

John F. Kennedy Space Center



LAUNCH SERVICES PROGRAM

“Developing New Tools for the ELaNa”

Garrett Skrobot

ELaNa Mission Manager
Launch Services Program

NASA

Small Sat 2016

Launch Services Program

ELaNa
NASA
GSLI

“Launching CubeSats”

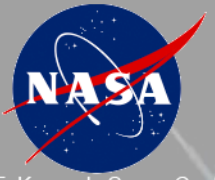
www.nasa.gov

Educational Launch of Nanosatellite

NASA CubeSat Launch Initiative

NOT READY TO LAUNCH? TRY SPACEKIT!

Start building your own satellite!

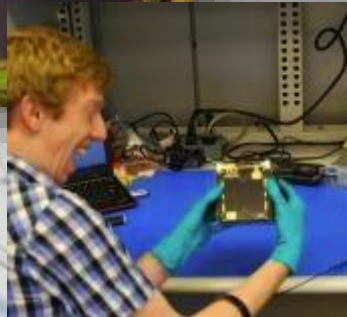
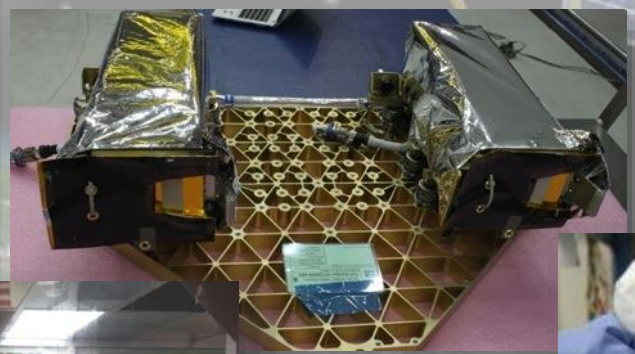


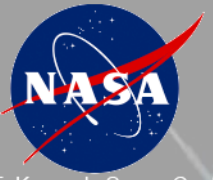
John F. Kennedy Space Center

What's going on!



**“ELaNa is moving forward,
launching CubeSat missions for
CubeSat Launch Initiative (CLSI)
and Science Projects!”**





John F. Kennedy Space Center

ELaNa Launches Since Last Workshop



ELaNa XII – NROL-55
Oct 8, 2015

- AMSAT Fox-1**
Radio Amateur Satellite Corporation
- BisonSat** Salish Kootenai College
- ARC** University of Alaska – Fairbanks
- LMRST-Sat** JPL



ElaNa VII - ORS4
Oct 29, 2015

- Argus - Saint Louis**
University
- PrintSat** Montana State
University

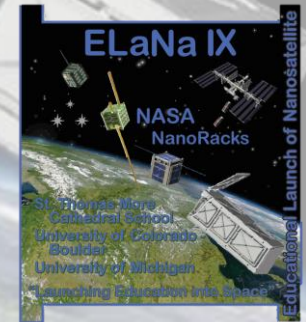


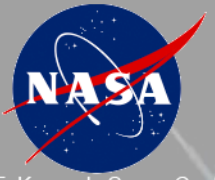
ElaNa IX – OA-4
December 6, 2015

May 16, 2016
MinXSS(HiLite) Colorado,
Boulder

STMSat-1 St. Thomas More
Cathedral School

CADRE – U of Michigan





CubeSat Missions Manifest

(NASA Internal Only)



John F. Kennedy Space Center

| LV Provider | FY 2016 | FY 2017 | FY 2018 |
|------------------------|--|--|--|
| NASA | | ELaNa XIV 1/20/17 JPSS-1 (DII) 5* | ELaNa XVIII 10/31/17 ICESat-2 (DII) 3* MarCO May 2018 InSight (AV) 2* |
| NASA ISS | ELaNa XVII 12/30/16 OA-7 5* | ELaNa 22 6/1/17 SPX-12 6* | ELaNa XVI TBD TBD 1* |
| NRO | | | |
| ORS/STP | | ELaNa XV 3/1/17 (U/R) STP-2 3* | |
| Commercial | ELaNa XIII NET Dec 2016 FORMOSAT-5 2* | ELaNa XIX June 2017 VCLS (RL) 14* | ELaNa XX Dec 2017 VCLS (VG) 18* ELaNa 21 Mar 2018 VCLS (FF) 13* |



SPL Manifested

July 2016



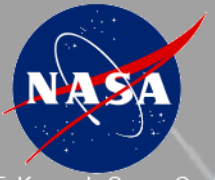
ELaNa Manifested

* # CubeSat Missions



In Work

| Launched | Manifested | Un-Assigned |
|----------|------------|-------------|
| 46 | 53 | 21 |



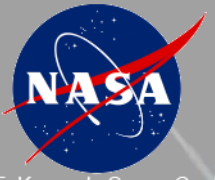
Upcoming ELaNa Launches



NASA CubeSat Missions scheduled for launch

- **ELaNa XIII (NET Oct, 2016)**
 - » **ISARA – JPL**
 - » **EcAMSat – Ames**
- **ELaNa XVII (NET December, 2016)**
 - » **IceCube - GSFC**
 - » **CXBN-2 Morehead State University/Kentucky Space**
 - » **HARP – University of Maryland, Baltimore County**
 - » **OPEN – University of North Dakota**
 - » **CSUNSat-1 California State University, Northridge**
- **ELaNa XIV (NET Jan, 2017)**
 - » **Golden Eagle-1 – Marquette University**
 - » **RadFxSat – Vanderbilt University/AMSAT**
 - » **EagleSat – Embry Riddle Aeronautical University, Prescott**
 - » **MiRaTa – MIT Lincoln Laboratory**
 - » **Buccaneer - Australian Defense Science and Technology Organization**





John F. Kennedy Space Center

Upcoming ELaNa Launches

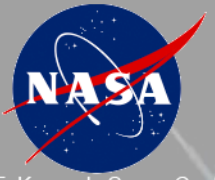


NASA CubeSat Missions scheduled for launch

- **ELaNa XV (NET March, 2017)**
 - » **ARMADILLO – Texas Spacecraft Laboratory**
 - » **LEO – CalPoly SLO**
 - » **StangSat – Merritt Island High School**

- **ELaNa 22 (NET June, 2017)**
 - » **ASTERIA - MIT**
 - » **RBLE – GSFS**
 - » **LAICE – University of Illinois at Urbana-Champaign**
 - » **AOSAT – Arizona State University**
 - » **OSIRIS-3U – Pennsylvania State University**
 - » **OPAL – Utah State University**





John F. Kennedy Space Center

Upcoming ELaNa Launches

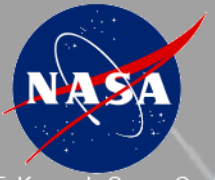


NASA CubeSat Missions scheduled for launch

– ELaNa XIX (NET June, 2017)

- » **CeREs - GSFC**
- » **ANDESITE – Boston University**
- » **SFT-1 – West Virginia University/ NASA IV&V**
- » **CHOMPPTT – University of Florida**
- » **CubeSail - University of Illinois at Urbana-Champaign**
- » **NMTSat – New Mexico Institute of Mining and Technology**
- » **DaVinci – North Idaho STEM Charter Academy**
- » **RSat – U.S Naval Academy**
- » **ISX – SRI/CalPoly**
- » **Shields-1 – Langley Research Center**





ELaNa and CSLI Score Card



2015 CubeSat Launch Initiative Missions

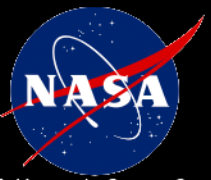
| Selected | Awaiting Manifest | Manifested | Launched | ELaNa Missions Launched |
|----------|-------------------|------------|----------|-------------------------|
| 106 | 53 | 16 | 37 | 9 |

2016 CubeSat Launch Initiative Missions

| Selected | Awaiting Manifest | Manifested | Launched | ELaNa Missions Launched |
|----------|-------------------|------------|----------|-------------------------|
| 130/121 | 21 | 53 | 46 | 12 |

Total U-Class Payloads (Cubes) Readiness

| 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
|------|------|------|------|------|------|
| 13 | 21 | 27 | 7 | 1 | 1 |



John F. Kennedy Space Center

ELaNa – *The Next Logical Step*

From 2011 Workshop

Have our own Nano-Launcher

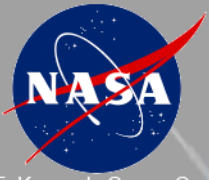


That's right, have our own dedicated launch vehicle where the CubeSats are now primary

The CubeSat no longer has to abide by the restrictions levied by a primary rideshare.



California Launch of Nanosatellite



Venture Class Launch Services (VCLS)




- **New class of commercial launch vehicle service at KSC, dedicated for U-class satellites**
- **Improved CubeSat manifesting via NASA's CubeSat Launch Initiative (CSLI)**
- **As reliability is demonstrated, some providers may be appropriate for future less risk-tolerant NASA missions**
- **Milestones-based payment structure; *limited* LSP insight through milestone reviews**
- **A *single demonstration* flight was awarded to Firefly, Rocket Lab, and Virgin Galactic**
- **Statement of Work: Minimum 60kg to LEO (425km), orbit inclination 33 to 98 degrees, launch date no later than April 15, 2018**
- **Companies are responsible for LV development costs**

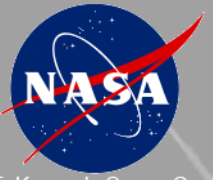


| Specification | Alpha 1.0 (Firefly) | Electron (Rocket Lab) | LauncherOne (Virgin Galactic) |
|------------------|---|--------------------------|-------------------------------|
| Length | 23 m | 17 m | 20 m |
| Payload Mass | 200 kg | 150 kg | 300 kg |
| Payload Diameter | 1.45 m | 1.1 m | 1.3 m |
| Orbit | 500 km (Sun Synchronous) | 500 km (Sun Synchronous) | 500 km (Sun Synchronous) |
| LV Certification | No certification High risk-tolerant spacecraft | | |

For Comparison Only



| |
|--|
| Pegasus XL (Orbital) |
| 16.9 m |
| Up to 443 kg to LEO |
| 1.18 m |
| Multiple |
| Certified; Low risk-tolerant spacecraft |



John F. Kennedy Space Center

VCLS Missions

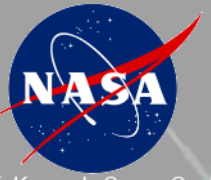


So where we going with VCLS?

RocketLab – ELaNa XIX – 14 CubeSat Missions
500km Cir at 85° Inclination
June 2017

Virgin Galactic – ELaNa XX – 18 CubeSats Missions
500km Cir at 90° Inclination
December 2017

FireFly – ELaNa 21 – 10 CubeSat Missions
375km Cir at 55° Inclination
March 2018



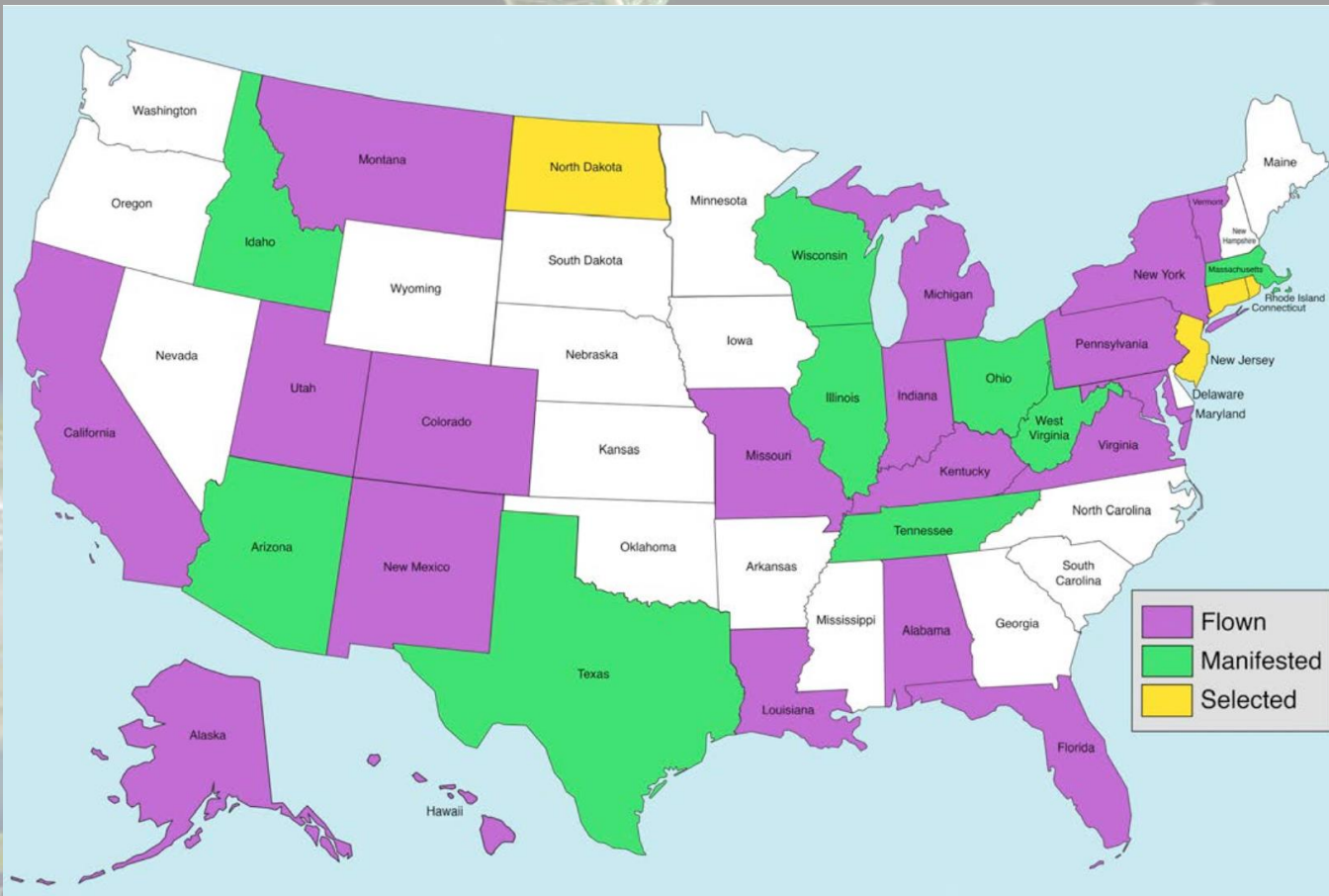
John F. Kennedy Space Center

White House Maker Initiative



LAUNCH SERVICES PROGRAM

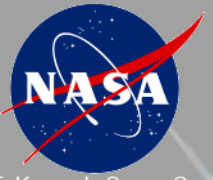
Goal to broaden NASA's CubeSat Launch Initiative to reach all states by targeting the 20-18 "rookie states" that have had no previous presence in space.



Previous CubeSat Launch Initiative selectees are encouraged to partner with and/or mentor organizations from these states.

“will leverage the existing NASA Space Grant network of colleges and universities.”

~ White House Maker Faire Fact Sheet



Path Forward



So what is our Path Forward?

- **Focus on securing ISS and Commercial UCP LEO launches**
 - **Contract in place where NASA can procure ISS UCP deployment slots from the ISS through NanoRacks**
 - **Working to execute a contract for a Commercial Launch Broker (CLB) to provide launch services for UCP**
 - » **CLB will be required to provide the launch service and integration of the UPC for high inclination orbits**
 - » **Expect to have contract in place in of FY17**
- **Launch UCP on a dedicated Small Launch Vehicle for those missions with unique orbital requirements**

