



# **2014 Ground Systems Architecture Workshop**

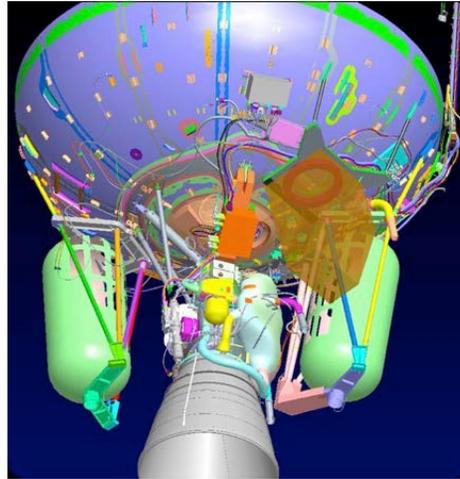
## **Current and Future Ground Systems for CubeSats**

### **Panel Discussion**

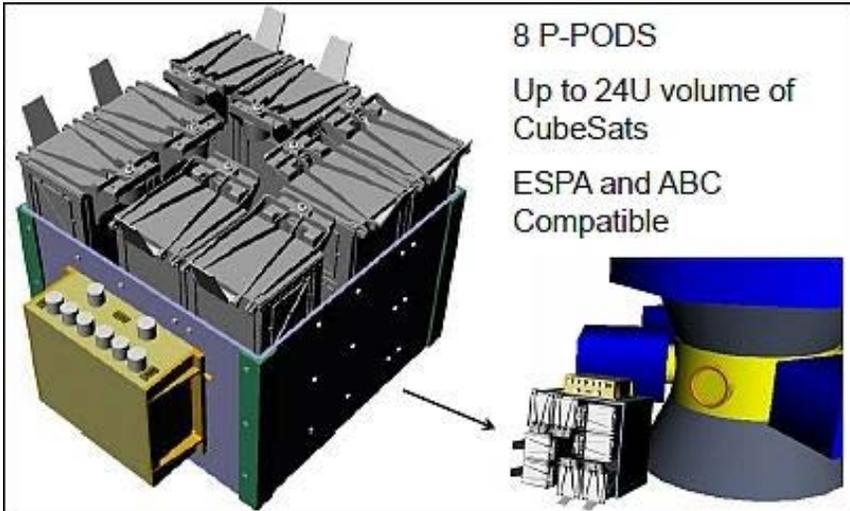
Dr. Charles D. Norton  
Jet Propulsion Laboratory  
California Institute of Technology

# ELaNa-II GEMSat (NROL-39) December 5, 2013

## ELaNa-X Manifest for October 31, 2014

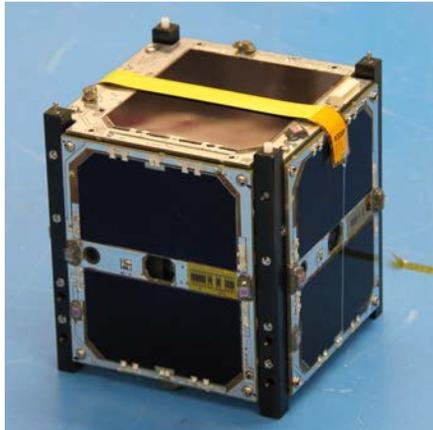


VAFB Manifest of MCubed-2 and IPEX on GEMSat NRO L-39  
12/5/13 launch and operational



VAFB Manifest of GRIFEX on ELaNa-X planned for  
10/31/14 launch

# Active JPL Projects (Earth Technology and Science)



## M-Cubed/COVE-2 (NASA ESTO)

High data-rate on-board processing  
P. Pingree: JPL, U. Michigan

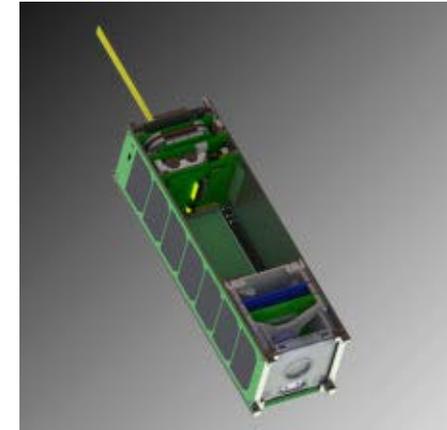
*Launched VAFB: Dec. 5, 2013 (NASA CLI)*



## IPEX/CP-8 (NASA ESTO)

Autonomous low-latency product generation  
S. Chien: JPL, GSFC, Cal Poly SLO

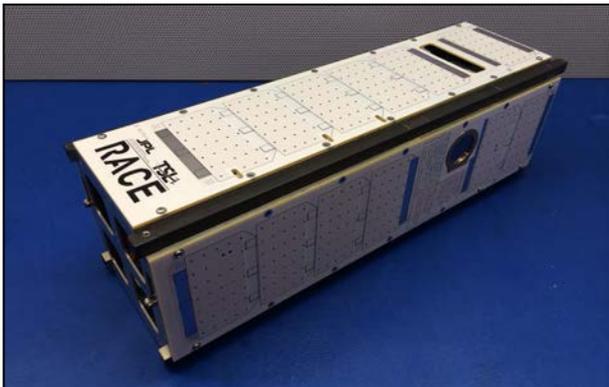
*Launched VAFB: Dec. 5, 2013 (NASA CLI)*



## GRIFEX (NASA ESTO)

Unprecedented frame-rate ROIC/FPA  
D: Rider JPL, U. Michigan

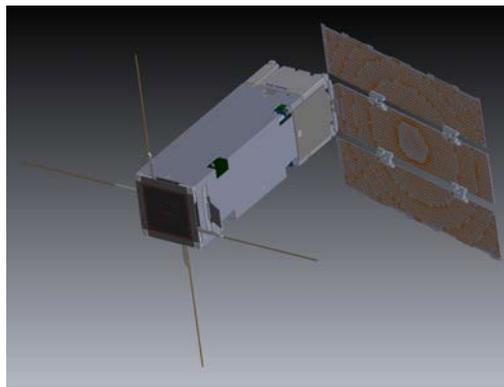
*Launch Manifest: Oct. 2014 (NASA CLI)*



## RACE

Hydrometric Atmospheric Radiometer  
B. Lim: JPL, ARC

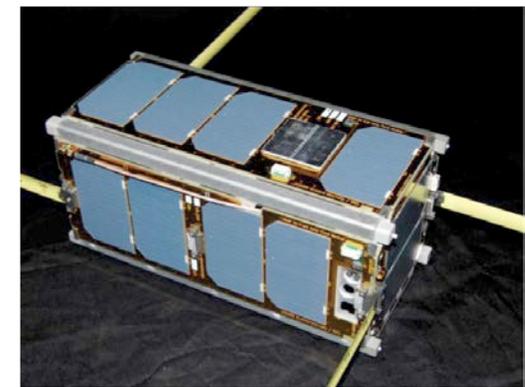
*Launch Awarded (NASA CLI)*



## ISARA (EDISON)

Integrated Solar Array & Reflectarray Antenna  
R. Hodges: JPL, Pumpkin Inc.

*Launch Awarded (NASA CLI)*



## LMRST

Low Mass Radio Transponder  
C. Duncan: JPL, Stanford

*Launch Awarded (NASA CLI)*

# Active JPL Projects (Beyond LEO Exploration)



## INSPIRE

*Interplanetary NanoSpacecraft Pathfinder In a Relevant Environment*

*Low-cost mission leadership with the world's first CubeSat beyond Earth-orbit*



## INSPIRE

Interplanetary Nano-Spacecraft Pathfinder in Relevant Environment

A. Klesh: JPL, Cal Poly SLO, UM, UT Austin

*Launch Awarded (NASA CLI)*



## NEA Scout\*

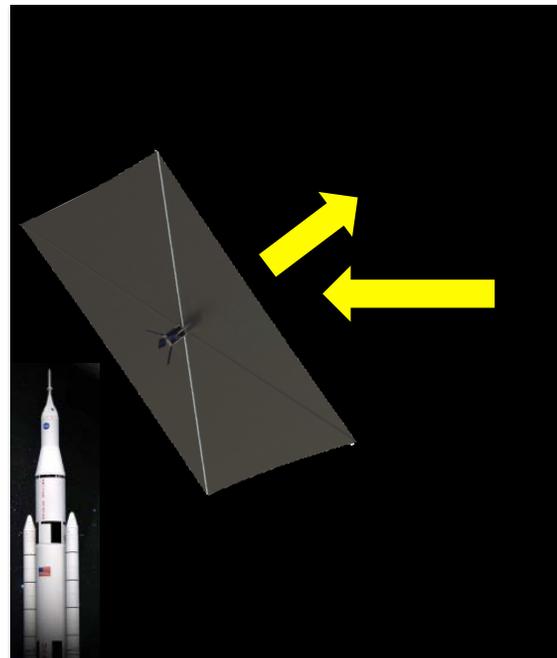
Asteroid characterization mission

MSFC, JPL

## Lunar Flashlight\*

First lunar CubeSat to search for ice deposits in permanently shadowed craters

JPL, MSFC



\*Proposed Mission - Pre-Decisional – for Planning and Discussion Purposes Only  
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Government sponsorship acknowledged.

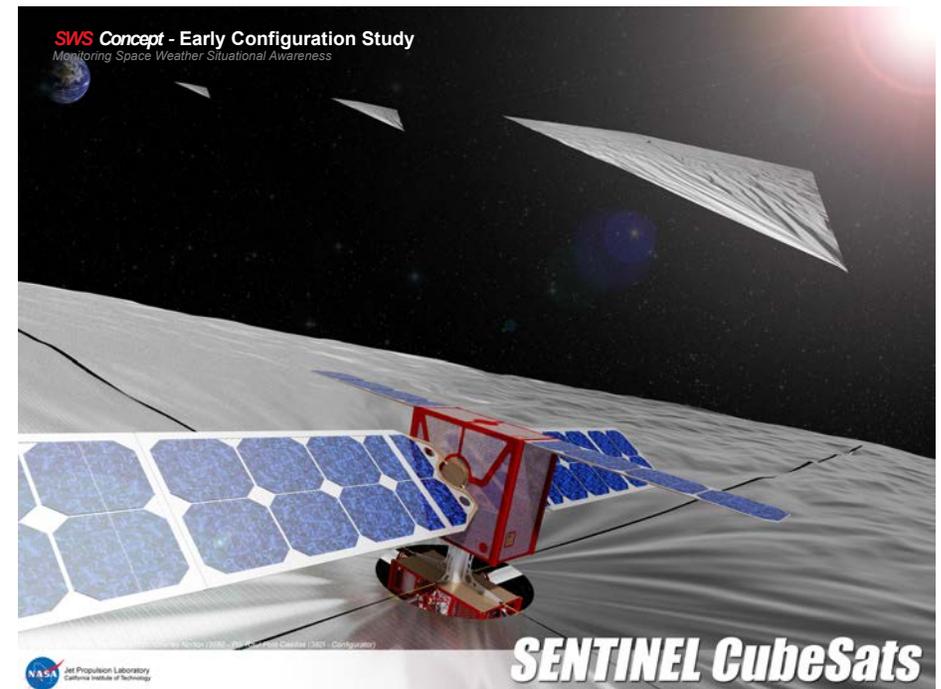
# Future Mission Concepts (Many Others In Formulation)



## RELIC\*

Understanding energy transport from black holes to the intergalactic medium

*Keck Institute for Space Studies (KISS)*



## SWS\*

Fractionated Earth-Sun L5 space weather base for prediction and understanding solar variability effects

*Keck Institute for Space Studies (KISS)*



# Ground Systems Challenges for CubeSats



## Future Challenges

- Throughput and bandwidth
- Maintenance and use of amateur antenna systems
- Distributed data management
- Use and planning of large dish systems for future deep space exploration
- Standards and architectures for reusable systems, especially GDS software
- Global networked access to spacecraft