High-Resolution wavefront measurement system for Industrial applications

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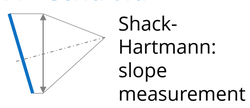
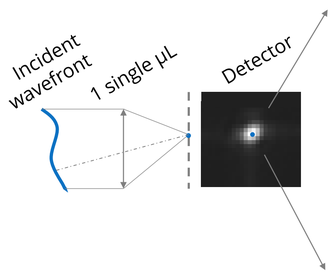
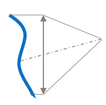
The LIFT revolution

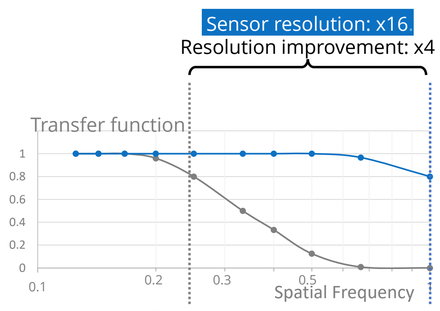
A> Centroid





B> PSF shape analysis
Phase retrieval





A> Shack-Hartmann wavefront sensor:
a matrix of microlenses (µL) is placed in front of a camera detector so that each µL focuses a centroid onto it.
By tracking the lateral position of each centroid, the wavefront slopes (tilt) can be calculated. Integrating them on the whole pupil then results in a phase map.

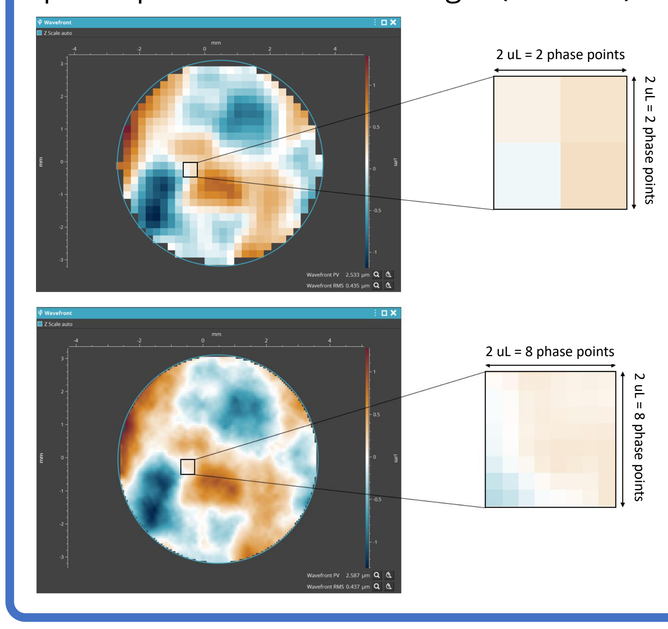
B> LIFT [1, 2, 3] **sensor:**
intensity distribution of the centroids is analyzed along with their lateral position in order to reconstruct a **complete phase map in front of each individual µL**.

This new approach leads to a **16-fold increase in resolution** without compromising the other specs of the WFS

[1] R. Gonsalves, "Small-phase solution to the phase-retrieval problem", Opt. Lett., Vol. 26, No 10, pp. 684-685 (2001)
[2] S Meimon, "LIFT: a focal-plane wavefront sensor for real-time low-order sensing on faint sources", Opt. Lett., Vol. 35, No 18 (2010)
[3] A. Tokovin and al., "Donut: Measuring optical aberrations from single extrafocal image" Pub. Astron. Soc. Pacific 118, 1165 (2006)

High resolution...

LIFT improvement is displayed below with the characterization of freeform phase plate at SWIR wavelength (1550nm):



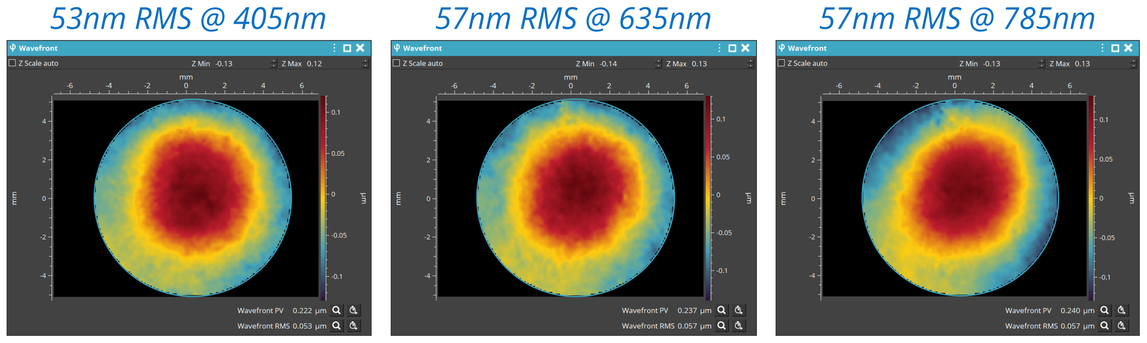
Standard Shack-Hartmann wavefront measurement
Resolution = 28 x 28
PV = 2.350µm,
RMS = 0.444µm

LIFT wavefront measurement
Resolution = 112 x 112
PV = 2.552µm,
RMS = 0.452µm

...and achromatic !

Plane optics measured on Ø4" diameter at 3 wavelengths:

53nm RMS @ 405nm *57nm RMS @ 635nm* *57nm RMS @ 785nm*



MESO™

Key features:
- Insensitive to vibrations
- At wavelength metrology
- Insensitive to reflections from sample back surface

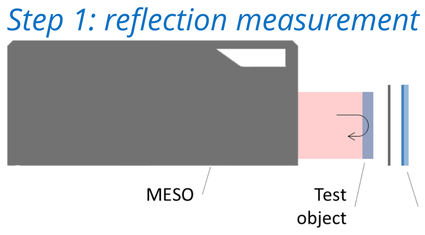
Key specifications:
- Horizontal or vertical integration
- Test beam diameter: from 1.5" up to 6"
- Up to 4 simultaneous sources: from 405nm to 1064nm
- Phase sampling: 680 x 500,
  camera: 4096 x 3000 pixels, 10 bits, 27µs

Parallel Optics testing

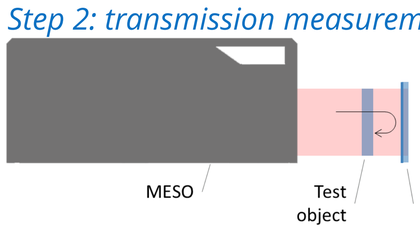
Parallel Optics represent a **challenge** for many of the established optical metrology solutions, such as laser interferometers because of the back surface reflection from the sample (windows for cell phones, filters for lidar or biophotonics, substrates such as wafer, etc.)

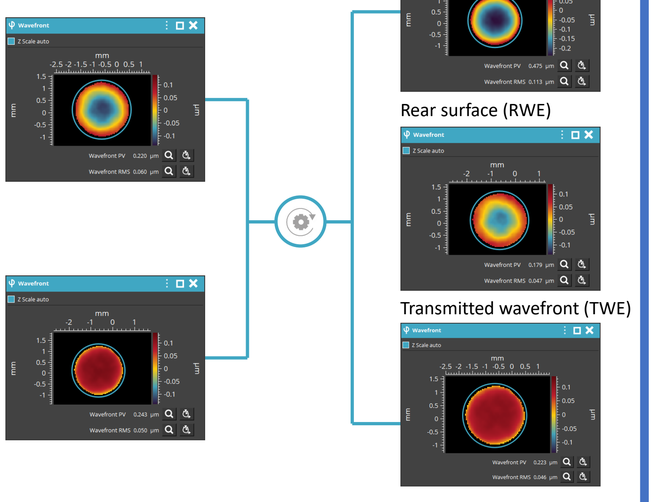
Imagine Optic **patented** a 2-steps procedure:

Step 1: reflection measurement



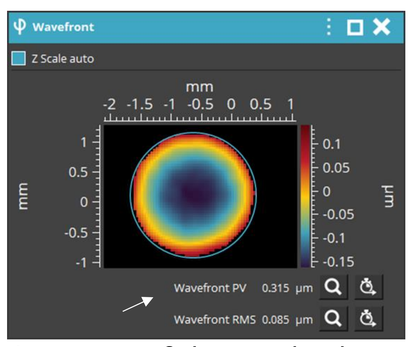
Step 2: transmission measurement





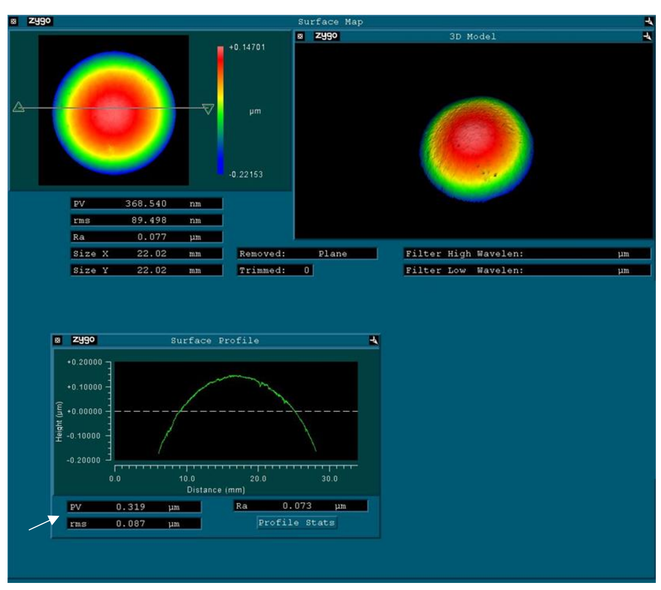
Advantages:
- 3 measurements surface shape of both surfaces and transmitted wavefront
- No preparation of the sample, no manipulation during measurement

5 min.



Accuracy of the method can be compared with a surface map acquired with a white light interferometer (on small pupils stitched together)

5 hours



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