

From QUETZAL-1 to QUETZAL-2

How KiboCUBE Ignited Guatemala's National Space Program

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Where did UVG and Guatemala start?

A team with **no space experience or heritage:**

- Guatemala had never built or operated a satellite.
- No prior satellite design experience at UVG.
- Our team: mostly **undergraduate students**.
- **Everything had to be learned and built from zero.**

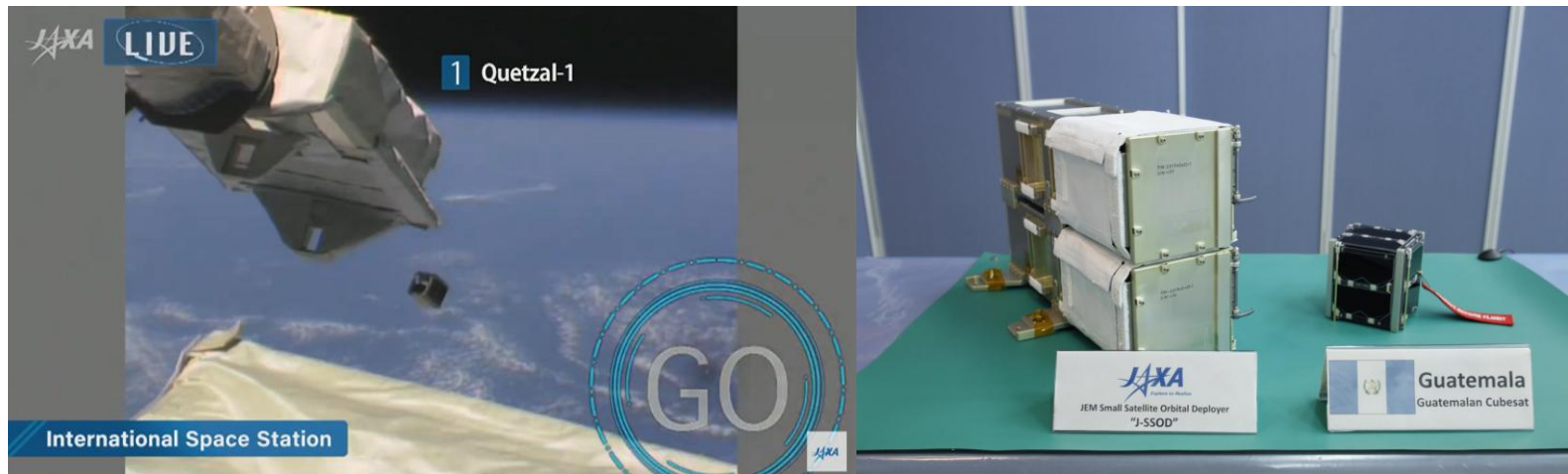


Source: Wikimedia Commons and UVG

Why KiboCUBE mattered for Guatemala

Access to orbit was **the real barrier for us**:

- A university team can design, build, and test a CubeSat.
- What it cannot do on its own is **reach orbit**.
- KiboCUBE removed that barrier.
- Selected in the 2nd round of KiboCUBE in 2017.



Source: JAXA

QUETZAL-1 mission overview

QUETZAL-1: Guatemala's first satellite

- 1U CubeSat, designed, built, and operated at UVG.
- Payload: test a multispectral imaging sensor.
- Launched to the ISS on March 7, 2020.
- Deployed from the ISS Kibo module on April 28, 2020.
- Operated for **211 days**.



Source: UVG Aerospace Laboratory

QUETZAL-1 mission overview (2)

QUETZAL-1: Guatemala's first satellite



Source: UVG Aerospace Laboratory

What we built ourselves

Almost every subsystem of the satellite was developed in-house:

- **EPS:** six body-mounted solar panels, three MPPT chargers, 3.3/5/7.6 VDC rails from a central unregulated line, Li-Po battery with a heater.

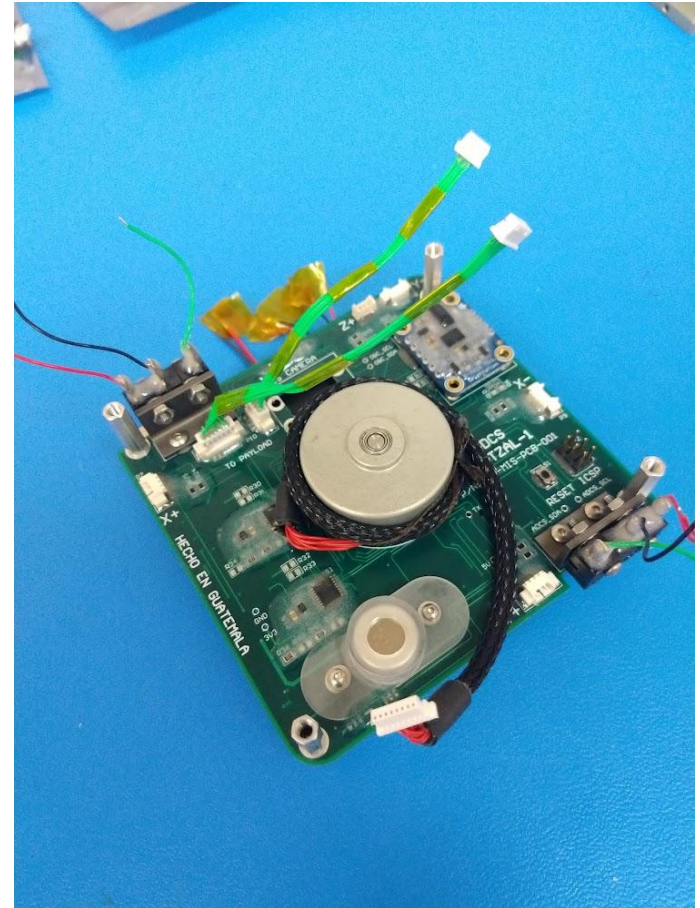


Source: UVG Aerospace Laboratory

What we built ourselves (2)

Almost every subsystem of the satellite was developed in-house:

- **ADCS:** passive, with a permanent magnet plus two hysteresis rods on orthogonal axes plus a three-axis magnetometer and two photodiodes per face (for SVD attitude determination).

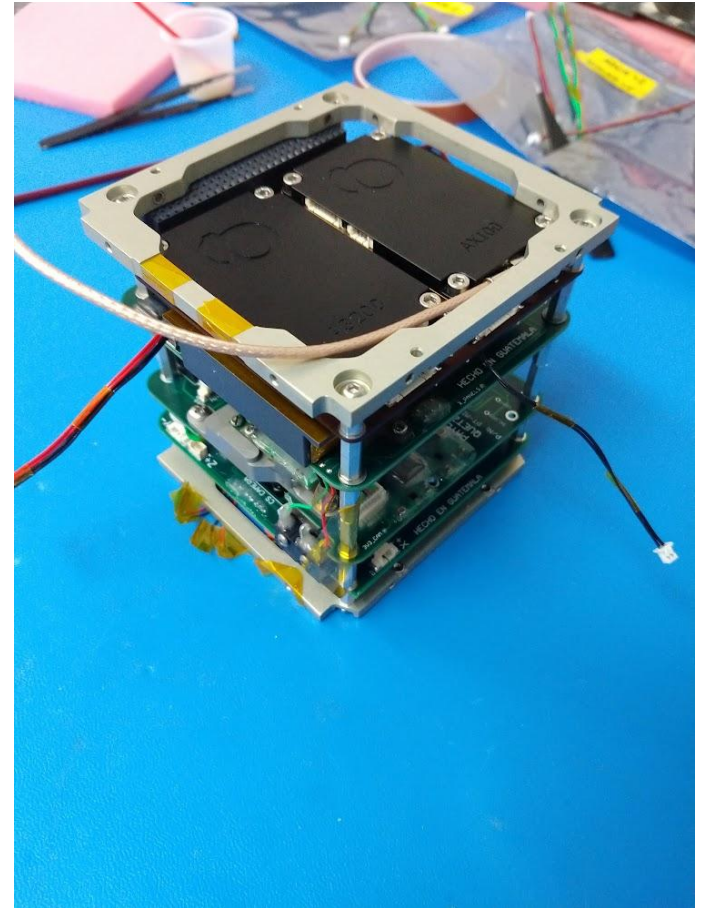


Source: UVG Aerospace Laboratory

What we built ourselves (3)

Almost every subsystem of the satellite was developed in-house:

- **CDHS and flight software:** for the GomSpace Nanomind A3200 OBC. With the satellite's UHF transceiver and antenna, these were the only space-ready components of QUETZAL-1.

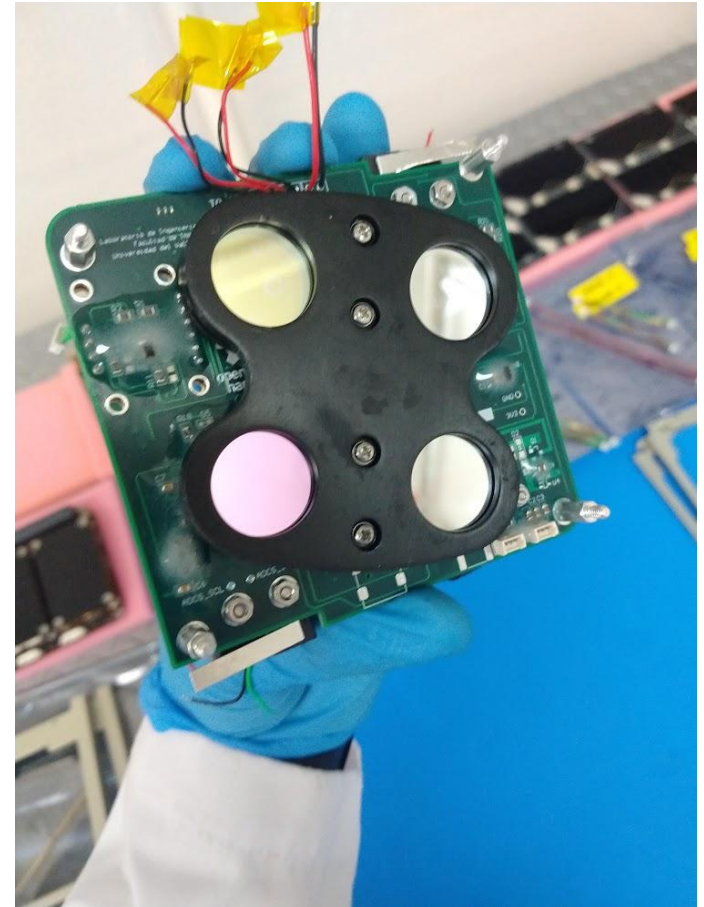


Source: UVG Aerospace Laboratory

What we built ourselves (4)

Almost every subsystem of the satellite was developed in-house:

- **Payload:** an in-house developed multispectral imaging payload that consisted of a piezoelectric motor rotating a carousel with four bandpass filters for water monitoring.



Source: UVG Aerospace Laboratory

What we built ourselves (5)

Almost every subsystem of the satellite was developed in-house:

- **Ground Control Station (GCS):** was built from scratch at UVG (it has been recently improved and updated).
- Built with open-source hardware and software.



Source: UVG Aerospace Laboratory

QUETZAL-1 on-orbit results

The satellite worked! Some important results are the following:

- Rotational rates went from $\pm 25^\circ/\text{s}$ on deployment to $\pm 3.5^\circ/\text{s}$ per axis within one week from deployment.
- The satellite aligned to the magnetic field vector to within 14.28° .
- Positive power budget throughout the mission; the heater prevented the battery from freezing even during maximum eclipse.

QUETZAL-1 on-orbit results (2)

The satellite worked!

- The **first images of Guatemala acquired from space** by a Guatemalan satellite (during Hurricane Iota).



Source: UVG Aerospace Laboratory

Lessons learned from QUETZAL-1

What we would tell a first-time team:

- **Documentation is a system, not a deliverable.** Students graduate; the mission does not. We built a documentation system for QUETZAL-1 specifically to withstand team turnover.



Source: Wikimedia Commons

Lessons learned from QUETZAL-1 (2)

What we would tell a first-time team:

- **If you are using COTS parts or components: assume they will misbehave.** COTS parts can fly, but they fail in ways datasheets do not describe. Fault-protection mitigation techniques are not optional.



Source: Wikimedia Commons

Lessons learned from QUETZAL-1 (3)

What we would tell a first-time team:

- **The satellite is not the product. The people are.** 211 days of telemetry mattered far less than the engineers the project produced.



Source: UVG Aerospace Laboratory

The programme outlived QUETZAL-1

One satellite that created a permanent capability:

- QUETZAL-1 mission ended in November 2020. The Aerospace Laboratory at UVG was created that same year.
- Undergraduate students at UVG can now work **continuously** on CubeSat technology research and development in Guatemala.



Source: UVG Aerospace Laboratory

Paying it forward to the community

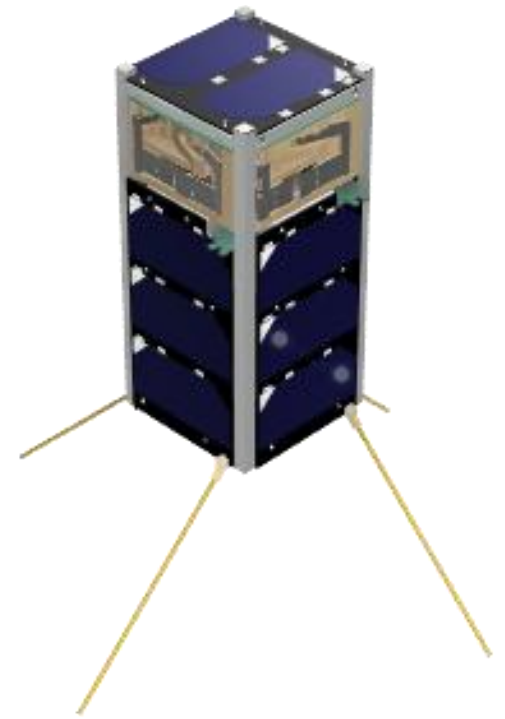
We started from someone else's open-source. So we published ours:

- One case of many: QUETZAL-1's ADCS was based on a previous mission from another team (CSSWE from CU Boulder). **We could start because someone else had published.**
- So, **we published everything**: open-source flight software, open-source satellite circuit schematics, and peer-reviewed papers documenting design and on-orbit performance.

QUETZAL-2 mission overview

From technology demonstration to a mission with real users:

- **2U CubeSat** built at UVG with a new generation of undergraduate students.
- Target orbit: **sun-synchronous, ~500 km.**
- Selected as one of the four global winners of UNOOSA's *"Access to Space for All"* EXOpod initiative, with Exolaunch.



Source: UVG Aerospace Laboratory

QUETZAL-2 mission overview (2)

From technology demonstration to a mission with real users:

- Satellite delivery: **December 2027** (currently in design and development).
- Building directly on QUETZAL-1 flight heritage and learned lessons.



Source: UVG Aerospace Laboratory

What QUETZAL-2 will fly to space

Three payloads, one mission:

- **MILO** (*Machine Intelligence for Layer Observation*): onboard edge AI for automatic cloud detection in images, so that only useful data is transmitted. Runs on commercial, accessible hardware with an in-house developed onboard computer.



Source: UVG Aerospace Laboratory

What QUETZAL-2 will fly to space (2)

Three payloads, one mission:

- **LoRa educational payload:** onboard low-power transmitter for a distributed ground segment. Students at secondary schools across Guatemala build their own antennas and receive the satellite's data directly.



Source: Semtech

What QUETZAL-2 will fly (3)

Three payloads, one mission:

- **Passive deorbiting system:** an in-house developed drag sail for end-of-life disposal.



Source: UVG Aerospace Laboratory

Who is building QUETZAL-2

The team behind the satellite and its mission:

- Predominantly **undergraduate students**.
- ~64% of the team are **women**.



Source: UVG Aerospace Laboratory

Closing remarks

KiboCUBE did not launch only one satellite. **It launched a national space program and changed a country forever.**

- **2017:** a team and a country with no way to reach orbit.
- **2020:** 211 days in orbit, and an aerospace laboratory.
- **2026:** a second satellite and a new generation of young students and researchers.

- **Do not forget:** the satellite is not the outcome. The created capabilities and the humans are.

Thank you for your attention!

Let's keep in touch:

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