Status report and lessons learned from the Univ. of Arizona NMSD

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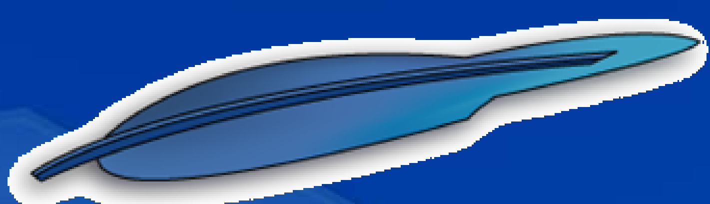
Lightweight Mirror Requirements

The next generation of space mirrors need to meet the following criteria:

Accurate

Easily stowed



Feather-light

Robust

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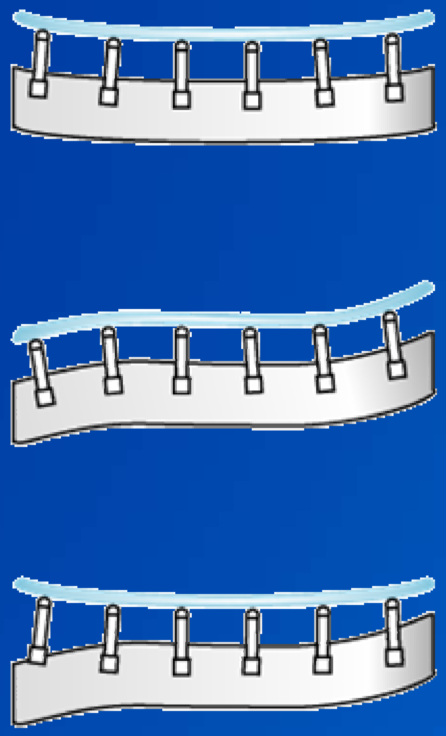
Arizona's Active Mirrors

Components

1. Glass facesheet
2. Position actuators
3. Lightweight reaction structure



Operation

1. Ideal Shape
2. Structure deforms, membrane follows
3. Actuators correct figure

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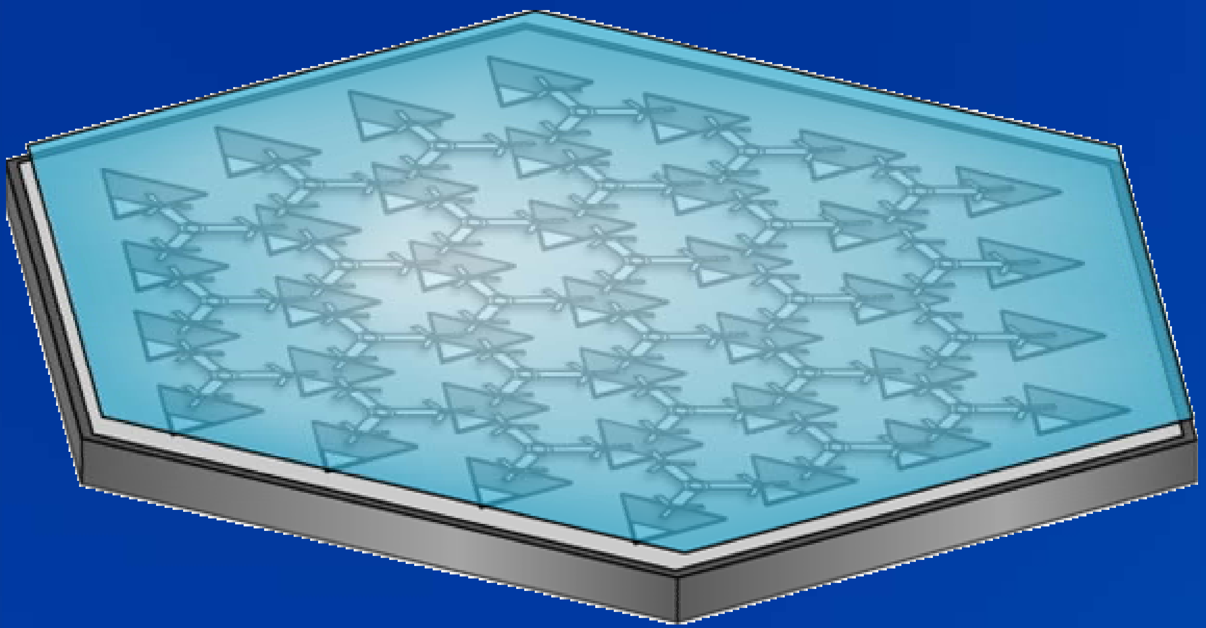
UA 2-m Prototype

Originally designed as NGST technology



- 2 meters in diameter
- 2 mm thick facesheet
- 166 actuators
- 35K operation
- 13 kg/m^2

86 pounds!

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UA 2-m Prototype

Deblocked 2-m facesheet (2 mm thick)

Assembled Mirror

Metrology Schedule

The mirror does not assume the proper figure when initially assembled

Phase 1	Phase 2	Phase 3
Hartmann Test	IR Interferometry	Visible Interferometry

INCREASED MEASUREMENT ACCURACY →

← INCREASED DYNAMIC RANGE

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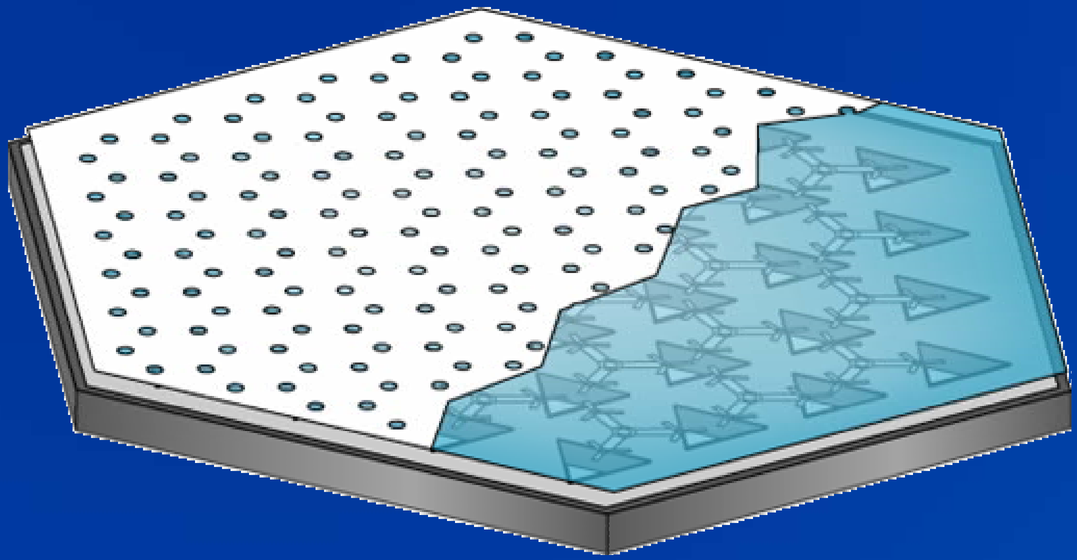
The Hartmann Test

Test Setup



Paper mask has 216 holes

Hartmann test has a large dynamic range

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The Hartmann Test

Step 1: Qualitative Testing Results

Adjust by hand until a set of six spots appear around every actuator

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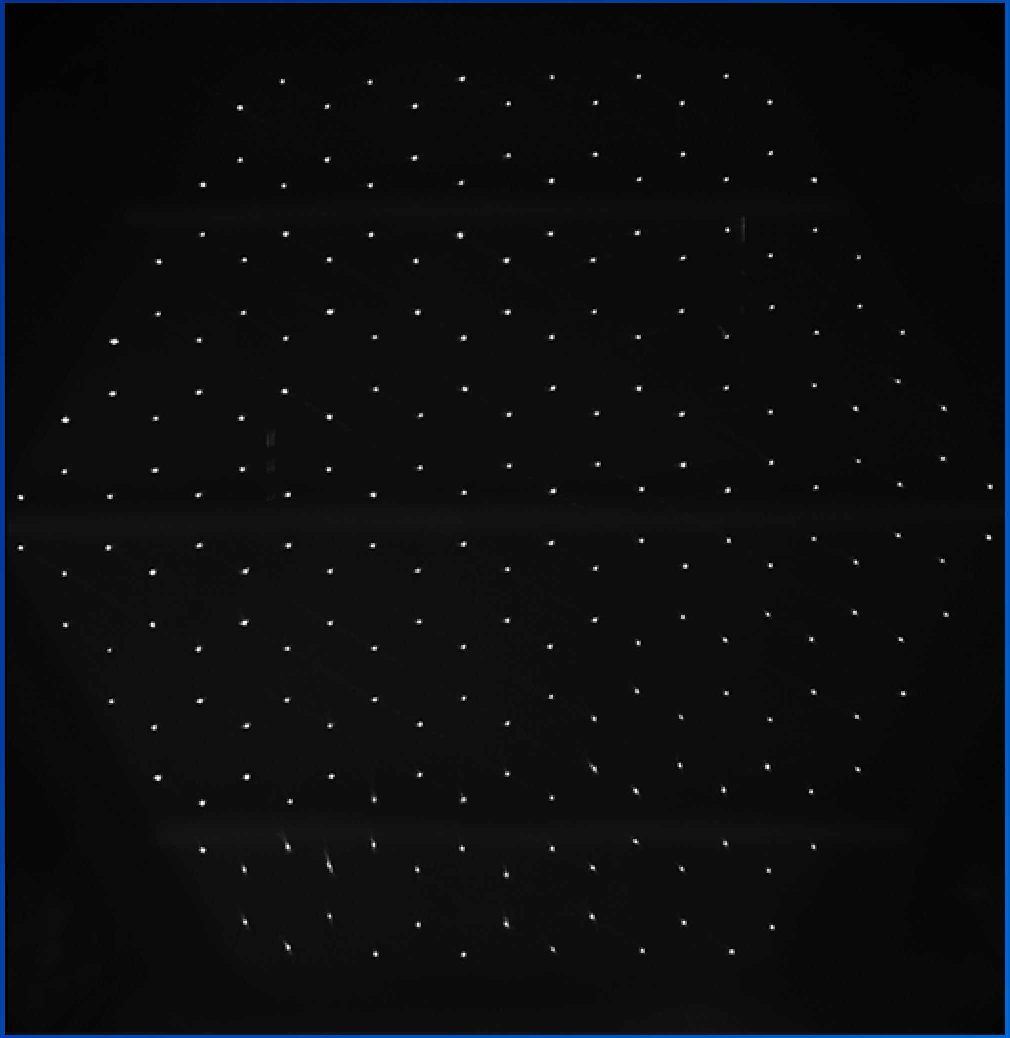
The Hartmann Test

Step 2: Quantitative Testing

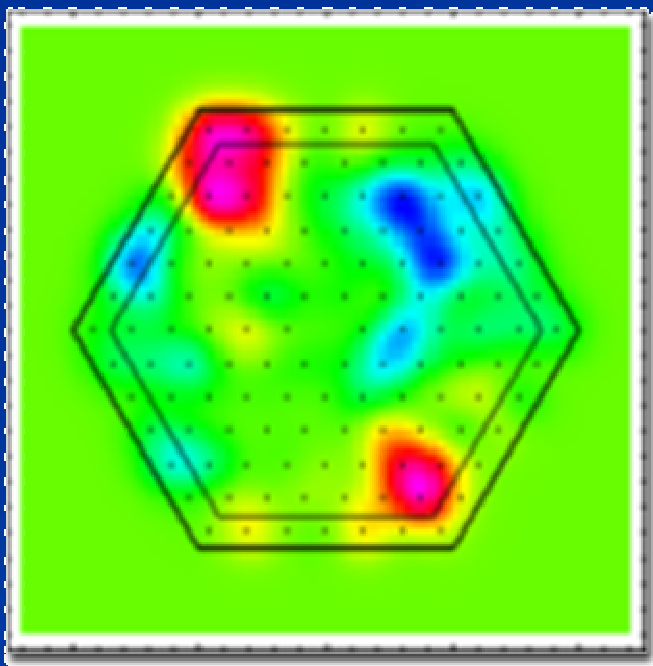
Hexagons that get larger contain actuators that are too high

Hexagons that get smaller contain actuators that are too low

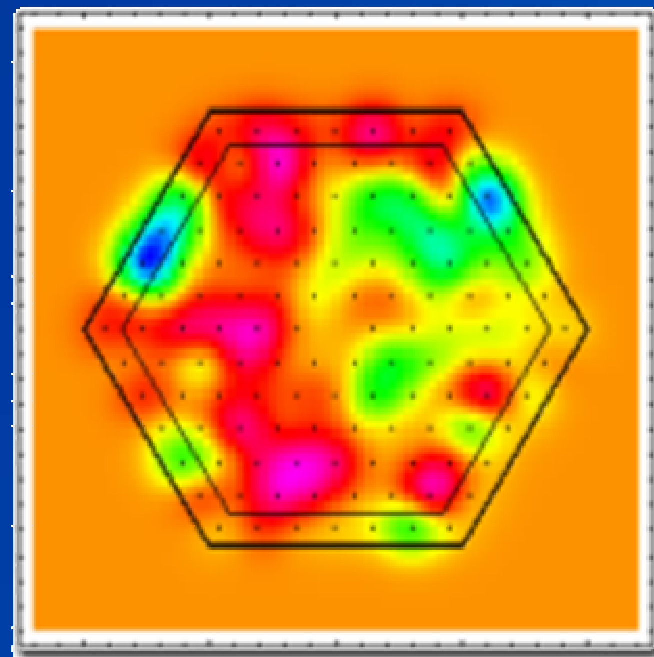


The Hartmann Test

Step 2: Quantitative Testing – Initial & Final Results



125 um PV
25 um RMS



23.1 um PV
3.7 um RMS

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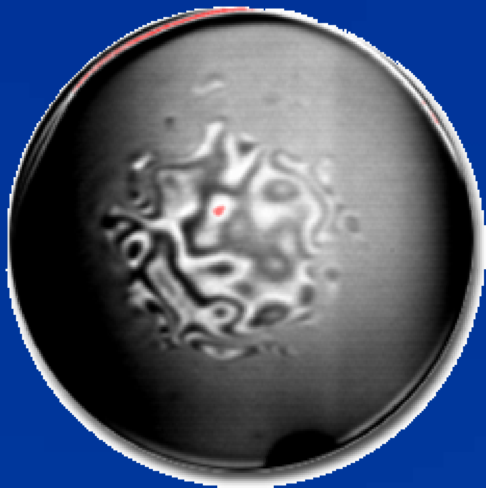
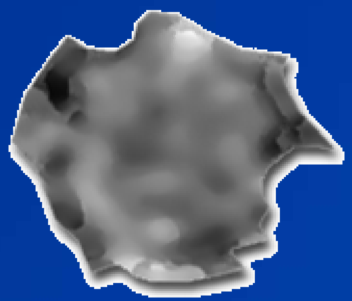
IR Interferometry

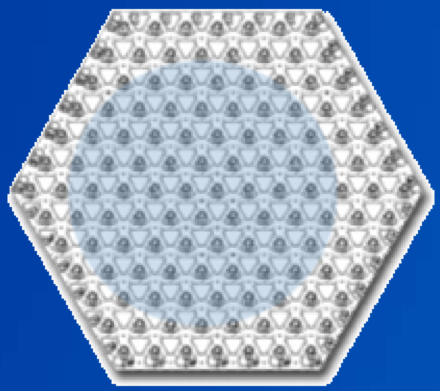
Final IR Measurement Results



IR Interferogram
(10.6 microns)



Surface Map



Area under test

1.4 wvs PV / 0.17 wvs RMS (10.6 um)

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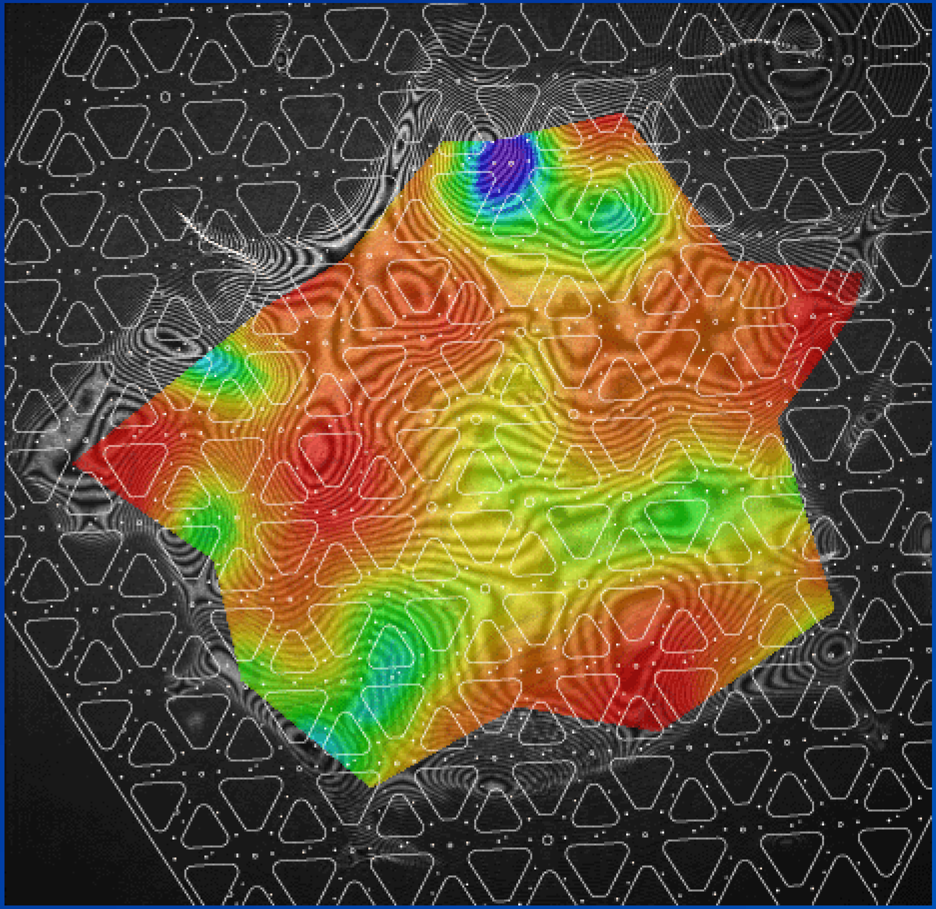
Visible Interferometry

Initial visible (HeNe) measurement

14 wvs P-V
2.0 wvs RMS
(HeNe 633 nm)

8.9 um P-V
1.266 um RMS

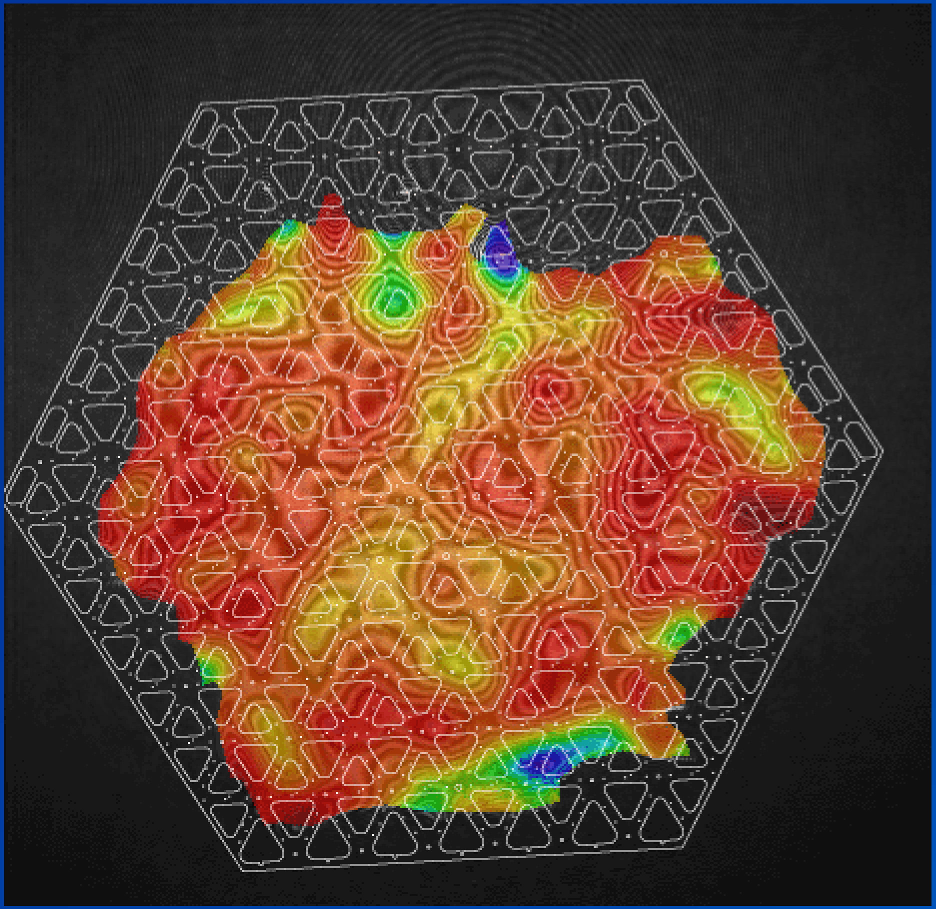


Visible Interferometry

Most recent visible measurement

9 wvs P-V
1.1 wvs RMS
(HeNe 633 nm)

5.7 um P-V
0.7 um RMS



Current Status

One final push to improve the figure

Characterize the errors in the system

- Measure actuator behavior
- Measure mirror stability

Lessons Learned

Scaling a half-meter design up to a two-meter model is not as easy as it sounds on paper!

Handling becomes a major engineering challenge

More than one measurement scheme is required

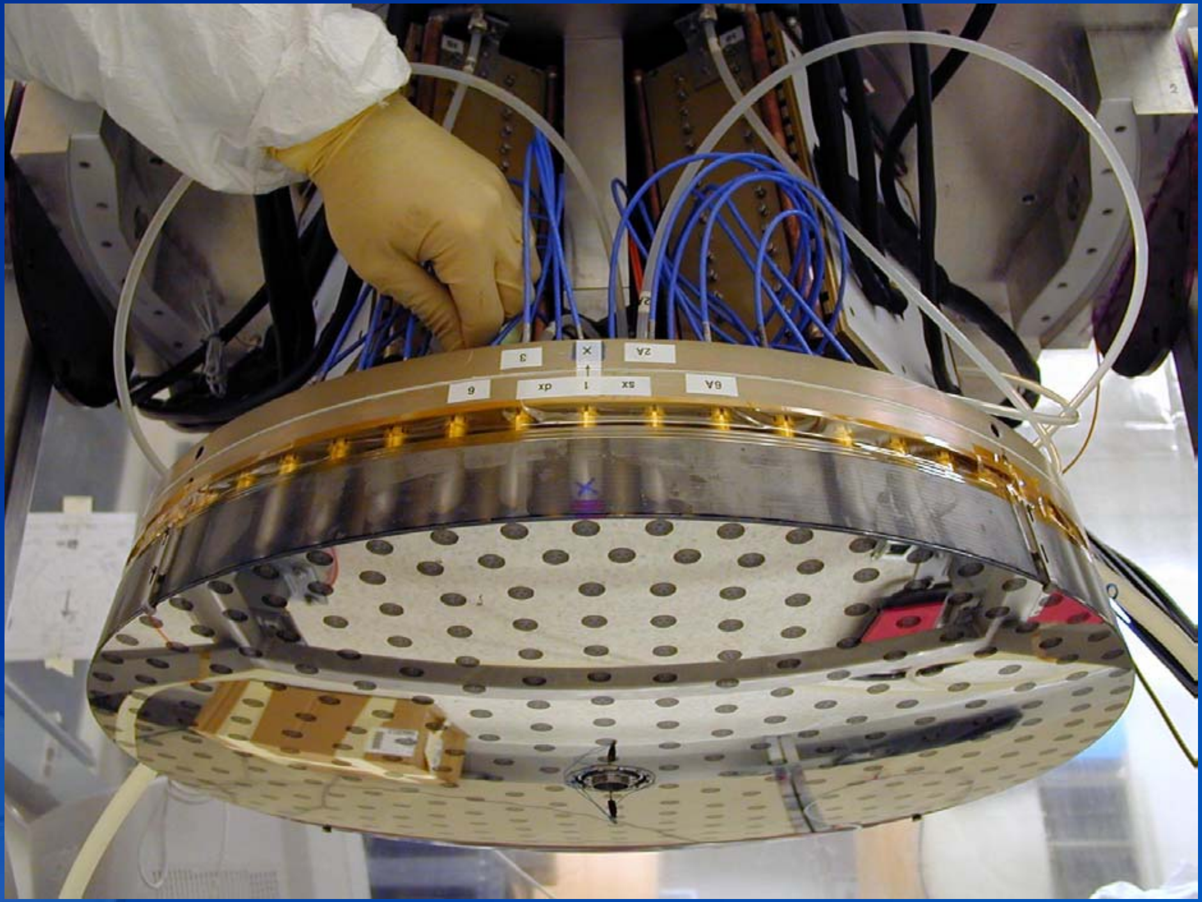
Distance encoders on the actuators would save a lot of time and money

Actuators with `run’ and `walk’ modes would be helpful

4D Technology’s PhaseCam was crucial

Technology Benefits

Immediate future: Experience gained with fabricating thin optics has led to successful AO secondary mirrors



Multiple Mirror Telescope (MMT) Adaptive Secondary Mirror

Technology Benefits

MMT results with and without adaptive secondary

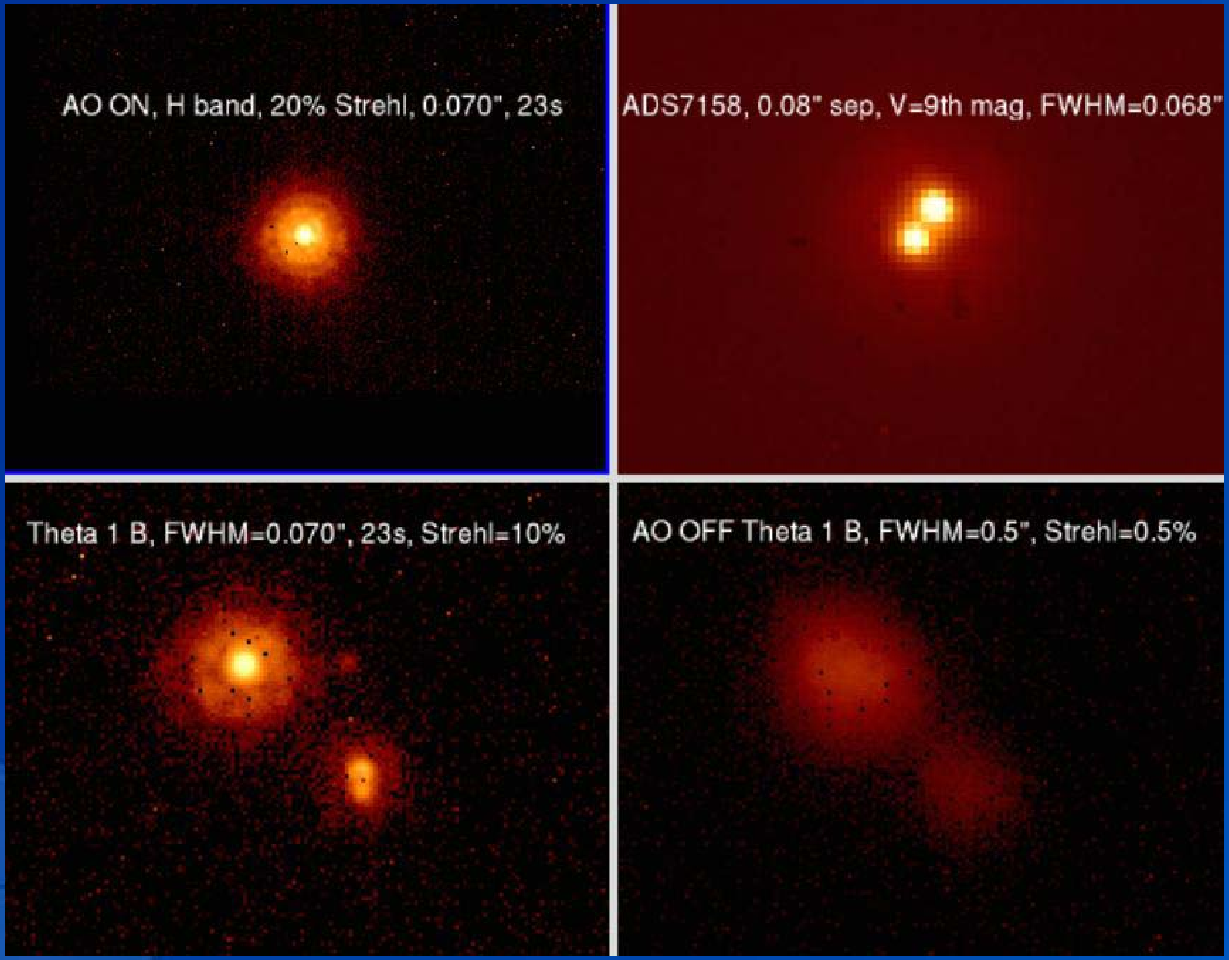


Photo: L. Close

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Current Arizona Research

membrane thickness

number of actuators

What's the most efficient way to distribute the mass for the best quality surface?

The minimum surface error occurs when…

Membrane mass = Total actuator mass

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In Conclusion

Visible interferometry results are in.

Fabrication experience has already been put to good use.

Experience gained with 2-m, 15kg/m^2 class mirrors will be helpful for post-JWST imaging systems.

Currently working on a design algorithm that produces the most accurate mirror for the lightest mass.

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