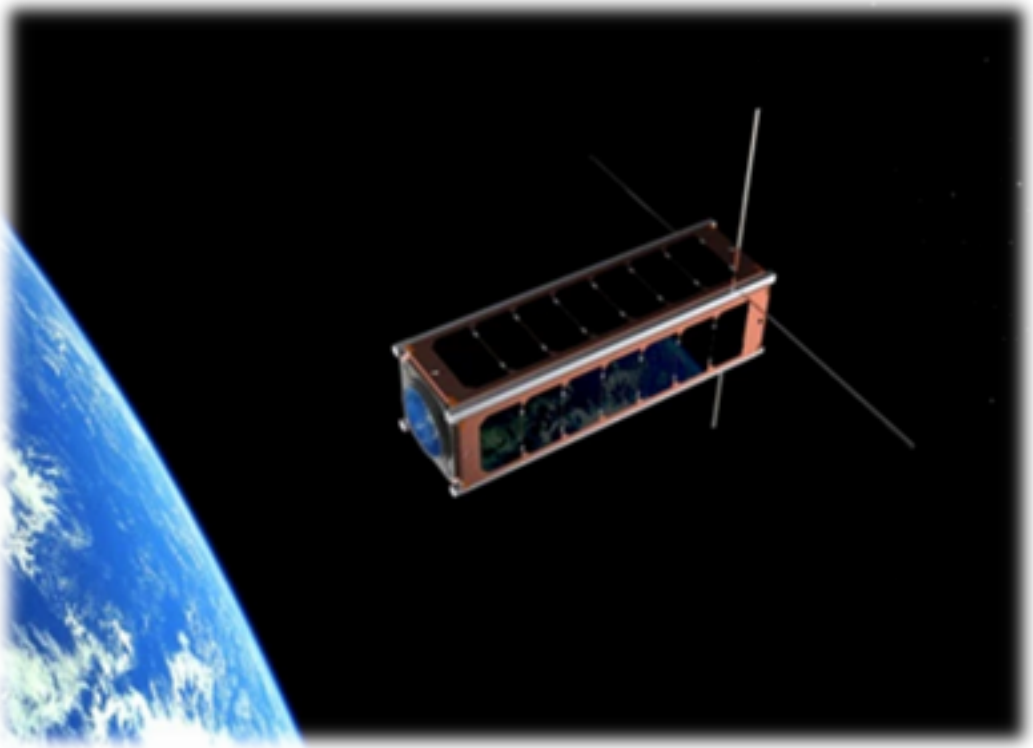
CubeSat Functionality and Microgravity Testing Platform



UKube-1 Amateur Radio CubeSat. Digital image. *AMSATUK*. N.p., 26 Sept. 2012. Web. 13 Apr. 2016. <https://amsat-uk.org/2012/09/26/uks-amateur-radio-cubesat-books-a-ride-on-russian-soyuz-2-rocket/>

Agenda

- Team Introduction
- Purpose
- Platform Design
- Free Fall Environment
- Benefits
- Scalability
- Additional Applications
- Conclusion

Team Introduction

- **Alex Crook** – Project Manager
  - B.S., Mechanical Engineering
- **Adam Block** – Team Member
  - B.S., Mechanical Engineering
  - B.S., Energy Systems Engineering
- **Dr. Kevin Kilty** – Faculty PI
  - Adjunct Professor UWYO
- **John Wickman** – Professional Adviser
  - CEO of Wickman Spacecraft & Propulsion Company

Purpose

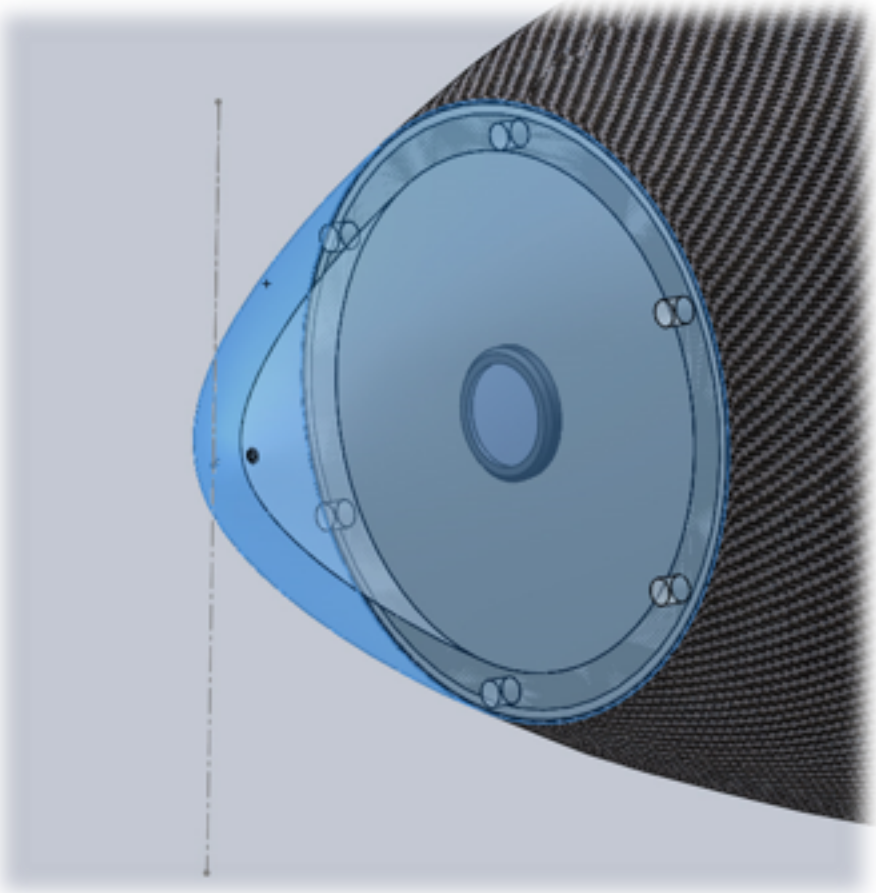
- Risk reduction
- Increase TRL
- Overflow testing
- Microgravity testing

Platform Design

- Drop methodology
  - Weather balloon
  - 30,480 m (100,000 ft.) AGL
- 20 seconds free fall
- Data telemetry during flight
- On board video capability

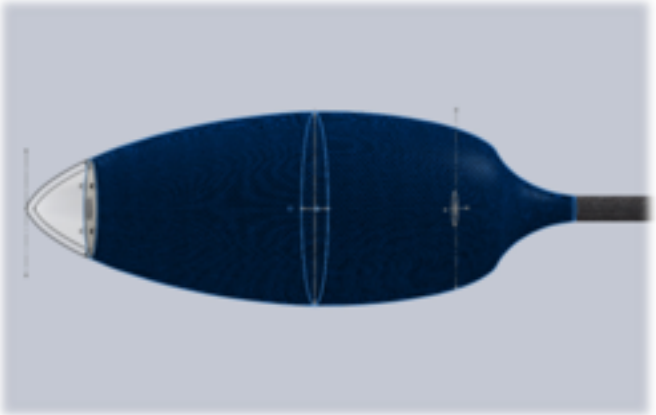
Nose Cone

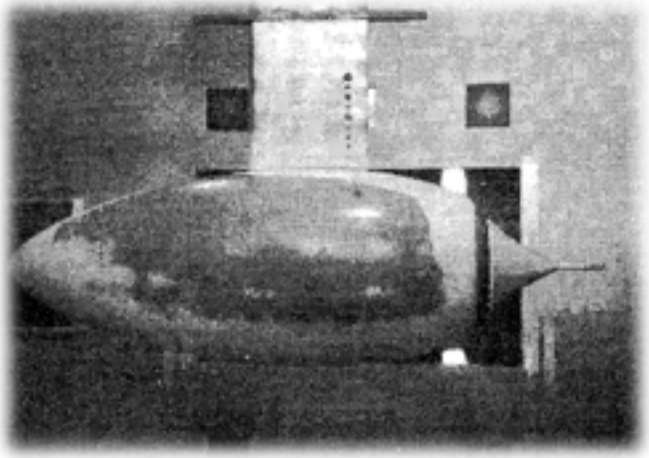
- Transparent cast acrylic accommodates video camera
- Transparent to radio frequency



Aerodynamic Body

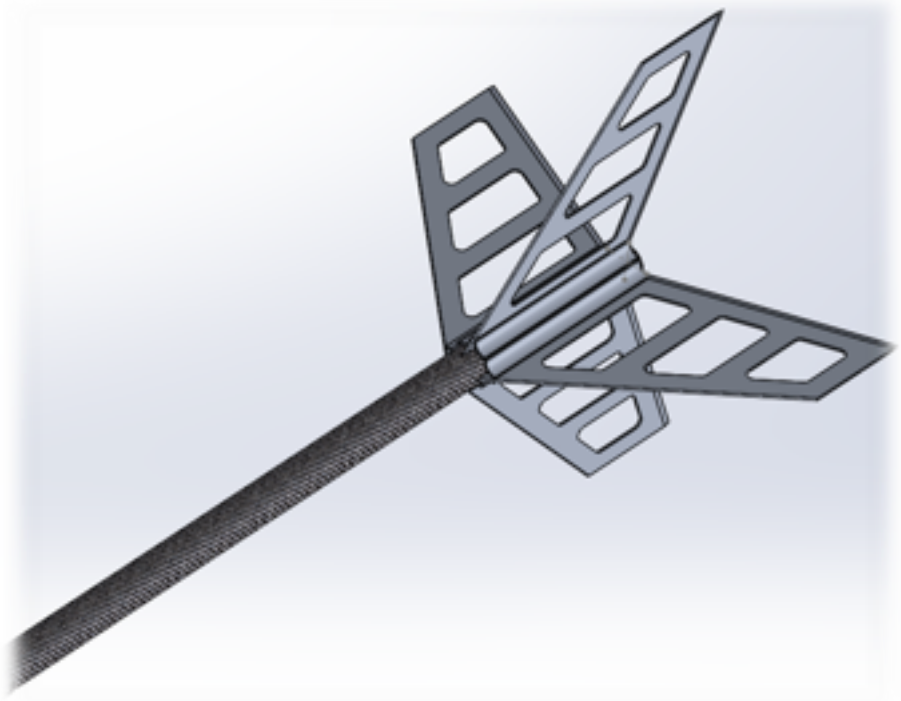
- Light, rigid, durable frame (carbon fiber)
- Proven, aerodynamic shape
- Low coefficient of drag
- Minimal buffeting and vibration
- Constrained to 12 lb. by FAA
- Scalable up to 12U CubeSat with FAA wavier





Goldschmied, F. Aerodynamic Hull Design for HASPA LTA Optimization. Vol 15, No. 9. 1978

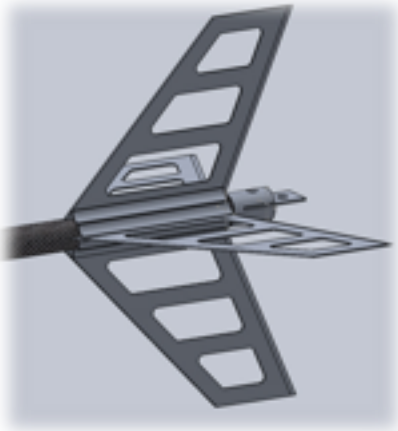
Boom



- Carbon fiber tube
- Low mass
  - Keeps center of gravity forward
- Length of 0.61 m (2 ft.)
  - Keeps center of pressure behind center of gravity
- Stabilizes flight

Fin Design

- Tapered, swept design to further push back the center of drag
- Addition of slots prevents lateral acceleration and mass reduction
- Moderate airfoil shape

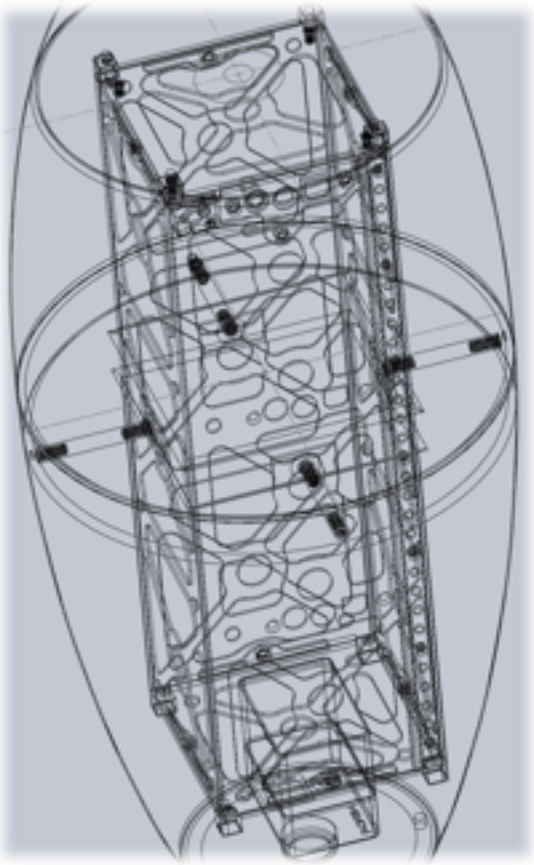


Parachute

- 1.83 m (6 ft.) panel parachute
- Geometry reduces shock
- 25.31 km/h (15.73 mph) decent rate for 6.80 kg (15 lb.) payload
- Single-stage parachute deployment

Engelgau, Gene. *Panel Parachute*. Digital image. *Types of Parachutes*. N.p., n.d. Web. <https://fruitychutes.com/uav_rpv_drone_recovery_parachutes/uas-parachute-recovery-tutorial.htm>.

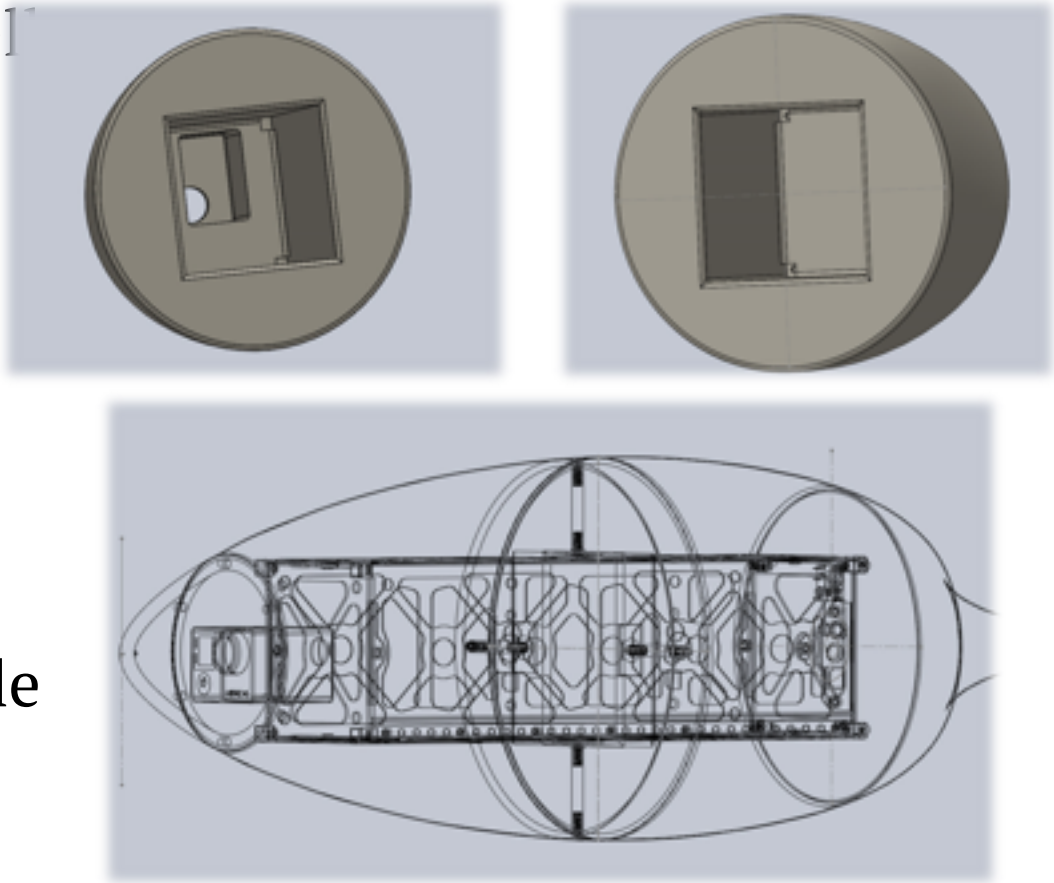
Experiment Bay



- 3000 cm^3 (183.1 in^3) of 3U CubeSat housing volume
  - Scalable
- 1000 cm^3 (61.0 in^3) of microgravity testing volume
  - Scalable

Foam Core

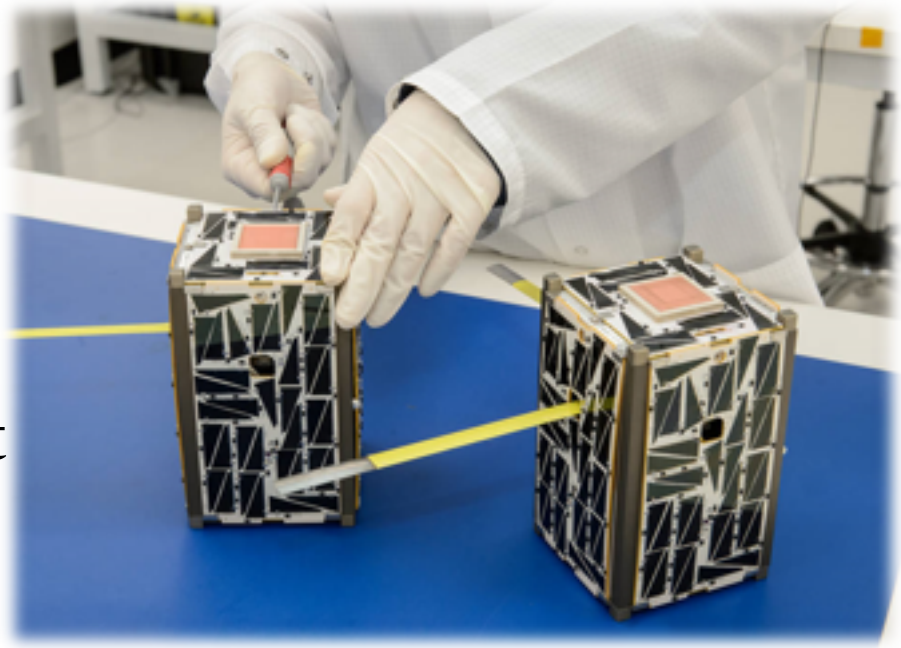
- Polyethylene closed-cell foam
- Ideal for shock absorption and vibration
- Durable and machinable
- Low density



Clockwise from top left: Front Form, Center Form, Wireframe Zoom

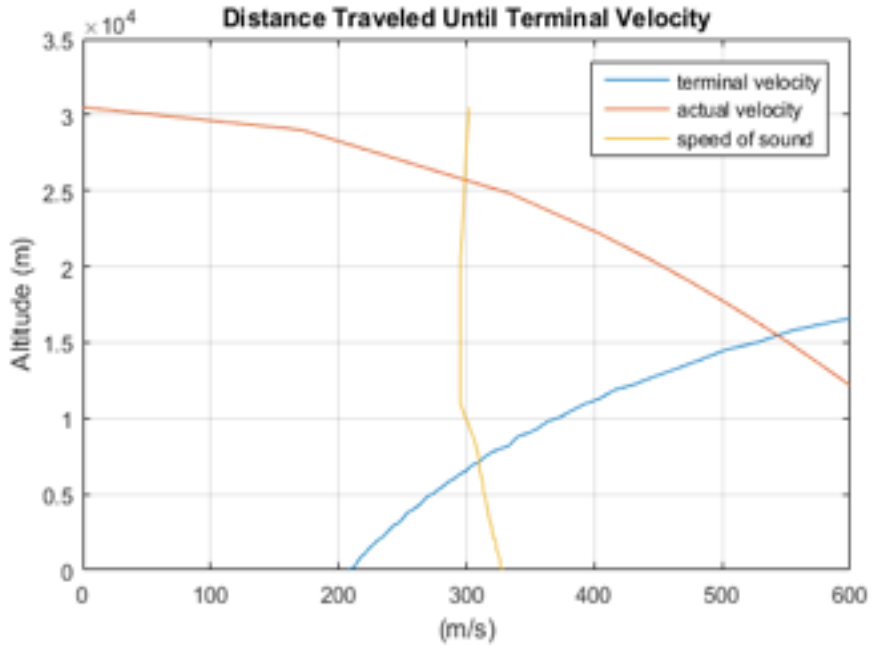
Data Acquisition

- Up to 500k samples per second
- 256 KB programmable memory
- Ability to telemeter CubeSat data to ground station
- 16 analog channels
- 85 I/O pins



Hart, D. Nodes. Digital image. *CubeSats undergo final inspection at NASA's Ames Research Center in Moffett Field, California*. www.nasa.gov/press-release. 2015

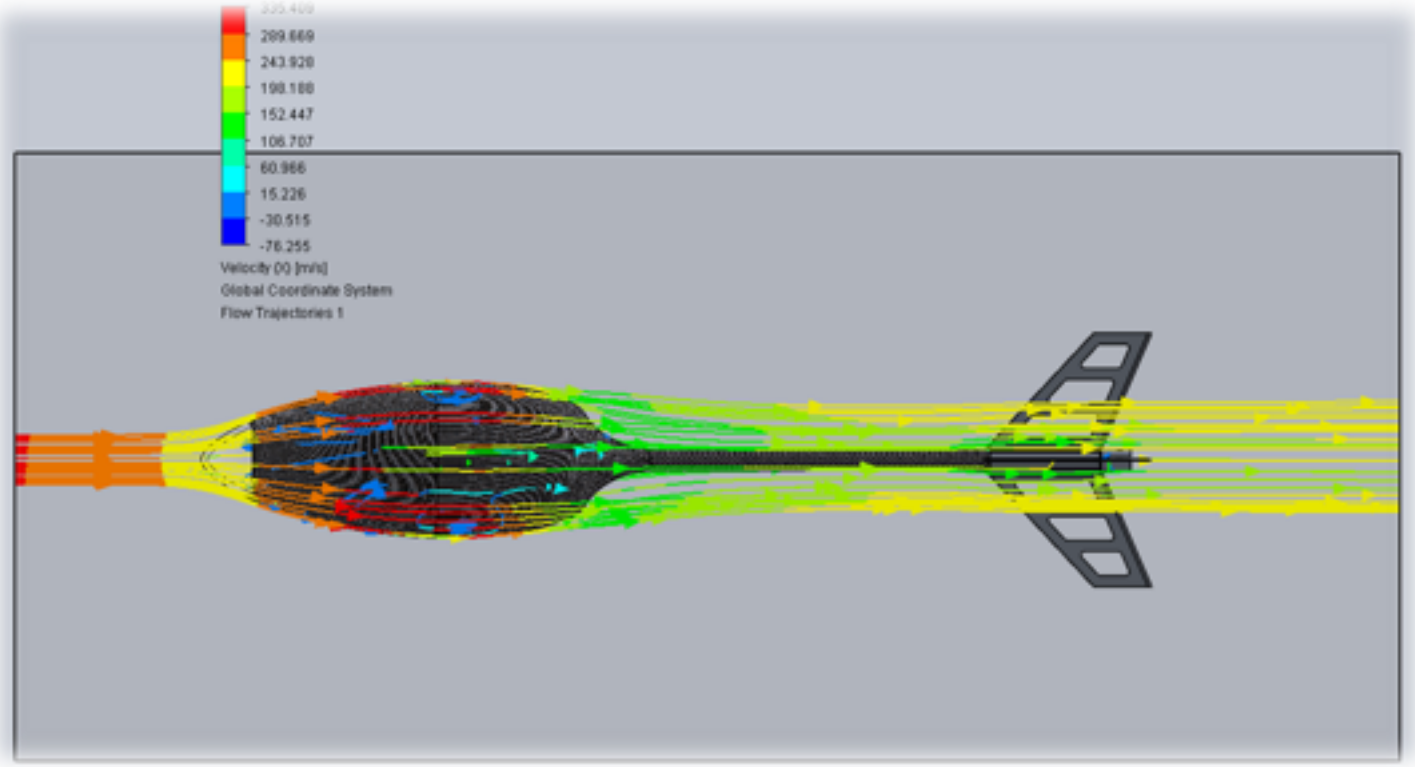
Free Fall Environment



Predicted aerodynamic events during free fall

- 30 seconds until sound barrier
- Terminal velocity 540 m/s (1207 mph)
- Absolute pressure at altitude 1116 N/m^2 (0.162 lb/in^2)
- Density at altitude 0.017 kg/m^3 (0.33 x 10^{-4} $slugs/ft^3$)
- Temperatures as low as -46.64 °C (-51.10 °F)

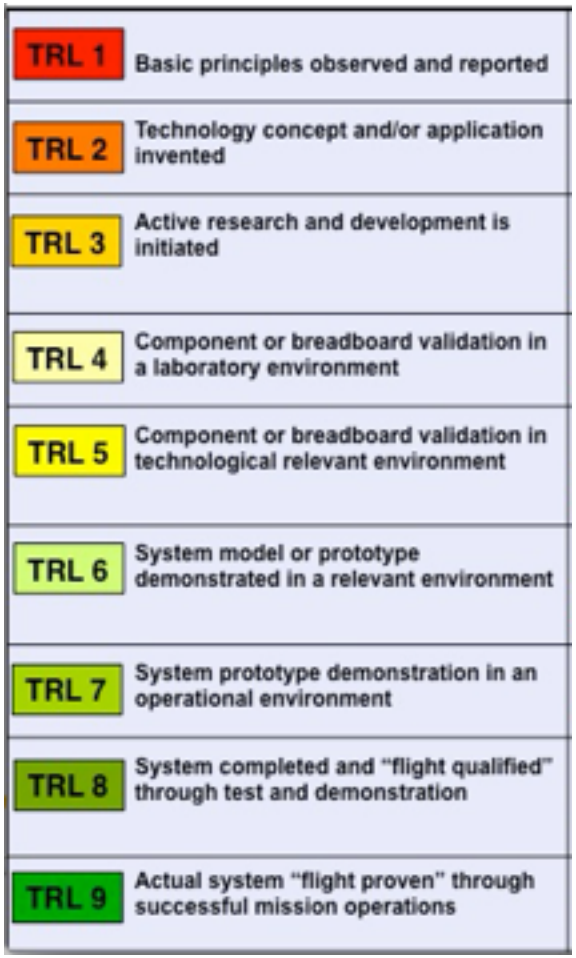
Free Fall Environment



Flow trajectory of flow at maximum velocity, max Cd=0.02

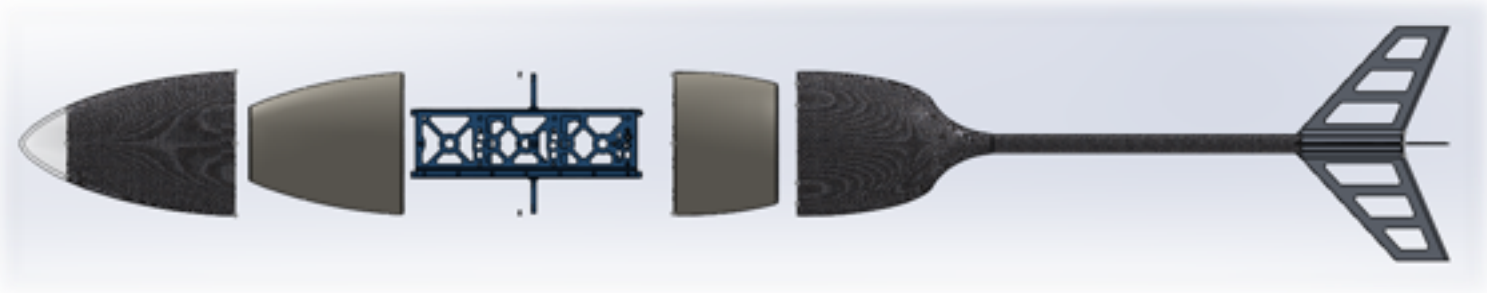
Benefits

- Increase Technical Readiness Level (TRL) to 6-7
- On demand testing capabilities
- Opening doors to CubeSat microgravity testing
- Overflow functionality testing
  - Further develop requirements

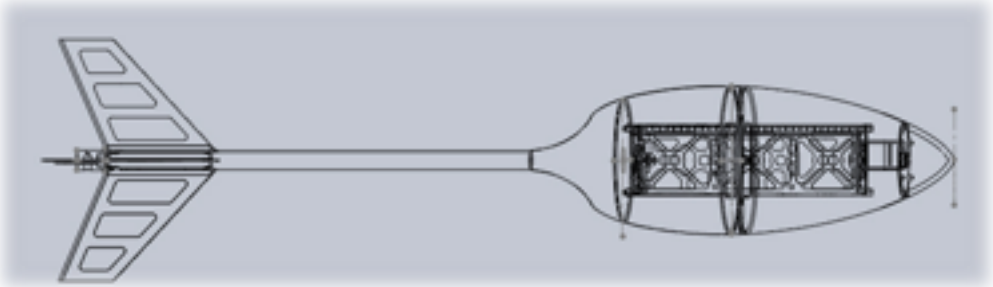


Scalability

- Fly up to a 12U CubeSat
- 10,000 cm^3 (610.2 in^3) microgravity testing volume
- Increase microgravity duration
- Increase velocity
- Launch Service Requirements Document (LSRD)



Additional Applications



- Fly multiple balloons
  - CubeSats communicate during flight
- Flying in formation
  - Situational awareness
- Fly to a laser designator
  - Movable fins

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Q & A

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