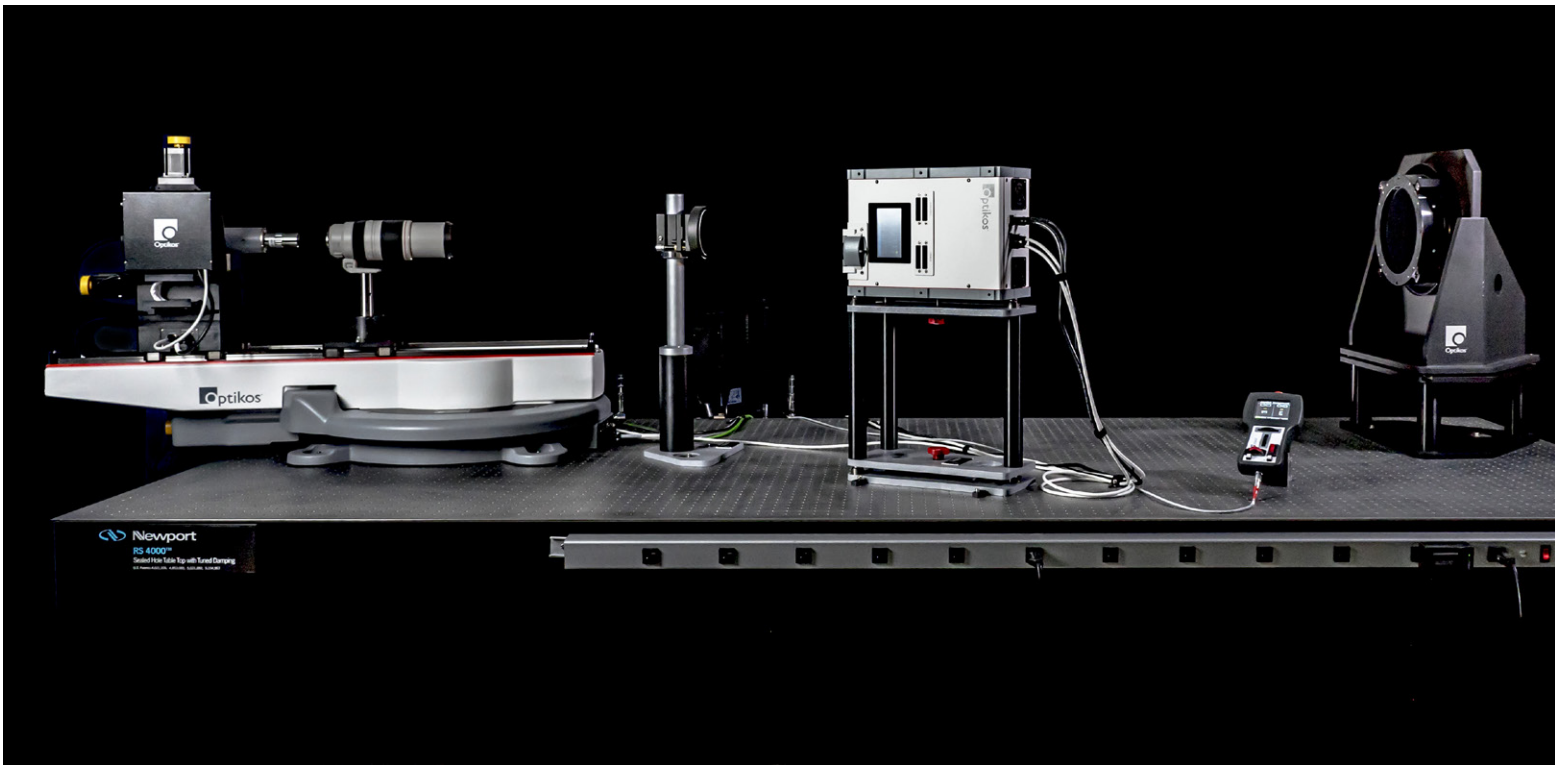
ptikos®

The Optical Engineering Experts®

OpTest®

A Complete Optical Measurement and Testing System



Understanding Lens and Image Quality

Optical design and fabrication engineers understand that lens elements and optical systems are seldom perfect. Despite the presence of the most sophisticated design and manufacturing techniques, lenses can still vary considerably in quality.

Optikos is a leader and pioneer in lens and image testing and our products and systems are based on over thirty-five years of experience and innovations in optical engineering. The result is that our customers are able to use the most advanced metrology tools for performing accurate and efficient lens and camera system measurements and improve their product quality and performance. Our flagship lens testing products include the OpTest® Lens Measurement System with a complete range of hardware options, and the LensCheck™ VIS and LWIR instruments—compact systems that are portable and easy-to-use for smaller lenses. Both are powered by OpTest® 7, Optikos® proprietary software.

WHATEVER YOU DESIGN, YOU CAN MEASURE WITH *OPTEST*® SYSTEMS

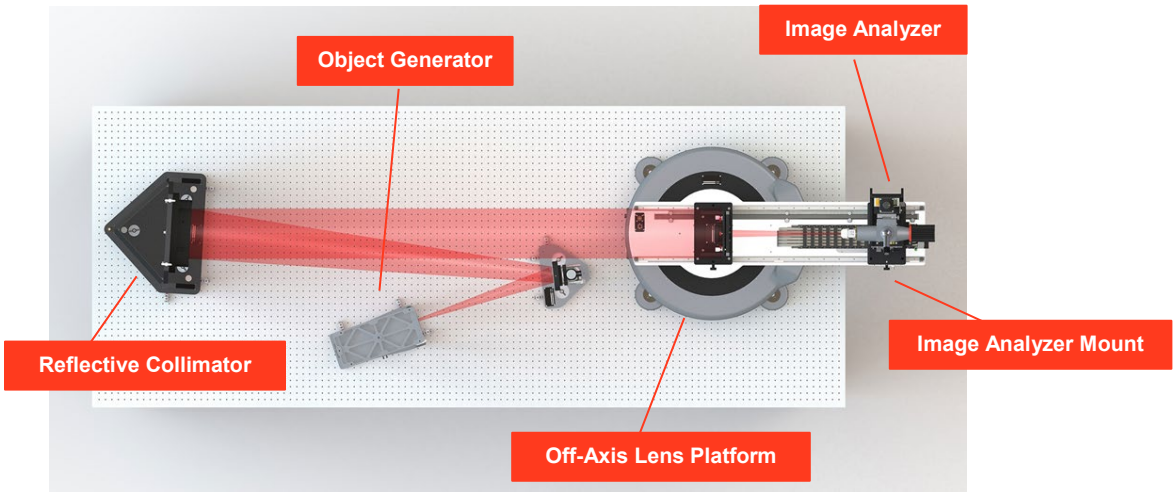
The OpTest Lens Measurement System includes the latest technologies and innovations in optical and opto-mechanical engineering. Other products on the market typically manufacture their systems around general purpose off-the-shelf lab components, while every step of an Optikos solution is a custom one. OpTest systems are composed of custom optics, mechanics, and electronics designed by Optikos engineers solely for the purpose of lens testing.

Optikos offers the most comprehensive product line for lens testing. Upgrade paths and modules are available to expand your testing capabilities with OpTest to include measurements such as transmission, stray light, afocal, finite conjugate and UV testing.

CUSTOM-DESIGNED TO FIT YOUR NEEDS

Optikos not only builds your optical testing system with sub-assemblies and components that meet your immediate needs, but also provides a simple upgrade path as your needs change. The Optikos approach provides you with a technical as well as economical solution: one that doesn't become obsolete as your application or business develops—one that is flexible enough to meet your requirements now and in the future.

With the range of products available, it's important to select the components that best suit your purposes and give you maximum flexibility. In the optical testing section that follows, you will be introduced to a range of products that will work together to perform the tests that meet your unique application. Descriptions and illustrations explain how each product may be used to create the overall system.

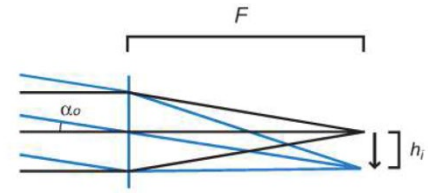


A BUILDABLE SOLUTION

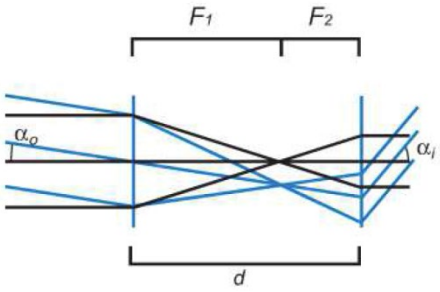
The modular components of the OpTest® system can be configured to test most types of lenses. Selecting and configuring modules appropriate for the optical system under test requires defining how the system is to be used, including:

1. Location of object and image conjugates
2. Spectral range
3. Spatial resolution
4. Image and object size and system field-of-view
5. Pupil diameter, f/number, and numerical aperture
6. Physical dimension and system layout

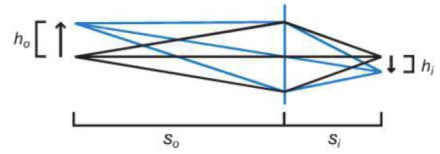
1. For location of object and image conjugates, most optical systems fall within three groups:



Infinite conjugate systems:
The object plane is located at infinity.
Examples: Camera lenses, eyepieces, infinity-correct microscope objectives

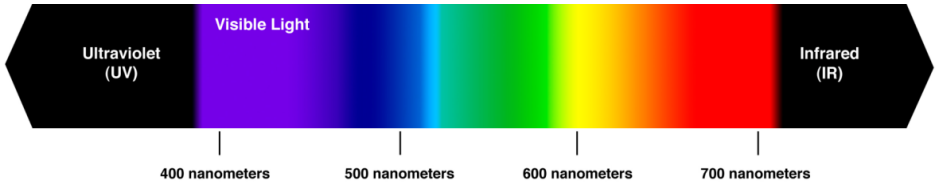


Afocal systems:
Both the object and image plane are at infinity.
Examples: Telescopes, binoculars, and beam expanders



Finite conjugate systems:
Both the object and image planes are located at finite distances.
Examples: Photographic enlarging lenses, macro lenses, fiber optic faceplates, image tubes, and photolithography lenses

2. The OpTest® System supports image analyzers that can operate over spectral wavelengths from UV to LWIR.



3. All optical systems are limited in their ability to form images due to spatial resolution. One fundamental limitation stems from the wave nature of light. In a case where the wave nature of light limits the performance of an optical system, the system has “diffraction limited” resolution.

   The performance of an optical system can also be limited by the design of the system or by manufacturing imperfections. In this case the optical system is resolution-limited by aberrations. The residual aberrations of

the optical testing system must be small compared to those of the system under test. The appropriate image analyzer in the test system must also have sufficient resolution to analyze the resulting image formed by the optical system under test. Spatial resolution is specified in line-pairs per millimeter for infinite and finite conjugate systems. It is specified in cycles per milliradian for afocal systems.

4. The test system must be able to cover the field-of-view (FOV) of the system under test in both object and image space. For infinite conjugate systems, the test system must cover the angular FOV in object space and the linear dimension of the full field image height. For finite conjugate testing the translation stages must be able to cover the full object and image heights and to set the required object distances. For testing afocal systems, it is necessary to span the angular FOV in both object and image space.

5. The test system must be able to fill the entrance pupil of the system under test in object space and collect light from the entire exit pupil. For infinite conjugate and afocal systems under test, the entrance pupil diameter sets a lower bound on the size of the collimated beam required in object space. Image space requirements are specified by the exit pupil diameter of afocal systems, whereas the working F/number or numerical aperture is relevant when testing infinite or finite conjugate systems.

6. An OpTest system requires an optical table to accommodate system components and a folded optical path. The optical system under test may be massive or may include folded optical paths or other unusual physical characteristics. An optical table with ¼”-20 threaded holes on 1” centers or M6 holes on 25mm centers is required for OpTest systems.

OpTest® System Hardware Options

OG-1000 SOURCE: EASILY SWITCH BETWEEN TEST SPECTRUMS

The OG-1000 series of multispectral Object Generators uses state-of-the-art light sources, optics, electronic controls and automation. These sources provide uniform, high intensity illumination from the UV to long-wave infrared (0.2 – 14µm). The unit electronically switches between two, co-aligned illumination channels (one populated with a visible source, and the other with either an IR or UV source), enabling multispectral testing with the touch of a button.

- Color touchscreen display provides intuitive user interface for computer and module control
- AlignMode feature substantially speeds up lens set-up and alignment, while a single touchscreen button switches from your test configuration (visible, infrared or UV) to a visible alignment target, and switches back to your original configuration
- Optical path designed to reduce losses and maximize output signal
- Single set-up testing of visible and infrared multispectral optical systems

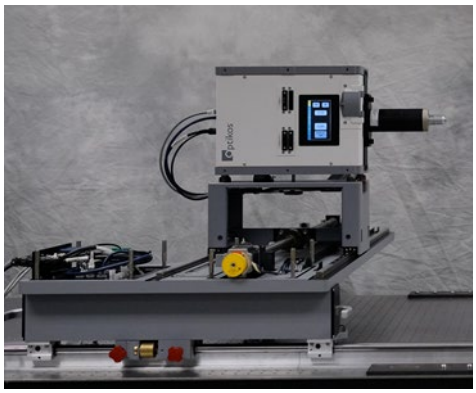
Table 1. OG-1000 Series Object Generator Model Numbers.

Model Name	Waveband	Integrated Chopper Wheel	Compatible Image Analyzers	Comments
OG-1010	UV-VIS	✓	VI-1010 SD-100-UV	UV Source with fiber
OG-1110	VIS-NIR		VI-1010	Best choice for VIS-only test benches
OG-1210	VIS-SWIR		VI-1010 VI-2000	Extends visible source into SWIR waveband
OG-1220	VIS-SWIR	✓	VI-1010 VI-2000 SD-500 SD-800	Extends visible source into SWIR waveband
OG-1310	VIS-LWIR		VI-1010 VI-2000 VI-4000	Best choice for IR video image analyzers.
OG-1320	VIS-LWIR	✓	VI-1010 VI-2000 SD-500 SD-800 VI-4000 SD-600 SD-900	Best choice for IR scanning test benches.

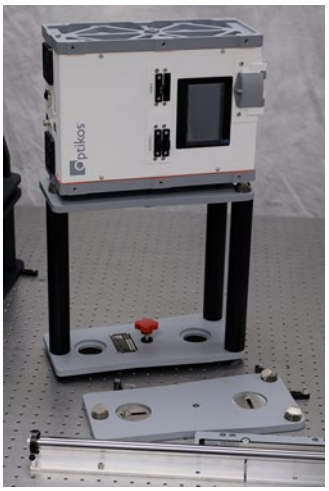
Table 2. OG-1000 Series Specifications

Optical Performance			
	Visible	**Infrared**	**Ultraviolet**
Maximum Color Temperature/Source Temperature	3000K	1000°C	N/A
Source Spectral Output	400 – 2500nm[1]	3 – 14µm	190 – 2100nm[2]
Typical Emitter Lifetime	2000 hrs	2000 hrs	>9000 hrs
Illumination Numerical Aperture	0.2 (f/5)	0.2 (f/5)	0.1 (f/10)
Illumination Extent (Maximum Target Size)	6mm diameter	6mm diameter	2mm diameter
[1]Visible spectral output range for OG-1110 is 400-1500nm; range is 400-2500nm for OG-12XX and OG-13XX *[2]Full UV spectrum may require Nitrogen purge of source and system*			
System Specifications			
Target Wheel	High speed 16 position motorized target wheel Typical target set: - 6 pinholes (3µm, 10µm, 30µm, 100µm, 300µm, 1000µm) - 4 pairs of horizontal and vertical slit targets (15µm, 50µm, 150 µm, 500 µm slit widths) - Alignment crosshair - Open target position		
Filter Drawers	2 slots per illumination channel for filter drawers Two blank filter drawers included with OG assembly Filter drawers accept 1” diameter filters, 0.5 – 8mm thick Filter drawer storage box included with OG assembly		
Filters	IR Cutoff filter (400-700nm) included with OG assembly, installed in a labeled filter drawer		
Chopper	Integrated in select OG assemblies for use with LA-1000 Lock-In Amplifier and scanning image analyzers. Typical chopping frequency: 1000 Hz		
Integral Shutter	High-speed shutter provides automated background correction		
Software/Controls			
Local Control via Touchscreen Display	Gives access to all source functionality		
Remote Control (OpTest)	Native OpTest software control OG functions can be accessed through OpTest 7 software Remote control also provided through HC-1000 Handheld Controller		
Remote Control (Custom)	Remote control via RS-485, RS-422 or RS-232 Full command set is freely available to allow users to write custom software or test macros		
Mechanical (mounting riser and options not included)			
Footprint	35 x 26.5 x 16 cm		
Weight	9.3 kg		

Object Generator Options and Accessories	
Risers	Kinematic risers for use with OpTest bench place target at 500mm optical axis height from the table. Riser mounting interface with optical table can be kinematic or fixed.
Custom Targets	Different target apertures and sizes are available upon request. Contact Optikos for more details.
Automated Filter Wheel	Replaced one filter drawer slot in each illumination channel Motorized filter wheel with 7 filter positions, accepting 1" diameter filters, 0.5 – 8mm thick.
Additional Filters	SWIR, MWIR and LWIR bandpass filters included with associated Image Analyzers. Optional filters available by request: Infrared cut filters, color filters, custom bandpass filters.
OGA-140 Re-Projection Assembly (visible only)	Accessory for use with the FP-1100 Finite Conjugate Platform Optical relay assembly mounts to the front of the OG and increases the cone angle of the source Includes 4X, 10X, 20X and 40X achromatic objectives

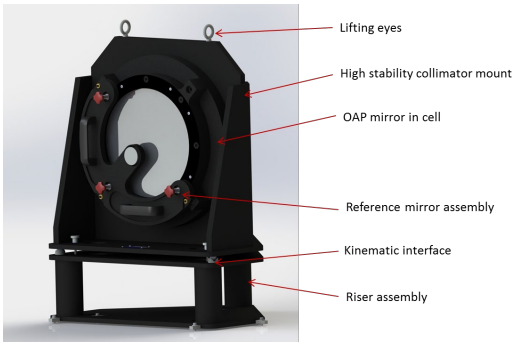


OG-1000 with OGA-140 Reprojection Assembly installed (shown on the FP-1100 Finite Conjugate Platform)



OG-1000 shown with kinematic riser assembly

REFLECTIVE COLLIMATORS WITH GUARANTEED SURFACE ACCURACY



The reflective collimator is used to project a source at infinity for testing of optical systems with one infinite conjugate. The projected beam from the collimator should overfill the entrance pupil of the optical system under test. This means that the clear aperture of the selected collimator should be larger than the entrance pupil of the system under test and should include some excess aperture for misalignment tolerances of the test setup.

Reflective collimators are the standard offered by Optikos. Each collimator is an off-axis parabolic mirror (OAP) with λ/8 (at 633nm) surface accuracy guaranteed after mounting and a protected aluminum coating for polychromatic testing. Each OAP is potted in a stiff high-stability mount and includes a kinematically seated reference mirror to be used during bench alignment. Most standard collimators are mounted with an axis at 500mm above the optical table.

Most OpTest benches include a fold mirror between the reflective collimator and the source, in order to reduce the overall footprint of the test bench. The size and location of the fold mirror to be used in a given system is determined by the collimator and other selected accessories.

Table 3. Reflective Collimator Model Numbers

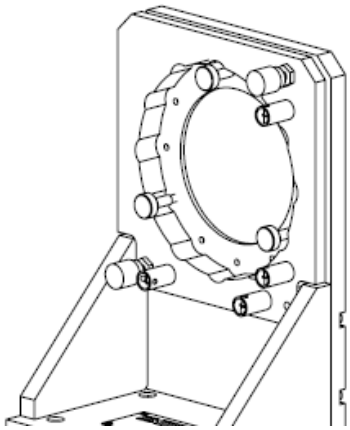
Model Name	Clear Aperture	Focal Length	Optical Axis Height	Footprint
OC-100	100 mm	1000 mm	500 mm	34 x 39 cm
OC-150	150 mm	1500 mm	500 mm	37 x 49 cm
OC-200	200 mm	2000 mm	500 mm	37 x 49 cm
OC-250	250 mm	2500 mm	500 mm	50 x 60 cm
OC-300	300 mm	3000 mm	500 mm	50 x 60 cm
OC-380	380 mm	3000 mm	500 mm	50 x 60 cm
OC-420	420 mm	3500 mm	500 mm	50 x 60 cm
OC-600	600 mm	6000 mm	580 mm	56 x 111 cm

Custom collimators with user-specified clear apertures and focal lengths can be provided. Contact Optikos for more information.

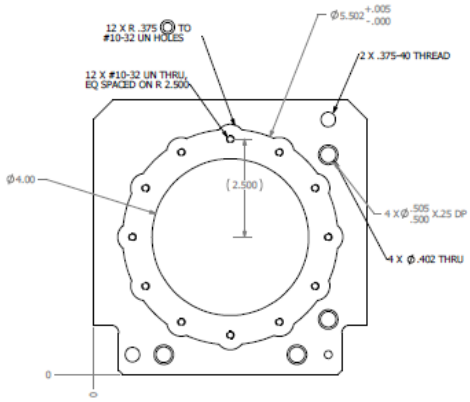
LENS MOUNTS: STURDY, STABLE MOUNTING FOR LENS UNDER TEST

LM-300 Tip/Tilt Lens Mount

Each OpTest system includes the standard LM-300 Tip/Tilt Lens Mount, a sturdy, stable mounting fixture for a lens under test. The LM-300 is bolted onto a carrier on the LP-1000 rotary platform, and the carrier slides along high precision steel linear rails with a long travel linear encoder, enabling the user to always know the location of the lens under test. Each standard OpTest bench is sold with one lens mount and a C-Mount adapter plate. Additional adapter plates and mounting options are available upon request.



LM-300 Tip/Tilt Lens Mount



LM-300 Bolt Pattern

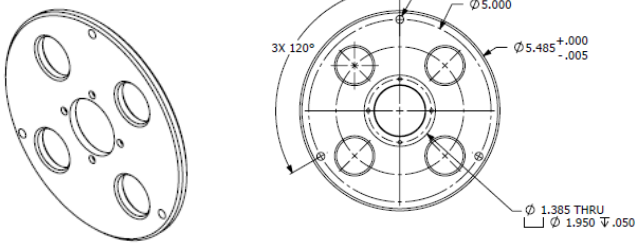
LM-300-XYZ Adjustable Tip/Tilt Lens Mount

When an OpTest bench is configured for finite conjugate testing, an adjustable version of the LM-300 Lens Mount is provided. This version has manual stages for positioning the lens under test along the X, Y and Z axes (100mm of travel along each axis) for precise alignment to the source at a finite object distance.

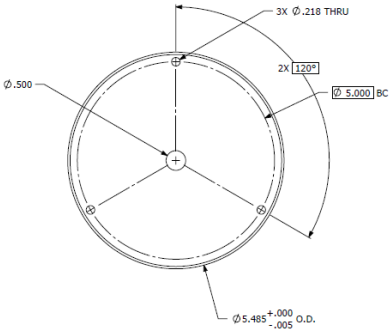
LM-300-XYZ Adjustable Tip/Tilt Lens Mount (shown mounted on LP-1000)

LM-300 Standard Lens Mount Adapters

Lens mount adapters are available for a variety of lens types, including both threaded lenses and bayonet-style lenses. The lens adapters generally consist of a circular plate with the appropriate lens mount features in the center of the plate and a set of holes near the circumference that allow the adapter plates to be installed into the LM-300 Lens Mount. Blank plates are also available, so that custom mounting features can be added as needed by the customer.



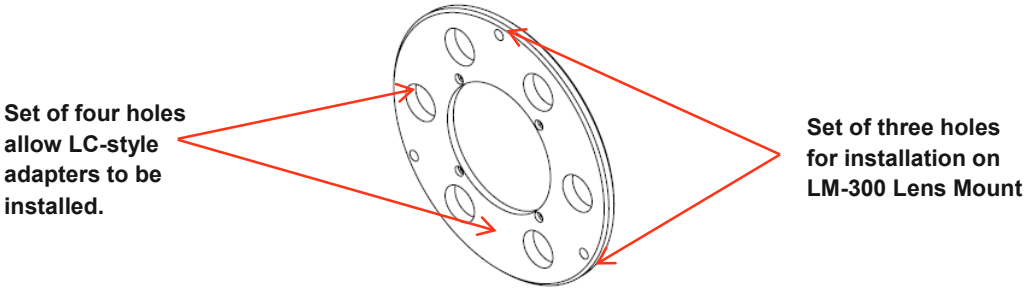
C-Mount Plate for LM-300



Blank Adapter for OpTest LM-300 Mount

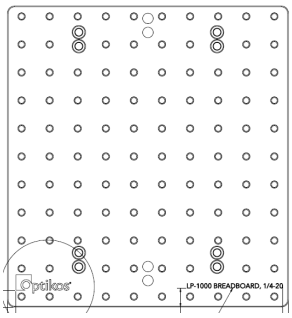
LensCheck™ Mounting Plate Adapter for LM-300 Lens Mount

The adapter plate shown below allows all LensCheck (LC) adapter plates to be installed on the LM-300 Tip/Tilt Mount.



OPT-LC-ADP Adapter for Using LensCheck Adapter Plates on the OpTest LM-300 Mount

Breadboard Plate for Custom Mounting Solutions



For customers requiring more flexible mounting options, Optikos offers a breadboard plate that installs directly onto the LP-1000 carrier and allows the customer to build their own mounting solution. The hole pattern on the breadboard plate can be either ¼”-20 or M6 tapped holes on 1” centers, and two sets of mounting holes are provided so that the hole pattern can either be centered or offset on the centerline of the LP-1000.

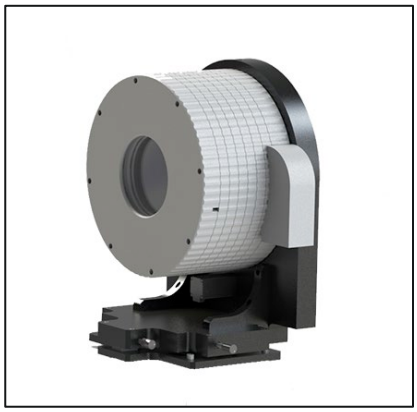
RM-1000 ROTARY LENS MOUNT

OpTest benches are designed to measure off-axis field points in a plane that is parallel to the surface of the optical table. These field points are accessed by rotating the lens under test about an axis that is perpendicular to the optical table. In order to access a field point that lies off of this plane, the field point must be brought into the measurement plane by rolling the lens under test about its the optical axis. In a typical laboratory setup this may be achieved by remounting the lens under test, but a more automated method is to make use of the RM-1000 rotary lens mount.

This assembly consists of a motorized annular roll stage mounted to a vertical plate. The user generally fabricates a suitable adapter plate for mounting the lens under test to the rotary stage. Either side of the rotary stage may be used for mounting. The choice often depends on the size, back focal distance, and mounting interface location for the lens under test.

RM-1000 System Specifications	
Total range of movement	±360°
Resolution	0.002°
Repeatability	0.005°
Inner Diameter	110mm
Load Capacity (Newtons)	36,000/(93+D)
Where D (in mm) is the distance from the center of the rotating annular ring mounting surface to the center of mass of the unit under test	

NEW THERMAL MODULE FOR TESTING LENS PERFORMANCE OVER TEMPERATURE



The Temperature Testing Modules enable the user to measure the same performance parameters as on a standard OpTest bench, but with the lens under test enclosed within an insulated chamber that can raise and lower the temperature of the lens. The modules can be installed directly on the LP-1000 carrier in place of the standard lens mount for easy integration with the rest of the OpTest system. The temperature of the module is controlled by an external recirculator (not shown).

The modules are especially well suited for measuring the change in the image location over the operating temperature range of the lens under test, and can be used to verify the performance of athermalized lens assemblies. Custom Invar mounting interfaces are provided with the Temperature Testing Module so that the mounting flange of the lens under test can be referenced outside of the chamber. This allows the flange focal length to be measured at various temperature points without needing to open the chamber to access the lens mounting flange directly.

See Thermal Module datasheet, or contact Optikos for more information.

LP-1000 LENS PLATFORM:
OFF-AXIS, HEAVY-DUTY PLATFORM FOR PRECISE, ANGULAR FIELD POINTS

It is impractical to rotate a long focal length collimator and source when illuminating an off-axis infinite conjugate field point, so OpTest uses the approach of fixing the collimator and rotating the lens instead. The platform on which the lens is mounted is the LP-1000 and, since the image analyzer must remain fixed with respect to the lens under test, it, too, is carried on the LP-1000. Optikos engineers utilized finite element analysis to design structural castings in the LP-1000 that maintain flatness when mounted to an optical table—improving on traditional rail systems that mount directly to the optical table and are vulnerable to bending to the shape of a less-precise optical table surface.

- Unique cable management system eliminates cables dragging on optical table which may introduce errors to centroid measurement routines (EFL, Distortion, Chief Ray Angle, Lateral Color, etc.)
- Main bearing surface is shielded to minimize exposure to contamination–a unique level of integration
- Lockable lens platform and image analyzer carriers ride on stainless steel linear guides aligned to granite master to ensure straightness
- Integrated linear encoder enables long flange and back focal length measurements

LP-1000 System Specifications	
Total Rotary Travel	±150°
Rotary Encoder	<0.1 arc second resolution
Free Linear Travel (optical rail)	750mm between lens mount carrier and image analyzer carrier
Linear Encoder Resolution	0.002mm
Software/Controls	
Remote Control (OpTest)	• Remote control via HC-1000 Handheld Controller • Native OpTest 7 software control • Full command set is freely available to allow users to write custom software or test macros
Mechanical	
Footprint	80 cm Diameter
Weight	77 kg
Maximum Load Capacity	80 kg

IMAGE ANALYZERS: FOR VIDEO AND SCANNING APPLICATIONS

Image Analyzers acquire the image formed by the optical system under test, converting the optical image into an electronic image of sufficient spatial resolution to be analyzed by OpTest 7 software. Optikos uses two types of image acquisition methods – video and scanning. The type of system most appropriate to a particular application depends on the type of optical system to be tested and the testing environment.

- A video image analyzer acquires the image by enlarging (magnifying) it onto an image sensor such as a CCD or microbolometer array.
- A scanning system acquires the image information by measuring the variation in the light level as an edge or slit is translated through the image plane.

Model Name	Waveband	Type	Sensor	Relay Lens	Output
VI-1010	400-1000 nm	Video	Sony ICX694 CCD (6MP)	40x 0.95 NA apochromat objective	12-bit video output
VI-2000	0.9 - 1.7 µm	Video	Uncooled InGaAs focal plane array	20X 0.40 NA NIR objective	Camera Link digital output
VI-4000	7.5 -13 µm	Video	Uncooled microbolometer	7.5x 0.70 NA objective	Camera Link digital output
SD-500	1 -5 µm	Scanning	Liquid nitrogen cooled InSb detector	Collects light from aperture at f-number up to 0.7	Low noise pre-amplified analog signal
SD-600	8 -12 µm	Scanning	Liquid nitrogen cooled HgCdTe detector	Collects light from aperture at f-number up to 0.7	Low noise pre-amplified analog signal
SD-800	1-5 µm	Scanning	Liquid nitrogen cooled InSb detector	Collects light from aperture at f-number up to 0.7 Incorporates a 90deg fold in relay lens path for testing folded lens systems	Low noise pre-amplified analog signal
SD-900	8-12 µm	Scanning	Liquid nitrogen cooled HgCdTe detector	Collects light from aperture at f-number up to 0.7 Incorporates a 90deg fold in relay lens path for testing folded lens systems	Low noise pre-amplified analog signal
SD-100-UV	200-400 nm	Scanning	UV sensitive Photomultiplier Tube	Collects light from aperture at f-number up to 0.7	Low noise pre-amplified analog signal

VideoMTF® Image Analyzers

A focal plane array or image sensor-based system using the VideoMTF Image Analysis Module will perform the image scanning quickly and allow you to directly view the image. This speeds up and simplifies the system set-up since both the image location and the plane of best-focus can be determined quickly.

VI-1000 Visible Image Analyzer (400-1000nm)

- Spectral responsivity, 400-1000nm
- Switch between electronic imaging and direct manual viewing of the image spot using integrated flip-mirror assembly
- Apochromatic tube lens; high-sensitivity camera, 12-bit video output
- Uses plan apochromat, high NA Nikon objectives as relay lens (sold separately)

VI-2000 SWIR Image Analyzer (900-1700nm)

- Spectral responsivity, 900-1700nm
- Integrated flip-mirror assembly included for viewing of image using visible light
- Custom designed tube lens; high-sensitivity camera, Camera Link digital video output
- Uses Mitutoyo NIR objectives as relay lens (sold separately)

VI-4000 LWIR Image Analyzer (7.5 – 14µm)

- Uncooled microbolometer
- Spectral responsivity 7.5 – 14µm
- 320x240 resolution
- Calibrated LWIR objective lens
  - 7.5x magnification
  - NA 0.70

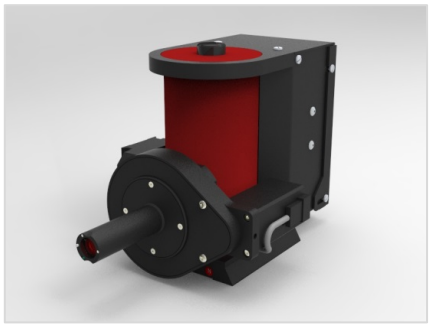
VI-1010 Visible Image Analyzer (shown without relay lens)

VI-4000 LWIR Video Image Analyzer and Relay Lens

EROS™ Image Analyzers – Three Standard Models Feature Various Spectral Responses

A knife-edge scanning system is inherently more flexible for testing a wider range of optical systems. There is a larger variety of single element detectors available compared with array detectors. Collection and relay optics do not need to provide the image quality that is required by video analysis. With the EROS Image Analyzer, relay optics collect light from the test optic's image plane and project it onto the detector. The sampling resolution is determined by the mechanical step size of the stages that carry the image analyzer.

SD-500 SWIR/MWIR Scanning Image Analyzer (1 – 5.5µm)



- Comprised of a SWIR/MWIR detector, relay optics, scanning aperture set, and ultra-compact, motorized rotary assembly (to switch the direction of the analyzing aperture between tangential and sagittal scanning)
- Unique geometry of the SD-500 enables measurements at image planes recessed up to 56mm with its <19mm diameter probe
- Detector assembly is an LN2-cooled InSb detector (1 to 5.5 µm range) with matched preamplifier and temperature sensor built into the 8-hour hold time dewar
- Multi-element relay lens collects light from scanning aperture at an f-number up to 0.7
- Scanning aperture set includes a 2.5µm nominal slit and a knife-edge, both metal film on sapphire substrates.

SD-600 LWIR Scanning Image Analyzer (7 – 13µm)

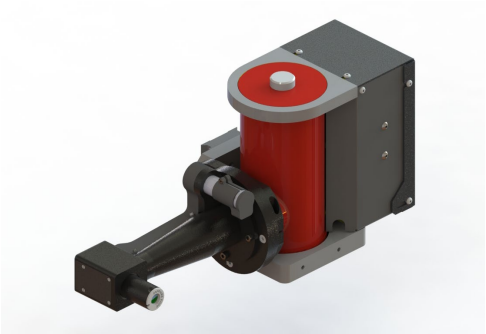
- Comprised of a LWIR detector, relay optics, scanning aperture set, and ultra-compact, motorized rotary assembly (to switch the direction of the analyzing aperture between tangential and sagittal scanning)
- Unique geometry of the SD-600 enables measurements at image planes recessed up to 56mm with its <19mm diameter probe
- Detector assembly is an LN2-cooled HgCdTe detector (7-13 µm sensitivity) with matched preamplifier and temperature sensor built into the 8-hour hold time dewar
- Multi-element relay lens collects light from the scanning aperture at an f-number up to 0.7
- Scanning aperture set includes a slit and a knife-edge, both metal film on ZnS substrates

SD-100-UV UV Scanning Image Analyzer (2200 – 5400nm)

- Composed of a UV detector, relay optics, scanning aperture, and preamplifier
- A novel scanning aperture design allows simultaneous tangential and sagittal scanning.
- Detector assembly is an ultra-sensitive Photo-multiplier tube with responsivity from 220-500nm.
- Multi-element relay lens collects light from the scanning aperture at an f-number of 0.7.
- Scanning aperture is metal film on UV grade fused silica substrate.

NEW *EROS™ Image Analyzers for Testing Folded Optics*

These two newly designed assemblies provide additional flexibility when measuring folded lens assemblies with recessed or obscured image plane locations.



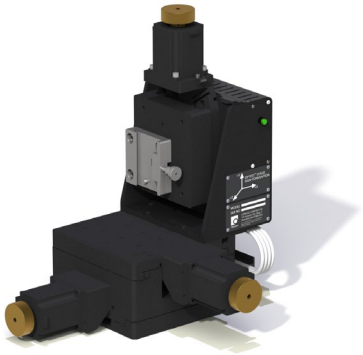
SD-800 SWIR/MWIR Scanning Image Analyzer (1 – 5.5µm) for Folded UUTs

- Comprises a SWIR/MWIR detector, relay optics, incorporated fold mirror, scanning aperture set, and ultra-compact, motorized rotary assembly
- Precision aligned internal fold mirror in the SD-800 allows access to difficult to reach image planes in complex folded optical assemblies. Able to reach recessed image planes up to 25mm and reach around features up to 120mm
- Flexible design enables detector snout to be rotated to four different folded testing orientations: up, down, left and right enabling measurements on a wide range of optomechanical designs
- Custom motor design rotates scanning aperture for automated measurements in tangential and sagittal directions
- Fully configurable software package able to readjust coordinate systems and stage axes to adapt to the folded test configuration of the SD-800
- Detector assembly is a LN2-cooled InSb detector (1 – 5.5 µm sensitivity) with matched preamplifier and temperature sensor built into the 8-hour hold time dewar
- Multi-element relay optics collects light from the scanning aperture at an f-number up to 0.7
- Scanning aperture set includes a slit and a knife-edge, both metal film on sapphire substrates
- Maintains all functionality of the non-folded SD-500

SD-900 LWIR Scanning Image Analyzer (7 -13µm) for Folded UUTs

- Comprises a LWIR detector, relay optics, incorporated fold mirror, scanning aperture set, and ultra-compact, motorized rotary assembly
- Precision aligned internal fold mirror in the SD-900 allows access to difficult to reach image planes in complex folded optical assemblies. Able to reach recessed image planes up to 25mm and reach around features up to 120mm
- Flexible design enables detector snout to be rotated to four different folded testing orientations: up, down, left and right enabling measurements on a wide range of optomechanical designs
- Custom motor design rotates scanning aperture for automated measurements in tangential and sagittal directions as well as measuring astigmatism
- Fully configurable software package able to readjust coordinate systems and stage axes to adapt to the folded test configuration of the SD-900
- Detector assembly is a LN2-cooled HgCdTe detector (7 - 13 µm sensitivity) with matched preamplifier and temperature sensor built into the 8-hour hold time dewar
- Multi-element relay optics collects light from the scanning aperture at an f-number up to 0.7
- Scanning aperture set includes a slit and a knife-edge, both metal film on ZnS substrates
- Maintains all functionality of the non-folded SD-600

AM-1000 IMAGE ANALYZER MOUNT: FOR ACCURATE POSITIONING OF LENS UNDER TEST



The AM-1000 positions the image analyzer at the image plane of the lens under test, and defines the following three-axis convention in the image space of the lens under test:

- X adjusts the lateral image height parallel to the optical table
- Y adjusts the image height perpendicular to the optical table
- Z is the focus adjustment along the optical axis

The AM-1000 employs the proprietary Optikos Motion Control system in which intelligent motion control circuitry is integrated with the module, and all calibration parameters are stored locally.

System Specifications		
X Stage (Off-Axis Stage)	100 mm travel	50 nm resolution
Y Stage (Vertical Stage)	50 mm travel	50 nm resolution
Z Stage (Focus Stage)	100 mm travel	50 nm resolution
Software/Controls		
Remote Control (OpTest)	Remote control via HC-1000 Handheld Controller Native OpTest 7 software control Full command set is freely available to allow users to write custom software or test macros	

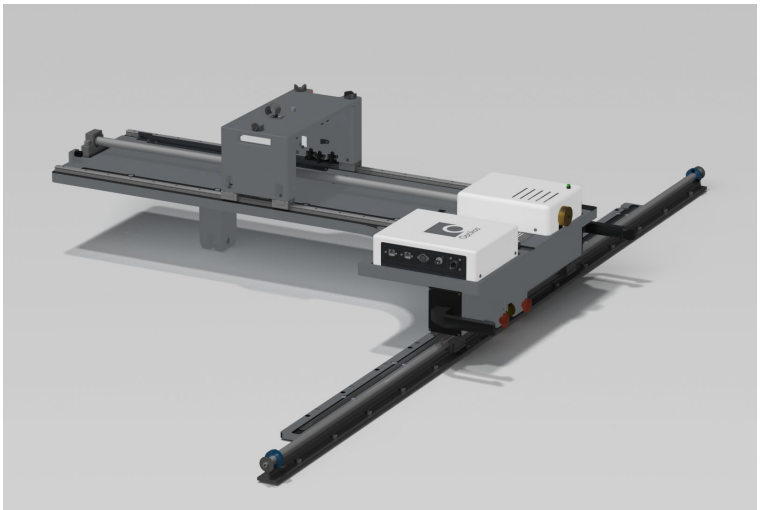
HC-1000 HANDHELD CONTROLLER FOR HARDWARE CONTROL AT YOUR FINGERTIPS

It is typical for a test bench with the Optikos Motion Control (OMC) System to include a PC running OpTest7 as well as an HC-1000 handheld controller. The HC-1000 provides remote access to a variety of functions that are primarily accessed through the main OpTest 7 window, allowing the user to manipulate the test bench even when they're away from the computer.

- Remote control and position display of all OMC axes
- Remote control of OG-1000 series object generators
- Lock in amplifier signal level display
- Flashlight function for working in darkened laboratories
- Emergency stop button for all axes
- Ability to reverse the directional behavior on any pair of tactile controls
- Two easily programmable waypoints for returning all axes to a defined position with a single button press

Mechanical Specifications	
Footprint	11.5 x 22 cm
Weight	0.9 kg

FINITE CONJUGATE PLATFORM: FOR TESTING AT FINITE OBJECT DISTANCES



Not all lenses may be tested with an infinite conjugate. In these cases it is necessary to employ the FP-1100 Finite Conjugate Platform. This assembly includes a kinematic interface for the object generator and an orthogonal system of long travel linear bearings that together may be used to set the object height and object distance for testing. The transverse axis on the FP-1100 is motorized and includes a linear encoder, while the object distance is set manually and then locked in position. A threaded fine-adjustment is provided and a second linear encoder runs the length of travel.

The FP-1100 may be used alone or it may share the optical table with a collimator setup. Because of its kinematic seating arrangement, the same OG-1000 series object generator may be shared between the collimator and the FP-1100. Even when performing finite conjugate testing, the LP-1000 lens platform (see below) is still used to carry the lens mount and the image analyzer. In this case, the object distance may be found from the sum of the FP-1100 linear encoder and that on the LP-1000 rotor.

- Integrated Optikos Motion Control system minimizes cabling and provides control of object height from Optest7 and from the HC-1000 Handheld Controller.
- Adjustable stops on z-axis rail.
- Energy chain on transverse axis neatly handles all Object Generator cabling.
- Low carrier height ensures that there is no beam shadowing with any standard Optikos collimator when the two assemblies share the same bench.

System Specifications		
Object Height	900 mm total travel	2 µm resolution encoder
Object Distance (set manually)	1400 mm total travel	2 µm resolution encoder
Mechanical		
Platform footprint	61cm x 122 cm	
Rail footprint	12 cm x 215 cm	
Recommended Accessories		
OGA-140 Reprojection Assembly for OG-1000 series (visible only) LM-300-XYZ Adjustable Lens Mount		

AF-1100 AFOCAL MODULE FOR AFOCAL LENS MEASUREMENTS

The AF-1100 is an accessory to the LP-1000 that is essential when the lens under test does not form a real image. In these cases, it is necessary to introduce an auxiliary “de-collimating lens” into the path of the collimated output in order to form a real image for analysis. In order to minimize the contribution of the de-collimating lens to the MTF being measured, it is necessary to ensure that it is only ever used on axis.

In other words, the axis of the de-collimating lens and the image analyzer must follow the chief ray of the afocal lens under test. This requires a second rotation in addition to that needed in order to set the field angle for the measurement in the first place, and it is this second rotation that is introduced by the AF-1100 Afocal Module riding on the lens carrier of the LP-1000. The parameters of the lens under test are used by OpTest7 to report how the lens and AF-1100 should be arranged. Of particular importance is the separation between the two axes of rotation and the placement of the de-collimating lens at the location of the exit pupil of the lens under test. The correct setup minimizes the walk of the entrance pupil of the lens under test in the collimated beam.

- Compatible with inverting and non-inverting afocal lenses
- Well defined platform interface for users to design their own lens mounts
- Well defined bridge interface for the placement of external pupils and de-collimating lenses
- Comes standard with adjustable diaphragm aperture and 50mm de-collimating lens suitable for many visual instrument measurements.
- Alignment mode implemented in OpTest7 helps locate external exit pupil plane during lens setup.

System Specifications	
Angular Range	±60° from nominal home position
Angular Accuracy	±0.0075°
Encoder	0.001° resolution
Centered Load Capacity	150 kg
Mechanical	
Footprint	25.4cm x 47cm
Weight	20 kg

OPTEST® 7 SOFTWARE POWERS OPTEST METROLOGY BENCHES AND LENSCHECK INSTRUMENTS

At its core, OpTest 7 is a software application that integrates with all OpTest and LensCheck systems to control electronic hardware assemblies and motorized motion elements, to acquire and analyze video and scanning detector signals, and to present the measurement results to the user in a graphical manner. OpTest 7 runs under Windows 7 and includes a licensed version of Microsoft Excel with each installation. All measurement data may be exported directly to formatted Excel workbooks for easy inclusion in customer reports, etc.

Sophisticated measurements for a wide range of users

OpTest 7 not only makes a sophisticated measurement technique accessible to a wide range of users, but also ensures that application endures across future generations of operating systems by carefully considering the underlying architecture—adopting the latest Microsoft® programming environments, and coding the graphical user interface separately from the application.

OpTest® 7 includes Python™ scripting and support for new OpTest modules

The OpTest 7 flexible platform allows a wide range of measurements; and now includes Python™ scripting using an integrated editor, while maintaining OLE support through a COM object in legacy programming environments, such as Microsoft Excel VBA. OpTest 7 also supports the new OpTest Finite Conjugate and Afocal Modules.

Easily select the interface to match your information requirements

OpTest software was originally designed for engineers and presented a single interface to the operator—with all of the sophistication of the controls and processing functions exposed to anyone using the software. OpTest 7 features operating modes that are designed to match the requirements and technical sophistication of various users. This makes OpTest 7 a powerful laboratory tool in Engineering Mode, while at the same time ensuring that manufacturing operators are comfortable using it in Production Mode. Whereas earlier versions of OpTest required the use of separate macros to make measurements of focal length, field curvature, etc.,

OpTest 7 is able to measure many first order parameters (such as focal length, field curvature, etc.) is included in in a manner that makes the setup and execution easy to understand. It allows you to easily perform sequences of measurements without the need for macros, and to extract many of these measurements from a single data structure. OpTest 7 also includes the option to make intelligent choices about camera gain, exposure, sample reticule width and more without asking the operator to make these choices.