

# NASA's ELaNa Program and it's First CubeSat Mission

Educational Launch of Nanosatellite

NASA's Kennedy Space Center –  
Launch Service Providers

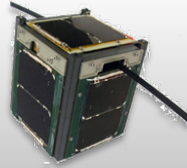
Colorado Space Grant Consortium  
Kentucky Space  
and  
Montana State University

14 October 2010  
Portland, ME

# NASA's ELaNa PROGRAM

## Educational Launch of Nanosatellite

*"Launching Education Into Space"*



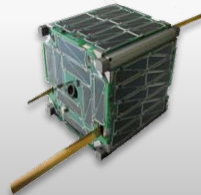
### Explorer-1 PRIME [E1P]

- Montana State University
- Ehson Mosleh



### Hermes

- University of Colorado
- Nicole Doyle



### KySat1

- Kentucky Space
- Daniel Erb

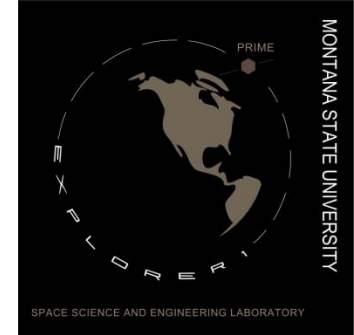
# MONTANA STATE UNIVERSITY



SPACE SCIENCE AND ENGINEERING LABORATORY

# Explorer-1 Prime

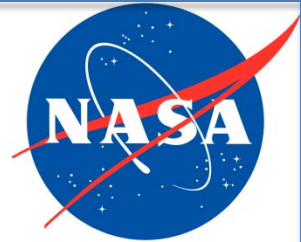
Space Science and Engineering Lab  
Montana State University



Satellite  
Development



Launch Provider



Launch Sponsor

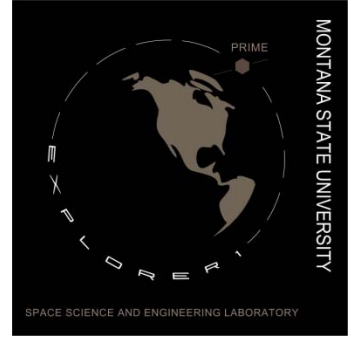


Environmental  
Testing



**Space Dynamics**  
LABORATORY  
Utah State University Research Foundation

# Mission Objectives



- Explorer-1 [Prime] (E1P) is a commemorative re-flight of America's first satellite Explorer-1 in a CubeSat form-factor.



1958

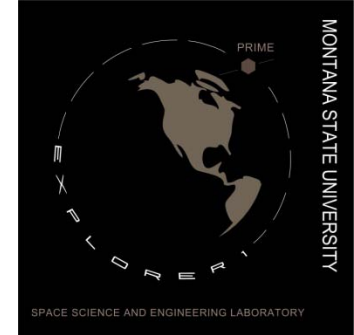


2010



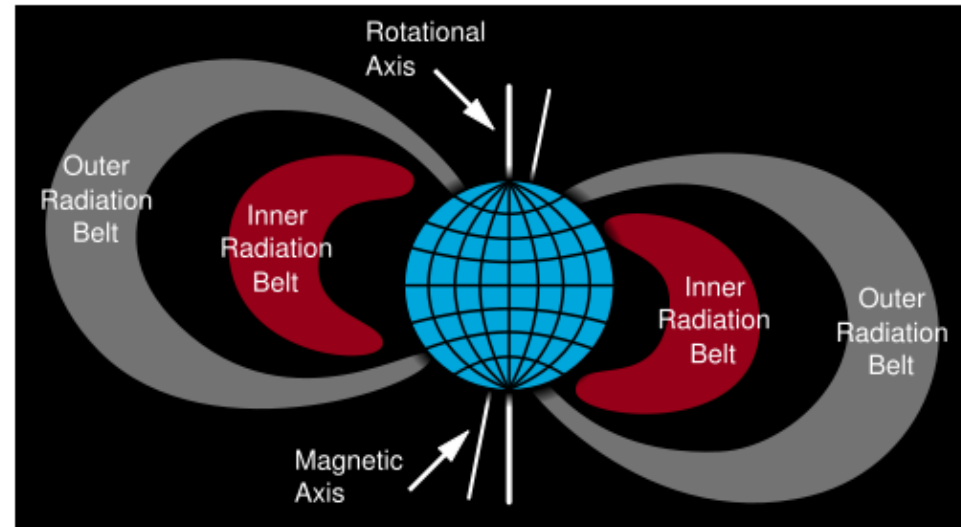


# Mission Objectives



## Van Allen Radiation Belts

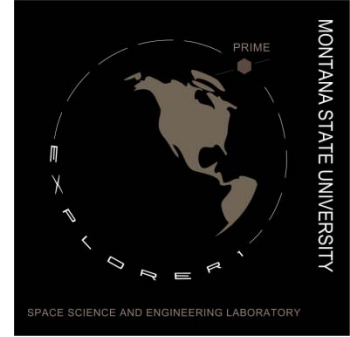
- First detected by Explorer-1 in 1958.
- Consists of high energy protons and electrons trapped in Earth's magnetic field
- Dynamics of particles still not fully understood (Interaction of Sun and Earth)
- Dangerous to spacecraft, disrupts communications
- Respond to solar wind variations



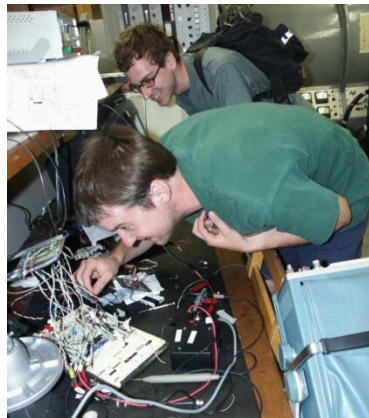
- E1P will demonstrate the utility of low-cost CubeSats to provide critical observations for space weather forecasting and specification.
- E1P will illustrate the feasibility of a constellation of similar CubeSats to provide focused observations at a fraction of the cost of larger dedicated systems

# Mission Objectives

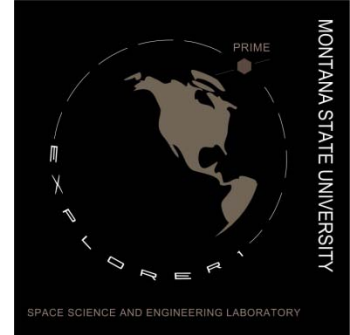
E1P contributes to the development of the aerospace workforce by involving university students in spacecraft design, development, and operations.



**Over 50 Students involved since 2006!**



# Student Involvement



## Design & Development

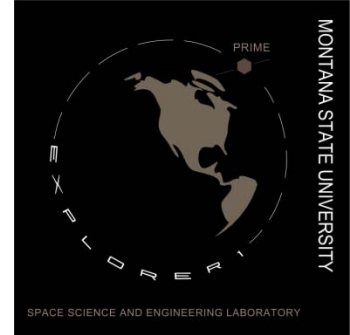
- All Subsystems in house
- Mentorship from SSEL staff
- Training in Configuration and Document Management
- Training in good System Engineering and Design Practices
- Training in Fabrication & Assembly practices.

## Testing

- Design Test Plans and Procedures
- Manage As-Runs
- Produce Nonconformance Reports and Engineering Change Orders
- Validate and Verify Mission, System, Sub-system Level Requirements



# Student Involvement Cont.



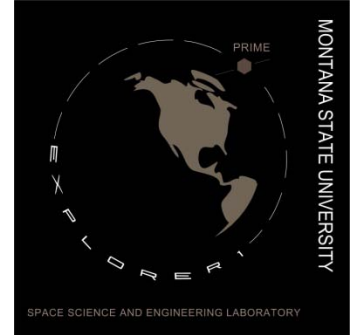
## Delivery

- Support Transport activities.
- Conduct in house Flight Readiness Reviews
- Support Mission Readiness Reviews with CalPoly and NASA Launch Services Program

## Operations

- HAM Radio Licensing
- Ground Station Training for principal operators
- Training program for local High School Students as operators.

# E1P Status



- E1P-1 (flight unit #1)
  - July 2010 - Delivered E1P Flight Unit #1 to CalPoly.
  - Feb. 25, 2011 Launch on the ELaNa Mission.
- E1P-2 (flight unit #2)
  - Fully Assembled – bench top testing.
  - March 2011 - Environmental Testing
  - June 2011 – Delivery
  - Oct. 25, 2011 – Launch as a secondary payload on the NPP Mission.

Both Launches have been facilitated by Garrett Skrobot and his team at NASA-KSC Launch Services Program.

# Hermes CubeSat

University of Colorado - Boulder



# MISSION OVERVIEW



## Primary Mission Goal:

- Create a ***generic bus*** for future use
- Provide ***valuable knowledge*** and ***experience*** to undergraduate students

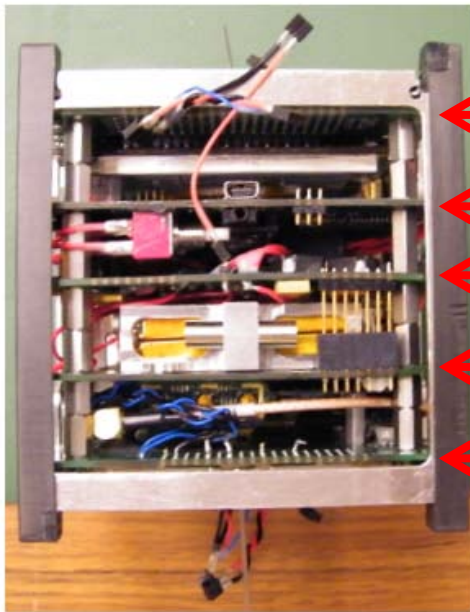
## Secondary Mission Goal:

- Demonstrate the use of an ***S-Band communication system*** for higher data throughput
- Gather ***environmental data***

# SYSTEM OVERVIEW

*Named after the Greek Messenger  
God **Hermes**.*

## Hermes Subsystems:



**HSCOM**

**CDH**

**EPS**

**BATTERIES**

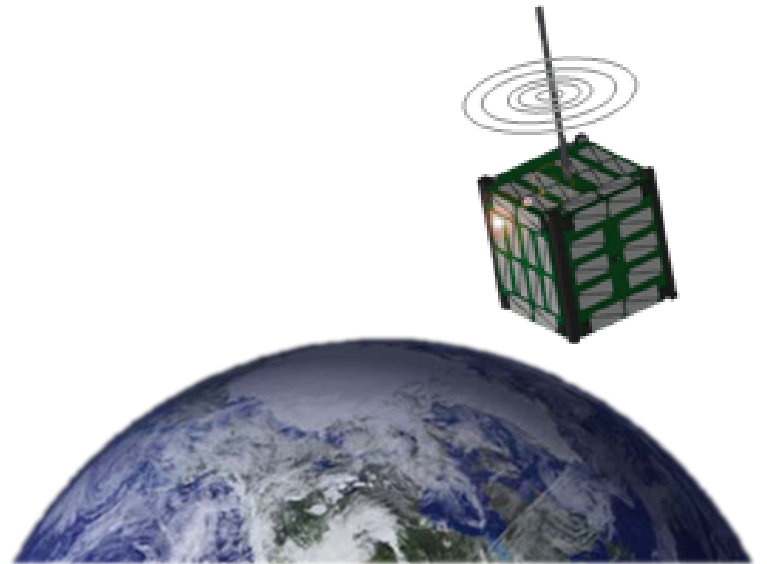
**PCOM**

**Subsystems not shown:**

Ground Software, Mission Operations, Ground Station

## Hermes Communications:

- COSGC Ground Station
  - PCOM: 427.425MHz
- S-Band Ground Station:
  - HSCOM: 2.4GHz





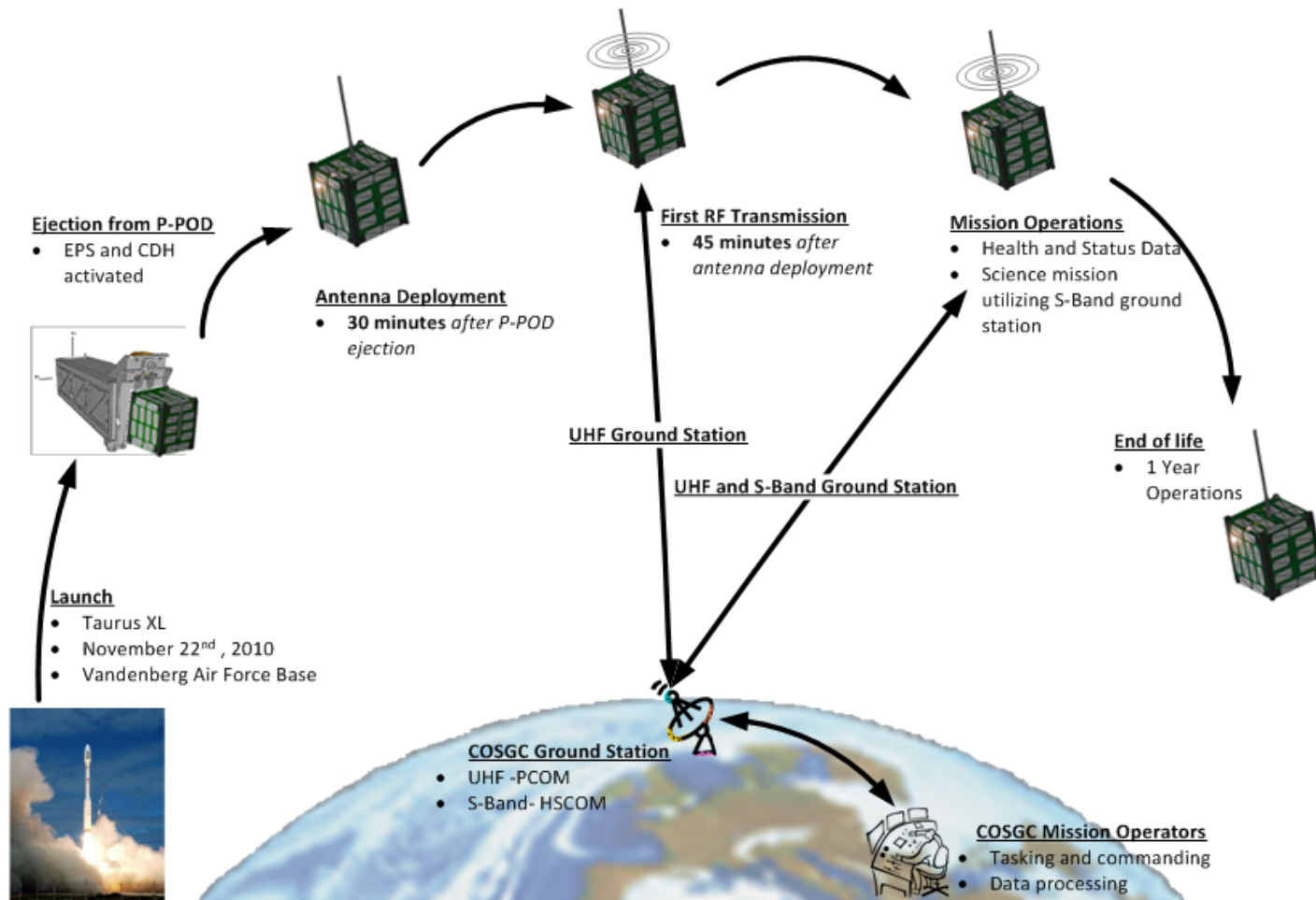
# THE TEAM

- **Completely student-led & student-run project**
  - Mostly *undergraduates*
  - Budgets, management and systems engineering by students
  - Subsystem design, fabrication and testing by students

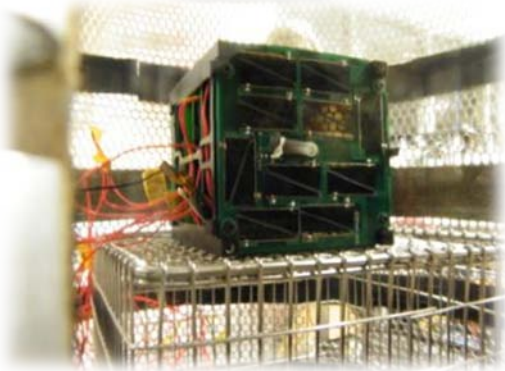


Position	Member
Project Manager	Nicole Doyle
Systems	Mike Opland
Structures, I&T	Tyler Murphy
Command and Data Handling, Flight Software	Brian Roth
Primary Communications, High Speed Communications	Logan Finch
Electrical Power System	Jared Russell, Anthony McDougale
Ground Software	Mike Mozingo
Mission Operations	Felix Bidner, ZachCuseo
Ground Station	Aaron Russert, Lauren Persons

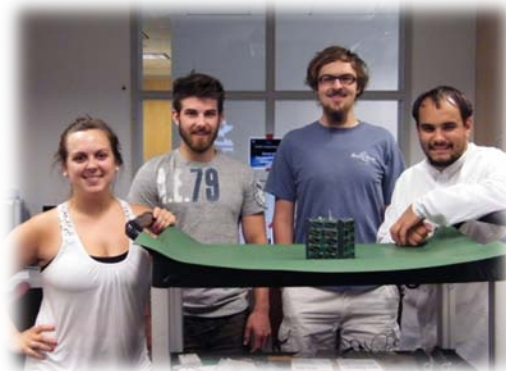
# CONCEPT OF OPERATIONS



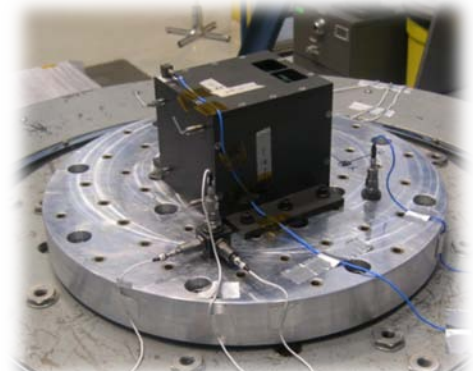
# HERMES SUMMER 2010 - PRESENT



1. Day In The Life Testing



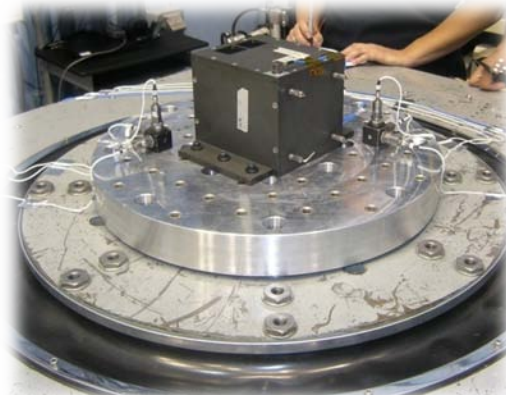
2. 36 hour stretch for final integration



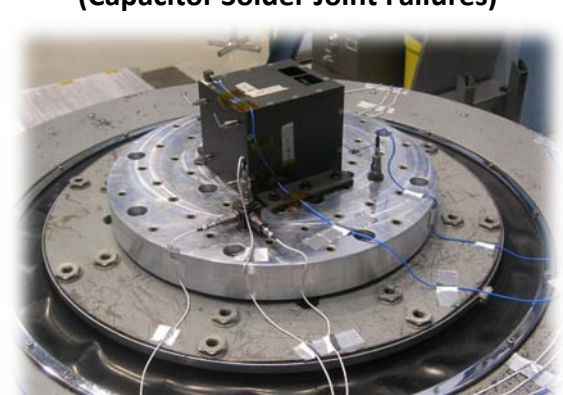
3. Hermes first Random Vibration Test  
(Capacitor Solder Joint Failures)



4. Failure Investigation review at CalPoly  
(after several Red Bulls)



5. Hermes second Random Vibration Test  
(HSCOM Modem Failure)



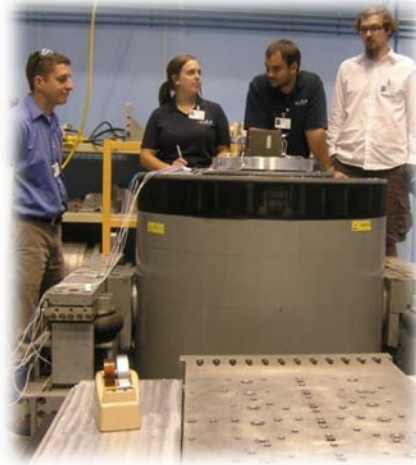
6. Hermes third Random Vibration and  
Shock Test (SUCCESSFUL!)

# HERMES STATUS



## System Testing

- Long Range Communications
- Day In The Life



## Environmental Testing

- Random Vibration
- Shock
- Thermal Vacuum Bakeout



## Delivery

- Integration to P-POD
- Acceptance Environments
- Diagnostics



## Launch

- NASA's Glory Mission
- February 23<sup>rd</sup>, 2011
- Vandenberg Air Force Base
- 2:10 am launch

**We are here**

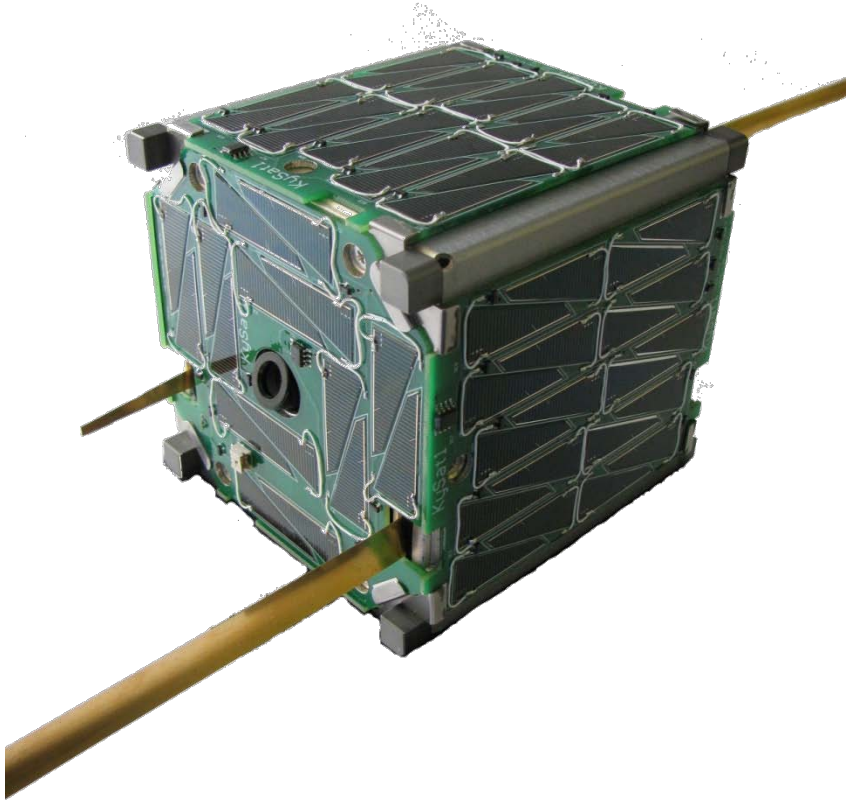
**Up Next:**  
Delivery to CalPoly  
October 31<sup>st</sup>, 2010



# KySat1

Kentucky Space

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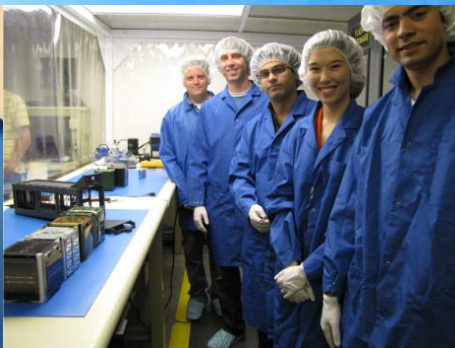
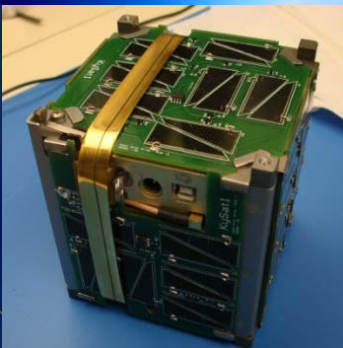




# Kentucky Space Missions



New NanoRacks/CubeLab Standard on the ISS, July 2010



First Student Built Satellites to be  
Launched by NASA (ELaNa/Glory)  
November 2010



First CubeSats Ejected into Sub-  
Orbital Space, March 2010



Balloon-1, July 2008  
(Background Image)



Garvey  
P-12A

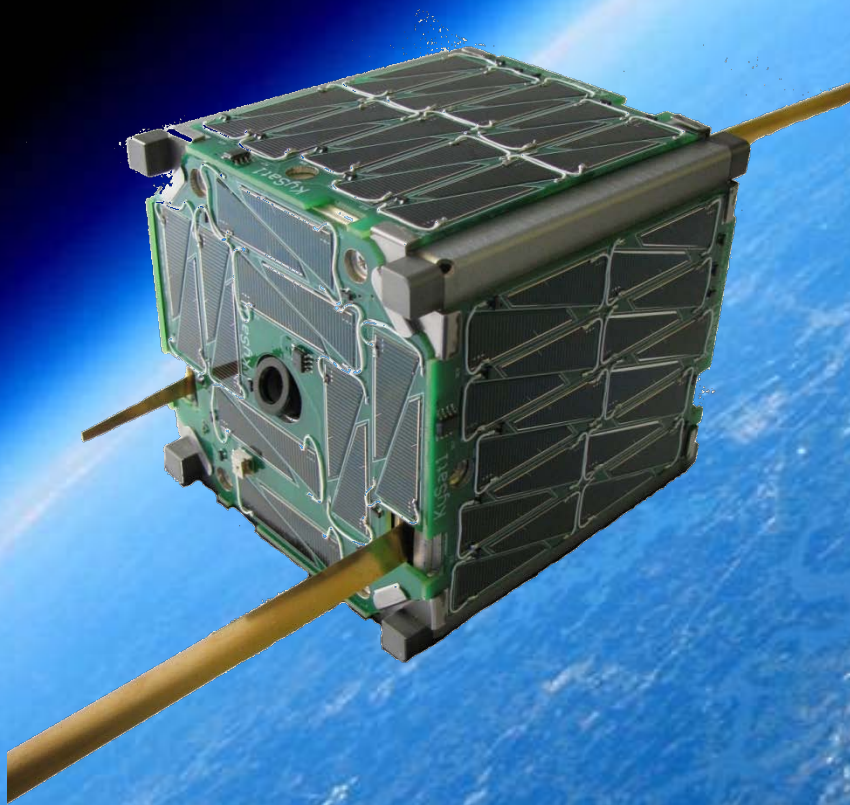


First Flight, Composite  
Super Loki, December  
2007





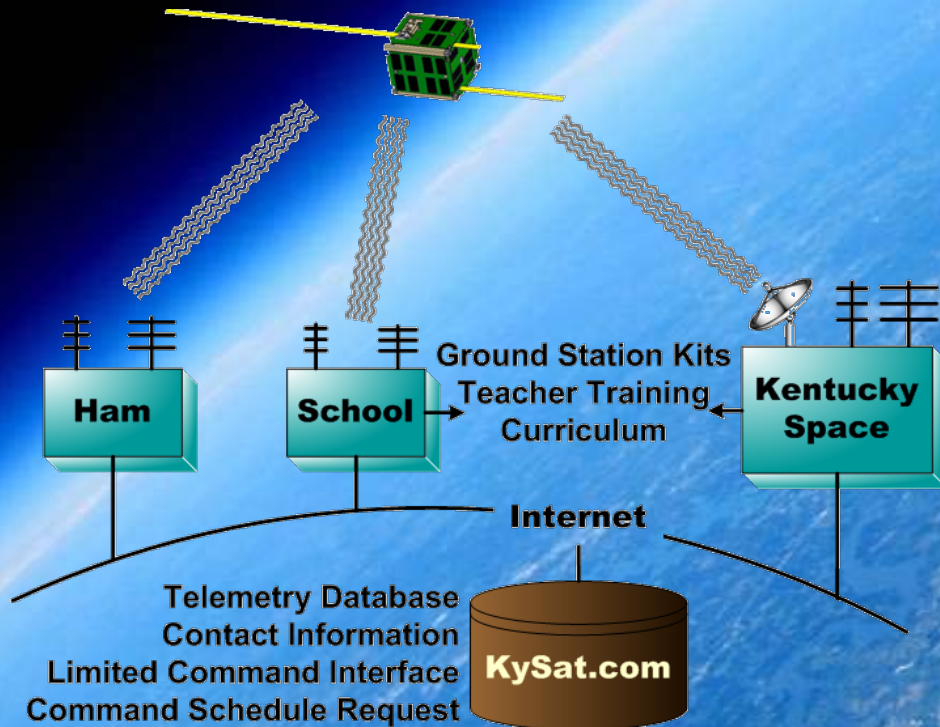
# KySat-1



- The Purpose
  - Build Technological Interest in Students
  - Science, Technology, Engineering, Math
  - K-12, 13-16, 17 plus...
- The Plan
  - Design an Attractive Concept of Operations
  - Design and Build a Satellite to Enable ConOps
  - Provide Educational and On-Orbit Support

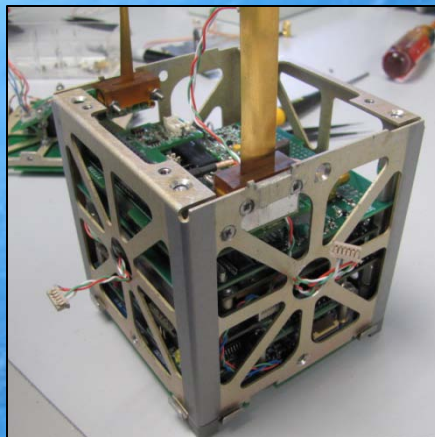
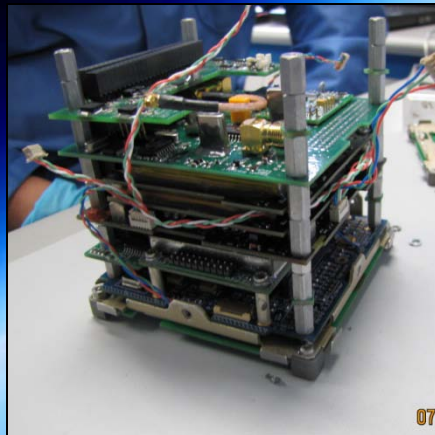


# Concept of Operations



- Basic Communication
  - Capabilities
    - Audio Playback
    - Photo Capture
    - Morse Code Telemetry
  - Actions Initiated Automatically or by Radio Keypad
  - No Computer Required for “Playground Station”
- Advanced Communication
  - Capabilities
    - Upload Data
    - Download Data
    - Digipeating
  - Transactions Archived on Server
  - Additional Hardware Required







# Questions?

Explorer1Prime, Hermes, KySat1

