

ALPAO Deformable Mirrors (DMs) feature large strokes, high dynamic motion and an excellent optical quality. ALPAO DMs are providing state-of-the-art performances which will meet and exceed your requirements for fast and accurate wavefront corrections.



## Key features

### LARGE DEFORMATION

Up to 90 $\mu$ m  
PV for tip-tilt

### HIGH DYNAMIC MOTION

Settling time as low as  
400 $\mu$ s at +/-10%

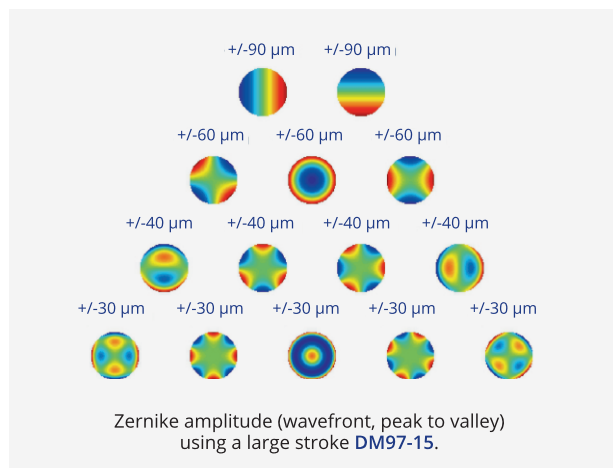
### EXCELLENT OPTICAL QUALITY

Active best flat <7nm RMS  
(<3nm RMS optional)

## LARGE DEFORMATION

Using **ALPAO DMs**, you can correct large aberrations and shape wavefronts with high precision, including high-order Zernike modes.

Such large amplitudes of deformation allow to use adaptive optics as never before. You can, for example, skip the separate tip-tilt mirror (astronomy), use the large defocus capability for fast z-scan (microscopy) or correct large eye-aberrations (ophthalmology).



## FEATURES AND BENEFITS

Additional DMs typical features and benefits:

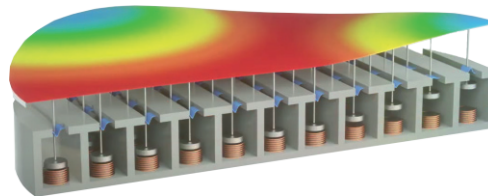
- Operating temperature:  $-50/35^{\circ}\text{C}$ <sup>1</sup>
- Protected Silver coating (other coatings available)
- Vacuum compatibility
- Sub-nm resolution
- No protective glass
- Surface roughness  $<15\text{\AA}$  RMS
- LIDT for protected silver coating<sup>2</sup>:  $880\text{mJ}/\text{cm}^2$  (@12ns,10Hz, 1064nm) / 50W (CW @ 1064nm)
- MTBF<sup>2</sup>:  $10^{11}$  cycles
- $<10\text{nm}$  RMS open loop stability over hours<sup>3</sup>
- Square grid-pattern except for large size DM (hexagonal pattern)<sup>2</sup>

Additional drive electronics typical features and benefits:

- Few W average power dissipation
- Thin and flexible cables

## TECHNOLOGY

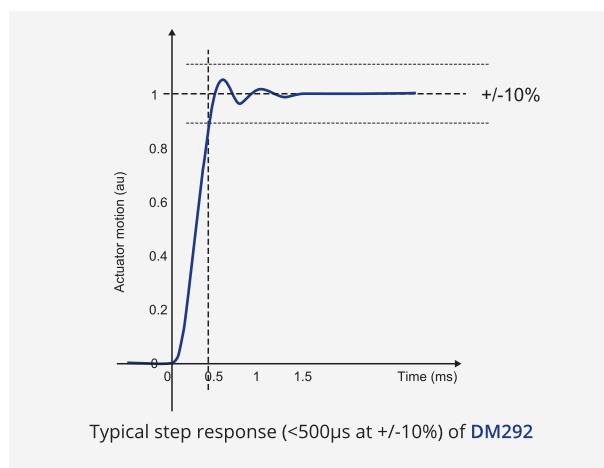
**ALPAO DMs** are based on continuous reflective surface motioned by magnetic actuators.



## HIGH DYNAMIC MOTION

The settling times of **ALPAO DMs** are as low as  $400\mu\text{s}$  (at  $\pm 10\%$ ) with very low overshoot.

Consequently, the deformable mirror provides excellent correction because adaptive optics temporal errors are drastically reduced.



## EXCELLENT LINEARITY AND LOW HYSTERESIS

**ALPAO DMs** have almost no hysteresis ( $<2\%$ ), as well as high linearity ( $>97\%$ ) and great stability.

Straightforward control of an **ALPAO DM** results in very low residual wavefront errors.

## SOFTWARE DRIVERS

**ALPAO DM** includes software drivers (SDK) for Labview®, Matlab®, C/C++ and Python.

Our hardware and software are compliant with Microsoft Windows® XP (32bit), 7, 8.1, 10 (32/64bit) and many Linux® (32/64bits) operating systems.

**ALPAO PERFORMANCE**

		SIZING			Number of actuators across a diameter	QUALITY			STROKE			SPEED		
		Number of actuators	Pitch (mm)	Pupil diameter (mm)		Tip/tilt stroke (µm RMS, mechanical)	Defocus/astig. stroke (µm PV, wavefront)	3λ/3 stroke (µm PV, wavefront)	Settling time (ms at +/-10%, any stroke)	First resonance of the membrane (Hz)	Frequency at phase lag of 45° (Hz)	Mechanical dimensions WxHxD (mm <sup>3</sup> )		
DM69	DM69-08	69	0.8	5.6	9	7	80	40	25	1.5	400	300	52 x 74 x 35	
	DM69-15		1.5	10.5	9		60	40	25	0.8	800	700	52 x 74 x 22	
	DM69-25		2.5	17.5	9		40	30	25	1.5	600	500	62 x 84 x 23	
	DM69-50		5.0	35	9	25	40	30	25	1.5	600	500	100 x 120 x 40	
DM97	DM97-08	97	0.8	7.2	11	7	80	40	25	1.5	400	300	52 x 74 x 32	
	DM97-15		1.5	13.5	11		60	40	25	0.8	800	700	52 x 74 x 22	
	DM97-25		2.5	22.5	11		40	30	25	1.5	600	500	62 x 84 x 23	
	DM97-50		5.0	45	11	25	40	30	25	1.5	600	500	100 x 120 x 40	
	DM192	192	1.5	21	16	7	15	10	10	0.5	2000	1500	70 x 110 x 82	
	DM241	241	2.5	37.5	17		40	30	25	1.5	600	500	91 x 113 x 27	
	DM292	292	1.5	26.5	20		15	10	10	0.5	2000	1500	70 x 110 x 82	
	DM468	468	1.5	33	24		12	10	10	0.5	1600	1500	90 x 110 x 124	
	DM820	820	1.5	45	32		12	10	10	0.5	1600	1500	100 x 120 x 120	
	DM3228	3228	1.5	93	64		10	8	8	0.5	1200	1000	140 x 180 x 180	
LARGE SIZE DM	DMX37	37	20.6	100	7		25	30	25	25	2	400	400	244 x 290 x 78
	DMX61	61		130	9		25	50	40					244 x 290 x 78
	DMX85	85		170	11	25	50	40	244 x 290 x 78					
	DMX121 <sup>3</sup>	121		200	13	30	50	40	350 x 380 x 90					
	DMX163 <sup>3</sup>	163		240	15	30	50	40	350 x 380 x 90					

Non-linearity below 3%, hysteresis as low as 2% for all DMs and 6% for DMXs. Performances at room temperature

**LOW-VOLTAGE ELECTRONICS**

	Less than 100 actuators electronics	More than 100 actuators electronics
Protocol / Resolution	16 / 14 bit	
PC connection	USB / Ethernet	PCIe card (included)
Power consumption	<150W	<500W
Power supply	from 110 to 250V AC, 50 to 60Hz	
Weight	4kg (9pounds)	10kg (22pounds)
Dimensions (L x l x h)	31.5 x 23.5 x 13.5cm (12.4 x 9.3 x 5.3 inches)	37.1 x 45 x 17.5cm - rackable 4U (14.6 x 17.7 x 6.9 inches)
Operating temperature	0 to 35°C	
Cable length <sup>4</sup> (power supply, PC to drive electronics, drive electronics to DM)	2m - 6.5 foot	
Analog response time	< 10µs	



Electronics of less than 100 actuators DMs



Electronics of more than 100 actuators DMs

**OPTIONAL ITEMS**

- Large stroke, High speed or High optical quality options provide additional specific features:

	Best flat (nm RMS)	Stroke evolution	Settling time	First resonance freq.	Phase lag freq. of 45°
Large stroke	7	x1.5	x2	/2	/2
High speed	7	/2	/2	x2	x2
High optical quality	3	-	-	-	-

- High stability option provides increased open-loop performances.
- Other coatings: gold, aluminium or dielectric for higher LIDT.

ALPAO custom DMs are available upon request. No matter what your needs are: OEM versions, custom pitch or diameters, custom number of actuators (up to several thousand), contact us to build the DM that will suit your needs.

**ACCESSORIES**

- Rotation stage for precise tip-tilt and alignment adjustment.
- Motorized rotation stage
- Trigger-IN and trigger-OUT to synchronise sharply the hardware of your system.
- Alignment static mirrors which use the same housing and mirror positioning. It replaces your ALPAO DM for alignment or when you must move the DM to a different optical bench.
- LEDBOX: 64 LEDs on the LEDBOX represent your DM (one LED per actuator). This device helps advanced users to develop and test their control software prior to any optical installation.

**ORDER TODAY**


Need more information?

Fitting simulation, open loop control, LIDT, MTBF, software compatibility, cryogenic environment, external size drawings, 3D files or any other requests, we have more information to share.

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

- ▶ [www.alpao.com](http://www.alpao.com)
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ALPAO Deformable Modal Mirrors (DMM) provide an excellent correction of the most common optical aberrations. Each control channel corresponding to one optical mode (e.g. focus or astigmatism), the control is straightforward.



## Key features

### SIMPLE USE

One control channel per mode  
Embedded electronics

### OPTIMIZE ZERNIKE CORRECTION

Large deformation (up to 100 $\mu$ m)  
Low fitting error (down to 2%)

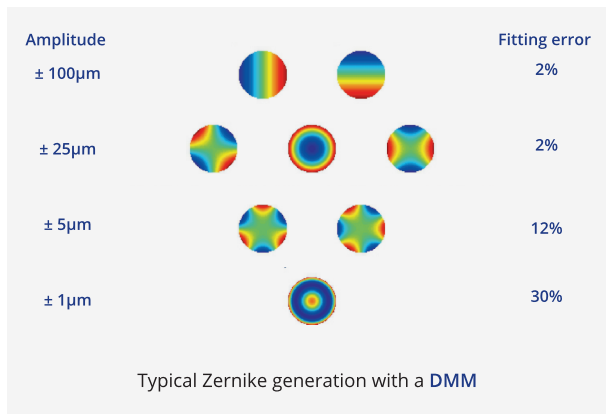
### COST EFFICIENT

Designed for  
OEM applications

## ZERNIKE CORRECTION

Using **ALPAO DMM**, you can correct the first optical aberrations at large amplitude and with high precision.

**DMM** allows to use adaptive optics as never before. You can, for example, correct alignment errors, use the defocus capability for z-scan or correct large optical aberrations.



## ALPAO DMM PERFORMANCE

		DMM
Sizing	Number of control channels	8
	Pupil diameter (mm)	13.5
Quality	Active best flat (nm RMS)	≤ 30
Tip-tilt correction	Stroke (µm PV, wavefront)	≥ 100
	Fitting error (%) <sup>1</sup>	≤ 2
Focus / astigmatism	Stroke (µm PV, wavefront)	≥ 25
	Fitting error (%) <sup>1</sup>	≤ 2
Spherical correction	Stroke (µm PV, wavefront)	≥ 1
	Fitting error (%) <sup>1</sup>	≤ 30
Speed	First resonance of the membrane (Hz)	≥ 150
	Settling time (ms at +/-10%, any stroke)	≤ 10
Linearity	Non linearity (%)	≤ 5
	Hysteresis (%)	≤ 5
Mechanical dimensions	Cylinder diameter (mm)	50
	Cylinder length (mm)	50

**DMM** can be customized according to your needs (larger stroke, pupil diameter, different coating, etc).

## SIMPLE CONTROL

Each control channel corresponds to Zernike. As simply as you would do an auto-focus, you can now do an auto-astigmatism or an auto-spherical.

Straightforward control of an **ALPAO DMM** results in very low residual wavefront errors.

## FEATURES AND BENEFITS

Typical **ALPAO DMM** characteristics:

- Protected Silver coating
- No protective glass
- Surface roughness <15Å RMS
- LIDT for protected silver coating<sup>2</sup>: 880mJ/cm<sup>2</sup> (@12ns, 10Hz, 1064nm) / 50W (CW @1064nm)

## INTERFACES

**ALPAO DMM** presents a low-voltage and low power consumption embedded electronics, with a standard Ethernet interface (or USB using a dongle). The control and monitoring are easily performed from any web browser. A simple API based on web-services is provided, it is compatible with any language and operating system. No drivers are required.

Thanks to their standard tube packaging, **ALPAO DMM** is easily integrated into systems.

## PRELIMINARY

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- ▶ [contact@alpao.fr](mailto:contact@alpao.fr)
- ▶ +33 476 890 965