Herbert Wertheim College of Engineering
UNIVERSITY of FLORIDA

# G.E.R.A.L.D.

*Grounded Electronic Reliable Autonomous Laser Deflector*

*Heliostat Design*


Group 243D – ***Traum***atized Kids

Cristian Hooker, Daniil Kardashov, Benjamin Lehmann, Brooke Ohlsson, Joshua Owens, Joseph Rios, Abraham Sheikh

# Meet the G.E.R.A.L.D. Team

Cristian Hooker

Daniil Kardashov

Benjamin Lehmann

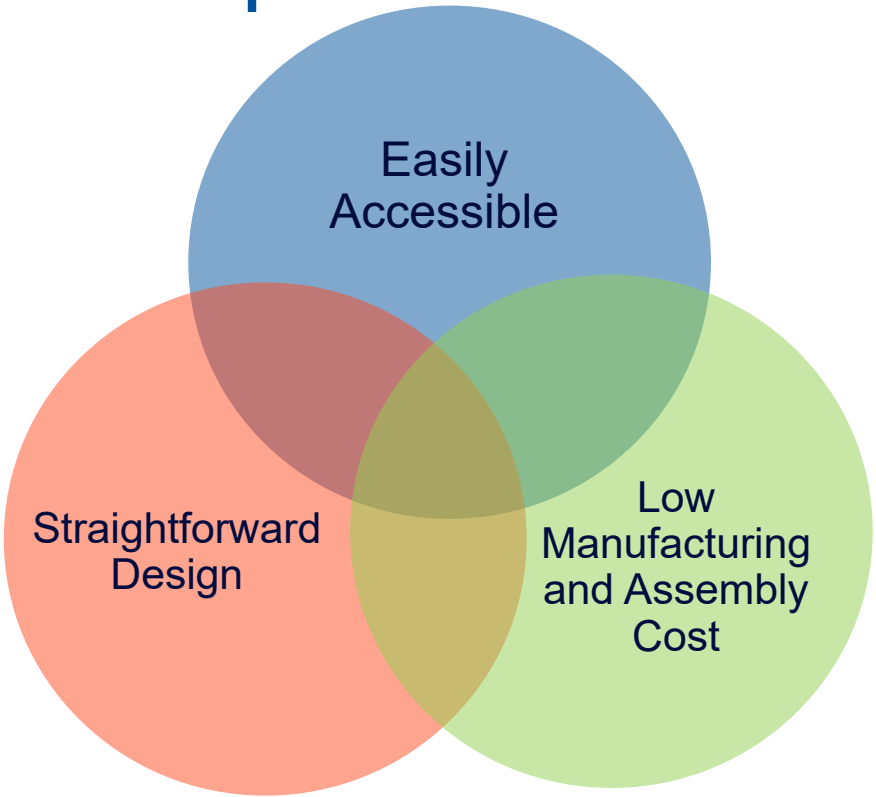
Brooke Ohlsson

Joshua Owens

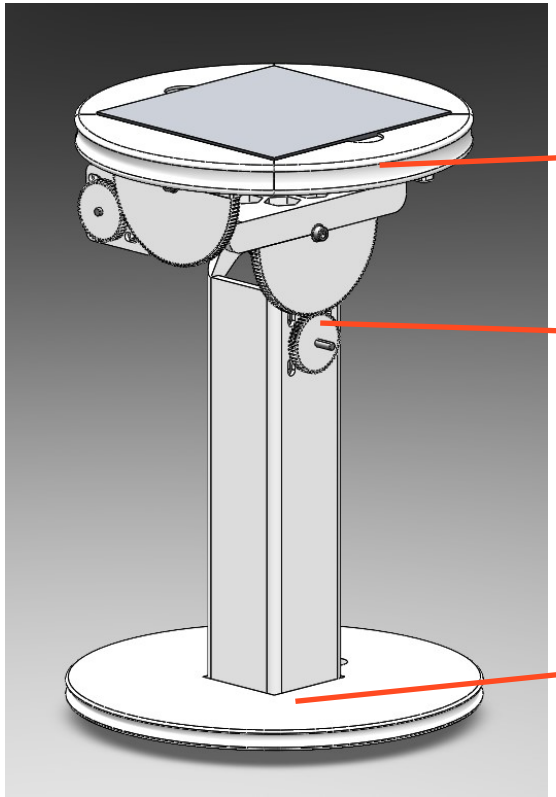
Joseph Rios

Abraham Sheikh

# Hedgehog Concept



# The Design

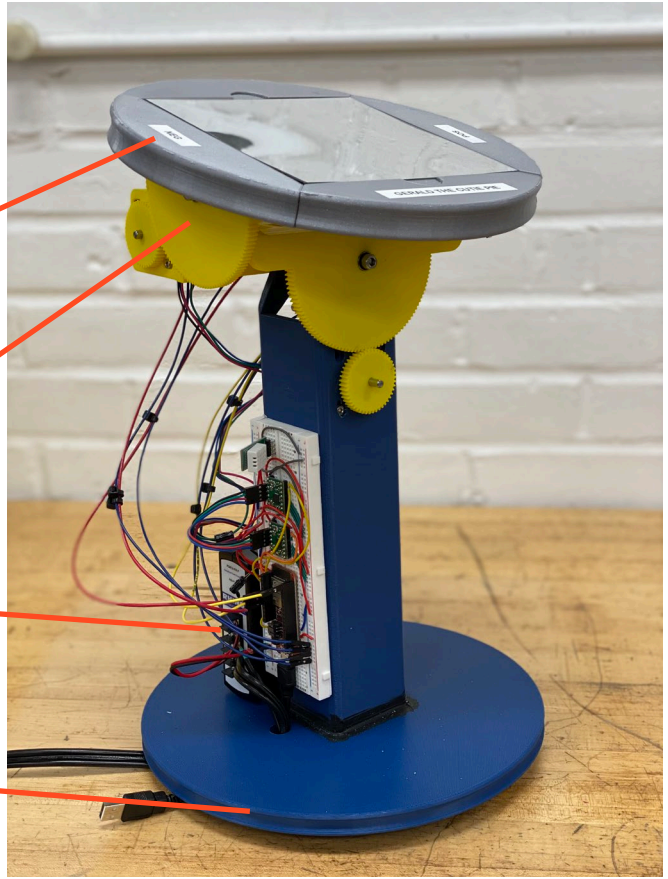


Mirror Subsystem

Actuation Subsystem

Electronics

Base Subsystem

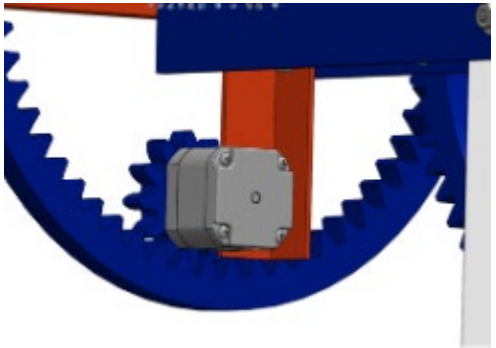


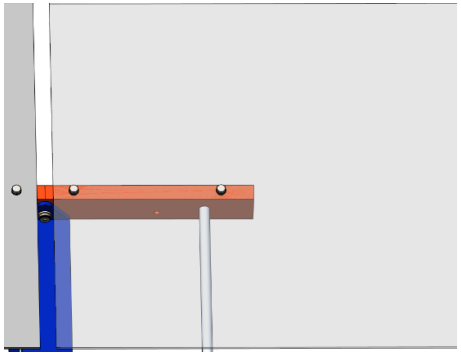
# Design Highlights & Key Features

- What makes us better than other designs
  - Compact design that integrates subsystems within each other
  - 3D Printed
  - Azimuth and elevation gears
  - Smaller motor
  - Protective Duct
  - Simple Design

# Initial Design Changes from Fall Group 3 Design

- Internal elevation gear replaced with an external gear.
- Mirror mounting method switched to adhesive.
- Heliostat enclosure changed to use a protective duct.

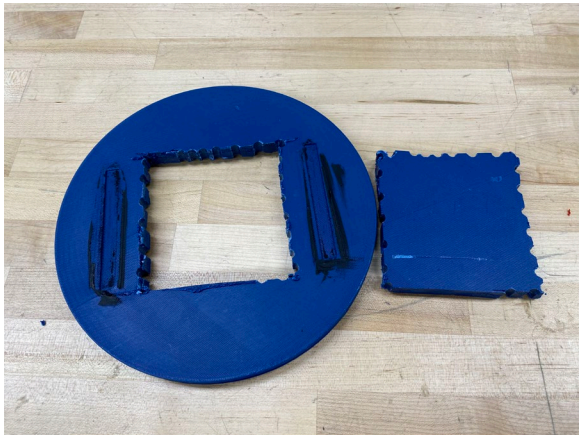




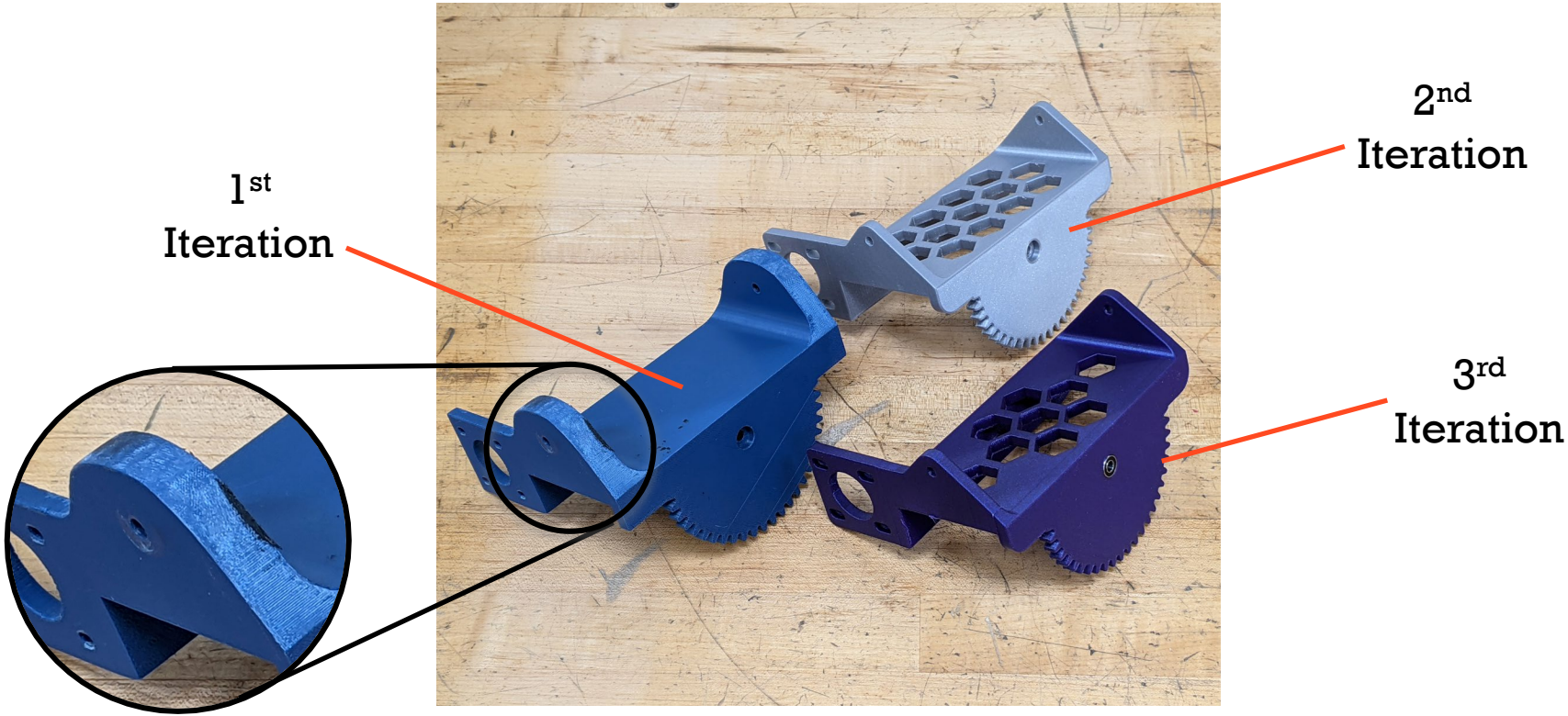
Fall 2021
Group 3

# Design Revisions

- **Elevation Motor –** size reduced due weight constraints
- **Counterweights –** required for proper rotation
- **H-bridge (4 redesigns)**
- **Labels** – overall organization
- **Electrical box** - eliminated due to bulkiness
- **Front Face** – redesigned for weight reduction



# H-Bridge Changes



# Final Iteration of H-Bridge

- **The initial design gear ratio, G:**

$$G = \frac{\text{Driven Gear Teeth}}{\text{Driver Gear Teeth}} = \frac{48}{12} = 4$$

- **Final design gear ratio:**

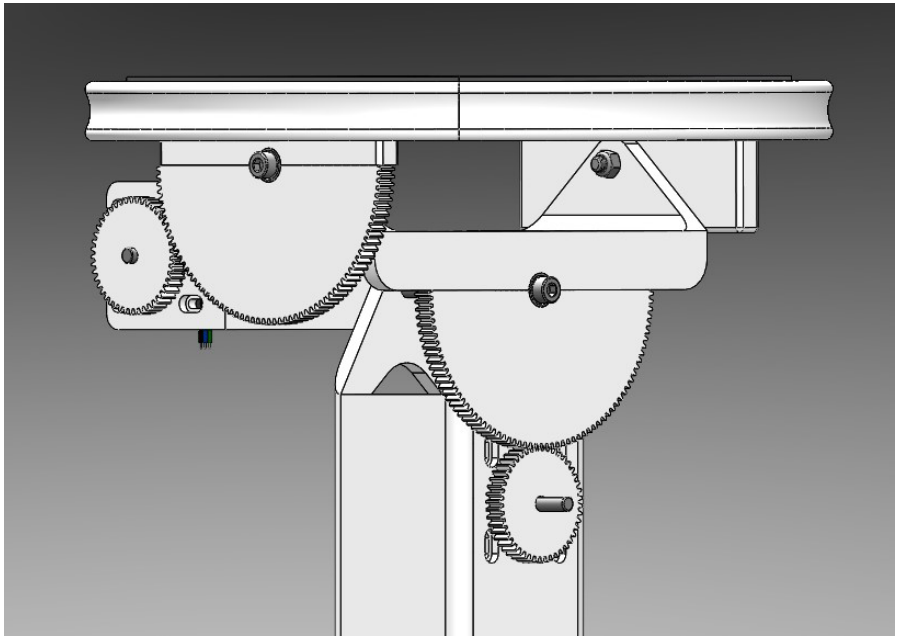
$$G = \frac{128}{44} = 2.9$$

- **Initial design:**

$$\text{accuracy} = \frac{1.8}{4} = 0.45°$$

- **Final design:**

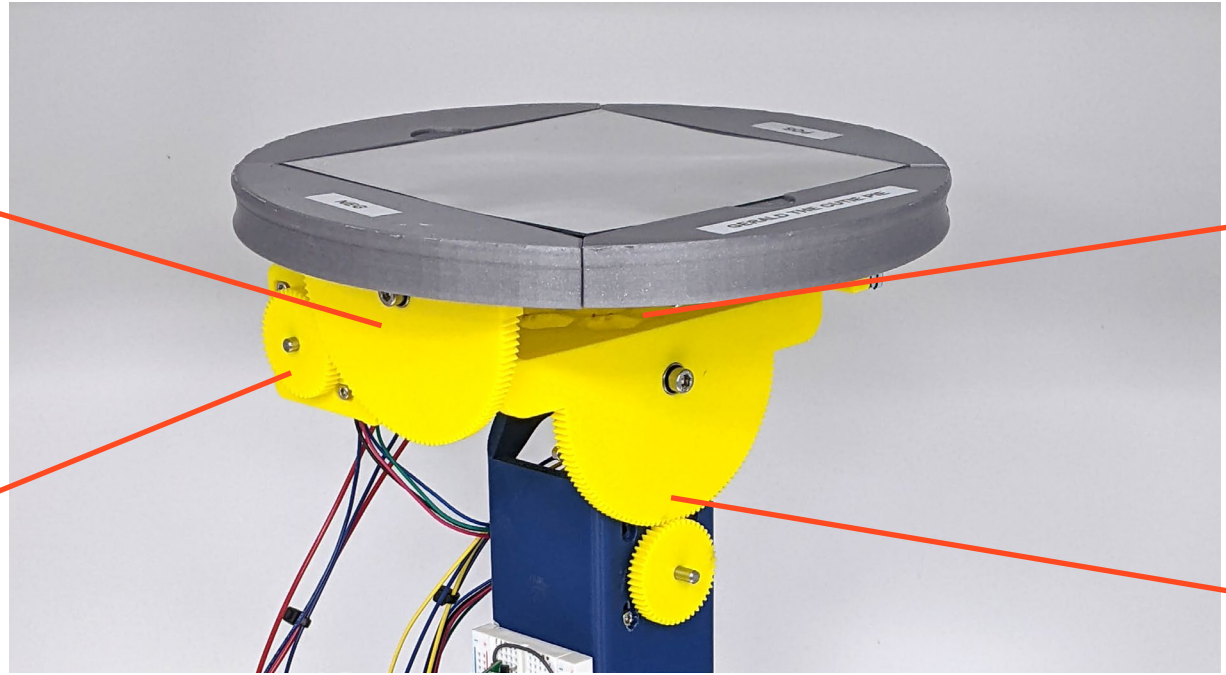
$$\text{accuracy} = \frac{1.8}{4 \text{ microsteps} \cdot 2.9} = 0.16°$$



# Final Iteration of H-Bridge

Improved Mirror Base Mounting

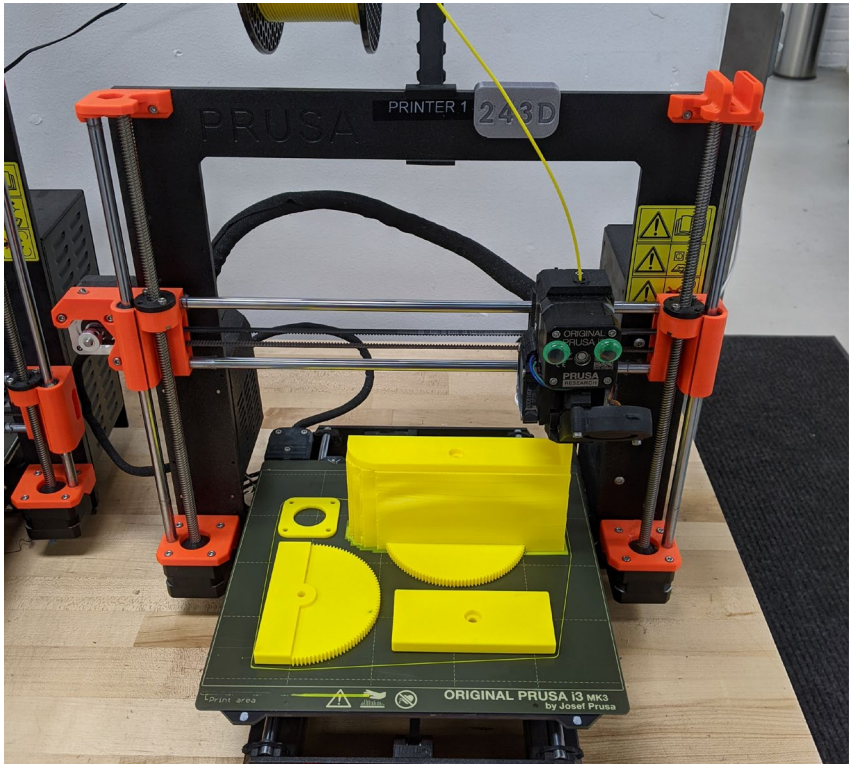
Improved Motor Mounting



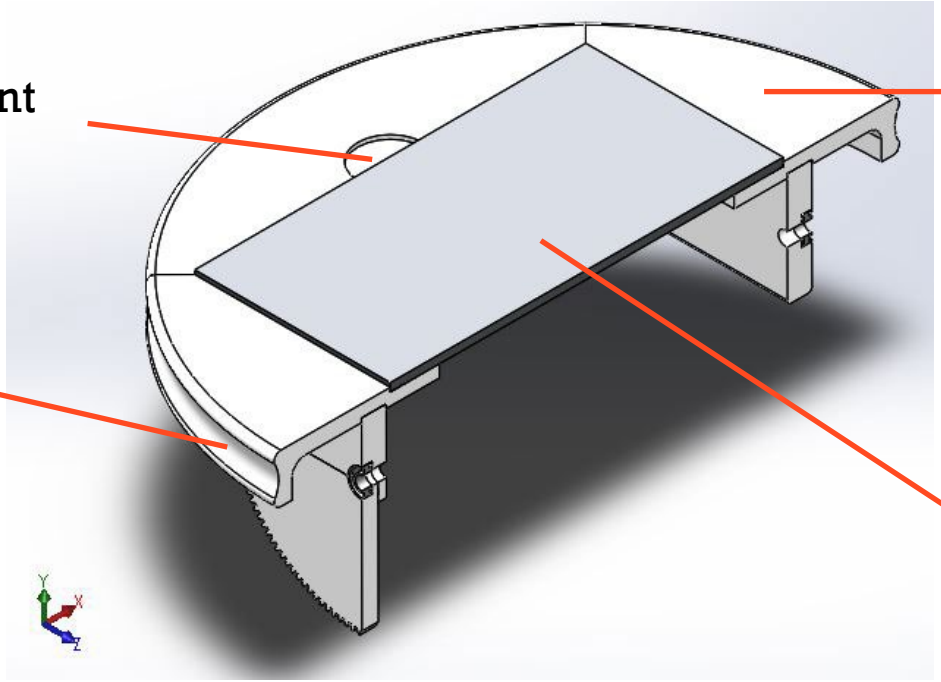
Lightened Center Structure

Refined Azimuth Control

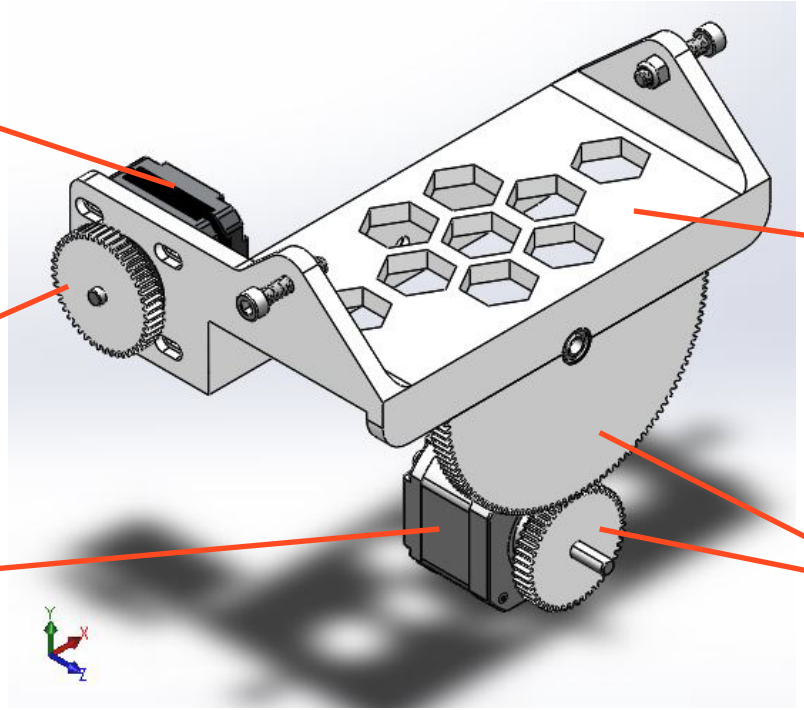
# Fabrication of Parts



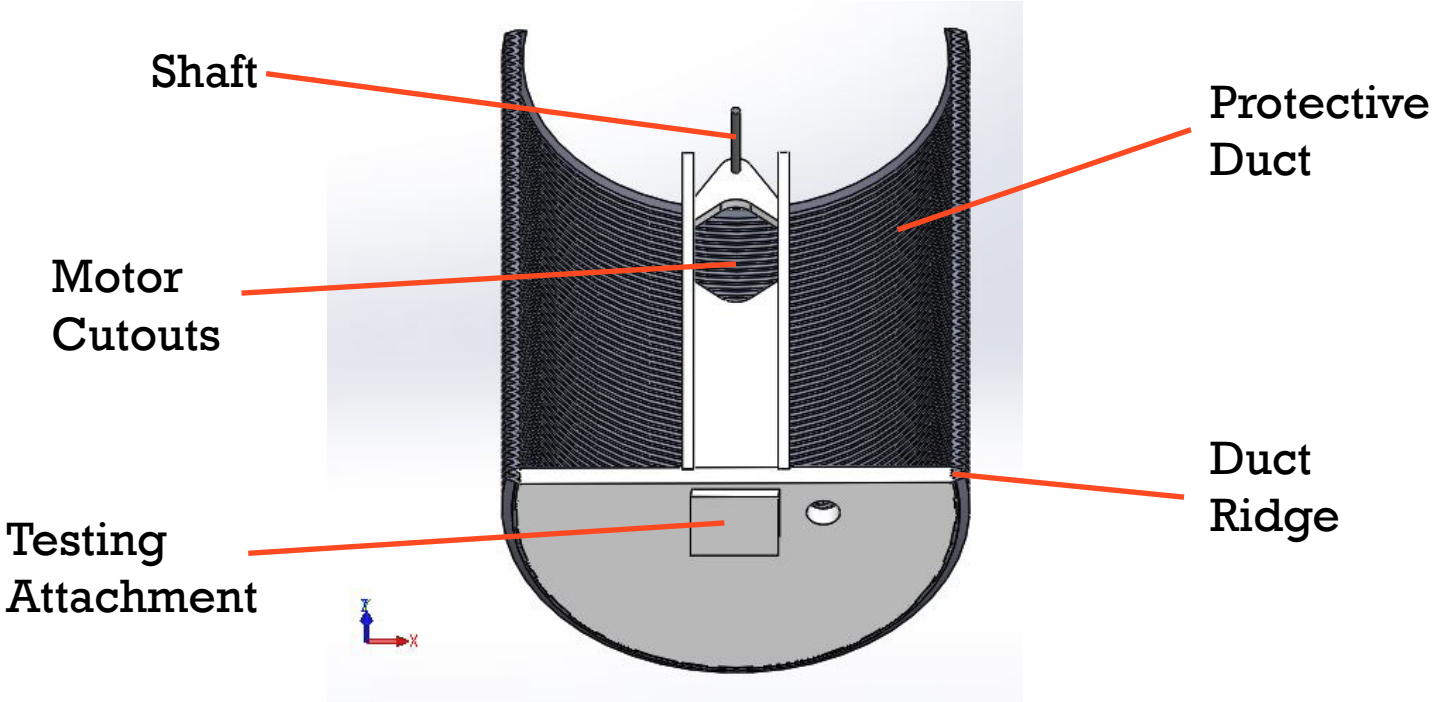
# Mirror Subsystem 3D CAD Model



# Actuation Subsystem 3D CAD Model

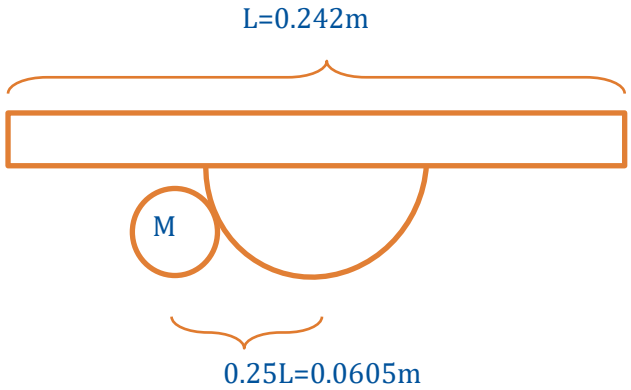


# Base Subsystem 3D CAD Model



# Elevation Motor Modifications

- **Elevation Motor-** made smaller because of weight and power was overkill




The previous motor is rated at 0.45N-m and has a mass of 0.28 kg

The new motor is rated at 0.16 N-m and has a mass of 0.041kg

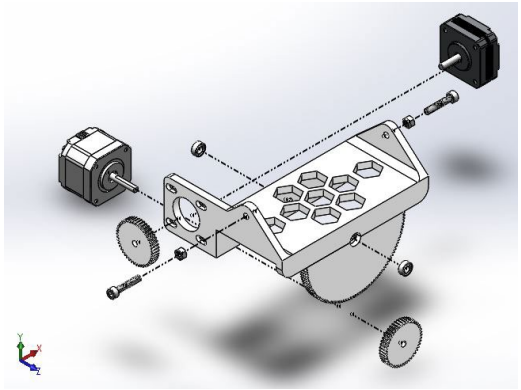
Assuming the weight acts at the center of mass:

m = 0.25kg, l=0.0605m, g=9.81m/$s^2$

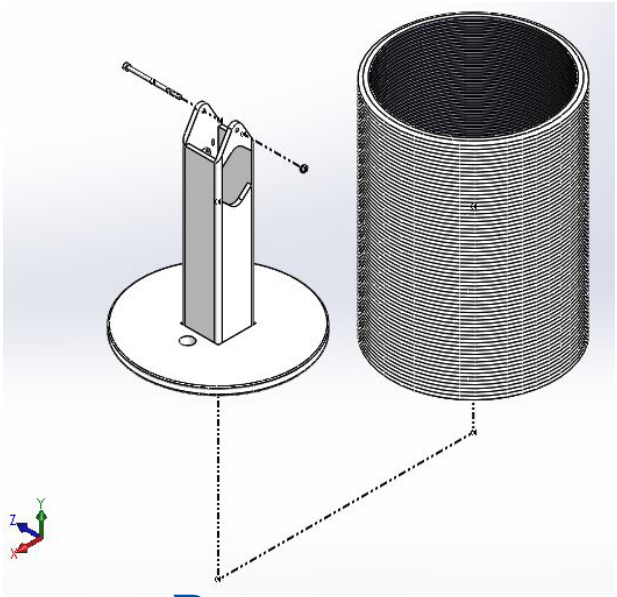
$T = Fl = mlg = (0.25)(0.0605)(9.81) = 0.1484N - m$

Almost a 1/10 reduction in weight for a ~1/3 reduction in torque

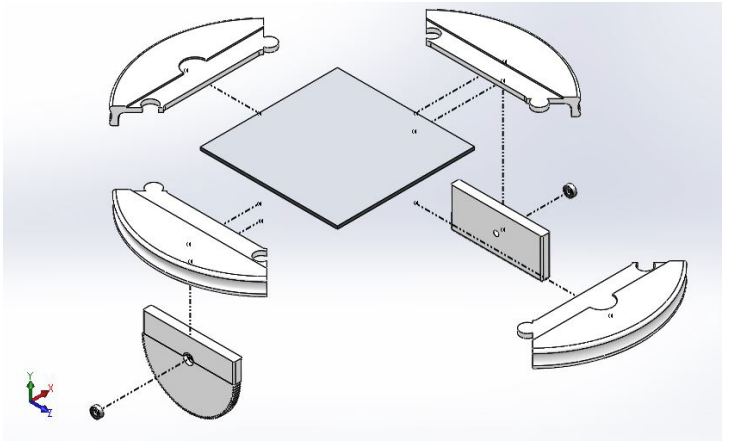
# Exploded CAD Views



**Actuation Subsystem**



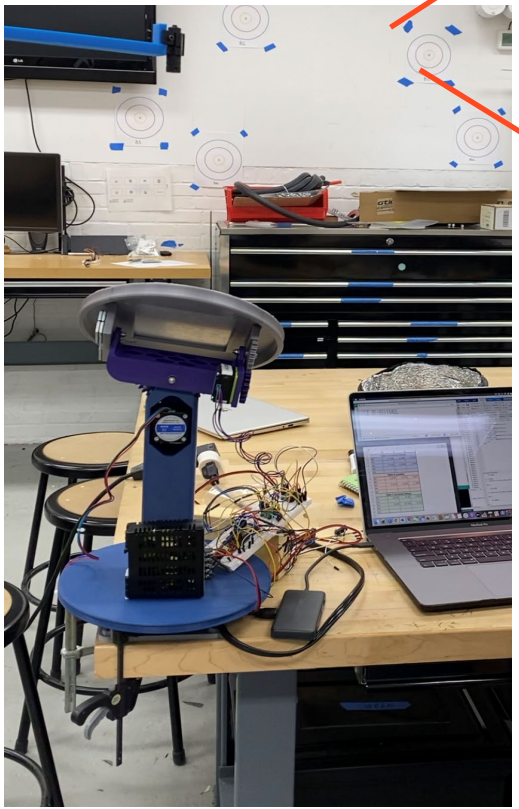
**Base Subsystem**



**Mirror Subsystem**

# Prototype Testing


Wind Test

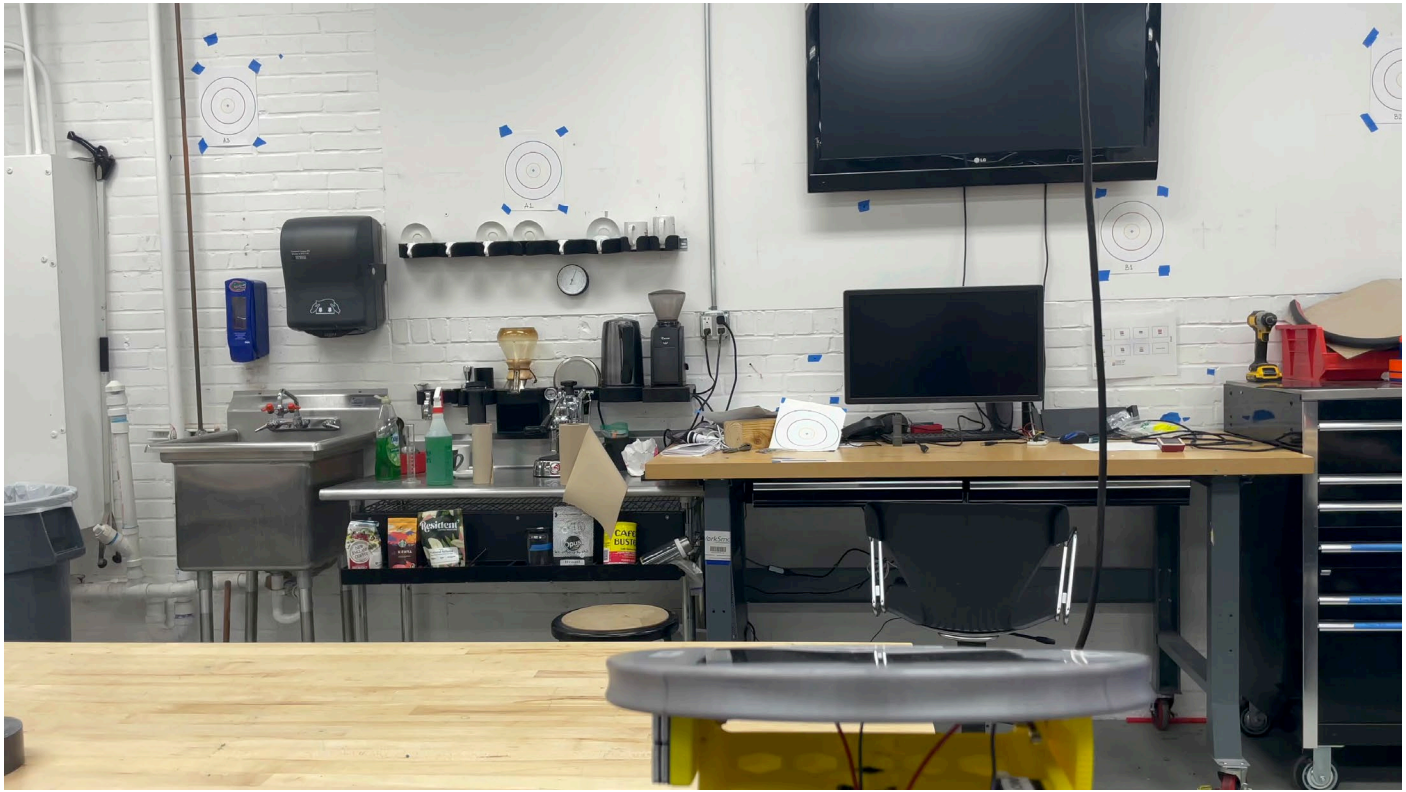



Tracking Test

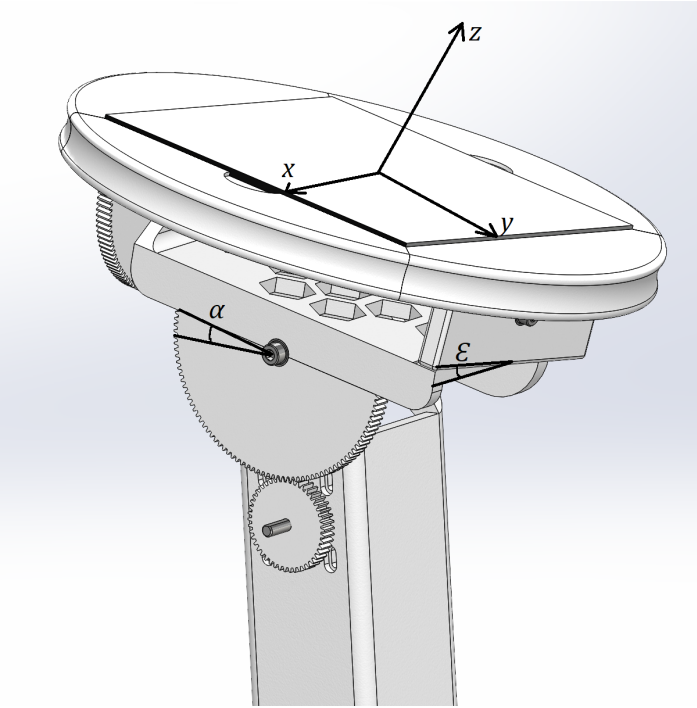
# Wind Testing

- 2 tests with the heliostat being subjected to the low and high settings of an industrial fan while in the least ”safe” position. (15 full base plate revolutions each)
- 2 tests with the low and high settings of the leaf blower while in the “safest” position. (15 full base plate revolutions each)

# Laser Targeting Test



# Kinematics




Target coordinates - P(a,b,c)

Heliostat height - h

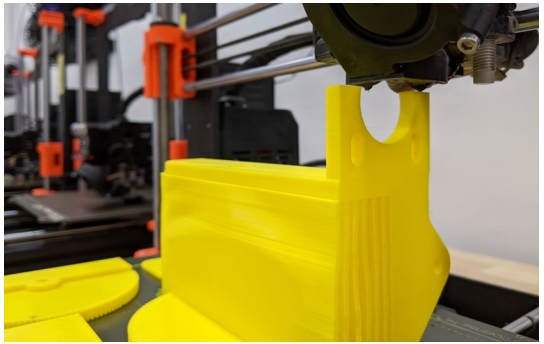
$$\alpha = arctan\left(\frac{b}{1+c-h}\right)$$

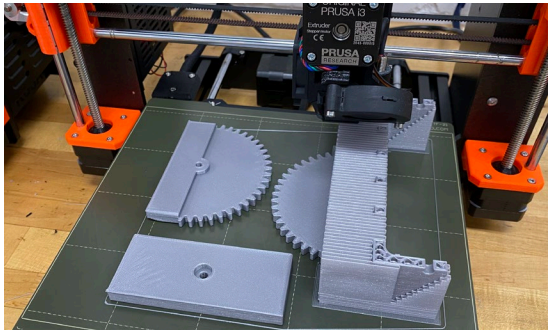
$$\varepsilon = \arctan\left(\frac{b^2+c^2+h^2-2ch-1}{a\sqrt{(1+c-h)^2+b^2}}\right)$$

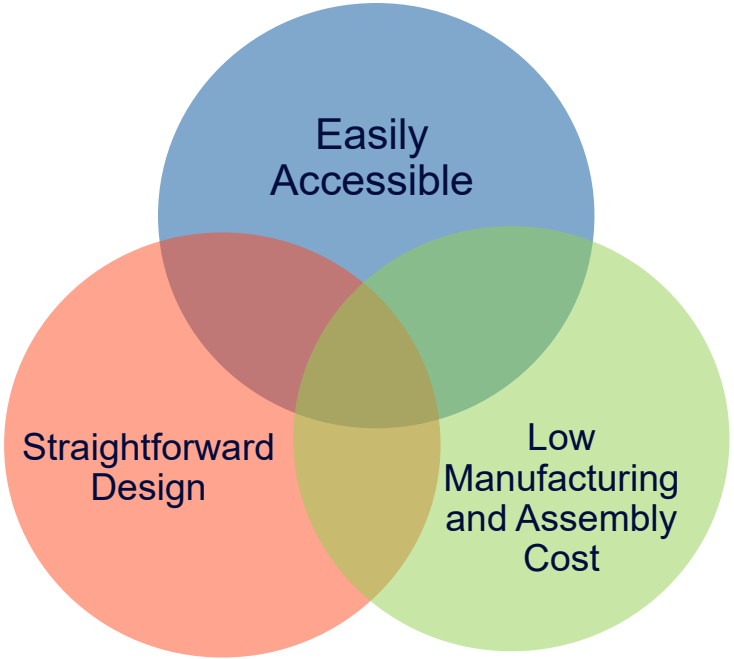
# Cost Summary

| Expense | Lab Cost | Prototype Cost | Bulk Cost |
|---|---|---|---|
| OTS Parts | $26.09 | $119.34 | $71.60 |
| Raw Materials | - | $16.78 | $44.15 |
| Manufacturing Labor | - | $6.44 | - |
| Assembly Labor | - | $22.86 | $11.43 |
| Energy Consumption | - | - | - |
| **Total** | **$26.09** | **$171.42** | **$127.18** |

# Why Manufacture G.E.R.A.L.D.?



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# THANK YOU

Questions?





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