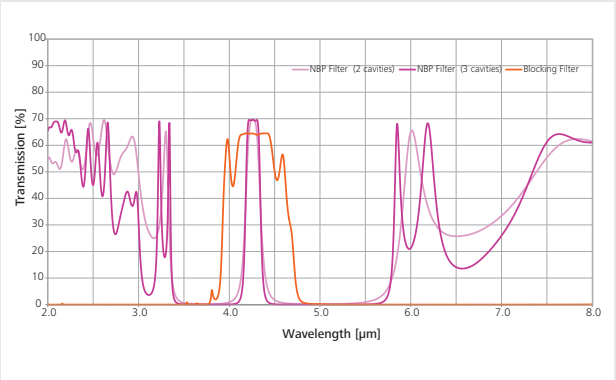


Fig. 1 shows the design principle of a NBP

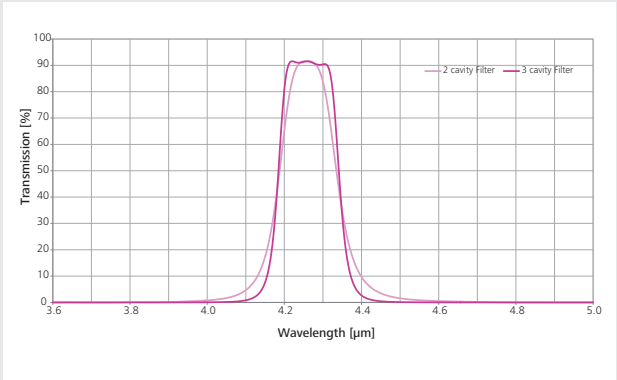


Fig. 2 shows different slopes related to the respective design

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

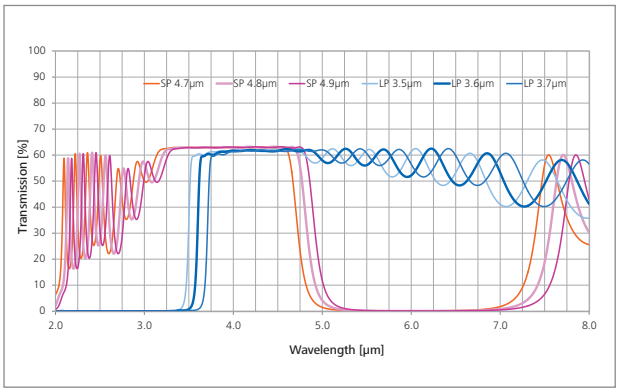


Fig. 1 shows the design principle of a BP filter generated by a short- and longpass filter design

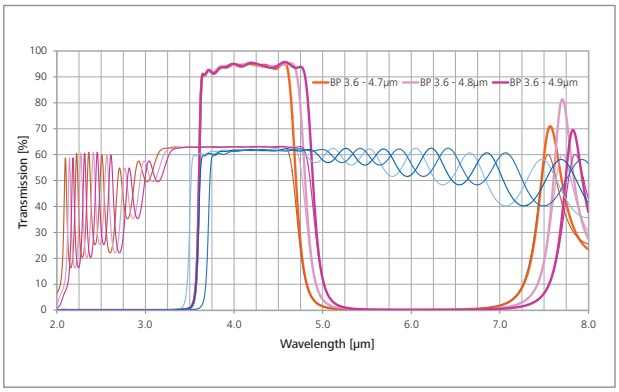
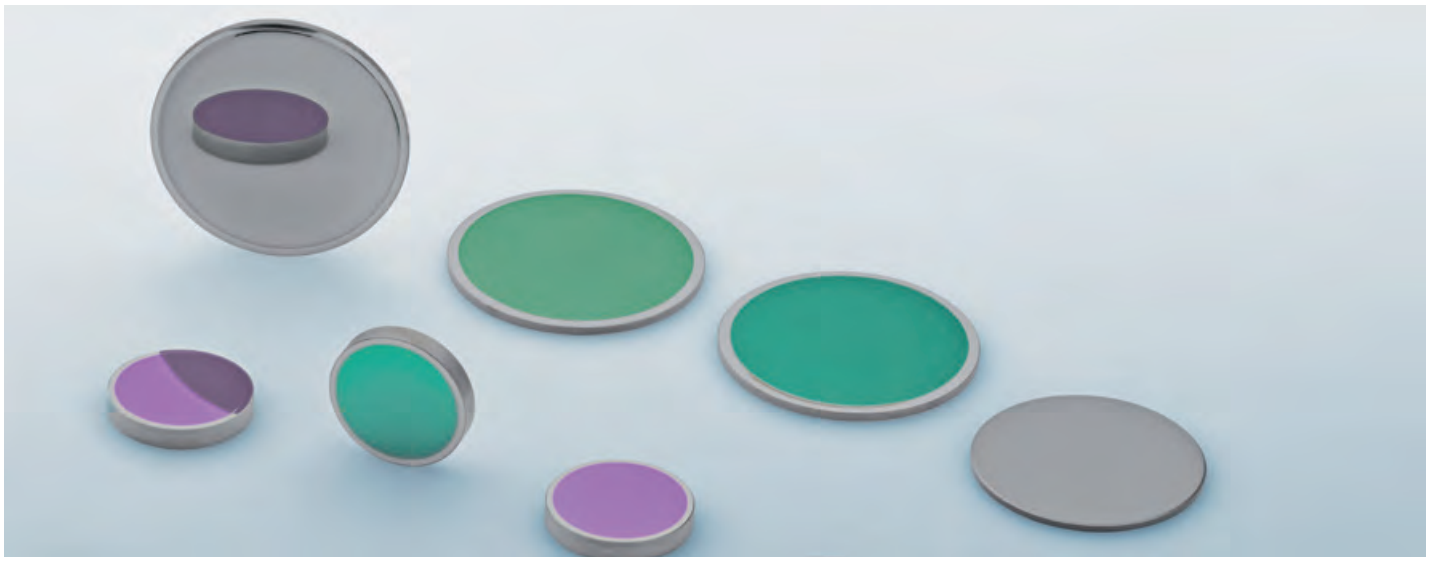


Fig. 2 shows different options of a BP filter. The bandwidth can be determined by the cut-on and cuf-off wavelengths

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

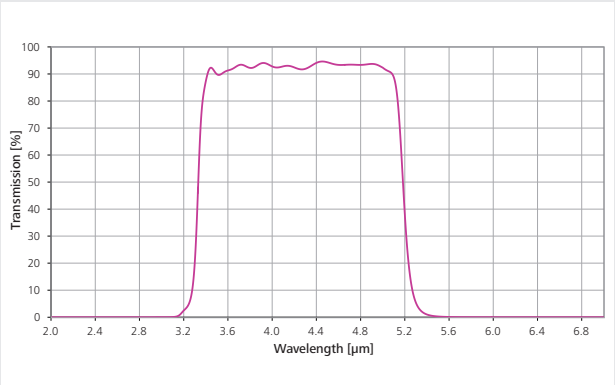


Deliverables

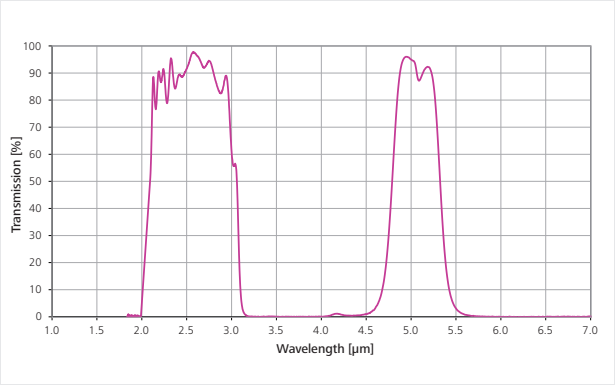
- Manufacturing on single filter or wafer-level base according to customer specification
- All IR substrates adjusted to respective specification (e. g. Ge, Si, Sapphire, Fluorides)
- Adaption to respective operating temperature is possible (measurement at Cryo temperature down to 95 K)
- Filter geometries: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

Durability

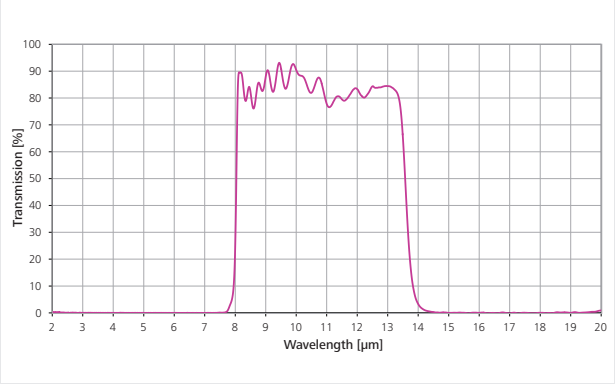
- Adhesion: MIL-C-48497A / section 4.5.3.1
- Humidity: MIL-C-48497A / section 4.5.3.2
- Moderate Abrasion: MIL-C-48497A / section 4.5.3.3
- Temperature: MIL-C-48497A / section 4.5.4.1
- Solvent Resistance: MIL-C-48497A / section 4.5.4.2



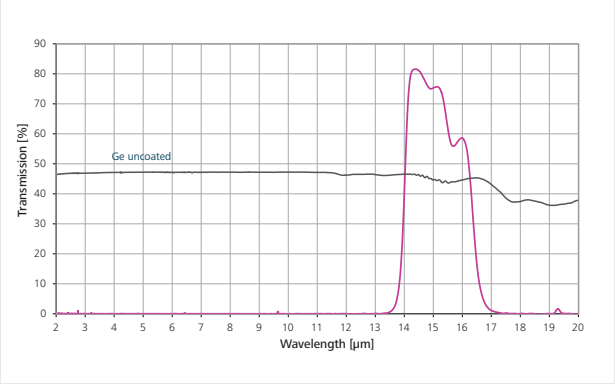
Bandpass Filter 3.2 - 5.2 µm on Ge



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, it works under the terms of an approved TAA
- All manufacturing processes are conform to ISO 9001
- Top of the notch Czochralski type crystal growing up to diameter 450 mm
- Fine ground, ready to polish surface option
- Refractive index can be measured on all IR materials with transparency from 2 to 15 µm and also for a temperature range from 15 to 30°C
- Complete value-added chain of IR optics components

Fields of Application

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

Europe & Asia

JENOPTIK · Light & Optics

Photonic Sense GmbH
Am Goldberg 3
99817 Eisenach · Germany
www.photonic-sense.com

Mr. Andreas Zickler
andreas.zickler@photonic-sense.com
Phone +49 3691 7318-21

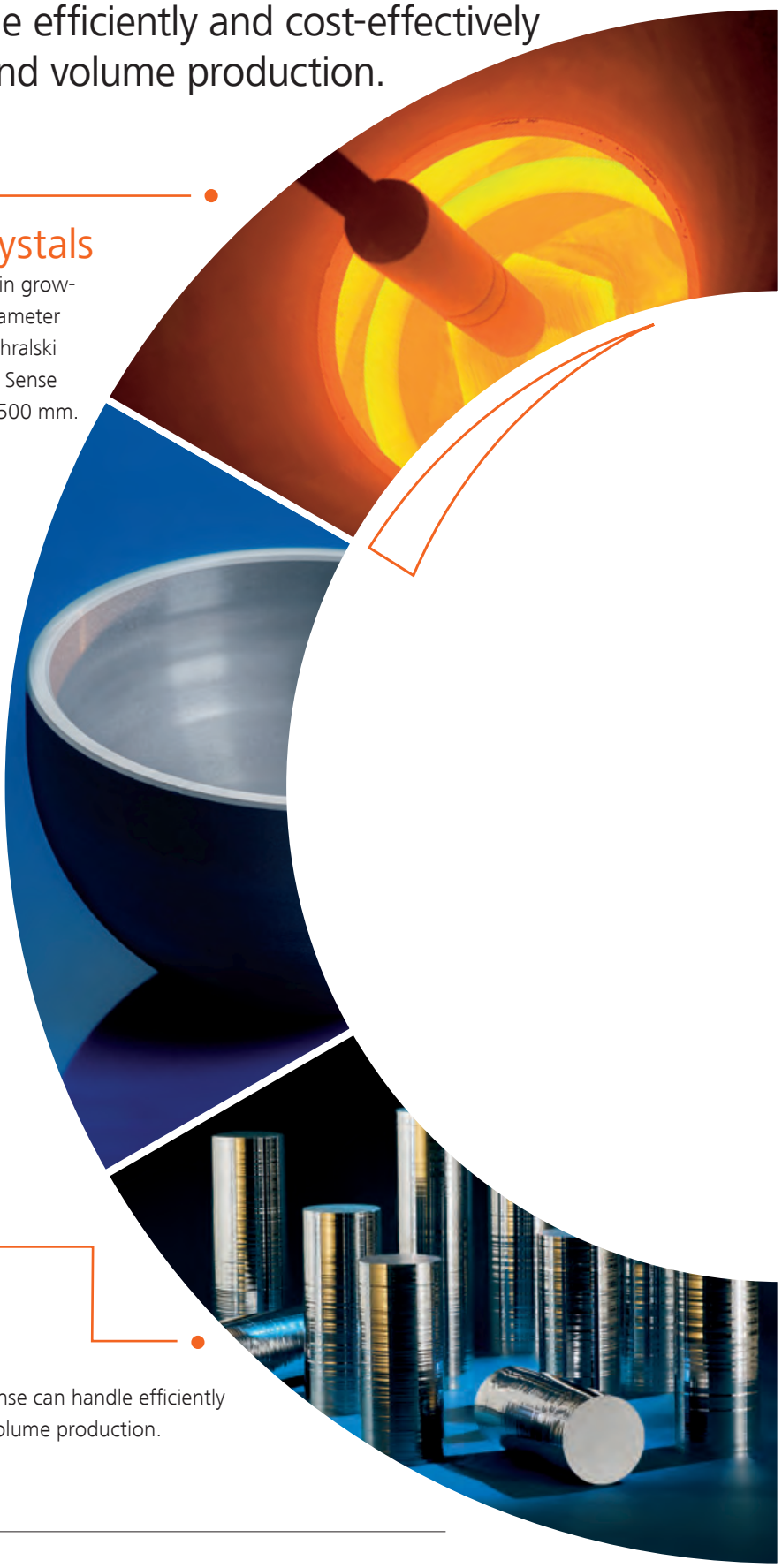
North America

Mr. Eric Brambani
eric.brambani@photonic-sense.us

Photonic Sense, Inc.
16490 Innovation Drive, Suite B
Jupiter · FL 33478 · USA
Phone +1 201 569 8695

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.

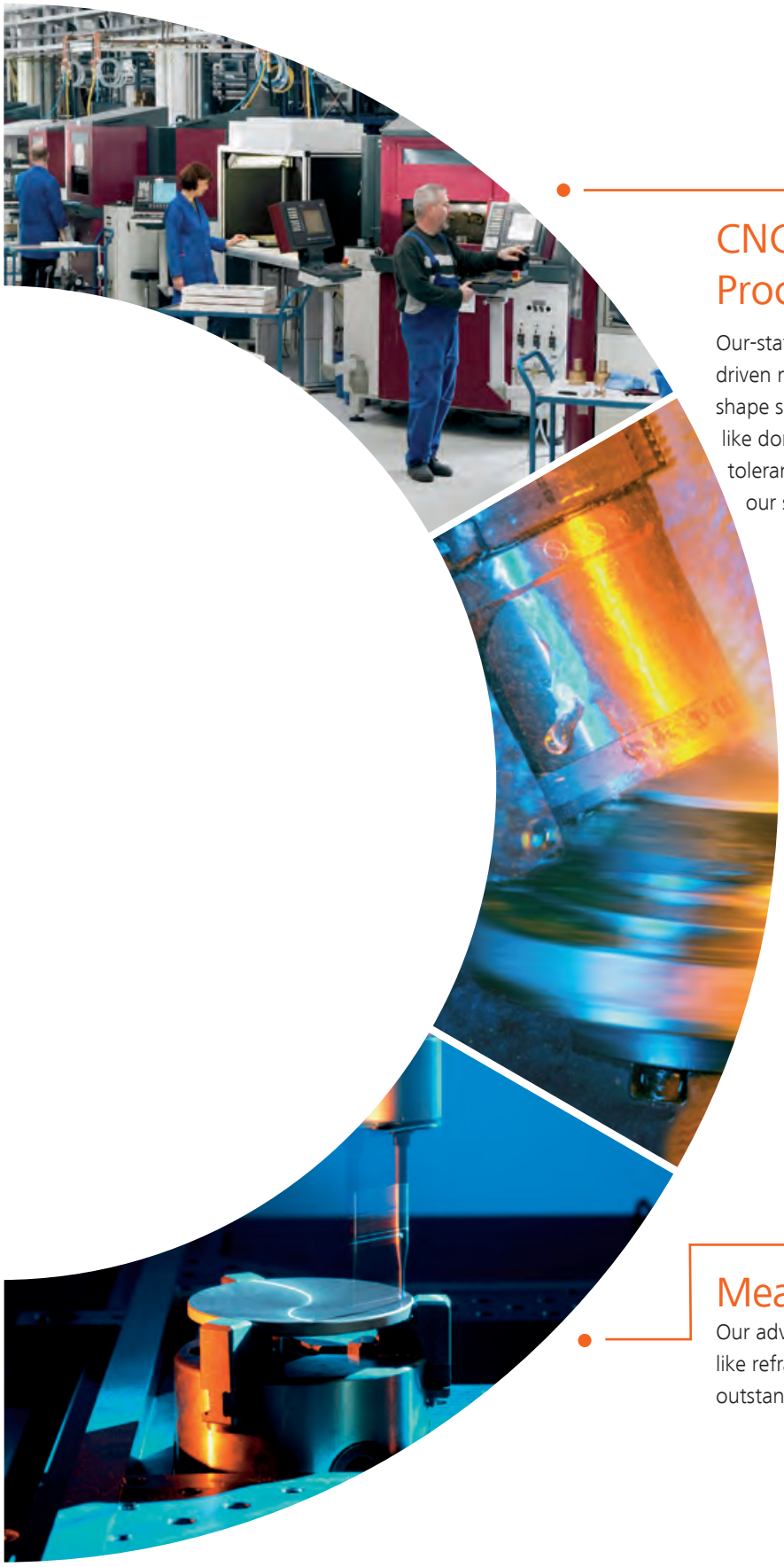
Products and Scraps

Besides domes, windows and various blankets, Photonic 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.

Photonic Sense™: Trademark registered in EU, US, CA, CN



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

Photonic 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.

Connected Optics

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 connected Optics 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 automation

Fields of Application

- 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, welding and cutting
- Smart farming and optical sorting
- Imaging based process control
- Particle counting for process industry

Contact

JENOPTIK · Light & Optics

JENOPTIK Optical Systems GmbH
Goeschwitzer Strasse 25
07745 Jena · Germany
www.jenoptik.com/optics

Mr. Steffen Reinl
steffen.reinl@jenoptik.com
Phone +49 3641 65-3314

F-Theta Bundle

Your F-Theta Lens Ready to Use Package

Jenoptik cooperates with different scanner suppliers throughout the world of photonics and laser material processing. Based on our experience and your knowledge along with needs for cost and time saving solutions, Jenoptik offers you a complete suitable integrated setup. A one source solution which includes a galvanometer scanner set, one of our market known F-Theta lenses and an adapter ring to assist in integration giving you a economical, technically optimized solution for your application requirements.

We consider all optical parameters that could effect the overall performance and deliver a ready to integrate setup. Focus on your key competences!

Customer Benefits

- Optimized performance
- Short delivery times
- Tailored configuration
- Calibrated setup
- Scaleable volume

Consulting

- Application support
- Back reflection optimization
- Configuration
- Interfaces

Specification and Technical Information

Summarized technical specs:	
Wavelengths [nm]:	355, 515…540, 900…1100, 1030…1080
Apertures [mm]:	10, 15, 20, 30, 50
Scan speed:	Up to 20 m/sec (@ f=160 mm)
Scanner control (depending on scanner type):	Analogue or digital
Controller type (depending on scanner type):	Standard controller or model based state space control (smartmove - no tracking error)
Controller card:	External or internal
Auto tuning:	Depending on scanner type
Configuration:	Optimized setup with Jenoptik F-Theta lenses
Laser power range:	From low power up to kW range

Fig. 1 Example of ECO IR

Standard configurations:	Specification
A: High Performance IR	Configuration for high power IR applications fulfills highest requirements for speed, laser-power and accuracy. It includes a high performance 2D scanner with 20 mm aperture incl. Jenoptik´s Silverline full-fused silica objective lens at f=255 mm for laser wavelengths between 1030…1080 nm
B: High Performance UV	Our setup for high demanding UV applications consists of a high performance 2D scanner with 15 mm aperture includes Jenoptik´s Silverline full-fused silica objective lens (f=100 mm) for laser wavelengths of 355 nm
C: ECO IR	Cost optimized package for applications which do not need highest speed and accuracy. This bundle includes a 2D galvo scanner with 20 mm aperture and our JENar™ F-Theta objective lens at f=420 mm. The bundle is designed for use with lasers that emmits at 1030…1080 nm
D: High Performance GR	This setup is optimized to serve applications that need high speed movement of the beam and fast positioning combined with medium laser power levels at 532 nm. It comes with our JENar™ F-Theta objective at 255 mm focal length

Applications
for Laser Material Processing

Fig. 2 Example of High Performance IR

- Micro Welding of Metals
- Black Marking / UDI
- Welding of Plastics
- Glass Processing
- Drilling of Ceramic

Looking forward
to Meeting You in 2019!

Exhibition	Location	Country	Date
SEMICON Korea	Seoul	South Korea	January 31 - February 02
SPIE BiOS	San Francisco, CA	USA	February 02 - 03
SPIE Photonics West	San Francisco, CA	USA	February 05 - 07
ISE (Integrated Systems Europe)	Amsterdam	Netherlands	February 05 - 08
SPIE Advanced Lithography	San Jose, CA	USA	February 26 - 27
OFC	San Diego, CA	USA	March 05 - 07
KIMES Korea	Seoul	South Korea	March 14 - 17
LASER World of PHOTONICS China	Shanghai	China	March 20 - 22
AACR (American Association for Cancer Research)	Atlanta, GA	USA	March 29 - April 03
ITEM - The International Technical Exhibition of Medical Imaging	Yokohama	Japan	April 12- 14
SPIE Defense + Commercial Sensing Conference	Baltimore, MD	USA	April 16- 18
Control	Stuttgart	Germany	May 07 - 10
CMEF Spring	Shanghai	China	May 14 - 17
LAMP (Laser Advanced Materials Processing)	Hiroshima	Japan	May 21 - 24
LASER World of PHOTONICS	Munich	Germany	June 24 - 27
LASER Korea	Seoul	South Korea	July 03 - 05
AACC Annual Scientific Meeting & Clinical Lab Expo	Anaheim, CA	USA	August 04 - 08
SPIE Optics + Photonics	San Diego, CA	USA	August 13 - 15
Next Generation Dx Summit	Washington, DC	USA	August 20 - 22
CIOE (China International Optoelectronic Exhibiton)	Shenzhen	China	September 04 - 07
DSEI (Defense & Security Equipment International)	London	United Kingdom	September 10 - 13
CIIF (China International Industry Fair)	Shanghai	China	September 17 - 21
ECOC Conference and Exhibiton	Dublin	Ireland	September 23 - 25
AAO (American Academy of Ophthalmology)	San Francisco, CA	USA	October 12 - 15
LASER World of PHOTONICS India	Mumbai	India	October 17 - 19
productronica	Munich	Germany	November 12 - 15
COMPAMED	Duesseldorf	Germany	November 18 - 21
SEMICON Japan	Tokyo	Japan	December 11 - 13

Make Your Notes

Find Your Way into Our Optics …

Make Your Notes

Find Your Way into Our Optics …

Light & Optics –
working to ensure your success!

Imprint:

Editor:
JENOPTIK Optical Systems GmbH
Layout:
JENOPTIK Optical Systems GmbH
Print:
Druckhaus Gera GmbH
Images:
lochtephoto - Kurt Lochte (page titel, 3, 6, 8, 18, 33, 38, 40, 68, 78, 81, 83, 85-91)
JENOPTIK Optical Systems GmbH (page 3-4, 12, 48-49, 67, 69, 82, 99)
JENOPTIK Optical Systems, LLC (page 3, 51-59, 62-63, 70-71)
JENOPTIK Automatisierungstechnik GmbH (page 99)
Fotolia (page 5)
Wolfgang Oberle Fotograf (page 50)
Jeibmann Photographik - Torsten Proß (page U4, 3, 5, 64, 67)
Augenwerke Fotografie - Nadine Grimm (page 1, 7, 47-48, 65, 79, 97)
Art-Kon-Tor - Peter Eichler (page 67)
Photonic Sense GmbH (page 92-95)
Scheere Photos - Jürgen Scheere (page 2-3, 49, 96, 103)
Step-Ani-Motion Studio für Computertrick GmbH (page 3, 46, 49)
FAIRNET GmbH (page 100)

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

We are a globally operating photonics group which is present in more than 80 countries; the Light & Optics division, for example with production and assembly sites in the USA and China. Additionally, the division is represented abroad by shareholdings in India, Israel, Japan, South Korea and Singapore.

It is our policy to constantly improve the design and specifications. Accordingly, the details represented herein cannot be regarded as final and binding.
The items may be subject to the German and European Union Export Control Regulations/Laws.

JENOPTIK Optical Systems GmbH | Goeschwitzer Strasse 25 | 07745 Jena | Germany
Phone +49 3641 65-3148 | optics@jenoptik.com | www.jenoptik.com/optics

JENOPTIK

000000-100-99-11-en-004-210-1905