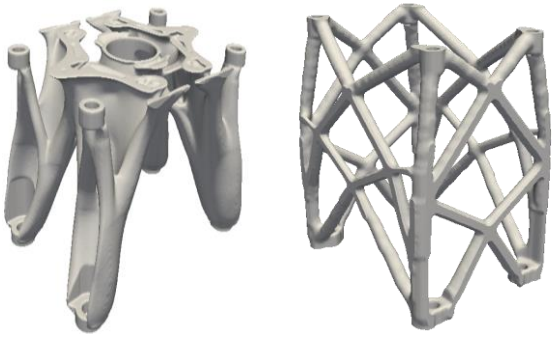
Topology Optimization of Lightweight, Additively Manufactured Lattice Systems for Space Applications

- PI: Prof. James Guest, Department of Civil Engineering, Johns Hopkins University
- Co-I: Dr. Elizabeth Congdon, Johns Hopkins University Applied Physics Laboratory
- Co-I: Prof. Kevin Hemker, Department of Mechanical Engineering, Johns Hopkins U.
- Co-I: Dr. Steven Storck, Johns Hopkins University Applied Physics Laboratory

Research Objectives:

- New physics driven topology optimization-based design methods capable of deriving lattice and shell features.
- Design secondary structures for multiple mechanical functionalities considering manufacturing process-specific constraints and variations.
- Validate the design framework with a fabricated demonstrator component tested under simulated application loads.
- Advance approach from TRL 1 to TRL 3.



Attachment bracket topology optimized for relatively large (left) and small (right) magnitude applied loads.

Approach:

- Four thrusts: (1) Topology Optimization, (2) Additive Manufacturing, (3) Property Characterization, and (4) Large-scale Experimental Validation and Calibration.
- Utilize projection-based topology optimization methods with gradient-based optimizers.
- Leverage history of close collaboration and team expertise to produce space application-relevant optimized secondary structures.

Potential Impact:

- Demonstrate that lightweight secondary structures can be designed using topology optimization and directly fabricated with predictable performance using metallic AM.
- An integrated framework coupling application-relevant topology optimization with manufacturing that can be extended to alternate manufacturing processes and performance properties of use to a broad range of NASA applications.