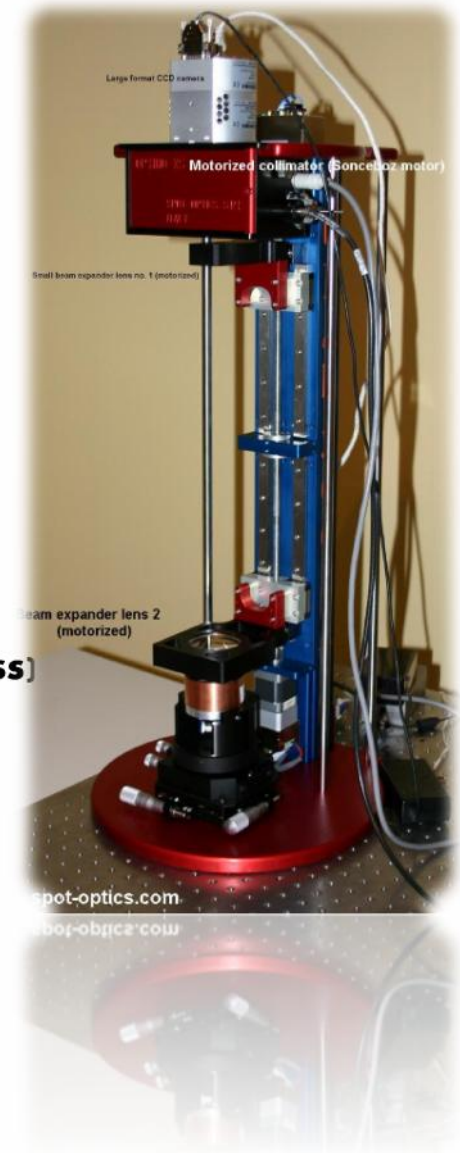# SpotOptics

The software people for optics

OPAL

AUTOMATED WAVEFRONT SENSOR

- **Accurate metrology of standard and aspherical lenses** (single pass)
- **Accurate metrology of spherical and flat mirrors** (double pass)
- $\phi=0.3$ **to** $\phi=50$ **mm**
- **F/1 to F/15**
- **Accurate motor for z-movement**
- **Accurate XY and tilt stages for easy centering of lenses**

Technical Specifications

SYSTEM	
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 XP

MOTORIZED STAGE	
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

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 Γ**=21.7Ê**. 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 Γ that can be tested is set by the **NA** of the collimator (i.e. Γ**=64.1Ê**). 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 Iluminates 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 paralle again. It then illuminates the Shack-Hartmann system of Opal, where it is maged 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 $\alpha = n \sin^{-1}(NA)$ is covered by the collimator, where **n (refractive index)=1 (in air)**
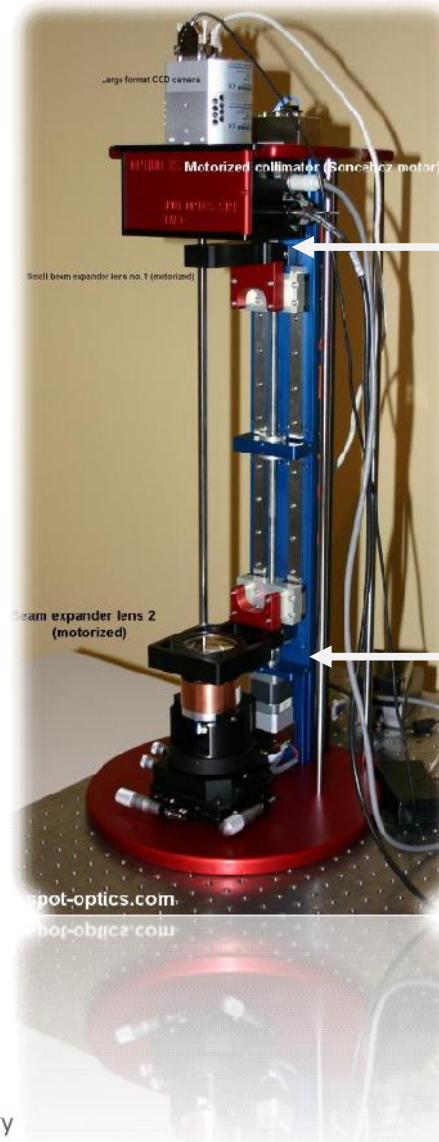3. The various collimators that can be used are given in Table 1 below
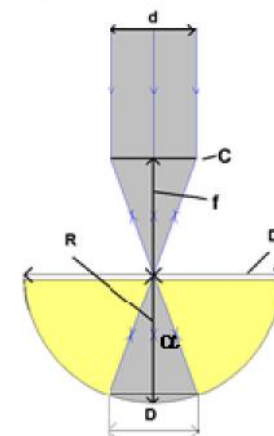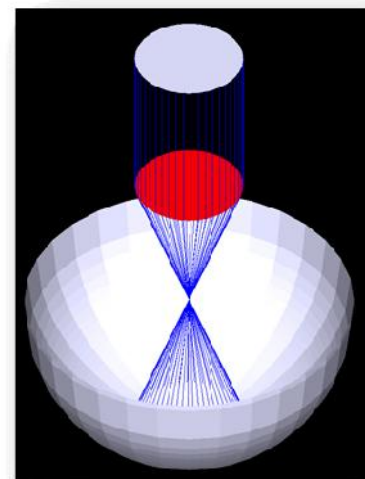
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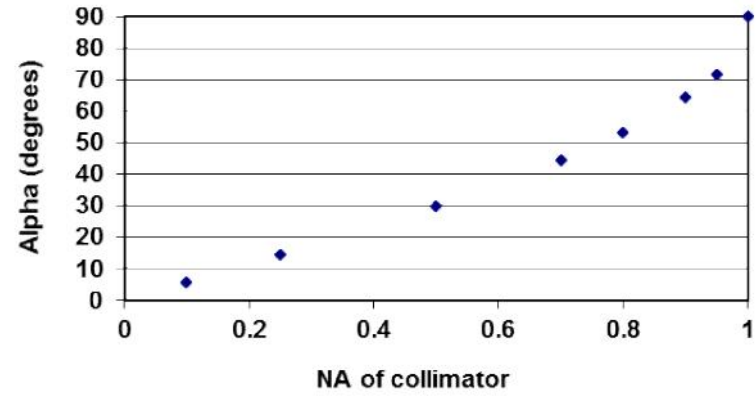
No.	NA	Collimator F/#	Angle r covered (deg)	Focal length (mm)	Working distance (mm)	Diameter of output beam (mm)	Number of spots
1	0.42	1.19	24.8	10	20	6.6	29x29
2	0.90	0.56	64.1	2	10	3.6	18x18

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Large format CCD camera. Other cameras available

Small beam expander no. 1 (motorized)

Beam expander lens no. 2 (motorized)

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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