

From Baseline Science Instruments to CubeSats

Challenges and Opportunities with the Growth of Space Based Data Acquisition and the Commercial World

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Element 84

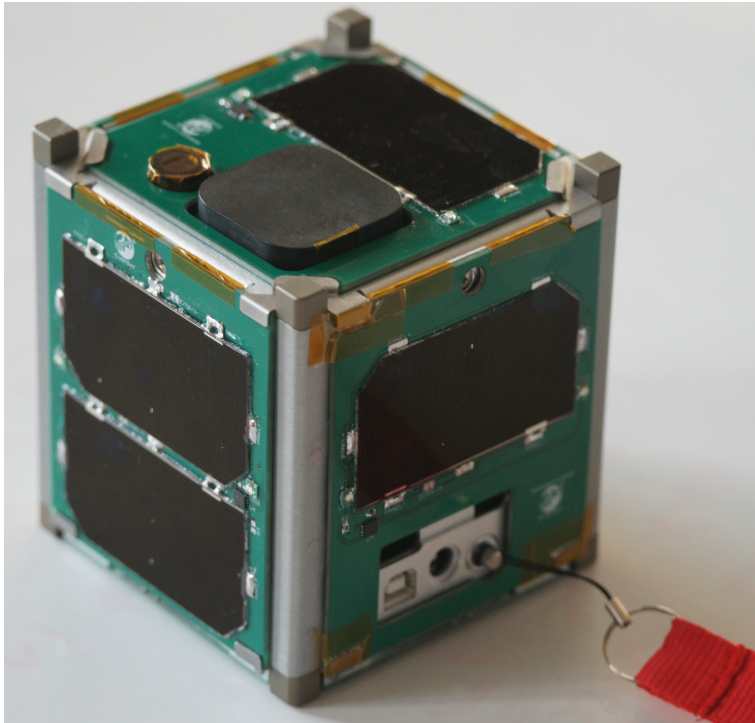


WINTER 2019

CubeSat 101



What are CubeSats

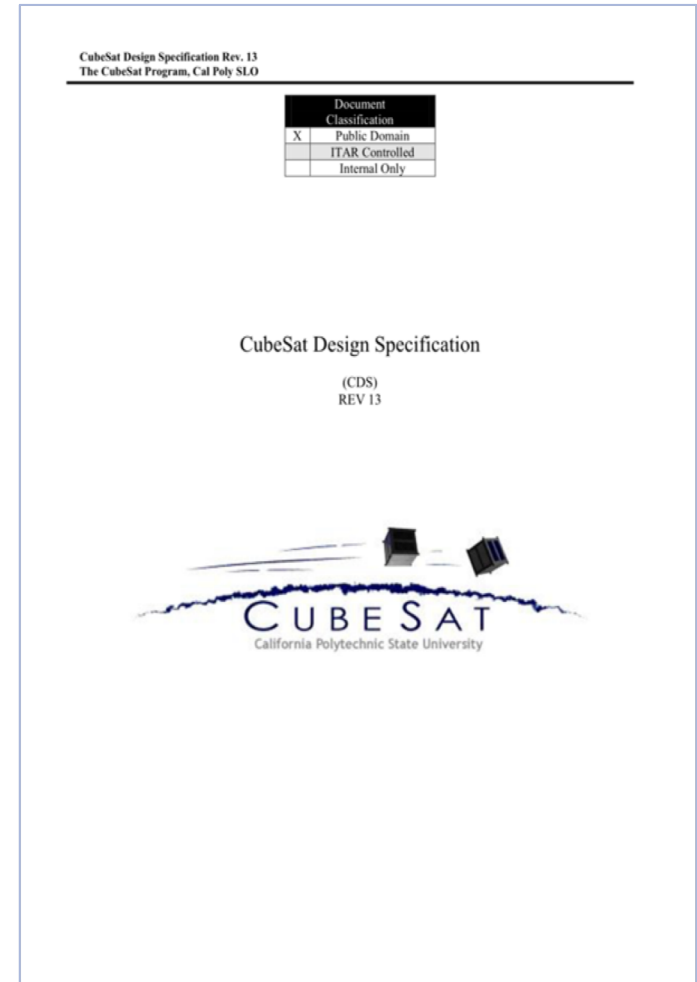


Satellite mass classification

- Large satellites: >1000 kg
- Medium satellites: 500 to 1000 kg
- Small satellites: < 500 kg
 - Minisatellites: 100 to 500 kg
 - Microsatellites: 10 to 100 kg
 - Nanosatellites: 1 to 10 kg
 - Picosatellites: 100 g – 1 kg
 - Femtosatellites: 10 g – 100 g
 - Attosatellites: 1 g – 10 g
 - Zeptosatellites: 0.1 g – 1 g
- CubeSat sizes:
 - From ~0.2 kg to ~40 kg
 - From 0.25U to 27U

What are CubeSats

Strict specifications
allows for mass
production of parts,
reducing cost.



CubeSat Design Specification (CDS): <http://www.cubesat.org>

OneNote 6:29 PM Sun Jan 13 ecm-space.de

system for small satellites

Supported CubeSats

Leading technology & support
for your mission success

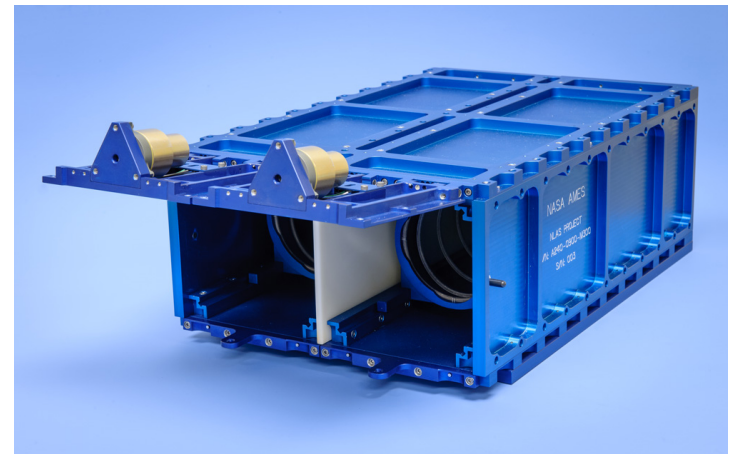
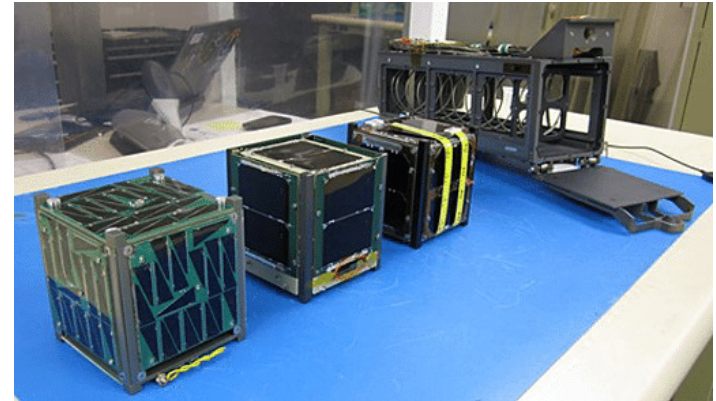
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ecm-space.de/index.php/launch-adapters-h/cubesat-sizes



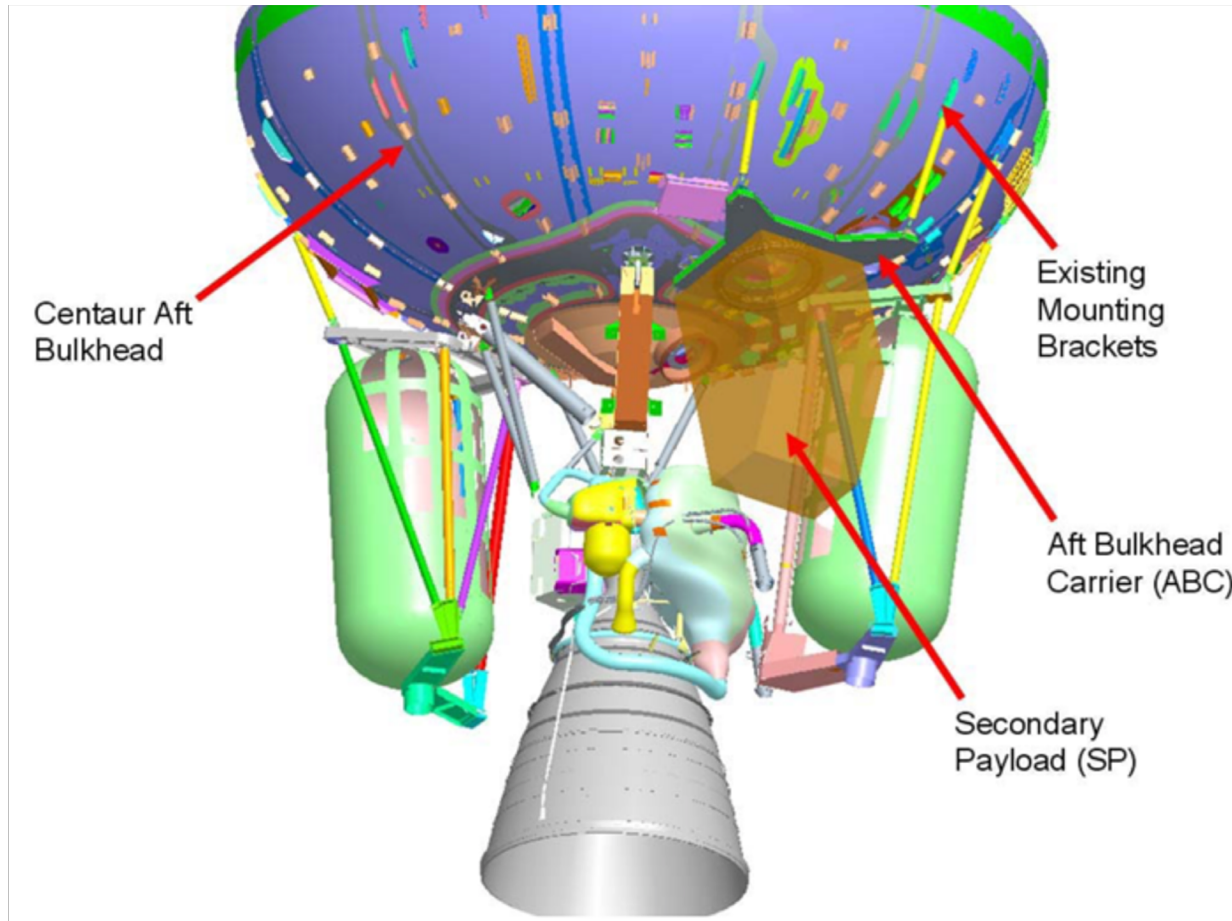
CubeSat Dispenser Systems

- Poly-Picosatellite Orbital Deployer (P-POD) supports up to 3U worth of CubeSats.
- Bigger dispensers now available
- Kind of bolted onto whatever won't fall off.
- Launch vehicle says when to release, door opens, satellites stream out.

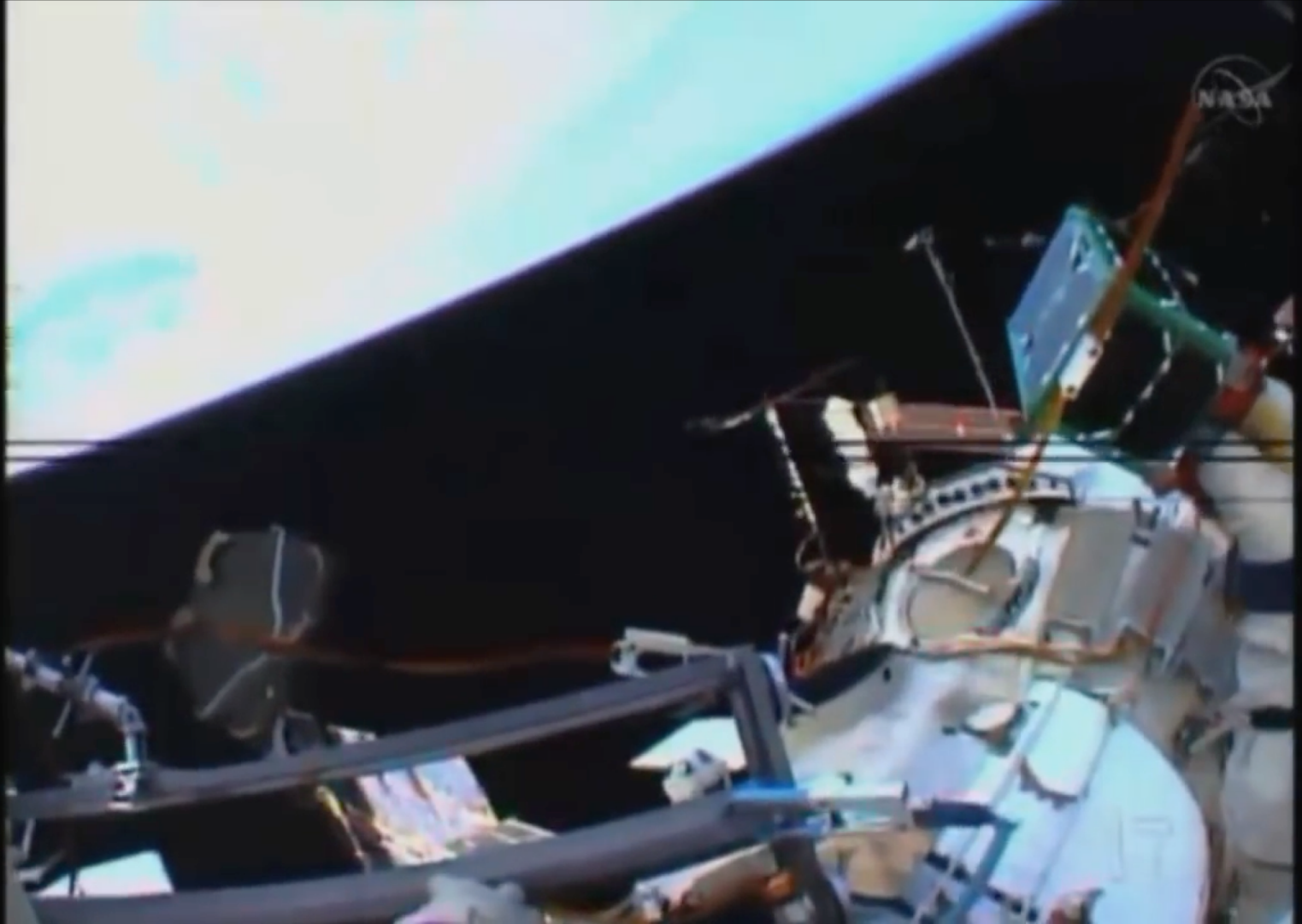


<https://www.nasa.gov/centers/ames/engineering/small-sat/nlas>
https://www.researchgate.net/figure/Three-1U-CubeSats-beside-a-3U-Poly-Picosatellite-Orbital-Deployer-PPOD-developed-at_fig2_317036984

CubeSat Dispenser Systems



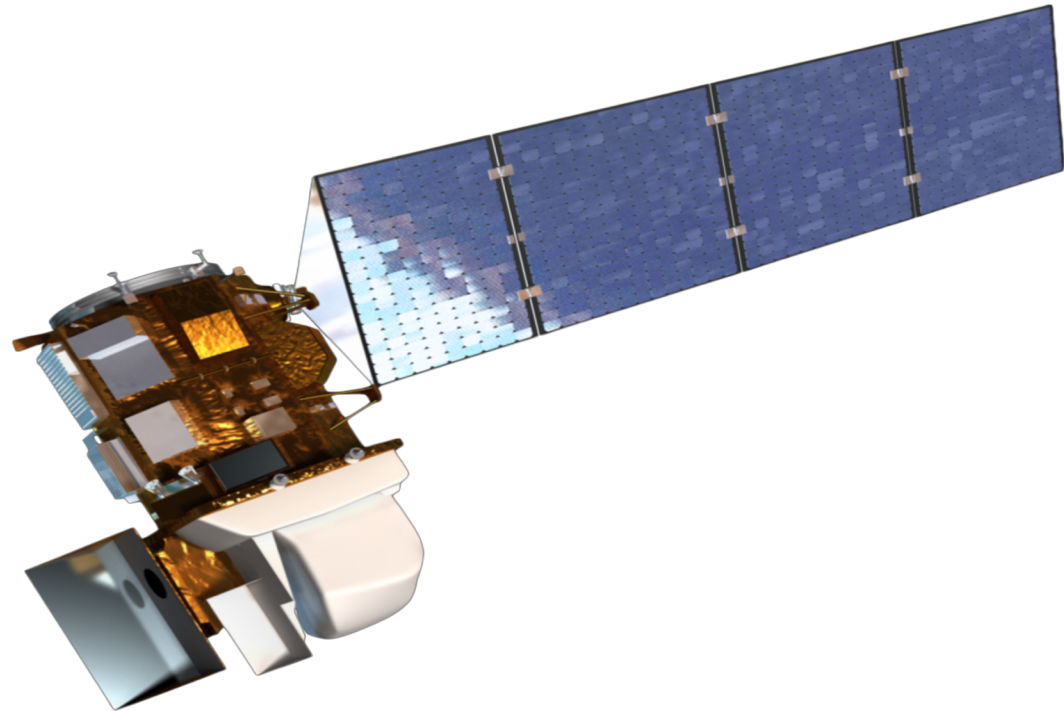
Naval Postgraduate School CubeSat Thesis apps.dtic.mil/dtic/tr/fulltext/u2/a509158.pdf



HD

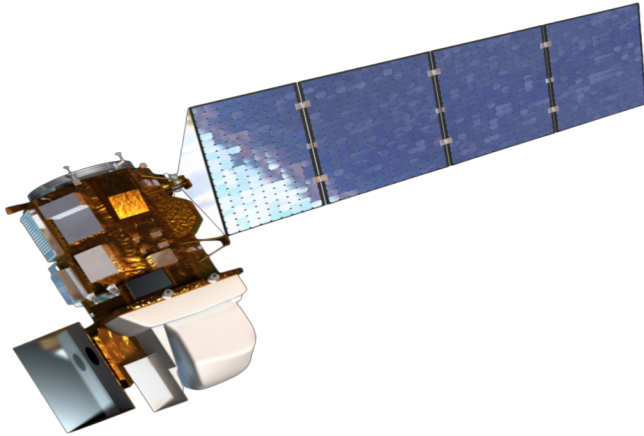


Putting this in context...

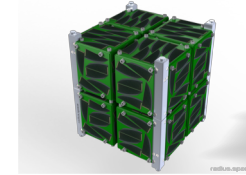


landsat.gsfc.nasa.gov/landsat-8/landsat-8-overview/
<https://www.nanosats.eu/cubesat.html>

Different Goals

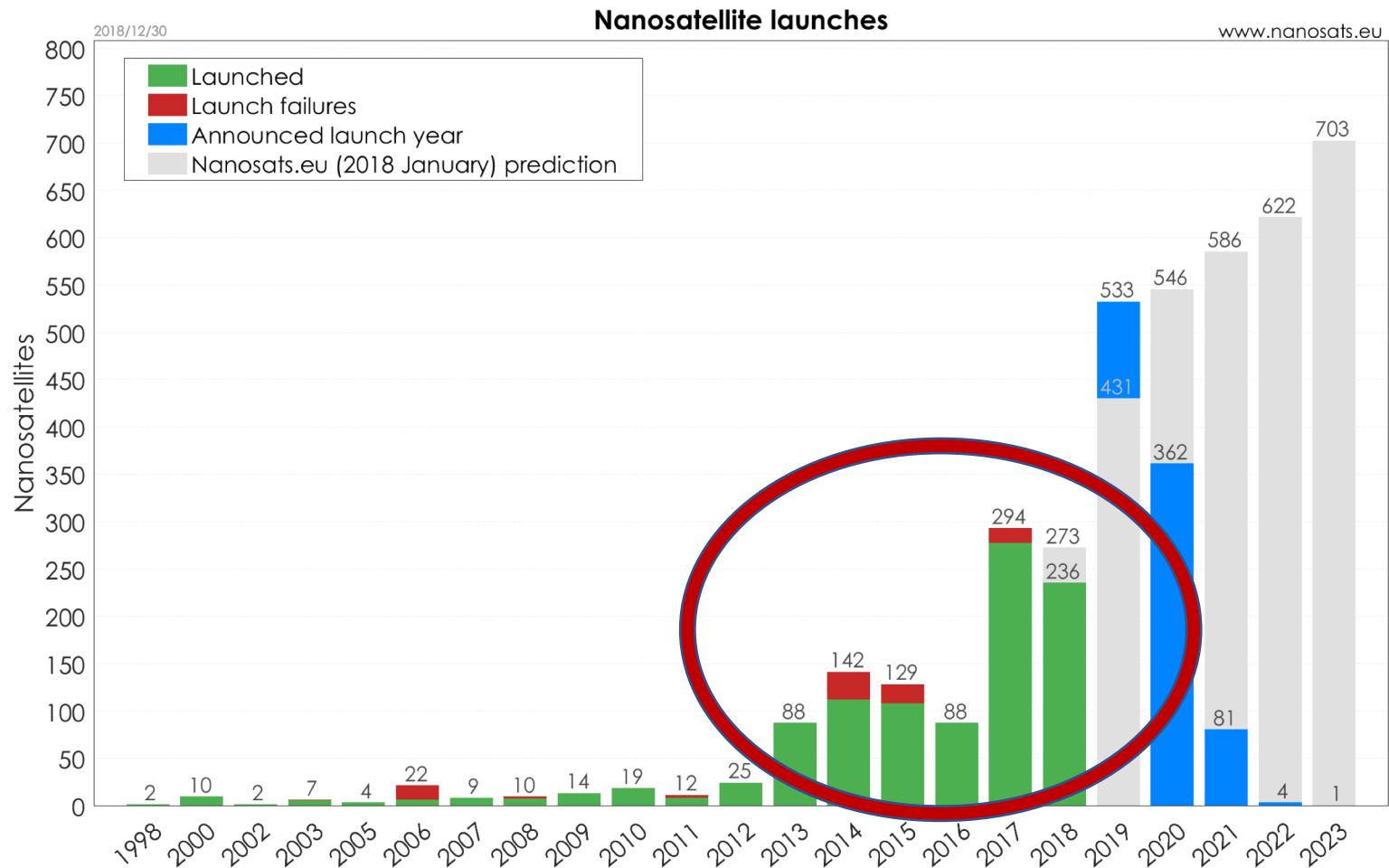


- Baseline science quality data
- 2623kg
- 3m long, 2.4m diameter
- ~\$850 billion
- 5+ year design life (Landsat 5 flew for 29 years)



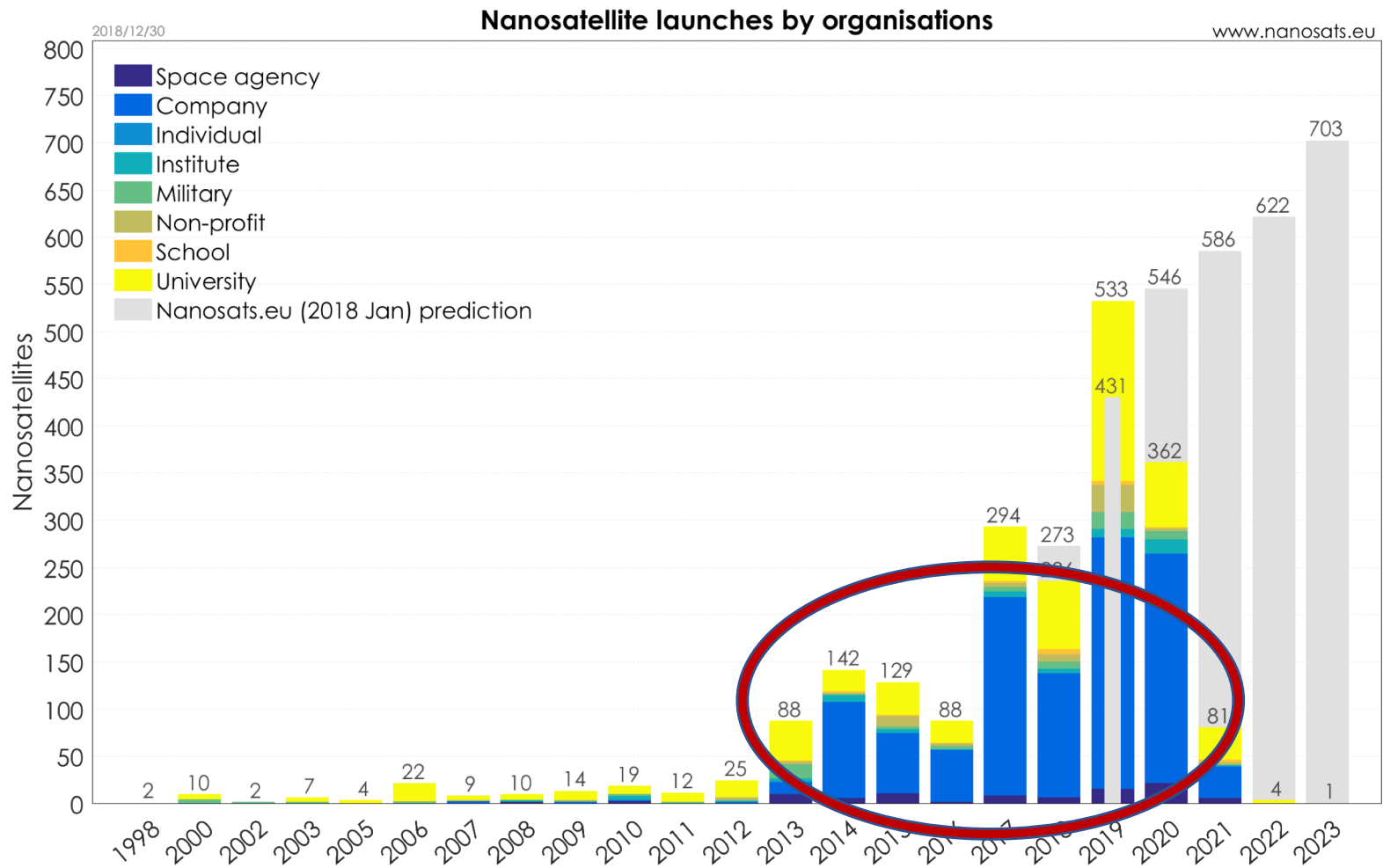
- Experiments, rapid iteration, “good enough” data
- ~1-1.33kg
- 10cm Cube
- ~\$40k + Launch Fees
- Weeks to months design life

Launches



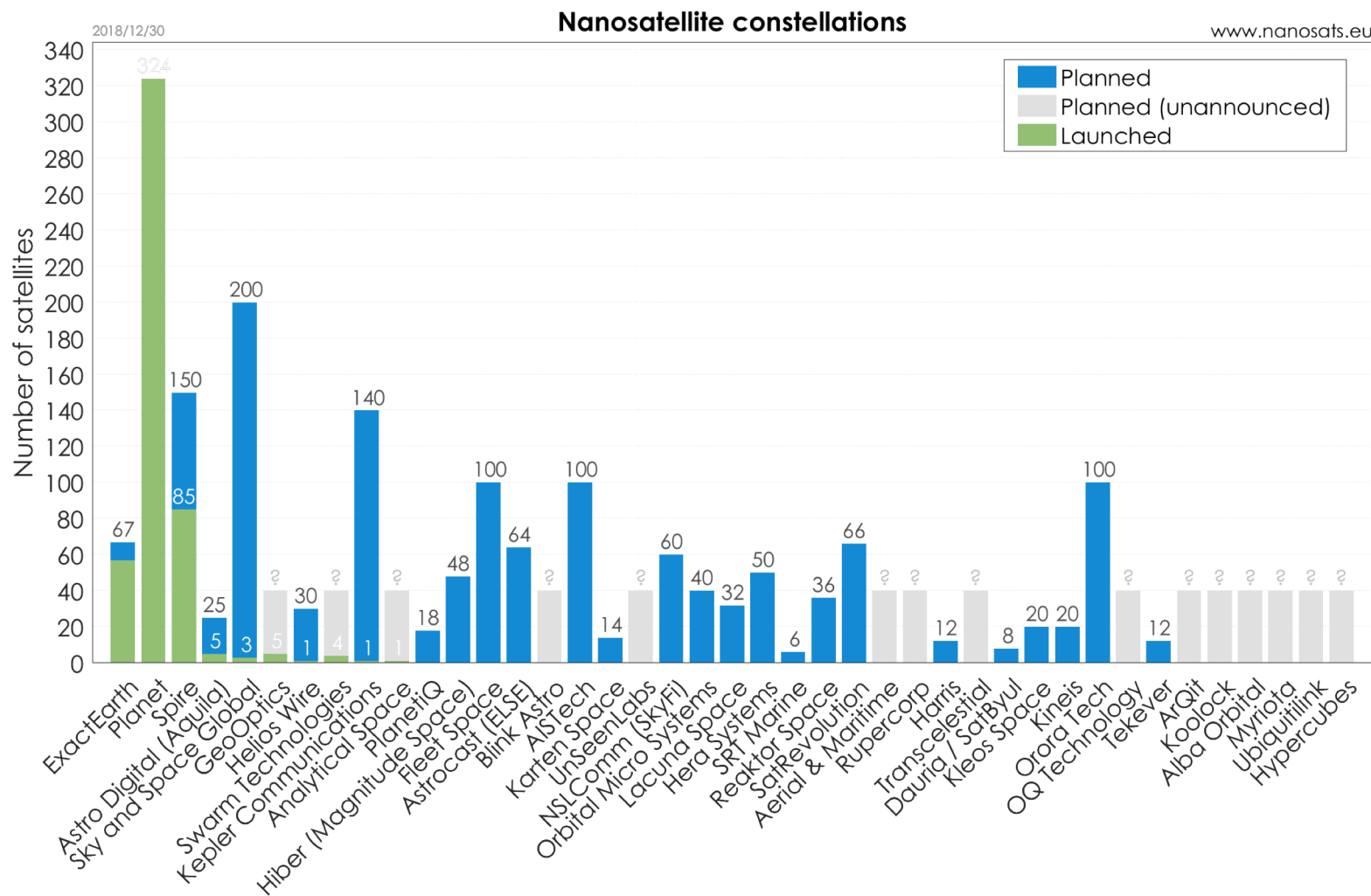
nanosats.eu/index.html#figures

Launches by institutions



nanosats.eu/index.html#figures

Constellations



[nanosats.eu/index.html#figures](https://www.nanosats.eu/index.html#figures)

spaceflight.com



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SEARCH

Upcoming launches filtered by Launch Date

LAUNCH DATE	ORBIT	
Q2 2019	555km 42°	DETAILS >
Q2 2019	450-500km 45-50°	DETAILS >
Q2 2019	450-500km 51.6°	DETAILS >

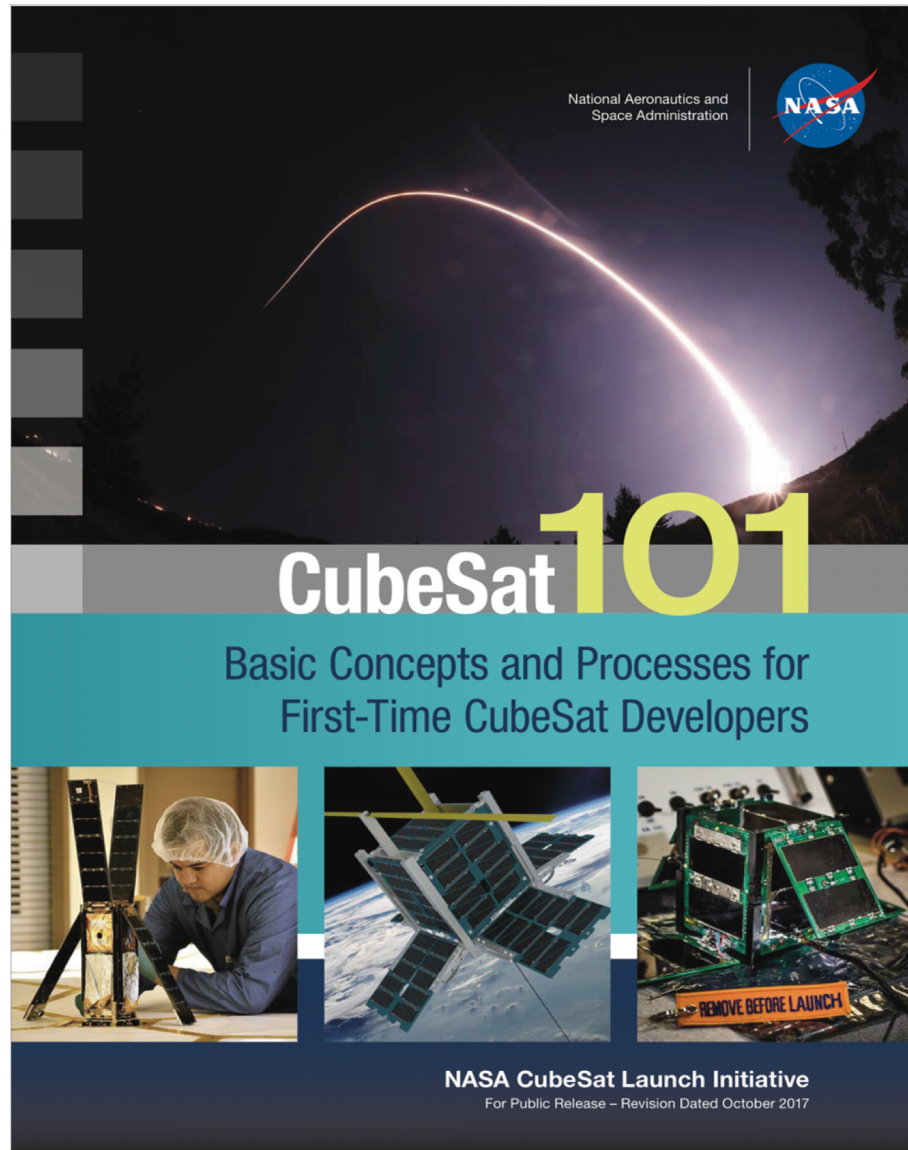
[SEE ALL FLIGHTS](#) >

VIDEO CREDIT: SPACE-X

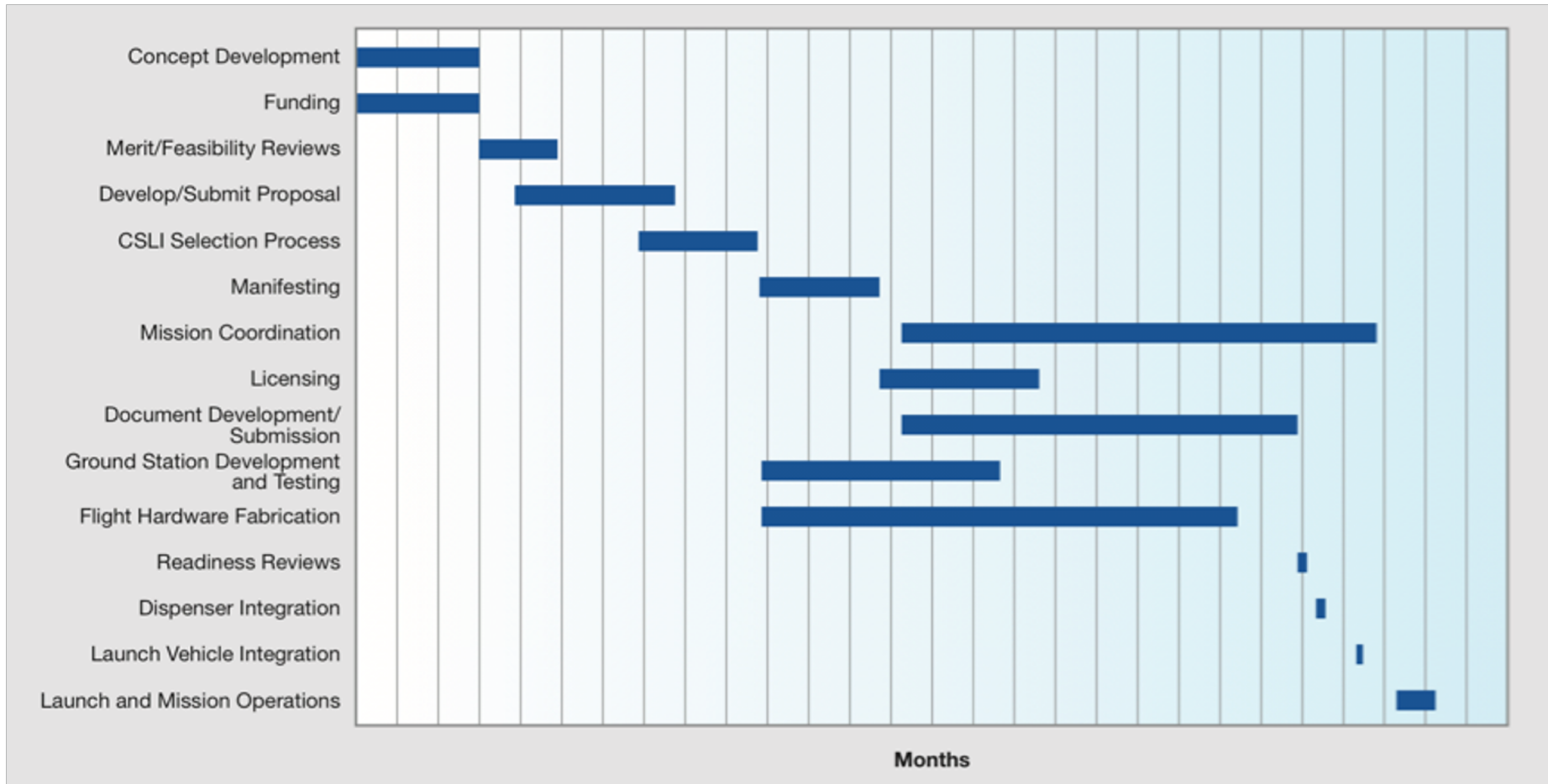




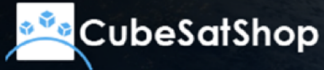
So you want to build a CubeSat...



NASA CubeSat 101



cubesatshop.com



PRODUCTS ▾

VENDOR INFORMATION ▾

HOW IT WORKS

FAQ

INQUIRY LIST (0)



ONE-STOP WEBSHOP

STANDARDIZED PRODUCTS

AVAILABLE AS OFF-THE-SHELF

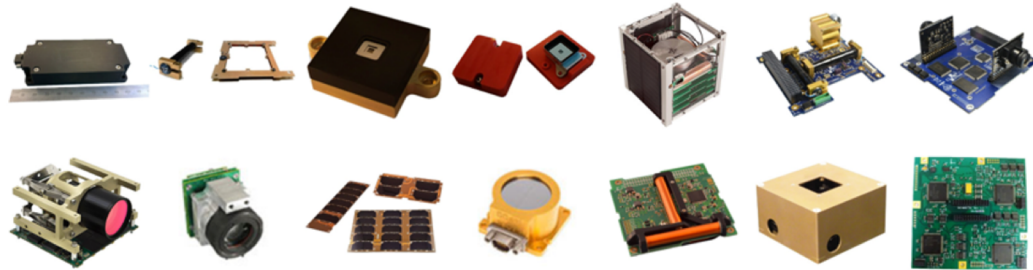
MULTIPLE VENDORS

- Antenna systems >
- Attitude actuators >
- Attitude sensors >
- Cameras & payloads >
- Command & data handling >
- Communication systems >
- CubeSat kits & buses >
- CubeSat Structures >
- Ground stations >
- Integrated ADCS >
- Launch adapters >
- Propulsion & pressurisation >
- Solar panels & power systems >
- Ground support equipment >
- Software services >
- Training & simulators >

One-stop webshop for CubeSats and Nanosats

More than 100 products available

View products ▶

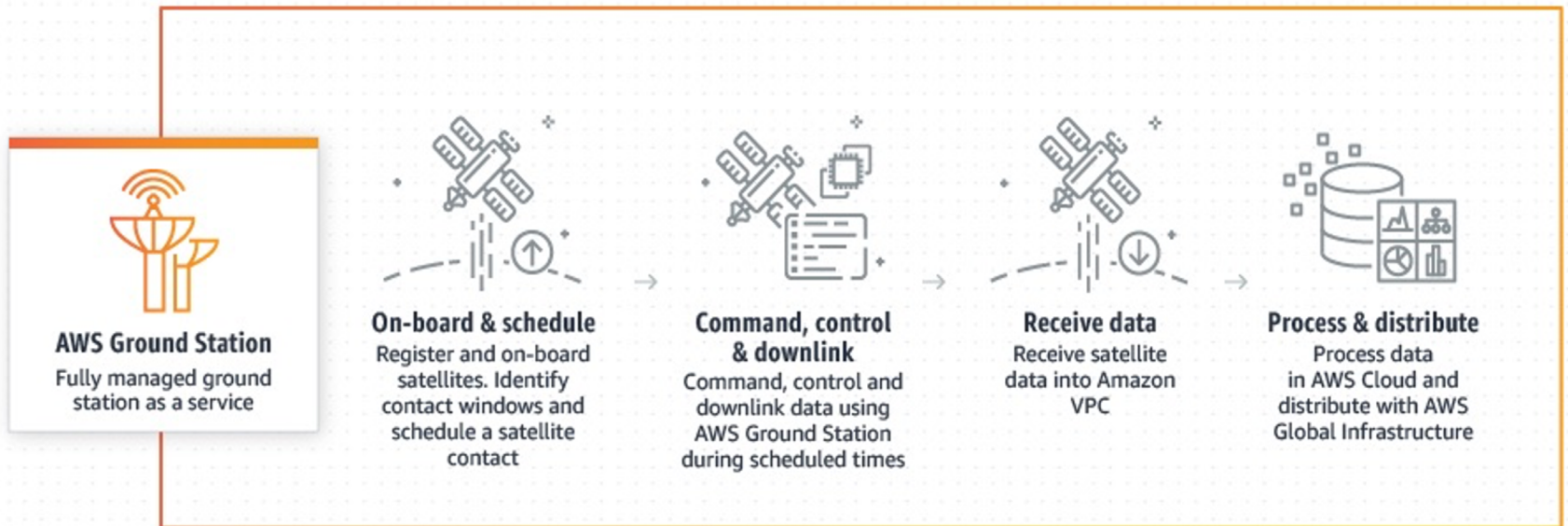


Join CubesatShop

Start now ▶

FEATURED PRODUCTS

AWS Ground Stations



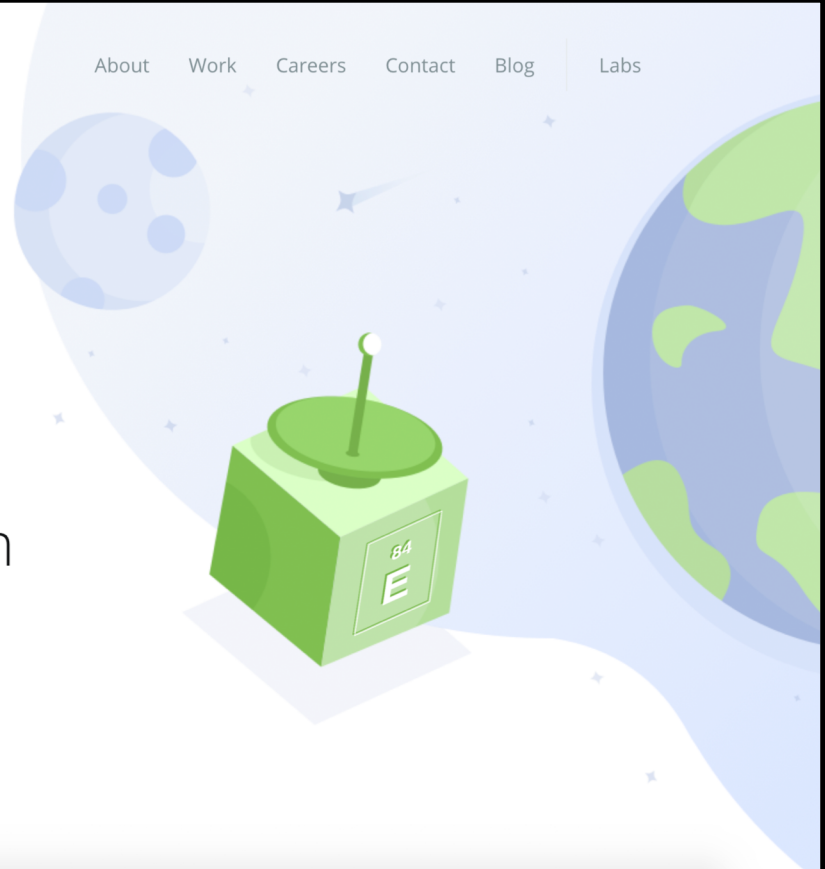
cubesatdata.com



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Element 84

CubeSat data management that lets you focus on your mission

CubeSat Data can manage the entire data pipeline of your cube or microsatellite mission-- from ground station downlink and data storage to automated archives of convenience so you can put your data to work solving problems.

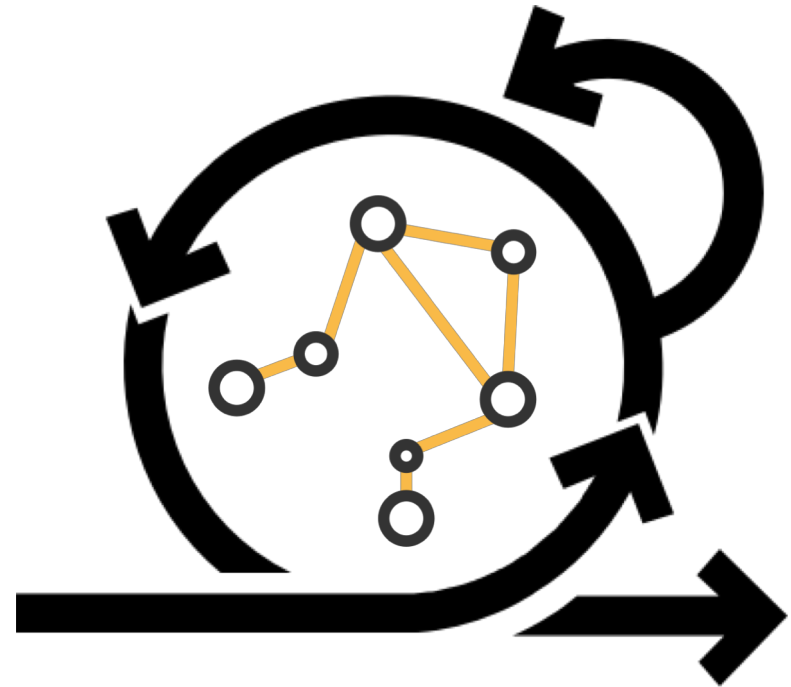


Implications



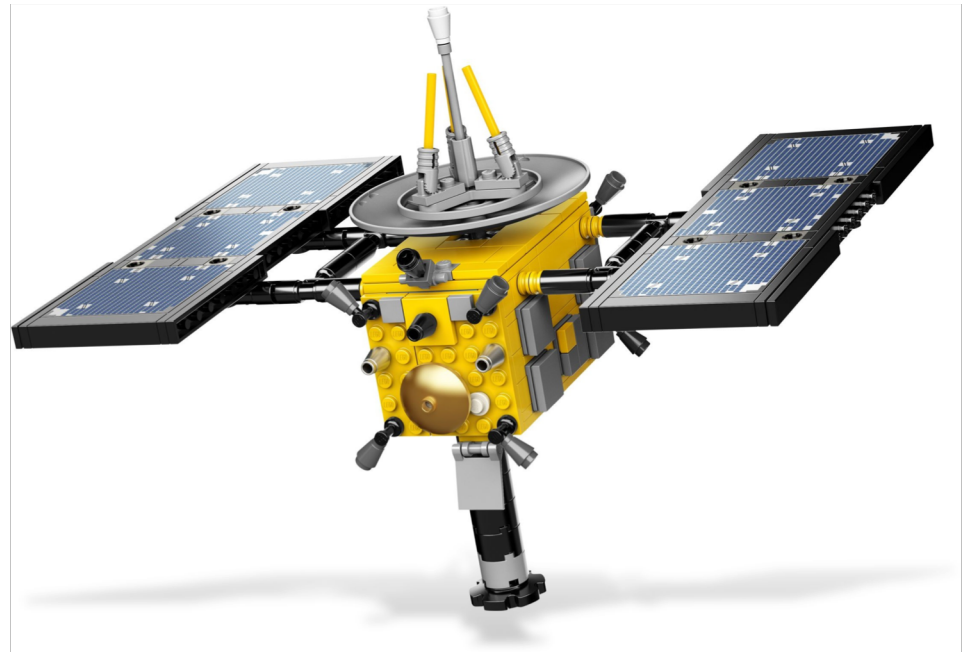
Agile Satellite Development

- Rapid iteration and learning
- Power Systems
- Positioning Methods
- Radios
- Sensors
- Propulsion Systems
- Satellite Constellations
- Operations Prototyping



Personalization of Space

- Education
- Broom-closet clean rooms
- University clubs
- Small and Developing country satellites
- Makes Space real



Marketing and Entertainment



- Vanity Satellites?
- Rick-rolling from space?
- Sounds from space
- FunCube

Space Debris

- Hundreds of new CubeSats deployed each year
- Trending toward a 50 percent increase in the number of collisions
- Over the past 25 years, the number of tracked space objects >4in has increased from 8k to 18k.
- Only 7% of these objects are operational satellites.
- Each of the LEO satellites operated by ESA has to perform a maneuver to avoid a tracked piece of debris at least once a year



en.wikipedia.org/wiki/Sentinel-1
<https://www.space.com/36506-cubesats-space-junk-apocalypse.html>

MOAR SPACE DATA

Where do we put it?

Individuals are going to have to face the problems NASA, NOAA, etc. have been wrestling with for years:

- Ingest & Archive
- Metadata & Discovery
- Interoperability
- Quality
- Distribution
- Visualization

How do we get at it?

How do we share it?



Geostrategic and Political Implications

- Construction of artificial islands in the South China Sea
- Deforestation
- Suburban Sprawl
- Population movement and humanitarian crisis
- Military Facilities
- “Outting” of undisturbed populations
- US Government restricts spatial resolution to 25cm / pixel. Other governments allow for higher resolution



<https://revolutions.org/2017/07/13/planet-labs-rapid-response-team/>

Satellite imagery from Google Earth



PLANET LABS INC/HANDOUT VIA REUTERS



History can be recorded...

Seeing the whole Earth as a single entity is not new. ... Satellites have enough resolution to observe every big tree in the world every day.

Martin Rees

Cosmologist, Astrophysicist and Britain's Astronomer Royal



**SINGLE, BURST,
& MULTI-ANGLE**

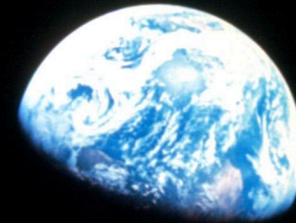


VIVID-I

2018 ©Earth-i

"You realize that all the lines on the maps really do not exist. You can't even tell where one country starts and the other one stops. All those things that create conflict just melt away, and you can see our planet as one home for all of us"

Anousheh Ansari on the view from the ISS



Thank you.

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