Team 501
Tribometer in Spacelike Conditions

VDR4 240130

Team Introductions

Branham Channell
Materials Engineer

Cobi Johnson
Systems Engineer

Madison Retherford
Mechatronics Engineer

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Structural Engineer

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Computer Hardware Engineer

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Sponsor and Advisor

Dr. Brandon Krick

Dr. Shayne McConomy

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Objective

The objective of this project is to design, develop, and implement a system that enables the simultaneous testing of multiple samples within a vacuum chamber using a tribometer. This system aims to increase testing throughput and enhance overall efficiency while maintaining prior accuracy and control.

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What is a Tribometer?

Tribometers measure quantities such as coefficient of friction, friction force, and wear volume on two surfaces in contact by simulating friction in controlled conditions.
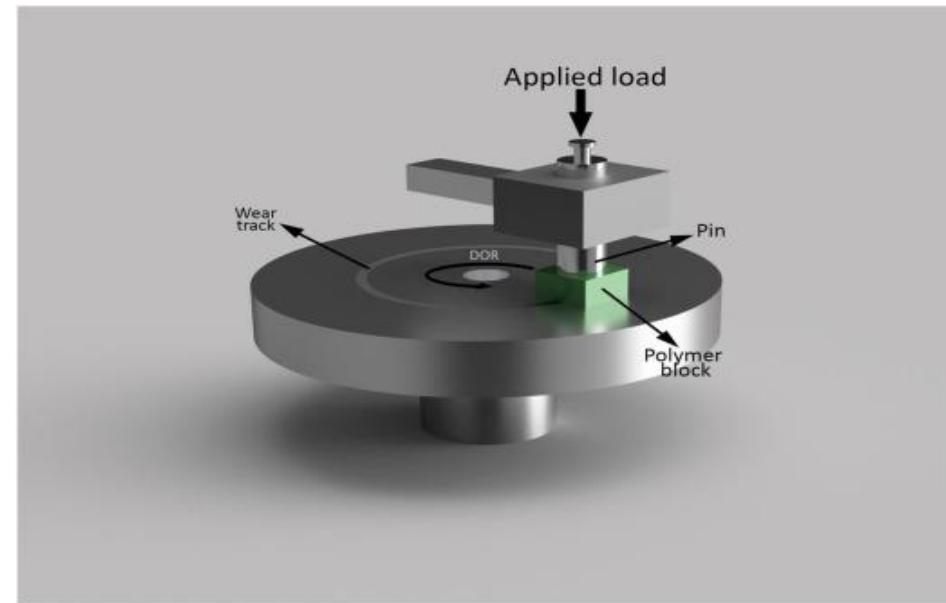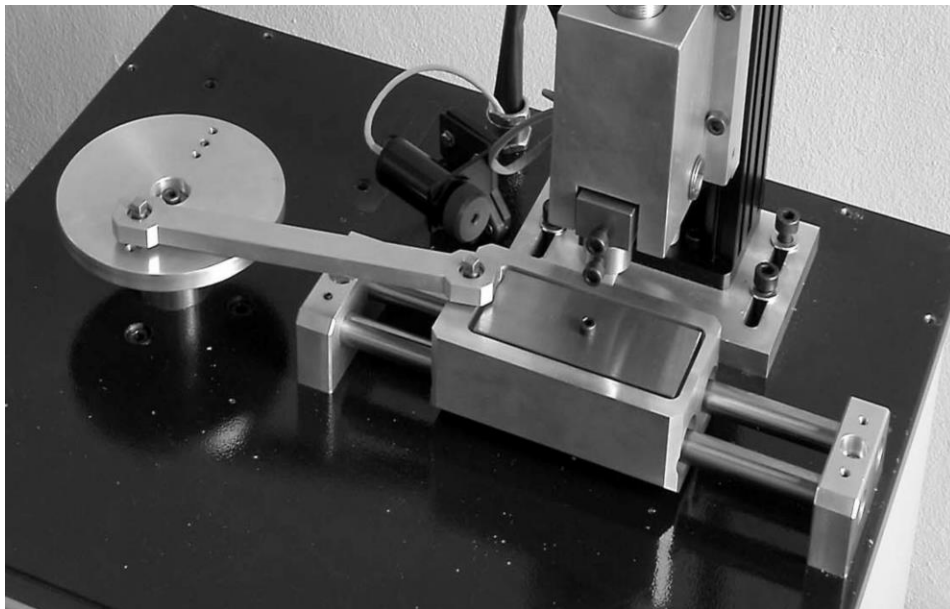
AME's Vacuum Chamber

- Vacuum chambers work by removing air and gas from a vessel using a pump.

- The lab's is a bell-style high-vacuum chamber.

- It can reach pressures as low as 1.5×10^{-6} mbar.

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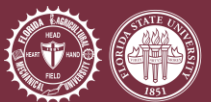Engineering
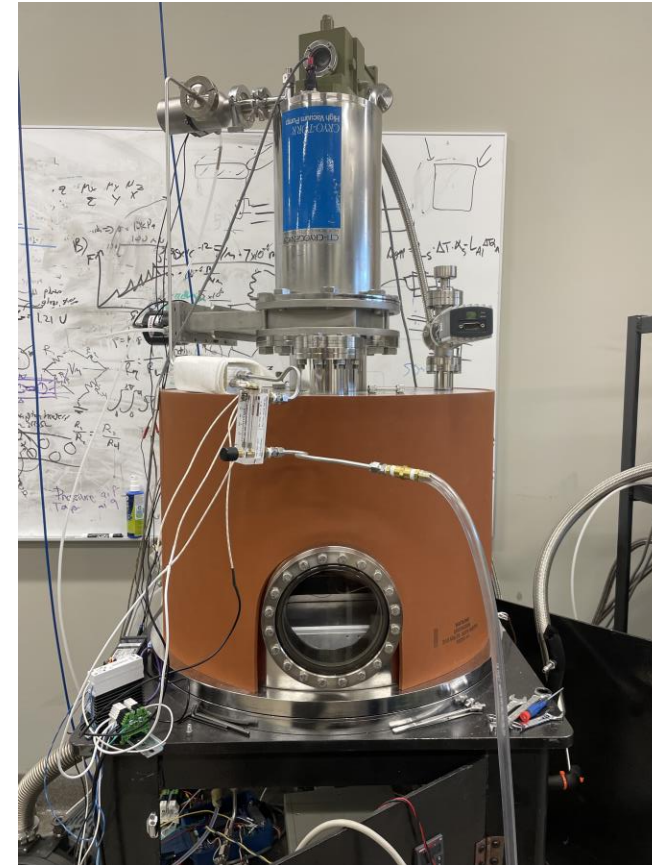
Steps to High-Vacuum

Step 1
- Roughing pump pulls initial vacuum on system.
- This "rough vacuum" is around 10^{-1} to 10^{-2} mbar.

Step 2
- Switched to the much stronger cryo-pump.
- Takes vacuum down to 10^{-5} mbar quickly.

Step 3
- Let sit overnight (or at least 12 hours).
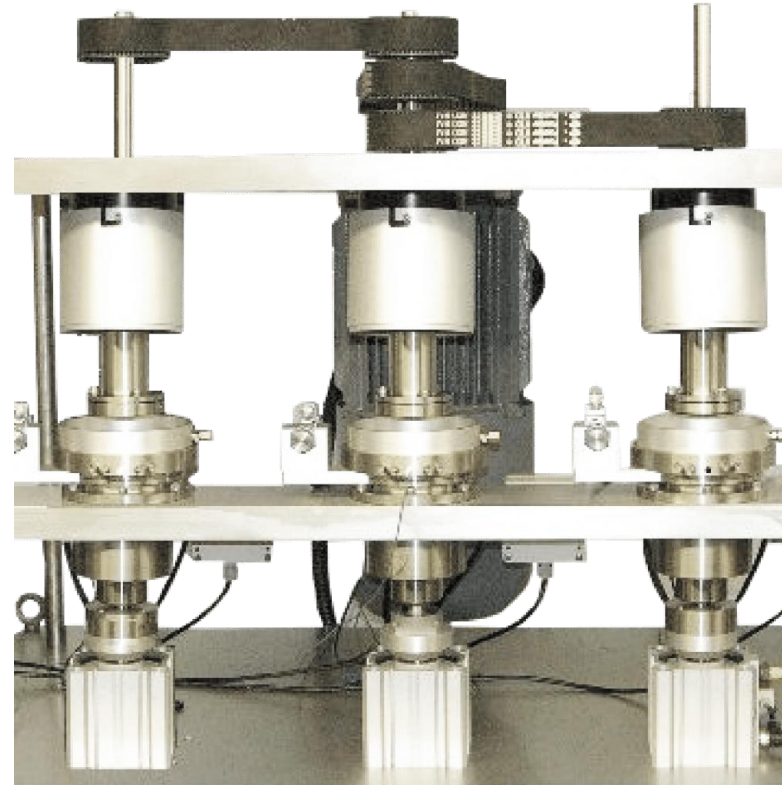- Achieves 10^{-6} mbar range.

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Key Goals

Test multiple samples

Control parameters

Operate in specific conditions

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Key Goals

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Preview

My parameter

Option 1

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Key Goals

Test multiple samples

Control parameters

Operate in specific conditions
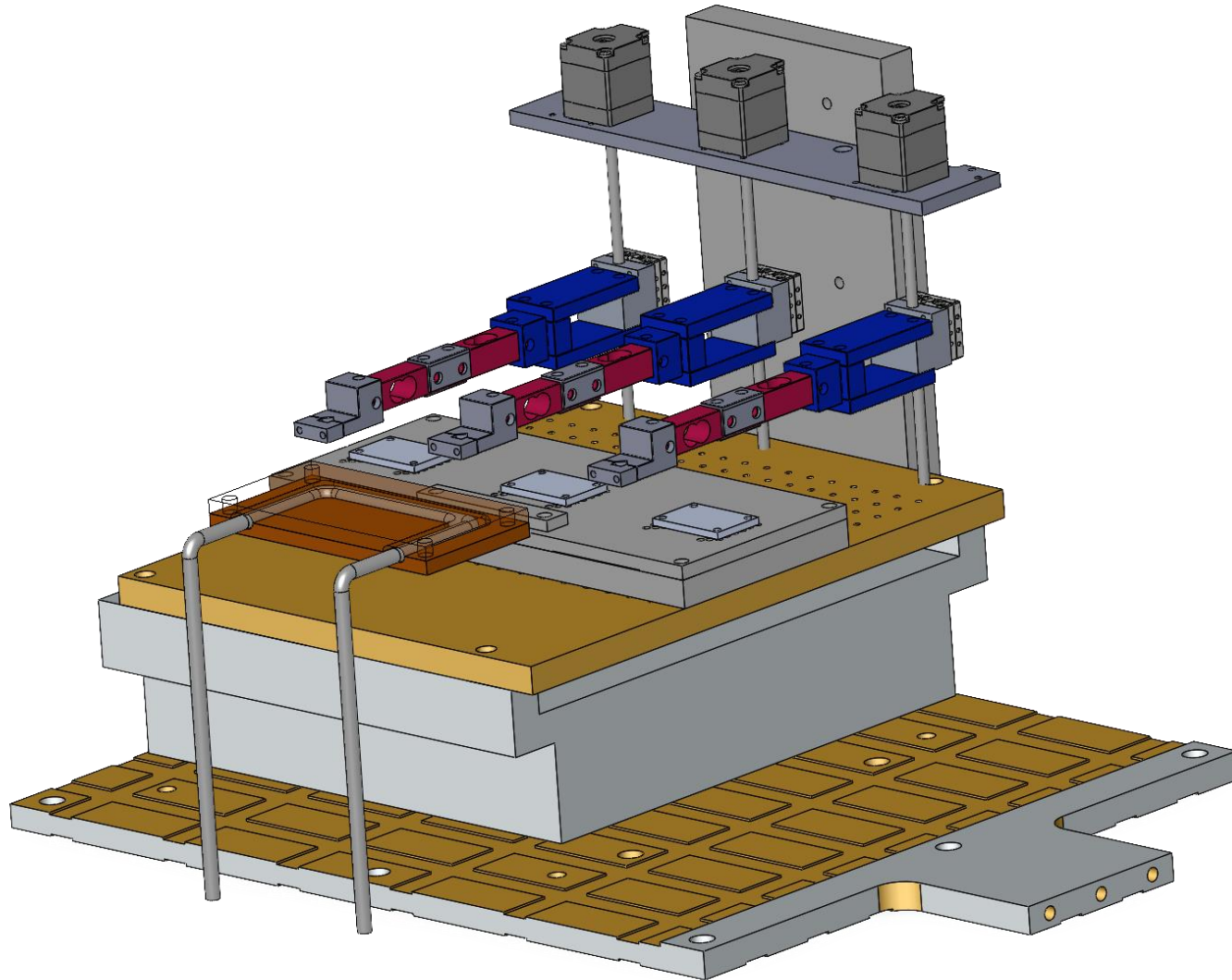
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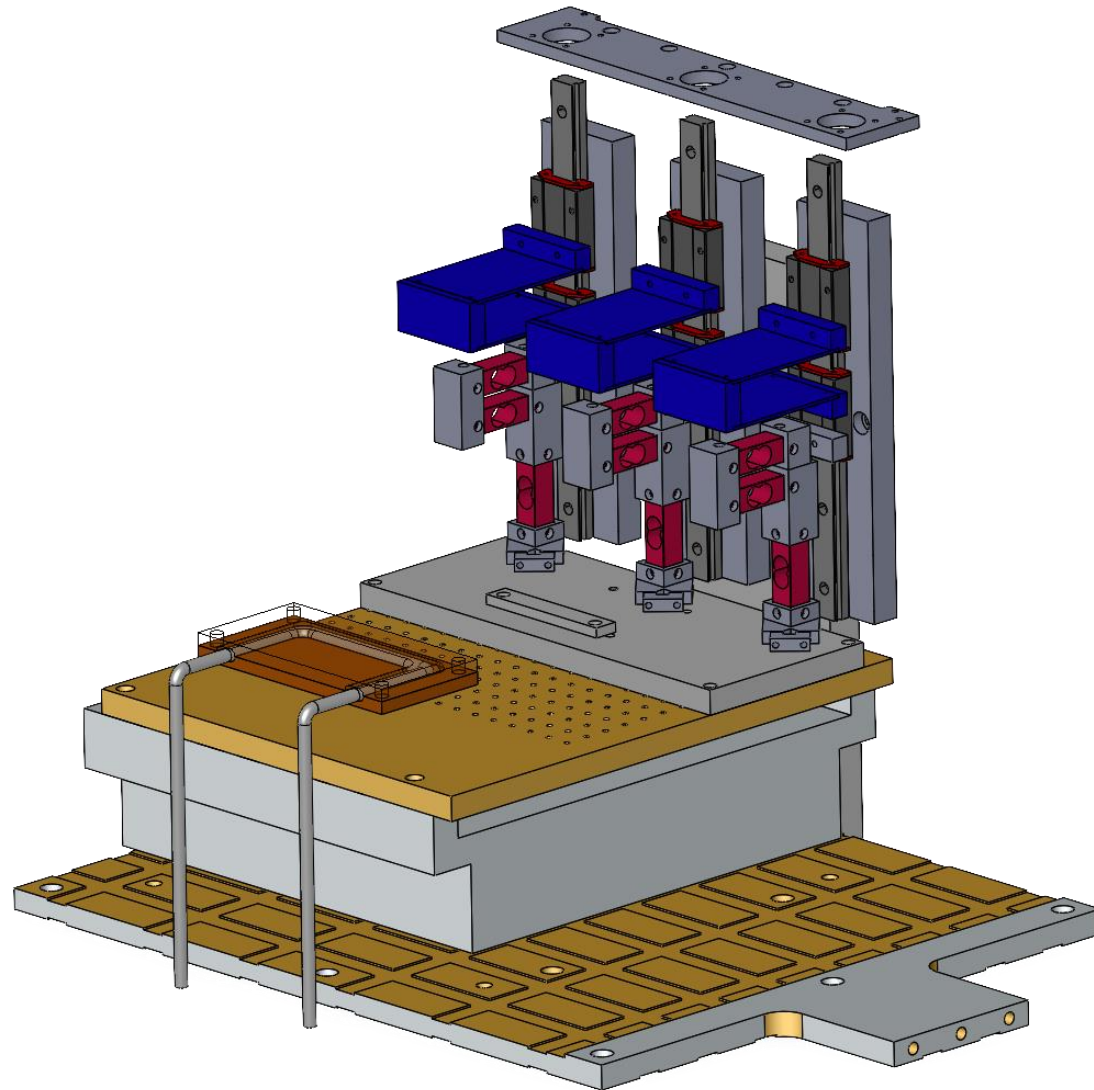Engineering
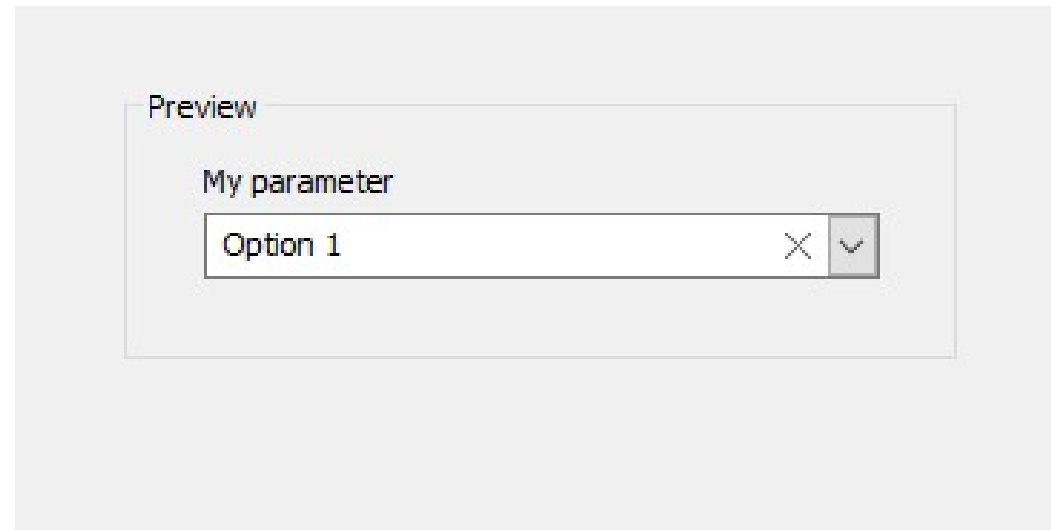
Final Concept Selection
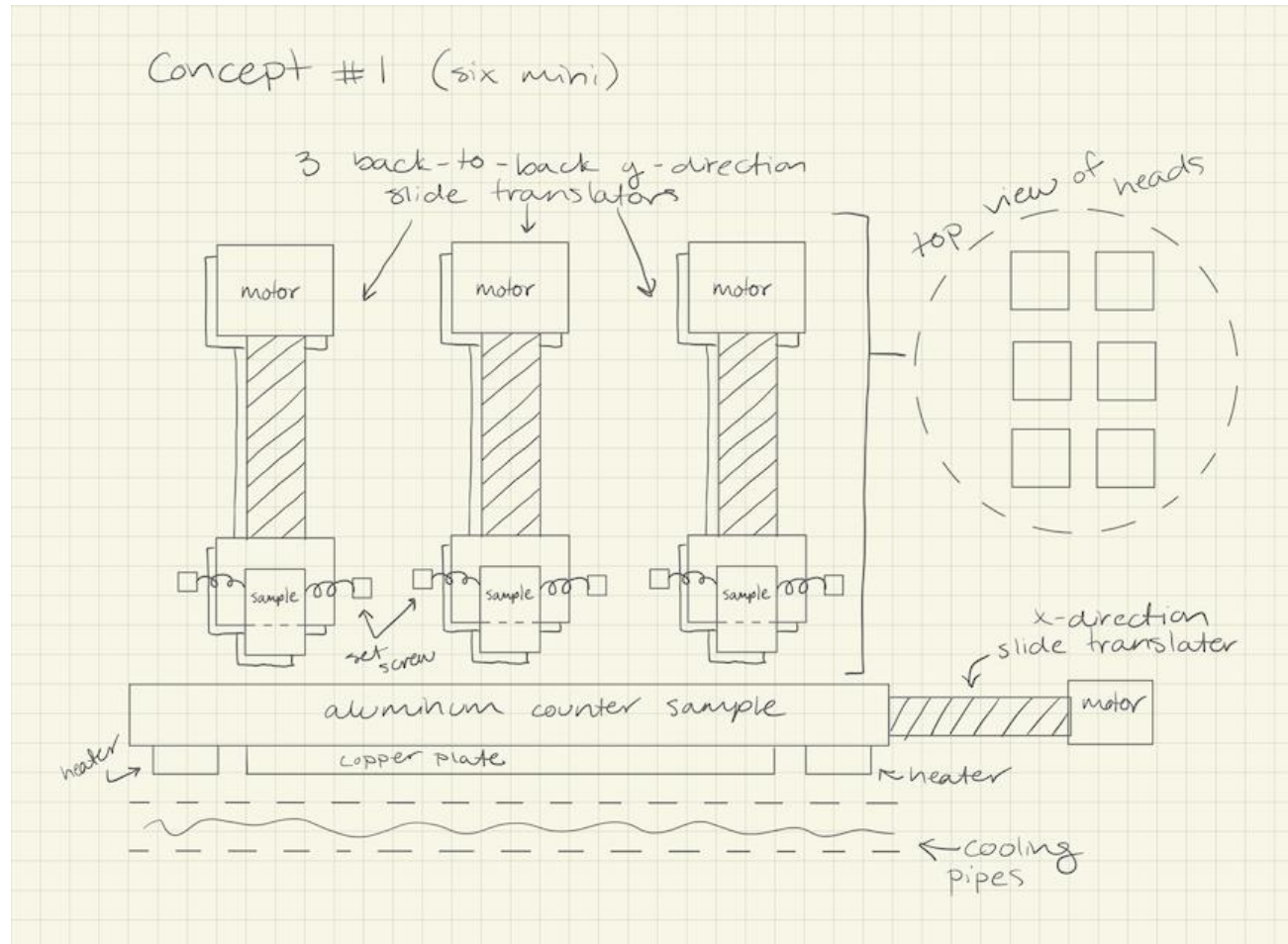
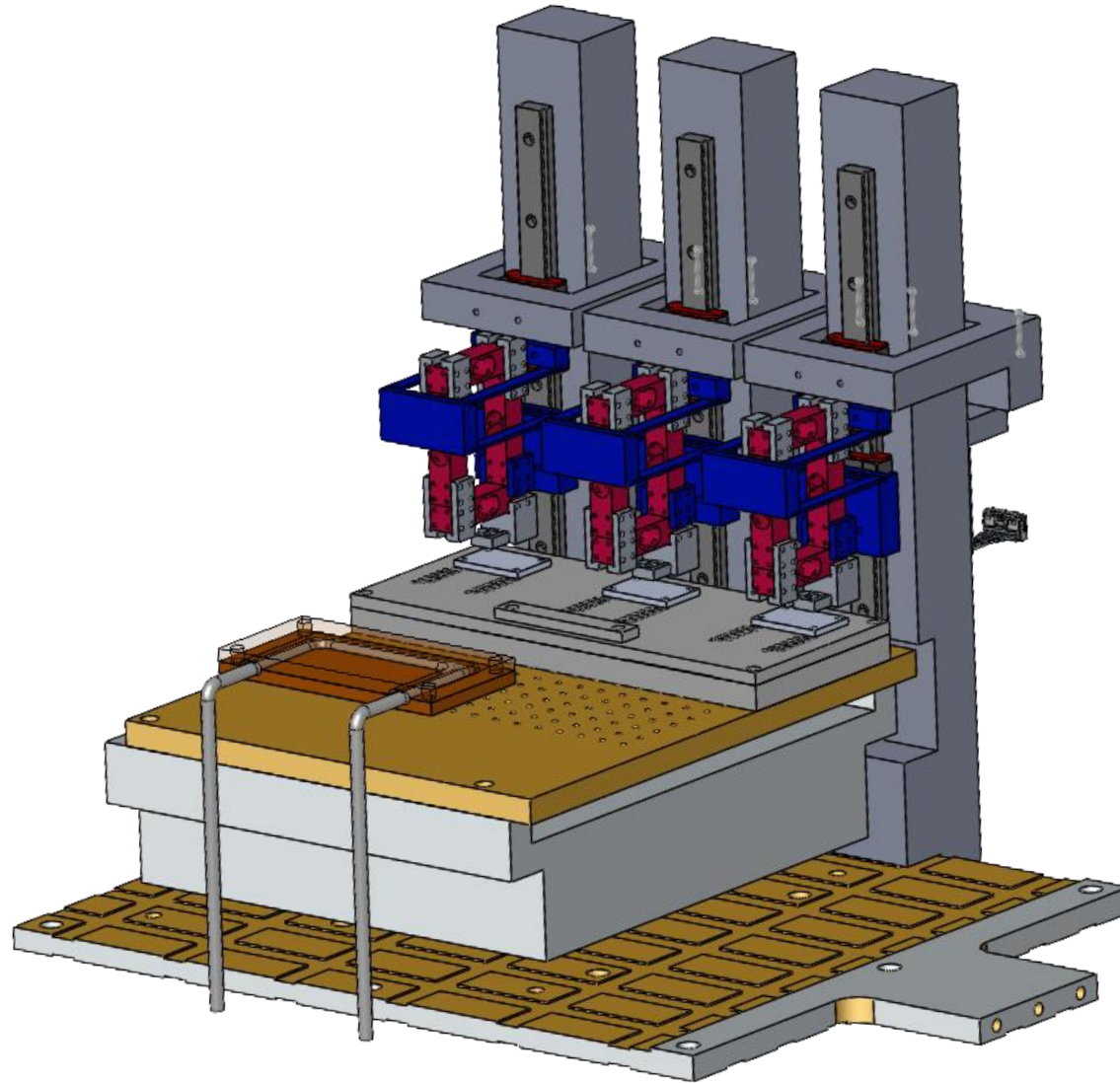

6 mini-identical tribometers.

CAD Design: Mach 1 (Rejected)

CAD Design: Mach 2 (Rejected)
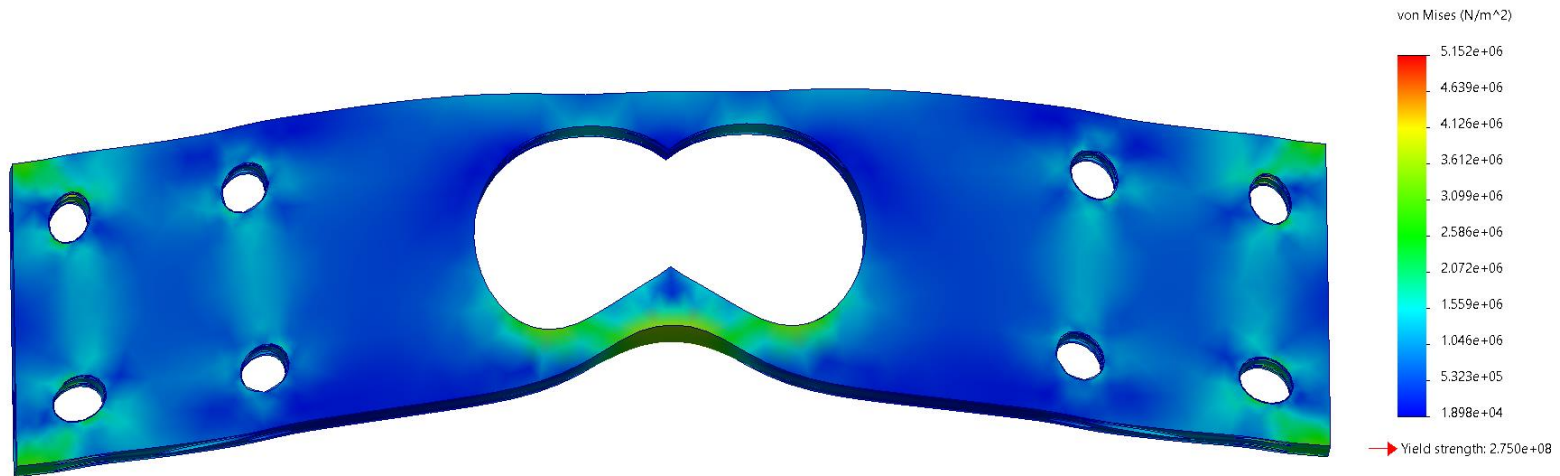
CAD Design: Mach 3 (Approved)
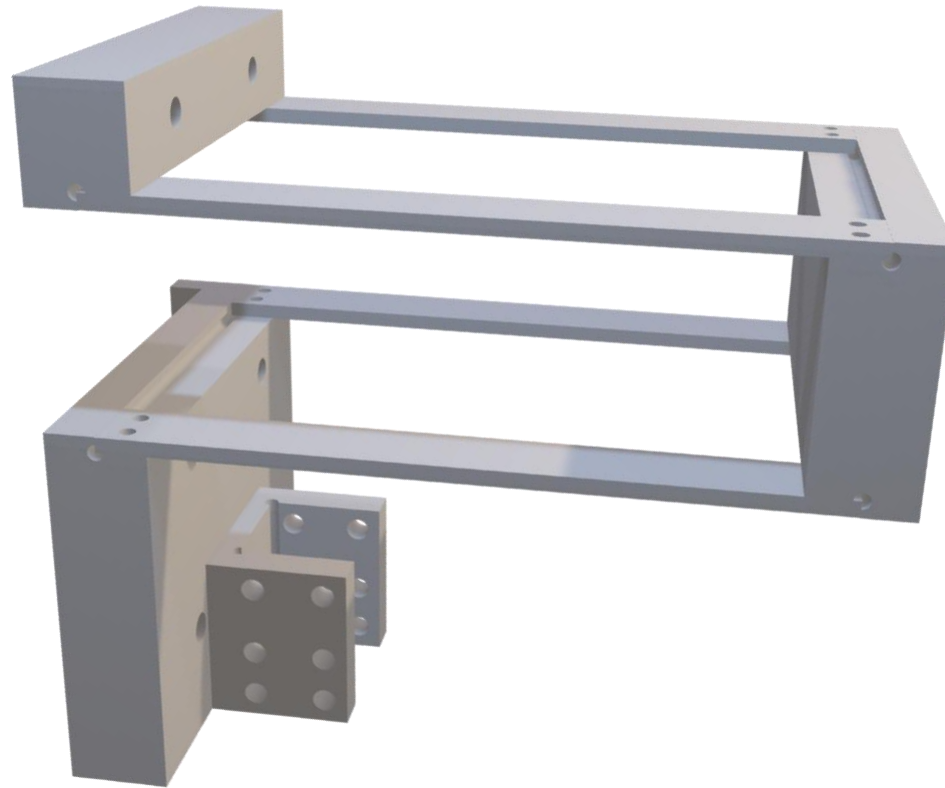
CAD Design: Load Cell

FEA: Load Cell

Model name: SD Load Cell
Study name: Normal load(-Default-)
Plot type: Static nodal stress Stress1
Deformation scale: 3,734.24

von Mises (N/m^2)

5.152e+06
4.639e+06
4.126e+06
3.612e+06
3.099e+06
2.586e+06
2.072e+06
1.559e+06
1.046e+06
5.323e+05
1.898e+04

→ Yield strength: 2.750e+08
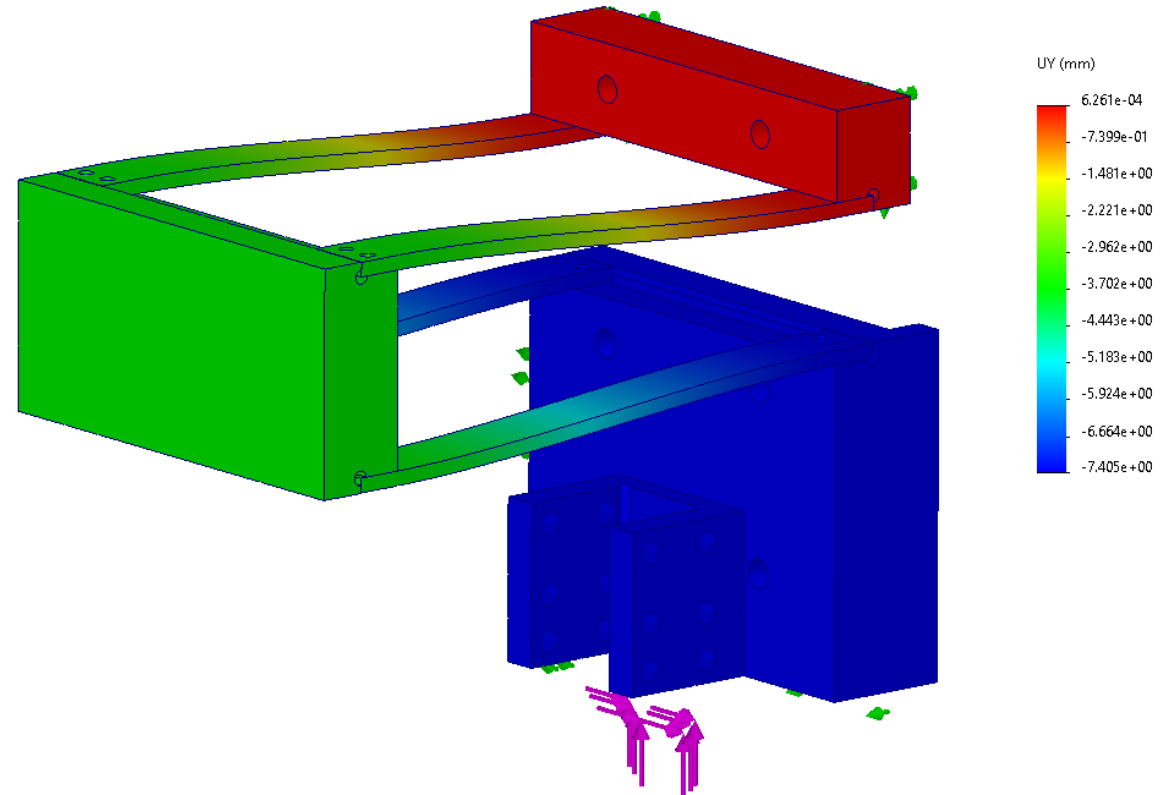
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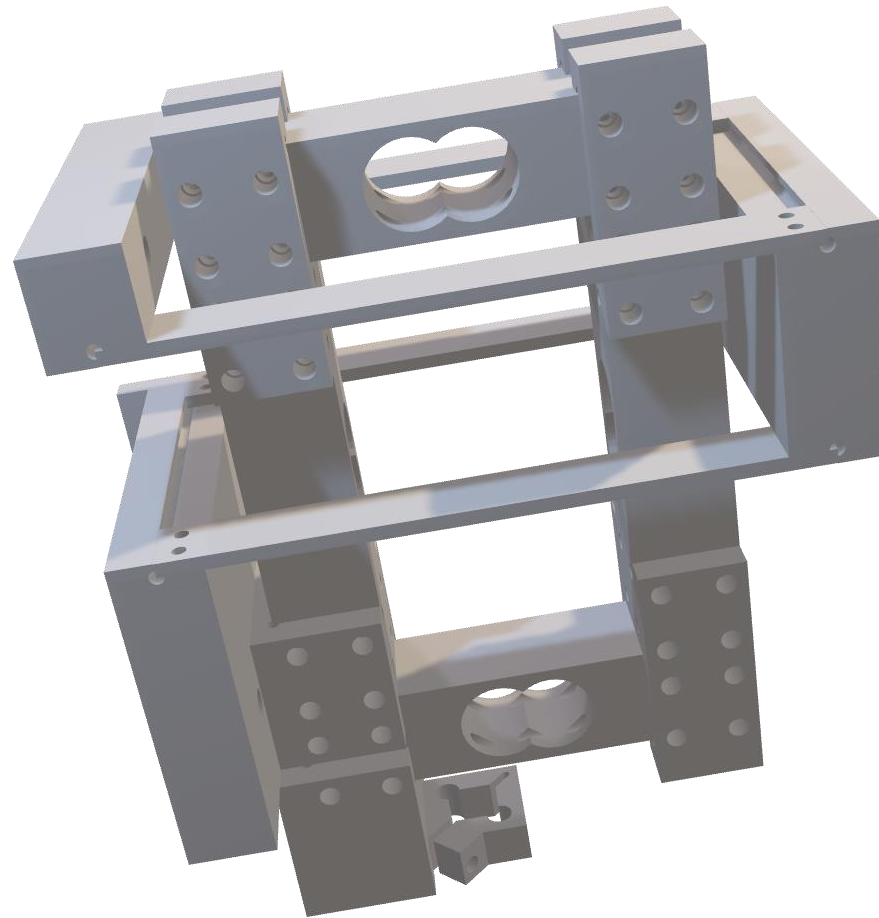# CAD Design: Leaf Spring

FEA: Leaf Spring

Model name: SD Leaf Spring 240118
Study name: Static 4(-Default-)
Plot type: Static displacement Displacement1
Deformation scale: 1

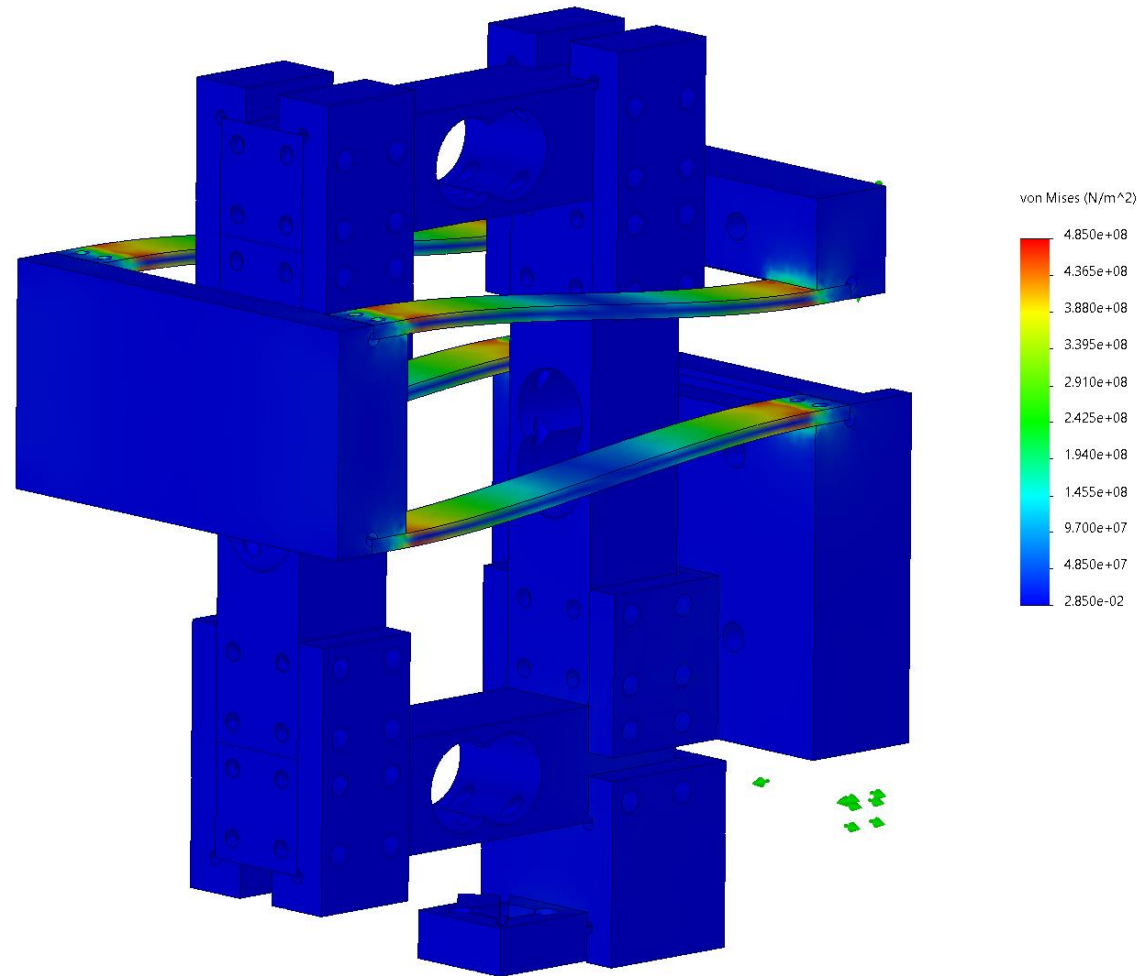SOLIDWORKS Educational Product. For Instructional Use Only.

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CAD Design: Tribometer Assembly

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FEA: Tribometer Assembly

Model name: 240126
Study name: Static 2(-Default-)
Plot type: Static nodal stress Stress1
Deformation scale: 1.38122

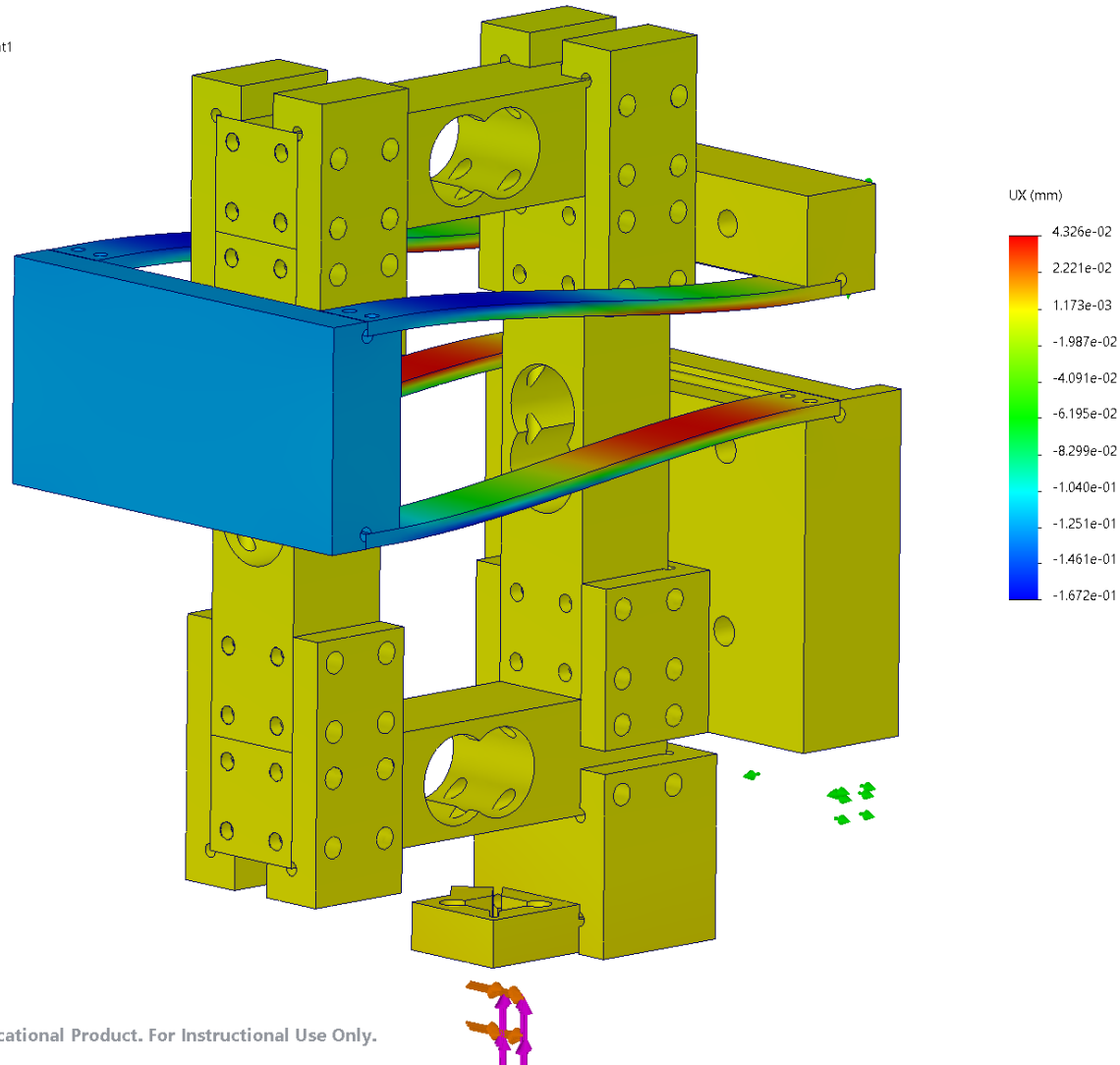von Mises (N/m^2)

4.850e+08
4.365e+08
3.880e+08
3.395e+08
2.910e+08
2.425e+08
1.940e+08
1.455e+08
9.700e+07
4.850e+07
2.850e-02

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FEA: Tribometer Assembly

Model name: 240126
Study name: Static 2(-Default-)
Plot type: Static displacement Displacement1
Deformation scale: 1.38122

UX (mm)

4.326e-02
2.221e-02
1.173e-03
-1.987e-02
-4.091e-02
-6.195e-02
-8.299e-02
-1.040e-01
-1.251e-01
-1.461e-01
-1.672e-01

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FEA: Tribometer Assembly

FEA: Tribometer Assembly

Model name: 240126
Study name: Static 2(-Default-)
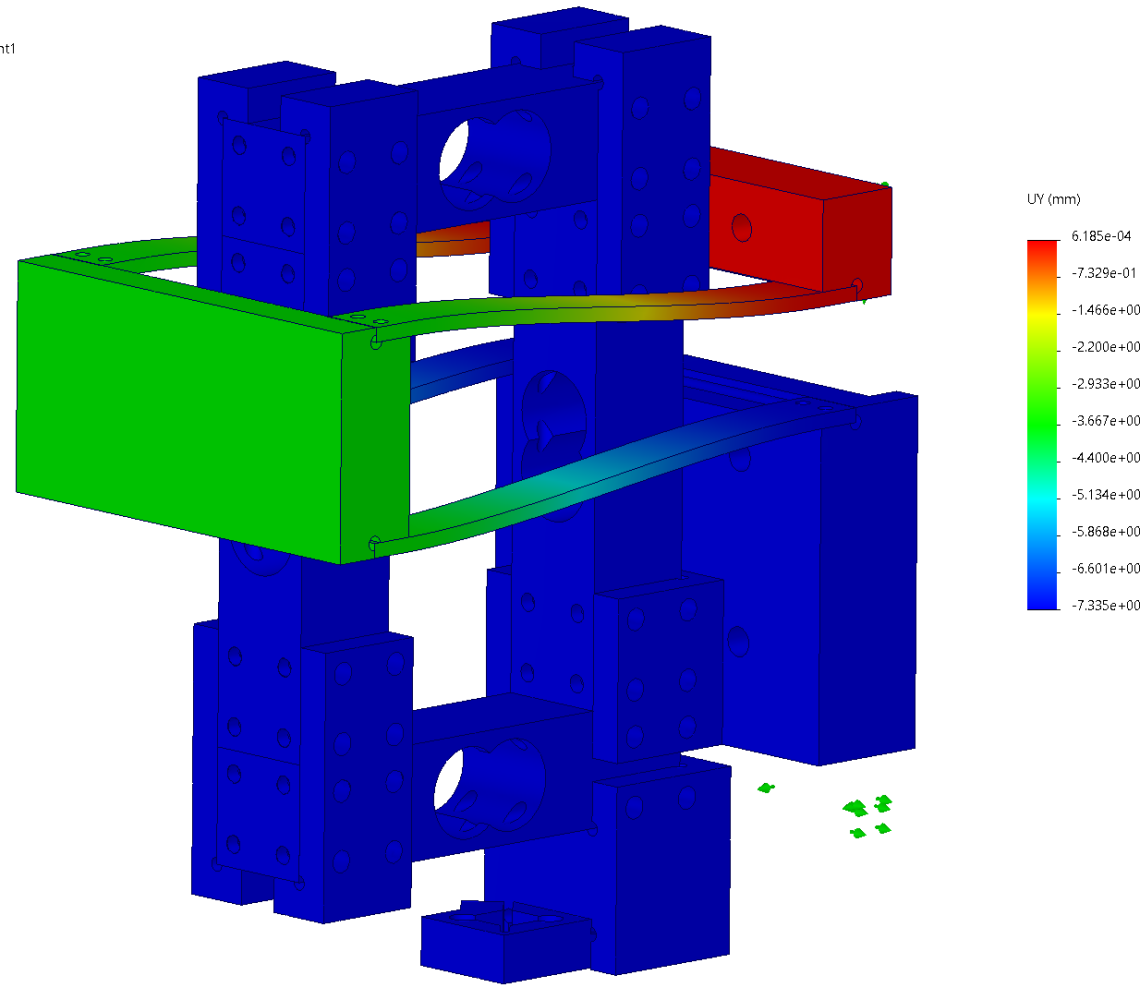Plot type: Static displacement Displacement1
Deformation scale: 1.38122

UZ (mm)

3.861e-03
-5.474e-02
-1.133e-01
-1.720e-01
-2.306e-01
-2.892e-01
-3.478e-01
-4.064e-01
-4.650e-01
-5.236e-01
-5.822e-01

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FEA: Tribometer Assembly

Model name: 240126
Study name: Static 2(-Default-)
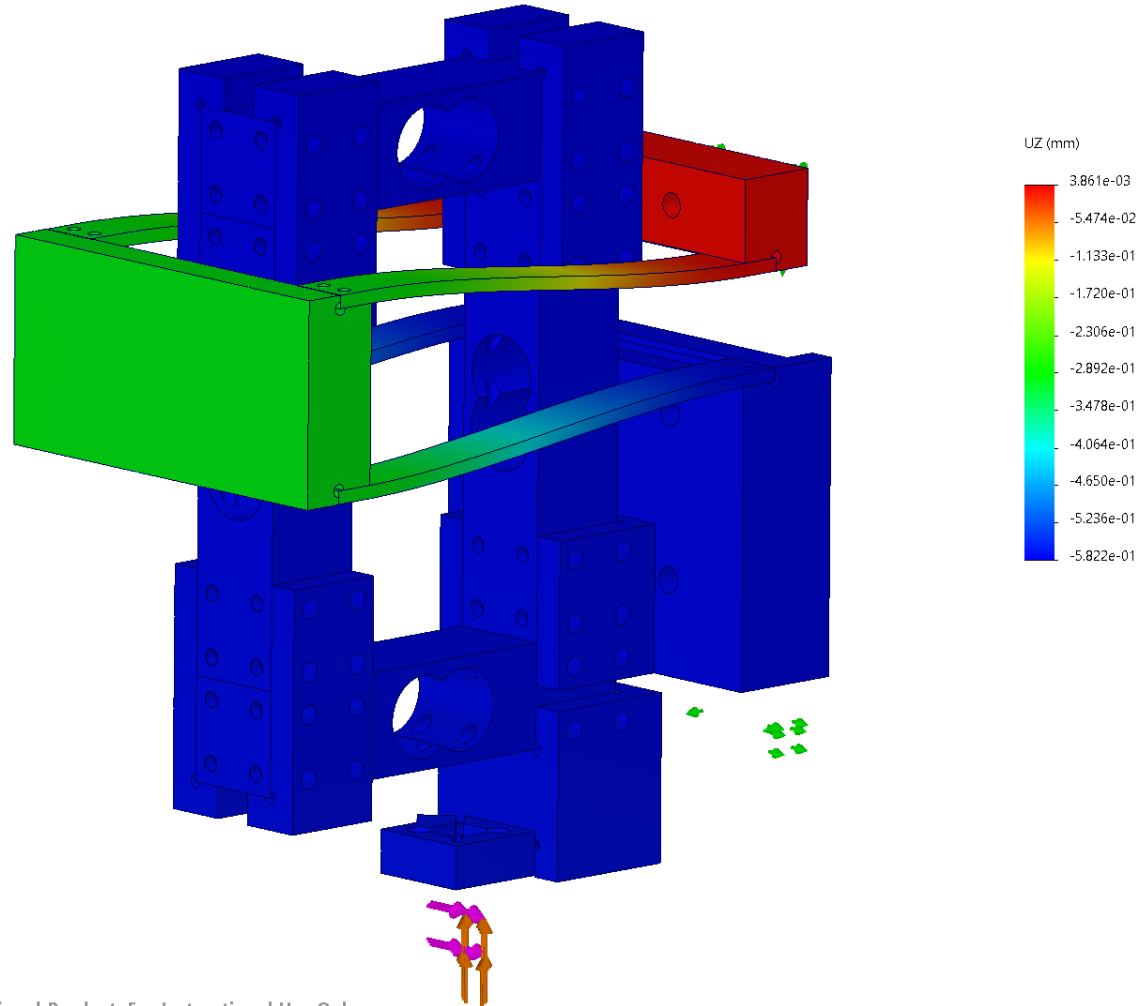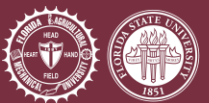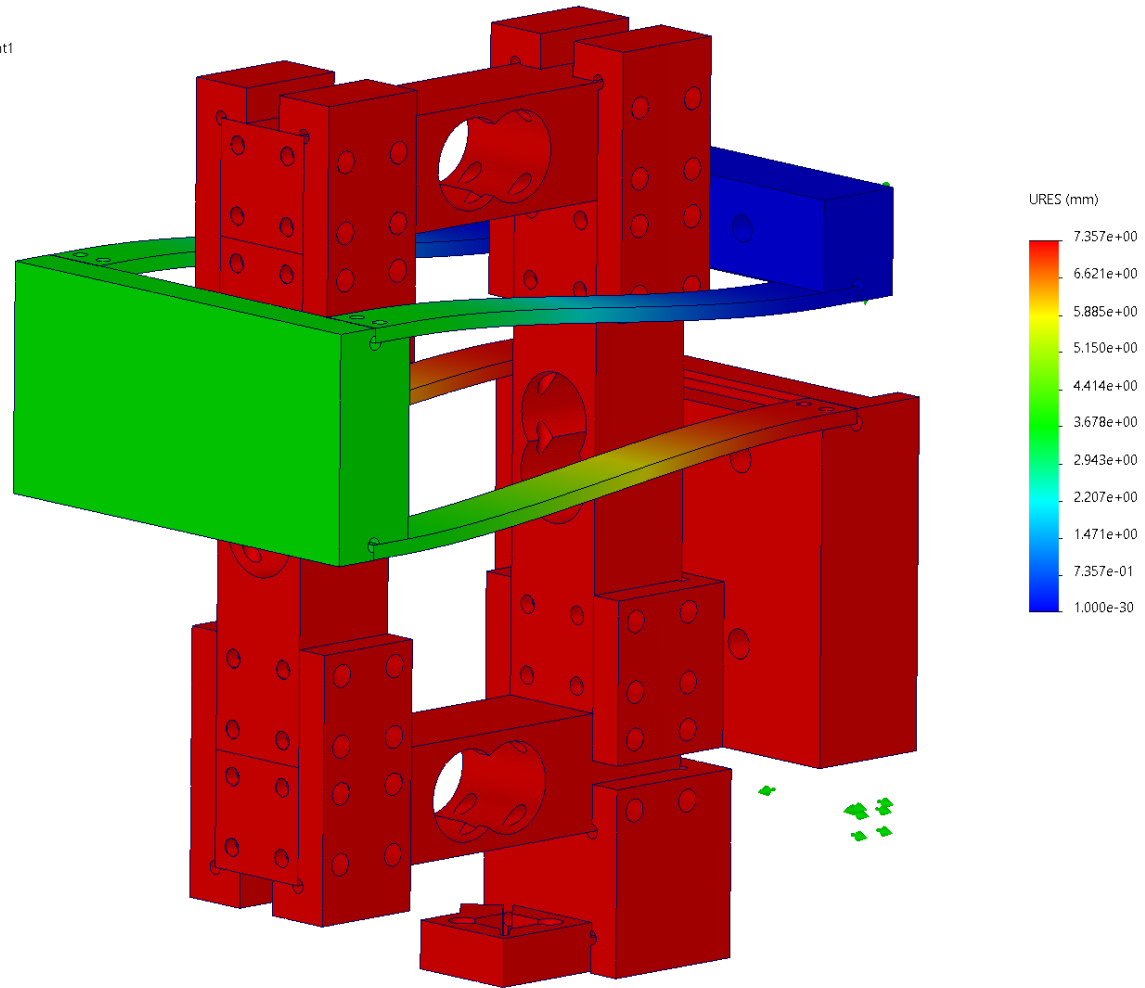Plot type: Static displacement Displacement1
Deformation scale: 1.38122

URES (mm)

7.357e+00
6.621e+00
5.885e+00
5.150e+00
4.414e+00
3.678e+00
2.943e+00
2.207e+00
1.471e+00
7.357e-01
1.000e-30

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Future Work

Speak with machine shop and order material stock.

Add vents, countersinks, wire holes, and fillets to CAD model.

Check material properties for fatigue failure under cyclic loading.

Machine prototype.

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Future Work

Test load cells using weights.

Integrate vacuum compatible strain gauges to load cell.

Revise and finalize pre-existing software.

Test final design.

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