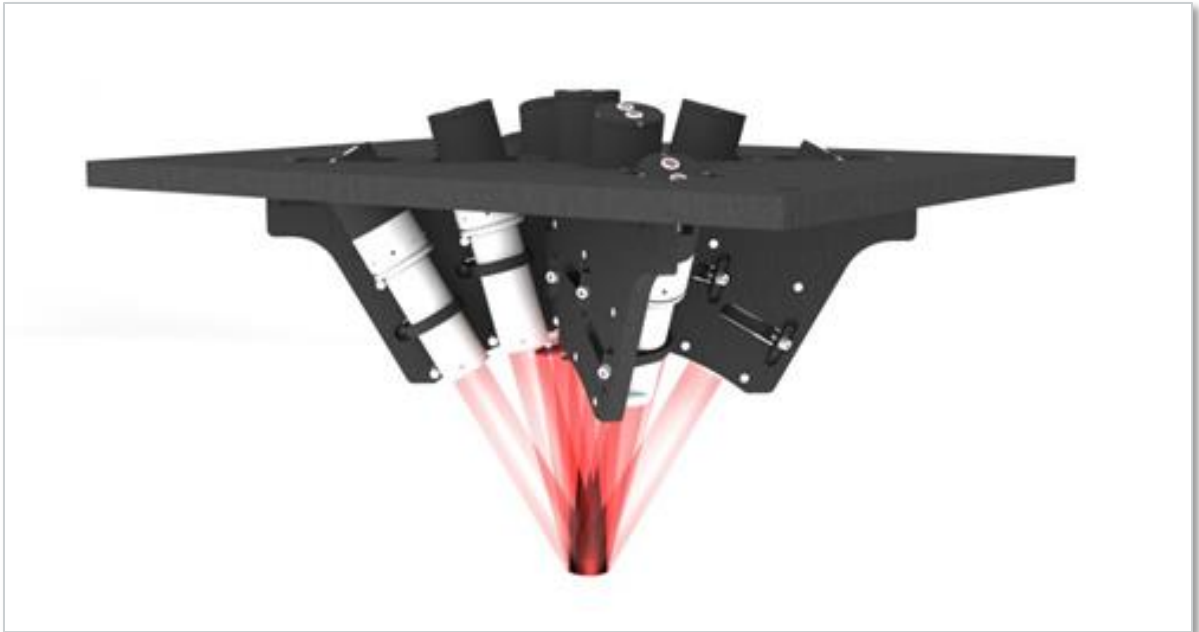


MERIDIAN™ PRODUCTION CAMERA TESTING

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# The Concept

The proliferation of camera technology in small aperture devices such as webcams, vehicle cameras, and cell phones has created a need for high-speed optical test equipment that is capable of qualifying the alignment and focus of a lens to a camera in just a single snapped frame. This requirement necessarily means that all pertinent field points within the image must be presented to the unit under test simultaneously. Some camera manufacturers will make use of large printed test charts for this purpose, but this approach can consume considerable space, is unsuited to presenting targets at infinity, and is difficult to incorporate in a modular test cell configuration.

## A UNIQUE APPROACH

Optikos has developed and deployed the Meridian™ suite of products in answer to this need. Designed for rapid customization, the Meridian product line offers a revolutionary hardware and software approach to production camera testing. It's a flexible testtool kit that's compact, cost-effective and easy to incorporate in your production line: the graphical user interface facilitates setup and selection of metrology parameters; and a library of functions integrates easily into your testing software.

The idea behind the Meridian concept is to employ multiple target projectors (frequently collimators, but not always so) to project a back-illuminated target from the required object conjugate into the pupil of the Unit Under Test (UUT) from each of the required field points. This idea is fundamentally different from the laboratory testing approach of our I-SITE™ product line in which each field point is addressed and tested sequentially by changing the altitude of the UUT with respect to the collimator. The image analysis principles are, however, very similar and the algorithms that are called on to locate and analyze multiple images within the field have a legacy extending back over a long tradition of optical system testing at Optikos.

## CUSTOM DESIGNED TO FIT SPECIFIC TESTING REQUIREMENTS

An important point of differentiation between the Optikos® Meridian product line and other clusters of target projectors is the manner in which the field angles are established. After considering several approaches in which collimator angles, for example, could be adjusted and indeed would need to be individually established by the user, we dismissed the idea of a "universal" system as simply being too clumsy and unworkable in a production environment. Instead, we recognized that we could leverage the parametric capabilities of today's CAD software and the remarkable precision of three and five axis CNC machining to deliver target projector assemblies that are custom designed to perfectly fit the testing requirements of specific cameras.

# Meridian™ Hardware

## MERIDIAN™ ARCH

The primary advantage of the Arch mounting scheme is that it consists of just two different types of machined plates (one top plate and four identical wings), each of which may be fabricated using a 3-axis CNC milling machine. This makes CAM programming time relatively short and the qualification of the machining program largely unnecessary. All of the positioning accuracy in these plates arises from the planarity of a single surface and the locational accuracy of several dowel pins.

The Arch assembly is a textbook example of exact constraints. It uses the barrel of the center target projector to locate each of four wings that radiate out along the diagonals or the cardinal directions of the field of

view. Each wing holds the required number of projectors, each of which is located on the wing by being pulled into the corner established by the plane of the plate and two dowel pins. Tangency to these features and the roundness of the tightly-toleranced projector barrel are sufficient to accurately locate the field angle for each projector. The radial directions of the four wings are set by the locations of dowel pins pressed into the top plate. The Meridian Arch mount is well suited to customers who require just a few projector assemblies or to those who need a test setup for evaluation purposes or production use with the shortest possible delivery time.

## MERIDIAN™ STARFIELD

If the number of test setups is relatively large and the delivery schedule may be somewhat more extended then the Meridian Starfield may be the mounting scheme of choice. Whereas the Arch consists of an assembly of machined plates, a Starfield mount is a monolithic design consisting of a thick plate into which precision bores are machined to receive the target projector barrels. This machining operation necessarily requires a 5-axis CNC machining center and the CAM programming, prototype machining, and fixturing for the machining operation take longer and are more expensive than is the case for the Arch. On the other hand, these costs are non-recurring and are less significant when amortized over several Starfield plates.

## MERIDIAN™ TARGET PROJECTORS

Both the Arch and Starfield mounting schemes may be designed to accommodate a number of different target projectors. These projectors consist of precision cylindrical barrels that house projection optics, the target reticle, and an illuminator. Each target projector is factory-set to the required conjugate and the center of the target reticle is precisely bore-sighted to the outer barrel. Furthermore, targets with inherent orientations, such as crossed targets, are aligned about the optical axis with respect to an external feature so that the roll angle of the target may be mechanically set when inserting the projector into the mounting assembly. The illuminators are generally based on surface mount LEDs; either visible monochromatic, white LED, RGB, or infrared monochromatic depending on the customer's requirements. Each illuminator circuit board includes a microcontroller for setting and monitoring the LED current and for providing a remote serial interface to each illuminator. By assigning a unique node address to each illuminator and daisy-chaining them together, illuminators may be remotely turned on and off at will and the brightness of each of the illuminators can be individually set.

## SUPPORTED MERIDIAN™ SYSTEM MEASUREMENTS

Supported Meridian measurements include, but are not limited to:

- Camera Modulation Transfer Function (MTF) at multiple field points
- Camera Line of Sight (LOS) tip-tilt relative to camera housing
- Camera roll angle relative to camera housing
- Camera diagonal field of view
- Camera imaging distortion
- Camera sensor hot pixels/dead pixels (requires optional full-field illuminator)
- Sensor color fidelity (requires optional module)

## NOTES

Geometric measurements such as bore sighting and line of sight are always made with respect to the datum features that locate the Unit Under Test with respect to the Meridian assembly. Field of view and distortion measurements are made using the image locations from known field angles/positions in the Meridian assembly. In some cases (such as field of view), the measurement necessarily requires extrapolating to the edge of the FOV from field positions within the FOV.



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