COMPOSITE TECHNOLOGY DEVELOPMENT, INC.

ENGINEERED MATERIAL SOLUTIONS

Deployable Articulating Array for Nanosatellites

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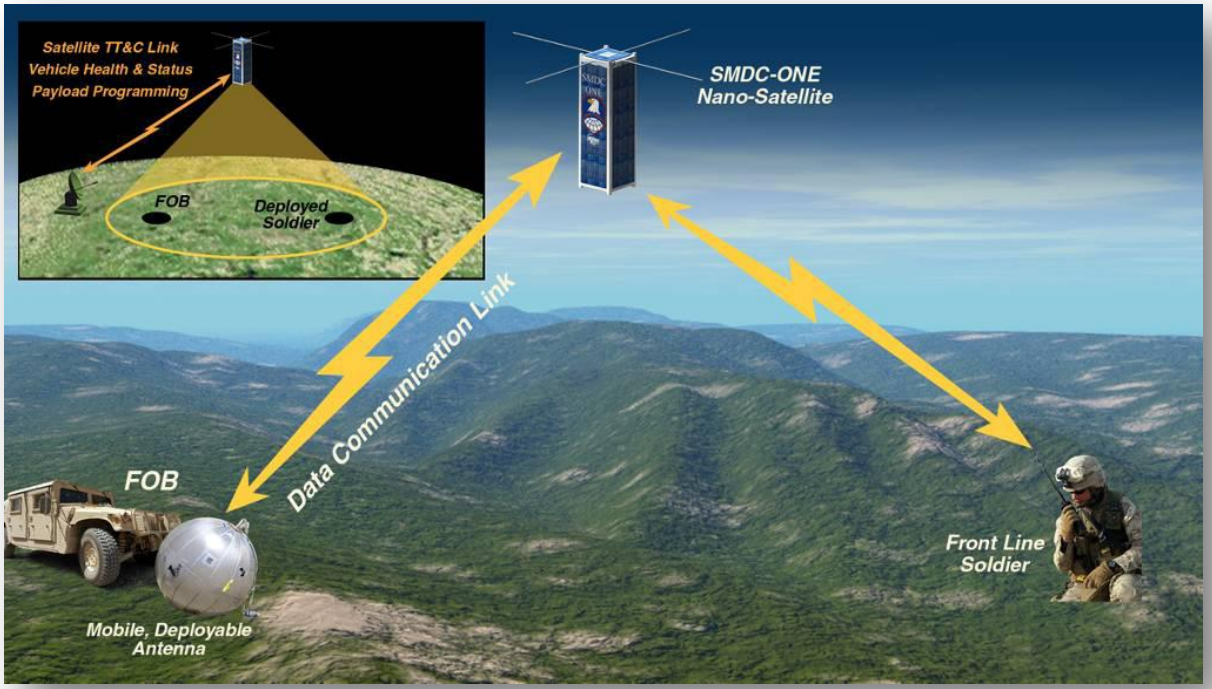
Needs of the U.S. Army SMDC

(Space and Missile Defense Command)

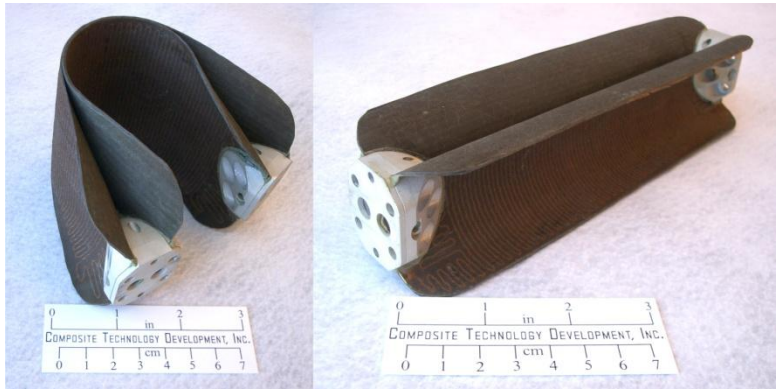
Nanosatellite capabilities limited by power

- Nanosatellites are rapidly deployable and less expensive than bigger systems
- Large satellite arrays do not efficiently scale to smaller sizes
- U.S. Army SMDC state of the art generates less than 5 Watts



Deployable Composites

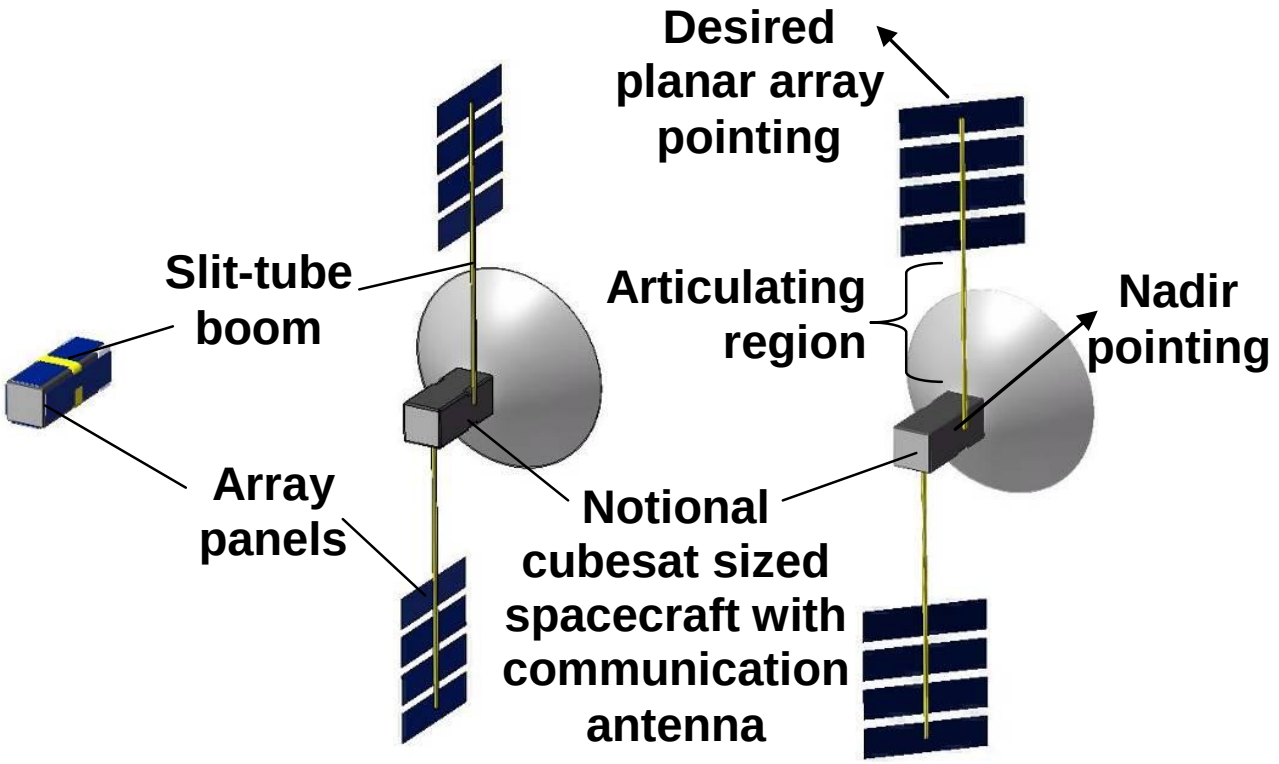
- **Lightweight, thermally stable, multi-functional structures**
- **Deployment mechanism and deployed structure in a single component**
  - ***Reduces number of components, mass, and can simplify structural design***
  - ***Allows for efficient packaging to minimize launch volume***
  - ***Components can be rolled or folded to reduce volume for launch and store energy for deployment***
  - ***Deployments can be actuated by stored strain, shape memory, or motors***



Scale-able & Modular Deployable Structures

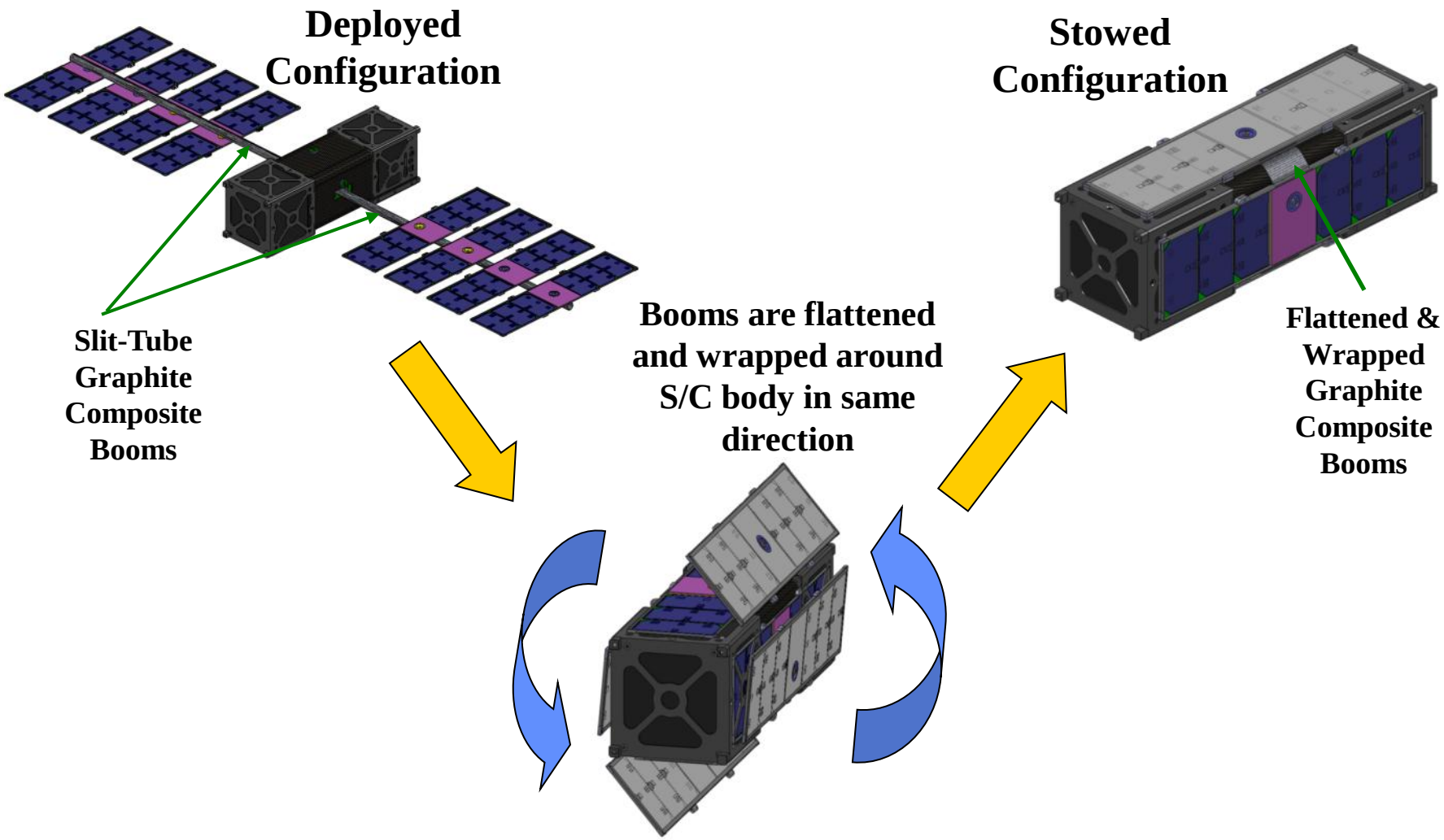
- **Booms developed covering large range of properties**
  - **size**
    - **0.5” to 8” diameter**
    - **Up to 75ft (22m) in length**
  - **Architecture**
    - **Open, overlapped, Slit-lock, zipper**
  - **Deployment method**
    - **SMP, motorized, strain energy driven**

CASA – CubeSat Articulating Solar Array



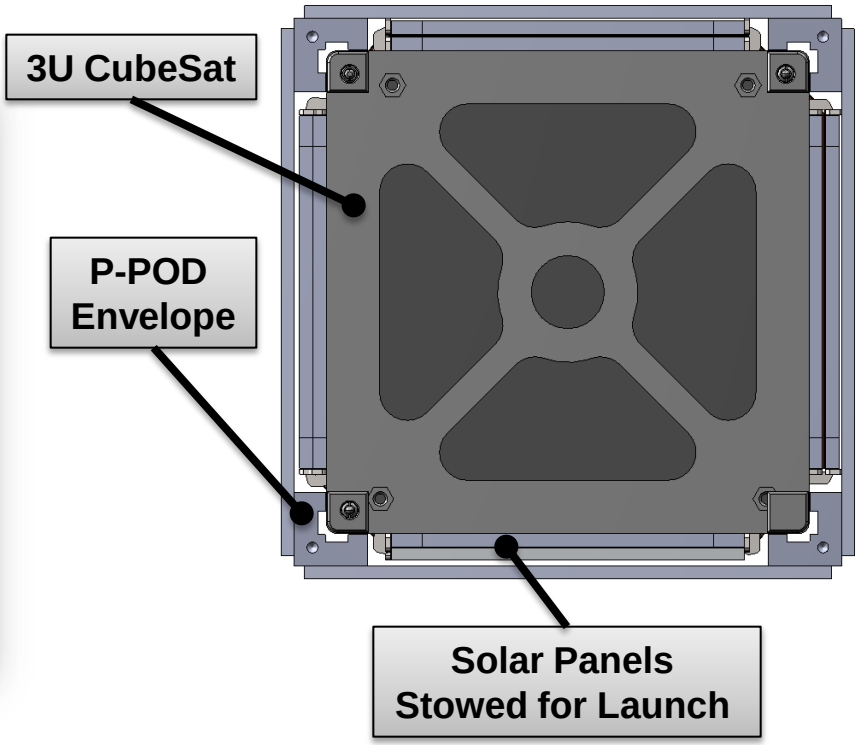
- Larger planar area than SOA
- Distanced from S/C to eliminate shading
- Articulated to maximize solar exposure

Stowage of CASA



SBIR Objectives

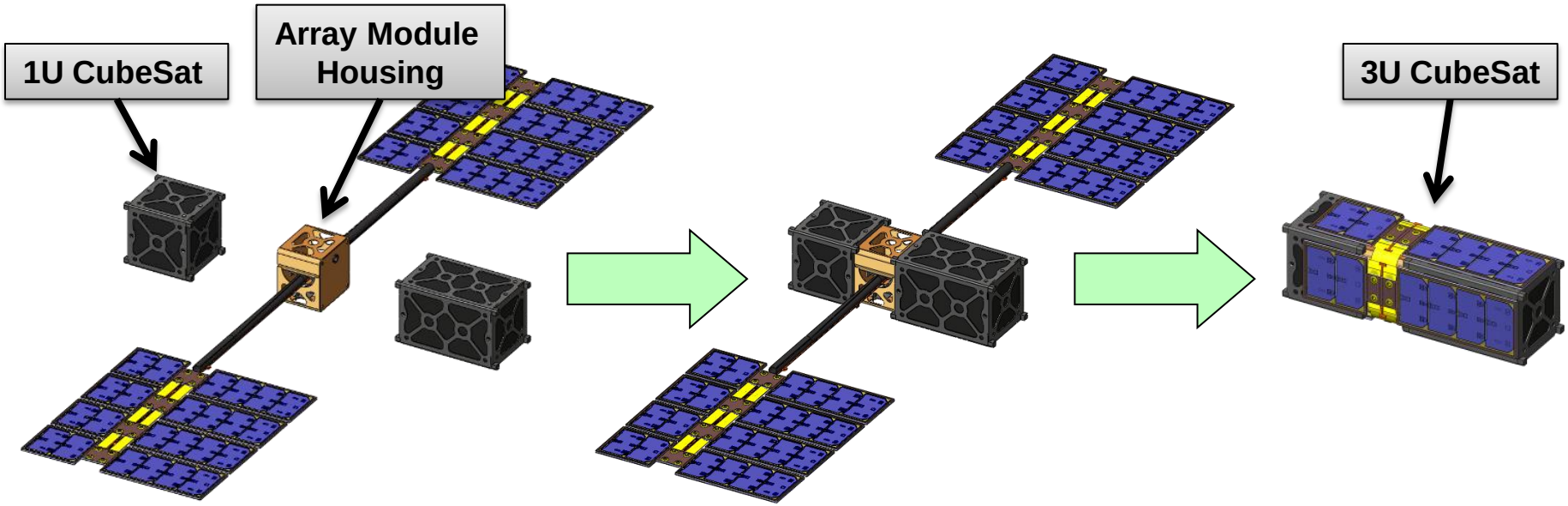
- **Demonstrate feasibility of a deployable, articulating planar array**
- **Size @ 50W on 3U CubeSat; launch within a P-POD**
- **Fabricate “turn-key” hardware to maximize flight demonstration opportunities**



“Turn-key” Array Module

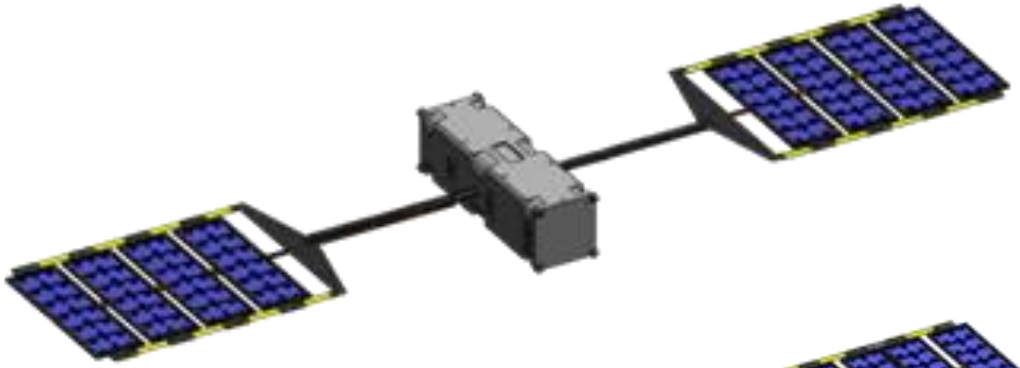
CASA may be:

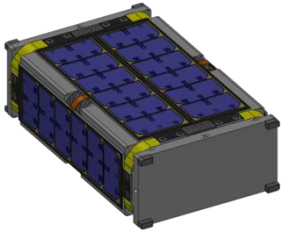
1. **Optimized for a specific mission; integrated into the bus design**
2. **Offered as a “turn-key” module; easily integrated into standard sized nanosatellites**
   - **This configuration was selected for the Phase II SBIR effort**



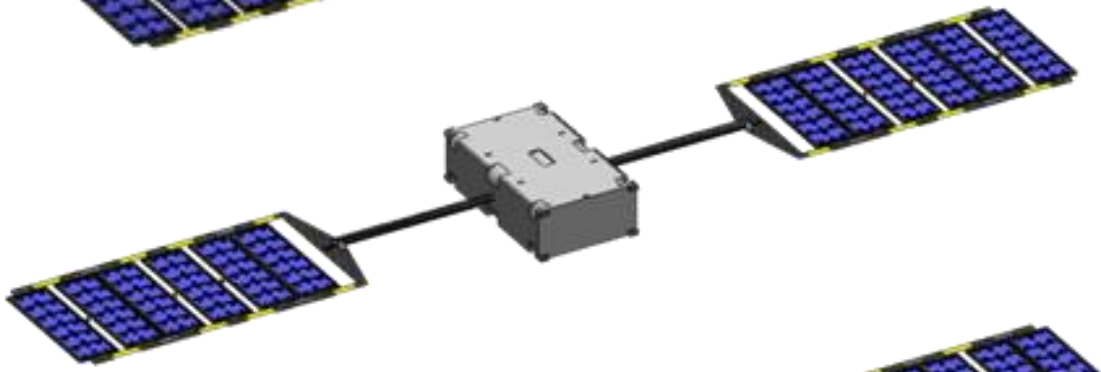
Scalable System Design

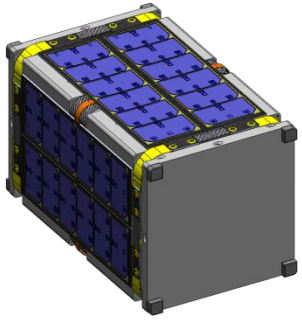
3U CubeSat



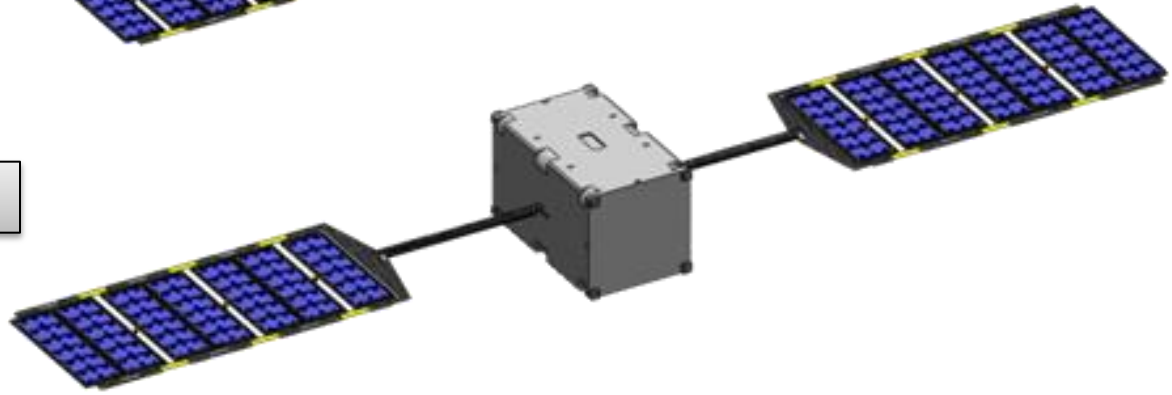


6U CubeSat





12U CubeSat

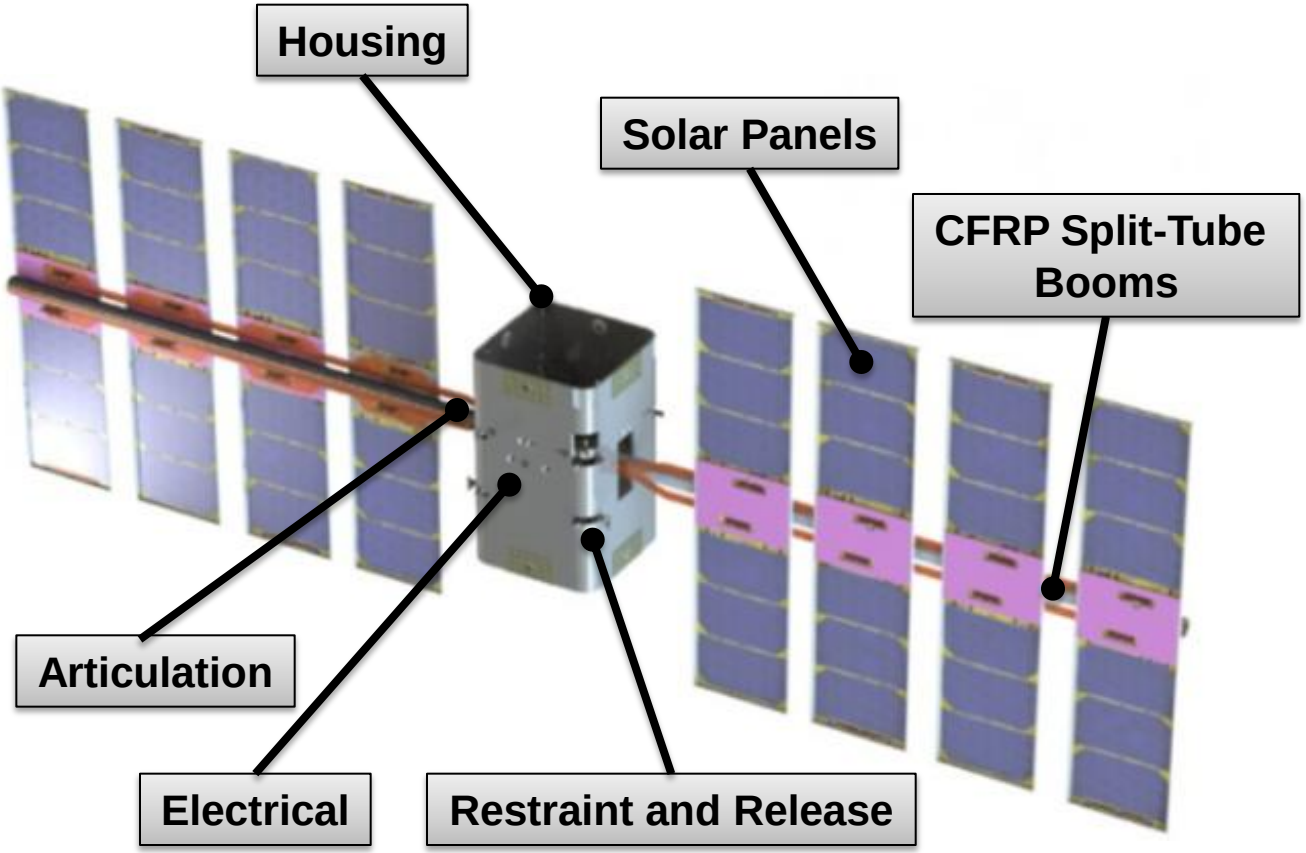


CASA Technology Overview

CASA Subsystems

6 sub-systems:

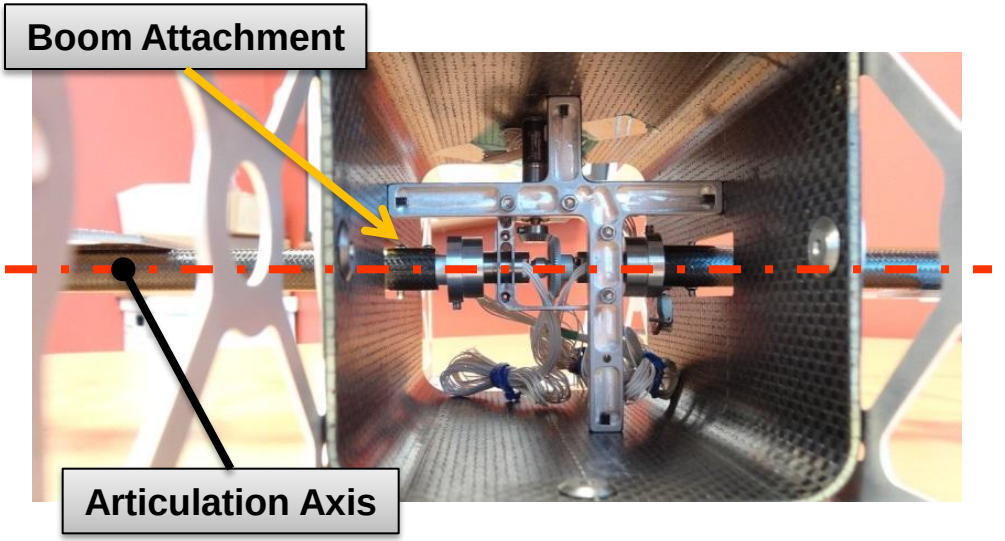
1. **Multifunctional composite booms**
2. **Solar panels (each wing has four solar panels)**
3. **Stepper motor articulation system**
4. **Launch restraint & release system**
5. **Electrical sub-system (including power harnessing)**
6. **Central hub/housing**

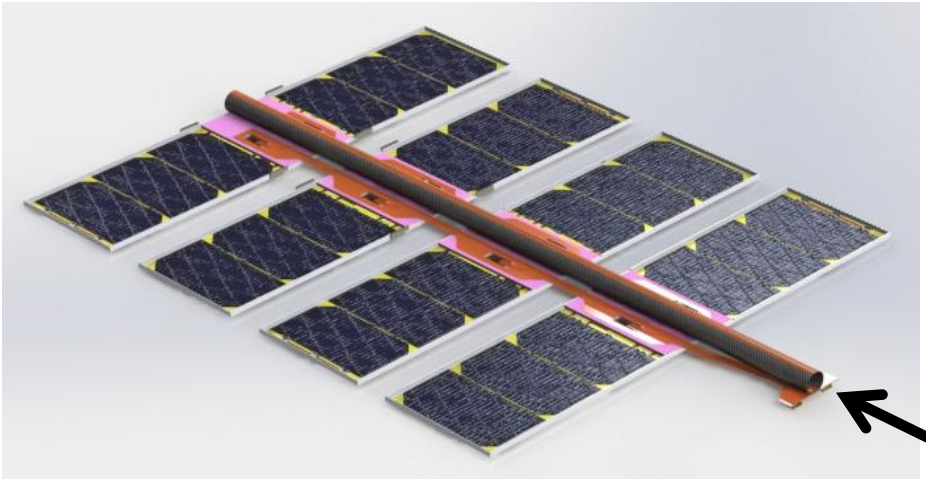


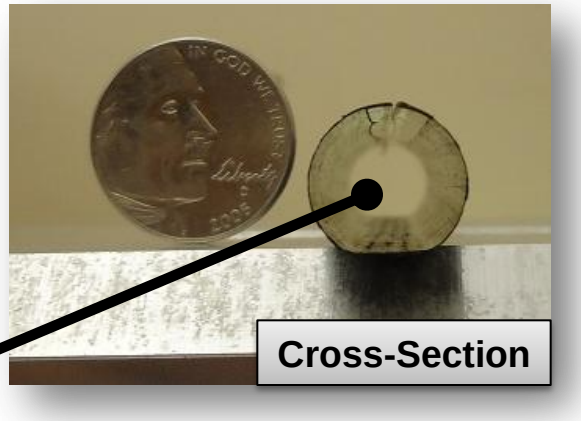
Phase II System Mass (for 3U CubeSat): 598g

Deployable Boom

- **Elastically deformed composite slit-tube boom provides:**
  - Deployed structure for solar arrays
  - Primary deployment mechanism
  - Interface with articulation system, and articulation axis

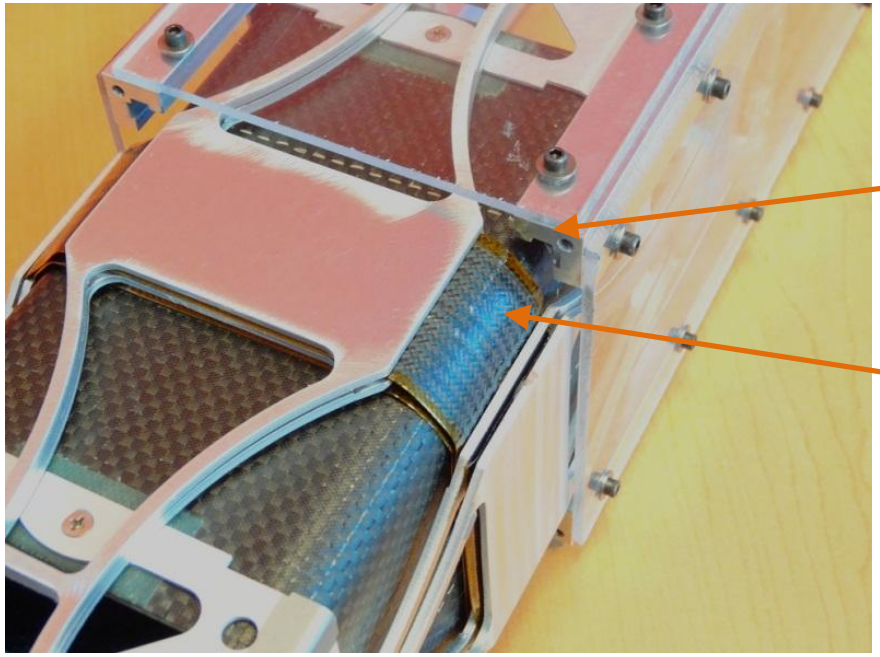






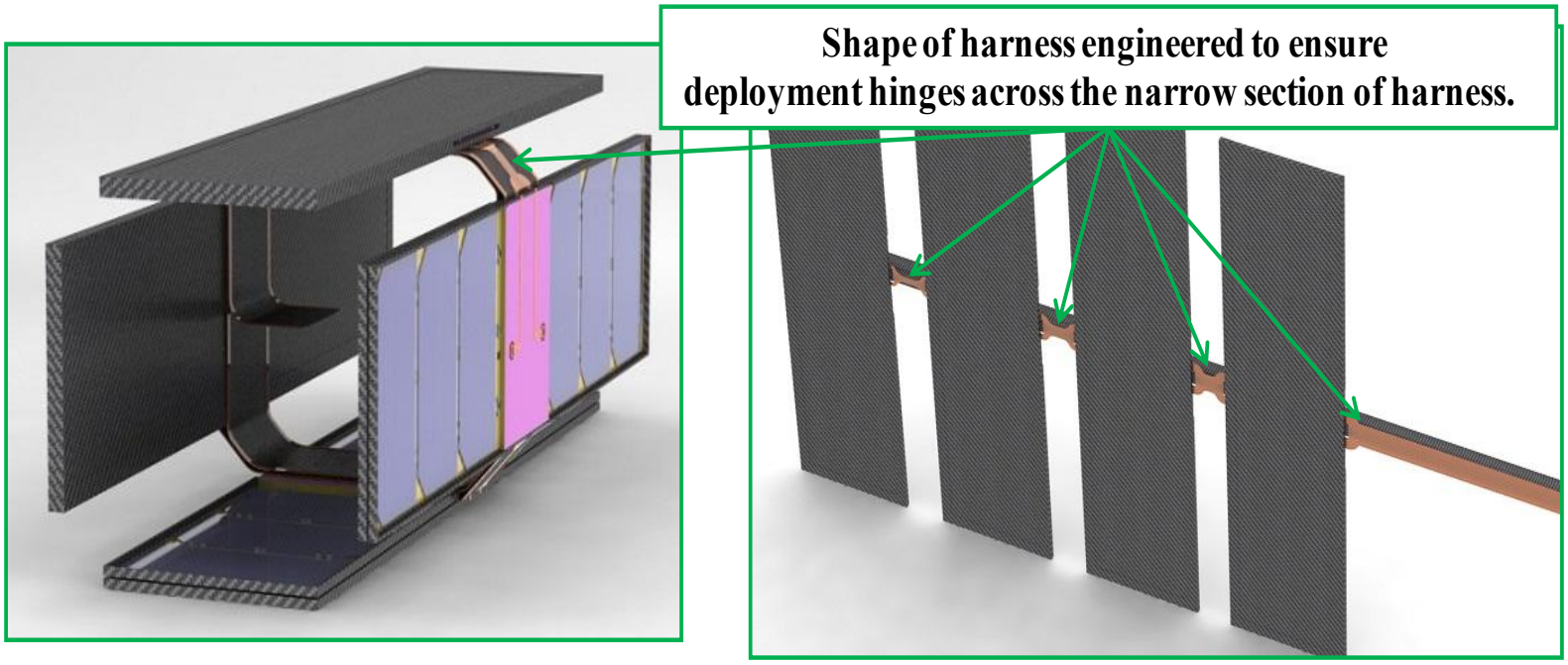
Deployable Boom, Cont'd

- **Booms are flattened and bent around housing**
- **Stowage efficiency of thin-walled boom is extremely high, meets P-Pod requirement**



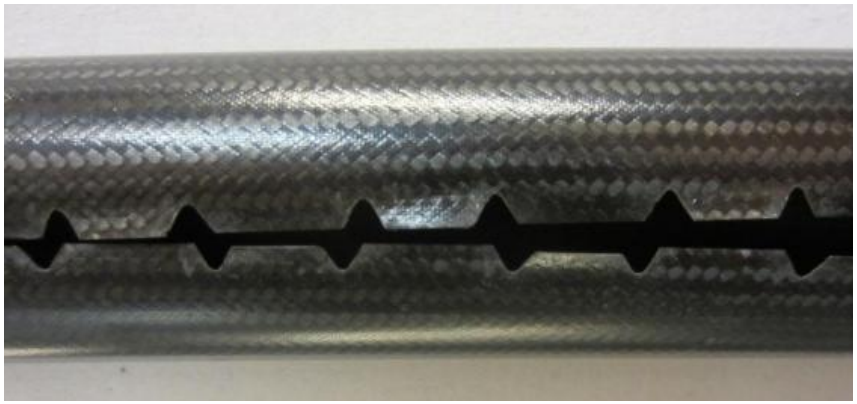
Flex Harness

- **Main resistive torque contributor is flex harness across hinge lines**
- **Deployable boom meets 3:1 torque margin**



Slit-Lock™

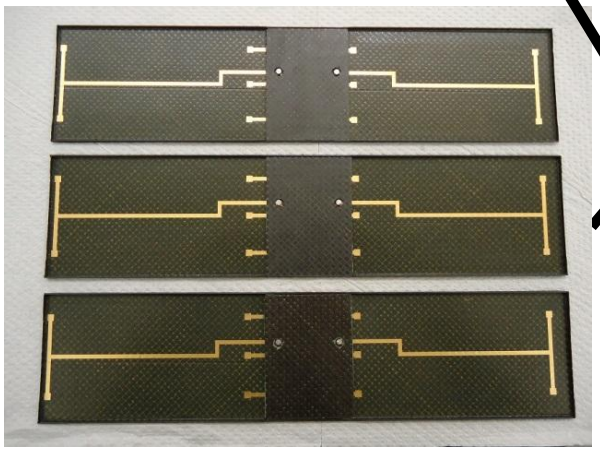
- Edge features interlock upon deployment
- Drastic improvement in stiffness and stability

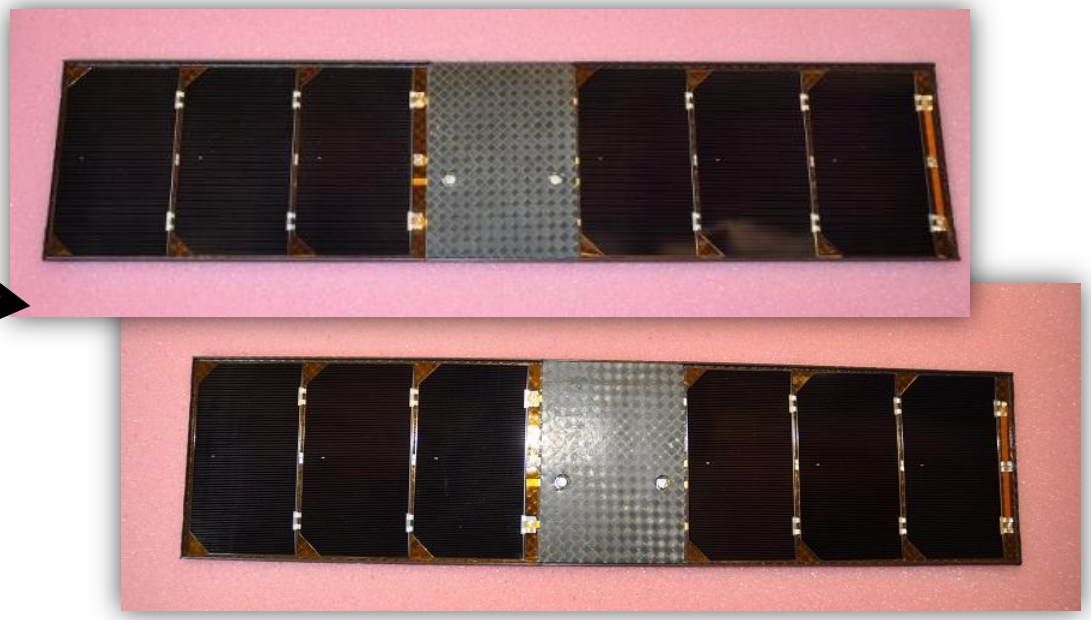


Solar Panels

- **Carbon-composite panel structure**
  - **Co-cured solar cell interconnect circuit**
  - **Honeycomb central structure reacts launch restraint loads**

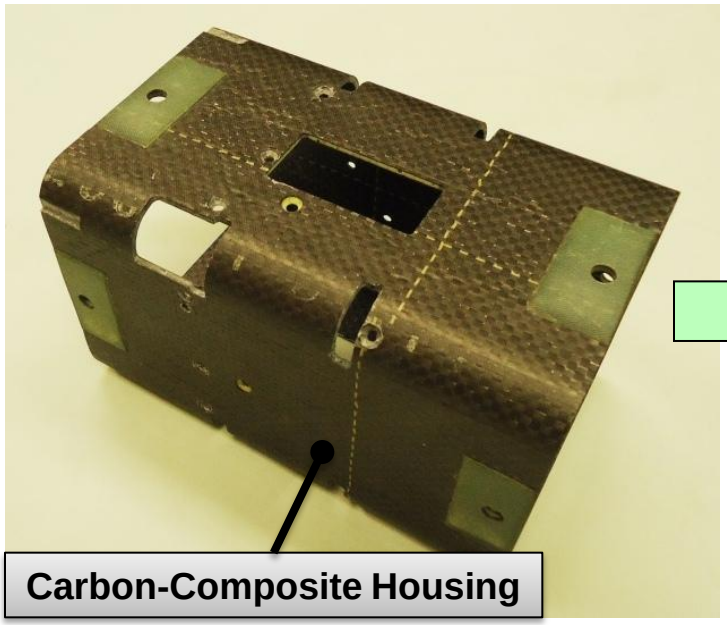
Attribute	Value
Solar Cells	Qty. 48 Spectrolab 28.3% UTJ
Total Power Production (maximum power point)	48.9 W
Bus Voltage (maximum power point)	14.1 V

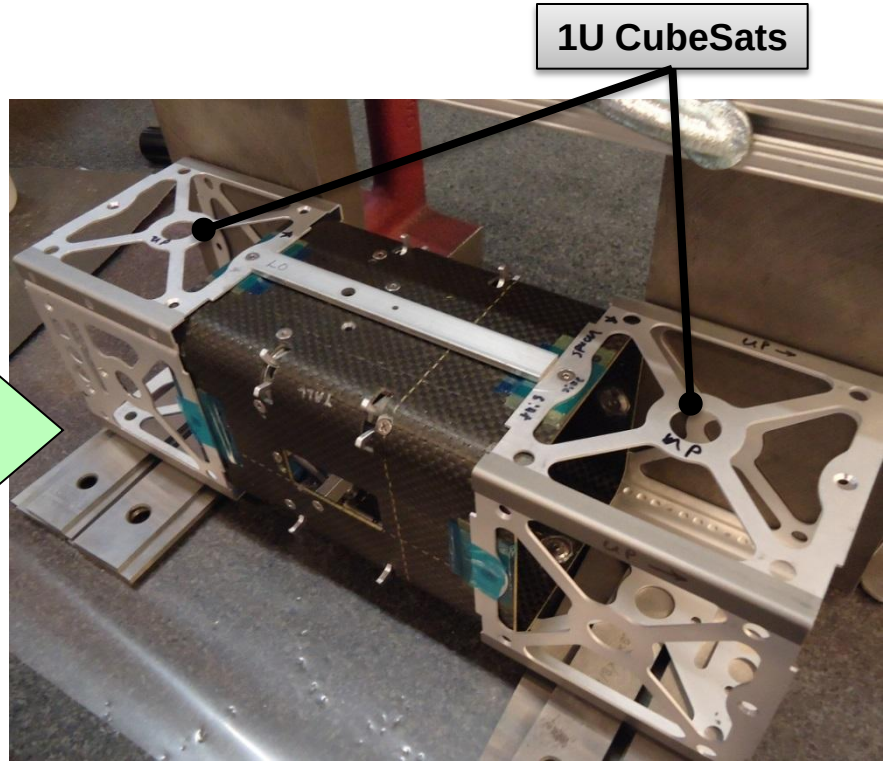




Modular Housing

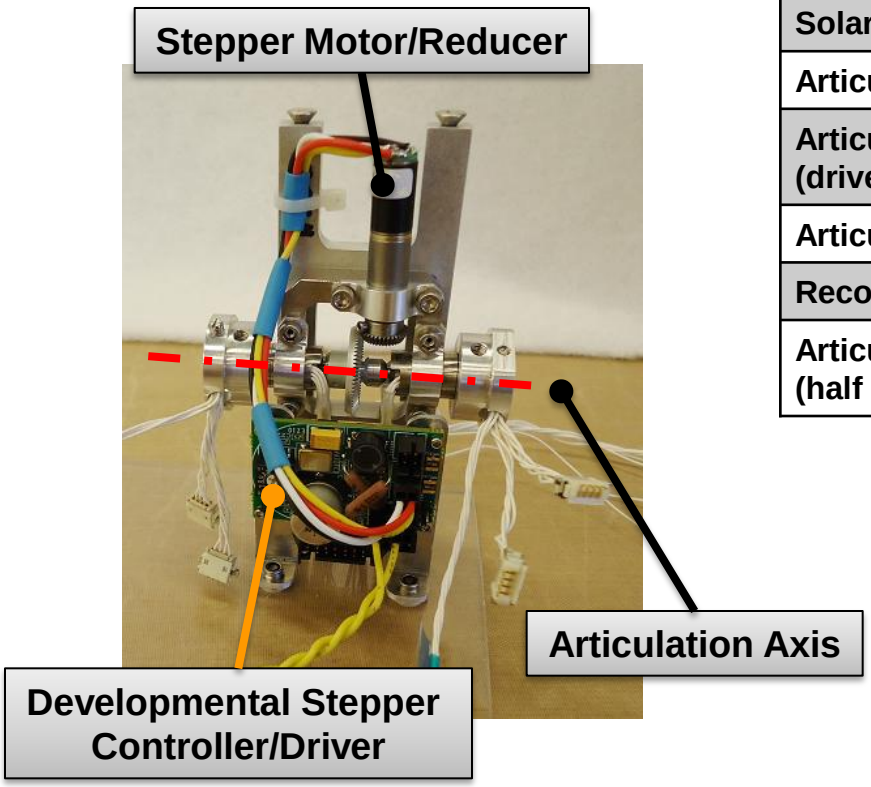
- **Integrates with standard sized nanosatellite bodies**
- **Provides common attachment for CASA systems**





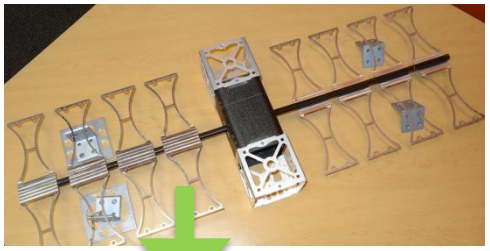
Array Articulation

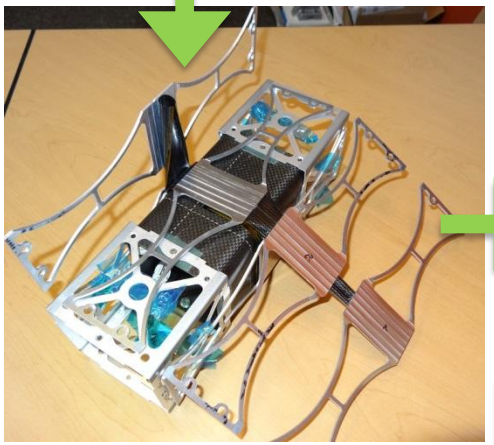
- **Maximizes solar irradiance exposure**
- **Controlled via CubeSat motherboard using mission-specific algorithm**

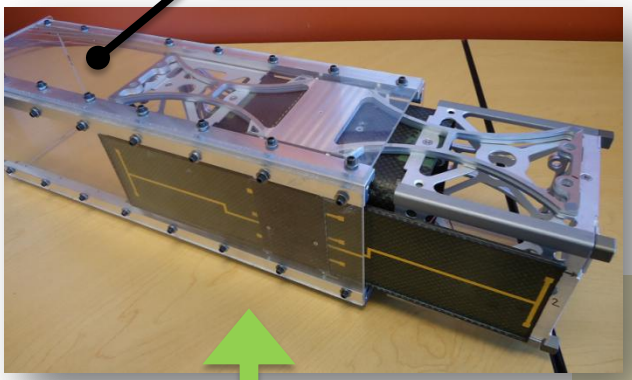


Attribute	Value
Solar Array Articulation	Stepper motor
Articulation Rotation	±360° continuous
Articulation Power Dissipation, Idle (driver may be turned off during idle)	0 - 1.34 W
Articulation Power Dissipation, Running	1.37 W
Recommended Articulation Rate	0.7 deg/s
Articulation Resolution (half stepping motor)	0.07 deg

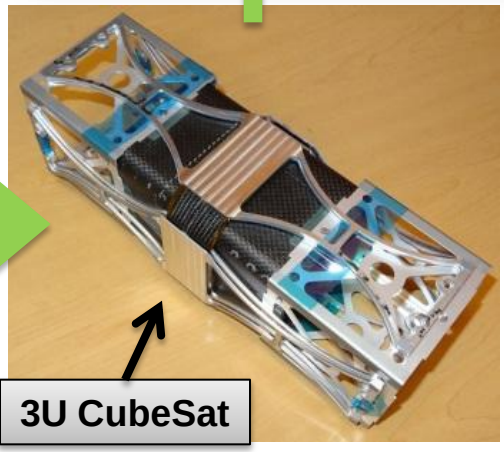
Array Packaging and Restraint





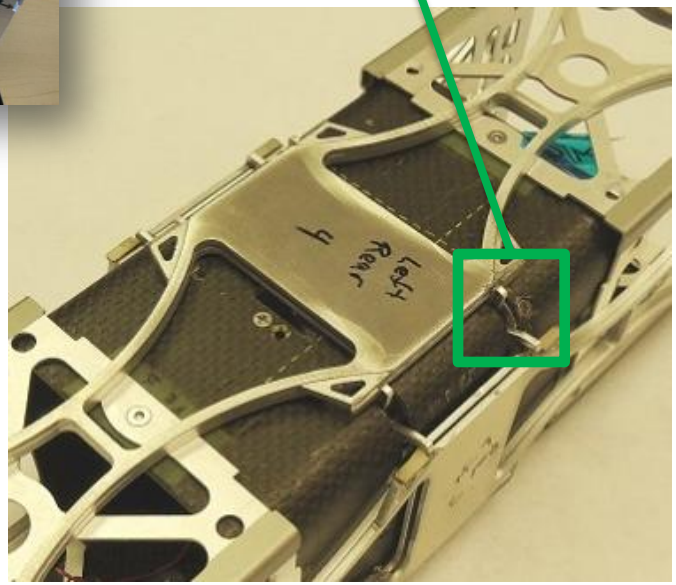


Mockup of P-POD



3U CubeSat

Solar Panels Restrained via Preloaded Latches

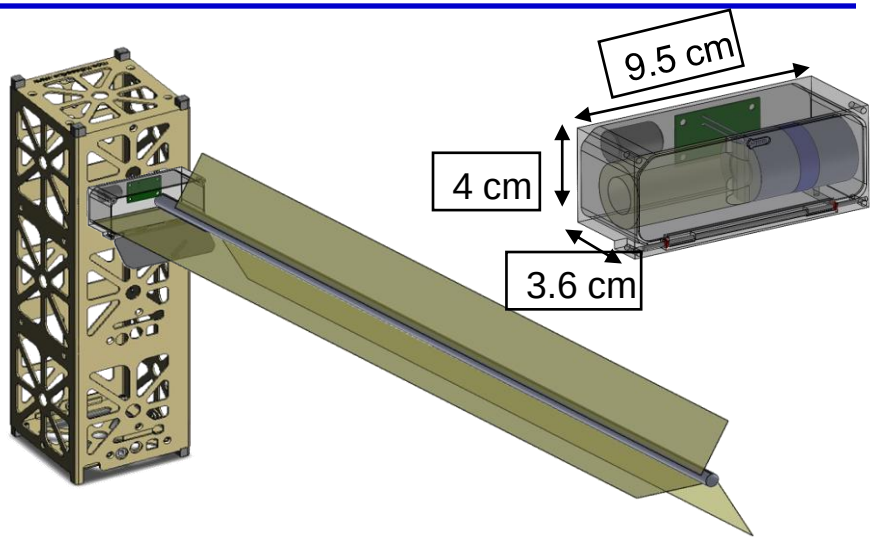


Conclusion and Future Efforts

- **Feasibility of deployable, articulating planar array concept has been demonstrated. Demonstration included:**
  - **“Turn-key” modularity**
  - **50W nominal power point-design**
  - **3U CubeSat and P-POD compatible**
  - **Simple and elegant elastically deployed multifunctional boom structure**
- **Further development continues with system-level qualification testing**
- **Additional collaboration opportunities are welcome and appreciated**

RODEO
Roll Out DEOrbiting Device

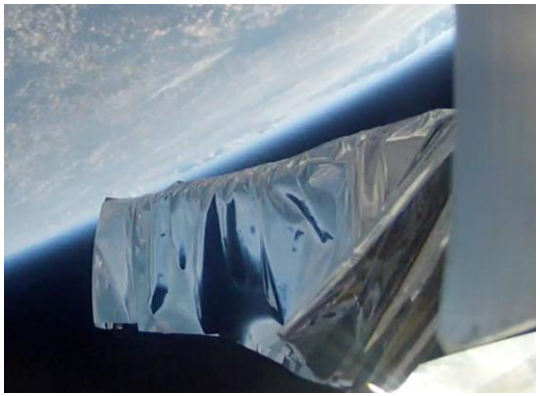
- Minimize system complexity
- Eliminate parasitic costs and mass
- Reduce volume
- Proven de-orbit technology
- Meets all NASA specs with minimal risk
- Designs available for up to 100 kg



Start of Deployment

Deployment

In Drag



Acknowledgement

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Thank You!