

ImageMaster[®] Universal

Horizontal MTF measurement
in the spectral range
UV-VIS-IR





Passion for optics

TRIOPTICS develops and produces the world's largest range of optical measurement and manufacturing technology for the development, quality control and production of lenses, lens systems and camera modules.



ImageMaster® Universal

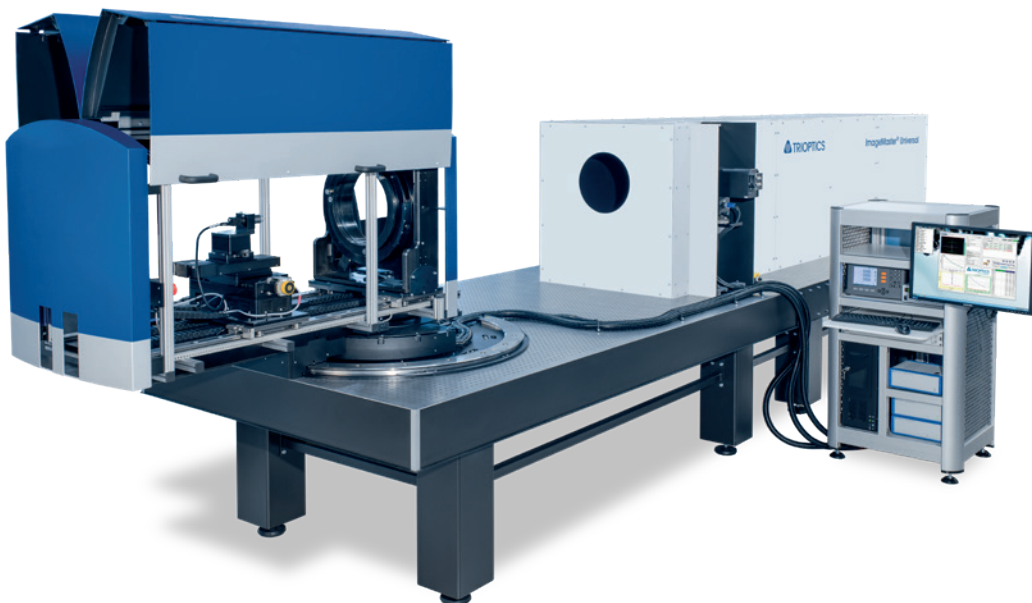
MTF measurement in the entire spectral range UV-VIS-IR

The ImageMaster® series from TRIOPTICS has been specially developed for measuring the MTF (modulation transfer function) and enables the precise determination of the imaging quality of lenses and optical systems. For this purpose, in addition to the MTF as the generally accepted method for determining the imaging quality of a lens, a variety of other optical parameters are measured.

Through the use of mirror collimators, the ImageMaster® Universal allows highly accurate MTF measurements in the entire spectral range UV-VIS-NIR-SWIR-MWIR-LWIR. As opposed to collimators with lenses, the light is reflected in the mirror collimator. This means it works independently of a lens's refractive

index and thus of the wavelength. Thanks to its horizontal design, large lenses can be tested both in terms of focal length and free aperture. One major advantage of the ImageMaster® Universal is that measurement-relevant components are uniformly and stably covered. This effectively shields mirror collimators, detectors and samples from environmental influences. In conjunction with extremely stable precision sample holders, this ensures highly precise results in MTF measurement.

Trust TRIOPTICS – the market leader for MTF measurement equipment – and take us at our word. After all, our measurement results are traceable to international standards.



ImageMaster® Universal

Applications

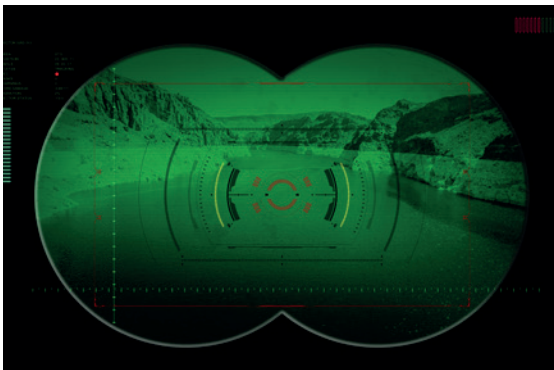
Virtually all existing lens systems – from simple single-lens systems to complex high-resolution telescopes with multiple lenses – can be precisely measured with the ImageMaster® Universal.



Camera lenses (e.g. for photo/cine/TV)



Aerial lenses and lenses for space applications



Night vision / defense and security



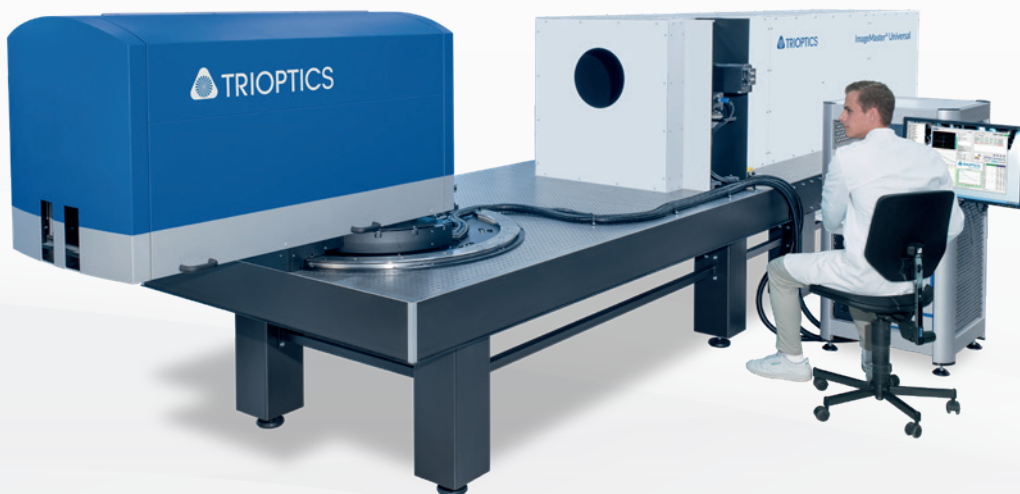
Telescopes

Typical samples for the ImageMaster® Universal

ImageMaster® Universal

Advantages at a glance

- **Traceability**
MTF values are traceable to international standards according to DIN ISO15529
- **Wide spectral range**
Measurement of the MTF (on-axis and off-axis) in the spectral range UV-VIS-NIR-SWIR-MWIR-LWIR, fast spectral range change possible, e.g. from VIS to IR
- **Flexible measurement configuration**
The measurement configuration can be easily adapted to the sample (e.g. switching from finite to infinite object distances).
Possible measurement positions include: Finite -> finite, infinite -> finite and afocal
- **Stability and precision**
The horizontal design ensures increased stability, e.g. when using heavy samples and high stability of the sample holders. The covering of measurement-relevant components reduces influences from ambient light and air turbulence
- **Universally applicable in production and development**
 - High measurement speed in production through the use of camera-based detectors in the wavelength ranges VIS, NIR, MWIR and LWIR
 - Cost-effectiveness and time savings for institutes as well as research and development thanks to the modular, easily retrofittable and universally flexible use of scanning detectors with complete coverage from the UV and VIS to the LWIR spectral range



ImageMaster® Universal 3D

Customer-specific solutions

We offer a wide range of customer-specific special solutions. Here, too, the factors of traceability, flexibility and versatility as well as stability and precision play an essential role. One example of this is the ImageMaster® Universal 3D for special samples that may not be rotated due to their size and dimensions. Here, the MTF is measured in the complete field of view without the sample rotating.

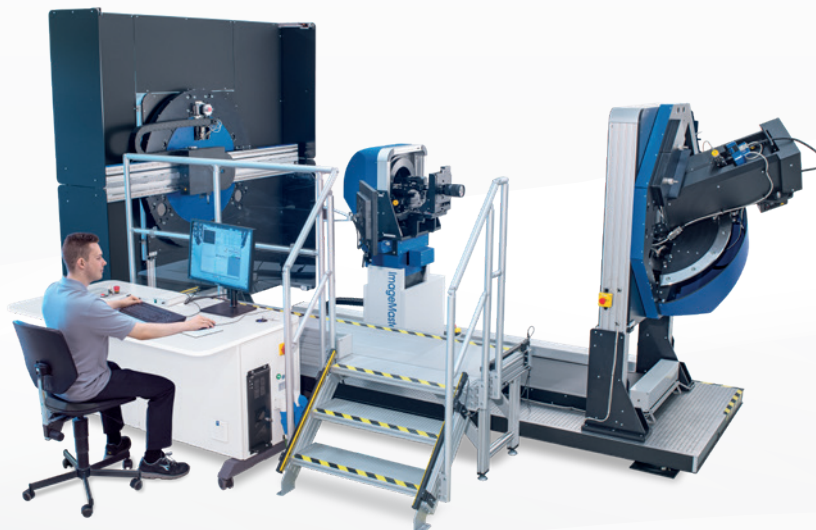
The sample remains in a fixed horizontal position while the automated object generator and detector scan the complete sample or image plane. MTF values measured with ImageMaster® Universal 3D are traceable to international standards.

Please contact us for more information on our customized special solutions.

- **Traceability**
MTF values based on international standards

- **Flexibility and versatility**
 - No rotation of the sample: Optimal for samples that can only be used in one orientation (e.g. TV camera lenses)
 - The collimator can be rotated around two axes
 - Measures the complete field of view for infinite and finite measurement situations
 - Measures the modulation transfer function (MTF) off-axis and on-axis
 - Motorized guidance for measurements with samples with large object distances

- **Stability and precision**
 - Fully automatic, ultra-precise, multifunctional MTF test bench
 - High-quality image analyzer
 - Optimal system design prevents loss of brightness on edges



ImageMaster® Universal

Measurement parameters

With the MTF test station ImageMaster® Universal lenses can be measured in all spectral ranges from UV to LWIR. In addition, we offer customer-specific special solutions on request.

A wide range of parameters for testing optical performance is available:

- MTF on-axis and off-axis
- Effective Focal Length (EFL)
- Distortion
- Field curvature
- Lateral and longitudinal chromatic aberrations
- Astigmatism
- Chief ray angle
- PSF (Point Spread Function), Encircled/Ensquared Energy
- Depth of focus
- Field of view
- Back focal length (absolute/relative)
- Relative and absolute transmission
- Relative illumination

All MTF measurements can be performed with the ImageMaster® Universal in finite, infinite and afocal measurement position.

MTF measurement can be performed both on-axis and off-axis.

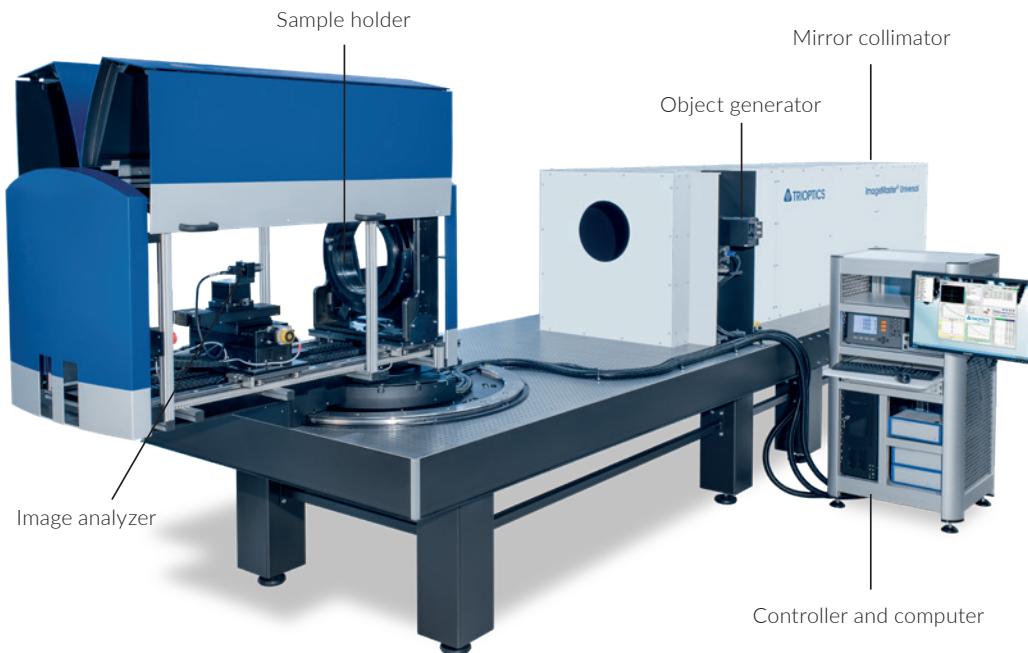


Measurement on-axis and off-axis with the ImageMaster® Universal

ImageMaster® Universal

Configuration

The following configuration overview shows the main assemblies of the ImageMaster® Universal:



The main components of the ImageMaster® are the mirror collimator, object generator, sample holder, image analyzer, controller and computer.

The sample is mounted in a self-centering mount on the sample holder and precisely positioned. The basic element of the stable holder is an ultra-precise, heavy-duty pivot bearing. Fine adjustments in the x- and y-directions enable the samples to be precisely centered on the optical axis.

The object generator contains a light source for the extended visible range, which can easily be exchanged for an infrared or UV light source. An illuminated reticle is used as the object. Optionally, the object generator can

be mounted on a linear guide (finite stage) to position objects at finite distances.

The objects are imaged to infinity by a precisely aligned mirror collimator. For maximum precision, the collimator is covered by a sturdy housing.

The image analyzer is equipped with a CCD camera for measurements in the visible spectral range. The camera's optics focus into the image plane of the lens to be tested and magnify the image onto the camera sensor. Alternatively, camera-based and scanner-based detectors are available to cover the spectrum from UV to IR.

The data acquired is analyzed by the MTF Lab software.

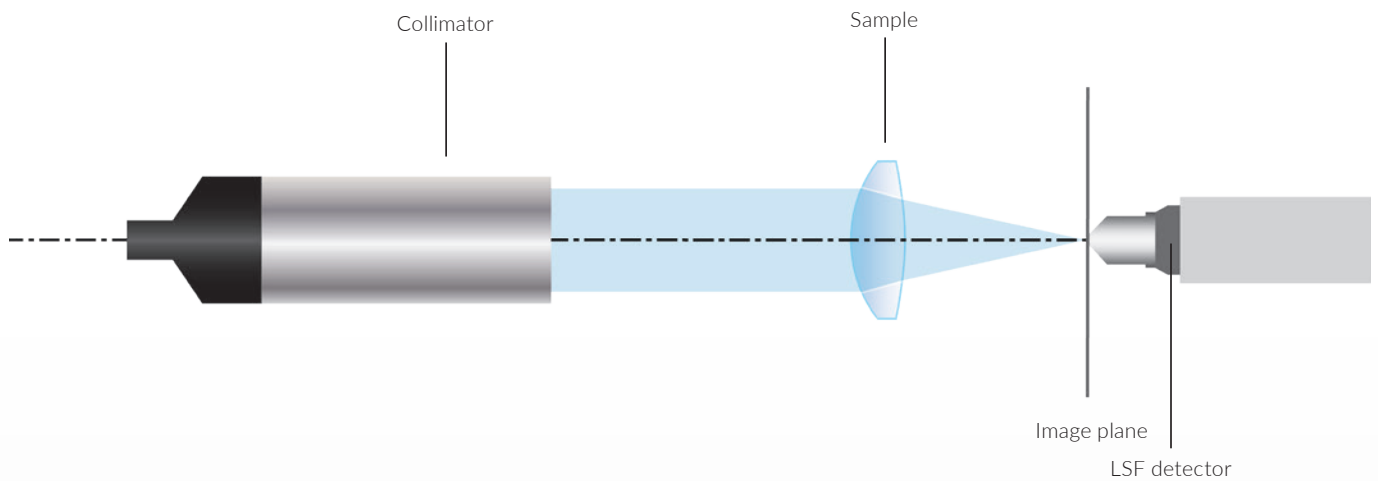
ImageMaster® Universal

Measurement configurations

Optical systems can be tested in the following configurations:

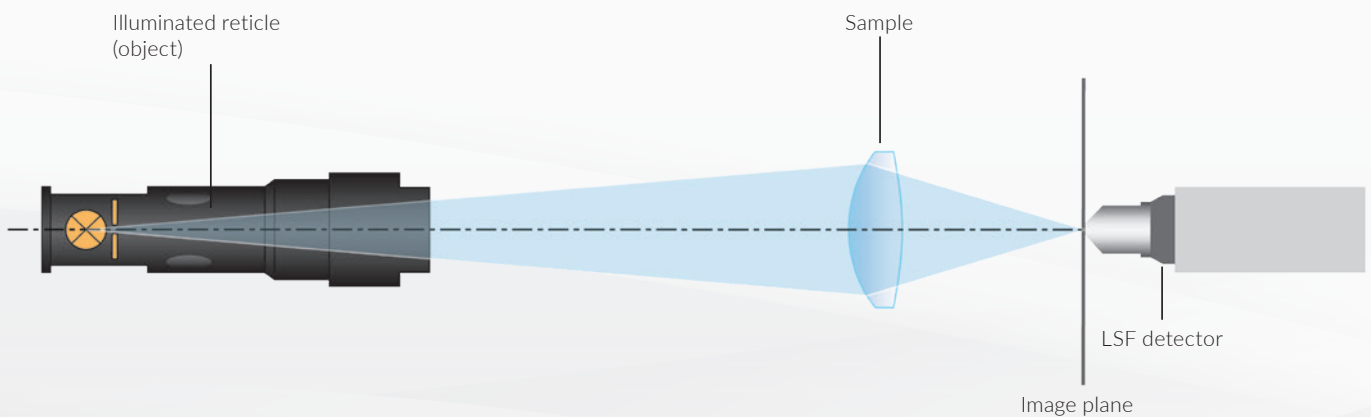
a) Object at infinity using the collimator on the swivel arm

In the “infinite - finite” test configuration, the collimator on the swivel arm projects the object to infinity, illuminating the entrance pupil of the sample. The sample images the object in the focal plane and is captured by a CCD sensor.



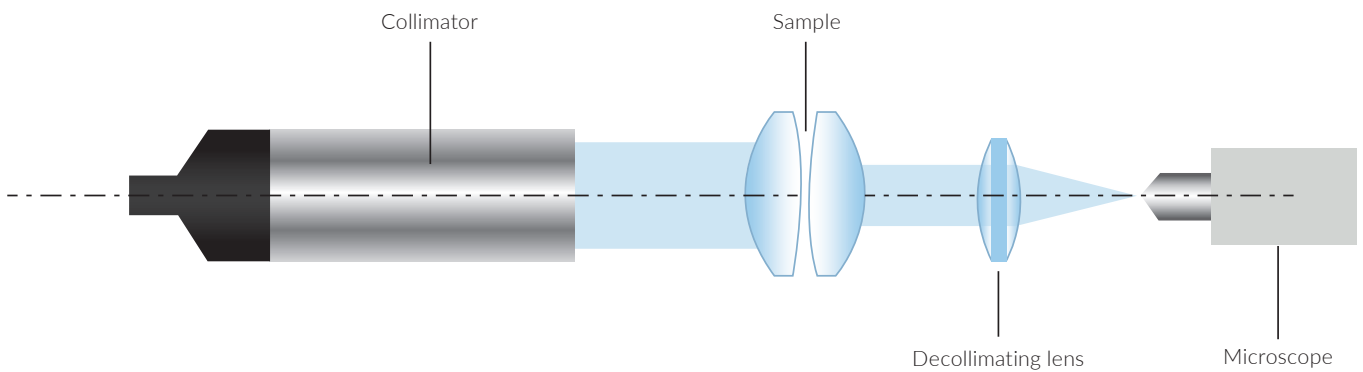
„Infinite - finite”

b) Object and image at finite distance using the linear guide, measurement with illuminated object or reticle



„Finite - finite”

c) Object and image at infinite distance using the afocal unit



„Infinite - infinite“ using afocal unit

With the automated afocal unit, it is also possible to measure afocal samples such as riflescopes or binoculars in the infinite - infinite measurement configuration. To do so, the collimator simulates a distant object and a detector captures the image reproduced by the sample.

ImageMaster® Universal

Mirror collimators

The ImageMaster® Universal uses high-quality diffraction-limited collimators that are completely covered by a sturdy, dust-shielding housing with a matte black coating on the inside. This prevents wavefront distortions caused by air turbulence and ambient light

influences, ensuring maximum precision in the measurement of imaging quality. Mirror collimators are available in the following sizes:

Type	Width (mm)	Length (mm)	Height (mm)	Free aperture (mm)	EFL (mm)
300-50	430	650	740	< 50	300 ±1%
600-100	770	910	740	< 100	600 ±1%
1500-150	800	2,200	850	< 150	1,500 ±1%
2000-150 2000-200	800	2,700	850	< 150 < 200	2,000 ±1%
2500-150 2500-200 2500-250	800	3,200	850	< 150 < 200 < 250	2,500 ±1%
3000-150 3000-200 3000-250 3000-300	800	3,700	850	< 150 < 200 < 250 < 300	3,000 ±1%

Other sizes up to 5000-500 are available on request

ImageMaster® Universal

Upgrades & accessories

Extensive accessories and various upgrades allow the ImageMaster® Universal to be configured individually and also to be adapted to changing requirements at a later date. The

operator can quickly and easily exchange the different modules, e.g. when changing from VIS to IR.

Light sources

Light sources for different wavelengths are available for the ImageMaster® Universal. Thanks to the kinematic mount, the light

sources can be easily changed without the need for re-adjustment.



UV



VIS/NIR/SWIR



MWIR/LWIR

Object generator

High-precision optical filters allow you to narrow down the wavelength range. Switching between different wavelength ranges is made

possible by the use of different filters. With the motorized reticle and filter changer they are changed easily and within short time.



Reticle and filter changer



Reticles



Filter

Image analyzer

Various camera based or scanning based detectors are available as image analyzer for different wavelength ranges. Thanks to the kinematic mount, the detector can be changed

quickly and easily. No re-adjustment is required, allowing the operator to convert to changing measurement requirements within a very short time.

Detector	UV	VIS/NIR	SWIR	MWIR	LWIR
Scanning based					
Camera based					

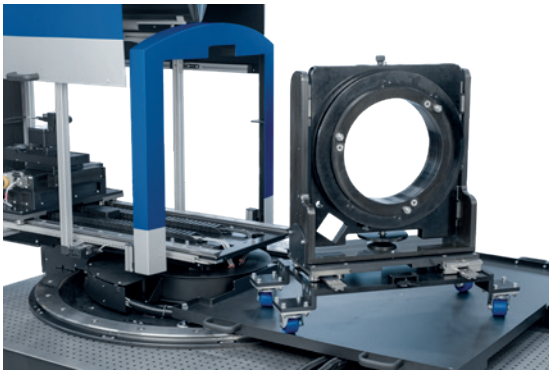
Image analyzers/detectors for different wavelength ranges

The image analyzer is equipped with a CCD camera for measurements in the visible spectral range. Alternatively, it can also be equipped with an InSb or MCT detector to cover the infrared spectrum from the shortwave (SWIR) to the longwave (LWIR) range.

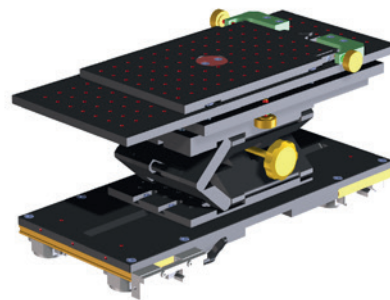
In the UV and SWIR ranges, the scanner-based slit-scan method is used for data acquisition. In the VIS, MWIR and LWIR ranges, both the slit-scan method and camera systems can be used for data acquisition.

Sample holder

A stable mounting of the sample is of particular importance for precise measurements of large and heavy lenses. This is the purpose of the sample holders, which are available for various sample diameters.



Sample holder for large/heavy samples



Lifting table for large samples

A ramp facilitates the handling of large and heavy sample holders. The lifting table is used for samples up to a diameter of 500 mm that do not fit into rotation sample holders.

Test piece holder	D150	D210	D300	Lifting table
Free aperture (mm)	150 mm	200 mm	300 mm	500 mm
Sample weight (kg)	40 kg	40 kg	40 kg	80 kg

Sample holder for different sample sizes

Finite Stage

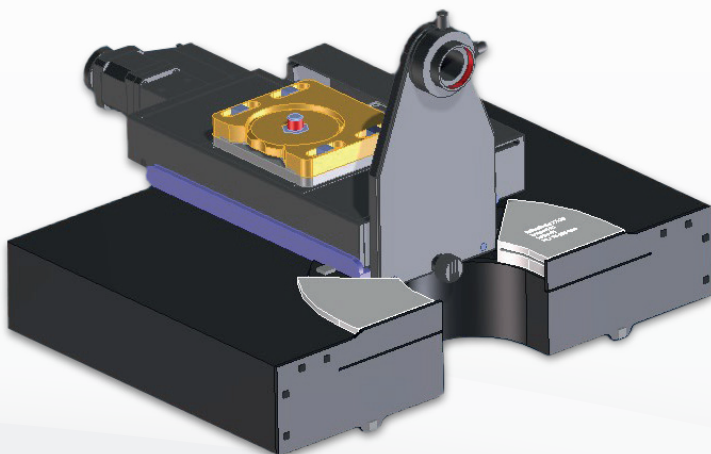
For finite conjugate measurements, a finite stage is available in lengths of two meters and three meters. The object generator is mounted on the finite stage so that finite object distance measurements can be performed by adjusting the object distance.



Finite Stage

Afocal unit

The automated ultra-precision afocal unit is available for afocal samples such as riflescopes or binoculars. With different decollimator lenses, the measurement can be executed in different wavelength ranges. Decollimator lenses are available for VIS, MWIR and LWIR.



Afocal unit

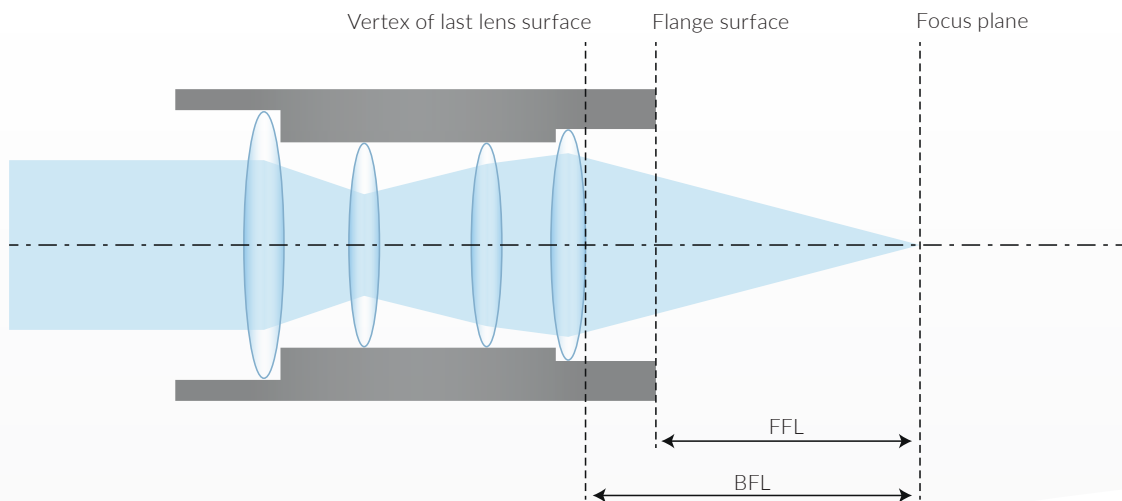
Upgrade for BFL/FFL measurement in VIS spectrum

The upgrade enables BFL/FFL measurement without replacing mechanical components. Simply insert the beam splitter of an autocollimator via a slider.

To measure the BFL (back focal length) of a sample, the distance between the last lens surface and the focal plane is measured. This is achieved by using an autocollimator which is integrated into the detector for the VIS range. The detector is first positioned via the automatic focus stage so that the cross of the autocollimator is sharply imaged through the microscope

objective on the last lens surface of the sample. In the second step, the detector is moved to the focal plane of the sample with the light source turned off. The distance between these two positions is the BFL.

The procedure is similar for the FFL measurement. Instead of the sample, a reflective plane plate is mounted on its holder. The second step is the same as for the BFL measurement after the sample has been reinserted.



Upgrade for BFL/FFL measurement

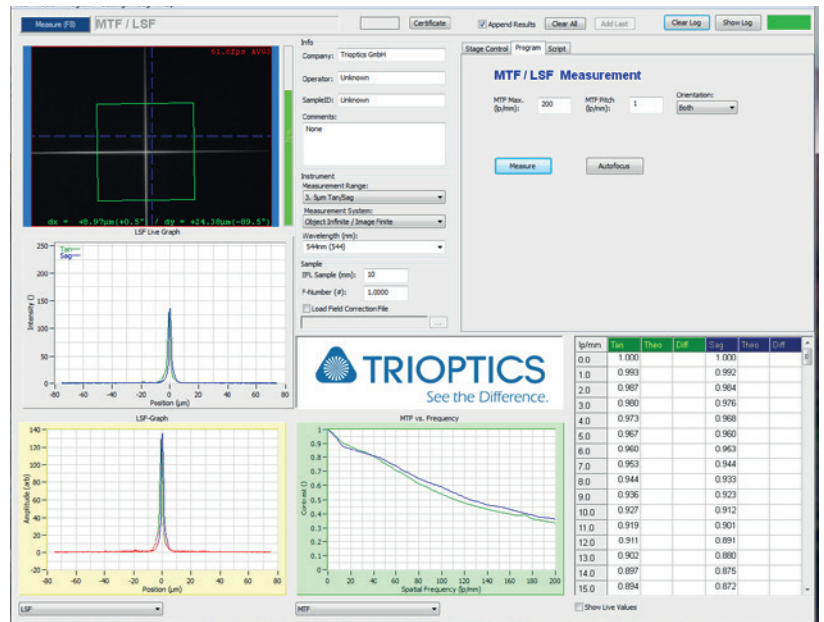
ImageMaster® Universal

Software

The powerful ImageMaster® MTF Lab software provides an easy-to-use graphical user interface for fast imaging quality measurements.

A key feature of the software is the support of UV or IR detectors using the scanning aperture method.

Several integrated functions help the user to scan and detect the correct image position of the sample. The software allows the user to switch easily and quickly between the different measurement modes.



Its versatile functionality makes the ImageMaster® MTF Lab software the product of choice for R&D and laboratory work.

Advantages at a glance

- Easy-to-use graphical user interface
- User-specific window arrangement with graphical evaluations
- Scripting tools for creating automated user-defined measurements including programming functions such as guide control, data manipulation as well as loops and variables
- Data export to a variety of file formats
- Logging of successive measurements
- Certificate creation with the hypertext language protocol (HTML)

ImageMaster® Universal

Technical data

Type	ImageMaster® Universal*
Optical set up	Finite, infinite or afocal
Max. off-axis angle	±180°
Spectral range	UV: 250 nm ... 450 nm VIS: 450 nm ... 700 nm NIR: 700 nm ... 1,000 nm SWIR: 1,000 nm ... 2,500 nm MWIR: 3 µm ... 5 µm LWIR: 7 µm ... 13 µm
Azimuth range	360°
Max. image height	±50 mm
Spatial frequency (in specification) Max. spatial frequency	UV: 100 lp/mm VIS/NIR: 200 lp/mm SWIR: 120 lp/mm MWIR: 80 lp/mm LWIR: 60 lp/mm
Accuracy** (MTF on-axis and off-axis)	UV-NIR: ±2 % MTF on-axis, ±3 % MTF off-axis SWIR-LWIR: ±3 % MTF on-axis, ±3 % MTF off-axis
Repeatability (MTF on-axis and off-axis)	UV-NIR: ±1 % MTF SWIR-LWIR: ±2 % MTF
EFL accuracy	±0.2 %
Distortion Accuracy (without / with encoder) Repeatability (without / with encoder)	±0.7 % / ±0.25 % ±0.3 % / ±0.1 %
Lateral chromatic aberration Accuracy Repeatability	±0.5 µm ±0.3 µm
Longitudinale chromatische Aberration Accuracy Repeatability	±1 µm 0.2 µm
CRA Accuracy Repeatability	±1° ±0.4°
FFL (relative) Accuracy Repeatability	±10 µm ±3 µm
Astigmatism Accuracy Repeatability	±4 µm ±1 µm
Field curvature Accuracy Repeatability	±2 µm ±1 µm

* All specifications can vary with wavelength and sample characteristics.

** MTF accuracy is verified with TRIOPTICS reference samples.



TRIOPTICS GmbH

Strandbaddamm 6
22880 Wedel
Germany

+49 4103 18006-0
sales@trioptics.com
www.trioptics.com

