HASO LIFT

Imagine optic

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wfs2022 Porto
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imagine optic™

Wavefront sensors and adaptive optics for optical metrology, lasers and microscopy

Optical Metrology Applications

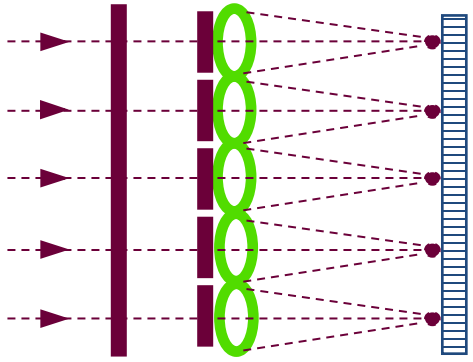
Adaptive Optics for Laser Beam Control

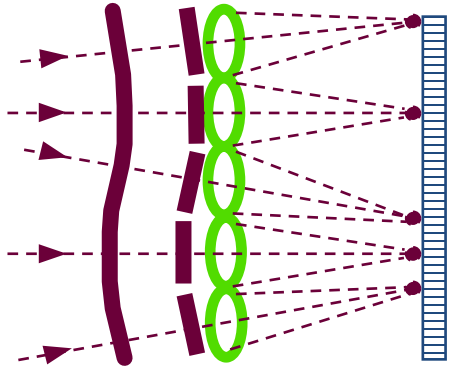
Adaptive Optics Solutions for Microscopy

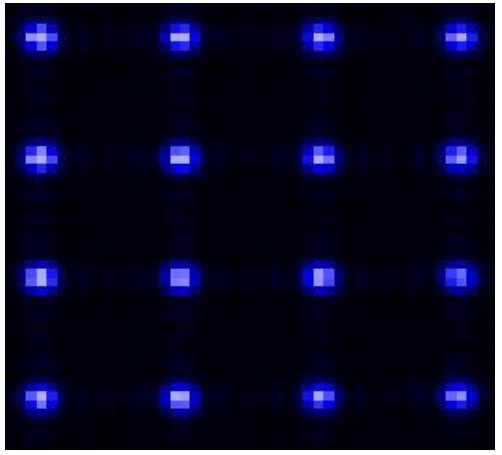
Optical metrology & adaptive optics for X-EUV

Standard Shack-Hartmann

Association of a microlenses array and a detector

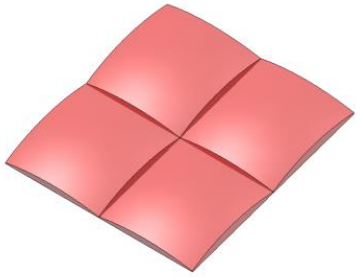




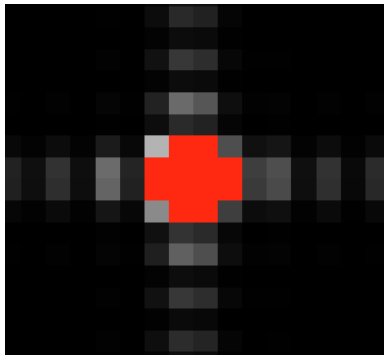


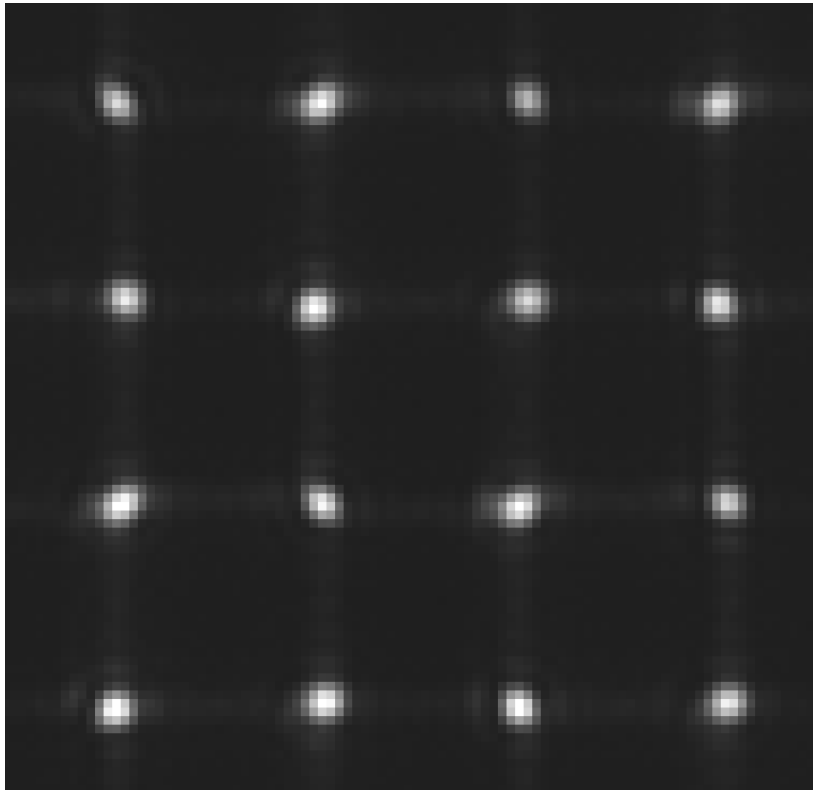
Spot positions are proportional to the local wavefront slopes

Shack-Hartmann hartmanngram

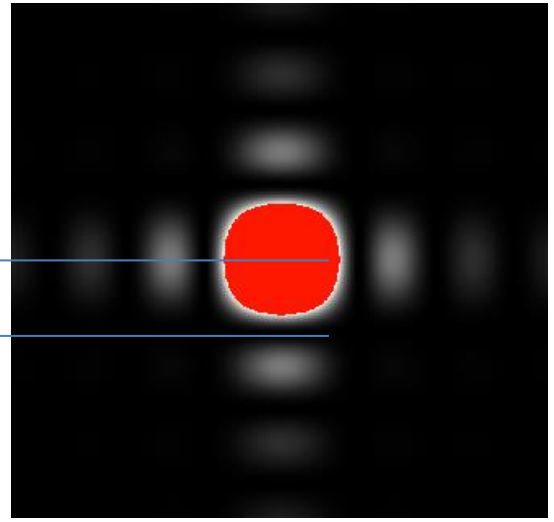


Square microlenses



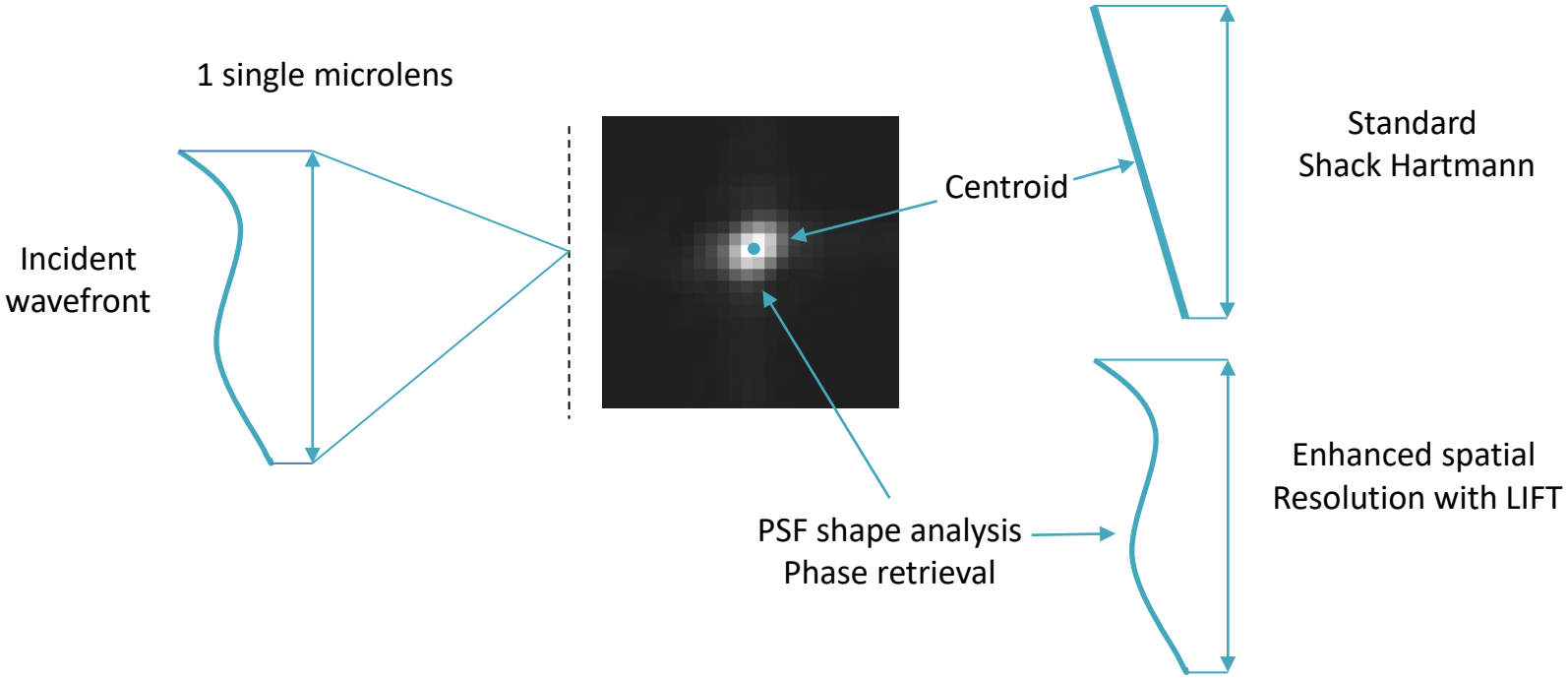


focale length f, Size D
On the detector : Sinc² function



$$r_{premier\_zero} = \frac{\lambda f}{D}$$

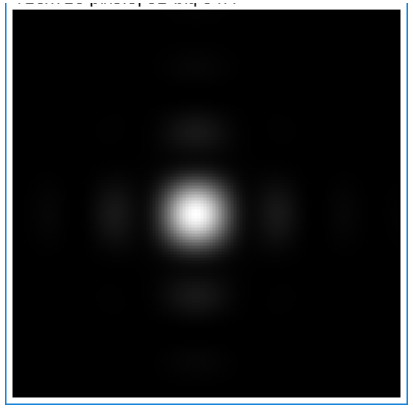
Concept : phase retrieval at microlens scale



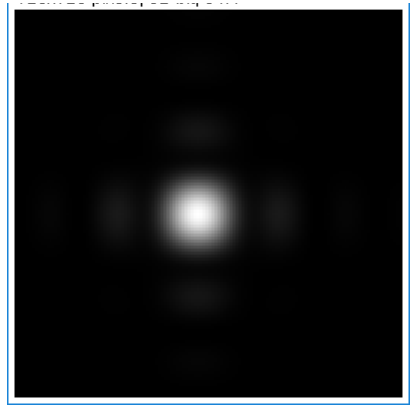
Spot shape vs local aberrations

For example

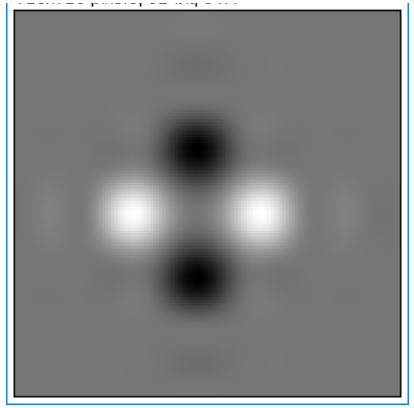
Without aberration



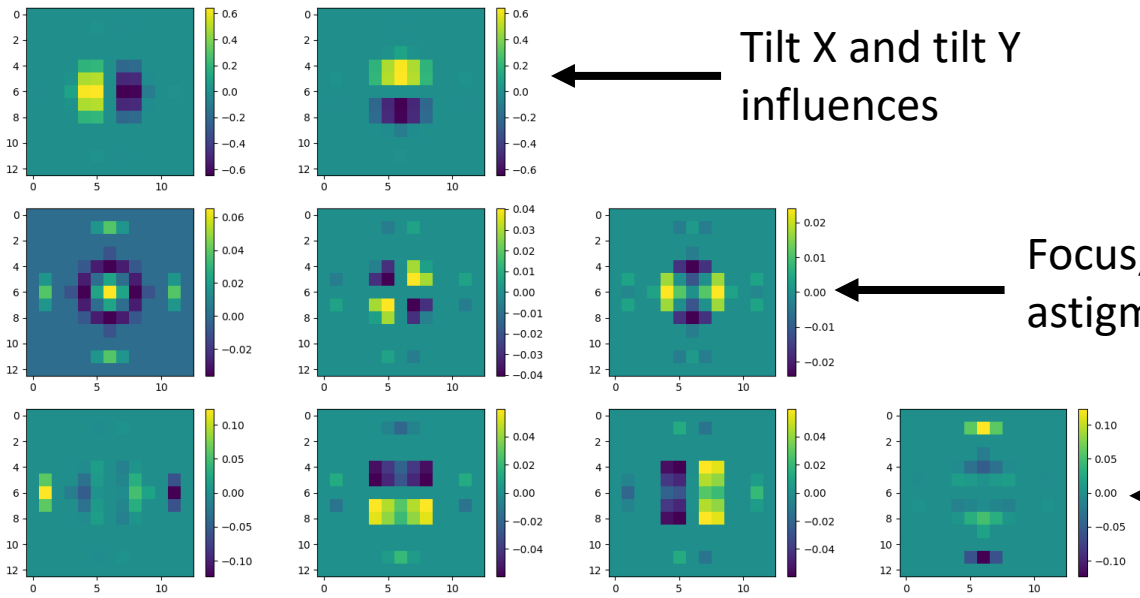
With astigmatism :10 nm PV



Difference



Spot differences for the 9 first Legendre



Tilt X and tilt Y influences

Focus, 45° astigmatism and 0° astigmatism influences

3rd order influences

Problem : the focus signature is the same for a positive or a negative value

The solution : change the shape of the microlenses to create an offset in the transmitted aberration

for instance, if the microlens itself contains pure astigmatism, a positive and a negative focus will have a different influence

To learn more about LIFT

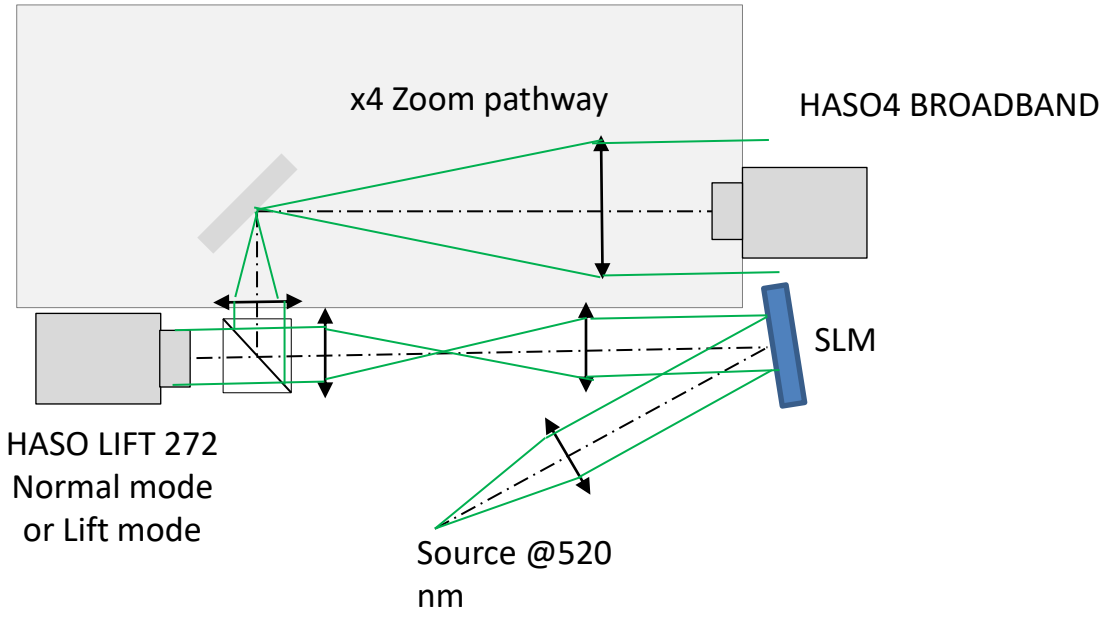
LIFT is « Linearized Focal plane Technique »

Sensing more modes with fewer sub-apertures: the LIFTed Shack–Hartmann wavefront sensor
Serge Meimon and al ONERA, May 15, 2014 / Vol. 39, No. 10 / OPTICS LETTERS

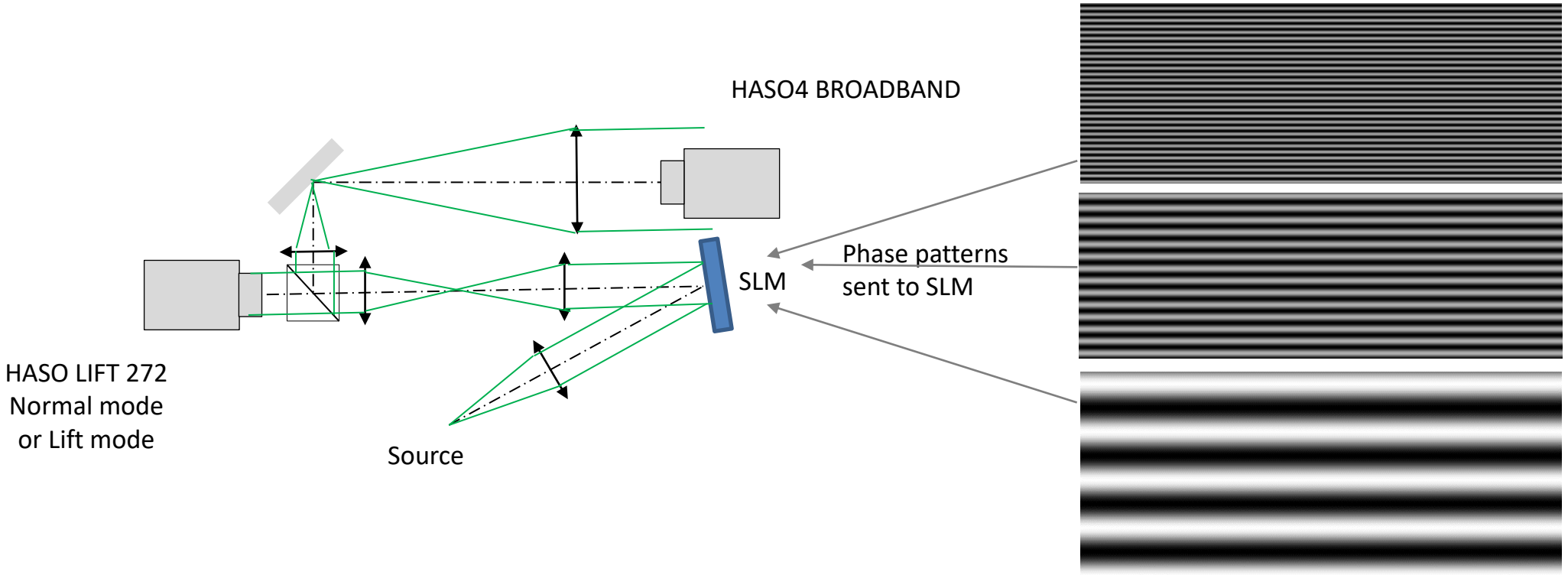
Experimental validation of LIFT for estimation of low-order modes in low-flux wavefront sensing
C. Plantet, S.Meimon, J.-M. Conan and T. Fusco, 15 July 2013 | Vol. 21, No. 14, OSA

Small-phase solution to the phase-retrieval problem
R. Gonsalves, Opt. Lett., Vol. 26, No 10, pp. 684-685 (2001)

Optical setup



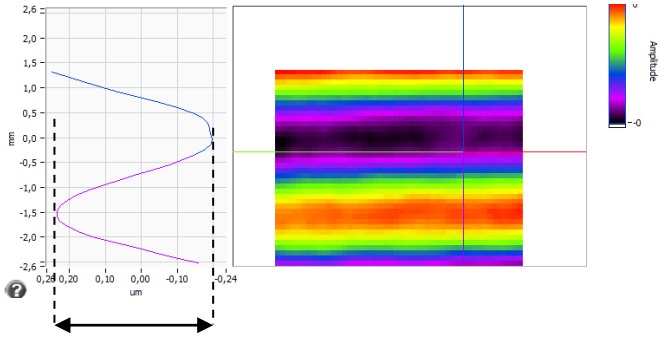
Transfer function : Wavefront amplitude/spatial frequency



Transfer function : examples for 0.125 cycles/µlens

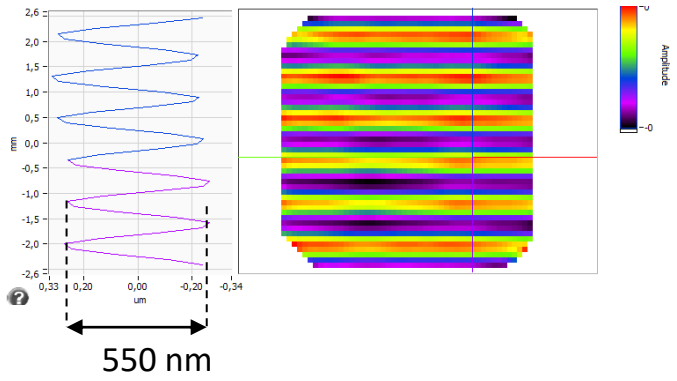
HASO4 BROADBAND

Zoom x4 : reference
32 µlenses per cycle



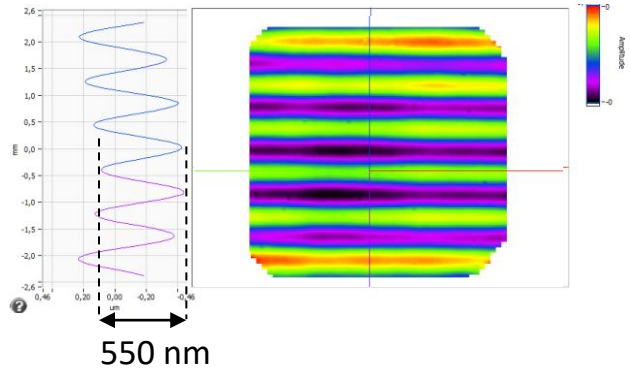
HASO LIFT 272 wo LIFT

Standard HASO
8 µlenses per cycle



HASO LIFT 272

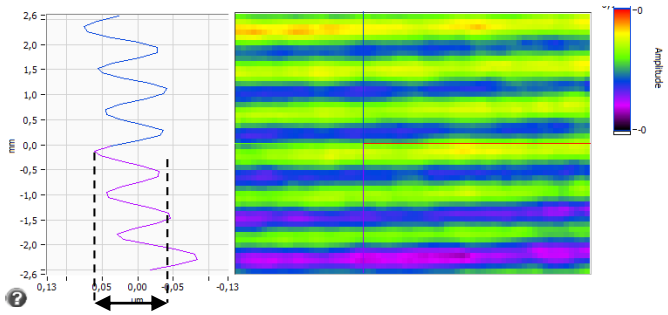
Enhanced resolution
but still
8 µlenses per cycle



Transfer function : examples for 0.5 cycles/µlens

HASO4 BROADBAND

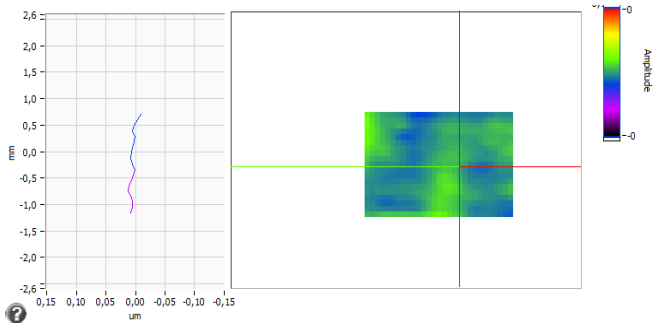
Zoom x4 : reference
8 µlenses per cycle



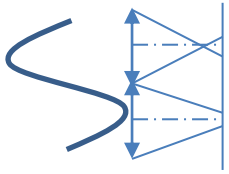
100 nm

HASO LIFT 272 wo LIFT

2 µlenses per cycle



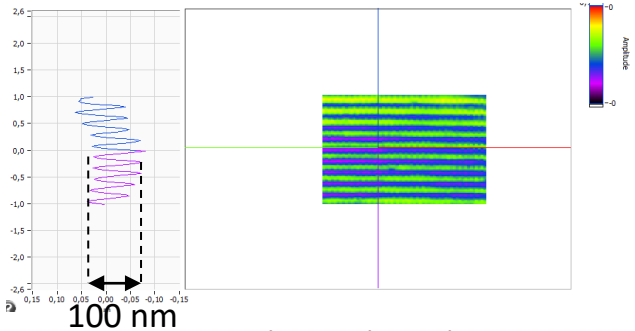
The oscilaltion in the wavefront is not measured



No centroid displacement

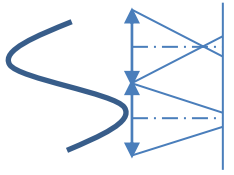
HASO LIFT 272

2 µlenses per cycle



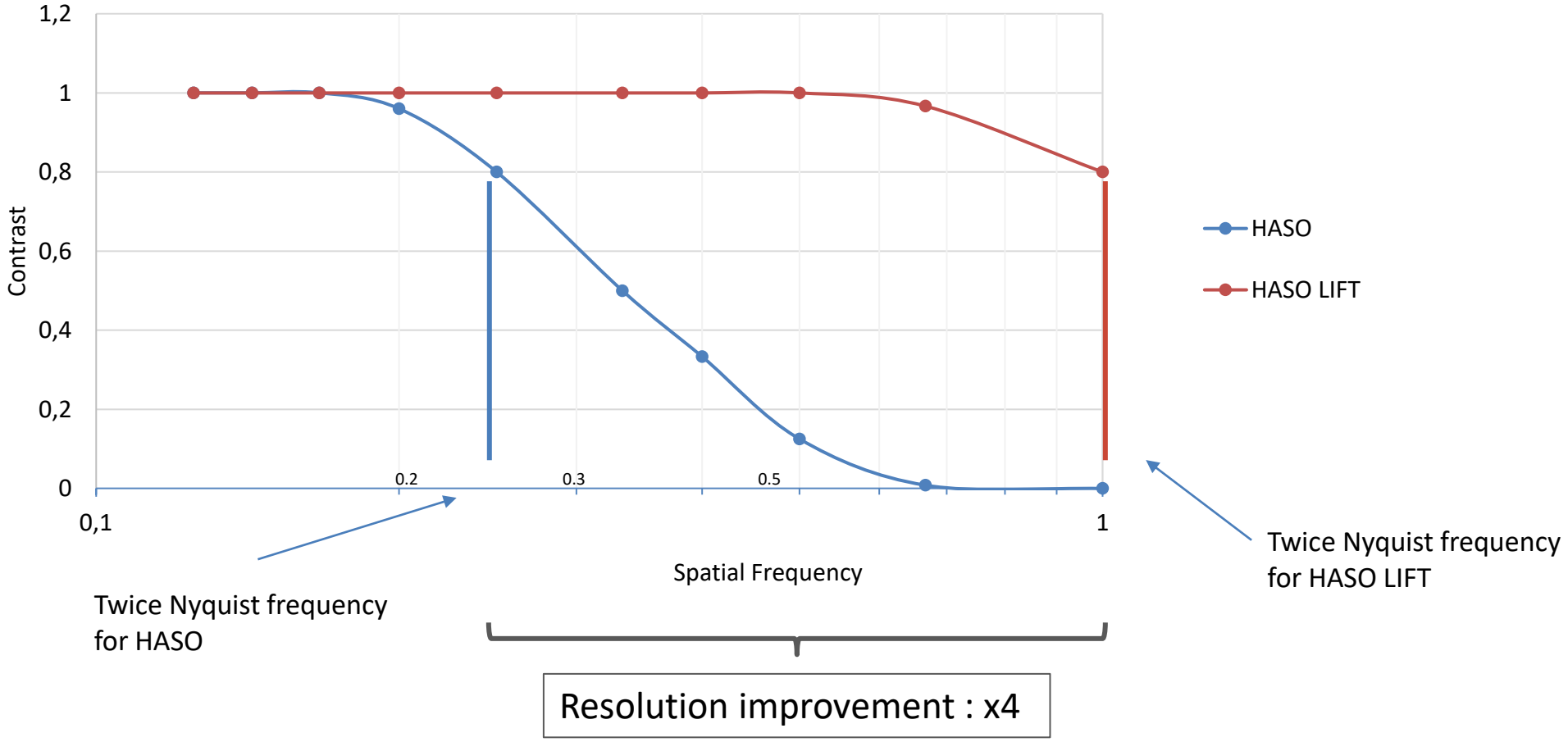
100 nm

Enhanced resolution

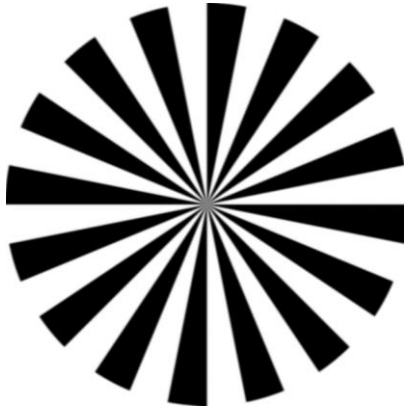


No centroid displacement but PSF shape modification

HASO and HASO LIFT Transfer function

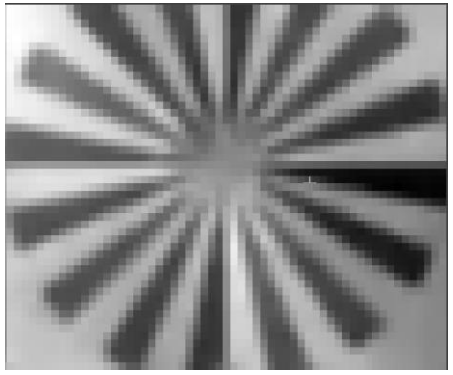


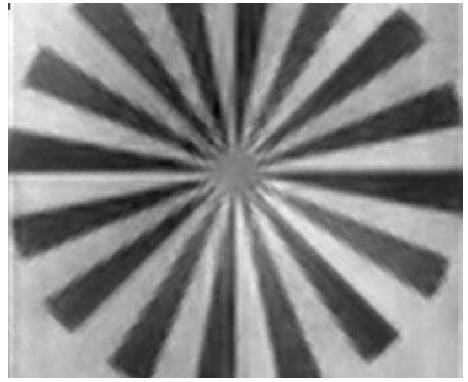
HASO LIFT 272



Phase hologram sent to SLM
Black is 0
White is 2π

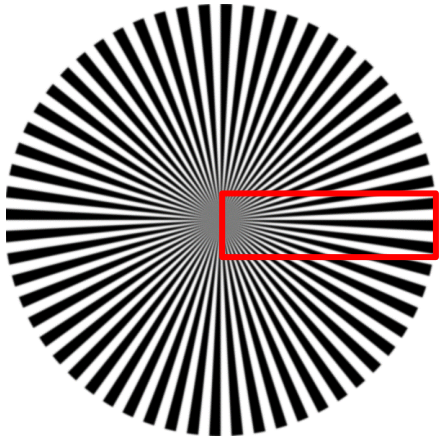
Phase reconstruction with standard Shack-Hartmann algorithm





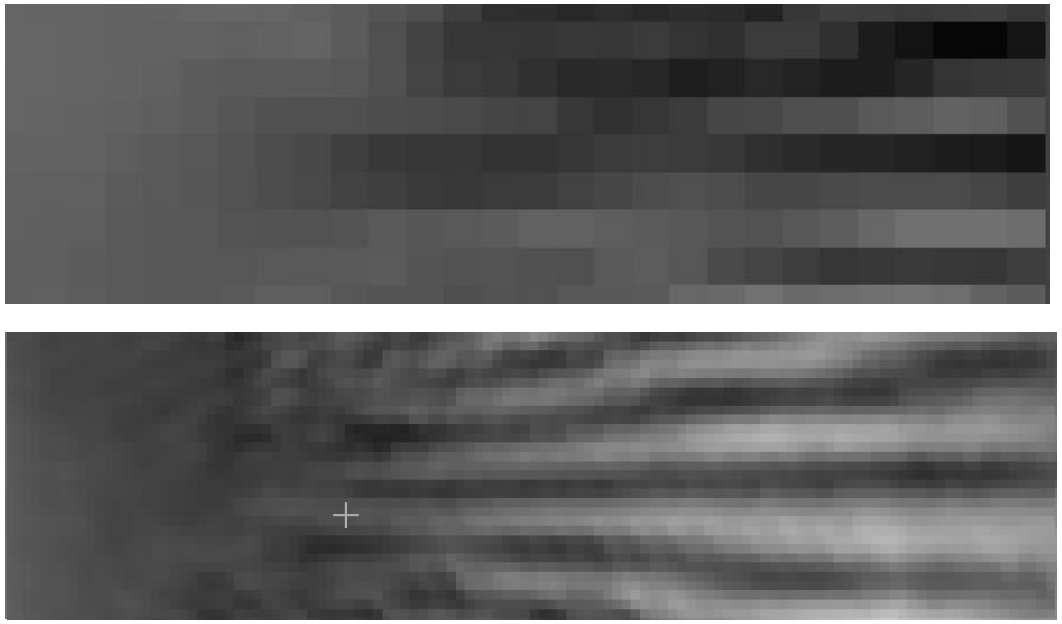
Phase reconstruction with LIFT algorithm

HASO LIFT 272



Phase hologram sent to SLM

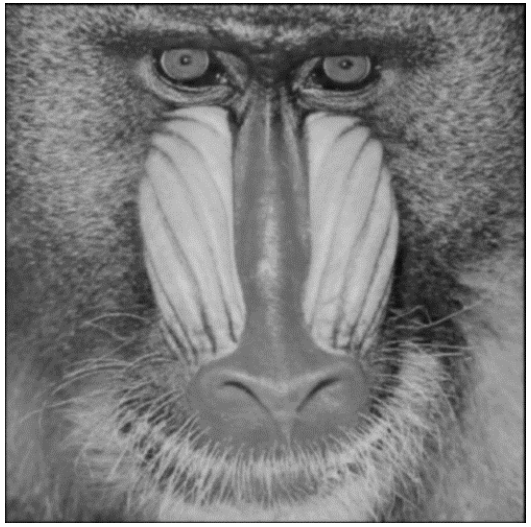
Spatial Frequency



standard
Shack-Hartmann

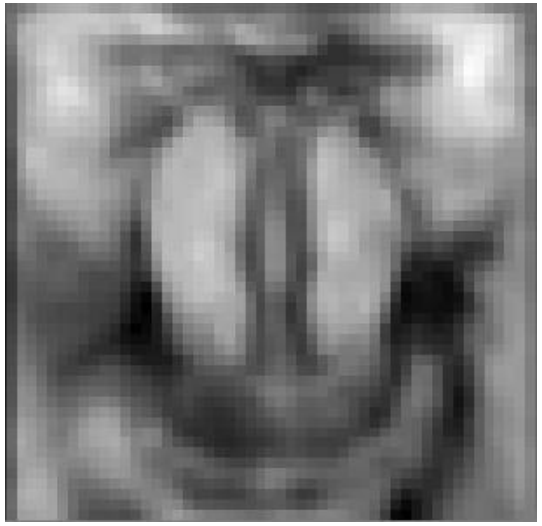
LIFT algorithm

HASO LIFT 272



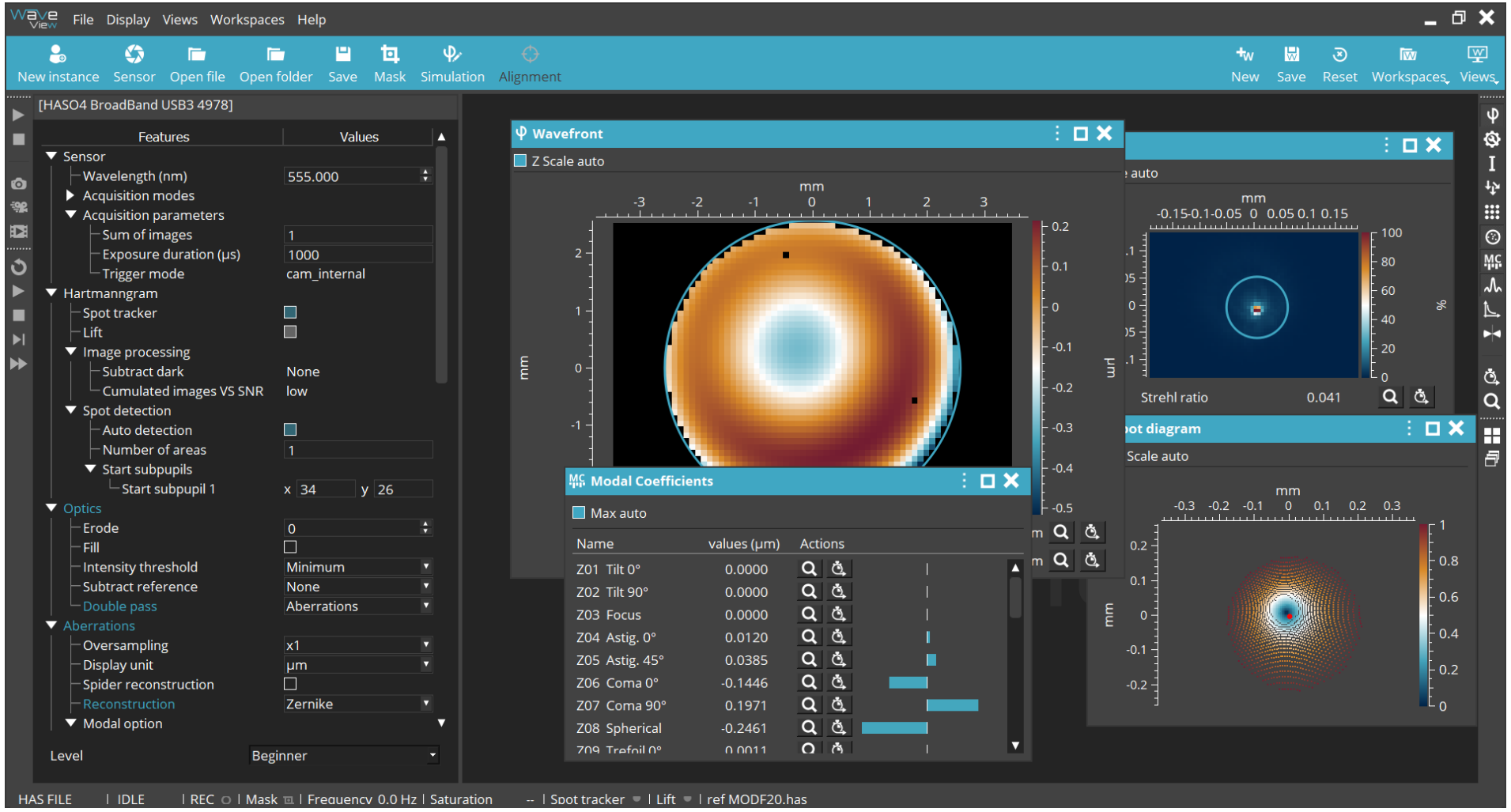
Phase hologram sent to SLM

Phase reconstruction with standard Shack-Hartmann algorithm



Phase reconstruction with LIFT algorithm

Implementation in Waview4



Our HASO LIFT

HASO LIFT SERIES

HASO LIFT 272

400-800nm
5.2 x 7 mm²
λ/100 RMS absolute accuracy

HASO LIFT 680

400-800nm
10.2 x 13.8 mm²
λ/100 RMS absolute accuracy

HASO SWIR LIFT 160

1050-1700nm
7.4 x 9.3 mm²
λ/100 RMS absolute accuracy

Some other newly released HASO

The ultra-low light

7.12 x 5.33 mm²
14 microlenses on 3.6mm diameter
Optimized for 637nm
Accuracy (systematic errors) : 5 nm RMS
Repeatability at saturation : 5 nm RMS
10nm RMS of repeatability at 1000ph/s in the pupil
USB3.0

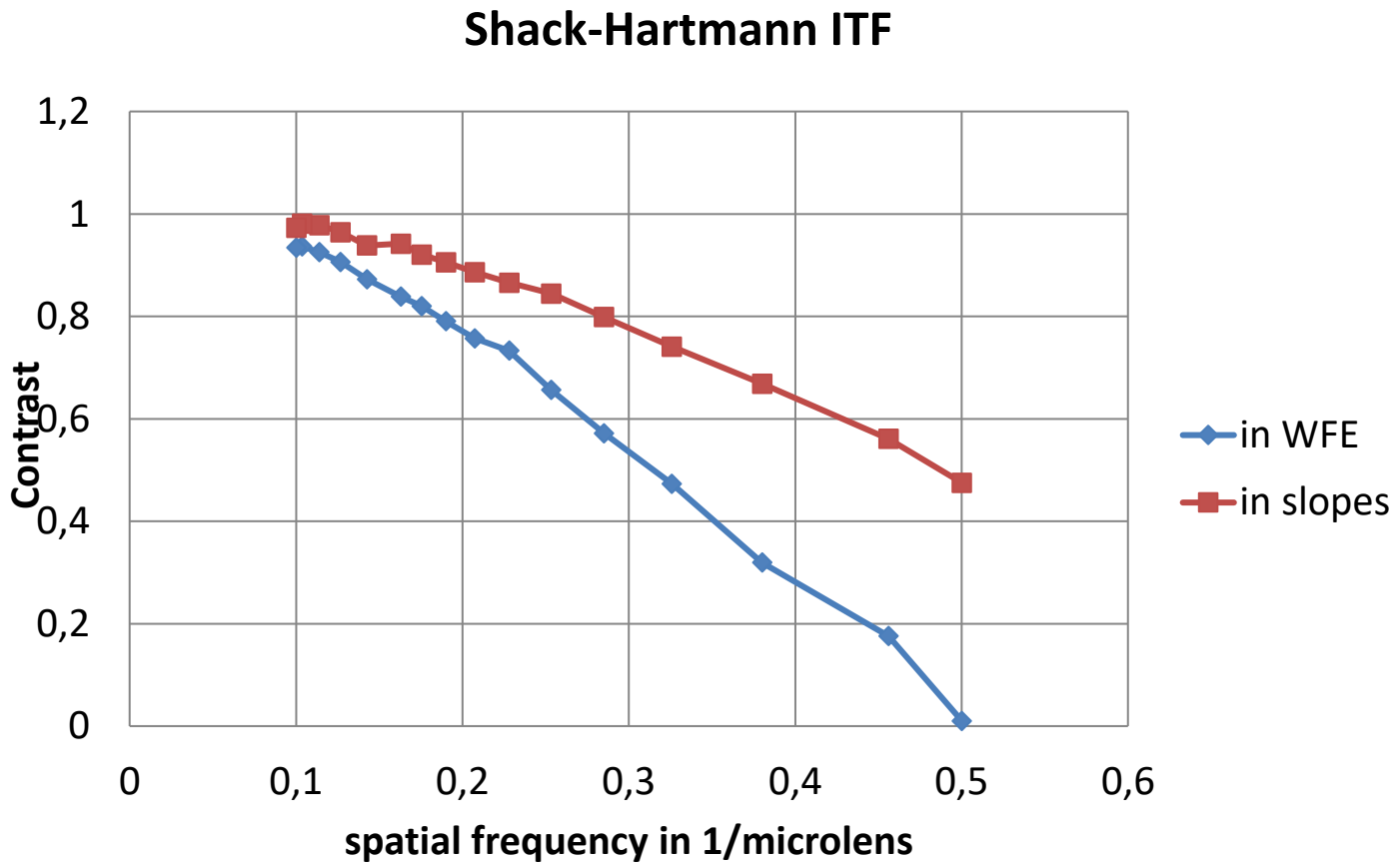
Thank you

or

??

BACK-UP SLIDES

Shack-Hartmann transfer function



R-FLEX LA SWIR

The SWIR collimating platform for large optics & optical surfaces

See details

HASO LIFT 272

400 – 800 nm High-Resolution Alignment-Free Wavefront Sensor

See details

R-FLEX2

Visible & NIR optical characterization

See details

WAVEFRONT RUNNERS SINCE 1996

Catalogue

The 2021 edition of our e-Catalogue just came out, featuring our SWIR HASO4 sensors and R-FLEX systems, along with the full range of our wavefront analysis equipment, correction equipment, and software. Browse and compare, check out specs and application notes. This can be done easily from your phone or desktop using the interactive PDFs.
You may also like our HASO comparative spreadsheet.

Conclusions

HASO LIFT = The best of Shack-Hartmann technology + High sampling density

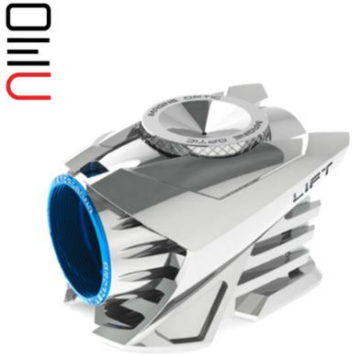
- High accuracy : λ/100 RMS
- Huge dynamic range
- Insensitive to vibrations
- And now high spatial resolution

HASO LIFT 272 : 200x**272** phase points
HASO LIFT 680 : 504x**680** phase points

HASO LIFT opens the door to new applications and, together with R-Flex LA, allows for multispectral interferometry applications.

HASO LIFT 272 and HASO4 BROADBAND

HASO LIFT 272



ABSOLUTE ACCURACY (RMS)	REPEATABILITY (RMS)	PHASE-POINTS RESOLUTION	PUPIL SIZE (mm²)	MAX. FRAME RATE (Hz)	WAVELENGTH (nm)	INTERFACE
λ/100	λ/200	272 x 200	5.2 x 7.0	20	400 - 800	USB 3.0

HASO4 BROADBAND

ABSOLUTE ACCURACY (RMS)	REPEATABILITY (RMS)	MICROLENS NUMBER	PUPIL SIZE (mm²)	MAX. FRAME RATE (Hz)	WAVELENGTH (nm)	INTERFACE
λ/100	λ/200	50 x 68	5,2 x 7,0	20	350 – 1100	USB 3.0 or GigE

HASO LIFT 680

Phase hologram sent to SLM

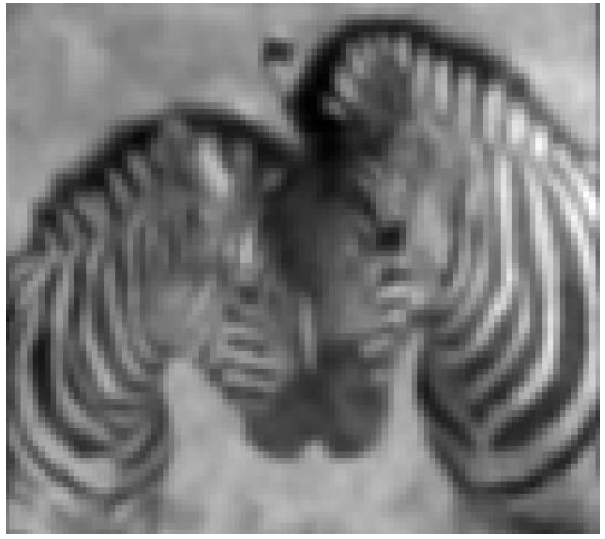
Phase reconstruction with standard Shack-Hartmann algorithm

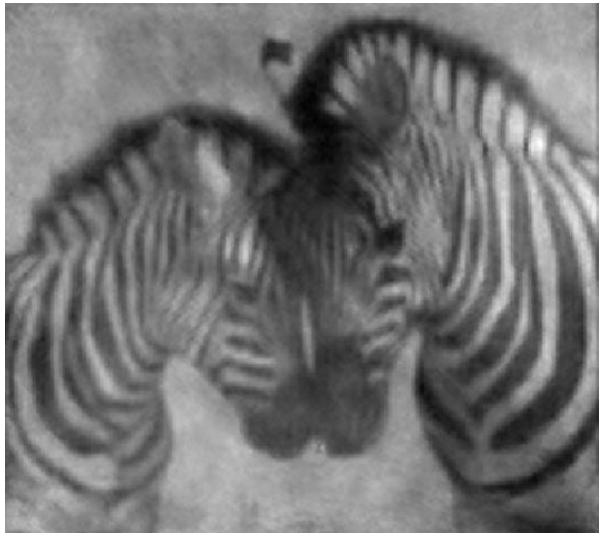
Phase reconstruction with LIFT algorithm

HASO LIFT 680

Phase hologram sent to SLM

Phase reconstruction with standard Shack-Hartmann algorithm

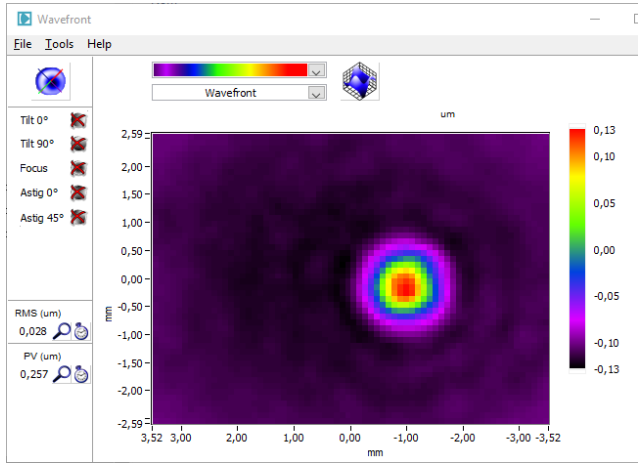




Phase reconstruction with LIFT algorithm

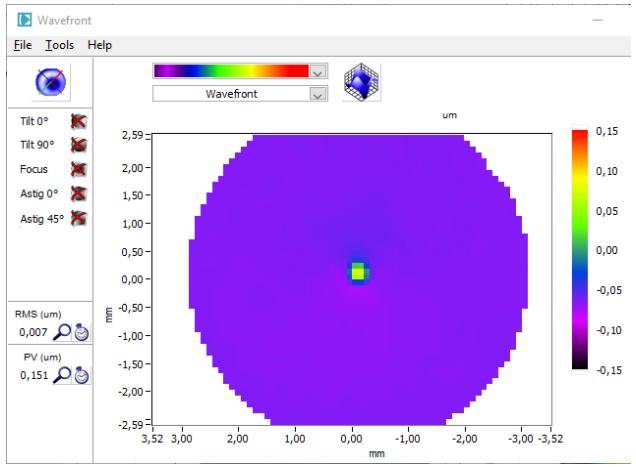
Example : small diameter phase gaussian defect (FWHM = 2 µlens)

Zoom x4 : reference
FWHM = 8 µlens



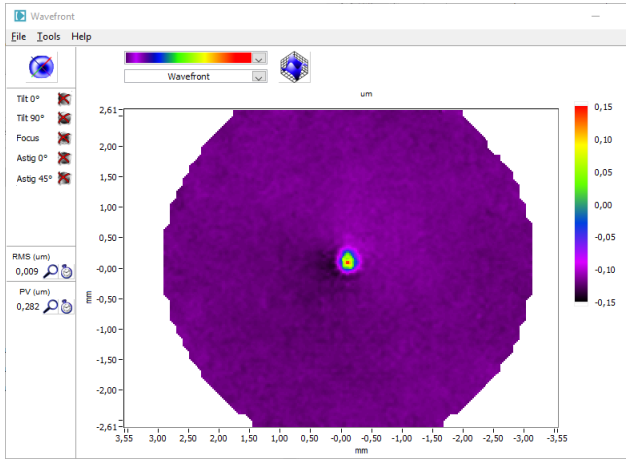
PV = 260 nm

Standard HASO
FWHM = 2 µlens



PV = 150 nm
Detectable but wrong amplitude

Enhanced resolution
FWHM = 2 µlens

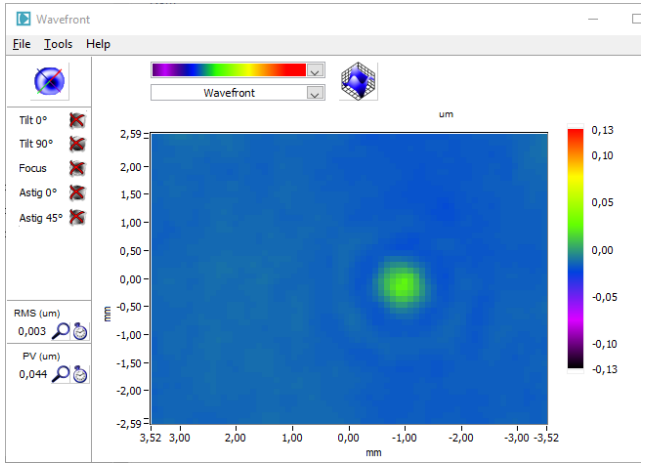


PV = 280 nm

Enhanced resolution = refrence resolution

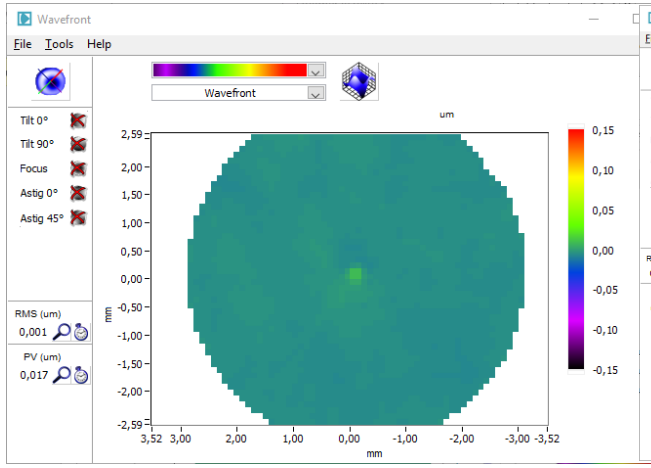
Example : small diameter phase gaussian defect (FWHM = 1 µlens)

Zoom x4 : reference
FWHM = 4 µlens



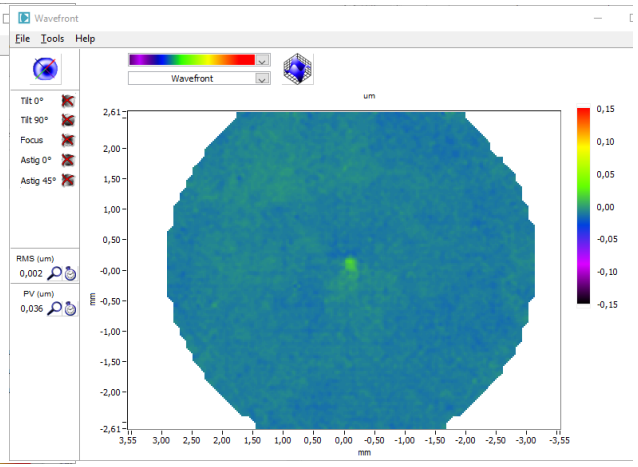
PV = 44 nm

Standard HASO
FWHM = 1 µlens



PV = 17 nm
Hardly detectable, wrong amplitude

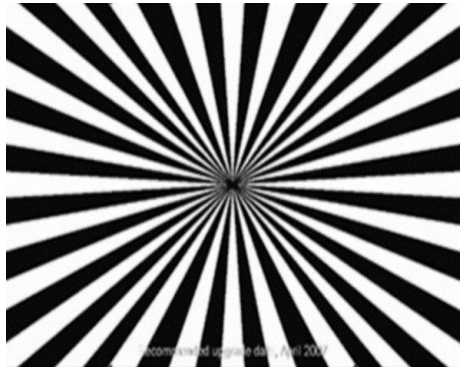
Enhanced resolution
FWHM = 1 µlens



PV = 36 nm

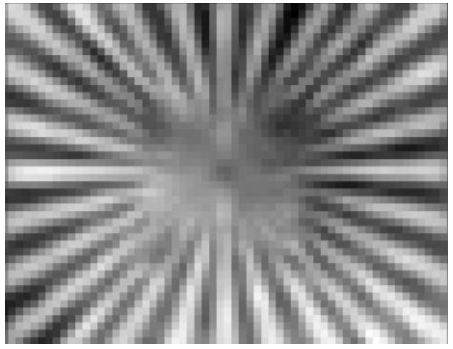
Enhanced resolution = refrence resolution

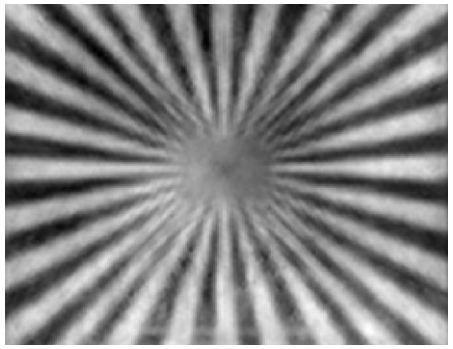
HASO LIFT 272



Phase hologram sent to SLM

Phase reconstruction with standard Shack-Hartmann algorithm

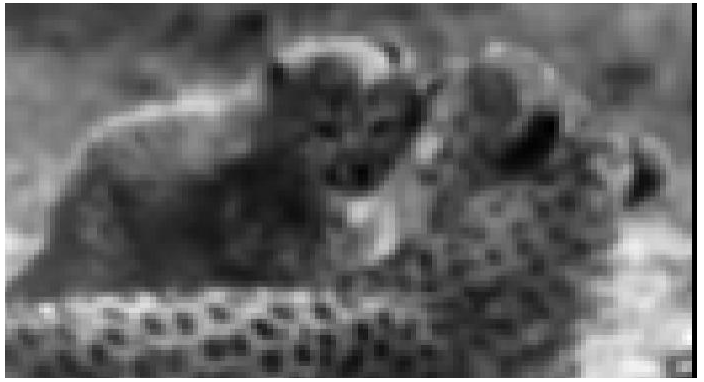




Phase reconstruction with LIFT algorithm

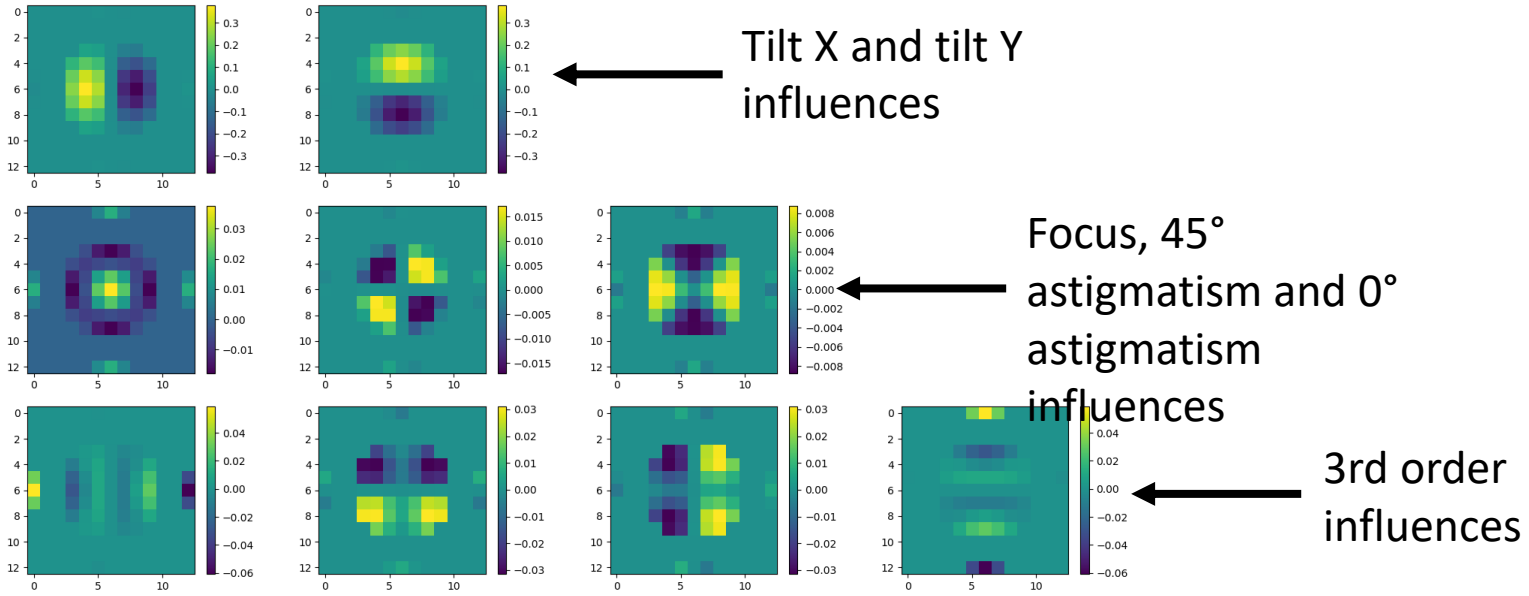
Phase hologram sent to SLM

Phase reconstruction with standard Shack-Hartmann algorithm



Phase reconstruction with LIFT algorithm

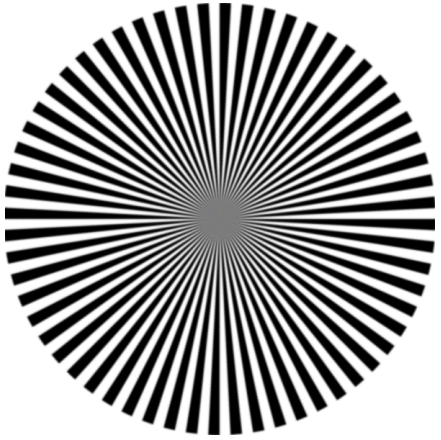
Spot differences for the 9 first Legendre @ 650 nm



Tilt X and tilt Y influences

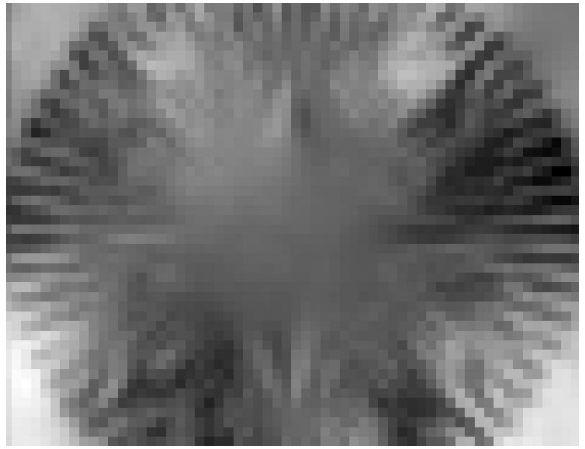
Focus, 45° astigmatism and 0° astigmatism influences

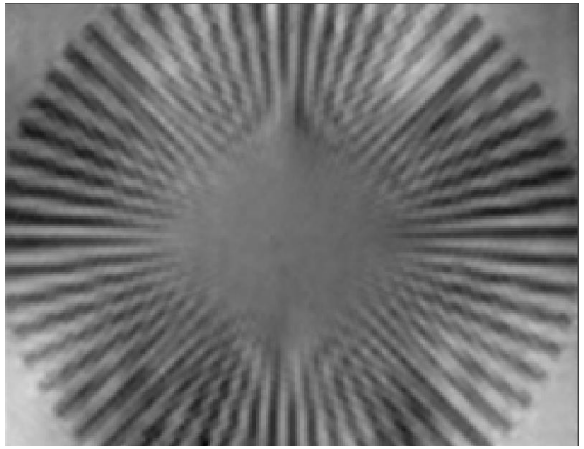
3rd order influences



Phase hologram sent to SLM

Phase reconstruction with standard Shack-Hartmann algorithm





Phase reconstruction with LIFT algorithm