ASU ASCEND StratoDevils

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School of Earth and Space Exploration

Project Overview

ASCEND is a NASA-funded Arizona Space Grant program that gives undergraduate students hands-on experience in the full lifecycle of a science and engineering mission—building, launching, and analyzing a high-altitude balloon payload. Students work to create custom hardware to collect and analyze atmospheric data. The payload includes onboard cameras to capture footage and sensors to monitor environmental conditions throughout the flight.

By combining systems engineering with scientific inquiry, ASCEND prepares students to tackle real-world challenges and produce meaningful data from the upper atmosphere.

Engineering Mission

GOAL: Mimic how power and communication is done through the Squid uniform bus system become a testbed for SquidSat hardware.

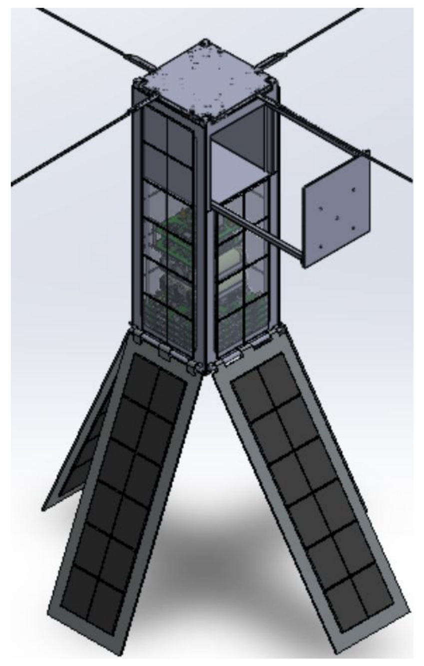
Based off of design choices made by the SquidSat Team - SDSL's planned 3U CubeSat. Each system is controlled independently with communication between MCUs via CANbus.

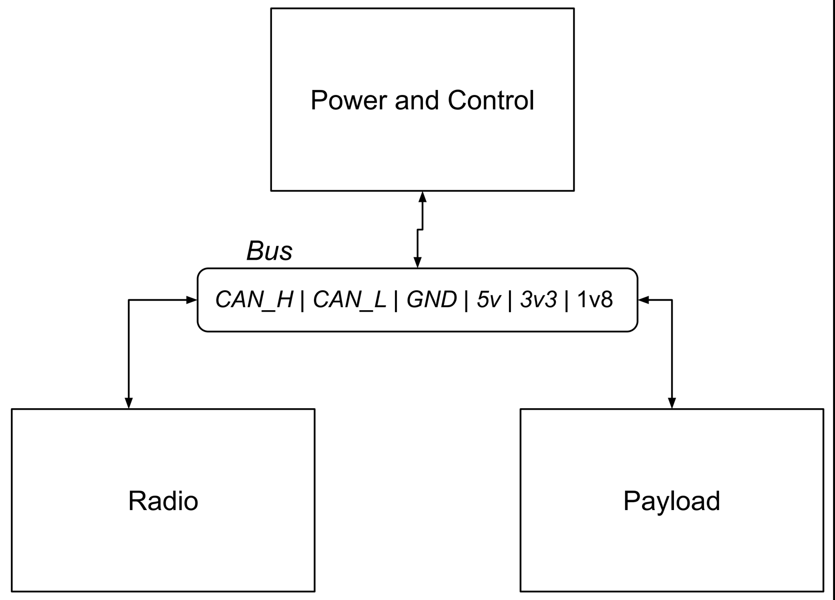
Power and Control (PAC) → OBC + EPS (RP2350)

Reusable with power regulation for the other boards and standard sensors (GPS, INA, RTC, backup Temp/Hum/Pres)

Payload → Science Mission, most sensors (RP2350)

Radio - STM32 (Squid) + LoRa radio module

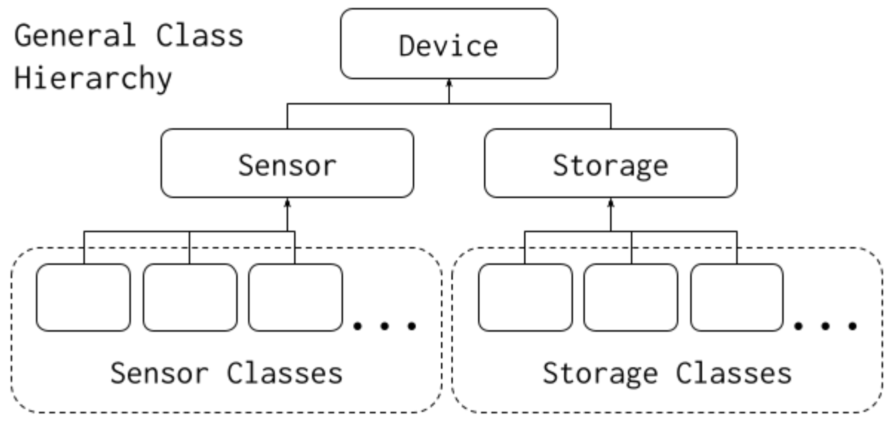


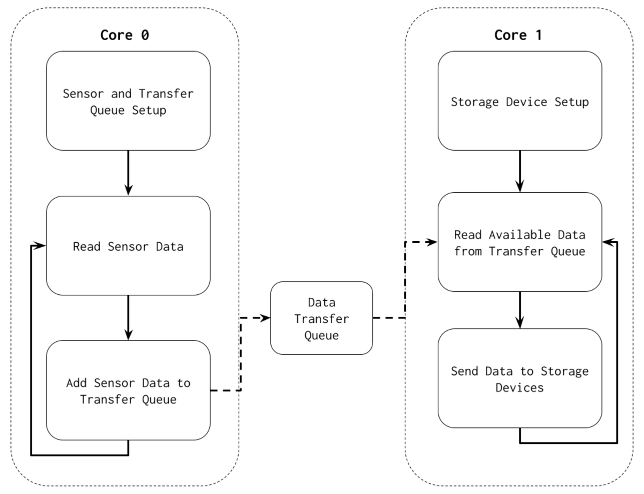


Payload Software

Continuing the reusability of past software.

A single overarching parent class, **Device**, for device with two sub parent classes **Sensor** and **Storage**, for the two types of peripherals
Device implements the device recovery system, allowing for connecting to each device to be reattempted if the connection is lost.





Multicore Design

Sensor classes are interacted with on Core 0, **Storage** classes are interacted with on Core 1

Core 1 services the RP2350's built-in **watchdog**, stalling if the queue is fully drained, effectively watching both cores

Header (10 Bytes)				
Sync Bytes	Sensor Presence	Packet Length (N)	Data	Checksum
4 Bytes	4 Bytes	2 Bytes	N - 11 Bytes	1 Byte

Variable Length Packet Structure

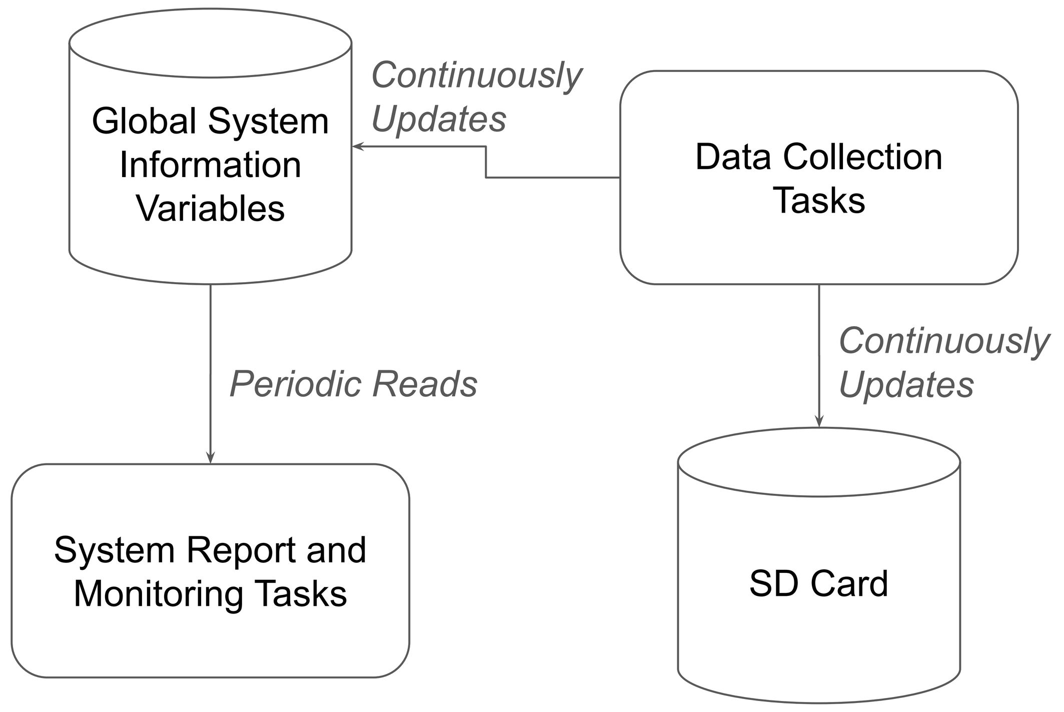
Sensors are read from with varying frequency. Each is then encoded into the packet for both using less space and, maintaining full float precision

Power and Control Software

System data logging and monitoring.

On-board sensors are read from continuously with the **Data Collection Task,** results are logged on the SD card and used to update the **Global System Information Variables**

System Report and Monitoring is simultaneously done, allowing the system to respond to critical events, such as servicing the on-board watchdog timer and providing debugging output such as LED error codes and USB logging.



RadiaCode Controller

To enable RadiaCode Control to coexist with a more powerful C++ based architecture, the previous semester's MicroPython controller was **rewritten as a C++ library** built on Arduino-Pico BLE. The updated spectrogram is saved to the SD card every 30 seconds, giving altitude resolution to energy level data.

SquidSat Antenna Board

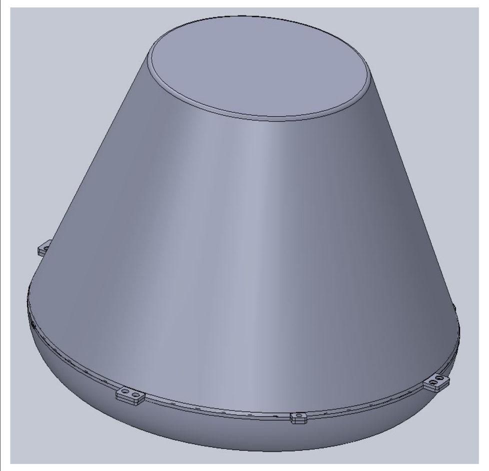
Deployable crossed-dipole CubeSat antenna at **915MHz**
Independent microcontroller for **LoRa** module control and link data transfer
Flight is used as a stress test due to long range and chaotic movement to mirror orbit and tumbling

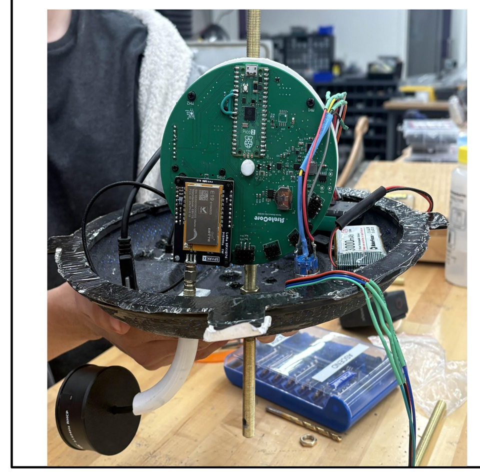
Link Achieved

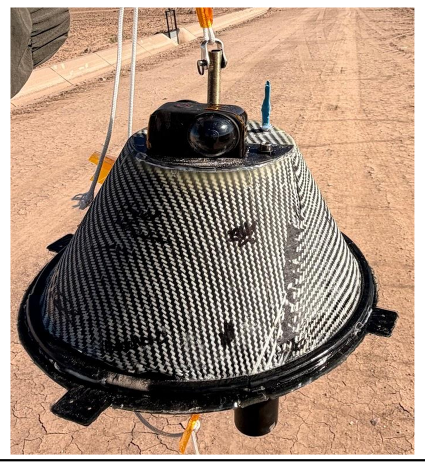
TX Power: 27dBm

Estimated Distance: 2.8-4.3 km
RSSI: -128.00 dBm
SNR: -2.00 dB
Frequency Error: -6420.96

Previous Semester: Command Module







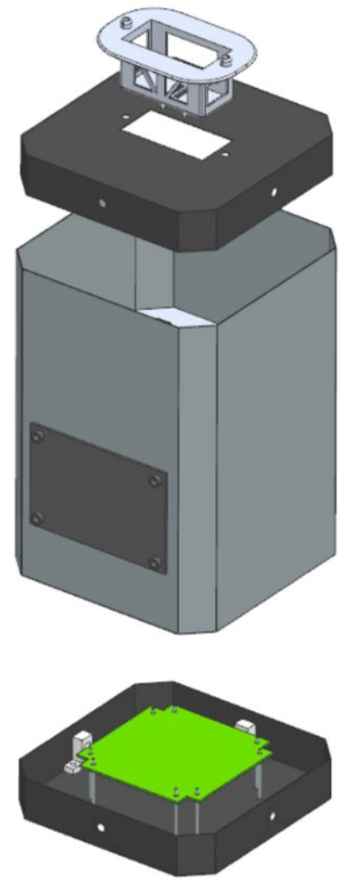
Previous Semester:

1. Aerodynamically efficient shape based on re-entry pods.
2. Explored new lamination techniques for curved surfaces.
3. Flaws: inefficient volume use, difficult accessibility, and complex manufacturing

Manufacturing Process:

Unique Themed Payload
- Custom mold for cone shape
- Carbon fiber layup over curved surface
- Vacuum bagging to achieve final shape

This Semester: Modular CubeSat Box Design



This Semester:

1. Modular payload with drawer compartment
2. Improved Accessibility
3. Enhanced reusability compared to prior designs

Design Improvements

Reusability and Accessibility
- Sliding drawer for easy internal access
- Improved internal mounting and organization
- Reduced assembly/ disassembly design

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Electrical Design

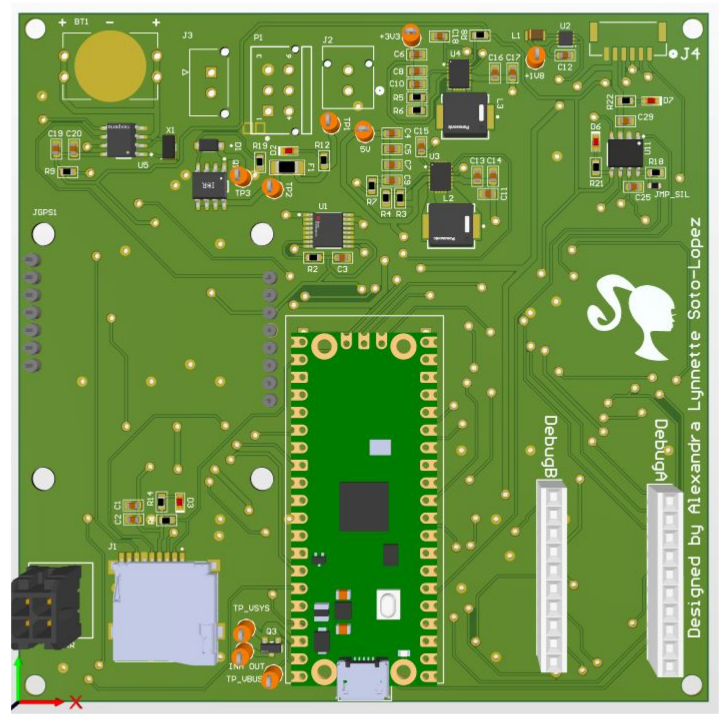
Previous Semester:

Hardware Mission: Power and Control, Internal & External PCBs

A modular architecture consisting of a Power and Control PCB and multiple Payload PCBs. The Power and Control board acts as the central hub, handling power distribution, regulation, and system-level control, while the payload boards manage sensor integration and data collection. Communication across the system is enabled through a CAN bus, providing reliable and noise-resistant data transfer.

Power & Control PCB:

- Central hub for power distribution and system control
- Regulated voltage rails (5V, 3.3V, 1.8V) for all subsystems
- Integrated power protection for safe and reliable operation
- Communication and power signals broken out for debugging
- Supports system monitoring and data logging
- Designed for reuse

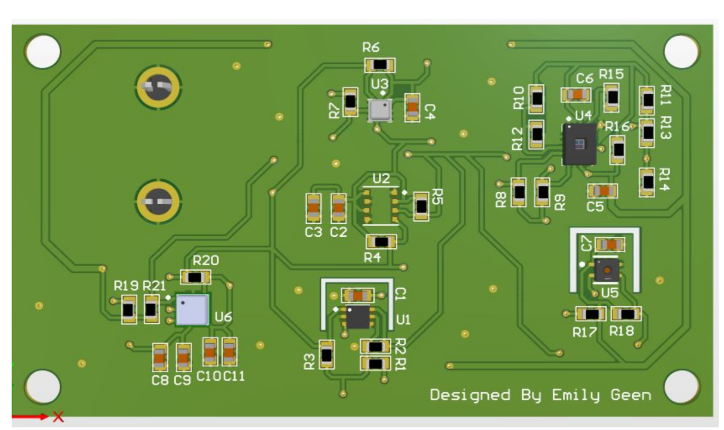


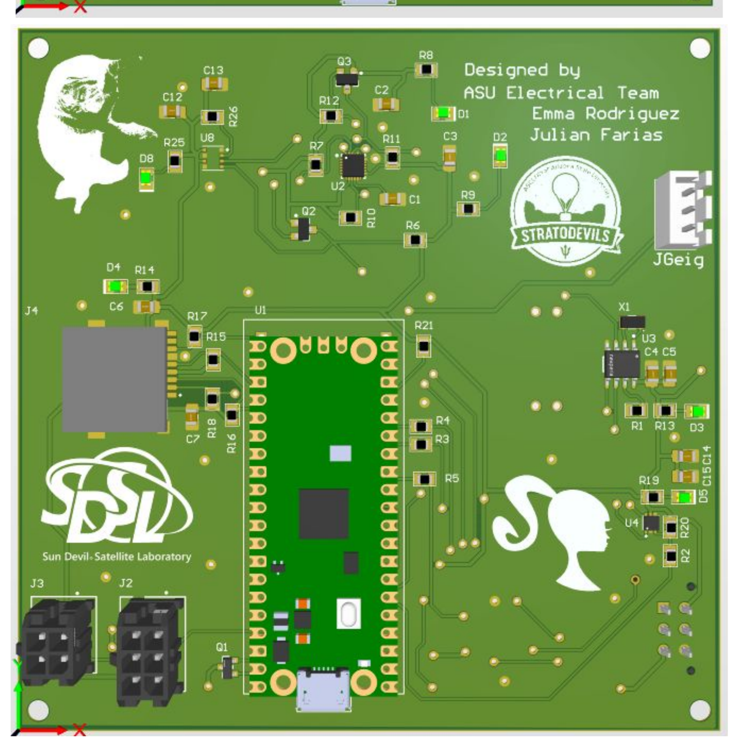
Payload PCBs:

- Separate external and internal boards that operate as a joint system
- Designed to be completely powered by power & control board
- Multiple I2C lines routed between boards to read sensors
- Data from payload PCBS is collected to an SD card

PCBs Capture Data On:

- Pressure
- Temperature
- Relative Humidity
- Altitude
- UVA/B/C
- CO_2
- Air Quality Index
- Ozone (O_3)
- Radiation
- GPS





Atmospheric Sounding

Showalter Index: TE500-TP500 → 24-(-5)=8

Vertical Totals (VT): TE850-TP500 → 24-(-5)=29

Cross Totals (CT): TD850-TE500 → -3-(-5)=2

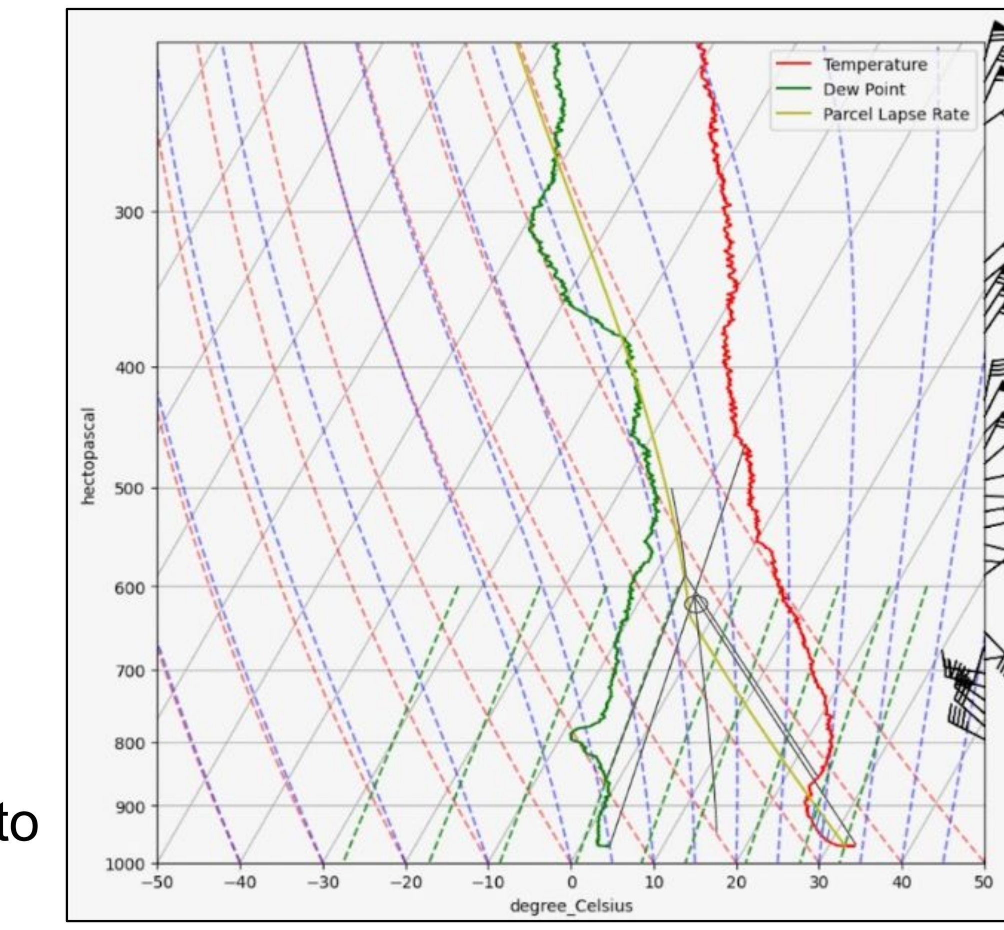
Total Totals (TT): VT+CT → 29+2=31

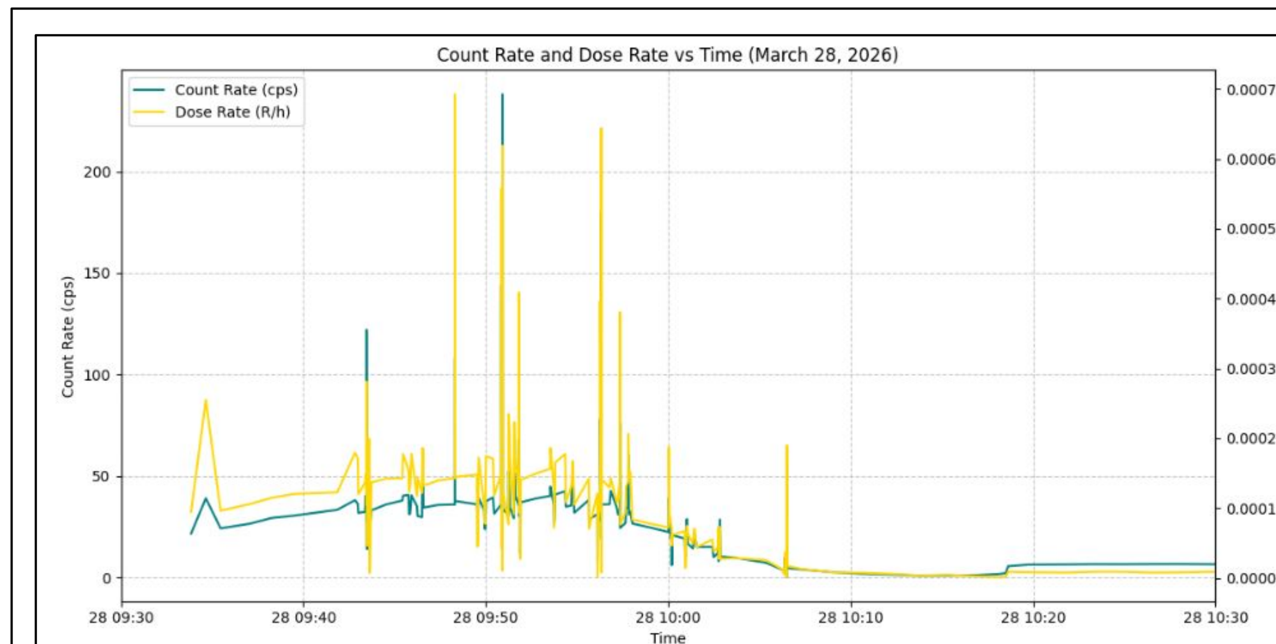
LCL: 615mb LFC: n/a CCL: 465mb;

Sounding displays a lot of CIN (Negative Area)

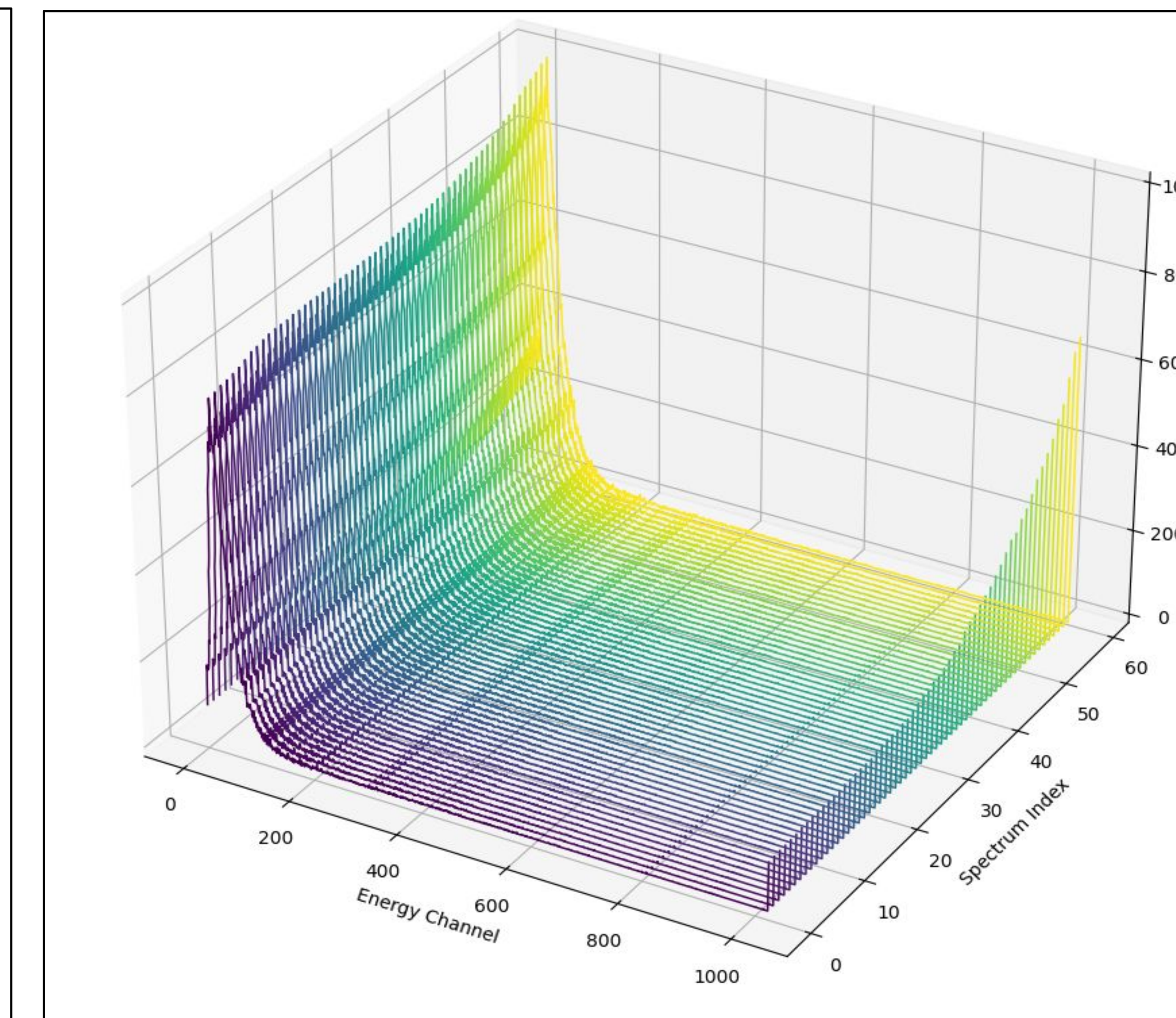
Vertical wind shift 700mb-500mb from NE-E

Dry-limited low level moisture. Deep, dry boundary layer inhibiting the formation of clouds and/or high cloud bases. Overall, a capped environment resulting in clear to partly cloudy skies with no chance of thunderstorms.





An increase in radiation is observed upon entry to the stratosphere, approximately 40 minutes after launch. The Regener-Pfotzer Maximum was not reached, yet trends of increasing and decreasing radiation are apparent in the graph. Spikes correspond to payload interaction with reactive isotopes in the stratosphere.



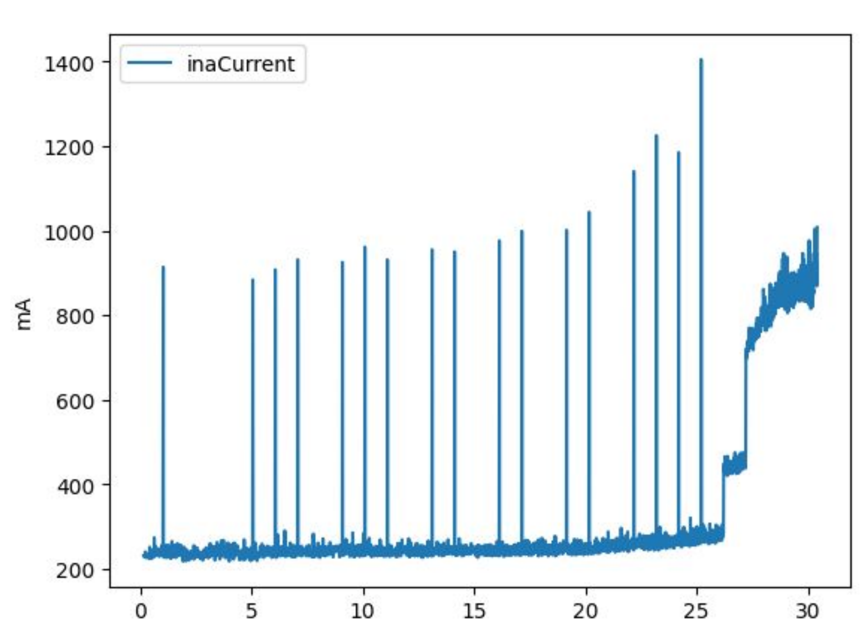
The stacked waterfall spectra shows change with time of the recorded radiation spectrum during ascent, with each curve representing one sequential spectrum. Counts are concentrated at low energies and increase overall through the flight.

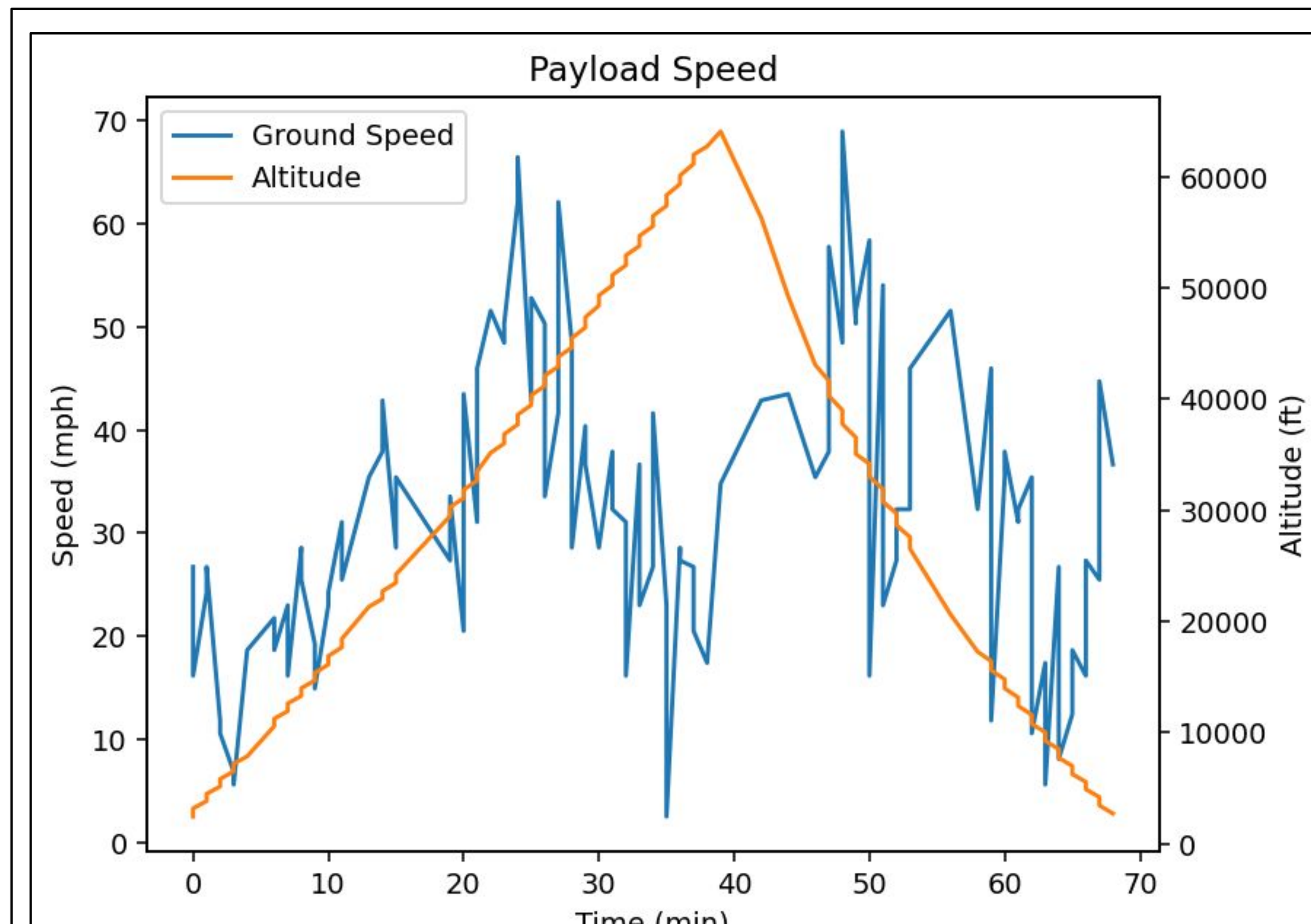
Short Circuit Protection

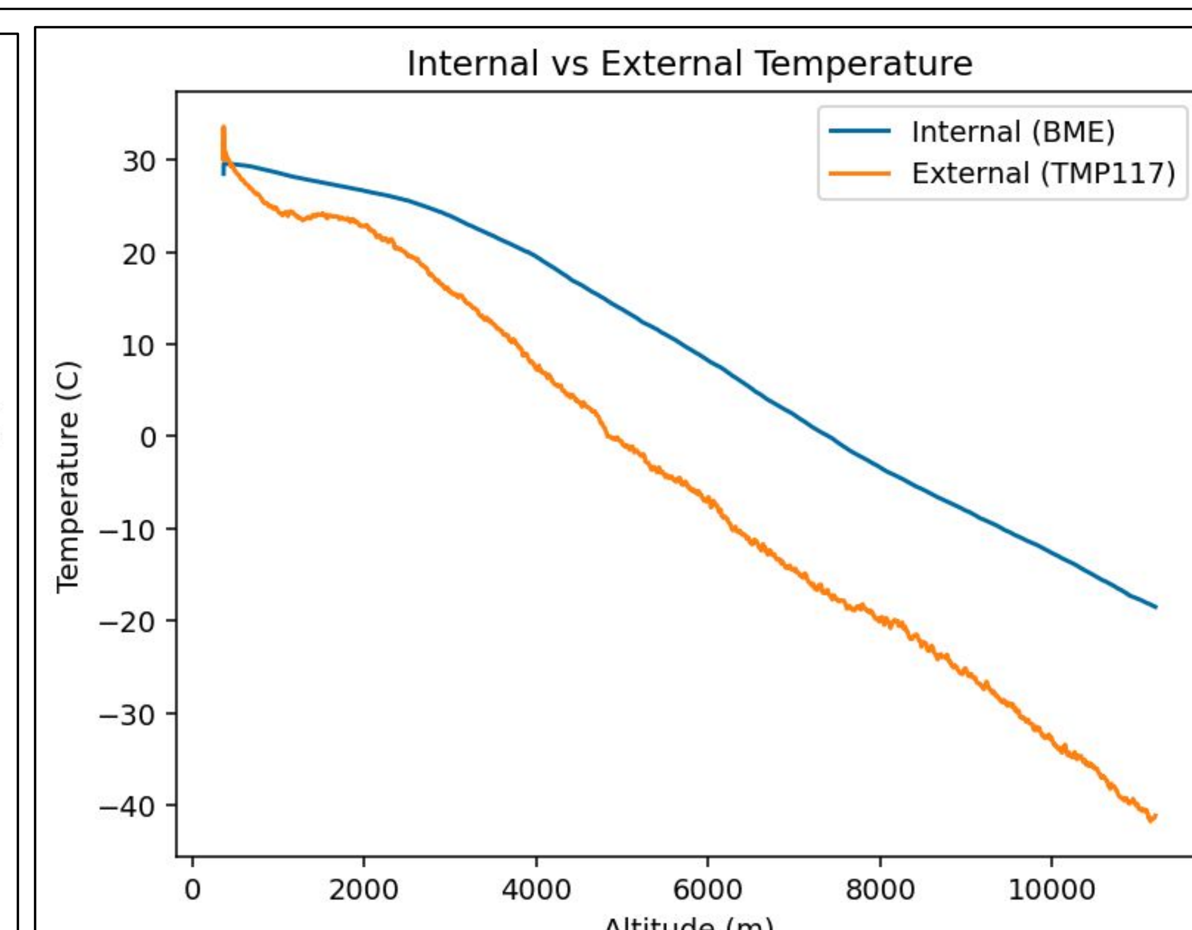
Connector failure during flight bridged Vcc and Gnd causing runaway circuit draw from the **Power and Control** PCB.

Cut-off protection triggered at 1000mA through a **resettable fuse**

Payload returned to normal operation after battery disconnect / reconnect







Project Repository

Checkout our source code and raw data collected from the flight and analysis.

Acknowledgments

Dr. Michael Goryll, Desiree Crawl, Sun Devil Satellite Laboratory, Interplanetary Lab, Arizona Near Space Research