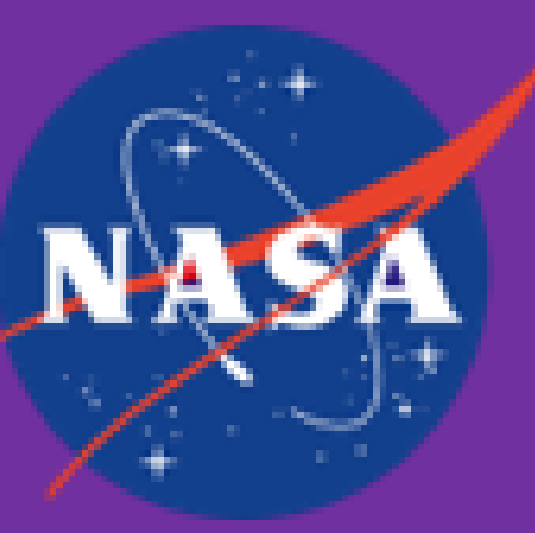




# Lunar Terrain Vehicle (LTV)



Tarleton State University | Mayfield College of Engineering | RELLIS Campus  
 Team Members: Nick Ekleberry, Behram Khan, Yashasvi Gullapally, Alyssa Castro, Irving Wistam, Syeda Roushan  
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## Background

Our Project is about the challenging mission to revolutionize the way we transport astronauts and supplies on the lunar surface, which will be achieved by the introduction of the Lunar Terrain Vehicle (LTV). The lunar terrain is famous for its extreme changes in elevation, and the changes in temperature, low gravity and the regolith that has very abrasive properties.

## Objective

The main objective for the Lunar Terrain Vehicle (LTV) project is to research, design, and develop a lightweight, cost effective, and durable transportation system for traversing the lunar terrain. The end product is expected to be a vehicle that can withstand the lunar terrain for an extended period of time and do so reliably, and while under the constraints of cost, weight, and power.

This semester's objective is to finalize the wheel design and add a suspension to the LTV, specifically taking the feedback from last semester and refining the wheels. The goal is to optimize the wheels to achieve the optimal traction, and stability. With these aspects being perfected, it will lay a foundation for further development of the LTV as a whole. The ultimate goal of our project is to deliver a complete prototype ready for the lunar terrain.

## Conclusion

The design for the wheels of the LTV are tailored for the rugged lunar environment providing durability, stability and traction. Using a SMA (Shape Memory Alloy) material like NiTiNol that has self-healing and super elastic properties, provides the wheels with lightweight, long-lasting material, while our different tread designs maximize traction and prevent slippage on the regolith. By undergoing extensive testing under lunar simulated conditions, we can refine aspects of our designs and allow the LTV wheel to become the best choice for the future of lunar travel.

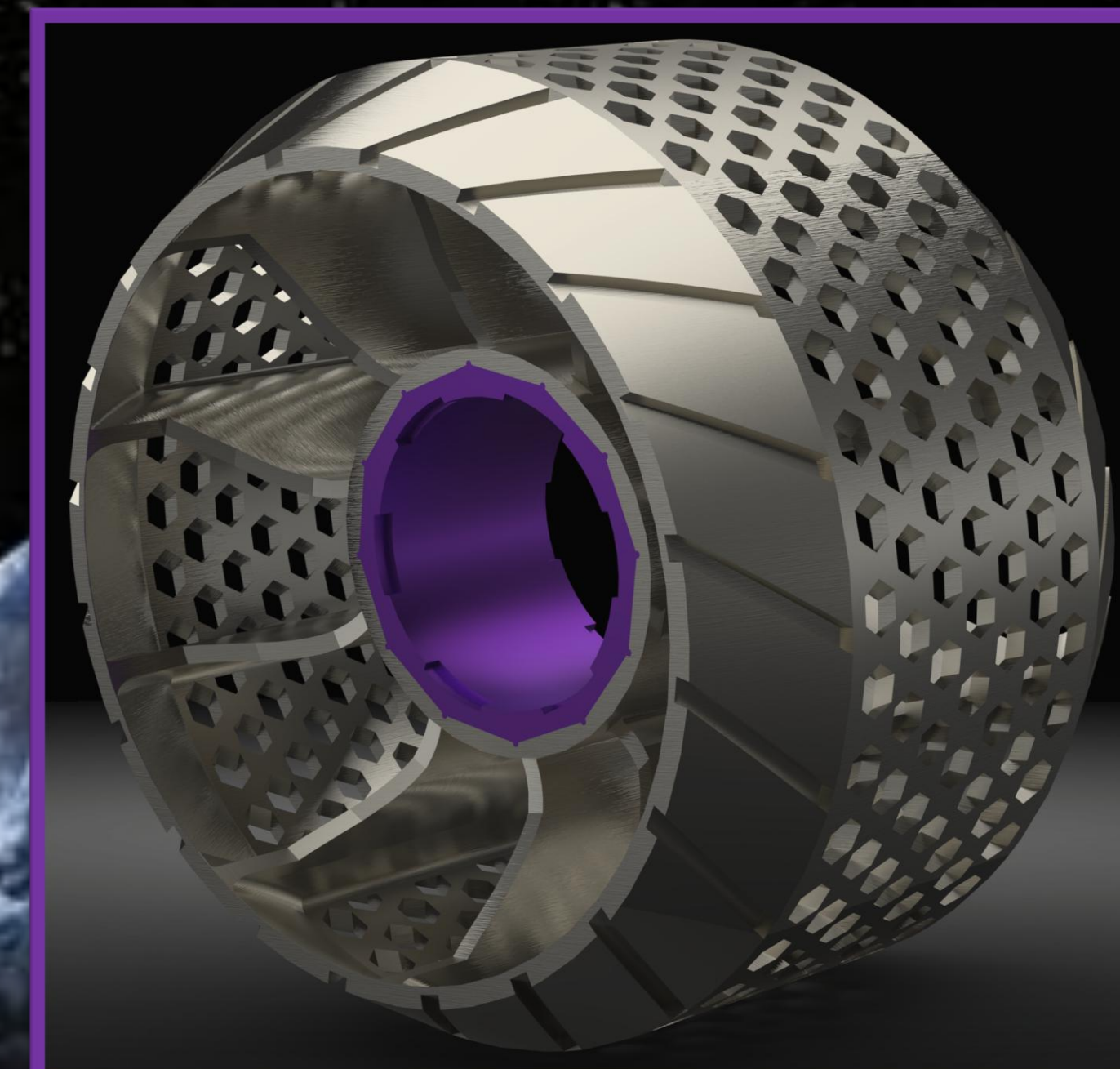
### Future Considerations (Implemented):

- Implement the deformable property to our wheel designs ✓
- Refine how our wheels attach to the motors ✓
- Testing and development of hyper deformable wheel with newly acquired materials ✓
- Have new dynamic FEA simulations of our updated wheel designs ✓

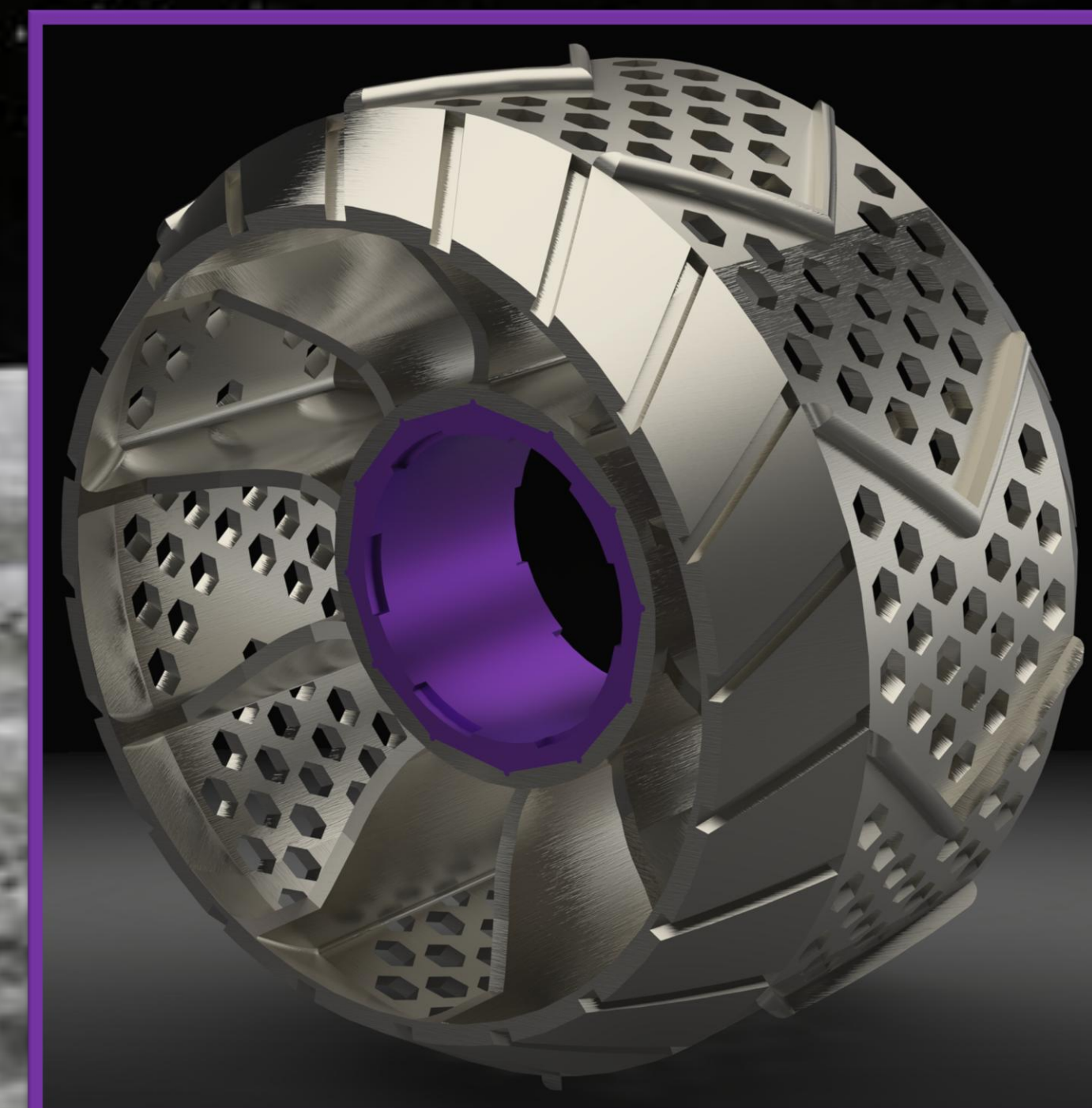
## Wheel Designs



Slant



Hex (No Ridge)



Hex (Ridge)



Arrow

## Test Data

### Average Force Test Data (N):

Slant: 18.084  
 Hex (no ridge): 18.860  
 Hex (ridge): 22.460  
 Arrow: 22.020

### Average Sinkage Test Data (cm):

Slant: 3.38  
 Hex (no ridge): 3.42  
 Hex (ridge): 4.54  
 Arrow: 4.76

### Average Power Test Data (W):

Slant: 25.61  
 Hex (no ridge): 24.79  
 Hex (ridge): 27.62  
 Arrow: 27.38

### Average Slope Time Test Data (s):

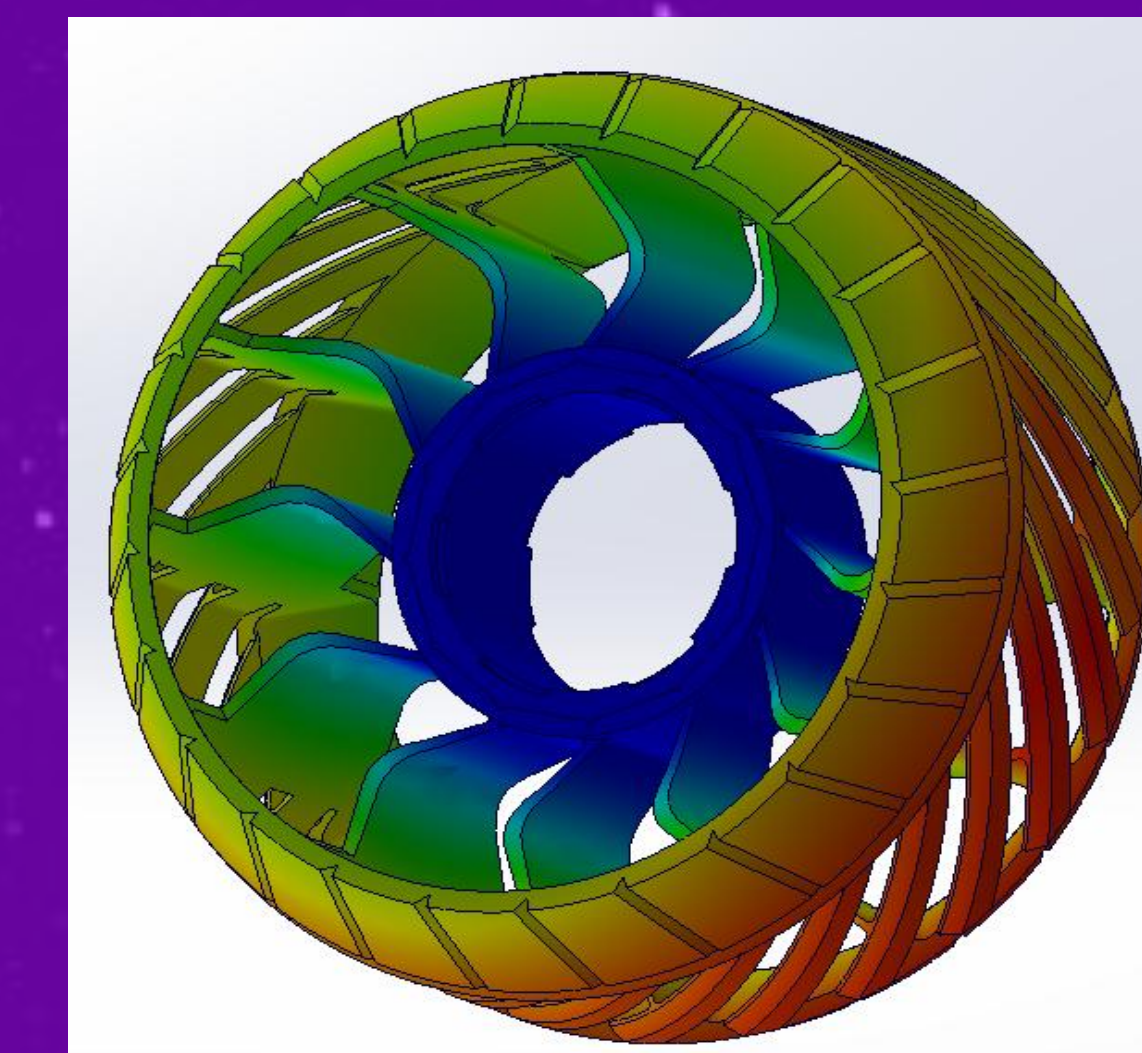
Slant: 5.20  
 Hex (no ridge): 4.85  
 Hex (ridge): 3.39  
 Arrow: 3.26

Decision Matrix (Higher is Better)

Wheels	Force Sinkage Ratio	Slope Time Test	Energy	FEA	Total
Slant	1.154	2.000	1.078	3.913	8.145
Hex (no ridge)	1.192	1.608	1.114	5.003	8.918
Hex (ridge)	1.069	2.300	1.000	11.072	15.442
Arrow	1.000	2.392	1.009	5.305	9.706

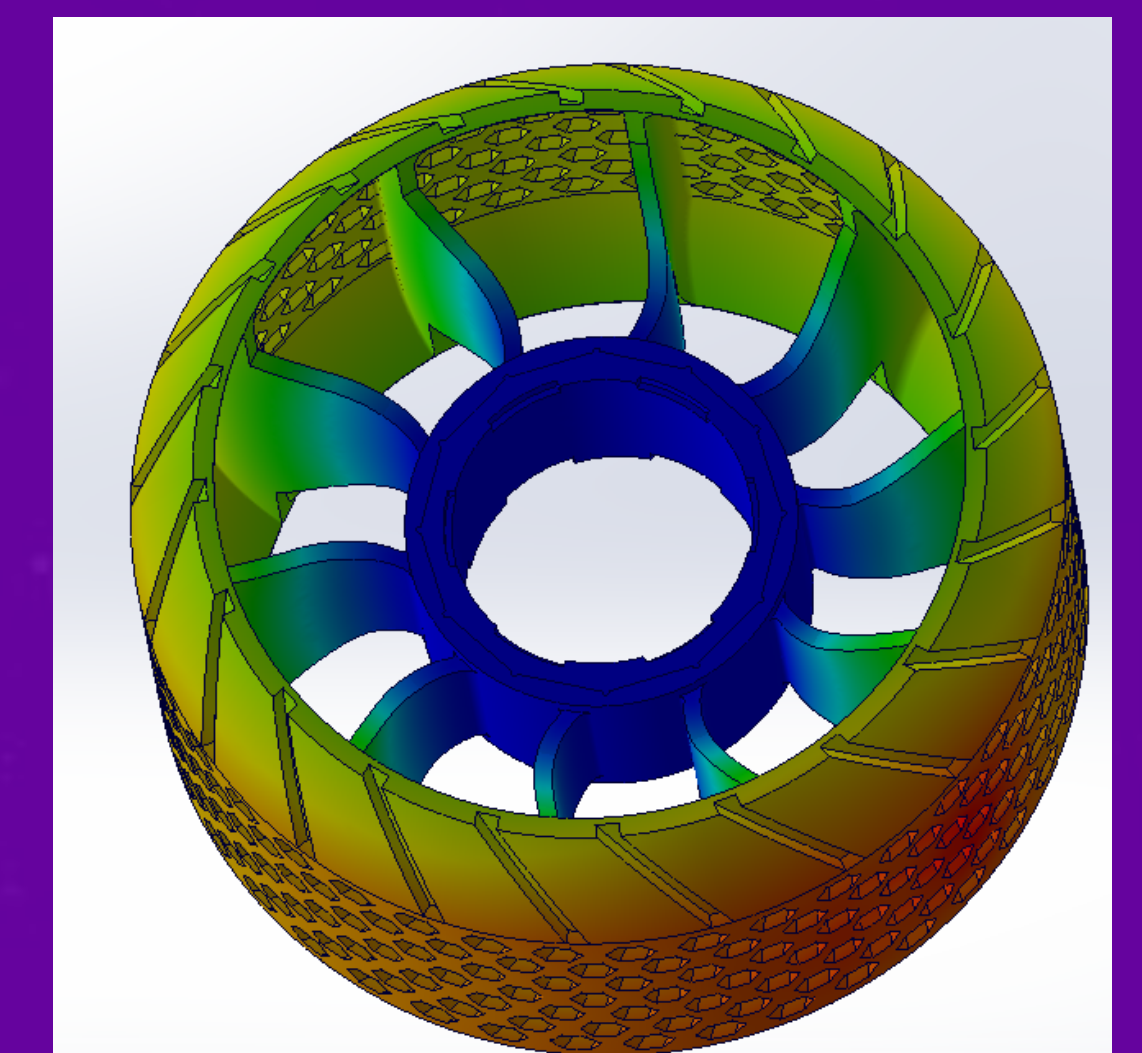
## FEA (Finite Element Analysis)

Normal Force on All Wheels: (1145.5N), Friction Force on All Wheels: (686.7N)  
 (Resulted Displacement Shown for All Wheels)



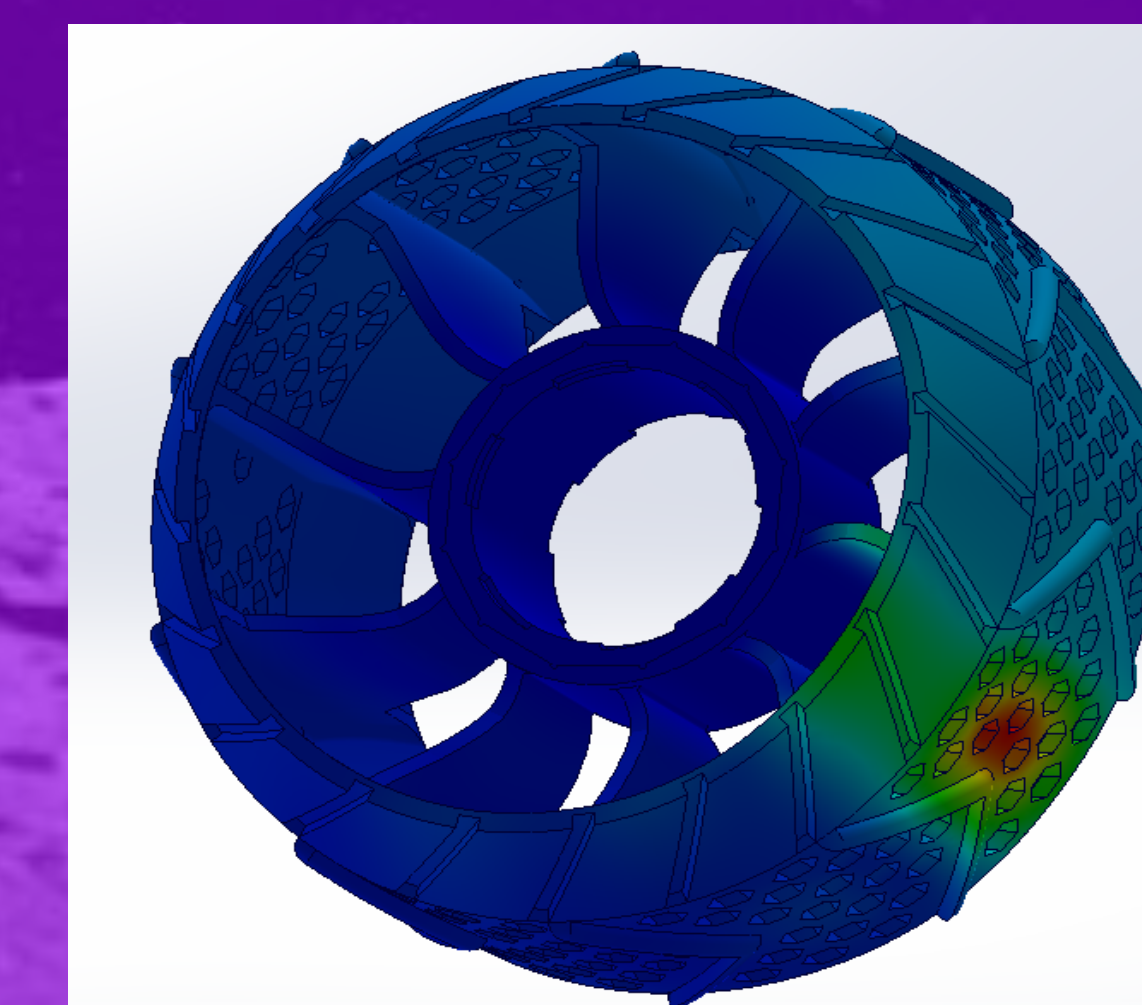
Slant

-Maximum Displacement- 3.544 mm  
 -Maximum Stress-  $3.154 \times 10^7 \text{ N/m}^2$   
 -Maximum Strain-  $6.1778 \times 10^{-3}$



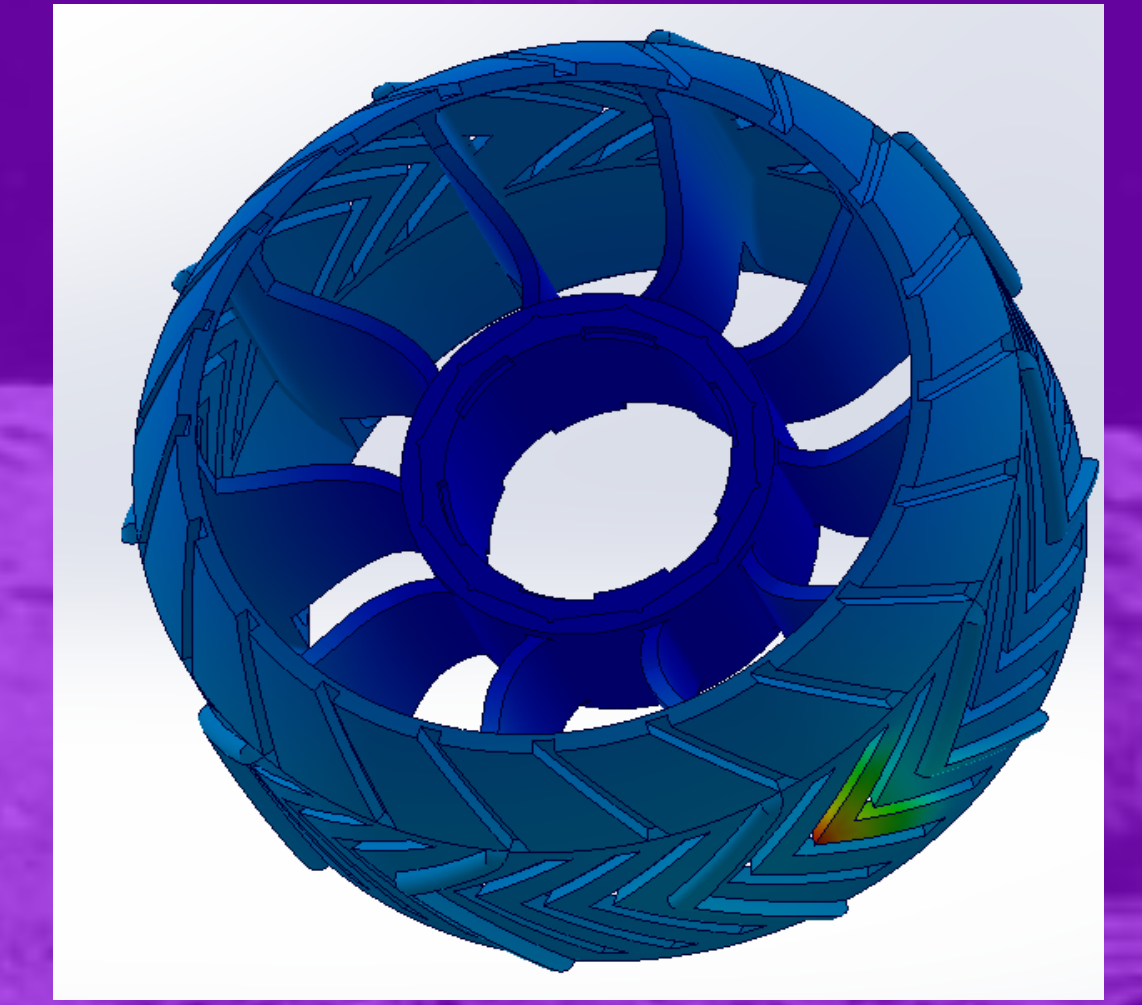
Hex (No Ridge)

-Maximum displacement- 6.781 mm  
 -Maximum Stress-  $1.476 \times 10^7 \text{ N/m}^2$   
 -Maximum Strain-  $3.31 \times 10^{-3}$



Hex (Ridge)

-Maximum Displacement- 2.385mm  
 -Maximum Stress-  $8.076 \times 10^6 \text{ N/m}^2$   
 -Maximum Strain-  $1.429 \times 10^{-3}$



Arrow

-Maximum Displacement- 2.784mm  
 -Maximum Stress-  $2.171 \times 10^7 \text{ N/m}^2$   
 -Maximum Strain-  $4.361 \times 10^{-3}$



### Thermal FEA

From -250°C to 127 °C  
 -Maximum Displacement- 6.610 mm  
 -Maximum Stress-  $7.278 \times 10^8 \text{ N/m}^2$   
 -Maximum Strain-  $5.581 \times 10^{-2}$   
 From 23.5°C to 127 °C  
 -Maximum Displacement- 4.289mm  
 -Maximum Stress-  $4.728 \times 10^7 \text{ N/m}^2$   
 -Maximum Strain-  $3.631 \times 10^{-3}$

## Acknowledgements

- We thank our NASA mentor, Chatwin Lansdowne for much needed guidance and feedback. We Thank our Capstone Professor, Dr. Nourouddin Sharifi, for aiding in testing and development of ideas.
- We are grateful to TSGC for sponsoring our project and we appreciate NASA for administering this design challenge.
- We also thank Dean Dr.Landaeta and Associate Dean Dr. Xu for the constant support from Mayfield College of Engineering.



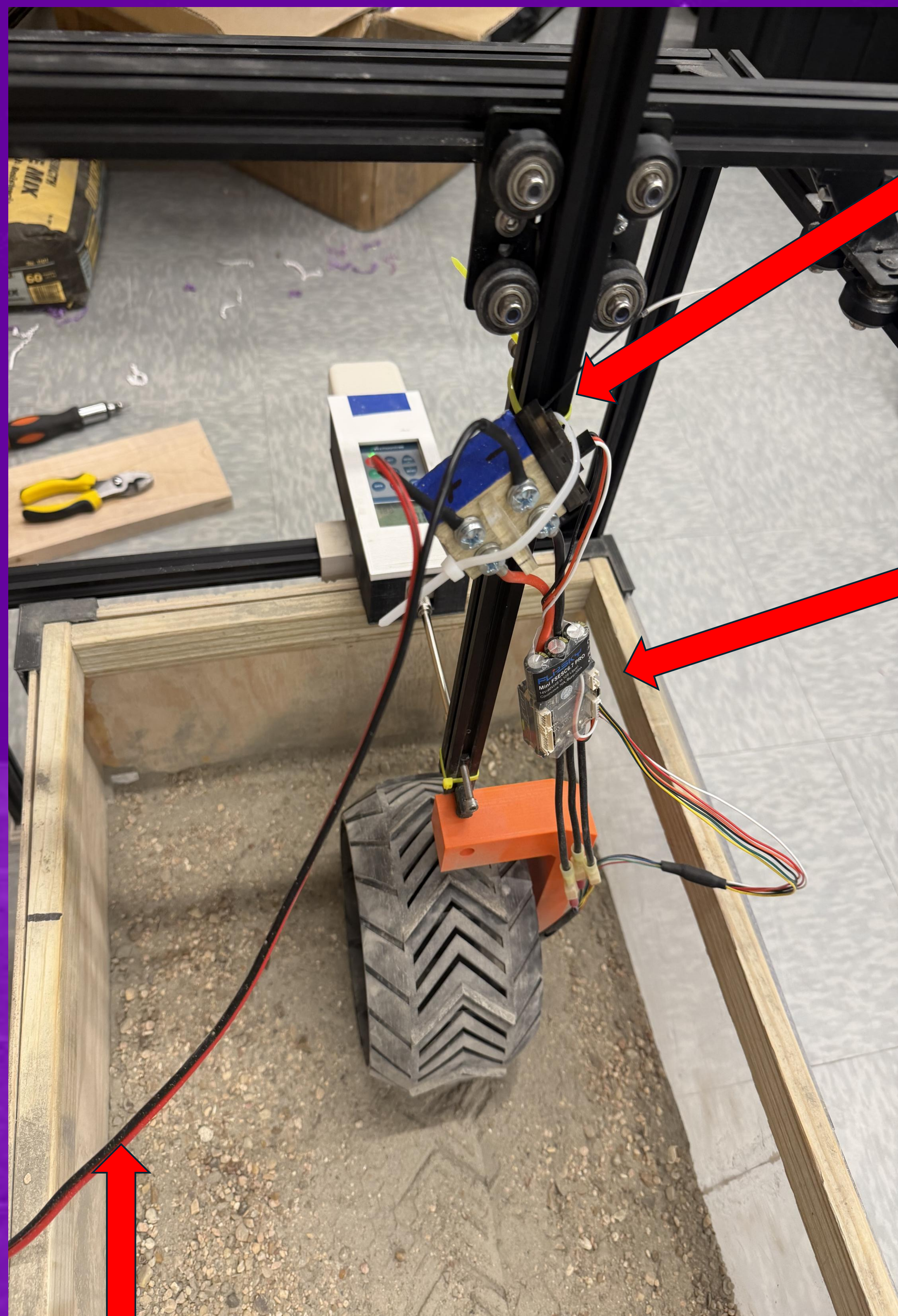
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## Testing Setup



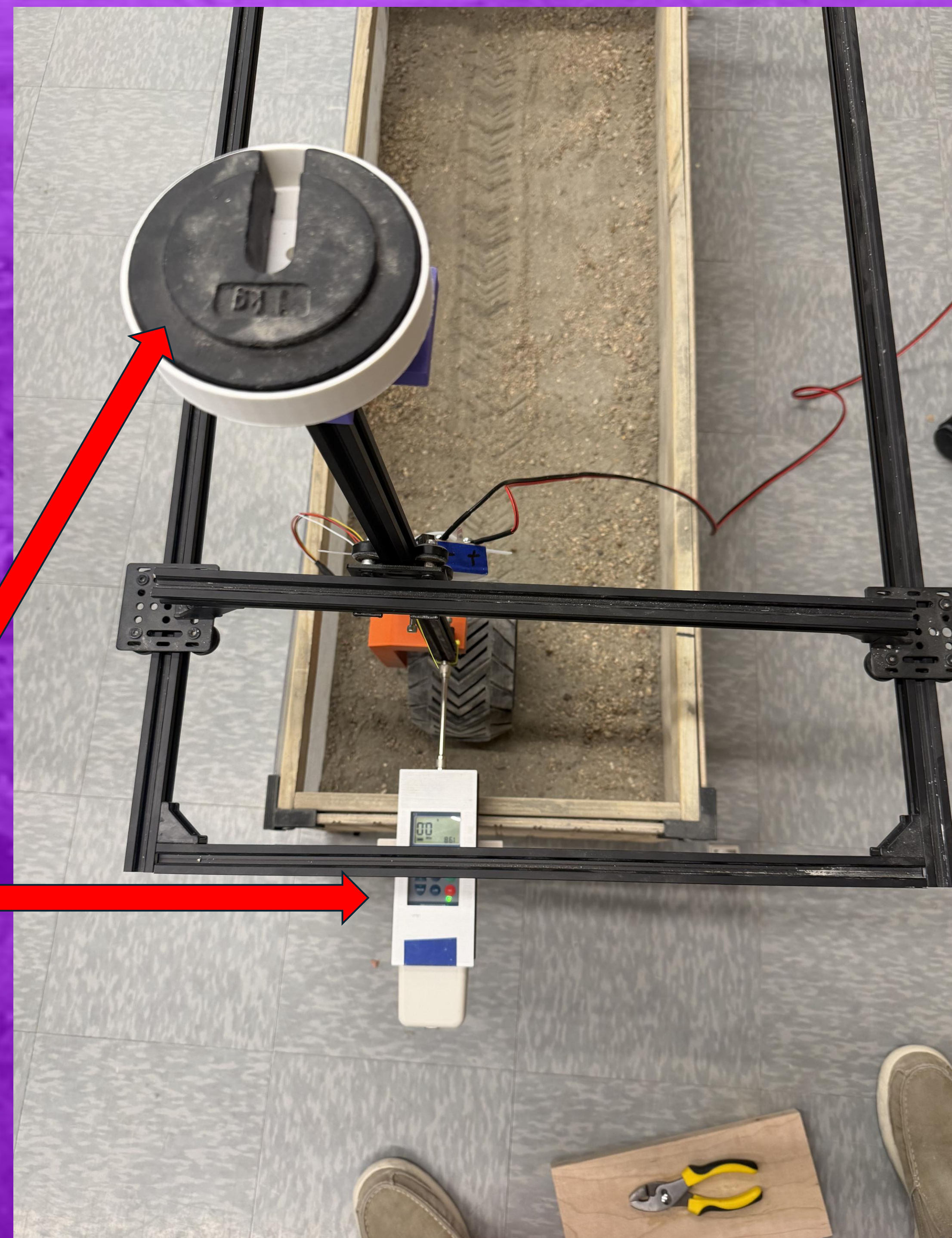
Receiver

ESC (Electronic Speed Controller)

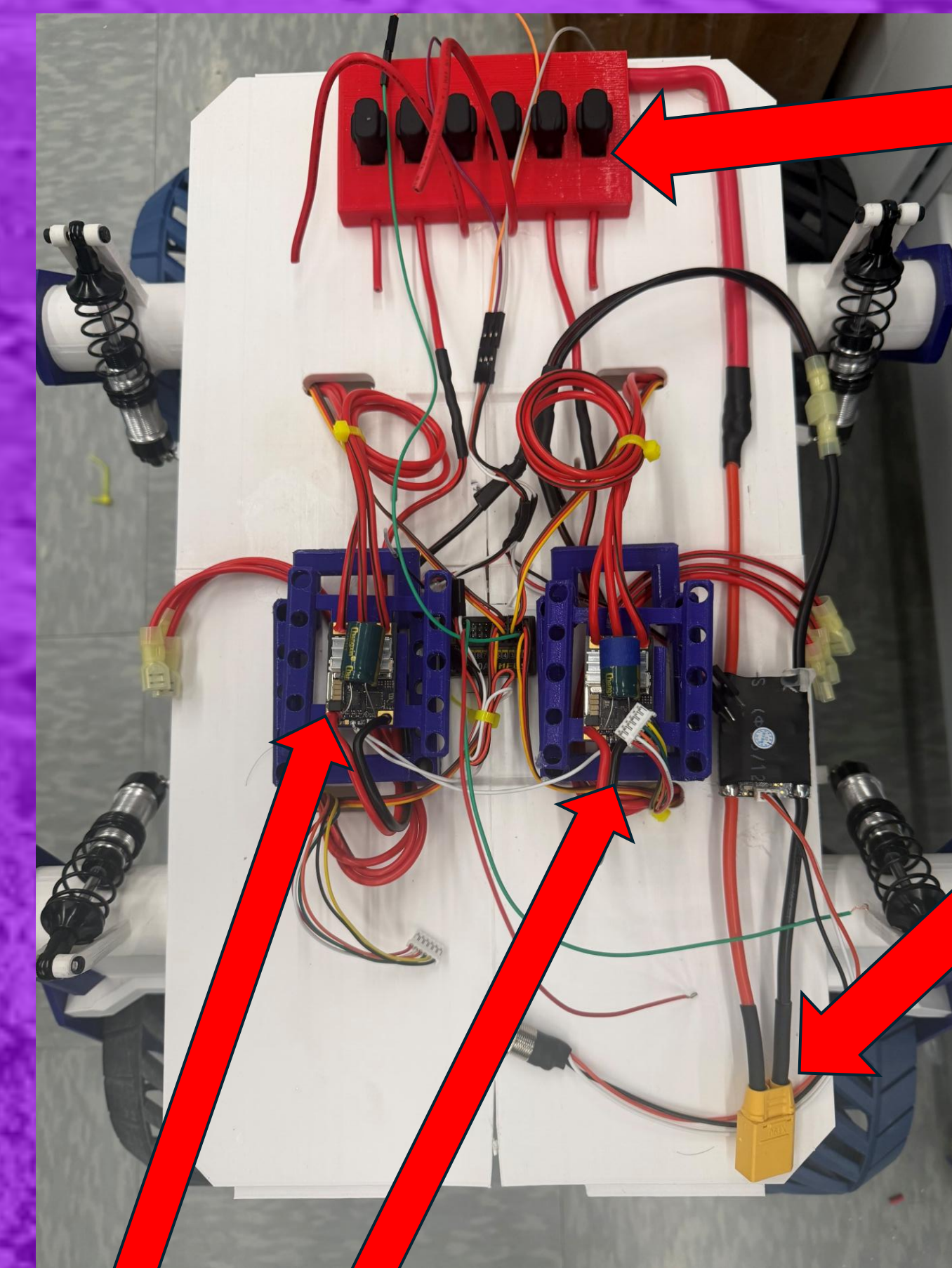
Wires to Power Supply

Weight Holder

Force Gauge



## LTV Design



Fuses

Connector to 29.6V Battery source

ESC's

