OreSat Mechanical Design

Open Source CubeSat Workshop 2021

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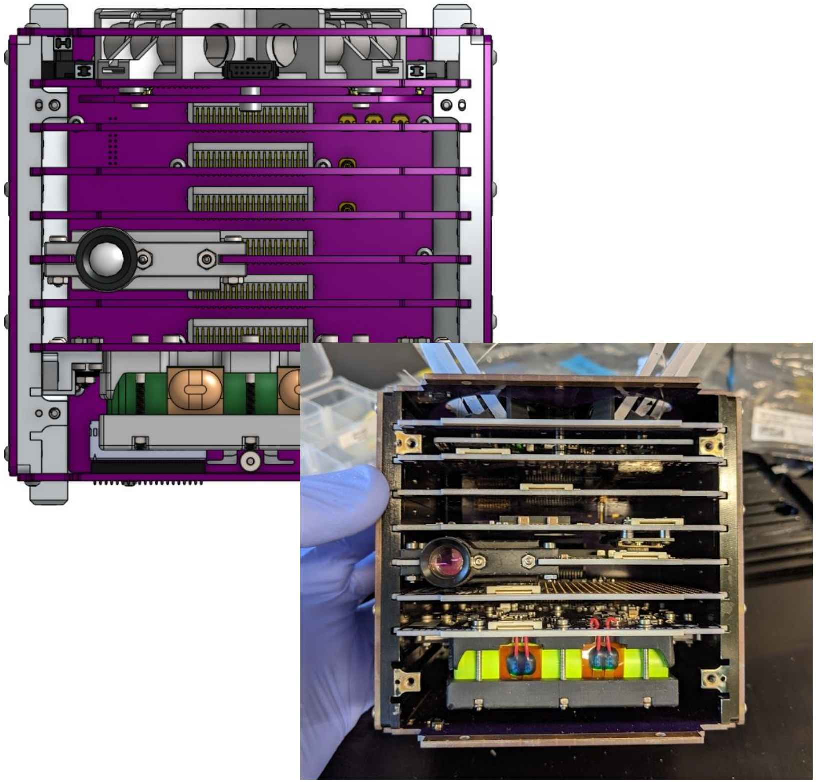
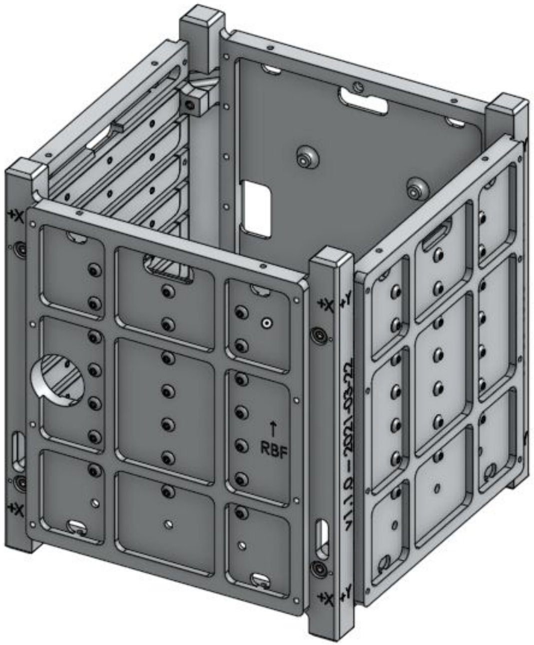
The OreSat Card Cage Design Features



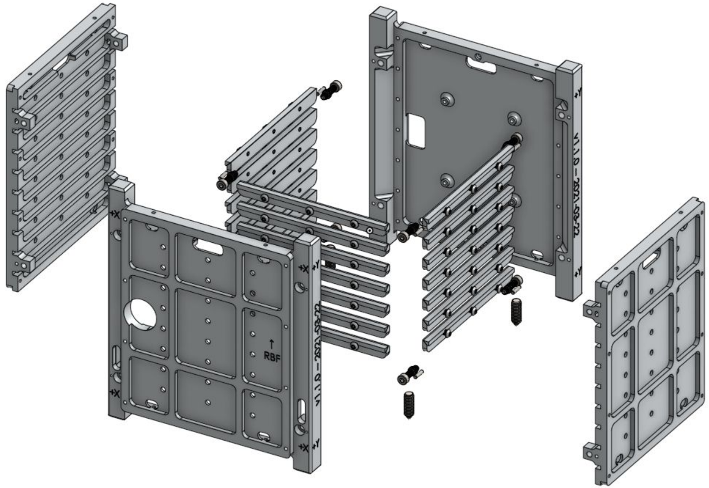
1. **Card wedge clamp** design ensures structural rigidity throughout launch
2. Designed with modularity in mind, each “card” is its own independent system
3. The OreSat design has a 40% greater packing density than the PC/104 CubeSat stack

Icons made by Freepik

The OreSat Structure

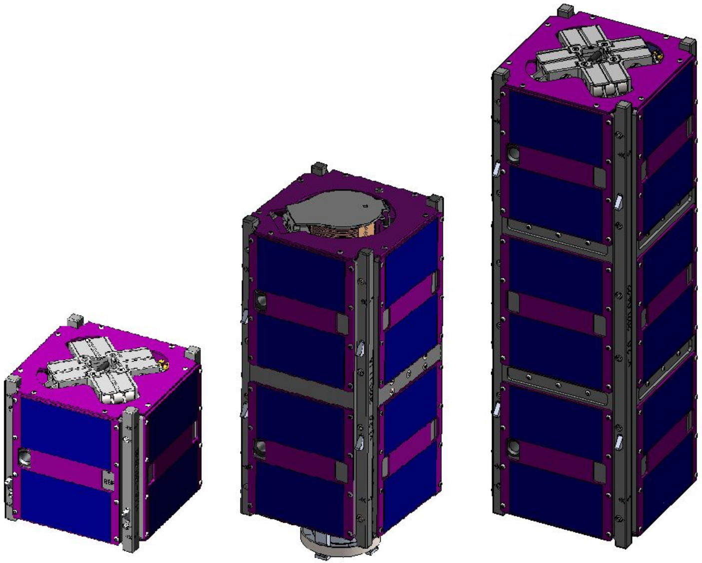


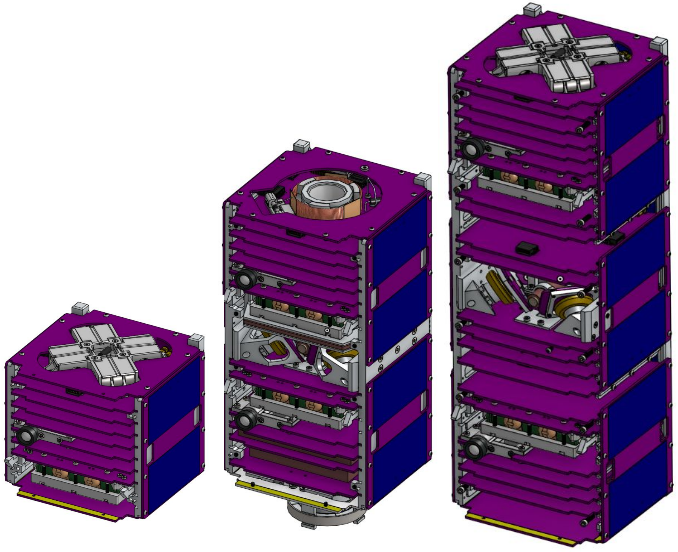
CAD of assembled view of 1U structure



Exploded view of 1U structure

Designed for Scalability





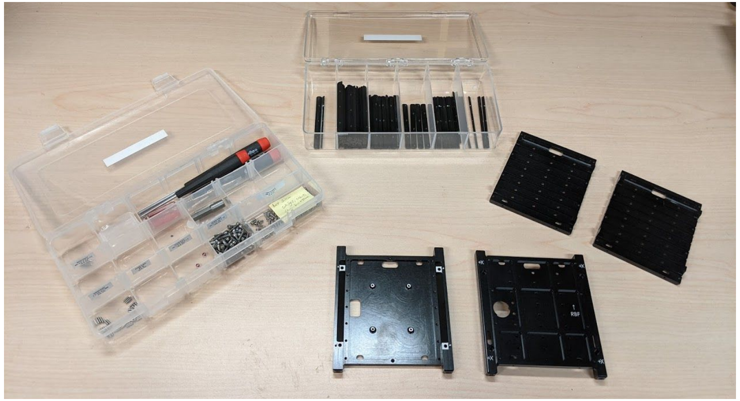
Designs adapted for 1U, 1.5U, 2U, and 3U CubeSats exist on the OreSat GitHub page (oresat-structure)

Material and Construction

Machinable from ½” **or 15mm stock 6061-T6 Aluminum**, anodized black and machinable by student groups

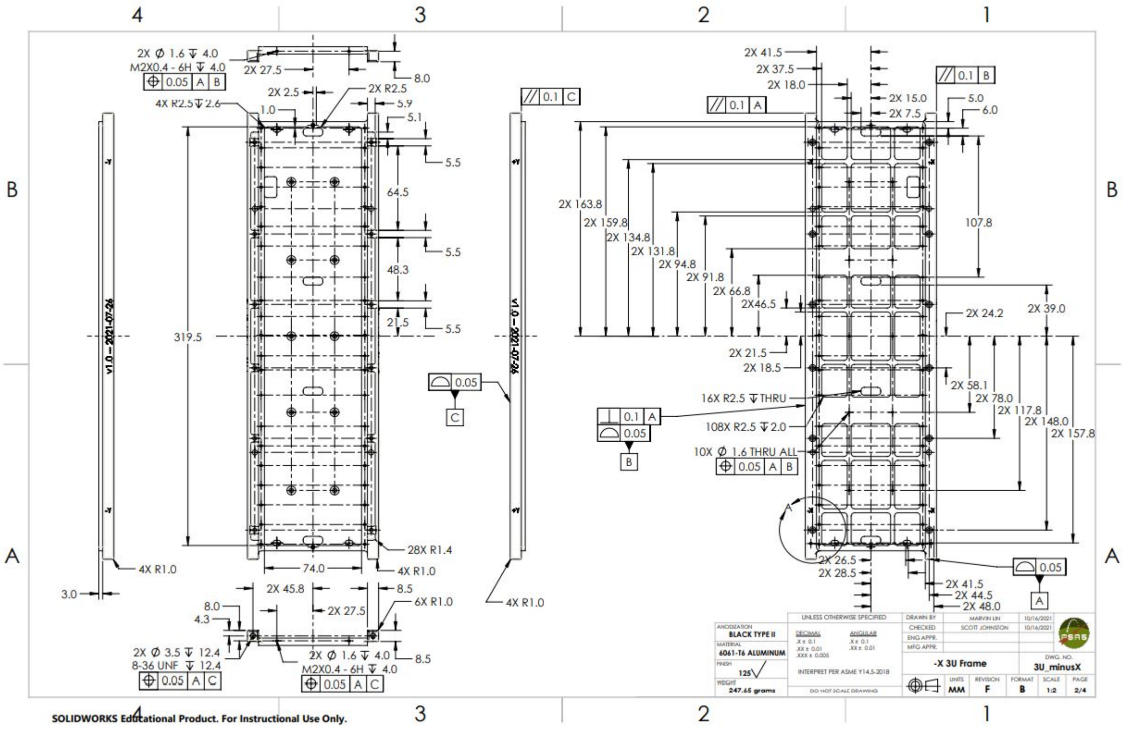
Constructed from **standardized** Torx button head SS 18-8 M2 and M2.5 fasteners

Costs can be significantly reduced if produced commercially. For the 1U, $1,200/ea @ 2 down to **$400/ea** @ 10



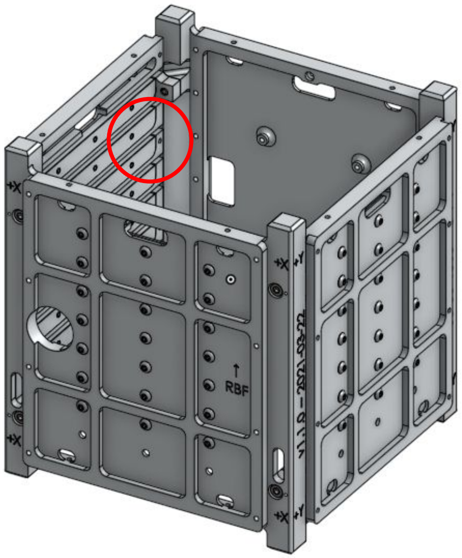
A 1U CubeSat “Kit”

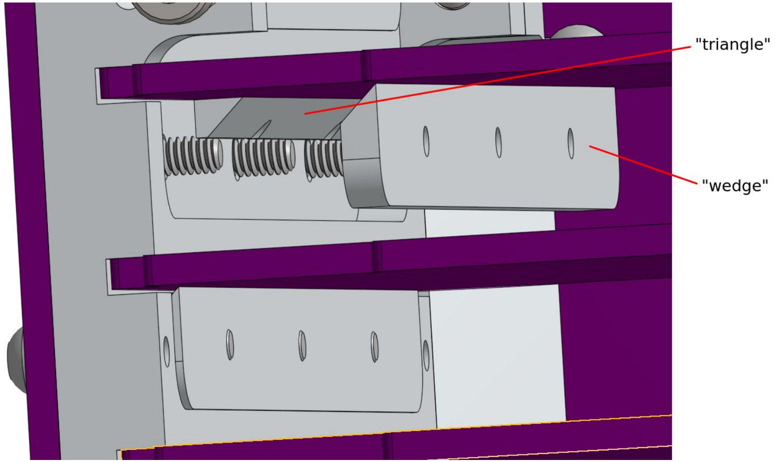
Manufacturing Drawings



Completed according to ASME Y14.5-2018 and ready for download at https://github.com/oresat !

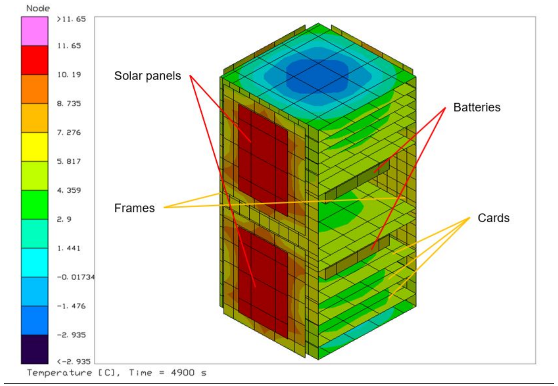
Built-in Card Clamp

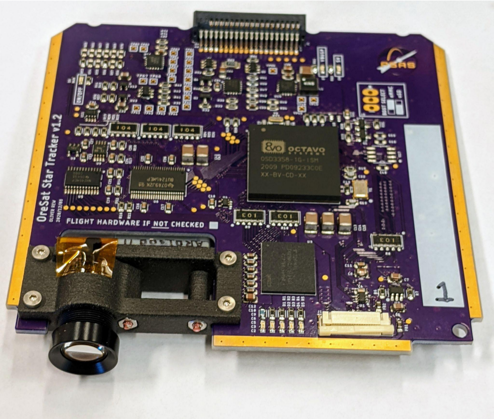




The card clamp design fully mates the cards with the surface of the frame, providing structural rigidity and optimal thermal conductivity

Thermal Designs





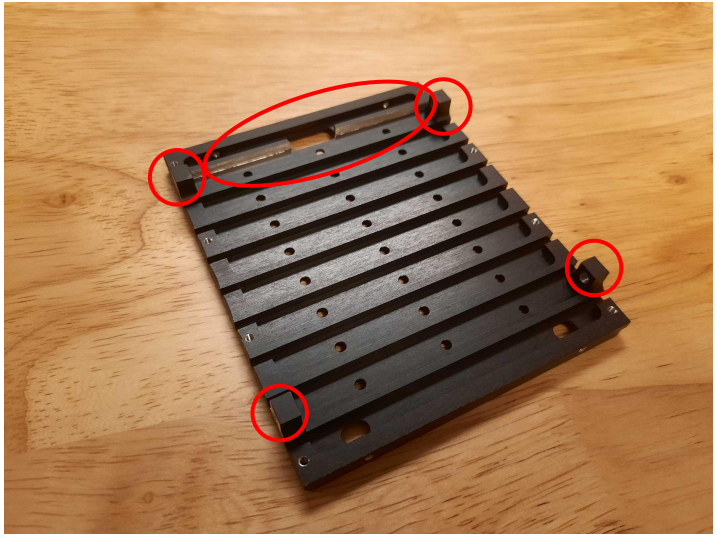
Designed to be **thermally, but not electrically** conductive

- ❖ Type II anodization allows for this
- ❖ Thermal transfer occurs with copper ground plane on PCBs

Electrical Grounding

While most areas need to be electrically non-conductive, some areas, like the turnstile antennas and backplane, **require grounding**

- ❖ Frame bosses are bare aluminum between frames
- ❖ Top of antenna card slot is non-anodized
- ❖ Structure is grounded at backplane and frame elements are grounded together
- ❖ Antenna cards are RF grounded to frame using anodization mask + Alodine 1201 coating at card clamp features



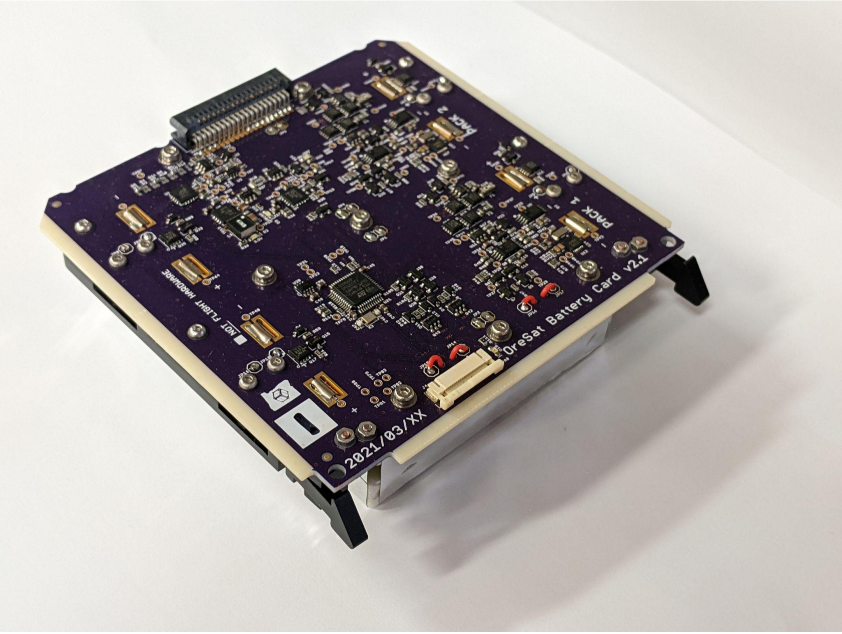
The OreSat Battery Card

Key Design Considerations

- Supports 4 independent inhibits to meet Nanoracks/ISS deployment specs
- Needs to be thermally isolated from structure
  - Batteries need to be above 0°C

Solutions

- Four rail-based inhibits protrude from the -X and +X frames
- Non-thermally conducting contacts with the structure



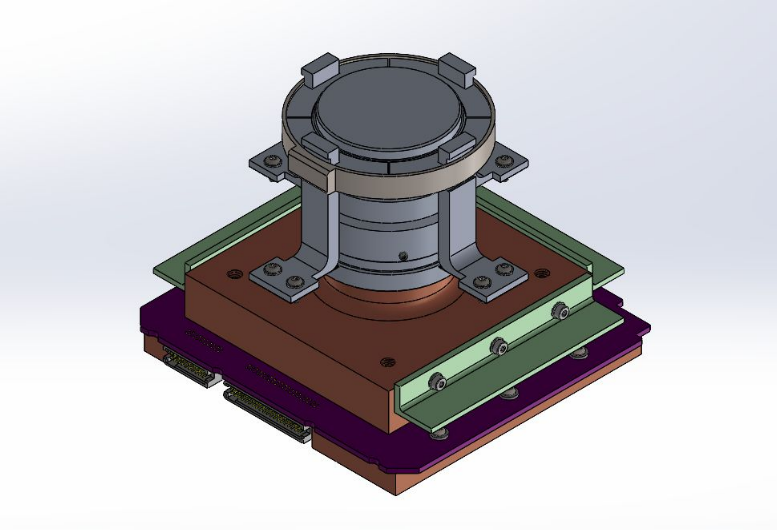
The Cirrus Flux Camera (OreSat1)

Key Design Considerations

- ❖ Requires rigid mounting
  - ➢ ~1kg mass
- ❖ Needs to be thermally isolated from structure
  - ➢ High thermal load from SWIR sensor

Solutions

- ❖ Fiberglass brackets for mechanical mounting with low thermal conduction
- ❖ Copper thermal masses are isolated from the conductive aluminum frames



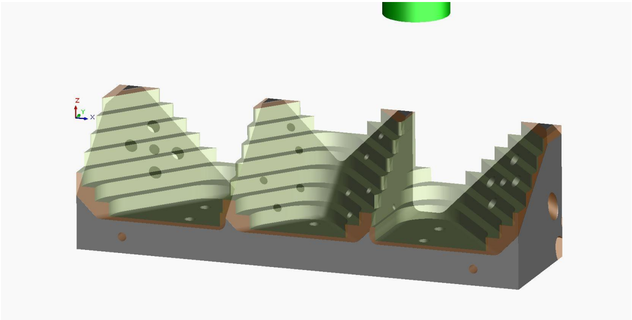
Reaction Wheels

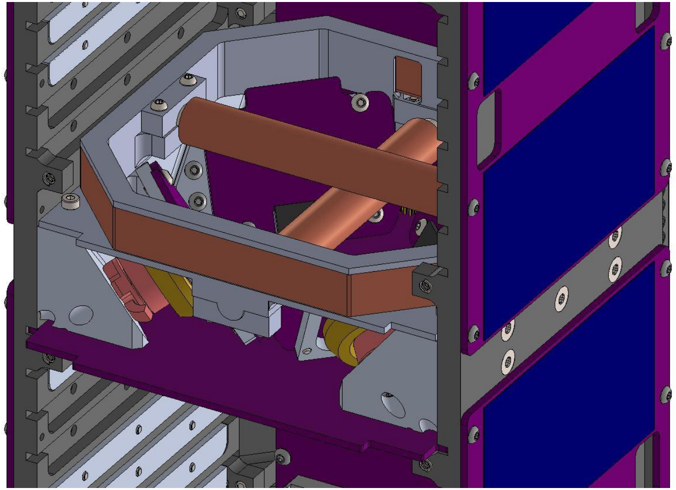
Key Design Considerations

- ❖ Needs to rigidly support tetrahedral reaction wheel mounting
  - ➢ Ideally Easily Manufactured
- ❖ Space Efficient
  - ➢ As with all things OreSat

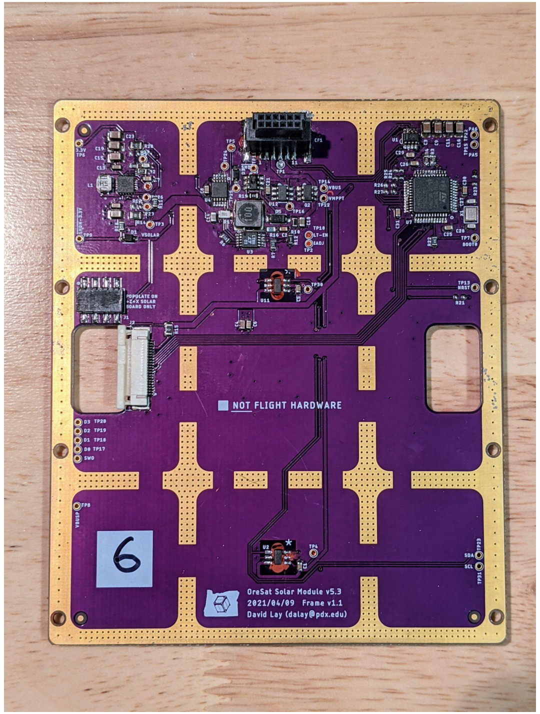
Solutions

- ❖ Single Mounting Beam, machineable with a 3 axis CNC
- ❖ Solenoid and open air magnetorquers occupying open volume between reaction wheels

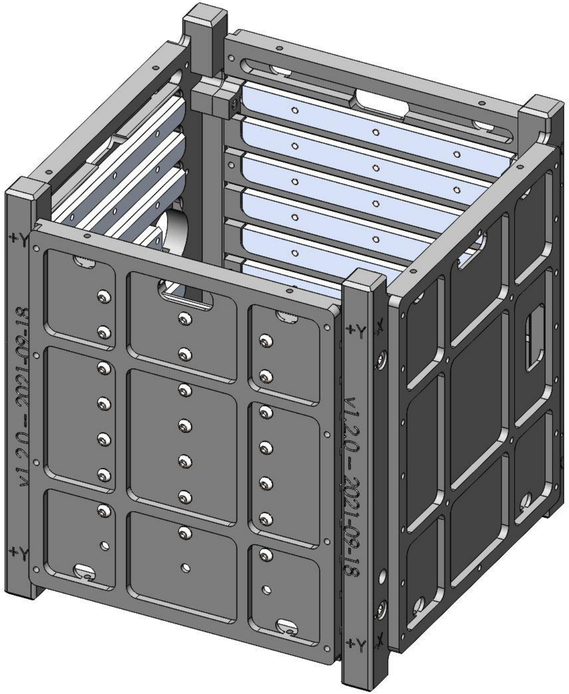




Solar Panels

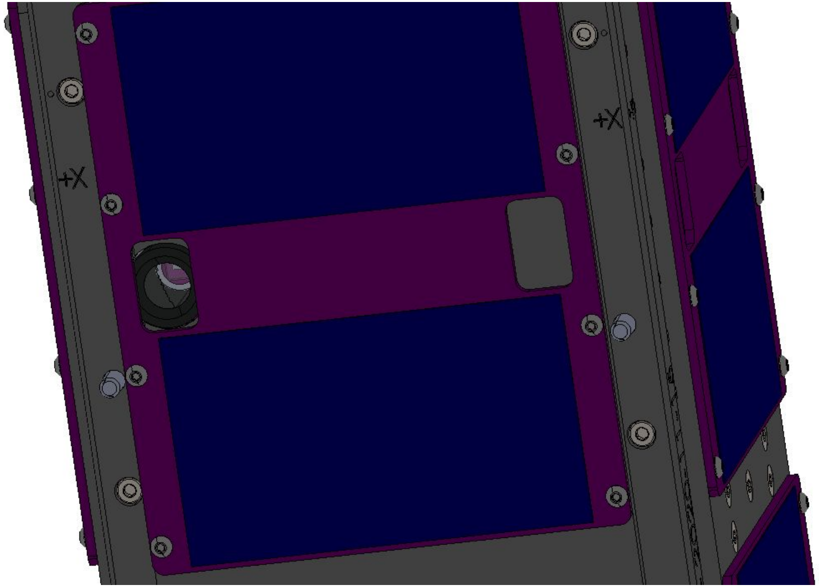


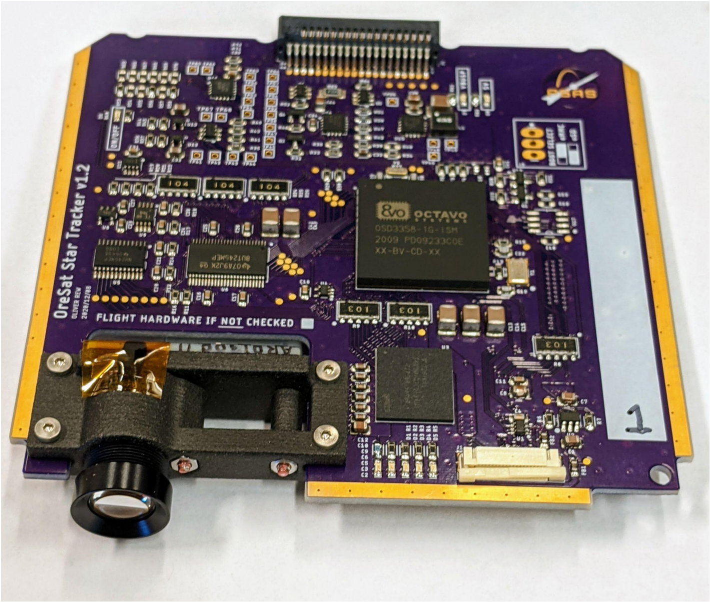
Solar Card has PCB mask removed to dump heat to frames



Matching Solar Panel Pattern for Thermal Connection to Frames

Startracker





The star tracker lens points outwards from the +X face of the CubeSat

Tools and Workflow

SOLIDWORKS 2020

All mechanical designs, including CAD and manufacturing drawings are completed using Solidworks by Dassault Systemes

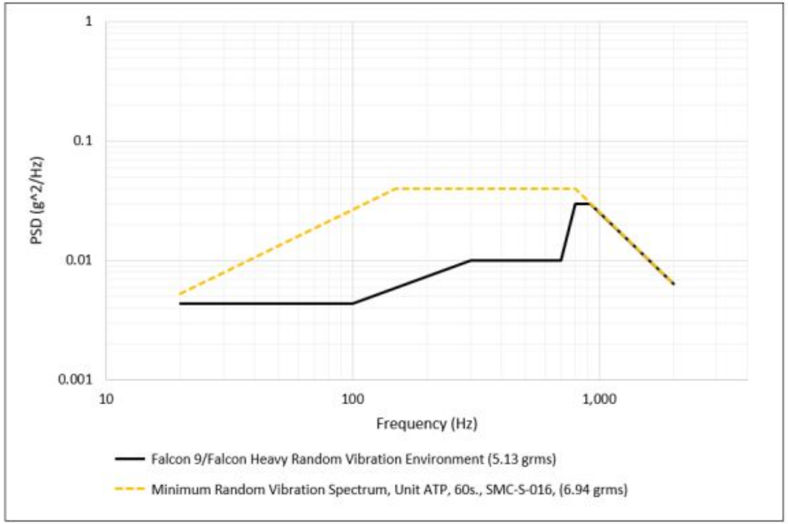
GitHub

Versions of designs and changes are pushed to GitHub for public release and storage

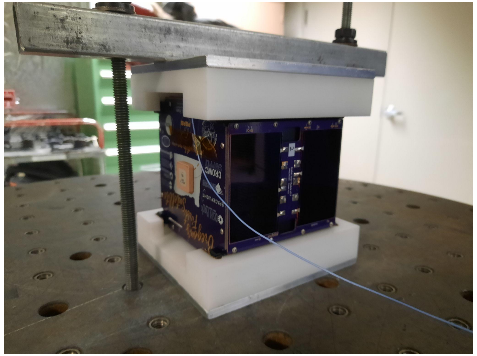
Git

Designs are controlled and versioned utilizing Git, and Open-source distributed version control system

Vibration Testing



Structure vibration tested to SpaceX Falcon 9 specifications



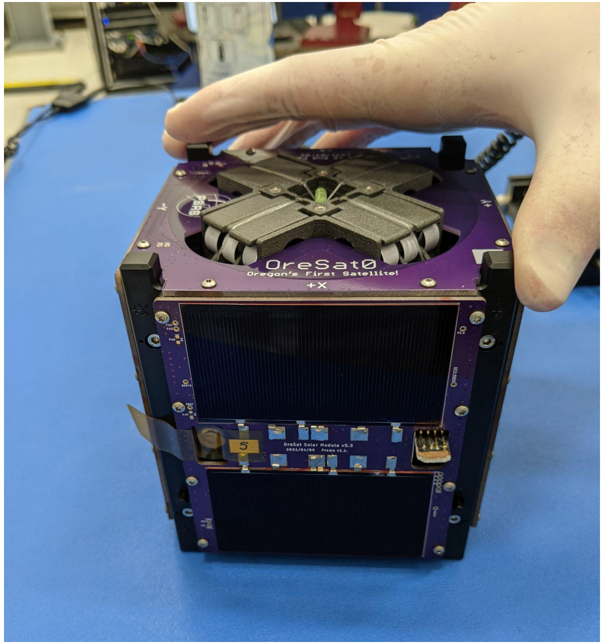
Frequency	Falcon 9/Heavy Payload Vibration MPE, (P95/50), 5.13 GRMS
20	0.0044
100	0.0044
300	0.01
700	0.01
800	0.03
925	0.03
2000	0.00644
GRMS	**5.13**

OreSat0: First Flight of the OreSat Structure

LAUNCH DETAILS

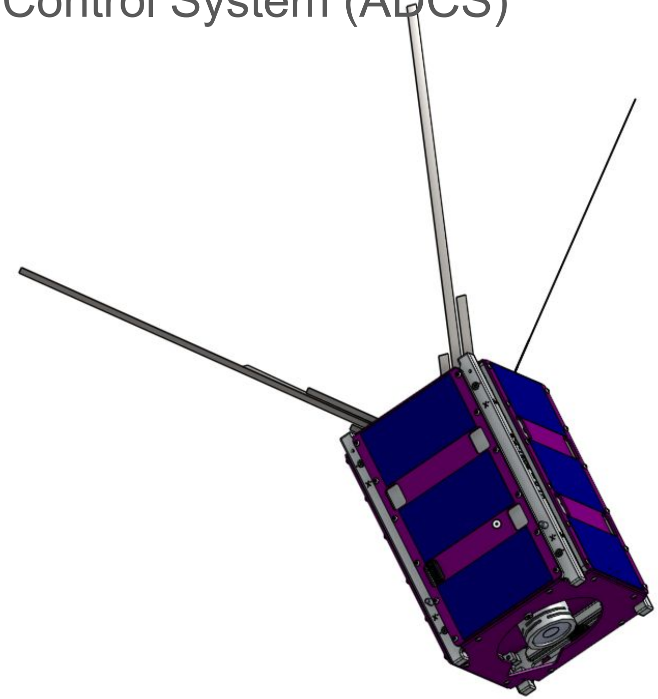
Handoff: December 3rd, 2021
Launch: SpaceX Transporter-3
Launch Date: NET January 10th, 2022

SPACEFLIGHT



Q2 2022: OreSat0.5

- 1.5U OreSat bus
- Test of the OreSat Attitude Determination and Control System (ADCS)
- Handoff April 2022
- Launch June 2022 (SpaceX Transporter-4)



Q4 2022: OreSat1

- 2U OreSat bus
- **2017 NASA CubeSat Launch Initiative (CSLI) program**
- Handoff Q4 2022
- Deploy off International Space Station (ISS) Q1 2023
- 2 optical payloads
  - Cirrus Flux Camera
  - Oresat Live

Thank You!

Website: https://oresat.org
CAD Files: https://github.com/oresat

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