



PMN Deformable Mirrors

*Stable, uniform deformable
mirrors for precise
applications*



**NORTHROP
GRUMMAN**

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Northrop Grumman AOA Xinetics fabricates the highest quality deformable mirrors in the world today, expanding access to advanced imaging technology to research institutes, astronomical observatories and commercial industry.

AOA Xinetics has preserved critical deformable mirror technology based on lead magnesium niobate (PMN) electroceramic actuators. Its commercial deformable mirror product has helped astronomers see the beginnings of time and helped ophthalmologists see the beginnings of eye disease.

The PMN discrete actuator deformable mirror is driven routinely in high-speed adaptive optics systems to 1×10^{11} cycles without failure. By using the cofiring process, an actuator stack can be made that has nearly the same modulus as the bulk ceramic material. In the past 12 years, AOA Xinetics has built and delivered more than 200 mirrors that contain over 25,000 actuators.

AOA Xinetics deformable mirrors also have been delivered internationally to customers in Germany, Japan, United Kingdom, South Korea, and Italy.

Deformable Mirror Firsts:

- First images of individual photoreceptors in the living human retina, 1996.
- Built and fielded 941-channel deformable mirror systems for 3.5-meter class government large aperture telescopes, 1996.
- First demonstration of dimensionally stable response when exposed to the 0 Celsius ambient conditions of Mauna Kea, 1997.

- First demonstration of high-energy laser train operation without using liquid cooling, 1998.
- First demonstration of ten-fold fluence increase by using beam cleanup in a femtosecond pulsed laser, 2000.

Standard Mirror Sizes

AOA Xinetics mirrors range in size from 37 to 941 channels. With athermalized ultra low expansion glass and PMN construction, the mirrors are dimensionally stable over a broad temperature range.

PMN, the flagship actuator material, features extremely low hysteresis, minimal creep and is the material of choice for precision positioning. In dimensional stability tests, PMN-based mirrors were stable to $\lambda/2000$ at $0.63 \mu\text{m}$ for a period of months. Aluminum or protected silver coatings can be applied, and other coatings are available upon request for additional cost.

Electronic Driver Summary

AOA Xinetics has both high-speed and lower priced multiplexer driver electronics. The drivers have a digital front end that uses a parallel interface that can be connected to computers or reconstructors at rates up to 30 million commands/second.

The design of a new driver confines all the electronics and power supplies to a single 4U subchassis. The high-speed systems can add a PC-based diagnostic system for monitoring operation and provide simple mirror control. A front panel display allows access to a wide variety of driver information.

PMN:RE Model	Channels	Stroke	Array	Spacing	Aperture	Layout
DM37PMNS4	37	4 μm	7 x 7	7 mm	47 mm	4.3 x 3.2 x 2.3"
DM97PMNS4	97	4 μm	11 x 11	7 mm	77.5 mm	6.0 x 4.5 x 2.5
DM177PMNS4	177	4 μm	15 x 15	7 mm	105.4 mm	7.0 x 5.3 x 2.5"
DM349PMNS4	349	4 μm	21 x 21	7 mm	148.6 mm	9.8 x 7.3 x 3.0"
DM941PMNS4	941	4 μm	35 x 35	7 mm	241.3 mm	12.3 x 11.0 x 4.2"

PMN Deformable Mirror Product Options

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