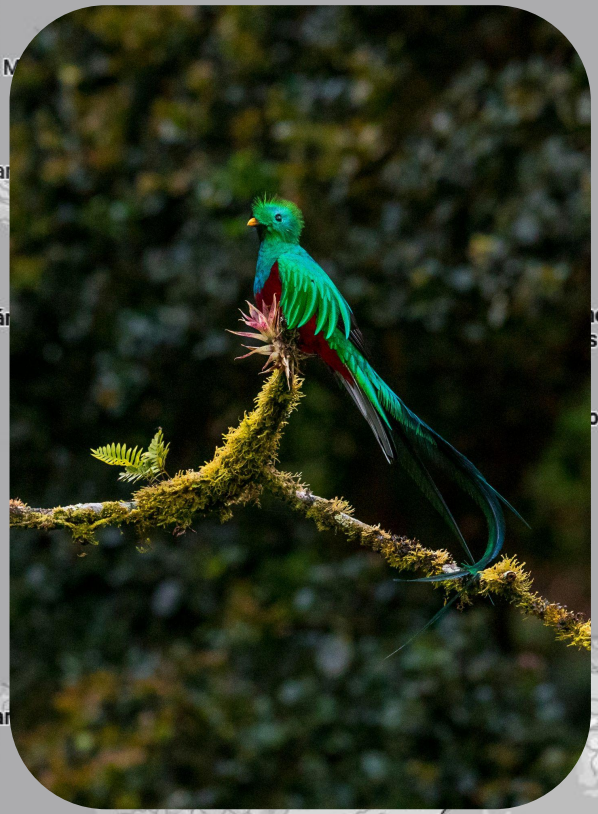
The Quetzal-1 CubeSat:

Open Sourcing the Design for Guatemala's First Satellite

UVG | UNIVERSIDAD DEL VALLE DE GUATEMALA

May 30th, 2025

So what is a “Quetzal”?

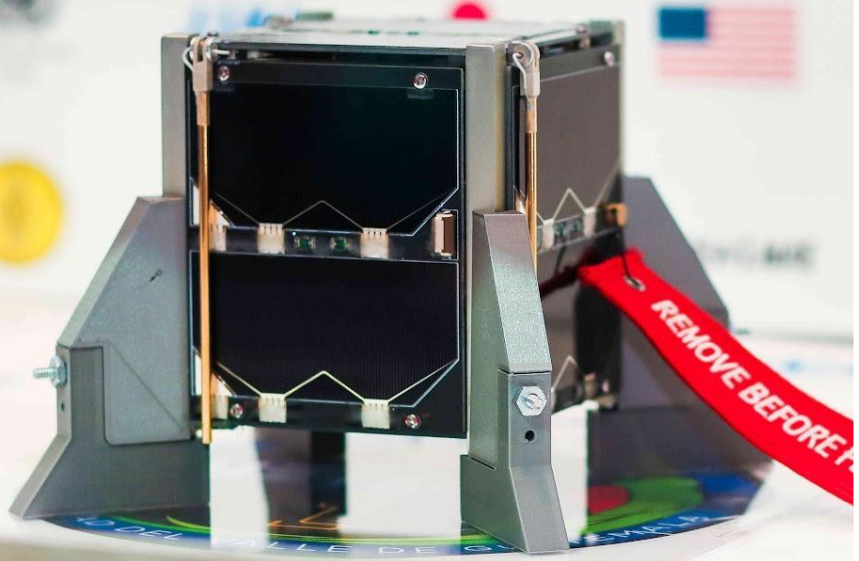


Guatemala’s National Bird

Sometimes also called:

La serpiente emplumada

What about a “Quetzal-1”?



Quetzal-1 was Guatemala’s first satellite and Central America’s second.

A 10x10x10cm CubeSat, construction began in 2014 and it was successfully **deployed from the International Space Station in 2020**.

It **operated 211 days in orbit**, from April to November of 2020.

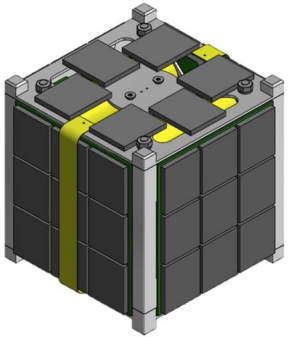
How did we get to Quetzal-1?

01

Quetzal as a CanSat (2012)

Back then, Quetzal-1 wasn't even in our minds. ***But space was.***

Two teams from UVG participated in the annual CanSat competition.



02

Quetzal as an idea (2014)

One of our first renders of what the satellite could be.

We would end up making dozens of iterations on this.

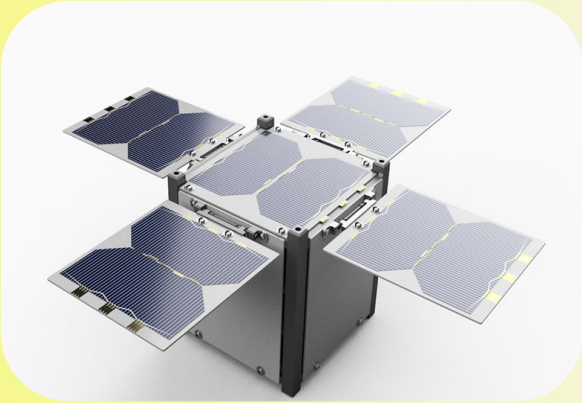
03

Quetzal as a prototype (2015)

First time we held it in our hands.

Also the first time we found out we needed to **improve our machining capabilities**. 🤭

How did we get to Quetzal-1?

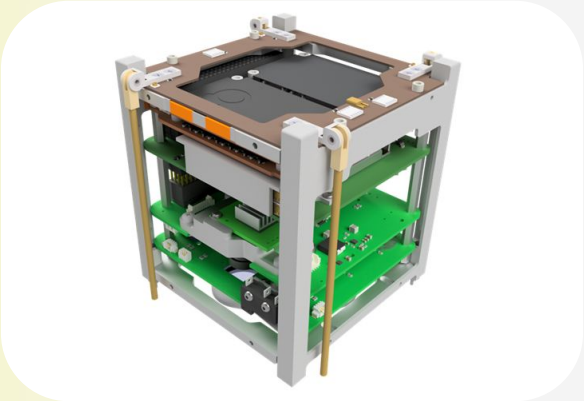


04

Quetzal as a Transformer (2015)

More solar panels, more better (?)

We had some crazy ideas for a first satellite, definitely.



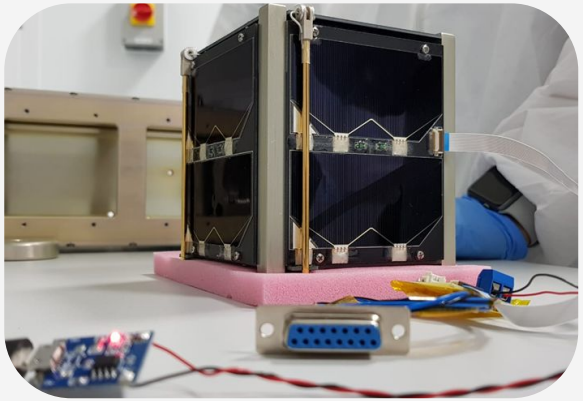
05

Quetzal as render (2018)

Many things happened in 2017.

KiboCUBE being one of them and **our launch being secured**.

Now we had to hurry up and build it!



06

Quetzal as a satellite (2019)

A fully-built, fully-tested CubeSat.

Ready to fly.

Quetzal as a flying machine

Among a worldwide pandemic shut-down, Quetzal-1 was deployed from the International Space Station on April 28th, 2020.

JAXA LIVE

SUCCESS!!

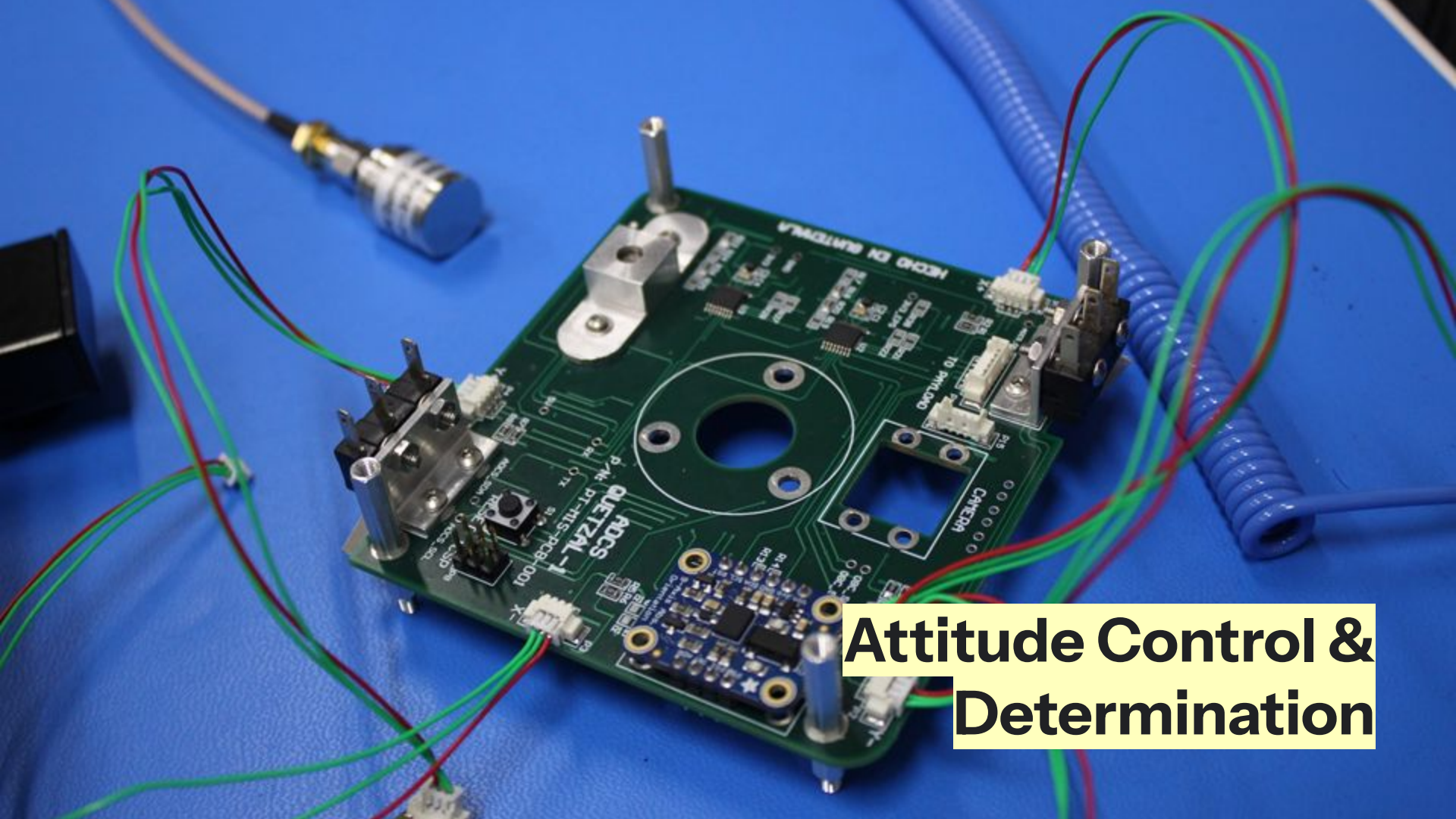
1 Quetzal-1

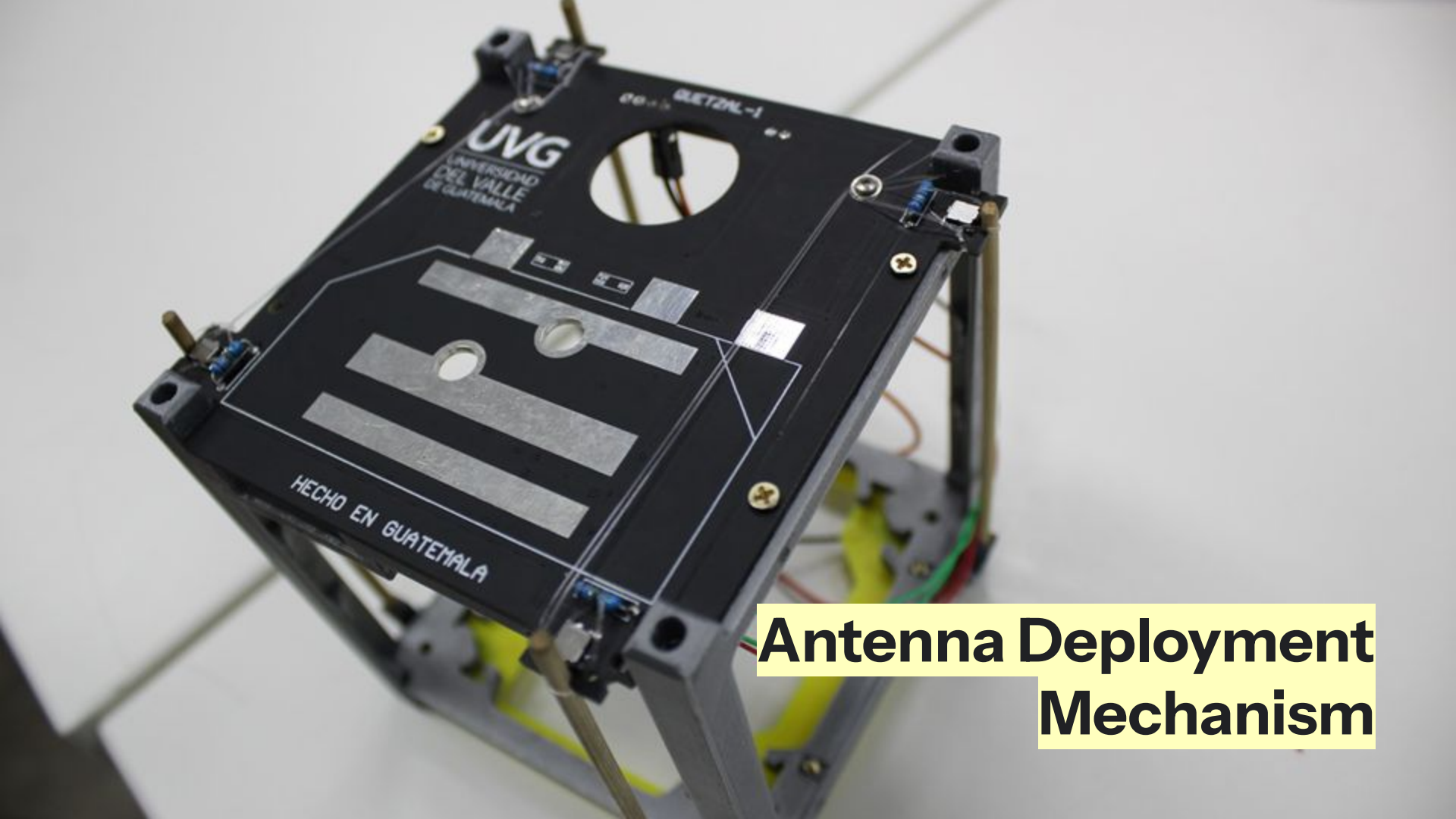
Voice NASA Astronaut
Christopher J. Cassidy

International Space Station

What about the hardware?

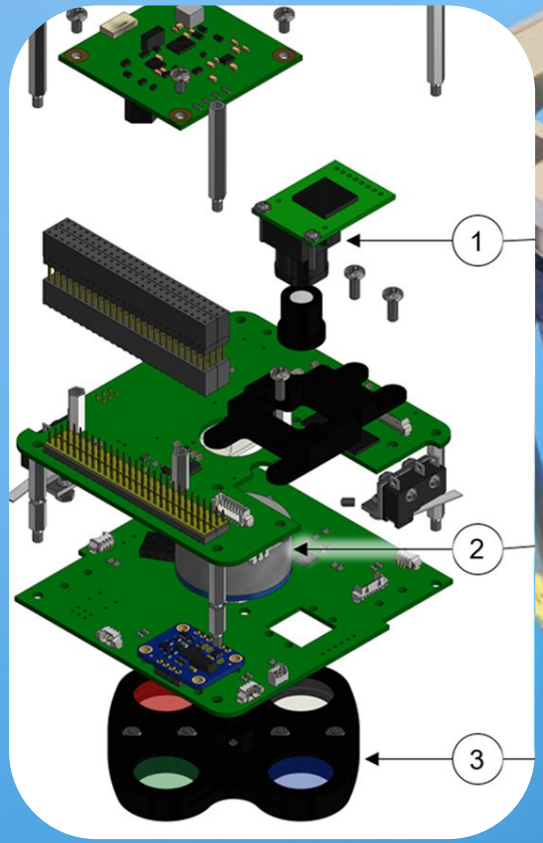
70% of the hardware was developed at UVG


Attitude Control &
Determination



Antenna Deployment Mechanism

Electrical Power System



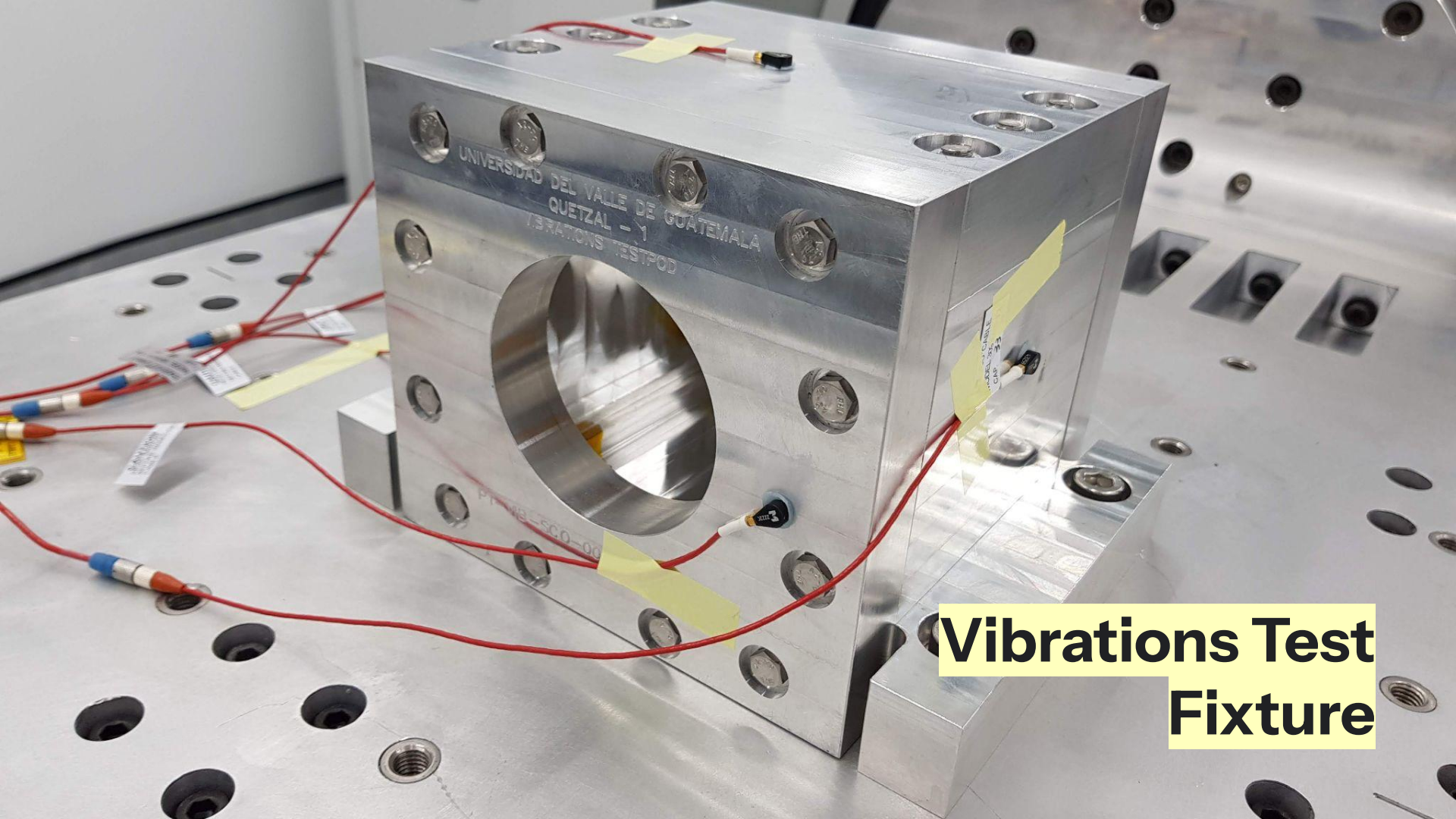
Camera

Motor

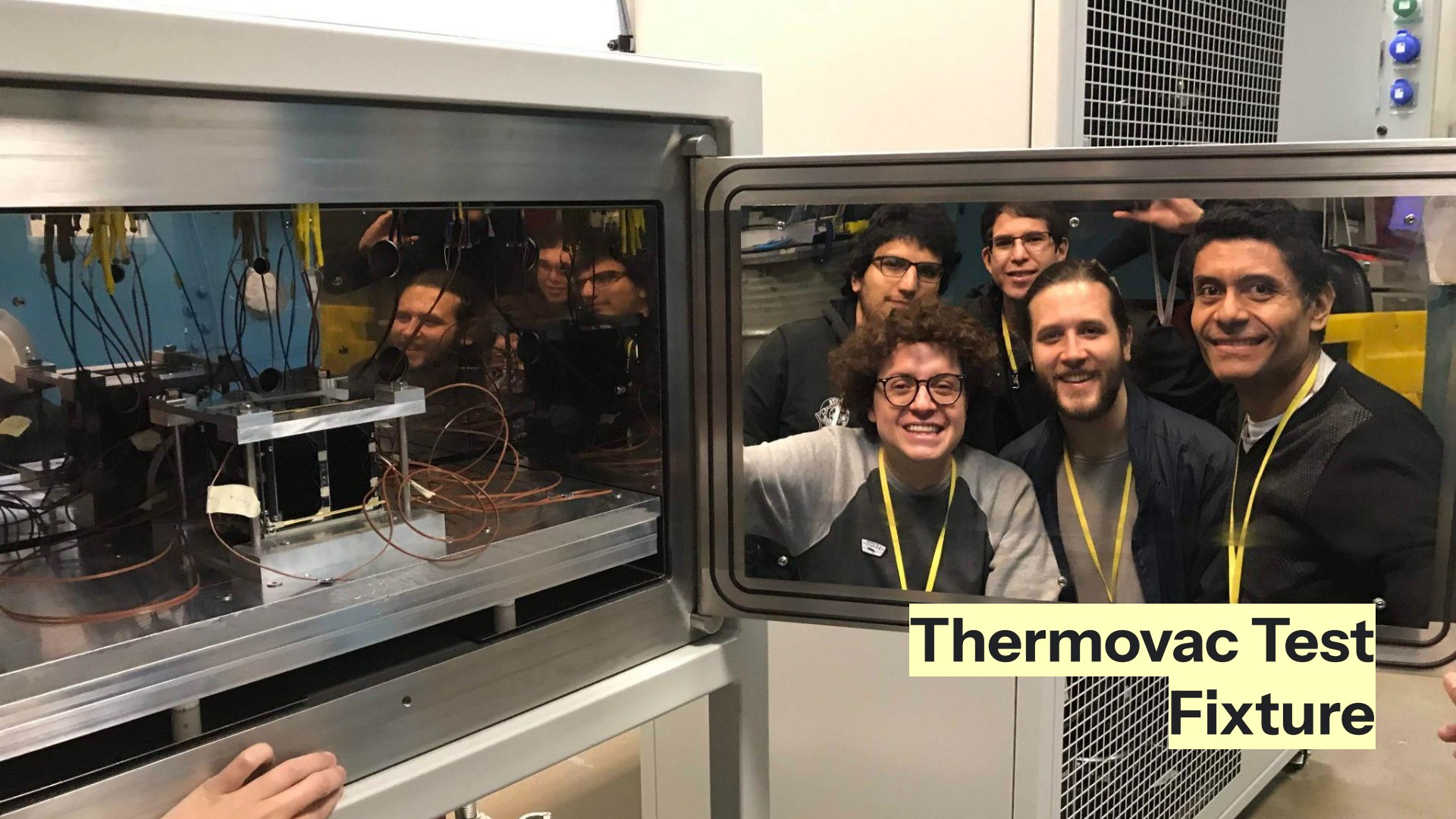
Filter carrousel

Payload

Ground Control Station



Vibrations Test Fixture


Thermovac Test
Fixture

Software

Software written by all undergraduate students!

On-Board Computer

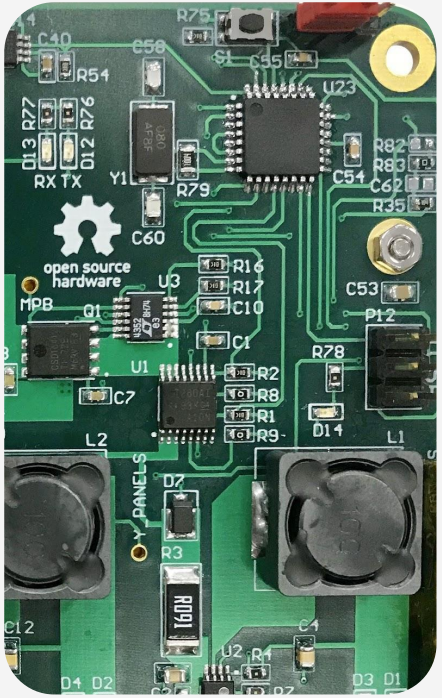
GomSpace Nanomind A3200 based on AVR32 MCU with RTOS

- ❏ Data collection
- ❏ Telemetry transmission
- ❏ System-level monitoring & control

Subsystem Microcontrollers

ATMEGA328P embedded within each subsystem

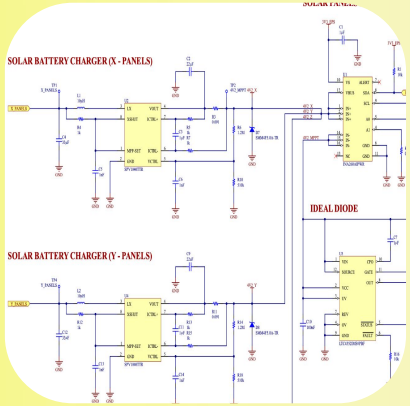
- ❏ Subsystem monitoring & control
- ❏ Interface with OBC via I2C
- ❏ Arduino

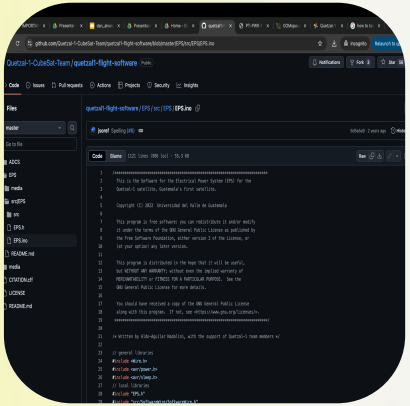


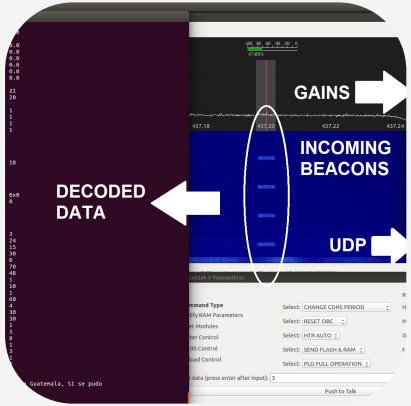
The Open Source Software & Hardware Community Was Invaluable

- Hardware development based on openly-available designs, manufacturer recommendations & app notes
- Arduino-based software and open source libraries for subsystem microcontrollers
- Ground Control Station running GNURadio-based software

How are we giving back to the community?







	x_eci	y_eci	z_eci	
	5142354.749	4322.049862	-1035.749052	5133.984774	-12.
	5109981.091	4389.991965	-902.3059112	5101.48028	-119.
4	5056546.349	4487.714533	-701.302996	5047.857388	-116.9
7	4216772.393	5167.413404	1314.65602	4206.777899	-94.99
7	4142363.442	5192.403812	1446.244742	4132.321228	-93.79
3	4065842.91	5214.755193	1577.098561	4055.758085	-92.61
9	3987249.836	5234.455941	1707.150795	3977.127523	-91.4
2	3947188.62	5243.309102	1771.855573	3937.049494	-90.89
1	3865561.97	5259.015317	1900.581453	3855.393099	-89.77
1	3824007.076	5265.866323	1964.586074	3813.825259	-89.22
3	3781964.603	5272.04808	2028.34118	3771.771148	-88.68
4	3474477.391	5296.523766	2466.957654	3464.238759	-85.04
9	4681702.844	4916.973197	336.6076156	4672.185544	-128.0
5	4623326.957	4961.027152	471.2318258	4613.725118	-126.6
4	4499538.699	5041.552487	739.6941783	4489.782451	-123.8
7	4467148.616	5060.088896	806.5959676	4457.356853	-123.1
	4434189.414	5077.982426	873.3953803	4424.363385	-122.
	4366580.325	5111.832089	1006.653081	4356.689502	-12
	4939.159	5127.783779	1073.094157	4322.017821	

01

Hardware

Hardware design for **3 subsystems**:

- ❏ EPS
- ❏ ADCS
- ❏ ADM

02

Flight Software

Flight software for **2 subsystems**:

- ❏ EPS
- ❏ ADCS

03

GCS Software

Was very useful for **ham radio operators tracking the satellite!**

04

Telemetry

All telemetry (**and photos!**) taken by the satellite while in orbit.

3 peer-reviewed papers on subsystem design

Alvarez et al. (2023): JoSS, Vol. 12, No. 2, pp. 1231–124
(Peer-reviewed article available at www.jossonline.com)
www.adeepakpublishing.com

Design and On-Orbit Perfor
Attitude Determination and Pa
System for the Quetzal-1

Dan Alvarez, Aldo Aguilar-Nadalini, .
Víctor Ayerdi, and Luis Zea
Universidad del Valle de Guatemala
Guatemala City, Guatemala

Abstract

Quetzal-1, a 1U CubeSa
November of 2020. It includ
based on a previous mission
Quetzal-1's ADCS used a 0
constraints, Quetzal-1 only i
of them. The rods were loca
nation over Guatemala, the
nents and the camera with r
tion. A Singular Value Decomposition
a three-axis magnetometer and two pho
from the International Space Station (I
±25 °/s to ±3.5 °/s per axis. Additional
14.28°. The ADCS' gyroscope operate
data at temperatures below 10°C. Most i
and performance of Quetzal-1's ADC
manuscript, including the impact of flig
oscillation amplitudes. Detailed description of the design approach, comp
recommendations based on lessons learned may be valuable to other teams de
ADCS.

1. Introduction

Quetzal-1 (ket-sahl-oo-noh) was a 1U CubeSat de-
veloped by Universidad del Valle de Guatemala
(UVG) and suppo
ployment from th
by the United Nat
(UNOOSA) and

Corresponding Author: Luis Zea – lpzea@uvg.edu.gt / Víctor Ayerdi – vhayerdi@uvg.edu.
Publication History: Submitted – 10/30/21; Revision Accepted – 12/0/22; Published – 05/3

JARS Journal of Applied Remote Sensing

Academic development and spa
of a multispectral imaging pa
1U CubeSats

Luis Zea,* Aldo Aguilar-Nadalini, Marvin Martín
Emilio Miranda, Fredy España, Kuk Chung,
José Antonio Bagur, Carlo Estrada, Rony Herrarte
Universidad del Valle de Guatemala, Guatemala City

ABSTRACT. Multispectral remote sensing can enable myriad app
change mapping and monitoring of vegetation activi
few. Although the acquisition of multispectral remote
developing countries toward better management of t
ing this type of data is not trivial. To assess a potential
to entry for these types of missions, Quetzal-1, a 1U

Keywords: remote sensing; nanosatellite; developi
Paper 230173G received Apr. 20, 2023; revised Oct. 20, 2023; ac
6, 2023.

1 Introduction

Universidad del Valle de Guatemala's (UVG) developed Guatema
1U CubeSat, as an academic project for undergraduate students. Its
titatively compared via a methodology that considered their feasibil
CubeSat platform, relevance to institutional and national priorities
nical output, required resources, and programmatic risks.[1] From t

*Address all correspondence to Luis Zea, lpzea@uvg.edu.gt; Víctor Ayerdi, vha

Aguilar-Nadalini et al. (2023): JoSS, Vol. 12, No. 02, pp. 1201–1229
(Peer-reviewed article available at www.jossonline.com)
www.adeepakpublishing.com
JOSS JOURNAL OF SMALL SATELLITES
www. JoSSonline.com

Design and On-Orbit Performance of the Electrical Power System for the Quetzal-1 CubeSat

Aldo Aguilar-Nadalini, Kuk H. Chung, Cecilia Marsicovetere, José A. Bagur, Juan F. Medrano, Emilio Miranda, Víctor Ayerdi, Luis Zea
Universidad del Valle de Guatemala
Guatemala City, Guatemala

Abstract

atemala (UVG), operated on orbit
Power System (EPS) that supplied
yable solar panels coupled to three
PS architecture was implemented
ributed from a central, unregulated
incorporated protection circuitry
he satellite after deployment from
design specifications of the EPS, as well as
EPS ensured a positive power budget through-
atellite's demand and keeping the battery re-
to remain power positive even at times when
their superficial temperature during high beta
vented battery freezing even during maximum
ns, as well as open-source circuit schematics
CubeSat missions.

1. Introduction

Quetzal-1 (ket-sahl-oo-noh) was a 1U CubeSat de-
veloped by Universidad del Valle de Guatemala
(UVG) and supported, in terms of its launch to and de-
ployment from the International Space Station (ISS),
by the United Nations Office for Outer Space Affairs
(UNOOSA) and the Japan Aerospace Exploration
Agency (JAXA) under their joint KiboCUBE Pro-
gramme (Taniguchi et al., 2020). Quetzal-1's mission
was selected via a methodology based on maximizing
benefits while considering programmatic risk and
technical feasibility (Zea et al., 2016). The satellite's

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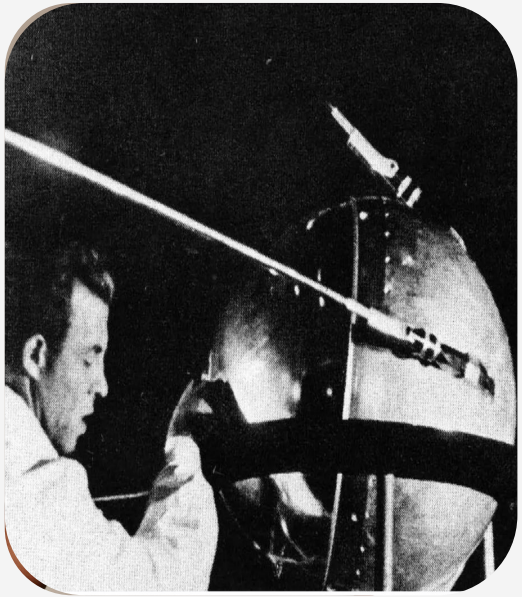
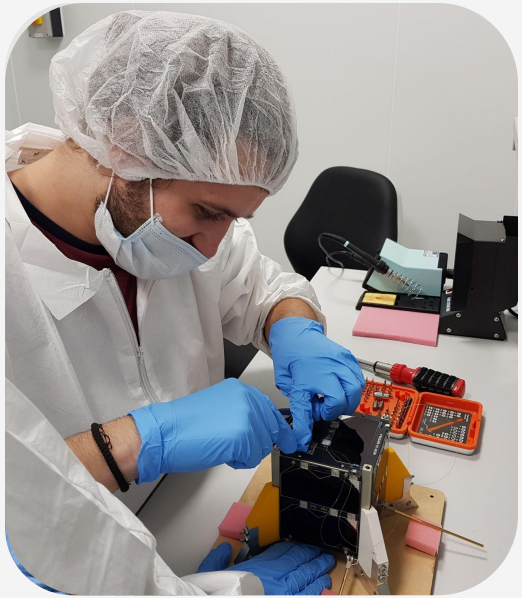
Why build a satellite **in Guatemala?**



↖

Sputnik 1

USSR
1957



↖

Quetzal 1

Guatemala
2019


To teach children


It can be done


The first aerospace lab in Guatemala

Thank you!

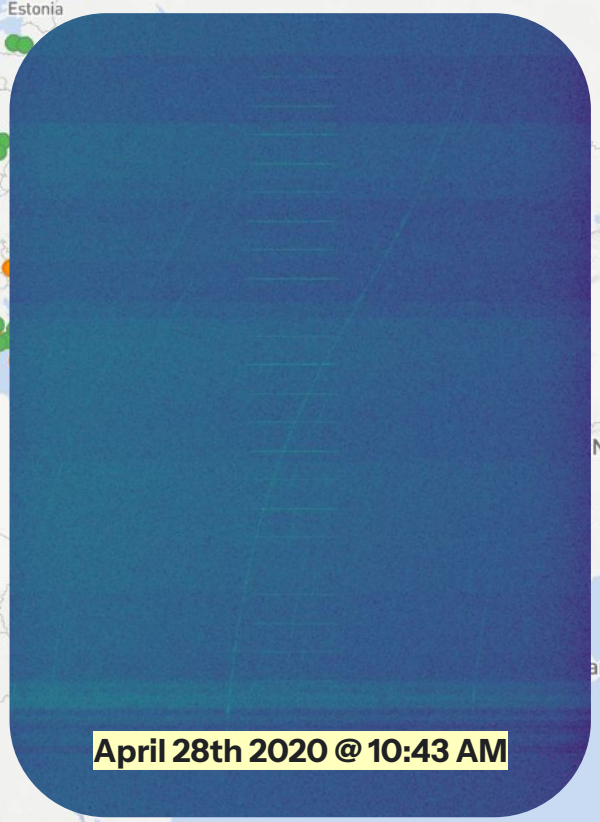
Check out our GitHub profile to access all of the hardware we released!

Or contact us at satelite@uvg.edu.gt

Annex

Quetzal-1's data collection was crowd sourced!

Thanks to the amateur radio community and SatNOGS!



Some quick examples!

We published bi-monthly articles in the most popular newspaper in Guatemala!

UVG UNIVERSIDAD DEL VALLE DE GUATEMALA

GUATE CUBE SAT VA AL ESPACIO

CON EL APOYO DE PRENSA LIBRE

Comienza la cuenta regresiva

Por Víctor Ayerdi*
satelite@uvg.edu.gt

El primer satélite guatemalteco se lanzará en 2019. *Prensa Libre* publicará reportajes quincenales relacionados con este.

Con mucha alegría, hoy