Undergraduate Design of a Proprietary, Low-Cost "QUbeSat"

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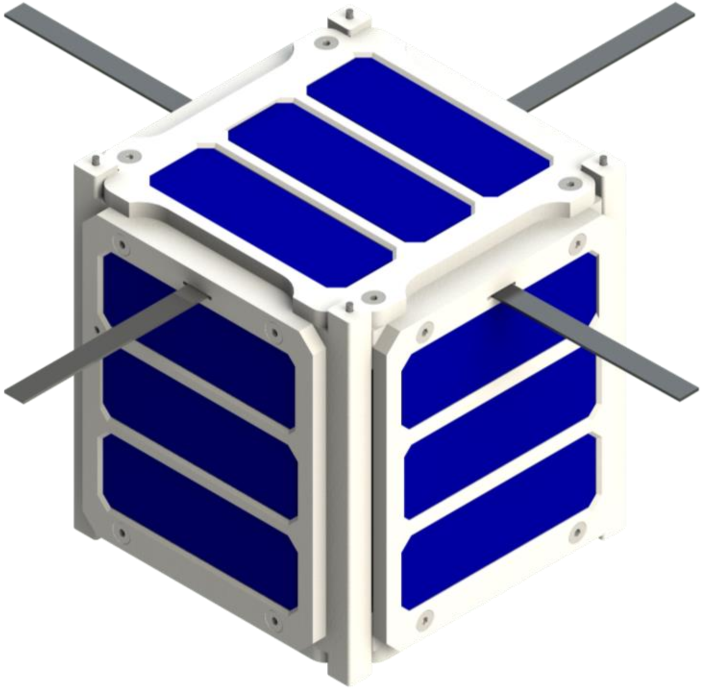
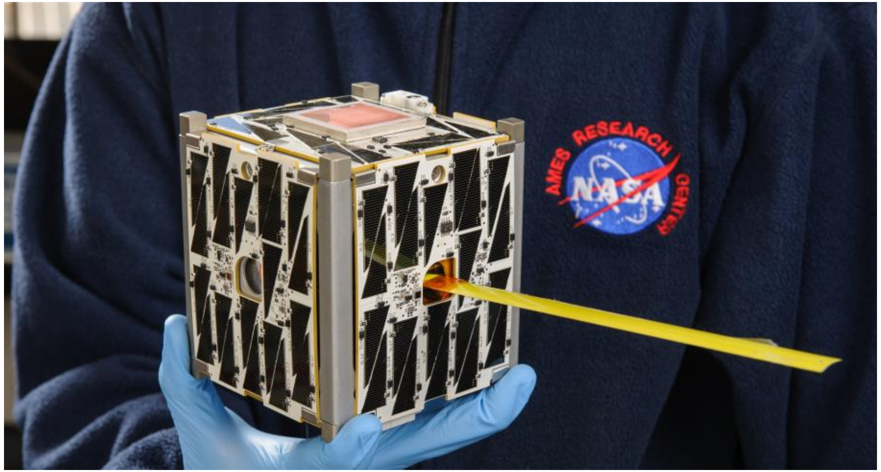
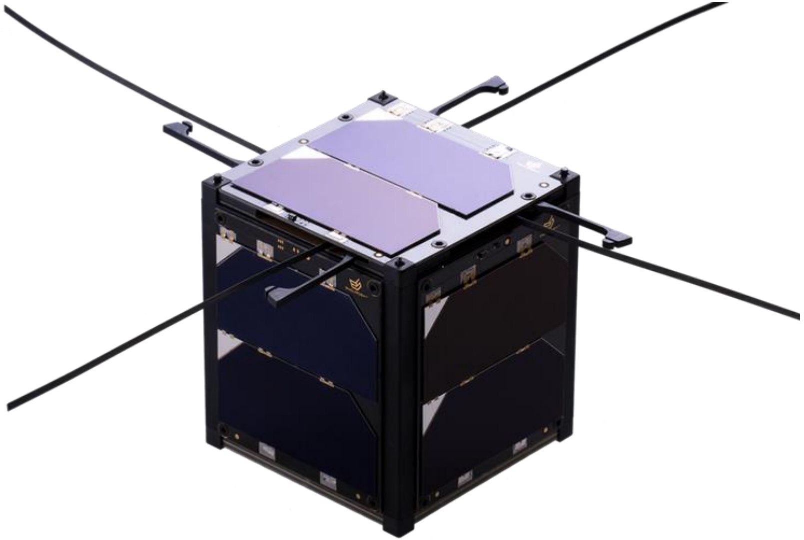


What is a CubeSat?

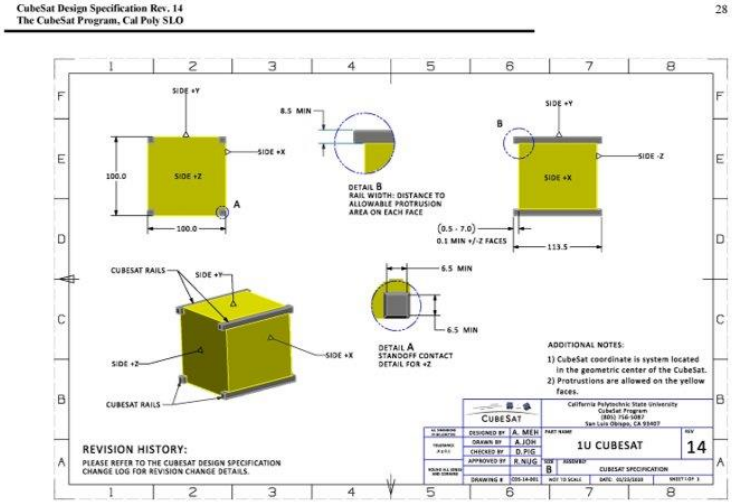
- Class: nanosatellites
- Standardized form factor
- Ideal academic projects
- Application of many engineering disciplines





Problem Statement

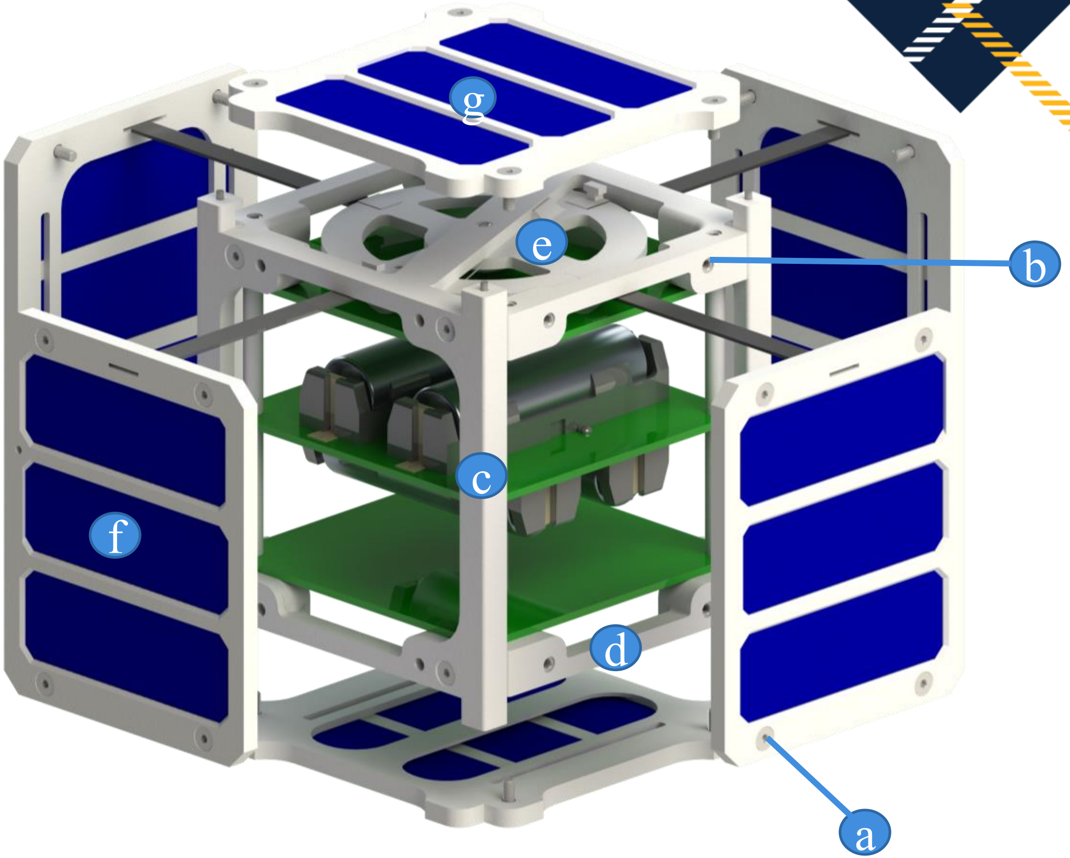
- Test an additively manufactured frame material
- Collect on-orbit temperature data to transmit to ground station
- Meet launch requirements by NASA and Cal Poly
- No more than $2000 and complete by May 2023



Frame Design

- ULTEM 9085 thermoplastic resin
- Houses the main systems on PCBs
- Proprietary frame, solar panels, and antenna deployment

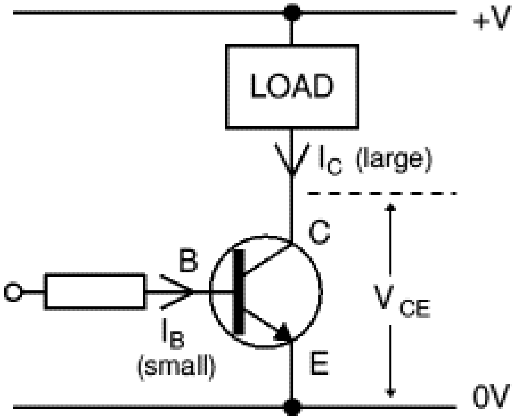
a M3x0.5 Heat Set Insert
b M3x0.5 Steel Screw
c Pillar Wall
d Bottom Support
e Antenna System
f XY Solar Panel
g Z Solar Panel

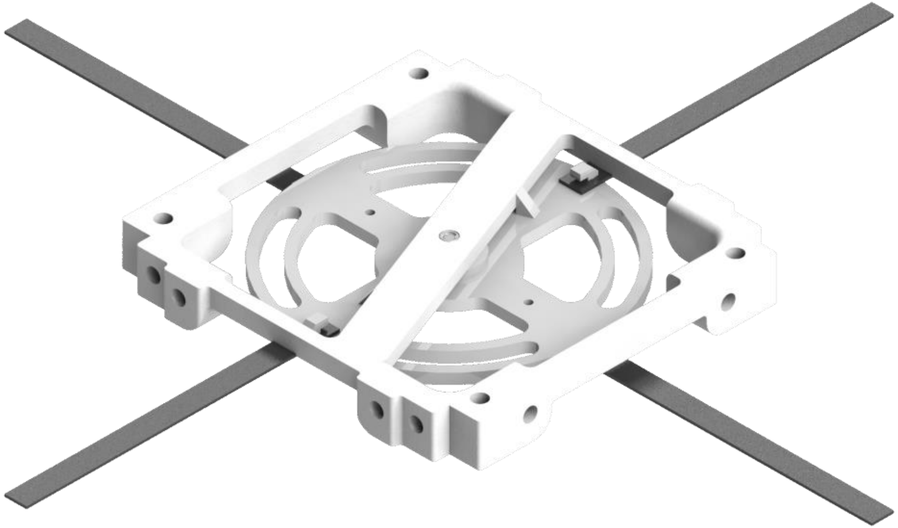


QUbeSat exploded view

Antenna Deployment System

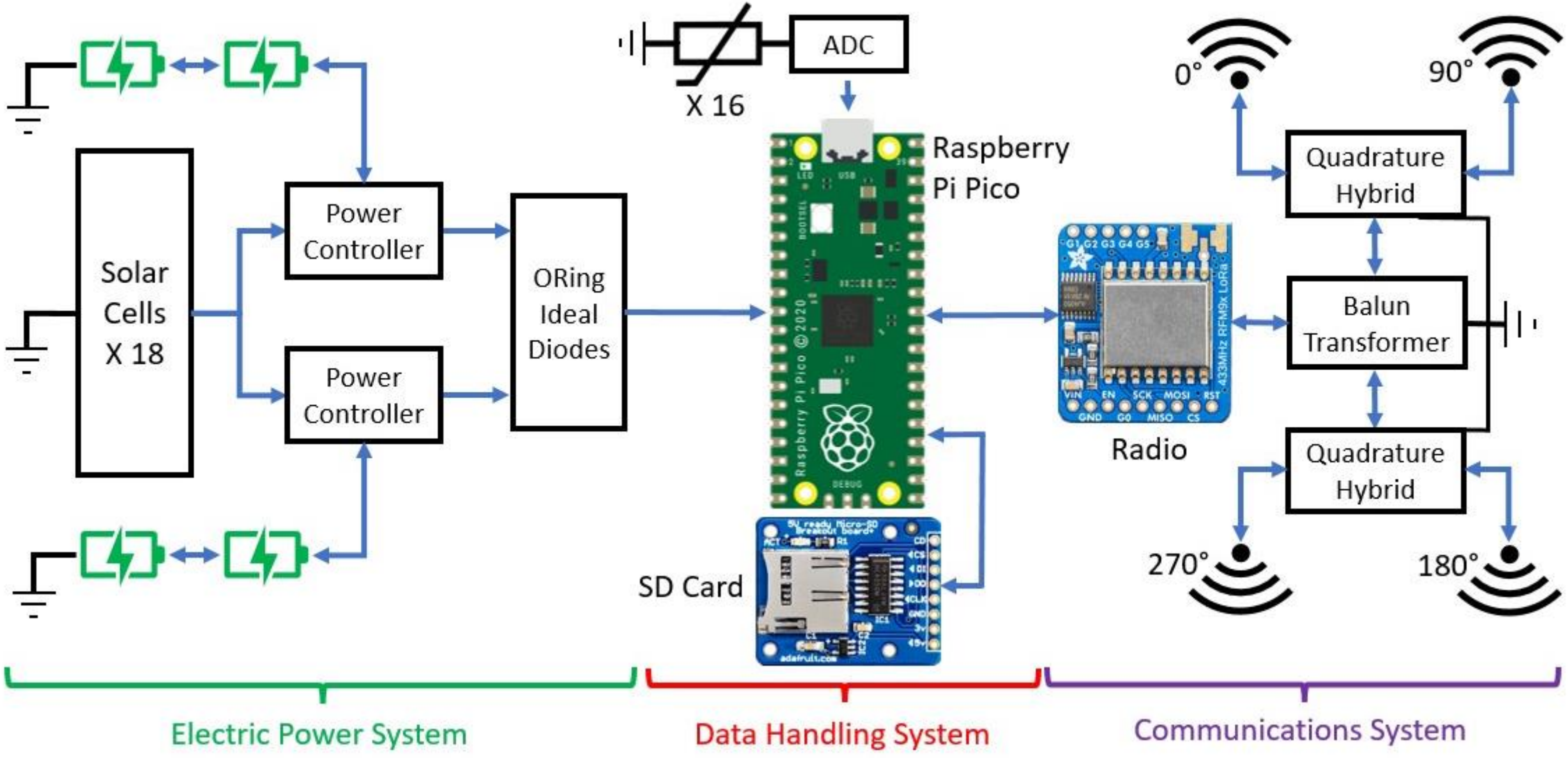
- Antennas are hidden until deployment
- Transistor receives signal to send current for deployment
- Spring mechanism releases antennas





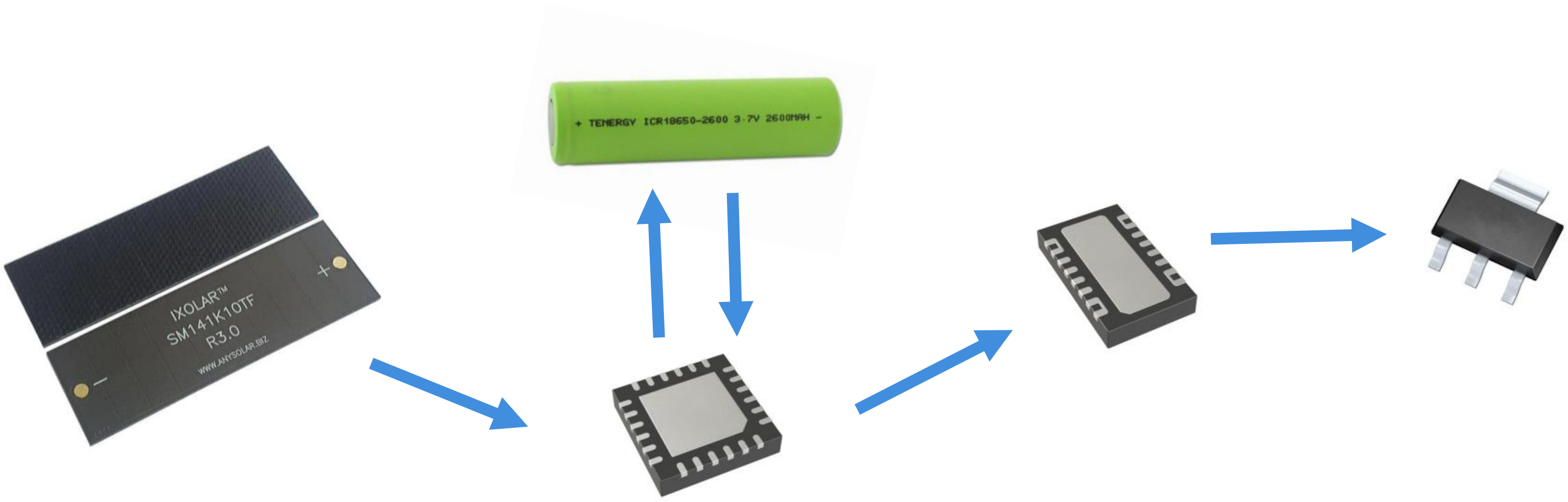
FINAL DESIGN & SYSTEMS

System Workflow



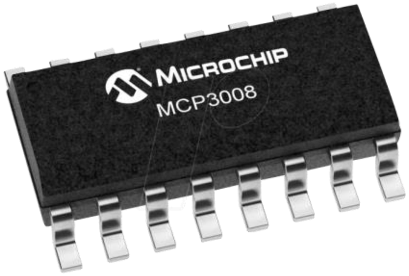
Electrical Power System

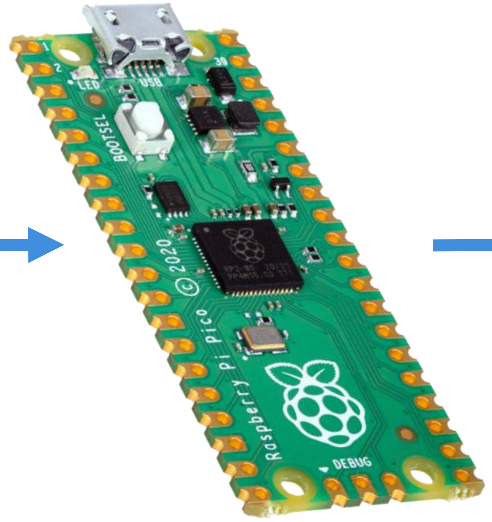
- 6 Solar Panel Assemblies
- Charge batteries and power data handling system
- Redundancy and voltage regulation



Data Handling System

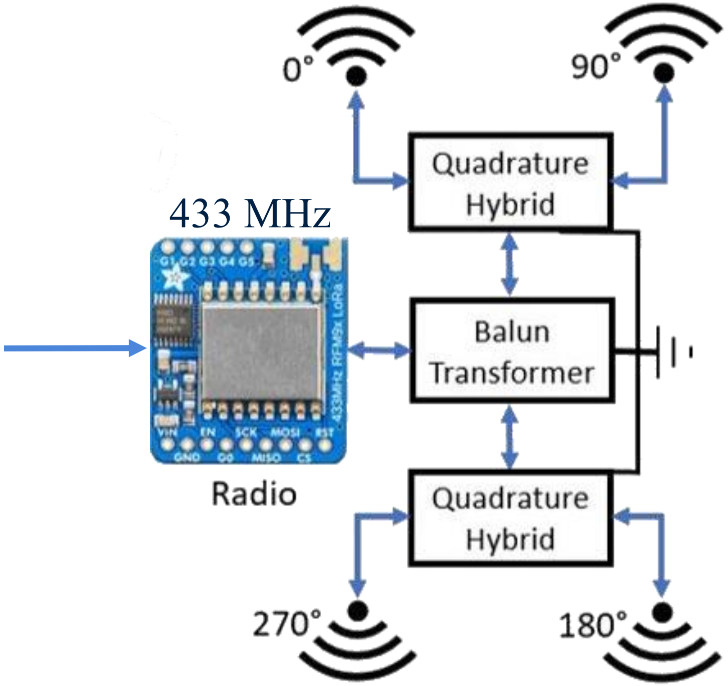
- Raspberry Pi Pico
- Thermistors to analog-to-digital converters to an SD card
- Prepare the data to transmit





Communications System

- Operates in the UHF US Amateur Radio Band at 433MHz
- Uses an Adafruit RFM96W LoRa Radio Transceiver Breakout Board
- Radio obtains a digital signal from the Raspberry Pi and converts it into an analog signal
- Future designs will use a crossed-dipole antenna to increase gain and range



Engineering Characteristics & Target Values

Many of the engineering characteristics chosen for this project were selected based on standards outlined by the California Polytechnic Institute, testing requirements established by The Aerospace Cooperation and NASA, and specifications needed to carry out this CubeSat's mission.

Engineering Characteristic	Priority	Target	Units
High Temperature Requirement	1	> 100	°C
Low Temperature Requirement	1	< -54	°C
Vibration Resistance	2	> 2000	Hz
Mass	2	< 1.33	kg
Cost	3	< 2000	$
Rail Surface Roughness	4	< 1.6	µm
Volume	5	== 1000	cc
Frame Material Density	6	< 3	g/cc
Axial Distance of Center of Mass to Geometric Center	7	< 2	cm

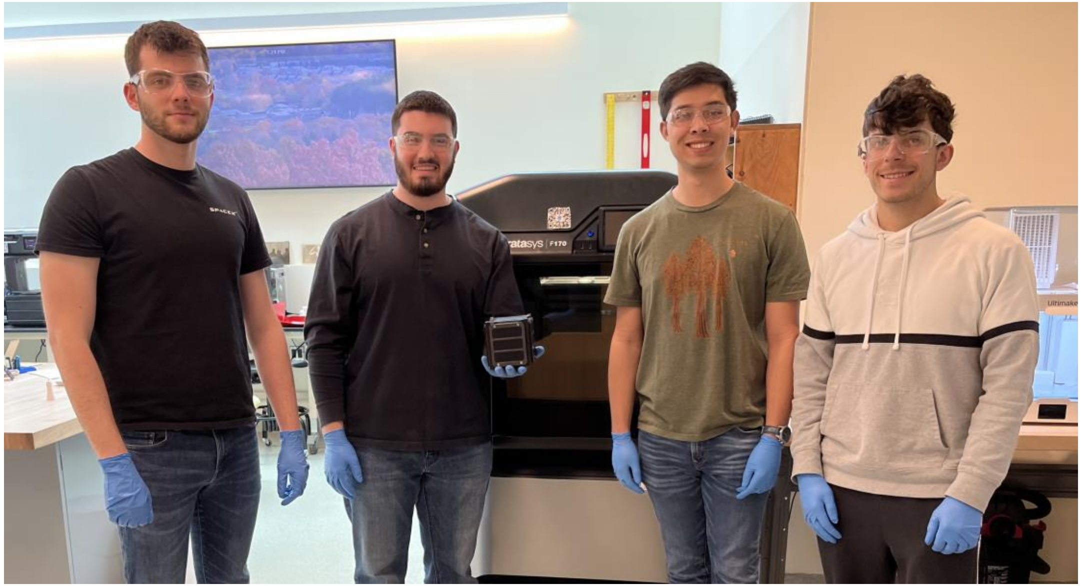
Full Vibration Resistance Table

20 Hz	@	0.01 g^2/Hz
20 to 80 Hz	@	+3 dB/oct
80 to 500 Hz	@	0.04 g^2/Hz
500 to 2000 Hz	@	-3 dB/oct
2000 Hz	@	0.01 g^2/Hz
Overall Level	=	6.8 grms

CONCLUSION

Conclusions

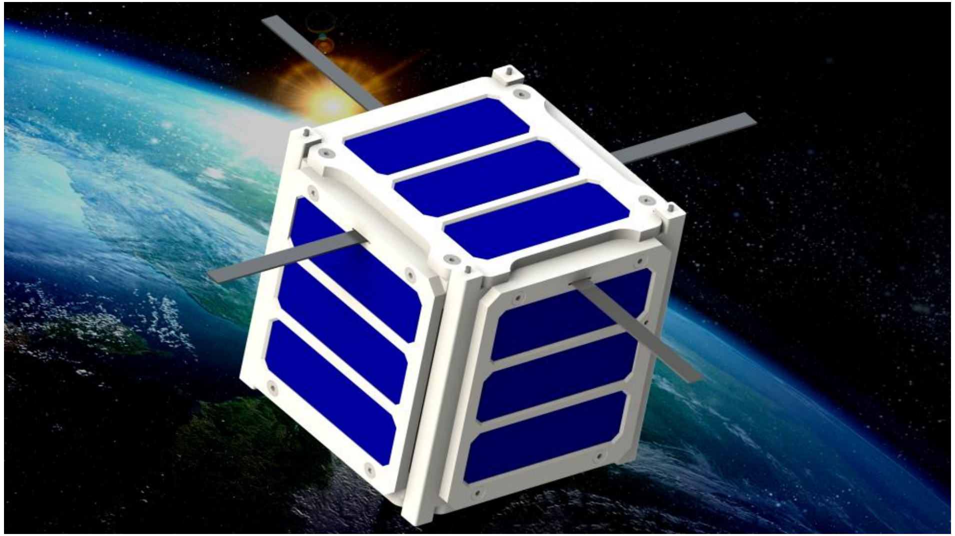
A proprietary frame, antenna deployment system, and solar panel assembly can be efficiently designed with complex geometries enabled by additive manufacturing at a lower weight and cost than OTS parts



CONCLUSION

Future Work

- Focused on hardware development
- Prototype "QUbeSat 0"
- Expand on the software (communications, data handling, etc.)



Thank You