Optimax SBIR Commercialization

Enabling customer satisfaction, revenue growth and job creation utilizing SBIR developed technologies

Jessica DeGroote Nelson, Kate Medicus, Todd Blalock, Brian Myer, Matt Brunelle, Tim Lynch, Mark Walters, Greg Frisch and Mike Mandina

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Outline

- Company overview
- SBIR commercialization strategy
- Review Phase II SBIR projects completed at Optimax
  - Report resulting *revenue* and *job creation* due to SBIR developed technologies
- Successful technology transition from R&D to production
- Summary
  - Highlighting *customer satisfaction* due to SBIR developed technologies
- Future work

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Optimax Overview
Profile

Inc 5000 Top Growing Business

Rochester Top 100

- Founded 1991
- Ontario NY
- 60,000 ft^2 facility
- 250 employees
- ISO 9001:Certified
- ITAR compliant

OPTIMAX

Optimax Systems, Inc. – Custom Precision Optics

Committed to Small Volume, High Quality, Quick Delivery

- Materials
  - Glass Materials
  - Ceramics
  - Crystals
  - Fused Silica
  - Low Expansion
- Shapes
  - Aspheres
  - Conformal & Freeform
  - Cylinders
  - Domes
  - Flats
  - Prisms
  - Spheres

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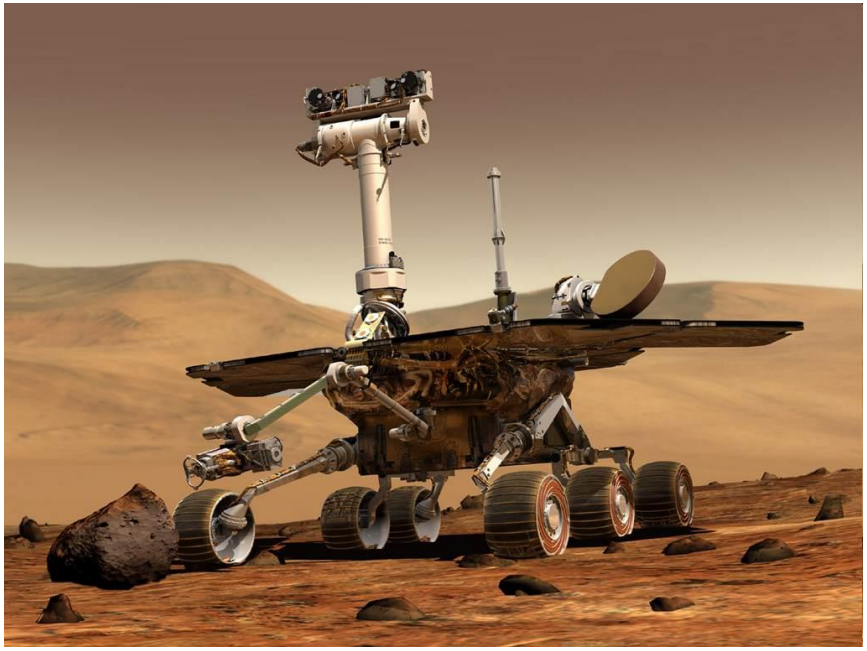
Optimax Overview
Markets We Serve

- Semiconductor
- Aerospace & Defense



- Medical
- Commercial

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Optimax in Space

Pluto New Horizons

Jupiter Flyby - New Horizons

2005 Rovers - Spirit & Opportunity

2011 Rover - Curiosity

Mars 2020 Rover

Lunar Reconnaissance Orbiter

OSIRIS-REx

Global Warming OCO

International Space Station

Mercury Messenger

Supporting Missions . . .

Polar Orbiting

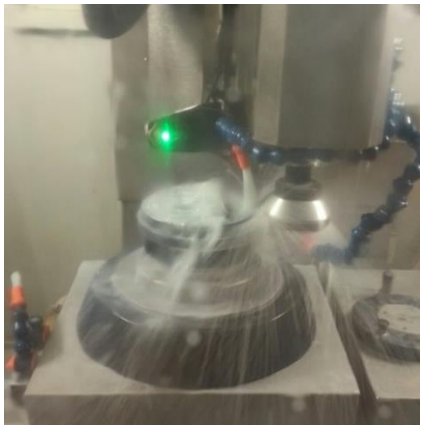
Searching for Earth Like Planets

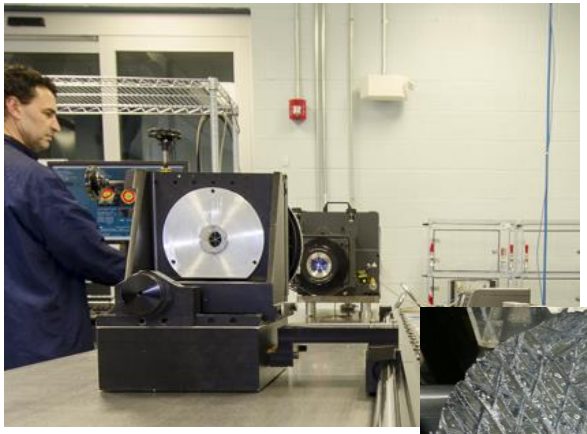
OPTIMAX®

Aspheres | Cylinders | Prisms | Spheres | optimaxsi.com

Standard Processes
Cylindrical, Plano, and Spherical Optics

- Lean manufacturing
- CNC generation for speed
- Traditional pitch & deterministic polishing
- Application specific processing – HEL, UV, high strength





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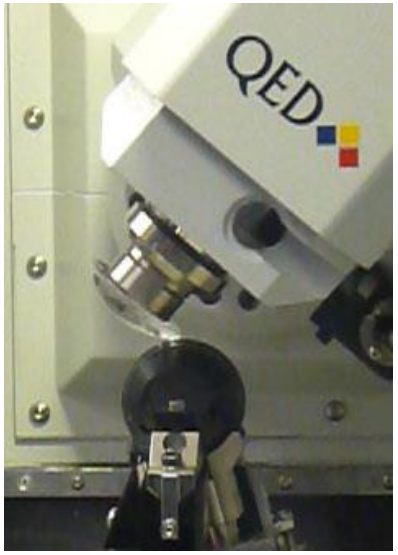
Standard Processes
Asphere, and High Precision Optics

- Deterministic processing – sub-aperture tools
- Iterative processing – metrology ↔ fine finishing tools



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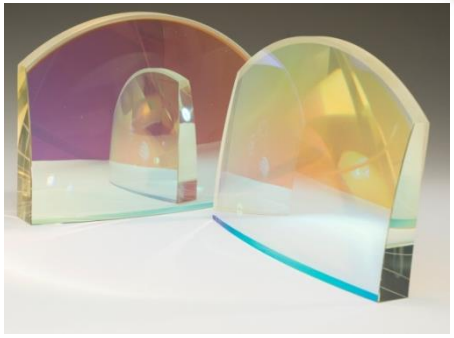
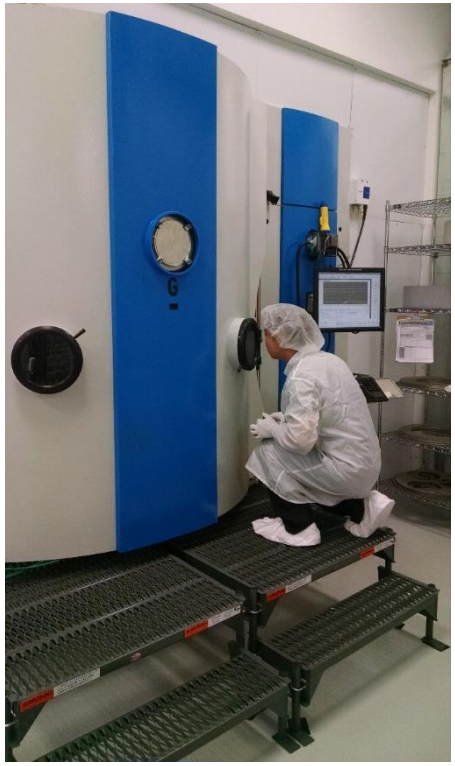
Optimax Coatings
Coating Capability

- Antireflection, mirrors, filters, beamsplitters
- Thermal and e-beam evaporation, IAD technologies
- 4,000ft^2 class 10,000 facility: optics cleaned in class 1,000 space under class 100 benches
- 193nm to 5µm
- Large apertures
- High laser damage thresholds
- Coating uniformity on flat and curved surfaces





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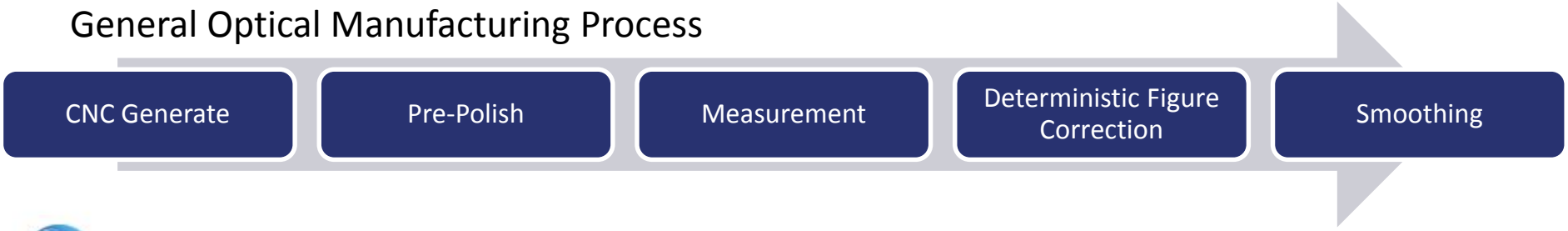
SBIR strategy at Optimax

- Optimax business model: Service industry
  - Provide high precision custom optics
- Early adopters of novel technology
- SBIR and R&D projects at Optimax fill gaps in technology
  - Projects focus on processes to enable higher precision, more complex geometries and ability to work with novel materials

General Optical Manufacturing Process



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Optimax Completed Phase II SBIRs

Federal Agency	Project Title	Year Completed
DOD/NAVY	Aerodynamic Infrared Dome	2011
NASA	Removing Mid-Spatial Frequency Errors with VIBE	2013
DOD/NAVY	Optically Precise Conformal Sensor Window	2013
DOD/NAVY	Fabrication of Corrective Optics for Aerodynamic Domes	2014
DOD/NAVY	Reduced-Cost Grinding and Polishing of Large Sapphire Windows	2014

Current SBIRs:

- Five Phase I SBIRs
- Three Phase II SBIRs
- One Phase II STTR (in contracting negotiations)

Please check out Optimax presentations tomorrow by Kate Medicus, highlighting current NASA Phase I work

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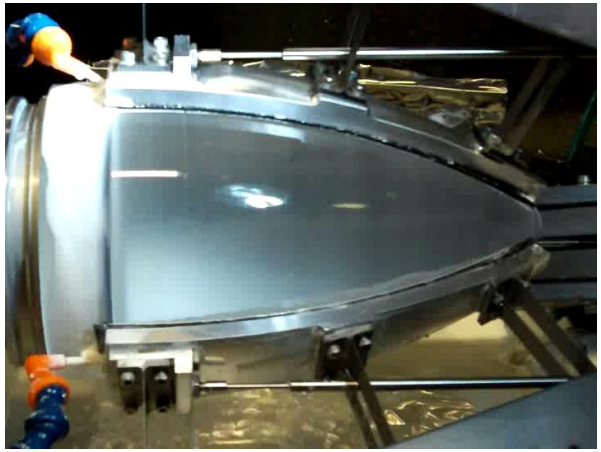
Aerodynamic Infrared Dome (2009 – 2011)

- **Summary:** The goal of this SBIR Phase II was to produce a polished PCA tangent ogive dome using VIBE.
- **Key Technology Enabler:** VIBE polishing freeform optics and hard ceramic materials



CNC Generate → VIBE Pre-Polish → Measurement → Deterministic Figure Correction → VIBE Smoothing

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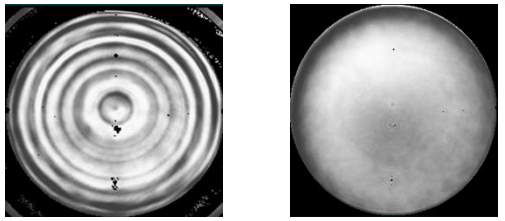
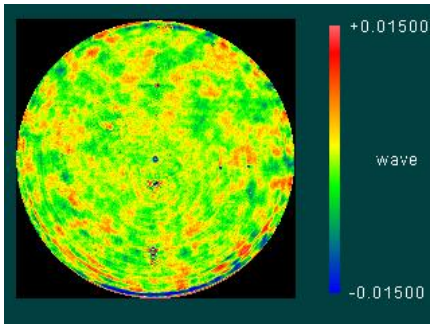
Removing Mid-Spatial Frequency Errors with VIBE (2011 – 2013)

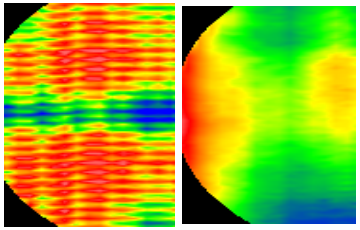
- **Summary:** Utilizing VIBE finishing process to rapidly reduce or eliminate mid-spatial frequency (MSF) errors created by deterministic polishing.
- **Key Technology Enabler:** VIBE finishing to reduce MSF errors on spheres and aspheres



Fringe pattern from before (left) and after (right) the VIBE smoothing process.



Zernike Residual map for asphere with 300 µm of departure with 128 mm clear aperture, rms = 0.003 wv.



CNC Generate → VIBE Pre-Polish → Measurement → Deterministic Figure Correction → VIBE Smoothing

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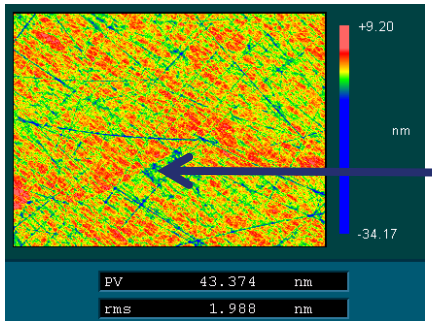
Optically Precise Conformal Sensor Window (2011 – 2013)

- **Summary:** Phase II goal was to combine novel optical generation and high speed polishing along with deterministic finishing to produce optical quality spinel conformal windows
- **Key Technology Enabler:** Implementing ultrasonic generation in combination with VIBE polishing to fabricate spinel conformal windows.



The grain boundary is visible, but not pronounced.

CNC Generate → VIBE Polish → Measurement

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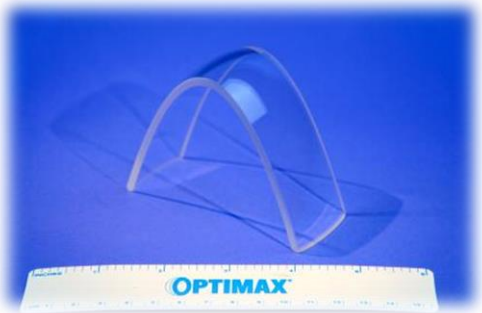
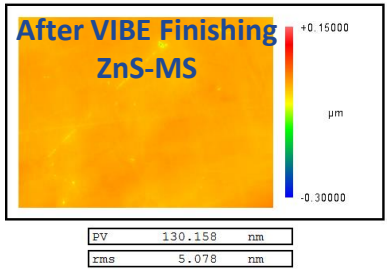
Fabrication of Corrective Optics for Aerodynamic Domes (2012 – 2014)

- **Summary:** Goal was to manufacture a corrector element that was a bilaterally symmetric arch with aspheric terms using a suite of manufacturing technologies.
  - The material chosen for the corrector optic was difficult to produce aspheric components due to its incompatibility with sub-aperture polishing techniques.
- **Key Technology Enablers:** VIBE polishing and smoothing of soft polycrystalline ceramic materials, plus initial work on sub-aperture polishing tools to minimize grain decoration.

No visible "orange peel"





CNC Generate → VIBE Pre-Polish → Measurement → Deterministic Figure Correction → VIBE Smoothing

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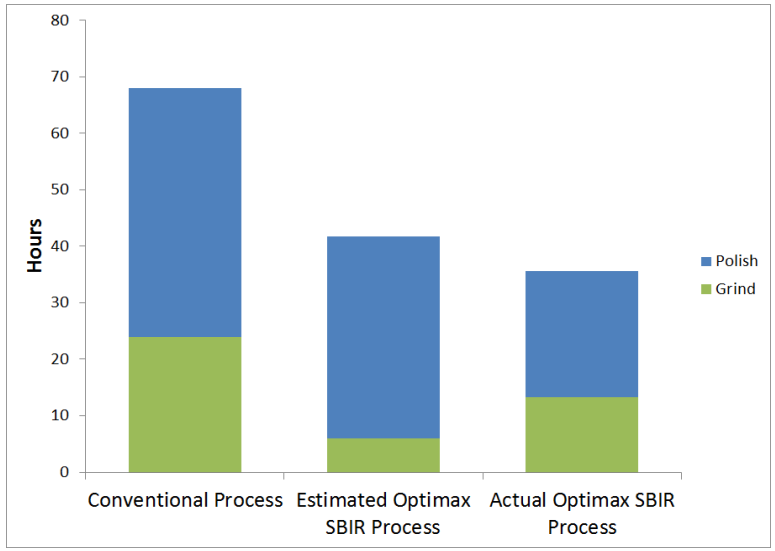
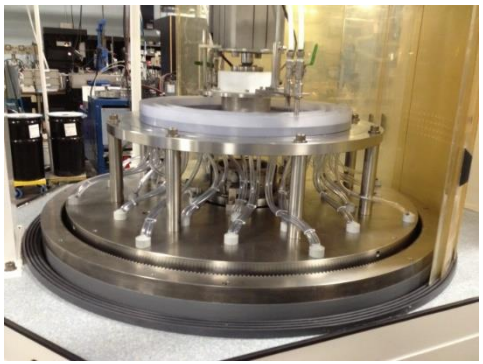
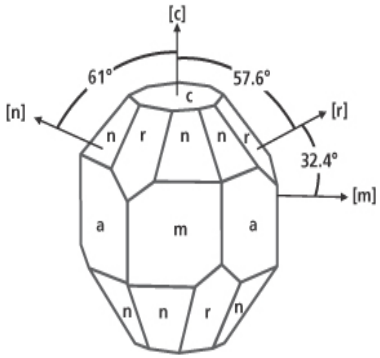
Reduced-Cost Grinding and Polishing of Large Sapphire Windows

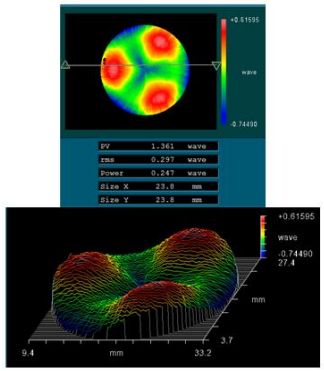
- **Summary:** This Phase II project focused on high speed polishing to result in high strength large sapphire windows.
- **Key Technology Enabler:** High speed polishing of sapphire and new polishing slurries for optimized sapphire polishing.



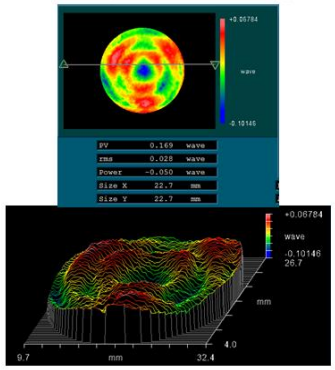




Sapphire before polishing



Sapphire after polishing with specialized slurry



Optimax SBIR commercialization success

Federal Agency	Project Title	Total Revenue (through CY 2014)
DOD/NAVY	Aerodynamic Infrared Dome	$561,750
NASA	Removing Mid-Spatial Frequency Errors with VIBE	$3,149,260
DOD/NAVY	Optically Precise Conformal Sensor Window	$387,170
DOD/NAVY	Fabrication of Corrective Optics for Aerodynamic Domes	$1,004,386
DOD/NAVY	Reduced-Cost Grinding and Polishing of Large Sapphire Windows	$286,273

- **Total Revenue 2011 - 2014 due to SBIR enabled processes: $5,388,839**
  - 2015 Estimate Additional Revenue: $4,000,000
- **Number of new employees due to SBIR developed technology: 25**
  - 2015 Estimate Additional Jobs Created: 10

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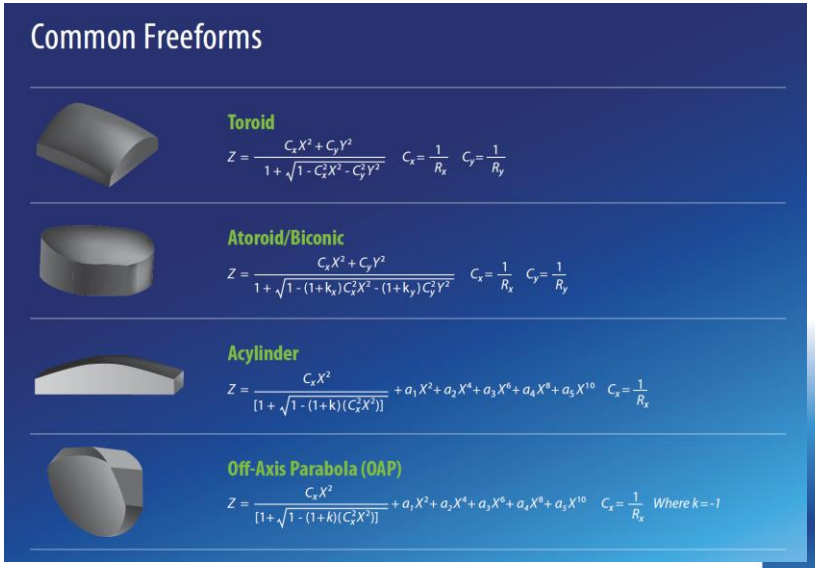
Approximately $4M initially invested through SBIR programs

2015: Official roll out of Freeform manufacturing from R&D to Production

- Successful commercialization of several SBIR funded technologies
  - New Manufacturing Lean Cell dedicated to freeform manufacturing



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Optimax SBIR Commercialization Success Story

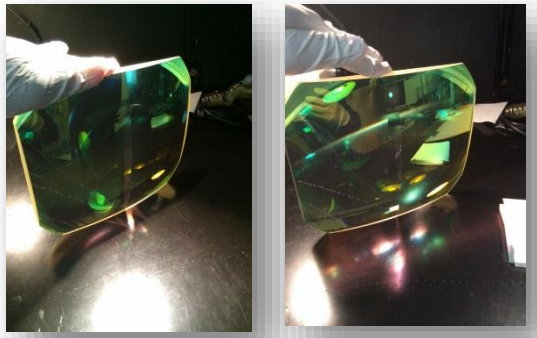
Optimax SBIR Commercialization Accomplishments:

- Commercialization Index: 90 (out of 100)
- First SBIR awarded in 2009
  - Five Phase II contracts completed
  - Three current Phase II contracts (One new Phase II contract currently in negotiation)
  - Jobs created at Optimax since 2009: 90 (~25 directly due to SBIR developed technology)
- Successful SBIR technology transfer from R&D to production
  - Optimax officially introduced custom *freeform optics* to the market in 2015
  - Example customer request ($400,000 project)
    - Specific Customer Need
      - Two freeform optics with dimensions 240 mm x 200 mm and 140 mm x 150 mm
        - Asphere on Side 1: Manufactured using standard processes
        - Freeform on Side 2: Manufactured using Optimax SBIR developed processes

Deterministic Surface Form Correction

VIBE Smoothing

Final Freeform Optics After Coating



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Future commercialization success

Currently funded SBIR projects at Optimax

Project title	Funding Agency	SBIR Phase
Additive Manufacturing for Lightweight Reflective Optics	NASA	Phase I
Manufacture of Monolithic Telescope with a Freeform Surface	NASA	Phase I
Freeform Optics: A Non-Contact “Test Plate” for Manufacturing	NASA	Phase I
Low Cost Finishing of Optical Ceramic Domes with Embedded Grids	Army	Phase II
High Precision Conformal Sensor Window	Navy	Phase II
Corrective Optics Manufacturing for Aerodynamic Infrared Domes and Conformal Sensor Windows	Navy	Phase II
Manufacturing of Visibly Transparent Large Conformal Window	Navy	Phase I
Metrology of Visibly Transparent Large Aspheric Optics	Navy	Phase I

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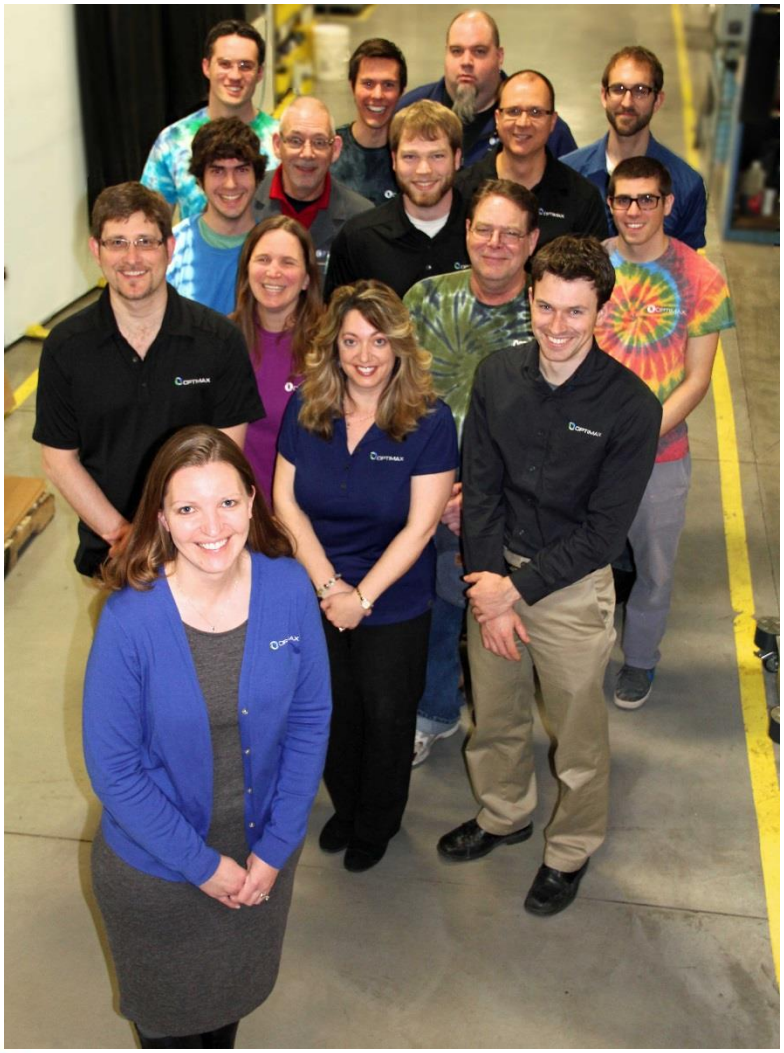
Thank you for the challenges!



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Contact information:

Jessica DeGroote Nelson
email: jnelson@optimaxsi.com
office: (585) 265-1020 x276
cell: (585) 820-8008
www.optimaxsi.com