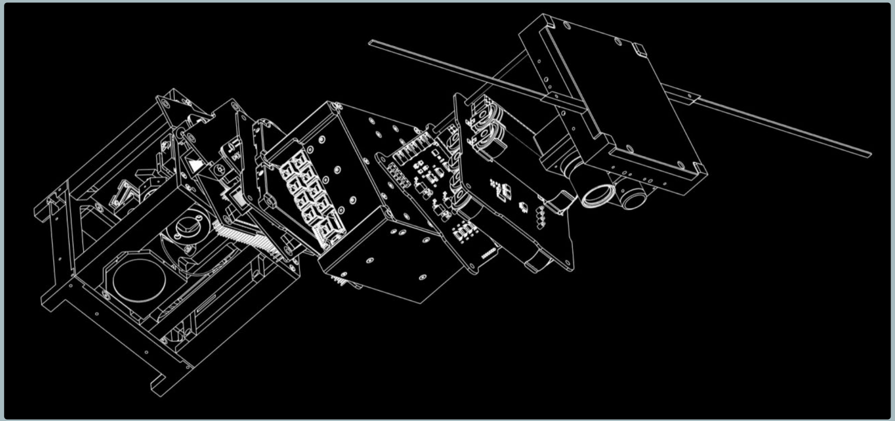
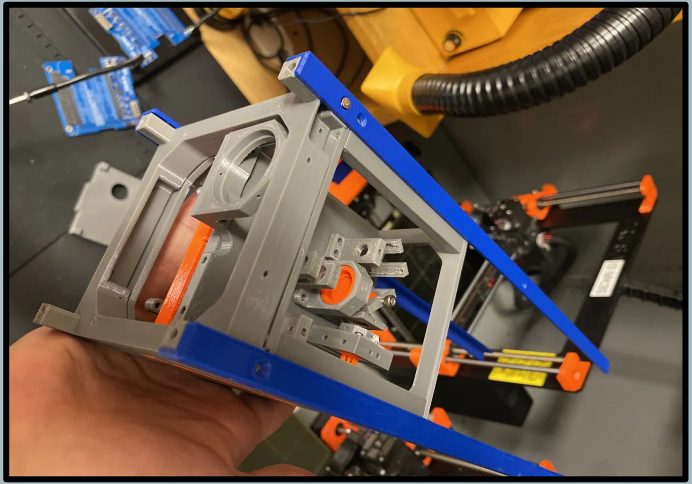
Project Portfolio





Henry Czarnecki

Skills: Fusion 360 | CNC Machining | TVAC Prep | Precision Tolerancing | First-Order Structural Analysis | Thermal-Mechanical Considerations | System Interface Verification

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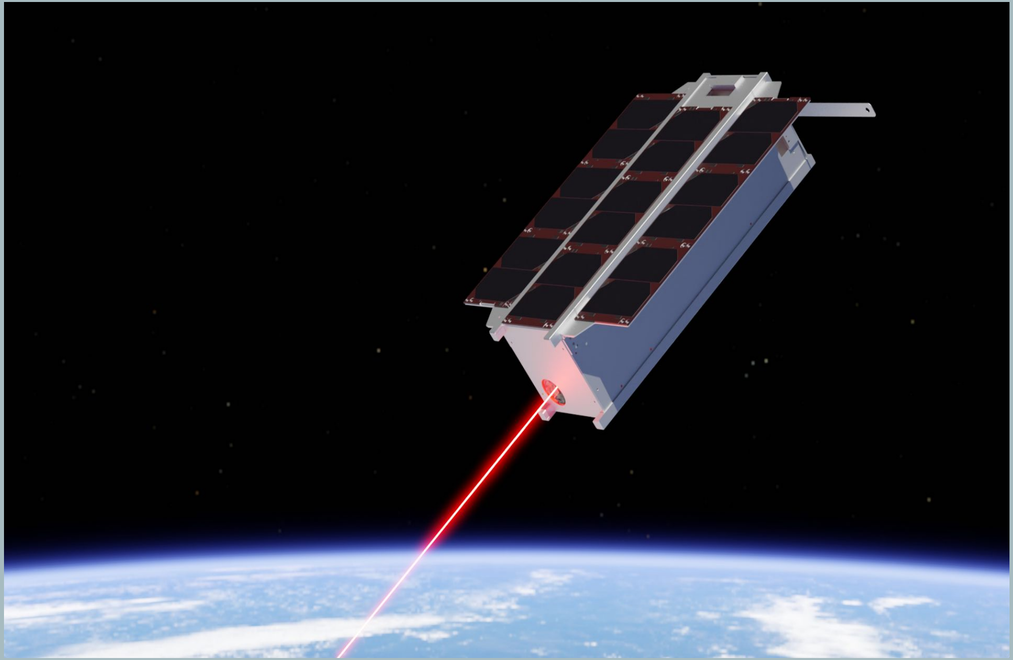
PULSE-A Satellite

- Integrated avionics, payload, and mechanical interfaces within a 3U bus.
- 3D modelled and prototyped the deployment mechanism for the antennas and the solar panels
- Preparing to test components in a thermal vacuum environment at Fermilab
- Whole project is funded by NASA CSLI, and undergoes regular design reviews from engineers from JPL, Fermilab, etc…

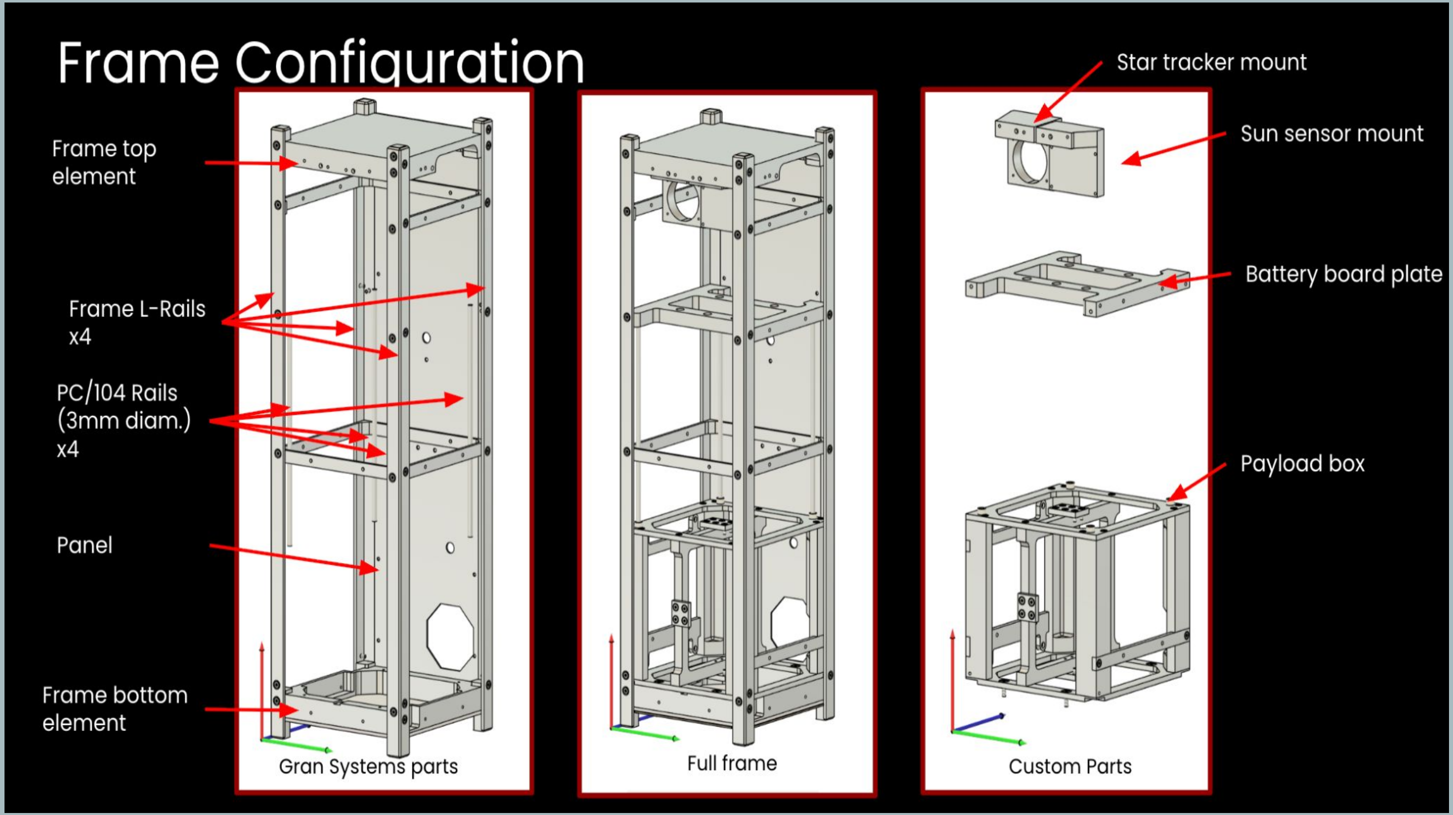
Lead structural engineer of a cubesat mission targeting 2027 orbital deployment for circular-polarization experiments; managing material testing, CAD modeling, and manufacturing processes. Leading four other members through design iteration and test planning.



Rendering of deployed Pulse-A in space

PULSE-A Satellite

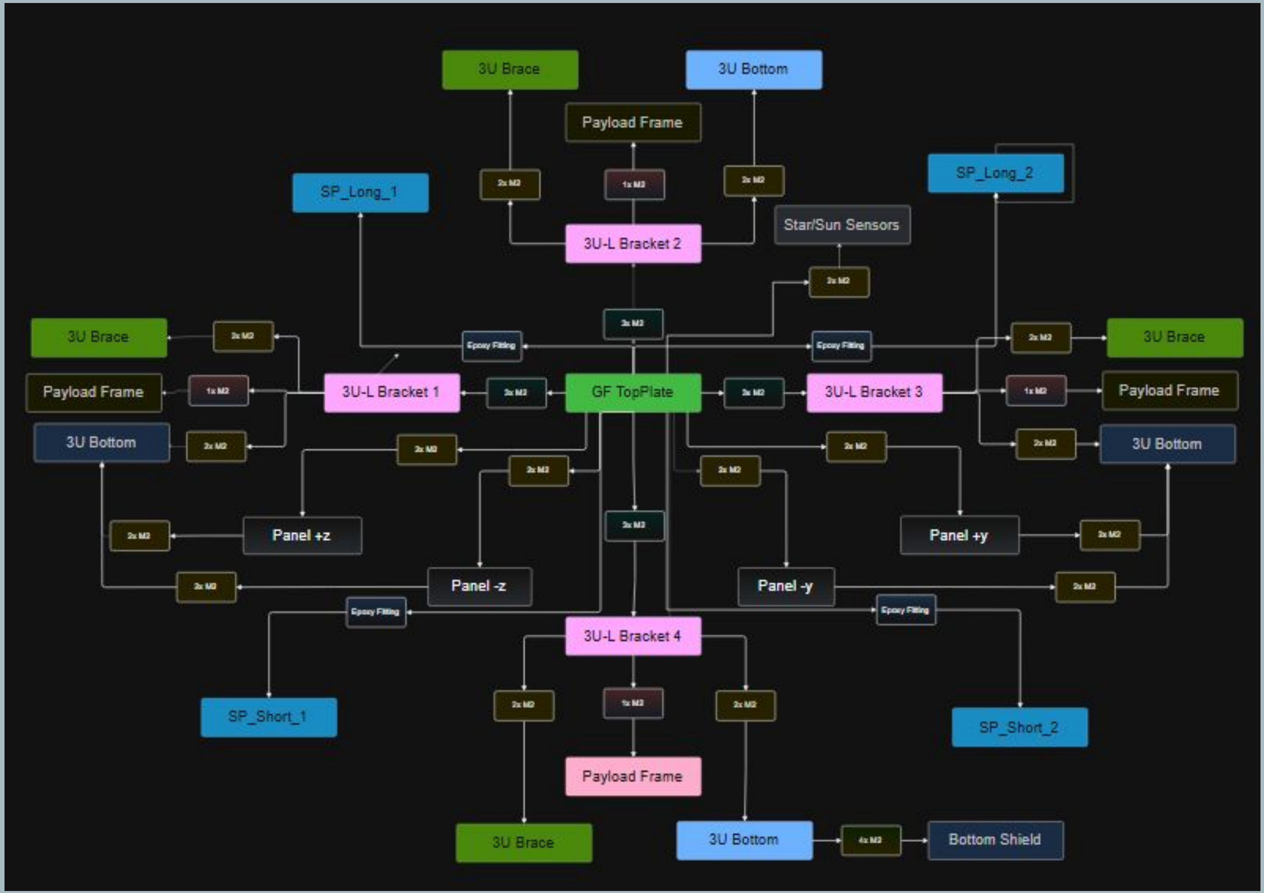
Helped design the custom parts for certain components, such as the mounting plates for the battery board and the sun/star sensors, as well as the housing for the optical payload. The next step is to perform structural load and vibration analysis to ensure integrity during launch.



UChicago Space Program

Full Stack

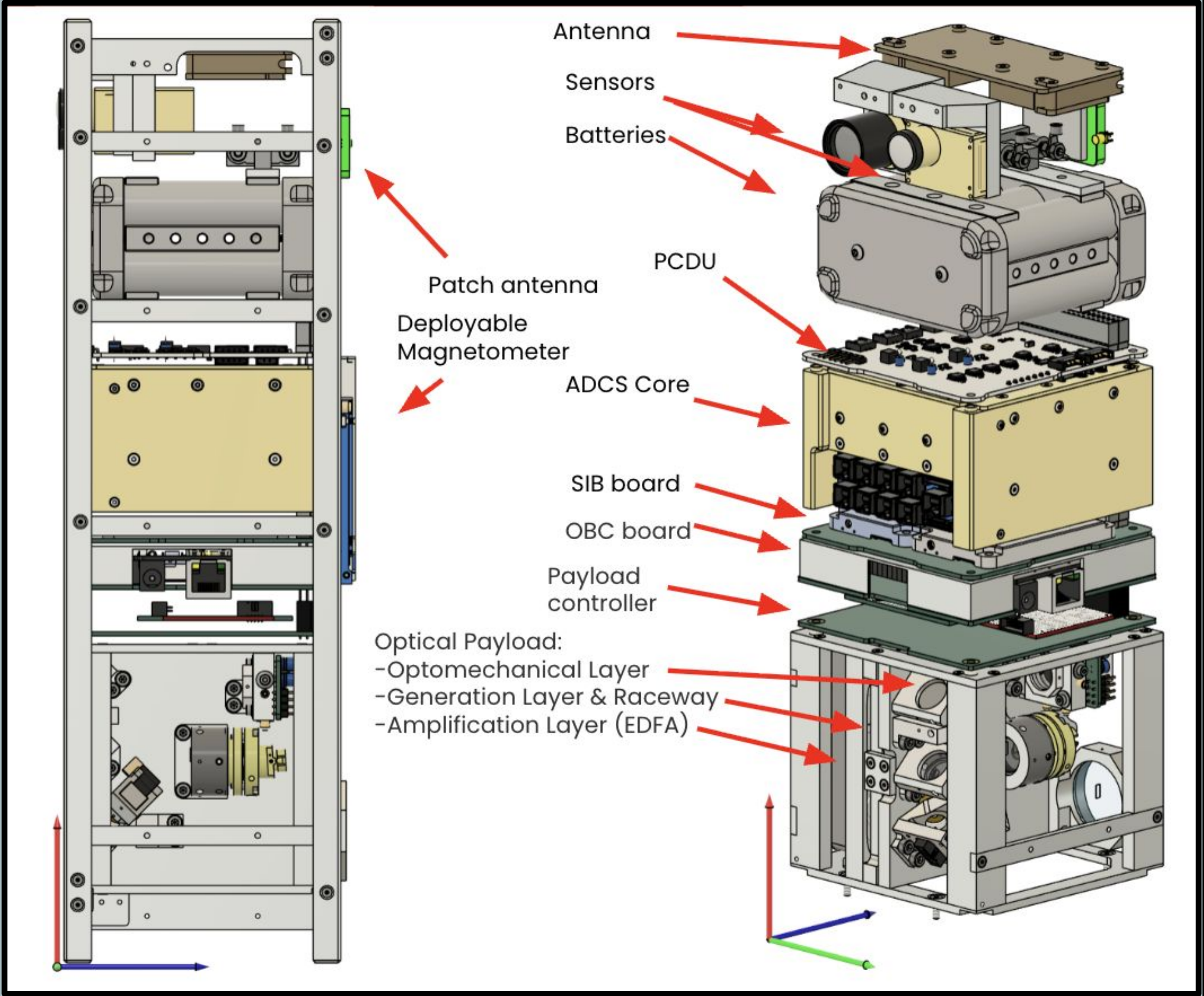
- Also constructed diagrams to verify connections within the satellite when modelling.
- Similar diagrams were also made for electrical, payload, and external bodies.



UChicago Space Program

Full Stack

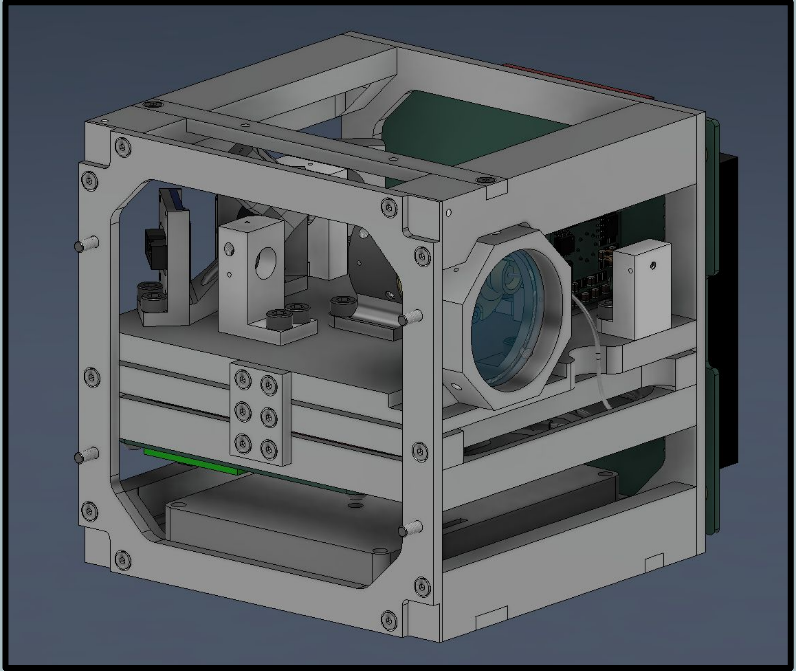
- Worked with frame manufacturer and avionics/payload subteams to model the satellite bus
- Currently working on connections between component interfaces
- Reduced structural mass by 12% through interface consolidation
- Achieved <0.5 mm alignment tolerance across payload-bus interface (required for mission success)



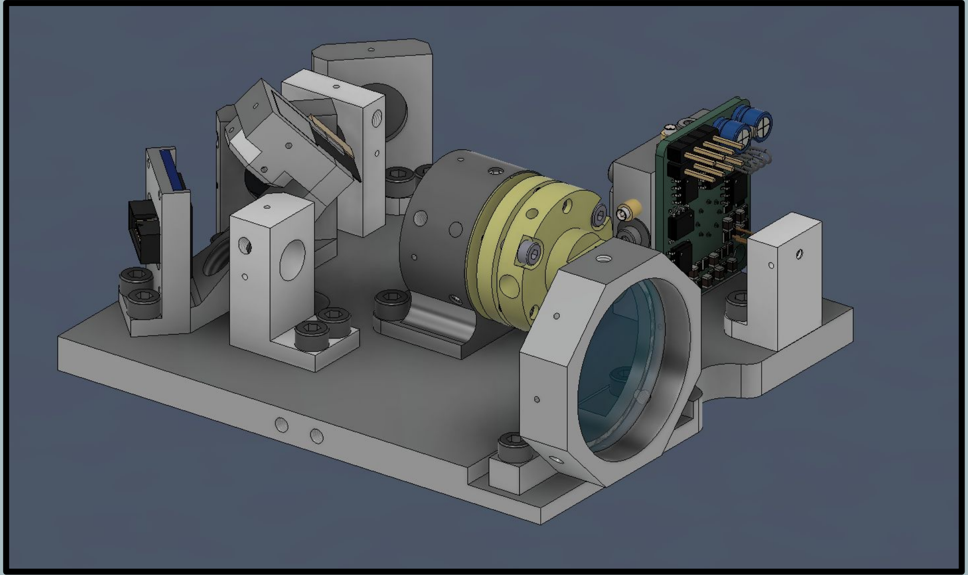
UChicago Space Program

PULSE-A Satellite

Worked with the payload subteam to design the optomechanical layer to properly interface with the whole satellite and fulfill the mission objective. Below the optomechanical layer is the layer housing the seed lasers, with the bottom layer containing the Erbium-Doped-Fiber-Amplifier (EDFA) layer.



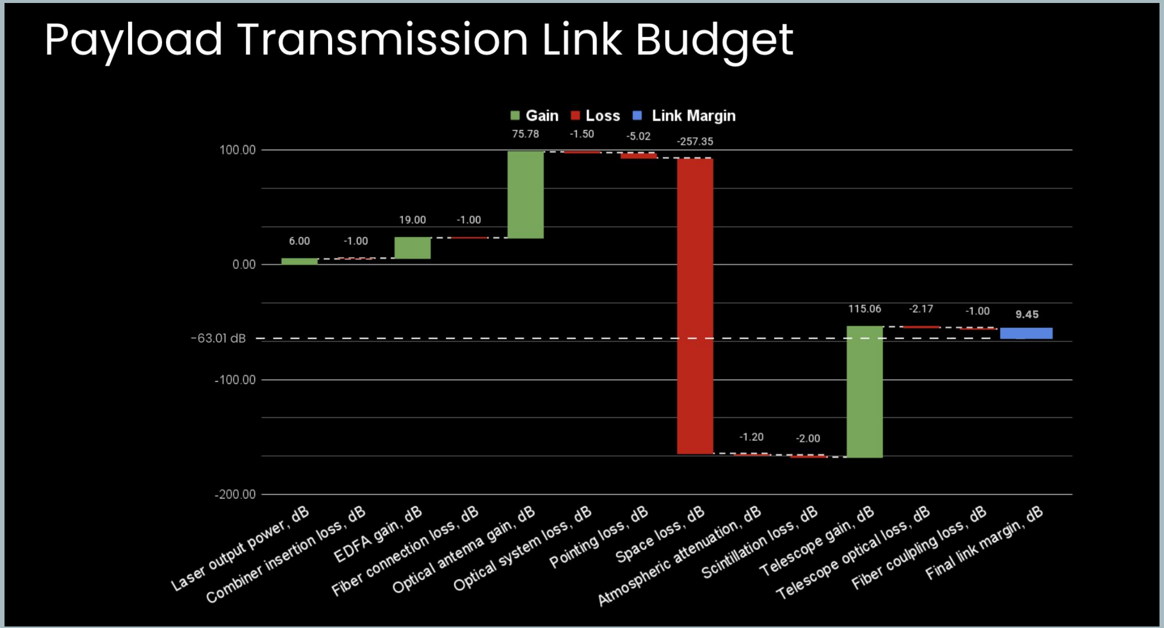
Payload Box with optomechanical, EDFA and generation layer



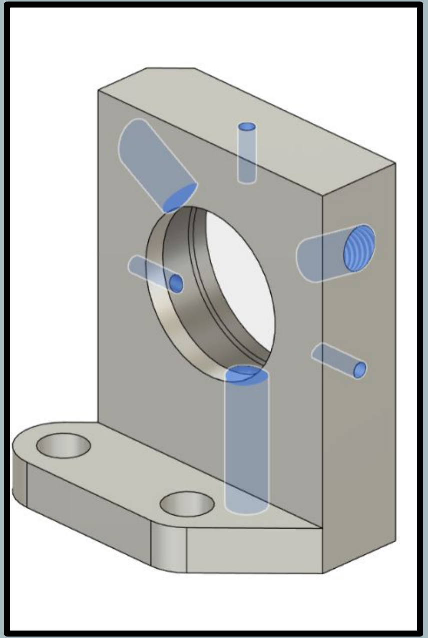
Optomechanical Layer alone

PULSE-A Satellite

Worked with the payload subteam to create a link budget and establish tolerances for the lens mounts in order to maintain alignment. Came to 9.45dB of margin which translates to ~0.01mm depending on the mount. Also helped design adjustment mechanisms in the mounts to maintain the link after assembly.



Link Budget with Tolerance Margin



Lens Mount with Set Screw, Mounting Spring, and Epoxy Holes

UChicago Space Program

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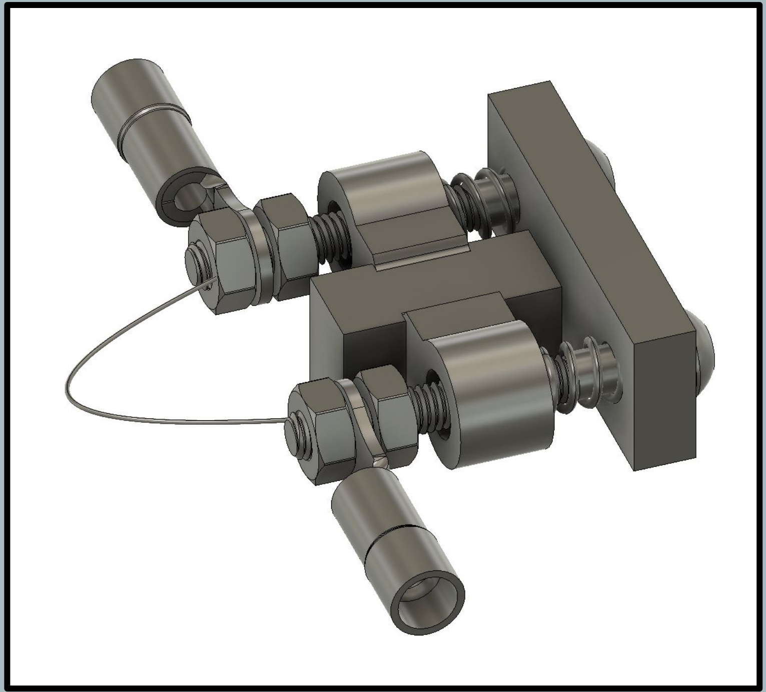
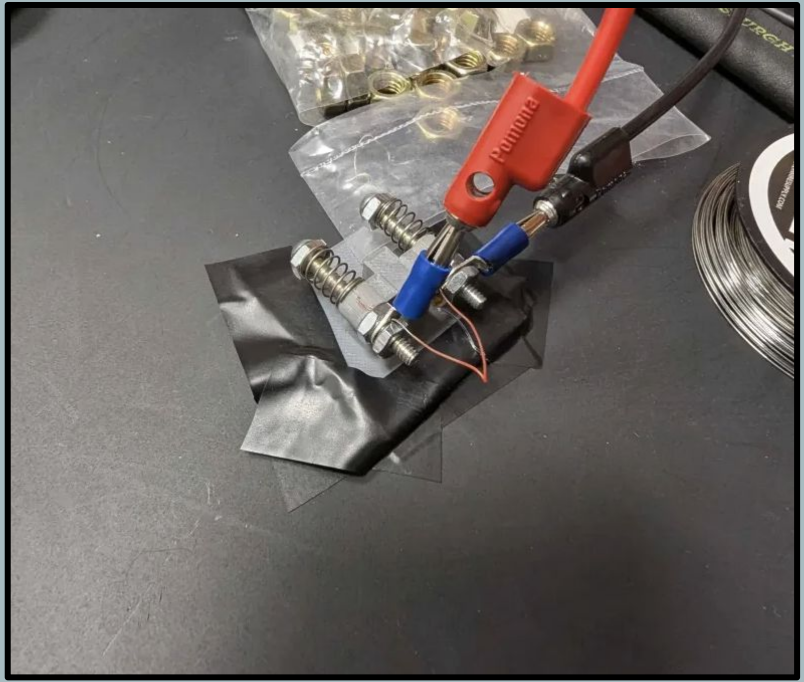
PULSE-A Satellite

Designed the deployment mechanism for the solar panels and the antennas using a traditional burn wire method. Spring loaded hinges keep tension between the restraint (vectran cable) and the burn wire, which is held to the restraint by two other springs. Deployment is then triggered via resistive heating of burn wire.



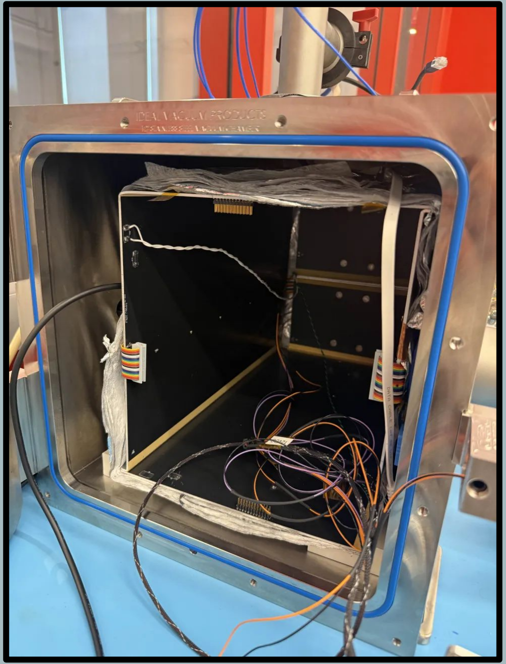
Deployment Mechanism (CAD)



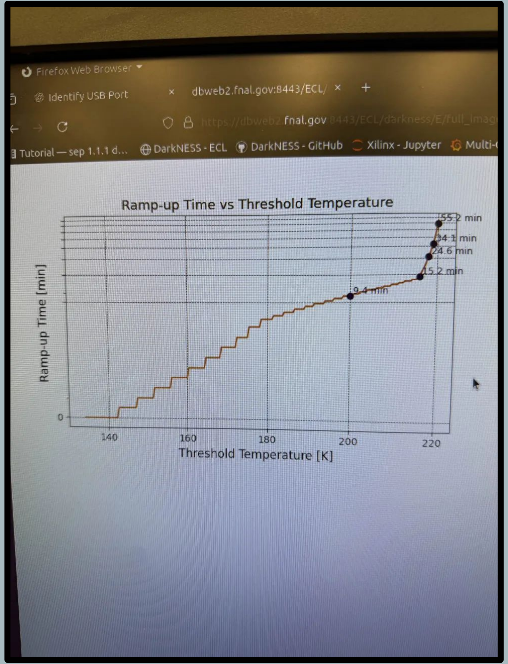
Deployment Mechanism (testing)
(Hinges and solar panels not shown)

PULSE-A Satellite

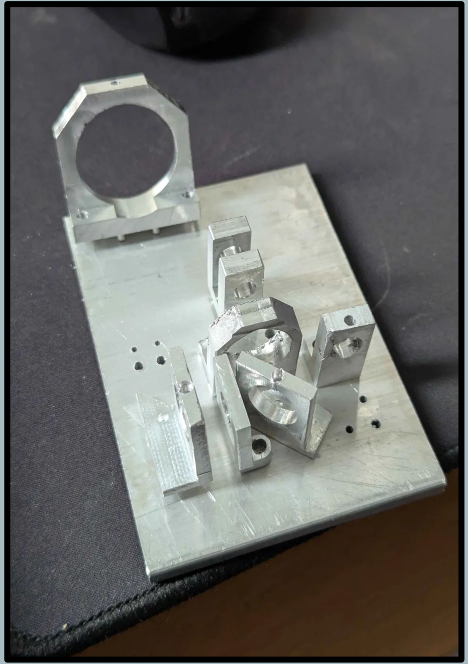
Preparing to test the avionics stack, optomechanical layer, and deployment mechanism within the context of the frame in a thermal vacuum. Designing qualification test plan for 160–300 K operation at 1×10^{-5} torr.



Thermal vacuum chamber to be used at Fermilab



Example ramp-up time vs temperature graph provided to us



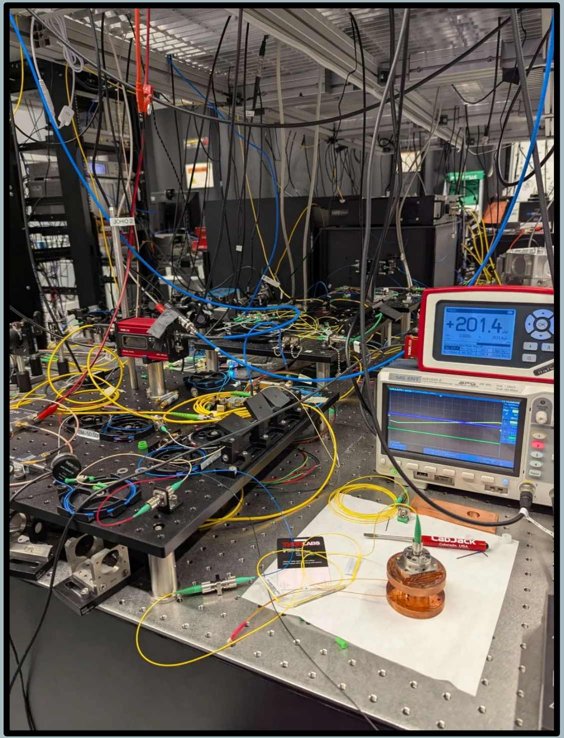
Prototype optomechanical layer I machined in a CNC

UChicago Space Program

Zhong Quantum Lab

Working with two graduate students on achieving quantum transduction with an efficiency rate of 70%. Currently working on designing an optical/microwave cavity to improve coupling between sample energy states.

- Main problem is achieving optical and microwave resonance at the same time to enough of a degree.
- Machined copper cavity spacers to ±0.05 mm spacer tolerance which corresponds to a ~20 MHz resonance shift.
- Redesigning the laser and microwave mounts to improve alignment and centering.

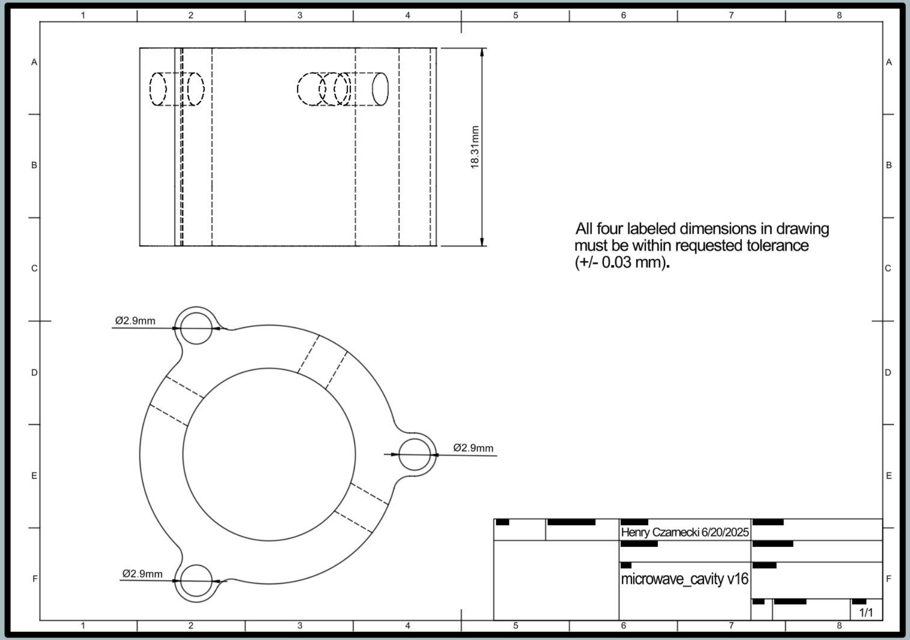


Full Setup (not supercooled)

Zhong Quantum Lab

3D modelled, wrote manufacturing workflows, and machined the cavity currently being used in lab. Went through multiple iterations and prototypes until now, with more improvement being needed from our current efficiency (38%)

Current CAD prototype of Cavity

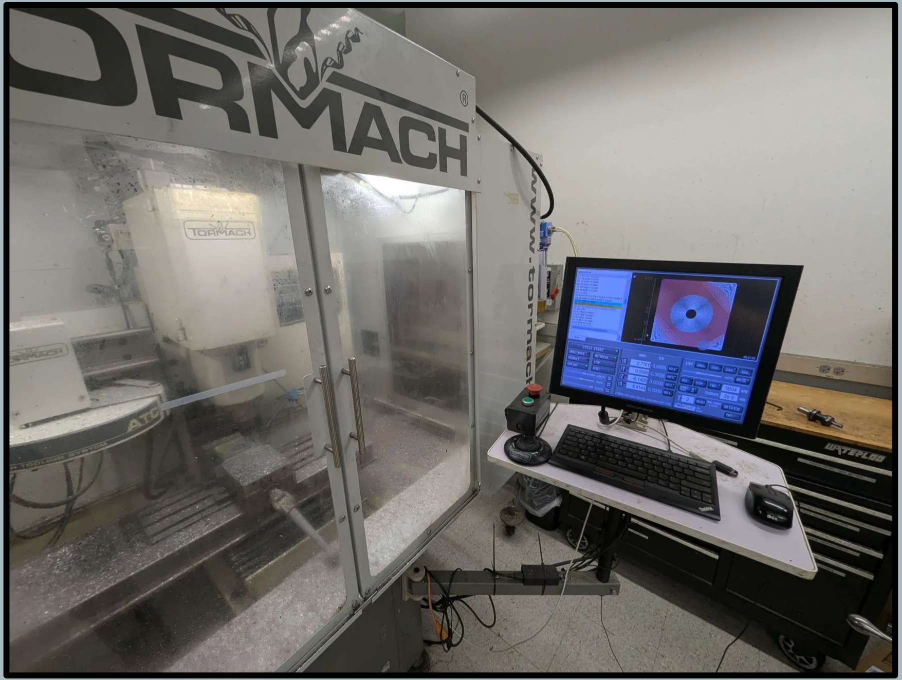


Drawing for machining cavity spacer

Zhong Quantum Lab

Designed cavity accounting for copper's CTE (16.5 ppm/K) under mK-scale temperature stability conditions, while iterating the external laser over 2 THz for coarse tuning.

Fully Machined Cavity

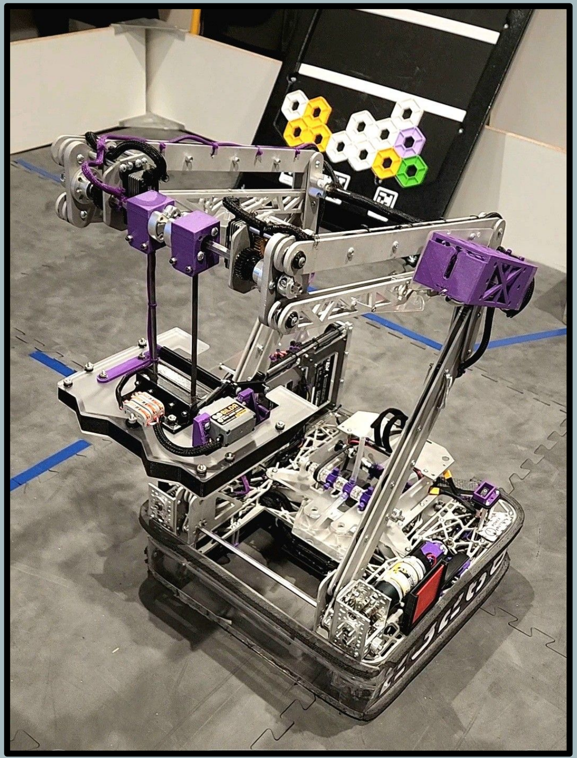


Machining Process with CNC

23268 Ultraviolet

Lead 3D modeller for FTC team 23268, which involved 3D modelling and constructing a custom-built robot for competitions. The year shown involved picking up hexagon shaped pixels and placing them on sloped ramps.

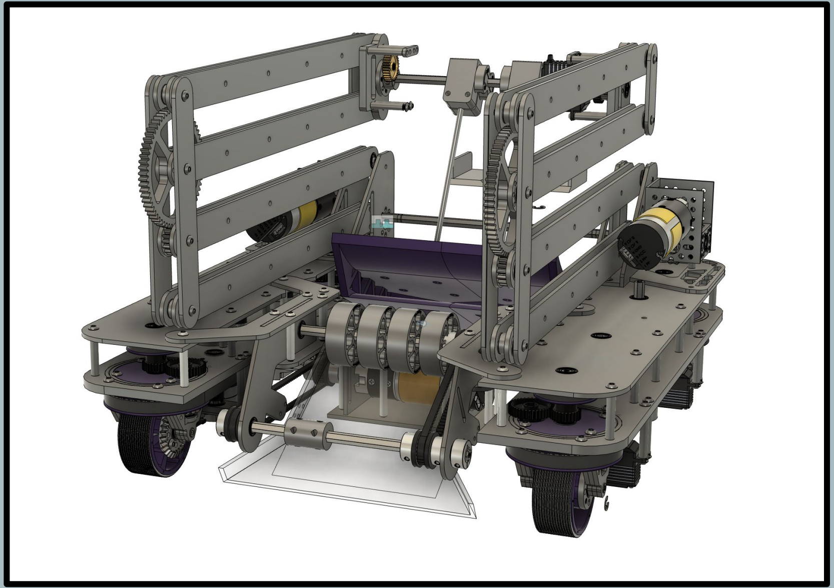
- Used Fusion 360 to design the preliminary robot and future iterations after competitions
- Optimized material and tolerance selection when sending designs to a sponsor manufacturer
- Won first place in the North Jersey league and advanced to the state competition, where we placed 6th.



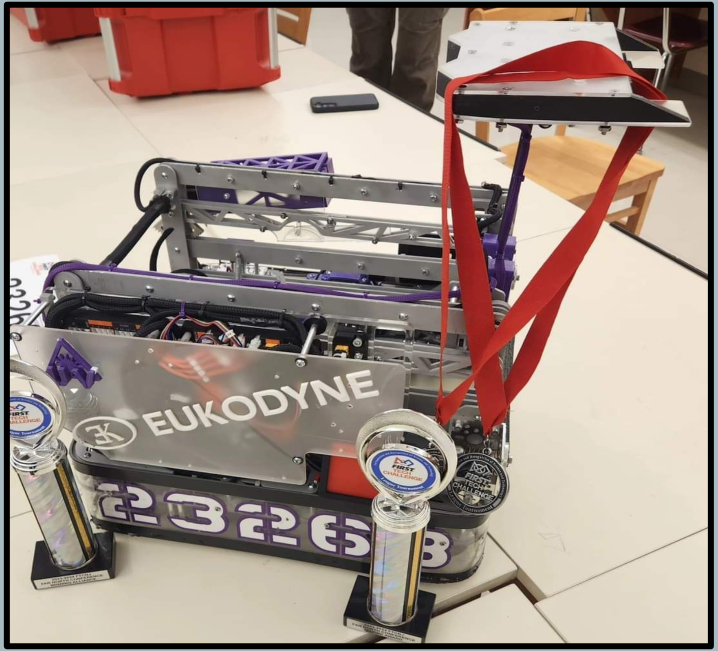
Full Robot

23268 Ultraviolet

23268 Ultraviolet



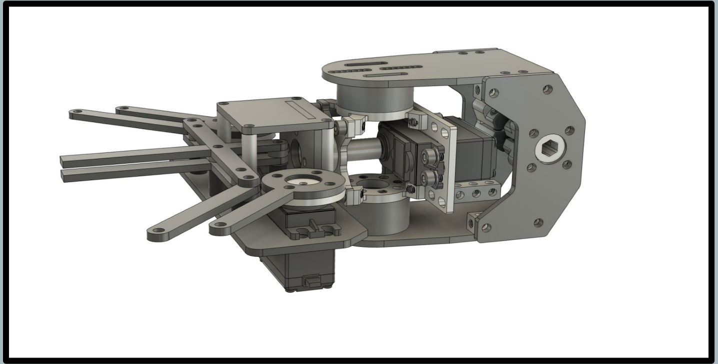
3D Model of robot

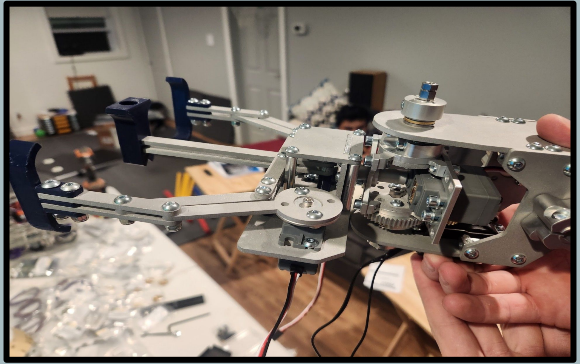


Fully built robot after competition

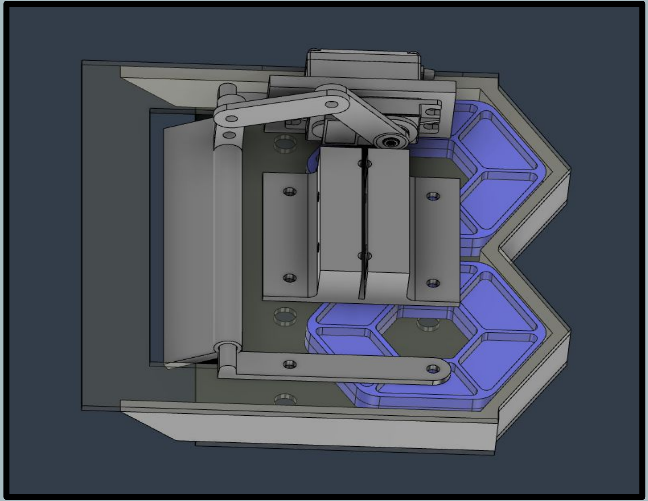
23268 Ultraviolet

Modeled a prototype gripper which was later scrapped due to weight and power draw, as it proved to be awkward and difficult to control during testing. It would also overload the batteries when used while the robot was moving, causing the computer to shut down.





Prototype Gripper



Replaced this during the season with a bucket system modeled after the shape of the pixels.