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NASA Tech Days 2014

Phase II SBIR

“Low Cost Method of Manufacturing Space Optics”

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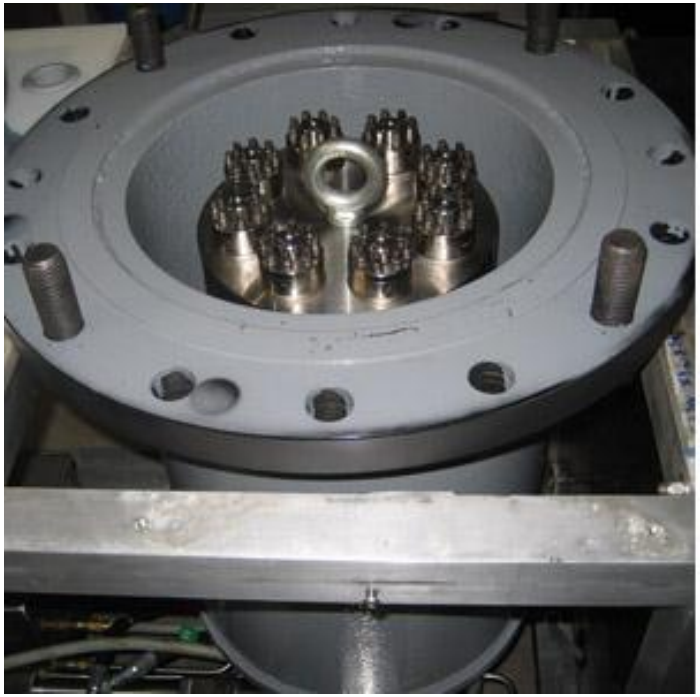
NASA POC: Ron Eng

About Ormond, LLC

- Performs contract engineering and R&D.
- Staff with unique engineering expertise.
- Mostly related to ultra-high pressure abrasive waterjet manufacturing processes and hyperbaric testing.
- Multiple SBIR programs with major ongoing commercialization success.

About Ormond, LLC



Ormond designs and operates test chambers up to 120,000 psi, built custom reciprocating pumps to generate up to 200,000 psi.

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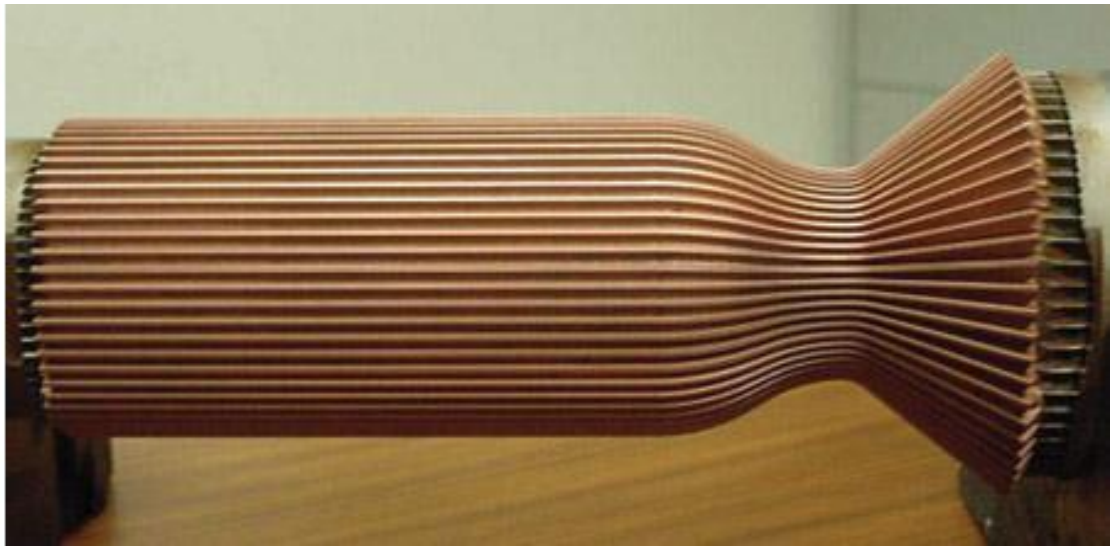
The Ormond Process

- Developed patented abrasive waterjet milling process to manufacture NASA/USAF X-43 and X-51 Waverider scramjet Inconel engine parts.
- Addressed channel wall rocket nozzle liners; reduced time and cost, increased design options.
- Precision machining small and complex features in hard metals and ceramics.
- Applications include increased design options, volumetric removal rate, and low residual stress parts.

Optics Manufacturing SBIR

- Current Phase II SBIR Contract No. NNX13CM22C.
- “Low Cost Method of Manufacturing Space Optics”.
- Manufacturing technology R&D; goal to increase large optics design options, reduce cost and schedule risks with improved optical performance.
- Specifically addressed are near net shape light-weighting of large mirror facesheets and cores.

Ormond Milling Technology



Proprietary maskless abrasive waterjet milling process was used to machine complex geometries on difficult to machine materials.

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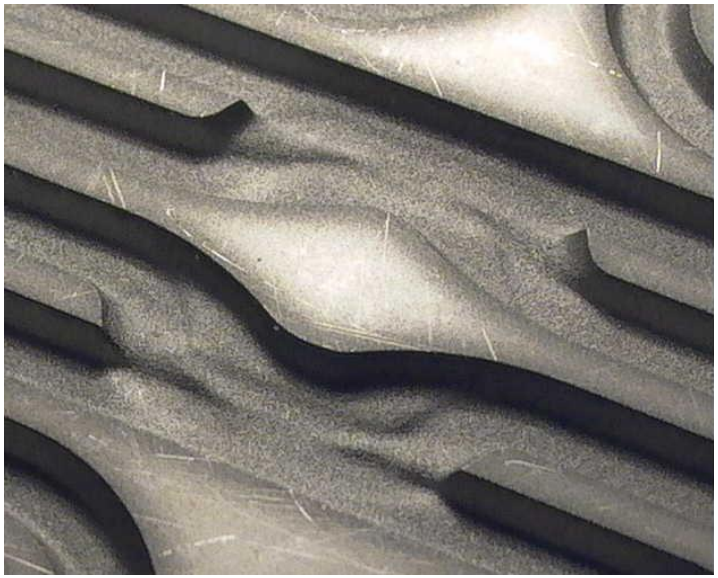
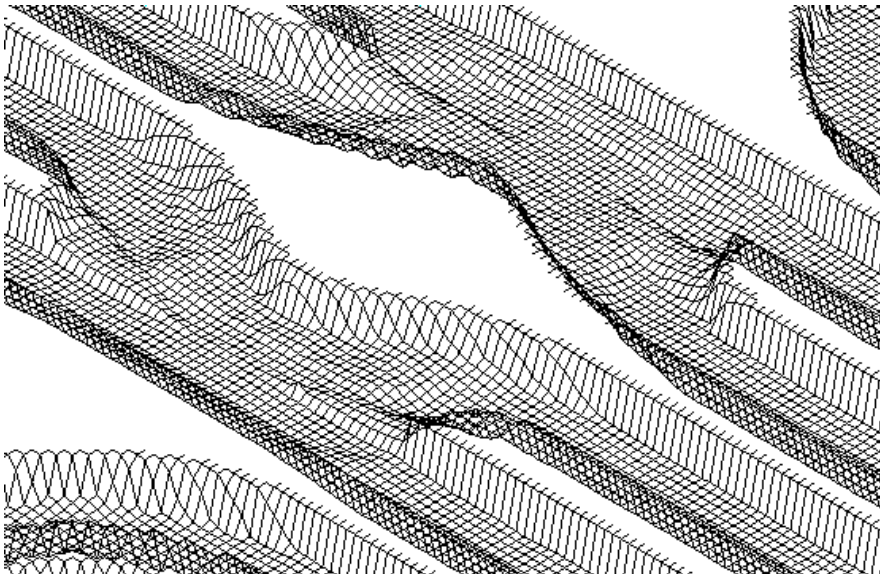
Ormond Milling Technology

Process capable of milling with minimal subsurface damage or residual stress. (CVC SiC shown)

Ormond Milling Technology





Proprietary software semi-automates CNC machine code development and numerical model predicts machined geometry prior to machining test coupons.

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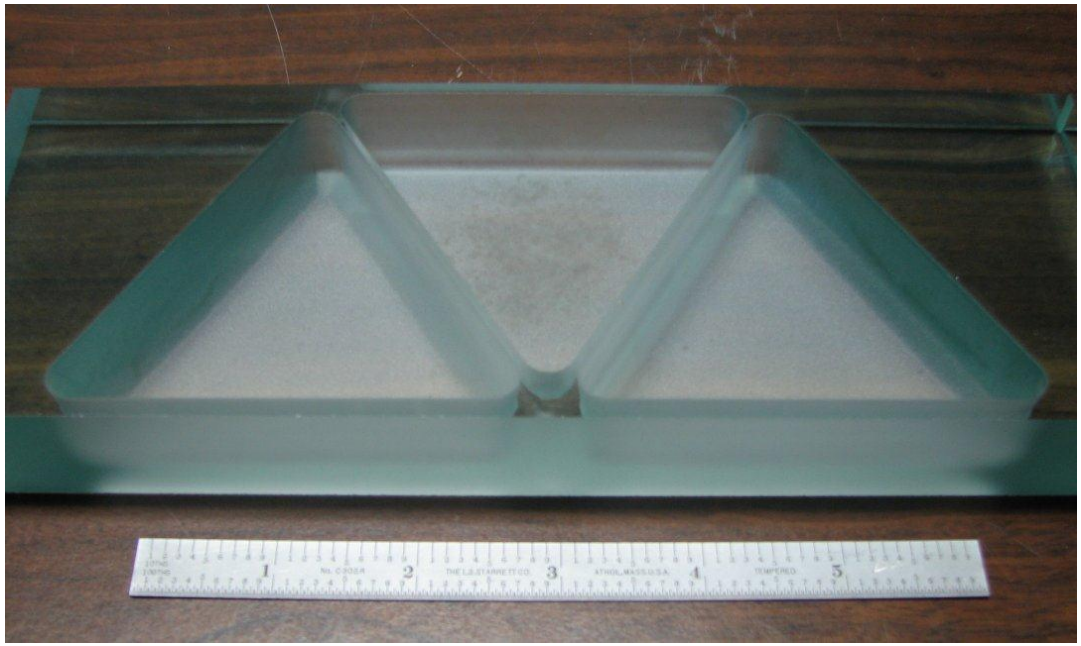
Phase I results

- Maskless abrasive waterjet milling adapted for mirror facesheet light-weighting; demonstrated full scale mirror cell geometry.
- Demonstrated reduced residual stress and increased 4-point bending strength compared to grinding.
- Significant higher removal rate than grinding.
- Material removal rate is currently 2.4 cm^3/min, goal is to exceed 8 cm^3/min.
- Currently TRL-5.
- Can readily scaled up to 4 meters or larger mirrors.
- Offers flexibility to manufacture complex design.

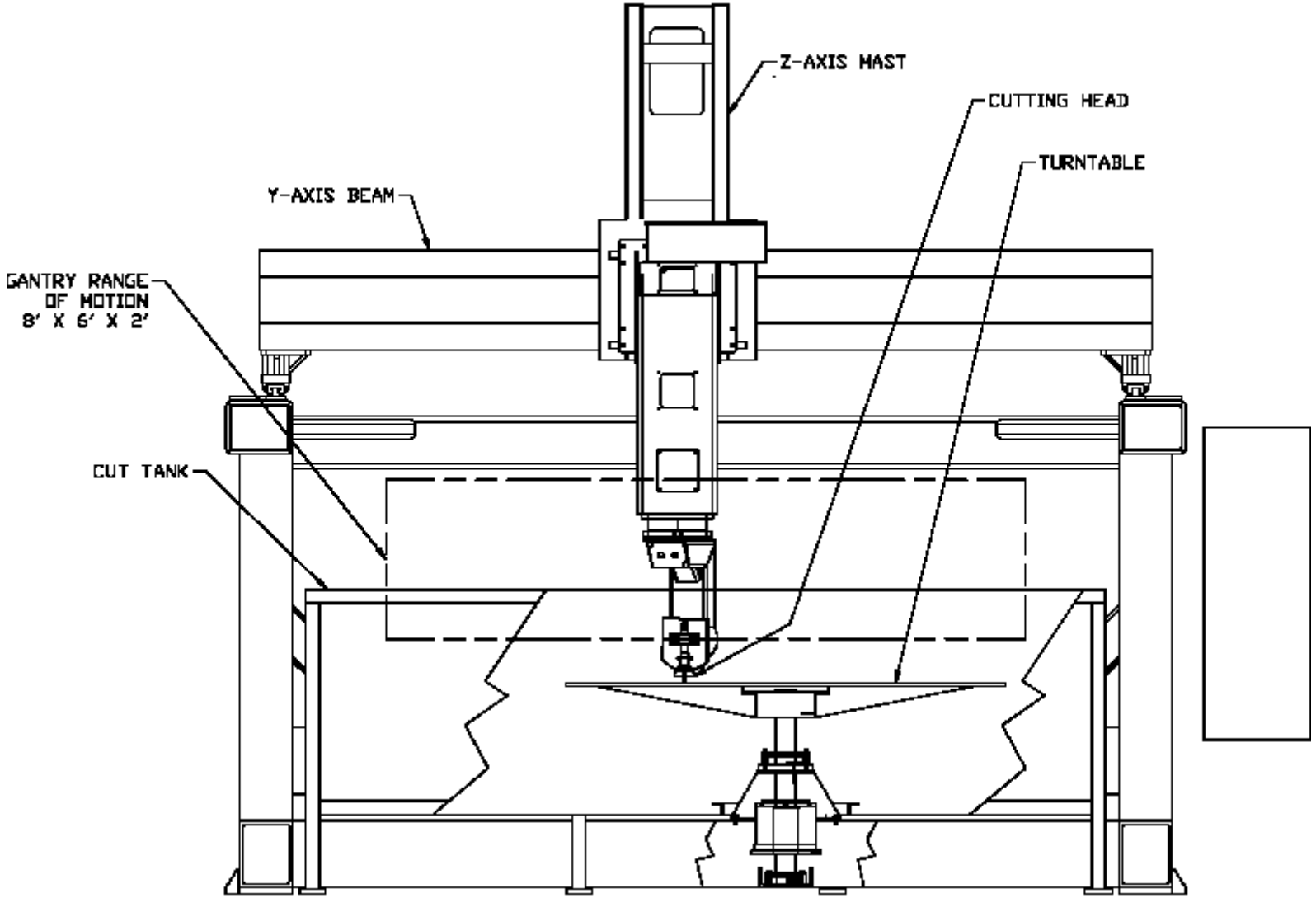
Phase I Results



AMTD-2 geometry demonstrated: Total depth range of the 19 mm deep pocket with ±0.32 mm with the majority being within ±0.13 mm. The cell wall taper is ~3°. Will improve with continual effort.

Phase II goal

- **Building abrasive waterjet milling machine** for mirror facesheets and core lightweighting.
- **X-Y-Z motion volume:** 2.4 x 1.8 x 0.6 meter with a 1.66 meter diameter turntable.
- **Proprietary abrasive waterjet precision depth milling** for mirror facesheet lightweighting.
- **5-axis abrasive waterjet through cutting** for mirror core lightweighting.
- **Manipulator configuration** based on 5-axis gantry with 6^{th} axis turntable/indexer and CNC controller.
- **Closed loop controls** to manage machining parameters.
- **Non-contact inspection** for in-process inspection and final inspection/as-built modeling.



Layout sketch of workstation that is now being built

Phase II Project

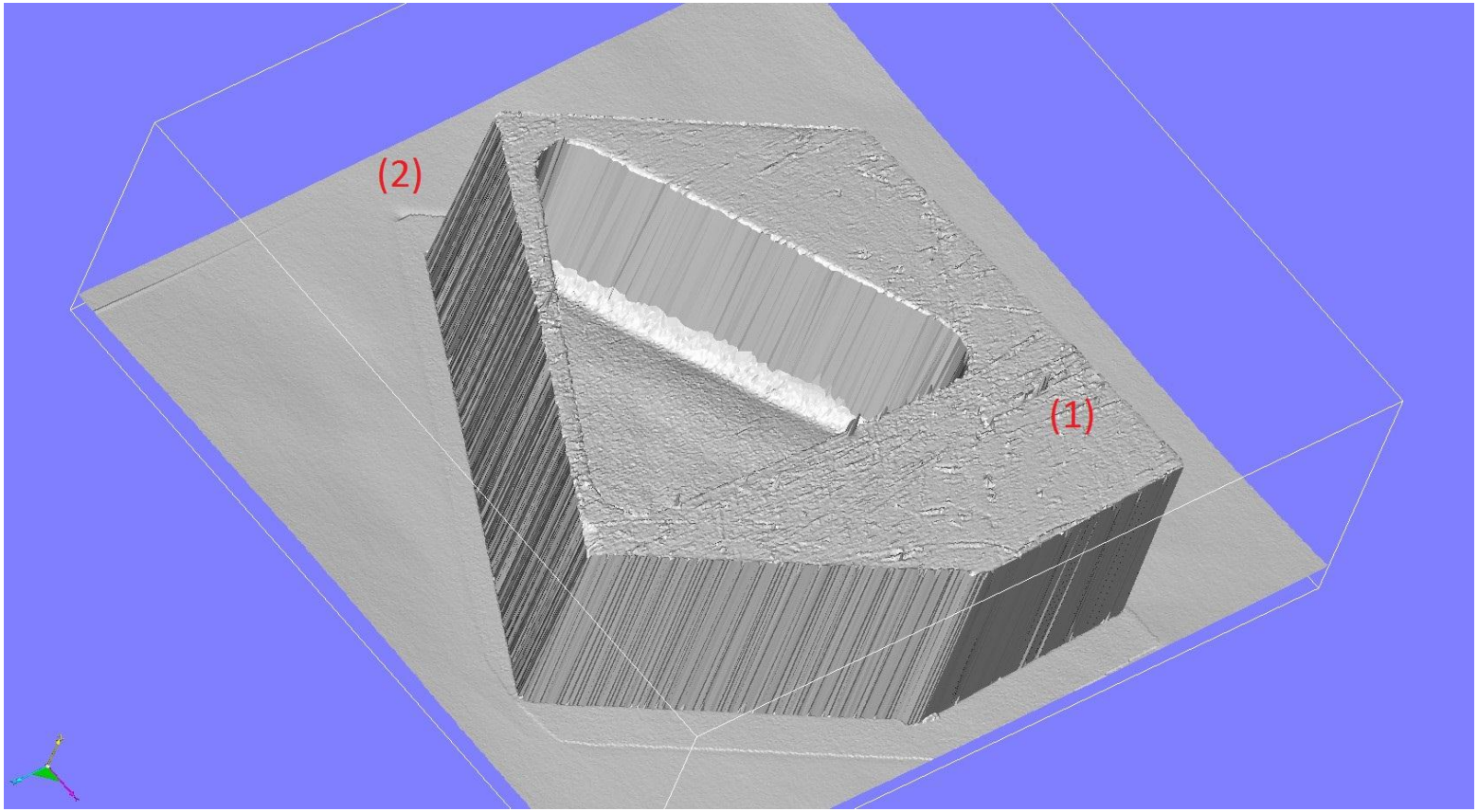


Image of actual milled glass scanned with optical sensor

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NASA SBIR/STTR Technologies

Phase II NNX13CM22C – Low Cost Method of Manufacturing Space Optics

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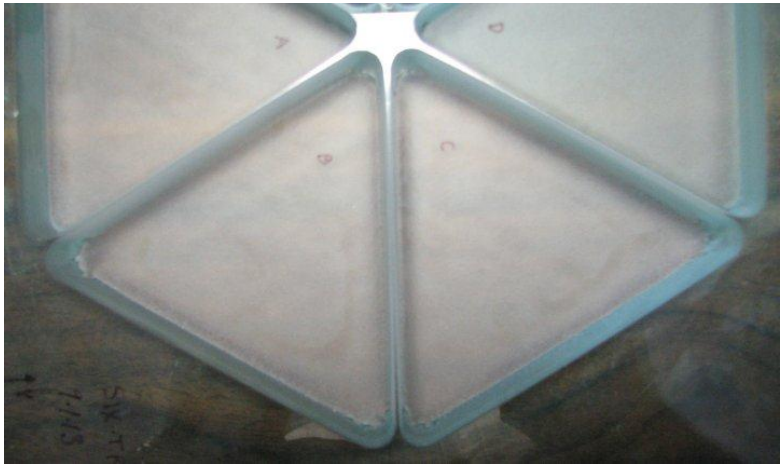

Identification and Significance of Innovation

A manufacturing technology is under development to increase large optics design options, significantly reduce manufacturing time, cost and risk involved in manufacturing large optic components and to improve optics performance. Specifically addressed is light weighting of glass and ceramic optical components. This gentle process is capable of milling with minimal subsurface damage or residual stress generation and has demonstrated increased glass strength compared to ground specimens.

Expected TRL Range at the end of Phase II (1-9): 6

Technical Objectives and Work Plan

The primary goal of this Phase II SBIR is to develop and demonstrate a working system that is capable of light-weighting a 1.5 m AMTD-2 type mirror faceplate and core.

The Phase II scope includes building and testing a workstation that will be available to support AMTD-2 and similar optics fabrication operations. Demonstration of scalability, risk reduction, and manufacturing cost data will be reported.

NASA and Non-NASA Applications

This SBIR is being conducted in support of NASA Advanced Mirror Technology Development (AMTD) program. Raytheon Space and Airborne Systems group stated that the developments made under this SBIR will directly support NASA programs including JDEM, IXO, LISA, ICESAT, ATLAST, CLARREO and ACE. Non-NASA applications include various ceramic and challenging metal milling applications, shaping armor, channel wall combustors, scramjet channel heat exchangers, etc.

Contacts

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