National Aeronautics and Space Administration

SBIR Company Creates Low-Cost Tool for Measuring and Polishing Mirrors

Bauer Associates, recipient of Small Business Innovation Research (SBIR) funding from NASA's Goddard Space Flight Center, has developed and is commercializing a low-cost, highly reliable tool for measuring large aspheric mirror surfaces, the type found on research telescopes. Traditional technology must be housed in a multi-story facility, but Bauer's fits in a 12x12x8.5-foot room. Using an innovative configuration of the same type of laser gauges found in semiconductor lithography machines, Bauer's tool does not need to be recalibrated for different mirrors (e.g., concave, convex). Furthermore, Bauer has shown the feasibility of adding a polishing capability in the future.

SBIR-Sponsored Improvements

- **Less expensive:** Fits into one room and eliminates the need to build or retrofit a multi-story building to house an interferometer capable of measuring large (meter-class) mirror surfaces
- **Safer:** Allows measuring and polishing with one piece of equipment, eliminating the need to move a delicate mirror from the interferometer to the polisher
- **Adaptable:** Measures mirrors that are flat, concave, or convex over a tremendous range of curvatures—a flexibility far beyond that of traditional interferometry
- **Faster:** Provides quick reconfiguration between mirror types

success

On the Record

"Having an SBIR helped us advance the technology. This was the perfect project for a Phase I SBIR because it was really innovative and completely untried. It was wild to say we were going to re-invent how to measure mirrors. This has redefined our capabilities." — *Paul Glenn, CEO, Bauer Associates*

"Bauer Associates has developed a state-of-the-art metrology tool. The instrument combines polishing and metrology capabilities in a single platform and is ideal for the metrology and fabrication of large and midsized mirrors."— *Timo T. Saha, Physicist, NASA's Goddard Space Flight Center*

About Bauer Associates

Bauer Associates of Natick, Massachusetts designs and manufactures electro-optical instruments, from straightforward components to full systems. Bauer also offers related consulting, contract R&D, and contract manufacturing services. The company's laser-based technique for measuring surface shape errors on optical surfaces earned a Photonics Circle of Excellence Award, and NASA used the technique to help characterize the mirrors used in the Hubble Repair Mission.

Addressing a Technology Need

Interferometers have been used since Galileo's time, but as mirrors have gotten larger and more aspheric, the technology to measure and polish them has lagged. Errors in telescopes that are launched into space are costly or impossible to repair. An SBIR grant allowed Bauer to follow up on its laser-based technique for measuring surface shape errors on optical surfaces and create a noninterferometric, optical technique for measuring absolute aspheric shape over the full surface of large mirrors to the nanometer level, without the need for known reference surfaces. The measuring system uses four laser gauges in an innovative configuration that is unaffected by heat or slight movement. Unlike traditional interferometry for large mirrors, a multi-story facility with custom-outfitting is not required, and it just takes a few hours to adjust the equipment to measure a new mirror.

Proven Performance

In the early stages of development, Bauer contracted with the Smithsonian Astrophysical Observatory (SAO) to measure NASA's HIREX Pathfinder mirror. Since then, Bauer also has contracted with both industry and the government to measure several other mirrors.

The Transfer Process

The highly competitive, three-phase SBIR program reserves a specific percentage of federal R&D funding for awards to small businesses, to move ideas from the laboratory to the marketplace, foster high-tech economic development, and address the technological needs of the federal government. Bauer developed its technology under multiple Phase I and Phase II grants, along with the SAO grant.

Looking Ahead

Bauer has made inquires into testing the secondary mirror on the James Webb Space Telescope, an infrared optimized space telescope set to launch in 2013. The secondary mirror is convex and aspheric, making it difficult and expensive to test using traditional processes. Bauer also has completed an SBIR Phase II project, proving its ability to measure and polish with the same equipment, a technique that Bauer continues to refine. With growing acceptance of Bauer's measuring technology, the company expects increased commercial interest. Bauer has introduced its new technology at conferences and currently has customers from both industry and the government.

For More Information

If you would like additional information about Goddard's partnership with Bauer Associates or other technology transfer opportunities, please contact:

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