SMALL-SCALE OPTICAL SATELLITE

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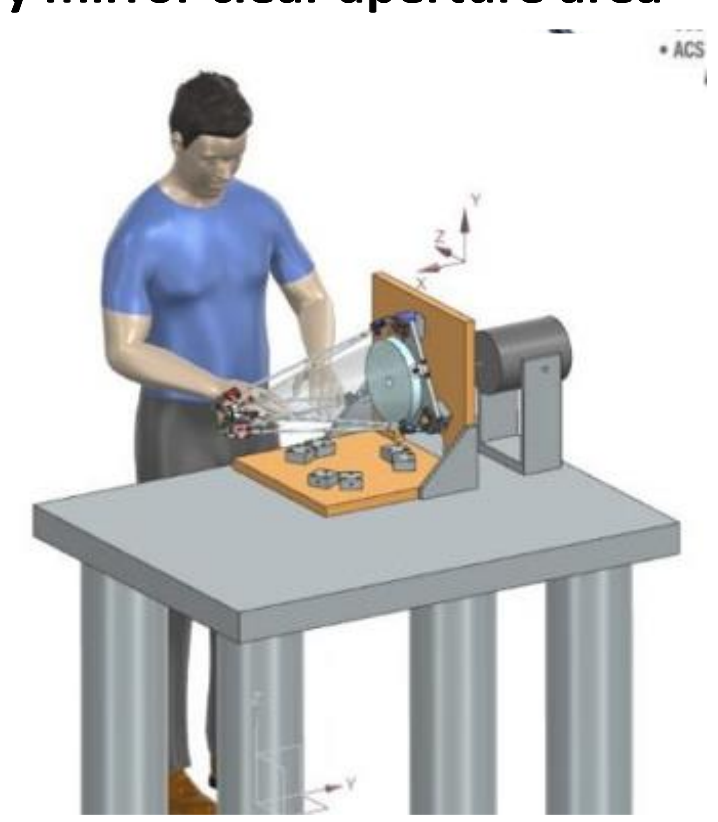
Problem Statement

- By testing, analyzing and redesigning the tabletop Cassegrain telescope, the issues that arise in full-scale models such as the Hubble telescope will be better understood.
- We will be specifically working on the **primary support**, **secondary mirror support** and the **alignment structure**.
- Based on our requirements, this will improve **manufacturability**, the **strength to weight ratio**, and increase the **resonant frequency** to ultimately provide better imaging of objects from large distances.
- The changes in design are to be correlated and tested against simulations.

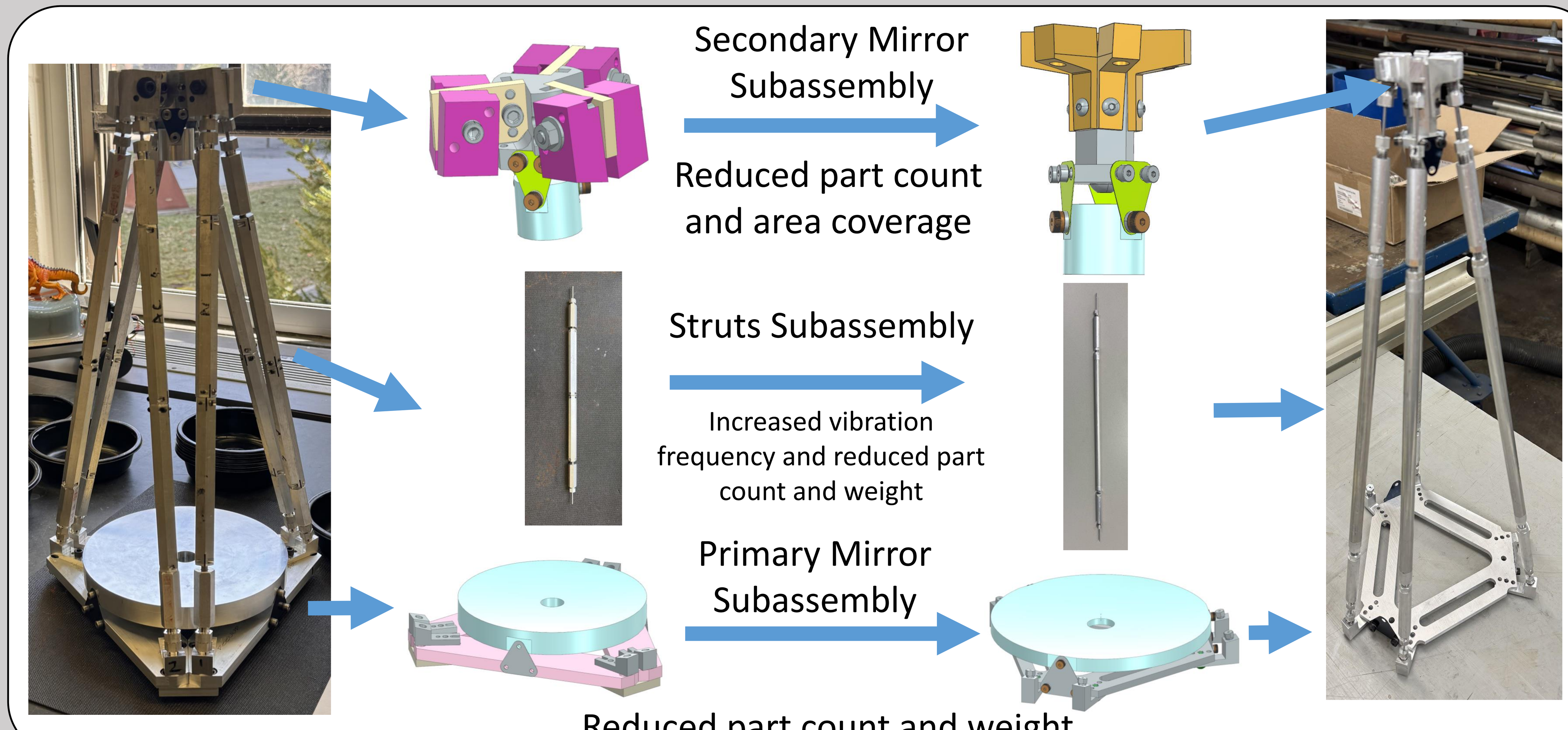
Requirements and Specifications

- **10%** reduction in weight
- **10%** reduction in total **part count**
- **First vibrational mode above 120 Hz** when grounded at the Primary Mirror Support Structure (PMSS) interface and supporting all hosted hardware
- Secondary Mirror Support Structure (**SMSS**) shall interface to the Support and Alignment Structure (**SAS**) at **three locations 120 degrees apart**
- **PMSS** shall interface to the **SAS** at **three locations 120 degrees apart**
- Structure shall have positive margins of safety against **yield and ultimate failure** when exposed to a quasi-static load of **12 G laterally and 18 G axially simultaneously** (lateral swept 15° increments)
- **SMSS** and **SAS** shall not obstruct more than **14%** of the **primary mirror clear aperture area**



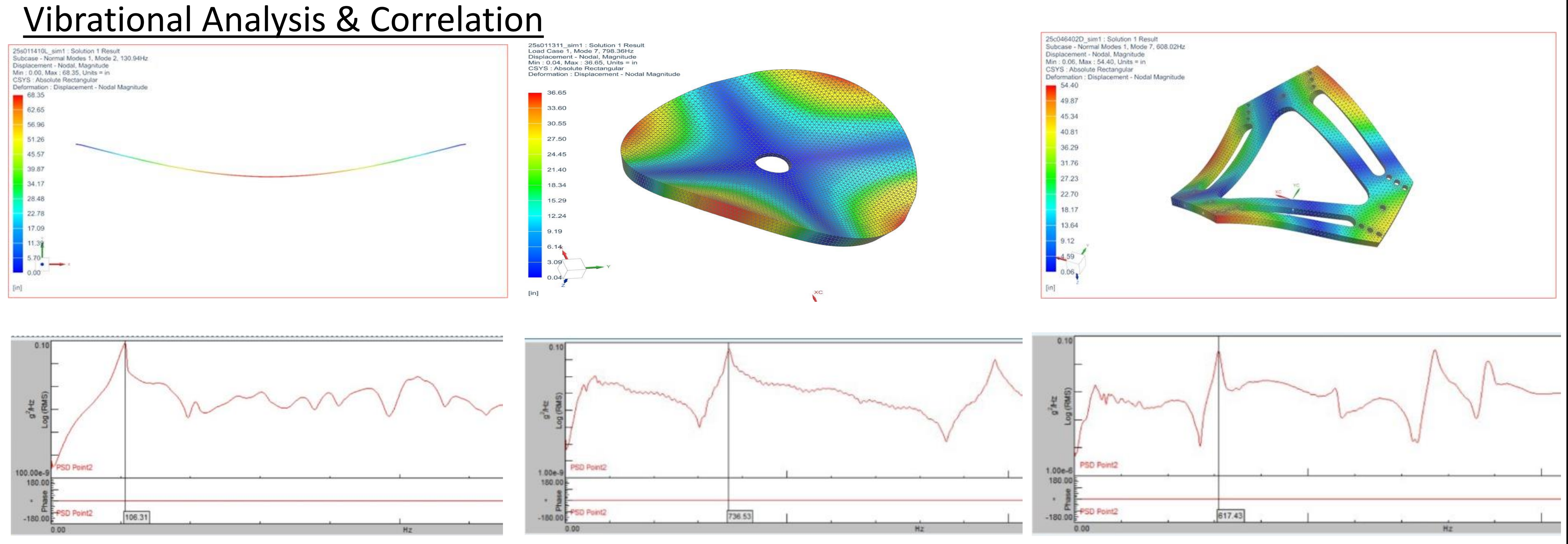
Model of system on tabletop

Concept Description

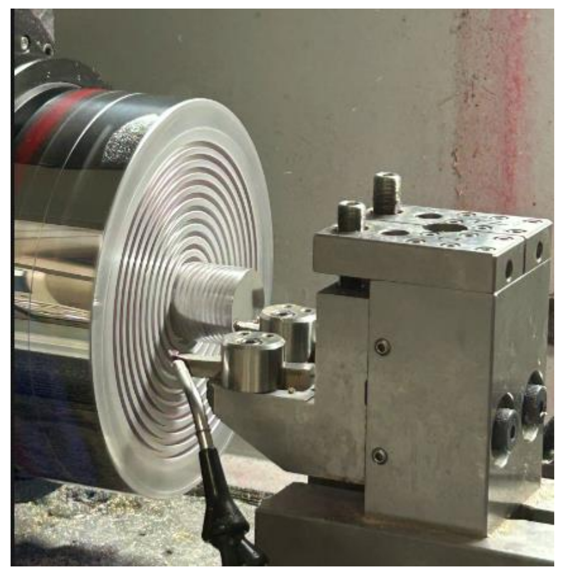


Analysis

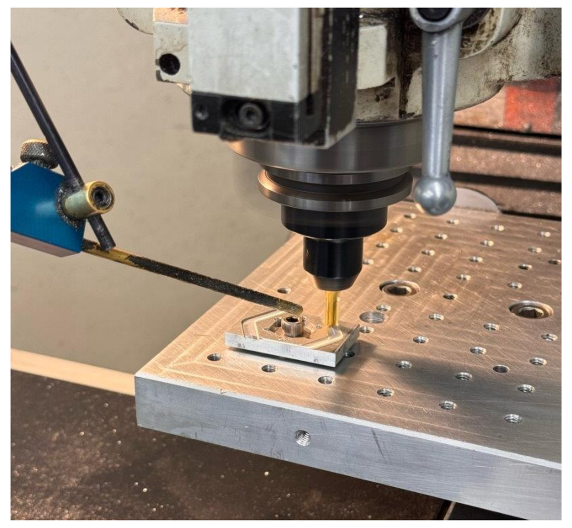
Vibrational Analysis & Correlation



Manufacturing



Diamond turning secondary optic



Flexure mount fabrication on Prototrak

The parts were manufactured using a combination of manual mills/lathes, Prototrak and 4-axis Haas mill and CNC lathe.
The primary mirror was made on the Haas mill due to its weight saving geometry, both mirrors were initially turned on the CNC lathe and then diamond turned to their optical prescription.
The hex shaft and flexure mounts were made on the Prototrak and the struts were primarily made on the lathe.

Testing

The simulated fundamental frequency of the simplified strut model is 130Hz, while the test of the fabricated strut model shows a frequency of 106Hz. In the simplified strut model screws were not included and the strut bolts were fully threaded. The fabricated model has a pre-set adjustment on both the coarse and the fine adjustment sides; however, the tested model did not incorporate that adjustment. The additional weight, imperfect connection caused by the screws and differences in total strut assembly length, contributed to the lower fundamental frequency observed in the test.

Both the primary mirror and primary base have relatively low differences between their simulated and test results. The simulated frequencies were 798Hz and 608Hz, while the tested frequencies were 736Hz and 617Hz, respectively. These differences are likely due to differences in material properties from the simulated 6061-Aluminum and the actual material used. Additionally, there are likely minor differences in thickness and geometry, as the simulations used an idealized model.

Evaluation of Requirements and Specifications

Requirements	Initial	Final	% Improved	Status
Weight Reduction	7.2 lbs	2.57 lbs	64%	Met
Part Count Reduction	288	203	30%	Met
>120 Hz	30 Hz	127 Hz	323%	Met
120 Degrees Apart				Met
G Loads				Not Met
<14% obstruction	35%	21%	40%	Improved

Future Work

- Thermal testing
- Gravity-load testing
- More in-depth vibrational testing
- Image testing

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