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SpotOptics

The software people for optics

OPAL

AUTOMATED WAVEFRONT SENSOR

Single and double pass

- Accurate metrology of standard and aspherical lenses
- Accurate metrology of spherical and flat mirrors
- ϕ=0.3 to ϕ=60 mm
- ~F/1 to ~F/15
- Accurate motor for z-movement
- Accurate XY and tilt stages for easy centering of lenses

Technical Specifications

Measurement Technique	Shack-Hartmann wavefront sensor
Measurement software	Sensoft
Measurement Capability (single pass)	Wavefronts of small lenses and optical systems in transmission
Measurement Capability (double pass)	Measurement of reflecting surfaces
Wavelength	White light or any wavelength of choice using a filter
Mounting	Vertical
Computer	User supplied standard PC. On request, SpotOptics can supply it
Software	Control and analysis software Sensoft for Windows 8/ Windows 10
TWO MOTORIZED STAGES	
Motorized Axis	Vertical z-axis
Length Measurement	Stepper motor with integrated magnetic encoder
Resolution of stepper motor	0.02µm (for a screw with pitch of 1mm)
Repeatability of home position	0.8µm
Measurement range	300mm
Length measurement uncertainty	8µm
Speed	Maximum 50 mm/sec
Control software	Integrated with analysis software Sensoft
DIMENSIONS (L x H x D)	
Size	600 x 370 x 320 mm (approx)
Weight	approx. 20 kg
ACCURACY (all values at 632.8nm)	
Zernike coefficient repeatability	λ/300
Measurement Uncertainty	λ/20

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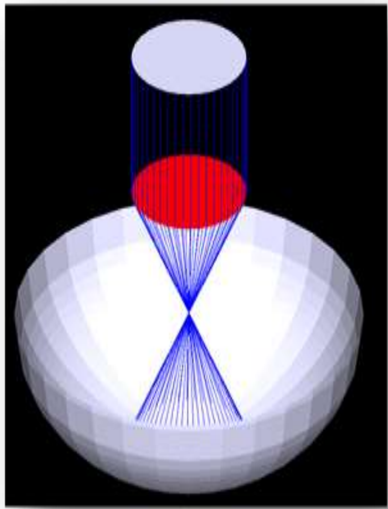
Measuring a spherical hemisphere

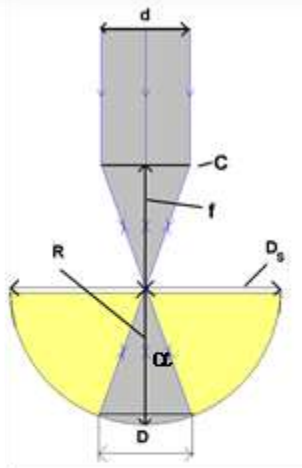


Method 1

It is important to note that a high-quality sphere is required to calibrate out the aberrations of the collimator and the OMI system. For practical reasons, it is not possible to have a reference sphere that has an F/# of less than 0.68, which in double pass becomes 1.36 (since the sphere is used at its radius of curvature). This corresponds to **NA=0.37**, covering an angle **α=21.7°**. See Table 1, row 1.

Method 2

Opal can also be calibrated in single pass using a pinhole light source supplied with the instrument. In this case, the limit to the angle α that can be tested is set by the **NA** of the collimator (i.e. **α=64.1°**). See Table 1, row 2.

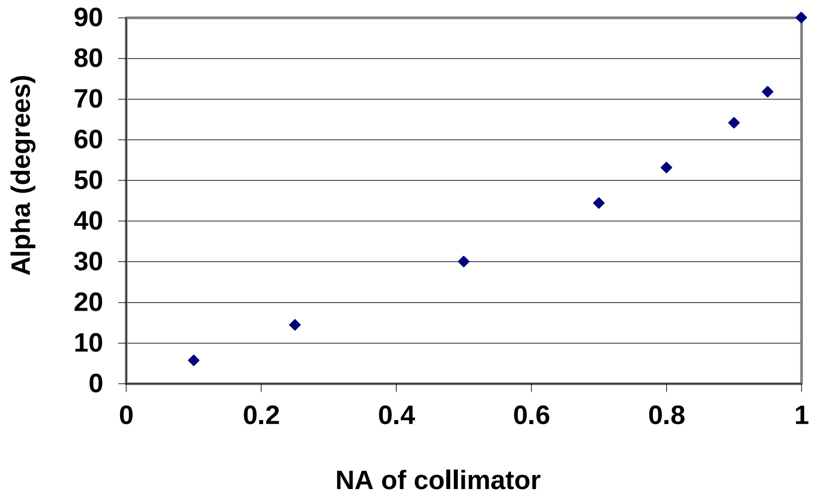


Method

1. Parallel light (coming from Opal) of diameter ***d*** falls on the collimator lens ***C*** of focal length ***f***
2. It comes to focus, and illuminates the hemisphere of diameter ***D_s*** and radius ***R***
3. It then illuminates part of the sphere with diameter ***D***
4. The light is reflected back to the focus, passes through the collimator and is made parallel again. It then illuminates the Shack-Hartmann system of Opal, where it is imaged on the camera after passing through the lenslet array
5. Sensoft then gives the surface error etc.

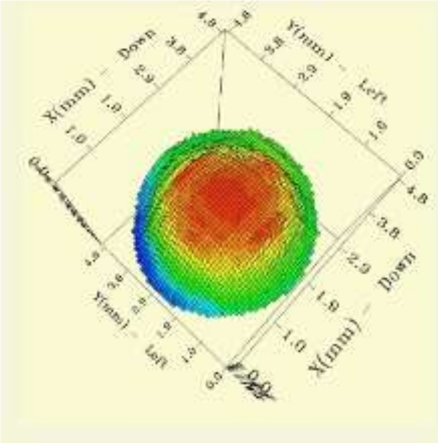
Some relations

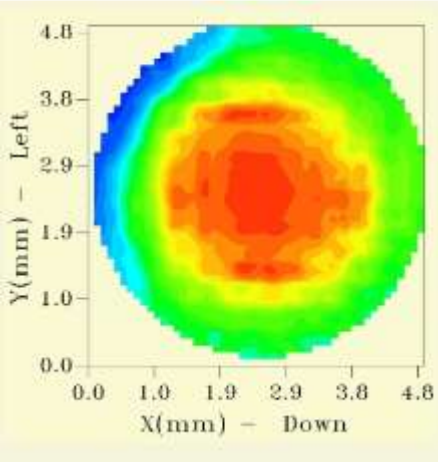
1. The above figure shows that ***$D/R=d/f=1/F_\#= 2NA$***
2. The angle **α =n sin^{-1}(NA)** is covered by the collimator, where **n (refractive index)=1 (in air)**
3. The various collimators that can be used are given in Table 1 below



No.	***NA***	***Collimator F/#***	***Angle α covered (deg)***	***Focal length (mm)***	***Working distance (mm)***	***Diameter of output beam (mm)***	***Number of spots***
1	0.42	1.19	24.8	10	20	6.6	**29x29**
2	**0.70**	**0.71**	**64.1**	**2**	**10**	**3.6**	**18x18**

SENSOFT: THE SOFTWARE





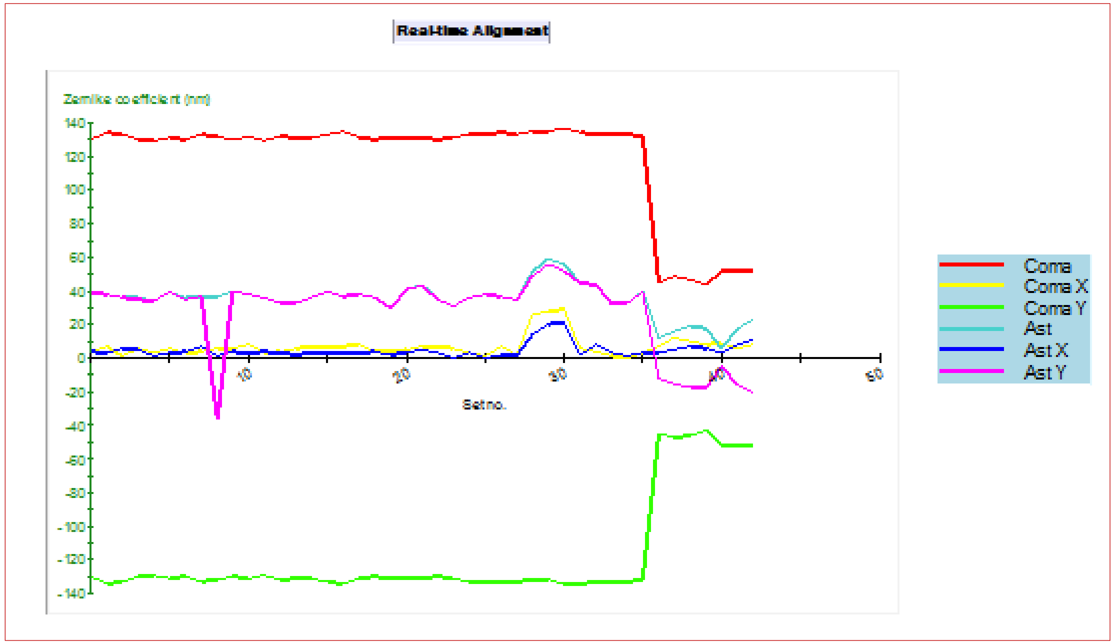
Sensoft: The modular software package:

- Fully controls the hardware of Lentino
- Performs the Shack-Hartmann (SH) analysis
- Computes Zernike coefficients, diagnostics (alignment and correct focal plane), wavefront, MTF, spot diagram
- Has a Loop mode for on-line adjustment of optical system

Opal in your production line:

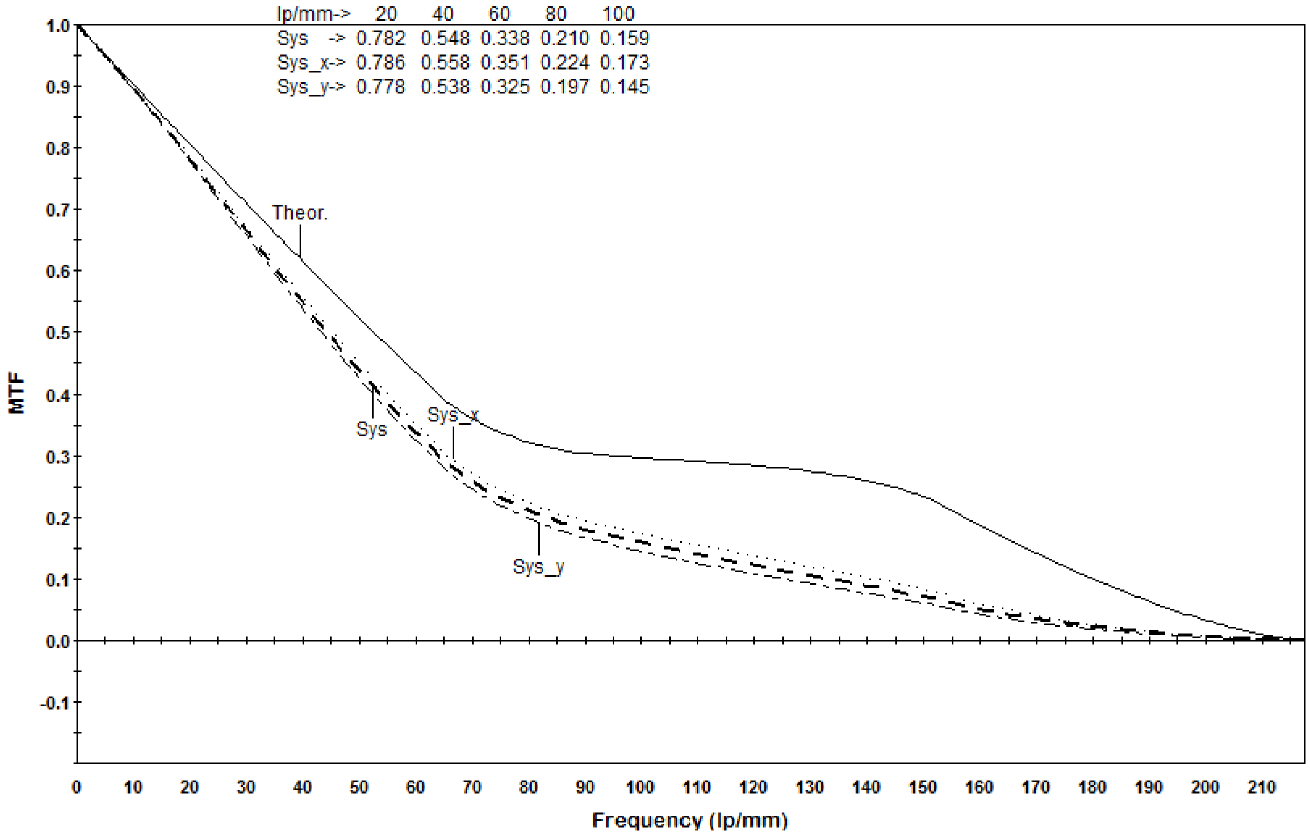
- Opal – with its own PC - can easily be adapted to the production line
- It can work in a closed-loop with the PC of the manufacturing machine
- A software module defines the communication protocol and transfers the results between the PCs
- Additional package for remote setup of Opal and communication of output results over the Local Area Network

ON-LINE ALIGNMENT OF COMPLEX OPTICAL SYSTEM IN A FAST LOOP



- The alignment of complex optical systems becomes easy by monitoring coma and astigmatism in a continuous loop
- The individual (x, y) components of coma and astigmatism, as well as the total coefficients are displayed
- The optimization can be done for one component at a time, as the software can display one component of interest
- Optimal alignment is reached when the coma and astigmatism components converge towards a given tolerance

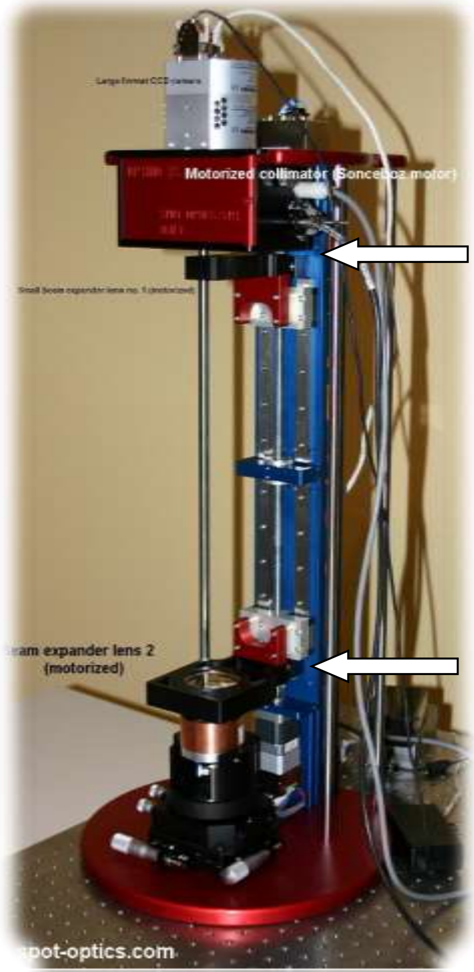
MTF MEASUREMENTS



MTF after subtracting the contributions of tilt and defocus present in the data

The instrument with beam expander

Large format CCD camera. Other cameras available



Small beam expander no. 1 (motorized)

Beam expander lens no. 2 (motorized). Up to ϕ=58mm

OPAL

- Shack-Hartmann wavefront sensor for use in production line and laboratory
- Insensitive to vibrations
- Modular design allows measurement on a variety of surfaces (flat and spherical components)
- Can be used in double pass or single pass, giving flexibility
- Lenses can be tested in transmission using parallel light or pinhole
- Absolute and relative radius of curvature measurements as well as focal length
- Automated measurement
- High-resolution integrated encoder in stepper motor
- Built-in autocollimator for ensuring that the lens mounting is parallel to the axis of OMI

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