



# NevadaSAT: High-Altitude Ballooning

## Keeping High-Resolutions Cameras Operational at 100,000'

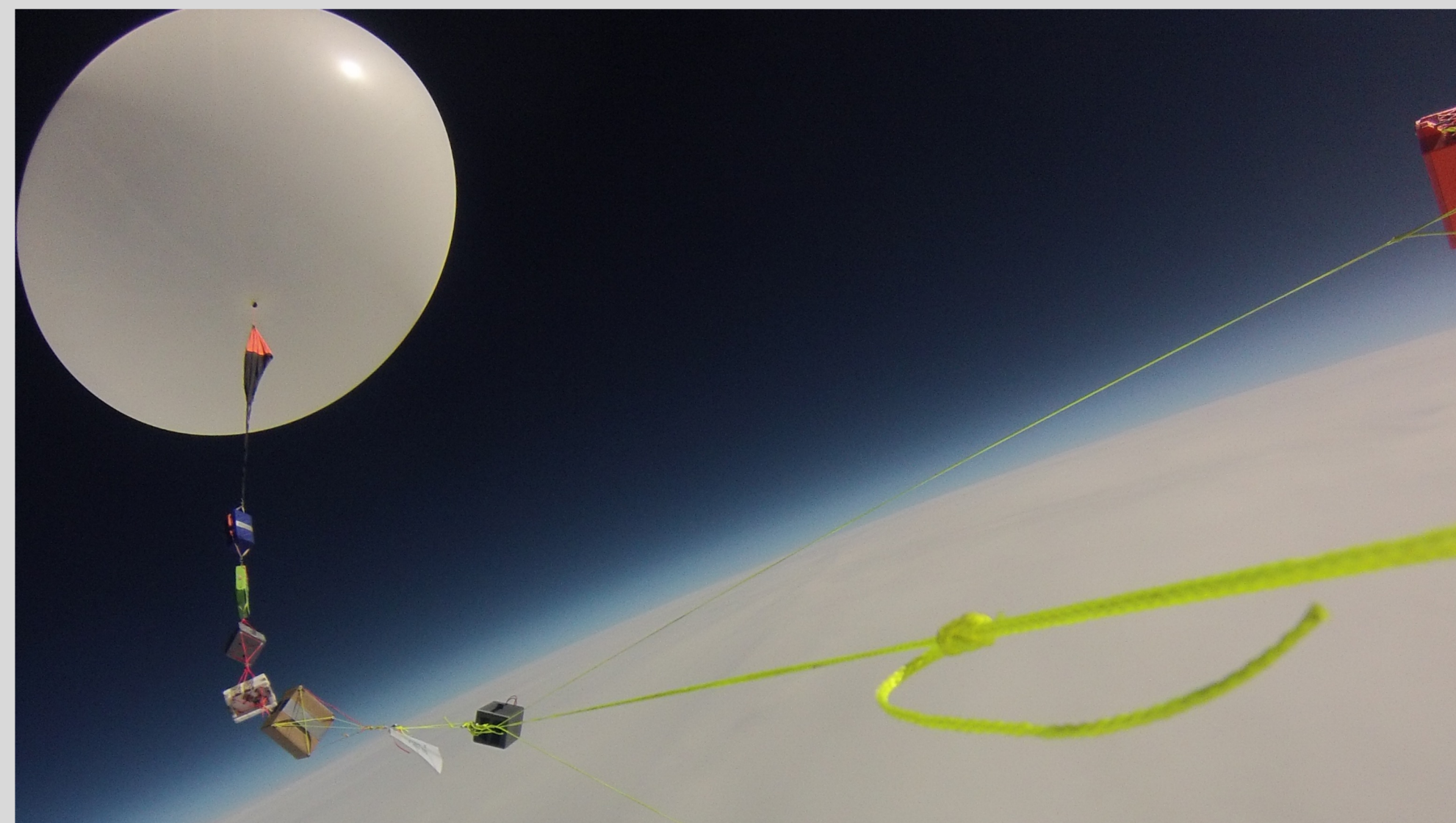
Brayden Griffie, Robert Gillespy, Sanpreet Singh



### Introduction &

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The NVSat: High Altitude Ballooning UNR team is participating in the National Eclipse Ballooning Project (NEBP), tasked with the acquisition of high-resolution photos and videos from 100,000 ft above the Earth's surface, during the 10/14/2023 annular and 4/8/2024 total solar eclipses.



A string of weather balloon payloads, captured by a GoPro HERO3

#### Background

- At max altitude (~100,000 ft), temperatures reach -60 °F, causing high-resolution cameras to turn off.

### Hypothesis & Equipment

#### Hypothesis

The high-altitude environment's frigid temperatures cause low voltage in the battery, causing the cameras to turn off prematurely. Containing or generating heat within the housing will enable the cameras to record the entire duration of the flight

#### Equipment

- Onset HOBO UX120-006M 4-Channel Analog Data Logger
- GoPro HERO9
- GoPro Max



GoPro HERO9

### Methodology



Preliminary tests done in residential freezers

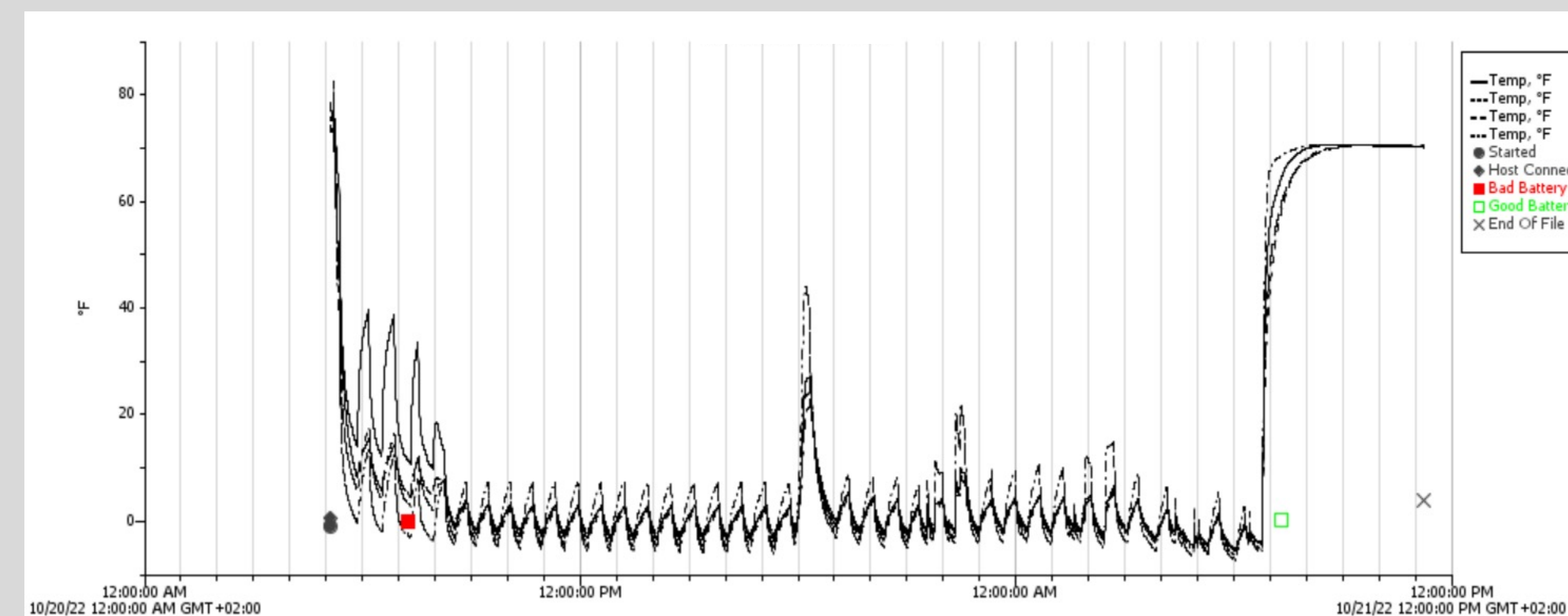
- Tested multiple camera configurations (PLA case, insulation, active heating elements)
- Variety of different environments (residential freezers, dry ice, biological sample freezer).



Multiple camera configurations in an industrial-grade freezer

### Results

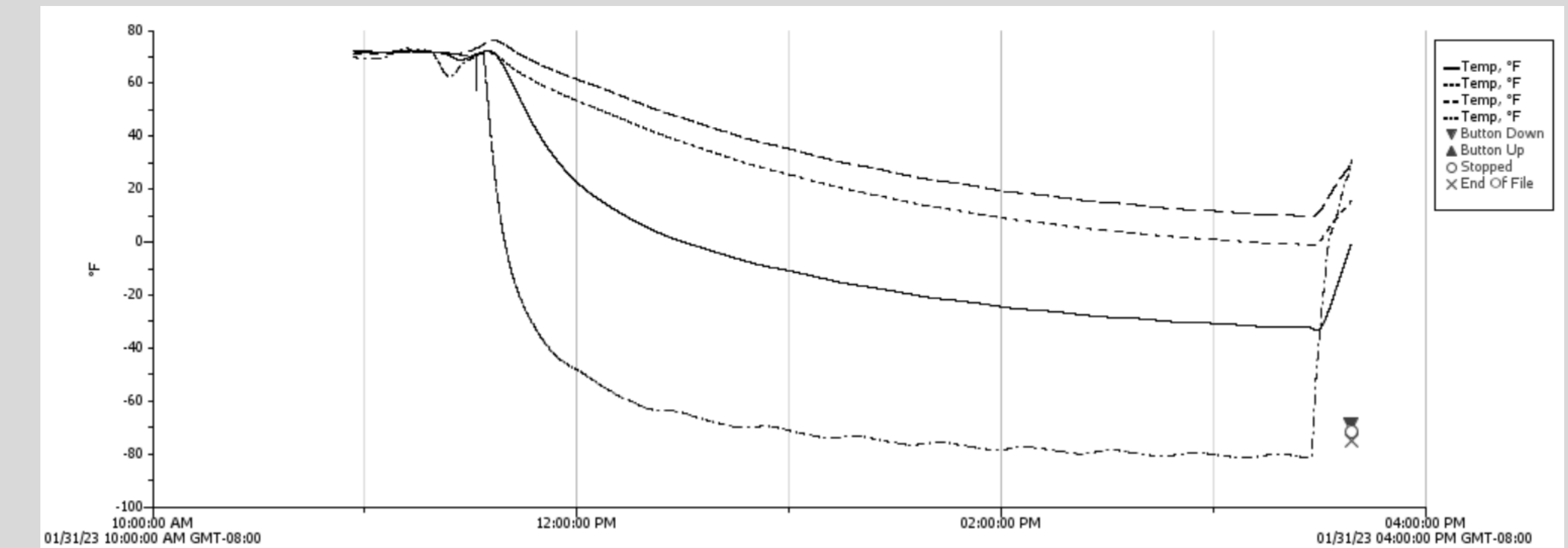
#### Exposed GoPro Hero 9: Residential Freezer



This graph depicts temperature difference between various spots on the camera/battery set-up

- In the initial freezer test, the back of the camera stayed around 20 °F warmer than the ambient temperature
- Cameras died after an hour and a half in the residential freezer

#### Insulated GoPro Hero 9: Industrial-Grade Freezer



This graph depicts temperature differences between various spots on the camera/battery after insulation was added

- The addition of a 1/2" layer of insulating foam kept operating temperatures around 70 °F warmer than the ambient temperature.
- All camera configurations recorded the duration of the four-hour test while in ambient temperatures of around -80 °F

### Conclusions



The final camera housing design

- Insulating the camera increases thermal retention by over 3x, which allowed cameras to record the duration of a weather balloon flight.
- The cause for the low temperatures, and the duration of the tests that were recorded.

### Ac

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