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Fabrication and Testing of Active and Adaptive Cyanate Ester Composite Mirrors

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OPEN LITERATURE PUBLICATIONS DURING PHASE I, NAS8-01035 & PHASE II, NAS8-02008

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•***"Laser Spot Size Control in Space***," Bennett, **First International Symposium on Beamed Energy Propulsion**, 571-581 (2003).

•***"Ground-Based Adaptive Optic Transfer Mirrors for Space Applications: I. Design and Materials***," Bennett, Shaffer, Romeo and Chen, **First International Symposium on Beamed Energy Propulsion**, 582-592 (2003).

•***"Ground Based Adaptive Optic Transfer Mirrors for Space Applications: II. Composite Prototype Mirror***," Bennett, Shaffer, Romeo and Chen, **First International Symposium on Beamed Energy Propulsion**, 593-607 (2003).

•***"Powering Ion-Engine Equipped Orbital Transfer Vehicles with a Ground-Based Free Electron Laser,"*** Bennett, **First International Symposium on Beamed Energy Propulsion**, 649-661 (2003).

•***"Development of Lightweight Mirror Elements for a Very Large Astronomical Adaptive Optic Primary Mirror***," Bennett, Shaffer, Romeo and Chen, **Future Giant Telescopes**, Hawaii, SPIE **4840**, 258-272 (2003).

•***"Development of Lightweight Mirror Elements for the EURO-50 Mirrors***," Bennett, Shaffer, Romeo and Chen, **Second Bäckaskog Workshop on Extremely Large Telescopes**, SPIE **5382**, 526-532 (2003).

•***"Powering the Space Elevator Using a 0.2-1.0 MW Ground-Based Free Electron Laser***," Bennett. **The Space Elevator Conference**, Washington D.C., June 2004 (In-press).

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PATENTS FILED DURING
PHASE I, NAS8-01035 & PHASE II, NAS8-02008

1. **AN ACTIVE/ADAPTIVE ACTUATOR DESIGN OF AN ADAPTIVE OPTIC MIRROR** FILED 9/4/03, SER. #10/656-775.

2. **TRANSFER OPTICS** FILED 8/12/03, SER. #10/639,930.

3. **ADAPTIVE OPTIC MIRROR** FILED 1/23/03, SER. #10/348,731.

4. **DEVICE TO CONTROL LASER SPOT SIZE** FILED 10/25/02, SER. #10/280,712.

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LIGHTWEIGHT 1-3 MM THICK MIRROR

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Superpolisher, up to 1.4 meter mirrors, ½ meter shown

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FOUNDATION FOR NEW 3.0 M POLISHER

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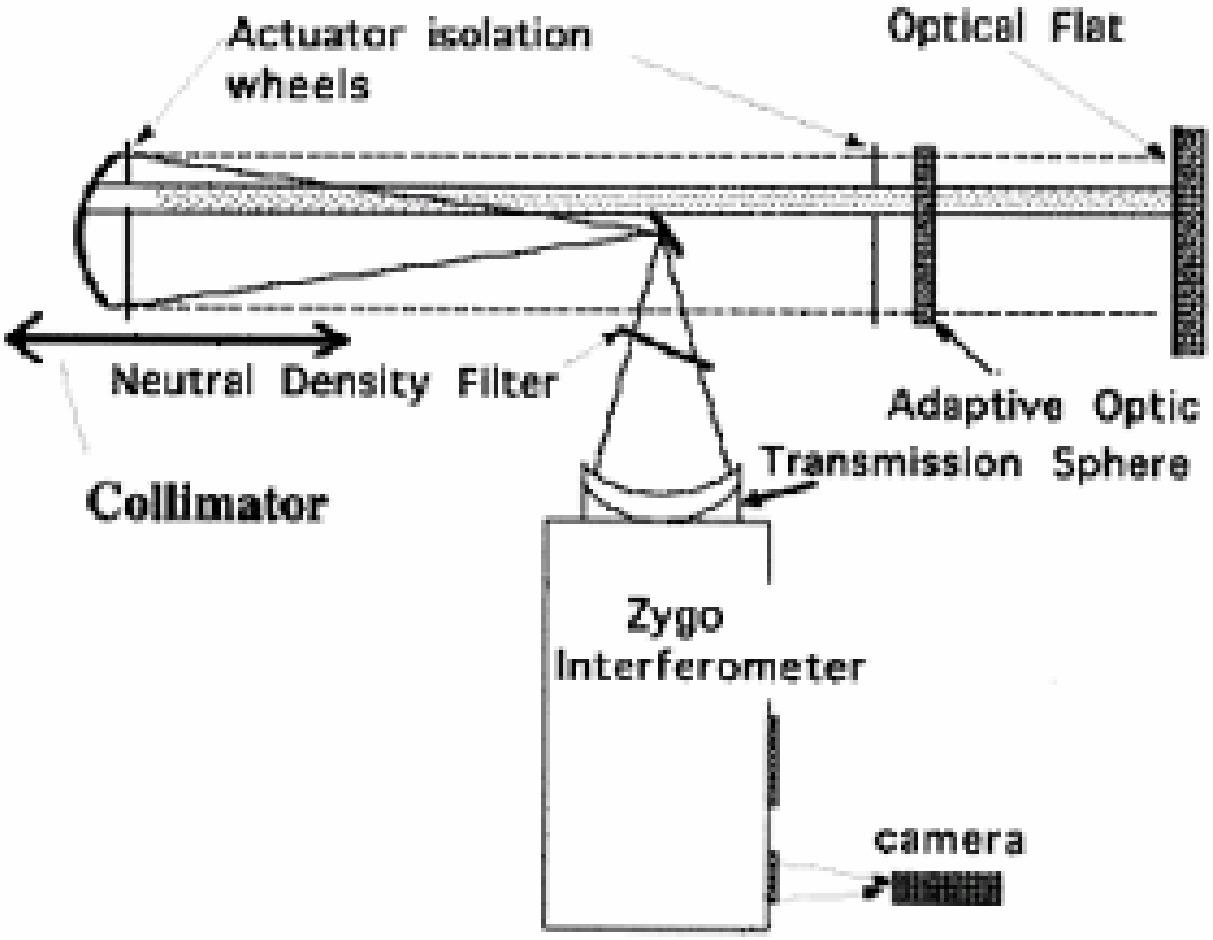
AO Alignment system



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BOR LARGE OPTICS FIGURE TEST FACILITY

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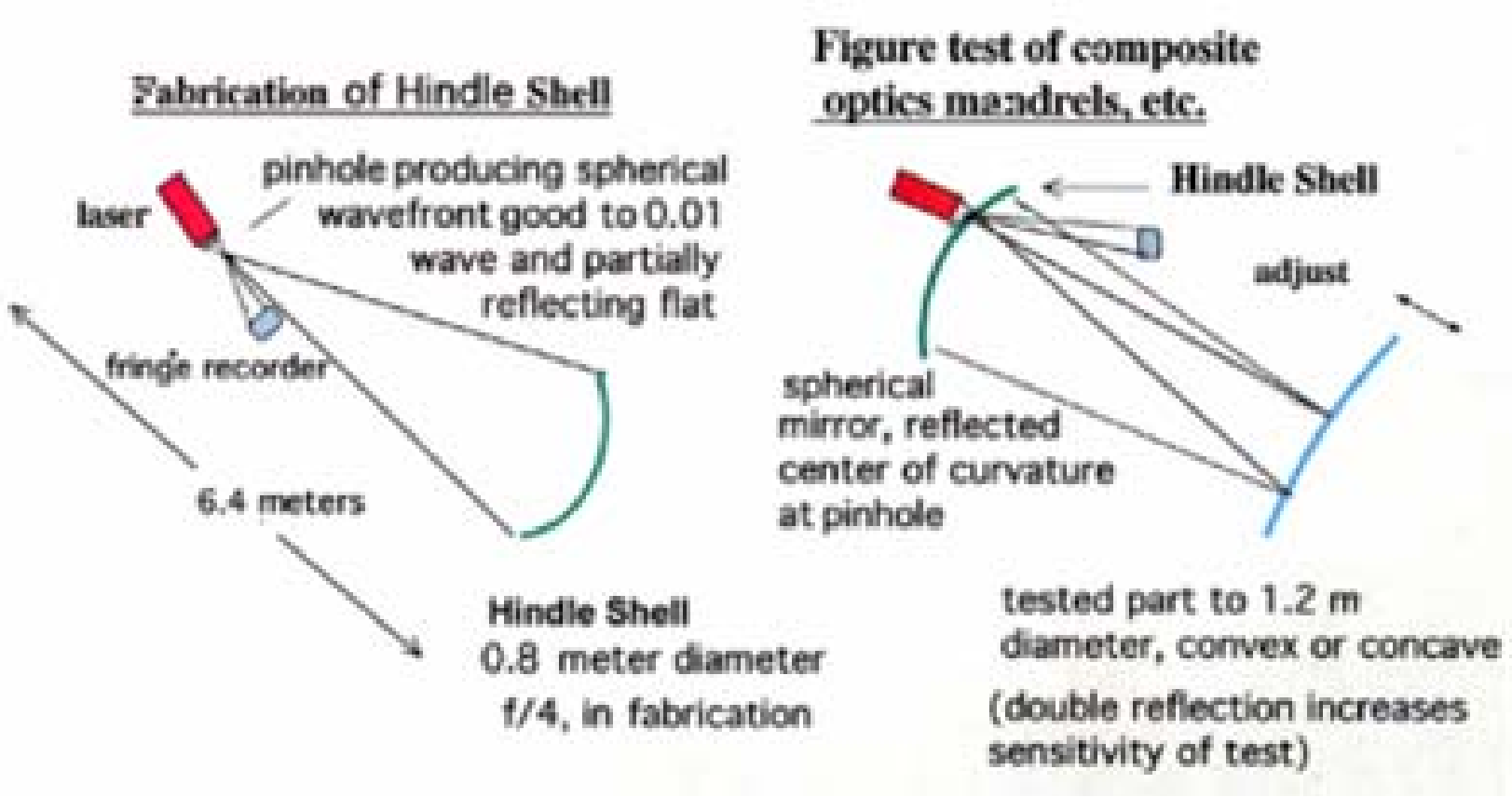

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0.56 meter superpolished 1/20th wave mandrel

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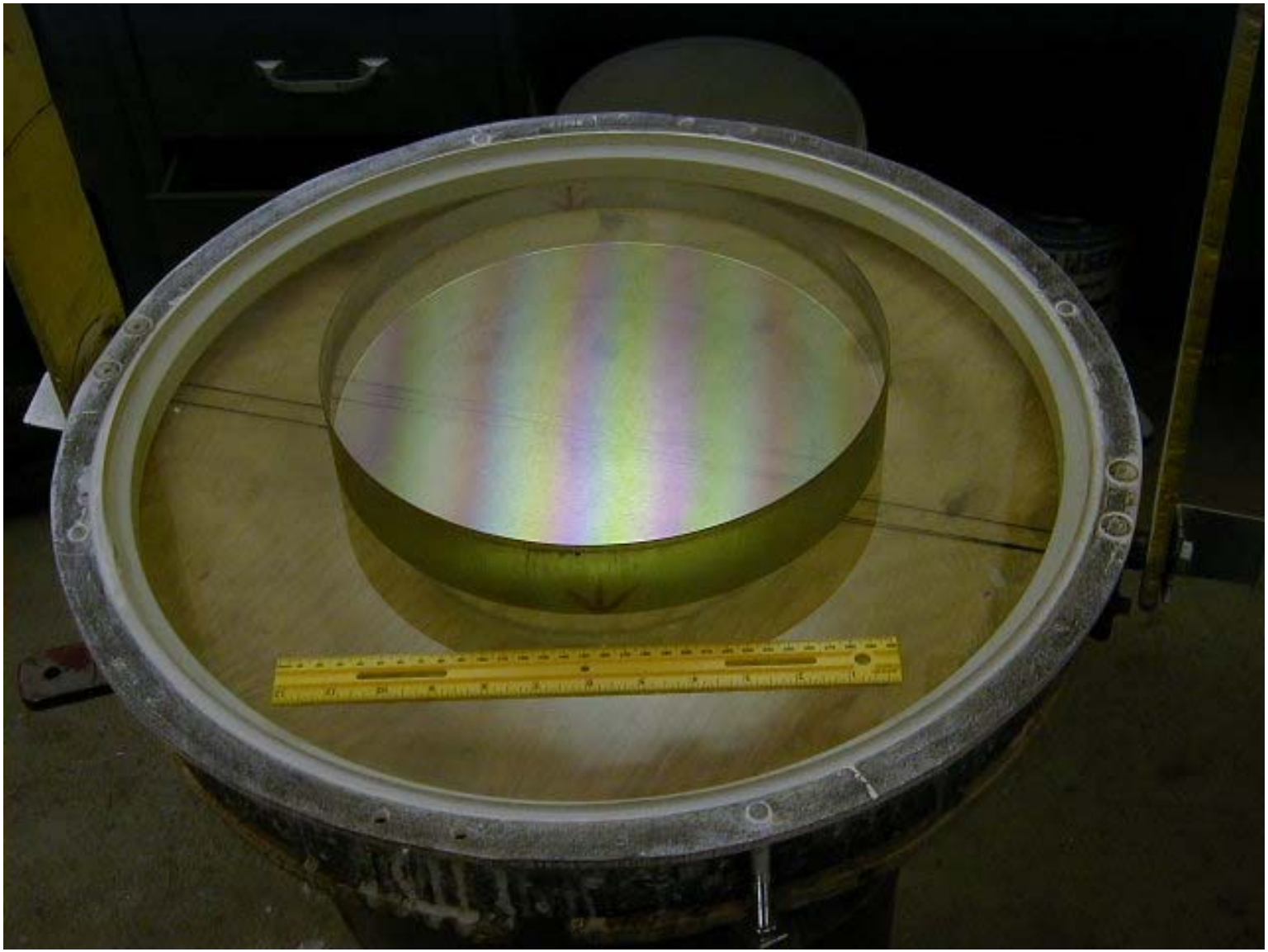

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Hyperbolic paraboloids formed when composite layer not quasi-isotropic

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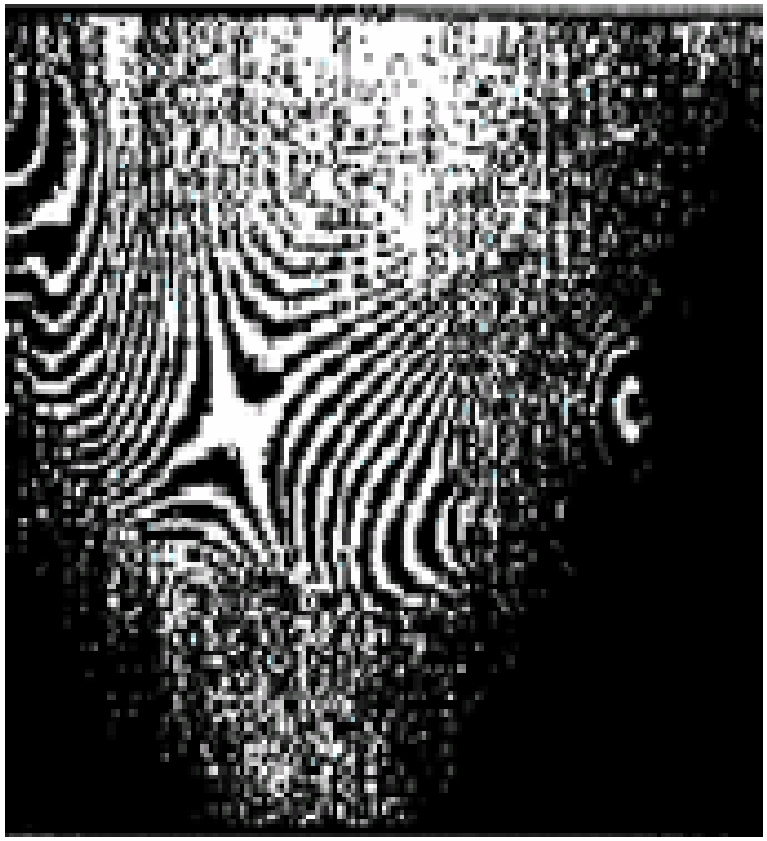

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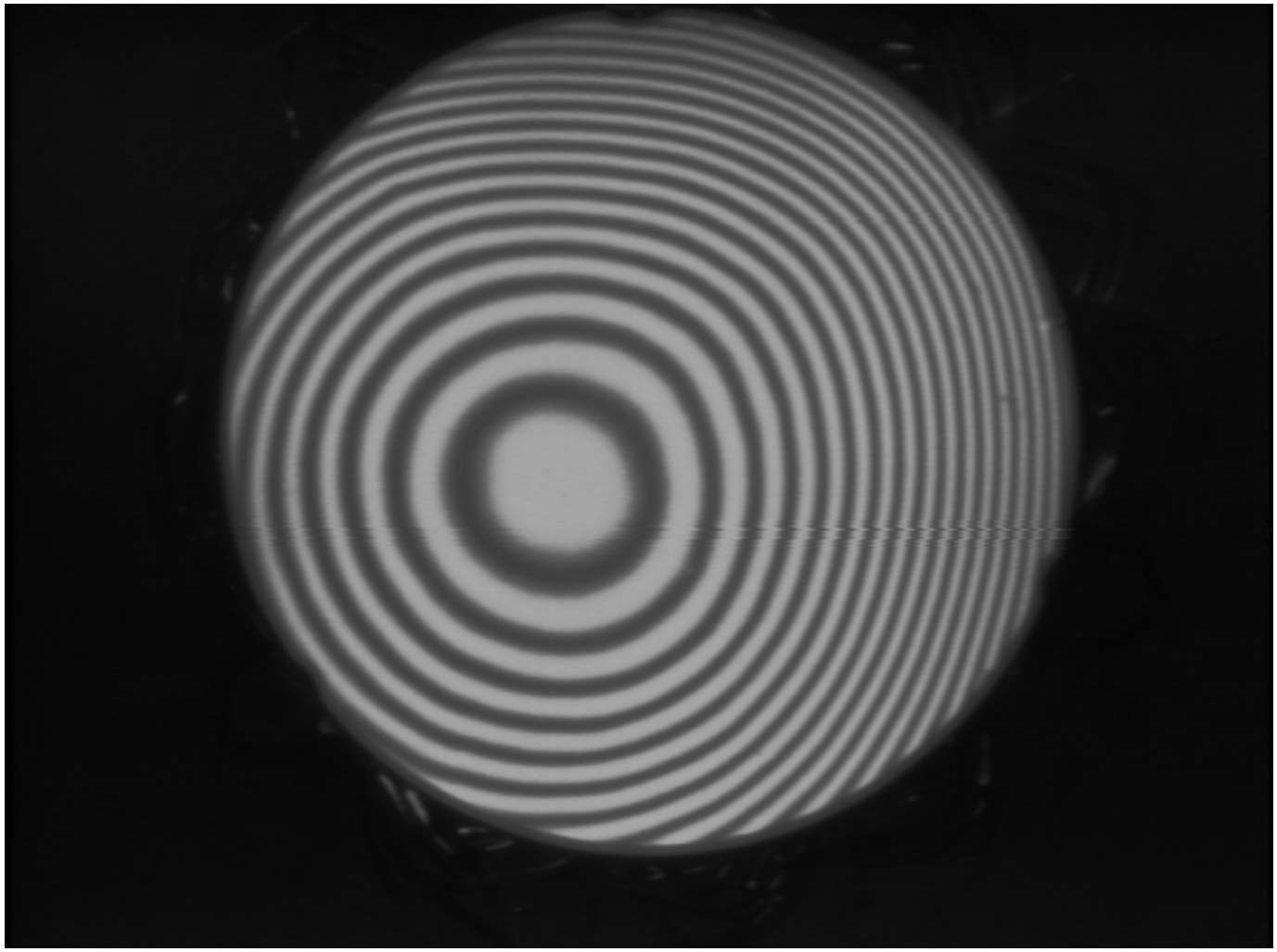
Interferogram for 3mm Thick 1/3m Diameter Composite Mirror. No Irregularities are Seen.



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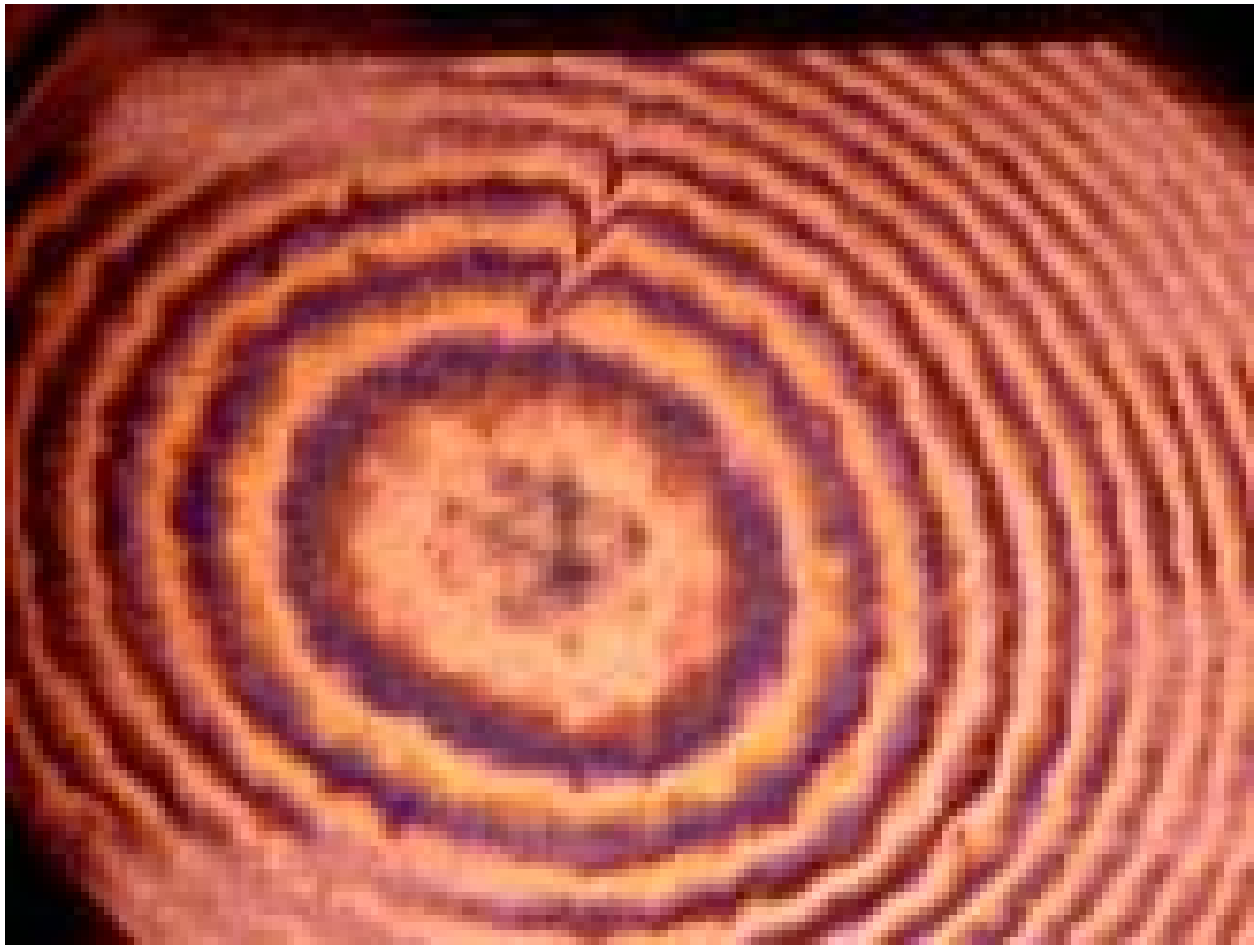
INTERFEROGRAM OF THE 3 MM THICK ½ METER DIAMETER MIRROR



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First and Second Mechanical Actuator Prototypes. Second weighs 5 gm

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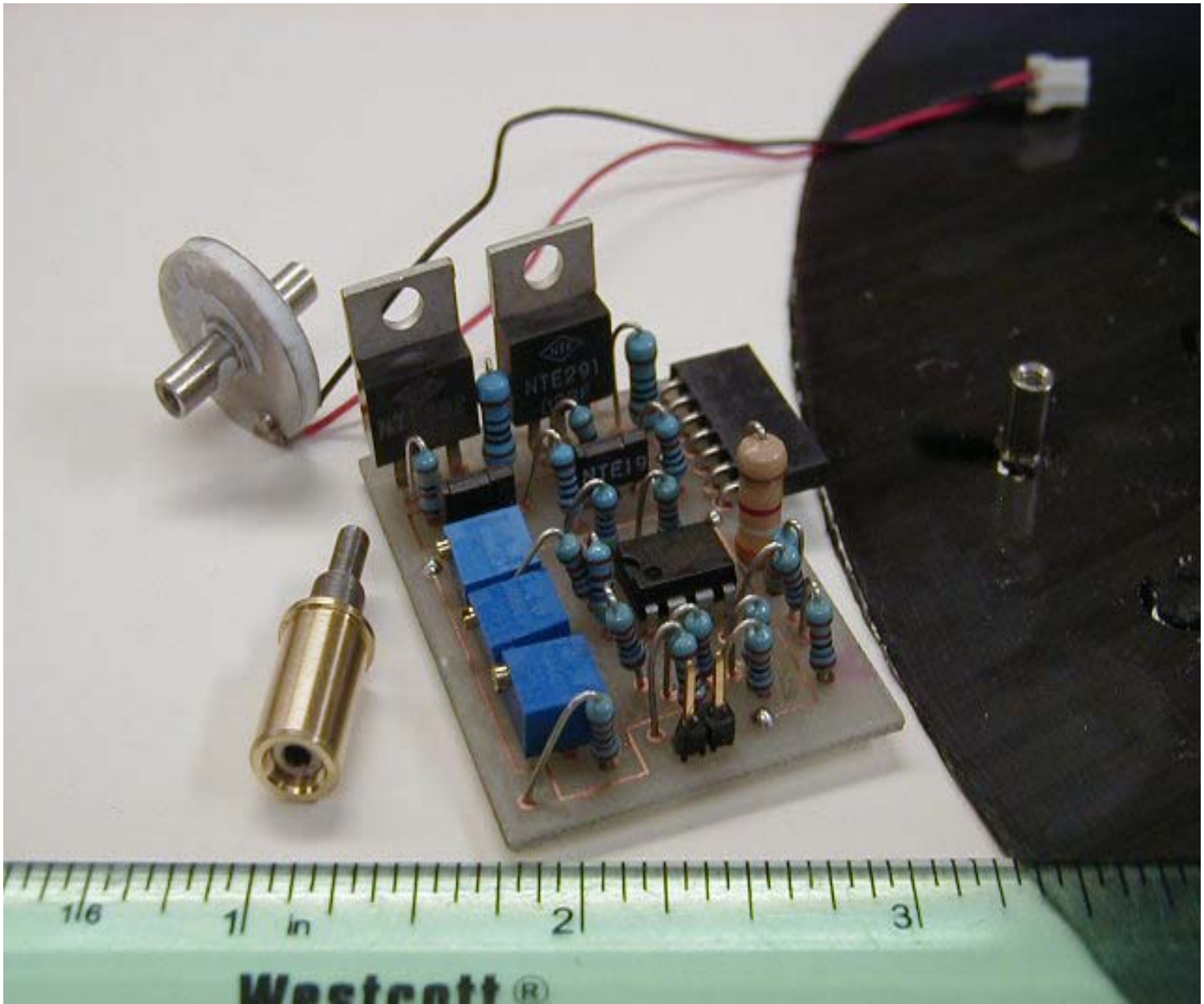
Differential Nut & Piezo Actuators With Driver Circuit & Faceplate



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Coblentz sphere collects scattered light from mirror to be tested

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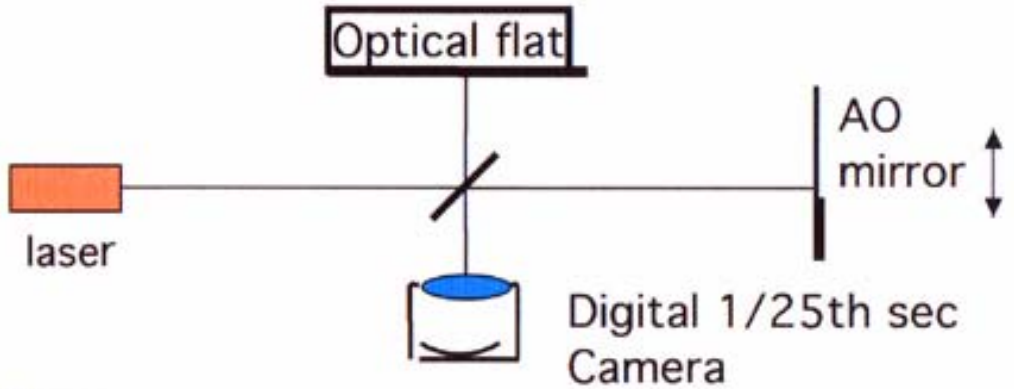
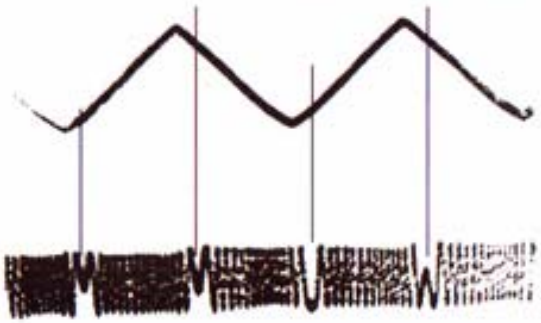
Interferometric Actuator & Influence Function Test

Michelson Interferometer



in phase

hysteresis



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AIRY FUNCTION OF STAR IMAGE

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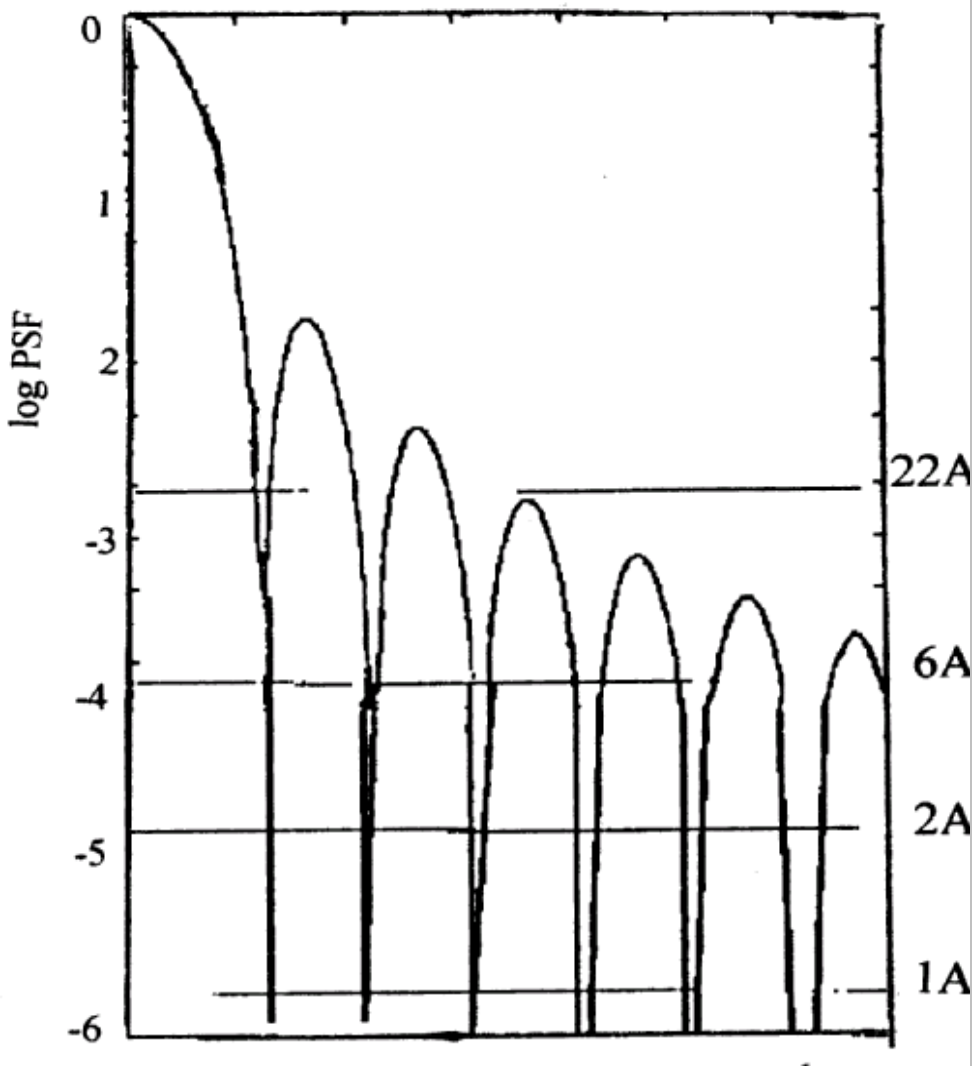

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CONCLUSIONS

Bennett Optical Research, Inc.
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Bennett Optical Research is building up a large astronomical optics production and testing capability facility.

- **B Besides conventional astronomical optics they are developing novel, graphite fiber filled, cyanate ester resin composite mirrors for active and adaptive optics.**

The new composites are lightweight, ultralow expansion (like Zerodur), superpolished mirror surface, do not fracture (unlike glass) and are relatively inexpensive.