Solutions for industry & science

"The SL-Sys liquid has significantly improved our R&D team's ability to design new lenses as well as the quality of our products on the line." Pierre Craen, Head of Systems Design, Varioptic

SL-Sys™ neo

The SL-Sys[™] neo is a unique lens characterization solution designed for industrial R&D programs and for production line quality control. Based on Imagine Optic's industry leading HASO[™] wavefront sensor technology, the SL-Sys neo is the only commercially available system that enables you to completely and automatically characterize convergent (positive power) optical components with pupil diameters ranging from 1.5-12 mm² over the entire field of view, regardless of the numerical aperture (NA).



One of the many advantages of the SL-Sys neo is its ability to precisely measure the optical element's aberrations as wavefront errors over the entire field of view and/or at any point therein. Contrary to systems that only provide simple Modulation Transfer Function (MTF) data, the precision wavefront data furnished by the SL-Sys neo enables you to move beyond rudimentary good/bad evaluation and into the domain of complete optical component analysis in order to identify the problem's source.

- Precision wavefront characterization of aberrations with either 1,280 or 7,600 measurement points (depending on model)
- Measure back focal length (BFL), effective focal length (EFL), chromatism, field curvature, distortion, vignetting, and relative illumination as a function of the field
- Calculate the 3D MTF and the MTF through-focus for all measured points in the field
- ±45° field angle
- λ /100 aberration measurement sensitivity
- Better than 0.005 MTF measurement sensitivity
- 1000 lp/mm maximum MTF frequency acquisition (automatically adjusted)
- Better than 0.5% focal measurement sensitivity

SL-Sys™ liquid

The SL-Sys liquid is a turnkey solution that provides industrial liquid lens manufacturers with an unparalleled quality control platform. It enables you to go beyond current testing methods that rely solely on focal length and MTF measurements by ensuring the overall lens quality as a function of true optical quality, directly on the production line.



The SL-Sys liquid goes beyond simply indicating if a lens is optically sound or not. The system's advanced features enable you to limit waste by detecting problems earlier in the

manufacturing process than other products, as well as by helping to understand their origin and to correct for irregularities using the provided data. Even more, the SL-Sys liquid lets you compare the lens' measured attributes versus its best theoretical optical performance, allowing you to set your own proper quality/cost standards.

- Intuitive configuration interface
- Define the measurement diameter for either all or part of the lens
- Choose between measurement modes static (wavefront error, power, hysteresis), dynamic (temporal behavior), or both simultaneously
- Enter precise command voltage values to determine the lens' optical power/voltage ratio and its hysteresis
- Select the temporal resolution and analysis range as well as the acceptable values for maximum allowable aberration RMS and hysteresis; minimum and maximum optical power limits; power range at zero commanded; maximum allowable lens-induced tilt on both the X and Y axis; maximum allowable centering error value on both the X and Y axis

e-Xplorer™

The e-Xplorer is designed to help increase precision and reduce costs in manufacturing semiconductor wafers. Its outstanding nanometric sensitivity enables the system to detect even the most elusive defects in form and planeness on wafers up to six inches in diameter. An optional zoom x3 option allows you to significantly increase the system's lateral resolution without compromising precision.



Industrial & scientific systems

"The AOKit - bio will enable us to image subcellular structures in live tissue at depths never acheived before." Peter Kner, Sedat Lab, UCSF

AOKit™

With 10 years of industry leading experience in the domain of adaptive optics, the AOKit line integrates the best of Imagine Optic's products into one solution. The AOKit includes a HASO[™]3 wavefront sensor that provides true absolute measurement with simultaneous and independent measurements of both phase and intensity; a deformable mirror adapted to your application; and our industry acclaimed CASAO[™] command & control software that provides instant access to control all of the instruments in your loop.

The AOKit - bio is specially designed to meet the demanding needs of biologists using today's most advanced imaging technologies by incorporating the award-winning mirao[™] 52-e Electromagnetic Deformable Mirror as its active component. Whether you use OCT, confocal, multiphoton or fluorescence microscopy, the AOKit – bio allows you to scan deeper inside samples with far greater precision than ever before. For the first time, you can dynamically fine tune your image to eliminate severe aberrations thereby improving overall image quality.

The AOKit - laser was developed for the demanding needs of laser users. By uniting a new generation of high-quality monomorph mirrors that have virtually no print-through effects with the unique security features of CASAO command & control software, laser professionals can control their beam's shape, increase intensity at the focal point and improve installation security like never before.

SH-LTP™

Imagine Optic's Shack-Hartmann Long-Trace Profiler (SH-LTP), developed in conjunction with the SOLEIL synchrotron, is the ideal solution for performing highly accurate, bidimensional, sub-microradian characterization of large optical component surfaces and planeness of semiconductor wafers. Even more, its wide curvature dynamic range enables it to characterize highly-curved objects (spherical, elliptical, toroidal). The SH-LTP is comprised of an illumination system functioning at 405 nm and a high-accuracy Shack-Hartmann wavefront sensor that incorporates our patented rotated-square technology in the microlens array to increase spatial resolution to the submillimeter level. Compact, robust and easy to integrate into existing setups, this flexibly designed system can also be delivered with its own translation stage. Our proprietary software package, StitchWave[™], enables the SH-LTP to accurately measure the surface of large optics at the sub-microradian level, while minimizing translation effects.

- 2D surface characterization with improved accuracy using stitching methods
- Sub-microradian performance (accuracy, sensitivity, repeatability)
- Flexable, simple, compact and robust design
- Wide curvature dynamic range
- Sub-millimeter spatial resolution

LIP™



Our easy to use LIP optical system is comprised of a collimator and an interchangeable focusing objective that allows you to augment the measurement abilities of our HASO3 product line. Combining a LIP with your HASO[™] sensor enables you to characterize concave mirrors up to a large diameter. It is also a very powerful solution to align large collimators and telescopes.

LIP functions with the ensemble of the HASO3 family of wavefront sensors thereby enabling users to work with sources ranging from visible light to NIR and with a wide range of spatial resolutions. Even more, and in contrast to standard interferometers, LIP enables users to perform precision metrology even in the presence of turbulence along the optical path and is insensitive to vibrations.







CCD Cameras

Semiconductors

Imaging

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Solar Cells Lighting

Instruments

Tests

Detection

Componen Mechanics

Positioning

cy using stitching methods ty, repeatability)



Light Sources

Lasers .

Wavefront metrology & analysis products

"Thanks to Imagine Optic's products, we are acheiving the beam intensity needed for multi-terawatt, and soon petawatt, femtosecond lasers." Jean Paul Chamberet, Applied Optics Laboratory (LOA)

The HASO[™] 3 family of wavefront sensing and analysis products & accessories

Our HASO products, based on patented Shack-Hartmann technology, are the only line of wavefront sensors that provide you with absolute achromatic measurement of both phase and intensity independently, simultaneously and in real-time. With hundreds of satisfied customers around the world, HASO sensors continue to expand the limits of wavefront metrology with their speed, performance and ease of integration. What's more, their insensitivity to vibration and compact design make them the ideal choice for demanding industrial and scientific applications. Key advantages include:

- Dynamic Spot Tracking[™] and Auto Spot Finder[™] offer an exceptionally high dynamic
- · Proprietary calibration, coupled with the exceptional optical quality of our microlenses, enables true absolute measurement and extreme accuracy without the need for a reference source, so you don't spend time recalibrating
- · Best combination of dynamic range and accuracy available on the market
- Unique design completely eliminates crossing spots
- Patented, simultaneous and independent phase and intensity measurements

HASO	spatial resolution (n° microlenses)	pupil size (mm²)	accuracy/ dynamic	spectral range	frame rate (Hz)	interface
FIRST	32 x 40	3.6 x 4.6	λ/100 - 400λ	Mono (±50) bet. 400 - 1100nm	60	FireWire
32	32 x 40	4.9 x 6.1	λ/100 - 520λ	R1 ¹ or R2 ²	50	FireWire
42	42 x 52	4.8 x 5.9	λ/100 - 600λ	R11	50	FireWire
76 - GE	76 x 100	8.7 x 11.4	λ/100 - 1200λ	R1 ¹ or R2 ²	17	Giga Ethernet
128 - GE	128 x 128	14.6 x 14.6	λ/100 - 1500λ	R1 ¹ or R2 ²	7.5	Giga Ethernet
Fast	15 x 15	1.7 x 1.7	λ/100 - 120λ	R1 ¹	950	Giga Ethernet
WSR 32	32 x 40	4.9 x 6.1	λ/100 - 520λ	400 - 800 nm or 532 - 1064 nm	50	FireWire
WSR 58	58 x 74	8.9 x 11.3	λ/100 - 1000λ	400 - 800 nm or 532 - 1064 nm	17	Giga Ethernet
HP	30 x 30	13.5 x 13.5	λ/1000 - 250λ	405 nm	7.5	Giga Ethernet
NIR	32 x 40	3.6 x 4.6	λ/35 - 400λ	1500 - 1600 nm	60	FireWire
UV	50 x 50 ³	7.8 x 7.8	λ/75 - 2000λ	193 - 300 nm	20	CamLink
λEUV	51 x 51 ³	19.7 x 19.7	λ/100 - 5000λ	7 - 25 nm (50 - 200 eV)	0.5	PCI board
λX	75 x 75 ³	10.1 x 10.1	λ/10 - 5000λ	0.3 - 1 nm (1 - 4 keV)	0.5	PCI board
X	36 x 48 ³	0.7x1	0.1nm - 10µm	8 - 15 keV	60	FireWire

Rotation stage ΘXΘY™ The perfect companion product for your HASO wavefront sensors, the OXOY enables you to securely mount CCD Cameras the sensor unit onto an optical bench or other structure. The stage's integrated OX and OY rotation axis are Imaging adjustable with high precision and are designed to work seamlessly with our HASO products, coordinating the angular alignment without translation of the microlens array. Laser Diode Monomode fibered reference source available in several wavelengths (635nm, 670nm, 780nm and others on Cor Sem request) with an easily adjustable power output regulated using a potentiometer or optional USB driver. munications Magic Source[™] Iductors A monochromatic point source (635nm, 670nm, 780nm and others on request) ideal for measuring and characterizing high N.A. optics. Magic Source offers users excellent optical quality (λ /100) combined with a very large numerical aperture (>0.45). Solar Cells HASOv3 Tests Instruments HASOv3 is the most complete, easy to use wavefront metrology and analysis software available today. Even more, we provide HASOv3 as an SDK for customers that want to build their own feature-rich applications. · Zonal and modal reconstruction spot diagram, MTF*, PSF*, M2*, and more • Editable and printable reports Multi-user · Client-server interactivity via Ethernet and WiFi Sensors Detection StitchWave™ Wavefront analysis software tool that allows you to stitch together the multiple wavefronts that form the otality of the surface to be characterized. Offers extended lateral resolution · Characterize large diameter optics · Measure aspheric components Mechanics Components Positioning 1) R1 = range 400-600nm/500-700nm/650-900nm/800-1100nm. Light Sources 2) R2 = extended range 400-700nm/500-900nm/630-1100nm. 3) Hartmann microhole array. * Sold separately.





Adaptive optics components & software

"The results we have acheived using HASO have been remarkable... Coupled with a deformable mirror, we reached the highest possible intensity." Gérard Mourou, Director of the Applied Optics Laboratory (LOA)

mirao[™] 52-e Electromagnetic Deformable Mirror

The mirao 52-e Electromagnetic Deformable Mirror is a unique product for professionals conducting cutting edge research in some of today's most exciting domains. Versatile and innovative, when used in in vivo imaging applications, mirao enables users to increase contrast as well as to augment both the axial and transverse resolutions of their equipment. The only product of its kind on the market today, mirao offers unique advantages including:

- Unparalleled stroke of ±50 µm (tilt p/v)
- 52 actuators on a 15 mm pupil
- Exceptional optical guality of 10 nm RMS
- 95% linearity
- Virtually no hysteresis (<2%)
- Plug & play USB2 installation
- TRIG out functionality for TTL synchronization
- · Compact electronics unit

Monomorph deformable mirrors for high-power lasers

In high-power laser applications with beam diameters between 40 and 150 mm, today's monomorph deformable mirrors offer the best wavefront correction available. When compared to bimorph mirrors, monomorphs provide superior optical quality and wavefront shaping capacities (stroke). Even more, monomorph mirrors virtually eliminate print-through effects which can, during propagation, cause dangerous hotspots inside the laser amplification chain.





CASAO[™] command & control software

CASAO is a unique application that seamlessly combines wavefront measurement and correction features, extensive instrument diagnostics and client/server interactivity via Ethernet or WiFi to provide users with an ergonomic adaptive optics PC workspace. Perfectly adapted to Imagine Optic's HASO[™] family of wavefront sensors as well as a wide variety of active components including deformable mirrors, MEMS and SLMs, CASAO is the only software tool that you need to get the most out of your open or closedloop system.

For newcomers to adaptive optics, CASAO provides a unique, hands-on

tutorial mode that guides users step by step through measurement, correction and diagnostics. Experienced users can choose between standard and automatic modes that put the ensemble of CASAO's features at your disposal right away. From sensor configuration to acquisition and on to determining correction, a few clicks are all it takes to get underway.

CASAO provides unique security features for high-power lasers that you won't find anywhere else. When the program detects a suspicious event, it automatically shuts down the loop to let users investigate. It equally offers automatic pupil and loop-gain management features that further enhance operating safety.

GENAO[™] command & control software for sensorless adaptive optics

GENAO is a unique, iterative adaptive optics command and control software package that enables users to perform precision wavefront correction in situations where using a wavefront sensor is either impractical or impossible. Perfectly adapted to life sciences imaging applications, GENAO enables you to correct wavefront aberrations even when, due to absorption by the specimen, the backscattered source signal is extremely faint.



If you're working in multiphoton, confocal, SHG (Second Harmonic Generation), THG (Third Harmonic Generation) or structured light microscopy, GENAO is easy to use and outperforms other software products based on standard iteration algorithms.

HASO3

Imagine Optic's HASO family of wavefront sensors offer professionals unsurpassed quality, precision and ease of use. Key features include:

- high-resolution from 1280-16384 measurement points
- independent and simultaneous measurement of both phase & intensity
- true absolute measurement
- unbeatable accuracy and dynamic range

Exceptional results come from accurate measurement. We conceive, build and support our products to meet and exceed our customers' needs. For over 10 years, Imagine Optic's wavefront sensors have become an industry standard for reliability and durability. Their independent yet simultaneous measurements of both phase and intensity are key in consistently providing customers with the high-quality wavefront metrology results they can depend on.

HASO3, the most recent evolution of our award-winning HASO product line., is based on our patented Shack- Hartmann technology. Fast, performing and easy to integrate, their insensitivity to vibration and • Wide dynamic range compact design make them the ideal choice for demanding industrial and • Unequaled precision scientific applications. Even more, our all-new HASO3 76 GE and HASO- • True absolute measurement 128 GE are equiped with Giga Ethernet ports for fast and easy control over local networks.

In laser and optical metrology, your HASO3 wavefront sensor used with HASOv3 software enables you to: conduct zonal and modal wavefront reconstruction

- · visualize the spot diagram and raw camera data
- · calculate the PSF*, MTF* and Strehl* ratio
- obtain the M^{2*} parameter

For adaptive optics, HASO3 coupled with our CASAO™ software, lets you: perform precision metrology to control your active components including deformable mirrors and SLM · perfect your beam's shape and optimize its focal spot

Dynamic Spot Tracking™ & Auto Spot Finder™	provide HASO3's excep
Refractive microlenses	their exceptional optic dynamic range
Absolute measurement	thanks to our proprie outstandingly accurate need for a reference be
Independent phase and intensity measurement	patented technology th intensity simultaneously
Dynamic range	and accuracy HASO3 accuracy available





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tional dynamic range

al quality (λ /50) enables HASO3's precision and

etary calibration technology, HASO3 provides absolute measurements every time, without the am

hat lets you directly measure both the phase and , independently and in real-time

offers the best combination of dynamic range and

pectroscopes · Imaging Commu	CCD Cameras Semico
nications	nductors .
Lighting	Solar Cells ·
Instruments	Tests ·
Sensors	Detection ·
Mechanics .	Components
Positioning	0
Light Sour	Lasers .

HASO HP Shack-Hartmann wavefront sensors provide sub-nanometric precision with the standard functionalities that HASO customers have come to rely on, including absolute measurement, wide dynamic range, unequalled accuracy and insensitivity to vibration.

Perfectly compatible with our LIP™ and ΘXΘY™ Rotation Stage accessories, HASO HP allows you to avoid using expensive components including null lenses or CGH matrixes, and is ideal for characterizing mirrors and catadioptric systems as well as aligning high-precision optical systems.

Aperture dimension	13.5 x 13.5 mm ²			
Number of microlenses ¹	30 x 30			
Tilt dynamic range	> ± 0.5 °			
Focus dynamic range	± 0.35 m to ± ∞			
Measurement dynamic (specified in local curvature)	± 0.30 m			
Repeatability (rms)	< λ/3000			
Wavefront measurement accuracy in absolute mode (rms) ²	~ λ/1000			
Wavefront measurement accuracy in relative mode (rms) ³	~ λ/2000			
Tilt measurement sensitivity (rms)	0.05 µrad			
Focus measurement sensitivity (rms)	5.10 ⁻⁴ m ⁻¹			
Spatial resolution	~ 450 µm			
Maximum acquisition frequency	20 Hz			
Processing frequency	2 - 10 Hz			
Working wavelength range	350 - 500 nm			
Calibrated wavelength range	390 - 430 nm			
Working temperature	20 – 25°			
Dimensions / weight	90 x 100 x 210 mm / 1500 g			
Power supply	+5, -5, -15, 28 V / 20 W			
Interface	Giga Ethernet			
Data represented here is based on the HeNe wavelength 633 nm.				

1. other configurations are available.

- 2. wavefront as seen by the analyser. performance kept on the whole band.
- (10 λ of shift max).

	HASO3-32	HASO3-42	HASO3-76 GE	HASO3-128 GE
Aperture dimension	4.9 x 6.1 mm ²	4.8 x 5.9 mm ²	8.7 x 11.4 mm ²	15 x 15 mm²
Refractive microlens technology	standard square	rotated square	standard square	
Number of microlenses	32 x 40	42 x 52	76 x 100	128 x 128
Tilt dynamic range	>±3° (5	520λ)	>±3° (1100λ)	>±3° (1500λ)
Focus dynamic range - minimum local radius of curvature	20 mm 15mm			
Focus dynamic range - maximum NA		> ().1	
Repeatability		< λ/	200	
Wavefront measurement accuracy in relative mode (rms) ¹	λ/150			
Wavefront measurement accuracy in absolute mode(rms) ²	λ/100			
Tilt measurement sensitivity (rms)	3 µrad		1 µrad	<1 µrad
Focus measurement sensitivity (rms)	10 ⁻³ m ⁻¹		5.10 ⁻⁴ m ⁻¹	2.5.10 ⁻⁴ m ⁻¹
Spatial resolution	~160 µm		~115 µm	
Working wavelength range		350 - 1	100 nm	
Calibrated wavelength range	400 - 600 nr	n, 500 - 700 nm,	630 - 900 nm, 800	0 - 1100 nm
Extended wavelength range	see HASO3- 76/128	not available	400 - 700 nm, 500 - 900 nm, 650 - 1100 nm	
Interface	FireW	/ire	Giga E	Ethernet
Maximum acquisition frequency	50 H	łz	17 Hz	7.5 Hz
Processing frequency (CPU 3Ghz, 512 Mb RAM)	20 Hz		10 Hz	5 Hz
Working temperature	15 - 30° C			
Dimension / weight	75 x 62 x 68 mm / 510 g 1.1 Kg (controller)		/ 258 g (camera) controller)	
Power supply	12 V / 6 W			

1) Difference between the real wavefront and a reference wavefront obtained in similar conditions (10 λ of shift maximum).

2) Wavefront as seen by the wavefront sensor. Performance kept on the whole spectral range.



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3. difference between the real wavefront and a reference wavefront obtained in similar conditions



LIP is an easy to use optical system that transforms your HASO3 wavefront sensor into a portable, standalone metrology solution. Comprised of a collimator and an interchangeable focusing objective, LIP allows you to augment the measurement abilities of our HASO3 product line . With LiP, you can easily characterize large-diameter concave mirrors as well as align large collimators and telescopes.



LIP functions with the ensemble of the HASO3 family of wavefront sensors thereby enabling users to work with sources ranging from visible light to NIR and

with a wide range of spatial resolutions. Even more, and in contrast to standard interferometers, LIP enables users to perform precision metrology in the presence of turbulence along the optical path and is insensitive to vibrations.

Custom objectives are equally available for customers with unique needs.

LIP 32 for HASO-32	Objective f/# ¹	focal length (mm)
MOD32-3.7	3.7	18
MOD32-4	4	20
MOD32-6.4	6.4	31
MOD32-7.5	7.5	36
MOD32-10	10	45
MOD32-12.5	12.5	60
MOD32-16	16	80
MOD32-24	24	118.3
MOD32-30	30	149

LIP 76 for HASO-76	Objective f/# ²	focal length (mm)
MOD76-3.4	3.4	30
MOD76-8.7	8.7	75
MOD76-9.2	9.2	82
MOD76-13.4	13.4	115
MOD76-17	17	146

LIP 128 for HASO-128	Objective f/# ³	focal length (mm)
MOD128-2.1	2.1	30
MOD128-5.1	5.1	75
MOD128-5.6	5.6	82
MOD128-7.9	7.9	115
MOD128-10	10	146

1) Assuming 4.9mm pupil diameter. 2) Assuming 8.9mm pupil diameter. 3) Assuming 14.6mm pupil diameter.

HASO3 WSR (wide spectral range)

HASO3 WSR (Wide Spectral Range) is one of the latest additions to our award winning HASO product family. Available in two configurations, 32 x 40 and 58 x 74 microlenses, they combine the standard functionalities that customers have come to rely on, including absolute measurement, wide dynamic range, unequalled accuracy and insensitivity to vibration, with the capacity to measurement wavefronts across an exceptionally wide spectral band, even with monochromatic light.

HASO3 WSR is ideally suited for applications including laser beam characterization (particularly adapted for frequency doubling), optical system metrology over a large spectral band, measuring the effects of chromatic aberrations and aligning laser optics.

	WSR 32	WSR 58-GE		
Aperture dimension	4.9 x 6.1 mm ²	8.9 x 11.3 mm ²		
Number of sub-apertures dedicated for analysis	32 x 40	58 x 74		
Refractive microlens technology	Rotate	d square		
Tilt dynamic range	> ± 3	° (520λ)		
Focus dynamic range - minimum local radius of curvature	20 mm	15 mm		
Focus dynamic range - maximum NA	>	0.1		
Repeatability (rms)	< λ	/200		
Wavefront measurement accuracy in absolute mode rms ¹	~ λ	/150		
Wavefront measurement accuracy in relative mode rms ²	~ λ	/100		
Tilt measurement sensitivity (rms)	3 µrad	1 µrad		
Focus measurement sensitivity (rms)	10 ⁻³ m ⁻¹	5.10 ⁻⁴ m ⁻¹		
Spatial resolution	~ 160 µm			
Maximum acquisition frequency	50 Hz	17 Hz		
Processing frequency (CPU 3 Ghz, 512 Mb RAM)	20 Hz	10 Hz		
Working wavelength range	350-1100 nm			
Calibrated wavelength range	400 - 800 nm c	or 532 - 1064 nm		
Working wavelength range	350 - 1	1100 nm		
Working temperature	15 - 30° C			
Dimensions / weight	75x62x68 mm/510 g	115x51x60 mm/400 g		
Power supply	12 V	/ 6 W		
Interface	Firewire	Giga Ethernet		
 Difference between the real wavefront and a reference wavefront obtained in similar conditions (10 λ of shift maximum). Wavefront as seen by the wavefront sensor. Performance kept on the whole spectral range. 				

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Spectroscopes	
· Imaging	CCD Cameras
Communications	Semiconductors ·
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Sensors	Detection ·
Sensors Mechanics · Positioning	Detection · Components ·



HASO X-EUV

Imagine Optic's HASO X-EUV wavefront sensor, developed in conjunction with LOA and the SOLEIL synchrotron, is the only device of its kind available that offers you the extreme precision and direct measurement functionality needed for today's demanding laboratory and industrial applications.

- Synchrotron and X-fel beam alignment and characterization
- Micro and nano-beam focusing, automatic beam alignment, and high Strehl ratio for adaptive optics
- Perfectly adapted for laboratory applications
- · Independent phase and intensity measurement



Designed and built in collaboration with our customers and with their needs as the top priority, the HASO X-EUV incorporates our

patented rotated square technology to offer high spatial resolution and wide dynamic range, making it the ideal choice for EUV lithography, synchrotron and X-fel beam analysis. When used for adaptive optics, the X-EUV becomes a powerful tool for that provides you with micro and nano-beam focusing, a high Strehl ratio and precise control of the focal spot shape.

When combined with our powerful and easy-to-use software packages, you can easily conduct wavefront acquisition and reconstruction. Additional add-on modules offer features including extended wavefront reconstruction, PSF and MTF measurement, as well as a dynamic library that enables you to build your own software applications using this remarkable device.

	λΕυν	λX	X
Aperture dimension	19.7 x 19.7 mm ²	10.1 x 10.1 mm ²	0.7 x 1.0 mm ²
Number of sub-apertures dedicated for analysis	51 x 51	75 x 75	36 x 48
Curvature dynamic range	± 0.5 m to ± ∞	0.4 to 4 m – divergent beam	± 40 mm to ± ∞
Repeatability (rms)	~ λ/100	~ λ/10	0.03 nm
Wavefront measurement accuracy in absolute mode (rms)	~ λ/50 ~ λ/4		0.1 nm
Wavefront measurement accuracy in relative mode (rms)	~ λ/75 ~ λ/5		0.1 µrad
Tilt measurement sensitivity (rms)	0.05 µrad		-
Focus measurement sensitivity (rms)	< 1.10 ⁻⁴ m ⁻¹		< 2.10 ⁻⁴ m ⁻¹
Spatial beam sampling step	~ 390 µm ~ 130 µm		20 µm
Minimum readout time	~2 sec ~0.6 sec (@1 MHz digitization) (@2 MHz digitization)		17 ms
Working photon energy (wavelength) ¹	50 eV - 200 eV 1 keV - 4 keV (7 nm - 25 nm) (1 nm - 0.3 nm)		8 keV – 15 keV
Storage temperature / Operating environment	< 55°C / 5°C – 30°C		
Compliant vacuum (hydrocarbon free compatible with clean vacuum)	10 ⁻⁶ mbar		not vacuum compliant
Power supply	Via controller (100-110-220 or 240V AC)		Via Firewire (12V)
Interface	PCI board		Firewire

 HASO X-EUV wavefront sensors can be optimized for other wavelength ranges. Contact Imagine Optic for more details.

HASO UV

Our HASO UV Hartmann wavefront sensor is the ideal tool for customers working in the ultraviolet spectrum (190 - 300 nm). They provide fast, accurate and reliable measurements by taking advantage of the HASO family's standard functionalities that customers have come to rely on, including absolute measurement, unequalled accuracy and insensitivity to vibration at speeds up to 20 Hz.

HASO UV is the ideal tool for UV optical component metrology (mirrors, lenses, flat windows, etc.) and, when couple with our HASO v3 software, enables you to perform both zonal and modal wavefront reconstruction; calculate the PSF*, MTF* and Strehl ratio*; visualize the spot diagram; and obtain the M^{2*} parameter. These sensors are equally perfect for aligning and characterizing optical systems used in microlithography, measuring thermal and gravitational effects, and mechanical deformities.

Aperture dimension	7.8 x 7.8 mm ²
Number of sub-apertures dedicated for analysis	50 x 50
Tilt dynamic range	till ± 1.5°
Focus dynamic range1	± 0.030 m to ± ∞
Maximum operating aperture (half angle sin α)	0.13 (max)
Repeatability (rms)	~ 1.5 nm
Wavefront measurement accuracy in absolute mode rms ²	~ 3.5 nm
Wavefront measurement accuracy in relative mode rms ³	~ 2.5 nm
Tilt measurement sensitivity (rms)	0.5 µrad
Focus measurement sensitivity (rms)	2.5.10 ⁻⁴ m ⁻¹
Spatial resolution	~ 160 µm
Acquisition frequency / processing frequency	~20 Hz / ~ 3 Hz
Wavelength	193 - 300 nm
Working temperature	15 – 30° C / 5 – 45° C
Interface	CamLink
(1) For the central wavelength: 470 λ for the HASO UV 50. (2) wavefront directly measurement by the wavefront sensor (no (3) difference between a referenced wavefront and the measured	added lens). d wavefront, in a range < 10 λ.





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Communications	eras Semiconductors ·
Lighting	Solar Cells •
Instruments	Tests ·
Sensors	Detection ·
Mechanics · Positioning	Components ·
Light Sources	Lasers ·
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HASO NIR

Our HASO NIR Shack-Hartmann wavefront sensor is the ideal tool for customers working in the near infrared spectrum (1500 - 1600 nm). Exceptionally easy to integrate, they provide fast, accurate and reliable measurements by taking advantage of the HASO family's standard functionalities that customers have come to rely on, including absolute measurement, unequalled accuracy and insensitivity to vibration at speeds up to 60 Hz.



HASO NIR is the ideal tool for fiber coupling and, more generally, for aligning and characterize optical systems in the NIR (afocal, collimators, lenses, zoom, etc.). When coupled with our HASOv3 software, it enables you to perform both zonal and modal wavefront reconstruction; calculate the PSF*, MTF* and Strehl ratio*; visualize the spot diagram; and obtain the M^{2*} parameter.

Aperture dimension	3.6 x 4.6 mm ²
Number of microlenses	32 x 40
Tilt dynamic range	> ± 3 °
Focus dynamic range ¹	± 0.012 m to ± ∞
Maximum operating aperture (half angle sinα)	0.17 (max)
Repeatability (rms)	< \/70
Wavefront measurement accuracy in absolute mode (rms) ²	~ \ <i>\</i> 35
Wavefront measurement accuracy in relative mode (rms) ³	~ λ/50
Tilt measurement sensitivity (rms)	15 µrad
Focus measurement sensitivity (rms)	15.10 ⁻³ m ⁻¹
Spatial resolution	~ 115 µm
Maximum acquisition frequency	60 Hz
Working wavelength range	1500 - 1600 nm
Working temperature	15 - 30° C / 5 - 45° C
Dimensions / weight	30 x 35 x 54 mm / 150 g
Power supply	12 V / 2 W
Interface	Firewire

All specifications given with an average operating mode of 10 acquisitions.

(1) Central wavelengths: 120 λ .

(2) Wavefront directly measurement by the wavefront sensor (no added lens).

(3) Difference between a referenced wavefront and the measured wavefront, in a range < 10 λ .

mirao 52-e

mirao 52-e is a unique wavefront shaping technology that combines unparalleled wavefront shaping abilities and precision with low power consumption and USB2 connectivity to meet the needs of today's most demanding applications.

mirao 52-e is the latest addition to this award winning product line. mirao offers professionals unprecedented wavefront shaping abilities and features including:

- ±50 µm stroke (tilt p/v)
- 15mm pupil with 52 actuators
- exceptional optical quality (10 nm rms)
- surprising precision (20 nm rms)
- virtually no hysteresis (<2%)
- near perfect linearity (>95%)
- USB2 connectivity

mirao is a unique technology that overcomes many of the barriers that limited deformable mirror performance in the past. By using electromagnetic energy to deform the mirror's surface up to $\pm 50 \,\mu m$ (tilt p/v), it outperforms other commercially available mirrors in applications where severe aberrations need to be corrected. Even up to the Zernike 6th order with extreme precision.

In addition to its excellent optical quality, high linearity and lack of hysteresis, the fact that mirao functions with almost any beam wavelength and intensity makes it ideal for a wide range of applications. mirao 52-e's new, ultra-compact electronic unit connects to your PC via a stand USB2 port, and offers improved temporal performance and stability. What's more, we've added a trigger output to facilitate synchronization with other devices via a TTL signal.

The other major enhancement to the mirao 52-e is an all-new Application Programming Interface (API) that was painstakingly developed to provide easy access to mirao's powerful wavefront correction abilities. The API includes a complete, timesaving collection of high-level functions so that users can guickly develop feature-rich applications without having to rewrite driver libraries on their own. Thanks to its strict compliance to the ANSI C standards, the API library can be used in a large number of development environments.



Get more out of mirao with CASAO CASAO[™] is a unique application for open or closed-loops that is perfectly adapted to mirao and Imagine Optic's HASO family of wavefront sensors. It seamlessly combines wavefront measurement and correction features with extensive instrument diagnostic to provide users with an ergonomic adaptive optics PC workspace.

Zernike order	Maxim	um p	eak-to-	V
1		0		
1	:	±50µ	m	
2	1	4		
2	±30)µm		
2	~		0	2
3	±25µm		±10	μι
4	M	1	4	
4	±15µm	±	8µm	
Zernike	RM	/IS re	sidual v	Va
mode	(gene	ration o	f
quality	<5 with	an ar	nplitude	9 9

Wavefront Sensing Metrology







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Number of actuators	52
Maximum generated wavefront (PV)	±50 μm
Surface quality (rms active flat)	10 nm
Integrated tip/tilt correction	yes
Spatial frequency correction	Zernike orders up to 6
Effective diameter	15 mm
Linearity	>95%
Hysteresis	<2%
Actuator input voltage	±1V maximum ¹
Coatings	protected silver
Power consumption	50W max
Dimensions / weight	64 x 64 x 23 mm / 490g ²
 Total sum of applied voltages no Mirror unit only. 	t to exceed 25V







Harness the full power of your adaptive optics system

ICASAO is a unique application that seamlessly combines wavefront measurement and correction features with extensive instrument diagnostics to provide users with an ergonomic adaptive optics PC workspace. Perfectly adapted to Imagine Optic's HASO[™] family of wavefront sensors as well as a wide variety of active components including deformable mirrors, MEMS and SLMs, CASAO is the only software tool that you need to get the most out of your open or closed-loop system.

Perfect loop control for imperfect wavefronts

Whether you're an established expert in adaptive optics or just getting started, you'll be up and running guickly thanks to CASAO's user-friendly, feature rich environment.

Once again Imagine Optic leads the industry by providing newcomers to adaptive optics with a unique, hands-on tutorial mode that guides users step by step through measurement, correction and diagnostics. Experienced users can choose between standard and automatic modes that put the ensemble of CASAO's features at your disposal right away.



From sensor configuration to acquisition and on to determining correction, a few clicks are all it takes to get underway. Key measurement and correction features include:

- · Variable user modes
- Tutorial guides you through each step and advises you when there are special precautions to be taken
- Automatic ideal for large installations that follow established protocols, this mode allows you to define and automate repetitive tasks
- Standard in this mode, all of CASAO's features are available. The standard mode also provides access to the "Fast" mode.
- · Wavefront analyzer hardware control including integration time, trigger mode, averaging
- Wavefront measurement
- Target wavefront formation set tilt, curve and high-frequency aberrations independently using actual measurements or theoretical values using Zernike polynomials
- Measure the functional influence matrix (also called interaction matrix)
- Calculate the command matrix and modify filtering modes
- Open and closed-loop wavefront correction
- · Add command enables users to modify the target wavefront in real-time using Zernike polynomials to induce or correct for aberrations, either by manual intervention or over a network connection (localhost or Ethernet)
- Client-server interaction with HASOv3 software enables users to take advantage of HASOv3's advanced wavefront analysis features

Understanding your wavefront

CASAO's wavefront and instrument diagnostics enable you to better understand and use the information you acquire by providing detailed information on its nature. Key diagnostic features include:

- Wavefront sensor diagnostics
- Multiple views including raw measured wavefront, residual vs. target wavefront, and residual vs. target wavefront following the modifications applied using the "Add command" feature
- HASOv3 interaction used in clientserver mode with HASOv3, you can perform advanced wavefront diagnostics including Zonal reconstruction, create Zernike or Legendre polynomials, view the spot diagram, and calculate the PSF, MTF, M² and Strehl ratio
- · Active component diagnostics
- · Display mirror actuator states, applied voltages and 3D mirror form Show individual actuator influence on the interaction matrix Choose filtering modes by previewing changes and associated applied voltages to
- actuators
- · Camera diagnostics enable you to display the raw camera image

Making your installation safer

Only CASAO offers the security features that can play an important role in making your facility safer, most notably in high-power laser installations. The result of 10 years of working closely with customers to understand their needs, these features protect valuable laser facility equipment.

CASAO acts to detect and inform you of both suspicious events and parasite signals that can interfere with measurement. Once the software detects a potential problem, it acts immediately on the active component's command electronics to avoid erroneous or impertinent commands. Depending on your needs, several levels of security are available that may help improve overall safety.





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