CubeSat Launch Initiative

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Mission Manager
NASA-KSC Launch Services Program
What is a CubeSat?

• A CubeSat is a type of space research nanosatellite

• The base CubeSat dimensions are 10x10x11 centimeters (one "Cube" or "1U"), or approximately four inches

• CubeSats are typically 1U, 2U, 3U, or 6U in volume and typically weigh no more than 1.33 kilogram (about 3 pounds) per 1U Cube

• CubeSats are typically low-cost, high risk-tolerant payloads

• Deployed from standard deployers, such as the “Poly-Picosatellite Orbital Deployer (P-POD)”

• P-POD’s versatile, small profile, tubular design holds three 1U CubeSats or can integrate CubeSats of different lengths (i.e., up to 3U)
NASA’s CubeSat Launch Initiative (CSLI) provides launch opportunities to educational institutions, non-profit organizations and NASA Centers who build small satellite payloads that fly as auxiliary payloads on previously planned launches or commercial mission or as International Space Station deployments.
Objective

- Provide CubeSat Launch Services on Expendable Launch Vehicles and deployments from the International Space Station to U.S. Educational Institutions, Non-profits and NASA Centers.

Aligned to NASA’s Strategic Plan

- **Strategic Goal 1**: Expand the frontiers of knowledge, capability, and opportunity in space.
  - *Objective 1.7*: Transform NASA missions and advance the Nation’s capabilities by maturing crosscutting innovative space technologies.

- **Strategic Goal 2**: Advance understanding of Earth and develop technologies to improve the quality of life on our home planet.
  - *Objective 2.3*: Optimize Agency technology investments, foster open innovation, and facilitate technology infusion, ensuring the greatest national benefit.
  - *Objective 2.4*: Advance the Nation’s STEM education and workforce pipeline by working collaboratively with other agencies to engage students, teachers, and faculty in NASA’s missions and unique assets.
How It Works

NASA Announcement of Opportunity
• NASA solicits proposals through an Announcement of Opportunity (AO)
• Educational Organizations, Non-Profits and NASA Centers submit proposed CubeSat Missions in response to AO

NASA Review
• A NASA Selection Committee made up of members of HEOMD (including the Launch Services Program), Space Technology Mission Directorate, Science Mission Directorate, and Education reviews proposals
• Selection Committee makes final recommendations on CubeSats
• NASA announces selection recommendations

Selectees Develop/Design/Build CubeSat
• Selectee builds satellite
• Selectee raises all funds necessary for satellite construction
• Selectee provides NASA completed satellite for integration for launch

NASA Assigns CubeSats to Manifested Launches
• NASA manifests CubeSat on available flights using excess lift capacity
• Cooperative Research and Development Agreement executed by NASA
Payload Eligibility

Benefit to NASA
Investigation must demonstrate a benefit to NASA by addressing goals and objectives of the NASA Strategic Plan and/or the NASA Education Vision and Goals.

Merit Review
Prior to submission each CubeSat investigation must have passed an intrinsic merit review. In the review, goals and objectives of the proposed investigation must be assessed to determine scientific, educational or technical quality of the investigation.

Feasibility Review
Prior to submission each CubeSat investigation must have passed a feasibility review in which the technical implementation, including feasibility, resiliency, risk and probability of success, was assessed.
CubeSats are Developed/Designed/Built

Dispenser is integrated on the Launch Vehicle (LV)

Mission Launches

Signal Sent to LV, spring-loaded door is open, CubeSats deployed

Deployment spring and pusher plate

Students or Center track and operate CubeSat from Ground Station

CubeSat burns up on re-entry after completion of mission

Students or Center analyze data, write technical papers, provide results and data to NASA
ISS Deployment

Human Exploration and Operations Mission Directorate

CubeSat Launch Initiative
**CSLI Benefits**

**Benefit to Educational Organizations and Non-profits:**
- Enables students, teachers and faculty to obtain hands-on flight hardware development experience
- Advances the development of technologies
- Provides mechanism to conduct scientific research in the space environment
- Provides meaningful aerospace and Science, Technology, Engineering and Mathematics (STEM) educational experience

**Benefit to NASA:**
- Promotes and develops innovative public-private partnerships
- Provides a mechanism for low-cost technology development and scientific research
- Enables the acceleration of flight-qualified technology assisting NASA in raising the Technology Readiness Levels (TRLs)
- Strengthens NASA and the Nation’s future STEM workforce
CSLI Implementation Partnerships

Partnerships with other US Government Agencies/Departments
- NASA has established inter-agency agreements with USAF and NRO for CubeSat integration onto non-NASA launches
- NASA assists non-government CubeSat developers in seeking FAA, FCC and NOAA licenses (as necessary)

Partnerships with commercial entities
- NASA has established CubeSat Dispenser Hardware and Integration Services (CSDHISC) IDIQ contract to provide integration hardware and perform integration activities

Partnerships with commercial entities
- Public-Private Partnerships – Cooperative Research and Development Agreements with U.S. universities, Non-profits and NASA Centers to provide low-cost technology development and scientific research.
  - 105 projects involving 44 universities, five Non-profits and five NASA Centers
2009–2015 CubeSat
105 Selections – 61 Organizations – 30 States
2015 CSLI Selections

- OPEN
  University of North Dakota

- RadSat
  Montana State University

- TEMPEST-D
  Colorado State University

- MITEE
  University of Michigan

- ALBus
  NASA Glenn Research Center

- KickSat-2
  Cornell University

- CACTUS-1
  Capitol Technology University

- STF-1
  NASA IV&V Program

- CSUNSat-1
  California State University Northridge

- AOSAT
  Arizona State University

- CuSPP
  Southwest Research Institute

- SurfSat
  University of Central Florida

- Cu-PACE
  University of Central Florida
CubeSat Organizations

- Eligible Organizations include: Educational and Non-profit Institutions, NASA Centers
- Majority of proposing organizations are universities
- 61 Unique Organizations Selected
- 48% of the universities utilize Space Grant and Experimental Program to Stimulate Competitive Research (EPSCoR) Funding
- 2013 we launched TJ³Sat, the first CubeSat built by and launched for a high school
- 2016 we will launch STMSat-1, the first CubeSat built by and launched for a primary school

Types of Organizations

- Higher Ed 71%
- NASA 17%
- Non Profit 8%
- K-12 3%
- Museum 1%
## CSLI Proposals

<table>
<thead>
<tr>
<th>Initiative</th>
<th>Proposals</th>
<th>Selected</th>
<th>Flown</th>
<th>Manifested</th>
<th>% Launched</th>
<th>% Launch &amp; Manifested</th>
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</thead>
<tbody>
<tr>
<td>1st Selection</td>
<td>6</td>
<td>4</td>
<td>4</td>
<td></td>
<td>100%</td>
<td>100%</td>
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<tr>
<td>1st Initiative</td>
<td>16</td>
<td>12</td>
<td>11</td>
<td>1</td>
<td>92%</td>
<td>100%</td>
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<tr>
<td>2nd Initiative</td>
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<td>83%</td>
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<td>56%</td>
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<td>4</td>
<td>5%</td>
<td>26%</td>
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<td>5th Initiative</td>
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<td>6th Initiative</td>
<td>22</td>
<td>14</td>
<td></td>
<td></td>
<td>0%</td>
<td>0%</td>
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</table>

Total: 158 proposals, 110 selected, 36 flown, 15 manifested, 34% launched, 48% launched & manifested.
Proposed CubeSats must align to NASA's Strategic Plan and, if appropriate, the Education Strategic Coordination Framework.

- 72% conducting Technology Demonstrations
- 53% conducting Scientific Research
- 53% supporting Education

**Scientific Research**
- Biological Science
- Earth Science
  - Snow/Ice Coverage
- Near Earth Objects
- Orbital Debris Tracking
- Space Based Astronomy
- Space Weather

**Technology Demonstrations**
- In-Space Propulsion
- Space Power
- Radiation Testing
- Tether Deployment
- Solar sails
- Material Degradation
- Solar Cells
- Additive Manufacturing
## NASA CubeSat Carriers

<table>
<thead>
<tr>
<th>Atlas V</th>
<th>Delta IV</th>
<th>Delta II</th>
<th>Taurus XL</th>
<th>Athena</th>
<th>Falcon 9</th>
<th>ISS/CRS</th>
<th>Super Styrpi</th>
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</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>
<td>Fairing</td>
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<tr>
<td>Studied</td>
<td>Flown</td>
<td>Studied</td>
<td>Flown</td>
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<td>Studied</td>
<td>Flown</td>
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</tbody>
</table>

![Rocket Launches](image1.jpg)

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Human Exploration and Operations Mission Directorate

CubeSat Launch Initiative
## CubeSat Launch Initiative

<table>
<thead>
<tr>
<th>CubeSat Mission</th>
<th>Primary Mission</th>
<th>Launch Vehicle</th>
<th>Launch Date</th>
<th>Dispensers</th>
<th>CubeSats</th>
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<tr>
<td>ELaNa-I</td>
<td>Glory</td>
<td>Taurus XL</td>
<td>Mar 4, 2011</td>
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<td>3</td>
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<tr>
<td>ELaNa-II</td>
<td>NROL-39*</td>
<td>Atlas V</td>
<td>Dec 5, 2013</td>
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<tr>
<td>ELaNa-III</td>
<td>NPP</td>
<td>Delta II</td>
<td>Oct 28, 2011</td>
<td>3</td>
<td>5</td>
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<tr>
<td>ELaNa-IV</td>
<td>ORS-3*</td>
<td>Minotaur</td>
<td>Nov 19, 2013</td>
<td>4</td>
<td>11</td>
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<tr>
<td>ELaNa-V</td>
<td>CRS SpX-3</td>
<td>Falcon 9</td>
<td>Mar 16, 2014</td>
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<td>5</td>
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<tr>
<td>ELaNa-VI</td>
<td>NROL-36*</td>
<td>Atlas V</td>
<td>Sep 13, 2012</td>
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<td>4</td>
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<tr>
<td>ELaNa-VIII</td>
<td>ORB-3</td>
<td>Antares</td>
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<td>ELaNa-X</td>
<td>SMAP</td>
<td>Delta II</td>
<td>Jan 30, 2015</td>
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<tr>
<td>ELaNa-XI</td>
<td>AFSPC-5</td>
<td>Atlas V</td>
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<tr>
<td>ELaNa-IX</td>
<td>CRS OA-4</td>
<td>Atlas V</td>
<td>Dec. 6, 2015</td>
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</table>

Total Launched: 49

*Consistent with the National Space Policy of 2010, NASA has agreements with the national security space community to leverage our respective launch capabilities.*
**Planned Missions**

<table>
<thead>
<tr>
<th>CubeSat Mission</th>
<th>Primary Mission</th>
<th>Launch Vehicle</th>
<th>Launch Date</th>
<th>Dispensers</th>
<th>CubeSats</th>
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</thead>
<tbody>
<tr>
<td>ELaNa-XIII</td>
<td>FORMOSAT-5</td>
<td>Falcon 9</td>
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<td>CRS OA-5</td>
<td>Antares II</td>
<td>FY 2016</td>
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<tr>
<td>ELaNa-XV</td>
<td>STP-2</td>
<td>F9 Heavy</td>
<td>FY 2016</td>
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<td>ELaNa-XIV</td>
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<td>ELaNa-XIX</td>
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<td>Rocket Labs</td>
<td>FY 2017</td>
<td>TBD</td>
<td>TBD</td>
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<tr>
<td>ELaNa-XVIII</td>
<td>ICESat-2</td>
<td>Delta II</td>
<td>FY 2018</td>
<td>3</td>
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<td>ELaNa-XX</td>
<td>VCLS</td>
<td>Virgin Gal.</td>
<td>FY 2018</td>
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<tr>
<td>ELaNa-XXI</td>
<td>VCLS</td>
<td>Firefly</td>
<td>FY 2018</td>
<td>TBD</td>
<td>TBD</td>
</tr>
</tbody>
</table>

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**Missions Examples**

**CSSWE**  
University of Colorado – Boulder, Co.  
- Measure the directional flux of Solar Energetic Protons (SEPs) and Earth’s radiation belt electrons in support of NASA’s Radiation Belt Storm Probe Mission  
- Space Weather - Heliophysics  
- Payload: Relativistic Electrons and Proton Telescope  
**GOAL:** Understand the relationship between SEPs flares and coronal mass ejections

**KySat-2**  
University of Kentucky – Lexington, Ky.  
Morehead State University – Morehead, Ky.  
- Test components of a novel attitude determination system called a Stellar Gyroscope that uses sequences of digital pictures  
**GOAL:** Determine the three-axis rotation rate of the satellite
M-Cubed
University of Michigan – Ann Arbor, MI.
- Obtain mid-resolution imagery of the Earth’s surface and carry the JPL/Caltech CubeSat On-board processing Validation Experiment (COVE)
**GOAL:** COVE will advance technology required for real-time, high data-rate instrument process for future Earth Science

IPEX
JPL/Cal Poly – Pasadena, Calif
- Demonstrate Intelligent Payload Module (IPM) technologies including autonomous onboard instrument processing, downlink operations, and automated ground operations
**GOAL:** Validate IPM technologies which is a baseline for the HyspIRI Decadal Survey Mission
St. Thomas More Cathedral School

Student CubeSat onboard Cygnus

GO FOR IT 2!
Feedback

“The ELaNa program has been a game changing event for our research center. It has allowed us to be able to show past performance in the areas of nanosatellite development. This achievement has easily resulted in over $1M in future research projects for the University of New Mexico.”

Craig Kief – TrailBlazer
Deputy Director
Configurable Space Microsystems Innovations & Applications Center (COSMIAC)

“Universal, location-independent service is a distinguishing feature of satellite technology. In that spirit, this NASA launch has afforded for our students, here in Louisiana, the same access to this high-technology areas as anyone else anywhere in the nation, and indeed around the world.”

George Thomas – CAPE-2
Professor of Electrical and Computer Engineering
University of Louisiana, Lafayette

"The NASA ELaNa program provides an educational experience for the student team that can not otherwise be duplicated in a University setting. Students go from concepts on paper to operating their hardware on-orbit and the lessons learned between those two points is invaluable."

Professor James Lumpp – KYSat-2
Electrical and Computer Engineering, University of Kentucky
Want To Learn More?

http://www.nasa.gov/directorates/heo/home/CubeSats_initiative
