Origami-Based Drag Sail for Differential Drag Controlled Satellites

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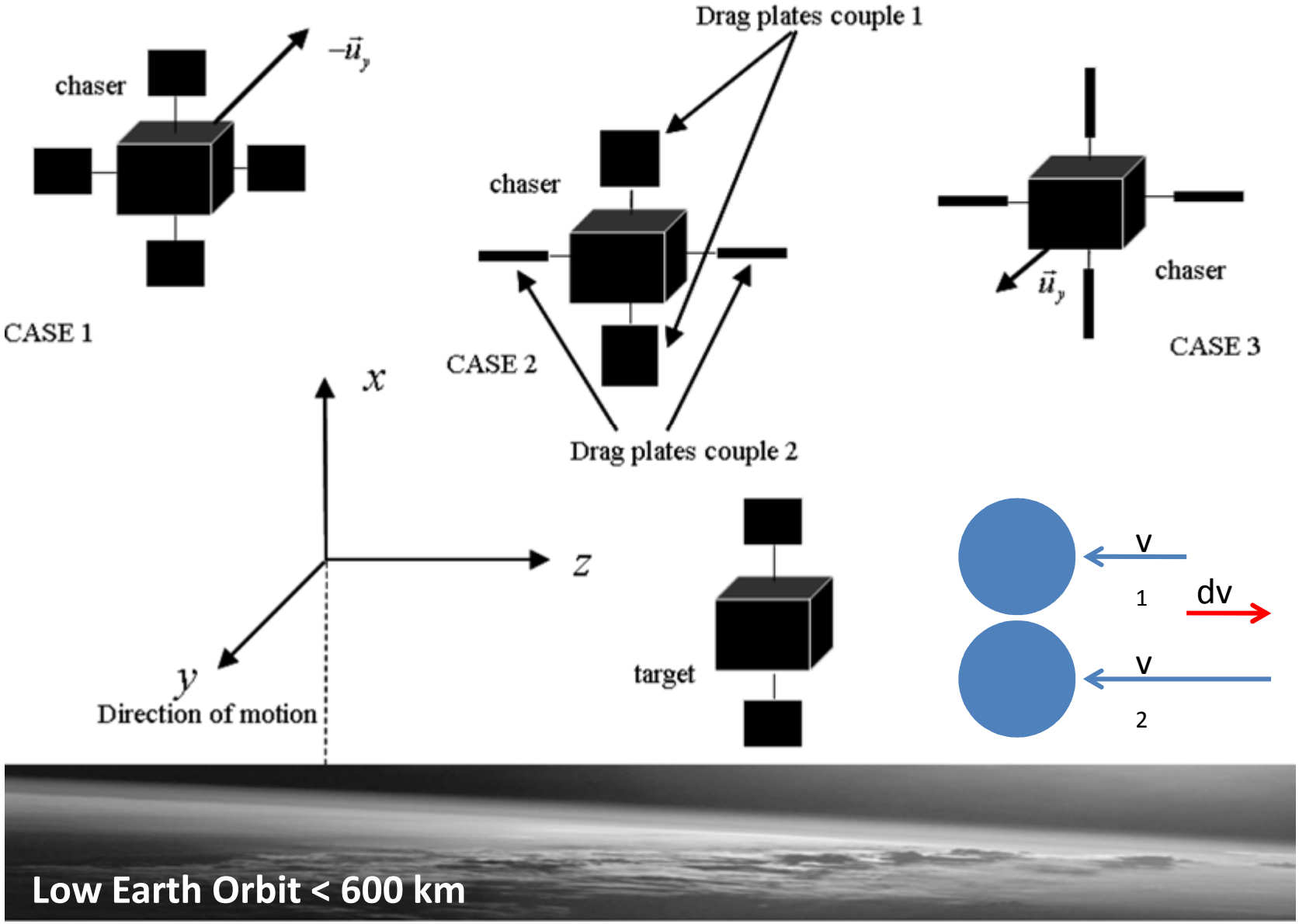
why not change the world?™

How do we move around in space?

- Propulsion systems use fuel
- Mission lifetimes are limited by fuel amount
- Propulsion systems take up space

Image credit to University of Surrey

Thinking Outside the Box



Motivation

- New method of control and exploration
- Less propellant, less cost
- More volume for instruments
- Lack of heat and gases emitted, harder to detect
- More control over retirement of dead satellites
- **Easier, cheaper, and faster access to space**

Differential Drag and Origami

- Origami – Japanese art of paper folding

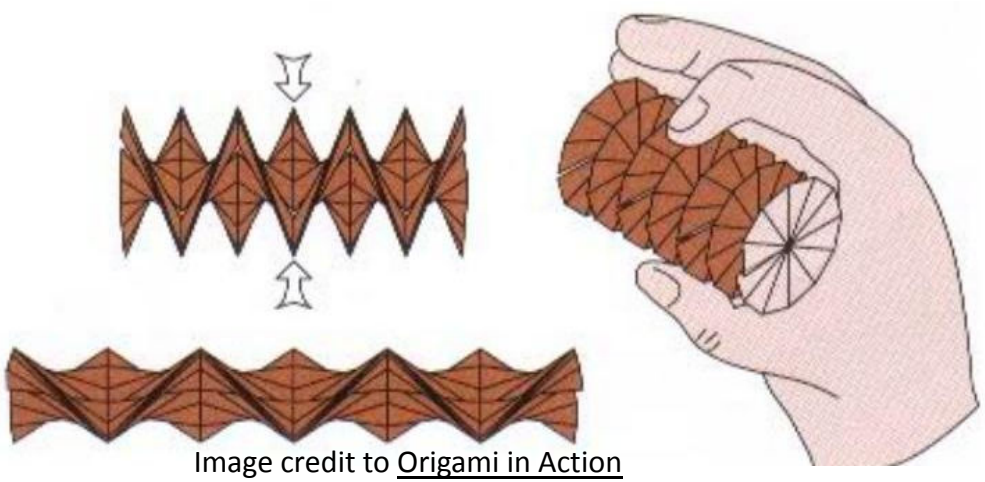


Image credit to Origami in Action

Miura-Ori Map Fold

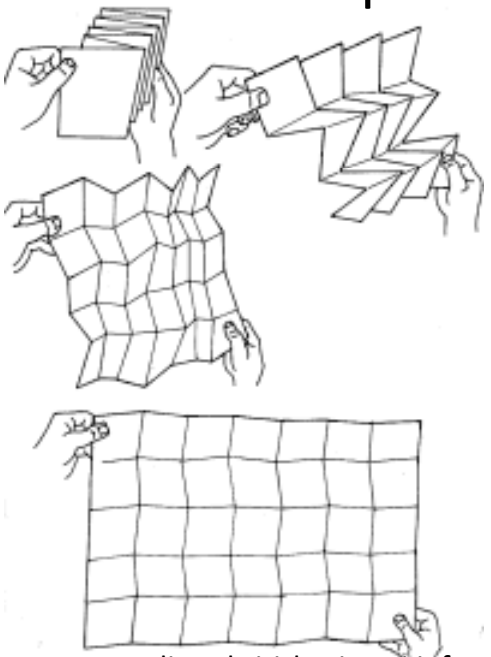
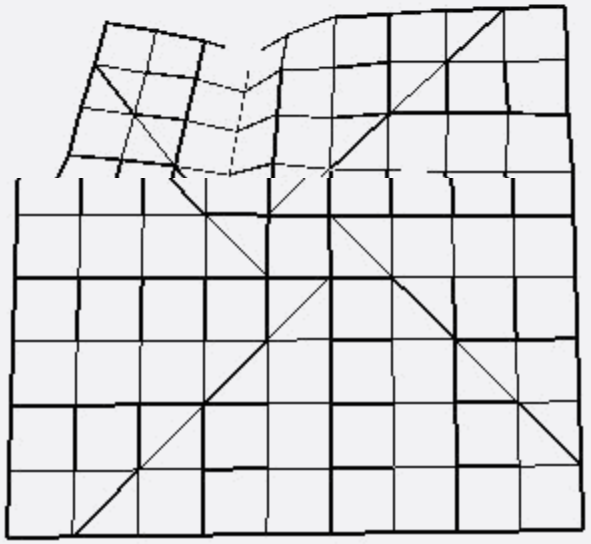


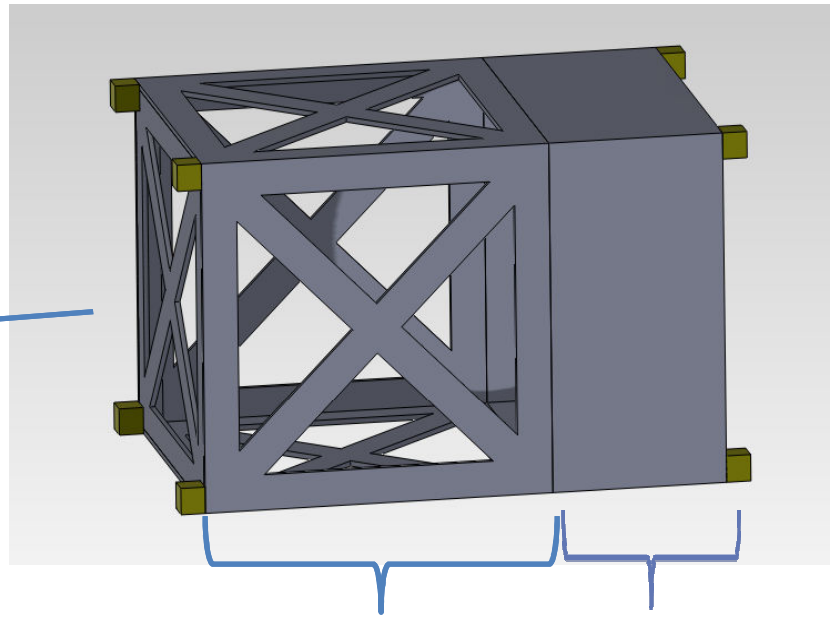
Image credit to britishorigami.info

Inspiration

Origami design is uniquely suited to making a large flat surface fit in a small volume



Project Goal



To fly two 1.5 U CubeSats of identical design to test differential drag maneuvering in low earth orbit

1U ≈ 10cm x 10cm x 10cm

Design incorporates ~1U for electronics and data collection and ~.5U payload for differential drag system

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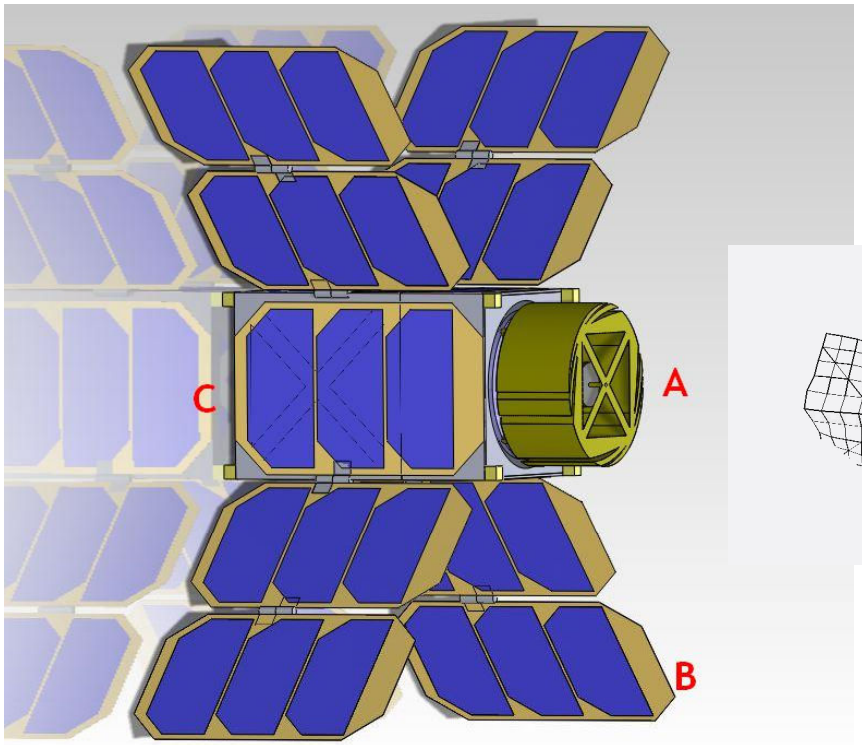
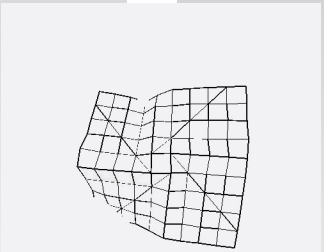
Design Process and Critical Steps

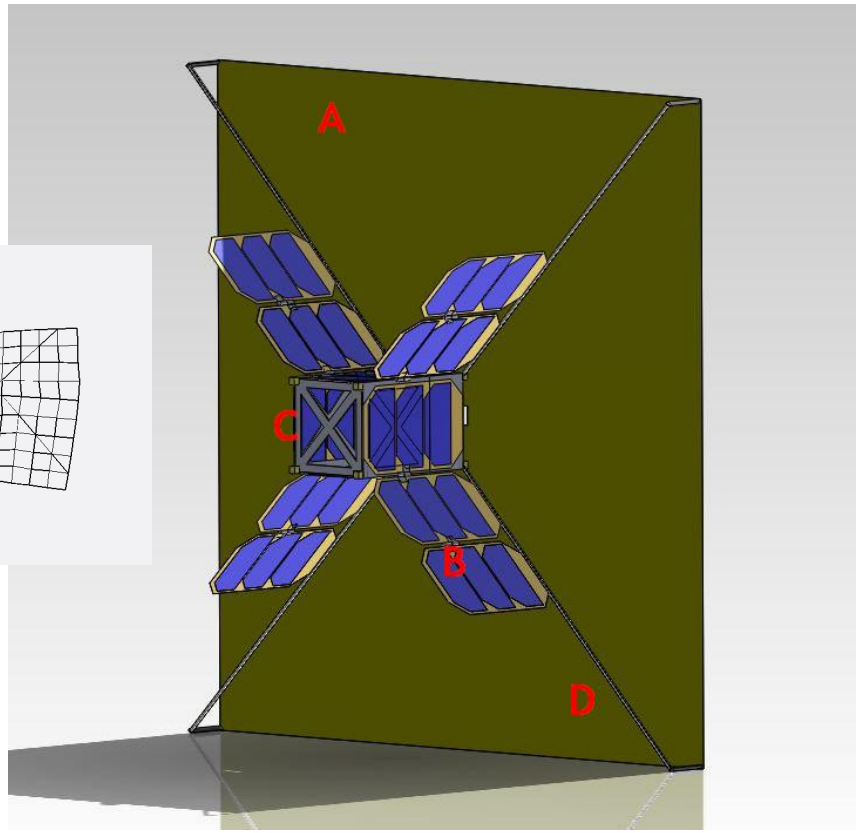
- Drag Sail Geometry
  - Stowed
  - Deployed
- Deployment Steps
- Material Selection
- Power System without Drag Interference
- Motor Selection

- Consideration of two possible sail designs
- Individual deployment methods for each design
- Mylar, Carbon Fiber
- Dependent on power availability and stowed sail geometry

Actuation







A: Drag Sail
B: Solar Panels
C: CubeSat Body
D: Deployable Boom

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Significance of Envisioned Results

- Air Force Office of Scientific Research (sponsor)
- National Science Foundation
- Technology developed
  - New method of control
  - Less propellant, more room for instruments
  - Lack of gases and heat emitted, harder to detect
  - More control over when to deorbit dead satellites
- **Easier, cheaper, and faster access to space**

Key Points to Take Away and Next Steps

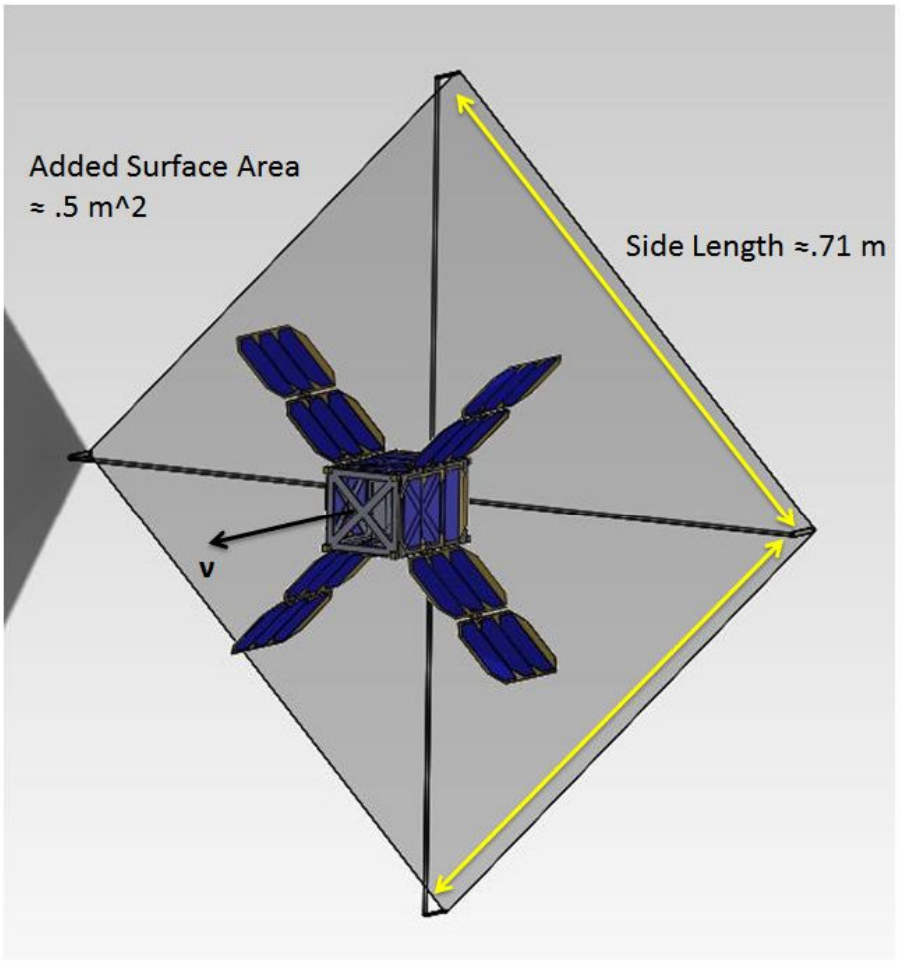
- Creatively solving engineering problems
  - Origami design
  - Real world application
- Undergraduate Research
  - Opportunity
  - Experience

- Next steps
  - Preliminary design almost completed
  - Materials and manufacturing
  - Prototype by June

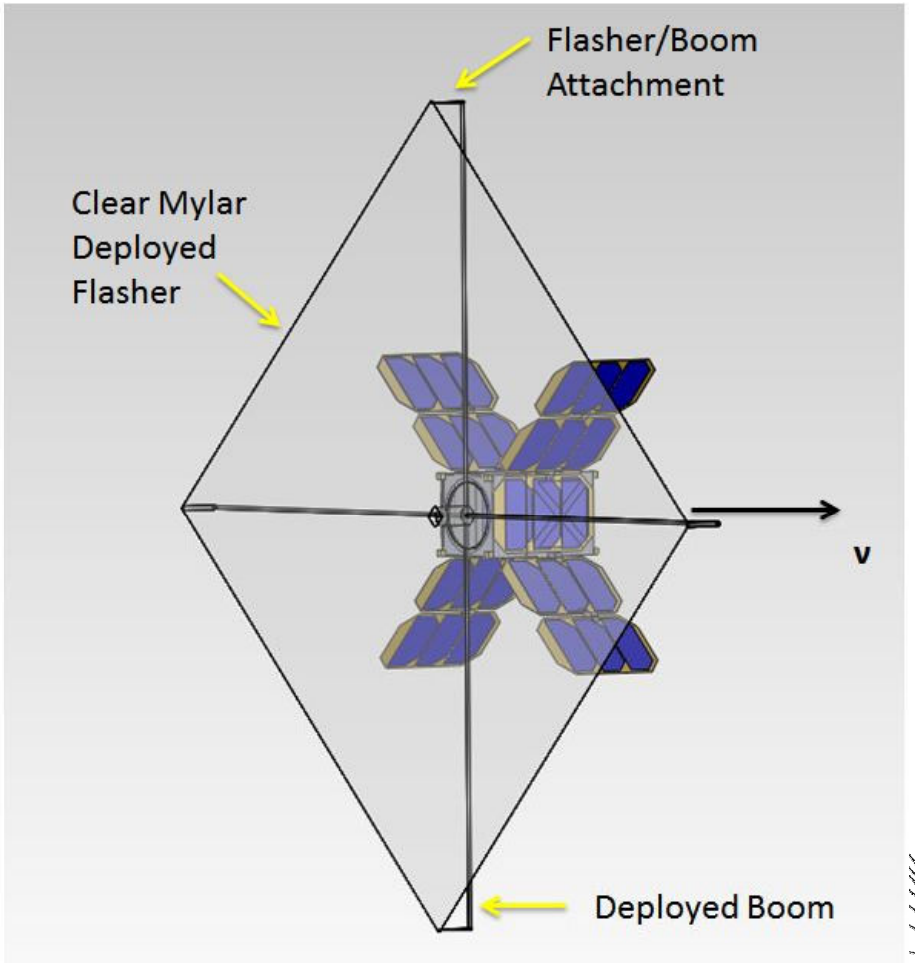
Questions

Designs

Satellite with deployed drag sail



Generic Sail and CubeSat



View of Deployed Flasher Design

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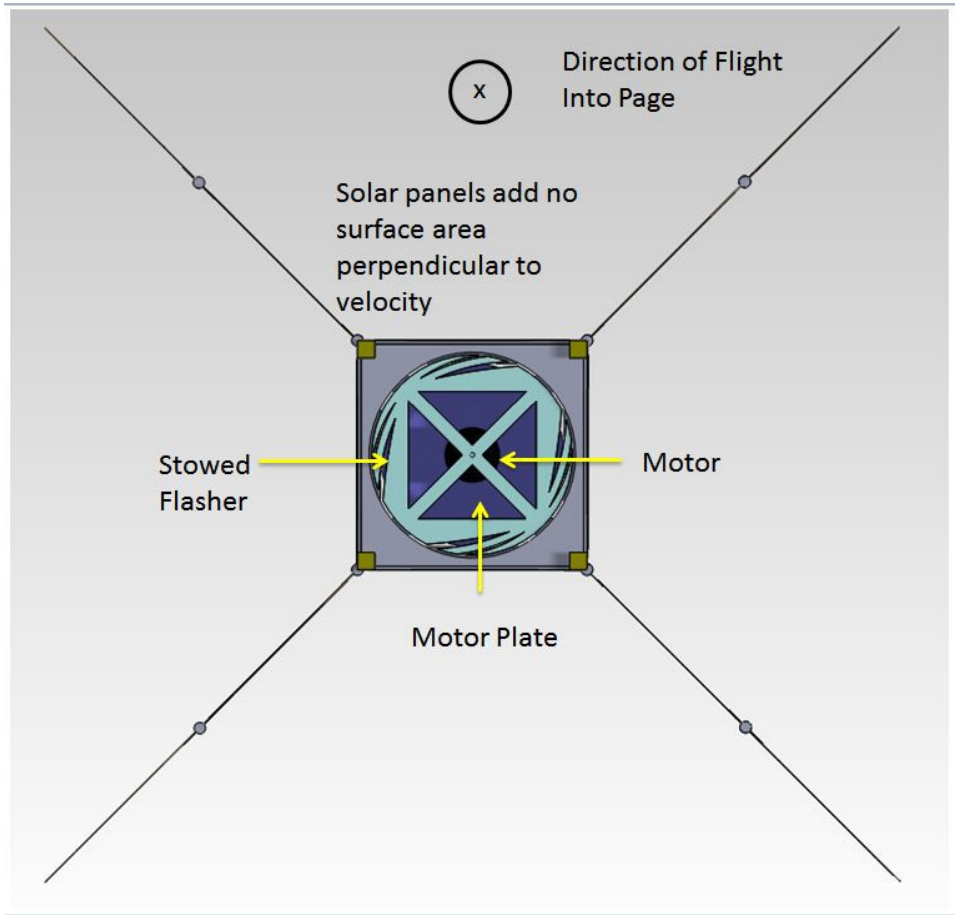
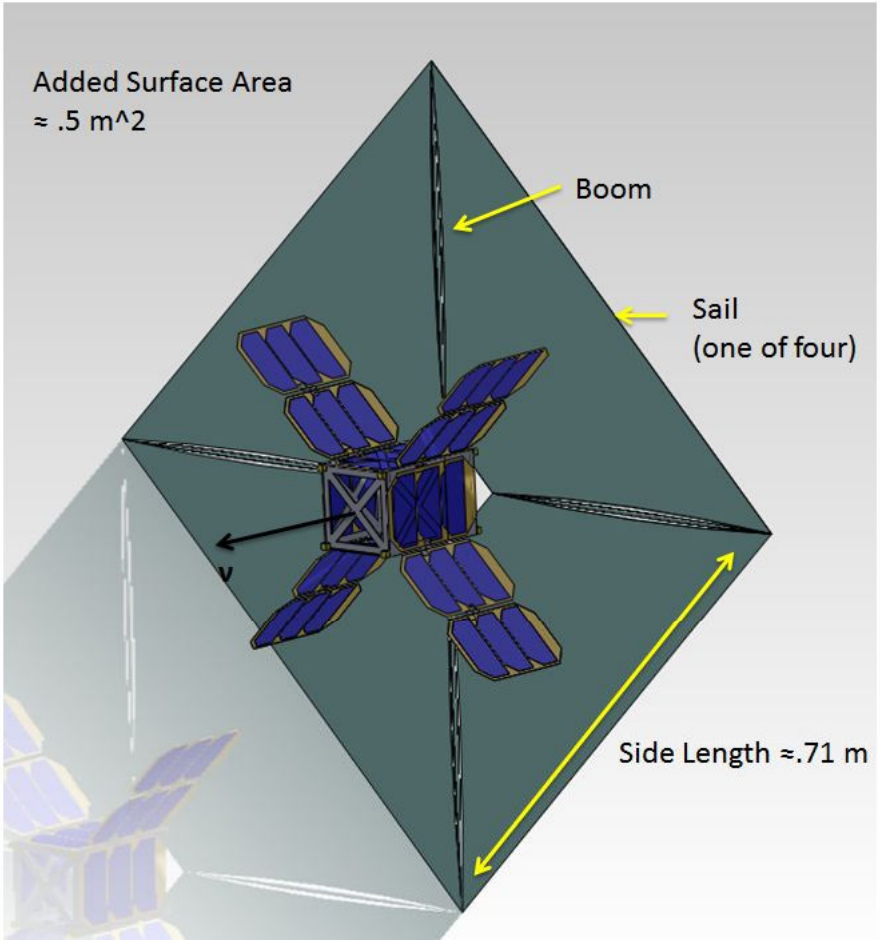
Components

Flasher Deployed and Stowed

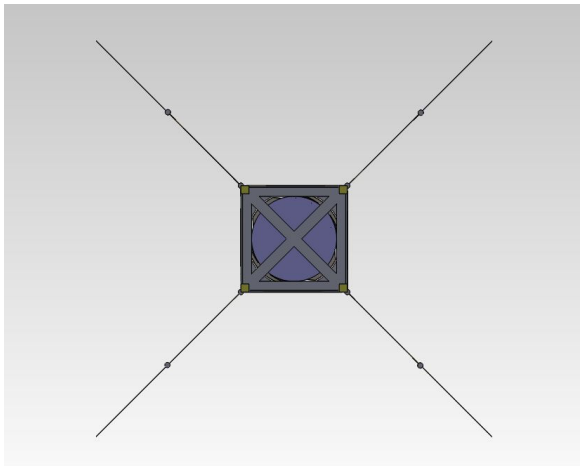


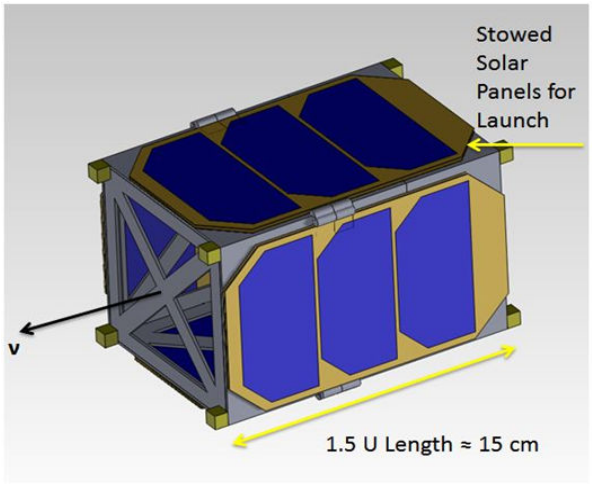


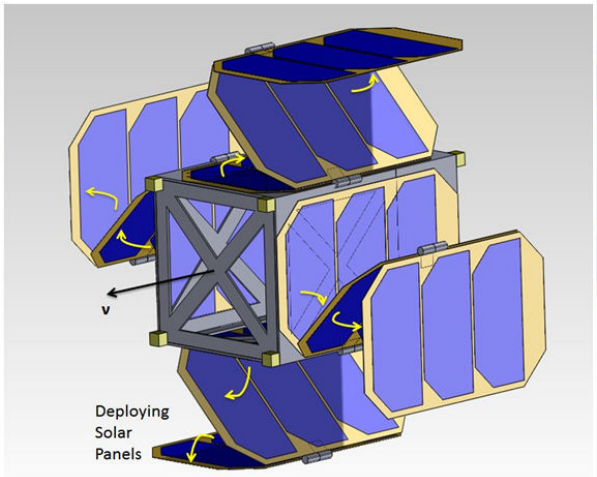
View of Deployed Quad Sail Design

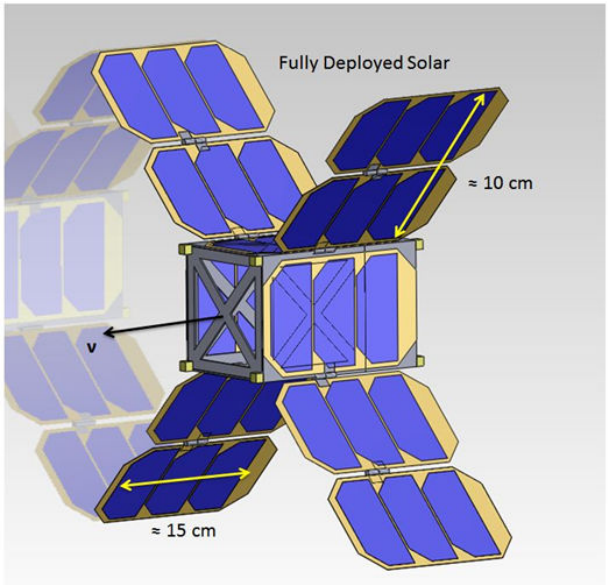
1.5 U Power System Design

Power system cannot interfere with differential drag









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