Automated Mirror Cover Naval Precision Optical Interferometer

4/26/2013

Rogelio Blanco
Miles Dehlin
Leland Doyle
Salazar Grey
Katherine Hewey
Paul Owen

Overview

- Introduce NPOI
- Problem Statement
- Constraints
- Iris Mechanism
  - Prototypes
- Fabrication Process
- Project Deliverables

The Naval Precision Optical Interferometer (NPOI)

- The facility uses several small mirrors to collect light from stars
- Combining the collected light allows for a composite image to be assembled
- The composite image replicates the resolution of a much larger single mirror telescope

NPOI Facility

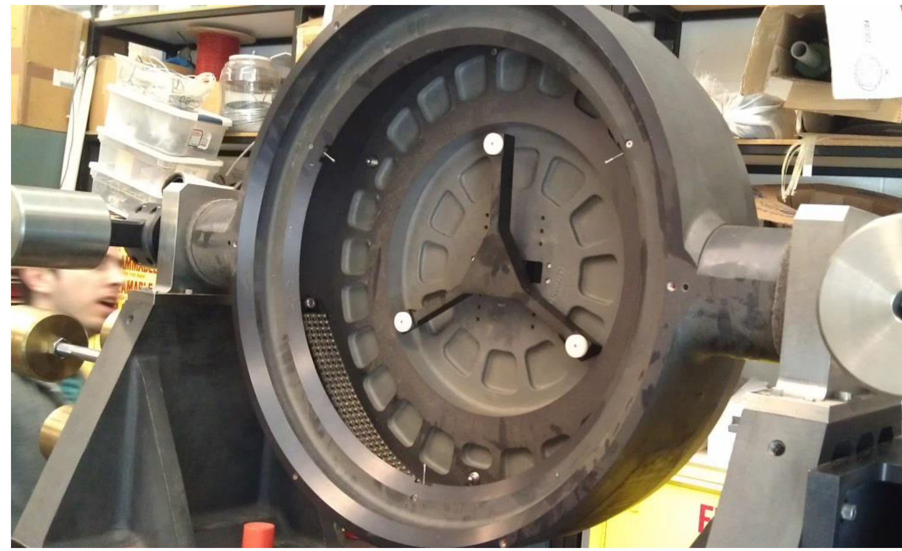
Aerial view of the NPOI facility

The Siderostat

- The small mirrors are housed by multi-axis siderostats
  - Movement of a siderostat is computer controlled to track an object star
- The light wave-front is directed through large vacuum tubes
  - This data is then used to recreate the composite image of a star

Siderostat

Side view of siderostat



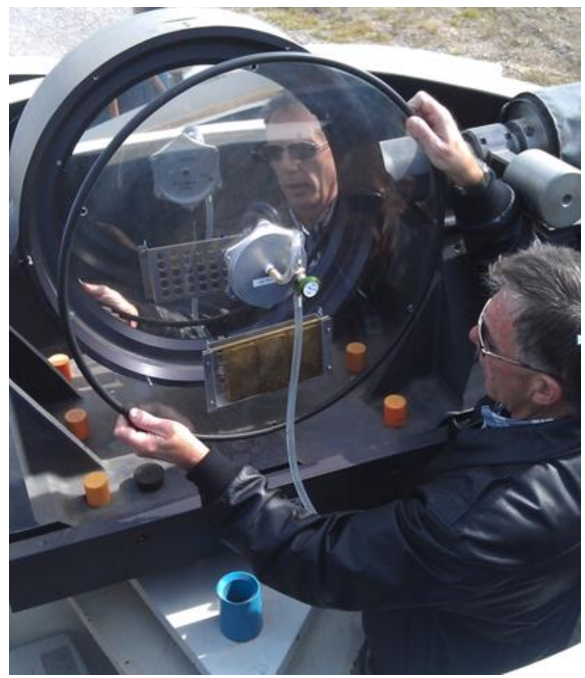
Front view of siderostat

The Mirrors

- Mirrors are approximately 22 inches in diameter
- The mirrors are made of glass coated with reflective aluminum

Current Mirror Cover

- When the mirrors are not in use they are protected by a Lexan cover with nitrogen purge



Siderostat with Current Cover being removed

Current System

Operational telescope and Siderostat

Telescope and Siderostat currently under construction

Problem Statement

- An automatic mirror cover is needed at NPOI and must operate without interfering with current equipment while maintaining a nitrogen purge.

Constraints

- The cover must not block any light from the mirror surface
- The cover must be able to open and close manually
- The siderostats are outside so the cover must be able to operate in the temperature range of -40°C to 40°C

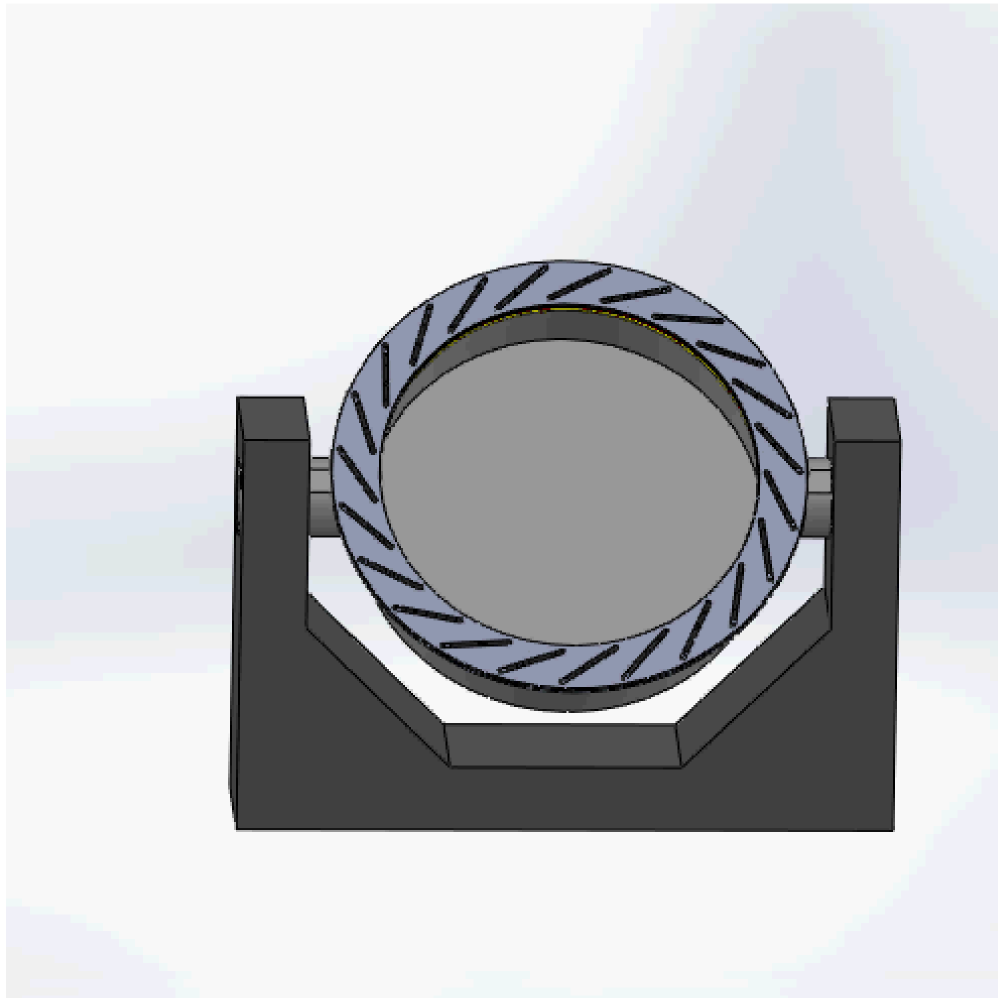
Constraints

- The full range of motion of the siderostat must be maintained
  - vertical tilt from -10° to 60°
  - horizontal pan of -60° to 60°
  - Top clearance of 10 inches
  - Bottom clearance of 4 inches

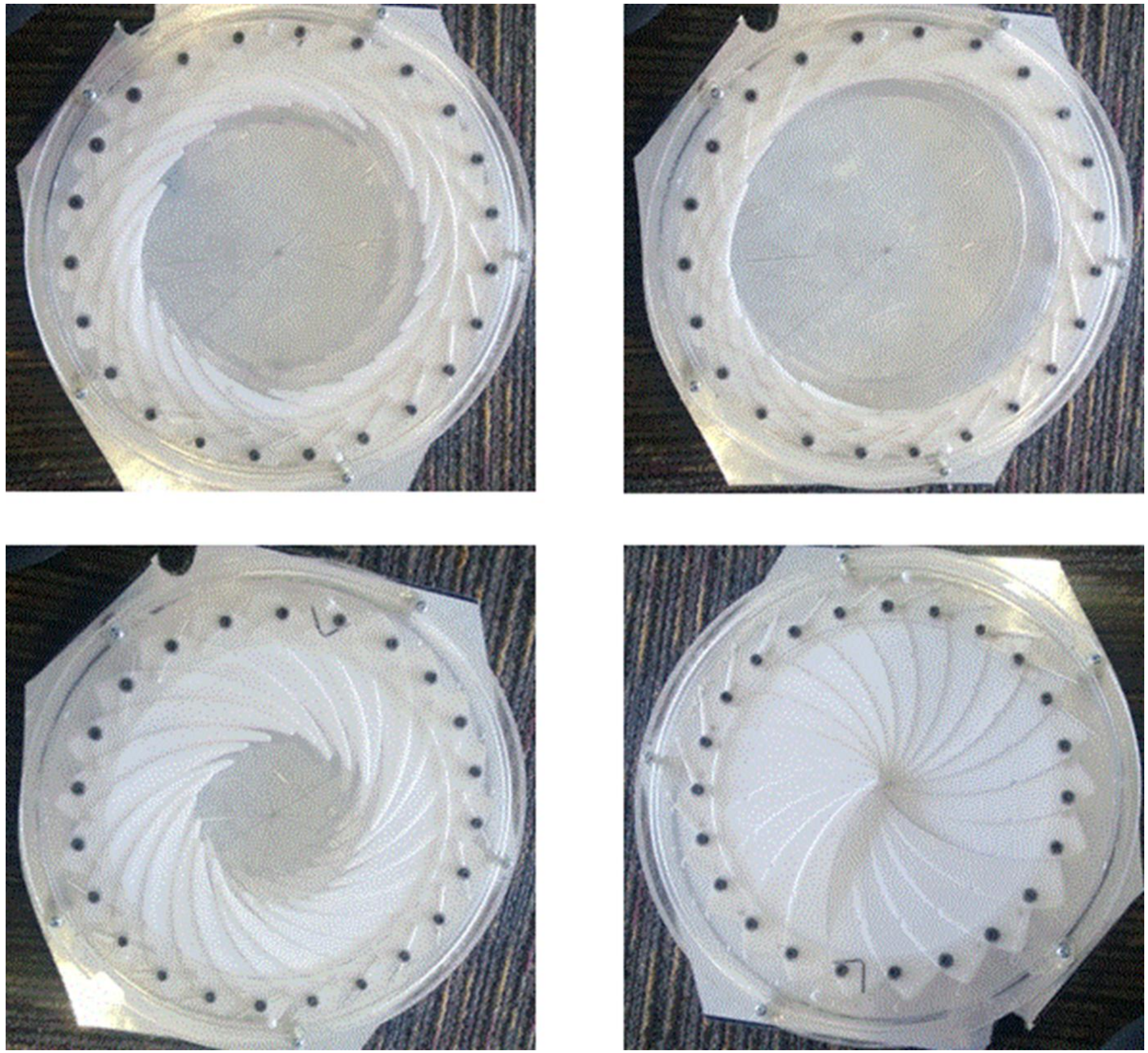
Constraints

- Any cover cannot use grease or lubricants
- If a polymer is used, it must be UV stabilized and it must be hydrophobic
- The prototype cannot cost more than $500

Iris Diaphragm



Initial Iris Mechanism



Iterative Design Process

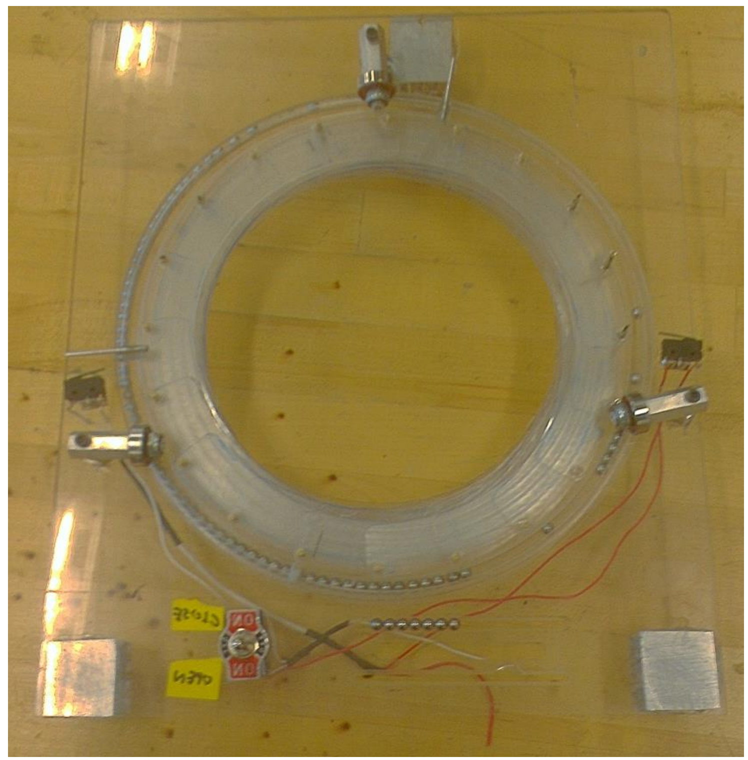
- Our first prototype highlighted problem areas:
  - Friction between rotating rings
  - Friction/binding of connecting pins
  - Critical tolerances hard to control
  - Unacceptable gaps
- Constraints were not met because lubrication was necessary for this prototype

Improved Prototype

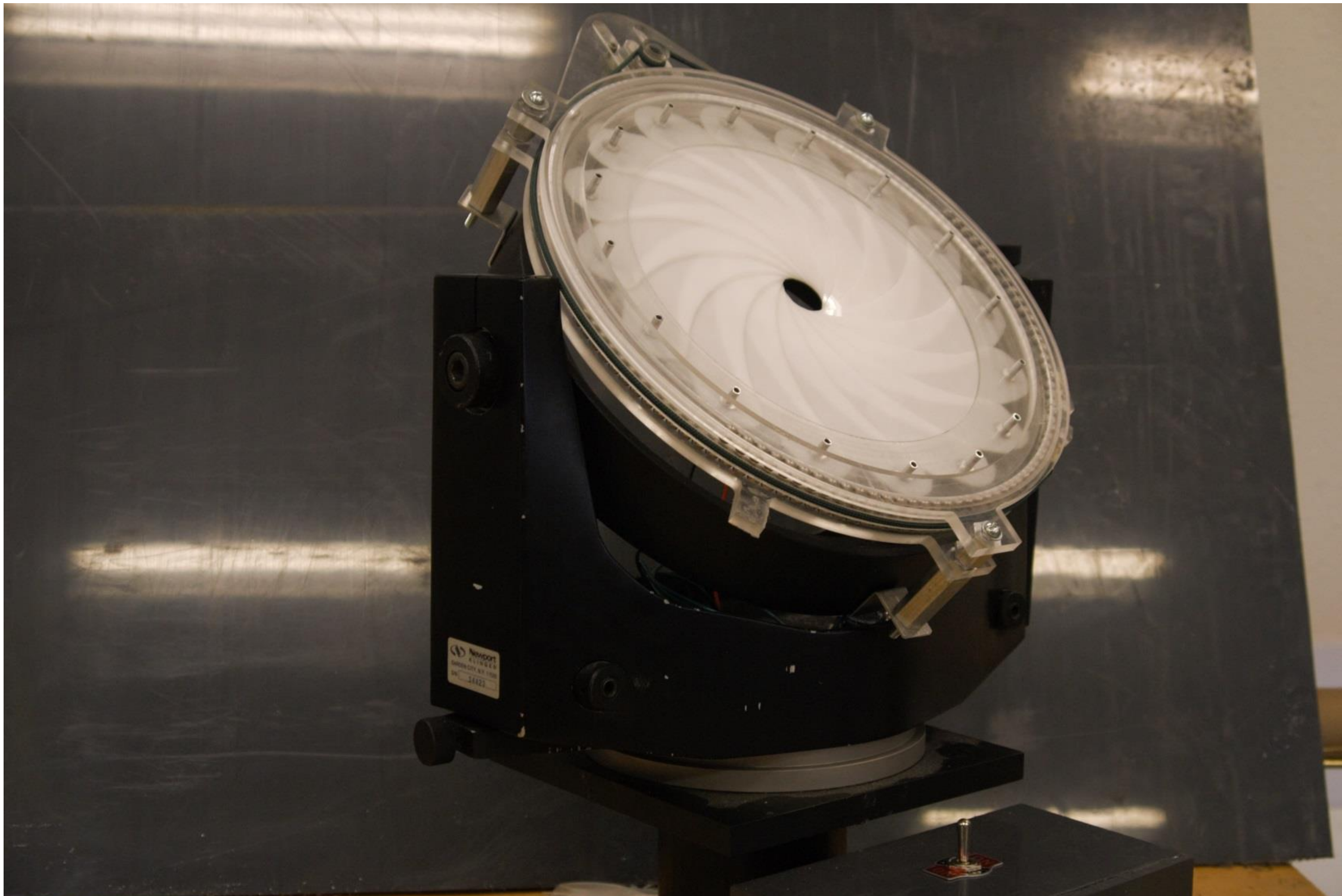
- The second design utilizes a long curved blade design that greatly reduced the friction between the blades and the rings.

Improved Prototype

- Used ball bearings to reduce friction between the rings.



Final Prototype

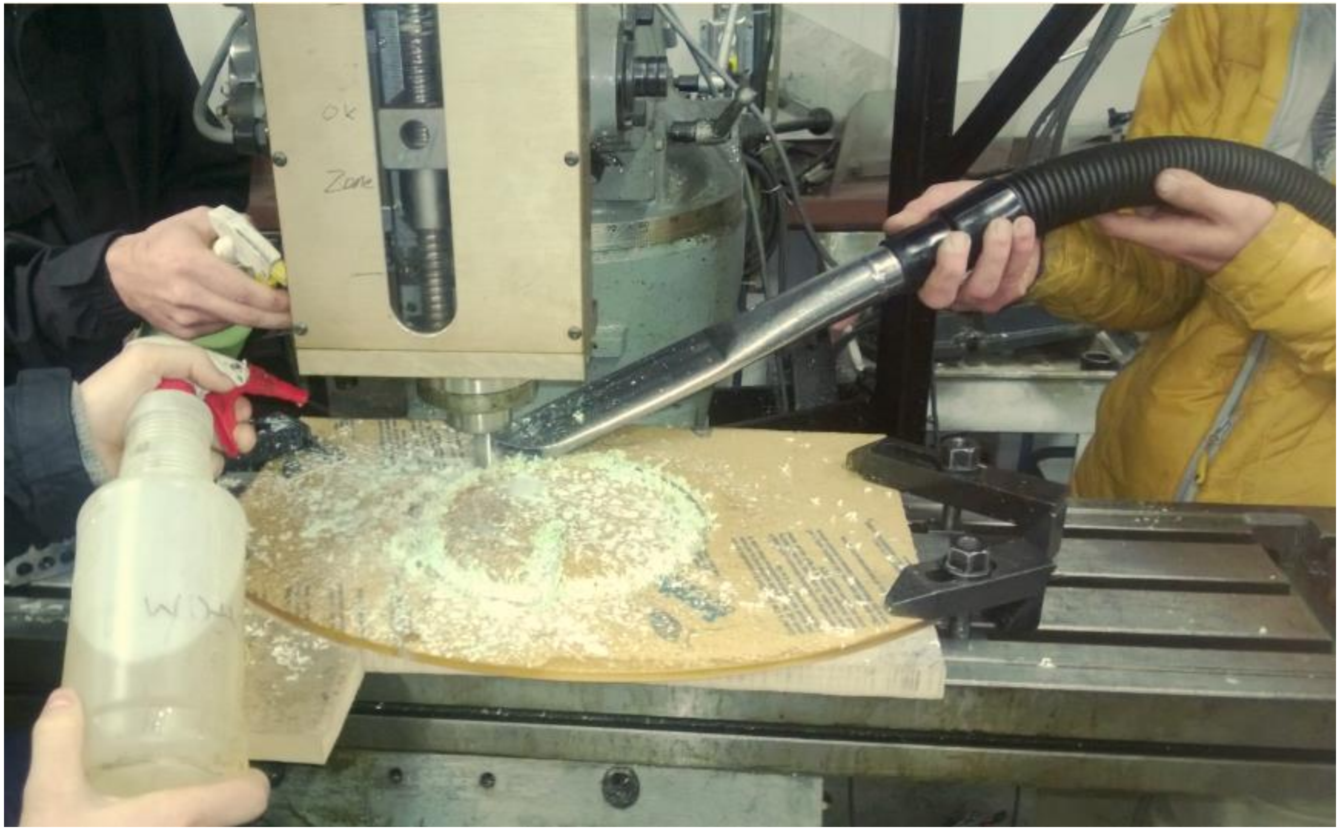


Final Prototype

- Features
  - Constrained actuation ring
  - Mounting tab
  - Improved drive mechanism
  - Constructed as a preassembled unit for ease of installation

The Final Prototype

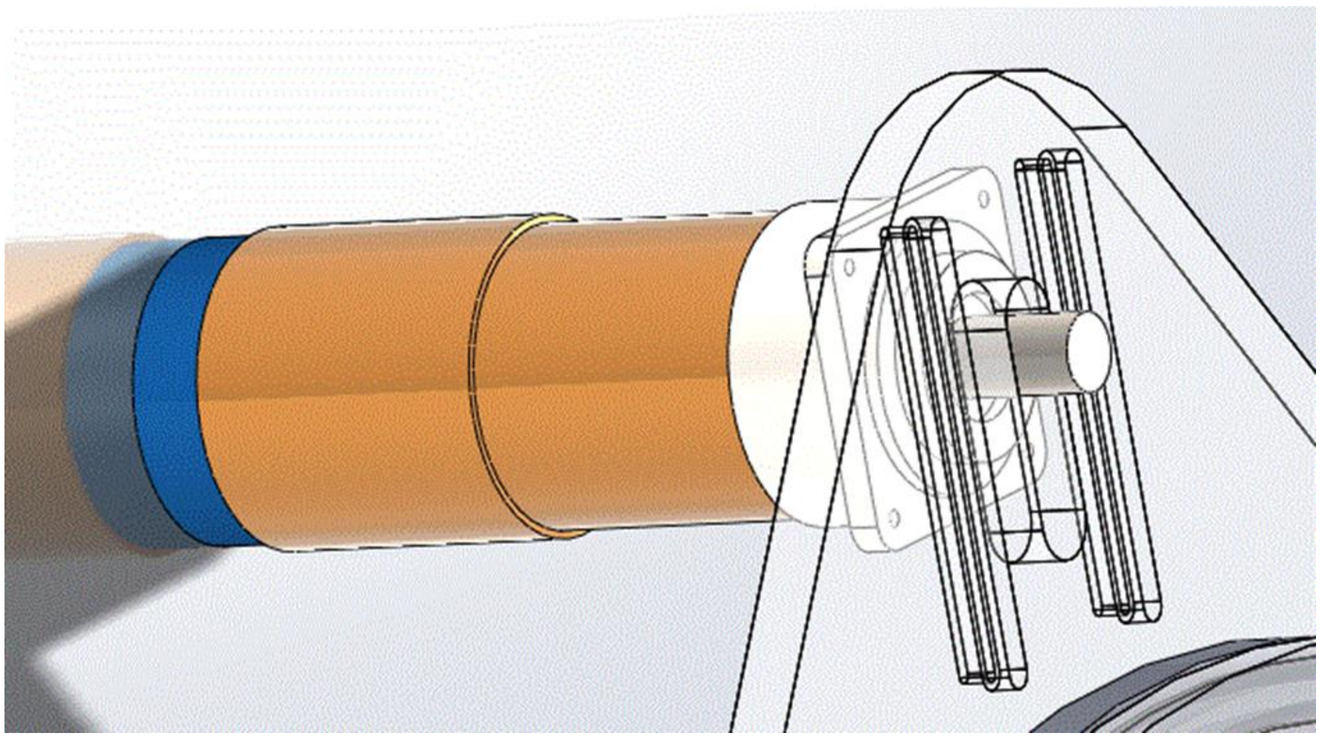
- CNC Fabrication



Budget			
Development			
Small Parts		$ 40.00	
Shop Hours	$40*10hours	$ 400.00	(pro-bono)
Materials		$ 27.64	
Final Prototype			
Small Parts		$ 100.00	
Shop Hours	$40*20hours	$ 800.00	(pro-bono)
Materials		$ 8.38	
		$27.64	
		$ 36.02	
Total		$ 1,439.68	
		$ 1,200.00	(pro-bono)
Cost		$ 239.68	
Under Budget		$ 260.32	

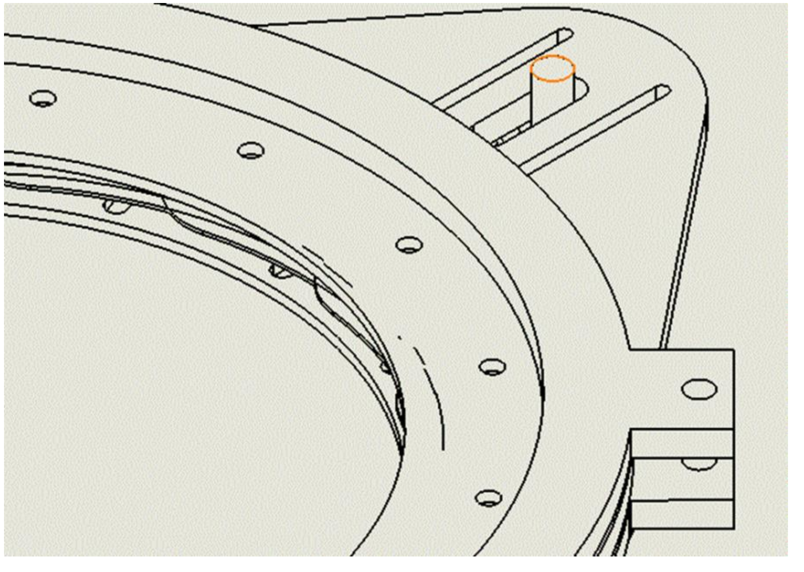
Deliverables

- Fully automated 8 inch diameter scale prototype



Deliverables

- To ensure the mirror covers are manufactured correctly all drawing submitted with the final report included appropriate tolerances and material certifications.



Conclusion

- The team was able to develop and fabricate a small scale prototype for NPOI
- It does not interfere with the current equipment and start light
- It took multiple iterations of the first design to meet all of our sponsors constraints

Questions?