

**ALPAO Shack-Hartmann (SH)** wavefront sensors (WFS) are the only range of WFS especially designed for Adaptive Optics (AO). They feature excellent performances to fit with every adaptive optics system. Sensitivity, speed and spectral range can be chosen depending on your needs. All **ALPAO SHs** perfectly fit with **ALPAO DMs** and **ALPAO software and real-time computers**.



## Key features

### OPTIMIZED FOR AO

Especially designed for adaptive optics

### SPEED

Frequency up to 31.8kHz  
latency as low as 5 $\mu$ s

### HIGH SENSITIVITY

Photon flux for SNR=1 down to 3 photons/frame/sub-aperture

## OPTIMIZED FOR AO

ALPAO SHs are specifically designed for adaptive optics.

ALPAO recommends the Fried configuration for low flux high speed applications. It allows for an optimal control of your DM.

The latency has been minimized for best AO performances.

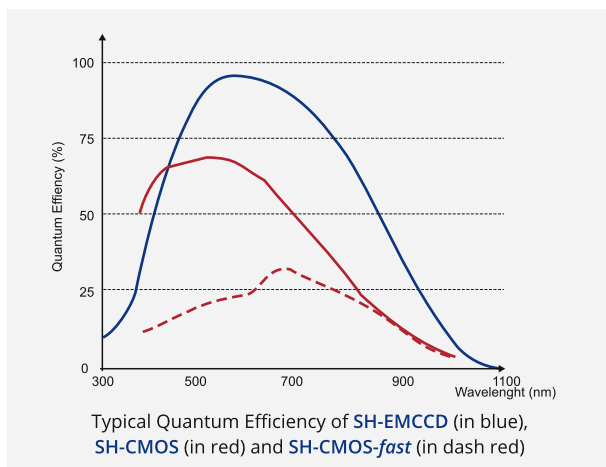
## HIGH SENSITIVITY

For some applications, like in microscopy or astronomy, a high-sensitivity wavefront sensor is required.

EMCCD technology allows great performance in terms of sensitivity thanks to very low read out noise. SH-EMCCD and SH-EMCCD-*fast* are featuring such performances.

## VIS WFS

ALPAO SH-CMOS and SH-EMCCD are perfect for large spectral applications and cover the range from 350 to 1000nm.



## SOFTWARE & DRIVERS

ALPAO WFS include software drivers (SDK). The SDK allows to recover spot diagrams for integration into your software or Real-Time Computer (RTC).

ALPAO WFS are designed to work with ALPAO Core Engine (ACE) or ALPAO RTC (ACE *fast*). They are not included and need to be purchased separately. ACE *fast* includes the necessary hardware. The minimum configuration for ACE is 4Gb RAM, 100MB disk space, MATLAB® R2017a or higher.

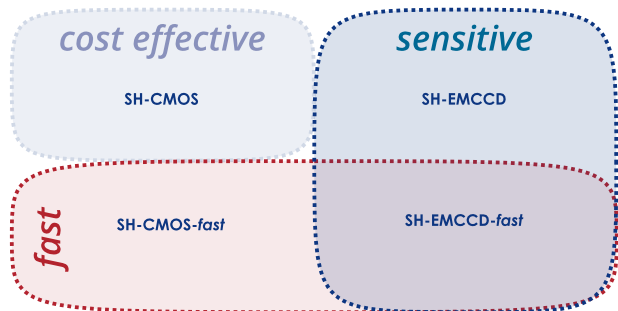
## FAST WAVEFRONT SENSING

For atmospheric perturbation correction, kHz frequency wavefront sensors are needed. ALPAO WFS can be run up to 5kHz.

Beyond frequency, latency is a key parameter for real time compensation of the perturbations. ALPAO WFS interfaces are designed for extremely low latency.

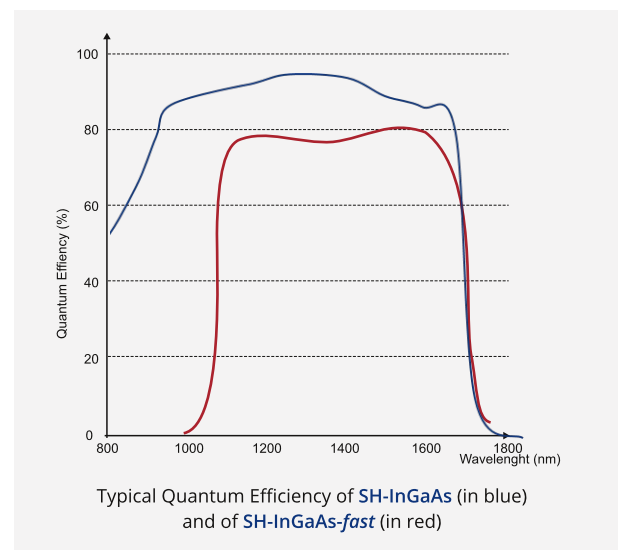
Thanks to their speed and low latency, those wavefront sensors associated with the ALPAO Real-Time Computer ACE *fast* and ALPAO DM can reach AO bandwidth greater than 100Hz.

## CHOOSE YOUR VIS-WFS



## NIR WFS

ALPAO SH-InGaAs are working in the near infra-red from 950 to 1700nm. They feature high sensitivity at 1.5µm combined with very high frequency.



## GENERAL SPECIFICATIONS

	SIZING		SPEED			SENSITIVITY		OPTICS	
	Number of sub-apertures	Microlens pitch (µm)	Acquisition frequency (Hz)	Maximum with ROI (Hz) <sup>1</sup>	Sensor maximum quantum efficiency	Photons for SNR=1 (ph./fr./sub-aperture)	Read-out noise (e- RMS)	Repeatability (nm RMS)	Spectral range
SH-CMOS	50x50	96.6	118	477	67%	100	2.1	2	VIS
SH-CMOS-fast	64x64	112	2030	31800	35%	1000	37	2	VIS
SH-EMCCD <sup>2</sup>	16x16	192	1004	1838	95%	3	0.1	2	VIS
SH-EMCCD-fast	23x23	192	2067	2067	95%	4	0.3	2	VIS
SH-InGaAs	23x23	240	600	3000	92%	1500	225	2	NIR
SH-InGaAs-fast	23x23	120	3020	9590	80%	300	30	2	NIR

<sup>1</sup> See specific table Speed for detailed acquisition frequency according to the WFS configuration.

<sup>2</sup> SH-EMCCD is available with a frame rate throttle at 999Hz.

## SPEED

Camera acquisition frequency (Hz) indicates the frame rate of the very camera upon which the WFS is based. Readout latency (µs) defined as the lag between the end of exposure and the beginning of data transmission.

WFS sub-aperture ROI	8x8	10x10	15x15	16x16	19x19	23x23	31x31	50x50	63x63
Compatible DM (Fried geometry)	DM69	DM97	DM192	DM241	DM292	DM468	DM820	-	DM3228
SH-CMOS	477Hz 5000µs	417Hz 5000µs	317Hz 5000µs	302Hz 5000µs	266Hz 5000µs	229Hz 5000µs	179Hz 5000µs	118Hz 5000µs	n/a
SH-CMOS-fast	31800Hz 5µs	25180Hz 5µs	16880Hz 5µs	15000Hz 5µs	12170Hz 5µs	9670Hz 5µs	6280Hz 5µs	3070Hz 5µs	2030Hz 5µs
SH-EMCCD	1838Hz 69µs	1004Hz 68µs	1004Hz 64µs	1004Hz 64µs	n/a	n/a	n/a	n/a	n/a
SH-EMCCD-fast	2067Hz 43µs	2067Hz 43µs	2067Hz 43µs	2067Hz 43µs	2067Hz 43µs	2067Hz 43µs	n/a	n/a	n/a
SH-InGaAs	3000Hz 18.7µs	2200Hz 19.5µs	1200Hz 21.5µs	1100Hz 21.9µs	900Hz 23.1µs	600Hz 24.7µs	n/a	n/a	n/a
SH-InGaAs-fast	9590Hz 6.2µs	7550Hz 6.4µs	5030Hz 6.6µs	4760Hz 6.6µs	3830Hz 6.7µs	3020Hz 6.9µs	n/a	n/a	n/a

## RANGE

Tip-tilt and defocus range (µm PV) are geometrical values without resorting to spot tracking algorithms.

WFS sub-aperture ROI	8x8	10x10	15x15	16x16	19x19	23x23	31x31	50x50	63x63
Compatible DM (Fried geometry)	DM69	DM97	DM192	DM241	DM292	DM468	DM820	-	DM3228
SH-CMOS	10/2	12/3	18/4	20/5	23/5	28/7	38/9	62/15	n/a
SH-CMOS-fast	14/3	18/4	27/6	29/7	34/8	42/10	56/14	91/22	115/28
SH-EMCCD	6/1	8/2	12/3	13/3	15/3	n/a	n/a	n/a	n/a
SH-EMCCD-fast	11/2	14/3	22/5	23/5	28/7	34/8	n/a	n/a	n/a
SH-InGaAs	29/7	38/9	57/14	61/15	72/18	88/22	n/a	n/a	n/a
SH-InGaAs-fast	16/4	20/5	30/7	32/8	38/9	46/11	n/a	n/a	n/a

## WFS HOUSING



**SH-CMOS**  
44x29x29mm



**SH-CMOS-fast**  
63x63x47mm



**SH-EMCCD**  
156x156x204mm



**SH-InGaAs**  
81x50x50mm

**SH-EMCCD-fast** 242x175x76mm - *picture to come*

**SH-InGaAs-fast** 282x75x60mm - *picture to come*

All our WFS are provided with a 5-meter cable, except SH-CMOS provided with a 3-meter cable.

## ORDER TODAY



Need more information?

Contact us for one-to-one guidance and technical support.

- ▶ [www.alpao.com](http://www.alpao.com)
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