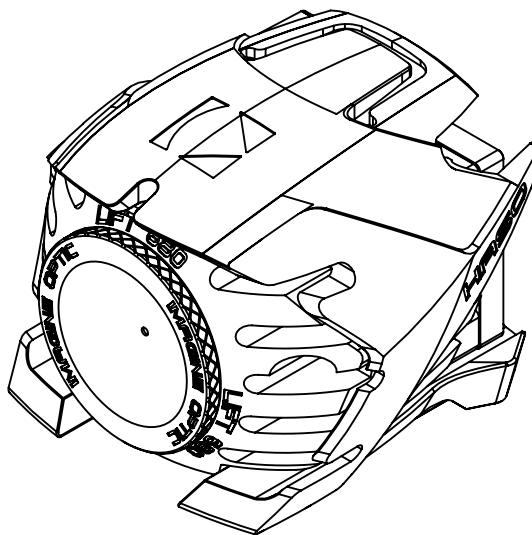


# WAVEFRONT SENSORS



# A 25-YEAR INNOVATION RUN IN WAVEFRONT SENSING METROLOGY

## Index

### Line-up

+ HASO LIFT series	4
+ HASO series	6
+ HASO EDGE series	9
+ Software WAVESUITE	10
+ Services	12

### Tech. insights

+ Imagine Optic's Unique Proposition	3
+ Reaching interferometry standard in resolution	5
+ Key advantages of Shack-Hartmann wavefront sensing	7

Imagine Optic 1<sup>st</sup> generation of -linear!- Shack-Hartmann wavefront sensors was designed and manufactured in Orsay 25 years ago.

Coupling with **deformable mirrors** and constant updates were developed since the early 2000s, leading to the current 4<sup>th</sup> generation of **HASO**, covering an ever-broader range of applications for optical metrology and adaptive optics.

In 2020 the **LIFT** series added ultra-high resolution, bringing wavefront sensing on par with Fizeau interferometers for most applications.

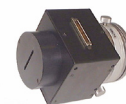
Today, the **Optical Engineer Companion** connects Imagine Optic wavefront sensors and illumination modules, offering over 800 possible metrology setups.



*Optical Engineer  
Companion*



*LIFT*



*H-LINE*

# IMAGINE OPTIC'S **UNIQUE PROPOSITION** IN THE WORLD

---



Imagine Optic implementation of the **LIFT** phase reconstruction provides a unique resolution increase of x16 to detect the smallest phase changes



Compatible with the **Optical Engineer Companion®** modular system means sensors and optical modules easily combine together to ensure any optical configuration needed



The patented **SpotTracker™** technology provides absolute wavefront and tilt information, eliminating alignment requirements for faster and easier implementation



Patented technology for simultaneous and **independent measurements of phase and intensity** prevents artifacts to compromise measurements

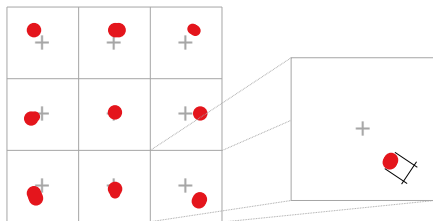


**POP™**, patented procedure for the characterization of (thin) plane parallel optics avoids the need for sample preparation or expensive accessories

# LIFT SERIES



The LIFT principle:



Linearized Focal Plane Technique (LIFT) was developed in the early 2010s and presented in a seminal paper by S. Meimon et al.

The principle is to **analyze the centroid intensity distribution** created by each microlens and use phase retrieval techniques to **reconstruct complex wavefronts at the scale of each microlens**.

Imagine Optic implementation of the LIFT results in a **16-fold increase in spatial resolution** bringing ultra-high resolution to wavefront sensors.

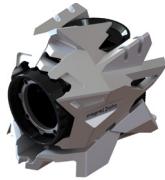




### LIFT SWIR 160

Best for:

- + SWIR metrology (980-1650nm)
- + High Resolution testing of IR optics and coatings



### LIFT LP

Best for:

- + Applications requiring large pupil (22x22mm) without adapting the beam diameter
- + High accuracy



### LIFT 680

Best for:

- + Ultra-High Resolution testing
- + Large optics, freeform & metasurface testing, polishing control



### LIFT 272

Best for:

- + Ultra-High Resolution on a budget

## REACHING INTERFEROMETRY STANDARD IN RESOLUTION

Shack-Hartmann is a very robust and precise technology with a long track record in optical metrology. Yet, its limitations in resolution when compared to interferometry were a clear obstacle to its applications in large and flat optics manufacturing.

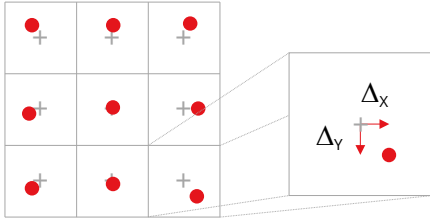
The LIFT technology is a game-changer. LIFT wavefront sensing is now poised to disrupt optical metrology by bringing together the best of two worlds:

- + simplicity, robustness and precision from its Shack-Hartmann core
- + single-frame, ultra high-resolution analysis from the LIFT algorithm.

# HASO SERIES



Shack-Hartmann principle:



Shack-Hartmann wavefront sensors use a microlens array and a camera to **measure the wavefront local slopes** and compute the aberrations of the beam.

Their reliability makes Shack-Hartmann the **most trusted reference in wavefront sensing** applications



## HASO BROADBAND

Best for:

- + Labs and teams with strong expectations for versatility
- + Use cases over a broad spectrum
- + Metrology, microscopy, laser diagnosis



## HASO FIRST

Best for:

- + Single wavelength use cases
- + Adaptive Optics applications for microscopy or Ultra-High Intensity Laser
- + OEM applications



## HASO FAST

Best for:

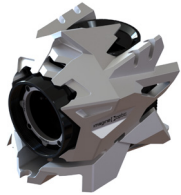
- + Adaptive optics for atmospheric turbulence correction and Free Space Optics
- + Laser beam optimization



## HASO 126

Best for:

- + Freeform optics & metasurface, parabolic mirror characterization
- + Applications involving high spatial frequency aberrations



### HASO LP

Best for:

- + Optical metrology without relay lens
- + Laser beam testing
- + Collimation and focusing distance adjustment



### HASO DUV

Best for:

- + Lithography, semiconductor manufacturing
- + Laser fusion
- + Excimer laser-based applications



### HASO SWIR

Best for:

- + Telecommunications, LIDAR
- + Adaptive optics for Free Space Optics
- + IR & SWIR lasers alignment and characterization



### HASO SWIR FAST

Best for:

- + Atmospheric turbulence quantification in SWIR range
- + Laser beam optimization

## KEY ADVANTAGES OF SHACK-HARTMANN WAVEFRONT SENSING

### #1 LIVE

Dynamic measurement of all the parameters

### #2 ROBUSTNESS

Insensitive to vibrations and atmospheric turbulences

### #3 ACCURACY

Standard accuracy of  $\lambda/100$  RMS

### #4 ACHROMATISM

Achromaticity on the whole spectral range of the sensor

### #5 EASE OF USE

Thanks to factory calibration and powerful WAVESUITE algorithms

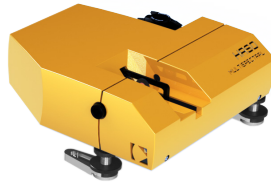
# HASO SERIES



**HASO HXR | The X**

Best for:

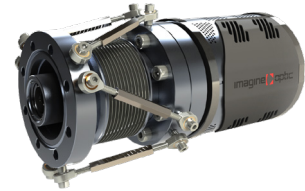
- + X Rays single shot wavefront sensing in the 5-25 keV energy range
- + Source characterization
- + Beamline, KB, toroidal mirrors, elliptical mirrors alignment



**HASO MULTISPECTRAL |  
The polychromatic**

Best for:

- + Spatio-temporal characterization
- + Compressor alignment
- + Measurement of spatial chirp, chromatic curvature
- + Characterization of phase spectral effects on dielectric coatings



**HASO EUV | The Hartmann**

Best for:

- + Synchrotron, EUV-FEL and laser-driven secondary source alignment and characterization
- + Micro- and nano-focusing
- + Dense plasma diagnostics



# HASO **EDGE** SERIES



## HASO HIGH ACCURACY

- + 3nm RMS absolute wavefront accuracy
- + 13.8 x 10.2 mm<sup>2</sup>
- + visible range



## HASO VACUUM

- + 10<sup>-6</sup> mbar with no outgassing
- + 60 x 38 phase points
- + 650 - 950 nm



## HASO VERY LOW FLUX

- + 10nm RMS repeatability @ 10000 ph/s
- + 26 x 18 phase points
- + visible range

Imagine Optic's trademark for over 25 years has been to develop and deliver made-to-measure solutions to scientific and industrial conundrums. Across dozens of wavefront sensors that were born to **meet specific needs**, we have carefully selected the EDGE series. They are essentially clones that can be quickly produced and delivered to meet specific requirements.

Other EDGE wavefront sensors are available : contact us to discuss our **extensive portfolio of custom wavefront sensors** and application-specific implementations.

# WAVESUITE SOFTWARE

## WAVEVIEW

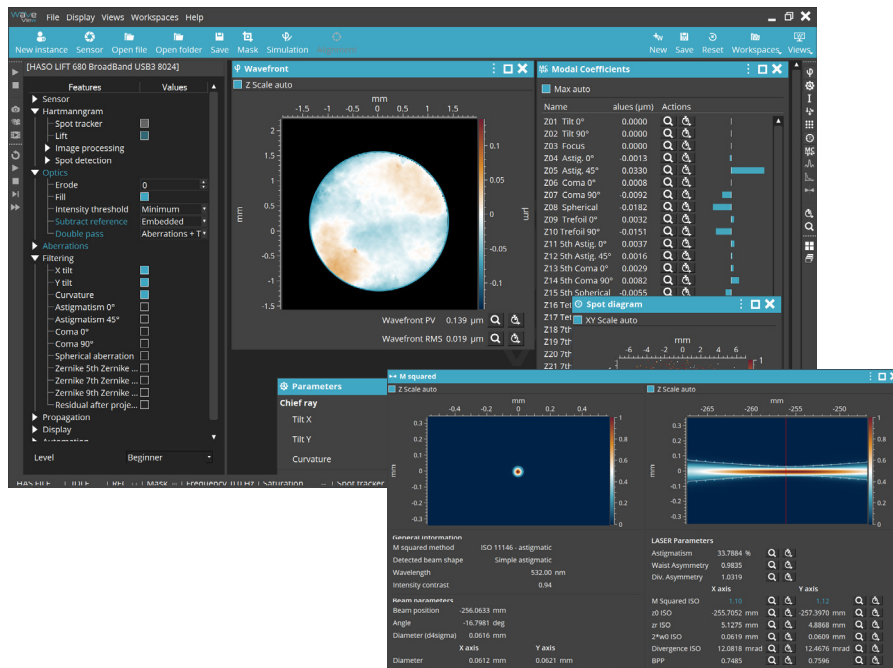
WAVEVIEW™ is the most advanced wavefront measurement and analysis software.

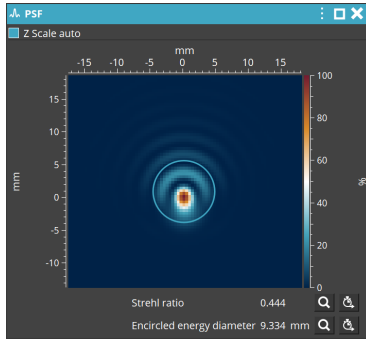
Its interface offers an **easy and optimized workflow**: configure the acquisition, analyze the results in live and export the results for an absolute traceability.

It offers more than 150 features and tools covering a wide range of highly demanding applications.

## WAVESQUARED

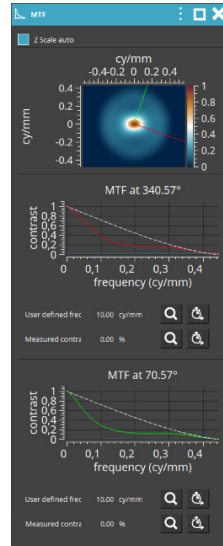
User interface software working in conjunction with CAM SQUARED sensors for laser beam diagnostics and live M2 testing.





Extensions are available to complete the features offered by WaveView.

Get the **PSF** (top) or calculate the 360 **MTF** (right) in only one shot!



## WAVEKIT

WAVEKIT is a versatile and **comprehensive SDK** allowing to integrate Imagine Optic wavefront sensors in complex applications: multi-modal platforms, automated benches, industrial control, etc.

Available for C/C++, LabVIEW™ and Python



## SERVICES

All our hardware equipment comes with complementary services:

- + **Installation** assistance by our technicians and engineers
- + **Training** on both software and hardware, on site or remote
- + **Support** through our Zendesk-powered interface featuring FAQs, troubleshooting and other useful resources as well as a customer login and assistance system with a > 90 % satisfaction rating

Imagine Optic also provides on-demand services :

- + **Recalibration** of HASO wavefront sensors
- + **Equipment rental**
- + **Characterization** of optical components and systems
- + **Custom** optical metrology and adaptive optics benches

## FOLLOW US

imagine-optic 

@wavefrontrunners 



## CONTACT US

### Imagine Optic Headquarters

18, rue Charles de Gaulle

91400 ORSAY · France

Phone +33 (0)1 64 86 15 60

[sales@imagine-optic.com](mailto:sales@imagine-optic.com)

[www.imagine-optic.com](http://www.imagine-optic.com)

