Development of High Resolution X-ray Telescope Optics

Completed Technology Project (2017 - 2020)

Project Introduction

We propose to develop novel high-precision x-ray telescope mirror fabrication and figure correction technology which will lead to thin-shell mirrors rivaling Chandra's mirrors in angular resolution but with 10-100X larger area—all with significantly reduced weight and cost. The proposed effort builds on previous research at MIT and complements NASA-supported research at other institutions. Thin shell mirrors with resolution in the sub-5 arc-sec domain require significant advances in mirror shaping and correction technology. The best thin-shell mirrors fabricated to date allow a mission-level angular resolution of only ~10 arc sec. For slumped glass mirrors the PSF is currently dominated by surface errors in the mid-range spatial frequency domain which are difficult to remove by any of the proposed post-fabrication correction schemes. MIT is developing novel glass slumping technology which supports hot mirrors on a thin film of air, thus eliminating mid-range errors due to mandrel surface contamination and anti-stick coatings. We are also developing a surface-stress mirror correction technique utilizing a scanning MeV ion beam to remove mid- and long-range spatial frequency errors from mirrors. Surprising recent results from our lab show that MeV ions are capable of applying the full stress tensor to surfaces, unlike competing methods such as piezoelectric films which can apply only equi-biaxial film stresses. Computer models show that access to the full stress tensor is essential in order to correct kinematically-mounted mirrors into the sub-1 arc-sec domain. We propose a research program which builds on these new tools to help accelerate progress in x-ray mirror figure quality while reducing the cost of both glass and silicon mirrors.

Primary U.S. Work Locations and Key Partners

Organizations Performing Work	Role	Type	Location
Massachusetts Institute of Technology(MIT)	Lead Organization	Academia	Cambridge, Massachusetts

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Organizational Responsibility

Responsible Mission Directorate:

Science Mission Directorate (SMD)

Lead Organization:

Massachusetts Institute of Technology (MIT)

Responsible Program:

Astrophysics Research and Analysis

Project Management

Program Director:

Michael Garcia

Program Manager:

Dominic J Benford

Principal Investigator:

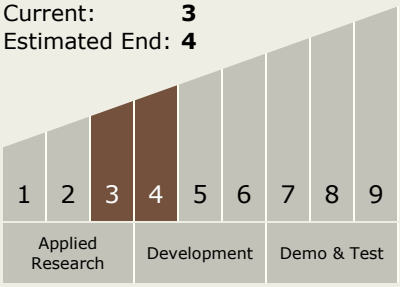
Mark Schattenburg

Co-Investigators:

Youwei Yao
Veronica Anne Morris
Ralf Heilmann
Graham Wright
William W Zhang

Technology Maturity (TRL)

Start: **3**
Current: **3**
Estimated End: **4**



Technology Areas

Primary:

- TX08 Sensors and Instruments
  └ TX08.2 Observatories
    └ TX08.2.3 Distributed Aperture

Target Destination

Outside the Solar System