

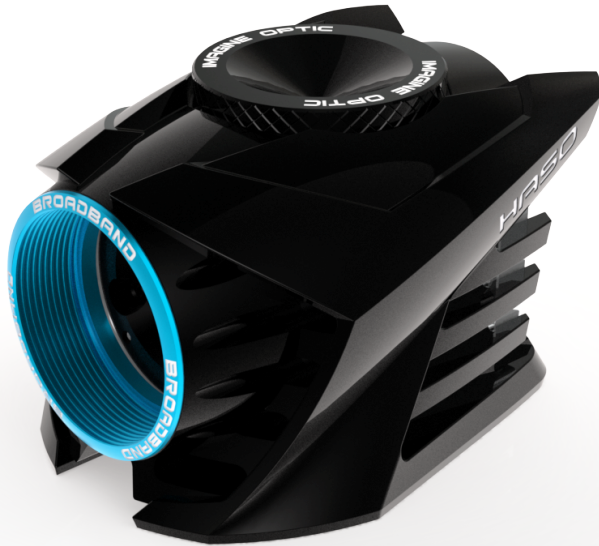
NEW DESIGN
More robust
Easy integration

HIGH ACCURACY
WAVEFRONT SENSOR

CALIBRATION
FOR $\lambda = 350-1100$ nm

COMPACT
ROBUST AND VERSATILE

EASY TO USE
AND INTEGRATE



Spot Tracker

Wavefront sensing has never been so easy,
no alignment required

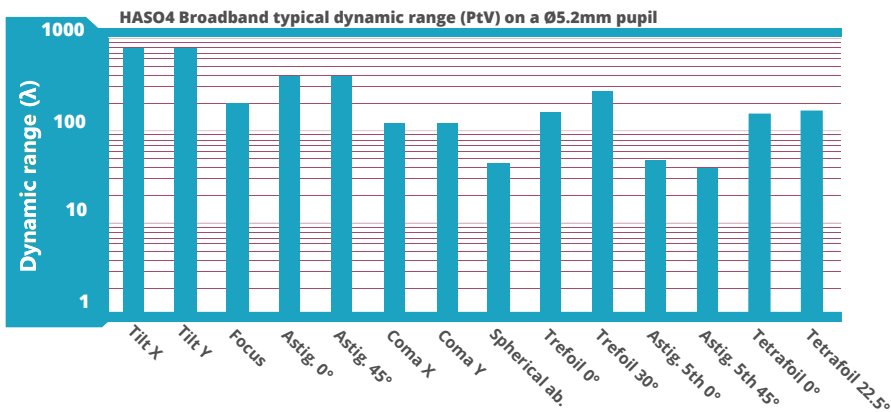
A UNIQUE SET OF ADVANTAGES

- Wavefront sensor in-house calibration for 350-1100 nm
- $\lambda/100$ rms absolute accuracy over 800λ dynamic range
- Patented technology for simultaneous and independent measurements of phase and intensity
- 20 Hz acquisition frequency
- External trigger capability
- Optimized for polychromatic and monochromatic beams over the wide spectral range (350-1100 nm)
- C-mount compatible entrance aperture
- USB 3.0 and Ethernet connectivities available
- Bundled with WaveView, the industry's most advanced metrology software
- Compatible with WaveKit (SDK) in C/C++, LabVIEW and Python

THE ADVANCED METROLOGY WAVEFRONT SENSOR

Providing outstanding performance, the HASO Wavefront Sensor family is used in the most demanding applications in optical metrology, microscopy and laser diagnostics worldwide. We offer a unique combination of expertise in high quality microlens production, software development and accurate factory calibrations. This allows the HASO4 Broadband to provide a level of performance beyond comparison for application over the full spectral range of silicon (350-1100 nm).

- $\lambda/100$ rms absolute accuracy on a huge dynamic range (see the graph below)
- Patented wavefront correction algorithms for intensity beam variations (laser, Gaussian, hyper Gaussian, apodized beams...)
- Measurement up to 64 Zernike polynomials with individual accuracy better than 6nm rms
- **S^{pot} Tracker** provides easy HASO installation, and the capability to precisely follow absolute tilt/wavefront evolution over time.



OUTSTANDING PERFORMANCE EXAMPLES WITH

- Beam collimation with an accuracy better than 300m radius of curvature
- A 20mm focal length measurement with a sensitivity of 1 μ m rms
- Direct wavefront acquisition of converging and diverging F/5 beams with an accuracy of about $\lambda/100$ rms including astigmatism and high order aberrations
- Control and adjustment of axial laser beam deviation better than 3 μ rad rms
- 3D localization of a focal spot up to 0.1 μ m rms and 1 μ m rms for lateral and axial resolution respectively (0.1 NA beam)

SOFTWARE

- WaveView is the most advanced wavefront measurement and analysis software. It offers more than 150 features and tools optimized for a wide range of highly demanding applications. WaveView development philosophy is based on tens of years of customer's feedback, improving the user experience at each version. Modules dedicated to PSF, MTF and Strehl ratio are available.
- WaveKit is a SDK in C/C++, LabVIEW and Python, providing the basis blocks on which one can build a fully customized software for specific HASO based applications or WaveView data processing routines. WaveKit is available on request.

Aperture dimension	7.0 x 5.2 mm ²
Number of microlenses	68 x 50
Tilt dynamics range	> $\pm 3^\circ$
Focus dynamics range	± 0.010 m to $\pm \infty$
Repeatability	< $\lambda/200$ rms
Wavefront measurement accuracy in absolute mode λ between 350-600 nm λ between 600-1100 nm	≤ 6 nm rms $\sim \lambda/100$ rms *
Spatial sampling	$\sim 105 \mu$ m
Maximum acquisition frequency	20 Hz
External trigger	TTL signal
Calibrated wavelength range	350 - 1100 nm
Dimension/weight for USB version	42 x 47x 60 mm ³ / 185g
Working temperature	15 - 30 °C
Interface / Power consumption	Ethernet / 2.9 W USB 3.0 / 2.9 W
Operating system	Windows 7 and 10
Minimum power	0.15 nW**

* The absolute accuracy may slightly decrease for the wavelengths longer than 800nm. Above 950nm, the accuracy is ensured for light sources with coherence length smaller than 3 mm.

** At 635nm and 20Hz acquisition frequency on the 5.2mm maximum pupil diameter

HASO SWIR

CALIBRATED FOR
0.9 - 1.7 μm

LAMBDA/100
ABSOLUTE ACCURACY

20HZ LIVE
WAVEFRONT DISPLAY

ULTRASHORT
EXPOSURE TIME OPTION



High accuracy Shack-Hartmann wavefront sensor for SWIR

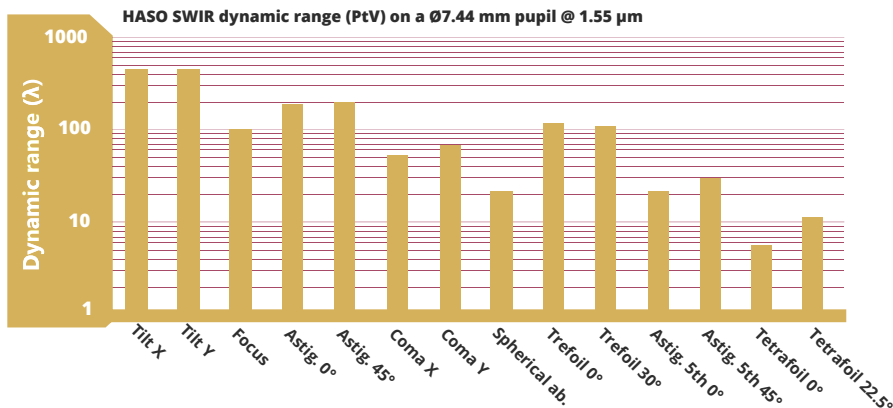
A UNIQUE SET OF ADVANTAGES

SpotTracker

- Calibration for 0.9 - 1.7 μm
- $\lambda/100$ rms absolute accuracy over 400λ PtV dynamic range
- Up to 150Hz in sequence mode
- Fast mode available for adaptive optics
- Patented technology for simultaneous and independent measurements of phase and intensity
- External trigger capability
- Absolute wavefront measurements without alignment, thanks to the new SpotTracker technology
- Optimized for polychromatic and monochromatic beams over a wide spectral range
- C-mount compatible entrance aperture
- Easy to deploy with USB 3.0 connectivity
- Bundled with WaveView, the industry's most advanced wavefront metrology software
- Compatible with WaveKit (SDK) in C/C++, LabVIEW and Python

Providing outstanding performance, the HASO Wavefront Sensor family is used in the most demanding applications in optical metrology, free-space communication and laser diagnostics worldwide. We offer a unique combination of expertise in high quality microlens production, software development and accurate factory calibrations. The new HASO SWIR provides a level of performance beyond comparison for applications over the short wavelength infrared range, 0.9 - 1.7 μ m.

- $\lambda/100$ rms absolute accuracy for incoherent and $\lambda/50$ rms for coherent light on a huge dynamic range (see the graph below)
- Measurement more than 150 Zernike polynomials with individual accuracy better than 5 nm rms



EXAMPLES OF APPLICATIONS

- Checking beam collimation with an accuracy better than 300m radius of curvature
- Direct wavefront acquisition of converging and diverging F/5 beams with an accuracy of about $\lambda/100$ rms including astigmatism and high order aberrations
- Control and adjustment of axial laser beam deviation better than 5 μ rad rms
- Optical quality control, metrology, LIDAR and adaptive optics

SOFTWARE

- WaveView is the most advanced wavefront measurement and analysis software. It offers more than 150 features and tools optimized for a wide range of highly demanding applications. WaveView development philosophy is based on tens of years of customer's feedback, improving the user experience at each version. Modules dedicated to PSF, Strehl ratio, MTF, M² are available.
- WaveKit is a SDK in C/C++, LabVIEW and Python, providing the basis blocks on which one can build a fully customized software for specific HASO based applications or WaveView data processing routines. WaveKit is available on request.
- Patented wavefront correction algorithms for intensity beam variations (laser, Gaussian, hyper Gaussian, apodized beams...)

SPECIFICATIONS

Aperture dimension	9.30 x 7.44 mm ²
Number of microlenses	40 x 32
Tilt dynamic range	> $\pm 3^\circ$
Focus dynamic range	± 0.042 m to $\pm \infty$
Repeatability	$\sim \lambda/200$ rms
Wavefront measurement accuracy in absolute mode	$\sim \lambda/100$ rms
Spatial sampling	232.5 μ m
Maximum acquisition frequency	150 Hz
External trigger	Possible
Calibrated spectral range	0.9 - 1.7 μ m
Dimension / Weight	75 x 78 x 63 mm ³ / 250g
Working temperature*	5 - 35°C
Interface / Power consumption	USB 3.0 / < 5W
Operating system	Windows10
Minimum power**	0.3 pW
Exposure time for Gated option	100ns - 9 μ s

* Internally stabilized temperature at 15°C

** On the largest circular pupil with 1s exposure duration



This new Imagine Optic technology provides easy HASO installation and the capability to precisely follow absolute tilt/wavefront evolution over time.

HASO4 SWIR 1550

NEW DESIGN
More robust
Easy integration

IDEAL WAVEFRONT
SENSOR FOR 1500 - 1600 nm

ADVANCED
METROLOGY WAVEFRONT SENSOR

COMPACT
ROBUST AND VERSATILE

EASY TO USE
AND INTEGRATE



The ideal tool for aligning and characterizing optical components or optical systems in the near infrared

A UNIQUE SET OF ADVANTAGES

- $\lambda/35$ rms absolute accuracy over 200λ dynamic range
- Calibrated wavelength range: 1500 -1600 nm
- Patented technology for simultaneous and independent measurements of phase and intensity
- 99 Hz acquisition frequency
- External trigger capability
- C-mount compatible entrance aperture
- Easy to deploy with USB 3.0 connectivity
- Bundled with WaveView, the industry's most advanced metrology software
- Compatible with WaveKit (Software Development Kit) in C, MATLAB, and LabVIEW

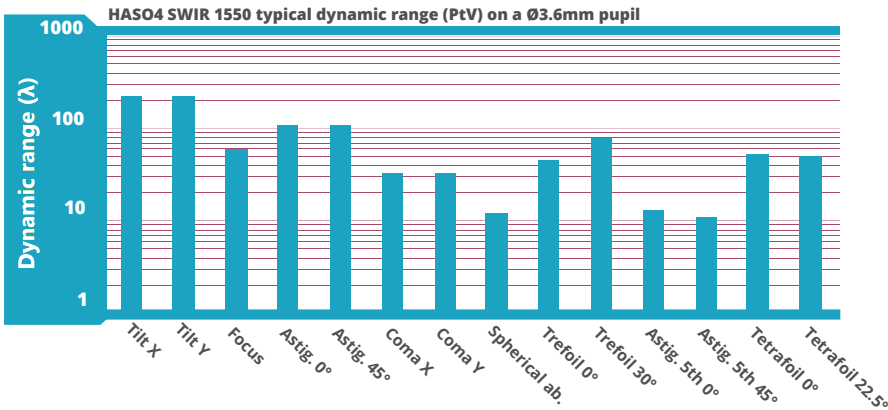
Contact us for more details: contact@imagine-optic.com or +33 1 64 86 15 60

HASO4: THE ADVANCED METROLOGY WAVEFRONT SENSOR

SWIR 1550

Providing outstanding performance, the HASO Wavefront Sensor family is used on the most demanding applications in optical metrology, microscopy and laser diagnostics worldwide. We offer a unique combination of expertise in high quality microlens production, software development and accurate factory calibrations. This allows the HASO4 to provide a level of performance beyond comparison.

- $\lambda/35$ rms absolute accuracy on a huge dynamic range (see the graph below)
- Measurement up to 64 Zernike polynomials
- Patented wavefront correction algorithms for intensity beam variations (laser, Gaussian, hyper Gaussian, apodized beams...)



OUTSTANDING PERFORMANCE EXAMPLES WITH HASO4 SWIR 1550

- Beam collimation with an accuracy better than 30m radius of curvature.
- Direct wavefront acquisition of converging and diverging F/5 beams
- Control and adjustment of axial laser beam deviation better than 20μrad rms
- 3D localization of a focal spot up to 0.5μm rms and 5μm rms for lateral and axial resolution respectively (0.1 NA beam)

SOFTWARE

- WaveView is the most advanced wavefront measurement and analysis software. It offers more than 150 functions and tools optimized for a wide range of highly demanding applications. WaveView development philosophy is based on tens of years of customer's feedback, improving the user experience at each version. Modules dedicated to PSF, Strehl ratio, MTF, M² are available.
- WaveKit is a SDK, providing the basis blocks on which one can build a fully customized software for specific HASO based applications or WaveView data processing routines. WaveKit is available on request.

Aperture dimension	3.6 x 4.5 mm ²
Number of microlenses	32 x 40
Tilt dynamic range	> ± 3 °
Focus dynamic range	±0.018m to ±∞
Repeatability (rms)	< $\lambda/70$
Wavefront measurement accuracy in absolute mode (rms)	~ $\lambda/35$
Spatial sampling	~ 110 μm
Maximum acquisition frequency	99 Hz
External trigger	TTL signal
Wavelength range	1500-1600 nm
Dimensions (LxWxH) / weight	60x48 x 42 mm ³ /185g
Working temperature	15 - 30° C
Interface / Power supply	USB 3.0 / 2.7W via USB
Operating system	Windows 7 and 10

HASO4 FIRST

NEW DESIGN
More robust
Easy integration

**IDEAL WAVEFRONT
SENSOR FOR VIS AND NIR**

**ADVANCED
METROLOGY WAVEFRONT SENSOR**

**COMPACT
ROBUST AND VERSATILE**

**EASY TO USE
AND INTERFACE**



**“An excellent instrument, indeed ! So powerful
and easy to use.”**

Bill Dougherty PhD, Senior Scientist
Applied Precision
A GE Healthcare Company

A UNIQUE SET OF ADVANTAGES

- $\lambda/100$ rms absolute accuracy over 400λ dynamic range
- Custom wavelength calibration in the 400 -1100 nm range
- Patented technology for simultaneous and independent measurements of phase and intensity
- Acquisition 99 Hz with full pupil
- External trigger capability
- Ideal for laser applications
- C-mount compatible entrance aperture
- Easy to deploy with USB 3.0 connectivity
- Bundled with WaveView, the industry's most advanced metrology software
- Compatible with WaveKit (Software Development Kit) in C, MATLAB, and LabVIEW

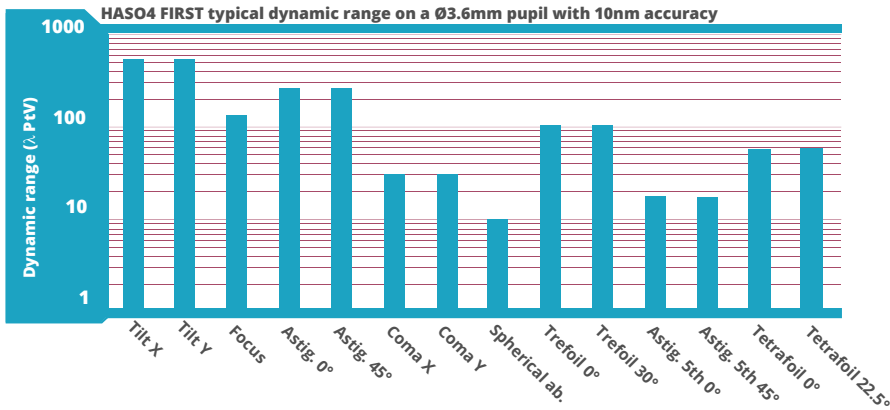
Contact us for more information: contact@imagine-optic.com or +33 1 64 86 15 60

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HASO4 FIRST: THE ADVANCED METROLOGY WAVEFRONT SENSOR

Providing outstanding performance, the HASO Wavefront Sensor family is used in the most demanding applications in optical metrology, microscopy and laser diagnostics worldwide. We offer a unique combination of expertise in high quality microlens production, software development and accurate factory calibrations. This allows the HASO4 FIRST to provide a level of performance beyond comparison.

- $\lambda/100$ rms absolute accuracy on a huge dynamic range (see the graph below)
- Patented wavefront correction algorithms for intensity beam variations (laser, Gaussian, hyper Gaussian, apodized beams...)
- Measurement up to 64 Zernike polynomials with individual accuracy better than 2nm rms
- Custom calibrations for one (included) or two (option) specific wavelengths in the 400-1100nm range



OUTSTANDING PERFORMANCE EXAMPLES WITH : HASO4 FIRST

- Beam collimation with an accuracy better than 200m radius of curvature
- A 20mm focal length measurement with a sensitivity of 1 μ m rms
- Direct wavefront acquisition of converging and diverging F/5 beams with an accuracy of $\lambda/100$ rms including astigmatism and high order aberrations
- Control and adjustment of axial laser beam deviation better than 5 μ rad rms
- 3D localization of a focal spot up to 0.1 μ m rms and 1 μ m rms for lateral and axial resolution respectively (0.1 NA beam)

SOFTWARE

- WaveView is the most advanced wavefront measurement and analysis software. It offers more than 150 functions and tools optimized for a wide range of highly demanding applications. WaveView development philosophy is based on tens of years of customer's feedback, improving the user experience at each version. Modules dedicated to PSF, Strehl ratio, MTF, M² are available.
- WaveKit is a SDK in C, LabVIEW and MATLAB, providing the basis blocks on which one can build a fully customized software for specific HASO based applications or WaveView data processing routines. WaveKit is available on request.

Operating mode	Full pupil	High speed (option)
Aperture dimension	3.6 x 4.5 mm ²	1.8 x 2.3 mm ²
Number of microlenses	32 x 40	16 x 20
Tilt dynamic range	> $\pm 3^\circ$	> $\pm 3^\circ$
Focus dynamic range	± 0.018 m to $\pm \infty$	± 0.018 m to $\pm \infty$
Repeatability (rms)	< $\lambda/200$	< $\lambda/200$
Wavefront measurement accuracy in absolute mode (rms)	$\sim \lambda/100$	$\sim \lambda/100$
Spatial sampling	$\sim 110 \mu$ m	$\sim 110 \mu$ m
Maximum acquisition frequency	99 Hz	165 Hz
External trigger	TTL signal	TTL signal
Wavelength range	400-1100 nm	400-1100 nm
Dimensions (LxWxH) / weight	60x 48x 42 mm ³ / 185g	60x 48x 42 mm ³ / 185g
Working temperature	15 - 30° C	15 - 30° C
Interface / Power supply	USB 3.0 / 2.7 W via USB	USB 3.0 / 2.7 W via USB
Operating system	Windows 7 and 10	Windows 7 and 10

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HASO4 FAST

HIGH PERFORMANCE
WAVEFRONT SENSOR

COMPACT
AND VERSATILE

HIGH
ACQUISITION RATE

EASY
TO USE



Shack-Hartmann wavefront sensor for fast inspection,
fast adaptive optics and free-space communication

A UNIQUE SET OF ADVANTAGES

- Acquisition frequency up to 1 kHz
- $\lambda/100$ RMS absolute accuracy
- Large wavelength range: 400 -900 nm
- 16 x 16 sampling points on 1.19mm x 1.19mm sensor pupil
- External trigger capability
- Patented technology for simultaneous and independent measurements of phase and intensity
- Bundled with WaveView, the industry's most advanced metrology software
- Compatible with WaveKit (Software Development Kit) in C, MATLAB, and LabVIEW

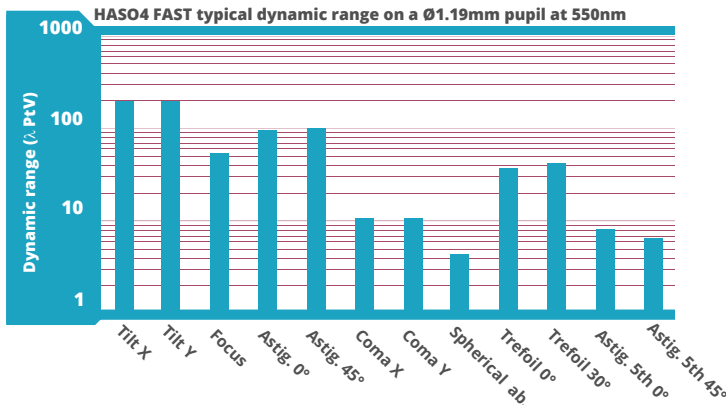
Contact us for more information: contact@imagine-optic.com or +33 1 64 86 15 60

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HASO4 FAST : 1KHZ WAVEFRONT SENSOR WITH HIGH ACCURACY

Providing outstanding performance, the HASO4 FAST is recommended for optical metrology, that needs high speed and high wavefront measurement accuracy, adaptive optics and free-space communication. We offer a unique combination of expertise in high quality microlens production, software development and accurate wavefront sensor calibration at factory. This allows the HASO4 FAST to provide an unprecedented level of performance.

- Large dynamic range (see the plot below)
- Patented wavefront correction algorithms for intensity beam variations (laser, Gaussian, hyper Gaussian, apodized beams...)
- Measurement up to 36 Zernike polynomials at 1kHz
- Optimized for polychromatic applications



OUTSTANDING PERFORMANCE EXAMPLES WITH : HASO4 FAST

- Direct wavefront acquisition of converging and diverging F/5 beams with an accuracy of $\lambda/100$ rms including astigmatism and high order aberrations
- Perfect knowledge of the measurement time by using the external trigger feature
- Latency optimized to less than 2.2ms, including wavefront measurement, allowing high performance adaptive optics
- Only 1 nW power level needed on the sensor to acquire the wavefront with an accuracy of $\lambda/100$ rms at 1kHz

SOFTWARE

- WaveView is the most advanced wavefront measurement and analysis software. It offers more than 150 functions and tools optimized for a wide range of highly demanding applications. WaveView development philosophy is based on tens of years of customer's feedback, improving the user experience at each version. Modules dedicated to PSF, Strehl ratio, MTF, M^2 are available.
- WaveKit is a SDK, providing the basis blocks on which one can build a fully customized software for specific HASO based applications or WaveView data processing routines. WaveKit is available on request.

SPECIFICATIONS

Aperture dimension	1.19 x 1.19 mm ²
Number of microlenses	16 x 16
Tilt dynamic range	> $\pm 3^\circ$
Focus dynamic range	± 0.008 m to $\pm \infty$
Repeatability	$\lambda/200$ nm rms
Wavefront measurement accuracy in absolute mode	6nm rms for 400-600 nm $\lambda/100$ nm rms for 600-900 nm
Spatial sampling	74.4 μ m
Maximum acquisition frequency	1 kHz
External trigger	TTL signal
Wavelength range	400-900 nm
Dimensions (LxWxH) / weight	60 x 48 x 42 mm ³ / 185g
Working temperature	15 - 30° C
Interface / Power supply	USB 3.0 / 3 W via USB
Operating system	Windows 7 and 10
Required power	1nW for the largest round pupil at 1kHz

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HASO4

126 BROADBAND

HIGH ACCURACY
WAVEFRONT SENSOR

HIGH RESOLUTION
21420 MICROLENSES

CALIBRATED FOR
350-1100 nm

EASY TO USE
AND INTEGRATE



Wavefront measurement tool
for optical systems alignment and characterization

A UNIQUE SET OF ADVANTAGES

- Wavefront sensor on the latest CMOS camera for the 350-1100 nm range
- 170 x 126 sampling points over a 13.77 mm x 10.22 mm sensing area
- 6 nm RMS or $\lambda/100$ rms absolute measurement accuracy
- 30 Hz acquisition frequency⁽¹⁾
- External trigger capability
- Spot Tracker eliminates alignment requirements
- Patented technology for simultaneous and independent measurements of phase and intensity
- USB 3.0 connectivity
- Compatible with WaveKit (SDK) in C/C++, LabVIEW and Python
- Compatible with R-Flex2 for optics alignment and characterization

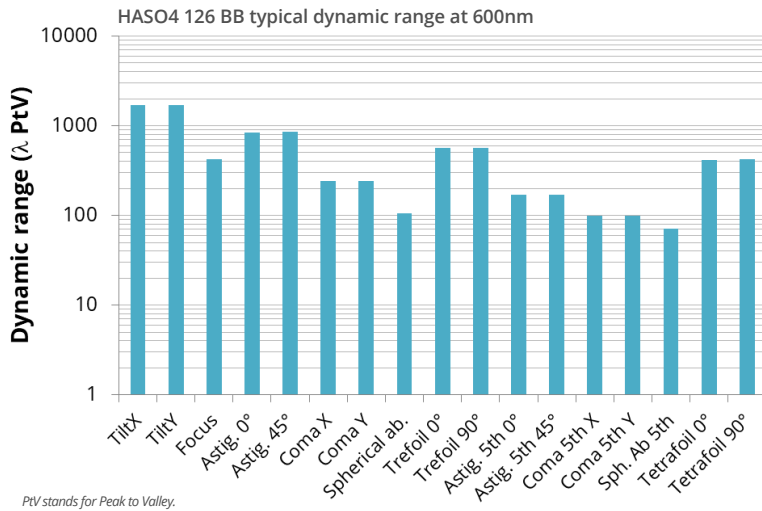
⁽¹⁾ 30Hz in sequence mode, 10Hz for wavefront display

HASO4 LARGE APERTURE, BROADBAND WAVEFRONT SENSOR

126 BROADBAND

Providing outstanding performance, the HASO wavefront sensor family is used worldwide in the most demanding applications in optical metrology, industrial control, microscopy and laser diagnostics. We offer a unique combination of expertise in high-quality microlens production, software development and accurate factory calibrations. This allows the HASO4 126 BB to provide high performance for applications requiring a high spatial frequency and very large dynamic range.

- Acceptable tilts up to +/-3°, and NA up to 0.1
- Large dynamic range (see the graph below)
- Independent phase (wavefront) and intensity (amplitude) measurements
- Easy hardware and software integration



EXAMPLES OF APPLICATIONS

- Optical metrology such as for freeform optics, parabolic mirrors, etc.
- Product quality control
- High spatial-frequency aberration detection

SOFTWARE

- **WaveView** is the most advanced wavefront measurement and analysis software. It offers more than 150 features and tools optimized for a wide range of highly demanding applications. WaveView development philosophy is based on tens of years of customer feedback, improving the user experience with each version. WaveView provides a function to analyze segmented wavefronts and allows autosave for sequence measurements. Modules dedicated to PSF and MTF are available.
- **WaveKit** is the SDK in C/C++, LabVIEW and Python, providing the basic blocks on which one can build a fully customized software for specific HASO-based applications or WaveView data processing routines. WaveKit is available on request.

SPECIFICATIONS

Aperture dimension	13.78 x 10.21 mm ²
Number of microlenses	170 x 126
Tilt dynamic range	± 3 °
Focus dynamic range	± 0.010 m to ± ∞
Absolute accuracy	6 nm or λ/100 RMS
Repeatability	<λ/200 rms
Spatial sampling	~ 81 μm
Maximum acquisition frequency	30 Hz ¹⁾
External trigger	TTL signal
Calibrated spectral range	350 - 1100 nm
Dimensions / weight	47 x 60 x 62 mm ³ / 200g
Working temperature	15 - 30 °C
Interface / Power consumption	USB 3.0 / 3.6W
Operating system	Windows 10
Minimum power	3 nW ²⁾

1) 30 Hz in sequence mode, 10 Hz for WF display

2) At 30 Hz, the maximum exposure duration is 33ms.