Project Imua 14

Integrated Subsystem Testing Review (ISTR)

University of Hawaii Community Colleges

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Order of Presentation

- Section 0: Action Item Summary
- Section 1: Mission Overview
- Section 2: Systems Overview
- Section 3: Updates on Subsystem Testing Results
- Section 4: Integrated Subsystem Testing Results
- Section 5: Plan for FMSR
- Section 6: Updated Summary Test Plan
- Section 7: Updated Wallops Test Plan
- Section 8: Project Management
- Section 9: Conclusions

Action Item Summary

STR Action Items

- Clarify your locking feature for the nuts on your experiment
  - Done (see slide 26)
- Document the actual weight of your ejectable and amount of Camphor using
  - Done (see slides XX)
- Update your PWR and TM pins per the manifest sent in this email
  - Done (updated documents in Google Drive and slides XX)
- More detailed drawing/images of your experiment design are still needed
  - Done (emailed on 2/28, uploaded to our Drive, also in presentation)
- Include updates and details for all aspects of your experiment (i.e. ScubeR)
  - Done (in presentation)

Mission Overview

Mission Statement (Summary)

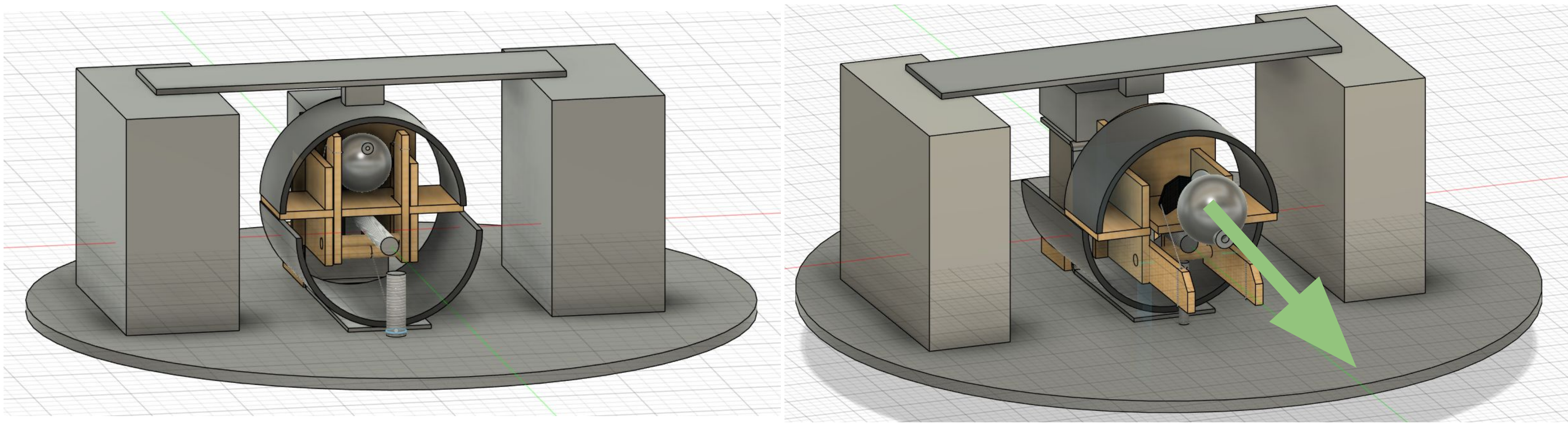
1. Project Imua
   a. Collaboration of Honolulu Community College (HonCC) & Windward Community College (WinCC)
   b. Promote STEM education & careers
2. Research
   a. Launch a small scale sublimation rocket
   b. Determine specific impulse I_{sp} of sublimate (camphor)
   c. Electronic Payload
      - Student Development & Understanding

Mission Statement

Project Imua Mission 14's goals are:

- To encourage UHCC students to explore and enter STEM-based careers by engaging in team-oriented, problem-solving activities that emphasize the integration process involved in the design, fabrication, testing and documentation of launch-ready, space-bound payloads supporting scientific and/or engineering experiments.
- To conduct research on the feasibility of using a sublimation–fueled motor for providing low-power vernier thrust. The specific impulse of the sublimate camphor will be determined by a static ground test and by deploying the rocket from a sounding rocket at apogee. On board cameras will record the sublimation rocket's flight parameters. This data will be supplemented by a multi-axis accelerometer that will provide a baseline for the payload's flight trajectory.

Mission Overview - Experiment Operation



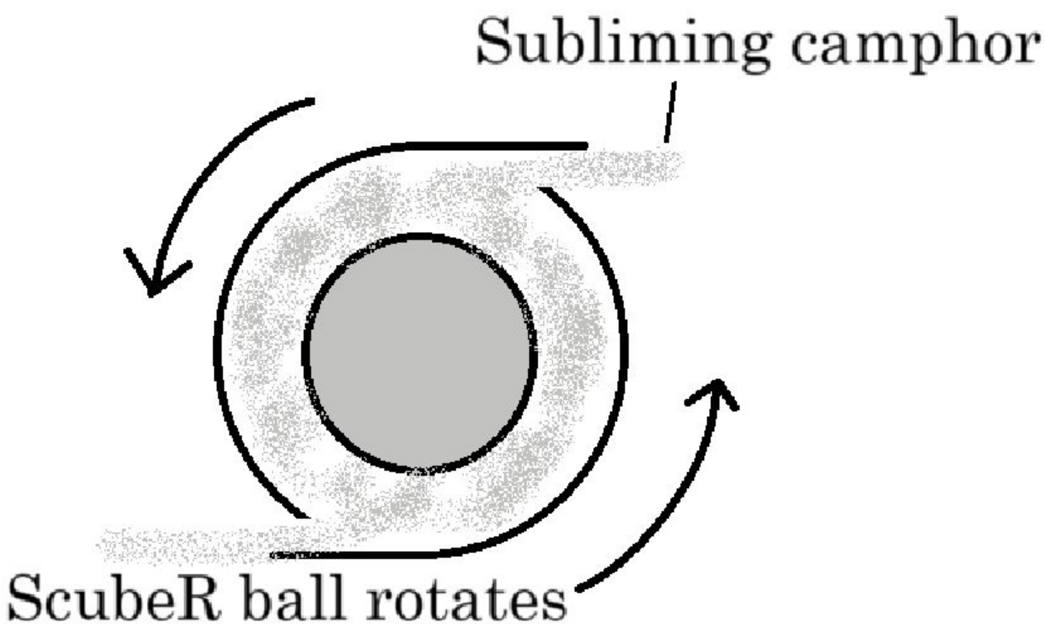
The experiment will eject a small scale sublimation rocket and measure its angular acceleration due to sublimation via video capture.

Expected Results (Sublimation Rocket)

- Possible low temperature means of propulsion
- Max depart velocity: 1 inch/sec
- Based on vapor pressure alone, sublimation will increase angular velocity

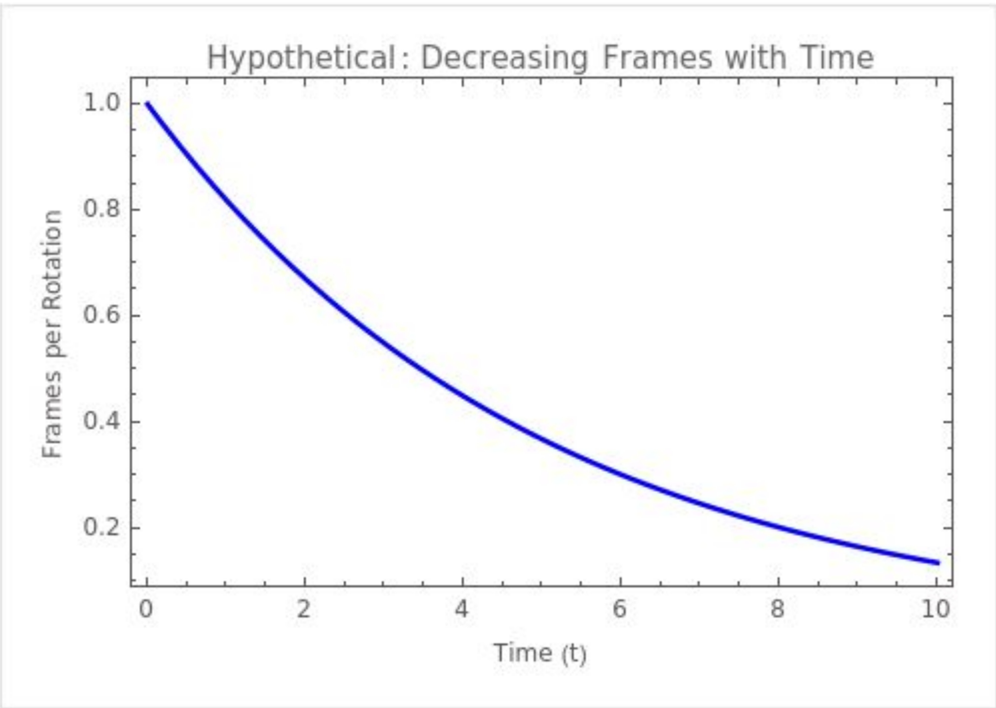
Expected Results (On-board Camera Systems)

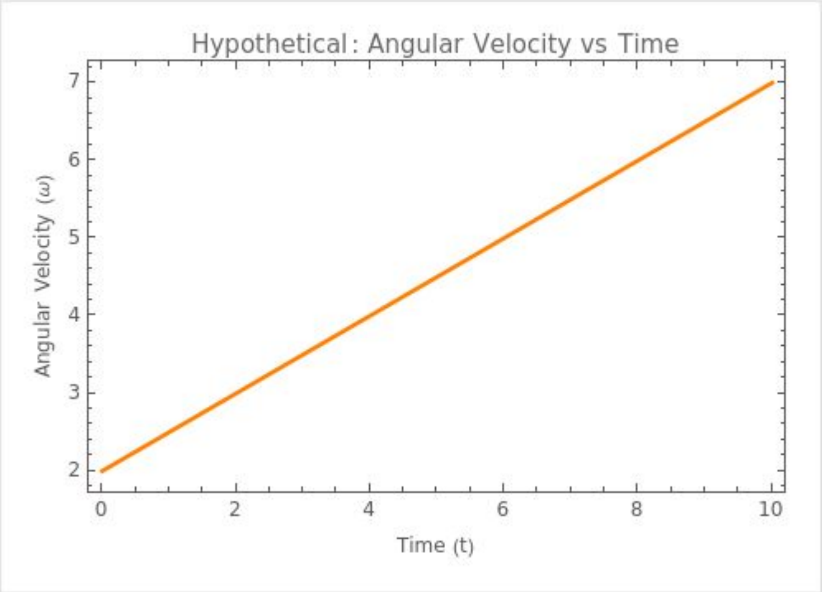
- Capture & store imagery of ScubeR deployment
- Determine ScubeR angular acceleration



Expected Results (On-board Camera Systems) (cont.)

Ryan

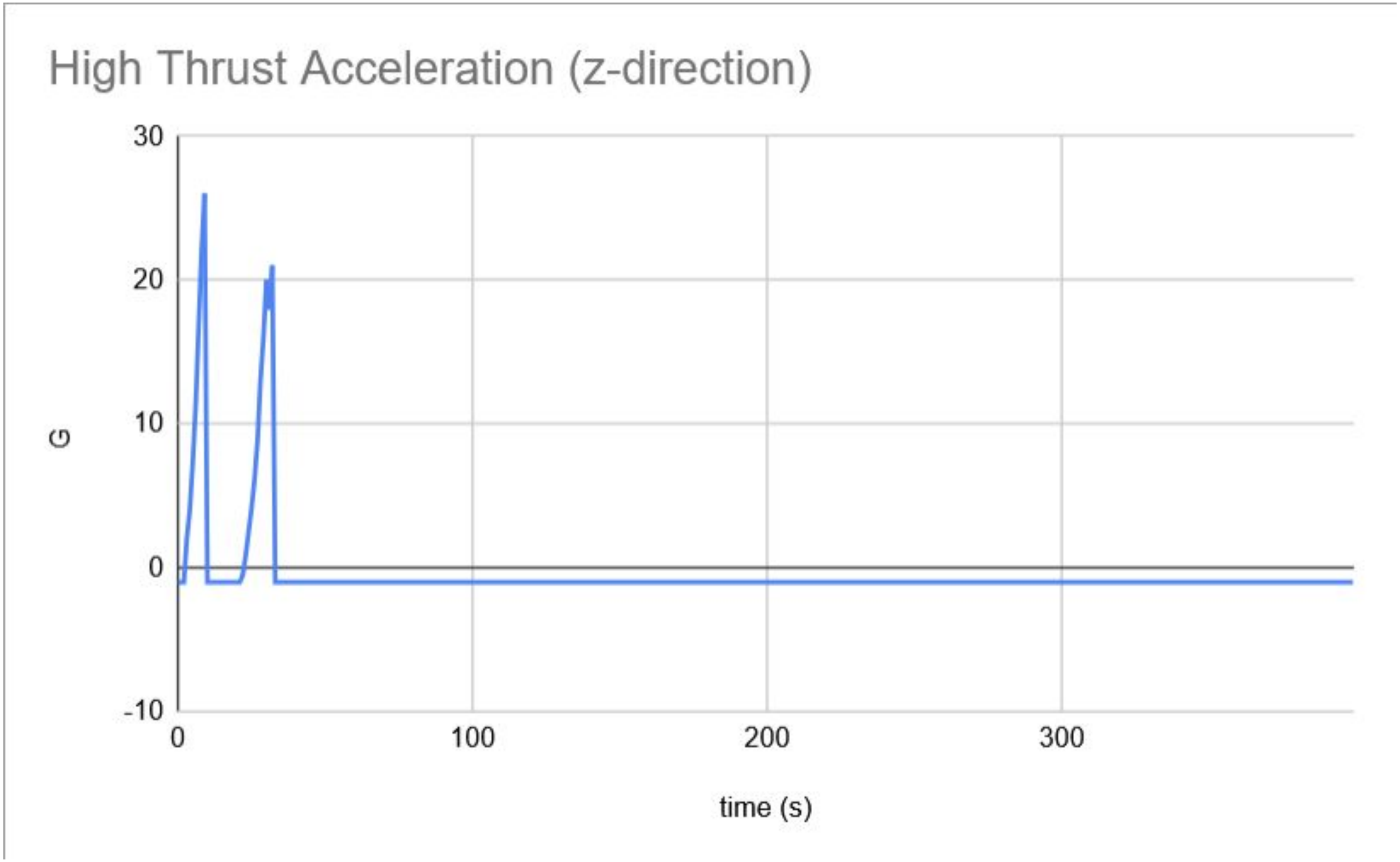




Expected Results (IMU and Accelerometer)

- Monitor rotation and acceleration of payload deck
  - Monitor low vibrations (±2g) and high thrust accelerations (±100g)
  - Determine if ScubeR movement on video is due to ScubeR itself or payload deck

Expected Results (IMU and Accelerometer) (cont.)



Systems Overview

System Overview (Contents)

Section 2: System Overview

- Changes Since STR
- Models
- Functional Block Diagram
- Manifest Location Confirmation
- Timer Event Matrix
- Pointing request confirmation
- Interfaces to Rocket
- Design Spec Summary
- User Guide Compliance
- Special Requests

Changes Since STR

- Updated documents placed in Drive and also given in this presentation:
  - Timed events spreadsheet
  - Pin assignment spreadsheet
  - Changes reflected in FBD
- WCC Hammond box size reduced to allow more room for SPEW
  - Updated models and layouts throughout presentation
- H bridge will be in a box on top of the stepper motor
  - Shown in updated models
- PDB now provides 5V to cameras instead of 15V
- Changes to SPEW design for more reliable ejection of ScubeR
  - Presented in Section 3
  - Updated weight table

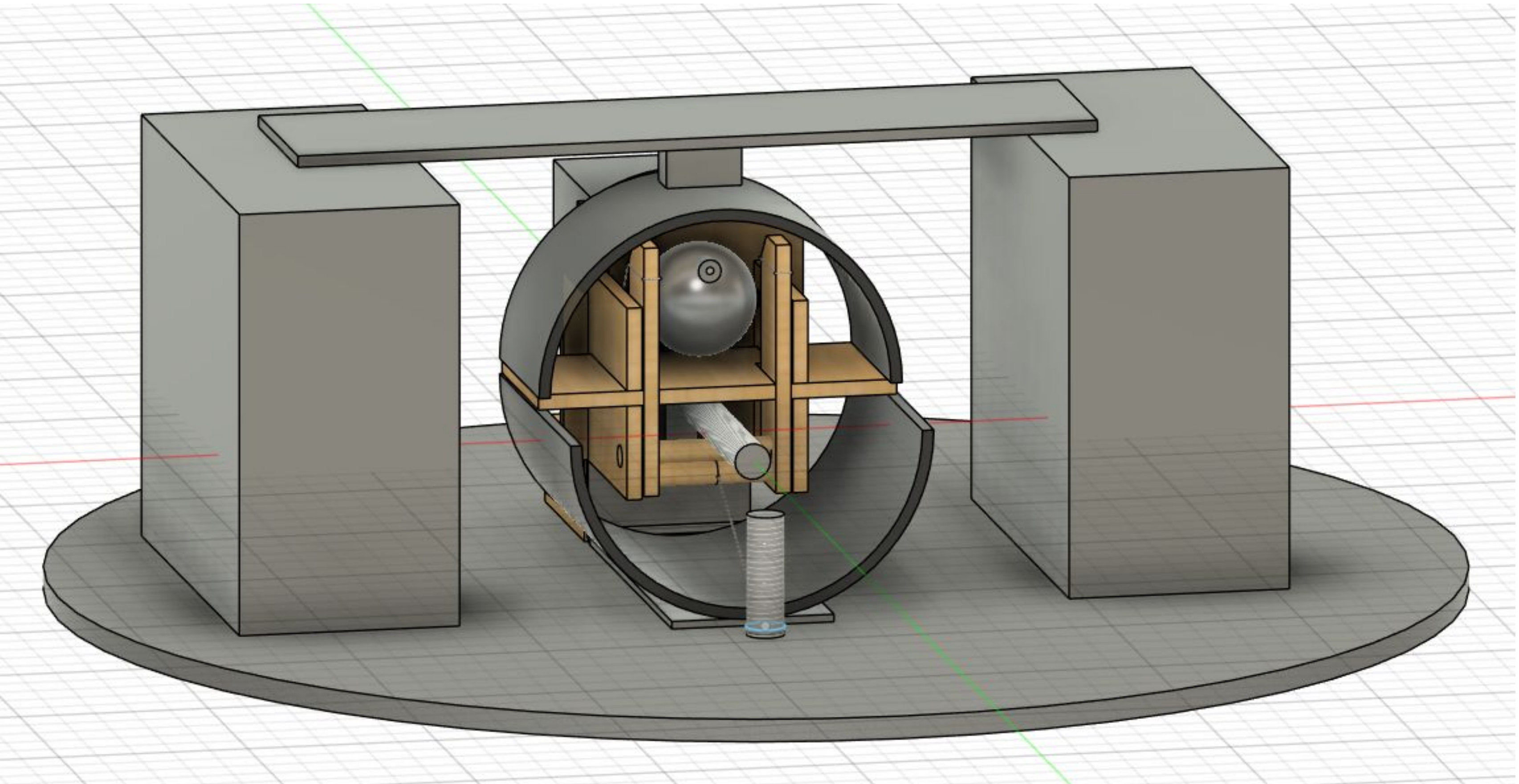
Engineering Design Overview - Subsystems

1. **Power Distribution Board (WinCC)**
   - Step down voltage from 28V to various voltages
2. **Motor Controller (WinCC)** - Arduino Nano Every
3. **Data Controller (HonCC) -** Arduino Nano Every
   - Receive data from 3 sensors
   - Save data to a MicroSD card
4. **ScubeR and SPEW (WinCC)** - Super Simple Sublimation Rocket and ScubeR Projectile Ejection Whatchamacallit
5. **On-board Cameras (HonCC) -** Mobius Camera Modules
   - 32GB MicroSD

- **Heritage Elements**
  - Arduino Nano Every, NEMA 17 Stepper Motor, LSM9DS1, MicroSD storage, Mobius Cameras, Power Conditioning Board, H-Bridge
- **Major technology dependencies?**
  - No

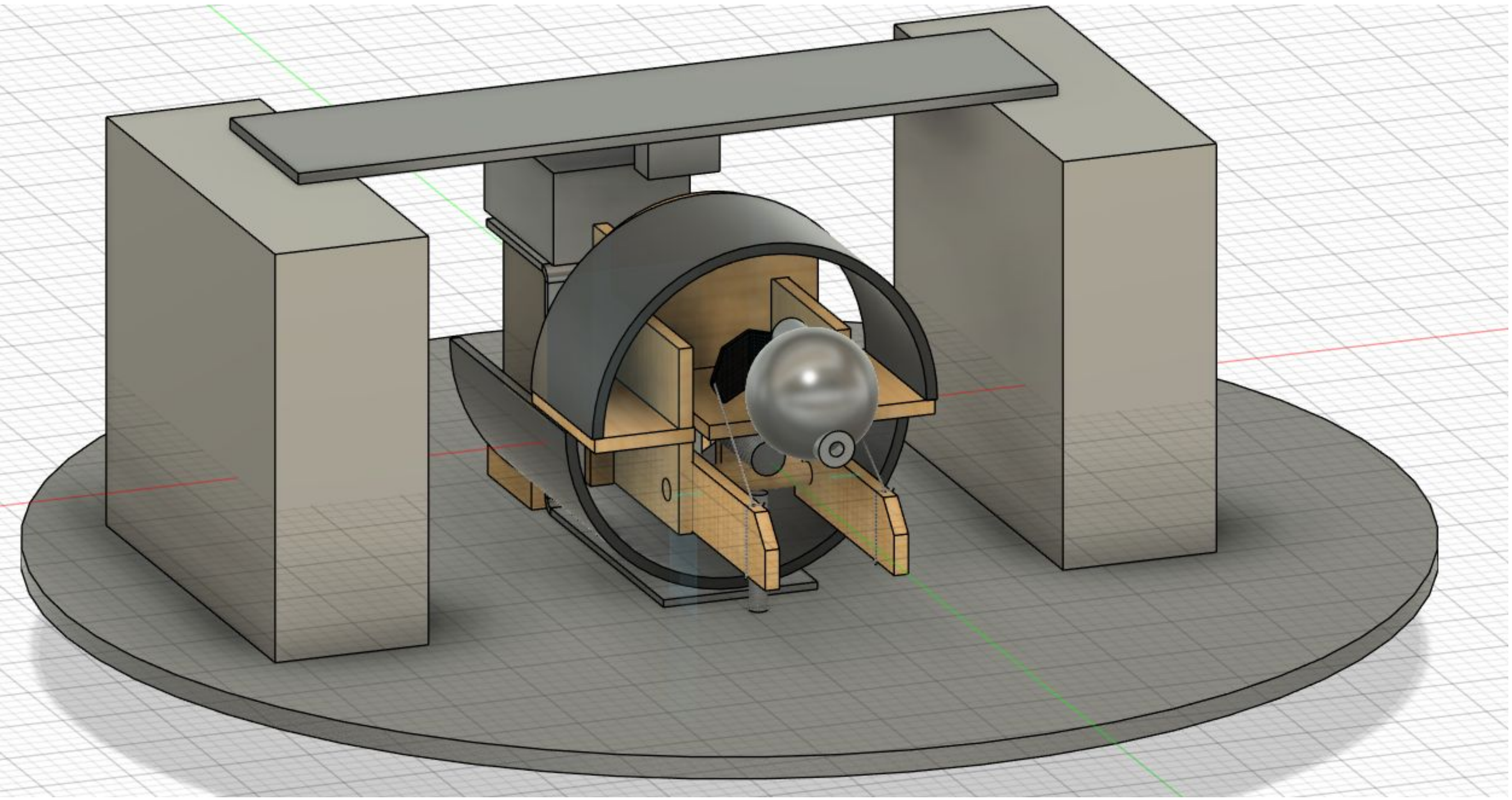
Experiment Models - Layout

Closed



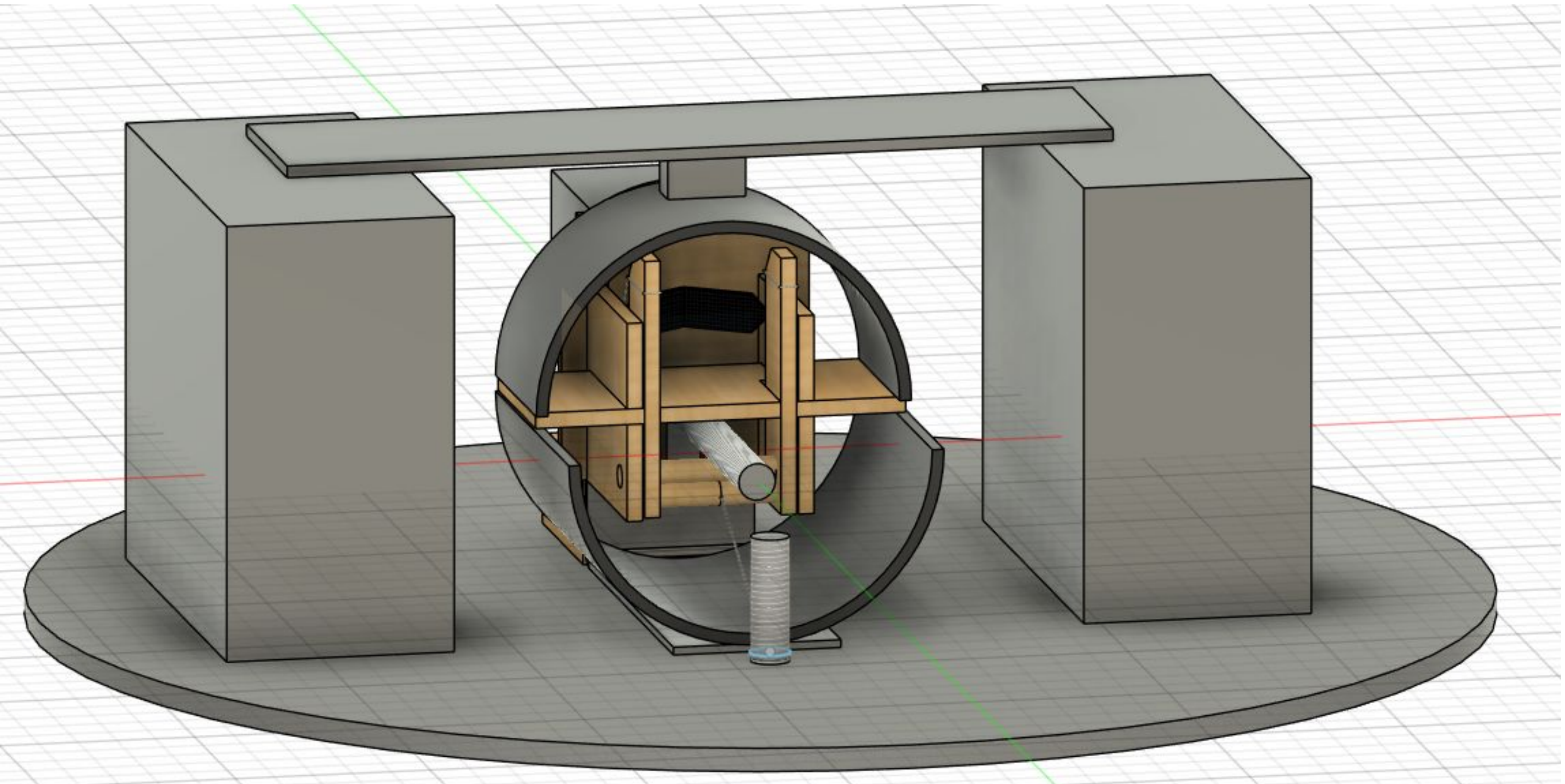
Experiment Models - Layout

Open



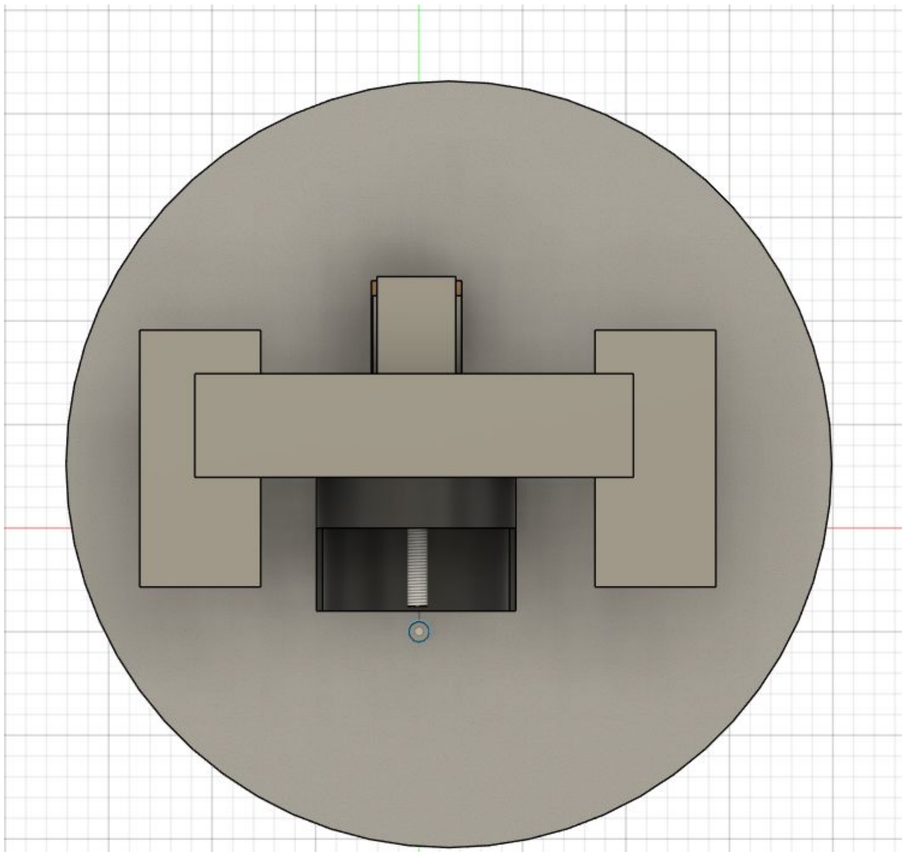
Experiment Models - Layout

retracted



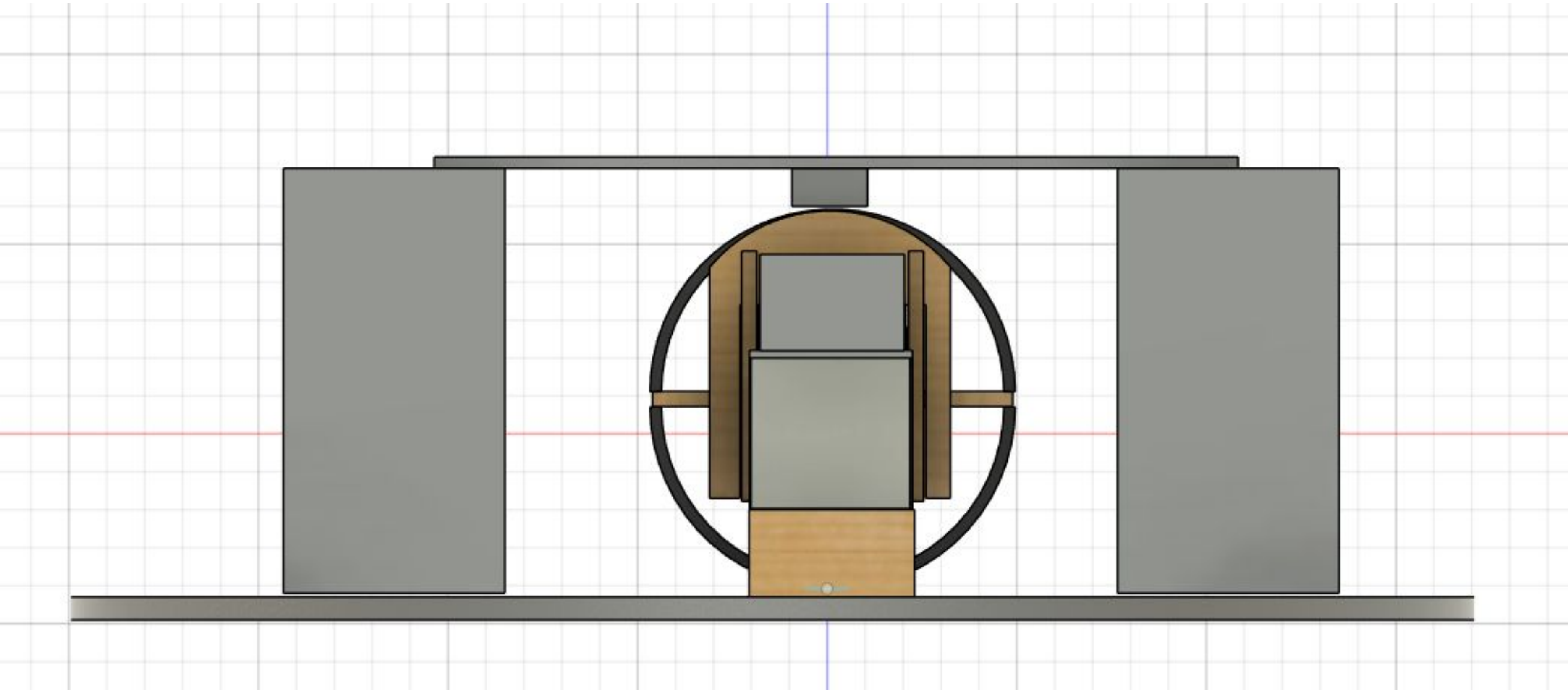
Experiment Models - Layout

top view



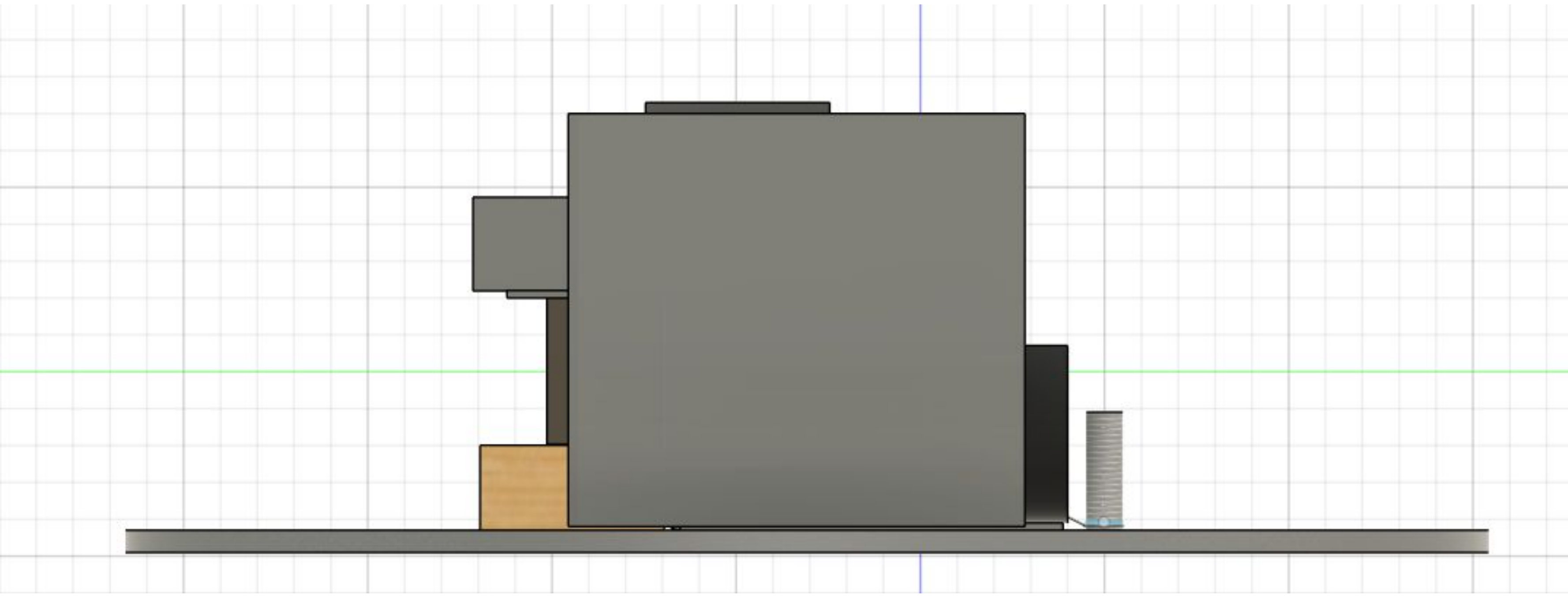
Experiment Models - Layout

back view



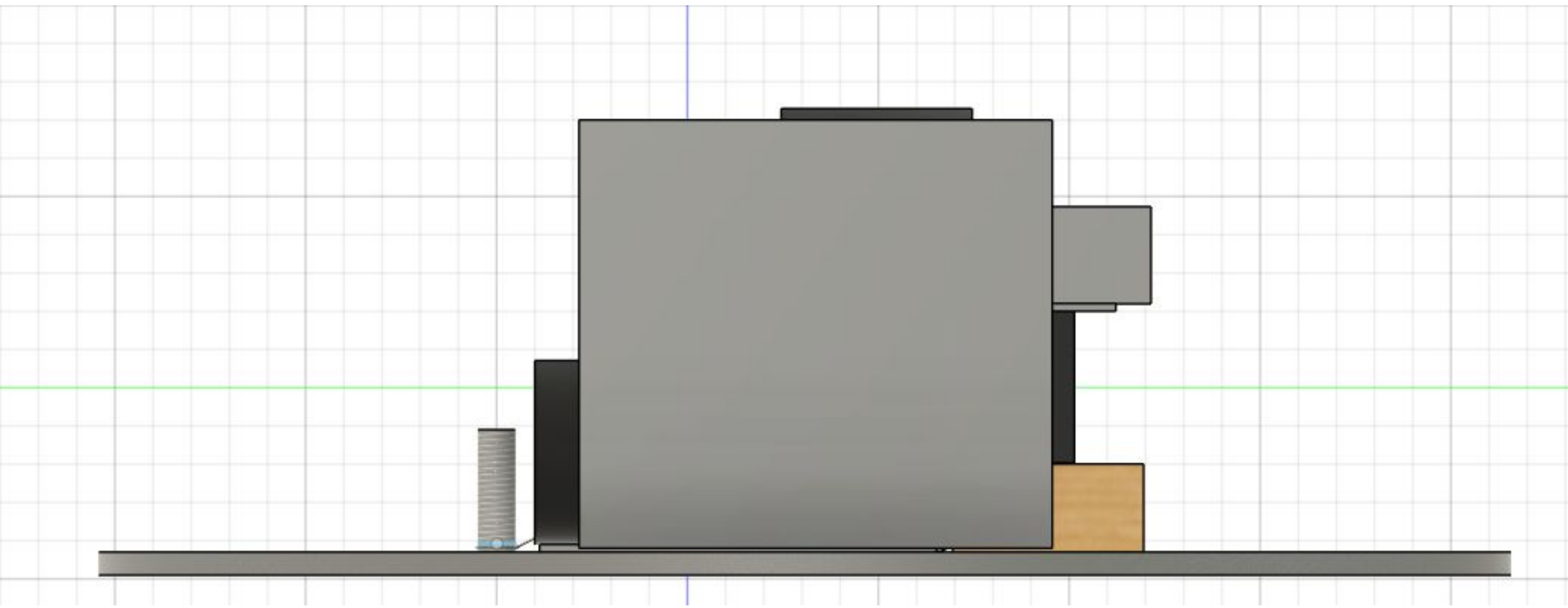
Experiment Models - Layout

left

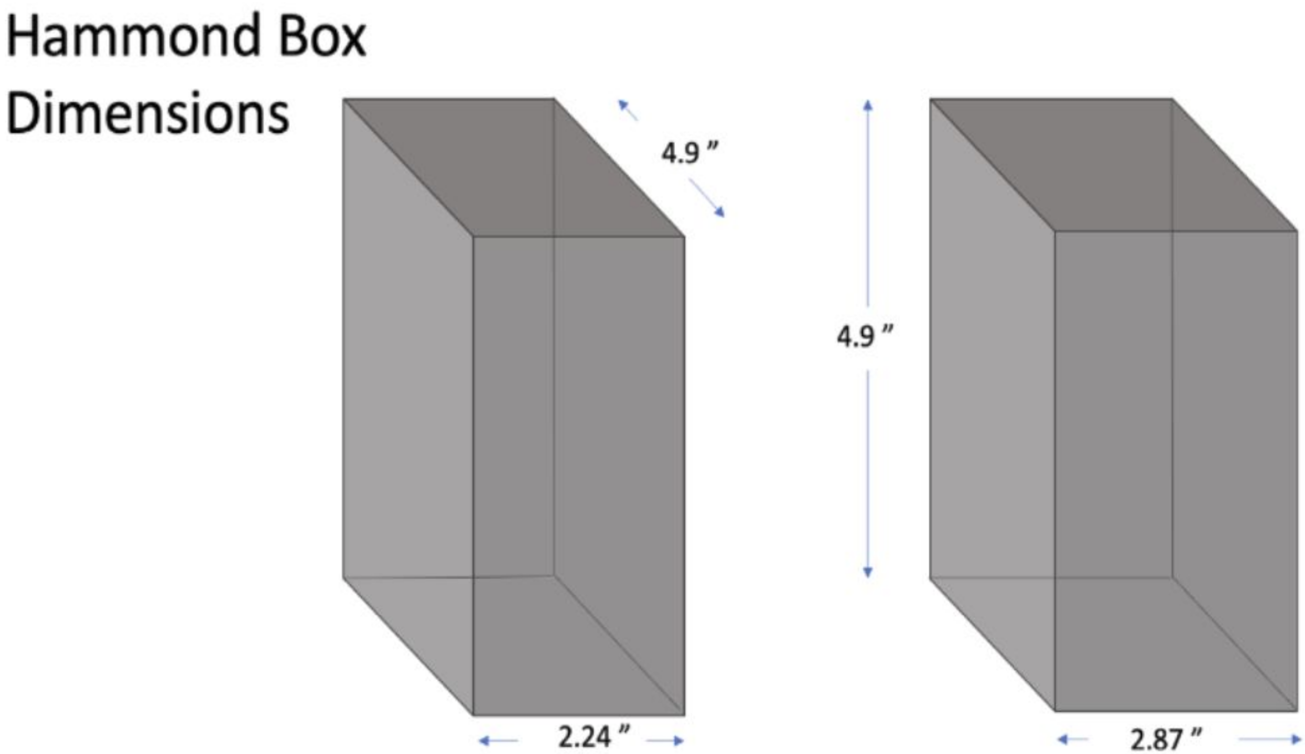


Experiment Models - Layout

right



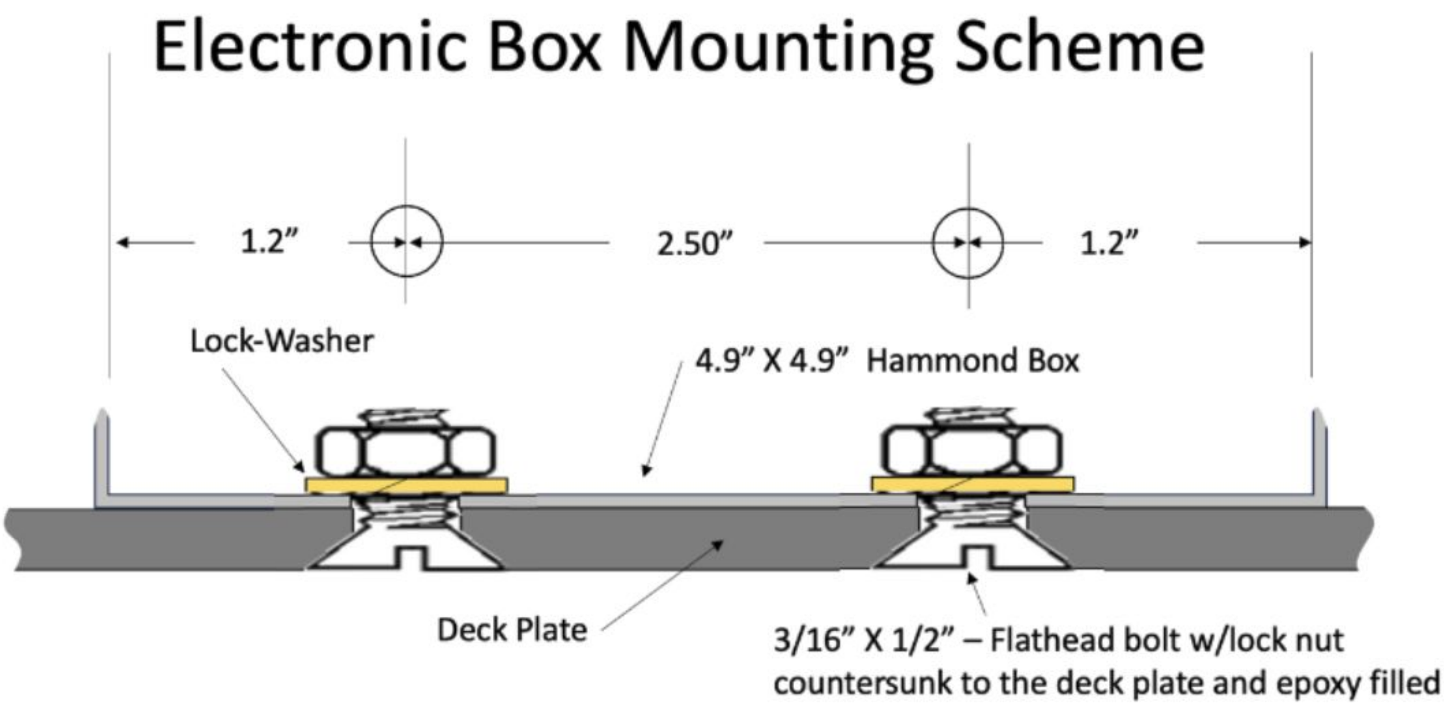
Experiment Information - Hammond Boxes



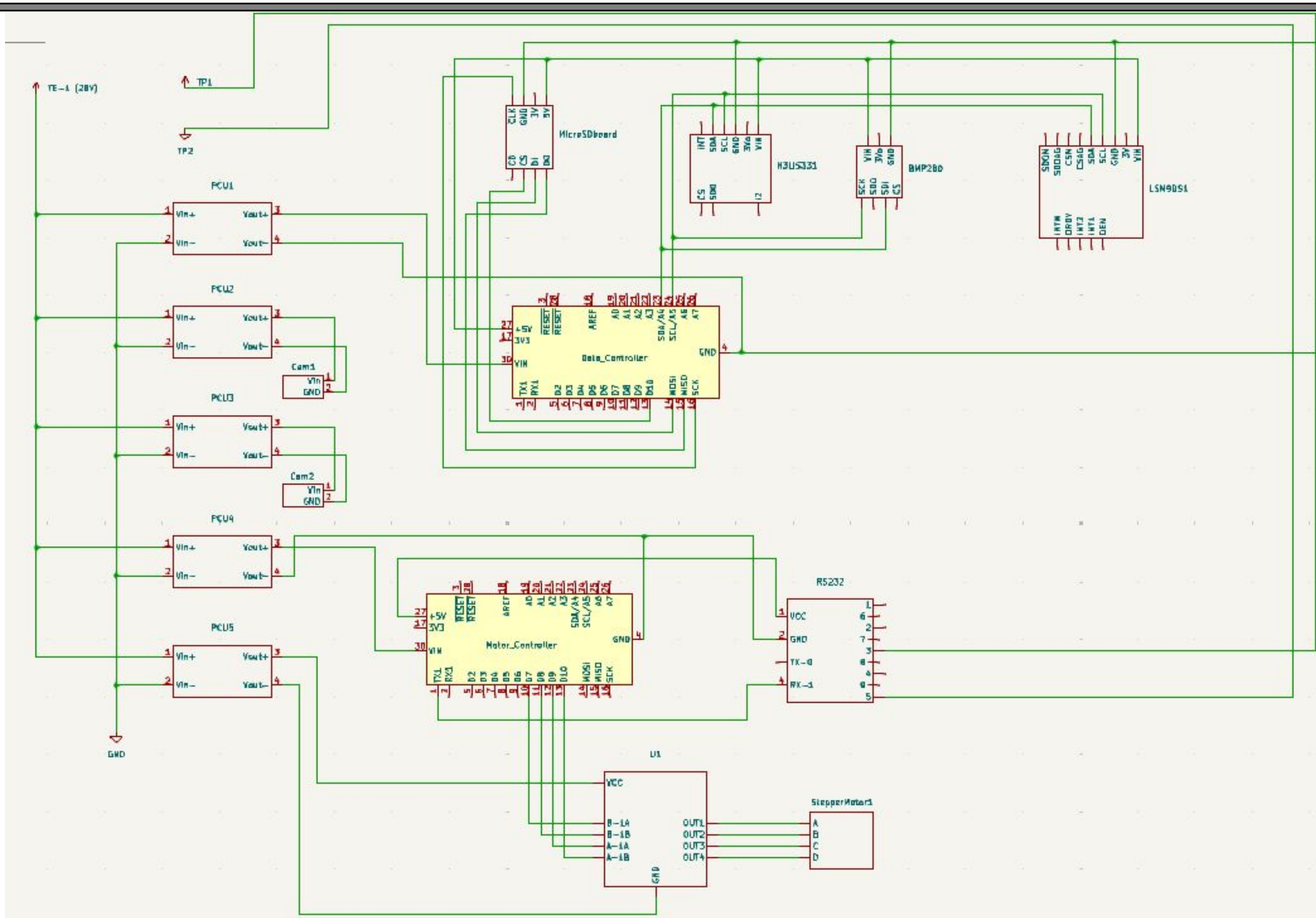
WCC HonCC

Experiment Models - Box Mounting Scheme

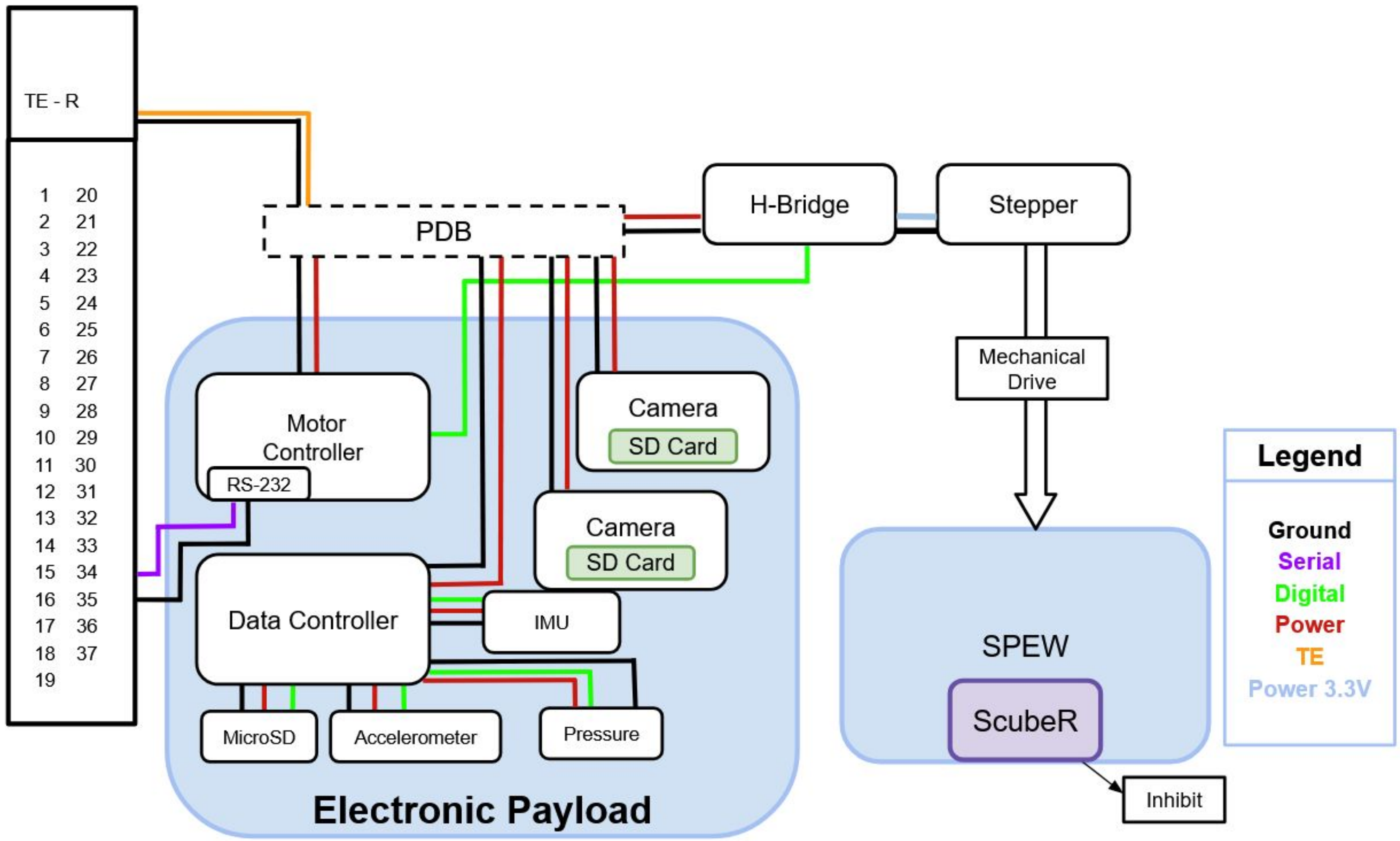
Lock washers and blue Loctite will be used to lock nuts onto bolts



Electrical Design



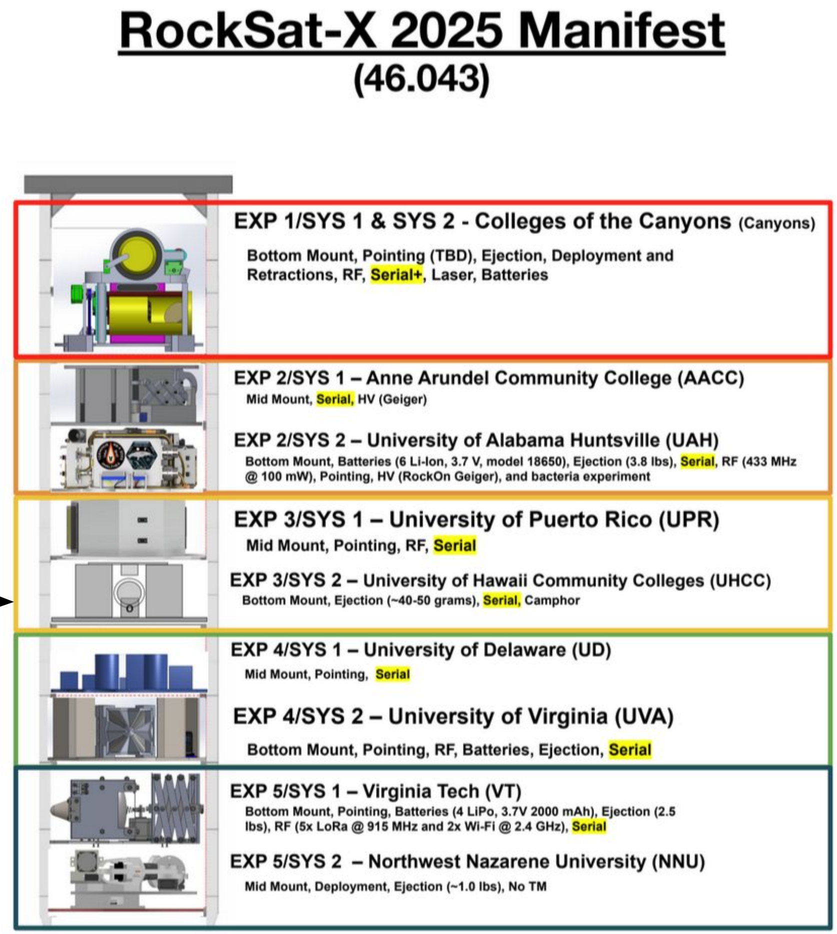
Functional Block Diagram



Manifest Location Confirmation

We confirm the manifest location and information given in the diagram shown to the right (revised 02-13-2025).

This is us



Rev 02-13-2025

Timer Event Matrix

Team Name: University of Hawaii Community Colleges					
Date: 3-22-2025					
Event	**Time On**	**Units**	**Dwell Time**	**Units**	**Event Description**
GSE 1		(T-X) (sec)		(sec)	
GSE 2		(T-X) sec)		(sec)	
TE-R	0.1	(T+X) (sec)	flight	(sec)	Power on experiment
TE-1		(T+X) (sec)		(sec)	
TE-2		(T+X) (sec)		(sec)	
TE-3		(T+X) (sec)		(sec)	

****If desiring dwell time to be until rocket power down put "flight"**

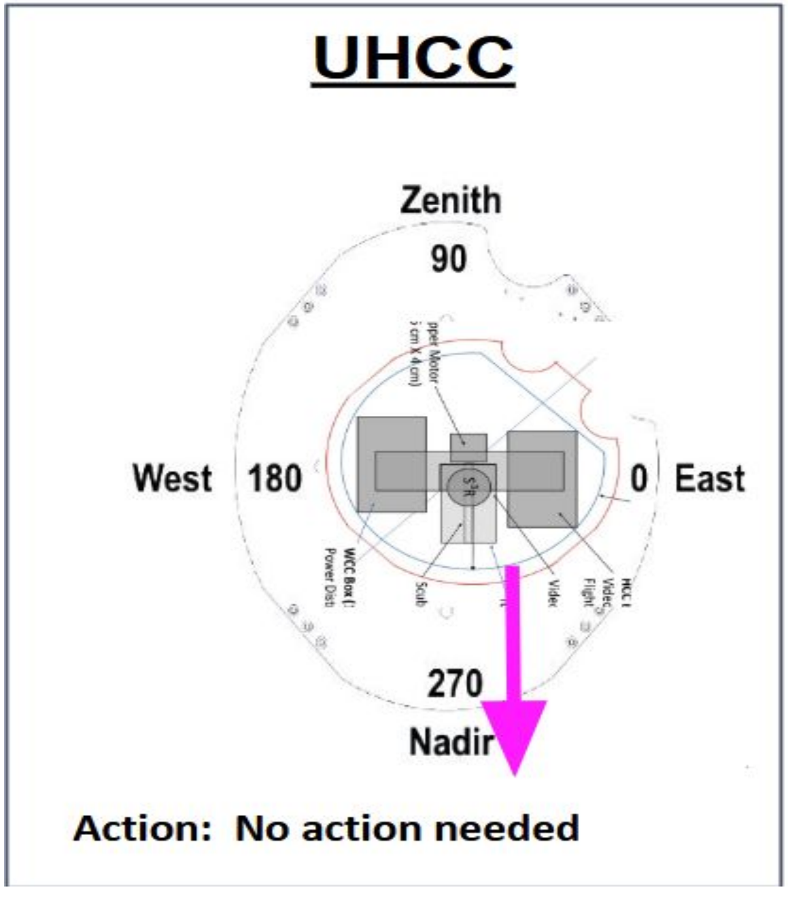
Changes since STR:

- updated matrix to reflect that we are using only TE-R

Pointing Request Confirmation

We confirm the pointing request as shown to the right (taken from the manifest, revised 02-13-2025).

We understand that this slide is to confirm pointing and is not intended to address scale.



Interfaces to Rocket - Power

Power Pin	Function	Intended Use
1	GSE 1	N/C
2	Timer Event Redundant (TE-RA)	Power on experiment
3	Timer Event Redundant (TE-RB)	Power on experiment
4	Timer Event 1 (TE-1)	N/C
5	GND	Ground
6	GND	N/C
7	GND	N/C
8	GND	N/C
9	GSE 2	N/C
10	Timer Event 2 (TE-2)	N/C
11	Timer Event 3 (TE-3)	N/C
12	GND	N/C
13	GND	N/C
14	GND	N/C
15	GND	N/C

Interfaces to Rocket - Telemetry

Telemetry	Function	Intended Use
1	Analog 1	N/C
2	Analog 2	N/C
3	Analog 3	N/C
4	Analog 4	N/C
5	Analog 5	N/C
6	Analog 6	N/C
7	Analog 7	N/C
8	Analog 8	N/C
9	Analog 9	N/C
10	Analog 10	N/C
11	Parallel Bit 1 (MSB)	N/C
12	Parallel Bit 2	N/C
13	Parallel Bit 3	N/C
14	Parallel Bit 4	N/C
15	Parallel Bit 5	N/C
16	Parallel Bit 6	N/C
17	N/C	N/C
18	Ground	N/C
19	Ground	N/C
20	Parallel Bit 7	N/C
21	Parallel Bit 8	N/C
22	Parallel Bit 9	N/C
23	Parallel Bit 10	N/C
24	Parallel Bit 11	N/C
25	Parallel Bit 12	N/C
26	Parallel Bit 13	N/C
27	Parallel Bit 14	N/C
28	Parallel Bit 15	N/C
29	Parallel Bit 16 (LSB)	N/C
30	Parallel Read Strobe	N/C
31	N/C	N/C
32	RS-232 Data (TP1)	N/C
33	RS-232 GND (TP2)	N/C
34	RS-232 Data (TP1)	Motor controller async communication via RS232
35	RS-232 GND (TP2)	Ground for motor controller RS232 device
36	Ground	N/C
37	Ground	N/C

Interfaces to Rocket - Changes Since STR

Changes to our listed rocket interfaces reflect the pins given in the manifest.

Power:

- Using only TE-RA (pin 2), TE-RB (pin 3), GND (pin 5)

Telemetry:

- Using pins 34, 35 for serial communication

Design Specifications - Power

Last modified:	2-8-25						
Power Board Output (Nominal Component Ratings)					Battery Usage		
Subsystem	Component	Voltage (V)	Current (A)	Power (W)	Time On (Min)	mAh	Ah
Motor Controller	Arduino Nano Every	9.00	0.0150	0.1350	6	1.5000	0.0015
	Stepper Motor	3.30	0.2900	0.9570	6	29.0000	0.0290
Camera1		5.00	0.8000	4.0000	6	80.0000	0.0800
Camera2		5.00	0.8000	4.0000	6	80.0000	0.0800
Data Controller	Arduino Nano Every	9.00	0.0150	0.1350	6	1.5000	0.0015
	MicroSD breakout	5.00	0.5000	2.5000	6	50.0000	0.0500
	H3LIS331	5.00	0.0004	0.0019	6	0.0370	0.0000
	LSM9DS1	5.00	0.0046	0.0230	6	0.4600	0.0005
	BMP280	5.00	3.69E-05	0.0002	6	0.0037	0.0000
			2.4250	11.7520		242.5007	
*Note: A fabricated Power distribution board will be taking the incoming voltage supplied by the rocket and it will be facilitating the power needs of the components listed above.					Total Current (A)	Usage in Ah	
					2.4250	0.2425	

Over/Under: 0.25 Ah

Design Specifications - Weight

Subsystem	Mass (g)	Weight (lbs)
Data Controller	62.45	0.14
Motor Controller	200	0.44
Camera	100	0.22
PBD	210	0.46
ScubeR	200	0.44
Hammond Box 1	450.87	0.99
Hammond Box 2	450.87	0.99
Total	**1674.19**	**3.69**
Estimated Inert Mass	5129.81	11.31

User Guide Compliance

Requirement	*Status/Reason (if needed)*
Center of gravity in 1" plane of plate?	Yes (once inert mass added)
Weight 15.0+/- 1.0	Yes (once inert mass added)
Max Height < 5.13”	Half deck < 5.13"
Bottom of deck has flush mount hardware?	Yes
Within Keep-Out Zone	Yes
Using < 10 A/D Lines	N/A
Using/Understand Parallel Line	N/A
Using/Understand Asynchronous Line	Yes, at 19,200 Baud
Using X GSE Line(s)	No
Using X Non-Redundant PWR Lines (TE-1, TE-2, TE-3)	No
Using X Redundant Power Lines (TE-R)	Yes, TE-RA, TE-RB
Using < 0.5 Ah	Yes
Using <= 28 V	Yes
Using RF (If yes, list frequency and TX Power)	No
Using deployable?	Yes
Whole team consists of US Persons	Yes
Using ITAR and/or Export Controlled hardware	No

Special Requests

No special requests

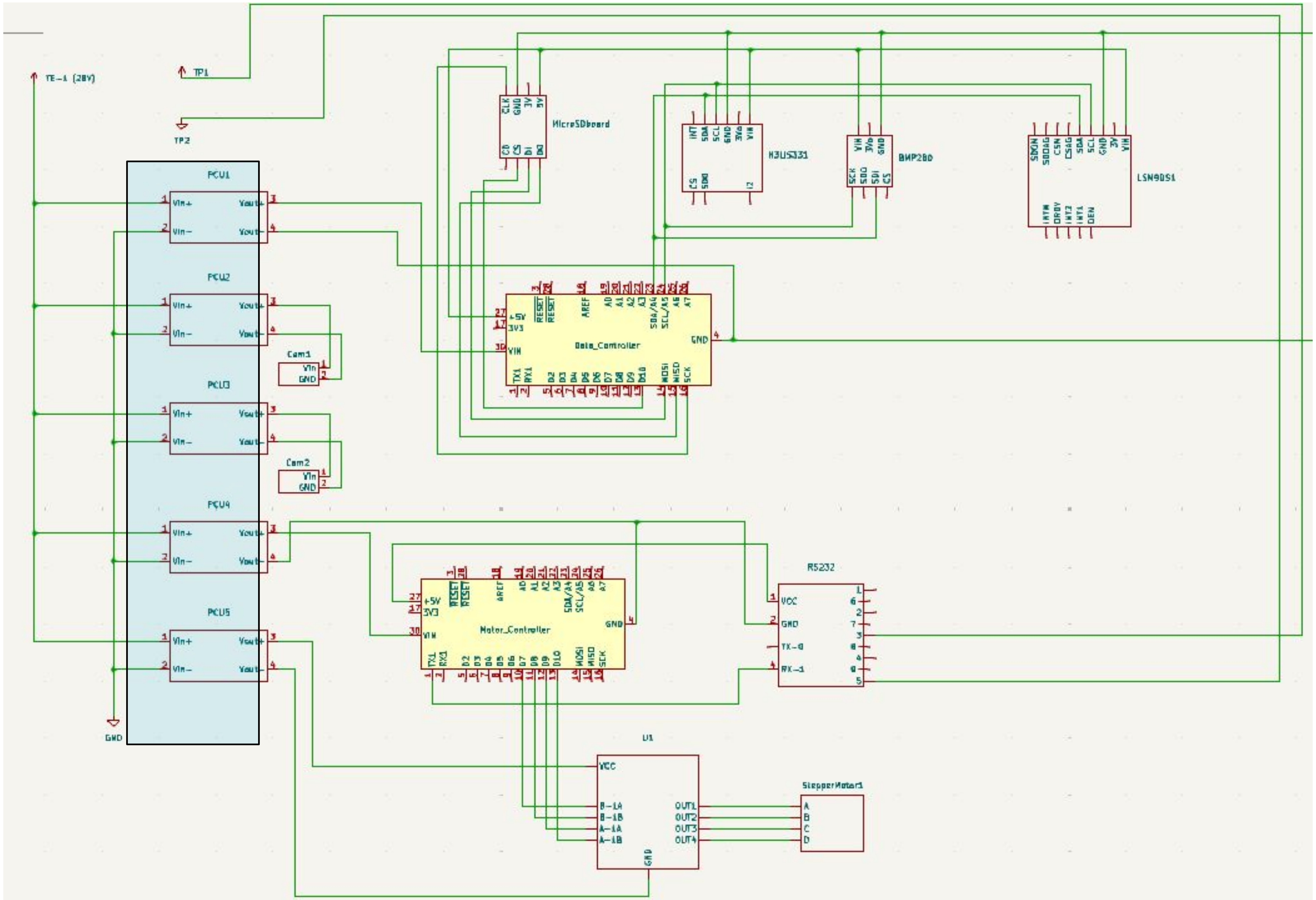
Updates on Subsystem Testing Results

Subsystem Testing Results (Contents)

Section 3: Updates on Subsystem Testing Results

- Power Distribution Board
- Motor Controller
- Data Controller
- SPEW
- Cameras

PDB - Subsystem Specs



PDB - Subsystem Specs

Power: 2.43A total (distributed across 5 units)
Weight: 95g
Volume: Within WCC Hammond box (4.9 x 4.9 x 2.24 in)

Interfaces:

- Receives +28V from rocket (TE-RA, TE-RB)
- Outputs various voltages to other subsystems

Unit: LM2596 voltage converter

Design final

Ryan

PDB - Subsystem Specs

Last modified:	2-8-2024						
Power Board Output (Nominal Component Ratings)					Battery Usage		
Subsystem	Component	Voltage (V)	Current (A)	Power (W)	Time On (Min)	mAh	Ah
Motor Controller	Arduino Nano Every	9.00	0.0150	0.1350	6	1.5000	0.0015
	Stepper Motor	3.30	0.2900	0.9570	6	29.0000	0.0290
Camera1		5.00	0.8000	4.0000	6	80.0000	0.0800
Camera2		5.00	0.8000	4.0000	6	80.0000	0.0800
Data Controller	Arduino Nano Every	9.00	0.0150	0.1350	6	1.5000	0.0015
	MicroSD breakout	5.00	0.5000	2.5000	6	50.0000	0.0500
	H3LIS331	5.00	0.0004	0.0019	6	0.0370	0.0000
	LSM9DS1	5.00	0.0046	0.0230	6	0.4600	0.0005
	BMP280	5.00	3.69E-05	0.0002	6	0.0037	0.0000
			2.4250	11.7520		242.5007	
*Note: A fabricated Power distribution board will be taking the incoming voltage supplied by the rocket and it will be facilitating the power needs of the components listed above.					Total Current (A)	Usage in Ah	
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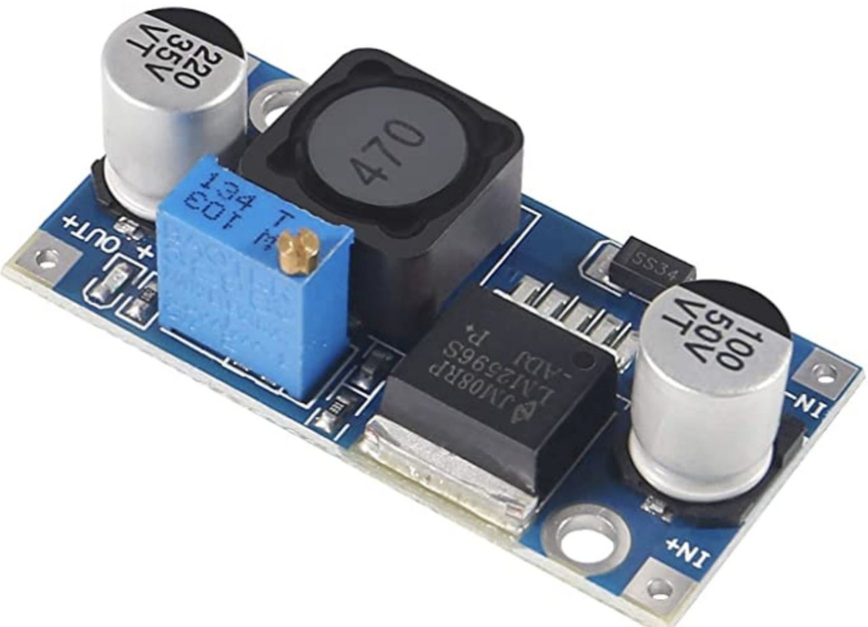
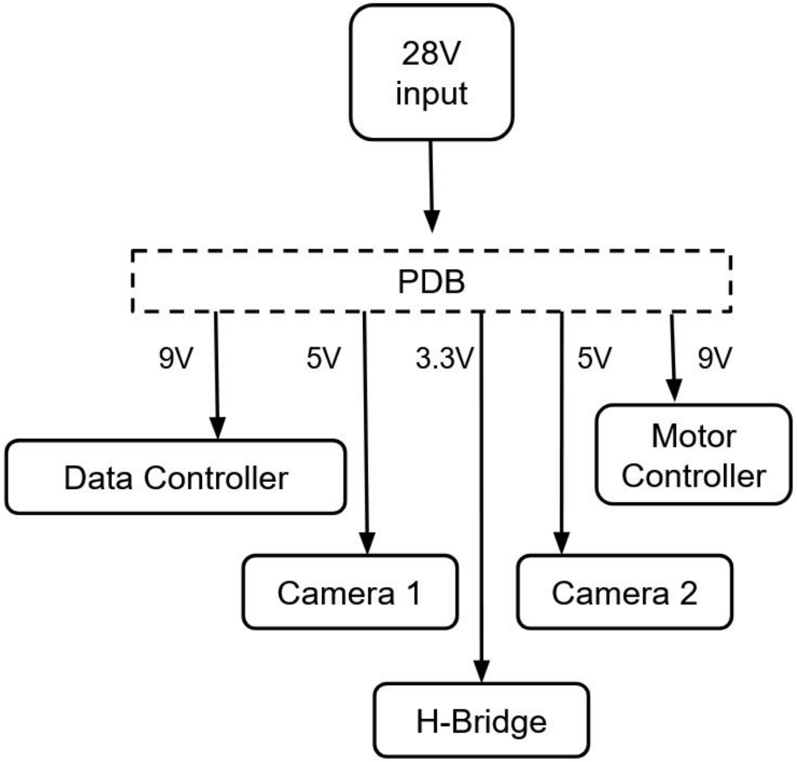
PDB - Subsystem Specs



- Input Voltage Range: DC 3 - 40 V
- Output Voltage Range: DC 1.5 - 35 V
- The input must be 1.5 V higher then the output voltage.
- 2A max
- Dimensions:
  - 1.071” x 0.827” x 0.551”
- Weight:
  - 0.396 oz
- Physically adjustable power limitation
- PDB will have 5 units
- Voltages can be easily adjusted by turning a potentiometer screw which will be epoxied in place prior to final assembly

PDB - Subsystem Specs



- PDB uses 5 power conditioning units
- Provide proper voltage for each subsystem

Subsystem Testing Results - PDB - Status

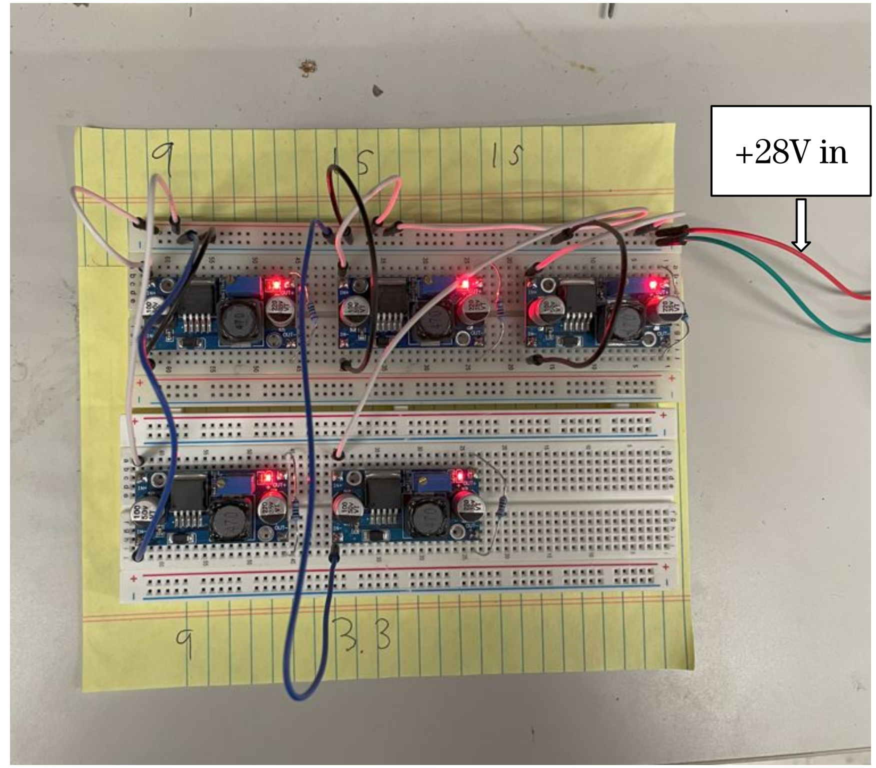
Completed tests:

2/8/2025 - All 5 units able to step down from 28V to their desired voltages within ±1%

3/8/2025 - PDB delivers power to motor controller to deploy SPEW

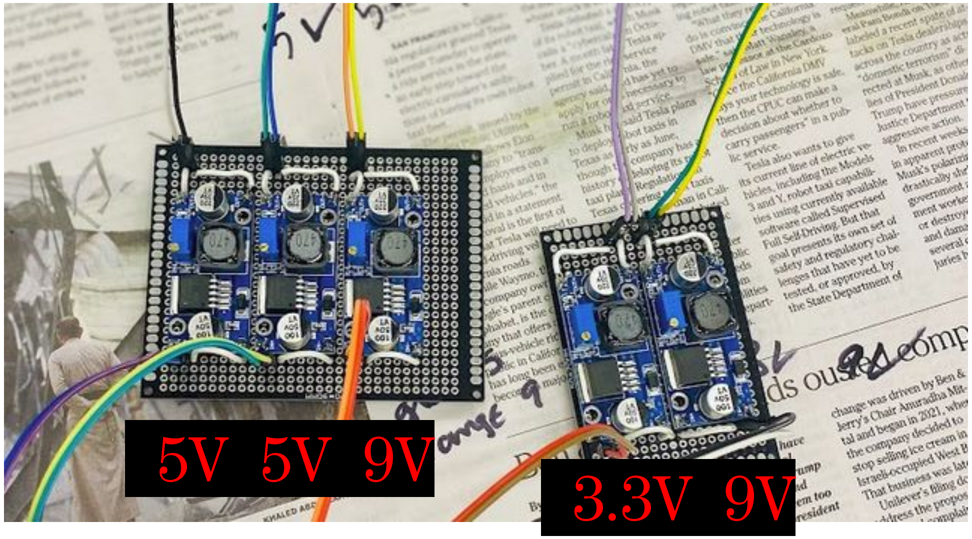
3/20/2025 - PDB delivers power to motor controller, cameras, and data controller all at once. Camera voltage updated to be 5V instead of 15V.

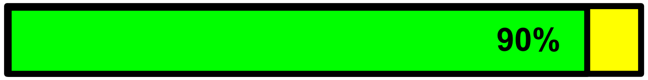
Assessment of test results: Success



Subsystem Testing Results - PDB - Summary

- In the tests mentioned, the PDB was able to provide the right voltages and all subsystems functioned as desired when powered by the PDB.
- PCBs arrived on 3/24
  - They will be populated and tested on 3/29





Motor Controller - Subsystem Specs

ScubeR Controller

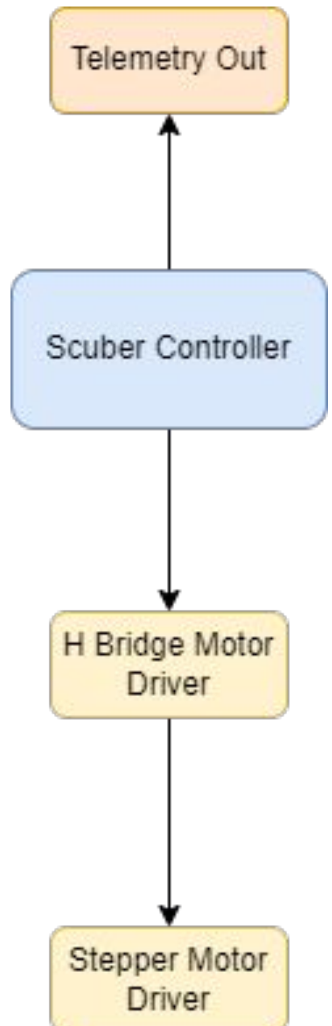
- Arduino Nano Every
- Send motor commands to H bridge motor driver
- Send motor status update to async telemetry lines

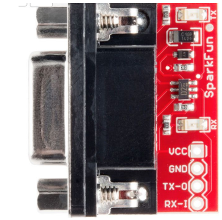
H Bridge

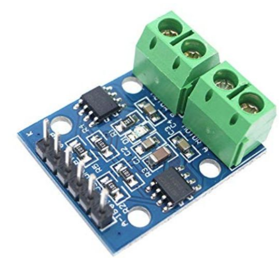
- HG7881 Bridge motor driver
- Mounted on top of stepper motor

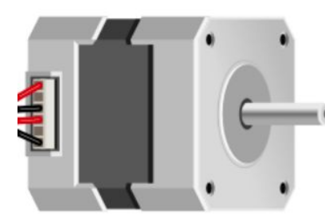
Mechanical Drive

- NEMA 17 stepper motor

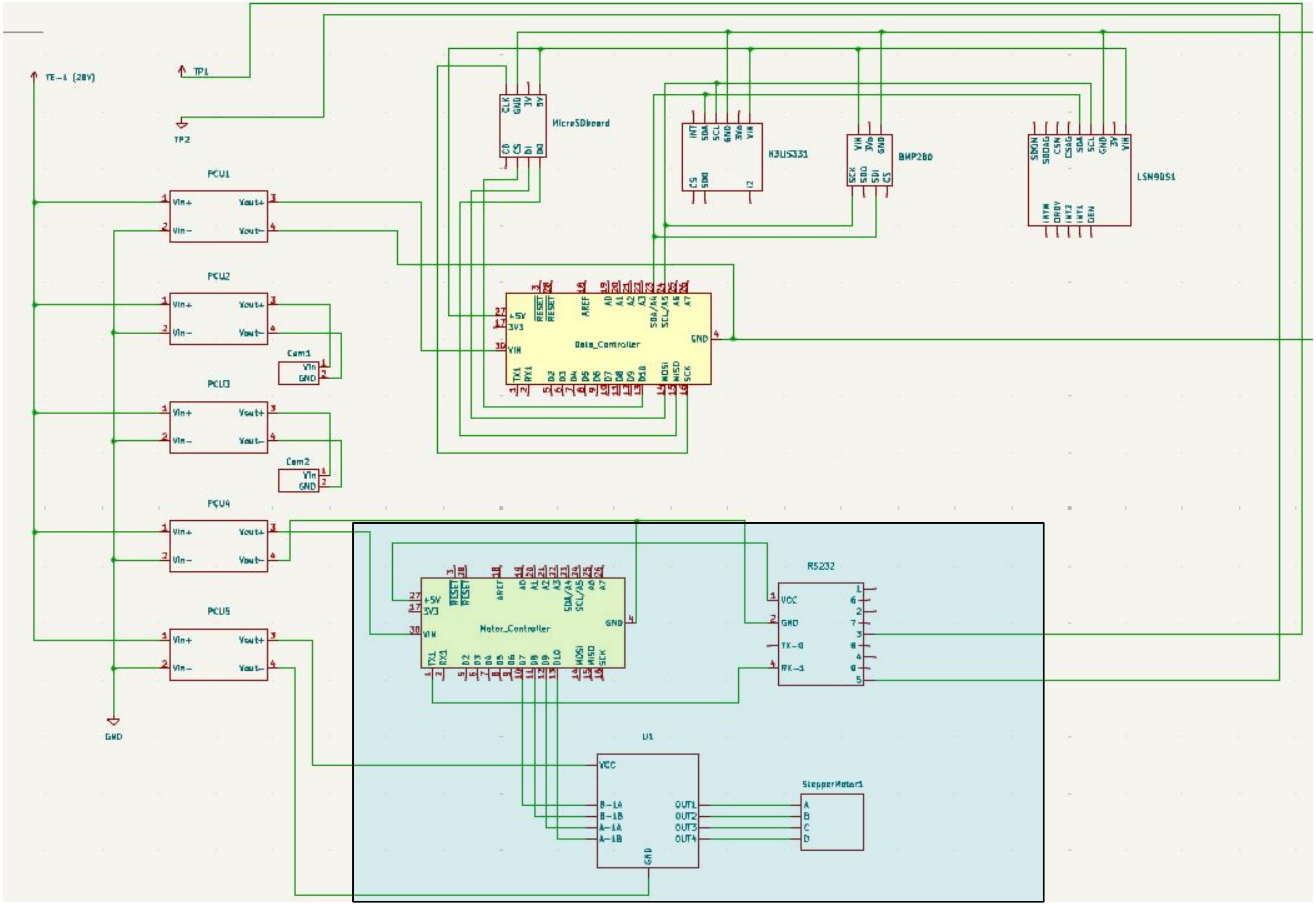








Motor Controller - Subsystem Specs



Subsystem Testing Results - Motor Controller - Status

Completed tests:

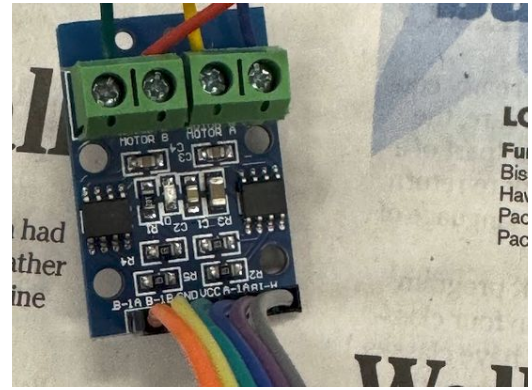
2/8/2025 - Motor controller carries out out backstep and deployment sequence.

3/8/2025 - Motor controller deploys SPEW.

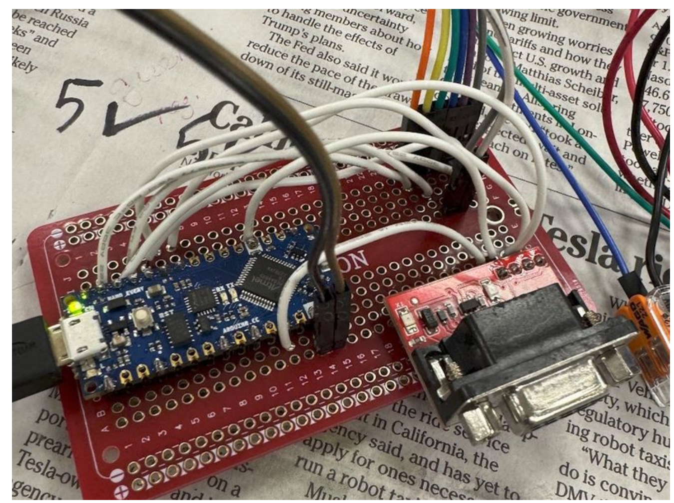
3/20/2025 - Motor controller deploys and retracts SPEW while data controller and camera are also powered on.

3/22/2025 - Motor controller deploys and retracts SPEW and send serial updates to a computer acting as ground station.

Assessment of test results: Success



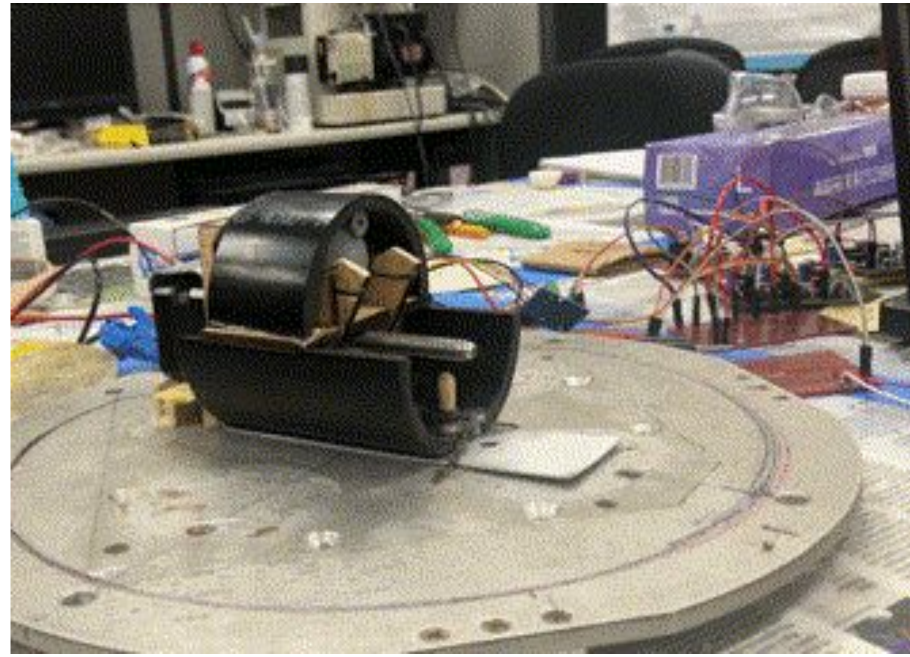
H bridge



Motor controller

Subsystem Testing Results - Motor Controller - Summary

- The motor controller is able to deploy and retract SPEW at the desired time (120 seconds after power on.)
- It also is able to communicate via serial the status of its routine.
- PCBs arrived on 3/24
  - They will be populated and tested on 3/29

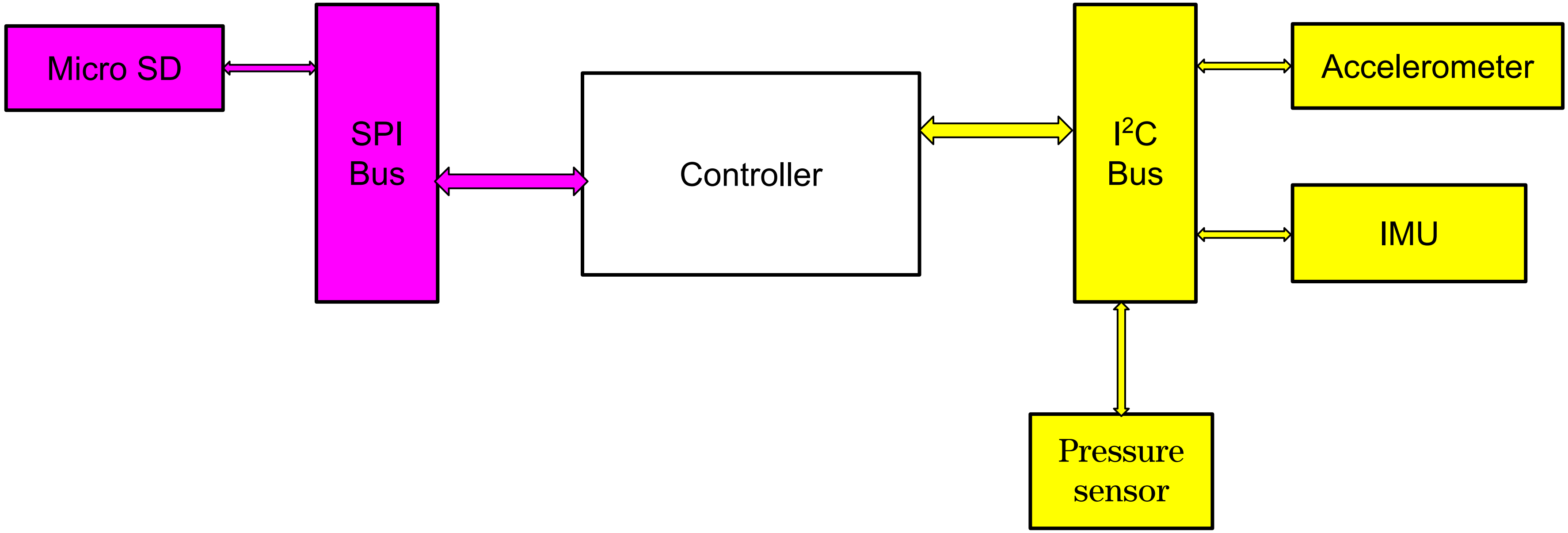


The deployment and retraction of SPEW in the 3/22 test

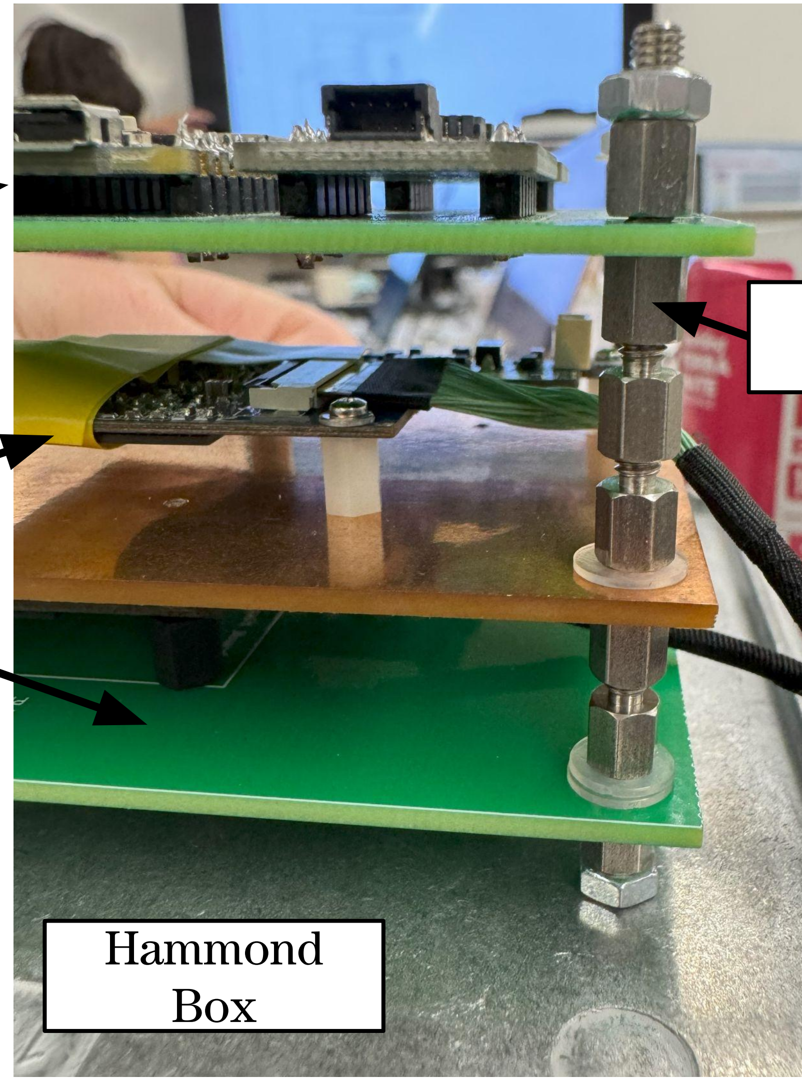
Subsystem Design: Structure (Data Controller)

Controller: Arduino Nano Every (5 grams - 9 Volts input - supplies 5 Volts to the rest of the subsystem)
Accelerometer: Adafruit H3LIS331 (1.5 grams)
IMU: Adafruit LSM9DS1 (2.5 grams)
Pressure Sensor: Adafruit BMP280 (1.3 grams)
MicroSD: Adafruit MicroSD Card Breakout Board+ (3.5 grams)

The Total mass of one device is approximately 44.45 - 45.49 grams

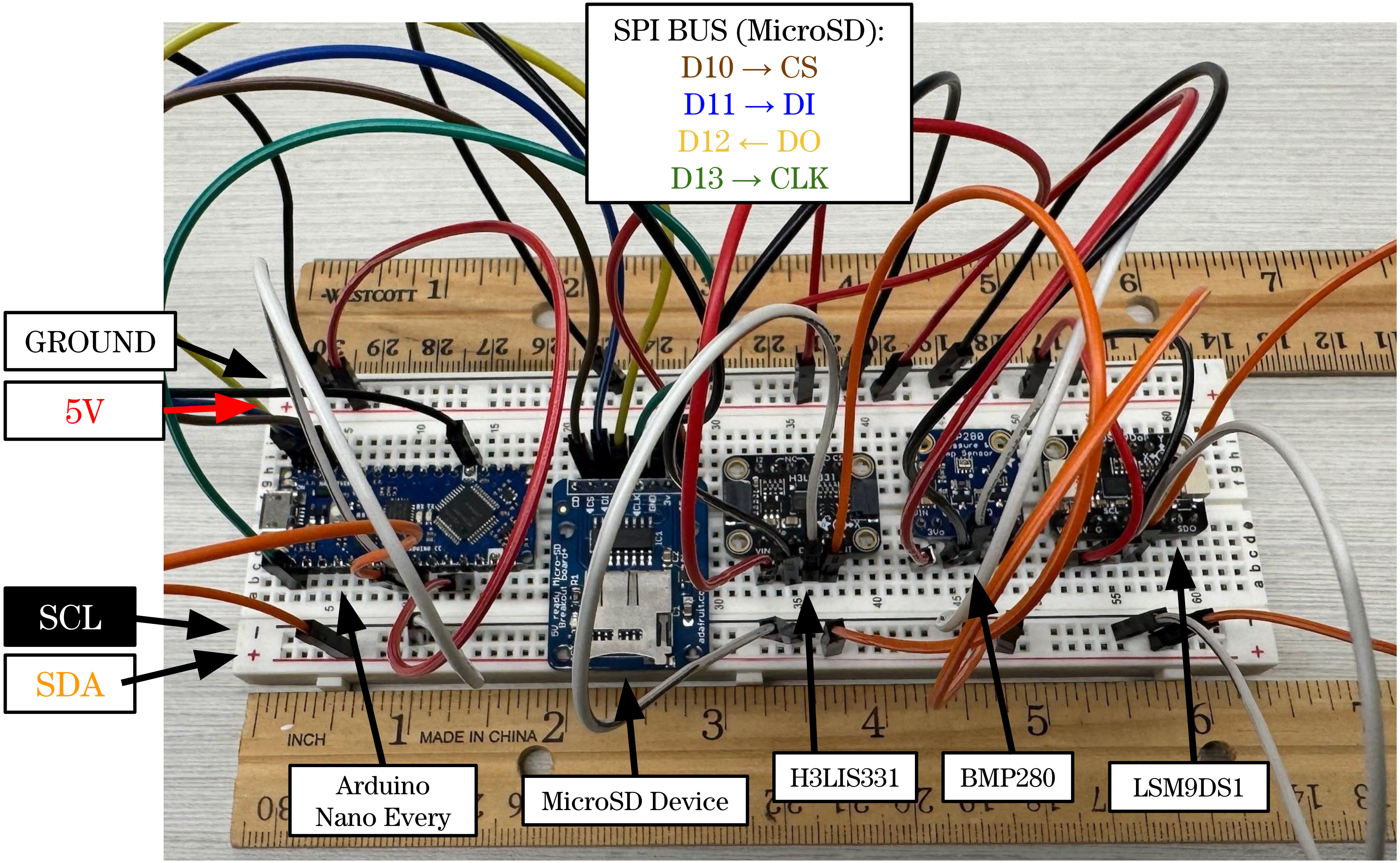


Subsystem Testing Results - Data Controller



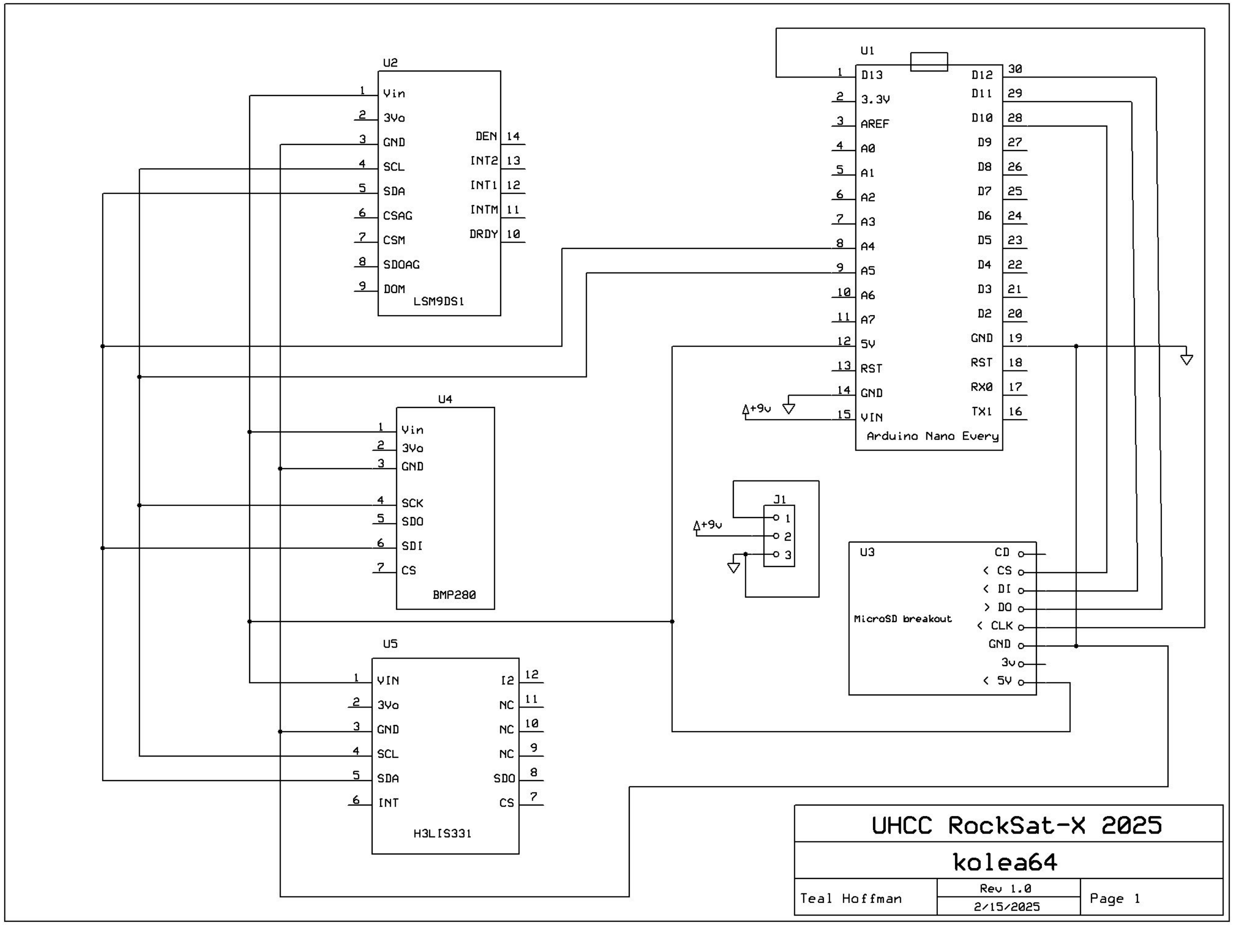
Example of Integration Into HonCC Hammond Box

Subsystem Testing Results - Data Controller



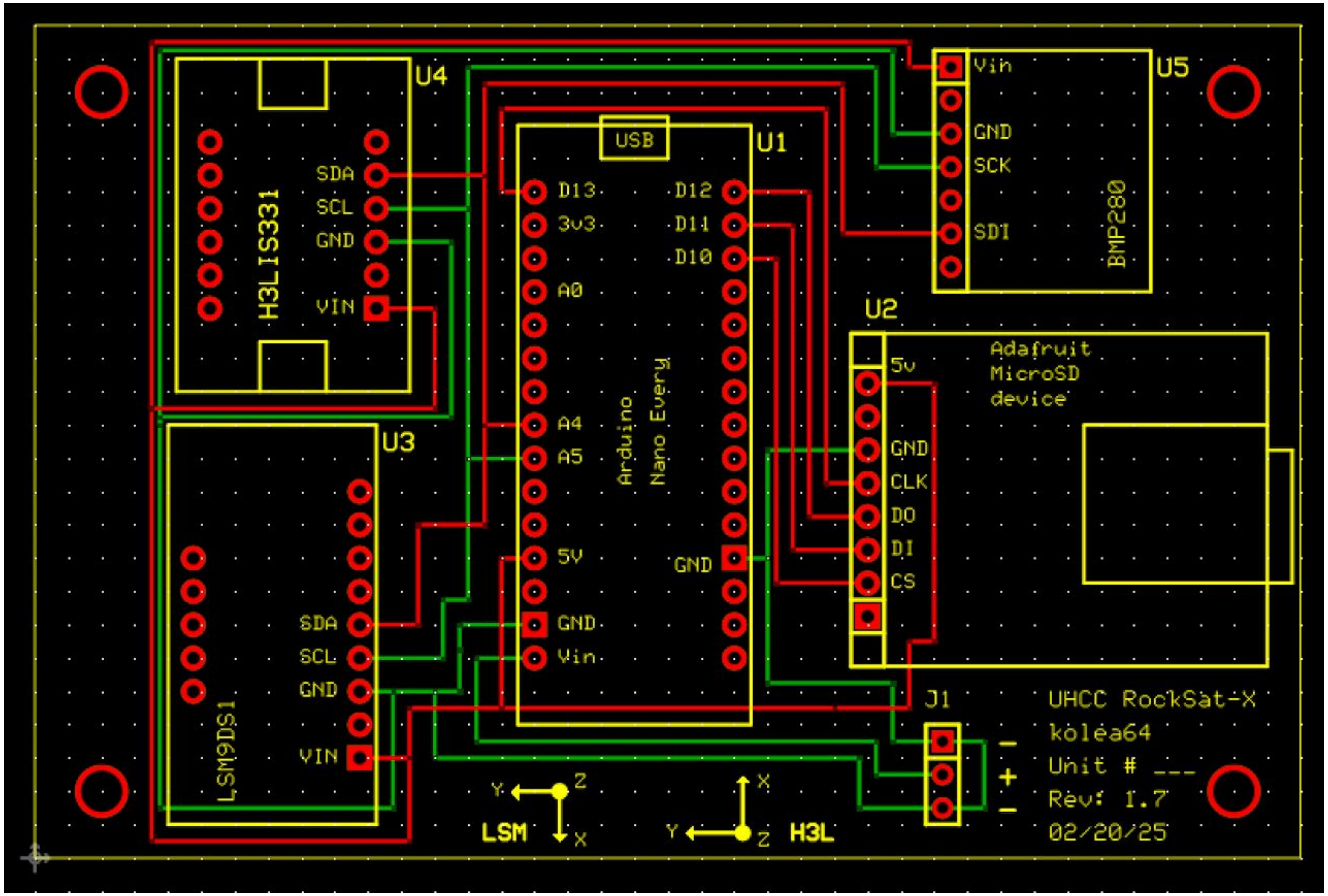
Prototype on Breadboard

Subsystem Testing Results - Data Controller



Data Controller Schematic

Subsystem Testing Results - Data Controller



Express PCB Board Layout

Default Board Size: 2.5" x 3.8"

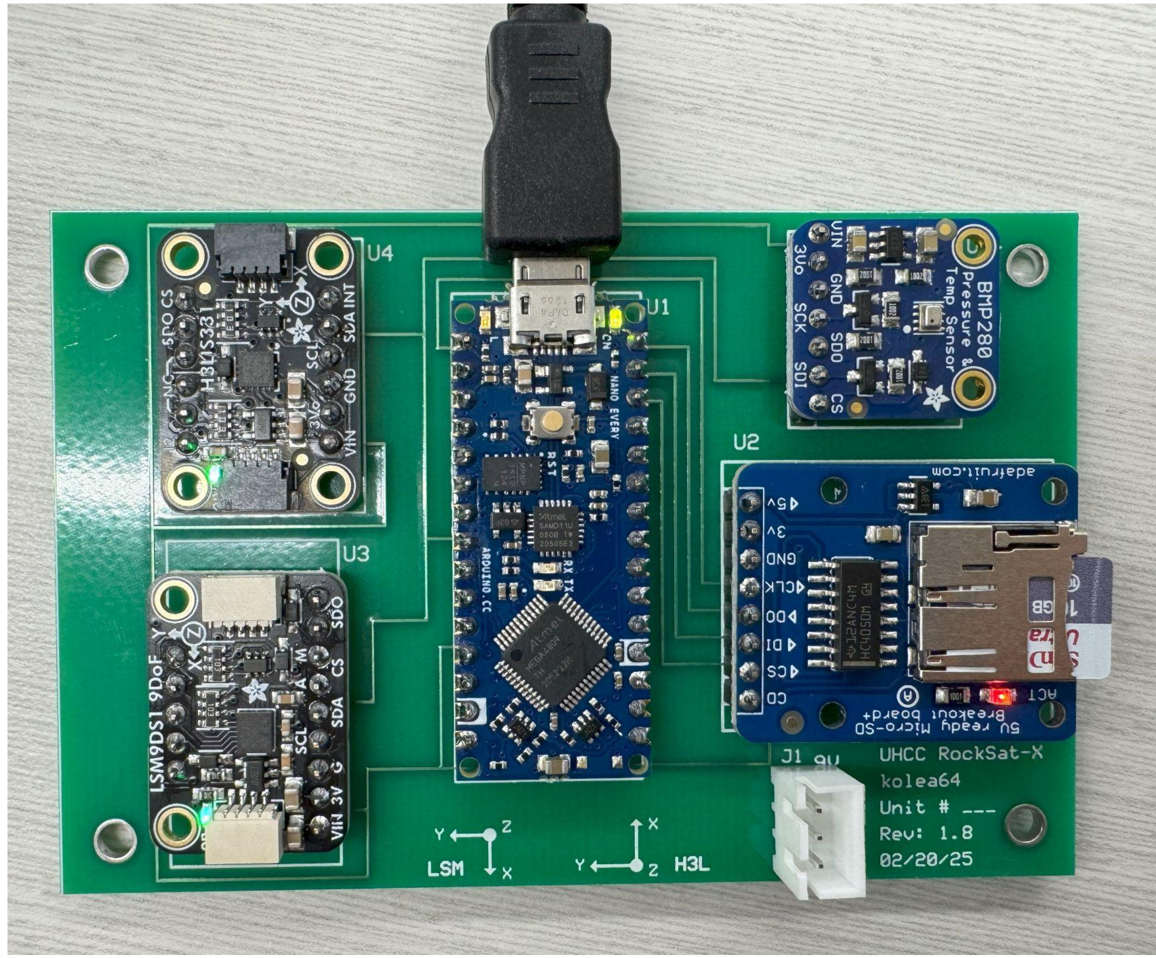
Teal

Subsystem Testing Results - Data Controller

Weights:

- Unit 2: 35.76 grams (w/out microSD)
- Unit 3: 36.80 grams (w/out microSD)
- MicroSD card: 0.28 grams
- Wires: 8.41 grams

Total: 44.45 grams - 45.49 grams



FINAL PCB Design: 100%

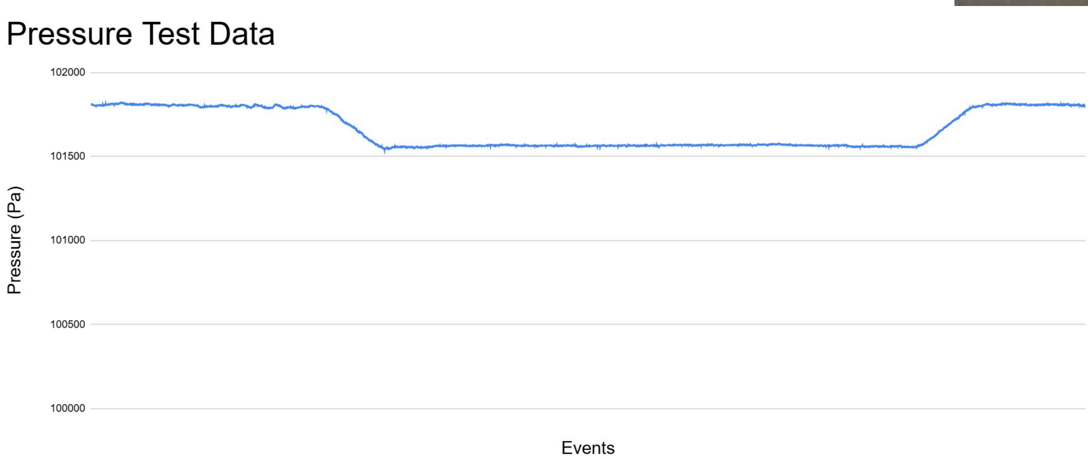
Subsystem Testing Results - Data Controller

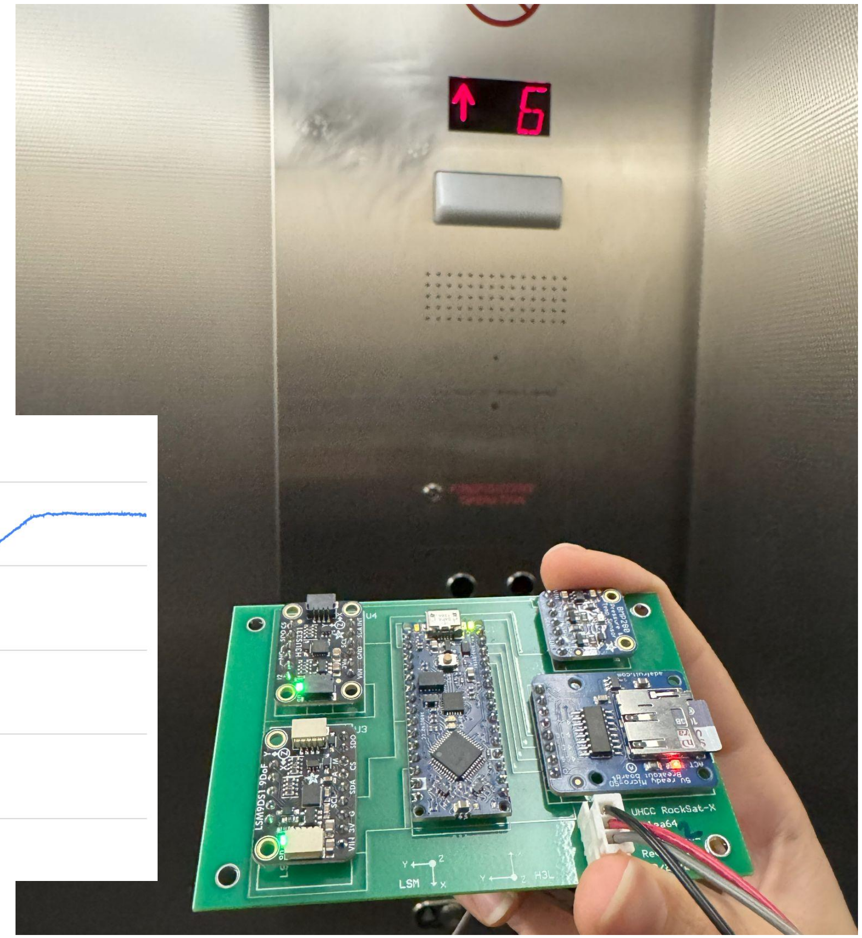
- Expected Results:
- **"Elevator" Test Run**
  - ☑ – Pressure lowers
  - ☑ – Temperature lowers
  - ☑ – Vibrations from walking (low acceleration)
- **Centripetal Force Apparatus**
  - ☑ – Magnetometer data represents a sine wave
  - ☑ – Gyroscope data relates to magnetometer data
- **Warm Temperature and Acceleration Data**
  - ☑ – Temperature rises
  - ☑ – Z axis from acceleration becomes -9.81 m/s when flipped upside down
  - ☑ – High acceleration data relates to acceleration data from IMU

Subsystem Testing Results - Data Controller

"Elevator" Test Run

- Used a 9V battery for power
- Started from first floor outside (room temperature) to 6th floor (Air conditioning)

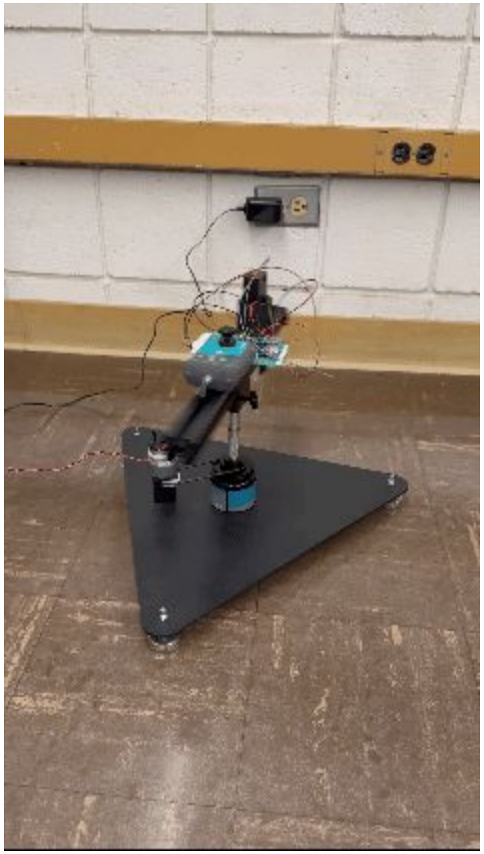




Software and Data Collection Testing: **100%**

Subsystem Testing Results - Data Controller

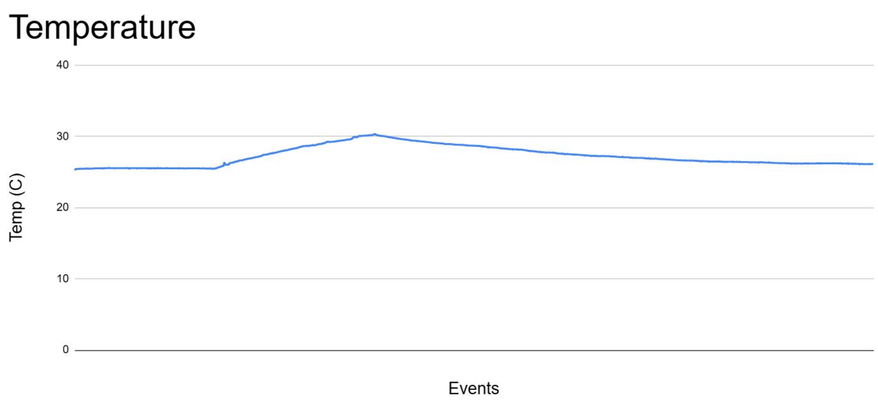
Centripetal Force Apparatus Testing

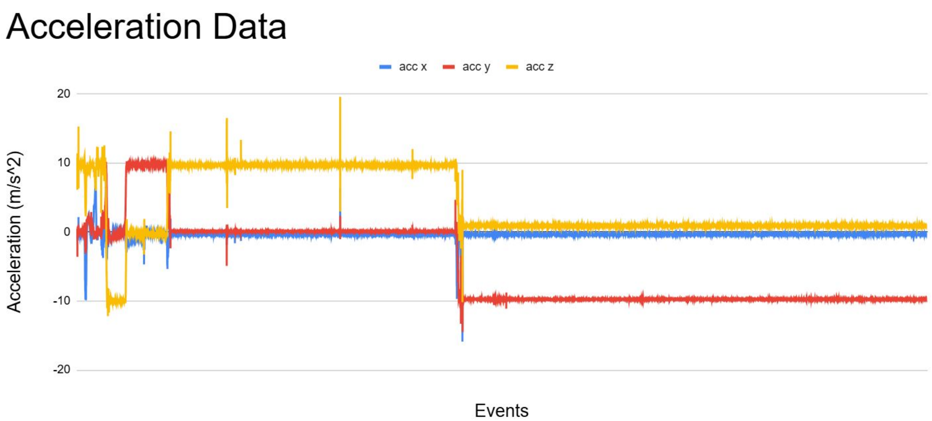


Software and Data Collection Testing: **100%**

Subsystem Testing Results - Data Controller

Warm Temperature and Acceleration Data

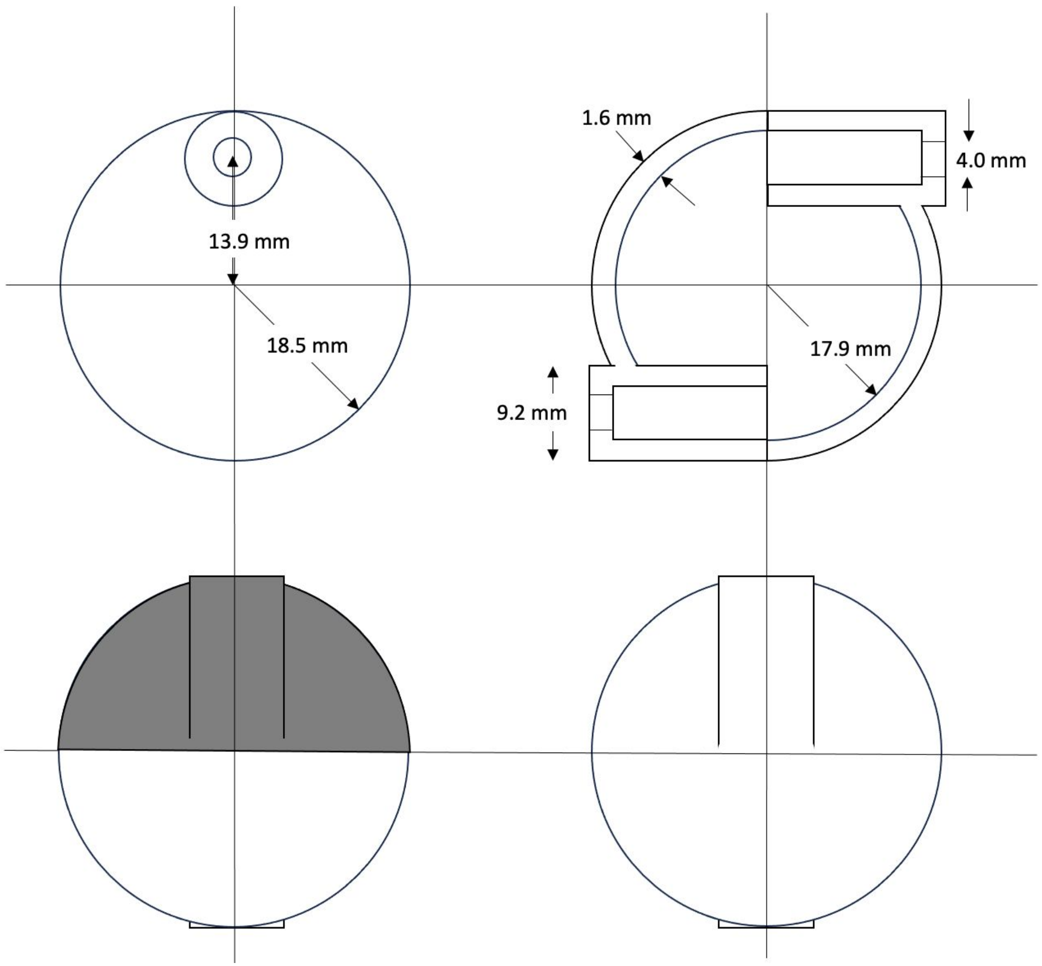


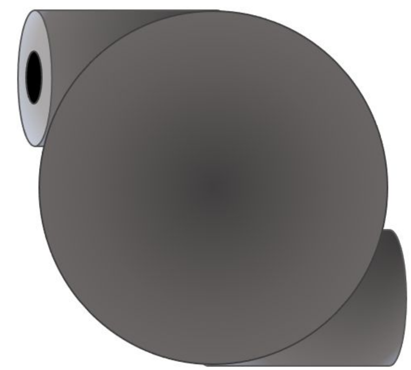


- Warm cup held near BMP280 to get slightly warmer temperature
- Device was rotated in different orientations to determine the acceleration of gravity and which axis it corresponds to

Software and Data Collection Testing: **100%**

Subsystem Information - ScubeR



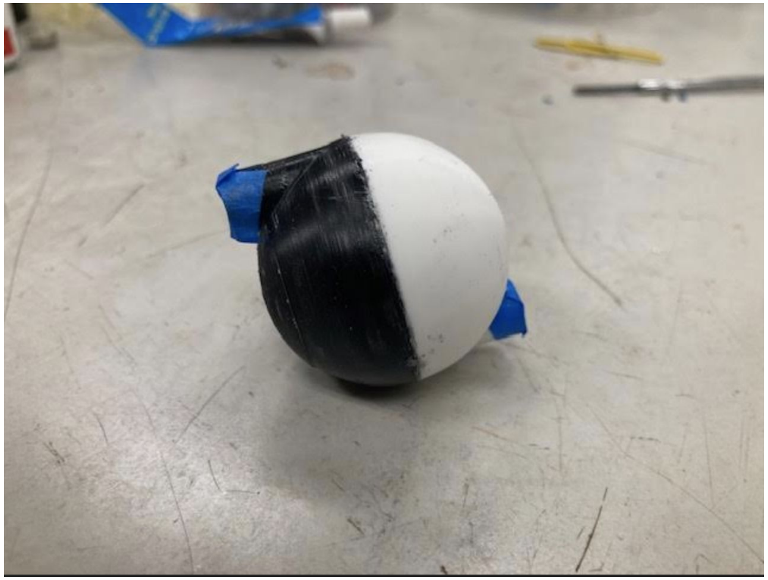


Subsystem Information - ScubeR

Total mass: 21.1 g
- ABS body mass: 8.2 g
- Camphor mass: 12.9g

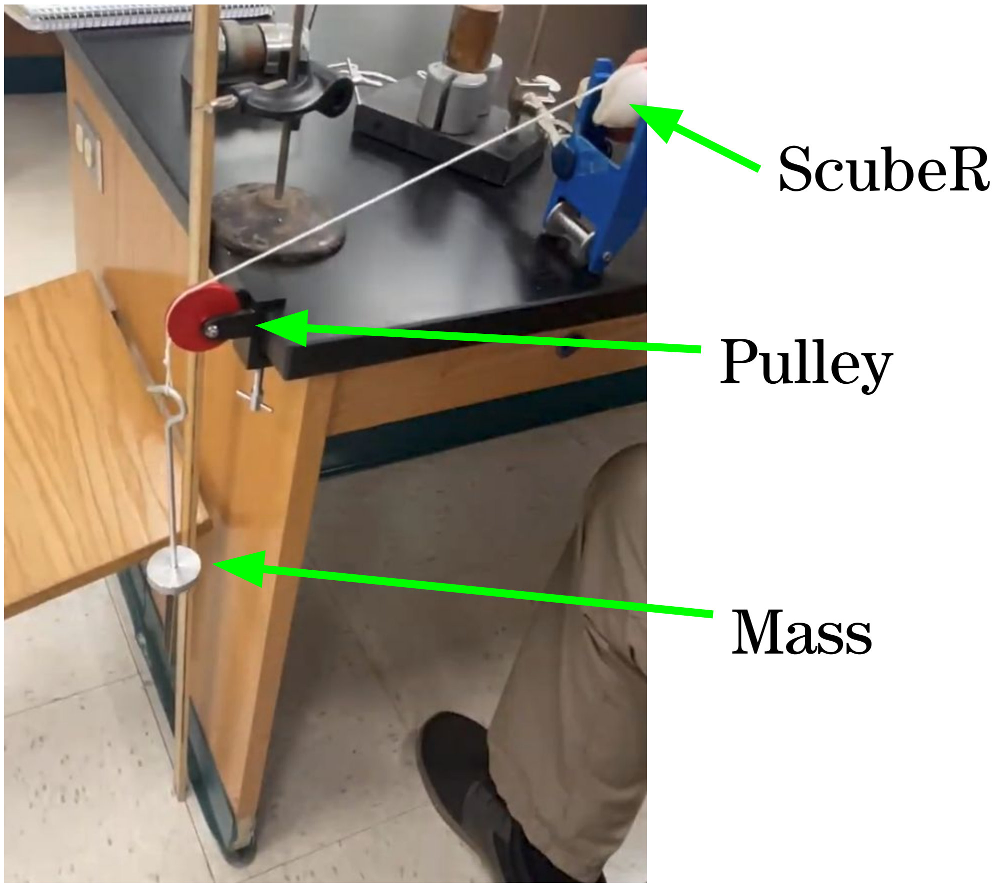
Rotational Inertia:

$I = 4.81 \times 10^{-6}$ kg-m^2



We plan on conducting more experiments to verify our calculation of the rotational inertia of ScubeR

ScubeR Rotational Inertia - Experimental Calculation



The string wrapped around ScubeR is released, causing the mass to fall to the floor. The time the mass takes to hit the floor allows us to calculate ScubeR's rotational inertia.

This experiment was already conducted but will be conducted again for verification.

ScubeR Rotational Inertia - Calculations

Rotational Inertia Calculation for ScubeR:

$$I = I_{Camphor} + I_{Shell} + 2I_{Chimney}$$

$$I = \frac{2}{5}M_{Camphor}(R-t)^2 + \frac{2}{3}M_{Camphor}R^2 + 2M_{Shell}\left\{\frac{1}{4}R_o^2\left[1-\left(\frac{R_I}{R_o}\right)^4\right] + \frac{1}{12}L^2\left[1-\left(\frac{R_I}{R_o}\right)^2\right]\right\}$$

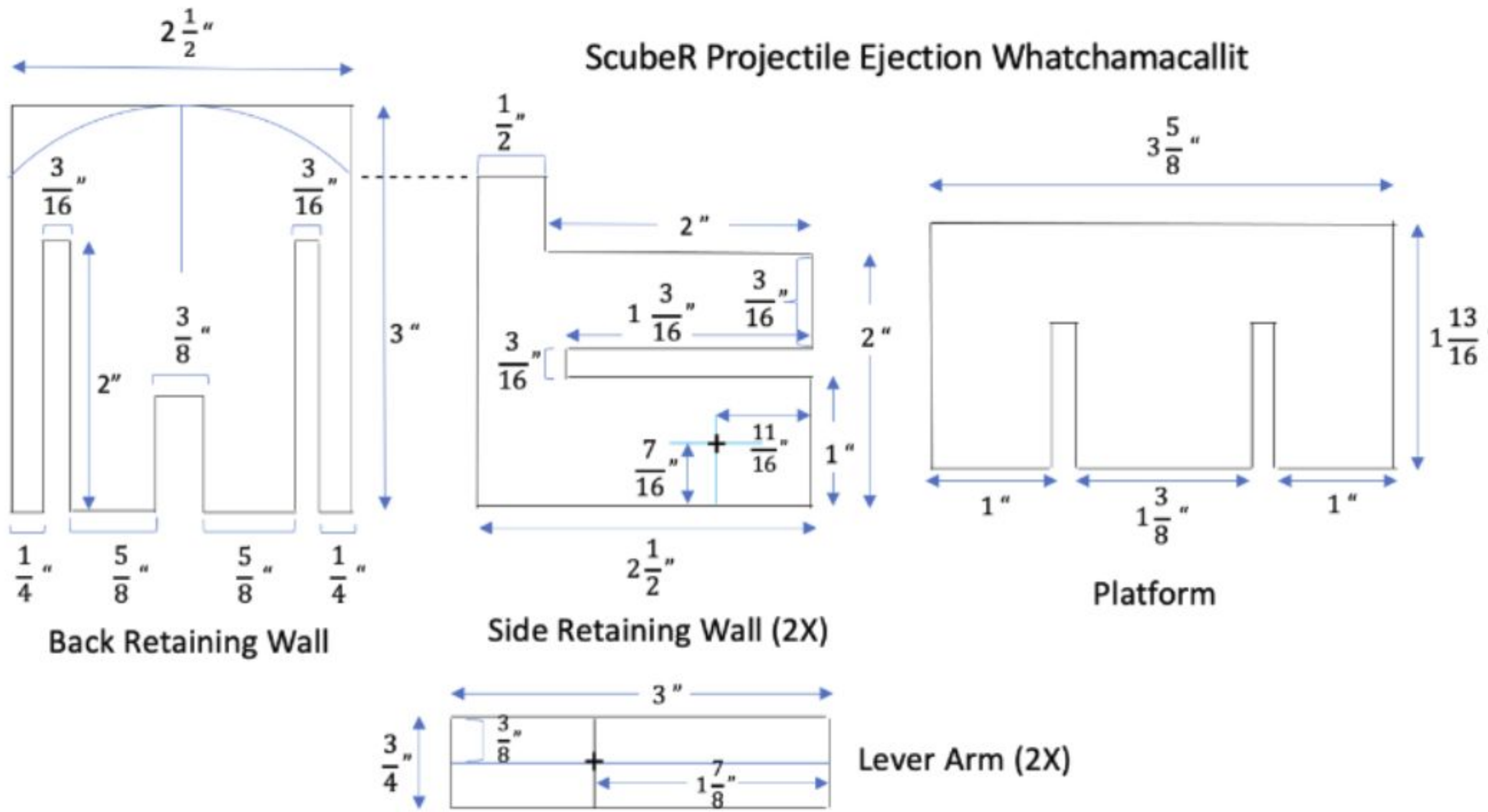
Where R is the outer radius of ScubeR, t is the shell thickness, R_o is the outer radius of a chimney, R_I is the inner radius of a chimney, and L is the length of a chimney.

Experimental determination of the Rotational Inertia of ScubeR:

$$I = MR^2\left\{\frac{gt^2}{2h} - \frac{m_p}{2M} - 1\right\}$$

Where M is the dependent mass, m_p is the pulley mass, h is the distance the dependent mass falls through, and t is the time it takes for the dependent mass to fall a distance of h.

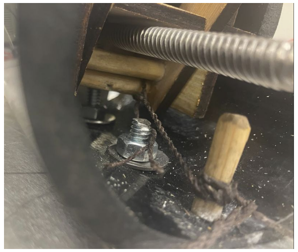
Subsystem Information - SPEW



Subsystem Information - SPEW Changes to Design

Sling to eject ScubeR

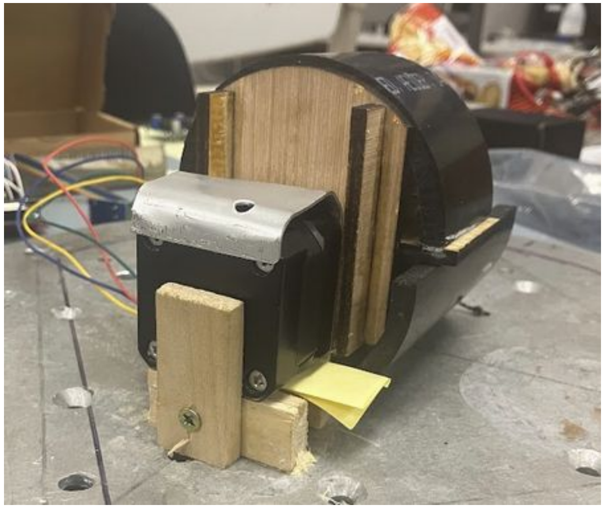
Beveled arms. This prevents collision with ScubeR.



Twisted polyester thread. Ensures arms remain closed, and closes them when SPEW retracts.

Dowel opening mechanism. This replaces the spring, which was too weak to open the arms. The lower dowel on the arms is pushed into the vertical, forcing the arms to rotate.

Subsystem Information - SPEW Changes to Design

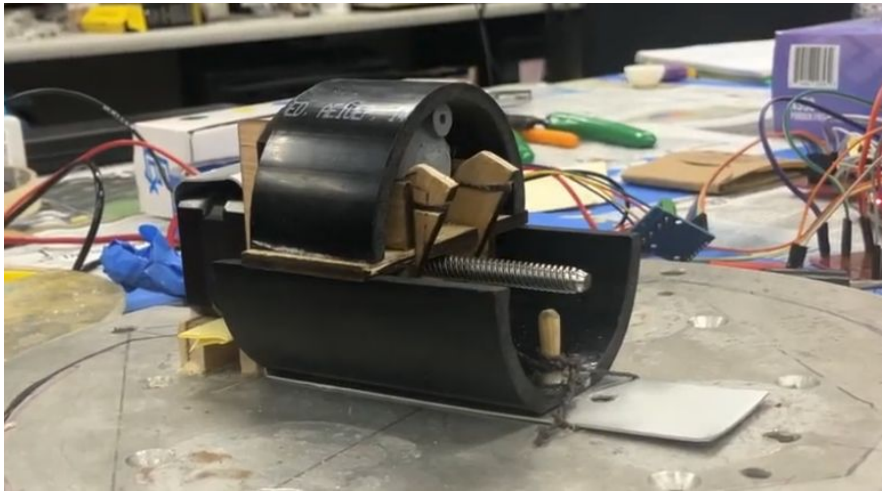


Motor housing made of wood. This is temporary and will be replaced with one made of lead.

Subsystem Testing Results - SPEW

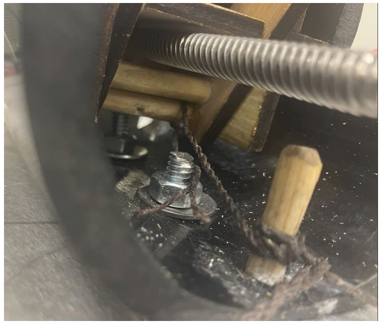
Power: none
Volume: 7.2” L x 3.5” W x 3.75” H
Weight: 0.305 pounds

- Interfaces with the Stepper Motor via barrel nut
- Hardware used (see next slide)
- Subsystem is not final.
  - Lead housing needs to be made for motor (lead block)
  - Replace wooden dowel stop with a bolt



Subsystem Testing Results - SPEW

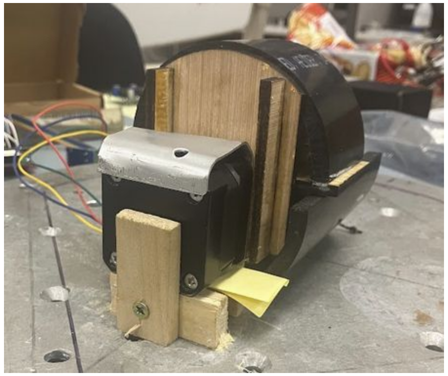
Hardware used
- 3/32” plywood
- ¼” Dowel
- ¼” Hex bolt and nut
- Flat washers
- 0.035” waxed polyester thread
- 5 minute epoxy
- Super glue
- Aluminum kick plate
- Wood screws
- ¼” Thick poplar wood



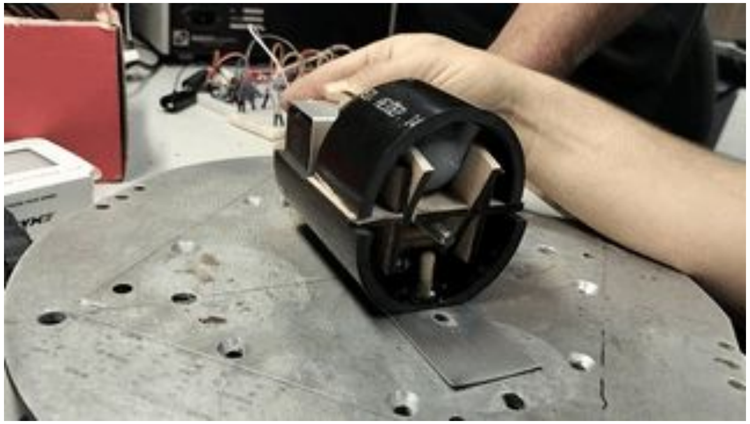
(both above) Polyester thread - sling and closing mechanism

(Left) screws used to hold spew to the Barrel nut.

(Right) poplar wood in use for temporary motor housing

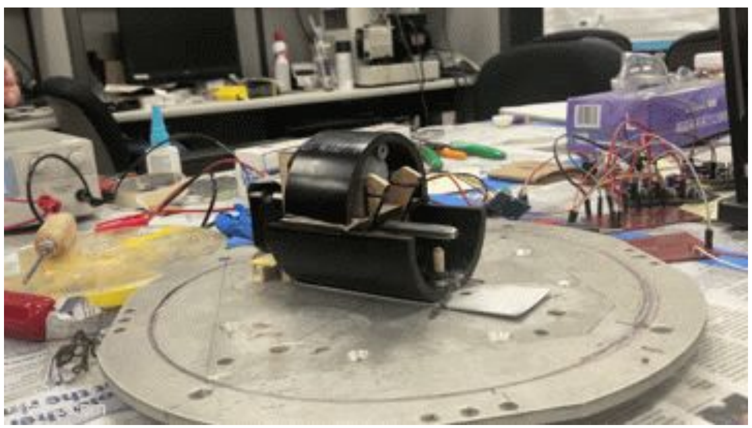


Subsystem Testing Results - SPEW



First Test (no sling) - Fail

ScubeR did not eject



Second Test (with sling) - Success

ScubeR did eject

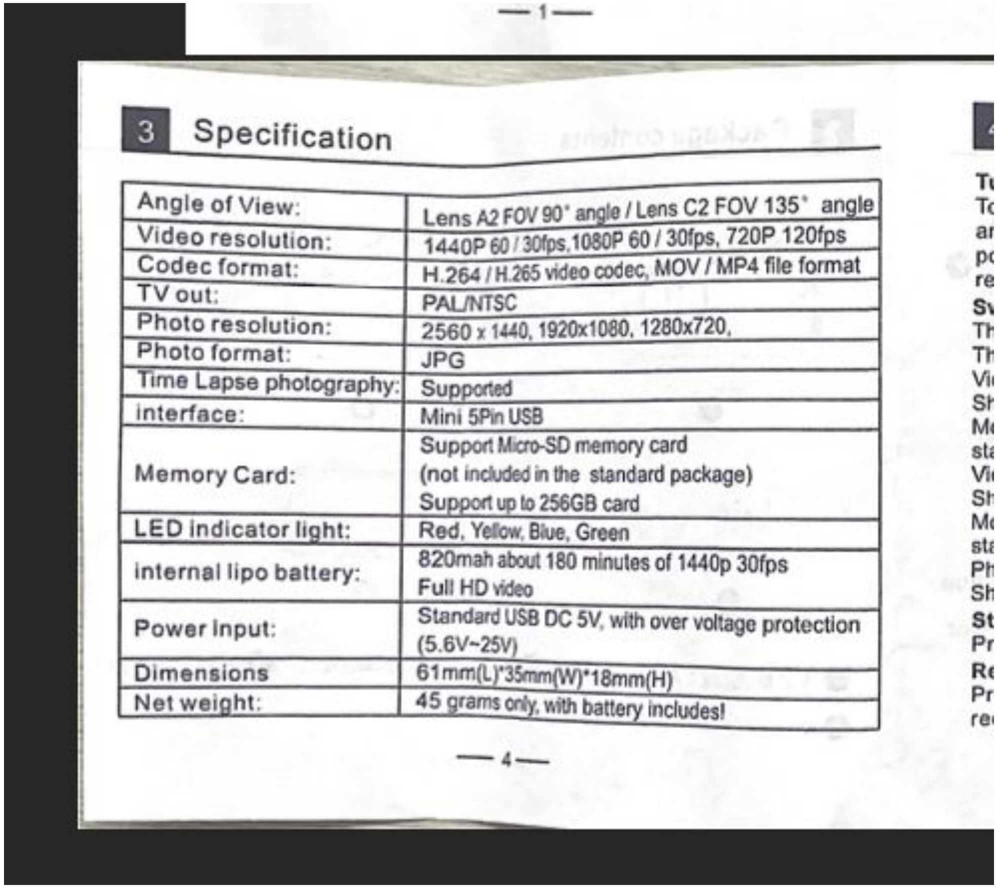
Subsystem Testing Results - SPEW

90%

- Spew is 90% done. Only minor improvements to parts need to be made.
- First test performed with stepper motor to see if ScubeR would eject (3/8/2025)
- Second test performed with other subsystems (3/20/2025)
- Third test after improvements were made to see if ScubeR would eject (3/22/2025)
- Tests needed: Retest after improvements to components
    - Improve motor housing (make lead)
    - Replace opening mechanism dowel with bolt
    - Remake aluminum flange to fit better

Subsystem Testing Results - Cameras

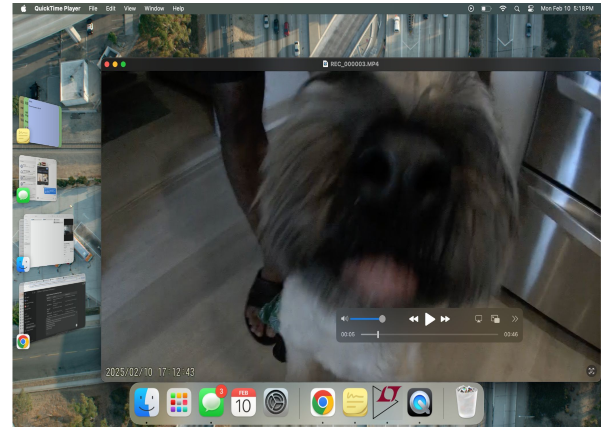
Shelby

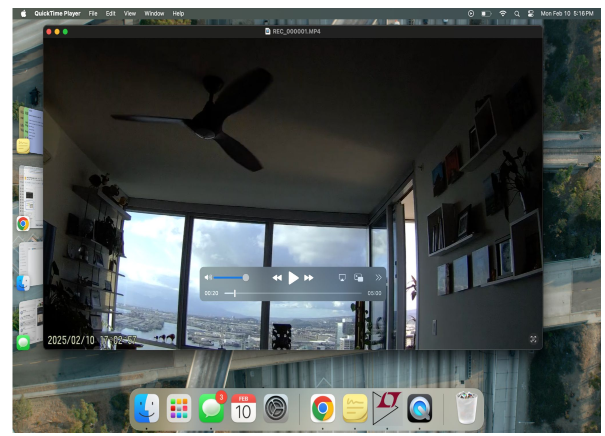


3 Specification

Angle of View:	Lens A2 FOV 90° angle / Lens C2 FOV 135° angle
Video resolution:	1440P 60 / 30fps, 1080P 60 / 30fps, 720P 120fps
Codec format:	H.264 / H.265 video codec, MOV / MP4 file format
TV out:	PAL/NTSC
Photo resolution:	2560 x 1440, 1920x1080, 1280x720,
Photo format:	JPG
Time Lapse photography:	Supported
interface:	Mini 5Pin USB
Memory Card:	Support Micro-SD memory card (not included in the standard package) Support up to 256GB card
LED indicator light:	Red, Yellow, Blue, Green
internal lipo battery:	820mah about 180 minutes of 1440p 30fps Full HD video
Power input:	Standard USB DC 5V, with over voltage protection (5.6V~25V)
Dimensions	61mm(L)*35mm(W)*18mm(H)
Net weight:	45 grams only, with battery includes!

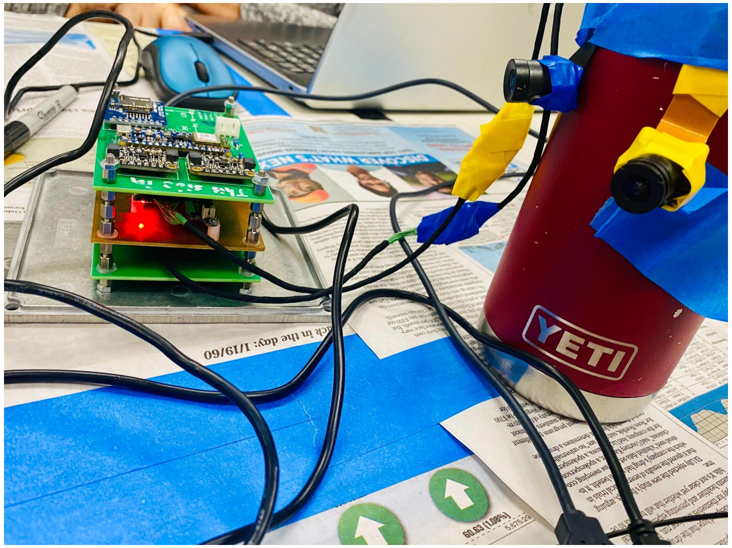
— 4 —

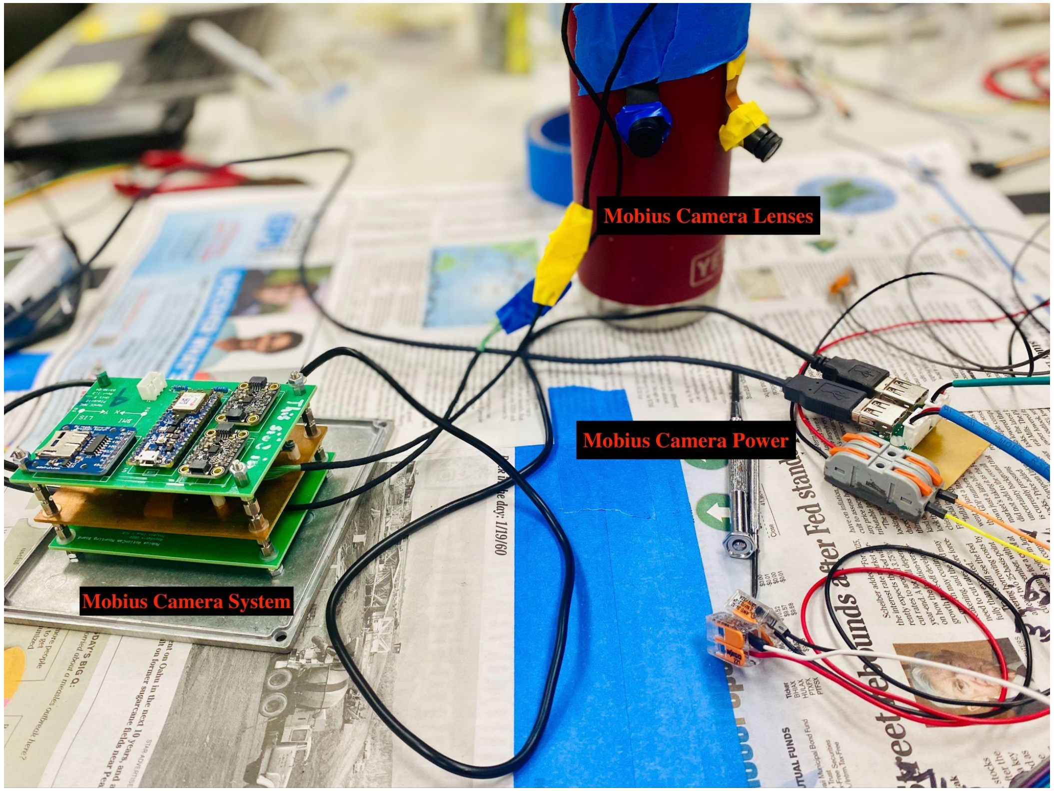




Subsystem Testing Results - Cameras

Shelby





100%

Subsystem Testing Results - Cameras

Shelby

Recorded Files Log for Camera B

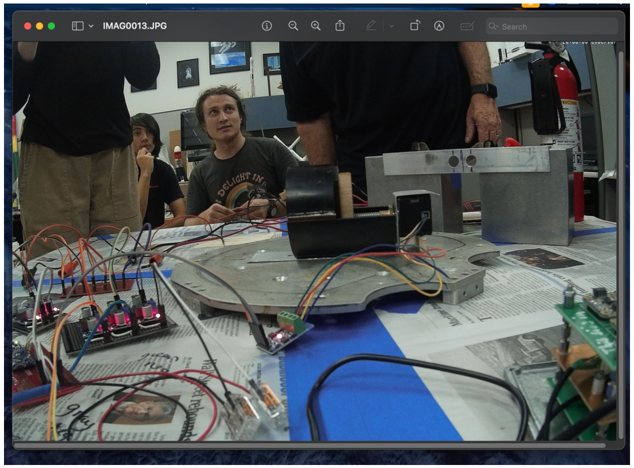
File Name	File Size (MB)	Created Time	Modified Time	Notes
REC_000001.MP4	486 MB	10:08 AM	10:13 AM	5 min file, correct length
REC_000002.MP4	486 MB	10:13 AM	10:18 AM	5 min file, correct length
REC_000003.MP4	166.5 MB	10:18 AM	10:20 AM	Shorter file, manually stopped

Test Log for Camera B

Test Name	Result	Notes / Observations
Power On Test	✅ Pass	No LED issues, powered on smoothly
Recording Test	✅ Pass	Recorded properly for 5 minutes each
File Length Check	✅ Pass	All files saved correctly, no overwriting
Playback Quality	✅ Pass	720p clear, 60fps smooth
Time Stamp Test	✅ Pass	Time stamp was accurate
Audio Test	✅ Pass	Sound was clear at medium volume
Power Stability Test (30 Min)	✅ Pass	No overheating, no shutdown

Subsystem Testing Results - Cameras

Shelby

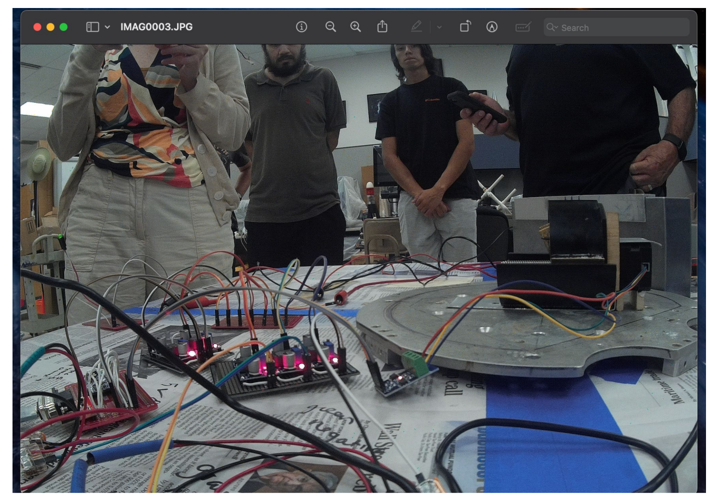


Recorded Files Log for Camera A

File Name	File Size (MB)	Created Time	Modified Time	Notes
REC_000001.MP4	486 MB	5:02 PM	5:07 PM	5 min file, correct length
REC_000002.MP4	486 MB	5:07 PM	5:12 PM	5 min file, correct length
REC_000003.MP4	74.5 MB	5:12 PM	5:13 PM	Shorter file, manually stopped

Test Log for Camera A

Test Name	Result	Notes / Observations
Power On Test	✅ Pass	No LED issues, powered on smoothly
Recording Test	✅ Pass	Recorded properly for 5 minutes each
File Length Check	✅ Pass	All files saved correctly, no overwriting
Playback Quality	✅ Pass	720p clear, 60fps smooth
Time Stamp Test	✅ Pass	Time stamp was accurate
Audio Test	✅ Pass	Sound was clear at medium volume
Power Stability Test (30 Min)	✅ Pass	No overheating, no shutdown



Integrated Subsystem Testing Results

Integrated Subsystem Testing (Contents)

Section 4: Integrated Subsystem Testing Results

1. PDB, motor controller, SPEW (3/8/2025)
2. PDB, data controller, cameras (3/20/2025)
3. PDB, motor controller, SPEW, data controller, cameras (3/20/2025)
4. PDB, motor controller, SPEW, again (3/22/2025)

Test #1 - PDB, motor controller, SPEW, (3/8/2025)

Purpose: Early testing of SPEW's functionality while connected to stepper motor. Determine if SPEW's current design can eject ScubeR

Summary of results:

PDB - PDB provided the necessary power to motor controller

SPEW - SPEW moved forward and retracted, ScubeR did not eject

Motor Controller - Motor controller went through intended routine: pushed SPEW forward, and retracted it

Assessment of test results: Failure

- A later test with a revised SPEW design was conducted, which will be covered later (Test #4)

Test #1 - Results (3/8/2025)

- Motor worked but ScubeR did not eject
- The spring in SPEW did not work; it was not strong enough to open the arms
- We opted to put a dowel to open the arms
- GIF to the Right was taken after the opening mechanism was changed

Ryan

Test #2 - PDB, data controller, cameras (3/20/2025)

Purpose: Verify HonCC subsystems' functionality when powered by PDB

- Data controller
- Camera

Summary of results:

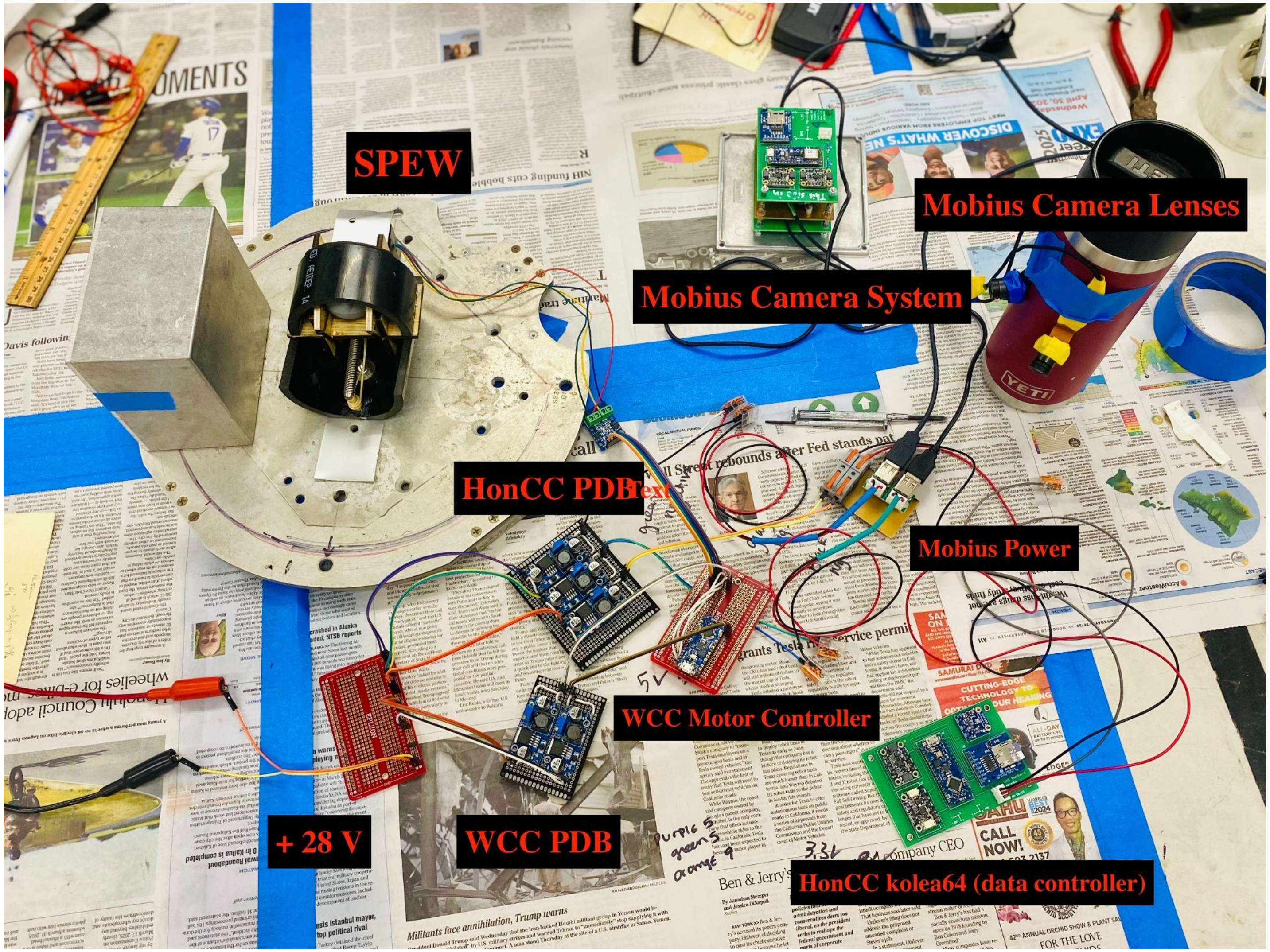
PDB - PDB provided 5V to each camera and 9V to data controller

Cameras - Cameras powered on and captured video.

Data controller - Data collected and stored accurately in microSD card

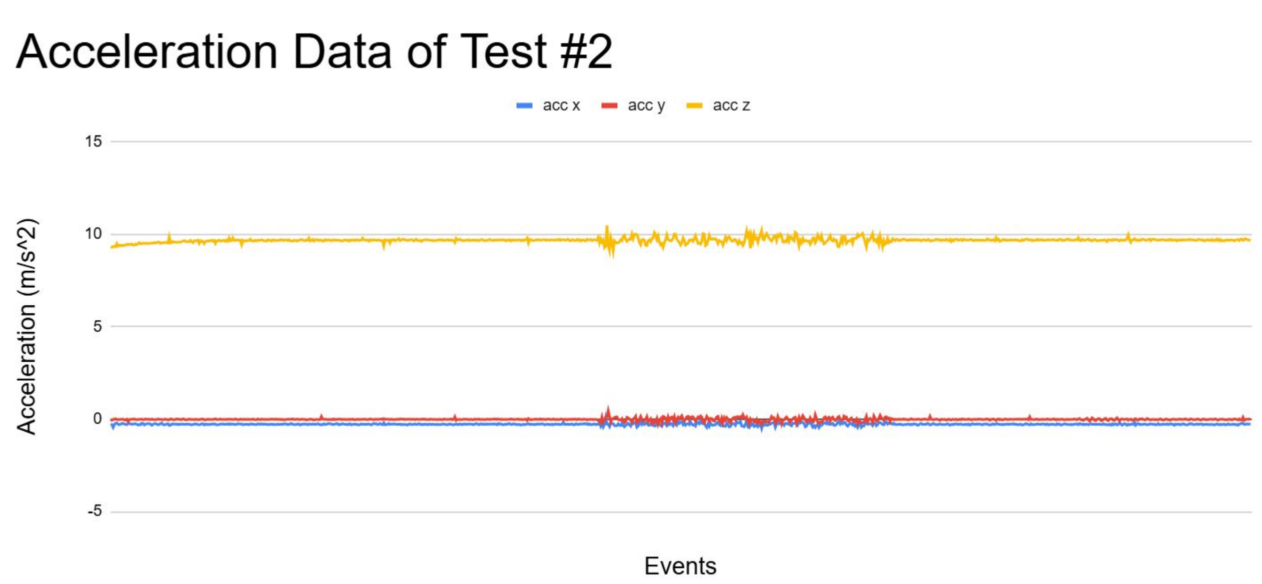
Assessment of test results: Success

Test #2 - Image of Test Setup



Test #2 - Data Controller Results

Assessment of Data Collection: Success



- Events were linear (No missing Data)
- Data accurately collected and stored on MicroSD card
- Acceleration from gravity in the Z direction (axis) corresponds to the device laying flat

Test #2 Mobius Camera Results

Shelby

Purpose:
Verify subsystem performance under extended operation, focusing on power stability, video quality, audio capture, and file storage reliability.

Summary of Results:

- **Power Stability:** Cameras operated continuously without overheating or shutdowns throughout extended testing period.

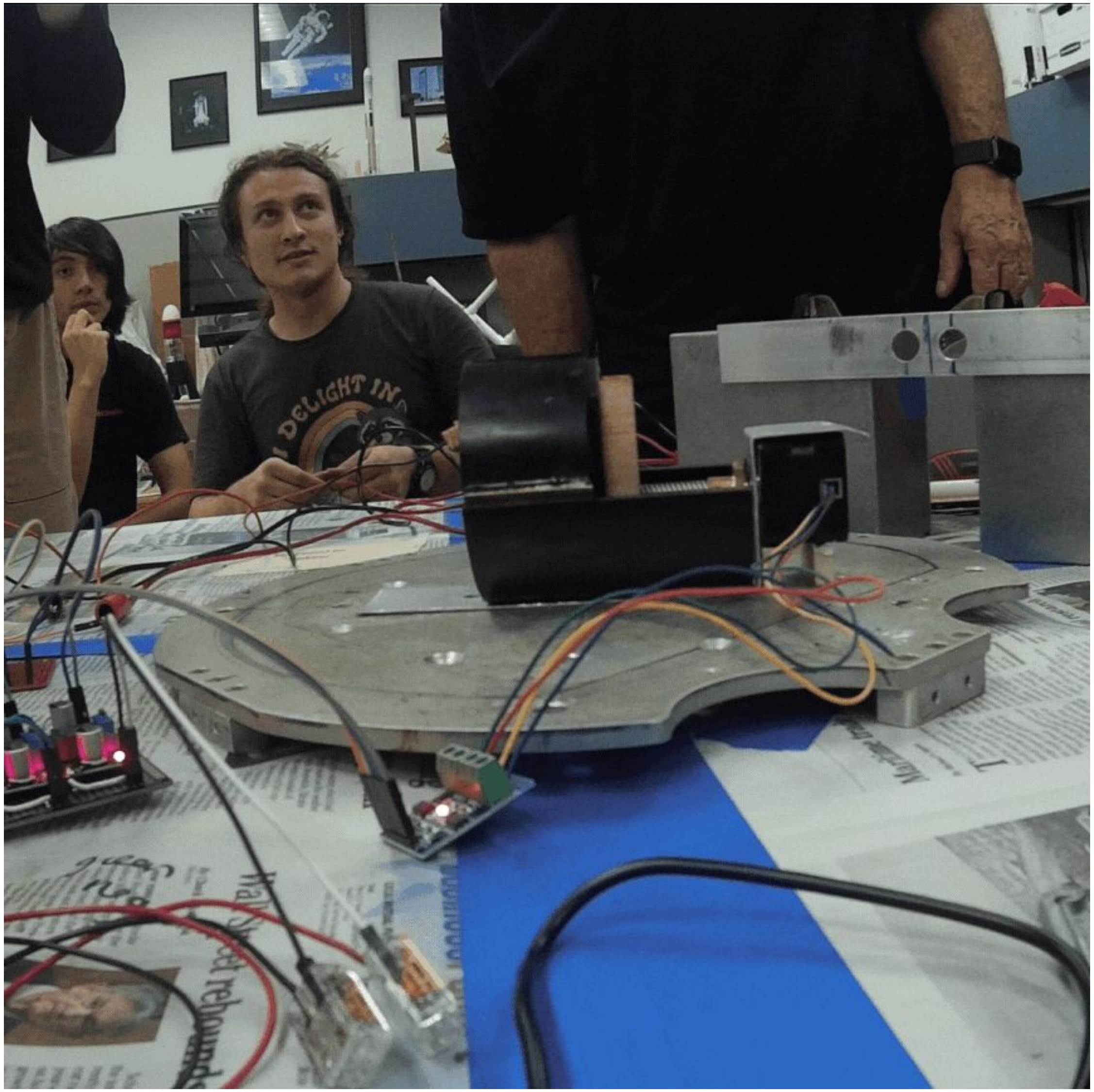
- **Video Quality:** Consistently maintained clear, detailed image quality; smooth recording at 60 fps confirmed.

- **Audio Capture:** Audio clarity confirmed at medium volume level with no noticeable distortion or interruptions.

- **File Storage Reliability:** All files stored accurately; no corruption or data loss detected during post-test analysis.

Test #2 Mobius Camera Results

Shelby



Test #2 Mobius Camera Results

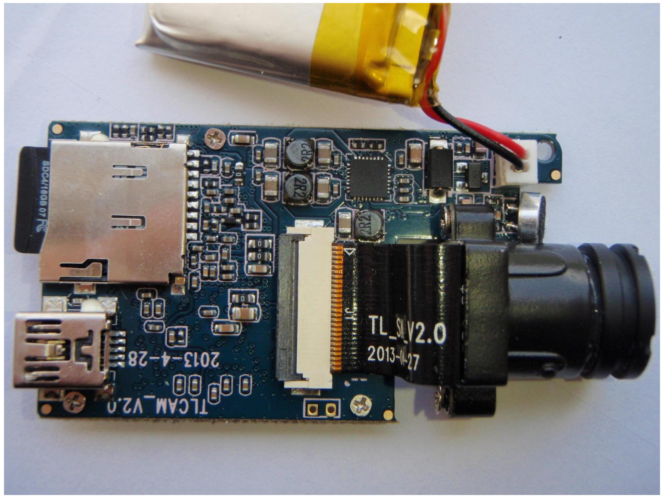
Shelby

Summary of Results:

- **Mobius Camera A:** Successfully powered on and captured clear footage at specified frame rate (60 fps), video stored accurately on microSD card. No interruptions during recording.

- **Mobius Camera B:** Successfully powered on, recorded stable and clear footage. Data integrity verified upon playback.

- **Data Handling:** All recorded video files correctly saved with accurate timestamps and file sizes consistent with expected lengths.



Test #2 - PDB Results

Assessment of PDB performance: Success

The data controller and cameras performed as desired while being powered by the PDB.

Test #3 - PDB, motor controller, SPEW, data controller, cameras (3/20/2025)

Purpose:

Summary of results:

PDB - PDB provided the necessary power to all subsystems

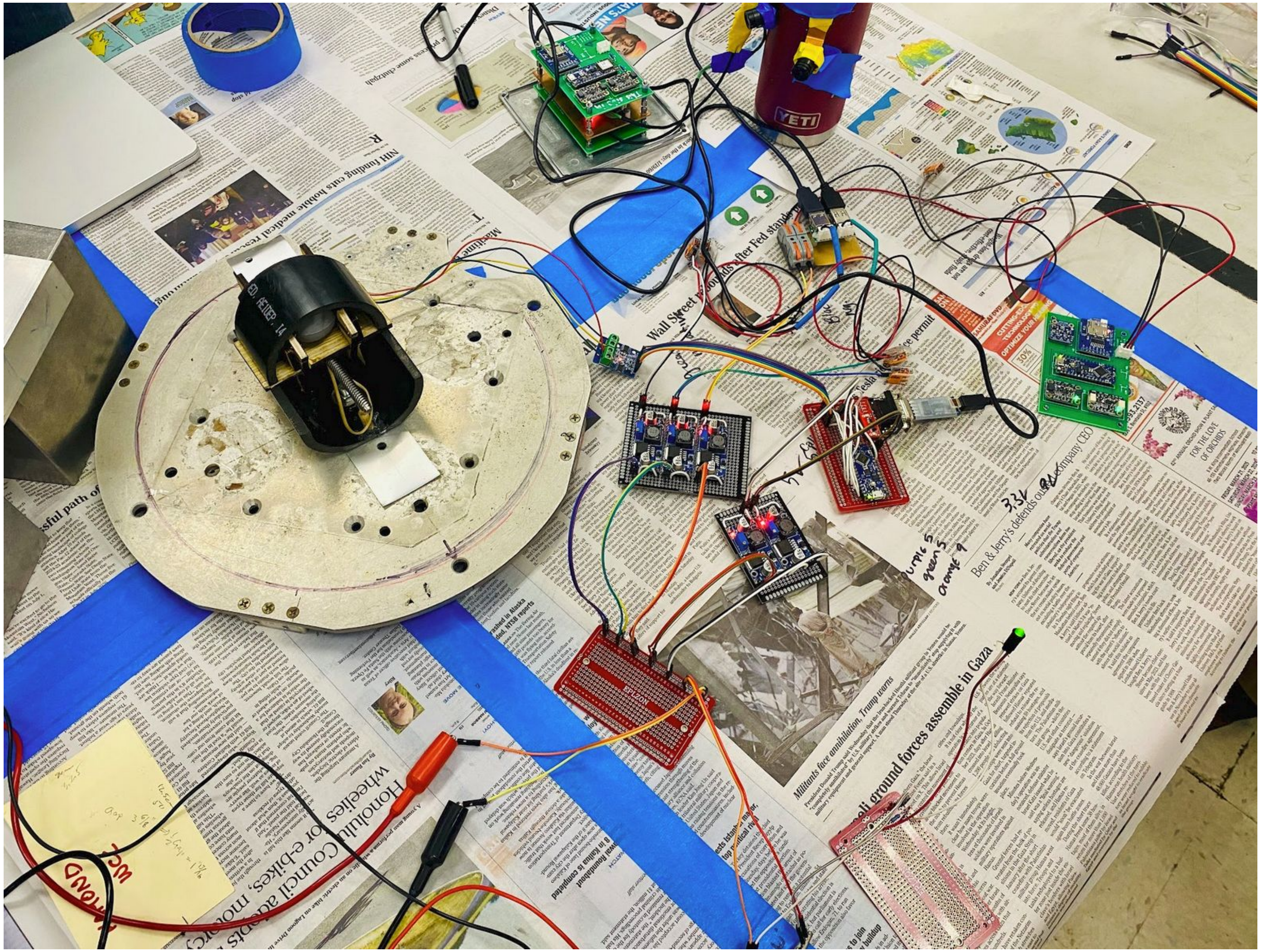
Cameras - Cameras powered on and captured video.

Data controller - Data collected and stored accurately in microSD card

SPEW - ScubeR was not consistently ejected from SPEW

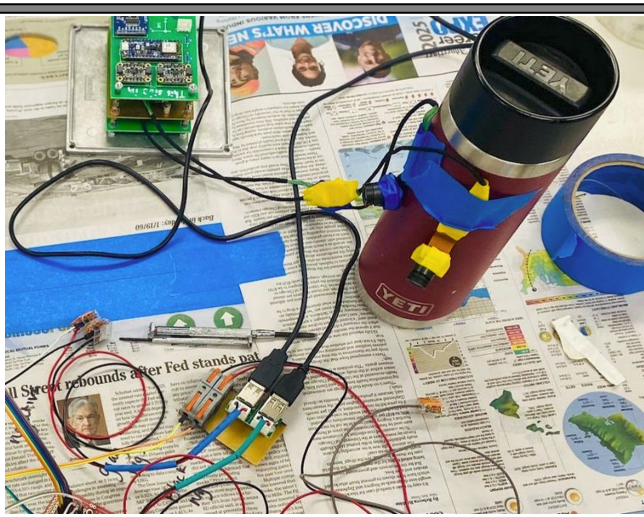
Motor Controller - Motor controller went through intended routine: backstepped for 2 minutes, pushed SPEW forward, and retracted it

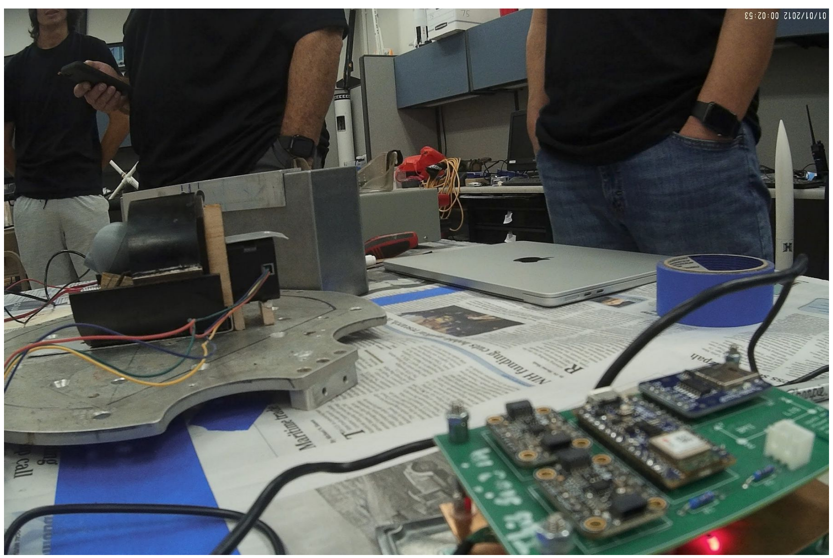
Test #3 - Image of Test Setup



Test #3 Mobius Camera Results

Shelby





Purpose:

To confirm the Mobius Camera's ability to capture clear, stable video at the desired frame rate and effectively record the testing environment from its installation location.

Summary of Results:

- Mobius camera activated smoothly and began recording without issues.
- Captured high-quality footage clearly displaying the test environment, accurately demonstrating camera angle and image sharpness.
- Consistently maintained a frame rate of 60 fps, resulting in fluid and uninterrupted video capture.
- Successfully stored and retrieved recorded files from the SD card.

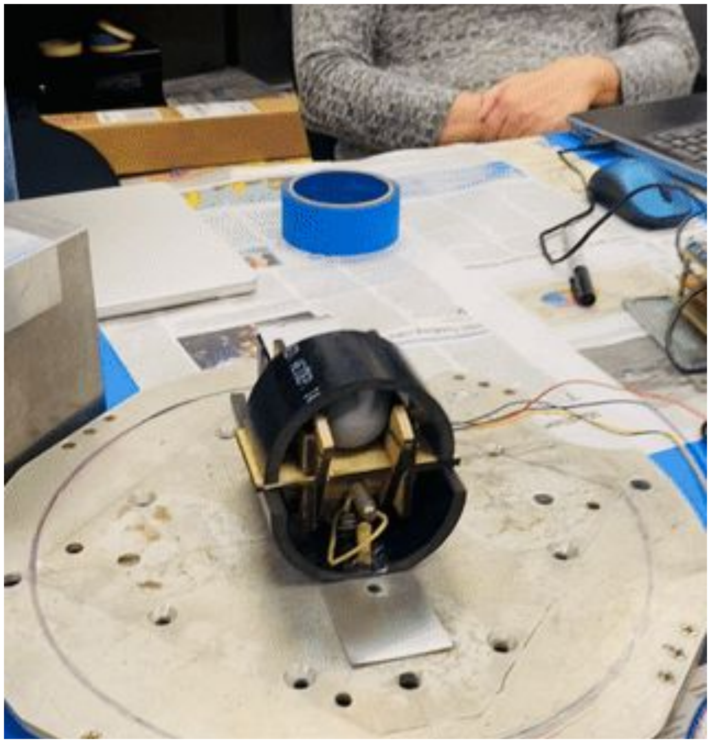
Test #3 Mobius Camera Results

Shelby

Overall Conclusion: The Mobius camera subsystem performed reliably and met all testing criteria.

- Both cameras captured and saved clear video
- Data integrity verified upon playback

Test #3 - SPEW and Motor Results



Test Result - Failure

ScubeR would not clear the arms reliably. The rendition of the sling used during this test yielded inconsistent results.

A rubber band was used on the bottom to hold the retaining claw shut until SPEW moved forward. This was deemed not effective enough and was replaced in Test #4 with a string.

This test showed that SPEW's sling needed to be revised, which occurs in Test #4.

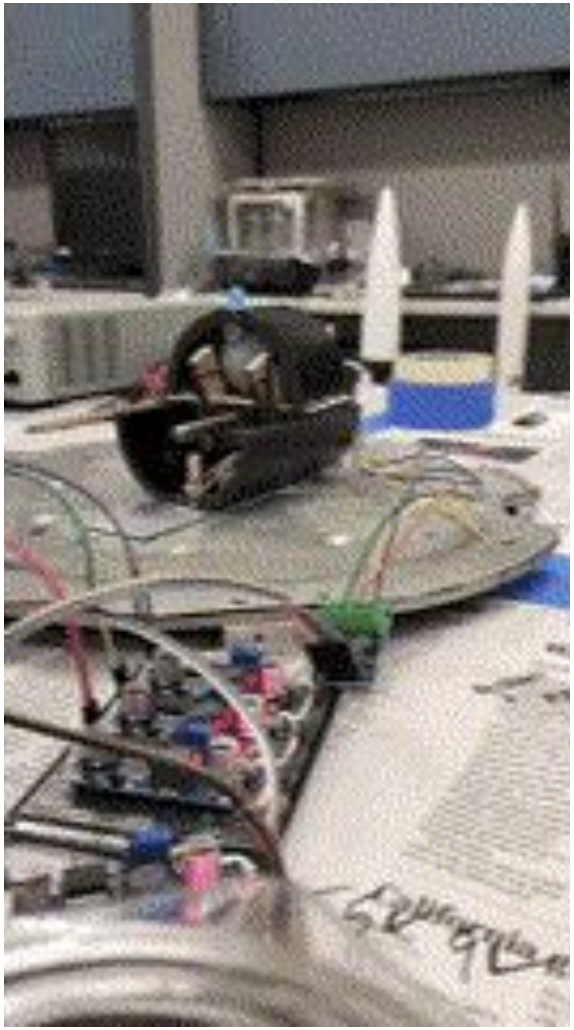
Test #3 - Data Controller Results

Assessment of Data Collection: Success

- Events were linear (No missing Data)
- Data accurately collected and stored on MicroSD card
- Acceleration from gravity in the Z direction (axis) corresponds to the device laying flat

Test #3 - Motor Controller Results

- Motor controller ran its routine and deployed and retracted SPEW at the desired time (120 seconds after power on.)
- Serial communication did not work; this was one of the focal points of Test #4.



Test #3 - PDB Results

Assessment of PDB performance: Success

The data controller, cameras, and motor controller performed as desired while being powered by the PDB.

Test #4 - PDB, motor controller, SPEW (3/22/2025)

Purpose:

- Test updated SPEW design's ability to release ScubeR
- Verify serial communication with a computer acting as ground station.

Summary of results:

PDB - PDB provided power to motor controller and stepper motor

Motor controller - Motor controller deployed and retracted SPEW and successfully communicated with ground station

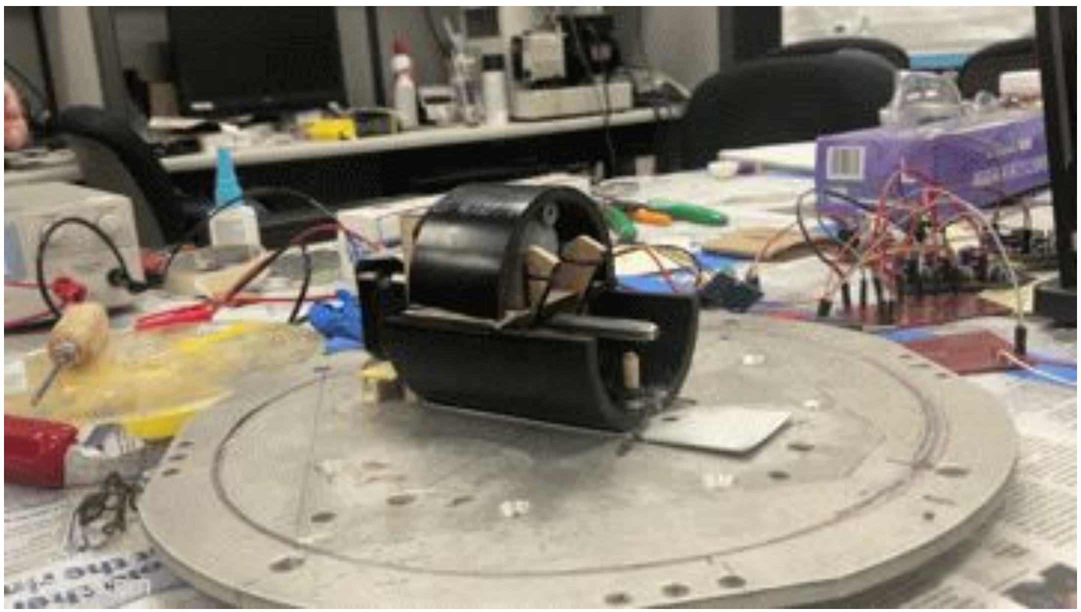
SPEW - SPEW released ScubeR at the intended time and retracted to its closed position

Assessment of test results: Success

Test #4 - SPEW and ScubeR Results

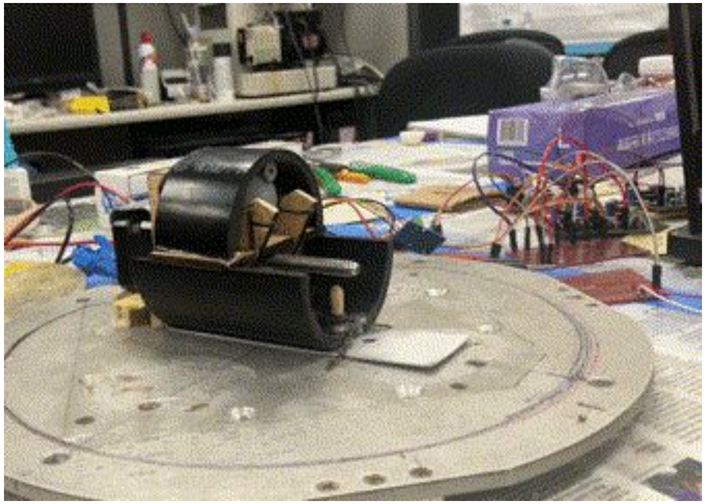
The sling successfully ejected ScubeR.

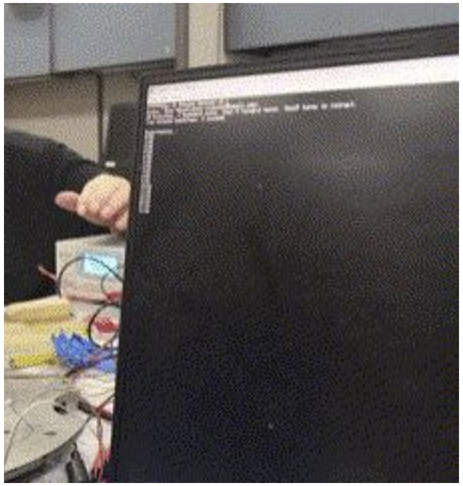
The bottom string closes the arms when SPEW returns to starting position.



Test #4 - Motor Controller Results

- The motor controller successfully deployed and retracted SPEW at the desired time
- Successfully gave status updates via serial communication





Integrated Tests - Remaining Tests

- Mount all hardware and subsystems, conduct full simulation of mission
  - Details in next section

Plan for FMSR

Plan for FMSR - Timeline of Events

Week of 4/13 - 4/18:

- Each campus mounts their subsystems onto their hardware
  - HonCC: Data controller and camera circuitry mounted inside Hammond box, camera lenses mounted to bridge between Hammond boxes
  - WCC: SPEW, stepper motor, H-bridge mounted on deck plate, motor controller and PDB mounted inside Hammond box

Saturday, 4/19:

- Campuses meet at WCC to mount hardware onto deck plate
- Full mission simulation conducted
  - At least 3 full mission simulations, with success criterion as outlined in the next slide
- Inert mass added to bring experiment up to spec on weight and balance

Plan for FMSR - Success Criteria

The assembled experiment conforms to all requirements entailed in the User Guide, such as keepout zone, weight, and balance. All hardware is mounted securely.

All subsystems perform their functions, which entails:

- Power distribution board delivers power to all subsystems
- Motor controller fully deploys and retracts SPEW on time, communicating its routine through a serial line
- SPEW spews ScubeR at the right time and returns to its starting position
- Data controller captures data from all sensors and the data is determined to be accurate
- Cameras captures and saves video of entire mission simulation, including ScubeR's release

Updated Summary Test Plan

Updated Summary Test Plan

- 3/29/2025
  - Population and testing of motor controller and PDB PCBs
  - Testing of improved SPEW design
- 4/5/2025
  - Further testing of improved SPEW design
- 4/13/2025 to 4/18/2025
  - Campuses mount hardware into boxes and onto deckplate
- 4/19/2025
  - Campuses meet for full mission simulation
  - Inert mass added to balance payload and bring weight up

Updated Wallops Test Plan

Initial Wallops Test Plan

- We plan to send a team consisting of 2-3 students and one mentor to the ETS testing led by CoSG (leave HNL 6/21, AR Chincoteague 6/22, Departure is scheduled for 2/28)
- It is our intent that the project will remain at WFF after testing
- No items are planned in August
- We are not planning any changes between ETS testing and launch
- Preflight checklist:
  - Verify that the payload takes power, and SPEW deploys properly
  - Remove tape over ScubeR chimney holes
- Nothing will be resource limited except for the camphor, but it shouldn't do anything sitting for a few days on the pad
- During testing, we can leave ScubeR out of SPEW as an inhibit
- Pointing requests have been provided already
- We are asking for No special requests

Project Management

Ryan

Project Imua Budget: Mission 14

rev 10-26-24			
UHCC Project Imua Mission 14: RockSat-X 2025			
Item	**Budgeted**	**Encumbered**	**Balance**
Student Summer Travel Stipend	$20,000	$0	$20,000
Mentor Summer Travel	$10,000	$0	$10,000
Supplies	$8,000	$0	$8,000
RockSat-X 2025 1st Install	$7,500	$7,500	$0
RockSat-X 2025 2nd Install	$7,500	$7,500	$0
Total	$53,000	$15,000	$38,000

- Both invoices paid
- June ETS:
  - 1 mentor, 2-3 students (TBD)
- August launch:
  - 2 mentors, 4-5 students (TBD)
- Experiment transported via checked luggage

Conclusion

Worries and Potential Points of Failure

- ScubeR deployment failure
  - Mitigation: Ensure forward retaining claw is horizontal upon ScubeR release, test ScubeR release sequence many times to verify ScubeR deploys smoothly and reliably
- Camera failure
  - Mitigation: 2 cameras recording for redundancy

Getting to FMSR

- Continue meetings within campuses
- Adhere to testing and integration schedule as outlined in previous sections
  - Campuses mounting hardware
  - Intercampus project assembly

Questions?

https://imua.wcc.hawaii.edu/default.html

Appendix

Mission Objectives

Mission: Our mission is to design a payload that supports two primary and two secondary experiments while fostering intercampus collaboration.

Objective 1: Student Engagement (STEM)

- Facilitate cross campus collaboration (HonCC +WinCC)
- Project-based internship in aerospace engineering

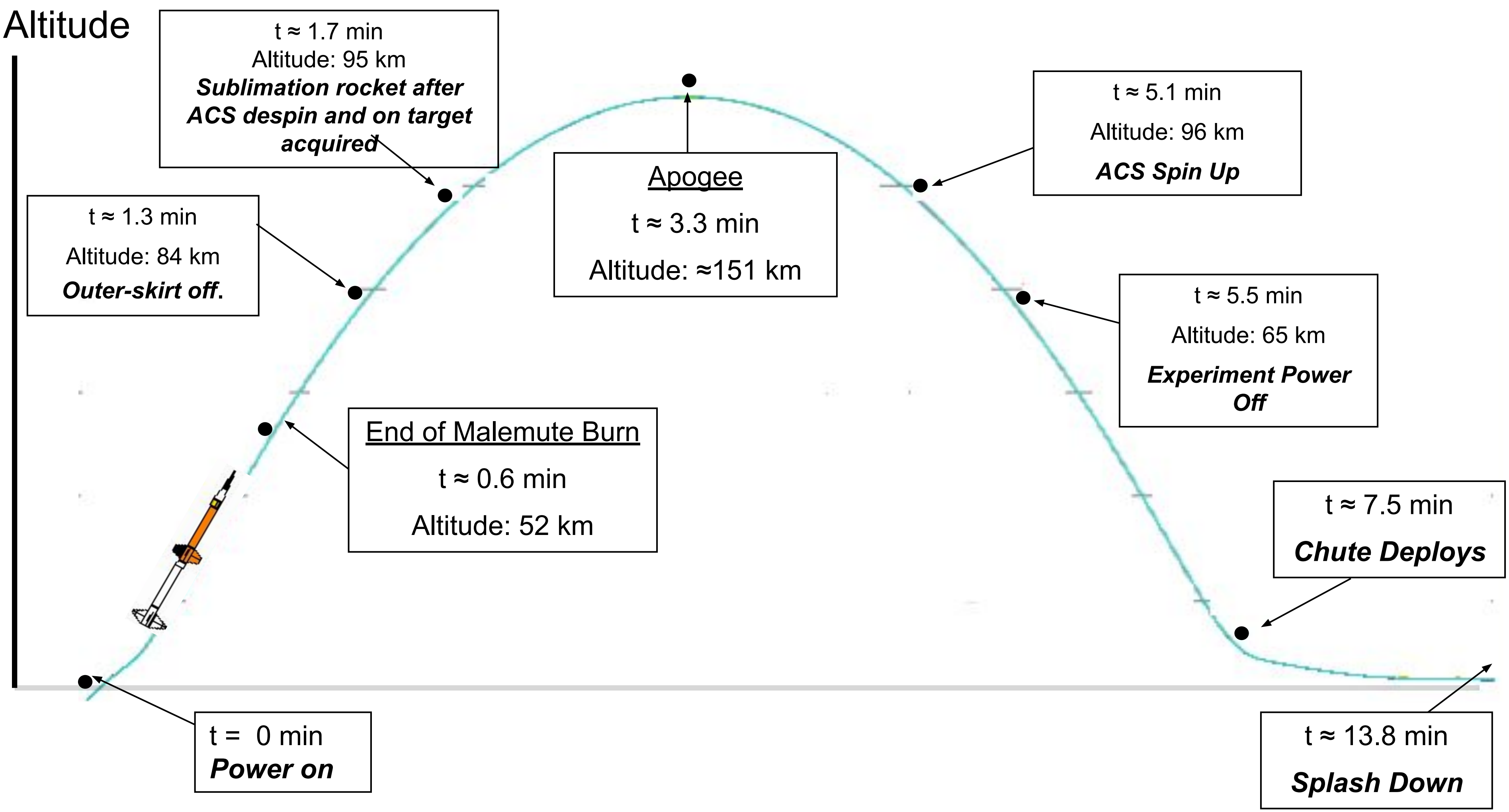
Objective 2: Primary Experimental Payload

- Deploy Super Simple Sublimation Rocket (S^3R or ScubeR)
- Determine specific impulse of camphor
- Record flight parameters of sublimation rocket

Objective 3: Secondary Experimental Payload

- Measure sounding rocket flight parameters with multiple motion sensors

Concept of Operations



Minimum Success Criteria

Primary Objectives	Minimum Success Criteria
Engage students in design, fabrication and aerospace engineering.	7 students awarded scholarship per semester & 2 faculty mentors attend RockSat-X 2025 test & launch at WFF with fully integrated, flight certified payload.
Deploy sublimation rocket from payload bay near apogee.	Rocket has sufficient inertia and clearance to fully clear CarRoll.
Capture imagery with cameras.	Record deployment of sublimation rocket with visual cues determining acceleration. Record a minimum of three images at three different times.

Desirable Success Criteria

Secondary Objectives	Desirable Success Criteria
Demonstrate operation of 9-axis motion tracking device.	Save data to SD card on deck plate.

Top Level Requirements (ScubeR)

Requirement	Verification Method	Description
ScubeR shall be launched in an orientation such that it is well-lit	**Test**	Orientation will be confirmed using our visual capture devices
Motor controller shall start up on T = 0.1 seconds	**Test**	Preliminary testing will be done to confirm motor controller ability to start on power on
The stepper motor driver shall turn on and reverse motor script shall execute backwards script then forward script to launch ScubeR.	**Test**	Preliminary testing will be done to confirm that our timed events and scripts are both functioning correctly.
ScubeR body shall be fully assembled and secured.	**Inspection**	Visual inspection will verify this requirement.
The system shall survive the vibration characteristics prescribed by the RockSat-X program.	**Test**	The system will be subjected to these vibration loads in June during testing.

Top Level Requirements (ScubeR) (cont.)

Requirement	Verification Method	Description
ScubeR must be released with a minimum velocity of approximately 0.4 inch/s (~1 cm/s) in order to clear the CarRoLL section but also remain in video	**Test**	Testing of the stepper motor and motor controller routine will ensure good velocity of ScubeR deployment

Top Level Requirements (Cameras)

Requirement	Verification Method	Description
Mobius Camera shall power on and save files to SD card before shutdown.	**Test**	The cameras will take photos and video of ScubeR as it leaves the rocket.
The system shall survive the vibration characteristics prescribed by the RockSat-X program.	**Test**	The system will be subjected to these vibration loads in June during testing week.
SD card shall be protected against heat and water damage during recovery phase.	**Test**	Storage compartment will be sealed and tested on campus.

Top Level Requirements (Data Controller)

Requirement	Verification Method	Description
IMU and Accelerometer shall power on and save files to SD card.	**Test**	The IMU will measure small vibrations and small rotations at ScubeR's deployment. The additional accelerometer will measure high accelerations.
The system shall survive the vibration characteristics prescribed by the RockSat-X program.	**Test**	The system will be subjected to these vibration loads in June during testing week.

Schedule

Gantt Chart UHCC RockSat-X 2025		Last updated 2-12-25									
Tasks	October	November	December	January	February	March	April	May	June	July	August
PCBs											
ScubeR, SPEW fabrication											
Mobius Camera development											
Mobius Camera fabrication											
Data Controller/IMU development											
Data Controller/IMU fabrication											
Motor Controller fabrication											
Sub-System test											
Integration											
Full Mission Simulation											
Review/Telecon		CoDR, PDR	CDR		STR	ISTR	FMSR	IRR	ETS	LRR	Launch
WinCC											
HonCC											

Wincc
HonCC
Everyone