A Presentation on our 2U CubeLab™ by Valley Christian High School Students

April 20, 2011

“The Sky is No Longer the Limit”
**Student Presenters**

- **Veronica Lane**
  - 12th Grade-Project Leader
  - Robotics Team Leader
  - Cross Country & Track
  - Pursuing Career in Engineering
  - Accepted at MIT, CIT, Cal & Stanford

- **Ross Martinez**
  - 12th Grade-Payload Design
  - Cross Country & Track
  - Accepted at University of Santa Clara, UC Davis, Pepperdine University

- **William Kohlmoos**
  - 12th Grade-Design Engineering
  - Involved in leadership, community outreach, marching band, and swimming and diving
  - Pursuing a career in business
  - Attending SJSU in the fall

- **Mason Ivy**
  - 10th Grade-Engineering Mgmt & Design
  - Competes in wrestling
  - Silicon Valley Science and Technology Championship Winner
  - Awarded for his efforts which resulted in February 28 being designated as “Rare Disease Day” in California
  - Pursuing Career in Engineering
  - Plans to attend Cal Poly

- **Michael Lee**
  - 10th Grade-Mechanical Design
  - Fixes computers for fun and profit
  - Pursuing a career in Computer Hardware Engineering
  - Wants to attend CIT or MIT

- **Tanya D’Silva**
  - 10th Grade Mechanical Design
  - Won numerous piano competitions
  - Pursuing a career in Astrophysics
  - Wants to attend Cornell or Princeton
  - Involved in track
Mission Objective

• Provide an exciting Space Project where students can apply their *Math, Science, and Engineering Skills*.
• Develop and document a process to launch a *low cost* student payloads into space *within the school year*.
• Research, design and fabricate experiments conducted in a microgravity environment
• *Learn* new technical and management skills.
• *Help* other high schools get into space.
What is a CubeLab™?

- Dimensions of 1U unit
  - 10cm x 10cm x 10cm
  - (expanded dimensions possible next year)
- Weight of 1kg maximum
- Power provided via a USB connector
  - 5 Volts @ 400ma
- Astronaut uplinks commands and downloads data via the USB interface
- CubeLabs™ can be installed in every ISS resupply mission
- Cubelab™ locker provides air cooling
- NanoRacks has space for 32 Cubelabs™ at one time onboard the ISS
Why CubeLab™?

- **Firm launch** dates from scheduled ISS Resupply Vehicles
- Low Launch cost of **$25k** for 10cm x 11.7cm x 15cm, CubeLab™ (For All Future Launches)
- **Benign Environment** inside Launch Vehicle & ISS
  - Low level launch vibrations
  - Packaged in Bubble Wrap
  - Shirt sleeve temperature
  - Earth like atmosphere
- NanoRacks provides electrical power and near real time commanding and data via astronaut laptop
- Optional **Return** via Soyuz or SpaceEx
Project Start July 12, 2010

Valley Christian High School ISS Project Team
Payload Determined – Plant Growth Experiment

- Type of Plants
- Plant Requirements

Electrical Design Requirements

- Microcontroller and I/O
- Electrical controlled devices
- Camera Selection

Mechanical Design

- Size and material

Data and Operational Requirements

- Download steps and file structures
Growing Plants
- Research needed for future long space travel
- Cannot bring enough food
- Trip to Mars 3-years (roundtrip)

Plants chosen:
- Basil
- Marigold
- Wisconsin Fast Plant
Design the Software and Build the Hardware

- Student designed, layout, and built hardware
- Project Software Tasks
  - Photos
    - High Resolution Plant Photos
    - Data Photos
  - Water Plants
  - Monitor Temp. & Humidity
  - Transmit Data
  - Error Recovery
    - Power Failure
    - Hardware Failure
Design – Mechanical

Incubator Assembly Design
Design – Mechanical

- Heatsink
- Water Valve-1
- Incubator
- Water Valve-2
- LEDS & Camera
- H₂O

AMSE Institute
CubeLab™ Design

Valley Christian High School
ISS Project Team

Outer Containment Assembly
(Aluminum)

Water Storage Assembly
(Medical IV bag with spring loaded pressure plates)

Water Valves
(not in view)

Incubator Assembly
(Plant growth area for 6ea plants)

International Space Station
CubeLab Engineering Prototype-1
September 30, 2010
Testing and Qualification

- Performed at University of Kentucky
- Form, Fit, and Function
- Power Consumption
- System Error Recovery
- System Operation and Procedures
- Weight and Fluid Containment
- Depressurization test to 4psi
CubeLab™ Final Ready to Ship (11/26/2010)

Flight unit ready to be shipped
JAXA HTV2 Launch (01/21/11)
CubeLab™ Location and Installation

Inside Japanese Kibo Module
HTV2 Rendezvous with ISS (1/27/2011)
Moving Cubelab™ from HTV2 to ISS
Installation of CubeLab™ (2/3/2011)
First Photo of 3,005 photos taken and downloaded from the ISS
1\textsuperscript{st} Data Set from ISS (02/03/2011)

Ambient Temperature/Humidity

Incubator Temperature/Humidity

Mission Time Clock

Status and Error Conditions
Orbital Operations

- In orbit **53 days** Power applied **28 days**
- Downloaded **3005 JPG photos**
- CubeLab™ **error recovered** after Astronaut laptop malfunction
- Data **download** every **3 days from ISS** to Marshall Space Center, to University of Kentucky, then to Valley Christian High School, San Jose, California
Soyuz Undocked and Landing (3/16/2011)
CubeLab™ returned from the ISS after Traveling 23,000,000 miles
Removing Incubator after Flight
Examination of the Incubator after flight
Flight Results

- All Systems ***performed as designed***
  - Plant Lighting System Simulated sunrise to sunset
  - Automatic Plant Watering System provided amount of water programmed
  - Digital Camera System Stored and Downloaded 3005 plant growth photos
  - Watertight three level containment System remained in tack

- CubeLab™ ***automatically recovered*** after Astronaut laptop malfunction.

- **Extensive ground testing revealed that Silicone sealant stopped the plants from growing after initial seed germination (acetic acid, low pH)**
Conclusions

- A Low cost CubeLab™ can be designed, built, qualified, and launched in 6.5 months.
- Commercial off shelf components can be used successfully in low vibration launch and transportation load applications.
- CubeLabs™ are a Viable Low Cost method to get student payloads into space in a Timely Manner.

“*The Sky is No Longer the Limit*”
Future Plans

  - Each Cubelab™ to house up to four independent payloads each with its own digital camera and microcontroller.
  - Three other high schools will be providing their own payloads
- Build a Satellite Tracking and Control Ground Station – 2011
- Planning to launch a CubeSat from the ISS in 2013
Thank You for attending our presentation.

Questions Please!

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http://www.vcs.net/sitemap/mathscience/iss-project/index.aspx