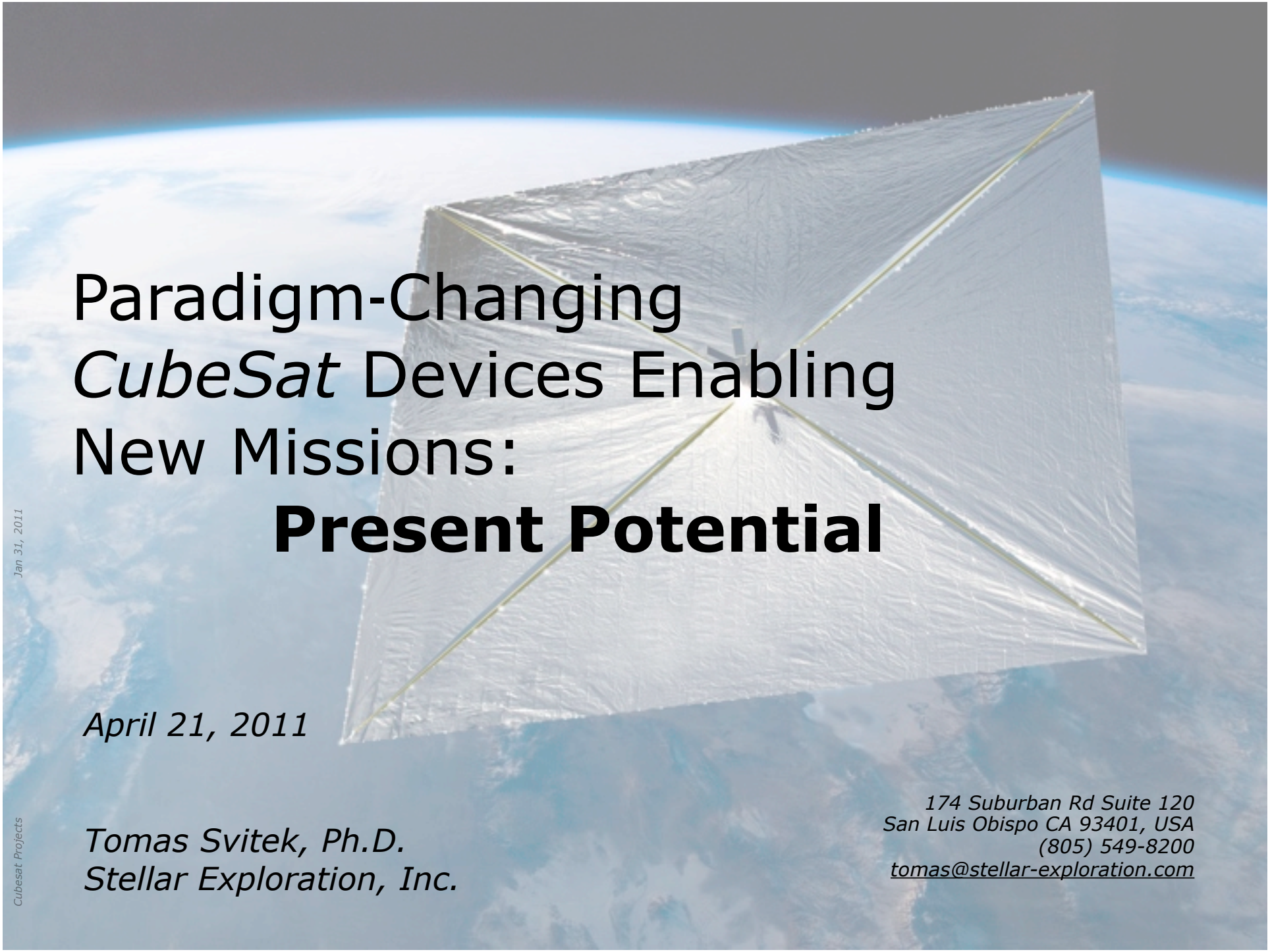

Paradigm-Changing *CubeSat* Devices Enabling New Missions: **Present Potential**

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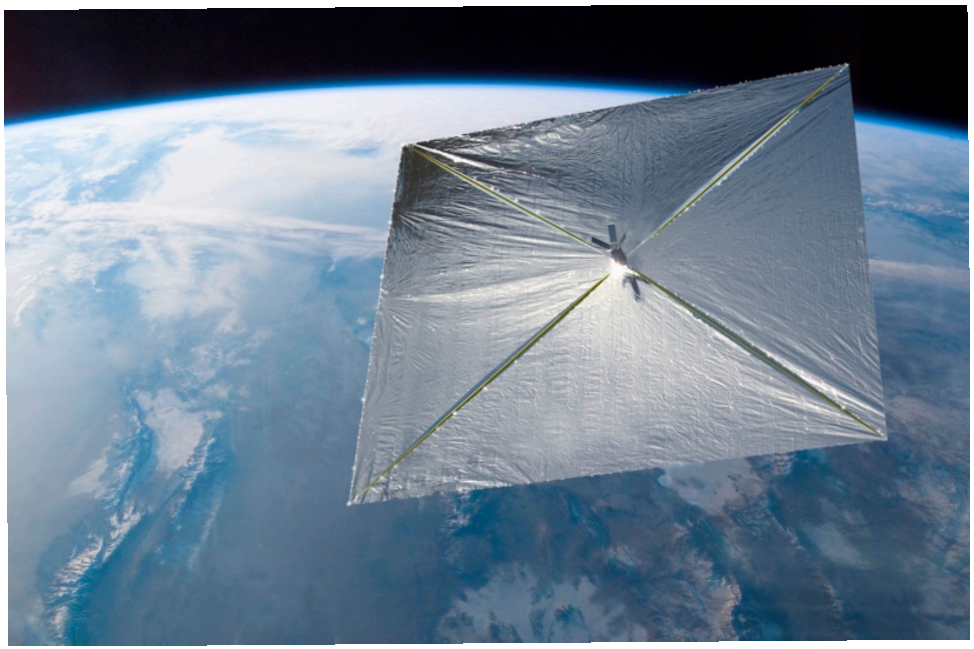
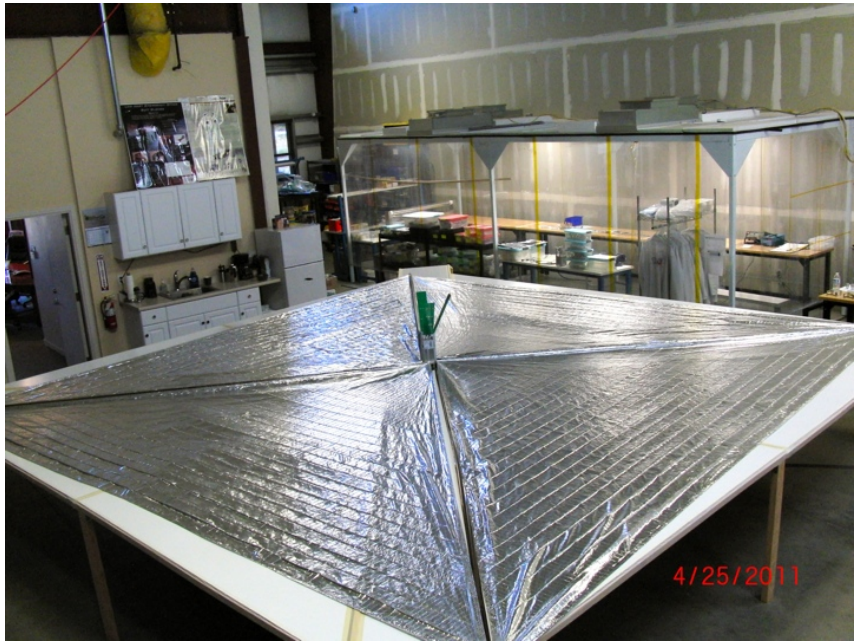
Motivation

- Lack of apertures is *last frontier* (limitation) of Cubesat world
  - Most traditional subsystem spacecraft hardware exists or will exist soon (CD&H, com, EPS, ACS)
  - Propulsion actively pursued by multiple groups
- ***Apertures still lacking***
- As we are completing LightSail-1 Cubesat, we have initiated an IRAD project to leverage solar sail boom technologies for larger RF antennas
- Several design concepts are explored
- Multiple diverse application
  - NASA science mission
  - Communications -- commercial, DOD
  - Signals collection

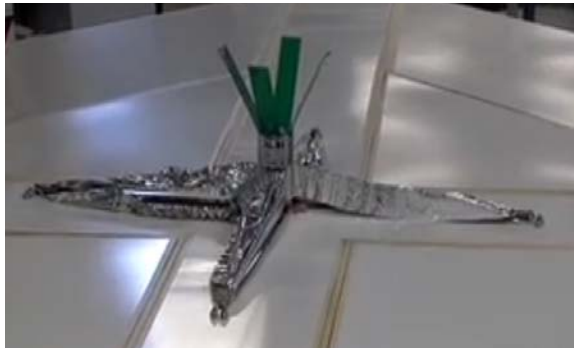
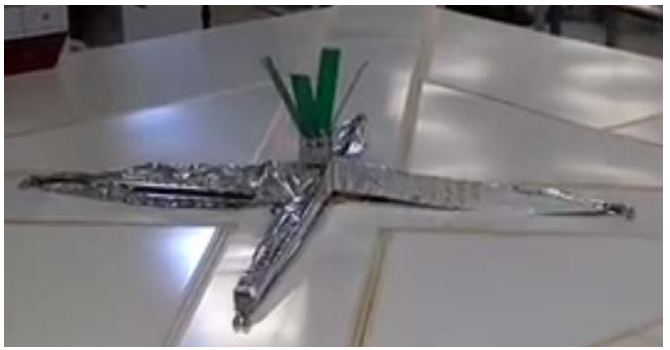
LightSail-1 Overview

- *The Planetary Society* is customer => Solar sail pioneers
- Under development since 2009
- Development completed, in system I&T
- Ready to launch later in 2011
- Sophisticated solar sailing propulsion demonstration in 3U
  - Largest performance ever attempted for solar sail => 8 meters tip-to-tip, 32 m^2
  - Active attitude control system (momentum bias), with solar power and battery power
  - 2 cameras, 3 MEMS inertial sensors, 2x3 high-precision accelerometer, laser corner cubes, DVD ....

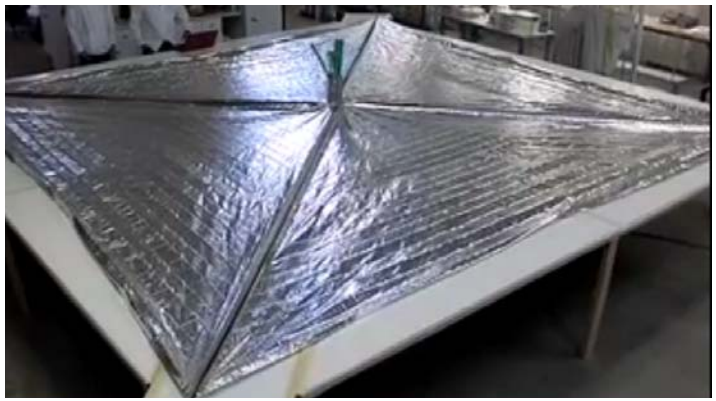




LightSail-1 Deployment Sequence

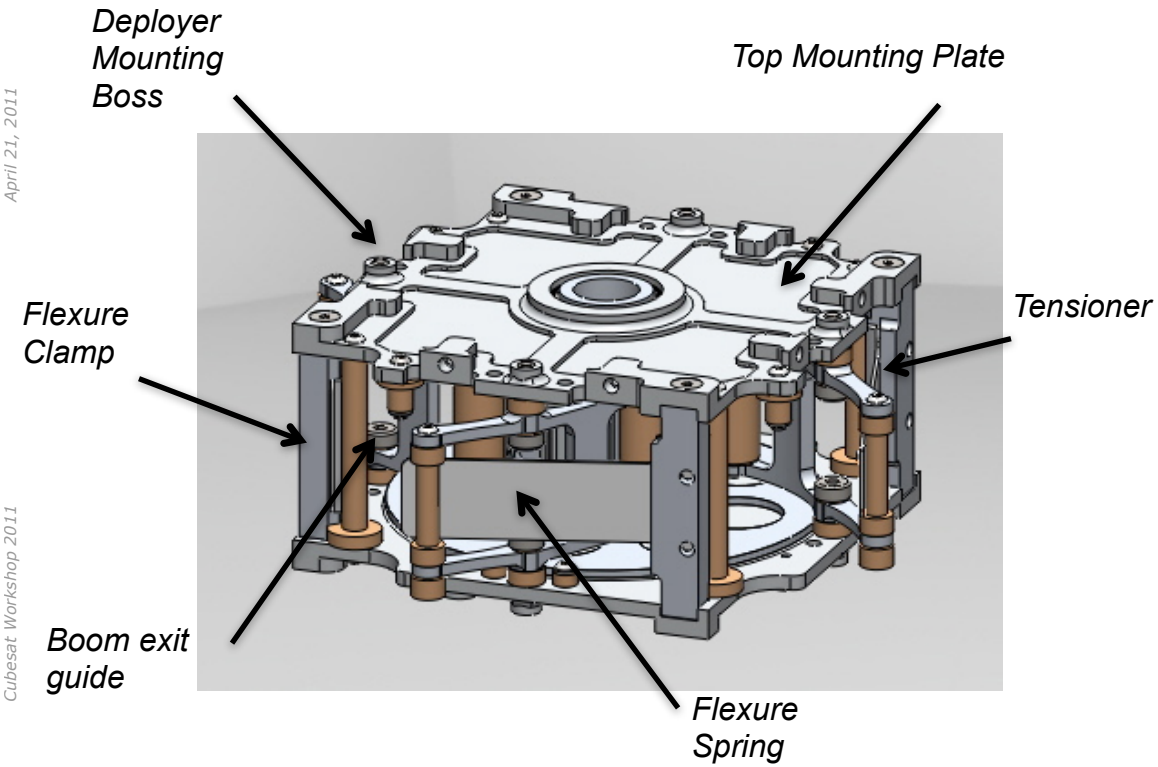








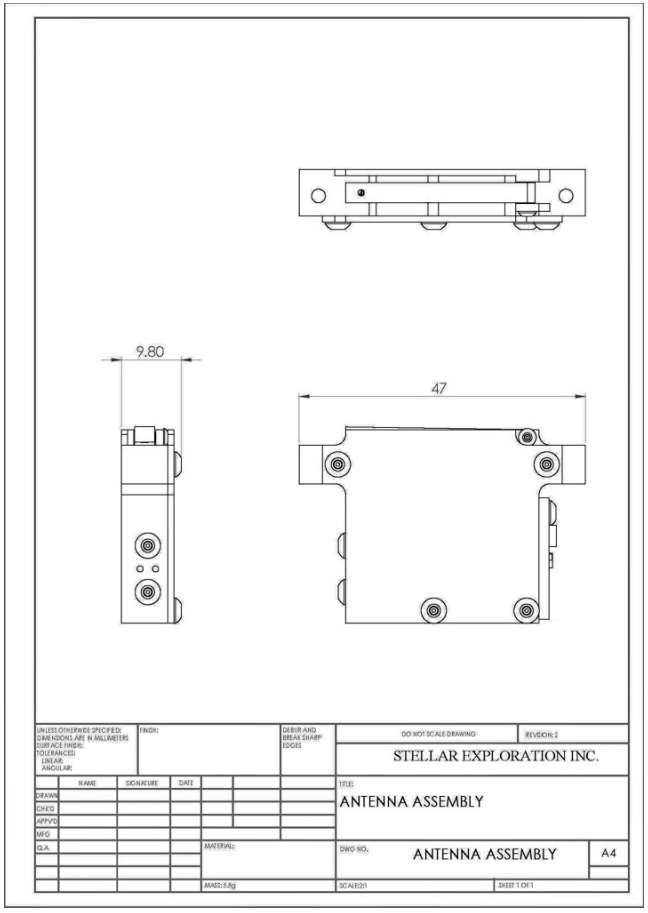
Large Deployable Cubesat *Structure*

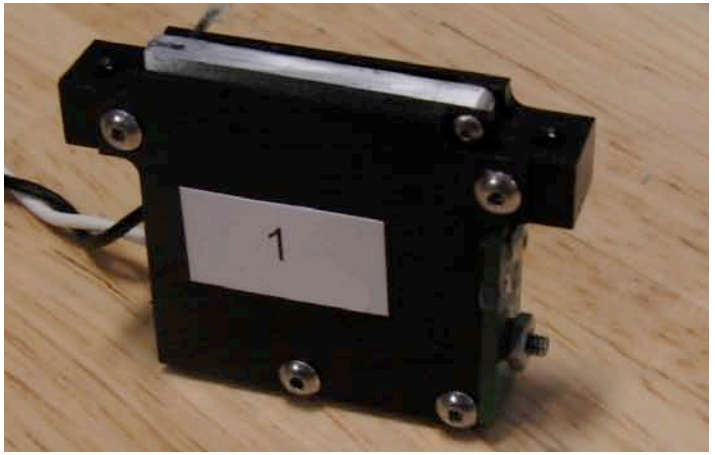
- For Lightsail-1 solar sail project, *Stellar* developed (with AFRL assistance) deployable structure using TRAC boom and motorized deployer for controlled deployment
  - Largest (known) ratio of pre/post-deployment dimensions
  - 10 cm => 8 m (end-to-end)
- Four booms inside single integrated deployer fits in volume ~0.5U and mass ~460 g

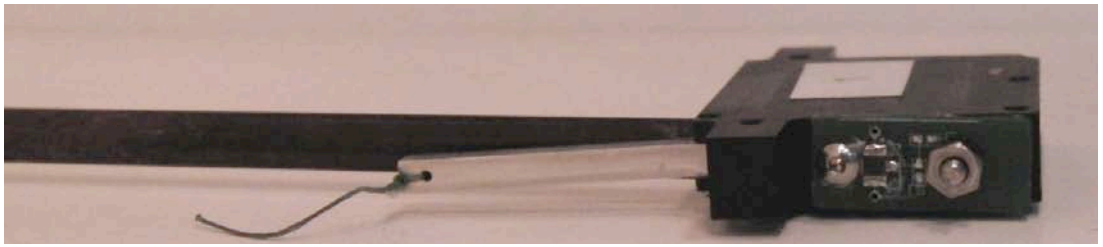


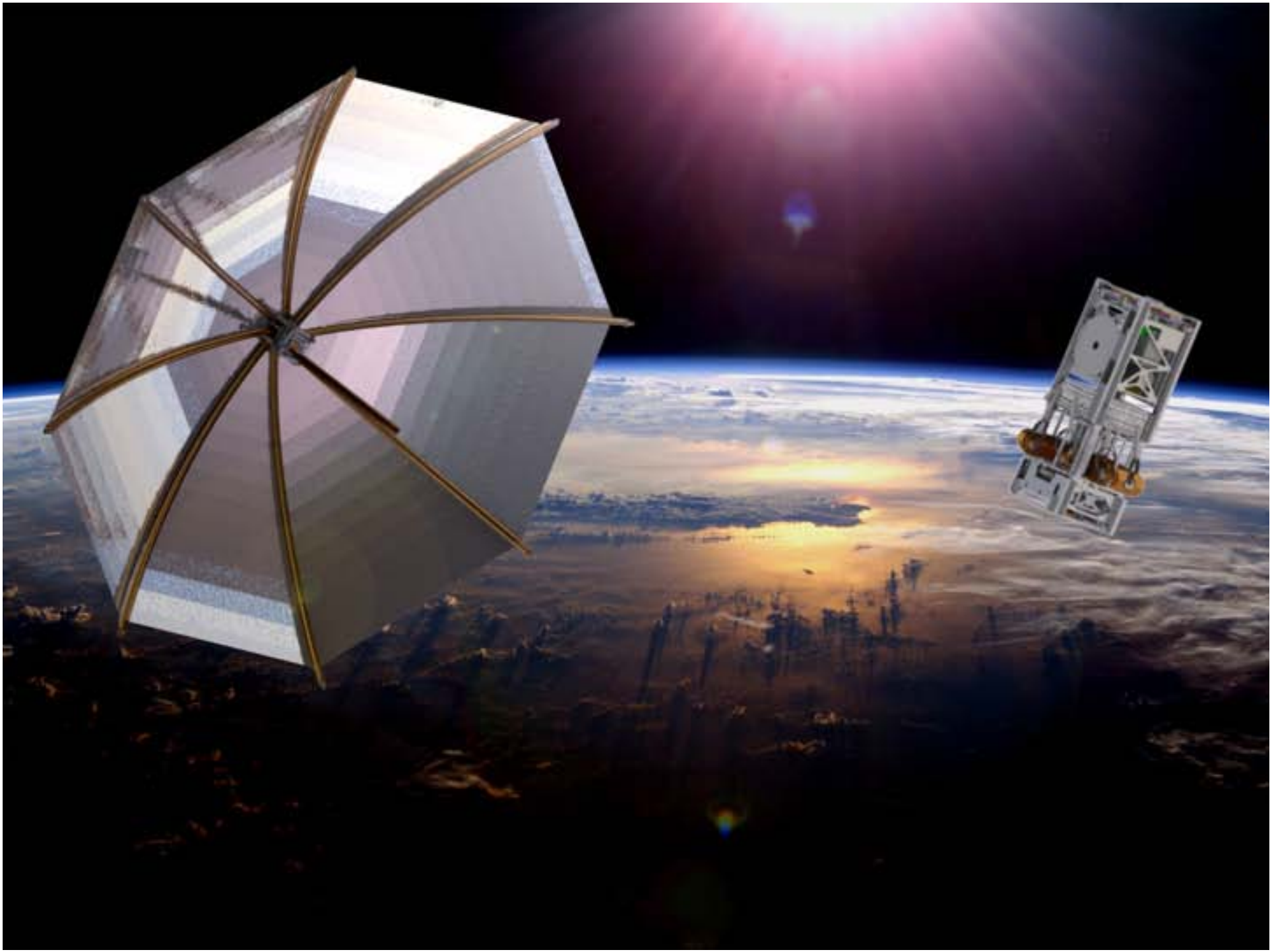
First, Small Antennas

- 430 MHz monopole
- <6 grams (including balun, grounding and deployer)
- Burn-wire initiator
- 3x improvement on previous SOA



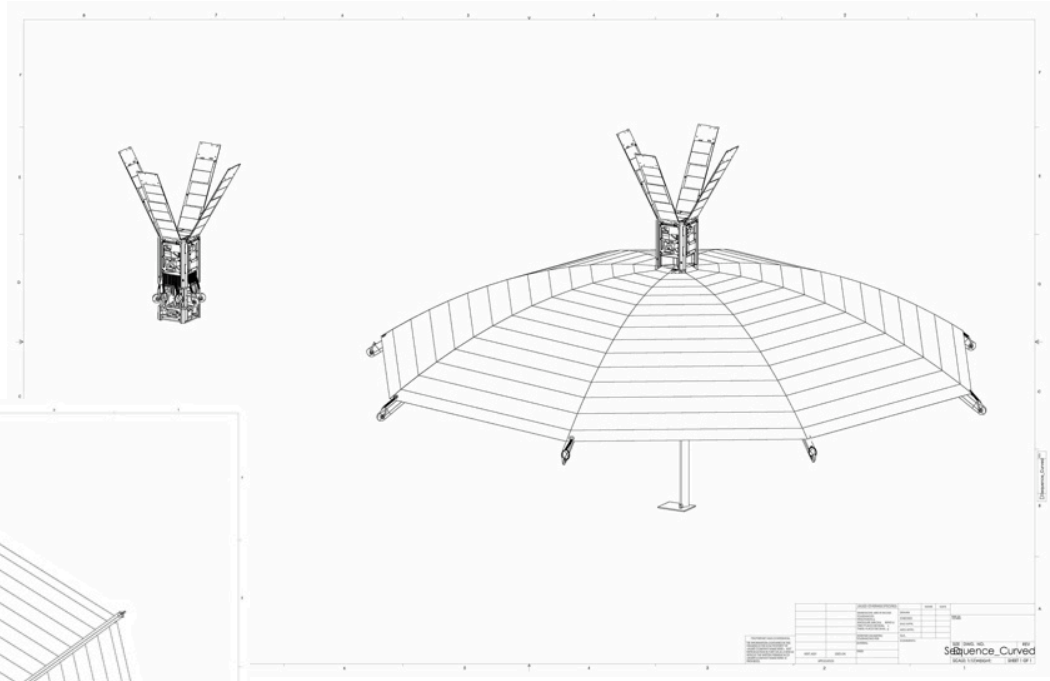


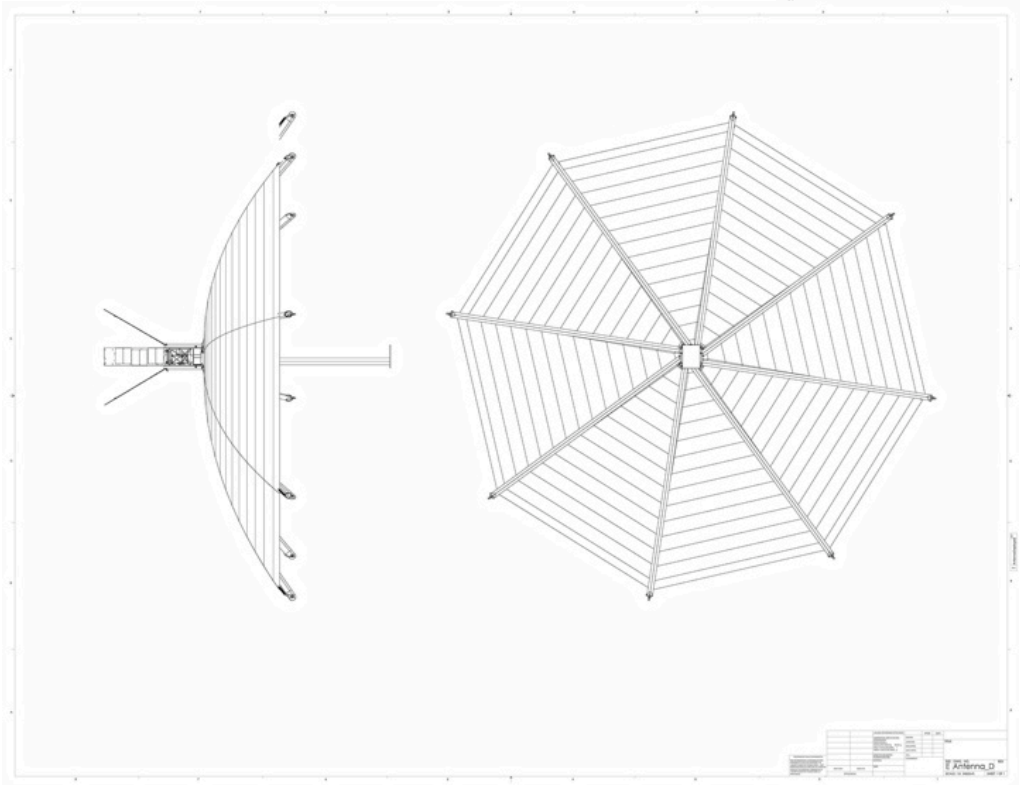




Reflector Antennas

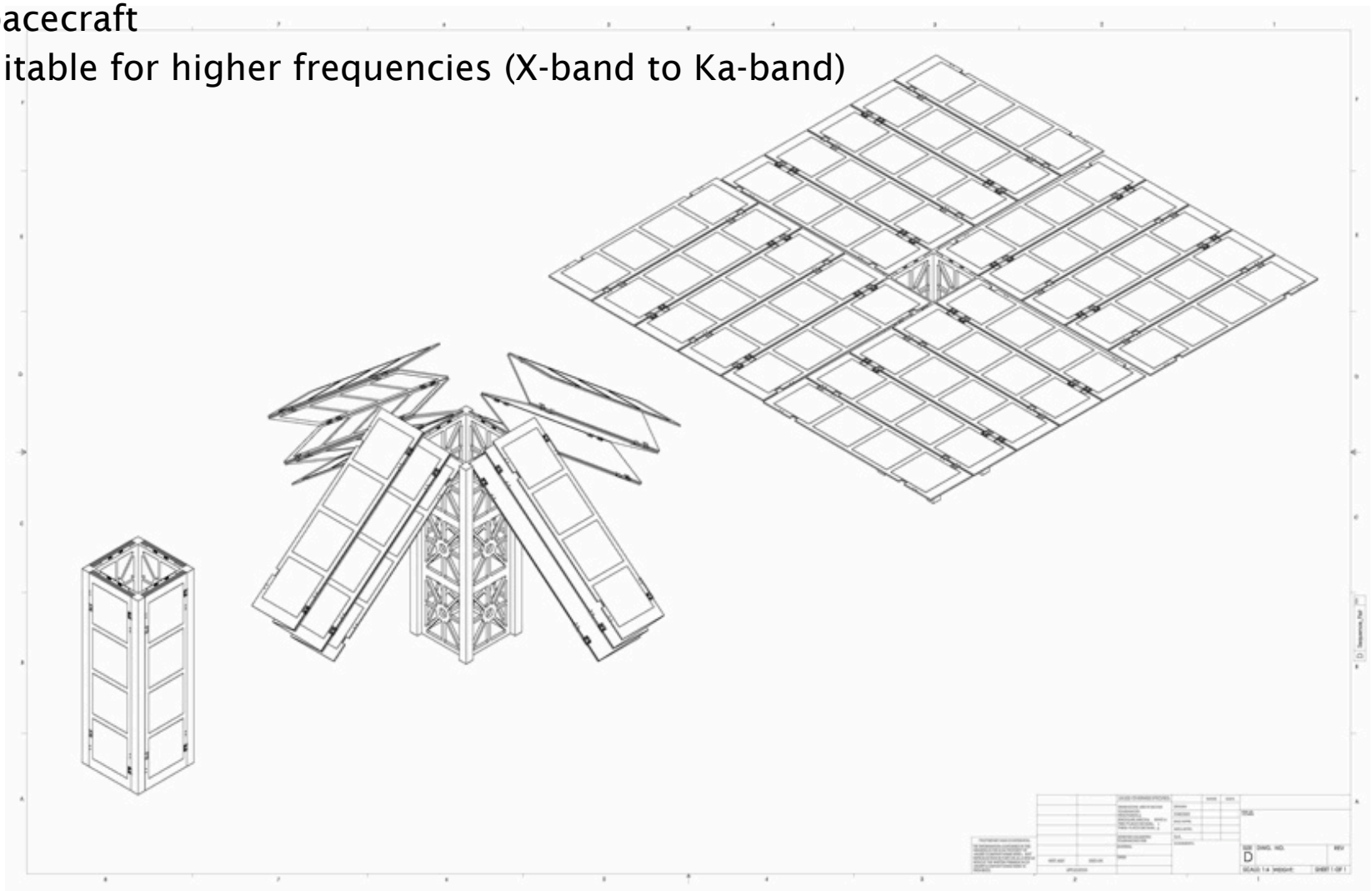
- Deployable parabolic reflector
- Up to 2 meter aperture from 1U volume
- Suitable for UHF, L-Band or S-Band applications





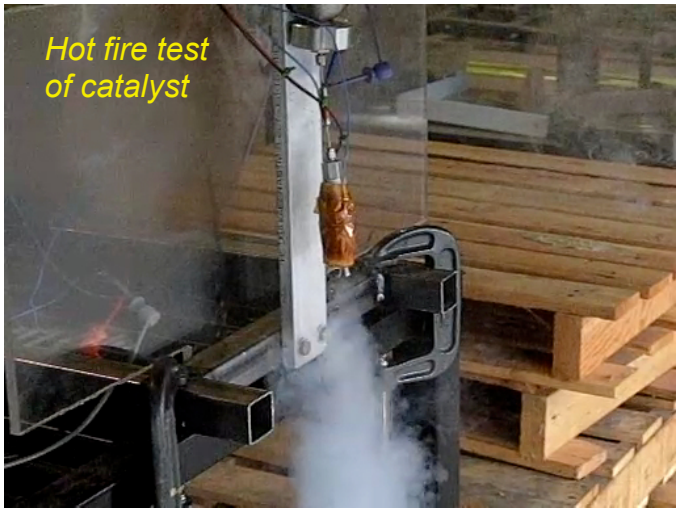
Planar Microwave Antenna

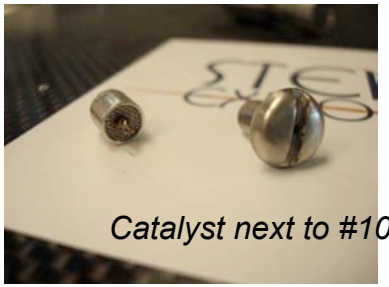
- Folding planar microwave antenna
- Leverage solar panel release/deployment technology
- Up to 0.6 m^2 aperture is compatible with 3U Cubesat spacecraft
- Suitable for higher frequencies (X-band to Ka-band)

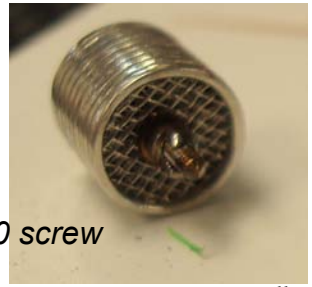


Hydrazine Monopropellant Micropropulsion

- Fully-integrated propulsion system in 1U Cubesat form factor
  - Attaches to additional Cubesat units
  - Low cost for complete unit (<<$1M)
- Large ΔV ~400m/s (3U total system)
- Range safety compliance
- Four canted thrusters translate and rotate about all three principal axes
- Hot firing testing underway
- Adaptable for multiple configurations
  - 0.5U form-factor (valves/catbed embedded inside tank
  - 2U for increased Δv
  - 2Ux2U (footprint) -- classical ellipsoid lightweight tank







Questions?