ELaNa

Making it Happen!

CalPoly CubeSat Workshop 2012
April 18 - 20

Garrett Skrobot
ELaNa Project Manager
Launch Services Program
NASA
ELaNa
Educational Launch of Nanosatellite

“Science, Technology, Engineering, and Mathematics”

“Launching Education into Space”
ELaNa CubeSat Missions

ELaNa
NASA
CalPoly

Montana State University
Kentucky Space
University of Colorado
Boulder
“Launching Education Into Space”

ELaNa III
NASA
CalPoly

Auburn University
Utah State University
University of Michigan
Montana State University
“Launching Education Into Space”

ELaNa VI
NASA
NRO
CalPoly
NPS SRI

Morehead State University
University of California
Berkeley
California Polytechnic State
University - SLO
University of Colorado - Boulder
“Launching Education Into Space”

CubeSat
California Polytechnic State University
ELaNa III

P-POD #3
DICE

P-POD #1
E1P-F2
AubieSat
Mcube/Cove

P-POD #2
RAX 2
ELaNa III

Here we are...

...and here we go!
NASA CubeSat Initiative

3 Calls for CubeSats has reached 24 States
68 CubeSats Selected with 23 Manifested
# NASA CubeSat Initiative Proposals

<table>
<thead>
<tr>
<th></th>
<th># of Props Submitted</th>
<th># of Props Selected</th>
<th># Manifested</th>
<th># Launched</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st Selection</td>
<td>6</td>
<td>4</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>1st Initiative</td>
<td>16</td>
<td>12</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>2nd Initiative</td>
<td>32</td>
<td>20</td>
<td>9</td>
<td>0</td>
</tr>
<tr>
<td>3rd Initiative</td>
<td>43</td>
<td>32</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>97</td>
<td>68</td>
<td>23</td>
<td>8</td>
</tr>
</tbody>
</table>
## NASA CubeSat Initiative Proposers

<table>
<thead>
<tr>
<th></th>
<th># of Univ</th>
<th># of NASA</th>
<th># of DoD</th>
<th># of Private</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1st Selection</strong></td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>1st Initiative</strong></td>
<td>12</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>2nd Initiative</strong></td>
<td>9</td>
<td>5</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td><strong>3rd Initiative</strong></td>
<td>20</td>
<td>4</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>45</td>
<td>9</td>
<td>13</td>
<td>2</td>
</tr>
</tbody>
</table>
### NASA CubeSat Initiative
CubeSat Sizes

<table>
<thead>
<tr>
<th></th>
<th>1U</th>
<th>1.5U</th>
<th>2U</th>
<th>3U</th>
<th>6U</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1st Selection</strong></td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>1st Initiative</strong></td>
<td>7</td>
<td>2</td>
<td>0</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td><strong>2nd Initiative</strong></td>
<td>6</td>
<td>4</td>
<td>3</td>
<td>9</td>
<td>0</td>
</tr>
<tr>
<td><strong>3rd Initiative</strong></td>
<td>5</td>
<td>3</td>
<td>4</td>
<td>20</td>
<td>3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>23</td>
<td>9</td>
<td>7</td>
<td>33</td>
<td>3</td>
</tr>
</tbody>
</table>

![Bar Chart](chart.png)

- **Legend**
  - 3rd Initiative
  - 2nd Initiative
  - 1st Initiative
  - 1st Selection

---

**Note:**
- The bar chart visually represents the number of CubeSats selected across different sizes and initiatives.
### NASA CubeSat Initiative
CubeSats by Orbit

<table>
<thead>
<tr>
<th></th>
<th>51° at 325km</th>
<th>LEO Sun Sync</th>
<th>LEO Non-Sun Sync</th>
<th>GTO</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1st Selection</strong></td>
<td>0</td>
<td>4</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>1st Initiative</strong></td>
<td>5</td>
<td>0</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td><strong>2nd Initiative</strong></td>
<td>3</td>
<td>4</td>
<td>12</td>
<td>1</td>
</tr>
<tr>
<td><strong>3rd Initiative</strong></td>
<td>13</td>
<td>4</td>
<td>15</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>21</td>
<td>12</td>
<td>33</td>
<td>2</td>
</tr>
</tbody>
</table>

- **51° at 325km**
- **LEO Sun Sync**
- **LEO Non-Sun Sync**
- **GTO**

---

### Graphical Representation

- **3rd Initiative**
- **2nd Initiative**
- **1st Initiative**
- **1st Selection**
# NASA CubeSat Carriers

<table>
<thead>
<tr>
<th></th>
<th>Atlas V</th>
<th>Delta IV</th>
<th>Delta II</th>
<th>Taurus XL</th>
<th>Athena</th>
<th>Falcon 9</th>
</tr>
</thead>
<tbody>
<tr>
<td>Common</td>
<td>ABC</td>
<td>Common</td>
<td>2nd Stg Struts Section</td>
<td>Aft End 3rd Stg</td>
<td>Aft End</td>
<td>CRS</td>
</tr>
<tr>
<td>Studied</td>
<td>In Development Aug ‘12</td>
<td>Studied</td>
<td>Flown</td>
<td>Flown</td>
<td>Studied</td>
<td>In Development Dec ‘12</td>
</tr>
</tbody>
</table>
Manifested Missions

- FY08: Failed to reach orbit
  - ELaNa I

- FY09: Failed to reach orbit
  - ELaNa II

- FY10: Successful
  - ELaNa III

- FY11: Successful
  - ELaNa IV
  - October 25th

- FY12: Successful
  - ELaNa V
  - August
  - December

- FY13: Successful
  - ELaNa VI

- FY14: Successful
  - Demo Flight
  - July
  - September
  - February
<table>
<thead>
<tr>
<th>Year</th>
<th>Mission</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>FY12</td>
<td>ELaNa II</td>
<td>Oct 2013</td>
</tr>
<tr>
<td>FY13</td>
<td>ELaNa VII</td>
<td>Mid 2014</td>
</tr>
<tr>
<td>FY14</td>
<td>ELaNa VIII</td>
<td>Early 2015</td>
</tr>
<tr>
<td>FY15</td>
<td></td>
<td>2015</td>
</tr>
<tr>
<td>FY16</td>
<td></td>
<td>2016</td>
</tr>
<tr>
<td>FY17</td>
<td>Potential CRS Flights</td>
<td></td>
</tr>
</tbody>
</table>
Nano Launcher System

• During the CubeSat Workshop in August 2011, we talked about the Next Logical Step for the launching of CubeSats

• Our own Nano Launcher System

• So where are we today?
Nano Launcher System

Conceptual

Phase I
- High Altitude
  - 1 Stage system
  - 15k to 100k feet flights
  - 6 to 12 months

Phase II
- Sub Orbital
  - 1 Stage system
  - Large Tanks
  - Increase Engine
  - 185 Km flights
  - 12 to 18 months

Phase III
- Orbital
  - 2 Stage system
  - Large Tanks
  - Increase Engine
  - 450 Km flights
  - 12 to 24 months
High Altitude Launcher

- Launch Service Program has placed Garvey Spacecraft Corporation on contract for a series of high altitude launches
  - Flight 1
    » Looking for riders!
    » Launch Date Sept 2012
    » Developing a system to eliminate P-POD and attach the CubeSat to the interface Deck
  - Flight 2
    » CP9 Mus-StangSat CubeSat system to test data collect system between two cubesats
      • CP9 Mus being developed by CalPoly
      • StangSat is a Merritt High School CubeSat project

- Options for three additional flights
Nano Launcher SBIRs

- Three NASA 2012 Phase I SBIR have been awarded under the Nano Launcher Technology topic
  - Garvey Space
    » Alternative Hydrocarbon Propulsion for Nano / Micro Launch Vehicle
      • Modify design of flight proven 5K lbf LOX/ethanol engine to use propylene instead
  - Interorbital Systems
    » Neptune modular rockets for breakthrough low-cost space access
      • A single CPM adapted as a rocket, such as the flight-ready Interorbital CPMTV, can be used as an ultra low-cost entry level rocket vehicle for educational programs
  - Ventions
    » A High-Payload Fraction, Pump-Fed, 2-Stage Nano Launch Vehicle
      • The proposed nano launch vehicle is aimed at providing low-cost and on-demand insertion of NASA cube- and nano-satellites into LEO as primary payloads
Future P-POD Task

- Development of a CubeSat Developers User Guide
- P-POD Power-On System
- Orbital Debris Request for Information
- Six U Carrier System
- ESPA Six U Mount
- Alternative Micro Switch
- Implementing RF Gasket
- Purge System
- CubeSat Propulsion System
In Closing

Taylor State  Virginia Tech
Massachusetts Institute of Technology
Kentucky Space  Auburn University
University of Alaska Fairbanks
University of Florida  Thomas Jefferson High School
Cornell University  University of Michigan
Naval Postgraduate School
University of New Mexico  The University of Louisiana
AFIT  University of California - Berkeley
University of Texas  California Polytechnic State University  West Point
University of Alabama  University of Arkansas