The CubeLab Standard for Improved Access to the International Space Station for Scientific Payloads

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- James Smith – Collaborator, Belcan
International Space Station

- Ten Year Process Nearing Completion
- Lifetime extended beyond 2016
- Charge to use ISS for research by all
Kentucky Space Missions

New NanoRacks/CubeLab Standard on the ISS, July 2010

First CubeSats Ejected into Sub-Orbital Space, March 2010

First Student Built Satellites to be Launched by NASA (ELaNa/Glory)
March 4, 2011

Balloon-1, July 2008 (Background Image)

First Flight, Composite Super Loki, December 2007

Garvey P-12A
HAMSTER High–Altitude Balloon (4/17/11)
ISS as National Laboratory

- National Lab Designation in 2005
- Initiatives and BAAs targeting diverse users
- "Lean" payload integration process
  - Limits on types of payloads
  - Requirements based testing
  - Ship and Shoot
  - 20 month process to a 6 months
NanoRacks Platform and CubeLabs

- Facilitate research aboard the ISS
- NanoRacks Platform interface between ISS and CubeLab Experiments
## Flight Program Working Group (FPWG)

Crew Rotation and Port Utilization Graphic – For Reference Only

<table>
<thead>
<tr>
<th>2011</th>
<th>2012</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Jan</strong></td>
<td><strong>Feb</strong></td>
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<tr>
<td><strong>Inc 26</strong></td>
<td><strong>Inc 27</strong></td>
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<tr>
<td>N S. Kelly (CDR-29) 255 days (268 days)</td>
<td>R A. Bortenkno (CDR-29) 165 days (288 days)</td>
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</tbody>
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### Crew Rotation

- **SRM2**
  - MRM2 (SM Zenith)
  - MRM1 (FGB Nadir)
- **DC-1/MLM**
- **SM-Aft**
- **Node-2 Zenith**
- **Node-2 Nadir**
- **PMA-2**

### Stage EVA

- 3/16
- 6/9
- 5/23
- 26S
- 24S
- 22S
- 21S
- 17S
- 12S
- 10S
- 5S
- 4S
- 3S
- 2S
- 1S
- 0S

### Launch Schedule

- HTV2 2/22 – 2/28
- HTV3 3/12 – 3/17
- ATV2 3/19 – 3/24
- ATV3 3/26 – 3/31
- ULF5 4/12 – 4/17
- ULF6 4/19 – 4/24
- ULF7 4/26 – 5/11

### Notes

- Strategic Timeline
- Day 129
- Day 157
Leverage Standards

- CubeSat Standard
  - Well defined form-factor
  - Familiar to academia and industry
- USB
  - Plug-and-play standard
  - USB Mass Storage Class
- EXPRESS Rack Locker
CubeLabs

- Designed as an accessible standard platform
- Low-cost entry to ISS
- Repeatable Access
- Down-mass options
- ICD familiar to CubeLab developers
- Form-factor accommodated by all current launch vehicles (Progress, Soyuz, HTV, ATV, DragonLab, Shuttle)
**CubeLab Form-Factor**

- **Various Form-Factors:**
  - 1U: $10\text{cm} \times 10\text{cm} \times 10\text{cm}$
  - 2U: $10\text{cm} \times 10\text{cm} \times 20\text{cm}$
  - And so on up to 4U

- **Maximum Volume:**
  - 4U x 2U: approx $51\text{ cm} \times 25\text{ cm} \times 14.5\text{ cm}$
Microgravity Experiments

- Plant Growth Experiments
- Biological/Pharma Experiments
- Microgravity Nano-crystal Growth
- Chemical Reactions in Microgravity
- Microelectronic Mechanical Systems (MEMS) testing in Microgravity
- Electronics Testing in Space Radiation Environment
- Fluidics
- Combustion
Ames TecNanoSat hology

- Developing Technologies to Support Biology and Pharma Missions
- Analytical Technologies
- Autonomy
- 5-50kg payloads and spacecraft
Ames CubeLab
Ames Imager Payload

- Developing
- 2-Color Fluorescent Imaging
- Hermetic Pressure vessel
- Custom fixed focus microscope
- C. elegans
  - fully sequenced, space studies
  - dauer “stasis” state
  - Fluorescence constructs
Development and Delivery
Launch STS–131 (NR–1, CL–1&2)
Road to the ISS for CubeLabs

CubeLab development follows two tracks on its way to the ISS:

- **Integration**
  - Manifesting
  - Engineering and technical data submission
  - Qualification testing
  - Safety reviews
  - “On-dock” delivery

- **Operations**
  - Planning models
  - Required activities
  - Procedure development
  - On-Board training
  - Real-time operations
  - Data dissemination
  - Payload return
Phases of Operations

- Increment Planning (pre-Ops)
- Real-time Operations
Operations

- Nominally constant power but can be powered down during off-nominal situations on station

Procedures
- Nominal CubeLab operational procedures are configuration, reconfiguration, file uploads and downloads
- Other crew interaction is possible but may require procedure development
NanoRacks Platforms are currently installed and operating in EXPRESS Rack 4 in the JEM.

CubeLabs have flown on STS–131, STS–132, HTV–2, STS–133, STS–134.

Manifesting on ATV, HTV, Progress, Soyuz, and DragaonLab.

Developing ICD for Ames payloads

Thermal and power design studies
Nominal Operation

Astronaut Shannon Walker (USA)
Thank You

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