Development Roadmap for an Adjustable X-ray Optics Observatory

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ABSTRACT

Technology Readiness Levels (TRL)

We are developing adjustable X-ray optics to use on a mission such as SMART-X (see posters 38.02, 38.03 and Presentation 30.03). To satisfy the science problems expected to be posed by the next decadal survey, we anticipate requiring effective area greater than 1 m² and Chandra-like angular resolution: ±0.5 ″. To achieve such precise resolution we are developing adjustable mirror technology for X-ray astronomy application. This uses a thin film of piezoelectric material deposited on the back surface of the mirror to correct for figure distortions, including manufacturing errors and deflections due to gravity and thermal effects. We present here a plan to raise this technology from its current Level 2, to Level 6, by 2018.

Acknowledgements: This work has been supported by the Gordon and Betty Moore foundation, by a Smithsonian Internal Research and Development grant, by NASA APRA contract NNX08AB62G and by NASA Astrophysics Strategic Mission Concept study award NNX09AE87G and by NASA Astrophysics Strategic Mission Concept study award NNX09AE87G.

LEVEL 2

Technology concept or application formulated

Criteria (cf. two figures below)
- Adjustment of X-ray mirrors used at synchrotrons. 1-d, 10˚ optical control
- Adaptive optics, ground based telescopes

Measure controlled deformations of a flat glass sheet produced by piezo-electric actuators

How can figure errors be reduced? Use bimorph technology!

LEVEL 3

Analytical and/or experimental proof-of-concept

Criteria
- Measure controlled deformations of a flat glass sheet produced by piezo-electric actuators
- Metric: Demonstrate control of displacements to 40 rms, over a range of +/- 4000 ˚A

Single piezo cell energized

LEVEL 6

System/subsystem model or prototype demonstration in a relevant environment

Criteria
- Subject a module to environmental testing. Then repeat the TRL 5 demonstration, showing that the shells retain the required 0.5 arcsec imaging with no further adjustment.
- Fly a (sparse) mirror set in a rocket, and obtain an image of a bright celestial point source.

MANUFACTURING READINESS LEVELS

These must be considered for making mandrels, slumping, mirror element metrology, depositing piezo films, electrical connections, calibrating influence functions, and alignment and assembly.

In Phase A:
- Level 4: Component or breadboard validation in a simulated environment
- Level 5: Component or breadboard validation in a simulated environment

In Phase B:
- Level 6: Produce a prototype subsystem in production-like environment
- Level 7: Capability to produce subsystems in a production environment
- Level 8: Pilot line capability demonstrated. Ready to begin low rate production
- Level 9: Capability in place to begin full Production at CDR