# The Pleiades CubeSat Cluster

## Enabling Open Architectures and Satellite Collaboration

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## I. Abstract

The Pleiades CubeSat Cluster is a large-scale inter-university collaboration to test open architectures for small satellites, develop methods for safer and more capable formation flight of spacecraft, while also creating robust pathways for the future of the New Space Industry. While the total number of free flying space missions has skyrocketed in recent years, very few organizations have emerged to produce repeats.

We believe that this is primarily due to the lack of a true community of practice and unclear pathways to flight for investigators in the CubeSat space. CubeSat missions often fall into a paradox of opportunity, where no predefined standards allow for incredible diversity, but also provide no stable foundation for investigators. Chemists are not asked to design and build their own pipettors before conducting an experiment, but investigators in CubeSats are often faced with all the complexities of satellite development before even approaching their core payload.

The Pleiades CubeSat Program combines the unique satellite architectures, expertise, and resources of a diverse consortium of US universities towards creating a satellite fleet to create and encourage the collaborative communities that are a hallmark of space exploration.

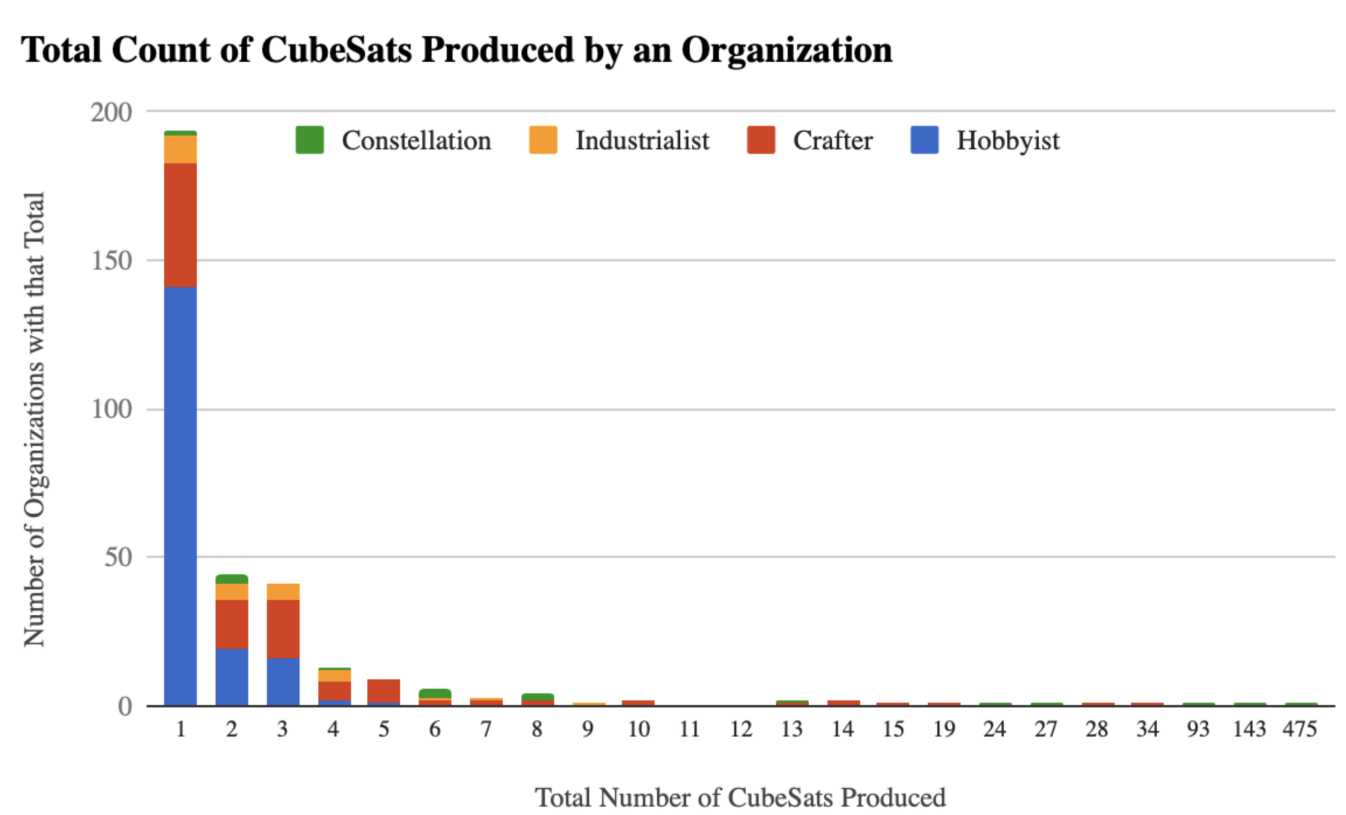


**Figure 1:** Data on Repeat CubeSat Developers From Dr. Swartwout's CubeSat Database [1]

## II. Background Information

The Pleiades CubeSat Program builds off the pedigree of three existing open-source CubeSat architectures. The PyCubed architecture[2], originally from Stanford University, represents a simple and affordable foundation for basic technology demonstration and science missions. The OreSat architecture[3], from Portland State University, provides the modularity and robustness needed for complex and time critical missions. The Artemis CubeSat Kit[4], from the Hawaii Spaceflight Lab, occupies a middle path between the two extremes of the complexity spectrum.

## III. General Goals

Primary Goals:

- To demonstrate that the each of the selected open-source architectures can be built and delivered by an independent organization to perform fundamental mission operations in Low Earth Orbit at low cost.
- To demonstrate that the concept of a general use satellite architecture that can meet the needs of an academic or research mission without extensive training or long lead times.
- To educate the current cohort of students participating, in all aspects of Space Mission Engineering

Secondary Goals:

- To provide a space mission architecture and infrastructure that is repeatable without the need for highly specialized training or long lead times.
- To develop a holistic space mission ecosystem that utilizes collaborative networks to ensure consistent access to space.

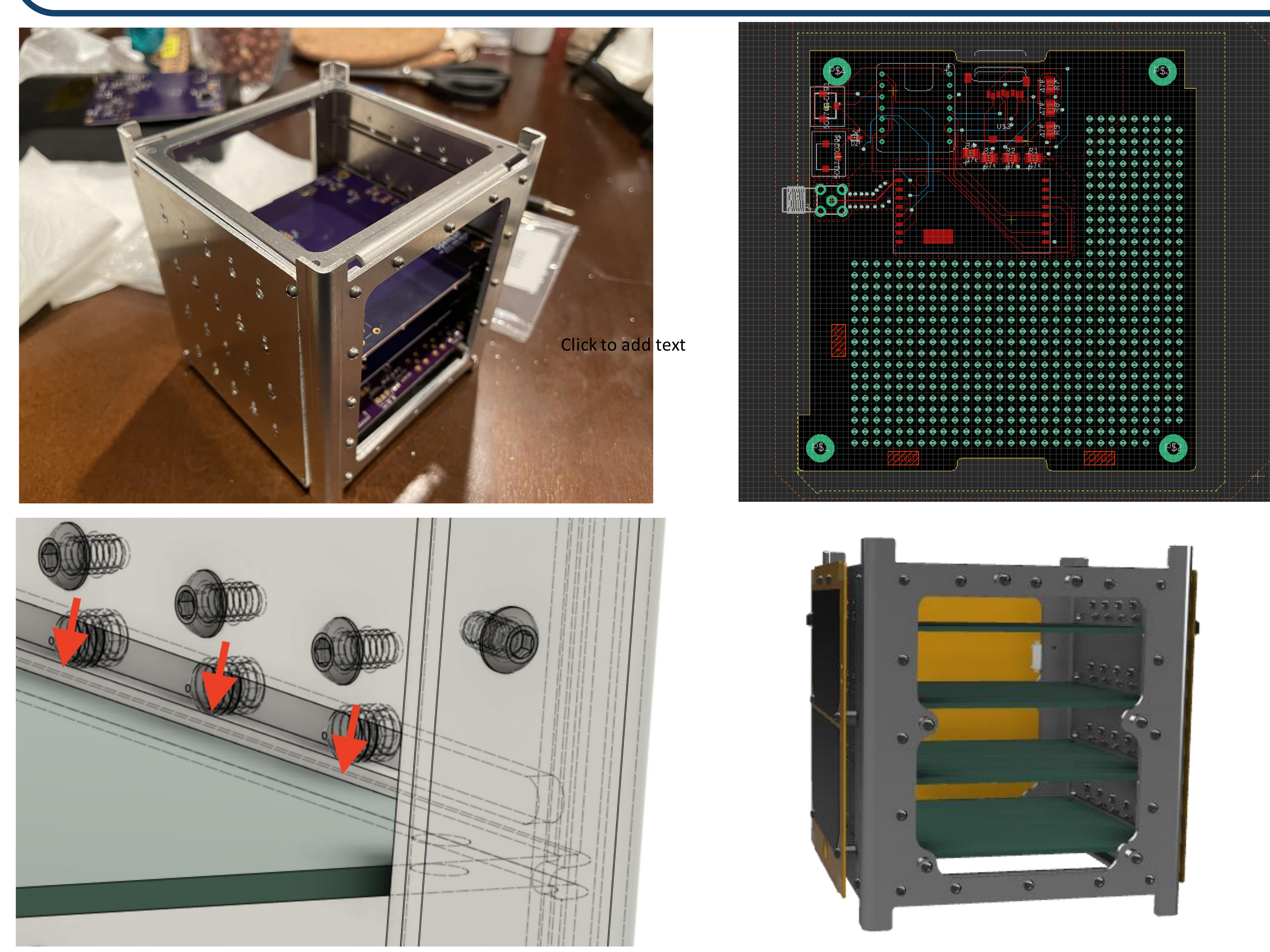


**Figure 2:** Various Pleaides Hardware & Designs
(Clockwise) PROVES Yearling Structure, LoRa Telemetry Board, Yearling Internal, Card Cage System

## IV. Methodology

A philosophical success for the Pleiades CubeSat Cluster would be for each of the three open-source architectures to be developed and documented to a point where new CubeSat mission developers can select an architecture and prepare a flight ready "minimum viable satellite" without any direct consultation with the original developers of the architecture.

To this end, upcoming Pleiades CubeSat Cluster flights will feature pure architecture demonstration mission in space. Where the originating organization for each architecture builds and integrates a flight model in parallel with a build and integration at an independent organization (Cal Poly Pomona). This parallel development will allow for a close feedback loop between integrator and developer. Ideally breaking the institutional knowledge barrier, in which the developing organization will tend to create a retain important information on key procedures or practices without publishing it in formal documentation for future end users.

## V. Current Status

Currently the Pleiades CubeSat Cluster is moving through critical path development on its first round of demonstration CubeSats. Shortly the program will also initiate an open comment phase, where potential investigators and end users of the CubeSat Architectures are invited to test existing hardware and comment on how the architectures should be adjusted to better facilitate their unique mission profiles.

The nominal demonstration calendar is as follows:

- September 2022 – High Altitude Balloon Test Flights
- November 2022 – Flight Demonstration of 1U CubeSats from Bronco Space, Stanford, and HSFL
- Early 2023 – Operation Flight of 1U CubeSats with Science Payloads

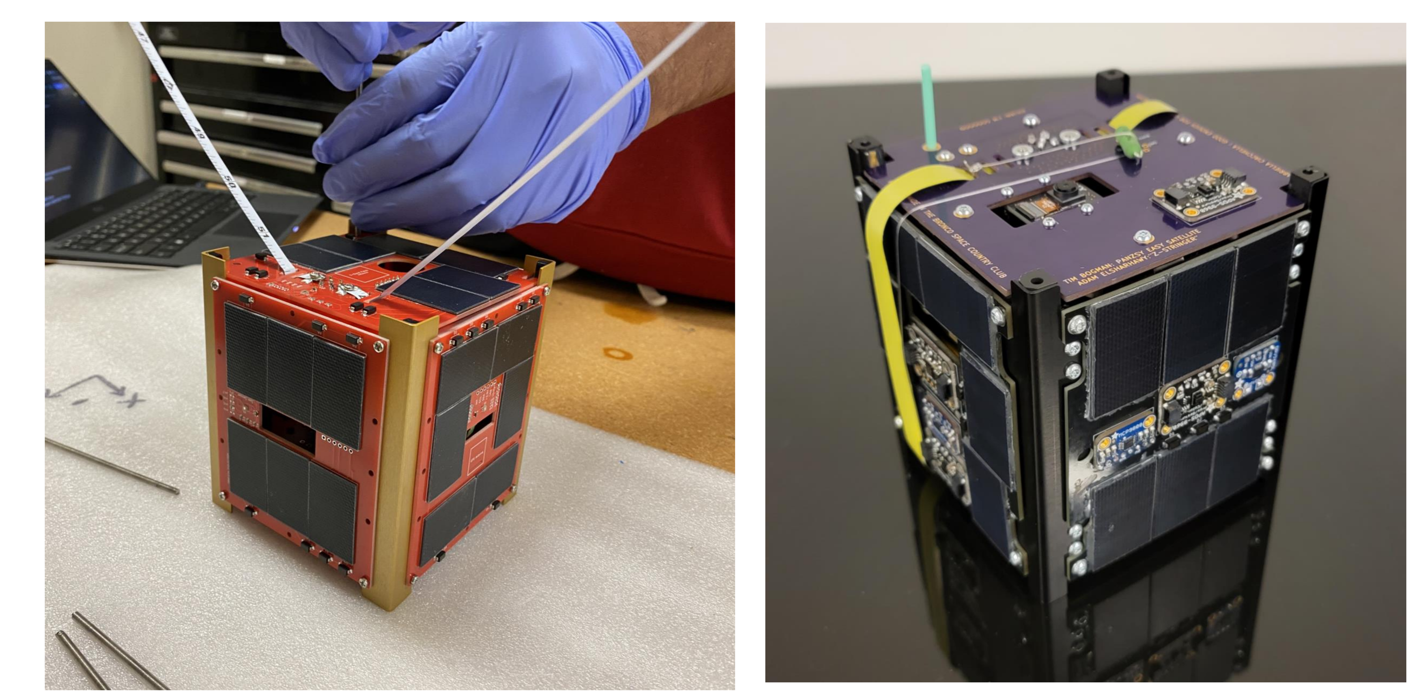

**Figure 3:** Example of Built Pleiades Architecture CubeSats
(Left) Stanford SSI Sapling, (Right) Bronco Space Yearling

## VI. Conclusions & Next Steps

Although access to space is at an all time high, thanks to new low-cost launch opportunities, access to systems that work in space is still severely lacking. Thus, an architecture that enables new investigators and developers interested in conducting free-flying satellite missions quickly, simply, and reliably is will be essential to support the widening industry for in space research, utilization, and commercialization.

On the immediate horizon for the Pleiades CubeSat cluster is successful on-orbit demonstrations of the core technologies within each CubeSat Architecture. Following that though will be an even more important consultation phase, where investigators must be engaged to see how these open architectures can fit their unique mission needs. Ideally, within a few years, a novel or veteran mission developer will have access to readily available and proven open platforms to conduct their CubeSat missions.

## References

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2. Holliday, Max. "PyCubed Project Page" https://pycubed.org/
3. Portland State Aerospace Society. "OreSat Project Page" https://www.oresat.org/
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