Possible JPL Concept Study for OST STDT

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OST f2f #5
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Overview

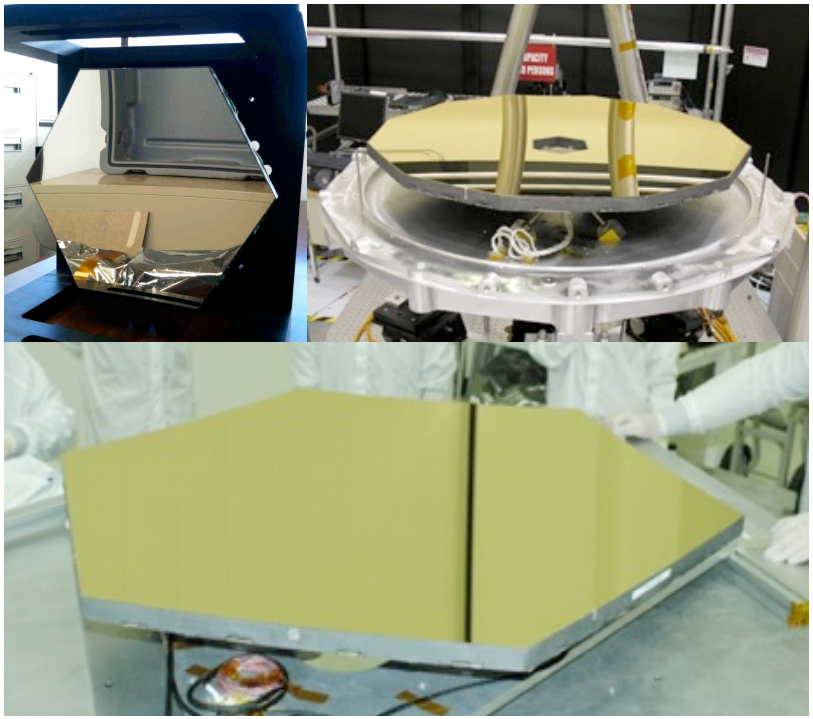
- JPL is enthusiastic about studying Concept #2
- Direction must come from the STDT
- What can we do that is the most useful?
  - Possible answer: cover a different range of possibilities than Concept #1
- Suggestion:
  - Design to cost

    Focus on active telescope architecture (including the simplification in ground testing that it promises)
  - Focus on architecture and science traceability, not a point design for observatory or instruments

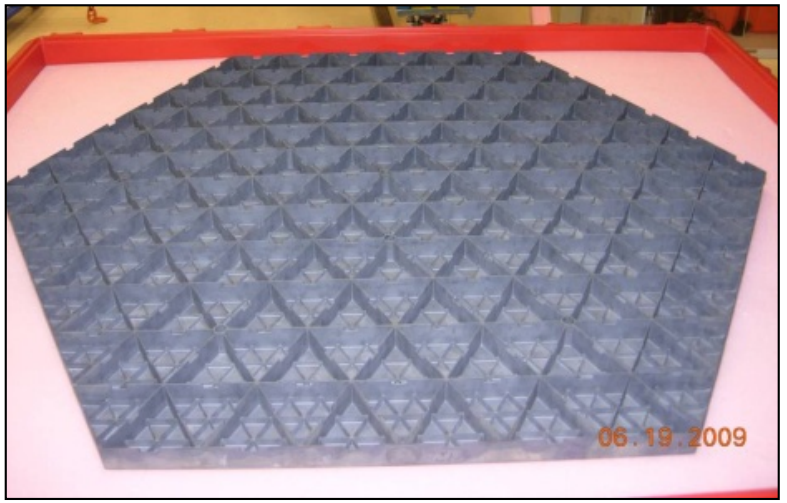
    Not a short Team-X study, but fewer people over longer time. Team X later.
  - Need cost reasonableness (upper limit and uncertainty) guide the work

Active Mirror Technology

Actuated Hybrid Mirrors (AHMs) demonstrate active mirror architecture

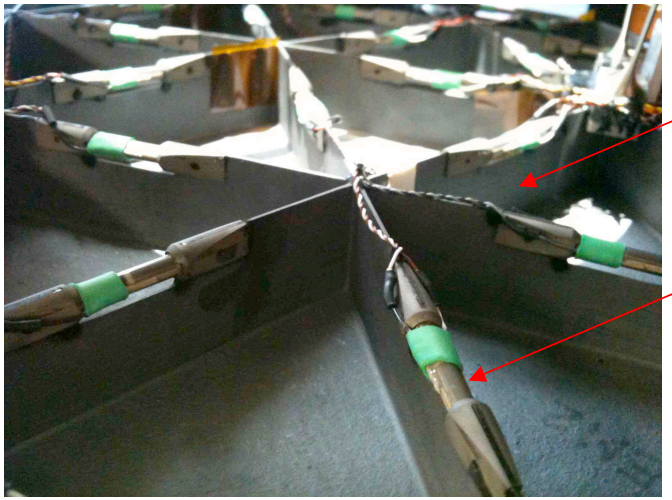


Unwin, S., et. al. (2010)



J. Wellman, G Weaver, D. Redding (2012), AAS Meeting 219-136.06

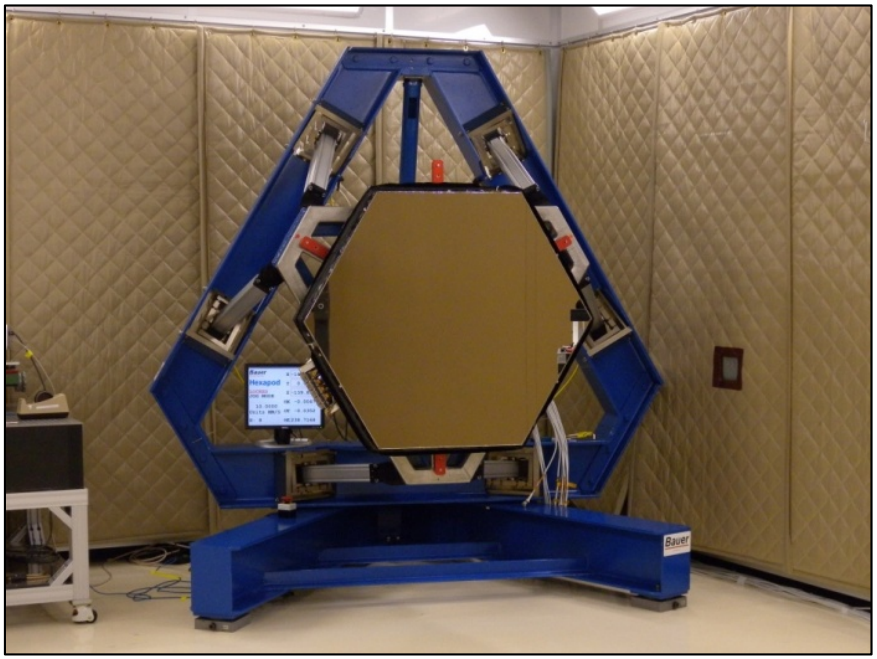
- **Lightweight SiC substrates**
  - 0.5 – 1.35m demonstrated
- **Distributed surface-parallel actuation**
  - 37 – 414 actuators demonstrated
- **Replicated nanolaminate front surface**

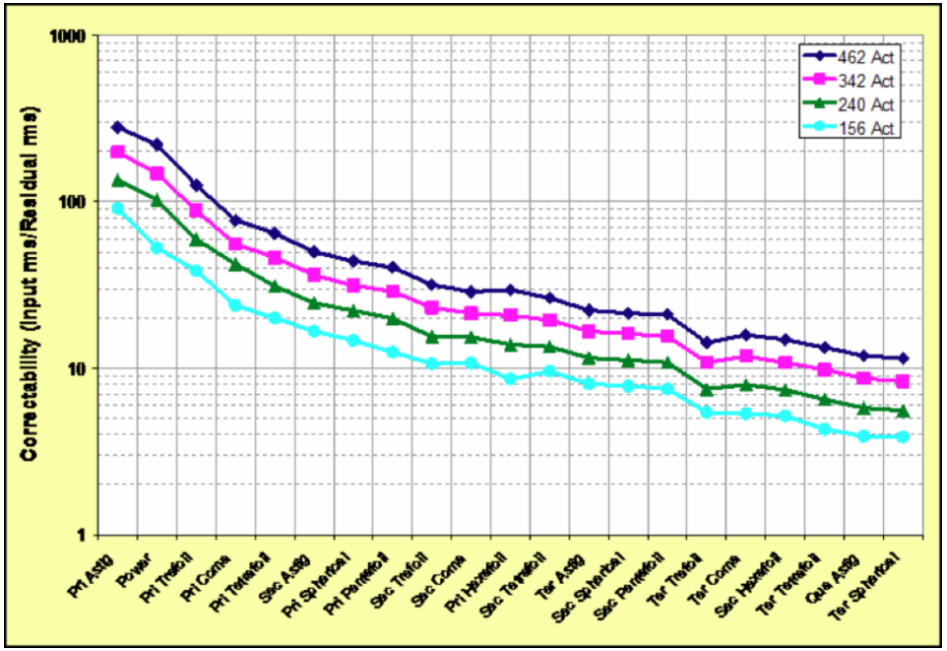


Unwin, S., et. al. (2010)

Active Mirror Technology

- **Figure control performance:**
  - <14 nm rms SFE demonstrated
  - High correctability over low-order modes
  - Tested in 1G to 0G specs
- **Areal density:**
  - 10-15 kg/m^2 substrate
  - < 25 kg/m^2 total





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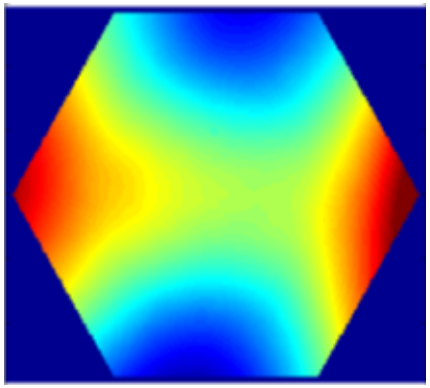
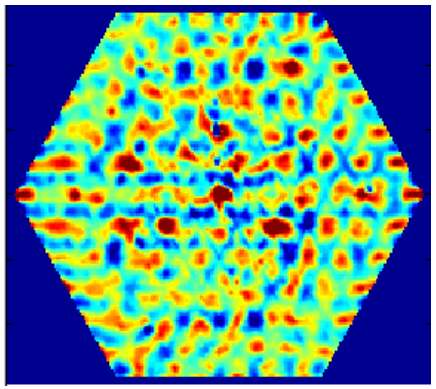
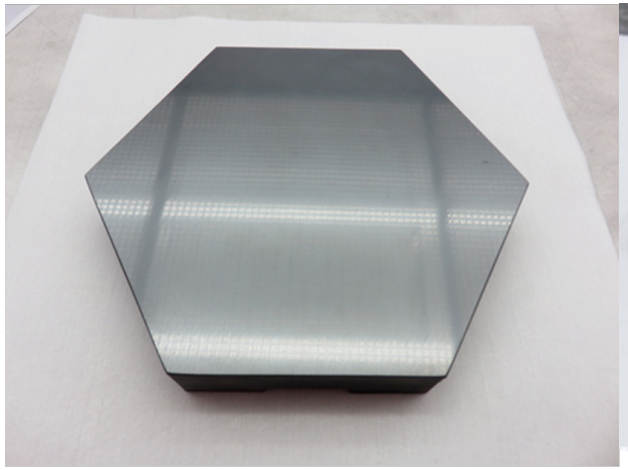
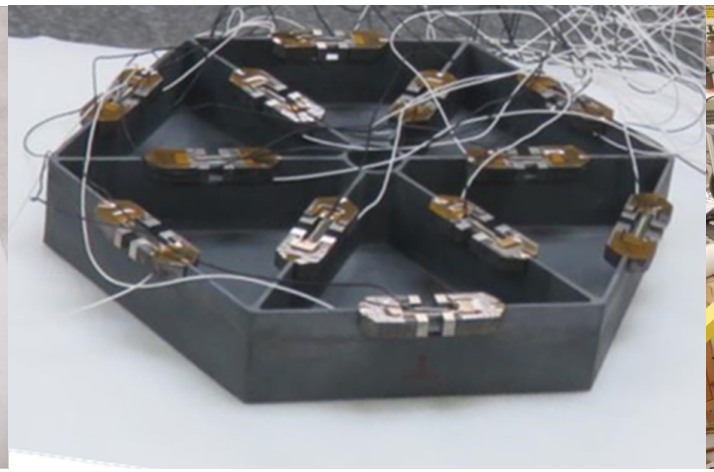
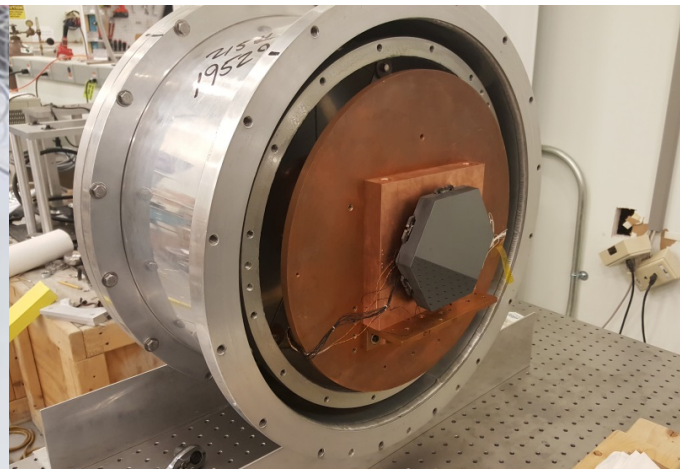


EM-4a Uncorrected
SFE = 1.88 µm RMS



EM-4a Corrected
SFE = 0.014 µm RMS

Cryogenic Active Mirrors

- **Cryogenic Active Mirror (CAM) Activity:**
  - Demonstrated cryo functionality via small-scale demonstrator mirror
- **Necessary to demonstrate:**
  - Direct-polish of SiC or Si-clad surface
  - Diffraction-limited performance at 293K and 4K
    - Eliminate cryo-null figuring
  - Athermalized actuator interfaces to minimize thermal distortions
  - Low dissipation actuators

Path forward: NASA SAT proposal; JPL Next proposal

Telescope Technology Plan — I

- Core technologies demonstrated at room temperature, nanolaminate surface
  - Lightweight SiC mirror segments
  - Parallel-to-survace actuators in ribs of substrate
  - Laser metrology for rigid-body positioning of segments
  - Wavefront sensing for segment shape

    Achieved 15 nm rms surface error (= 30 nm rms wavefront) in best segment
- Actuation and control demonstrated at 26 K on 15-cm mirror
- To be done:
  - (For short wavelengths: demonstrate Si cladding for surface, rather than nanolaminate)
  - Demonstrate performance of a $\sim$1.3 m segment over 270 to 4 K temperature range

    Zero-power-dissipation actuation at 4 K
  - Demonstrate/design appropriate methods for building large mirrors from segments
  - System engineering study of integration and testing required

    Including establishing that system-level cryo testing can be eliminated

Telescope Technology Plan — II

- Means
  - "JPL Next" program. Decision in $\sim$1 month, but contract with AOA Xinetics is being set up
  - NASA SAT. Decision in n months?
  - System engineering study by people from many institutions

    Led by Jon Arenberg of NGC
- Schedule
  - Work needs to be done in time for inclusion in STDT design concept reports
  - Depends on funding. We're optimistic...