Iris AO, Inc. used NASA SBIR funding to design extra-precision segmented mirrors which are being refined and prepared for inclusion in the next exoplanet mission scheduled for 2030.

SPECIAL MIRRORS HELP NASA DETECT DISTANT PLANETS

Stars are brighter than the planets they orbit. As a result, starlight can lower the contrast in images sent back to Earth from a telescope traveling in space, making it harder to detect planets light years away. To solve this problem, NASA sought to build a telescope that can filter out direct light from stars that limit the visibility of exoplanets.

PROJECT
Deformable mirrors for telescopes

MISSION DIRECTORATE
Science

PHASE III SUCCESS
IRIS AO products derived from SBIR funding are available for world-wide distribution by Edmund Optics - approximately $2 million revenue generated annually from the technology developed from NASA SBIR. NASA's SBIR program invested $875,000.

SNAPSHOT
Since the first exoplanet discovery in 1995, NASA has dedicated resources to develop deformable mirrors for powerful telescopes to determine if there are signs of life beyond Earth on planets outside our solar system.

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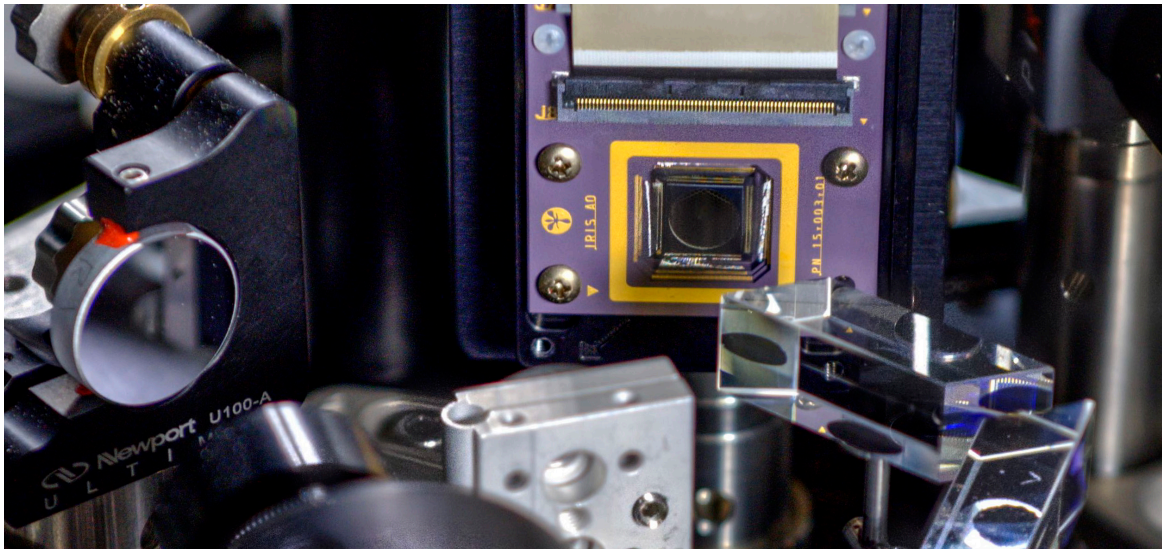
NASA enlisted the private sector to develop deformable mirror (DM) technology as a key component of starlight blocking instruments such as the Visible Nulling Coronagraph (VNC). The DM is used to correct optical aberrations that otherwise reduce the resolution of an image. By altering the shape of the DM surface, NASA scientists have more control to adjust the VNC with increased precision to block the starlight. For NASA's purposes, these DMs needed to meet strict requirements for stability, resolution, and accuracy levels for high-contrast astrophysical imaging.

Iris AO, Inc., a firm based in Berkeley, CA, applied for R&D funding through NASA's SBIR Program to design extra-precision, segmented mirrors for exoplanet discovery when this technology was just starting to be developed more than 10 years ago.

"When we sought to explore DM technology with NASA, our mirrors were in their infancy," according to Michael Helmbrecht, President of Iris AO. "They were unstable and low performing. SBIR funding from NASA allowed us to redesign DM electronics. We were able to refine the mirror calibration, improve the mirror production process and most importantly, develop the most stable adaptive optics system available to meet NASA's needs."

Iris AO's innovative approach for the telescope's VNC was to develop a small DM made up of many tiny mirrors. Iris AO's mirror technology consists of hexagonal segments closely packed together to form the surface of the DM, which enables advanced control when paired with other optics. The traditional DM consisting of a single, continuous surface does not afford the same control.



The compact Iris AO, Inc. PTT489 shown aligned to other components in the NASA GSFC Visible Nulling Coronagraph (VNC).

Iris AO developed an overall system with electronics and software which NASA scientists use to control the tiny individual mirrors at sub-nanometer precision (one nanometer equals one billionth of a meter). This allows for tiny modifications of the DM to maximize the filtering of starlight and get the best images of planets possible.

The data collected by the telescope using the Iris AO DM can be used to determine if the target investigated in space is an exoplanet based on its orbit, and if the exoplanet has atmosphere using color spectrum imaging analysis. The Iris AO DM is currently being refined and prepared for inclusion in the next exoplanet mission scheduled for 2030.

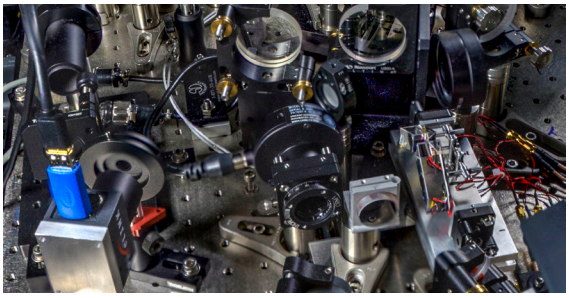
> "NASA's interest in DMs was a critical moment for fledging optics technology. SBIR funding gave our company a significant boost in R&D so we could refine the first production of our DMs."
>
> **IRIS AO**
> PRESIDENT
> MICHAEL HELMBRECHT

The high standards that NASA set for the DM enabled Iris AO to easily spinoff the technology to be used in the private sector. Specifically, the stability standard of the DM was an important factor for NASA. The Iris AO DM can hold a specific shape based on extreme requirements at a stability level needed to overcome exoplanet detector limitations. Leveraging this characteristic, Iris AO provides the same quality DM to customers seeking similar dependability and flexibility requirements.

Iris AO has further developed DM technology for new imaging applications in critical research. For example, the National Institutes of Health and the Air Force are using Iris AO DMs for retinal imaging. Similarly, the New England College of Optometry, the University of California, Davis and Simon Frasier University in Canada are using the spinoff technology to improve how images of the human eye are generated using existing ophthalmic instruments.

Additionally, researchers at the Howard Hughes Medical Institute and University of California, Berkeley are using IRIS AO DMs to study neural processes in ways not possible before by using the technology to peer deep into mouse brains. Today, Edmund Optics includes the Iris AO PTT111 DM, derived from the DM that was developed for NASA's VNC, in its catalog for distribution worldwide.

"NASA's interest in DMs was a critical moment for fledging optics technology. NASA SBIR funding gave our company a significant boost in R&D so we could refine the first production of our DMs," according to Michael Helmbrecht. "The additional funding from the Exoplanet Program allowed us to model and characterize DMs to increase shock robustness so DMs are suitable for launch environments. We were able to complement this initial funding with a Phase I/II SBIR from the National Science Foundation to make the DMs suitable for operation with lasers."



The compact Iris AO, Inc. PTT489 shown installed in the NASA GSFC Visible Nulling Coronagraph (VNC). Iris AO deformable mirrors have been developed to enable high-contrast direct imaging of extrasolar planets.