Wire-Driven Mechanisms for Deployable Components for Optical Payloads

Mark Honeth, Guglielmo Aglietti, Akash Yalagach

Presented by Mark Honeth

Team

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  - Space Institute Director

- Akash Yalagach
  - PhD Candidate

- Mark Honeth
  - Project Engineer

Deployable Optical Structures - Heritage

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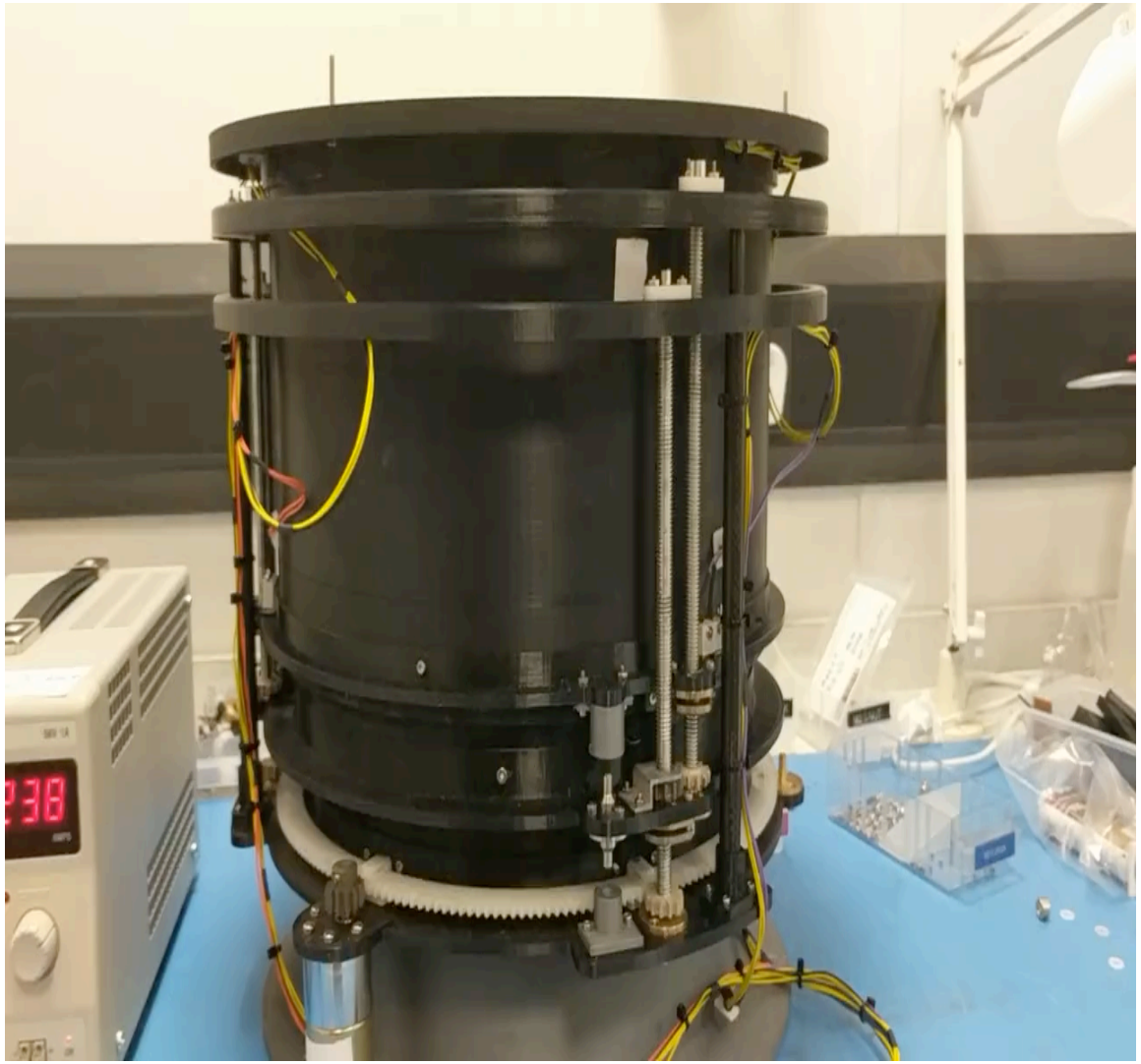
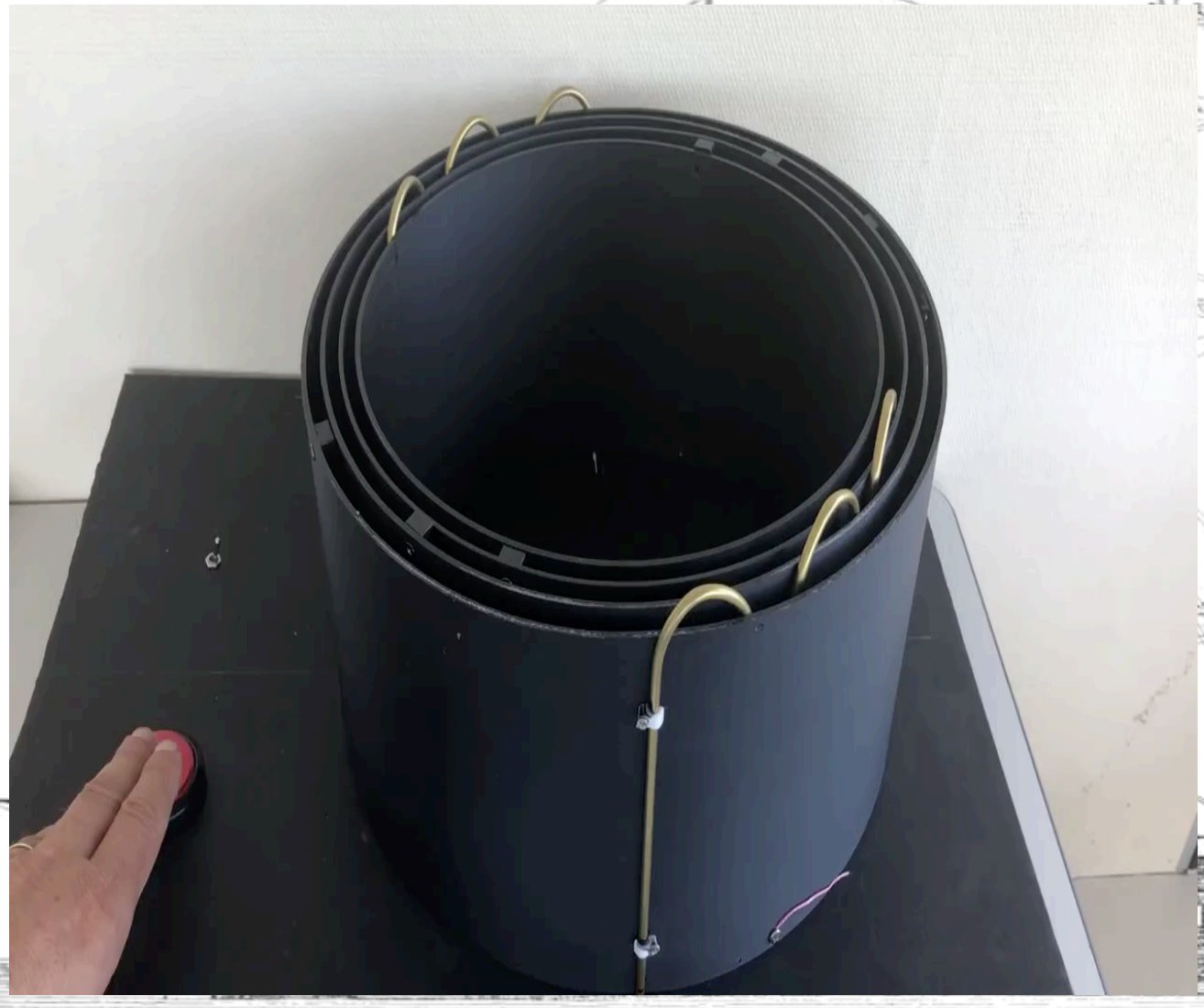
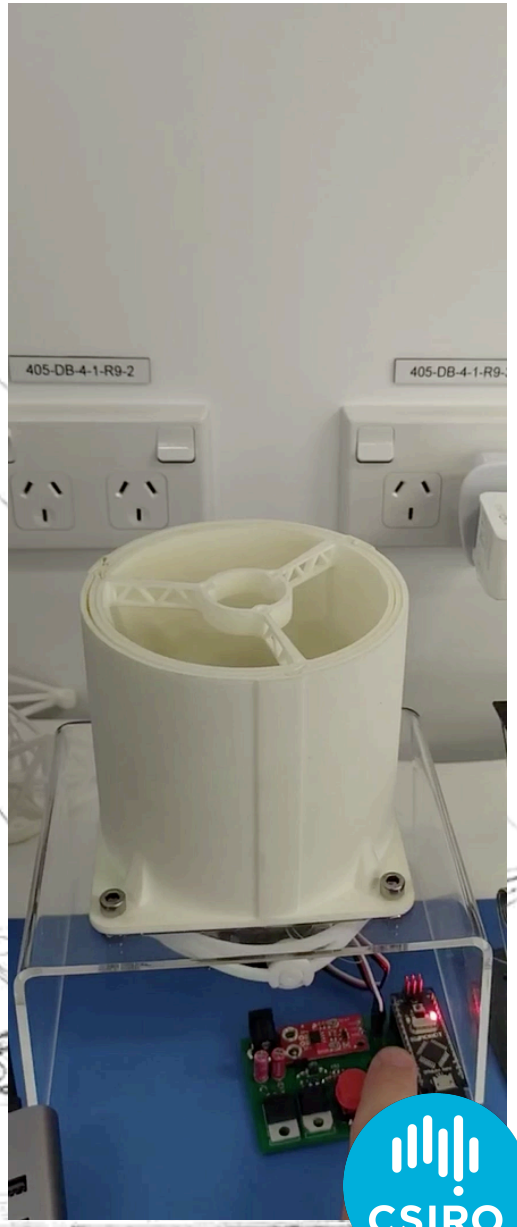
Deployment Scheme – Lead Screw



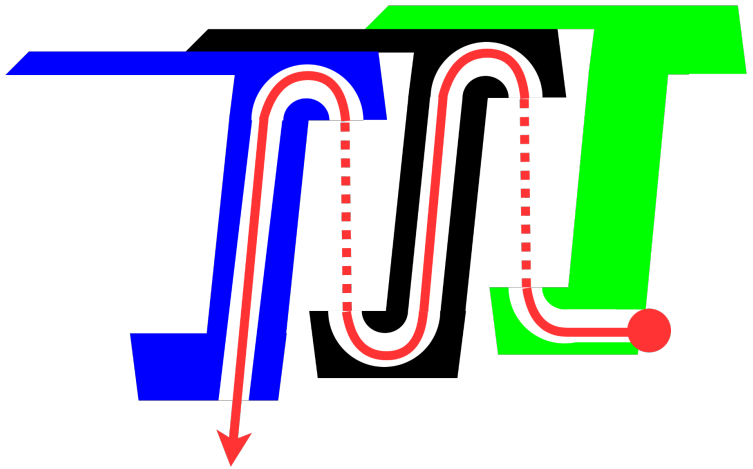
Deployment Scheme – Wire



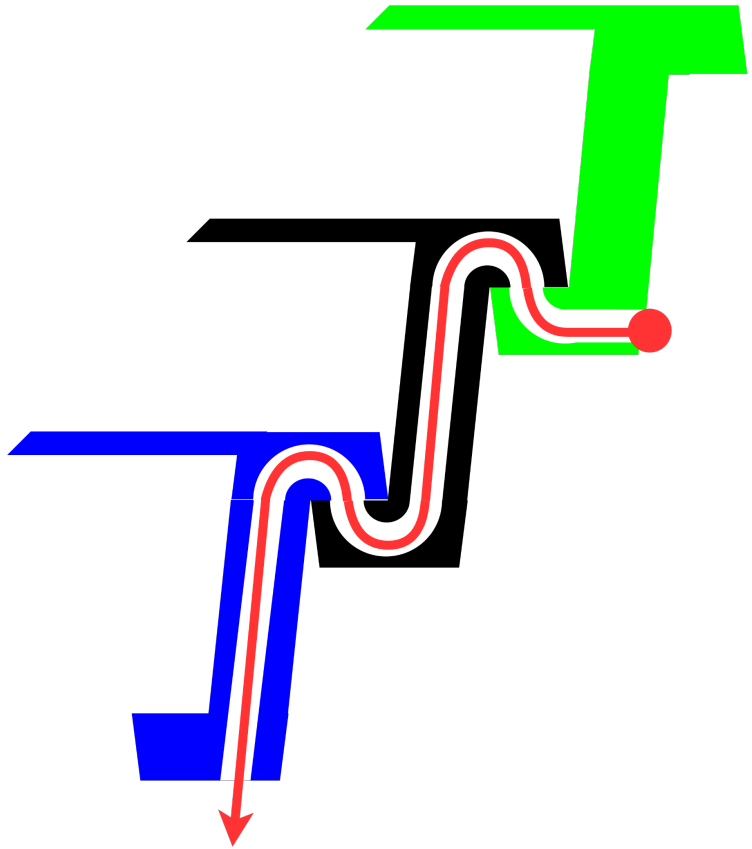


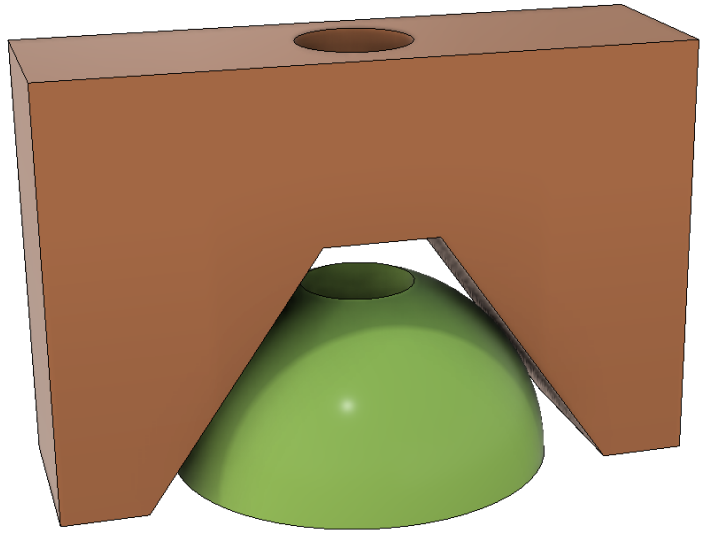
Wire Routing Scheme & Locating Features

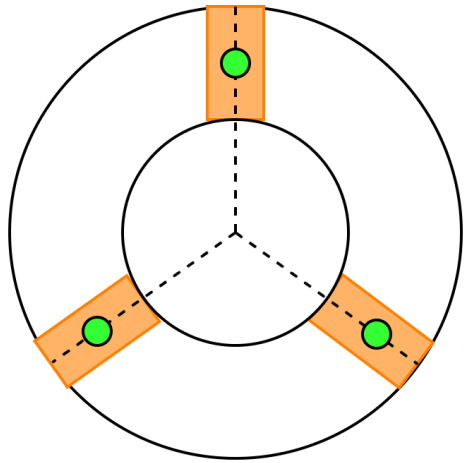
Stowed



Deployed



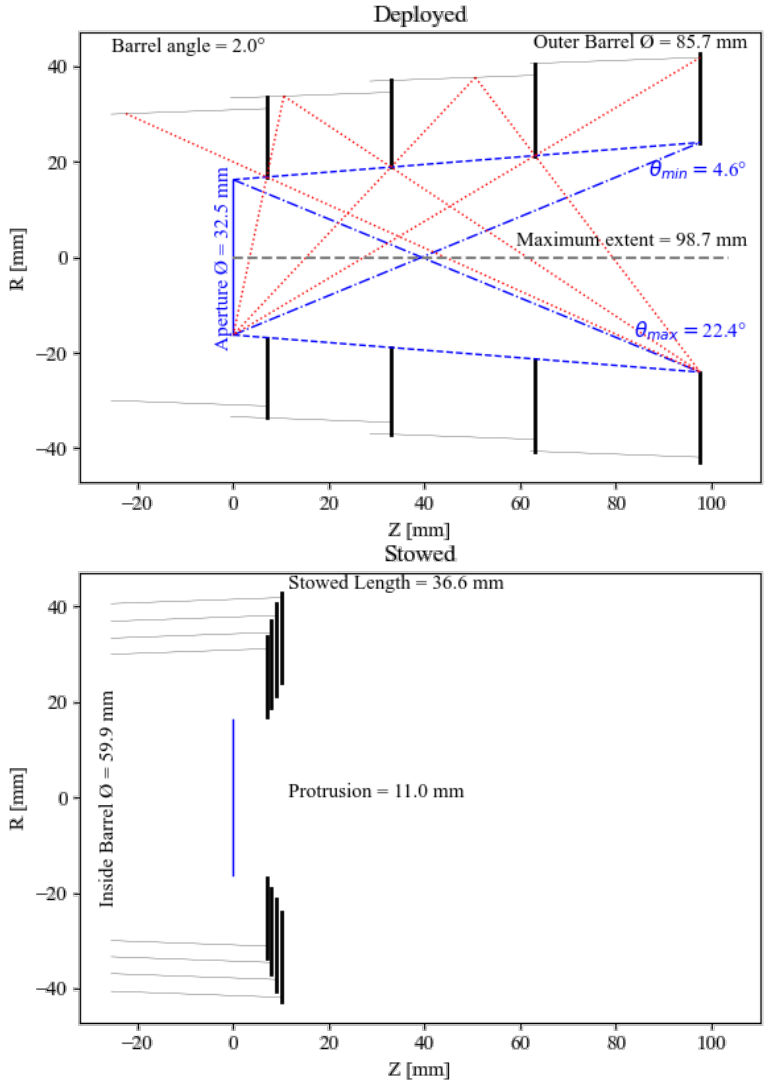


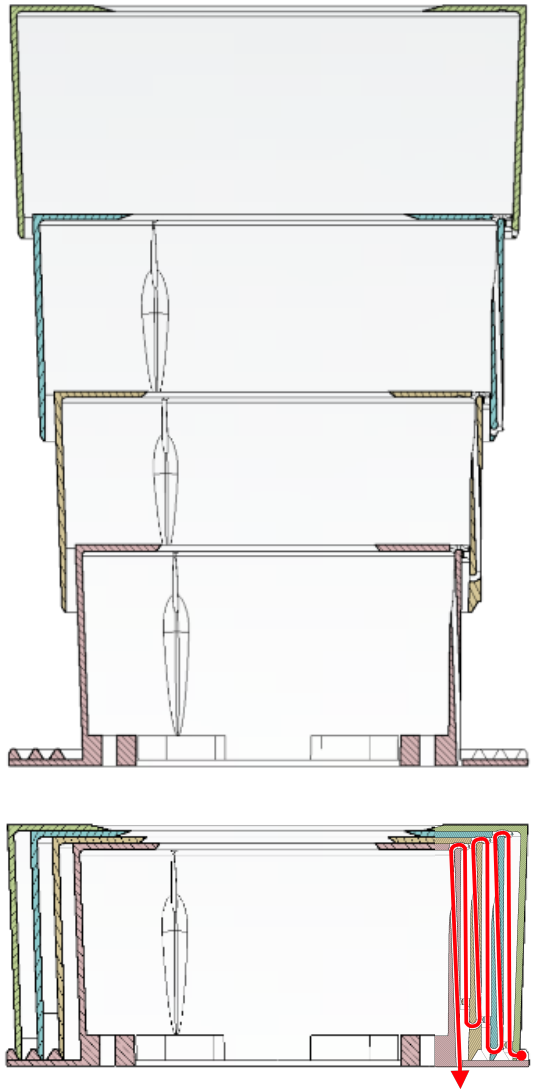


Baffle Design

- **Aperture Ø**
- **FOV**
- **Exclusion Angle ↔ Length**

- Maximum Outer Ø
- Barrel Angle
- Minimum Inner Ø
- *Protrusion beyond aperture*
- *Stowed length*
- *Volume behind aperture*
- Mass
- Materials, etc.





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Deployment Drive Mechanism Concerns

- Driver
- Tension Balancing
- Shock

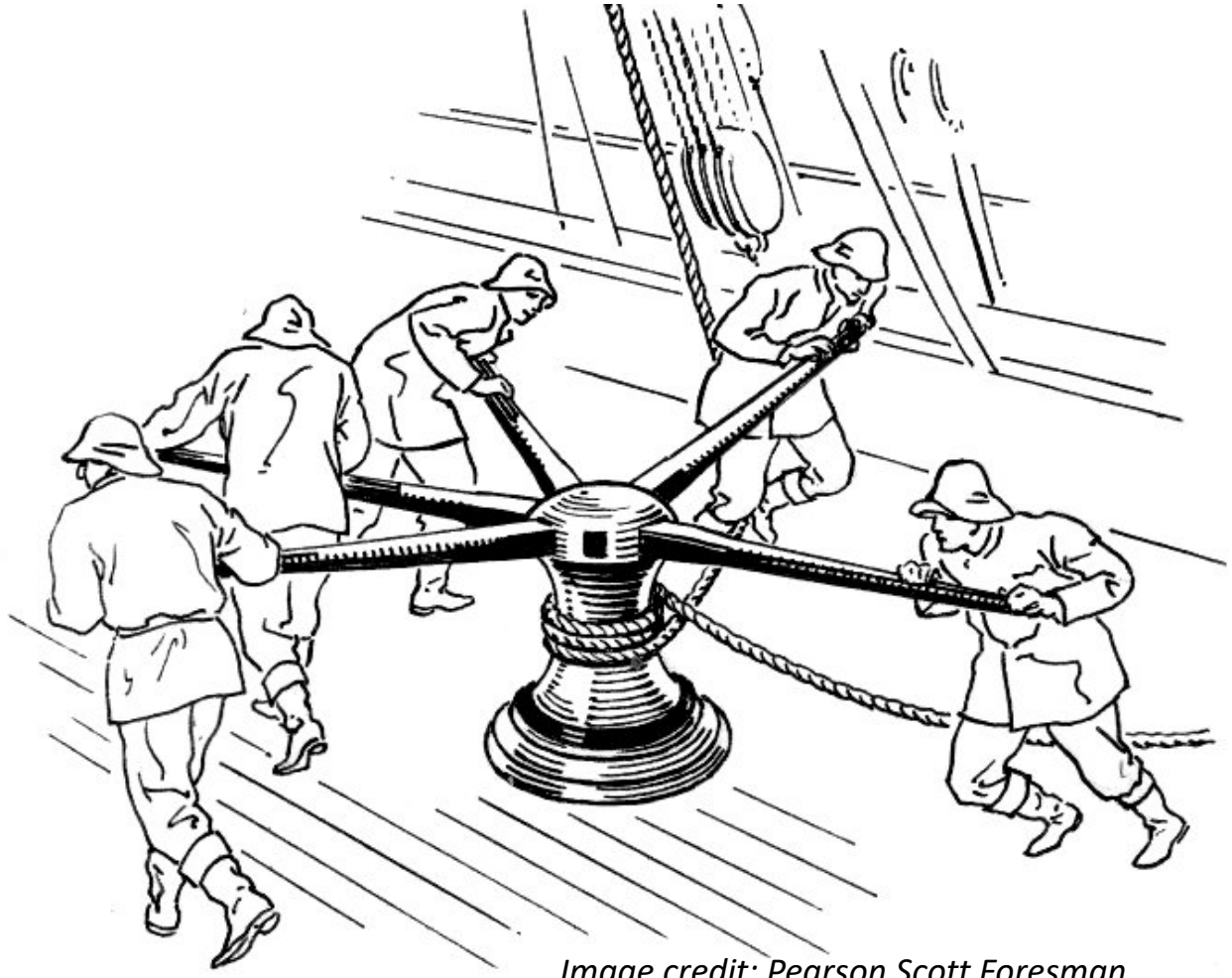
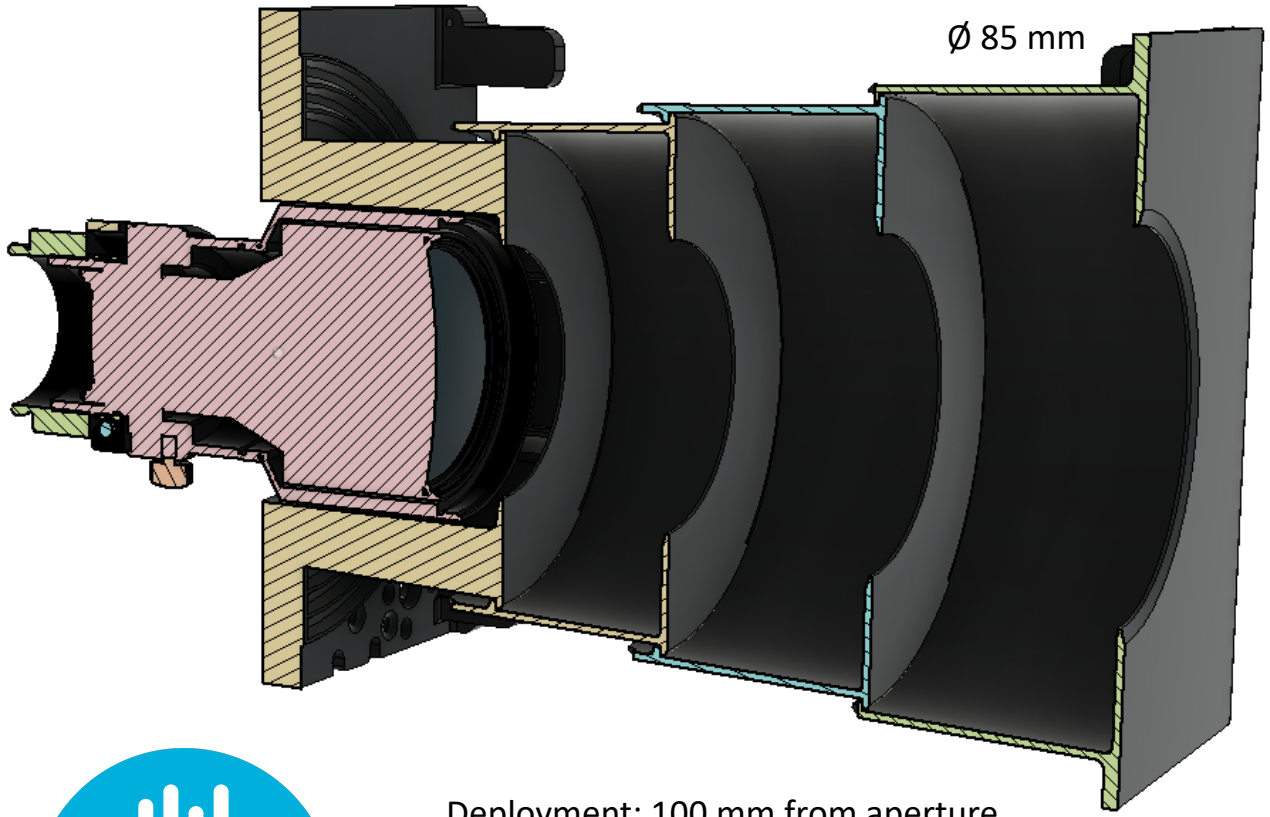
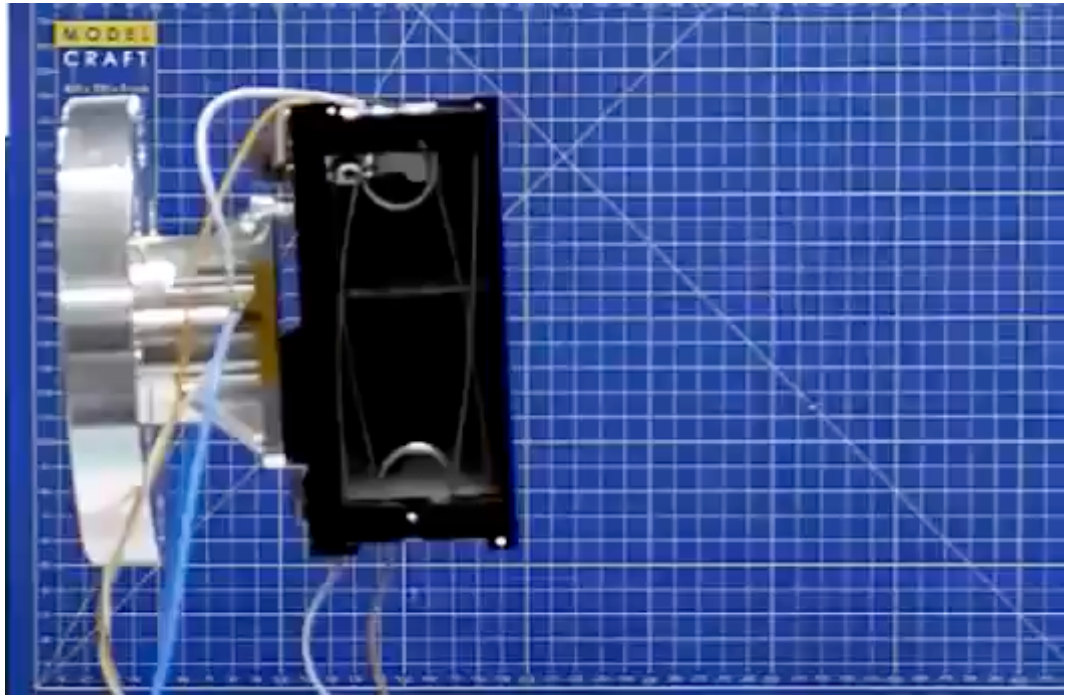


Image credit: Pearson Scott Foresman

Deployment Drivers – Torsion Spring

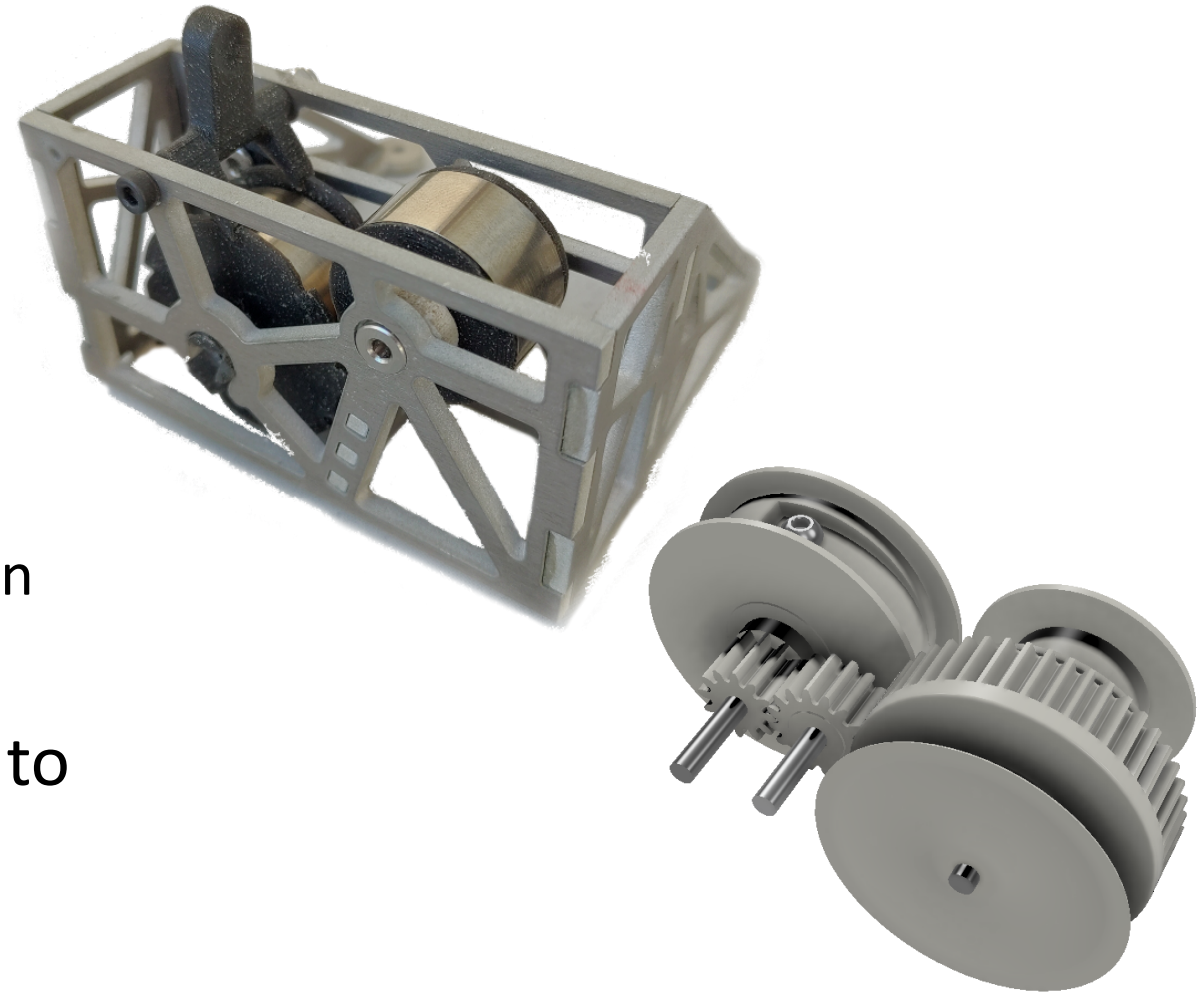




Deployment: 100 mm from aperture
Stowed length: ~42 mm
Mass: < 100 g

Deployment Drivers – Spring Motors

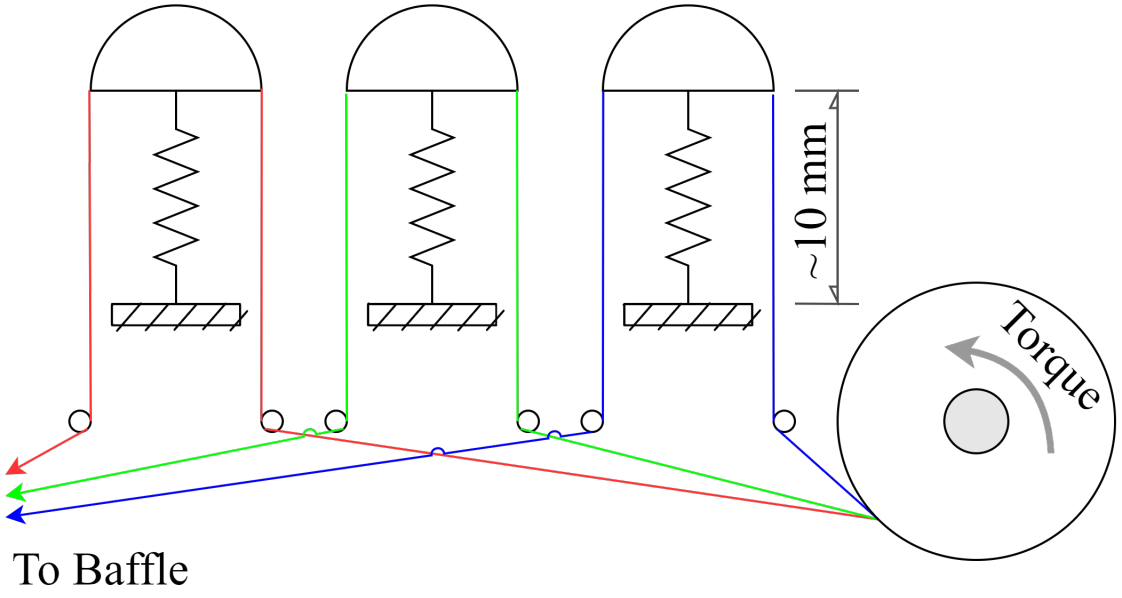
- Constant torque springs
- Gearing:
  - Torque multiplication
  - Deployment length augmentation
- Bulk of the torque is dedicated to terrestrial operation



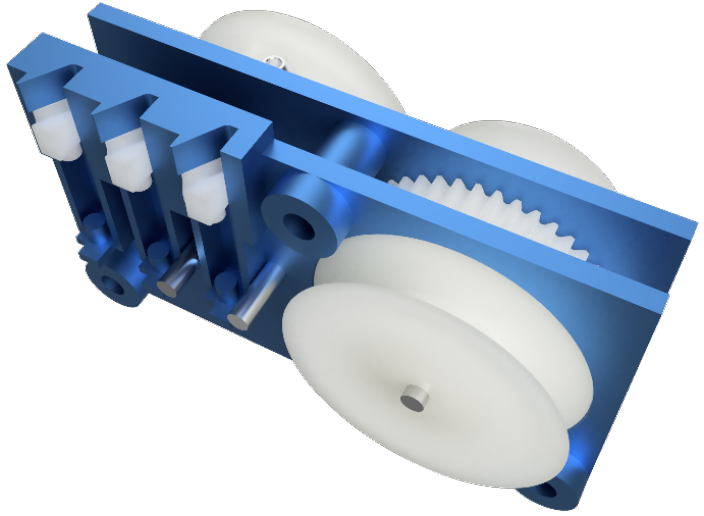
Tension Balancing

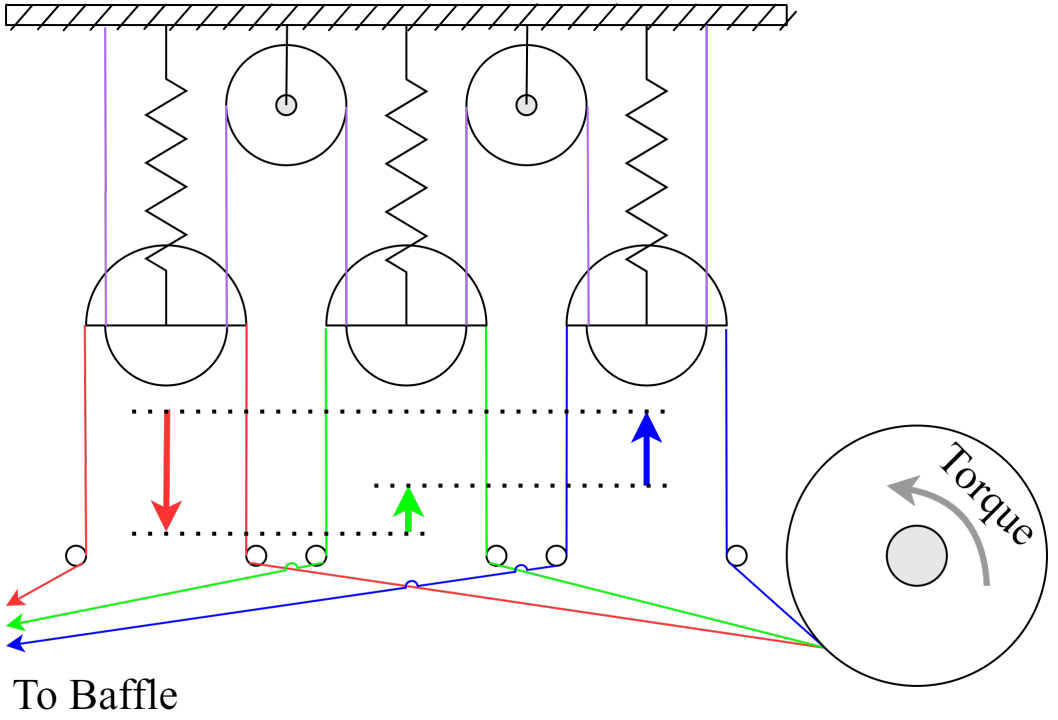
- 2 methods are proposed:

Absorber:



Equaliser:





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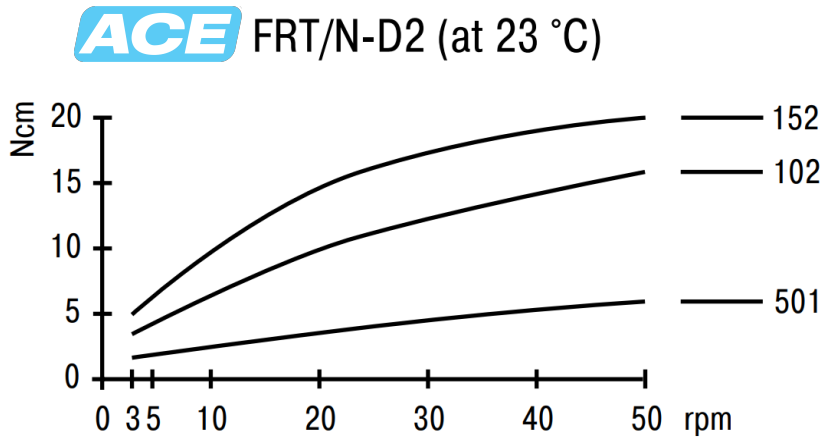
Deployment Shock

- COTS viscous damper integrated
  - Limits speed but does not compromise torque output



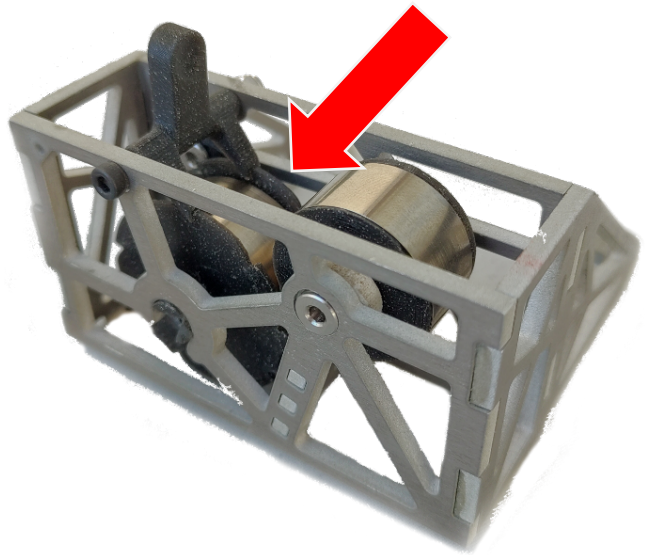


Image credit: ACE Stoßdämpfer GmbH

- Some shock could be absorbed by the tension balancing springs
- *For baffles <u>only</u>*: Is the transmitted shock *actually* significant?

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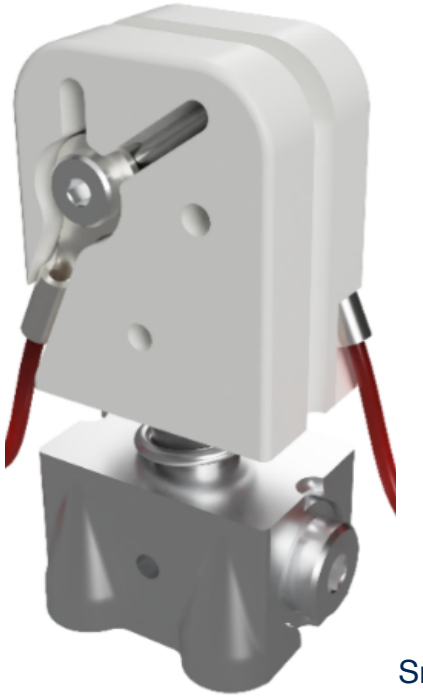
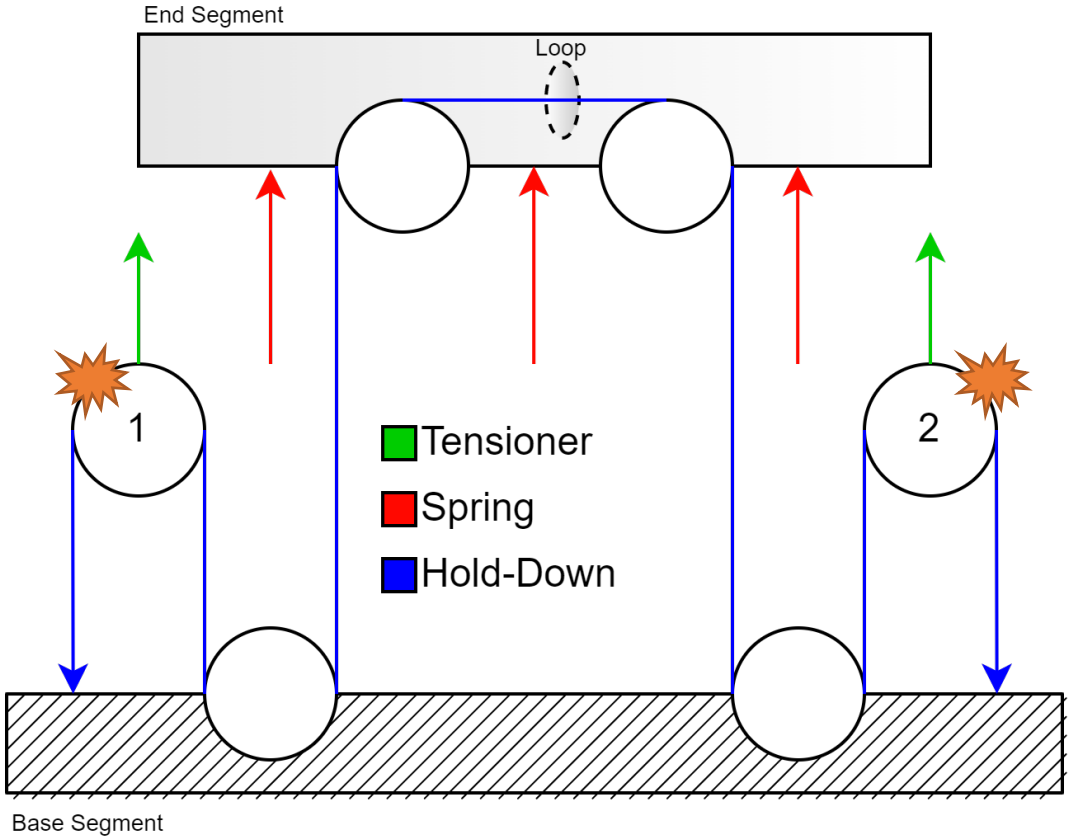
Hold-Down and Release Mechanism

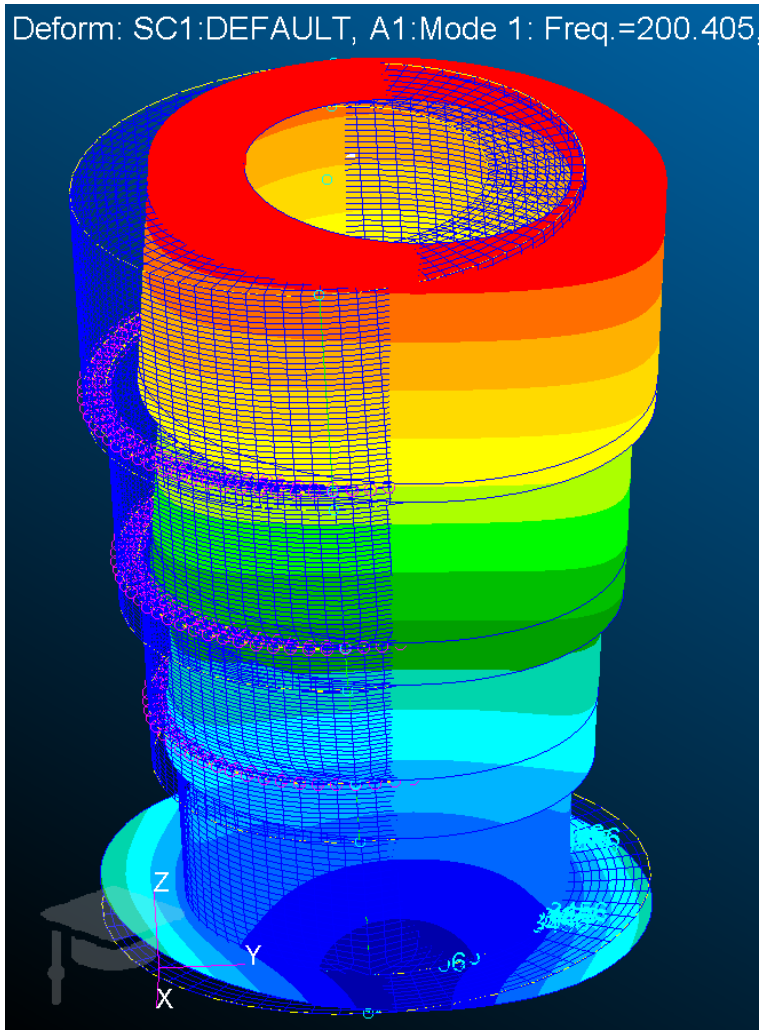
- Burn-wire tether system:
  - Simple
  - Compact
  - Low Mass
- Integrated Tensioning

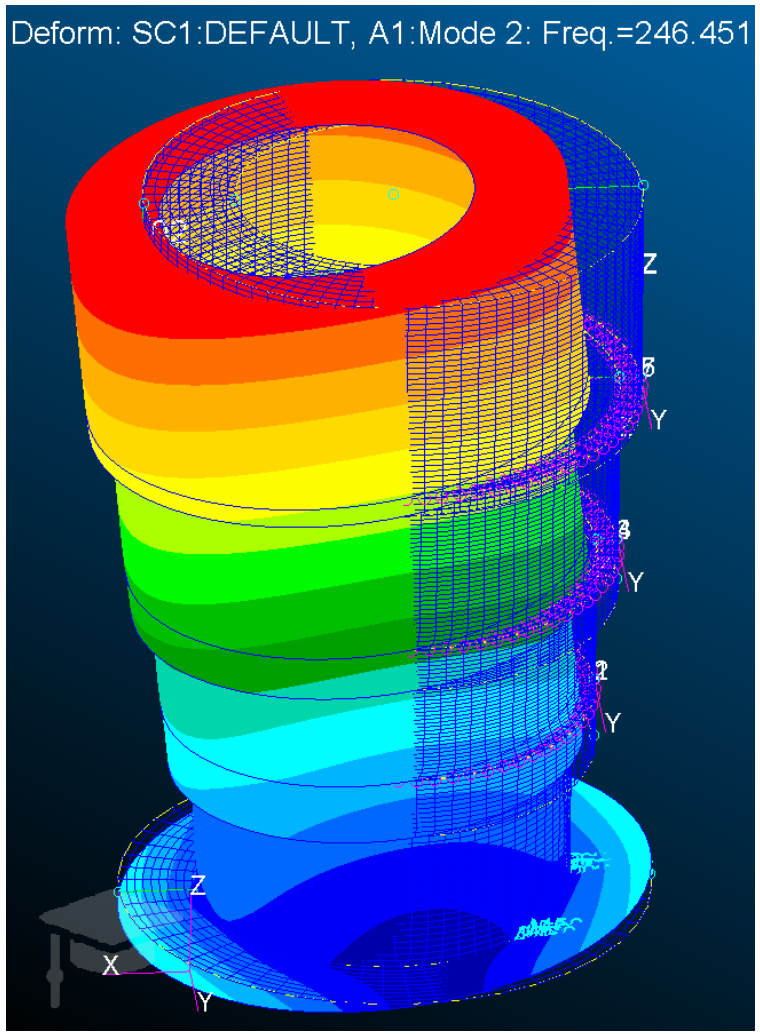


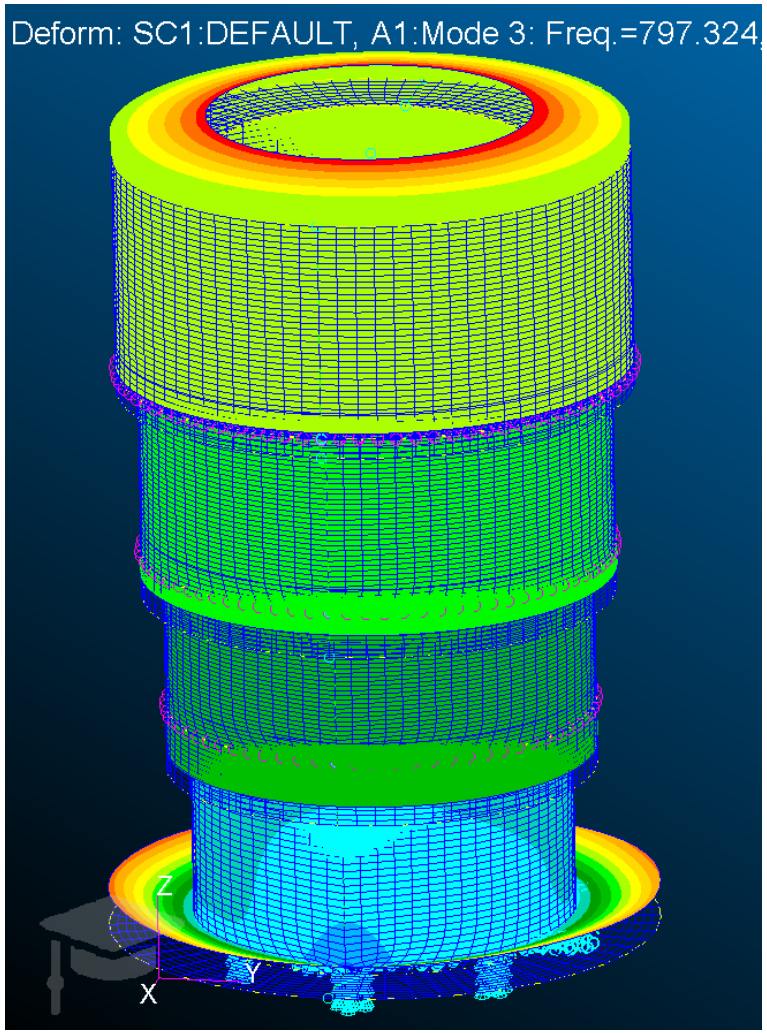
33 x 15 x 10 mm



Preliminary FEA







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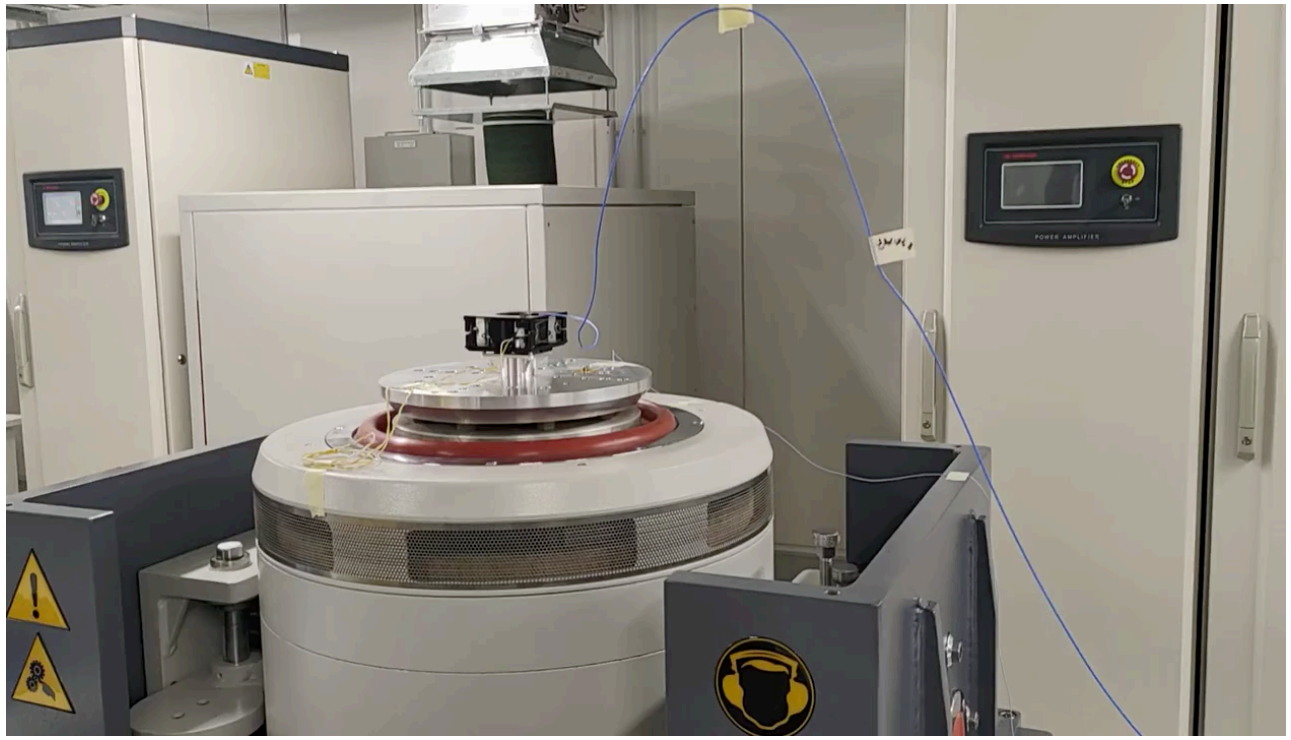
Testing

- Functional
- Vibration
  - 20 g Low Frequency Sine Sweeps
  - 14 g_{RMS} Random (NASA GEVS)
- Deployment Shock
- Thermal Vacuum

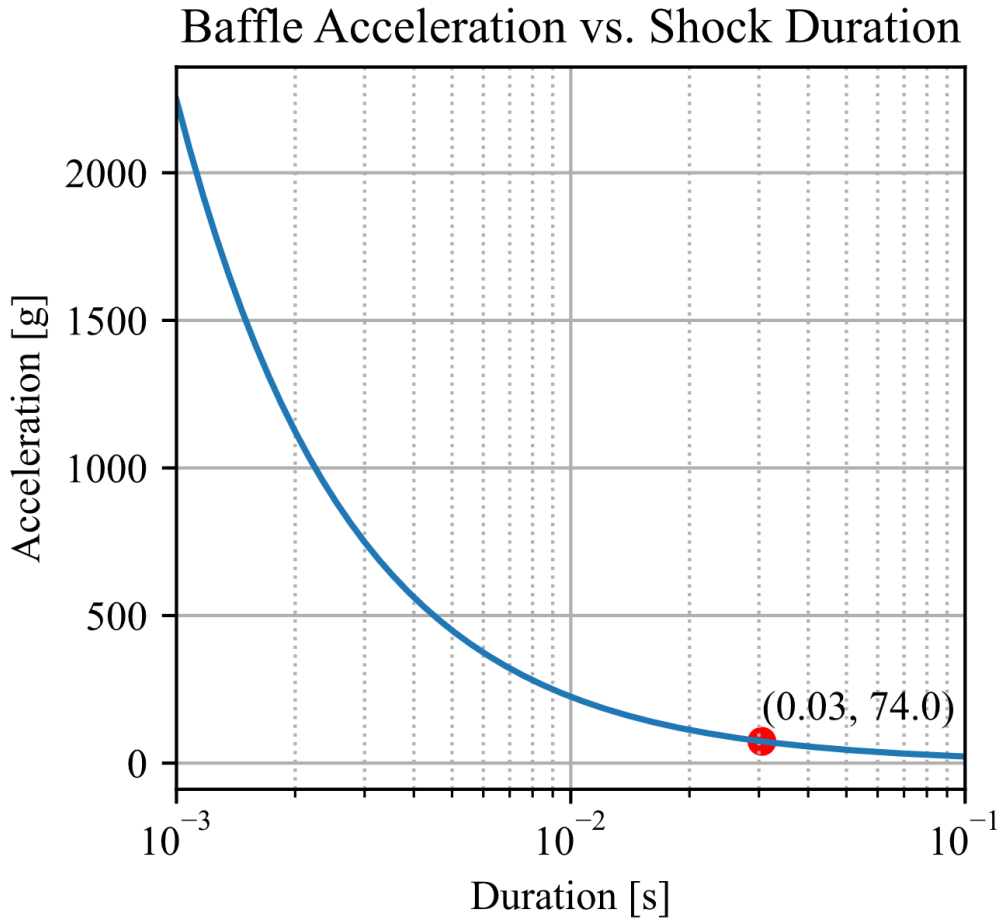


Deployment Shock Estimates

- Baffle mass = 81 grams
- Spring torque: $\tau \approx 0.145\ Nm$
- Rotations: $5\ .\ 4\ \therefore\ \theta \approx 33.9\ rad$

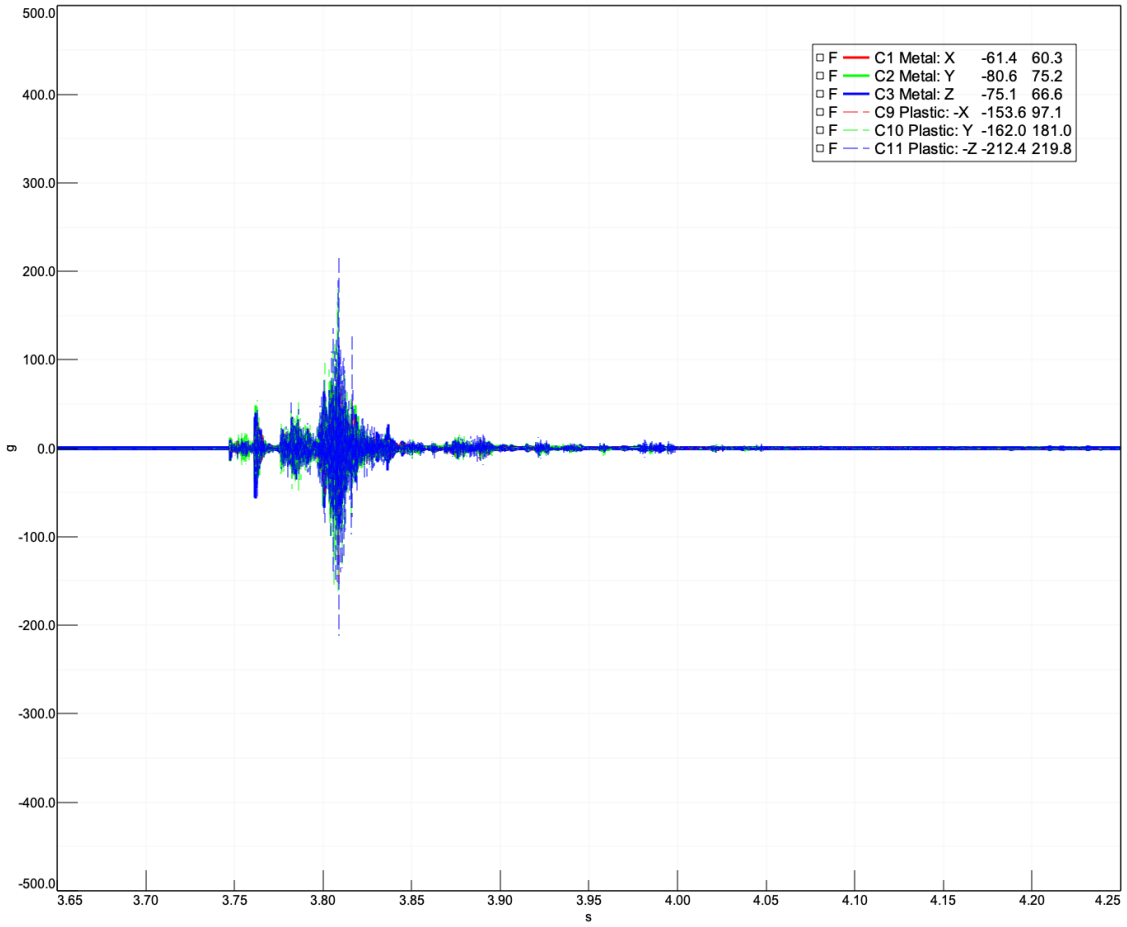
- Spring Energy:
  - $\Delta\ E = \tau \bullet \theta \approx 4.9\ J$
  - $\Delta\ \mathrm{v} = \sqrt{4 \bullet \Delta\ E \bullet \frac{2}{m}} \approx 22\ m \bullet s^{-1}$

- Acceleration dependant on shock duration

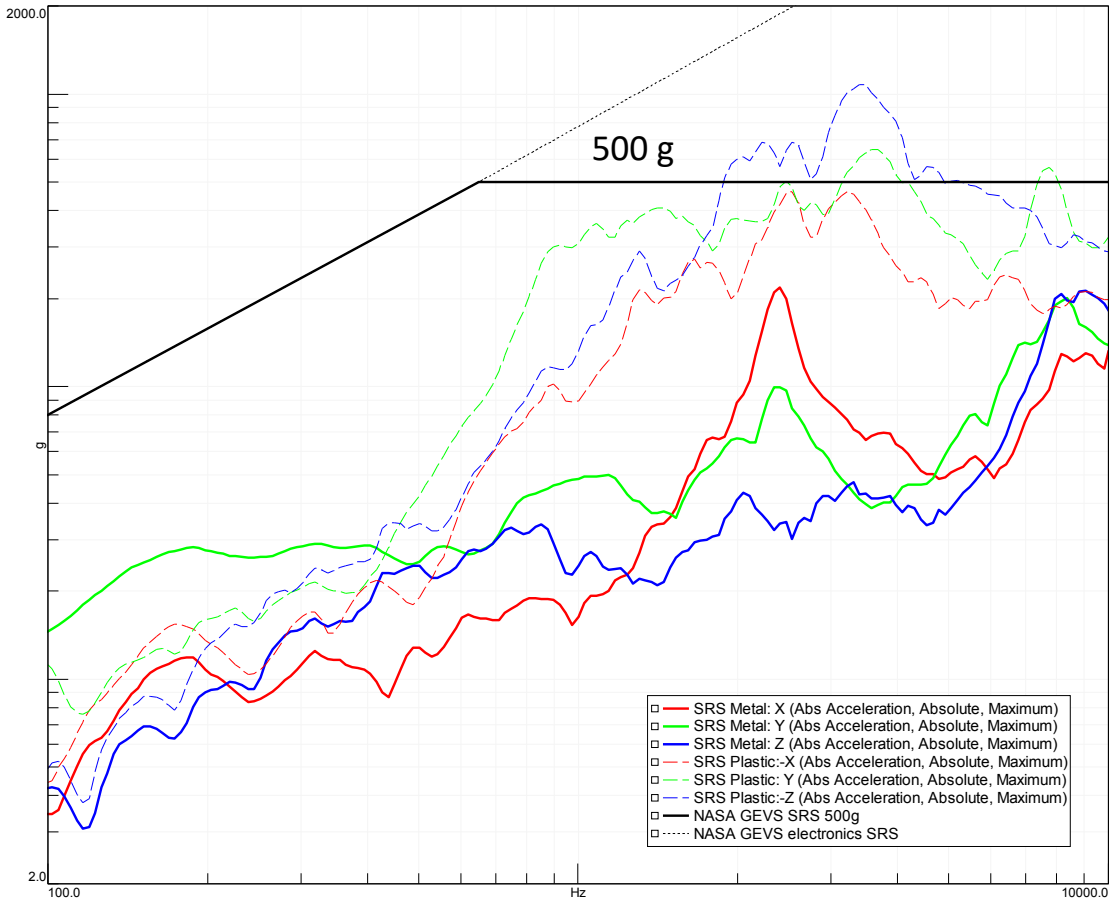


Deployment Shock Testing

Transient:



SRS:



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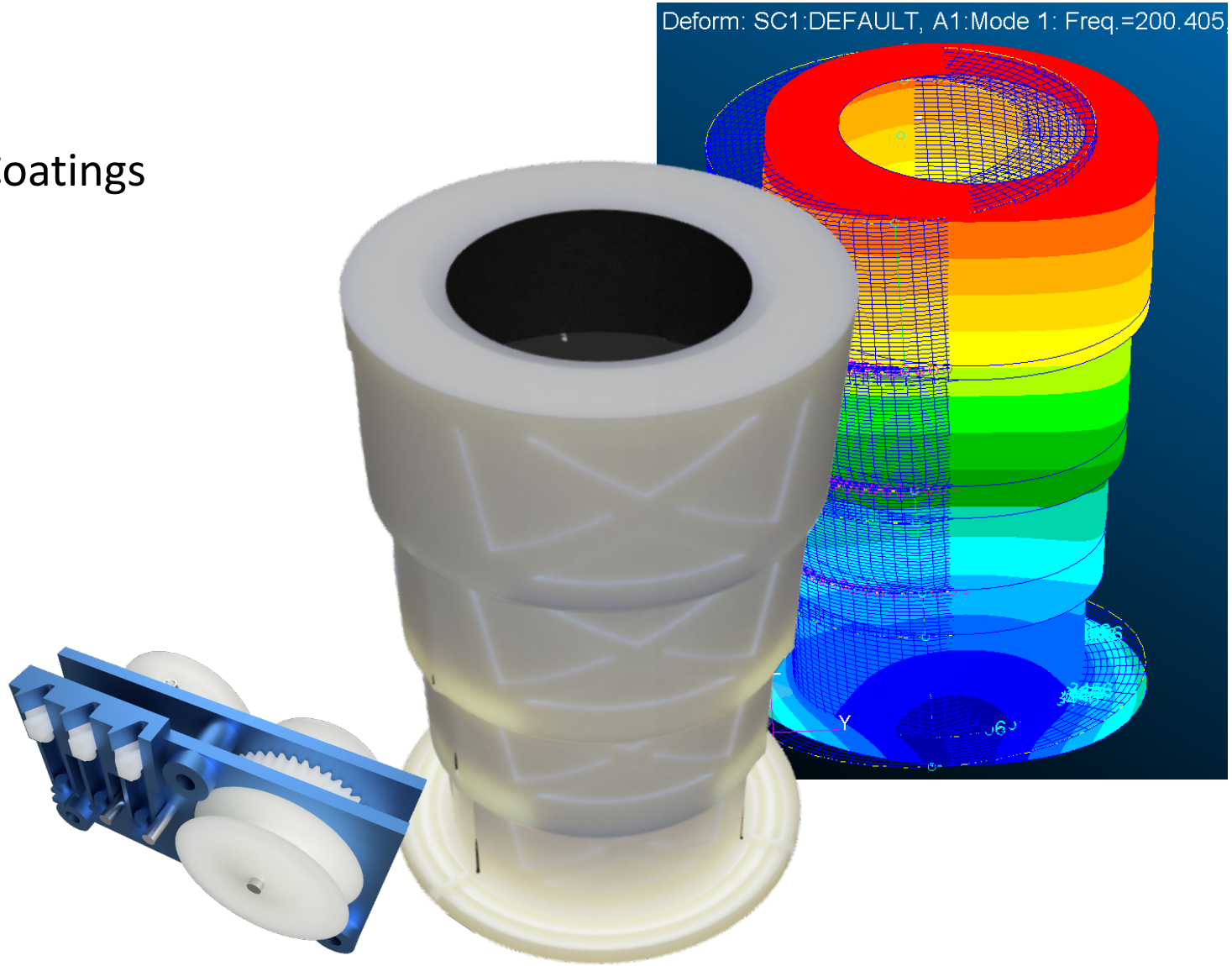
Future Work

- Manufacturing, Materials & Coatings
  - AM techniques
  - Optical Improvements
- Analysis & Design
  - Thermal deflection
  - HDRM improvements
  - Drive variations
- Verification
  - Complete TVAC Functional
  - Drive Integration



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  - Senior Research Scientist - Optical Systems
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  - Mechanical Design Engineer


Ngā mihi nui!
Thank You!
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