Bio-Inspired Additively Manufactured MMOD Protection

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ACCOMPLISHMENTS

- **Designed and tested a novel spacecraft shield design**
- Worked with a real-world, high impact stakeholder, the National Reconnaissance Office
- Completed multiple rounds of ideation, creating over 60 concepts prior to down final design
- Validated concepts using CTH simulation and HVI testing at Texas A&M and compared results to benchmark performance and specifications
- Began a materials testing project imbedded in the project to bridge the gap of how polymers react to extreme strain rates and how it influences hypervelocity resistivity

METHODS

- Named problem, stakeholder needs, and requirements

Geometry:

- Combined ideation concepts with background research, HVI testing results, and CTH simulation to down selection process
- Picked a prototype and began testing and iterating using above tools

Materials:

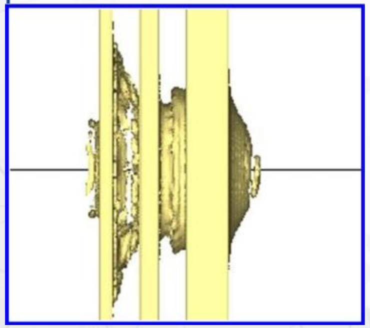
- Found gaps in knowledge about thermal cycling, impact testing, and effects print orientation has on energy dissipation
- Created test plan to bridge gaps using Charpy, SHPB, and HVI using various temperatures, orientations, and specimens

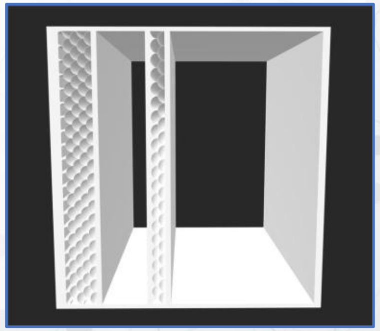
MISSION OVERVIEW

Problem: The **rapid increase** of man-made objects and debris in orbit increases the potential for **catastrophic damage (Kessler Syndrome)** that must be controlled to ensure **U.S. space superiority**.

The Double Fish Scale Spacecraft Shield: Our final design uses our findings from plate and prototype design testing (CTH and HVI Gas Gun shots) by combining multi-plate, complex geometry, and increasing plate thicknesses to provide a shield that compared to NASA's stuffed Whipple specifications prove our 3D printed ULTEM 9085 shields with complex internal geometry perform better, and offers an alternative route to future spacecraft shielding.

Solution: This project aims to **protect spacecraft from the hazards of space** (specifically micro-meteoroid orbital debris) and introduce novel, spacecraft shield designs that increase performance and decrease cost





IMPACT

- **Increased resiliency in space by creating versatile shield designs to protect national security assets from the space environment and orbital debris that surrounds our orbits**
- Provides concept for persistent protection and rapid repairments for ISR/Missile Warning assets that require around the clock protection
- Decreasing launch costs by decreasing weight and volume requirements for shielding parts- can send up ULTEM spools rather than pre-printed shields

FUTURE PLANS

- On orbit manufacturing, which allows for more complex internal geometry
- Scale up design to accommodate larger spacecrafts with challenging geometries
- Test different geometries (fractals, truss, spiral) with more differentiation in all 3 planes to find a most optimized design.
- Create geometries designed to be printed in orbit under micro-gravity conditions
- Create models for multiple materials that can be used in spacecraft shielding to make iteration easier for specific case missions

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