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Sandia Senior Design Bonanza – AM Optical Alignment Structure

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Introduction / Motivation

Our team is competing in Sandia National Laboratories' Senior Design Bonanza. This competition encompasses 15 teams from 10 different universities across the country.

We were tasked with creating a robust, reliable and deployable optical alignment structure. The optical alignment structure should feature an additively manufactured lens mount with the end goal of viewing debris in space.

The competition seeks to inspire novel approaches to the design and prototyping of small devices for space applications. This challenge aims to explore ways to enhance spatial awareness with respect to space debris. This improved awareness will provide multiple benefits, most importantly, the ability to detect obstacles and predict collisions with debris for space-bound structures.

Approach

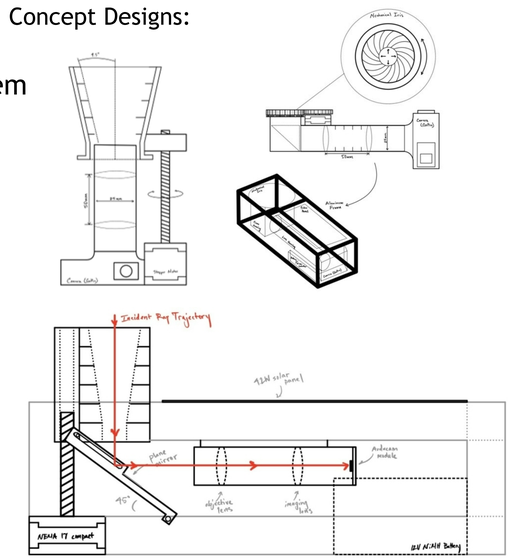
Background Research
- Draw upon existing baffle orientations and experimental procedures to provide a baseline methodology for proceeding through the problem

Concept Generation
- Provide various design approaches focusing on different methods of light filtration and baffle orientation

Prototyping
- Initial prototyping efforts with the use of 3D Printing
- Assemble components and subsystems within Aluminum extrusions
- Evaluate interfacing of components and subsystems
- Re-design and Re-prototype

Experimentation
- Simulation of shock and vibe profile using shaker table
- Verify optical alignment procedure and optical results
- Temperature testing and mitigation of off-gassing effects
- Verification of functional specs using proper experimentation

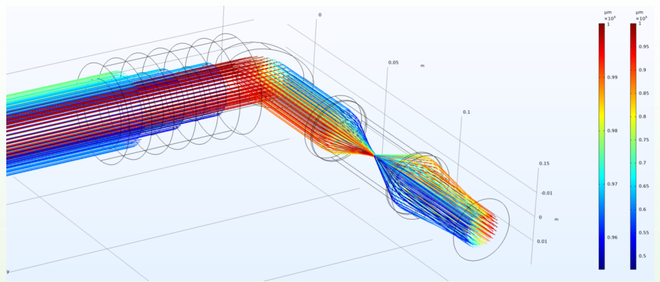
Concept Designs:



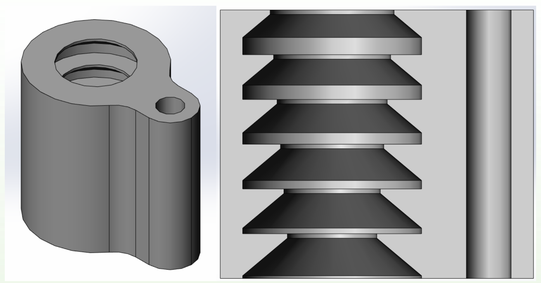
Current Status / Results

Design, Manufacture and Prototyping

- Constructing prototype assembly
- Exploring material options for additive manufacturing (AM)
- Evaluating 3D printing results against more complex AM techniques
- Finalizing optical geometry (COMSOL: Ray Tracing Simulation)
- Developing CAD model (SolidWorks)
- Programming microcontroller for motor/imaging/charge control & interface



COMSOL Multiphysics - Optical Simulation



SolidWorks Baffle Model

Challenges

Design and Fabrication Challenges:

- Experimental replication of provided shock/vibe profile
- Validation of thermal operational requirements (-40 to 70 Celsius)
- Balancing availability and cost of additive manufacturing techniques

Prototype-Specific Challenges:

- Solar charging (*trickle charging*) control scheme for Nickel-metal hydride battery (minimize battery capacity degradation)
- Ensuring components maintain proper alignment after launch

Next Steps / Future Work

Prototyping

- 3D Print lens, mirror & motor mounts
- Placement and attachment of subsystem components to Al T-Rail
- Optimize charge control scheme for electrical operation

Experimentation

- Verify material selection with temperature and shock/vibe specs
- Test coating methods to optimize surface reflectivity
- Verify optical simulation in COMSOL against prototype results
- Verify functional specs including vacuum and autonomous operation

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National Nuclear Security Administration

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