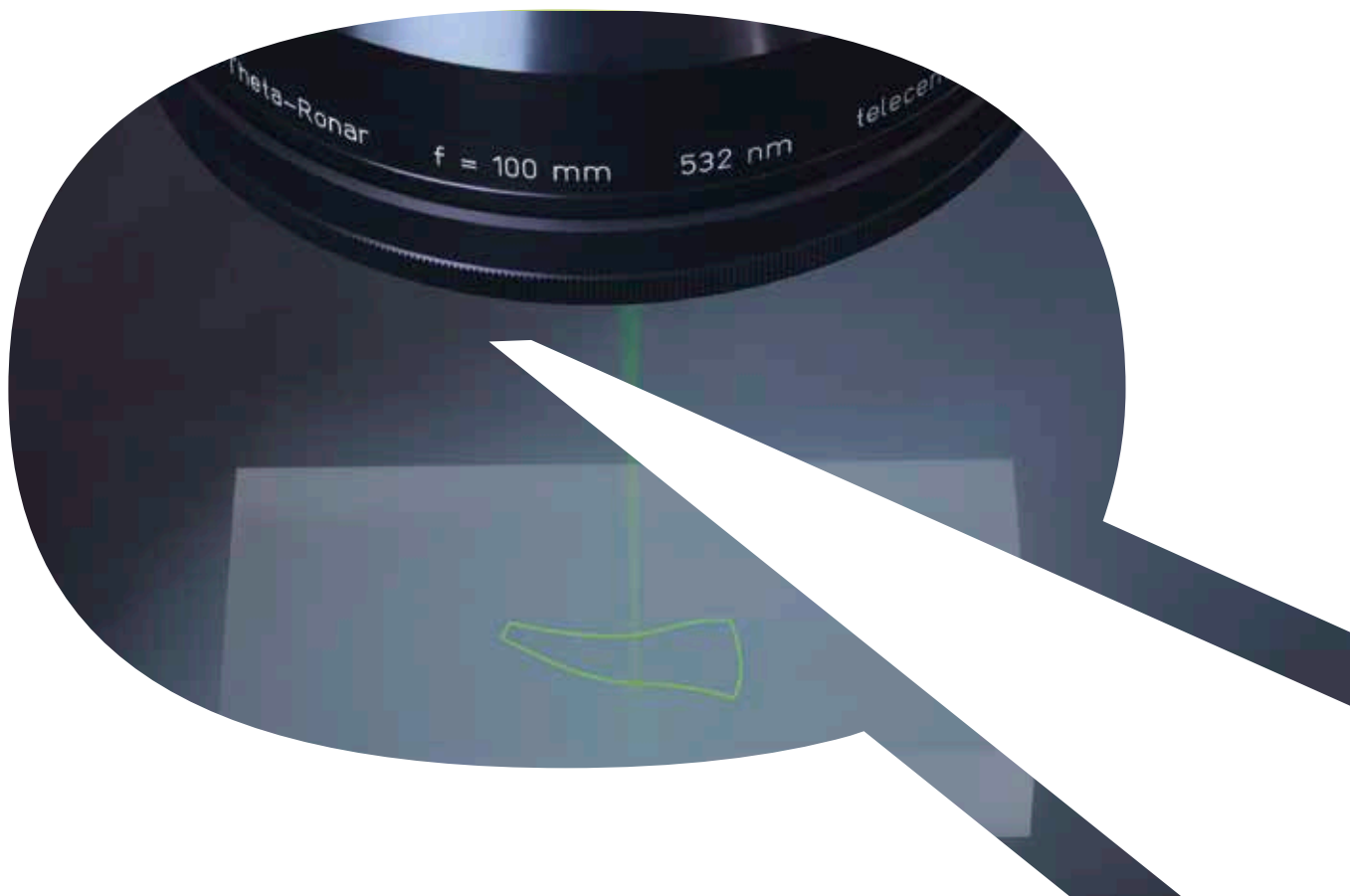


Laser Material Processing



Company Profile

Qioptiq, an Excelitas Technologies Company, designs and manufactures photonic products and solutions that serve a wide range of markets and applications in the areas of medical and life sciences, industrial manufacturing, defense and aerospace, and research and development.

Qioptiq benefits from having integrated the knowledge and experience of Avimo, Gsänger, LINOS, Optem, Pilkington, Point Source, Rodenstock, Spindler & Hoyer and others. In October 2013,

Qioptiq was acquired by Excelitas Technologies Corp., a global technology leader focused on delivering innovative, customized solutions to meet the lighting, detection and other high-performance technology needs of OEM customers. The combined companies have approximately 5,300 employees in North America, Europe and Asia, serving customers across the world.

Visit www.qioptiq.com and www.excelitas.com for more information.

1877



Rodenstock
founded

1898



Spindler & Hoyer
founded

1966

Pilkington PE
Ltd. founded,
which later
becomes
THALES Optics

1969



Gsänger
Optoelektronik
founded

1984



Optem
International
founded

1991



Point Source
founded

1996



LINOS founded
through the merger
of Spindler & Hoyer,
Steeg & Reuter
Präzisionsoptik,
Franke Optik and
Gsänger Optoelektronik



**Medical &
Life Sciences**



**Industrial
Manufacturing**



**Defense &
Aerospace**



**Research &
Development**

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LINOS F-Theta-Ronar Lenses

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LINOS Beam Expanders

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LINOS Focus-Ronar Lenses

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| 355 nm | 18 |
| 1064 + 532 nm | 19 |

2000



Rodenstock
Präzisionsoptik
acquired
by LINOS

2001



AVIMO Group
acquired
by THALES

2005

Qioptiq
founded as
THALES sells
High Tech
Optics Group

2006 / 2007



Qioptiq acquires
LINOS and Point Source
as "members of the
Qioptiq group"

2010



The new Qioptiq
consolidates all
group members
under one brand

2013



Qioptiq is acquired by
Excelitas Technologies

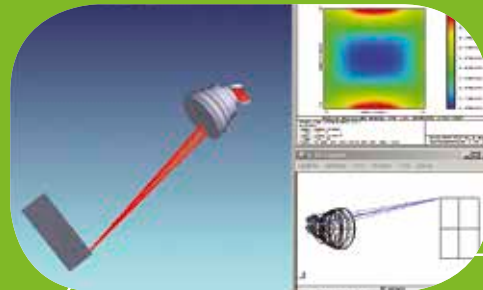


Products for Laser Material Processing

Benefit from over 30 years of experience in the development of optical systems for laser material processing!

Our broad selection of manual and motorized beam expanders and comprehensive range of LINOS F-Theta-Ronar and Focus-Ronar lenses are engineered to meet the most stringent requirements. We will serve you from development and prototyping to volume production. During the full lifetime of your product Qioptiq is your partner for your OEM needs.

Our Core Competencies:



Development

- Development of
 - Optical system design (in-house software-system, Code V®, Zemax®) including back reflection analysis
 - Mechanical design
 - Coating design
- FEM-analysis including thermal effects for high-power applications
- Advanced tolerance analysis and yield simulation adapted to Qioptiq patented mounting and gluing technologies

Consistent High-Quality Production from Rapid Prototype to High Volume



Manufacturing

- State-of-the-art machinery for optics and mechanics production
- Development of in-house processes for precise assembly of optical elements
- Mounting techniques with accuracies down to 2 μm
- Active positioning and gluing technologies
- Cleanroom facilities
- Coating process from conventional deposition up to ion-beam-sputtering in spectral range: UV, VIS, NIR
- Low absorption coating for higher laser power applications



Quality Control

- Automated measurement equipment for optical parameters (e.g. focal length)
- Measurements of the image spot diameter ($1/e^2$) for Gaussian illumination for 355 nm, 532 nm and 1064 nm
- UV to NIR transmission measurements
- Absorption testing at various wavelengths
- Environmental testing (temperature, humidity, vibration, shock)
- Quality report on request
- After sales service
- Technical support

LINOS F-Theta-Ronar Lenses



6

The extreme versatility of lasers as a tool creates a broad market for focusing systems. F-Theta-Ronar lenses are used in combination with mirror scanning systems. High-quality LINOS F-Theta-Ronar lenses are designed to achieve consistent results over the entire scan field and are built for a wide range of applications.

- Drilling and fine cutting of metals and ceramics (e.g. micro drilling in PCBs)
- Plastic welding (e.g. fusion of plastic materials without additional materials)
- Structuring or perforating of metallic and non-metallic materials (e.g. solar cells, glass)
- Marking (e.g. of smart cards, ICs, printing plates, in-glass, dashboard designs in the automotive industry)
- Cleaning with laser pulses for careful treatment of industrial products (e.g. wafers) as well as restoration projects (e.g. monuments).

Characteristics of F-Theta lenses

F-Theta lenses have two main characteristics. When a beam is deflected by a scanning mirror in front of a lens, then the scanned distance is proportional to the scanning angle. Secondly the focus position over the entire scan field is always in the same plane.

Basic calculations of F-Theta-Ronar lenses

All LINOS F-Theta-Ronar lenses achieve diffraction limited performance. The truncated entrance-beam diameter and the image spot diameter refer to the intensity $1/e^2$ at Gaussian illumination and for ideal $M^2=1$. The spot size of LINOS F-Theta-Ronar lenses can be calculated with the following formula:

$$\text{Spot-}\varnothing = 1.83 * \lambda * \text{FL} / \text{beam-}\varnothing$$

Spot- \varnothing : image spot diameter [mm]

1.83: factor of apodisation

λ : wavelength [nm]

FL: focal length [mm]

Beam- \varnothing : entrance-beam diameter [mm]

The scan length in each direction x or y can be calculated by the formula:

$$2y = \text{FL} * 2\Theta_y * \pi/180 \quad \text{and} \quad 2x = \text{FL} * 2\Theta_x * \pi/180$$

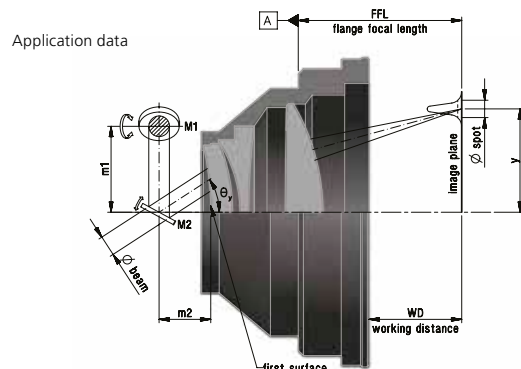
2x, 2y: scan length in direction x,y [mm]

FL: focal length [mm]

$2\Theta_{x,y}$: max. scan angle Theta for each mirror [°]

$\pi/180$: conversion factor (into radians)

The mirror distances m1 and m2 are recommended values and may vary. A smaller entrance-beam diameter allows larger scan angles and therefore larger scan fields are achievable.



Product range of LINOS F-Theta-Ronar lenses

Optical glass lenses

For all major applications a wide variety of lenses exist with various focal lengths ranging from 100 mm to 420 mm and for different wavelengths from 532 nm to 1550 nm.

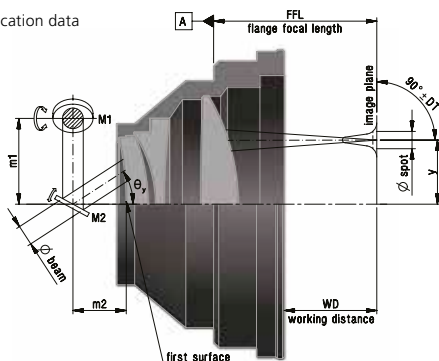
Fused-silica lenses

Qioptiq has developed a range of sophisticated F-Theta-Ronar scan lenses made of fused silica for high-power and short-pulse laser material processing. Fused-silica lenses provide minimized thermal focus shift and higher resistance when working at high power density. These lenses are usable for wavelength ranges of 340-360 nm, 515-540 nm, 1030-1080 nm, and 1900-2000 nm. A specially developed coating achieves very low reflection and qualified absorption values. The optical designs minimize damage due to back reflections onto the scanning mirrors and internal reflections. The LINOS fused-silica F-Theta-Ronar lenses are suitable for fiber- and disk lasers as well as short-pulse and ultra-short-pulse lasers.

Telecentric lenses

With telecentric lenses the beam impact angle on the work piece is nearly perpendicular over the entire scan field.

Application data



The maximum scan field of telecentric lenses cannot exceed the lens diameter. On the other hand the spot roundness and the impact angle is constant over the scan field. Qioptiq offers telecentric F-Theta-Ronar lenses made of fused silica and of optical-glass/fused-silica combination.

Further information for all standard F-Theta-Ronar lenses is available at: www.qioptiq-shop.com including 3D CAD data and lens data sheets.

Customized solutions

In addition to our existing LINOS F-Theta-Ronar lenses Qioptiq offers customized solutions from adapted wavelength shift of standard lenses up to complete new designs. Please contact Qioptiq to discuss your requests with our specialists.

Coating

Coatings are applied on each lens surface to maximize the transmission of the complete optical system like F-Theta-Ronar lenses or beam expanders. The additional challenge for coatings in laser material applications lies in a high damage resistance and minimized absorption. All our coatings are analyzed for laser damage threshold values. The tests are conducted according to the standardized test method DIN EN ISO 11254-2, a multi-pulse procedure (S-on-1) with given pulse lengths:

| | Laser damage threshold (J/cm ²) | Pulse length (ns) | Pulse length (fs) |
|-----------------------------|---|-------------------|-------------------|
| Optical-glass lenses | | | |
| 532 nm | 6 - 20 | 6 | |
| 1064 nm | 10 - 40 | 9 | |
| Fused-silica lenses | | | |
| 355 nm | 4 | 6 | |
| 515 nm | 0.7 | | 285 |
| 532 nm | 15 | 12 | |
| 1030 nm | 0.7 - 1.5 | | 285 |
| 1064 nm | 20 | 12 | |

There is no guarantee that the same values will result under the customer's conditions of use.

LINOS F-Theta-Ronar Lenses 340-360 nm



- Fused-silica designs
- Telecentric versions available
- Focal lengths ranging from 100 mm to 255 mm, tolerance $\pm 1\%$
- Screw thread M85x1
- All lenses can be used with enlarged beam diameters and different mirror distances. Accordingly the scan fields and spot size diameters will be changed. Please feel free to send us your request.
- Transmission $\geq 96\%$ with good performance in VIS-range
- Laser damage threshold coating up to 4 J/cm^2 at 355 nm, 6 ns, 100 Hz
- Includes interchangeable fused-silica protective glasses

LINOS F-Theta-Ronar telecentric lens for 355 nm, focal length 167 mm

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LINOS F-Theta-Ronar 340-360 nm, Fused Silica

| Focal length (mm) | Scan field (mm ²) | Max. scan angle $\pm\Theta_{x,y}$ (°) | Beam diameter truncated at $1/e^2$ (mm) | Spot diameter at $1/e^2$ (μm) | Mirror distances m1/m2 (mm) | Working distance (mm) | Protective glass | Part No. |
|----------------------|----------------------------------|--|--|---|--------------------------------|--------------------------|------------------|-----------------|
| 70 telecentric | 28 x 28 | ± 11.3 | 10 | 5 | 13/19 | 92.5 | PG4 | 4401-576-000-21 |
| 100 telecentric | 46 x 46 | ± 12.7 | 10 | 7 | 13/29 | 136.7 | PG11 | 4401-509-000-21 |
| 160 | 99 x 99 | ± 17.6 | 7 | 15 | 12/16 | 197.4 | PG4 | 4401-399-000-21 |
| 167 telecentric | 68 x 68 | ± 11.3 | 10 | 13 | 13/48 | 255 | PG15 | 4401-511-000-21 |
| 255 | 170 x 170 | ± 19.3 | 10 | 17 | 13/30 | 318.1 | PG11 | 4401-481-000-21 |

Subject to technical changes

High quality

Fused silica lenses

Qioptiq has developed a range of sophisticated F-Theta-Ronar scan lenses made of fused silica for high-power and short-pulse laser material processing. Fused-silica lenses provide minimized thermal focus shift and higher resistance when working at high power density. A specially developed coating achieves very low reflection and absorption values.

LINOS F-Theta-Ronar Lenses 515-540/532 nm



LINOS F-Theta-Ronar telecentric lens for 515-540 nm, focal length 100 mm

- Fused-silica and optical-glass designs
- Telecentric versions available
- Focal lengths ranging from 100 mm to 420 mm, tolerance $\pm 1\%$
- Screw thread M85x1
- All lenses can be used with enlarged beam diameters and different mirror distances. Accordingly the scan fields and spot size diameters will be changed. Please feel free to send us your request.
- Transmission $\geq 96\%$ with good performance in VIS-range
- Laser damage threshold coating up to 20 J/cm^2 at 532 nm, 6 ns and up to 0.7 J/cm^2 at 515 nm, 285 fs
- Includes interchangeable protective glasses

LINOS F-Theta-Ronar 515-540 nm, Fused Silica

| Focal length (mm) | Scan field (mm ²) | Max. scan angle $\pm\Theta_{x,y}$ (°) | Beam diameter truncated at $1/e^2$ (mm) | Spot diameter at $1/e^2$ (μm) | Mirror distances m1/m2 (mm) | Working distance (mm) | Protective glass | Part No. |
|----------------------|----------------------------------|--|--|---|-----------------------------------|--------------------------|------------------|-----------------|
| 100 telecentric | 43 x 43 | ± 12.2 | 14 | 9 | 17/28 | 138.5 | PG13 | 4401-547-000-21 |
| 167 telecentric | 86 x 86 | ± 15.4 | 14 | 12 | 17/33 | 215.5 | PG21 | 4401-517-000-21 |
| 255 | 170 x 170 | ± 19.3 | 10 | 25 | 13/30 | 318.1 | PG13 | 4401-496-000-21 |

Subject to technical changes

LINOS F-Theta-Ronar 532 nm, Optical Glass

| Focal length (mm) | Scan field (mm ²) | Max. scan angle $\pm\Theta_{x,y}$ (°) | Beam diameter truncated at $1/e^2$ (mm) | Spot diameter at $1/e^2$ (μm) | Mirror distances m1/m2 (mm) | Working distance (mm) | Protective glass | Part No. |
|----------------------|----------------------------------|--|--|---|-----------------------------------|--------------------------|------------------|-----------------|
| 100 | 58 x 58 | ± 17.7 | 6 | 15 | 16/12 | 90.8 | PG8 | 4401-304-000-21 |
| 100 telecentric * | 54 x 54 | ± 15.6 | 15 | 7 | 20/32 | 126.6 | PG7 | 4401-461-000-21 |
| 160 | 98 x 98 | ± 17.7 | 10 | 16 | 16/12 | 176.1 | PG8 | 4401-305-000-21 |
| 250 | 154 x 154 | ± 17.7 | 20 | 12 | 22/24 | 288.5 | PG7 | 4401-289-000-20 |
| 330 | 204 x 204 | ± 17.7 | 14 | 23 | 18/24 | 389.0 | PG7 | 4401-485-000-21 |
| 420 | 275 x 275 | ± 18.7 | 15 | 27 | 17/28 | 494.6 | PG7 | 4401-489-000-21 |

* Entrance lens made of fused silica

Subject to technical changes

LINOS F-Theta-Ronar Lenses 940-980 nm



- Focal lengths ranging from 100 mm to 420 mm, tolerance $\pm 1\%$
- Screw thread M85x1, except 4401-527-000-21: M76x1
- Transmission $\geq 97\%$
- Transmission $\geq 75\%$ at VIS-range
- Laser damage threshold coating up to 6 J/cm^2 at 1064 nm, 10 ns, 100 Hz
- Includes interchangeable protective glasses
- All lenses can be used with enlarged beam diameters and different mirror distances. Accordingly the scan fields and spot size diameters will be changed. Please feel free to send us your request.

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LINOS F-Theta-Ronar lens for 940-980 nm, focal length 330 mm

A closer look



Please look at www.qioptiq-shop.com for datasheets to our laser material lenses. The datasheets can be found at each product under Docs + Drawings.

Our Laser Material Processing brochure is also ready to download here.

LINOS F-Theta-Ronar 940-980 nm, Optical Glass

| Focal length (mm) | Scan field (mm ²) | Max. scan angle $\pm\Theta_{x,y}$ (°) | Beam diameter truncated at $1/e^2$ (mm) | Spot diameter at $1/e^2$ (μm) | Mirror distances m1/m2 (mm) | Working distance (mm) | Protective glass | Part No. |
|----------------------|----------------------------------|--|--|---|--------------------------------|--------------------------|------------------|-----------------|
| 100 | 43 x 43 | ± 12.3 | 14 | 14 | 17/18 | 96.9 | PG19 | 4401-528-000-21 |
| 163 | 96 x 96 | ± 16.9 | 14 | 20 | 17/30 | 183.7 | PG18 | 4401-527-000-21 |
| 254 | 139 x 139 | ± 15.7 | 20 | 24 | 26/28 | 294.2 | PG17 | 4401-526-000-21 |
| 330 | 204 x 204 | ± 17.7 | 20 | 32 | 26/28 | 386.0 | PG17 | 4401-524-000-21 |
| 420 | 259 x 259 | ± 17.7 | 20 | 40 | 26/28 | 491.7 | PG17 | 4401-525-000-21 |

Subject to technical changes

LINOS F-Theta-Ronar Lenses 1064/1030-1080 nm



LINOS F-Theta-Ronar lens for 1030-1080 nm, focal length 420 mm

- Fused-silica and optical-glass designs
- Telecentric versions available
- Focal lengths ranging from 70 mm to 420 mm, tolerance $\pm 1\%$
- Screw thread M85x1, except 4401-261-000-21: M76x1
- Transmission $\geq 96\%$ with good performance in VIS-range
- Laser damage threshold coating up to 40 J/cm² at 1064 nm, 9 ns and up to 1.5 J/cm² at 1030 nm, 285 fs
- Version 4401-xxx-000-26 with low absorption coating ≤ 20 ppm at 1064 nm
- Includes interchangeable protective glasses
- All lenses can be used with enlarged beam diameters and different mirror distances. Accordingly the scan fields and spot size diameters will be changed. Please feel free to send us your request.

LINOS F-Theta-Ronar 1030-1080 nm, Fused Silica

| Focal length (mm) | Scan field (mm ²) | Max. scan angle $\pm\Theta_{x,y}$ (°) | Beam diameter truncated at 1/e ² (mm) | Spot diameter at 1/e ² (μ m) | Mirror distances m1/m2 (mm) | Working distance (mm) | Protective glass | Part No. |
|----------------------|----------------------------------|--|---|---|--------------------------------|--------------------------|------------------|-----------------|
| 70 telecentric | 30 x 30 | ± 12.4 | 14 | 10 | 17/12 | 87.6 | PG22 | 4401-551-000-21 |
| 100 telecentric | 43 x 43 | ± 12.2 | 14 | 15 | 17/28 | 137.0 | PG14 | 4401-561-000-21 |
| 167 telecentric | 84 x 84 | ± 14.8 | 20 | 17 | 26/28 | 215.4 | PG16 | 4401-513-000-21 |
| 255 | 170 x 170 | ± 19.2 | 10 | 50 | 13/30 | 317.4 | PG14 | 4401-499-000-26 |
| 340 | 205 x 205 | ± 17.7 | 14 | 51 | 17/29 | 441.6 | PG16 | 4401-546-000-26 |
| 420 | 254 x 254 | ± 17.3 | 14 | 60 | 26/24 | 510.9 | PG14 | 4401-508-000-26 |

Subject to technical changes

LINOS F-Theta-Ronar 1064 nm, Optical glass

| Focal length (mm) | Scan field (mm ²) | Max. scan angle $\pm\Theta_{x,y}$ (°) | Beam diameter truncated at 1/e ² (mm) | Spot diameter at 1/e ² (μ m) | Mirror distances m1/m2 (mm) | Working distance (mm) | Protective glass | Part No. |
|----------------------|----------------------------------|--|---|---|--------------------------------|--------------------------|------------------|-----------------|
| 100 | 62 x 62 | ± 17.7 | 12 | 16 | 16/12 | 97.7 | PG2 | 4401-302-000-21 |
| 100 telecentric * | 54 x 54 | ± 15.6 | 15 | 13 | 20/32 | 126.0 | PG6 | 4401-464-000-21 |
| 160 | 99 x 99 | ± 17.7 | 12 | 26 | 16/12 | 176.2 | PG2 | 4401-301-000-21 |
| 163 | 115 x 115 | ± 20.2 | 10 | 32 | 13/24 | 185.9 | PG5 | 4401-261-000-21 |
| 254 | 157 x 157 | ± 17.7 | 20 | 25 | 26/23 | 296.2 | PG6 | 4401-288-000-20 |
| 330 | 217 x 217 | ± 18.7 | 16 | 40 | 18/24 | 387.6 | PG6 | 4401-360-000-21 |
| 420 | 291 x 291 | ± 19.8 | 15 | 55 | 30/16 | 494.2 | PG6 | 4401-350-000-21 |

* Entrance lens made of fused silica

Subject to technical changes

LINOS F-Theta-Ronar Lenses 1550/1900-2000 nm



- Fused-silica and optical glass designs
- Telecentric versions available
- Focal lengths ranging from 100 mm to 437 mm, tolerance $\pm 1\%$
- Screw thread M85x1
- All lenses can be used with enlarged beam diameters and different mirror distances. Accordingly the scan fields and spot size diameters will be changed. Please feel free to send us your request.
- Transmission $\geq 95\%$ at 1550 nm
- Transmission $\geq 96\%$ at 1940 nm
- Laser damage threshold coating up to 20 J/cm² at 1064 nm, 12 ns, 100 Hz
- Includes interchangeable protective glasses

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LINOS F-Theta-Ronar lens for 1550 nm, focal length 100 mm

LINOS F-Theta-Ronar 1550 nm, Optical Glass

| Focal length (mm) | Scan field (mm ²) | Max. scan angle $\pm\theta_{x,y}$ (°) | Beam diameter truncated at $1/e^2$ (mm) | Spot diameter at $1/e^2$ (μm) | Mirror distances m1/m2 (mm) | Working distance (mm) | Protective glass | Part No. |
|----------------------|----------------------------------|--|--|---|--------------------------------|--------------------------|------------------|-----------------|
| 100 telecentric * | 53 x 53 | ± 15.6 | 15 | 20 | 20/32 | 127.9 | PG20 | 4401-532-000-21 |

* Entrance lens made of fused silica

Subject to technical changes

LINOS F-Theta-Ronar 1900-2000 nm, Fused Silica

| Focal length (mm) | Scan field (mm ²) | Max. scan angle $\pm\theta_{x,y}$ (°) | Beam diameter truncated at $1/e^2$ (mm) | Spot diameter at $1/e^2$ (μm) | Mirror distances m1/m2 (mm) | Working distance (mm) | Protective glass | Part No. |
|----------------------|----------------------------------|--|--|---|--------------------------------|--------------------------|------------------|-----------------|
| 354 | 214 x 214 | ± 17.7 | 14 | 93 | 17/28.5 | 457.5 | PG24 | 4401-569-000-21 |
| 437 | 296 x 296 | ± 19.4 | 14 | 120 | 17/29.5 | 526.2 | PG23 | 4401-568-000-21 |

Subject to technical changes

Protective Glasses



- Optimum protection for the optical system
- Coated on both sides
- High transmission for the corresponding wavelength or wavelength range
- High laser damage threshold
- Short delivery time

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Protective Glasses, Fused Silica

| Protective glass | Protective glass diameter (mm) | Protective glass thickness (mm) | AR coated for λ (nm) | Part No. |
|------------------|--------------------------------|---------------------------------|------------------------------|-----------------|
| PG 4 | 75 | 1.5 | 340-380+633 | 4401-399-005-00 |
| PG11 | 113 | 3 | 340-380+633 | 4401-481-005-00 |
| PG13 | 113 | 3 | 515-540, low absorption | 4401-496-005-01 |
| PG14 | 113 | 3 | 1030-1080, low absorption | 4401-499-005-00 |
| PG15 | 113 | 3 | 340-380+633 | 4401-511-823-00 |
| PG16 | 132 | 3 | 1030-1080, low absorption | 4401-513-006-00 |
| PG21 | 132 | 3 | 515-540 | 4401-517-006-00 |
| PG22 | 75 | 1.5 | 1030-1080 | 4401-551-016-00 |
| PG23 | 113 | 3 | 1900-2000 | 4401-568-004-00 |
| PG24 | 132 | 3 | 1900-2000 | 4401-569-005-00 |

Subject to technical changes

Protective Glasses, Optical Glass

| Protective glass | Protective glass diameter (mm) | Protective glass thickness (mm) | AR coated for λ (nm) | Part No. |
|------------------|--------------------------------|---------------------------------|------------------------------|-----------------|
| PG 2 | 75 | 1.6 | 1064+VIS | 4401-301-001-00 |
| PG 5 | 100 | 3 | 1064+VIS | 4401-261-004-00 |
| PG 6 | 113 | 3 | 1064+VIS | 4401-288-005-01 |
| PG 7 | 113 | 3 | 532 | 4401-289-007-00 |
| PG 8 | 75 | 1.6 | 532 | 4401-304-005-00 |
| PG17 | 113 | 3 | 940-980 | 4401-524-004-00 |
| PG18 | 100 | 3 | 940-980 | 4401-527-004-00 |
| PG19 | 75 | 1.6 | 940-980 | 4401-528-005-00 |
| PG20 | 113 | 3 | 1550 | 4401-532-005-00 |

Subject to technical changes

LINOS Beam Expanders



LINOS beam expanders are optical systems for beam forming used in laser material processing. They can vary the diameter and the divergence of a laser beam and allow optimization of focus diameter, focus position and beam propagation.

Qioptiq offers standard versions of manual and motorized variable beam expanders made of fused silica and/or optical glass.

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LINOS Beam Expanders are optimally employed in conjunction with LINOS F-Theta-Ronar lenses for applications including:

- Laser structuring of foils
- Laser scribing of ceramic substrates
- Cutting of solar cells
- Micro drilling of sheet metal
- Marking of diverse materials with encodings

All LINOS beam expanders can also be implemented in reverse mode as beam reducers.

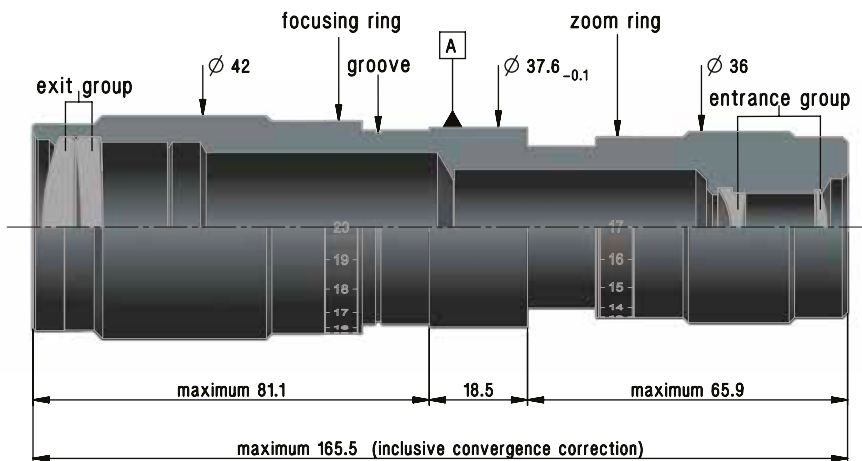
Manual version

Continuous magnification between 2x and 8x or between 2x and 10x are available. In addition Qioptiq offers manual variable beam expanders with fused-silica entrance lenses for higher laser resistance.

The back focal length of F-Theta-Ronar or Focus-Ronar lenses can be modified by changing the divergence of the incoming laser beam. Fine focusing of the beam expander compensates the focal length tolerances of other optical components as well as divergence of the laser source.

Handling

Zoom and focusing rings of the LINOS manual variable beam expanders are set according to product specific graphs. The expansion factor is adjusted by turning the focusing ring and zoom ring. To focus the beam expansion, only the focusing ring should be adjusted. The beam expander is mounted on surface A. Please take care that the laser beam is centered on the entrance lens and parallel to the optical axis of the beam expander (x/y tilt adjustment).



Variable beam expander

Motorized version

The motorized variable beam expanders of second generation are precise and easy to integrate. They are used in automatic production processes or in application laboratories. The controller is integrated into the beam expander.

For high-power or short-pulse laser applications full fused-silica designs are available with excellent transmission and thermal resistance performance. The special coating with low absorption and high transmission for these fused-silica beam expanders covers complete wavelength ranges of 340-360 nm, 515-540 nm and 1030-1080 nm. Additionally Qioptiq offers the motorized beam expanders made of optical-glass versions for the wavelengths 532 nm and 1064 nm. The customer can select between three electrical interfaces (SubD9/RS232, Phoenix Contact/RS232 or USB 2.0).



Motorized beam expander with Phoenix Contact interface

Software

The Windows™-based software developed with LabView allows an easy control of the motorized beam expander. After initialization, the desired expansion is achieved by moving the two independent stepper motors. The lens positions for the magnification range of 2-8x are listed for each motorized beam expander type in provided tables. Ten individual pre-sets can be stored.

The beam expander can also be directly controlled under other operating systems via the serial interface (e.g. terminal program). All serial interface commands are listed in the manual.



Windows™ software mask for easy control of motorized beam expansion.

Further information is available at: www.qioptiq-shop.com including 3D CAD data, product-specific graphs of variable beam expanders and the manual for the motorized beam expanders.

LINOS Variable Magnification Beam Expanders



- Continuous variation of magnification 2x...8x or 2x...10x
- Choice between fused-silica or glass entrance lens
- Continuous variation of exit-beam divergence
- Wavelengths 355 nm, 532 nm, 633/780/830/980 nm or 1064 nm
- Precise scales allow reliable settings and high repeatability
- Max. exit-beam diameter 31 mm
- Max. length 165.5 mm
- Max. diameter 42.0 mm
- Mounting diameter 37.6_{-0.1} mm, reference on surface A (see page 14)

LINOS Beam expander with a variable expansion factor 2x to 8x for 1064 nm

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A closer look

LINOS Beam Expanders are optimally employed in conjunction with LINOS F-Theta-Ronar lenses for applications including:

- Laser structuring of foils
- Laser scribing of ceramic substrates
- Cutting of solar cells
- Micro drilling of sheet metal
- Marking of diverse materials with encodings

All LINOS beam expanders can also be implemented in reverse mode as beam reducers.

LINOS Variable Magnification Beam Expanders 2x...8x

| Wavelength (nm) | Max. entrance-beam diameter at 1/e ² (mm) | Entrance lens made of | Part No. |
|------------------|--|-----------------------|-----------------|
| 355 | 3.4 | Fused silica | 4401-402-000-20 |
| 532 | 4 | Fused silica | 4401-446-000-20 |
| 532 | 8 | Optical glass | 4401-257-000-20 |
| 633/780/ 830/980 | 8 | Optical glass | 4401-258-000-20 |
| 1064 | 4 | Fused silica | 4401-359-000-20 |
| 1064 | 8 | Optical glass | 4401-256-000-20 |

Entrance-beam diameter max. = 31 mm / zoom factor.

Subject to technical changes

LINOS Variable Magnification Beam Expanders 2x...10x

| Wavelength (nm) | Max. entrance-beam diameter at 1/e ² (mm) | Entrance lens made of | Part No. |
|-----------------|--|-----------------------|-----------------|
| 1064 | 8 | Optical glass | 4401-531-000-20 |

Entrance-beam diameter max. = 31 mm / zoom factor.

Subject to technical changes

LINOS Motorized Beam Expanders



LINOS Motorized beam expander

- Continuous variable magnification 2x...8x
- Fused-silica or optical-glass designs
- Continuous variation of exit-beam divergence
- Wavelengths 340-360 nm, 515-540 nm or 1030-1080 nm
- Software running on the Windows™ platform (XP, Win7, Win8)
- Reduce machine setup times by automatic change of magnification
- Maintains laser-protection class during readjustment of the beam expander
- All-in-one design, controller integrated
- CE and ROHS conform
- IP 20
- Exit-beam diameter: max. 31 mm
- 10 individual pre-sets for magnification and divergence
- Pointing stability < 0.5 mrad
- Fast adjustment from 2x to 8x about 7 sec
- Mechanical dimensions: length 203 mm, width 58 mm, height 55.5 mm
- Mechanical interface via high-precision holes 6^{H7} (recommended) or mounting diameter 39_{h11}
- Different electronic interfaces: SubD9/RS232, USB 2.0, Phoenix Contact/RS232
- Baud rate: 9600 bit/sec
- Power input 7–12 V, Phoenix Contact 7–24 V
- Entrance-beam diameter max. = 31 mm / zoom factor

LINOS Motorized Beam Expanders, Fused Silica

| Wavelength (nm) | Max. entrance-beam diameter at 1/e ² (mm) | PC Interface | Part No. |
|-----------------|--|-----------------------|-----------------|
| 340 - 360 | 6 | SubD9/ RS232 | 4401-516-000-20 |
| 340 - 360 | 6 | Phoenix Contact/ R232 | 4401-516-000-21 |
| 340 - 360 | 6 | USB 2.0 | 4401-516-000-22 |
| 515 - 540 | 8 | SubD9/ RS232 | 4401-515-000-20 |
| 515 - 540 | 8 | Phoenix Contact/ R232 | 4401-515-000-21 |
| 515 - 540 | 8 | USB 2.0 | 4401-515-000-22 |
| 1030 - 1080 | 8 | SubD9/ RS232 | 4401-514-000-20 |
| 1030 - 1080 | 8 | Phoenix Contact/ R232 | 4401-514-000-21 |
| 1030 - 1080 | 8 | USB 2.0 | 4401-514-000-22 |

Entrance-beam diameter max. = 31 mm / zoom factor.

Subject to technical changes

LINOS Motorized Beam Expanders, Optical Glass

| Wavelength (nm) | Max. entrance-beam diameter at 1/e ² (mm) | PC Interface | Part No. |
|-----------------|--|-----------------------|-----------------|
| 532 | 8 | SubD9/ RS232 | 4401-502-000-23 |
| 532 | 8 | Phoenix Contact/ R232 | 4401-502-000-21 |
| 532 | 8 | USB 2.0 | 4401-502-000-22 |
| 1064 | 8 | SubD9/ RS232 | 4401-503-000-20 |
| 1064 | 8 | Phoenix Contact/ R232 | 4401-503-000-21 |
| 1064 | 8 | USB 2.0 | 4401-503-000-22 |

Entrance-beam diameter max. = 31 mm / zoom factor.

Subject to technical changes

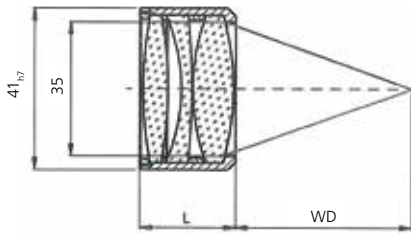
LINOS Focus-Ronar Lenses for 355 nm



Focussing lenses are optimized for high precision applications, as used in laser systems for welding, cutting, drilling and structuring.

- Focal lengths ranging from 58 mm to 120 mm
- Flexible lens exchange without any adjustment
- Three-lens-element designs
- Full fused-silica designs
- Diffraction limited up to 17.5 mm (1/e²) entrance-beam diameter
- High clear aperture 35 mm
- Housing diameter 41mm
- Transmission ≥ 98%
- Damage threshold 5 J/cm² with pulse duration of 5 ns, 100 Hz

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LINOS Focus-Ronar 355 nm, Fused Silica

| Focal length (mm) | Length L (mm) | Working distance WD (mm) | Part No. |
|-------------------|---------------|--------------------------|-----------------|
| 58 | 26.7 | 48.9 | 4401-519-000-20 |
| 77 | 25.1 | 68.8 | 4401-521-000-20 |
| 90 | 25.1 | 81.7 | 4401-522-000-20 |
| 120 | 24.7 | 112.1 | 4401-523-000-20 |

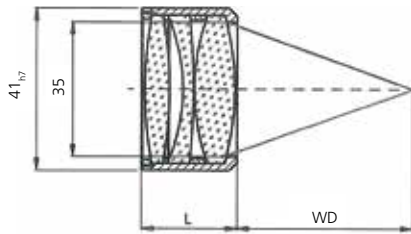
Subject to technical changes

LINOS Focus-Ronar Lenses 1064 nm + 532 nm



Focussing lenses are optimized for high precision applications, as used in laser systems for welding, cutting, drilling and structuring.

- Focal lengths ranging from 58 mm to 120 mm
- Flexible lens exchange without any adjustment
- Three-lens-element designs
- High clear aperture 35 mm
- Housing diameter 41_{h7} mm
- The coating is optimized for 1064 nm, T ≥ 97% and T(532 nm) ≥ 96%
- Good inspection performance at VIS wavelengths
- Laser damage threshold coating 10 J/cm² at 1064 nm, 9 ns, 100 Hz
- Laser damage threshold 6 J/cm² at 532 nm, 6 ns, 100 Hz



LINOS Focus-Ronar 1064 + 532 nm, Optical Glass

| Focal length (mm) | Length L (mm) | Working distance for 1064 nm (mm) | Working distance for 532 nm (mm) | Part No. |
|-------------------|---------------|-----------------------------------|----------------------------------|-----------------|
| 58 | 24.6 | 48.3 | 47.7 | 4401-505-000-20 |
| 77 | 18.9 | 72.2 | 71.5 | 4401-486-000-20 |
| 90 | 33.6 | 73.7 | 73.3 | 4401-490-000-20 |
| 120 | 24.0 | 110.7 | 109.8 | 4401-420-000-20 |

Subject to technical changes



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