RALPHIE

Radio **A**nd **L**aser **P**at**H** agnost**I**c communications **E**xperiment

University of Colorado at Boulder
University Nanosatellite Program NS-11
March 13th, 2023

Duncan Bark
Alex Nelson
Samantha Zerbel
Madeleine Bahorski

Mission Statement

*RALPHIE aims to **break down CubeSat barriers** of data throughput and power system development time through flight demonstration of Blue Cube's Path-Agnostic Communication (PAC) System, including a high-throughput optical communication link, and Amplified Space's Software-Defined Power Controller (SDPC) charge controller.*

Full Duplex

up to 3 Gbps#
Data Rate

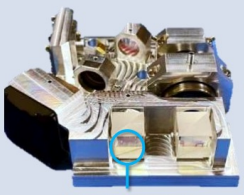
9x9x5 cm
size

< 900 g
Mass

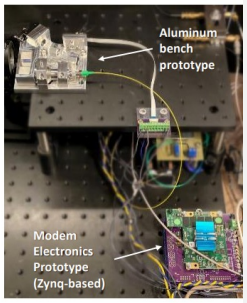
< 10 Watts
Power

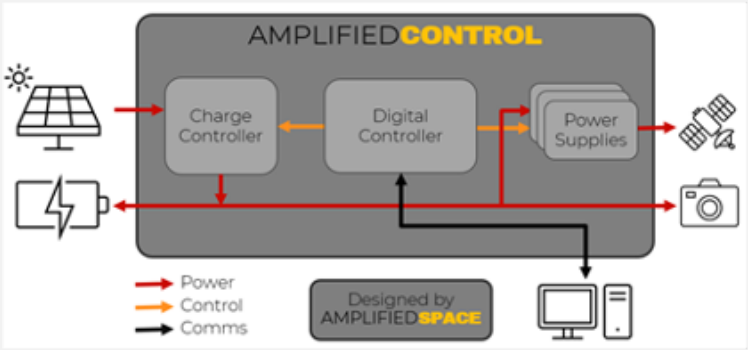
- expandable via WDM

Cobalt Optical Transceiver
(qualification unit)



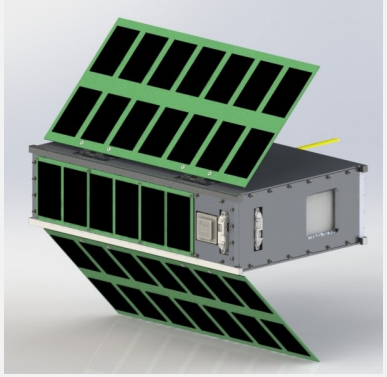
11 mm common aperture

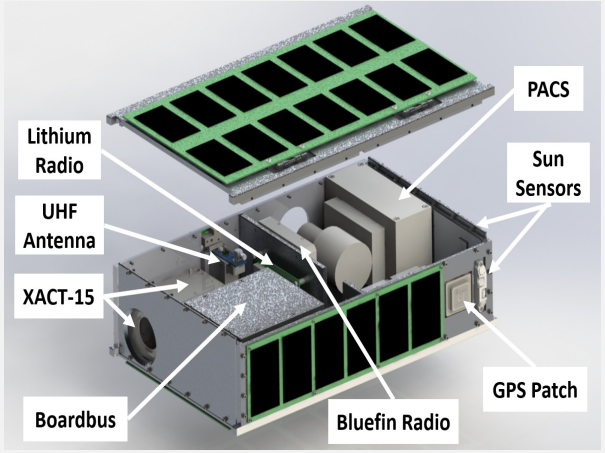




Mission Description

RALPHIE: 6U CubeSat





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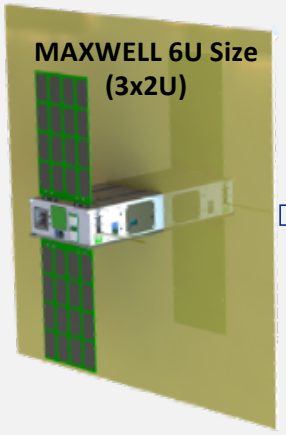

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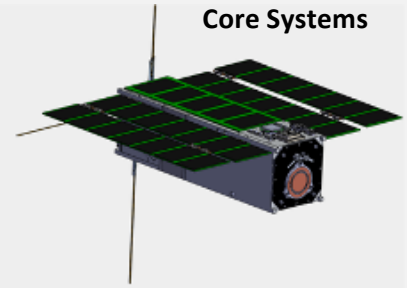
SWARM-EX: Core Systems



Mission Objectives

- Demonstrate the feasibility of the Cobalt optical link technology
  - Successfully downlink information using Cobalt (at 70 Mbps)
- Demonstrate communication using PACS
- Demonstrate PACS autonomous ability to route data over each communication and priority level
- Demonstrate SDPC operations (CC)

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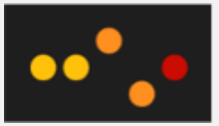

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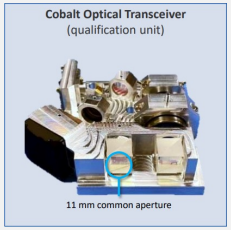
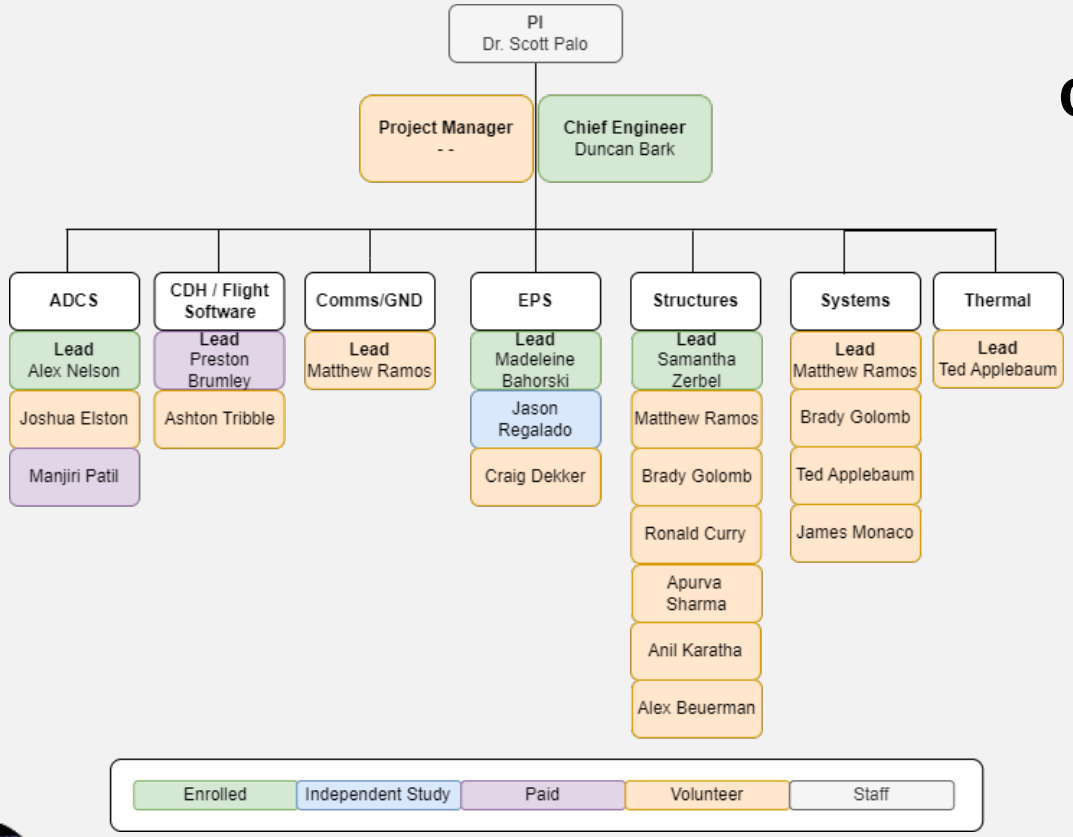


Power and Communication Payloads

Team Organization



Current Leadership:

PI: Dr. Scott Palo (he/him)

Acting PM: James Monaco (they/them)

CE: Duncan Bark (he/him)

ADCS: Alex Nelson (he/him)

CDH: Preston Brumley (he/him)

COMMs: Matthew Ramos (he/him)

EPS: Madeleine Bahorski (she/her)

STR: Samantha Zerbel (she/her)

SYS: Matthew Ramos (he/him)

THM: Ted Applebaum (he/him)

Stakeholders/Partners

AFRL
THE AIR FORCE RESEARCH LABORATORY
LEAD | DISCOVER | DEVELOP | DELIVER

Ann and H.J. Smead
Aerospace Engineering Sciences
UNIVERSITY OF COLORADO **BOULDER**

UNP UNIVERSITY NANOSATELLITE PROGRAM

BLUE CUBED

AMPLIFIEDSPACE

Spring Deliverables and Milestones

- Mid-semester Presentation in Graduate Projects Course: **March 13th**
- Mid-semester Review in CubeSat section: **March 15th**
- Recruiting events
  - March 15th review night
  - Aerospace Symposium
- No UNP deliverables or milestones this semester
- Looking forward:
  - *UNP Mini Review @ SmallSat 2023*: **August 5th-August 10th**
    - No required deliverables
    - RALPHIE booth requiring members present to answer questions and discuss RALPHIE
    - Poster materials, example hardware, etc.
  - *UNP Critical Design Review (CDR):* **September/October 2023**
    - Demonstrate progress since Preliminary Design Review (PDR) in December 2022
    - Demonstrate preparation for Flight Selection Review (FSR) in early 2024 (end of Phase A)
    - Assess status and progress of the project as it relates to:
      - Mission Design
      - Payload
      - Telecom
      - Structure
      - Power
      - CDH/FSW
      - Thermal
      - ADCS
      - Ground Station and Operations

Subsystems

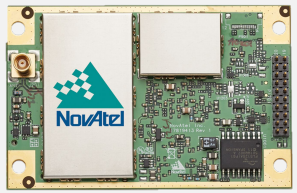
Spring Goals and Progress

Attitude Determination and Control (ADCS)

Goals:

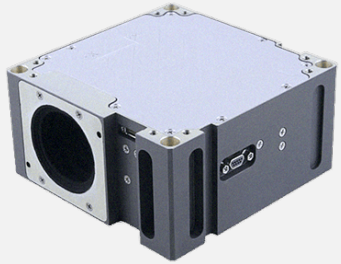
- Review and create action plans to address PDR feedback
- Finalize ADCS and GPS hardware (XACT, Sun Sensors, GPS Board, GPS Antenna)
- Analyze maneuvers for power consumption & keep out angles
- Characterize XACT jitter & control error

Taoglas GPS Antenna



Novatel GPS Board

XACT-15 ADCS



Progress:

- Reviewed all PDR feedback
- Finalized Hardware:

  XACT-15, Novatel OEM719, and Taoglas AGPSF.36C.07.0100C
- Began reviewing maneuvering power consumption

Command and Data Handling (CDH)

Goals:

- Develop a higher understanding of RALPHIE's CDH and FSW transition.
- Better define and document flight operational modes.
- Develop a plan on how CONOPs will work without stored commands.
- Document the communication algorithm between the dsPIC33 and the PACS.
- Develop a list of hardware and a first revision of the CDH PCB.

Progress:

- Analyzed and developed a higher understanding of CDH and FSW.
- Working with systems to develop the definitions of operational modes.
- Started developing the CDH board based on SWARM-EX and are currently in the stage of reallocating pins to hardware.

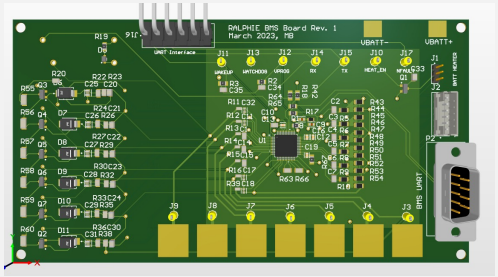
Electrical Power System (EPS)

Goals:

- Finalize power system diagrams defining interaction with other subsystems and UNP requirements (per PDR feedback)
- Develop Rev. 1 hardware for all EPS devices (BMS and EPS board)
- Receive Rev. 1 software defined power controller (SDPC) from Amplified Space

Progress:

- BMS board Rev. 1 design complete
- Backplane and EPS board Rev. 1 schematics 75% complete
- Inhibit scheme diagram solidified
- Full system power diagram complete, editing continues to reflect system status and design



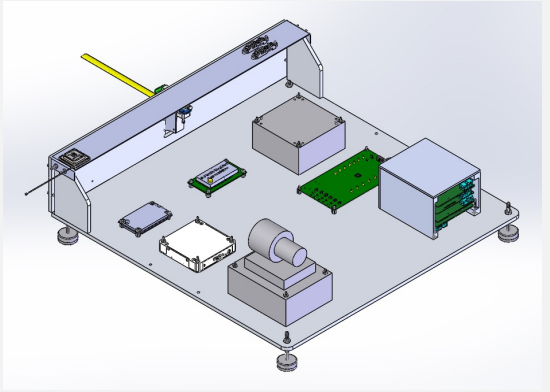
Structures (STR)

Goals:

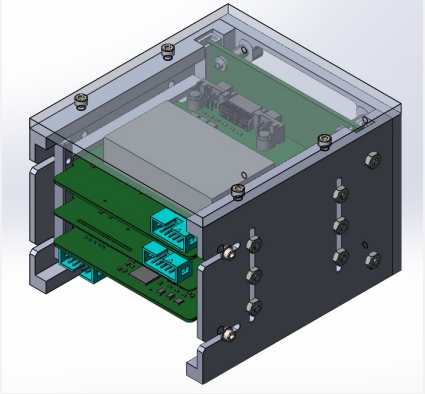
- Run structural analysis (FEA) on current CubeSat design
- Finalize FlatSat design and begin fabrication
- Complete preliminary assembly procedure
- Finalize component geometry and placement in CubeSat CAD
- Adjust structural design for manufacturability and assembly

Progress:

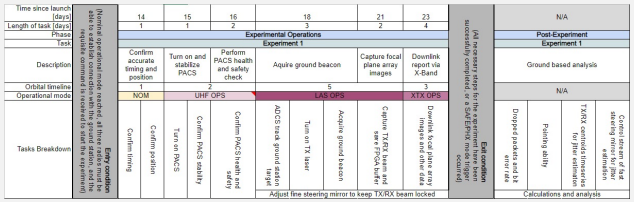
- FlatSat design (90% complete), documentation and order list in progress
- Preliminary assembly order established, currently flushing out document
- Simplification of current CubeSat components for FEA (70% complete)
- Component geometry fidelity (60% complete)



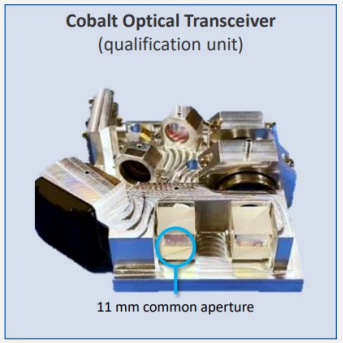
FlatSat



Boardbus



Systems (SYS)



Goals:

- Revise/finalize RVM (MO, MSC, UNP11 requirements, etc.)
- Revise experiment plans with the new scope of hardware (SDPC)
- Develop and implement FSW modes into CONOPs
- Finalize decision and documentation of radios, antennas, and ground stations
- Complete thermal analysis and implement hardware/changes

Progress:

- RVM revision complete
- Experiment plans are up to date with new hardware scope
- Working with CDH to develop FSW modes and revise operational modes
- Decision and documentation of radios, antennas, and ground stations is in progress

Project Worries/Concerns/Needs

- **Overall**
  - Limited time commitments from a number of members due to their volunteer status
  - Member turnover due to graduations, outside time commitments, and volunteer variability
  - Part acquisition delays and difficulties (solar cells, semiconductor parts, etc.)

Thank You!