Space Based Deployable Baffle and Optical Alignment System

Sandia National Laboratories

Paul M. Rady Mechanical Engineering
UNIVERSITY OF COLORADO BOULDER

Patrick Murphy | Jack deBloois | Isaac Brighton | Max Nyffenegger | Isaac Gordon | Kenny Colanto | Connor Jarolimek

Sandia National Laboratories

Background

- Baffle: Optical structure used to reduce stray light from interfering with an image acquisition device
- Optical alignment systems keep lenses in focus regardless of external factors

Objectives

- Design, build and test deployable baffle and optical alignment system
- Utilize additive manufacturing in design

Requirements

- System must be under 5lbs
- Launch configuration must fit within 1ft^3
- System must be operational after typical launch vibration profile
- System must function between temperature range of -40C to 70C
- Lens must maintain positional accuracy within 1 cm from 2 m away
- $2,000 budget

Design

Deployment Housing

Top Plate: Grade 2 titanium, maintains mechanism alignment, securing guide rods and lead screws

Truss Tubes: Carbon fiber, linked to connectors via 3M 2216 epoxy

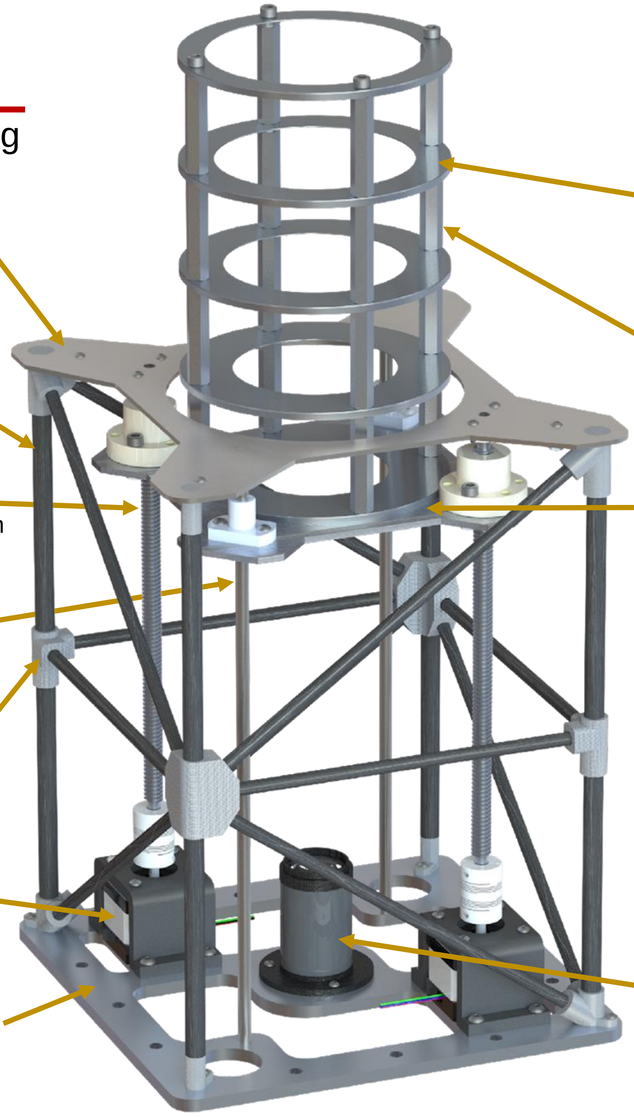
Lead Screw: Carbon steel, linear deployment mechanism

Guide Rods: Grade 2 titanium, adds support to structure, guides deployment

Connectors: Markforged Onyx™ 3D print material, 4 designs

Stepper Motor: Two motors drive lead screws with shaft couple

Base Plate: Aluminum 6061, mounts to external system



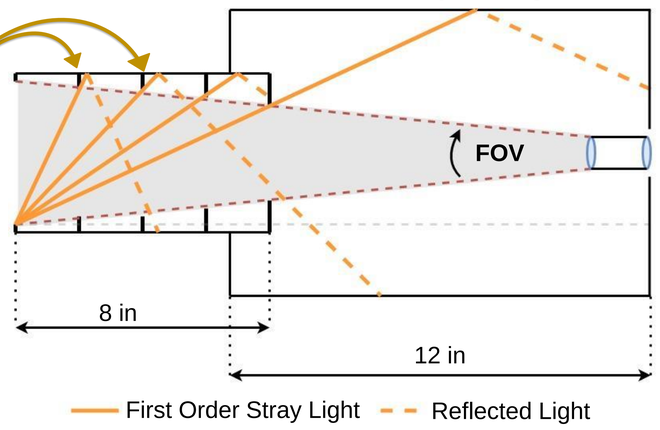
Baffle

Vanes: Thin aluminum 6061 sheet, each with different inner diameter designed to absorb light outside FOV

Standoffs: Aluminum 6061, provide structure for baffle

Baffle Flange: Aluminum 6061, houses linear bearings for guide rods, lead nuts for deployment

Baffle Cross Section Ray Tracing

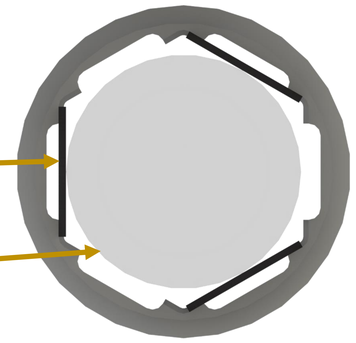


Optics

Flexures: Edge bonded to lens, reduces effect of thermal fluctuations

Lens: 1 inch diameter, double convex

Lens Tube: Carbon fiber, secures lenses at required distance, lens fixture mounted on each end



Optical Alignment Fixture: 6:1 Scale

Testing/Analysis

Environmental

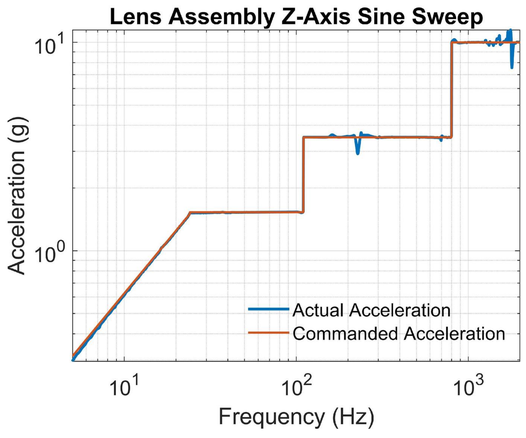
- Separate testing of Lens Alignment and Deployment systems

Vibration

- Tested with given rocket launch profile

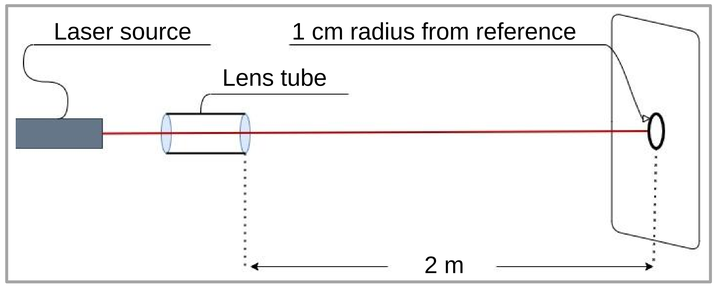
Thermal

- 10 cycles, 20-minute soak time at temperature limits,10 minutes at room temperature



Lens Alignment

- Optical mounting fixture used with laser to test positional accuracy, pre and post environmental testing
- **Misalignment measurements:** After vibration: <1mm, after thermal cycles: ~4mm



Epoxy

- Tested epoxy shear strength via tensile test machine
- Large variability in results from 3D print material, epoxy

Results

- System fits within given envelope and deploys properly
- Design weight: 4.97 lbs
- Actual weight: 5.17 lbs
- Deployment mechanism, optics met performance specifications

Future Recommendations

- Use flight grade hardware to reduce mass
- Investigate unlatching mechanism in case of motor failure
- Further analysis and research on epoxy, 3D print material readiness for environment

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