

OptiSpheric[®] IOL & OptiSpheric[®] IOL PRO 2

ISO 11979 compliant IOL testing



OptiSpheric OptiCentric OptiAngle



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OptiSpheric® IOL Series

Fully Automated IOL Testing in compliance with ISO 11979



OptiSpheric[®] IOL PRO 2 for fully automated measurement of IOL batches

The OptiSpheric[®] instrument is the industry's standard for lens parameters testing. With more than 500 installed units worldwide, it is used to fully measure and qualify optical components and systems.

The products of the OptiSpheric[®] IOL Series rely on this experience as well as on the experience TRIOPTICS gained in the field of intraocular lenses testing. With a technology following the guideline provided by the ISO 11979, we ensure a perfect transparency of the measurement process and a traceability of the measurement results. Furthermore, the technology used by the OptiSpheric® IOL allows measuring all modern types of IOLs: monofocal, multifocal bifocal or trifocal, with any type of structure (refractive, diffractive, sectors), toric, multifocal toric, spheric or aspheric designs. And of course it measures all type of materials - PMMA, hydrophobic, hydrophilic- in air or in situ according to the ISO 11979 standard.

The OptiSpheric[®] IOL Series comprises two products:

- The OptiSpheric[®] IOL for the measurement of single IOL
- The OptiSpheric[®] IOL PRO 2 for the fully automated and fast measurement of batches with up to 100 IOLs per batch.



OptiSpheric[®] IOL for measurement of single IOLs





Measurement Technology

Measurement Technology According to ISO 11979

The OptiSpheric[®] IOL bench is using the imaging of an object through the lens under test. The resulting image is analyzed in order to evaluate the parameters of the lens (Power, Imaging quality through MTF calculation, energy distribution, Strehl ratio, and more...). Using this imaging technique is similar to realistic conditions and allows testing any type of IOLs designs.

Different types of target are projected to infinity through a collimator. The lens under test gives therefore an image of the target in its focal plane. A measuring CCD microscope is used for analyzing the image by the help of an autofocus mechanism.

The instrument also includes different aperture sizes and different imaging objectives chosen automatically by the system according to the power of the lens under test. The wavelength used for the measurement is 546 nm as requested in the ISO 11979 standard.

Power measurement principle

Power, Add power and Cylinder are measured from the magnification of a double slit test target. The Powers are determined in each focal planes of the IOLs, two different focal planes in case of a bifocal lens, two different crossed focal planes in case of a toric lens, four different focal planes in the case of a bifocal toric IOL, etc... The Add Power is calculated by subtraction of the Near and Far Powers and the Cylinder is calculated by subtraction of the crossed directions powers of a toric lens.



Fig. 1: Setup for measurement in situ



MTF measurement principle

The measurement of the imaging quality is done through the evaluation of the Modulation Transfer Function (MTF). This objective and accurate method gives a full frequency resolved measurement of the optical quality. to use a cross (i.e. two perpendicular slits) giving the MTF in two image directions simultaneously or a pinhole giving as image a Point Spread Function (PSF) containing the complete MTF information in all directions.



Fig. 2: A perfect grid pattern is imaged through the sample into the image plane

The OptiSpheric[®] IOL measures the MTF on axis. It uses a single illuminated slit as object which is imaged on the focal plane of the sample. Due to diffraction and aberrations, there will not be a perfect slit image in this plane but a broadened slit, the so called Line Spread Function (LSF). The Fourier analysis of the LSF, giving the contribution of each spatial frequency, corresponds to the MTF of the sample. Alternatively to a slit it is also possible



Fig. 3: MTF = Contrast vs. spatial frequency. This figure shows the MTF of a diffraction limited optics and a measured MTF $\,$



Fig. 4: The image of a narrow slit is called "Line Spread Function"



OptiSpheric® IOL

OptiSpheric $^{\mbox{\tiny B}}$ IOL Quality Check According to ISO 11979

OptiSpheric[®] IOL is TRIOPTIC's established solution for the measurement of power and MTF of single IOLs. The instrument measures all kinds of IOL lenses.

Key Features

- Measurement set-up and principle according to ISO 11979
- Traceability to NPL and NIST international standards
- Measurement of monofocal, spherical and aspherical lenses
- Measurement of bifocal IOLs: diffractive, refractive, sectors
- Measurement of trifocal IOLs
- Measurement of polyfocal or adaptative IOLs
- Hydrophobic and hydrophilic measurements in air or in situ in model eye according to ISO 11979
- Automated and accurate autofocus
- Automated target changer
- Flexible software with easy production mode or advanced users script programming

Measured Parameters

 $\mathsf{OptiSpheric}^{\texttt{R}}$ IOL measures the following parameters:

- Effective Focal Length (EFL)
- Power, Add power, Cylinder
- Modulation Transfer Function (MTF)
- Point Spread Function (PSF)
- Cylinder axis, orthogonality and toric marks recognition
- Radius of curvature



OptiSpheric®IOL for the measurement of single lenses

- Back Focal Length (BFL)
- Through focus scans
- Relative transmission
- Energy distribution and Strehl ratio

Upgrades and Accessories

The OptiSpheric IOL can be delivered with the following accessories:

When measuring in air, the IOL is placed in a suitable holder designed for different kinds of IOL sample diameters and haptic shapes.



Self-Centering Lens Holder for Measurements in Air

OptiSpheric® IOL





Standard Model Eye

The aperture of typically 3 mm can be adjusted to diameters from 1 to 6 mm. The IOL holder is clamped by a self-centering mount equipped with accurate centering adjustment.

When measuring in situ, the IOL lens is inserted into a model eye simulating the effect of the human eye. Two types of model eyes are available, both are compliant to the ISO 11979 Standard. The IOL is placed in saline solution between two parallel plates on a sample holder including the aperture stop. An achromatic doublet simulates the eye cornea. The model cornea can be easily exchanged allowing the use of different cornea designs, e.g.cornea with spherical aberrations.

The standard model eye used with the Opti-Spheric[®] IOL single lens instrument includes a threaded cornea which can be easily removed for Power measurements or put back for MTF measurement. It is fixed with the selfcentering mount.



Fig. 5: Model Eye for Measurements in Situ

The advanced model eye contains a heater for measurements at 35°C. Furthermore it offers the following advanced adjustment features:

- Translation in X and Y directions of the sample inside the model eye
- Translation in X and Y directions of the complete model eye regarding to the optical axis
- Aperture size modification with the use of different lens holders
- Easily removable cornea lens with sliding holder
- Possibility to tilt the IOL holder up to 5° to simulate the behaviour of a tilted IOL when inserted in the eye



Advanced Model Eye



OptiSpheric® IOL PRO 2

Fast and Automated IOL Batch Testing According to ISO 11979



OptiSpheric[®] IOL PRO 2 for automated batch testing

OptiSpheric[®] IOL PRO 2 is a fully automated optical test station designed and optimized for use in production. All measurements are done in compliance with the ISO 11979 standard, for all types of IOLs: monofocal, multifocal (diffractive, refractive), trifocal, toric, aspheric.

Key Features

- High throughput batch measurement with up to 100 lenses per batch
- Motorized model cornea for automated testing with up to three different corneas
- Aperture changer with multiple aperture sizes
- Automated objective changer
- Measurement of toric lenses independent of the orientation
- Hydrophobic and hydrophilic measurements in air or in situ in model eye tray according to ISO 11979
- Traceability to international standards NPL and NIST
- Stand-alone instrument with small foot print (90x90 cm) including all accessories and the computer
- Flexible software with easy production mode or advanced users script programming

Measured Parameters

The following parameters of monofocal, multifocal, toric and aspherical lenses can be measured:

- Effective Focal Length (EFL)
- Power, Add power, Cylinder
- Modulation Transfer Function (MTF)
- Point Spread Function (PSF)
- Cylinder axis, orthogonality and toric marks recognition
- Radius of curvature
- Back Focal Length (BFL)
- Through focus scans
- Relative transmission
- Energy distribution and Strehl ratio

Upgrades & Accessories

TRIOPTICS offers trays for in situ and in air measurement. The in situ tray is designed in compliance with ISO 11979 and contains up to 100 lenses per batch.

OptiSpheric® IOL PRO 2





In situ tray with batch of 100 lenses



OptiSpheric® IOL PRO 2 testing a batch of IOLs in air



OptiSpheric® IOL PRO 2 testing a batch of IOLs in situ

It is also possible to make single lens testing with the OptiSpheric® IOL PRO 2. As the motorized cornea is already included with the instrument, only a simple wet cell is necessary. It is located on an adapted tray automatically centered on top of the motorized model cornea. This model eye can be provided with a heater in order to measure at 35°C.



 $\mathsf{OptiSpheric}^{\texttt{®}}$ IOL PRO 2 with model eye for single lens testing



Single seat model eye for OptiSpheric[®] IOL PRO 2



Software for OptiSpheric[®] IOL and OptiSpheric[®] IOL PRO 2

The advanced software is designed to work with Windows operating systems for easy and intuitive operation. Its flexible interface allows users with different experience working comfortably with the software. It offers a high level of speed and accuracy and provides consistent, reliable results. All aspects of data acquisition, data calculation and data display are under software control. The software package provides menu-driven operator guidance and advanced data management following the requirements of the Food and Drugs Administration (FDA) for Electronic Records.

Key Features of the OptiSpheric® IOL Software

- Flexible and modular friendly user interface adaptable to different users
- Predesigned measurement sequences depending on the IOL type
- Only a few clicks to start a fully automated alignment and measurement of batches of 100 IOLs
- High accuracy and repeatability
- Real-time camera and graph display (MTF, Through Focus, LSF, PSF)
- Advanced result correction (temperature °C, defocus)
- Database communication, bar code reader, dynamic tolerancing
- Multi language support
- Fully automated hardware control
- Automatic search of the focal planes
- Advanced user mode allowing for user defined scripts describing the measurement process



Software OptiSpheric® IOL / IOL PRO 2

Fig. 7: OptiSpheric® IOL Software with an advanced user interface showing the script and graphs

Overview Technical Data

	OptiSpheric IOL®	OptiSpheric IOL® PRO 2
Power Accuracy	0.05D	
Power Range	 With model cornea: -200D to +150D Without cornea: -50D to -2.5D and +3D to +125D 	
Power resolution	0.005D	
MTF Accuracy	±2% (0-300 lp/mm)	
MTF Range	With cornea: -200D to +150D	
Radius and BFL Accuracy	10 µm	<5 µm
Apertures diameter	1 to 6 mm with steps of 0.5mm	
Measurement time (Monofocal with model cornea)	12 sec for one IOL	12 Min for 100 IOLs

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