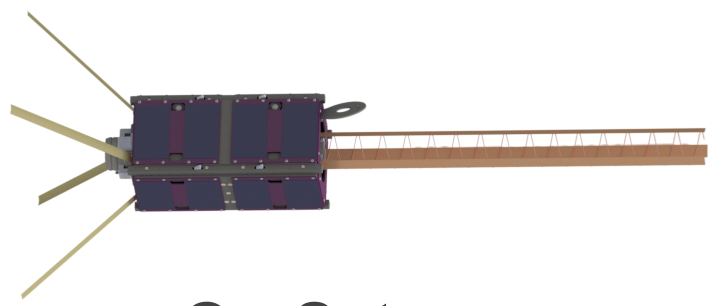
Design and Test of the OreSat Cirrus Flux Camera

Catie Spivey, Umair Khan, Davis Zarfas, Steve Hynes, Tiffani Shilts

OreSat

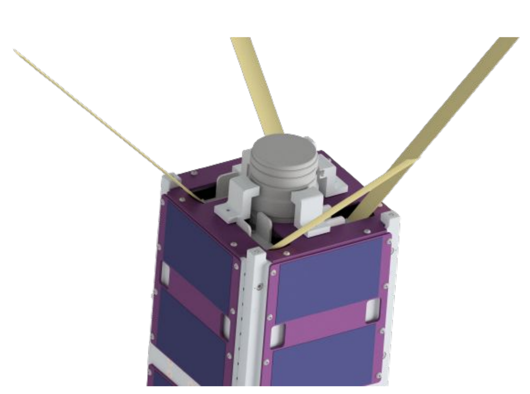
OreSat is an artisanally handcrafted 2U CubeSat being developed by the Portland State Aerospace Society. It was selected in 2017 as part of the NASA CubeSat Launch Initiative (CSLI) with handoff and launch scheduled for 2022. Its missions include the OreSat Live (DxWifi) STEM outreach mission, open source space technology demonstration, and the Cirrus Flux Camera science mission.



OreSat

Cirrus Flux Camera (CFC)

The CFC is a cirrus cloud imaging system (located on the -Z side of OreSat) with the goal of collecting data to enhance understanding of global cirrus coverage and frequency and potentially inform global climate models. Cirrus clouds are known to contribute significantly to atmospheric warming, but coverage has been underestimated due to detection difficulties. The other goal of CFC is to pioneer a low-cost, open-source approach to scientific instrumentation.



Cirrus Flux Camera Location

Acknowledgements

Dr. Jan-Peter Muller
Dr. J. Vanderlei Martins and the UMBC HARP team
Scott Dixon

This project was supported in part through NASA/Oregon Space Grant Consortium, grant NNX15AJ14H.

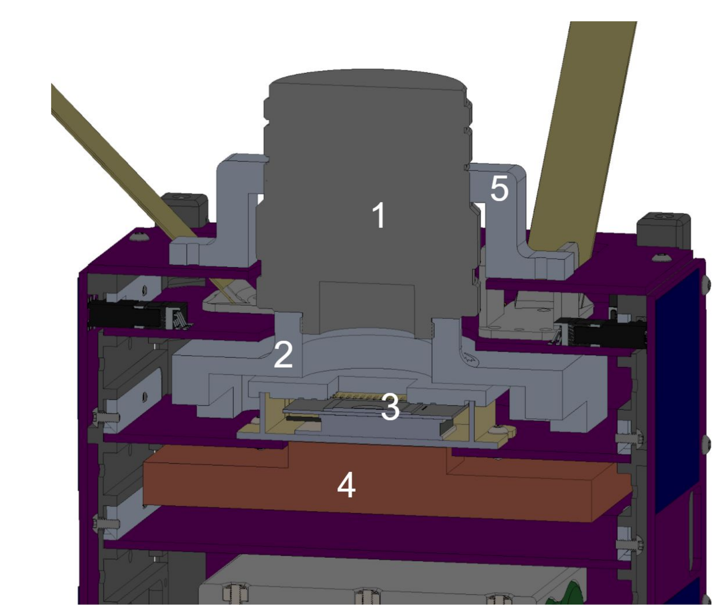
Concept of Operations

1. Find a potential cirrus observation site using near-live GOES data (or similar satellite imagery)
2. Send command to OreSat
3. Capture multispectral images over desired area (at multiple angles)
4. Compress and store onboard
5. Downlink data over SatNOGS network (slow but global) or through DxWifi (fast but over OR)

Mechanical Design

The mechanical design is limited by the locations of existing printed circuit board cards and turnstile antennas as well as the dimensions of the "tuna can" extension (maximum extrusion of 36 mm from the end of the rails and a maximum diameter of 64 mm).

The assembly includes NAVITAR SWIR-25 lens (1), an aluminum lens mount (2), detector and sensor housing (3), a copper heat sink (4), and aluminum thermal straps (5).



Cirrus Flux Camera Assembly

Electrical and Computational Design

- On-board computing will be performed by a custom Linux board powered by the Octavo OSD335x -- ARM A8, 1GB RAM, EEPROM, etc. in one chip
- Based heavily on OreSat's (functional) star tracker board
- Adding in an FPGA to process and buffer data coming off the sensor before going to the Octavo

Future Work

- Build it
  - lenses have arrived at UMBC
  - first round of 3D prints are on their way
  - sensor procurement is in process
  - electronics in development
- Test it
  - optical characterization
  - vibration testing
  - test run from a plane (or weather balloon)
- Launch it
  - figure out exactly what science to do
  - define capture protocols

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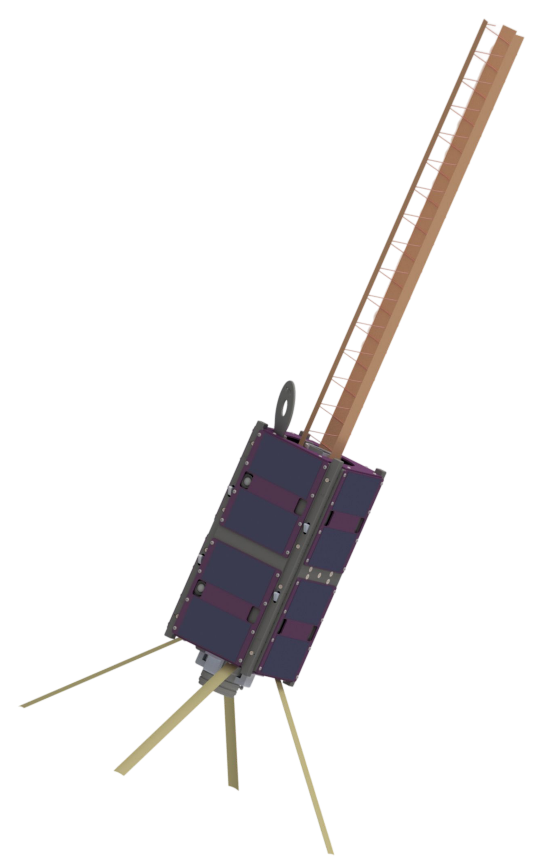
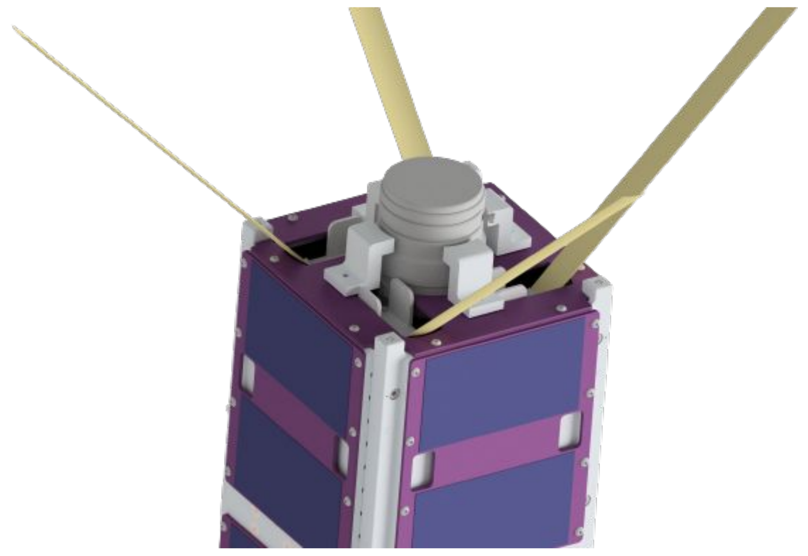


A render of OreSat.

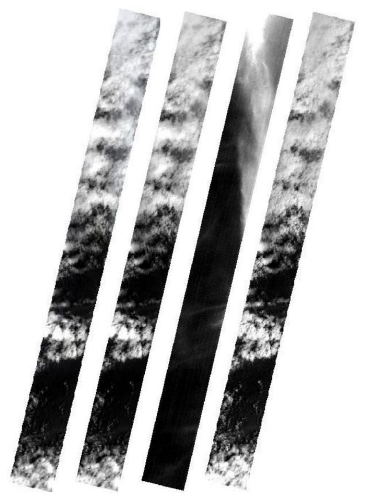
Cirrus Flux Camera (CFC)

The CFC is a shortwave infrared (SWIR) cirrus cloud imager that will enhance understanding of global cirrus coverage and frequency, potentially informing climate models. Cirrus clouds are known to contribute significantly to atmospheric warming, but coverage has been underestimated due to detection difficulties. Through the CFC, we hope to pioneer a low-cost, open-source approach to scientific instrumentation.



Left: The current design of the CFC, as situated on the -Z side of OreSat.

Right: Cirrus clouds as seen in visible, 870nm, 1.38µm, and 1.6µm bands.



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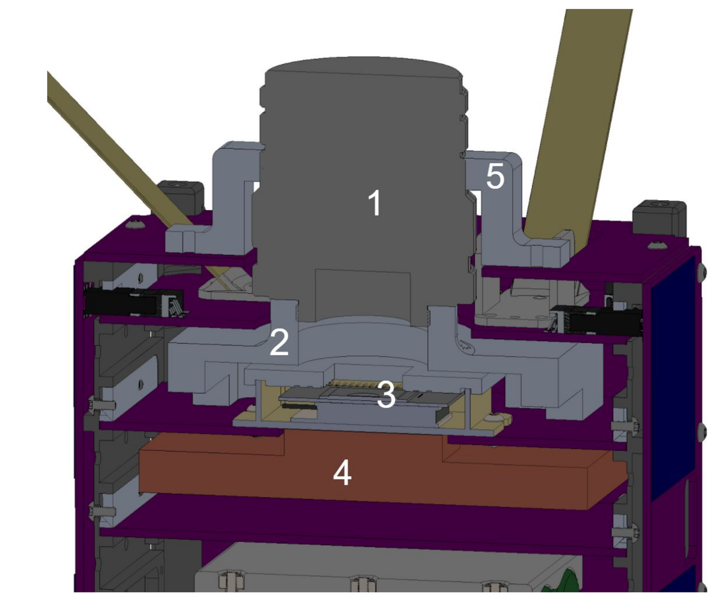
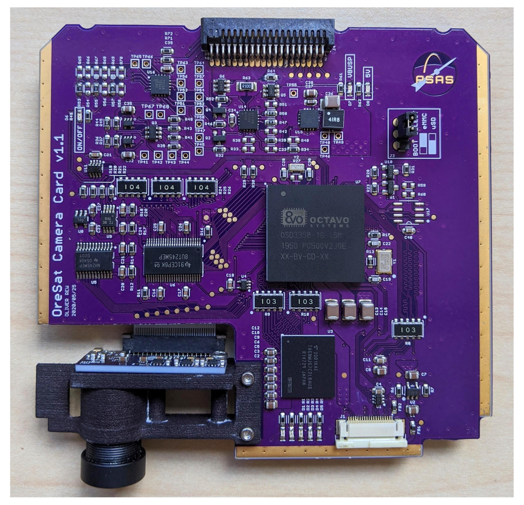


Cutaway view of the CFC.

Electrical and Computational Design

On-board computing will be handled by a custom Linux board powered by the Octavo OSD335x, based heavily on OreSat's already-functional star tracker board. An additional FPGA will be used to process and buffer data from the sensor before being read by the Octavo chip.



The star tracker board.

Concept of Operations

1. Find potential cirrus observation site using real-time satellite data.
2. Send command to OreSat.
3. Capture multispectral/multiangle images.
4. Compress and store on-board.
5. Downlink over SatNOGS or DxWifi.

Future Work

With the design largely complete, the next step is to build the CFC. The SWIR sensor is being procured, and initial 3D prints are on order. After extensive testing and characterization, the system will be ready to fly in 2022.

Acknowledgements

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Contact

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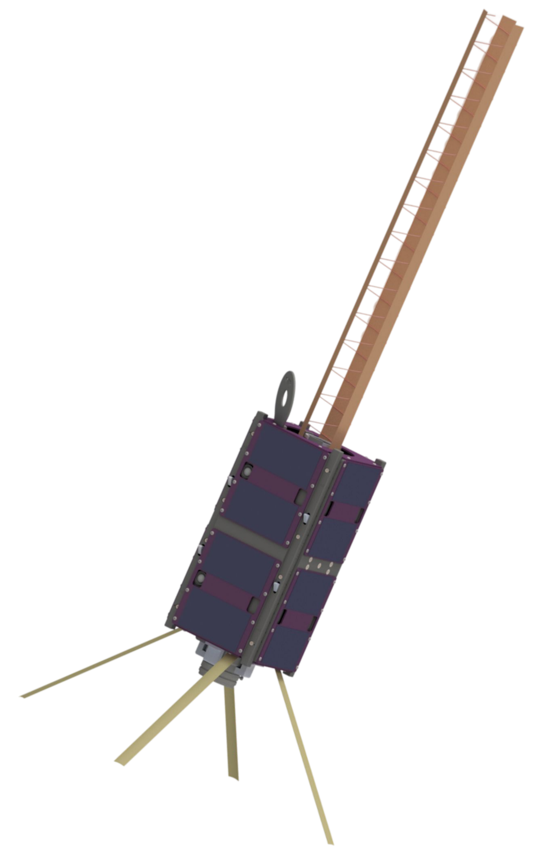

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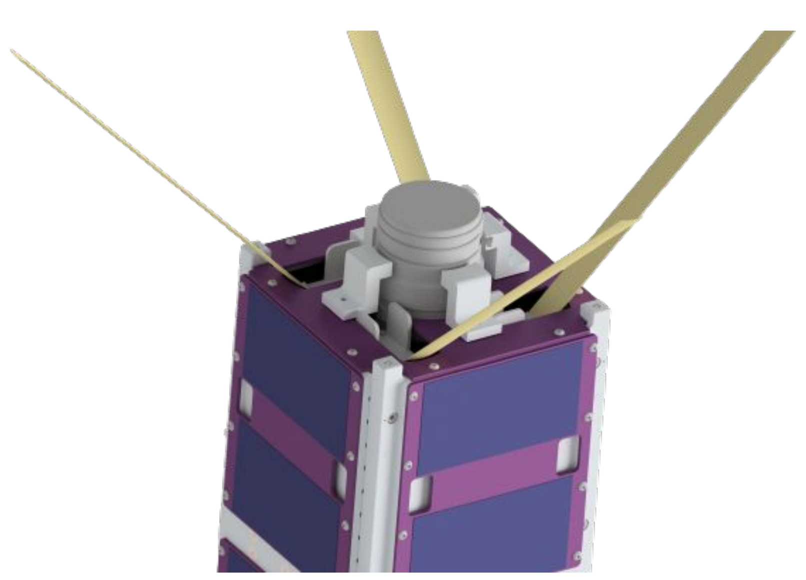

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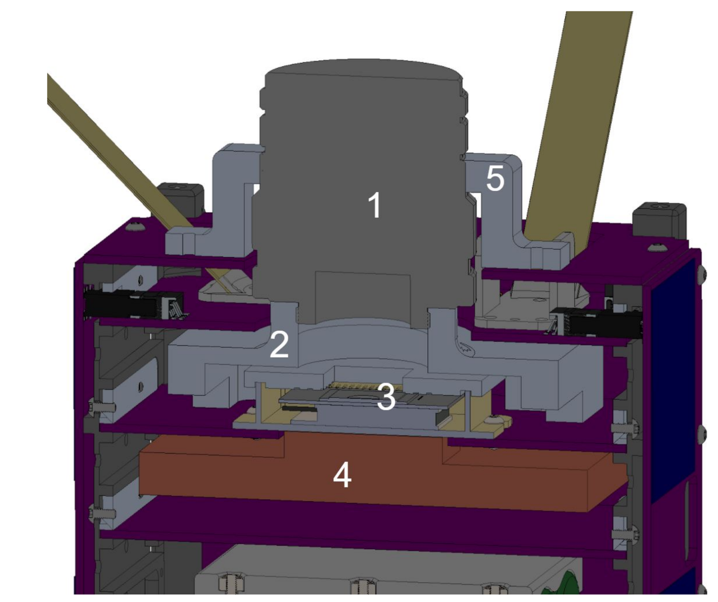

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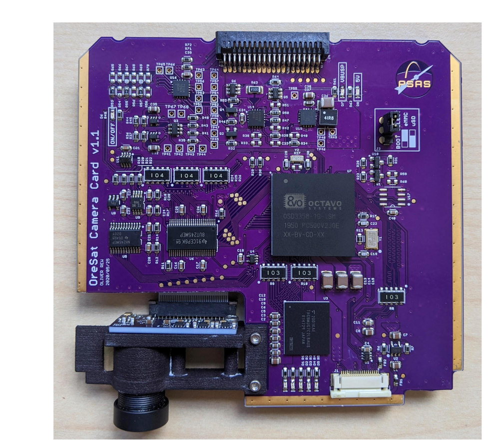

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