

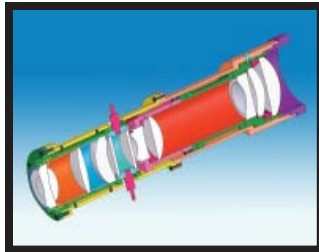


# SPECIAL



# About Us

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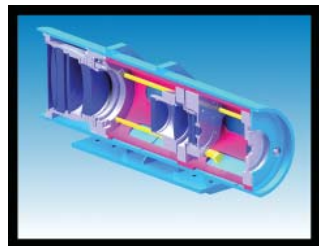
## Custom Lens Design and Precision Lens Manufacturing

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, and UV and IR imaging. 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. We believe that, - **"It happens by design"!**



## 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. Navitar is standing by ready to deliver repeatable performance of every unit that comes off the production line.



## Rapid Prototyping

With unmatched technical capability, Special Optics will provide you with a custom lens design, rapidly produced prototypes, and, with the addition of our parent company Navitar, we can help you bring your product to volume production. Together, Special Optics and Navitar are one of the few lens companies that can seamlessly integrate optical & mechanical engineering, rapid prototyping and volume custom lens production. By eliminating the complexity of managing multiple suppliers, the entire design and prototyping process will be reduced, cycle times shortened, and you will get a consistently better product delivered routinely month after month than what is possible from any other manufacturer.

### Typical Applications Include

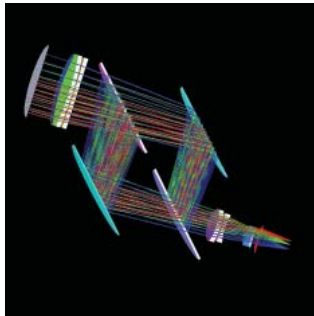
- Long Range Surveillance Lenses
- 360 Degree Surveillance Lenses
- Laser Optics for High Energy Laser Weapons
- Laser Optics for Missile Defense
- Hyperspectral Lenses Designed to Operate Over a Wide Range of Wavelengths
- Custom Lenses for Commercial DLP Projectors
- Lenses for Unmanned Aerial Vehicles
- High Resolution Imaging Lenses
- Telecentric Inspection Lenses
- Fluorescence Imaging Lenses
- Laser Projection Optics
- Holographic Projection Optics
- Missile Tracking Lenses
- Laser Beam Expanders
- UV Objective Lenses
- Laser Scanning Lenses
- Digital Radiology Lenses
- Fisheye Lenses
- SWIR Lenses



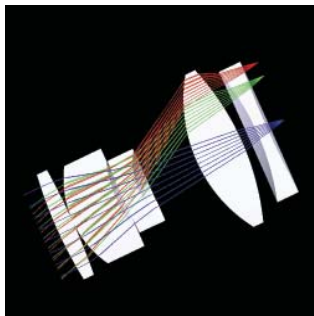
### Manufacturing Tolerances

| 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             | 0.025                   |
| Radius (power)               | 0.2% (8 rings)     | 0.1% (4 rings)    | 0.05% (2 rings)         |
| Irregularity (waves @ 633nm) | 1                  | 0.25              | 0.1                     |
| Wedge (mm)                   | 0.05               | 0.005             | .0025                   |
| Decenter (arc min)           | 0.05               | 0.01              | 0.005                   |
| Scratch - Dig                | 80 - 50            | 60 - 40           | 20 - 10                 |
| AR Coating (r avg)           | < 1.5%             | < 0.5%            | < 0.25%                 |

# Optical Design



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, Hyperspectral SWIR lenses, and IR zoom lenses. Having a large library of lens designs allows us to meet your design needs without disproportionate design costs. This means that 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.

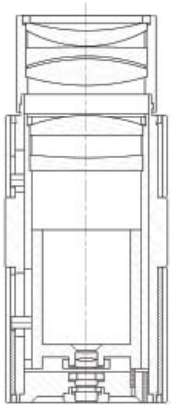


## Areas of Specialization

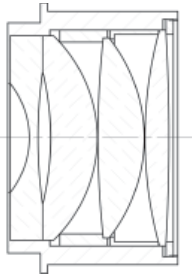
- Fourier Transform Optics
- High NA UV Objectives
- IR Scan Lenses
- Achromatic Beam Expanders
- Apochromatic Scan Lenses

# Mechanical Design

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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. That is why 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 that your lens systems are both technically feasible and mechanically manufacturable. By successfully integrating both optical and mechanical designs ensures that the solution that we have designed for you meets all your mechanical and performance specifications.



# Fabrication and Polishing



As well as the manufacture of a standard product line, Special Optics also supplies 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 optronics industry.

## The Process

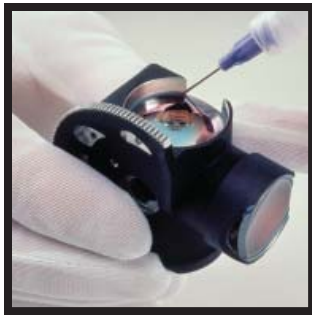
We start with raw bulk glass which is cut and coredrilled to the appropriate diameter. Next the lens radius is cut into the surface using standard industry generators. Two grinding steps follow, first a rough 20 micron grit followed by a 9 micron grit fine grind. The lenses are now ready for polishing. 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.



## Lens Manufacture 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

# Precision Assembly



Assembly of diffraction limited lens systems is equally as important as the polishing of the lens elements themselves. In fact, many times performance degradation is traced to poor lens assembly, not the lens elements. In particular, air-spaces, centration, tilt and wedge are the key determinants of a quality lens system.

## **Air-Spaces**

In high resolution systems, very often it is necessary to measure and maintain lens spacings to the order of a few microns. This is not an easy task, but one that we have worked extensively at perfecting. 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.

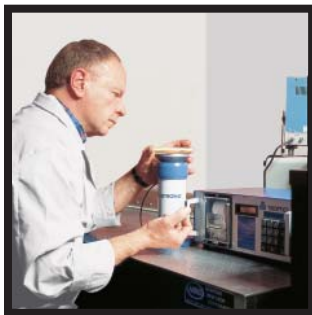
## **Assembly Capabilities**

- 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 Spindles
- Laser Alignment

# Testing



Interferometric Wavefront Measurement



Precision Radius Measurement

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.

## Interferometry

Evaluation of lens surfaces for spherical regularity is accomplished using a ZYGO interferometer with phase shift ability. 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.

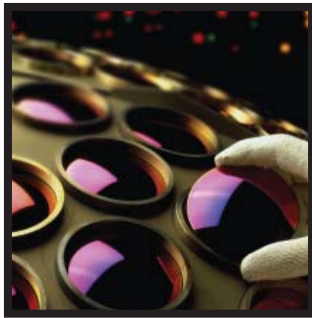
## Radius Testing

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 on 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

- Phase Shift Interferometry
- 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
- Effective Focal Length

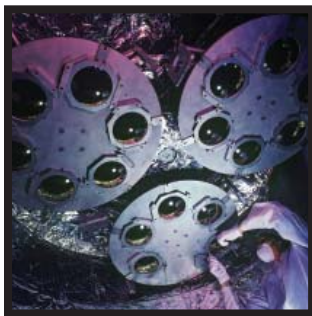
# Coating



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-reflection (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/cm<sup>2</sup> Damage Threshold
- 248-2200 nm Range Capability
- In-house Thin Film Design

# Off-the-Shelf Standard Products



Special Optics carries a complete line of standard products available for quick delivery. 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<sub>2</sub> lasers.

## Beam Expanders

- Achromatic/Apochromatic
- High Power
- IR Beam Expanders
- Large Output
- Low Power
- Motorized Zoom
- UV
- Variable

## Beam Steering Devices

- In-Line Beam Steerer
- Risley Prisms

## Best Form Lenses

- VIS Positive
- VIS Negative
- UV Positive
- UV Negative

## Laser Scanning Lenses

- Confocal Microscopy Lenses
- IR Scanning Lenses
- Telecentric UV Lenses
- VIS-NIR Scanning Lenses

## Mechanical and Misc.

- Calibrated Rotary Mount
- Collimation Tester
- Four Axis Positioner
- Gimbal Mount
- Neutral Density Filters
- Optical Filters
- Polarizer Adaptors
- Rotatable Waveplate Housing
- Single Element Lens Mounts

## Metric Zoom

- Long Range Surveillance Lens

## Multi-Element Objectives

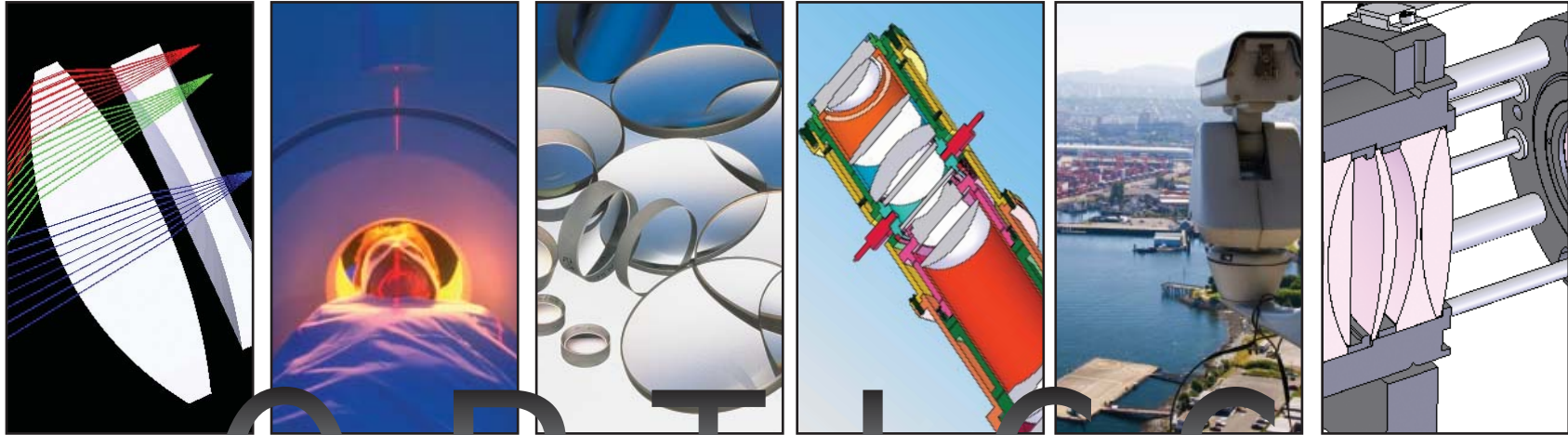
- Achromatic
- Apochromatic
- High N.A. UV Micro Objectives
- Laser Diode Collimators
- Single Line
- UV

## Polarization Optics

- Glan-Laser Polarizers
- Laser Beam Attenuators
- Polarization Rotators
- Soleil Babinet Compensators
- Waveplates
- Wedge Depolarizers

Visit [www.specialoptics.com](http://www.specialoptics.com) for complete product specifications and pricing





# OPTICS

