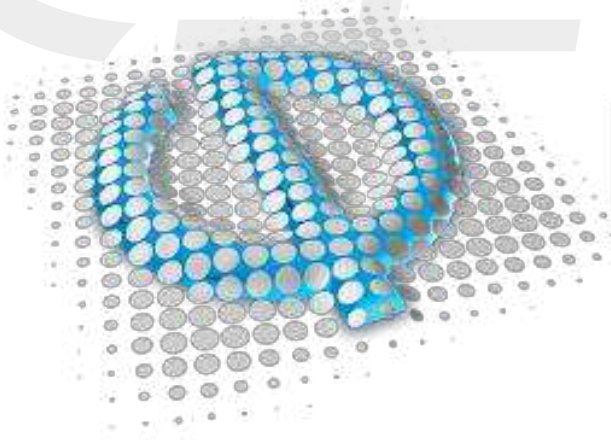
Innovative
Wavefront Sensing Technology



PHASICS
the phase control company

上海昊量光电设备有限公司 Phone: 4006-888-532 WeChat: Auniontech Website: www.auniontech.com E-mail: info@auniontech.com

Applications

LASER

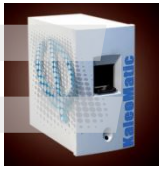
Laser Beam Characterization

Phase/Intensity, M^2, Waist position/size, Zernike/Legendre coeff.

Adaptive Optics

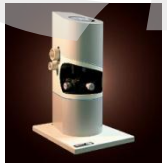
Focal spot optimization, Beam shaping

OPTICS



Optic Surface Characterization

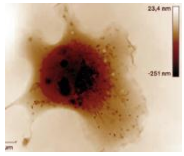
Surface quality (RMS, PtV, WFE), Radius of curvature



Optics Quality Characterization

MTF, PSF, EFL, Zernike coefficients

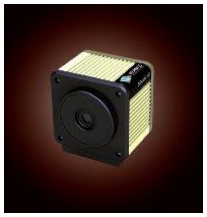
BIO



Biological Imaging

Quantitative Phase Imaging

SID4 wavefront sensors

UV	 **SID4UV-HR, SID4-UV-GE** Lasers, Wafer inspection	**193-400 nm** 250x250 0.5 nm sensitivity
Visible and NIR	 **SID4, SID4HR, SID4BIO** Lasers, Metrology, Imaging	**400-1100 nm** up to 400x300 1 nm sensitivity
	 **SID4-NIR** Telecom lasers @ 1,55 µm	**1,55 µm** 160x120 3 nm sensitivity
IR	 **SID4-LWIR, SID4-DWIR** IR objectives, CO2 lasers	**3-14 µm (II and III bands)** 96x72 10 nm sensitivity

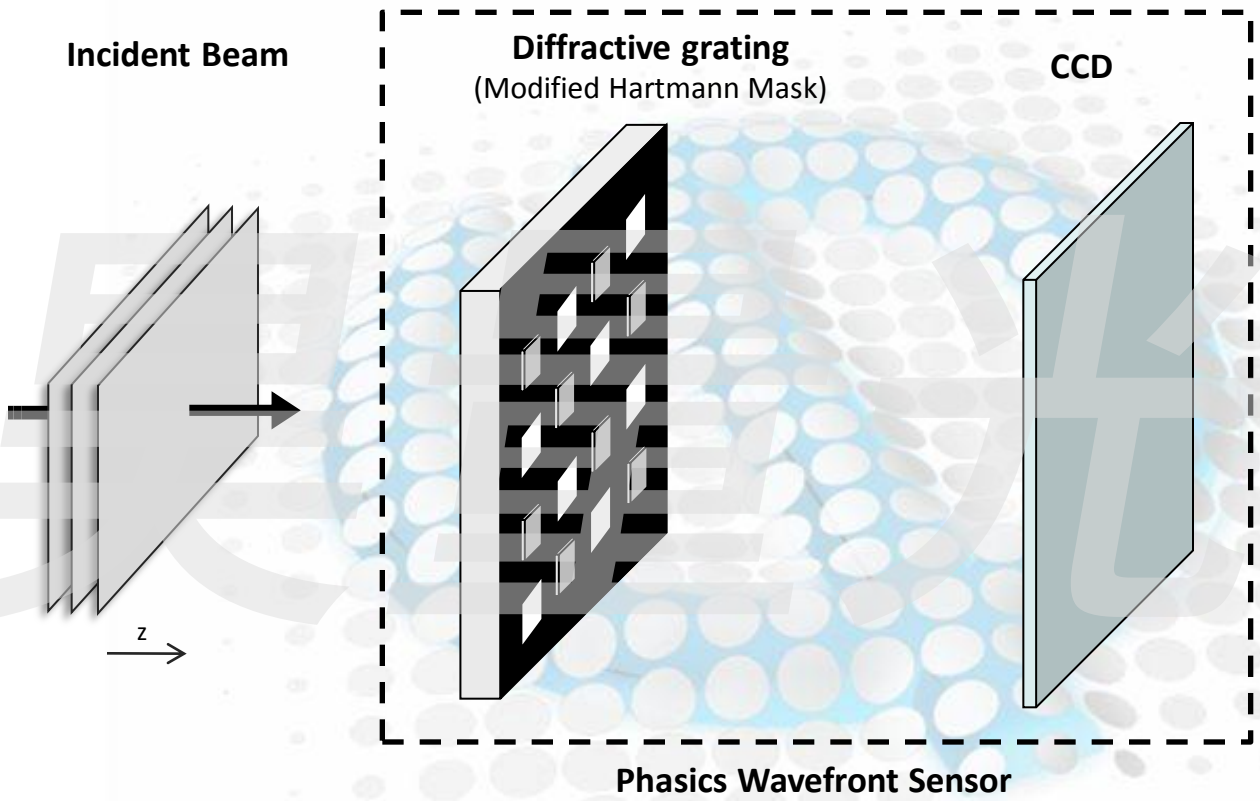
The Technology:

« *4-Wave Lateral Shearing Interferometry* »

How it works

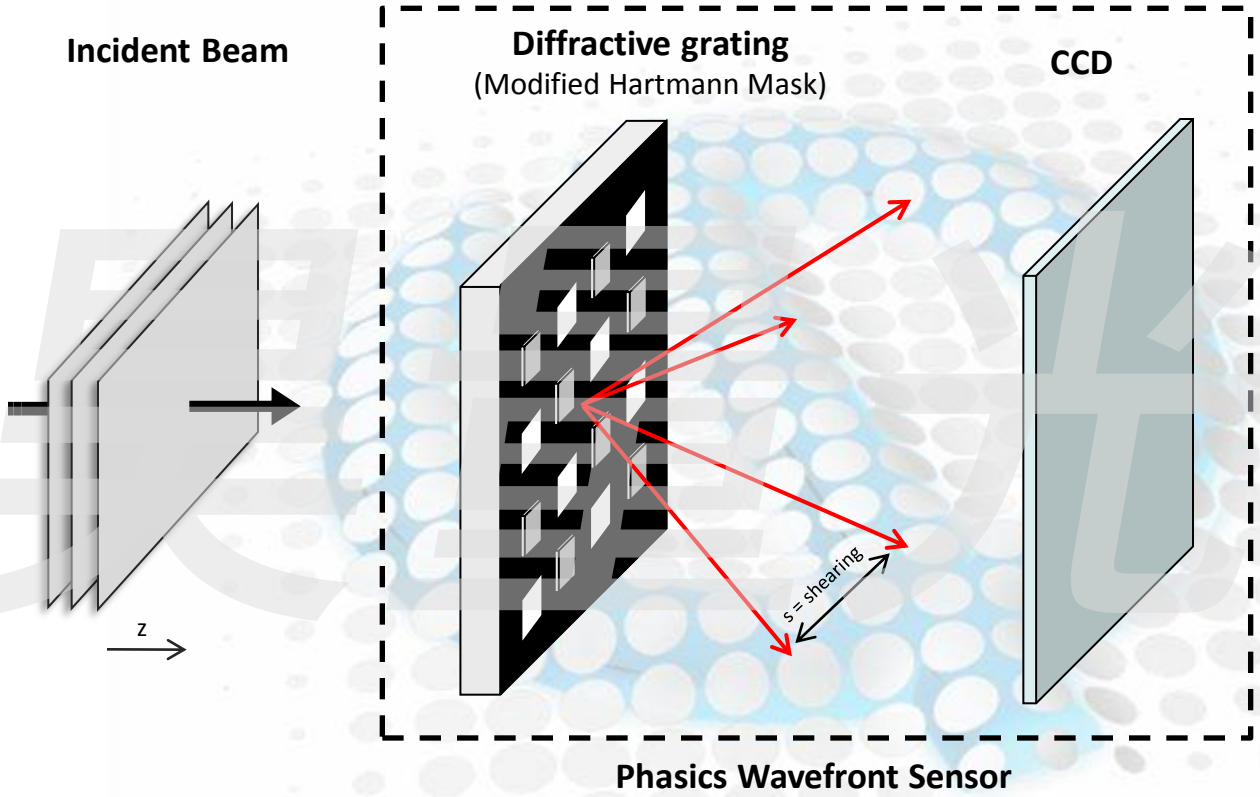
The advantages

How It Works



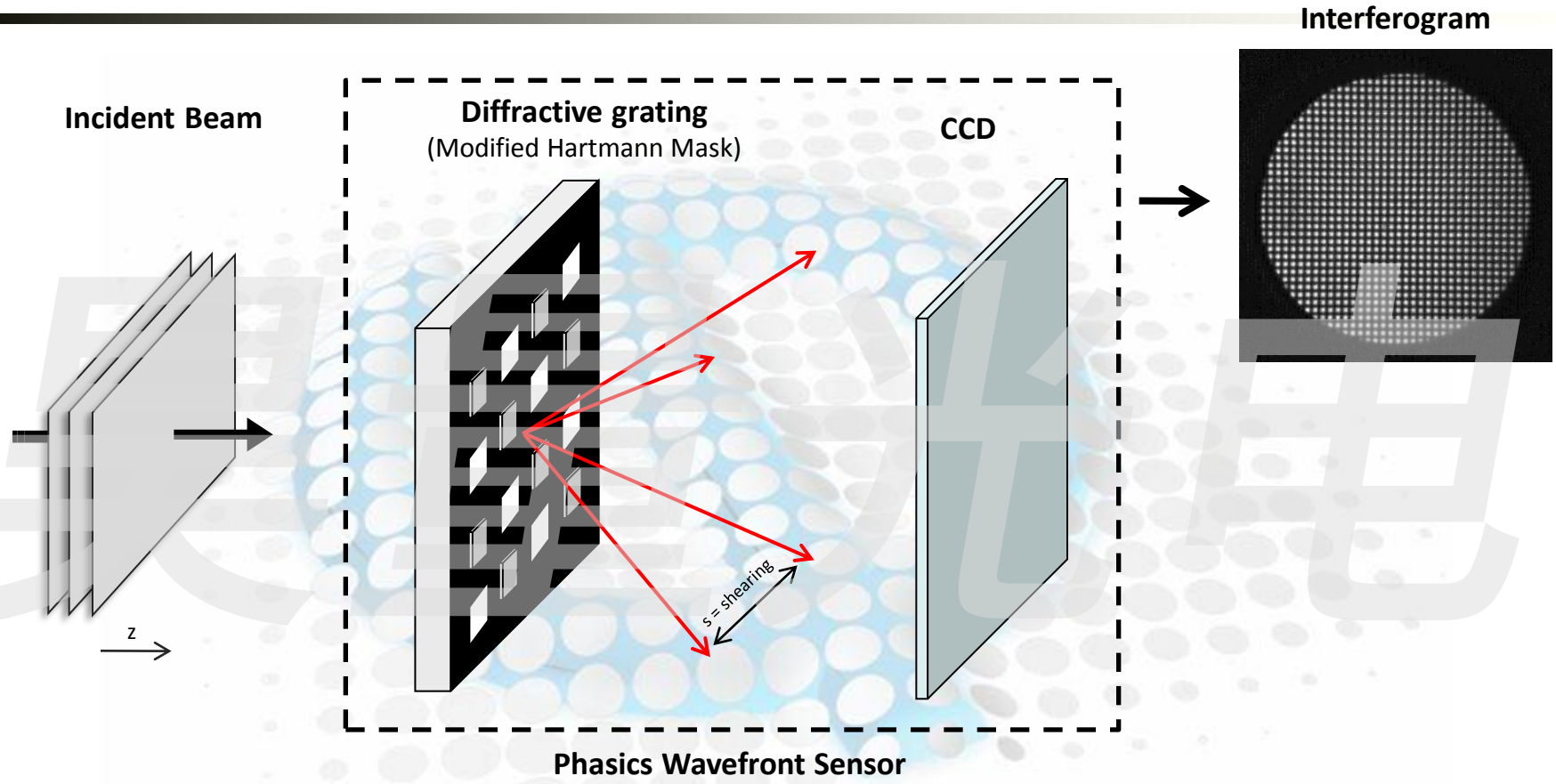
1. The incident wavefront is sampled through the diffractive grating.

How It Works



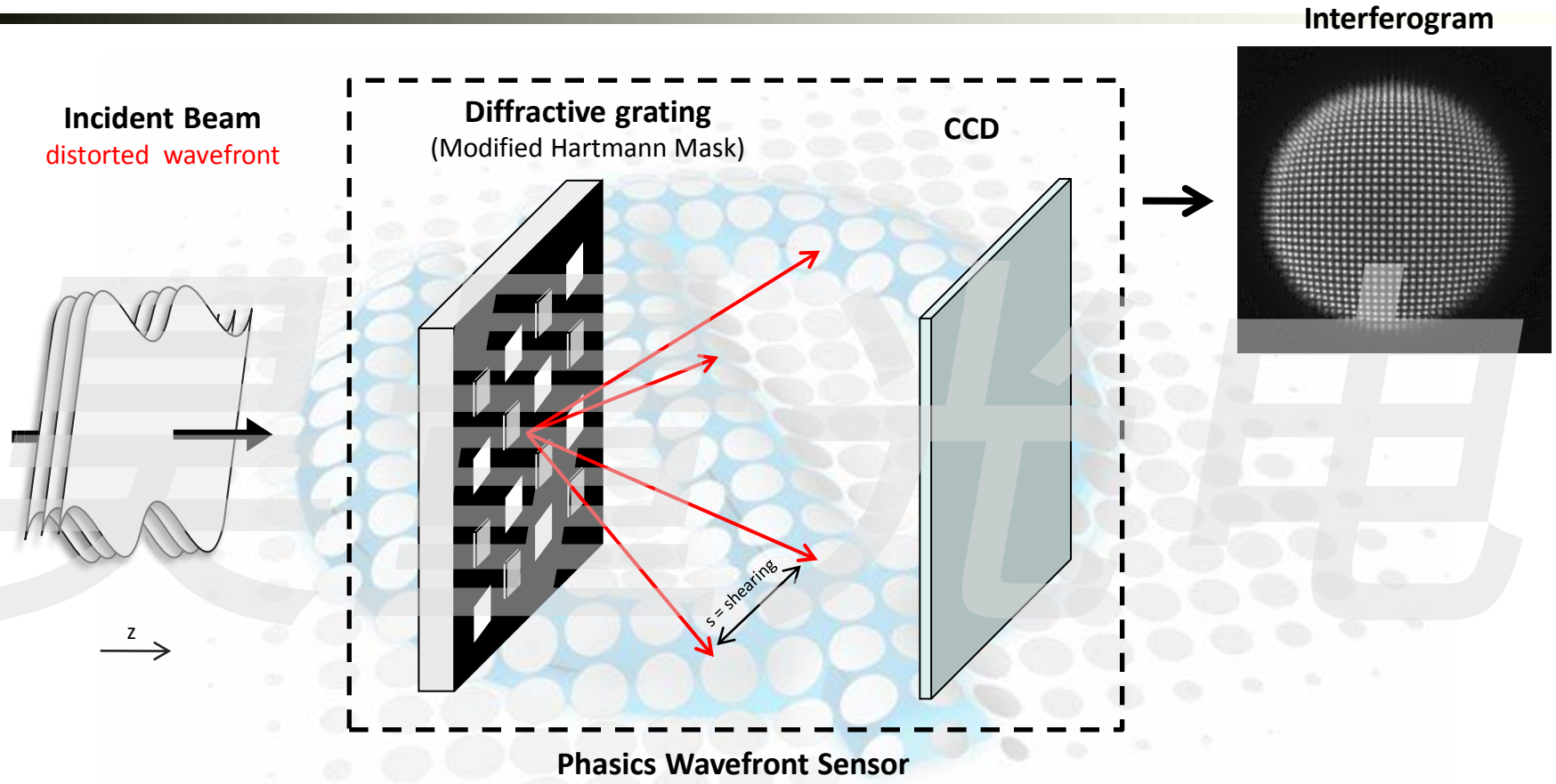
2. The diffraction grating replicates the incident beam into 4 identical waves which are propagated along slightly different directions.

How It Works



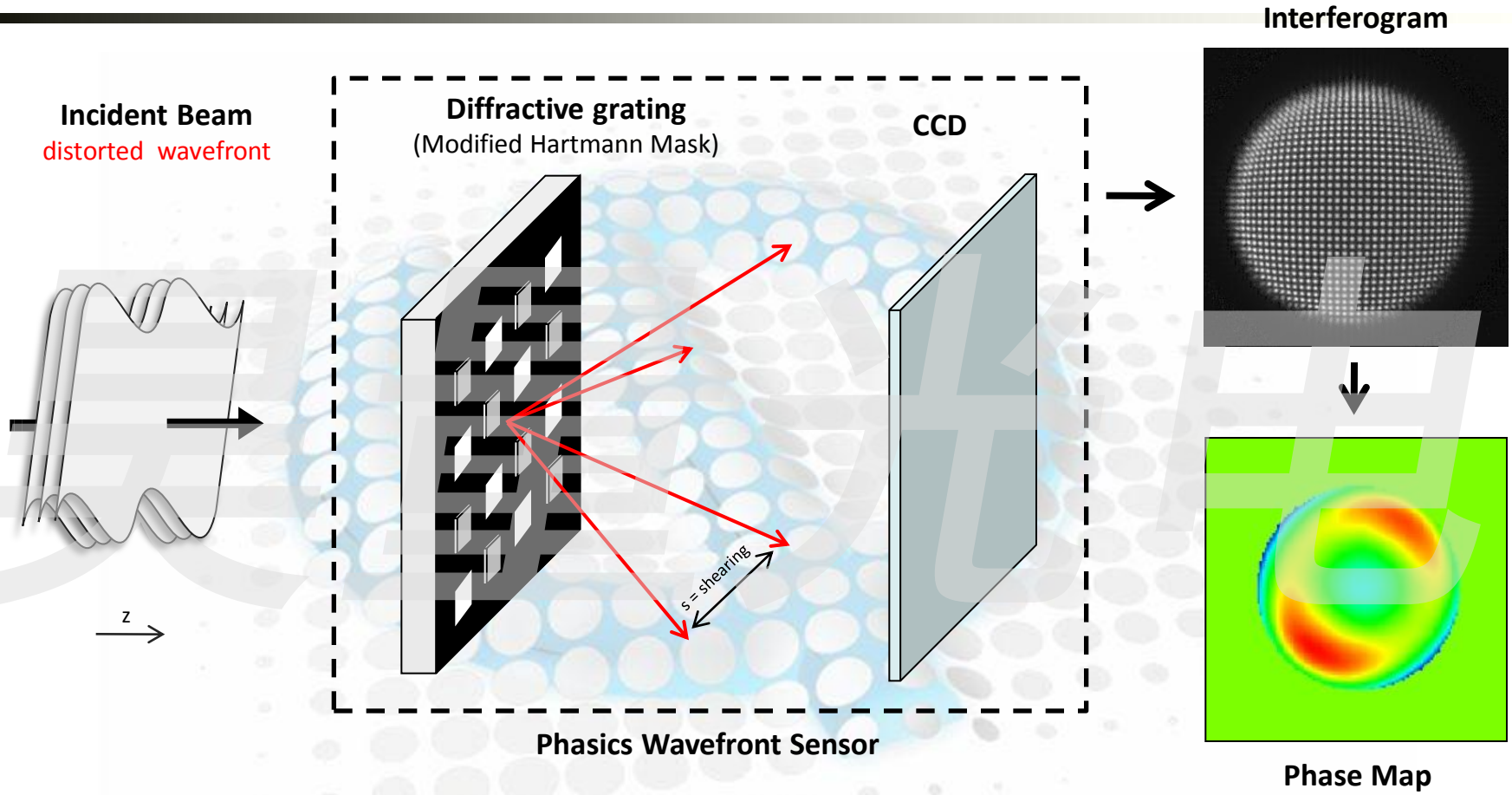
3. The direction differences create interference patterns. In our case, this is made of sinusoidal fringes.

How It Works



4. When aberrations are present on the beam, the interference grid is distorted.

How It Works



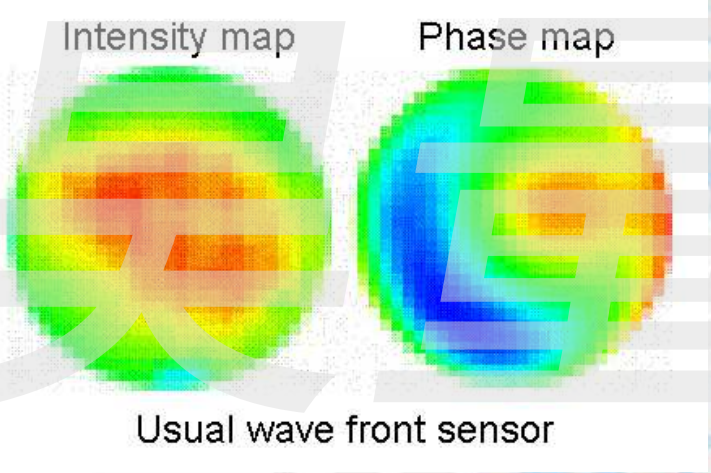
5. A spectral analysis using Fourier transform allows the phase gradient extraction in 2 orthogonal directions. The phase map is finally obtained by integration of these gradients.

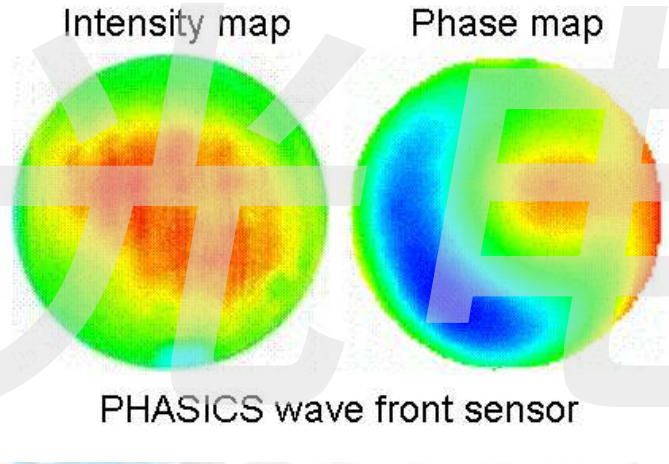
The Advantages

- ✓ **High Resolution** Up to 400x300 measurement points
- ✓ **Achromaticity** Works at different wavelength
- ✓ **High Dynamic** Up to 500µm
- ✓ **UV, Visible, NIR, MWIR and LWIR** (190nm to 14µm)
- ✓ **Easy Setup**

The Advantages

✓ **High Resolution** Up to 400x300 measurement points





The innovative technology developed by Phasics offers a **high resolution** phase map to the SID4 wavefront sensors range. The standard resolution is 160x120 measurement points and the highest is 400x300.

The Advantages

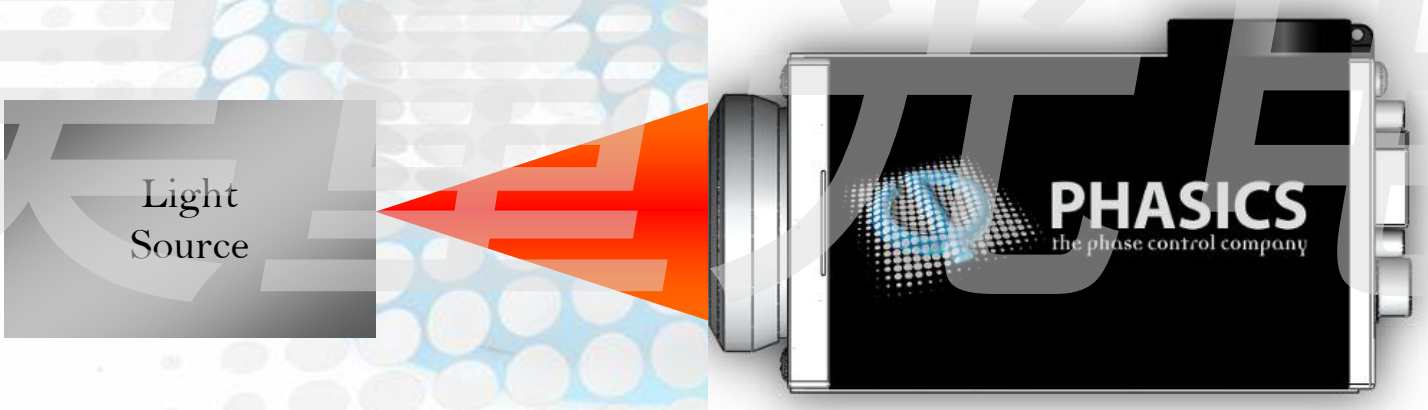
✓ Achromaticity

Classical interferometer pitch is strongly dependent on wavelength. In our case, thanks to the use of a diffraction grating, multi-wave lateral shearing interferometers are achromatic : the chromaticity of the grating is exactly compensated by the interference chromaticity. The interferogram pitch is exactly equal to the grating pitch.

Therefore The SID4 wavefront sensors can be used at different wavelength without additional calibration on the whole detection range of the camera. It can be used with polychromatic light, well adapted for short pulses laser.

The Advantages

- ✓ **Direct measurement of divergent beams** up to 0.1 NA (0.5 NA optional)



The Products

Setup and Features

Software

Setup and Features

Laser Characterization

Setup

Features

Complete Laser Beam Characterization

- ✓ High Resolution Phase and Intensity Map
- ✓ M^2, Strehl ratio, Zernike
- ✓ Waist position and size
- ✓ Beam profiler

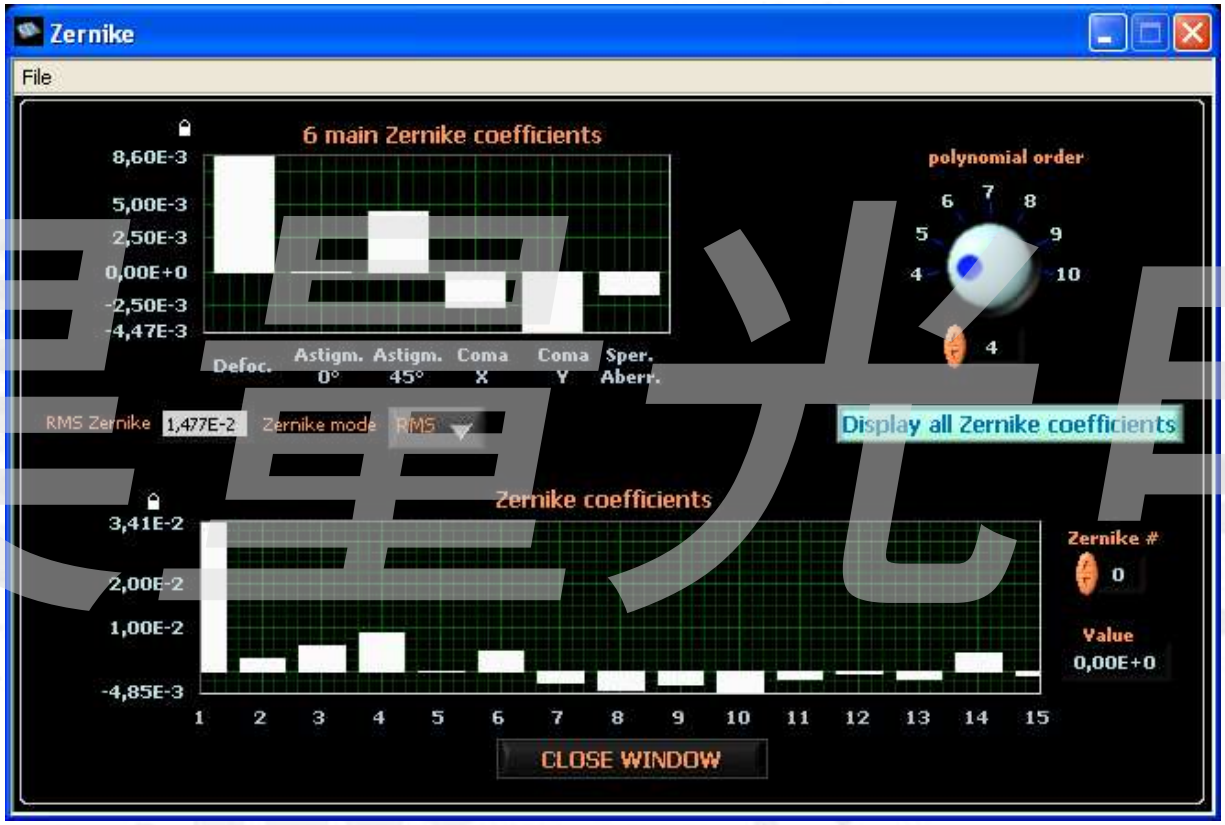
Software

(Laser Beam Characterization)

High Resolution Phase and Intensity Map

Software

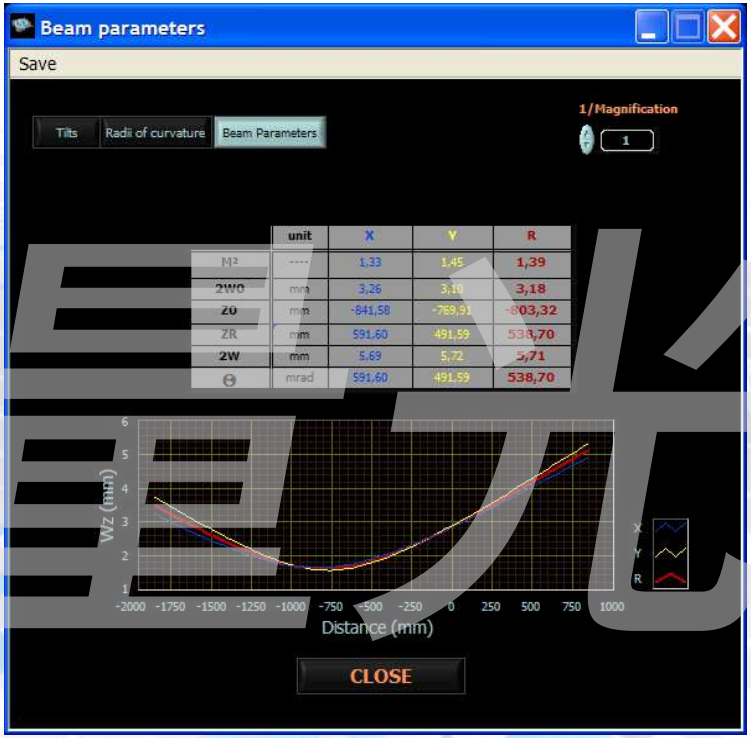
(Laser Beam Characterization)



Zernike coefficients

Software

(Laser Beam Characterization)



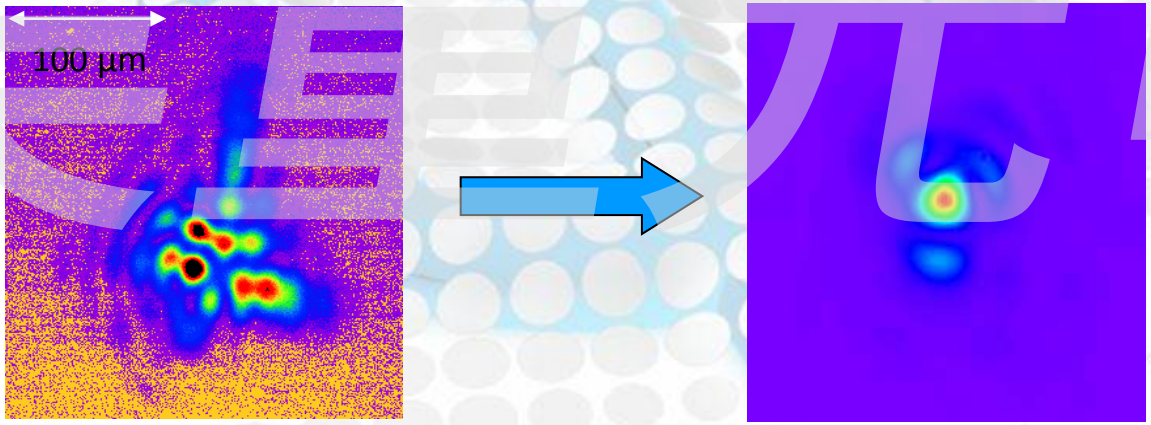
Beam parameters : Waist size and position, M^2, Strehl ratio..

Specifications of SID4 and SID4-HR

	SID4	SID4-HR
Aperture	3,6 x 4,8 mm²	8,9 x 11,8 mm²
Spatial resolution	29,6 µm	29,6 µm
Sampling	160 x 120 (>19000 points)	400 x 300 (>120 000 points)
Wavelength	350 nm - 1100 nm	350 nm - 1100 nm
Dynamic	> 100 µm	> 500 µm
Accuracy (absolute - relative)	10 nm RMS – 3 nm RMS	10 nm RMS – 2 nm RMS
Sensitivity	3 nm RMS	2 nm RMS
Acquisition frequency	60 fps	10 fps
Analysis frequency	> 10Hz (High resolution)	> 3Hz (High resolution)
Dimension	49 x 35 x 110 mm	76 x 63 x 132 mm
Weight	250 g	620 g

Adaptive optics by PHASICS

- ✓ Beam focus optimization
- ✓ Beam shaping
- ✓ **3D-position control of the focal spot**
- ✓ **Final focusing optics correction**



Without Adaptive Optics

With Adaptive Optics

Example on beam: 80 J / 600 ps

Adaptive Optics Loop software : OASys

The right solution for your AO loop

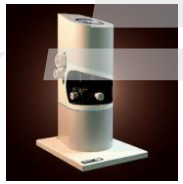
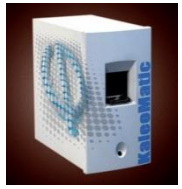
- Expertise on numerous high power laser facilities
- Advice & Design for your laser chain
- Customized deformable mirrors
- Compatible with various AO solutions

(bimorph, membrane, SLM…)

Products for Optical Metrology

KALEO systems

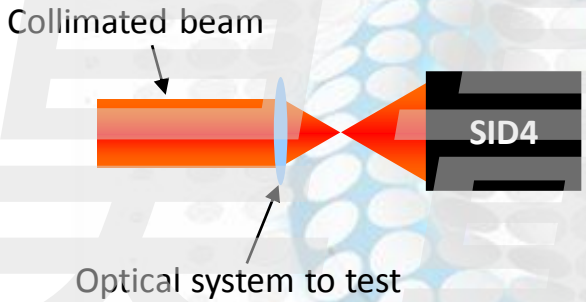
Characterization of optics (objectives, micro-lenses, intra-ocular lenses, ...)

	Surface (Roughness, Curvature)	Optical Quality (MTF, PSF, Zernike)
OEM		SID4 wavefront sensor + KALEO software
Manual		Manual KALEO system
Automated		Automated KALEO system

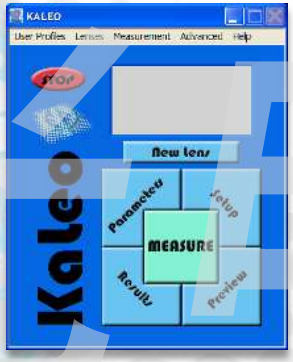
OEM KALEO

SID4 wavefront sensor + KALEO software

Analysis Method



KALEO Software



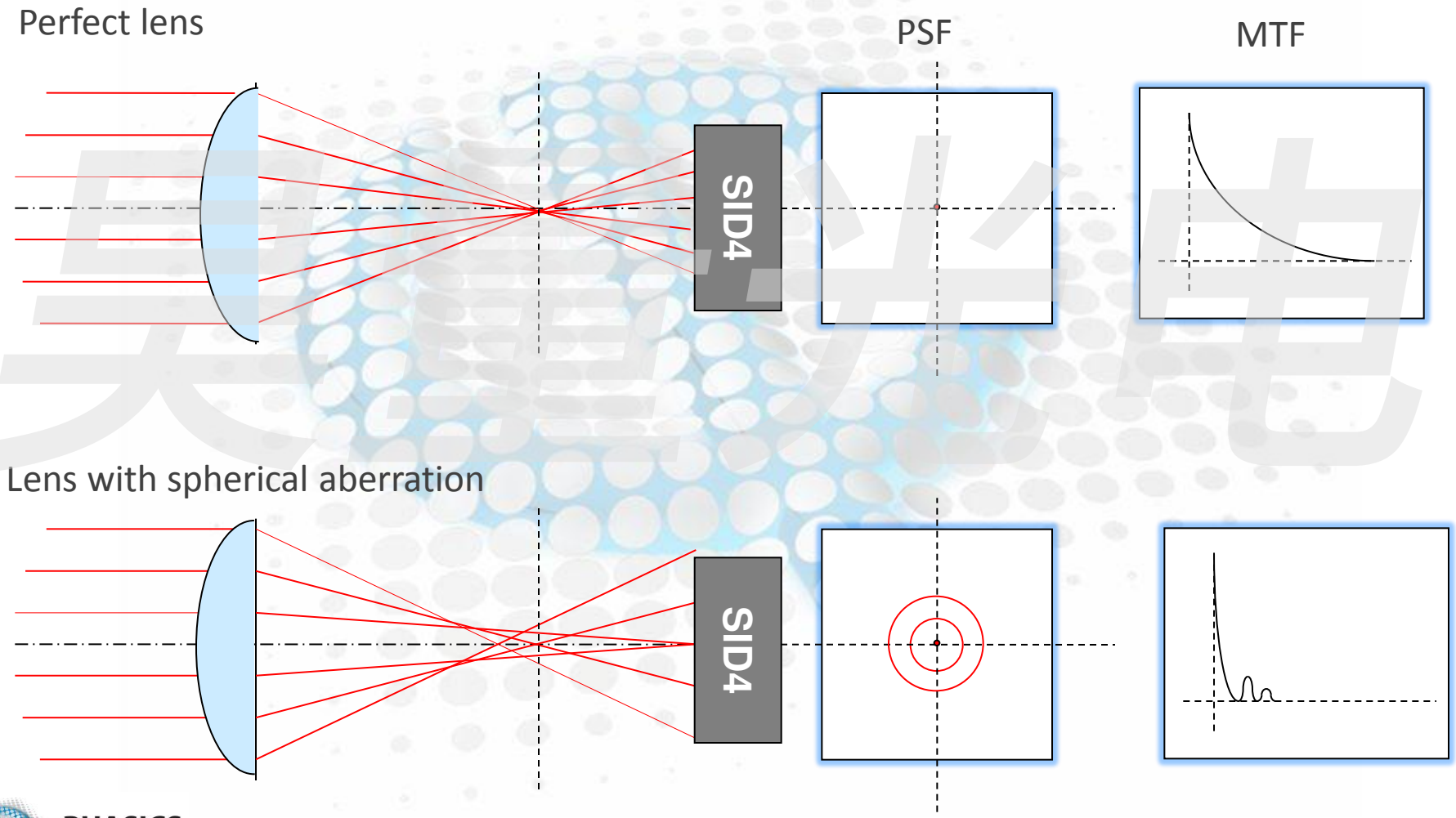
- ✓ Measure in diverging beam
- ✓ No lens diameter limitation
- ✓ Direct measurement
  (no additional optics needed)

One measurement → Complete characterization

- ✓ Aberrations (Zernike coeff.)
- ✓ MTF & PSF
- ✓ EFL

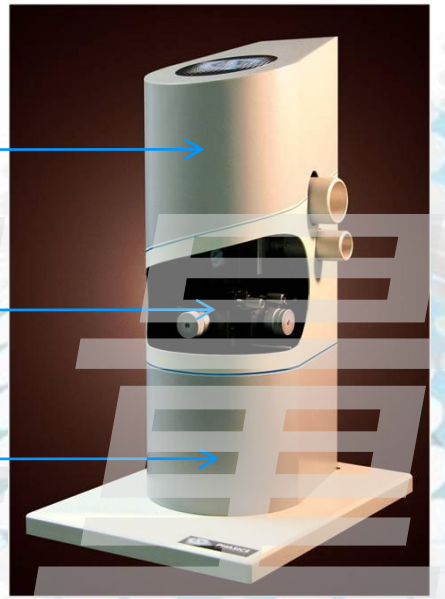
How It Works

Direct MTF measurement with wavefront sensing



KaleoT (Manual)

Complete characterization of lens and objectives



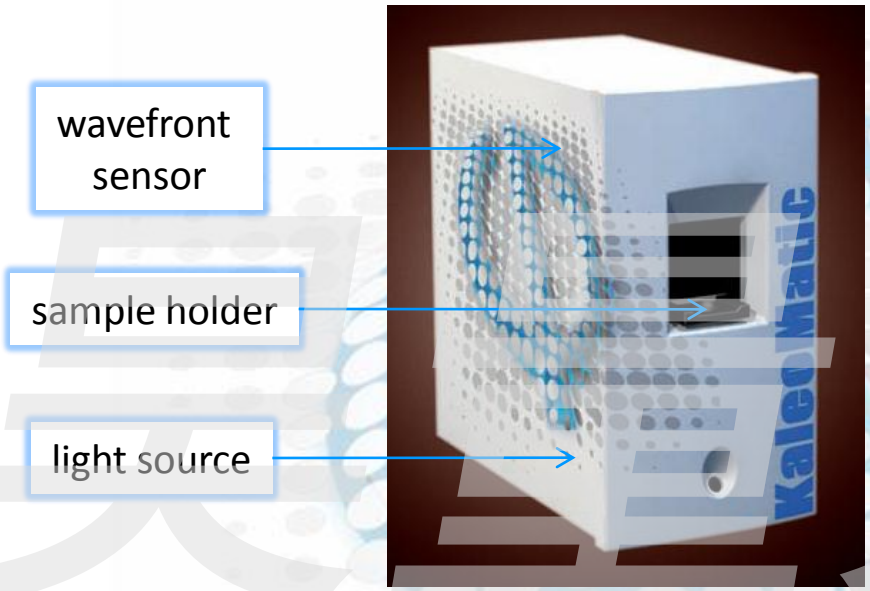
Diameter	3 mm to 20 mm
Numerical Aperture	NA : 0.03 to 0.3 f/16.6 to f/1.6
Focal length	3 to 50 mm
Resolution	120 x 120
Wavelength	350 nm - 1100 nm
Precision	10 nm RMS
Repeatability	1 nm RMS
Source interface	Fiber optic

Features

- Complete lens characterization MTF, PSF, Zernike/Seidel, EFL
- High NA optics measurement (no relay lens!)
- Customizable report

KaleoT (Automatic)

Complete characterization of lens and objectives



Diameter	3 mm to 20 mm
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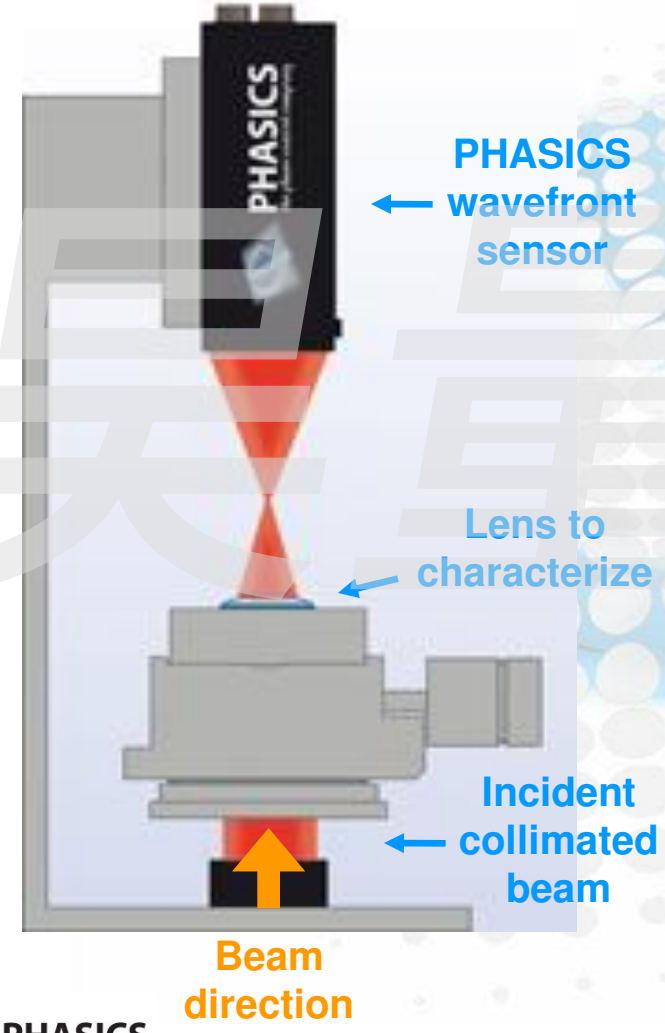
Source interface	Fiber optic

Features

- Complete lens characterization MTF, PSF, Zernike/Seidel, EFL
- High NA optics measurement (no relay lens!)
- Customizable report

Kaleo

Lens quality measurement



Description

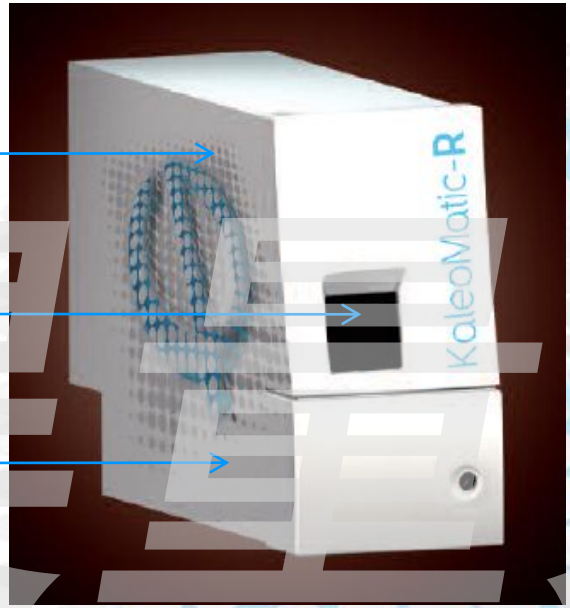
Calibrated light goes through the lens.
The sensor measures the deviation from a sphere of the wavefront transmitted.

Advantage

The wavefront sensor can work with very high diverging beams
→ No relay lens needed

KaleoR

Complete characterization of lens and objectives



	Kaleo R10
Collimated beam diameter	10 mm
Diameter - Range (up to)	9 mm (CX)
	25 mm (CC)
	10 mm (F)
Radius of curvature - Range (up to)	17 mm (CX)
	70 mm (CC)
Radius of curvature -Precision	< 2 µm
Surface quality - Precision	50 nm
Surface quality - Repeatability (RMS)	2 nm (1σ)
Surface quality - Sampling (up to)	300 x 300
	(90,000 points)
Aspherical SAG	100 µm

Features

- Radius of curvature measurement
- Surface quality measurement (RMS, PtV, WFE)
- Dedicated software

Conclusion

- 4-Wave Lateral Shearing Interferometry is a powerful tool for:
  - Laser characterization
  - Optical metrology
  - Complete lens characterization (Aberrations, MTF, focal length)
  - Surface characterization
- Optical metrology product range: SID4, Kaleo-T, Kaleo-R
- Customized solution and adapted advices given by PHASICS