SPECIAL OPTICS®

AMETEK®

Custom Optical Solutions

ABOUT US

Custom Lens Design and Precision Lens Manufacturing

Special Optics is dedicated to rapidly designing, prototyping, and manufacturing innovative and high performance optical systems. Our expertise spans applications from Defense & Security, Semiconductor, Medical, Hyperspectral Imaging, Laser Micromachining, Long Range Surveillance, Machine Vision, custom microscopy and UV. We routinely look at the toughest optical problems and deliver breakthrough solutions through world-class optical design. If you need an innovative partner to help turn your ideas into reality, we invite you to contact us about your application. Setting new standards for performance and beating the competition doesn't happen by accident.

From Concept to Design to Volume Production

Special Optics excels at the optical design and rapid prototyping of complete electro-optical systems while our parent company, Navitar excels at high volume precision lens production. So when your optical design project advances past the prototype stages, you can count on Navitar's world leading manufacturing capabilities and customer service to deliver the consistent quality that you need.

Our Products

UV Objective Lenses
Laser Scanning Lenses
Digital Radiology Lenses
Fisheye Lenses
SWIR Lenses
Long Range Surveillance Lenses
Hyperspectral Lenses
High Resolution Imaging Lenses
Telecentric Inspection Lenses
Fluorescence Imaging Lenses
Missile Tracking Lenses
Laser Beam Expanders
Custom Lenses

Typical Applications

Long Range Surveillance
Laser Eye Surgery
Unmanned Aerial Vehicles
Laser Micromachining
Two-Photon Microscopy
Physical Science Research
Lithography

Markets We Serve

Semiconductor
Biotech/Life Sciences
Defense/Security
Laser Machining
Research Institutes
OEM Optics

Manufacturing Tolerances

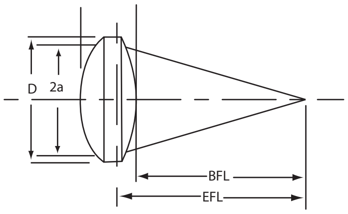
Attribute	Commercial Quality	Precision Quality	Ultra Precision Quality
Diameter (mm)	+0.00/-0.10	+0.000/-0.05	+0.000/-0.025
Center Thickness (mm)	0.150	0.050	0.005
Radius (power)	8 rings	4 rings	1 ring
Irregularity (waves @ 633nm)	1	0.25	0.10
Wedge (mm)	0.05	0.005	0.0025
Decenter (arc min)	0.05	0.01	0.005
Scratch - Dig	80 - 50	60 - 40	10 - 5
AR Coating (r avg)	< 1.5%	< 0.5%	< 0.25%

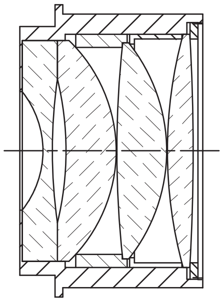
Since 1965 Special Optics has designed and manufactured thousands of unique lens systems. Our optical design team has cataloged base designs ranging from laser beam expanders, telecentric scanning lenses, laser projection optics and UV objective lenses to long range surveillance lenses and Hyperspectral SWIR lenses. Having a large library of lens designs allows us to meet your design needs without disproportionate design costs. This means we rarely have to design a system from “scratch”. We simply choose a base design, and modify and re-optimize to meet the necessary requirements. In this way the customer need not compromise performance by being forced to choose a standard off-the-shelf lens, but instead, can obtain an exact design without incurring extreme design charges.

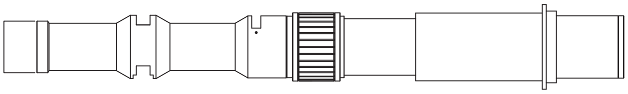
Areas of Specialization

- Achromatic Beam Expanders
- Apochromatic Scan Lenses
- Variable Zoom Beam Expanders
- IR Variable Zoom Beam Expanders
- Long Working Distance High NA Apochromatic Lenses
- Biomedical Optics
- High Resolution Projection Lenses
- Two-Photon Microscopy Lenses
- Custom Microscope Objectives
- Physical Science Research Optics

We recognize that producing high resolution, diffraction-limited lens systems is often dependent, not only on the optics themselves, but on the quality of the mechanical parts used for assembly. Our mechanical design team works closely with our optical and electronic designers to produce fully integrated opto-mechanical systems and sub-systems. Using state-of-the-art mechanical design software, we insure your lens systems are both technically feasible and mechanically manufacturable. By successfully integrating both optical and mechanical designs ensures the solution we have designed for you meets all your mechanical and performance specifications.







FABRICATION AND POLISHING

Special Optics supports the complete production and assembly of prototypes and OEM systems. The entire process of lens manufacture, from rough grinding through polishing, edging and coating, is completed in-house. During the process, we closely monitor all phases of production allowing us to maintain precision tolerances in wavefront, thickness and surface quality. Our experienced team of fabricators and polishers work with a great majority of glass and crystal materials used in the optics industry.

The Process

We start with raw bulk glass which is cut and coredrilled to the appropriate diameter. Next the lens radius is cut into the surface using standard industry generators. Two grinding steps follow, first a rough 20 micron grit followed by a 9 micron grit fine grind. The lenses are now ready for polishing. Once blocking and polishing is accomplished, a final edging step is applied to bring the lens into final diameter and then correct any decentration or wedge between the lens surfaces.

Fabrication and Polishing Capabilities

Glass and Crystal Polishing

Precision Grinding and Polishing of Optics from 4 to 280 mm in Diameter

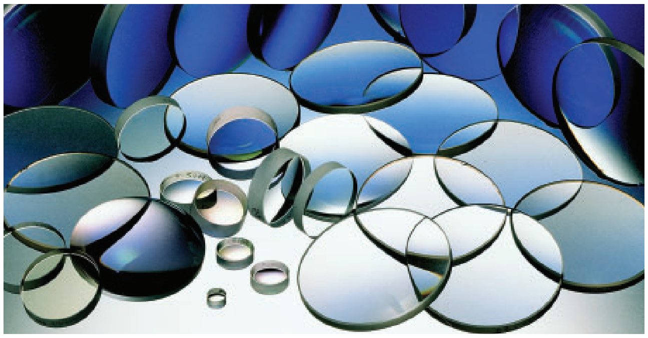
Over 1000 Test Plates on Hand

Surface Regularity Better than 1/20 Wave

10-5 Surface Quality

Interferometric Testing

Standard Radii from 2 to 13,931 mm



Air-spaces, centration, wedge and tilt are the key determinants of a quality lens system.

Air-Spaces

Through the use of micron indicators coupled with proprietary assembly equipment we can hold lens spacing tolerances to the order of 1 micron. This is only possible through constant reoptimization of the lens design during the assembly process.

Centration, Wedge and Tilt

A major challenge during assembly of diffraction limited optics is to maintain the centration, wedge and tilt specifications for the system of lenses as a whole. Simply inserting lenses and spacers into lens tubes is not sufficient or even possible in many cases. Over the years, we have developed both standard and proprietary techniques for insuring that all tolerances are met.

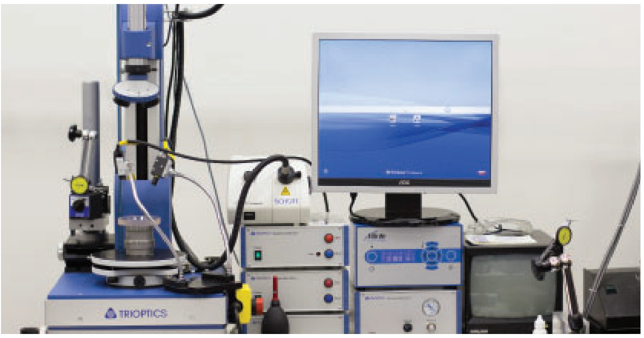
Assembly Capabilities

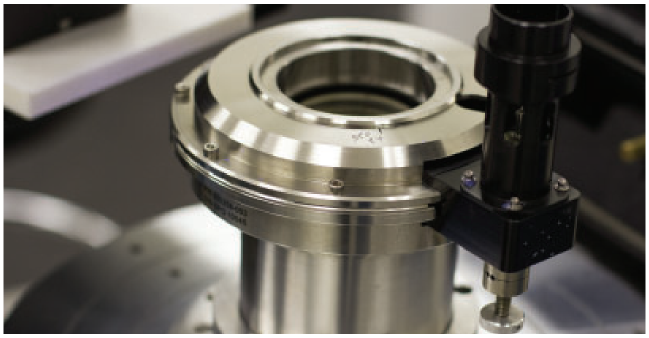
Air-Space Tolerances Held to 1 Micron

Continuous Lens Design Reoptimization During Assembly

Centration, Wedge and Tilt Tolerances Held to Better than 1 Micron

Air-Bearing Assembly and Alignment





TESTING AND VERIFICATION

Testing both during manufacture and after assembly is crucial to a successful lens system. In particular, surface regularity and power of individual lenses must be continuously monitored in production.

We go the extra step to first validate our designs through interferometric and MTF testing to ensure your optical solution is going to meet your specifications.

Interferometry

Evaluation of lens surfaces for spherical regularity is accomplished using Phase Shift Interferometry. With this equipment, we can quantitatively verify surface regularity to within 1/20 of a wave. In addition to surface evaluation, we also employ an interferometer to analyze complete lens systems. Through the use of reflection and transmission spheres, we can usually evaluate multi-element lens systems for coma, astigmatism and spherical aberration, and in some cases the resolution of the system can also be analyzed.

Radius Testing

During the design of any lens system, an attempt is always made to relax the manufacturing tolerances as much as possible. One method we have developed is to make very accurate lens radii measurements or finished elements and test plates, thereby eliminating the radius tolerance from the design equation. We accomplish this through the use of a precision spherometer which is capable of measuring lens sagittal heights to within 1 micron.

Lens Testing Capabilities

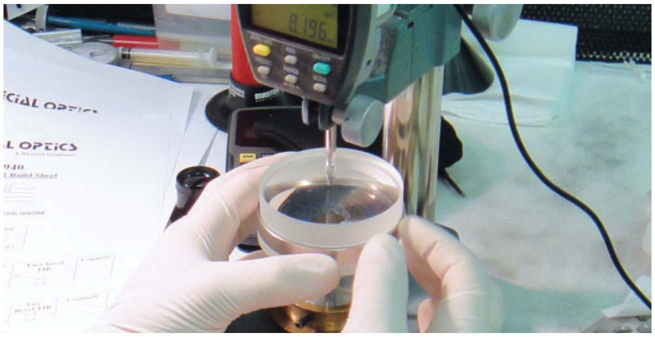
Interferometers @ 405, 532, 632 and 1064 nm

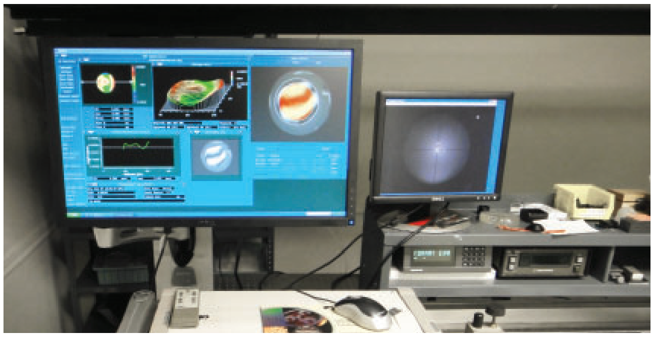
Radius Measurement to Within 1 Micron Sagittal Height

Centration to Within 1 Arc second

Flatness and Regularity to Within 1/20 Wave

Transmission and Reflection Wavefront Error





An essential part of any multi-element lens system is the anti-reflection coatings. They have the dual effect of maximizing transmission and minimizing ghost images. Unwanted reflections can cause laser damage, false signals, laser instability and image degradation. Our coating department is capable of depositing broadband anti-reflection coatings, as well as single, double- and triple-”V” coatings on all glasses. Capabilities extend from the 248-2200 nm range.

Broadband Coatings

Our standard broadband anti-reflecion (BBAR) coatings are multi-layer designs capable of providing less than 0.5% reflectivity throughout the specified range. In addition to the standard wavelength ranges, we can also offer shifted ranges to accommodate special requirements. For example, a 425-675 nm coating can be shifted to 500-750 nm for a minimal additional charge.

“V” Coatings

In applications where 0.5% reflectivity is higher than the system can tolerate, a narrowband “V” coating should be used. Standard “V” coatings which offer reflectances of less than 0.25%, can be single layer MgF_2 or multi-layer designs depending on the index of refraction of the substrate. In general, glasses with an index of greater than 1.7 can be coated with a single layer of MgF_2 to supply less than 0.25% reflectivity. The disadvantage of the “V” coating is the narrow wavelength range, which should be balanced against the fact that, in general “V” coatings have a higher damage threshold than broadband coatings.

Coating Capabilities

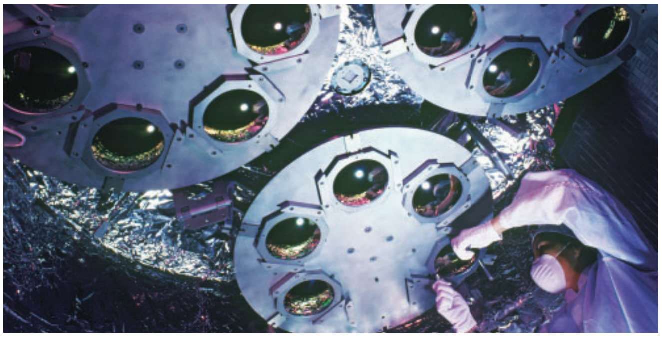
Broadband and “V” Anti-reflection Coatings

Double- and Triple-”V” Designs

> 500 MW/cm2 Damage Threshold

248-2200 nm Range Capability

In-house Thin Film Design



Special Optics offers an extensive line of high precision optics available in both standard models for quick delivery or custom designed for your unique requirements.

All of our optics are available for wavelengths throughout the UV and IR ranges. This includes beam expanders, focusing objectives, scanning lenses and collimators for excimer, dye, solid-state and CO_2 lasers.

Custom Objectives

Pre-Engineered High NA Objectives

Laser Beam Expanders

Low Power

High Power

UV

Variable Zoom

Large Output

Laser Focusing Objectives

Single Line

Achromatic/Apochromatic

Laser Diode Collimators

UV

High N.A. UV Micro Objectives

Laser Scanning Lenses

VIS-NIR Scanning Lenses

Confocal Microscopy Lenses

Telecentric UV Lenses

Polarization Optics

Retardation Plates

Waveplates

Mechanicals & Misc.

Vee Block

Threaded Adapters

Alignment Apertures

Beam Steering Devices

In-Line Beam Steerer

Metric Zoom

Long Range Surveillance Lens

Why settle when you can achieve perfection?

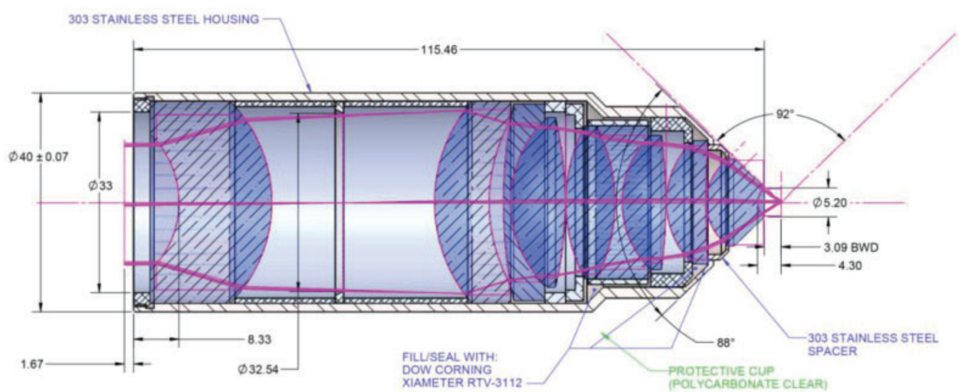
Searching for the right microscope objective for your application and still dissatisfied with the results? Stop compromising and set up a consultation with Special Optics. We will provide you with a feasibility study, basic preliminary optical design, recommendations, and estimates for prototypes and production for your specific application.

Our custom objectives are used in applications such as:

- Multi-photon Microscopy
- Cold Fermion/Atom Trapping
- Confocal Microscopy
- STED Microscopy
- Deep Tissues Imaging
- Microscopy and Analysis of Quantum Structures
- Super Resolution Microscopy
- Failure Analysis of Structural Materials
- Live Cell Fluorescent Microscopy

Examples of Custom Microscope Objectives:

- Stanford University Department of Neurobiology 0.96 NA objective, with stainless housing for life science research in aqueous environment. F#: 0.52, Aperture: 23, EFL: 12, WD: 1.5mm water, FOV: 0.4
- Janelia Research Campus, HHMI
  0.65 NA Water Immersion Microscope objective lens used for excitation in the Bessel Beam Structured Plane Illumination Microscope designed by Eric Betzig



CUSTOM OBJECTIVES CON'T

Pre-Engineered High NA Objective Lenses

In addition to our pre-engineered lenses, custom designed lens orders are welcomed.

Quantum Physics / Ultra Cold Atom Research / Physics Research / Industrial

Customer	Lens Type	Part Number	NA	F#	Aperture	EFL	Working Distance	FOV	Housing
BSCI	Dry	54-20-60@633&1550nm	0.17	3.00	20.0	60.0	55mm Air + 3mm Bk7	1.5mm	Stainless
U of Stuttgart	Dry	54-17-25@532&421.3nm	0.34	1.47	17.0	25.0	19mm Air + 6.35.. Silica	0.06um	Ultem
Uni-kl.de	Dry	54-22-30@767-852nm	0.37	1.36	22.0	30.0	21mm Air + 5mm Silica	0.1um	Stainless
U of Arizona	Dry	54-18-21@633nm	0.43	1.17	18.0	21.0	34.5mm Air	0.15um	Stainless
Uni-frankfurt	Dry	54-3.5-4@325nm	0.44	1.14	3.5	4.0	8.5mm Air	0.25um	Stainless
MIT Physics	Dry	54-36-41@671nm	0.44	1.14	36.0	41.0	25.83mm Air + 6.1mm Silica	0.4um	Stainless
MAX Planck	Dry	54-28-28@671&1064nm	0.50	1.00	28.0	28.0	16mm Air + 4mm Silica	0.15um	Ultem
MAX Planck	Dry	54-25-25@532&767&780&1064nm	0.50	1.00	25.0	25.0	12mm Air + 5mm Silica	0.15um	Ultem
U of Chicago	Dry	54-26-26@852nm	0.50	1.00	26.0	26.0	19mm Air + 6.336 Silica	0.15um	Ultem
Microcosm	Dry	54-10-10@266nm	0.50	1.00	10.0	10.0	1mm Air	0.7um	Stainless
Controlled Semi	Dry	54-5-5@266&488nm	0.50	1.00	5.0	5.0	4.5mm Air + 0.17mm Silica	0.09um	Stainless
USTC	Dry	54-26-25@780nm	0.52	0.96	26.0	25.0	19mm Air + 7.1mm Silica+1.9mm H-K9L	0.35um	Ultem
Monash.edu	Dry	54-33-31@767&780nm	0.53	0.94	33.0	31.0	15.5mm Air + 4mm Borofloat	0.1um	Ultem
Microcosm	Dry	54-6-5@266nm	0.60	0.83	6.0	5.0	0.6mm Air	0.4um	Stainless
MAX Planck	Dry	54-36-30@767&589nm	0.60	0.83	36.0	30.0	18mm Air + 4mm Silica	0.15um	Ultem
U of Toronto	Dry	54-4-3.3 @ 405 nm	0.61	0.83	4.0	3.3	3.5mm Air + 0.2mm Sapphire	0.2um	Stainless
U of Hamberg	Dry	54-33-26@532-770nm	0.63	0.79	33.0	26.0	6.5mm Air + 4mm Silica	0.15um	Ultem
U of Bonn	Dry	54-25-17@589&670&760nm	0.74	0.68	25.0	17.0	3mm Air + 3.5mm Silica	0.25um	Ultem
Ultra Point	Dry	54-3.1-1.62@244nm	0.96	0.52	3.1	1.6	0.3mm Air	0.13um	Stainless
U of Strathclyde	Dry	54-35-27@767&780nm	0.65	0.77	35.0	27.0	12mm Air + 6mm Silica window	200um	Ultem
Durham U Dept. of Physics	Dry	54-36.2-30@780&852nm	0.60	0.83	36.0	30.0	18mm Air + 4mm Silica	150um	Aluminum
U of Chicago	Dry	54-18-12@532-1064nm	0.60	0.66	15.2	12.3	16mm Vacuum + 4mm Spectrosil +3.2mmN-BK7 + 1mm silica 1.65 Air	820um	Ultem
USTC	Dry	54-23-20@532, 671, 767, 1064nm	0.55	0.86	23.0	20.0	1.5mm Air + 6.18mm Silica window +10.06mm Vacuum	200um	Ultem
UCSB	Dry	54-26-19@461-698nm	0.70	0.70	26.5	18.5	6mm Vacuum + 6mm Silica + 1mm Air	200um	Aluminum
U of Innsbruck	Dry	54-49-49@401&421nm	0.50	1.00	49.0	49.0	5mm Air + 6mm Silica + 29mm Vacuum	100um	Ultem
Korea Research Inst.	Dry	54-42-42@399,532,556, 1064nm	0.50	1.00	42.0	42.0	1.5mm air + 6mm silica window + 12mm Vacuum 3.78mm Vacuum + 5.72mm Silica + 0.5mm Air	200um	Stainless
U of Chicago	Dry	54-40-25@532-1064nm	0.80	0.62	40.0	25.0	2mm Air + 4mm Silica + 7mm Vacuum	100um	Ultem
MIT	Air	54-3.4-2@780nm	0.75	0.58	3.4	2.3	18.23mm Air + 5mm Silica	72um	Aluminum
U of Waterloo	Air	54-24-29@852-940nm	0.45	1.20	24.0	29.0	5mm Air + 6mm Silica	150um	Aluminum
U of Sussex	Air	54-14-102@369nm	0.50	1.00	3.9		5mm Air+6mm Silica+18.78mm Vacuum	1.2x1.2mm	Stainless
U of Sydney	Air	54-22-18.5@369nm	0.60	0.84	22.0	18.5	0.3mm	300um	Aluminum
OEM	Air	54-3.1-1.7@266nm	0.85	0.58	2.9	1.7	1.5mm	150mm	Aluminum
OEM	Air	54-6-3.3@266nm	0.80	0.55	6.0	3.3		100um	Stainless

Pre-Engineered High NA Objective Lenses

Life Science

Customer	Lens Type	Part Number	NA	F#	Aperture	EFL	Working Distance	FOV	Housing
Excelsius	Dry	55-S10-3@1030nm	0.44	1.14	8.75	10	5mm Air	2.8	Stainless
HHMI	Water	54-19-19@800-1200nm	0.50	1.00	19.0	19	5.8mm Water	1.4	Stainless
Excelsius	Dry	55-S5-0.4@1064nm	0.65	0.77	6.5	5	4.5mm Air	0.4	Stainless
Allen Institute	Water	54-68-50@900nm	0.68	0.74	68.0	50	11.35mm Water	5.0	Stainless
HHMI	Water	54-10-7 @ 488-910 nm	0.71	0.70	10.0	7	3.6mm Water	0.1	Stainless
NDA	Water	54-3.3-1.8@VIS	0.92	0.55	3.3	1.8	0.486 typeA+0.6mm Sapphire+0.25mm Seawater	0.15	Stainless
Stanford U	Water	54-23-12@1-1.07nm	0.96	0.52	23.0	12	1.5mm Water	0.4	Stainless
HHMI	Oil	54-10.6-5.3@480-700nm	1.00	0.50	10.6	5.3	3mm Oil	0.1	Stainless
U of NC	Water	54-51-40@910-1050nm	0.60	0.78	51.0	40	5mm Water	7.0	Stainless
Stanford	Air	54-30-19@900-920nm	0.80	0.63	30.0	19	10mm	2x2mm	Stainless
MIT	Water	54-23-15@435-950nm	0.70	0.65	23.0	15	3.09mm Water	800um	Stainless
MIT	Water	54-28-20@900-920nm	0.70	0.71	28.0	20	3.5mm Water	4mm	Stainless
Abberior Inst.	Water	54-12-30@355, 405 & 488nm	0.20	2.50	12.0	30	5mm	1.2mm	Stainless
HHMI	Water	54-25-15@435-950nm	0.70	0.60	25.0	15	3mm in Water	800um	Stainless
HHMI	Water	54-12-25@450-700&900-1000nm	0.25	2.00	12.0	25	4mm Water	1.5mm	Stainless
HHMI	Water	54-20-10@405-910nm	0.95	0.50	20.0	10	4mm Water	110um	Stainless
GWDG.DE	Water	54-20-25@532nm	0.40	1.25	20.0	25.0	13mm Water	0.18um	Stainless
OEM	Water	54-40-20@870-950nm	0.80	0.50	40.0	20.0	3.5mm Water	4mm	Stainless
OEM	Water	54-40-20@1200nm	0.80	0.50	40.0	20.0	3.5mm Water	4mm	Stainless

Large Output Beam Expanders

Features:

Dual Wavelength Correction

Adjustable Lens Spacing

Low Insertion Loss

Specifications:

Wavefront Distortion............... < 1/2 Wave

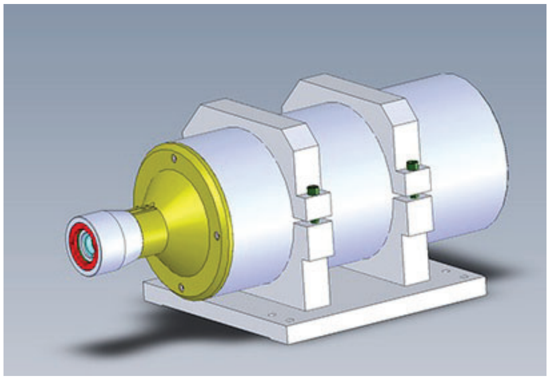
Transmission............................... > 92%

Coating Damage Threshold... 500 MW/cm2

Useable Spectral Range.......... 400 - 1650 nm

Model	Expansion Ratio	Input Aperture (mm)	Output Aperture (mm)
50-100-10X-λ	10X	10	100
50-100-5X-λ	5X	20	100
50-100-20X-λ	20X	5	100
50-100-40X-λ	40X	2.5	100

Special Optics line of large output beam expanders provide diffraction limited performance over the entire 100mm aperture, and deliver low wavelength distortion and high transmittance over a broad spectral range. They feature adjustable focus for collimation at various wavelengths, broadband anti-reflection coatings, large output and input apertures and a diffraction limited Galilean design. Wavefront distortion is standard at less than 1/2 wave, but 1/4, 1/8, or 1/10th wavefront distortion can be achieved upon request. Custom systems have been designed to provide output beam diameters of over 200mm as well as input beam diameters that exceed 100mm. Note: 1/4 or 1/8 Wavefront Distortion can be achieved.
Please call or email us for this request.



Low Power Beam Expanders

Features:

Adjustable Focus for Collimation at Various Wavelengths

Diffraction limited design

Large input apertures

High Transmission

AR Coated

Specifications:

Wavefront Distortion............... < 1/4 Wave

Transmission.............................. > 97%

Coating Damage Threshold... 500 MW/cm2

Useable Spectral Range.......... 248 - 1550 nm

Model	Expansion Ratio	Input Aperture (mm)	Output Aperture (mm)	Length @ 1064 nm (mm)
50-25-2X-λ	2X	11.0	22	89
50-25-3X-λ	3X	7.3	22	108
50-25-4X-λ	4X	5.5	22	118
50-25-4.5X-λ	4.5X	4.8	22	126
50-25-5X-λ	5X	4.4	22	122
50-25-6X-λ	6X	3.6	22	128
50-25-7X-λ	7X	3.1	22	131
50-25-8X-λ	8X	2.7	22	138
50-25-10X-λ	10X	2.2	22	140
50-25-12X-λ	12X	1.8	22	141
50-25-18X-λ	18X	1.3	22	145
50-51-4X-λ	3.9X	11.7	47	203
50-51-7X-λ	6.8X	6.7	47	239
50-51-10X-λ	10.2X	4.7	47	253
50-51-20X-λ	20.6X	2.3	47	267

Please replace λ in model number with working wavelength when ordering.

High Power Beam Expander

Features:

Adjustable Focus for Collimation at Various Wavelengths

Diffraction limited design

Large input apertures

High Transmission

No Focused Retro-reflections

Specifications:

Wavefront Distortion............... < 1/4 Wave

Transmission.............................. > 97%

Coating Damage Threshold... 500 MW/cm2

Useable Spectral Range.......... 248 - 1550 nm

Model	Expansion Ratio	Input Aperture (mm)	Output Aperture (mm)	O.D. x Length @ 1064 nm (mm)
52-25-2X-λ	2X	7.0	15.0	34.9 x 72
52-25-4X-λ	4X	7.0	30.0	44.5 x 127
52-51-7X-λ	7X	7.0	51.6	66.7 x 172
52-71-5X-λ	5X	14.0	71.6	85.7 x 248
52-71-10X-λ	10X	7.0	71.6	85.7 x 248
52-71-20X-λ	20X	3.5	71.6	85.7 x 248

Please replace λ in model number with working wavelength when ordering.

UV Beam Expanders

Features:

No Focused Retro-reflections

Adjustable Lens Spacing

Low Insertion Loss

Specifications:

Wavefront Distortion............... < 1/4 Wave

Transmission.............................. > 97%

Coating Damage Threshold... 500 MW/cm2

Useable Spectral Range.......... 0.248 - 0.355 nm

Model	Expansion Ratio	Input Aperture (mm)	Output Aperture (mm)	O.D. x Length (mm)	Wavelength Range (microns)
61-25-4X-λ	4X	6.25	25	34.9 x 72	0.248 - 0.355
61-25-7X-λ	7X	3.52	5	44.5 x 127	0.248 - 0.355
61-25-10X-λ	10X	2.52	5	66.7 x 172	0.248 - 0.355

Please replace λ in model number with working wavelength when ordering.

Variable Zoom Beam Expanders

Features:

Diffraction-limited design

5 element design reduces internal focus

Continuous zoom and focus adjustments

Mechanicals designed to minimize beam wander

Reduce machine setup times

Specifications:

Wavefront Distortion............... < 1/4 Wave

Transmission.............................. > 97%

Coating Damage Threshold... 100 MW/cm2

Useable Spectral Range.......... 450 - 1100 nm

Model	Expansion Range	Max Input Aperture (mm)	Max Output Aperture (mm)	O.D (mm)	Max length (mm)
56-30-4X-λ	1-4X	10	30	37.6	180
56-30-8X-λ	2-8X	10	30	37.6	167
56-45-8X-λ	2-8X	10	45	66.7	163

Large Output Beam Expanders

Features:

Adjustable Focus For Collimation At Various Wavelengths

Diffraction-Limited, Galilean Design

Large Output & Input Apertures

Broadband AR Coated For High Transmission

Specifications:

Wavefront Distortion............... < 1/2 Wave

Transmission.............................. > 92%

Coating Damage Threshold... 500 MW/cm2

Useable Spectral Range.......... 400 - 1650nm

Model	Expansion Ratio	Input Aperture (mm)	Output Aperture (mm)
50-100-5X-λ	5X	20	100
50-100-10X-λ	10X	10	100
50-100-20X-λ	20X	5	100
50-100-40X-λ	40X	2.5	100

Single Line Objectives

Features:

Diffraction Limited Design

Air-Spaced for High Power Applications

Standard Models Available for UV Wavelengths

Specifications:

Wavefront Distortion................ < 1/4 Wave

Transmission................................ > 97%

Coating Damage Threshold... 500 MW/cm2

Surface Quality............................ 20-10

Model	EFL (mm)	BFL (mm)	Aperture (mm)	F#	Wavelength Range (nm)	O.D. (mm)
54-15-15-λ*	15.0	3.0	15.0	1.0	600 - 1550	28.58
54-18-15-λ	15.1	4.2	18.0	0.8	780 - 1550	28.58
54-11-20-λ*	20.2	12.8	11.0	1.8	500 - 1100	14.98
54-18-23-λ	23.0	14.7	18.0	1.3	780 - 1100	31.75
54-17-30-λ*	30.9	21.9	17.0	1.7	300 - 1100	31.75
54-18-52-λ	50.6	42.3	18.0	2.8	750 - 900, 1300	25.40
54-25-60-λ*	60.5	46.8	22.0	2.7	500 - 1100	31.75
54-25-71-λ	70.1	60.0	27.5	2.6	750 - 900, 1300	31.75
54-25-87-λ*	88.7	81.7	22.0	4.0	300 - 650	28.57
54-25-100-λ	99.9	92.3	22.0	4.0	250 - 400	38.10
54-40-87-λ	87.0	50.0	40.0	2.2	532	53.98
54-40-100-λ*	99.9	84.1	40.0	2.5	532, 1064	57.15
54-40-180-λ	180.0	163.8	40.0	4.5	1064	50.80
54-25-125-λ*	127.2	121.9	23.0	5.5	500 - 1100	38.10
54-47-130-λ	134.9	121.5	47.0	2.7	320 - 1100	57.15
54-75-175-λ	174.8	163.8	75.0	2.3	1064	89.90
54-152-400-λ	401.2	389.4	152.0	2.6	500 - 650	165.10

* All Fused Silica. Please replace λ in model number with working wavelength when ordering.

To calculate spot size: Gaussian Input Beam $S=1.27F\#\lambda$

Uniform Density Input Beam $S=2.44F\#\lambda$

Achromatic Objectives

Model	EFL (mm)	BFL (mm)	Aperture (mm)	F#	Wavelength Range (nm)	O.D. (mm)
54-30-60	62.3	48.5	30	2.0	532 - 1064	41.3
54-37-117	117.4	109.4	37	3.2	532 - 1064	50.8
54-10-120	120.0	115.0	10	12.0	266 - 532	15.0
54-50-175	175.0	143.5	50	3.5	488 - 514	60.0
54-100-200	200.5	182.5	100	2.0	450 - 600	120.7
54-74-210	210.0	189.4	74	2.8	532 - 1064	88.9
54-75-250	250.0	210.6	75	3.5	488 - 514	88.6
54-120-260	258.0	231.5	120	2.2	450 - 650	152.4
54-106-370	370.0	305.2	106	3.5	488 - 514	119.4
54-100-576	575.5	563.5	100	5.7	480 - 650	120.7
54-200-1193	1192.7	1150.2	200	5.9	500 - 650	208.0
54-25-88N	-88.0	94.1	25	-3.5	488 - 514	33.3
54-50-175N	-175.0	186.1	50	-3.5	488 - 514	60.0

Apochromatic Objectives

Model	EFL (mm)	BFL (mm)	Aperture (mm)	F#	Wavelength Range (nm)	O.D. (mm)
54-2-7	7.1	5.9	2	3.6	400 - 700	6.4
54-22-40	40.0	22.8	22	1.8	480 - 550 & 1064	28.6
54-22-79	79.0	73.2	22	3.6	400 - 700	28.6
54-40-100	99.9	95.0	40	2.5	700 - 900	50.8
54-40-174	173.0	163.7	40	4.3	700 - 900	50.8
54-12-180	179.2	173.5	12	15.0	300 - 365	25.4
54-25-350	369.2	362.0	24	15.0	250 - 400	38.1
54-54-540	540.0	523.0	54	10.0	200 - 400	60.0
54-8-35N	-34.6	-35.9	8	-4.3	700 - 900	12.5

Laser Diode Collimators

Features:

Diffraction Limited Design

Corrected for 5 to 10 mil Window

Long Back Working Distance

Specifications:

Wavefront Distortion............... < 1/4 Wave

Transmission............................... > 97%

Usable Wavelength Range...... 670 to 1550 nm

Field of View................................ 1.5 degrees

Laser Diode Objectives are designed to accommodate the large input angles associated with compact laser sources. Standard designs offer diffraction limited performance for numerical apertures as high as 0.6, making them useful for fiber optic coupling or collimating. The spectral range of our Diode Collimators is extended into the infrared region allowing for operations with most diodes within the 670 nm to 1550 nm wavelength range. Though designed for use with Diode Lasers, these lenses may be used with other lasers requiring highly corrected lenses within the visible and near infrared spectral range.

Model	Aperture (mm)	N.A.	EFL λ = 835 nm	BWD λ = 835nm	O.D. (mm)
54-18-15-λ	18.00	0.60	15.04	0.1	28.58
54-18-23-λ	18.00	0.39	23.0	12.1	31.75
54-51-50-λ	50.80	0.50	50.86	0.7	63.50

The five positive air-spaced doublets described below focus the collimated output of diode lasers operating within the 670 to 1550 nm spectral range. They may also be combined to expand the 18 mm output of either the Model 54-18-15 or 54-18-23 Collimating Objectives. The Model 54-18-76N negative doublets is designed to serve as the input element of a Galilean Beam Expander when mated with any of the 0.12 N.A. positive lenses. All six lenses are fully corrected aplanats, and can be mixed and matched in a focusing or non-focusing configuration to obtain the desired magnification. With the appropriate antireflection coating, each lens may also be used with visible wavelength lasers.

Model	Aperture (mm)	N.A.	EFL λ = 835 nm	BWD λ = 835nm	O.D. (mm)
54-18-50-λ	18.00	0.18	50.6	41.3	25.40
54-25-71-λ	25.00	0.18	70.9	55.0	31.75
54-18-50-λ	18.00	0.12	75.3	70.2	31.75
54-47-200-λ	47.0	0.12	197.0	185.2	57.15
54-71-300-λ	71.0	0.12	297.0	280.0	82.55
54-18-76N-λ	18.0	0.12	-75.9	87.6	31.75

Please replace λ in model number with working wavelength when ordering.

UV Objectives

Features:

Diffraction Limited Design

Air-Spaced for High Power Applications

Achromatic Design

Specifications:

Wavefront Distortion............... < 1/4 Wave

Transmission.............................. > 97%

Coating Damage Threshold... 500 MW/cm2

Surface Quality.......................... 20-10

Model	EFL (mm)	BFL (mm)	Aperture (mm)	F#	Wavelength Range (nm)	O.D. (mm)
54-11-19-λ	19.0	11.8	11	1.8	248 - 400	14.98
54-17-29-λ	30.0	21.0	17	1.7	248 - 400	31.7
54-25-100-λ	99.9	92.3	22	4.0	250 - 400 (apochromatic)	38.1
54-10-120-λ	120.0	115.0	10	12.0	266 - 532 (apochromatic)	15.0
54-12-180-λ	179.2	173.5	12	15.0	300 - 365 (apochromatic)	25.4
54-44-220-λ	219.0	202.7	44	5.0	300 - 365	57.2
54-25-350-λ	369.2	362.0	24	15.0	250 - 400 (apochromatic)	38.1
54-54-540-λ	540.0	523.0	54	10.0	200 - 400 (apochromatic)	60.0
Please replace λ in model number with working wavelength when ordering.						

High N.A. UV Micro Objectives

Features:

Diffraction Limited Design

Air-Spaced for High Power Applications

Achromatic Design

Specifications:

Wavefront Distortion............... < 1/4 Wave

Transmission.............................. > 97%

Coating Damage Threshold... 500 MW/cm2

Surface Quality.......................... 20-10

Model	Field Size (mm)	EFL (mm)	N.A.	Aperture (mm)	BWD	Wavelength (nm)	1/e² Spot Size (microns) 248 nm	1/e² Spot Size (microns) 365 nm
54-10-5.5-λ	0.10	5.5	0.90	10	0.15	248 or 365	0.17	0.25
54-10-6.7-λ	0.12	6.7	0.75	10	0.28	248 or 365	0.21	0.31
54-50-510-λ	0.18	10.0	0.50	10	0.30	248 or 365	0.31	0.46
Please replace λ in model number with working wavelength when ordering.								

VIS - NIR Scanning Lenses

Features:

Diffraction Limited

Precision Manufacture and Assembly

Air Spaced Design

Achromatic Designs Available

Model	Wavelength (microns)	Scan Field (mm)	EFL (mm)	Max Input Beam*(mm)	BWD (mm)	Deflection (degrees)	FWD (mm)	1/e² Spot** (microns)
55-S70-30	1.064	30	63.4	8	70.0	13.6	17.0	10.7
55-S160-84T	1.064	84	160.0	28	190.0	15.0	35.0	8.0
55-S112-90T	1.064	90	112.2	13	155.6	23.0	27.6	11.7
55-S117-90	1.064	90	117.3	8	133.5	22.0	21.7	19.8
55-S181-90	1.064	100	181.3	19	229.0	15.8	35.8	12.9
55-S191-125	1.064	125	191.3	13	194.0	22.0	26.0	19.9
55-S236-150	1.064	152	236.8	25	298.0	18.4	55.4	12.8
55-S266-170	1.064/VIS	170	266.0	15	275.0	18.0	370.0	24.0
55-S266-252	1.064	252	266.5	10	338.0	27.0	48.0	36.0
55-S295-250	1.064	250	295.4	25	355.0	25.0	37.6	16.0
55-S459-432	1.064	432	459.0	26	540.0	27.0	48.0	24.0
55-S700-450	1.064/VIS	450	699.0	34	725.0	18.0	55.0	28.0
55-S700-560	1.064	560	699.0	35	580.0	23.0	35.0	27.0
55-S190-60-VIS	0.45 - 0.65 (apochromatic)	60	190.0	16	129.4	9.0	27.5	9.8
55-S190-100-VIS	0.45 - 0.65 (apochromatic)	100	190.0	16	161.0	15.0	24.0	9.8
55-S87-36T	0.488	36	87.0	27	5.8	12.0	29.0	2.0
55-S223-77T	0.632	77	223.0	22	231.5	10.0	33.0	8.1

* Single Axis Scanning
T denotes Telecentric
** Assumes a diffraction limited beam, spot size = 1.27 λ F#

Confocal Microscopy Lenses

Features:

Diffraction Limited

Fully Apochromatic

Precision Manufacture and Assembly

Model	Wavelength Range (nm)	Focal Length (mm)	Field Size (mm)	Max Input Aperture* (mm)	FWD (mm)	BWD (mm)	Scan Angle (degrees)	Lateral Color (microns)	1/e² Spot Size (microns)
55-S28-3T	530 - 590	28.6	3	28.6	16	2.8	+/- 3	< 1	0.5
55-S30-15T	488 - 600	30.0	13	9.0	14	12.5	+/- 13	< 5	3.0
55-S80-25T	450 - 650	80.3	25	8.0	16	53.0	+/- 9	< 3	6.0
55-S172-36T	500 - 1100	172.0	36	20.0	49	86.0	+/- 6	< 8	10.0

* Single Axis Scanning
T denotes Telecentric
Model 55-S28-3 transmits 50% @ 365 nm

Telecentric UV Scanning Lenses

Features:

Diffraction Limited

Precision Manufacture and Assembly

Air-Spaced Design

Achromatic Designs Available

Model	Wavelength (microns)	Scan Field (mm)	EFL (mm)	Max Input Beam* (mm)	BWD (mm)	Deflection (degrees)	FWD (mm)	Spot Size (microns)
55-S34-9UV-λ	266 or 355	9	34	17	10	7	17	1.0
55-S50-20UV-λ	266 or 355	20	50	10	15	12	23	2.5
55-S100-45UV-λ	355	45	100	10	150	16	28	5.0
55-S100-55UV-λ	266 or 335	55	100	10	135	16	28	5.0

Please replace λ in model number with working wavelength when ordering.

Retardation Plates

Features:

No UV Cement Used in Construction

(Air-Spaced Design)

High Damage Threshold (500 MW/cm2)

Minimal Insertion Loss

Specifications:

Material................................. Quartz

Retardation Tolerance ..... +/- 0.005 Waves

Parallelism............................ < 1 Arc Second

Wavefront Deformation... 1/8 Wave

AR Coatings........................ < 0.50 % Reflectance Per Surface

Stock Wavelengths For Immediate Delivery

442	458	488	510	514	527	531	532	543	546	568	578	589	594	612	633
647	676	694	750	752	755	760	768	780	810	820	830	835	850	855	864
960	905	980	1047	1053	1060	1064	1150	1300	1310	1315	1320	1523	1550		

Zero and Multiple Order Waveplates

Model[1]	Order	Retardance (degrees)	Aperture (mm)	*O.D. (mm) Unmounted	*O.D. (mm) Mounted	Thickness (mm)
8-8008-1/4-λ	Zero	90	8	11.0	12.7	6
8-8015-1/4-λ	Zero	90	15	17.5	25.4	8
8-8025-1/4-λ	Zero	90	25	27.3	31.8	8
8-8008-1/2-λ	Zero	180	8	11.0	12.7	6
8-8015-1/2-λ	Zero	180	15	17.5	25.4	8
8-8025-1/2-λ	Zero	180	25	27.3	31.8	8
8-3015-1/4-λ	Multiple	90	15	17.5	25.4	8
8-3025-1/4-λ	Multiple	90	25	27.3	31.8	8
8-3015-1/2-λ	Multiple	180	15	17.5	25.4	8
8-3025-1/2-λ	Multiple	180	25	27.3	31.8	8

Please replace λ in model number with working wavelength when ordering.

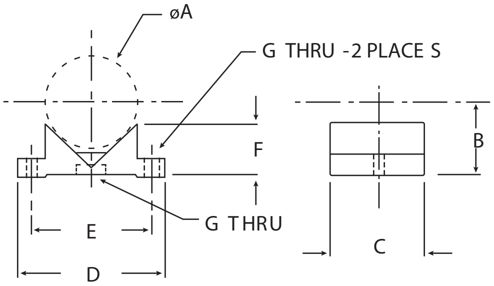
Achromatic Waveplates

Model	Retardance (degrees)	Wavelength Range (nm)	Aperture (mm)	*O.D. (mm) Unmounted	*O.D. (mm) Mounted	Thickness (mm)
8-9015-1/2	180	400-700	9	11	25.4	8
8-9012-1/4	90	600-900	9	11	25.4	8
8-9012-1/2	180	600-900	9	11	25.4	8
8-9014-1/4	90	700-1550	9	11	25.4	8
8-9014-1/2	180	700-1550	9	11	25.4	8

Please replace λ in model number with working wavelength when ordering.

Vee Block Mounts

The Vee Block Mounts are stable non-adjustable mounts which are used with the 50 and 52 Series Beam Expanders. Model 60-16-25 is suggested for barrel diameters between 25 and 45 mm, and Model 60-16-26 is suggested for diameters between 46 and 80 mm.



Model	AB		CD		EF		G
60-16-25	1.25	1.00	1.25	2.00	1.63	0.716	0.147
60-16-26	2.25	1.63	2.25	3.25	2.75	1.13	0.187

Threaded Adapters

These Threaded Adaptors, compatible with 50-25 and 50-51 Series Beam Expanders, are useful for mounting the beam expander directly to the laser or other threaded optical components.

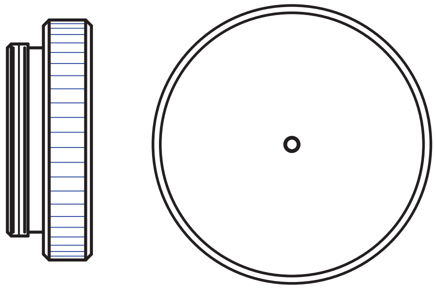
60-16-30

60-16-51

Model	Thread (B.E Side)	Thread (Laser Side)
60-16-30	1” - 32 TPI	1” - 32 TPI
60-16-51	1” - 32 TPI	2” - 32 TPI

Alignment Apertures

The Model 60-16-1.5 Alignment Aperture has a 1.5 mm central hole and screws into all 50-25 and 50-51 Series Beam Expanders. This removable aluminum plug is extremely useful in the initial centering and alignment of the beam expander.



Model	T Thread (inches)
60-16-1.5	1” 32 TPI
60-17-1.5	1.1/8” 32 TPI

In-Line Beam Steerer

In-Line Beam Steerers are convenient devices that precisely change the angle or alignment of optical beams without the use of mirrors. Unlike Risley prisms, In-Line Beam Steerers move the beams in a cartesian coordinate system rather than in a polar coordinate system. With a single adjustment, the In-Line Beam Steerer deflects the beam either horizontally or vertically. One In-Line Beam Steerer replaces typical two-mirror systems and makes adjustments easier. The In-Line Beam Steerer is an adjustable wedge formed by a plano-concave and a plano-convex lens that are connected to one another using a thin layer of index-matching fluid. Displacement of one lens with respect to the other changes the wedge angle, thereby steering the beam.

Features:

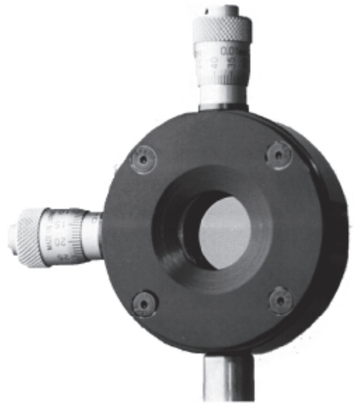
Independent two-axis Cartesian adjustments

Zero beam displacement

Mounts to 8-32 posts

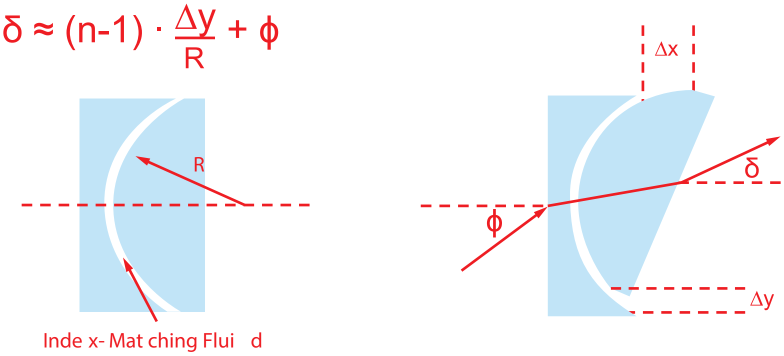
BK-7 (n = 1.52)

Broadband visible and IR coatings



Model	Clear Aperture(mm)	Max Deflection	Max Deflection	Dimensions (mm)	T (at 633 nm)	Adjustment
12-4008-20	8	± 20 mrad	14 µrad/deg	25 x 25 x 14	> 98%	Fine screw
12-4010-25	10	± 25 mrad	14 µrad/deg	44Ø x 16	> 98%	Fine screw
12-4015-20	15	± 20 mrad	14 µrad/deg	60Ø x 22	> 98%	Micrometer

$$\delta \approx (n-1) \cdot \frac{\Delta y}{R} + \phi$$



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