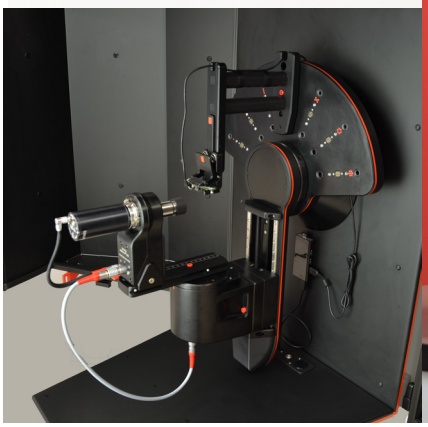
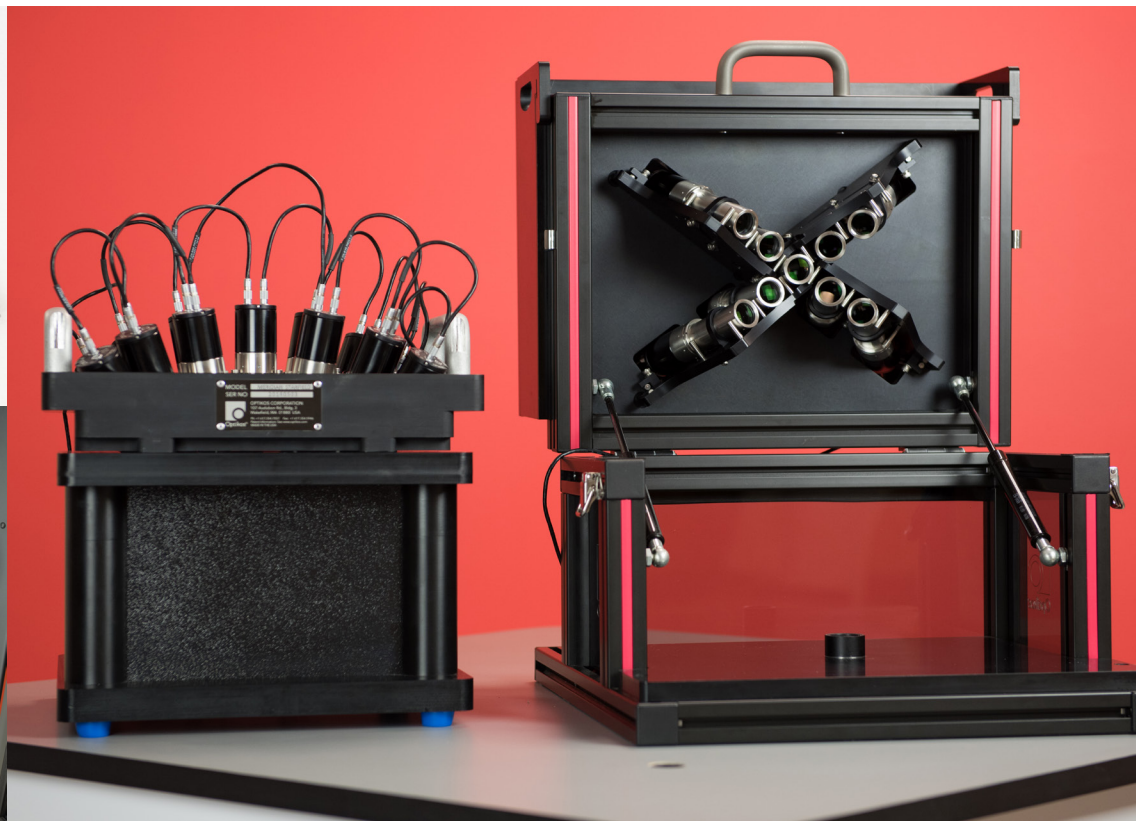
Optikos®

The Optical Engineering Experts®

Meridian® Family

Camera Testing Solutions





Optikos®

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Meridian® Product Family: Configurable and Compact Camera Testing Solutions

Short focal length small aperture cameras are everywhere you look, proliferating in cell phones, web cams, personal recording devices, drone surveillance systems, and of course, automobiles. Heightened consumer expectations regarding high quality imaging performance and the use of many cameras in automotive safety systems have established a need for high performance test equipment for these devices that did not exist just a few years ago.

The members of the Meridian family have this in common: they can generate fields of virtual objects in a compact space, obviating the need to place enormous test targets at a large distance. Wide field cameras need ever wider test targets, and there comes a point at which printed targets can no longer serve the need. Stray light measurements are also of growing importance to our Meridian customers, and printed targets are not an appropriate test solution. The newest additions to the Meridian family – the Brightfield and the Sunfield – address this need.

Target Projectors and Platforms

Optikos offers a wide variety of target* projectors that can be purchased separately as object generators to be built into your unique test setup, or incorporated into a larger Meridian system.

	Sold Individually	Starfield	Flex	Sunfield	Brightfield
Static Target Projectors (STPs) Image Quality	X	X			
Focusing Target Projectors (FTPs) Image Quality	X	X	X		
SOL Projectors Glare Spread Function/Image Flare	X		X**	X	
Light Trap Objects Veiling Glare Index					X

** We use the term "target" to refer to the patterned object such as a slit or crossedge that is being projected.*

*** Under development*

The Optikos Experience – Confidence In Your Optikos Product Purchase

We're obsessive about making sure that the system or projector that you purchase is suitable for your application. Customers are frequently surprised at the amount of analysis and modelling we perform before even issuing a quote. We take all the information you can provide us and figure out the target projector model and configuration that is best going to serve your needs.

Information we'll request about your device under test (DUT) includes focal length, f-number, radial distortion profile, and pixel size. When configuring Starfields for wide angle cameras we will also need to know something about the pupil distortion of the lens. In many cases, customers are able to simply provide us with lens drawings or black-box optical design models.

We then ask questions about the test setup: What field angles are required? What spectral content is needed? Is there a minimum working distance? And if your own software is analyzing the image for MTF, how many pixels are required along a slanted edge in the image?

We then find a projector configuration that ensures you get the image size required, unvignetted at the specified working distance, and of sufficient fidelity as to be certain that that projector is not adversely contributing to the measured MTF at the spatial frequency of interest.

Visible and NIR Static Target Projector (STP) Types and Specifications

Meridian visible and near infrared STPs are fixed focus optical target projectors that provide a virtual object for accurate image quality testing of cameras. STPs are available as standalone devices or integrated as clusters in Meridian Starfield systems. Optikos STPs are known for using precision machined components and proprietary assembly techniques that ensure accurate boresighting of the target to the outer barrel, and we use our ColliMeter™ technology for measuring collimation to set the object distance to the desired value - infinity or closer. Because of the precision with which boresighting, collimation, and target clocking are set, visible and NIR STPs must be factory configured.

STPs are designed to provide a smooth user experience and minimize the effort required to start testing. The brightness of each unit is linearly controlled by an embedded microcontroller that may be programmed to simply turn on a preset level while also responding to instructions issued over a daisy-chained serial bus. A single interface box can control a large number of STPs in series, each of which is assigned a unique address within the assembly. Factory calibration data for the source is stored within the device, so everything is plug and play. Machined features on the barrel make installing and removing the STPs simple and repeatable.

STPs are offered in a range of clear apertures and Effective Focal Lengths (EFLs) to accommodate a wide range of cameras. The LED source can be configured with various LED color temperatures or NIR and visible wavelengths. The standard target option is a high contrast, crossedge target but custom targets are available upon request. When built into a full-field Starfield configuration, STPs located off-axis can be assembled with pre-distorted targets (designed with a proprietary method) to reverse the lens distortion and produce a slanted edge image that will provide accurate MTF results even with large distortion values.

STPs can be sold individually to be integrated into each customer's test setups, or can be sold as part of a Meridian Starfield camera test system.

When sold individually, STPs are usually shipped with the following accessories:

- USB Interface box and 9VDC power adapter for establishing RS-485 + power bus
- USB Cable for computer connection
- 2-Meter long power + RS-485 bus cable from STP to interface box
- Benchtop cradle stand
- Thumb drive with demo control application, manual, and instruction set documentation
- Storage case

Specifications

STP Type	STP-035	STP-050	STP-075	STP-080	STP-102	STP-177
Nominal Focal Length (mm)	35	50	75	80	102	177
Clear Aperture (mm)	11	23	23	38	24	45
Standard Target Pattern Diameter (mm) **Custom options available*	9.5	9.5	5.6	14	10	24
Standard Target Diameter (°)	15.5	10.8	4.3	10.0	5.6	7.8
Typical Working Distance (mm)	30	70	140	140	120	200
Object Distance Uncertainty (diopters)	±0.010	±0.005	±0.003	±0.003	±0.002	±0.001
Mechanical Boresight (°)	<0.05° *(for targets with defined center features)*					
Target Geometries	Orthogonal crossedge (standard) Predistorted crossedge Single edge Crosshair					
Target Contrast Ratio	1000:1 (standard) 4:1 (optional)					
White LED Source CRI Options	4500K or 6500K *(standard options)* 3000K, 3500K, 4000K, 5000K, 5700K or NIR LEDs available					
LED Color Options	635nm, 940nm typical. Enquire about other options.					
Source Lifetime	>50,000 hours @ 50%					
Interface Bus	RS485 (9600 baud), 9VDC					
Power Supply Input Voltage	100 to 240 VAC					
Operating Temperature	10-40 °C					
Operating Humidity	30-60% *(non-condensing)*					

All specifications subject to change.

These examples show popular configurations for each STP Family. Many other options are available. Contact sales@optikos.com for more information.

STPs can be provided as standalone target projectors or as part of a Meridian Starfield system. Optikos product engineers are available to discuss your requirements and configure an appropriate solution for your unique metrology needs.

Long Wave Infrared Static Target Projector (LWIR STP) Specifications

This static target projector is the most recent addition to the Meridian family and has been designed specifically to serve the needs of the burgeoning automotive thermal camera industry. Although the projected object distance is fixed, this projector differs from the visible and NIR products by offering both user configurability and on-board controls.

At the heart of the LWIR STP is an extended blackbody source that may be set to the desired temperature either from a computer over the power+RS485 interface bus, or directly from the three-button interface on the rear panel where the actual source temperature is also displayed. An aperture target at ambient ("background") temperature mounted in front of this source is collimated by a germanium objective lens. Since the source and target temperatures are both monitored continuously, the source temperature control mode may be set to either absolute or differential behavior.

A key feature of the LWIR STP is that both collimator barrels and target assemblies may be interchanged, enabling the user to configure the projector according to the camera type to be measured.

As is the case with the visible and NIR STP family, an array of LWIR STPs may optionally be configured by Optikos in a Starfield mount at field angles specified by the customer.

When sold individually, LWIR STPs are usually shipped with the following accessories:

- USB Interface box and 36VDC power adapter for establishing RS-485 + power bus
- USB Cable for computer connection
- 3-Meter long power + RS-485 bus cable from LWIR STP to interface box
- Benchtop cradle stand
- Thumb drive with demo control application, manual, and instruction set documentation
- Storage case

Specifications

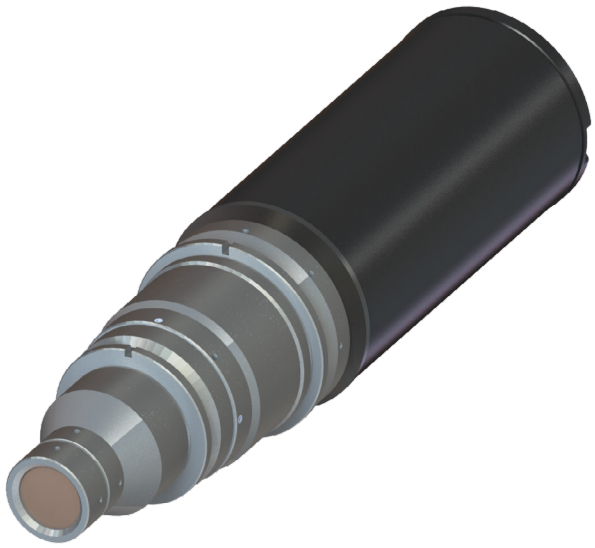
Specifications	
Nominal Focal Length **other options in development*	127mm
Clear Aperture (mm) **other options in development*	33mm
Maximum Standard Target Pattern Diameter (mm)	25mm
Object Distance Uncertainty (diopters)	±0.010
Mechanical Boresight (°)	<0.25° (for targets with defined center features)
Mechanical Boresight (°)	<0.25° (for targets with defined center features)
Target Geometries	Orthogonal crossedge (standard) Predistorted crossedge Single edge Crosshair
Source Temperature	Ambient to 70°C
Interface Bus	RS485 (9600 baud), 36VDC
Power Supply Input Voltage	100 to 240 VAC
Operating Temperature	10-30 °C
Operating Humidity	30-70% (non-condensing)

All specifications subject to change.

Focusing Target Projector Types and Specifications

The FTP provides a convenient means of placing a virtual standard target over a wide range of apparent object distances in a compact space for the purpose of performing MTF testing of small cameras. This functionality enables the test engineer to perform testing over a range of conjugates and to perform through-focus resolution testing of fixed-focus cameras in a compact space. Our patented drive scheme (patent numbers 11089292, 11689711) enables us to achieve a high degree of straightness of travel of the center of the projected target, and linear output encoders ensure accurate positioning of the target. All units are factory aligned and calibrated and all calibration information is stored in the device, which means that an FTP can be plugged in and used right away.

FTPs are available with different focal lengths and clear apertures to accommodate DUTs of different sizes and with varying object distance and working distance requirements. Standard FTP configurations have an orthogonal, low contrast, crossedge targets, but custom target options are available. FTPs can be assembled with white LEDs sources of different color temperatures, or with narrowband visible or NIR LEDs.



When sold individually, FTPs are usually shipped with the following accessories:

- USB Interface box and 12VDC power adapter for establishing RS-485 + power bus
- USB Cable for computer connection
- 3-Meter long power + RS-485 bus cable from FTP to interface box
- Benchtop cradle stand
- Thumb drive with demo control application for setting brightness and object distance, manual, and instruction set documentation
- Storage case

Specifications

Focusing Target Projector Specifications					
FTP Type	**FTP-018**	**FTP-039**	**FTP-064**	**FTP-102**	**FTP-153**
Nominal Focal Length (mm)	18	39	64	102	153
Clear Aperture (mm)	8	14	23	23	38
Standard Target Pattern Diameter (mm)	4	5	8	10	10
Standard Target Diameter when Collimated (°)	12.6°	7.3°	7.1°	5.6°	3.7°
Standard Target Contrast Ratio	20:1				
Closest Virtual Object Distance (m) *w.r.t. FTP forward flange*	0.025	0.05	0.35	0.80	1.70
Closest Real Object Distance (m) *w.r.t FTP forward flange*	-0.10	-0.30	-0.60	-1.20	-2.50
Maximum Time to Traverse Entire Adjustment Range (s)	5				
Object Distance Uncertainty at Infinity (diopters)	0.04	0.01	0.005	0.002	0.002
Object Distance Uncertainty at Closest Object Setting (diopters)	0.10	0.04	0.03	0.03	0.02
Maximum Infinity Boresight Deviation of Target Center *w.r.t. FTP mounting Features* (°)	0.04	0.04	0.02	0.01	0.01
Maximum Deviation of Target Edge from Notch in Mounting Flange (°)	0.5	0.5	0.5	0.5	0.5
LED Source Color Pptions	White LED (3000K, 3500K, 4000K, 4500K (standard), 5000K, 5700K, 6500K), 940nm IR LED				
Source lifetime	>50,000 hours @ 50%				
Interface bus	R485 (9600 Baud), 12 VDC				
Power supply input voltage	100 to 240 VDC				
Operating temperature	10-30°C				
Operating humidity	30-70 °C non-condensing				

All specifications subject to change.

Custom options available – contact sales@optikos.com for more information.

FTPs can be provided as standalone target projectors, as part of a Meridian Starfield system or as part of a Meridian FLEX. Optikos product engineers are available to discuss your requirements and configure an appropriate solution for your unique metrology needs.

Sol Projector and Specifications

The Meridian Sol-55 projector is a modular light source that serves as the stimulus when measuring the glare spread function (GSF) of camera assemblies. GSF is a measure of how much light from a bright source in or out of the field of view of the camera reaches other locations of the image (think of the image flare when the sun is in the field of view of a camera). The path that this "stray light" takes typically includes ghost imaging and scattering from optical and non-optical surfaces. The Sol-55 projector provides a laboratory and production floor source for characterizing GSF.

The Sol-55 was thoughtfully designed to incorporate the following features:

- Interchangeable object aperture drawers to achieve a specific object angular extent. Drawers are color coded and identifiable via a 2-wire EEPROM which is read by the Sol-55 projector when inserted and which may then be passed on to the system computer to verify the configuration.
- Source aperture wheel for controlling the lateral extent of the illumination at the DUT, thereby minimizing the effects of light scattered outside of the DUT on the measurement
- Careful baffling and special coatings inside the barrel to control any light reflected back into the lens barrel
- Factory installed color coded spacers for setting the working distance (the distance at which the source aperture – not the object aperture! – is re-imaged onto the DUT)
- Removable front objective lens for ease of cleaning to reduce scattered light from surface contamination
- High power white LED source with intensity control via a serial RS485 interface

When sold individually, Sol projectors are usually shipped with the following accessories:

- Ethernet Interface box and 18VDC power adapter for establishing RS-485 + power bus
- Ethernet Cable for computer connection
- 3-Meter long power + RS-485 bus cable from Sol projector to interface box
- Benchtop cradle stand
- Thumb drive with demo control application, manual, and instruction set documentation
- Storage case

Specifications

Sol-55 Projector Specifications	
Objective Lens Nominal Focal Length (mm)	120
Objective Clear Aperture (mm)	37
Maximum Object Aperture Diameter (mm)	10
Apparent Object Distance	Infinity (collimated)
Minimum Working Distance (for focused illumination aperture) (mm)	100 (must be factory configured)
Typical Working Distance Range (mm)	100-300
Illuminator	White LED, 3500K
Outside Diameter (mm)	55
Length (mm)	270
Mass (g)	850
Interface bus	RS485 (9600 baud), 18VDC
Maximum Projectors in a Single Daisy Chain	20
Power Supply Input Voltage	100 to 240 VAC
Operating Power Requirements	36VDC, 200mA
Operating Temperature	10-30 °C
Operating Humidity	30-70% (non-condensing)

All specifications subject to change.

**Custom Sol projector designs available – contact sales@optikos.com with your DUT requirements.*

The Sol-55 projector is also offered with factory-installed fixed apertures for use cases in which the projector requirements are not likely to change. The fixed source aperture version also accommodates a larger source aperture than the aperture wheel version, which may be necessary for some larger camera systems.

Sol projectors can be quoted as standalone target projectors, or as part of a Sunfield system. Optikos product engineers are available to discuss your requirements and configure an appropriate solution for your unique metrology needs.

Meridian Starfield Platform Specifications

A Meridian Starfield is a rigid assembly of multiple target projectors that together cover the field of view of the DUT by simultaneously projecting test targets from all prescribed field angles. This type of system is a compact and highly accurate solution for end-of-line camera testing or for performing active alignment of camera assemblies in high volume production environments.

Target projectors used in a Starfield assembly may either be Static Target Projectors (STPs), Focusing Target Projectors (FTPs), or a combination of both types.

Meridian Starfields are designed according to each customer's specific requirements. The Starfield mount consists of a thick plate into which precision bores are machined to receive the target projector barrels together with quasi-kinematic location features to interface with the customer's test station. This allows for consistent and repeatable testing of field points.

In cases where the DUT lens has a significant amount of distortion, the edges of a crossedge target for an off-axis projector may end up tilted significantly relative to the sensor array, producing undersampled MTF results. When provided with a customer's camera lens prescription or black box model, Optikos can predistort the off-axis target design to compensate for the distortion in the lens.

A Meridian Starfield System Includes:

- Target projectors installed in mechanical mount
- Interface box assembly and bus cable
- Protective cover

Specifications

Starfield Platform Specifications	
Number of Target Projectors	1 to 98 (9 and 13 are most common)
Target Projector Pointing Accuracy w.r.t line of sight of on-axis target projector (°)	Semi field angles <25: ±0.05 of nominal Semi field angles <40: ±0.1 of nominal Semi field angles <60: ±0.2 of nominal
Typical Dimensions (mm)	420 W x 230 D x 195 H
Typical Mass (kg)	17
Power Requirements	See STP or FTP specifications

In the case when the customer needs assistance with the image analysis, Meridian Starfield systems can be provided with the Meridian Prime software. The Meridian Prime software provides the following functions:

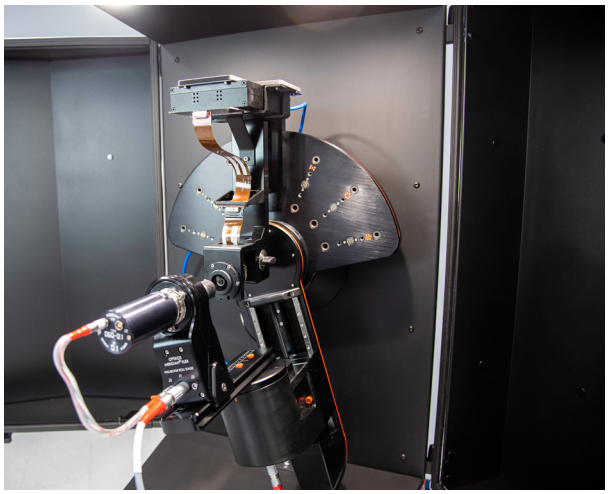
- Control of all connected target projectors
- Simultaneous horizontal and vertical MTF measurements at multiple field points in a single frame
- User definable regions of interest for sampling edge images
- Camera Line of Sight (LOS) and roll relative to the camera housing (requires alignment of the DUT nest to the Starfield
- Analysis of static images or batch processing of multiple images
- Quasi- realtime image analysis through shared folder handoff of image files
- Realtime video interfacing for certain video formats and camera manufacturers
- Customizable versions for interfacing to customer's unique video formats on request

Meridian FLEX Platform Specifications

The Meridian FLEX is a floor-standing configurable camera testing platform for small pupil, wide field of view cameras. At the heart of the Meridian FLEX is a high-speed high-precision robot that can place a target at any specified field point in a variety of different instrument configurations, making it a test system flexible enough for R&D labs while fast enough for modest production testing.

Features of the Meridian FLEX platform include:

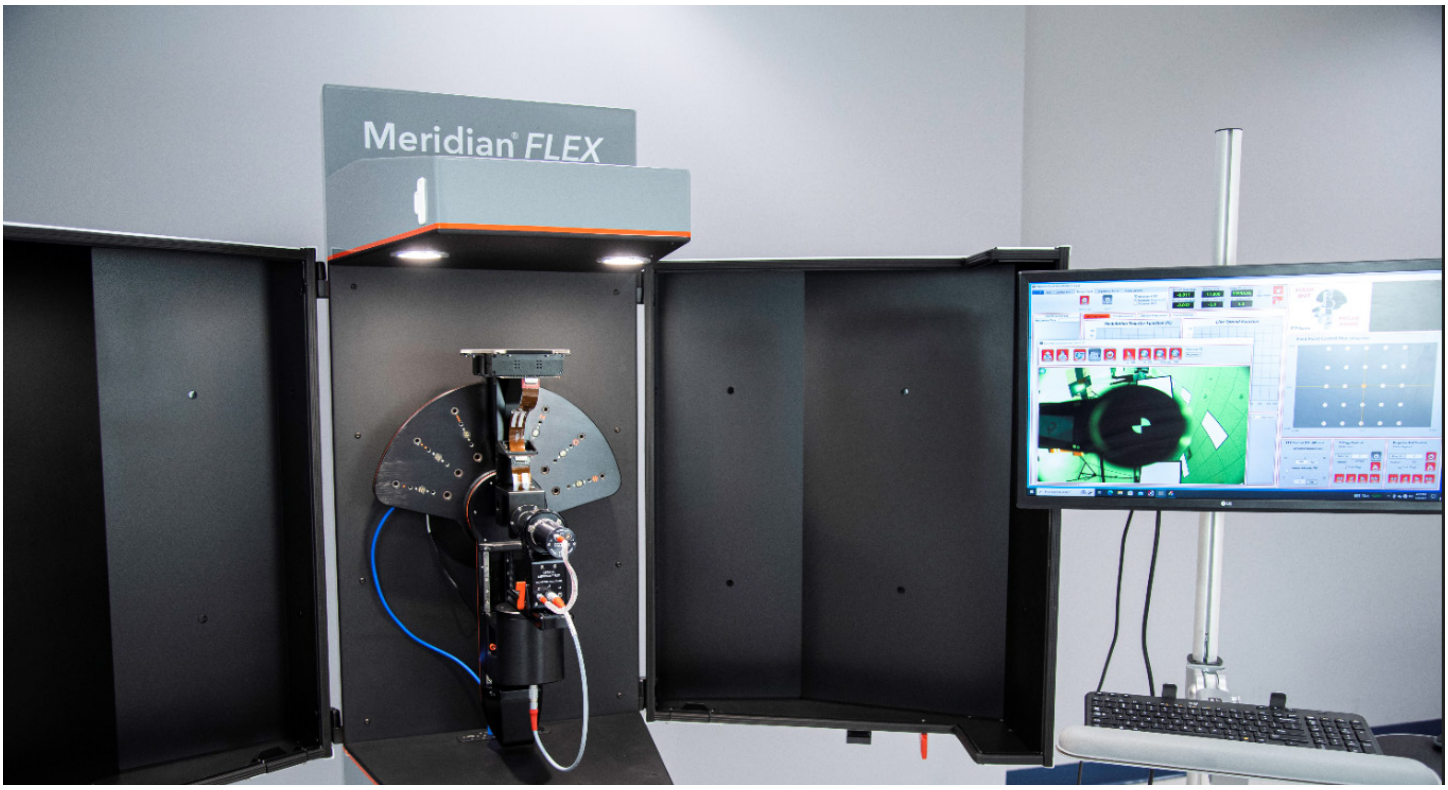
- Standard testing source is a Focusing Target Projector (FTP), and the operator can easily switch between different FTP types to accommodate different DUTs
- Latching enclosure doors to provide a dark environment for testing and to ensure operator safety
- Motorized adjustable height setting for the comfort of different operators
- Measurement of horizontal and vertical MTF and through focus MTF across the field
- Measurement of intrinsic parameters (focal length, geometric distortion coefficients)
- Standard base for holding the DUT can accommodate custom DUT nests and camera interface electronics



Specifications

Meridian Flex Specifications	
Typical Measurement Speed (s)	1-5 per field point
DUT Mounting Volume (mm)	100 D x 100 H
Robot Pointing Accuracy (°)	0.01°
Available Sources	FTP-018, FTP-039, FTP-064, FTP-102
Footprint (m)	1.5 x 1.5 (doors closed, not including computer station)
Power Requirements	120V(30A) or 220V(15A) (specify)

Meridian FieldPoint software runs on an integrated computer and controls the FLEX, interfaces to the DUT, allows the operator to configure unique and complex test routines for each DUT type, and performs all of the necessary image analysis.

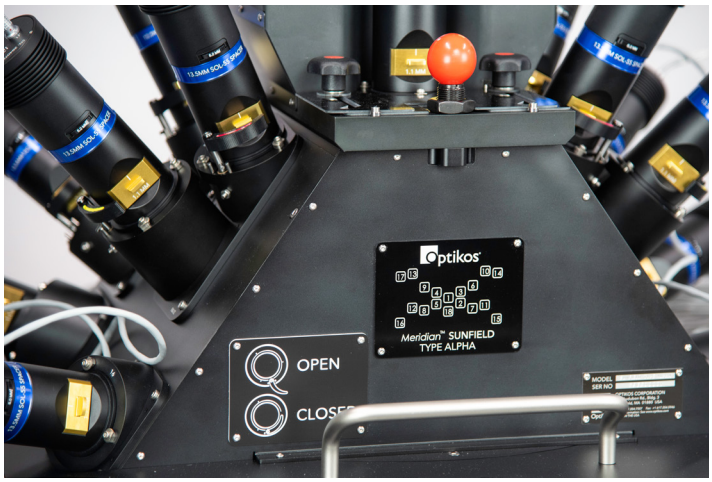


Meridian Sunfield Platform Specifications

A relatively new addition to the Meridian product family, the Sunfield provides a fixed array of bright objects (Sol projectors) against a black background to enable Glare Spread Function (GSF) measurements in a production environment. Like the Starfield, the Sunfield is tailored the specific requirements of each customer. It can be designed for one DUT type, or it can be designed to accommodate multiple DUT types with one system.

Features of the Sunfield platform include:

- A rigid, light-tight structure holds the Sol projectors at the required field angles. Sol projectors are easily removed from the Sunfield platform if needed.
- The DUT is introduced through an aperture in the floor of the unit. Quasi-kinematic features in the base assist the customer in placing the DUT correctly.
- All structure surface that is within the field of view of the DUT is coated with a high emissivity coating to minimize reflections and scattered light.
- Individual remote control of each projector's illumination allows for testing at one field point at a time
- Can be configured with pneumatic shutters to cover projectors that are not in use to further reduce scattered light

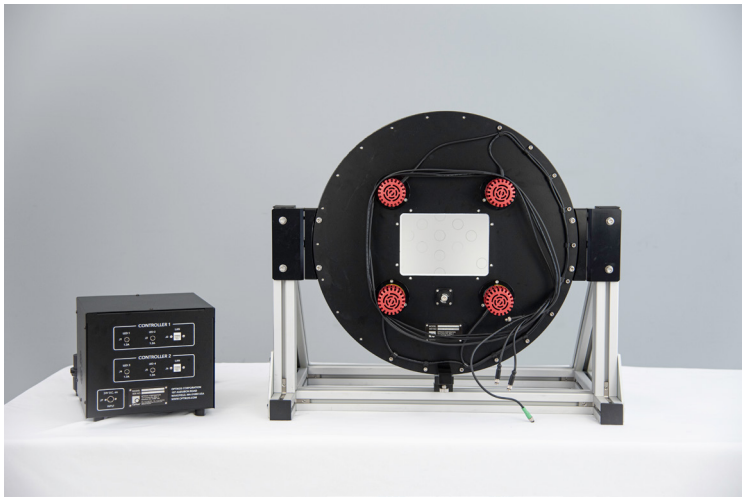


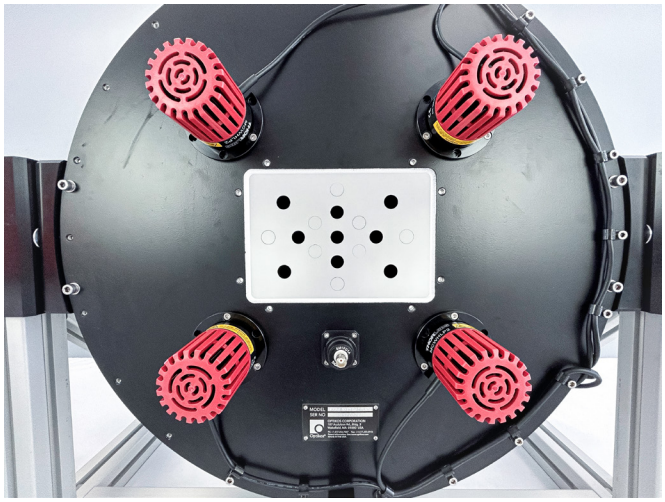
Meridian Brightfield Platform Specifications

The Meridian Brightfield is another new addition to the Meridian product line, and provides a fixed array of black objects against a uniform white background to enable Veiling Glare Index (VGI) measurements in a production environment. Like the Sunfield and Starfield, the placement and size of black objects in the Brightfield is tailored to the customer's specific requirements and may also be designed to accommodate one or multiple DUT types.

Features of the Brightfield platform include:

- Integrating hemisphere illuminated by multiple controllable white LED sources to ensure uniformity
- High efficiency light traps of various aperture sizes mounted at customer-defined locations
- Customer-specified mechanical interface at DUT port. Cover provided for shipping and protection when not in use
- Integrated light meter options available
- Light traps may be removed and replaced with coated port plugs for reconfiguration if needed.
- Benchtop aluminum extrusion standard is standard, other mounting schemes are available





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Anywhere Light Goes®

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