Active Project (2014 - 2017)

Fabrication Process and Electronics Development for Scaling Segmented MEMS DMs, Phase II Project

SBIR/STTR Programs | Space Technology Mission Directorate (STMD)

ABSTRACT

Microelectromechanical systems (MEMS) technology has the potential to create deformable mirrors (DM) with more than 10^4 actuators that have size, weight, and power specifications that are far lower than conventional piezoelectric and electrostrictive DMs. However, considerable development is necessary to take state-of-the-art MEMS DMs today and make them flight-like. This Phase II SBIR proposal addresses two critical areas in MEMS DM development towards the goal of developing flight-like hardware. Namely, Phase II research will further develop Iris AO's proven hybrid MEMS DM technology to: 1) develop and demonstrate wafer-scale assembly of deformable mirror arrays and 2) increase drive electronics resolution to >=18 bits using hardware-controlled super-resolution oversampling techniques. The increased spatial and actuator resolution afforded by the development here will enable picometer resolution DMs required to reach 10^10 contrast levels necessary for direct detection of Earth-sized terrestrial planets.

ANTICIPATED BENEFITS

To NASA funded missions:

Potential NASA Commercial Applications: Iris AO technology can be a key enabling component in a host of future NASA missions, including the space telescopes of the 'Origins' program including Terrestrial Planet Finder (TPF), Space Astronomy Far Infrared Telescope (SAFIR), Life Finder, and Planet Imager. Four recent ASMCS concepts require multiple DMs to implement coronagraphs. Two of these, DAViNCI and EPIC, specifically require segmented MEMS DMs. Other potential programs such as Structure and Evolution of the Universe (SEU) and ultraviolet telescopes will also require adaptive optics. Finally, ground based telescopes, like the Thirty Meter Telescope (TMT), Keck, and Gemini North

To the commercial space industry:

Potential Non-NASA Commercial Applications: The proposed

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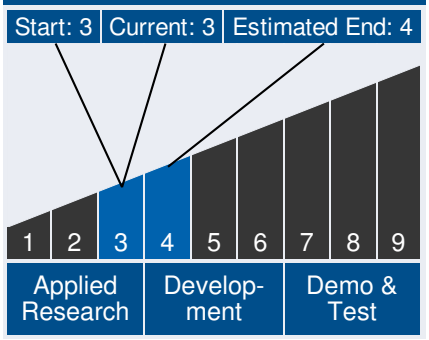
Technology Maturity



Management Team

Program Executives:

- Joseph Grant
- Laguduva Kubendran

Program Manager:

- Carlos Torrez

Continued on following page.

adaptive optics technology would find immediate application in several military communications and imaging products. Systems used in military surveillance such as in the Predator drone and Global Hawk would benefit from the high-resolution, light weight, and low power consumption afforded by Iris AO's MEMS. Atmospheric correction enabled by these low-cost but highly capable devices would benefit space situational awareness surveillance applications as well. In the commercial sector, adaptive optics has been employed in research systems in biological imaging, most notably in vision science and microscopy. Several research universities are reporting results using AO-equipped systems. The high segment-count devices enabled by this proposal would lead to unprecedented levels of spatial fidelity for biological imaging applications. Other commercial applications include metrology, laser processing, coherent combination of multiple fiber lasers, and laser beam quality improvement and drift compensation. Iris AO segmented mirrors are uniquely well-suited to higher power applications such as laser processing, combining fiber lasers, and laser beam quality improvement. This advantage lies in the relatively thick segments that enable the use of dielectric coatings which tend to warp conventional surface micromachined MEMS DMs. The precision open-loop operation of Iris AO DMs greatly simplifies the use of DMs in these applications.

Management Team *(cont.)*

Project Manager:
- Udayan Mallik

Principal Investigator:
- Michael Helmbrecht

Technology Areas

Primary Technology Area:
Science Instruments, Observatories, and Sensor Systems (TA 8)
└ Observatories (TA 8.2)
  └ Mirror Systems (TA 8.2.1)
    └ Normal Incidence Segmented Mirror for Large Aperture Ultraviolet/Visible/Near-Infrared Telescopes (TA 8.2.1.4)

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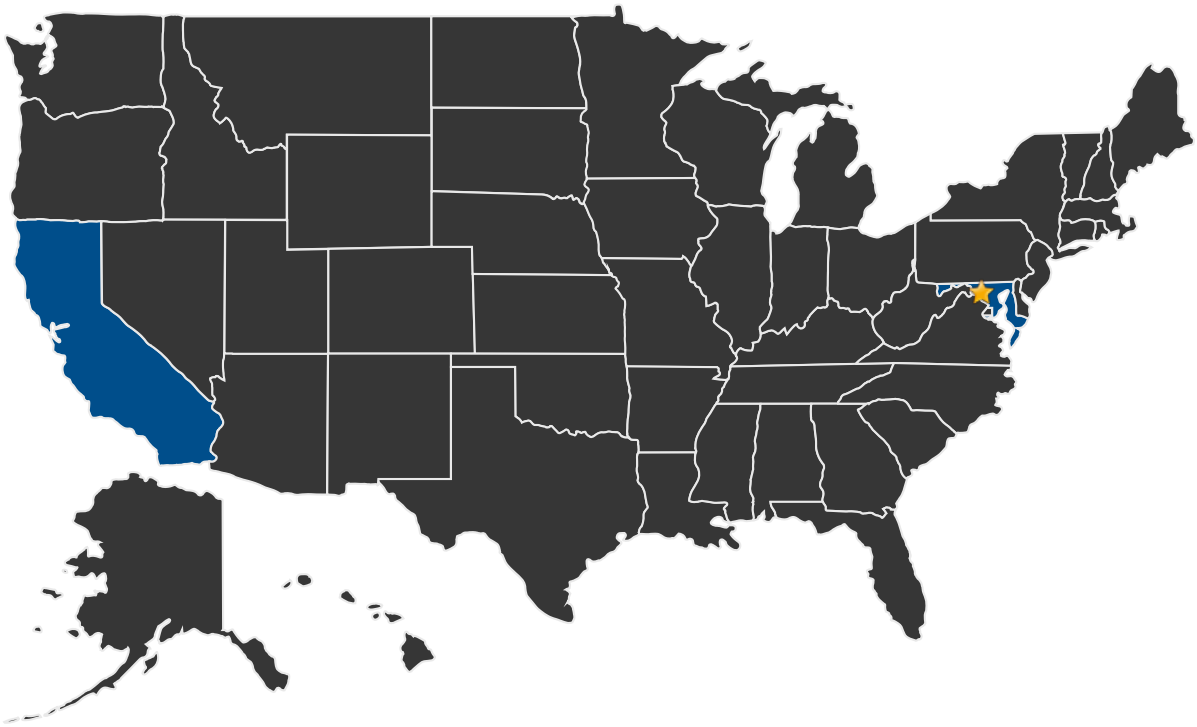
U.S. WORK LOCATIONS AND KEY PARTNERS



U.S. States With Work

Lead Center:
Goddard Space Flight Center

Other Organizations Performing Work:

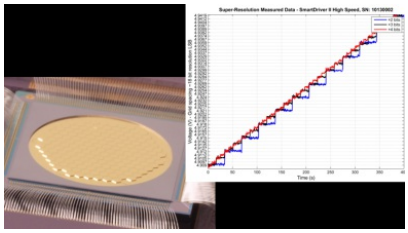
- Iris AO, Inc. (Berkeley, CA)

PROJECT LIBRARY

Presentations

- Briefing Chart
  - (http://techport.nasa.gov:80/file/23048)

IMAGE GALLERY



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DETAILS FOR TECHNOLOGY 1

Technology Title

Fabrication Process and Electronics Development for Scaling Segmented MEMS DMs

Potential Applications

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