Application Note

AN007: Linear Actuator Pad Array Deformable Mirror

Introduction

AgilOptics' deformable mirrors are constructed with two layers: the pad array and the mirror membrane. The pad array effects precision, resolution, and mirror shape. This application note discusses a special pad array design that uses linear actuators. For comparison, standard deformable mirrors from the Multi™ product line use hexagonal actuator pads. The 36-count Linear Actuator Pad Array was used in an experiment to remove turbulence and increased the laser beam output by 90%.

25 mm DM with Linear Pad Array

The pad array design shown in **Image 1** was used for correcting a one-dimensional 240 Hz periodic disturbance resulting from the forced flow in a heated-jet turbulence test-bed. This DM was made of one standard AgilOptics 25 mm membrane and a pad array consisting of 36 parallel bar-shaped actuators. An 18 mm diameter area in the center of the mirror was used in the tests.

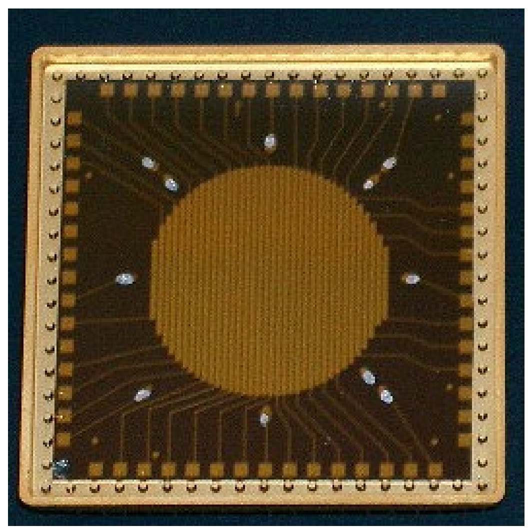

Image 1 Pad array with 36 parallel bars

In preparation for the test-bed experiments, we tested the frequency response of this mirror using a PolyTec Laser Doppler Vibrometer and an approximation to a sine wave applied spatially along the linear actuator array. The one-dimensional sine-wave was approximated by applying 170-volts to actuators 9, 10, 11,24, 25, and 26. Actuators 9-11 and 24-26 are located to the left and right, respectively, of the vertical centerline through the above pictured pad array. The RMS sine wave frequency response compared to that of focus for peak deflection is shown in **Image 2**. Deflection is much improved for the sine-wave response at higher frequencies. The frequency of the periodic disturbance in the heated-jet turbulence test-bed is about 240 Hz with peak-to-valley amplitude of about 0.2um. The P-V amplitude measured at 200 Hz and above is about 0.33um, exceeding requirements for the experiment.

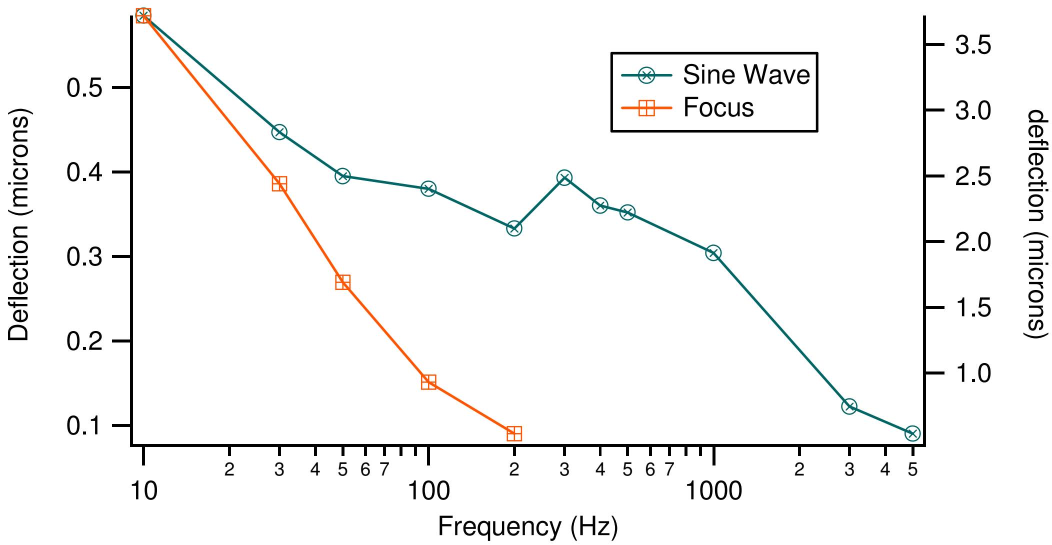

Image 2 Frequency response of 25 mm DM over a linear pad array driven in focus and in a 1-D Sine wave shape

Image 3 and **Image 4** show curves of mirror deflection as a function of position across the mirror for a range of temporal frequencies. The deflection curves in **Image 3** are modified to remove focus aberration induced by the electrostatic pull-down of the mirror surface. The peak-to-peak variation of the mirror surface is more than adequate for periodic variations of interest at frequencies below 400 Hz. **Image 4** shows that temporal focus removal is not necessary for frequencies near 400 Hz and above. As shown previously in **Image 2**, focus is severely damped before the temporal frequency reaches 200 Hz. Thus, focus removal is not an issue for correcting a forced sine wave aberration at 240 Hz, because the natural damping of ambient atmosphere suppresses temporal variations in the focus term. Only a static focus, resulting from a steady-state membrane pull-down bias, requires compensation in the optical system.

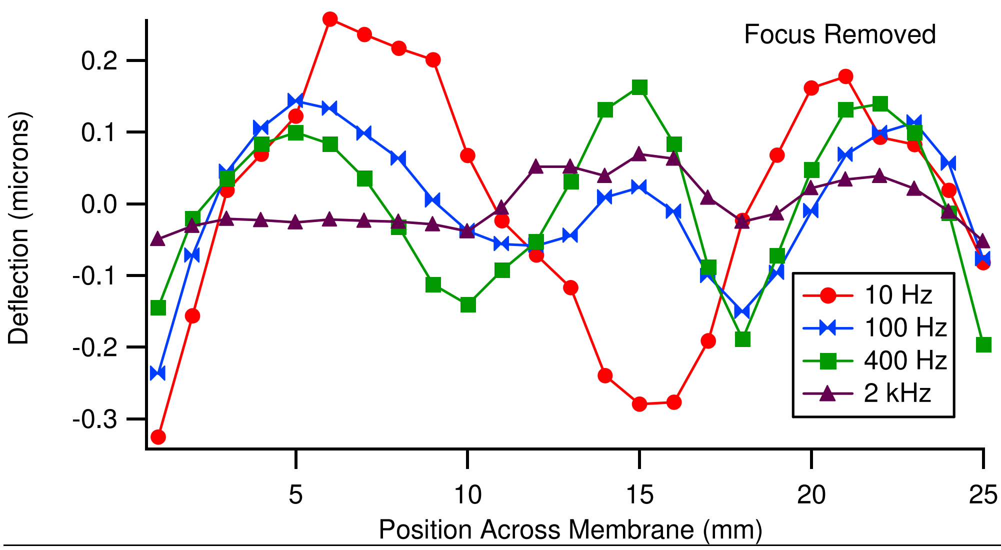

Image 3 Membrane deflection (with focus removed) across a 25mm 36-linear pad array DM driven with a 1-D Sine wave shape at various temporal frequencies.

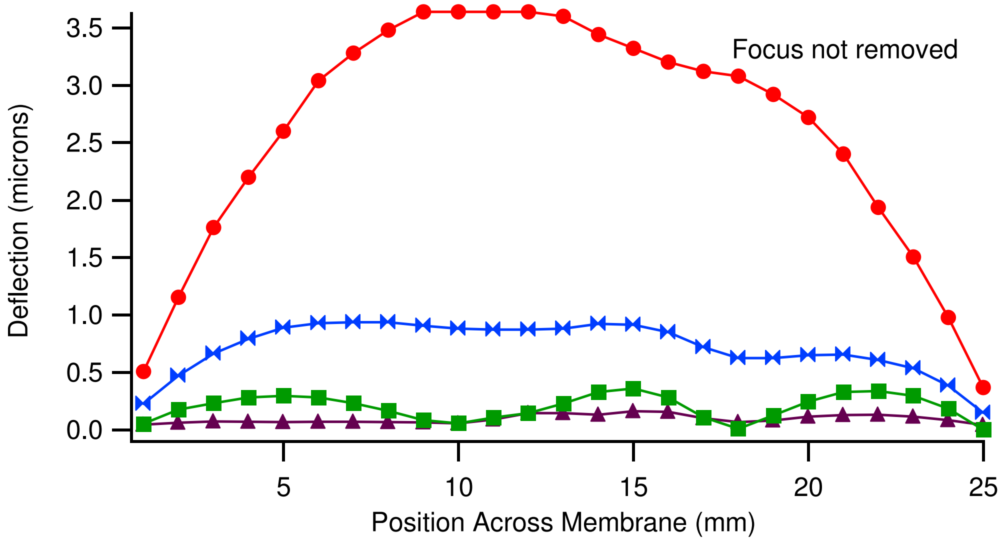

Image 4 Membrane deflection (without removing focus) across a 25mm 36-linear pad array DM

What Can Deformable Mirrors Do?

- Correct Optical Aberrations
- Laser Beam Shaping
- Optical Image Enhancement

Deformable mirrors are revolutionizing laser and optical systems by replacing static components with dynamic optics. Deformable mirrors (DM) are adaptive optics with dynamic faces able to optimize or change the characteristics of reflected light for a specific application. With time-varying control, a DM can focus a beam at several different points at different times or it can replace a lens in an optical system. Deformable Mirrors improve optical images in telescopes, cameras, and other imaging systems.

For further information and discussion about how deformable mirrors work and how they will solve your optical problems see the manuals for HVDD, Clarifi, and the application notes available on the Web.

http://www.agiloptics.com/AppNotes.htm

http://www.agiloptics.com/downloads.htm