# “Nationwide Eclipse Ballooning Project Engineering Systems Overview”


Randal (Randy) M. Larimer, PE

Special Projects Director, Montana Space Grant Consortium

NEBP Engineering Presentation
December 2022

# Abstract

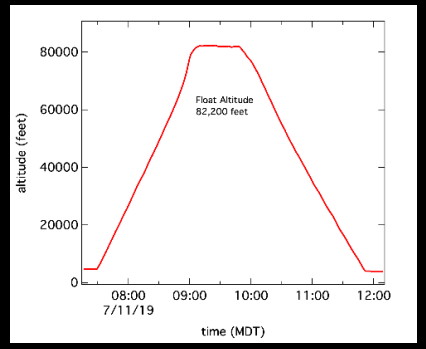
This presentation highlights the technical engineering systems used to safely and successfully capture real-time video and data from a high-altitude weather balloon during the October 14, 2023 annular eclipse and the April 8, 2024 total solar eclipse.  The engineering POD leads and their students have been carefully designing, documenting and testing the systems that will be distributed to the participating forty engineering teams.

System components include an Iridium tracking system, a cutdown system, a tracking ground station, a streaming video system, a dual camera system providing 360 degree views, a helium vent valve system for latex balloons, zero pressure balloons, temperature sensors, pressure sensors and precision GPS sensors.

Software to support the system components include a real time tracking website, tracking ground station code, dual camera and streaming code, along with the embedded code.
Participating teams will learn the systems and have an opportunity to create their own payload.

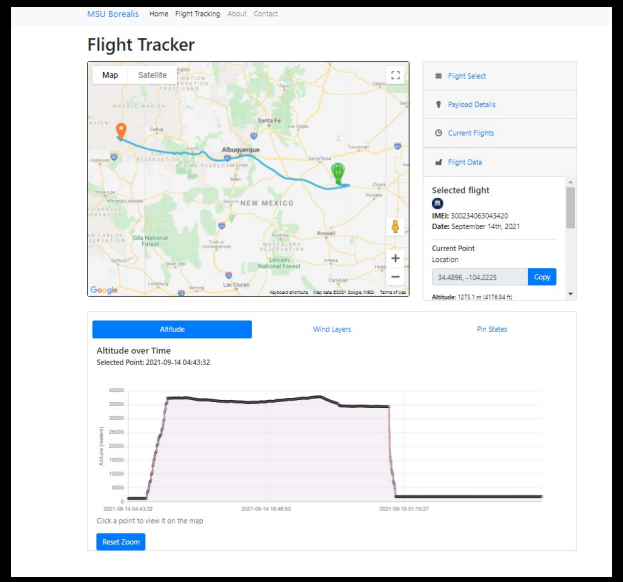
# Nationwide Eclipse Ballooning Project (NEBP) - Engineering

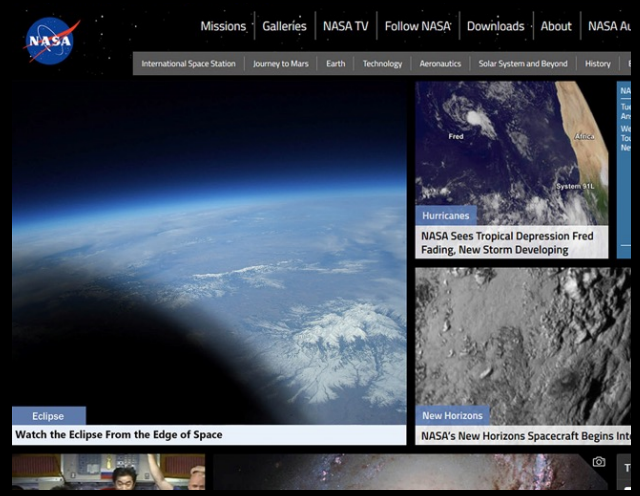





NEBP Engineering Presentation
December 2022

# Nationwide Eclipse Ballooning Project (NEBP) - Engineering




Iridium Satellites

Internet

Data Server

900 MHz antenna

Tracking Ground Station

Ground Station Computer

Ethernet

Internet

Video

5.8 GHz antenna

XBEE Terminate and Vent

RFD 900 MHz Downlink with Precision GPS

Tracking Iridium Modem and Xbee Control

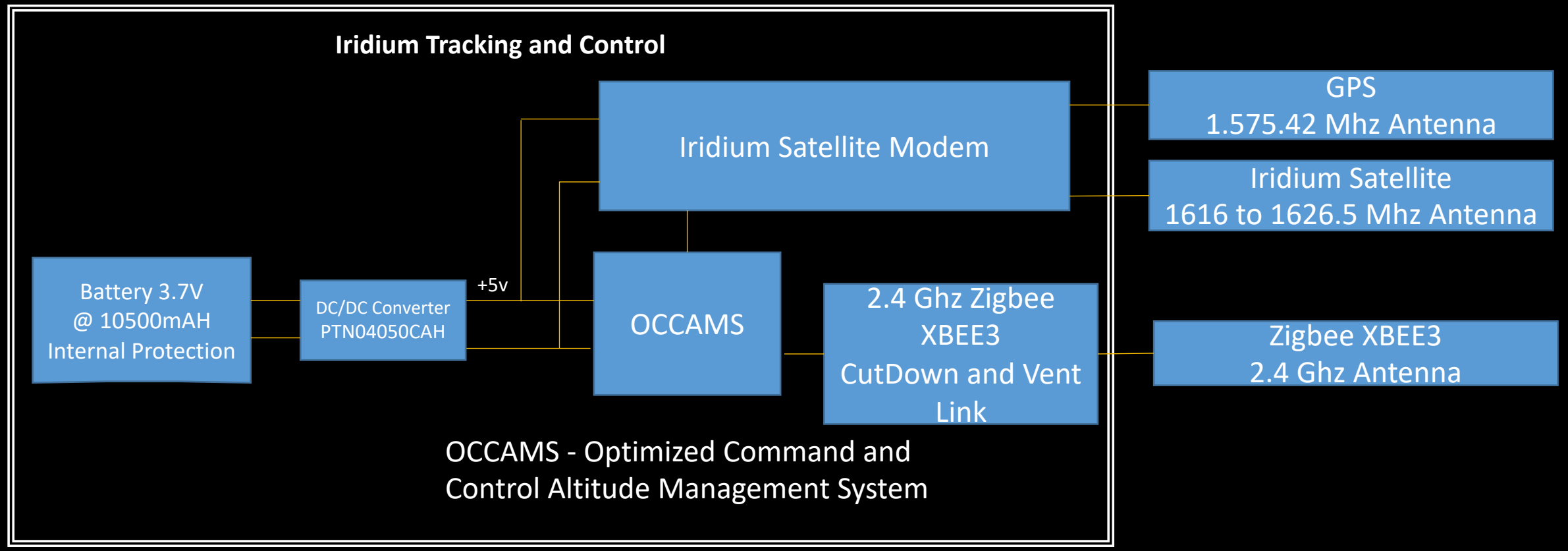
Atmospheric and Precision GPS Measurements

Custom Team Payloads

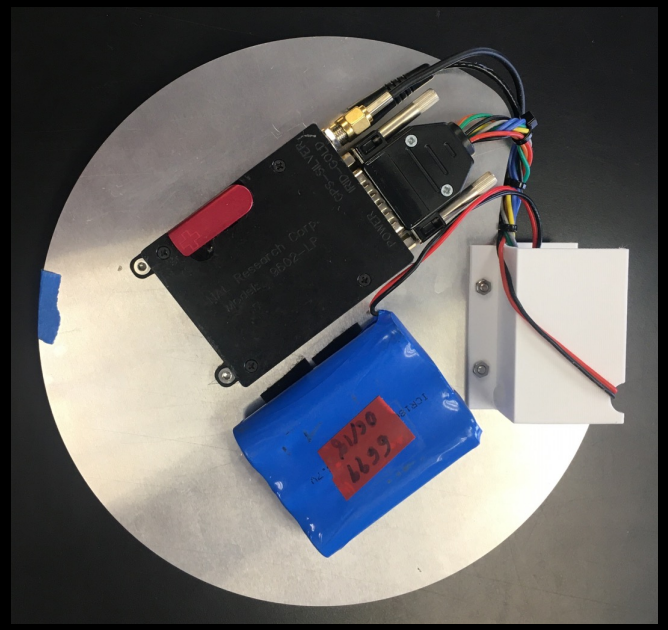
Cameras and 5.8 GHz Video Downlink

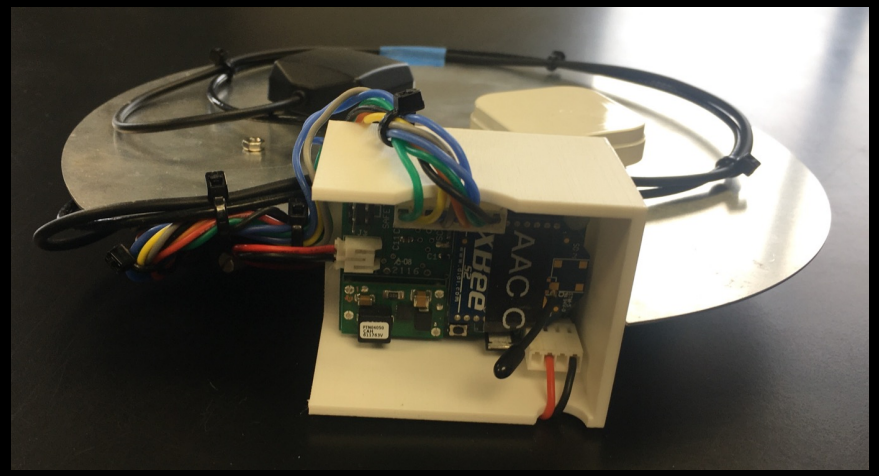
NEBP Engineering Presentation
December 2022

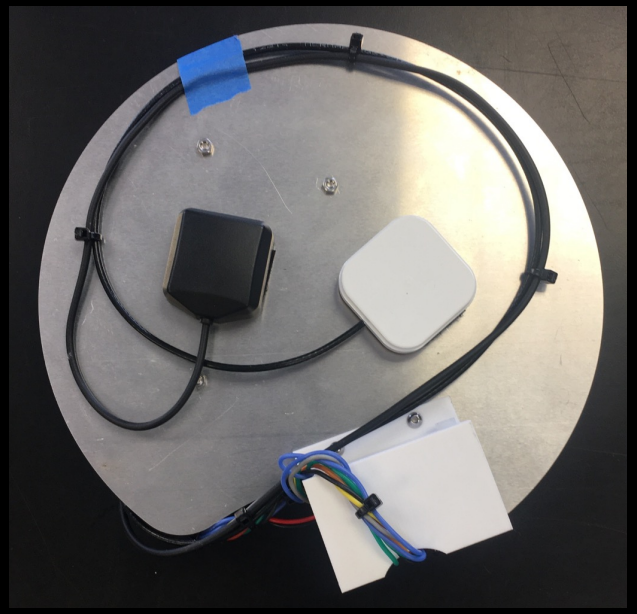
# NEBP Primary Payload Iridium Tracking and Control Block Diagram December 2022

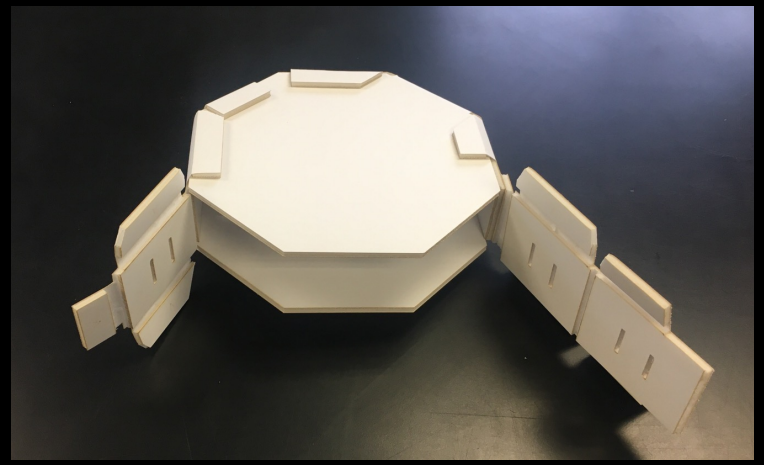


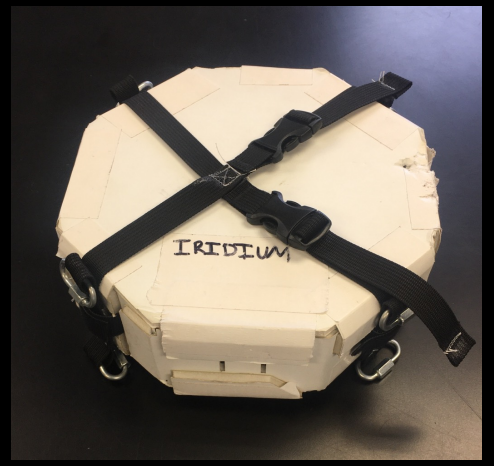
# NEBP Primary Payload Iridium Tracking and Control - December 2022





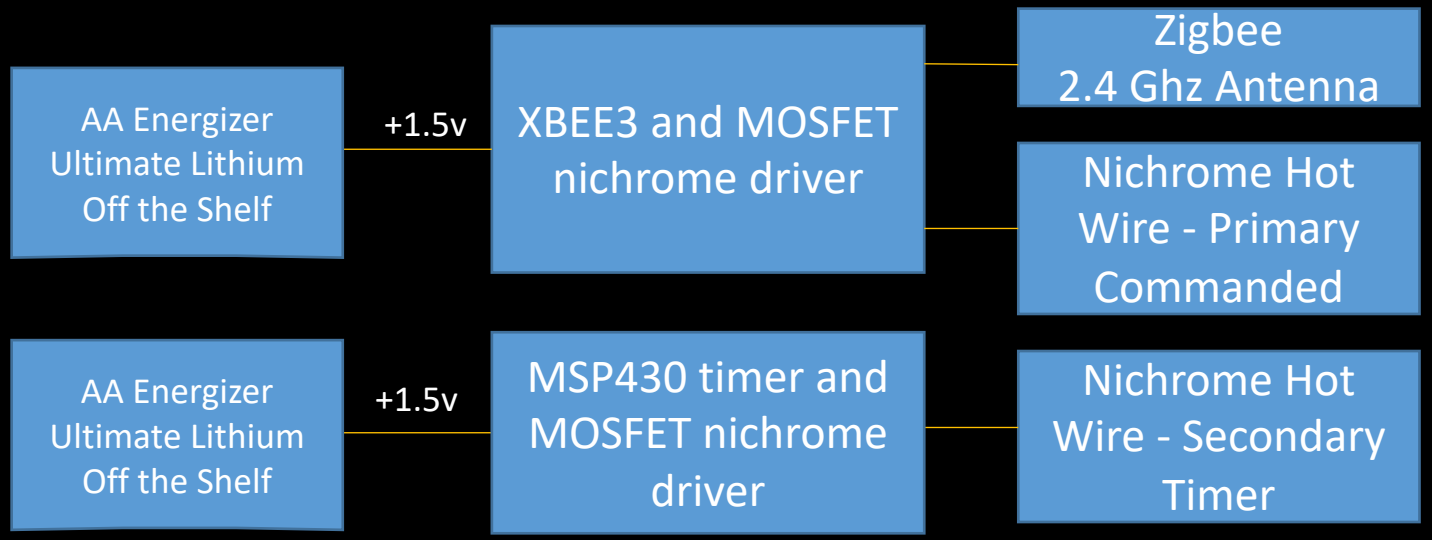




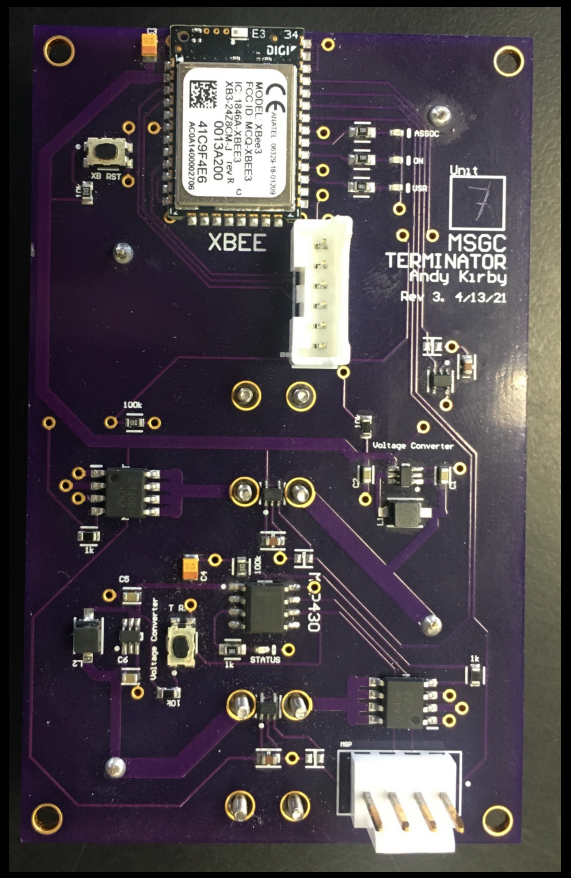



NEBP Engineering Presentation
December 2022

# NEBP Termination System Block Diagram – December 2022

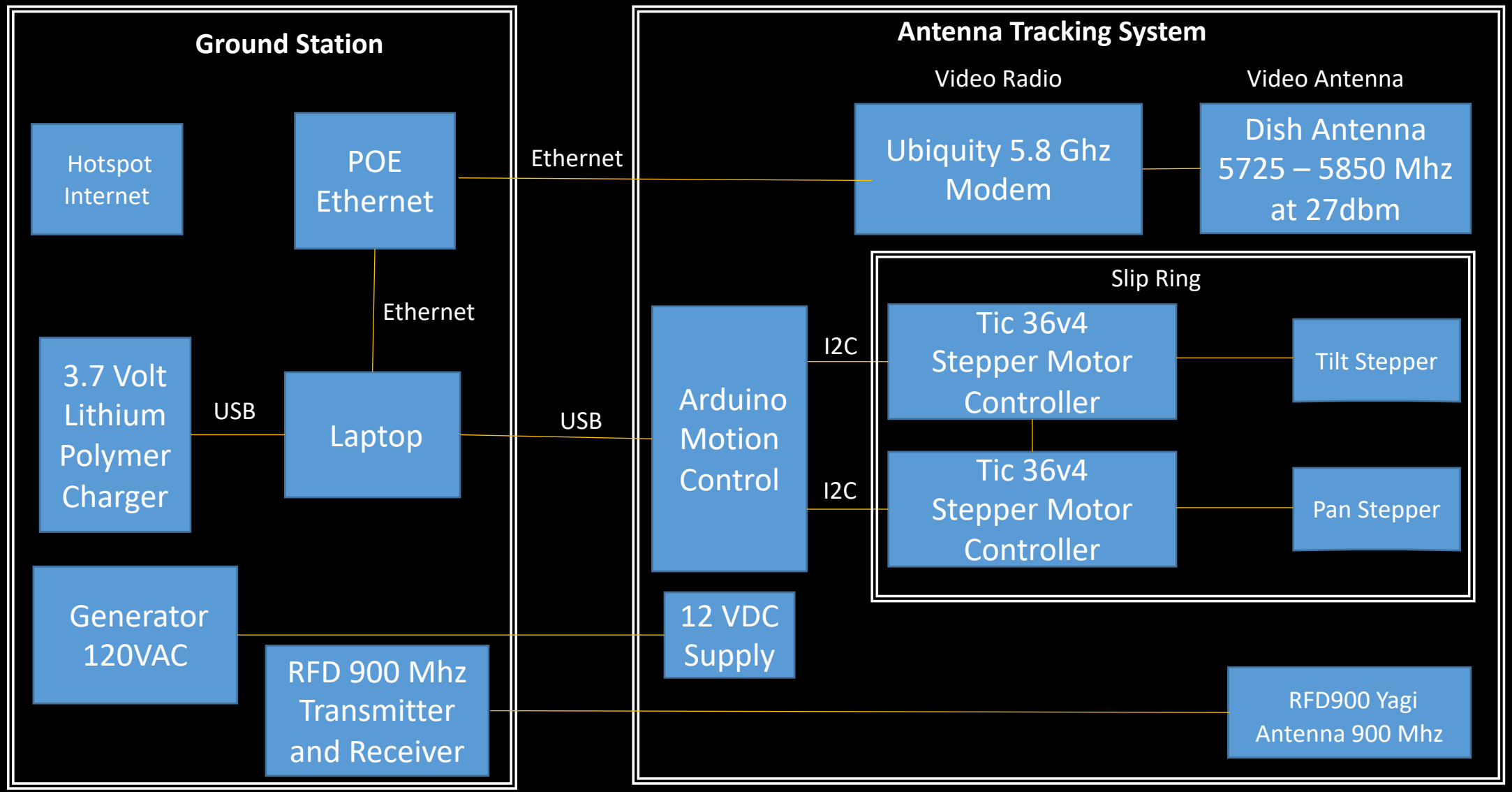


# NEBP Termination System – December 2022

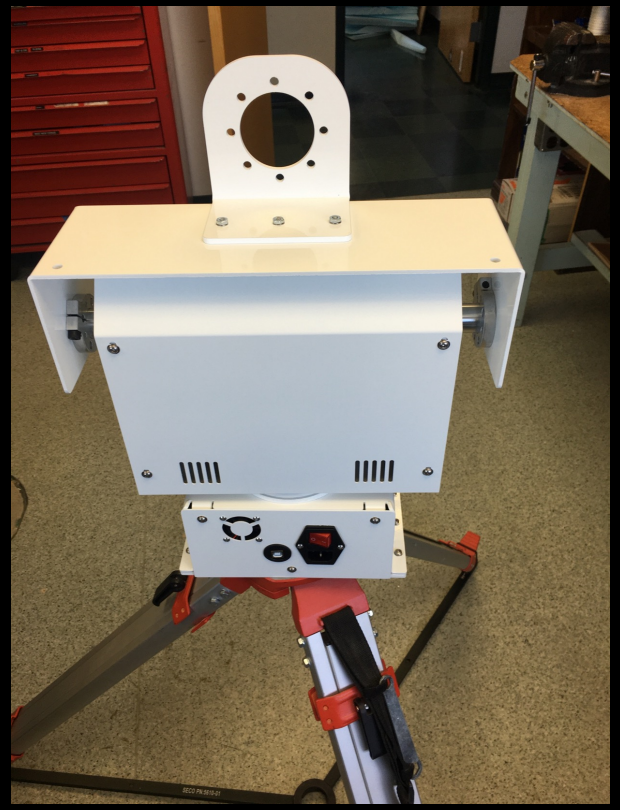




# NEBP Primary Payload Ground Station Block Diagram - December 2022



# NEBP Primary Payload Ground Station - December 2022



# NEBP Primary Payload Video Streaming Block Diagram - December 2022


**Power Board**

+22 volts

Battery 3.7V @ 10500mAH Larger for Longer Duration Internal Protection

DC/DC Converter

POE Ethernet

Ethernet

Ubiquity 5.8 Ghz Modem

Antenna 5725 – 5850 Mhz at 27dbm

Battery 3.7V @ 10500mAH Internal Protection

5v

DC/DC Converter PTN04050CAH

Raspberry Pi 4

Raspberry Pi's native high-speed MIPI CSI-2 port.

Camera Lens

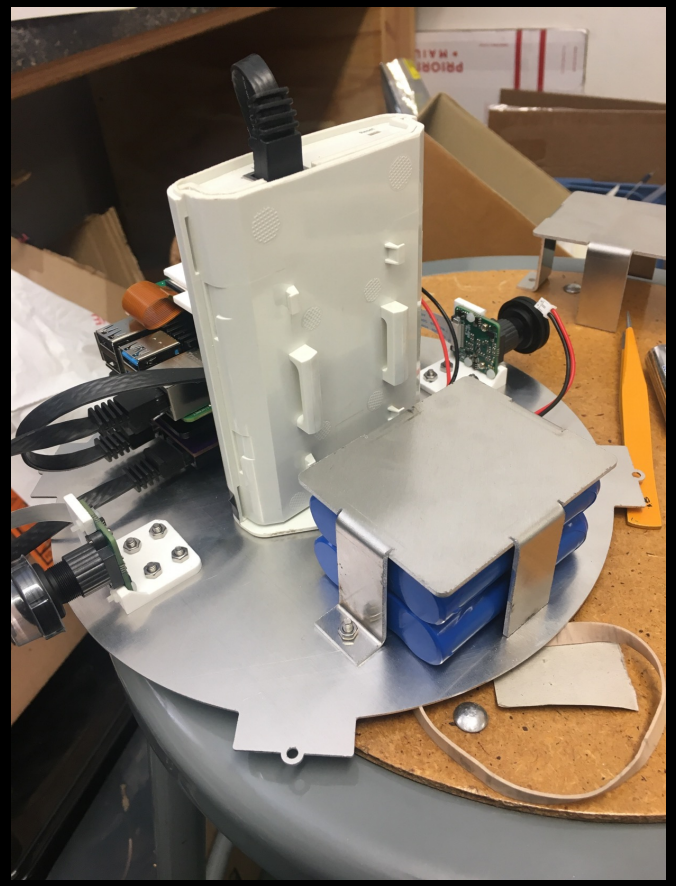
Camera 1

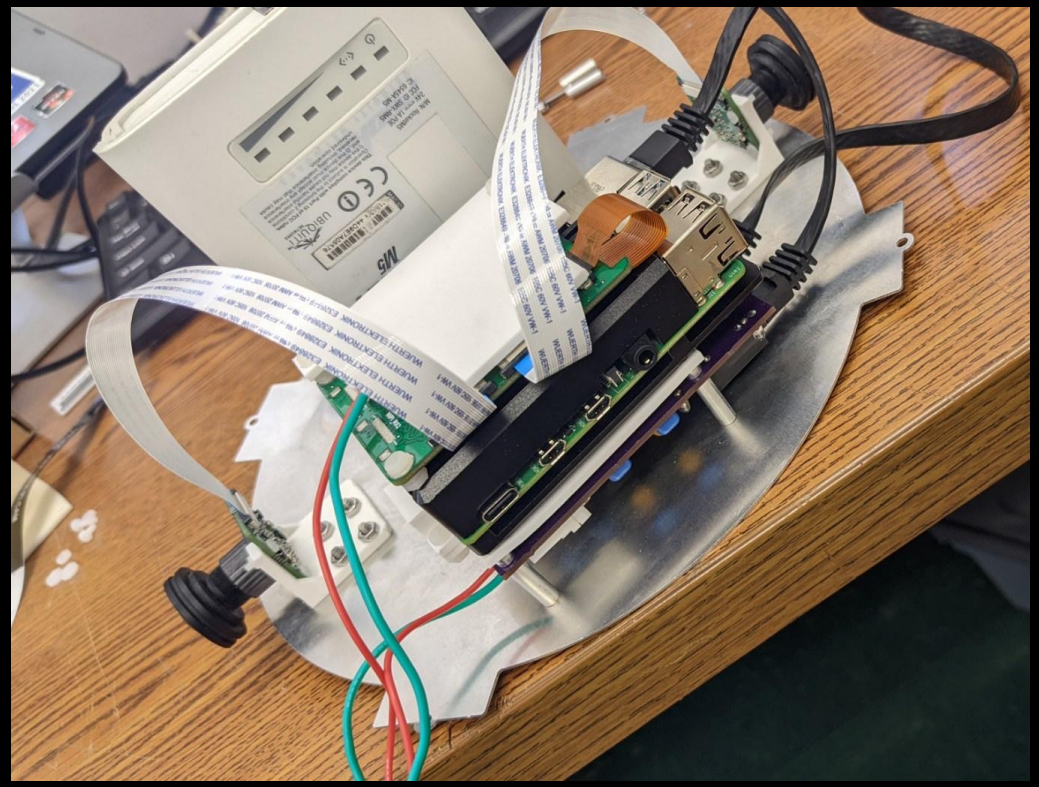
Arducam Stereo Pi Hat

Camera 2

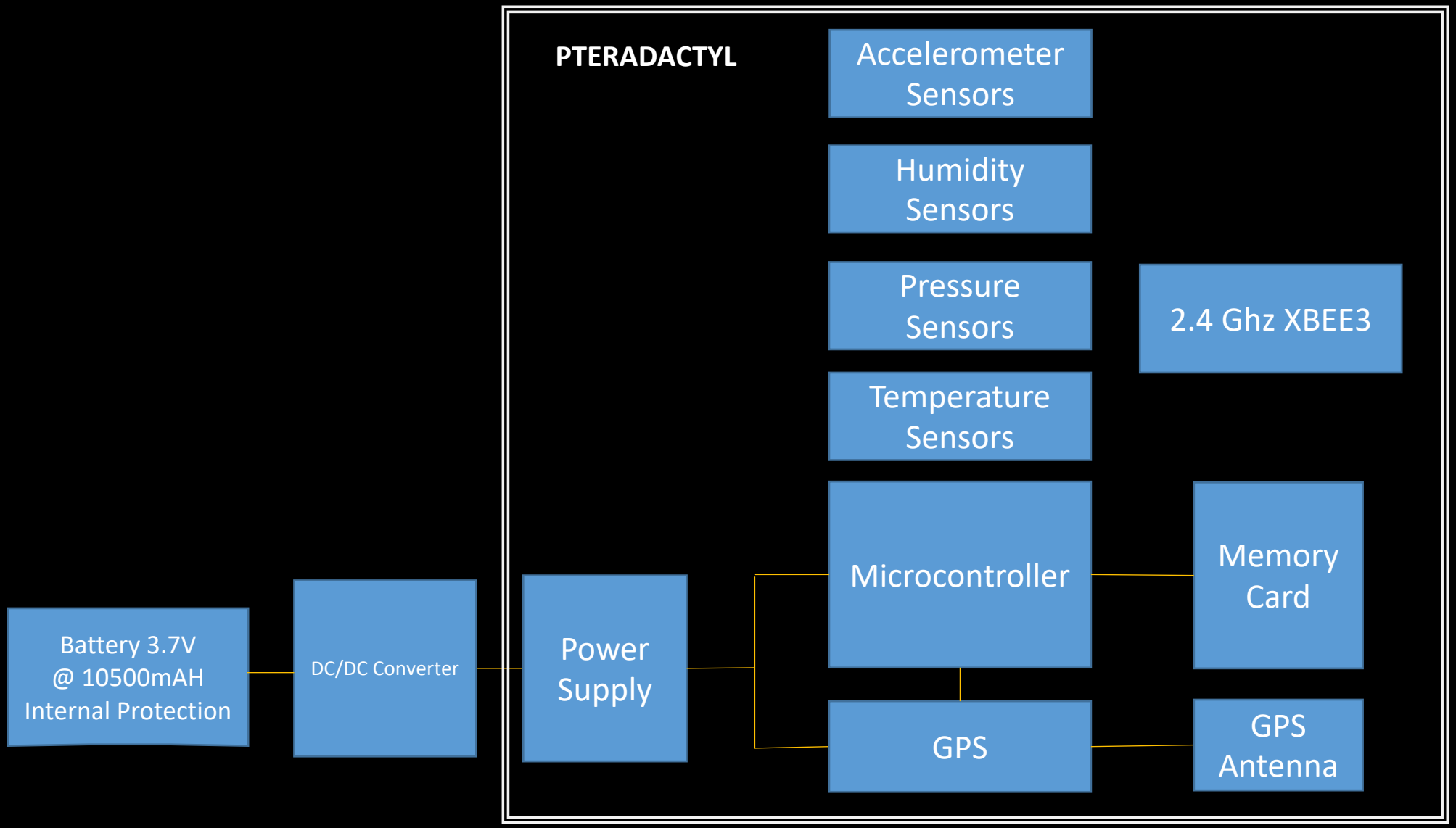
Camera Lens

# NEBP Primary Payload Video Streaming - December 2022

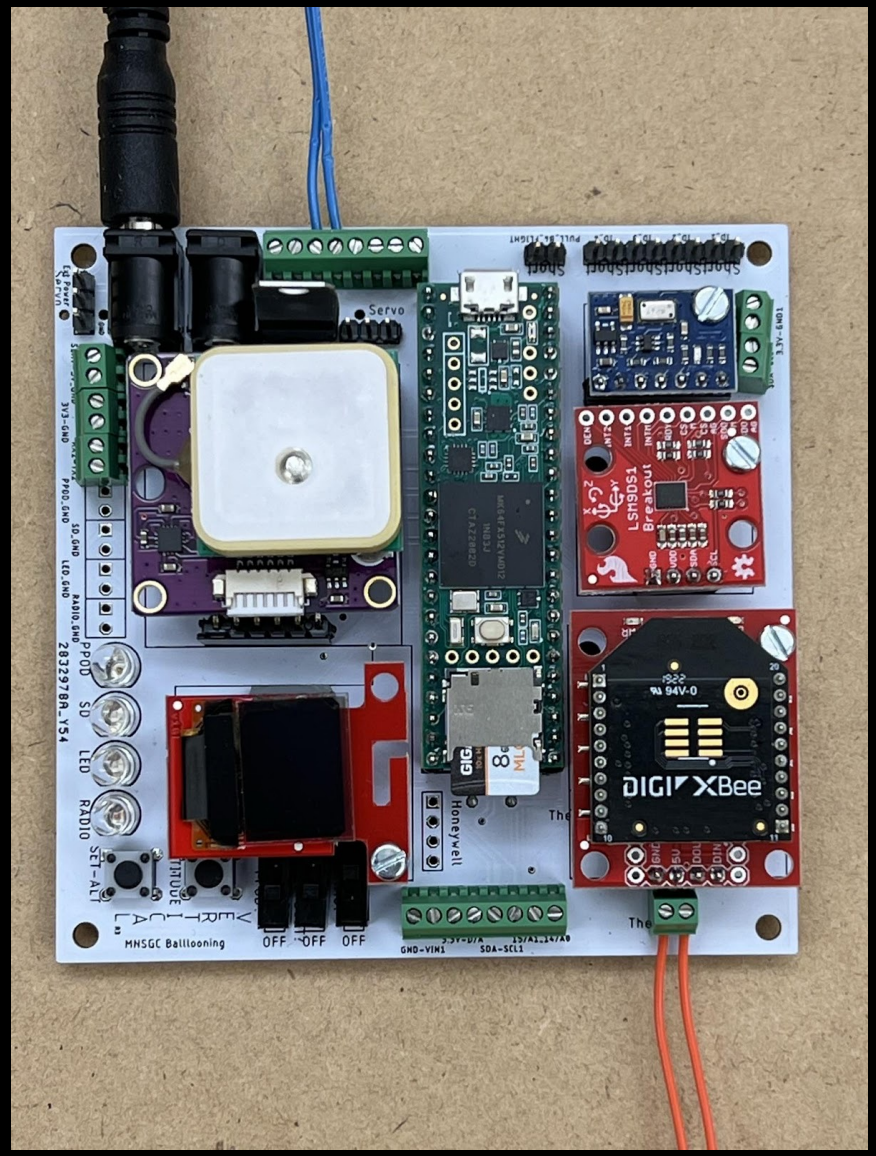




# NEBP Block Diagram Atmospheric Measurement System - December 2022

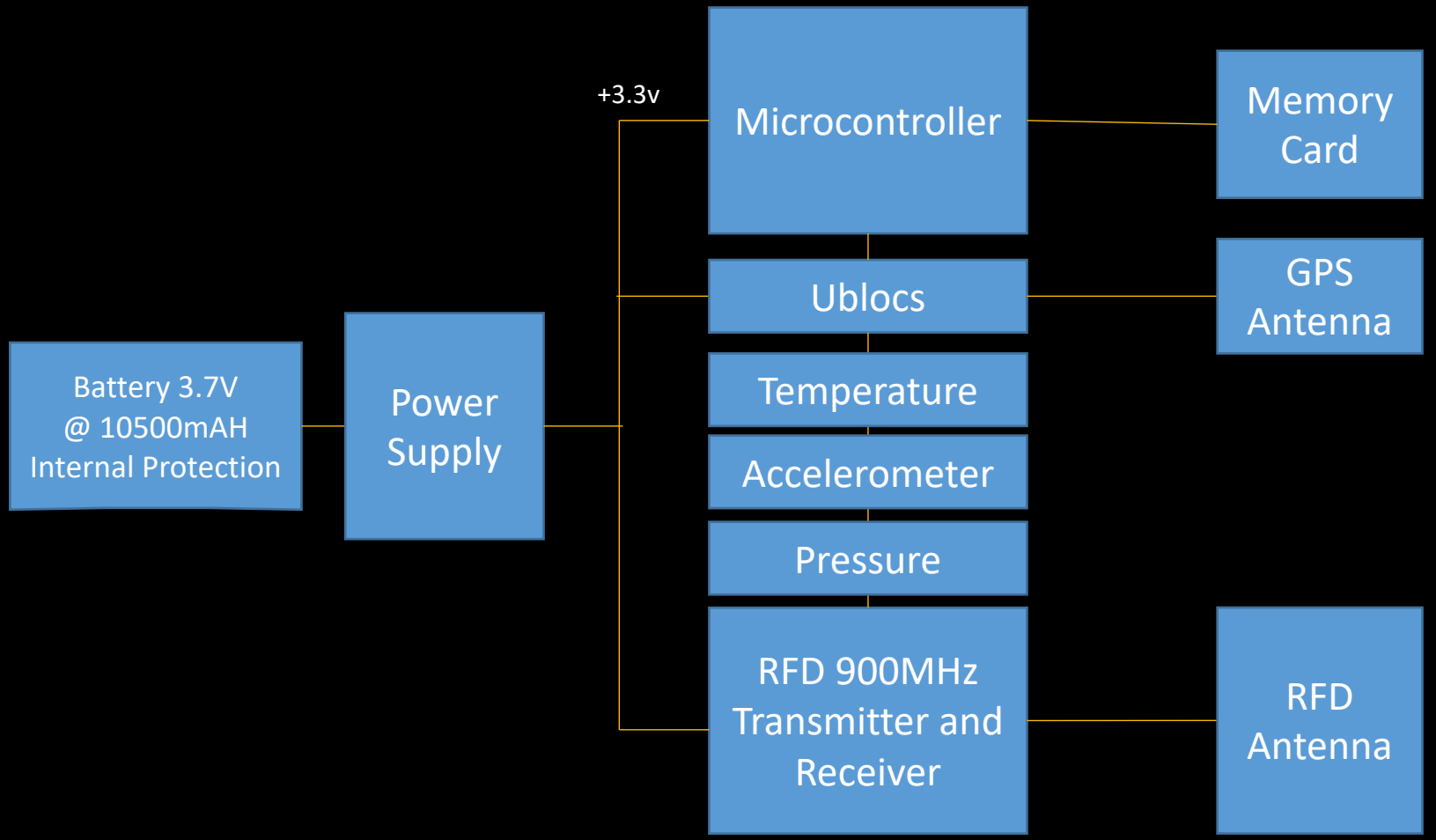


# NEBP Atmospheric Measurement System - December 2022

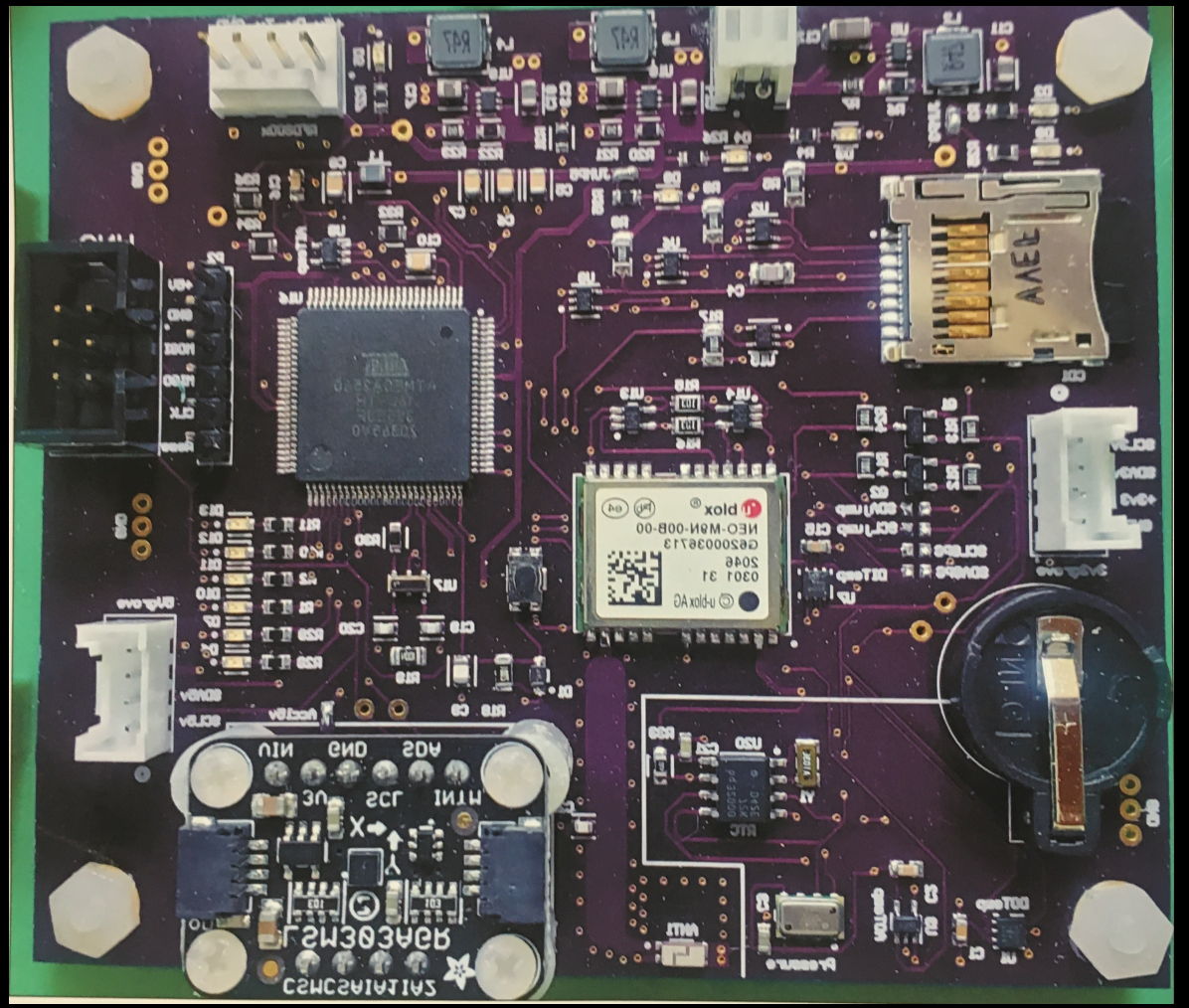



NEBP Engineering Presentation
December 2022

# NEBP Block Diagram RFD and Precision GPS System - December 2022

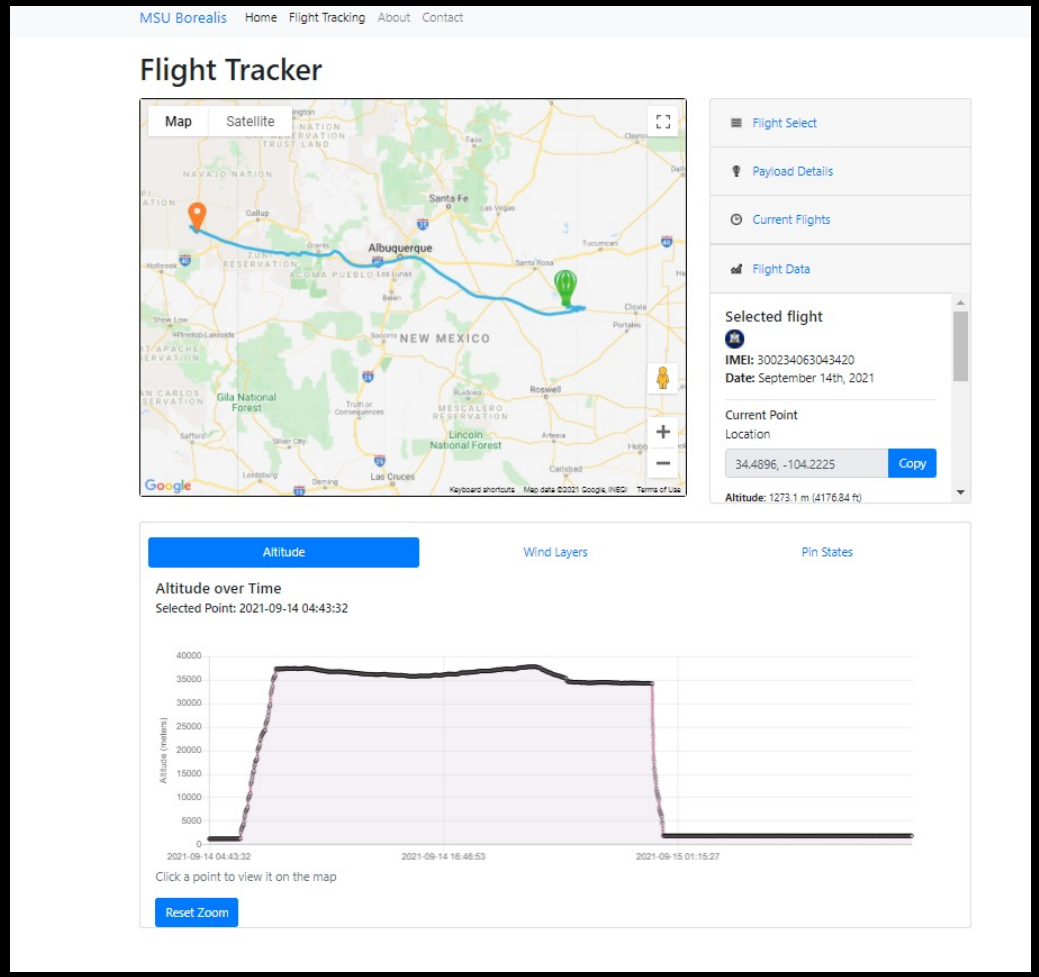


# NEBP RFD and Precision GPS System - December 2022

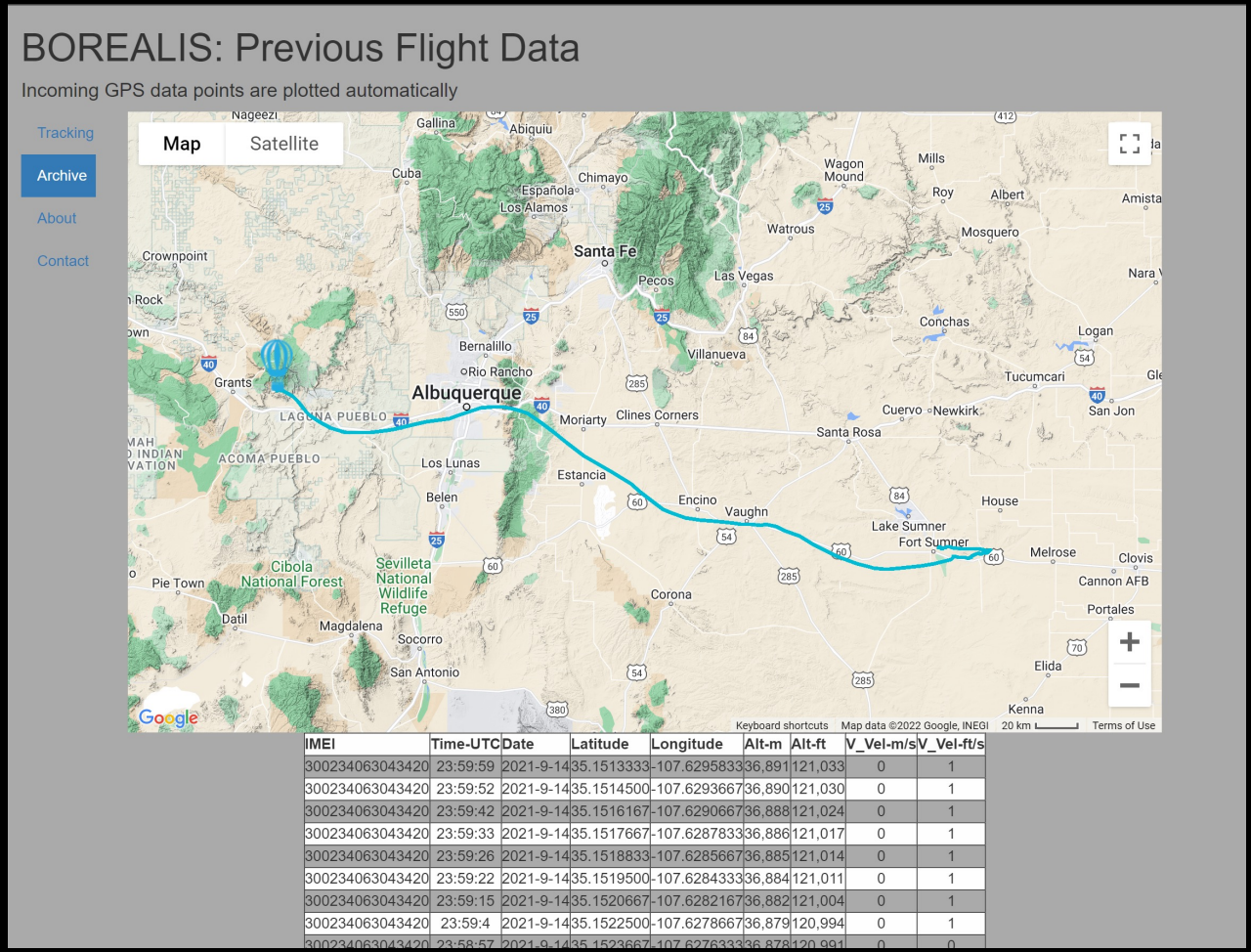


# NEBP Tracking Websites – December 2022

https://borealis.rci.montana.edu

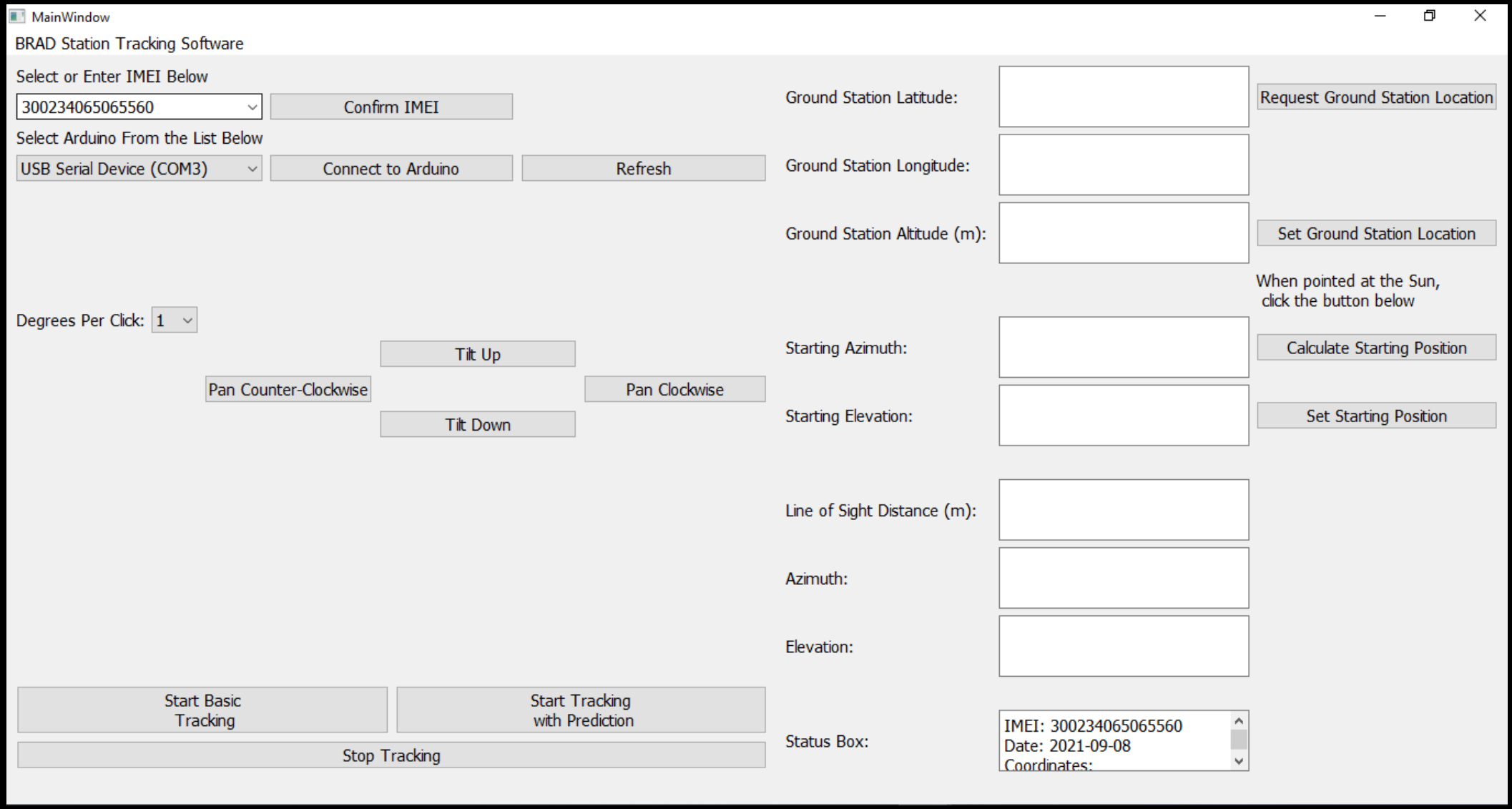



eclipse.rci.montana.edu

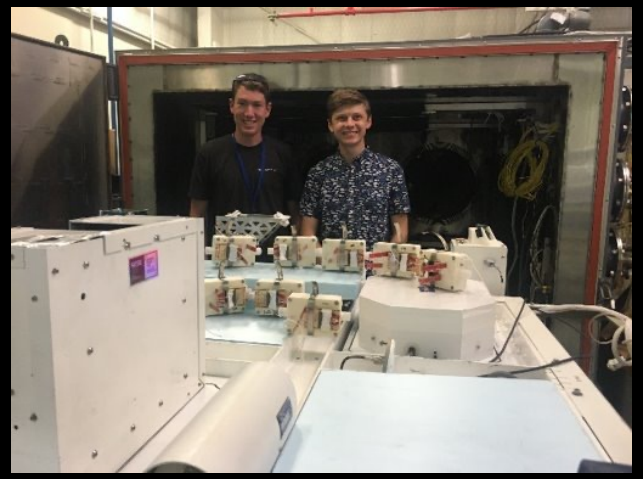


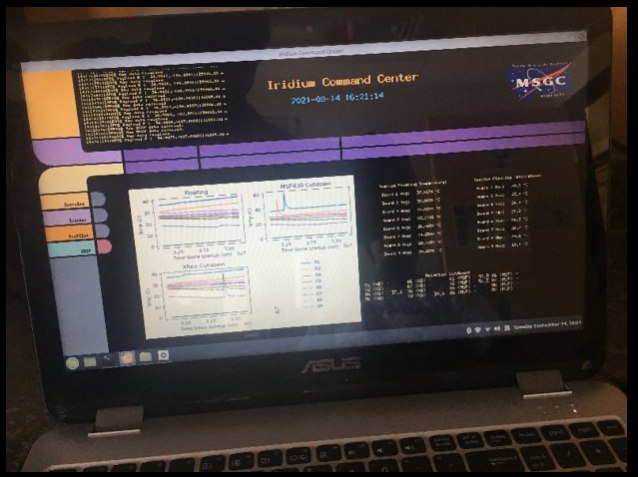

| IMEI | Time-UTC | Date | Latitude | Longitude | Alt-m | Alt-ft | V_Vel-m/s | V_Vel-ft/s |
|---|---|---|---|---|---|---|---|---|
| 300234063043420 | 23:59:59 | 2021-9-14 | 35.1513333 | -107.629583 | 36,891 | 121,033 | 0 | 1 |
| 300234063043420 | 23:59:52 | 2021-9-14 | 35.1514500 | -107.629367 | 36,890 | 121,030 | 0 | 1 |
| 300234063043420 | 23:59:42 | 2021-9-14 | 35.1516167 | -107.629067 | 36,888 | 121,024 | 0 | 1 |
| 300234063043420 | 23:59:33 | 2021-9-14 | 35.1517667 | -107.628783 | 36,886 | 121,017 | 0 | 1 |
| 300234063043420 | 23:59:26 | 2021-9-14 | 35.1518833 | -107.628567 | 36,885 | 121,014 | 0 | 1 |
| 300234063043420 | 23:59:22 | 2021-9-14 | 35.1519500 | -107.628433 | 36,884 | 121,011 | 0 | 1 |
| 300234063043420 | 23:59:15 | 2021-9-14 | 35.1520667 | -107.628217 | 36,882 | 121,004 | 0 | 1 |
| 300234063043420 | 23:59:4 | 2021-9-14 | 35.1522500 | -107.627867 | 36,879 | 120,994 | 0 | 1 |
| 300234063043420 | 23:58:57 | 2021-9-14 | 35.1523667 | -107.627633 | 36,878 | 120,991 | 0 | 0 |

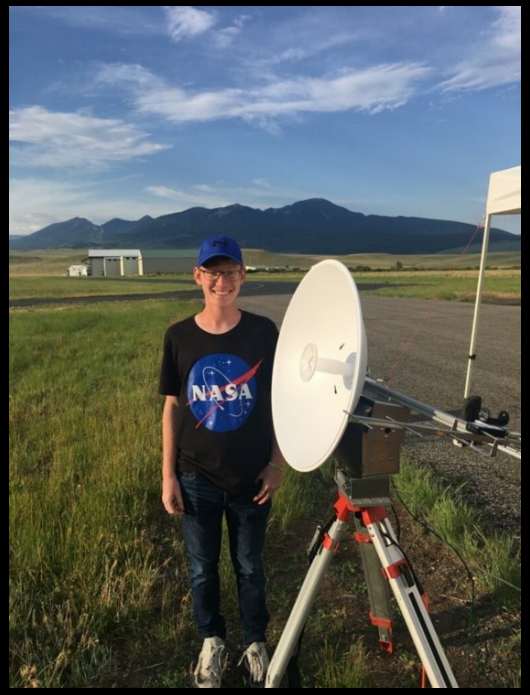
# NEBP Tracking Software – December 2022



# NEBP Testing of Engineering Systems HASP 2021






NEBP Engineering Presentation
December 2022

# NEBP Solar Balloon Build and Testing

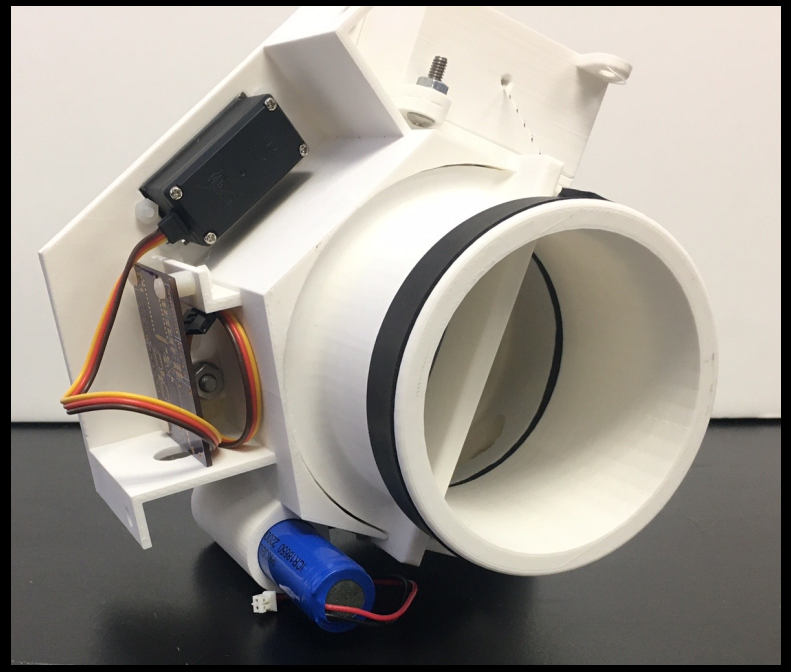
NEBP Engineering Presentation
December 2022

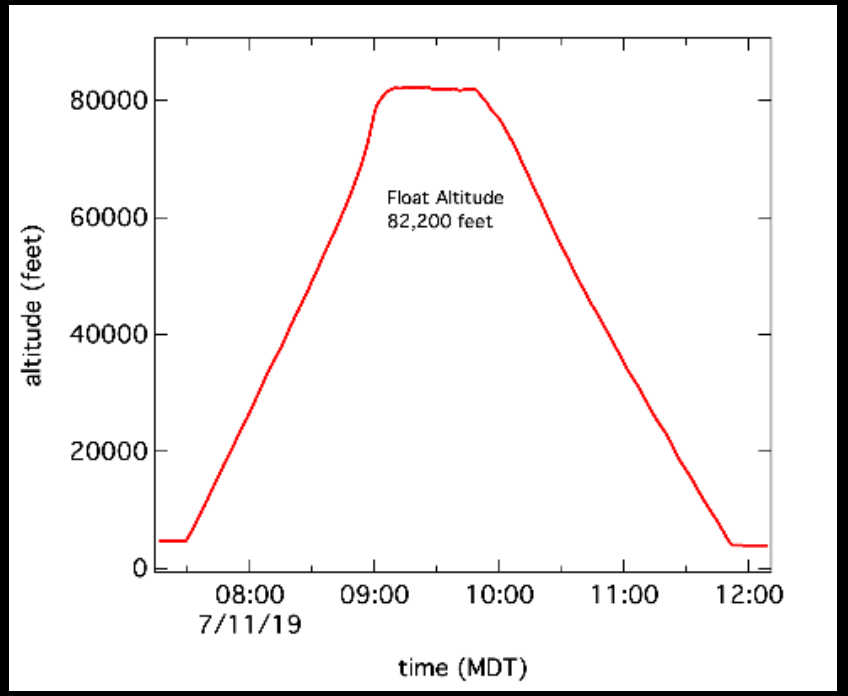
# NEBP Zero Pressure Balloon Build and Testing

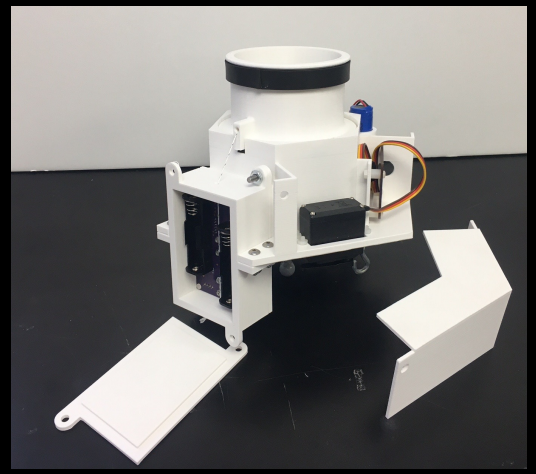
NEBP Engineering Presentation
December 2022

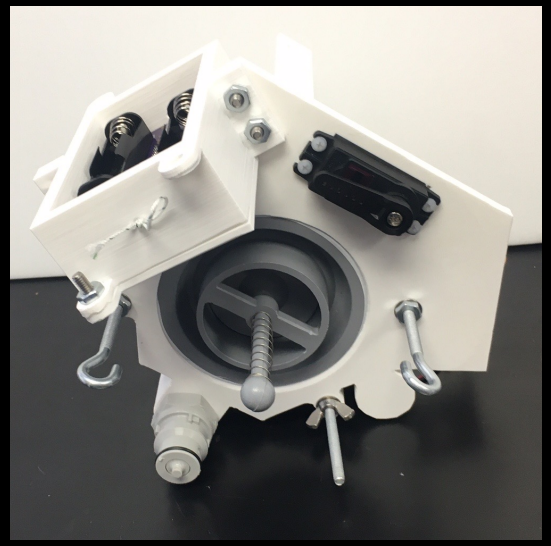
# NEBP Latex Vent System - December 2022

# NEBP Latex Vent System with Cutdown - December 2022

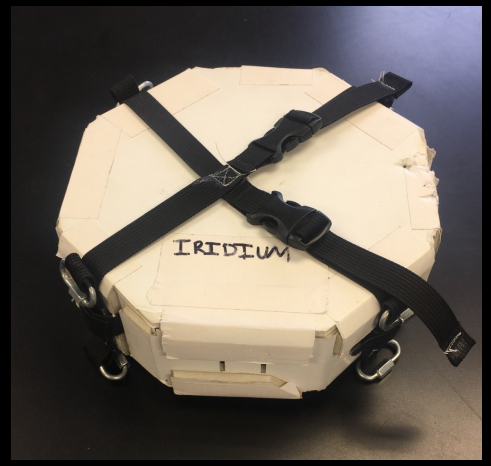


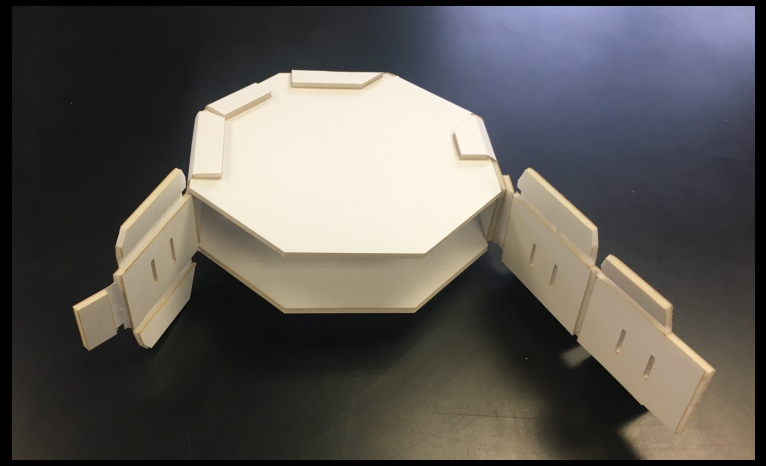


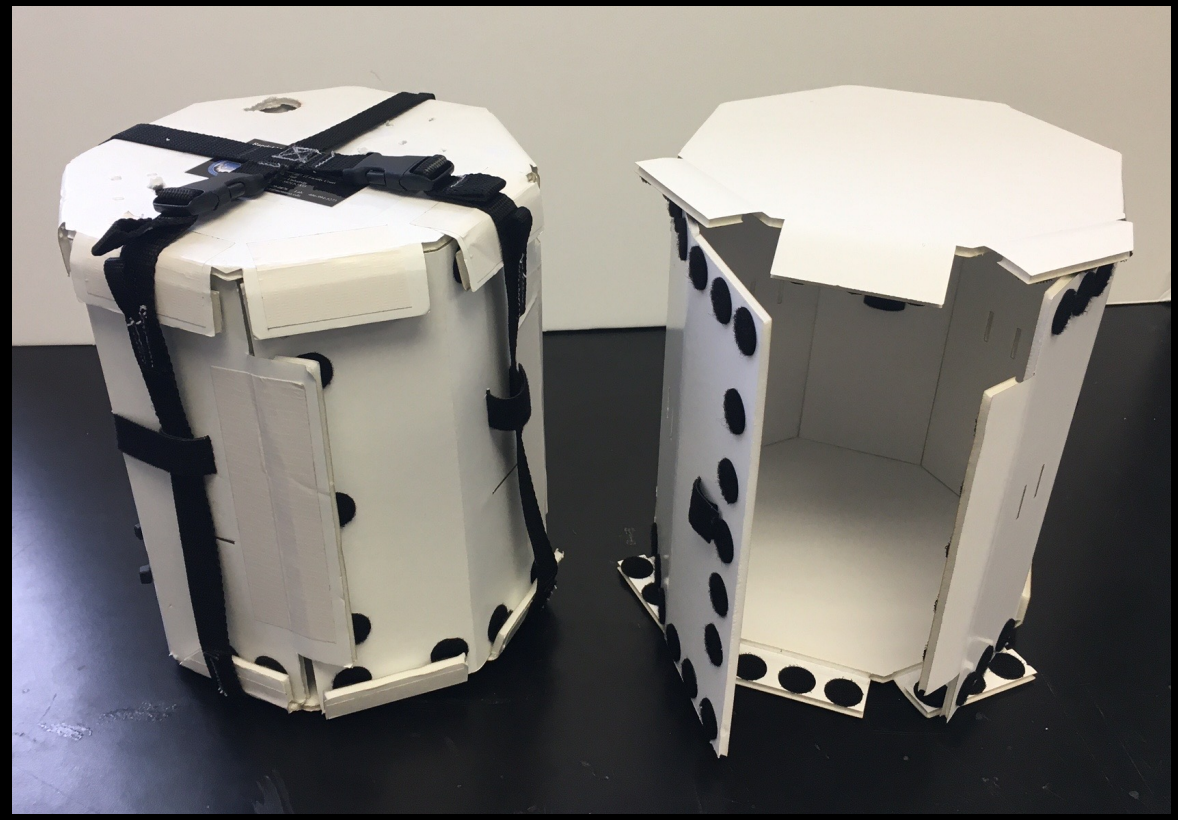





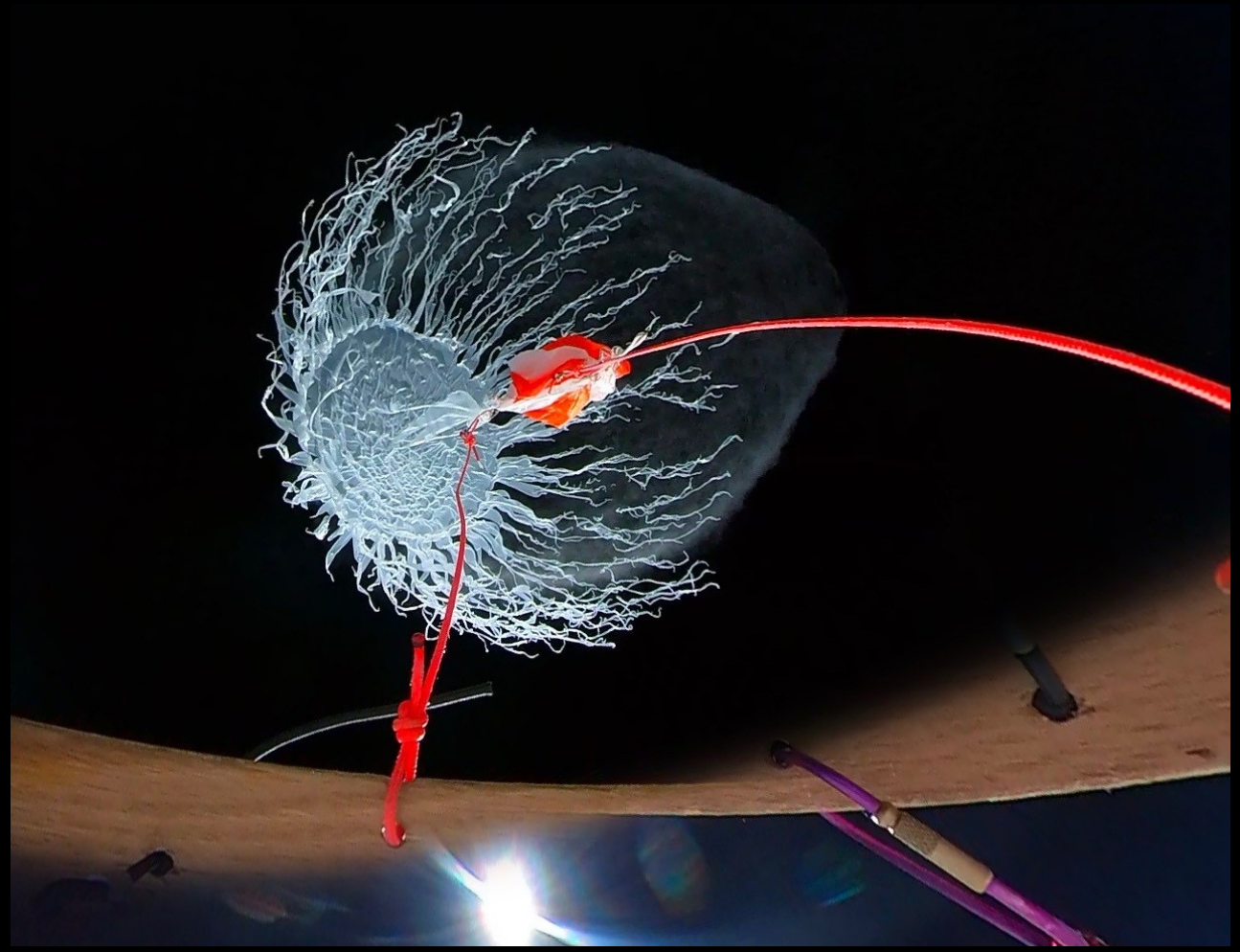
# NEBP Payload Packaging - December 2022





# Questions?



Bursting latex balloon at altitude showing powder around helium bubble.

More info:
https://eclipse.montana.edu

Randy Larimer
Email: rlarimer@montana.edu