1015 PTT Segment MEMS DM Development, Phase I 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 with 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 and make them flight-like for wavefront control in coronagraphs for exoplanet detection. This Phase I research proposal will begin development of a 1015-segment MEMS DM. It will result in a completed CAD layout of the DM, a conceptual package design, a conceptual electrical probe card design, and the fabrication of a key layer in the actuator process to demonstrate high-resolution field-stitched photolithography. The ultimate goal is to develop flight-like hardware based on Iris AO's proven hybrid MEMS DM technology. The increased spatial 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 SMEX, DISCOVERY and FLAGSHIP programs, and also technological development funded by the SAT and Exoplanet Research programs. Four recent mission concepts (Exo-C, WFIRST, EXCEDE, ACESAT) require multiple DMs to implement coronagraphs. One of these, ACESAT, which was submitted to SMEX, specifically requires MEMS DMs due to their low cost, low weight and low consumption. ATLAST, the next flagship space telescope, may likely be equipped with a VNC planet-finder as the VNC is compatible with segmented primary mirrors and obscurations. Similarly, the emergence of low-cost

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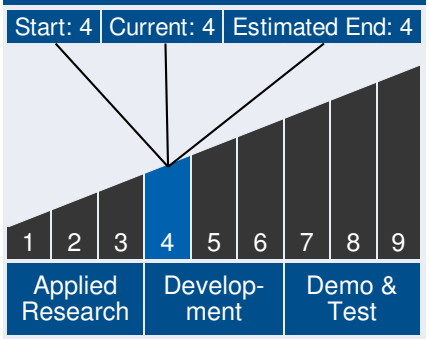
Technology Maturity



Management Team

Program Executives:

- Joseph Grant
- Laguduva Kubendran

Program Manager:

- Carlos Torrez

Continued on following page.

CubeSats for astronomy and Earth observations suggests that MEMS adaptive-optics technology could be common in the future. Finally, future NASA-funded instruments for ground-based telescope projects like the Extremely Large Telescopes (Thirty Meter Telescope, Giant Magellan Telescope and E-ELT), would likely require adaptive optics to remove aberrations from atmospheric turbulence. Another potential area for Iris AO technology is in laser communications with satellites. Iris AO DMs are capable of handling tens to hundreds of Watts of optical power with dielectric coatings. The DMs could be used to compensate for atmospheric turbulence that inhibits downlink and uplink bandwidth.

To the commercial space industry:

Potential Non-NASA Commercial Applications: The proposed adaptive optics technology would find immediate application in several military communications and imaging products. Systems used in military surveillance such as the Predator 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.

Management Team *(cont.)*

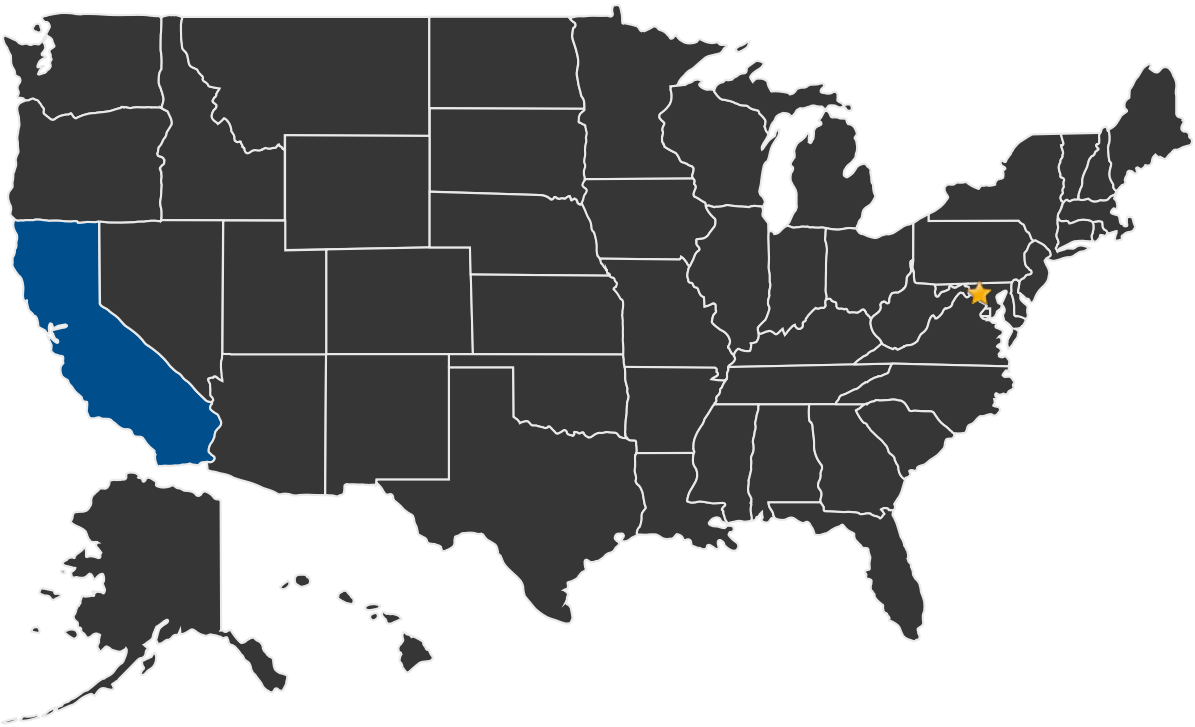
Principal Investigator:
- Michael Helmbrecht

Technology Areas

Primary Technology Area:
Science Instruments, Observatories, and Sensor Systems (TA 8)
└ Remote Sensing Instruments and Sensors (TA 8.1)
  └ Optical Components (TA 8.1.3)

The precision open-loop operation of Iris AO DMs greatly simplifies the use of DMs in these applications.

U.S. WORK LOCATIONS AND KEY PARTNERS



U.S. States With Work

Lead Center:
Goddard Space Flight Center

Other Organizations Performing Work:

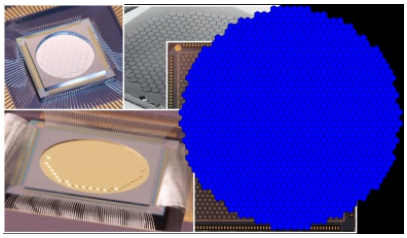
- Iris AO, Inc. (Berkeley, CA)

PROJECT LIBRARY

Presentations

- Briefing Chart
  - (http://techport.nasa.gov:80/file/23519)

IMAGE GALLERY



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DETAILS FOR TECHNOLOGY 1

Technology Title

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Potential Applications

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