

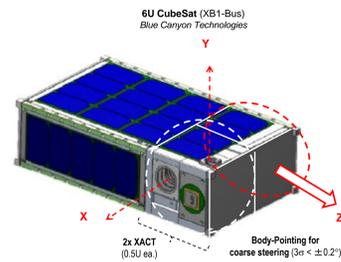
CubeSat Laser Com and Lidar for NASA Science Missions



Mark Storm

CubeSat Laser Com

- ❖ Originally designed (NASA SBIR 2014) to support NIAC concept for Deep Space CubeSat Science missions
- ❖ Comprehensive functionality in compact, thermally stable package
- ❖ Designed to support point ahead for deep space
- ❖ Precision pointing ensured by:
 - ♦ Fibertek's multiple layers of isolation and FSM
 - ♦ CubeSat coarse pointing capability and platform stability.



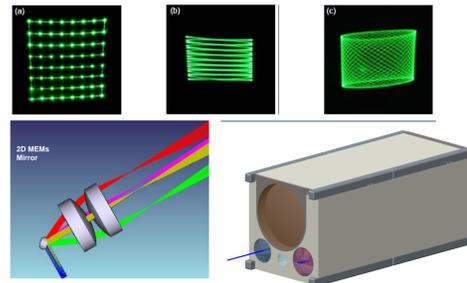
Key Takeaways

- CubeSat Laser Communications Terminal Developed for Planetary CubeSat applications – NIAC envision Mission, NASA SBIR
- First Spaceflight Unit in Space – To be tested in 2018
- CubeSat Lidar – Atmospheric, 3D imaging, Topology, Mapping Feasible
- See Small Sat Conference 2017 and 2018 Lunar Polar Volatile Meeting papers for more information.

Rendezvous – Sample Capture – Topology – Geodesy

3D Imaging Lidar, 2U CubeSat

- ❖ 2U CubeSat : < 20W
- ❖ Long Range: 10 - 1000km, + 6 degrees
 - ♦ Ranging, Topology
- ❖ Short Range: 0-300m, + 25 degrees
 - ♦ Sample Capture, Rendezvous
- ❖ Laser Coms - Sat-Sat coms, > 1 Mbps



High TRL Single Beam

- ❖ 5 km single pulse range
- ❖ High TRL components
- ❖ 1.3 kg, < 15W, < 2 U CubeSat size



< 2 kg TRL UAV package



TRL – 9 Laser & Detector

Atmospheric & Altimetry Lidar

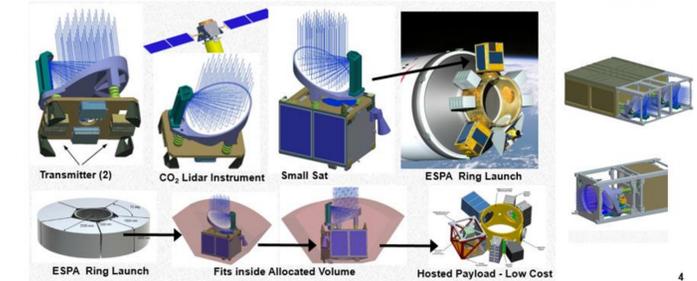
- ❖ Small Sat, CubeSat,
- ❖ Comets, Moons, Small bodies, planets
- ❖ Column Content lidar , < 5% accuracy

Trace Gases – Methane, CO₂, H₂O



- ❖ Fibertek Developing Cube/Small Sat Lidar Technology
- ❖ Orbiters - NASA Catalog COTS, ESPA rideshare
- ❖ Methane, CO₂, H₂O, O₃, UV signatures
- ❖ SWaP
 - ♦ CubeSat : 2U to 6U Lidar Systems, 10W - 40W
 - ♦ Small Sat Payload: ~ 50 kg, 70 cm telescope, 60-130 W

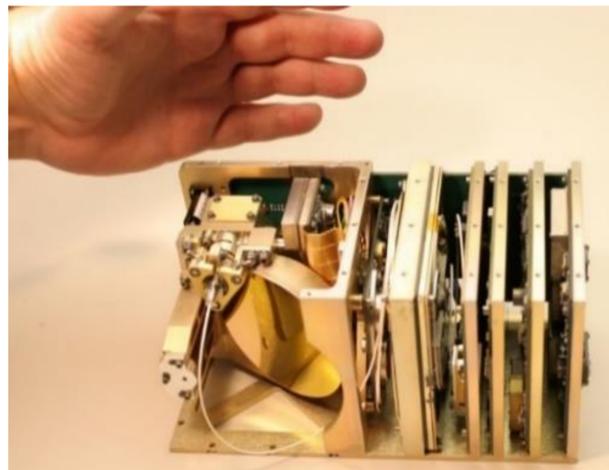
Lidar Type	Atmo				
	CH ₄	CO ₂	SO ₂	H ₂ O	O ₃
Laser Pulse Energy (uJ)	400	400	2000	400	500
Rep Rate (kHz)	4	4	2	4	2
Laser Power (W)	2	2	4	2	1
Satellite Power (W)	27	23	40	18	50
Mass Estimate (kg)	13	10	12	10	15



CubeSat Laser Com

Design Approach

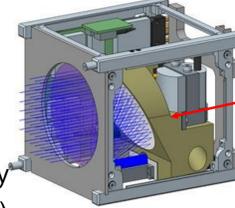
- ❖ Planetary Laser Com – NIAC concept, NASA SBIR 2014
- ❖ Up to 1.5 A.U. distance
- ❖ Supports variety of NASA missions
- ❖ Support Direct to Earth, Ring and Mesh topologies
- ❖ Use TRL-9 Tech for Coarse Pointing
- ❖ Applications:
 - ♦ Sensor data ingress, Direct to Earth, Inter Sat Links (ISL)



Cloud and Aerosol Lidar

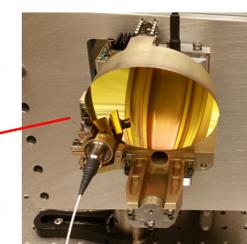
- ❖ Cloud Layer Lidar
 - ❖ Improve Passive IR and Microwave Data Products
- ❖ Exploration Applications
 - ♦ Haze layer in Pluto Atmosphere. – 20 haze layers, each about 2km thick
 - ♦ Pluto – Gas plume vertical layers and optical density
 - ♦ Enceladus – Saturn moon high velocity (1-2 km/sec) plumes, clouds.
 - ♦ Clouds - Water vs Ice, polarization receiver
- ❖ Small enough for a rover!

2U Lidar



1/2 U Fibertek Laser

Fibertek CubeSat Telescope



Water Vapor & CO₂

- ❖ Planetary Small Body Lidar – Planet, Comet, Moon, Asteroid
- ❖ 6U CubeSat
- ❖ 9W power draw for 20W laser, 10% duty cycle.
- ❖ 4U laser including wavelength locking and control

