Jared

Project Imua
Mission 10

Critical Design Review

University of Hawai‘i Community Colleges

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December 7, 2021

1.0 Mission Overview

Nikki

Mission Statement (Summary)

1. Project Imua
   a. Collaboration of Honolulu Community College (HonCC) & Windward Community College (WinCC) with Assets High School
   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
      i. Student Development & Understanding
      ii. Proof of Concept test of the 1U Artemis CubeSat

Mission Statement

Project Imua Mission 10'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 venier 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 an IMU and a multi-axis accelerometer that will provide a baseline for the payload's flight trajectory. In addition, a proof of concept test will be performed on a 1U Artemis CubeSat.

Mission Objectives

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

1. **Objective 1: Student Engagement (STEM)**
   a. Facilitate cross campus collaboration (HonCC +WinCC)
   b. Foster interest in aerospace education of high school students (Assets)
   c. Project-based internship in aerospace engineering
2. **Objective 2: Primary Experimental Payload**
   a. Deploy sublimation rocket (**ScubeR**) and determine specific impulse of camphor
   b. Record flight parameters of sublimation rocket
3. **Objective 3: Secondary Experimental Payload**
   a. Measure flight parameters of flight deck with multi-axis IMU and Accelerometer
   b. Proof of Concept of a 1U Artemis CubeSat

Theory & Concepts

Primary Experiments

- Super Simple Sublimation rocket – ScubeR (WinCC)
- On-board, deck-mounted imagery Mobius ActionCam (HonCC)

Secondary Experiment

- Multi-axis IMU & Accelerometer (HonCC)
- Proof of concept test: 1U Artemis CubeSat

  (Assets School/WinCC/HSFL)

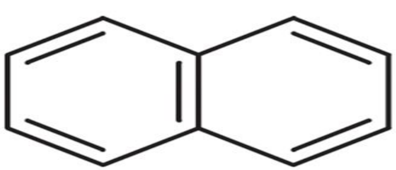
Theory & Concepts: Sublimating Material

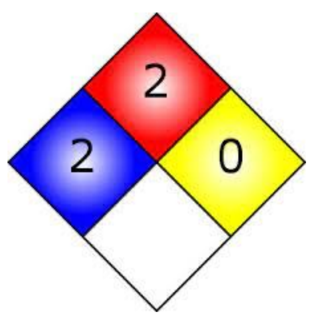
Naphthalene

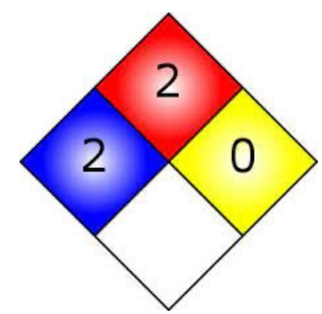
- Formula: $C_{10}H_8$
- Sublimates at: 0.338 Pa
- Molar Mass: 128.1 g/mol
- Density: 1.14 g/cm^3
- Boiling Pt: 218º C
- Melting Pt: 80.3º C

Camphor

- Formula: $C_{10}H_{10}O$
- Sublimates at: 166 Pa
- Molar Mass: 152.2 g/mol
- Density: 0.99 g/cm^3
- Boiling Pt: 209º C
- Melting Pt: 175º C



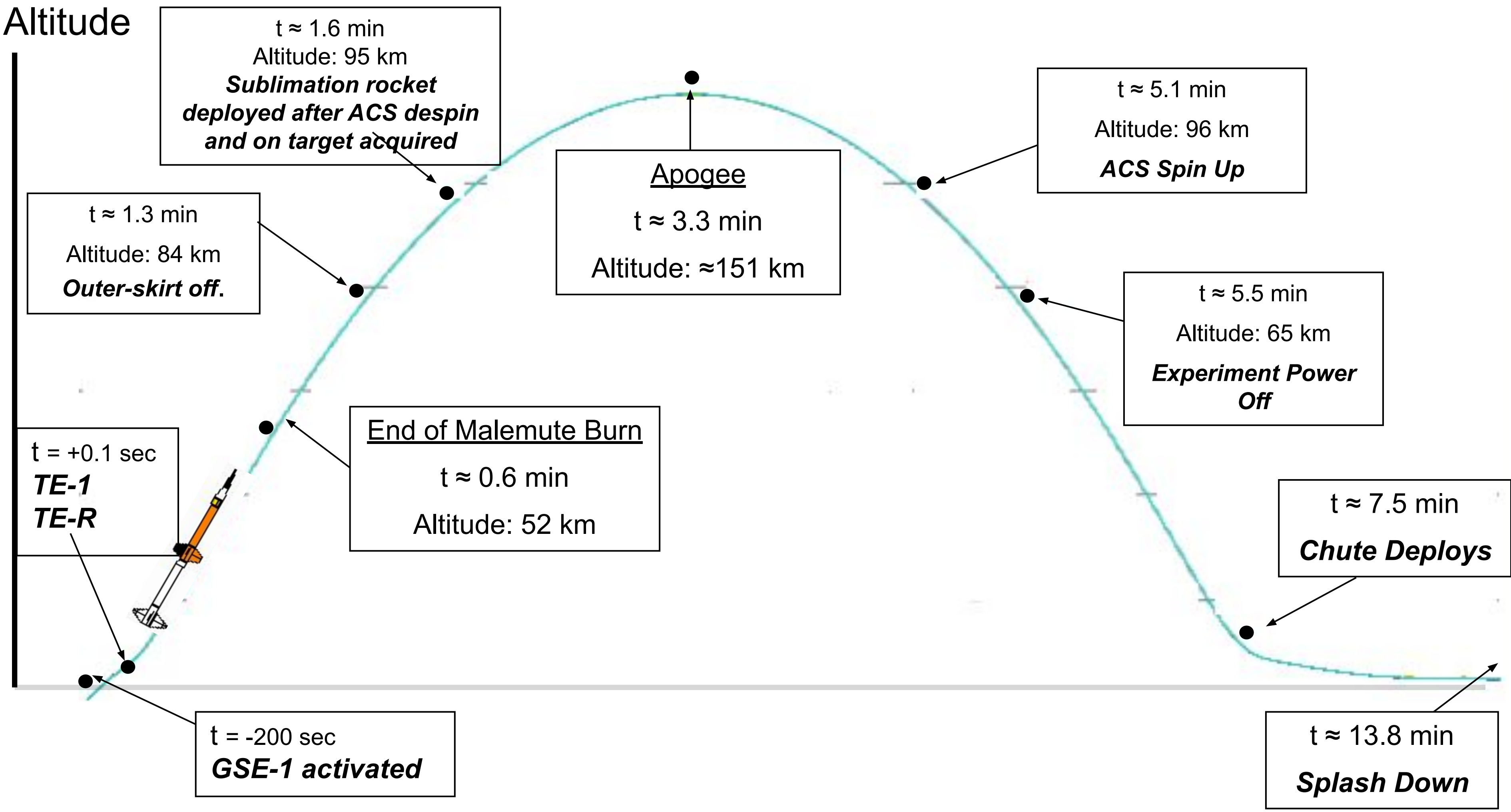




Theory & Concepts Artemis CubeSat Kit

- Part of Hawaii Space Flight Laboratory (HSFL)
- To promote STEM
- The general capabilities of this standard unit satellite (1U) include onboard computing, radio communication, rudimentary dynamic sensors, basic infrared camera, and an electrical power system. The hardware components are designed to have the most basic functionality of a small spacecraft.
- https://www.hsfl.hawaii.edu/artemis-cubesat-kit-2/

Concept of Operations



Timer Event Matrix

Team Name: UHCC Date: 11/29/21					
Event	**Time On**	**Units**	**Dwell Time**	**Units**	**Event Description**
GSE 1	T = -200 sec	(T-X) (sec)	Flight	(sec)	Powers on Artemis Raspberry Pi.
GSE 2		(T-X) sec)		(sec)	
TE-R	T = +0.1 sec	(T+X) (sec)	Flight	(sec)	Supply power to Power Distribution Board.
TE-1	T = +0.1 sec	(T+X) (sec)	Flight	(sec)	Supply power to Power Distribution Board.
TE-2		(T+X) (sec)		(sec)	
TE-3		(T+X) (sec)		(sec)	

Subsystem Design: Command and Data Handling Mechanical Interface (ScubeR)

Jared

ScubeR Deployment Timeline	Event
T = -200s	Artemis powered on via GSE
T = +0.1s	ScubeR Controller to give H bridge command to power motor, level shifter turned on via TE-1 and TE-R through PDB.
T = +70s	ScubeR Controller to start full backwards turn step command towards puncturing sublimate chamber for experiment start
T = +85s	ScubeR Controller to start full forwards rotation command
T = +96s	ScubeR is released from the shaft
T = +100s	ScubeR Controller to complete command cycle and cease all commands

Subsystem Design: Command and Data Handling Mechanical Interface (Data Controller)

D'Elle

Data Controller Deployment Timeline	Event
T = +0.1s	Power Distribution Board (PDB) supplies power to data controller and turns on. One accelerometer at ±2g & the other at ±16g. The gyroscope will be set to ±245 dps Magnetometer set to ±4 gauss Saving Data to MicroSD card
T = +336s	Power off.

Subsystem Design: Command and Data Handling Mechanical Interface (On-board Video Camera)

Caleb

On-board Cameras Deployment Timeline	Event
T = +0.1s	Power Distribution Board (PDB) supplies power to Mobius Action Cameras and turn on. Video Camera starts recording video of the ScubeR deployment. Recorded video will be stored onto MicroSD card.
T = +300s	Video recording has ended the 1st video clip and data is stored on MicroSD. 2nd video clip now recording (Internal event to the camera. Nothing is needed)
T = +336s	Power off and video will end.

Subsystem Design: Command and Data Handling Mechanical Interface (On-board Photo Camera)

Caleb

On-board Cameras Deployment Timeline	Event
T = +0.1s	Power Distribution Board (PDB) supplies power to Mobius Action Cameras and turn on. Photo Camera constantly takes a photo every 2 seconds throughout the deployment and stores data onto a MicroSD card.
T = +336s	Power off and picture taking will stop.

Expected Results (Sublimation Rocket)

- Possible low temperature means of propulsion
- Maximum departure velocity of 1 inch/sec
- Based on vapor pressure alone, sublimation will increase velocity

Expected Results (ScubeR Thrust Estimates)

Expected Results (ScubeR Thrust Estimates)

$$T = \dot{m} v_{ex} + A_{th} P_{vap}$$

Thermodynamic Considerations; The payload compartment radiates heat (on ascent) lowering the temperature by less than 2K at the time of ScubeR deployment. The exhaust speed, v_{ex}, is essentially the thermal velocity of the reaction mass particles. The vapor pressure P_{vap}, can be related (to first order) to the rate of sublimation of the reaction mass, $\dot{R}$.

$$P = \frac{N k_B T}{V} = (\dot{R} \frac{N_A}{\mathfrak{M}} \Delta t)(\frac{k_B T}{V})$$

Where $\mathfrak{M}$ is the molar mass of the sublimating substance, N_A is Avogadro's number, and Δt is the elapsed time from when the ambient pressure has dropped below the sublimation pressure. The rate of mass loss is the ratio of the throat area A_{th}, to the total surface area of the sublimation chamber $\dot{m} = \frac{A_{th}}{A} \dot{R}$.

$$T = \dot{R} A_{th} \left\{ \frac{1}{A} \sqrt{\frac{3RT}{\mathfrak{M}}} + \left(\frac{N_A k_B T}{\mathfrak{M} V} \right) \Delta t \right\}$$

Using the current design dimensions for ScubeR, the first term is effectively zero and the second term yields an increase in thrust of 99 µN per second after the on-set of sublimation. The maximum thrust will be 521 µN, approximately 5.3 s after sublimation begins.

Expected Results (On-board Camera Systems)

Capture & Store Imagery of ScubeR Deployment

- Determine ScubeR Distance versus Time
- Determine ScubeR Acceleration
  - From minimum of 3 consecutive pictures

Expected Results (IMU & Accelerometer)

Monitor Acceleration and Rotation of Payload Deck

- Determine if ScubeR deployed at total zero acceleration
  - Monitor low vibrations (±2g) & high vibrations (±16g)
- Determine rotations caused during ScubeR deployment
  - Monitor small rotations (±245 dps)
- Determine orientation of CarRoLL
  - Monitor magnetometer orientation (±4 gauss)

Minimum Success Criteria: Primary Objectives

Primary Objectives	Minimum Success Criteria
Engage students in design, fabrication and aerospace engineering.	5 students awarded scholarship per semester; 5 students & 2 faculty mentors attend RockSat-X 2022 test & launch at WFF with fully integrated, flight certified payload.
Deploy sublimation rocket from payload bay near apogee.	Achieve sublimation thrust sufficient for rocket to fully clear CarRoLL.
Capture imagery by Mobius ActionCam.	Record deployment of sublimation rocket with visual cues determining acceleration. Record a minimum of three images at three different times.

Minimum Success Criteria: Secondary Objectives

Secondary Objectives	Minimum Success Criteria
Demonstrate operation of 9-axis motion tracking device.	Save data to SD card on deck plate.
Demonstrate operation of 3-axis accelerometer.	Save data to SD card on deck plate.
Proof of Concept flight for modified Artemis CubeSat Kit.	Demonstrate Artemis CubeSat onboard utilities

Desirable Success Criteria: Primary Objectives

Primary Objectives	Minimum Success Criteria
Engage students in design, fabrication and aerospace engineering.	10 scholarships awarded per semester; 8 students and 3 faculty mentors to attend RockSat-X 2022's test and launch events at WFF with a fully integrated, flight certified payload.
Deploy sublimation rocket from payload bay near apogee.	Achieve sublimation thrust sufficient for rocket to fully clear the CarRoLL and with a greater than initial release velocity.
Capture imagery by Mobius ActionCam.	Record deployment of sublimation rocket with visual cues determining acceleration. Obtain a video recording of ScubeR's flight for approximately 2 minutes.

Desirable Success Criteria: Secondary Objectives

Secondary Objectives	Minimum Success Criteria
Demonstrate operation of 9-axis motion tracking device.	Save data to SD card on deck plate.
Demonstrate operation of 3-axis accelerometer.	Save data to SD card on deck plate.
Proof of Concept flight for modified Artemis CubeSat Kit.	Demonstrate Artemis CubeSat onboard utilities (same as minimum success criteria)

Top Level Requirements (ScubeR)

Requirement	Verification Method	Description
ScubeR shall be oriented so as to be released in sunlight — preferably along the eastern edge of the horizon.	**Inspection**	Orientation will be confirmed using our visual capture devices.
The stepper motor driver shall turn on and reverse motor routine shall execute backwards script then forward routine 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 week.

Top Level Requirements (On-board Cameras)

Requirement	Verification Method	Description
Mobius Action Cameras shall power on and save files to MicroSD card before shutdown.	**Test**	The Mobius Action Cameras will take multiple photos and video. Verification will be made to ensure images were stored on the MicroSD card after each test.
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.
MicroSD 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, Accelerometer, Controller and Data Storage shall power on and save data to MicroSD card.	**Test**	The IMU will measure small vibrations as well as small rotations created by ScubeR's deployment. The additional Accelerometer will measure high G forces.
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.
MicroSD card shall be protected against heat and water damage during recovery phase.	**Test**	Storage compartment will be sealed and tested on campus.

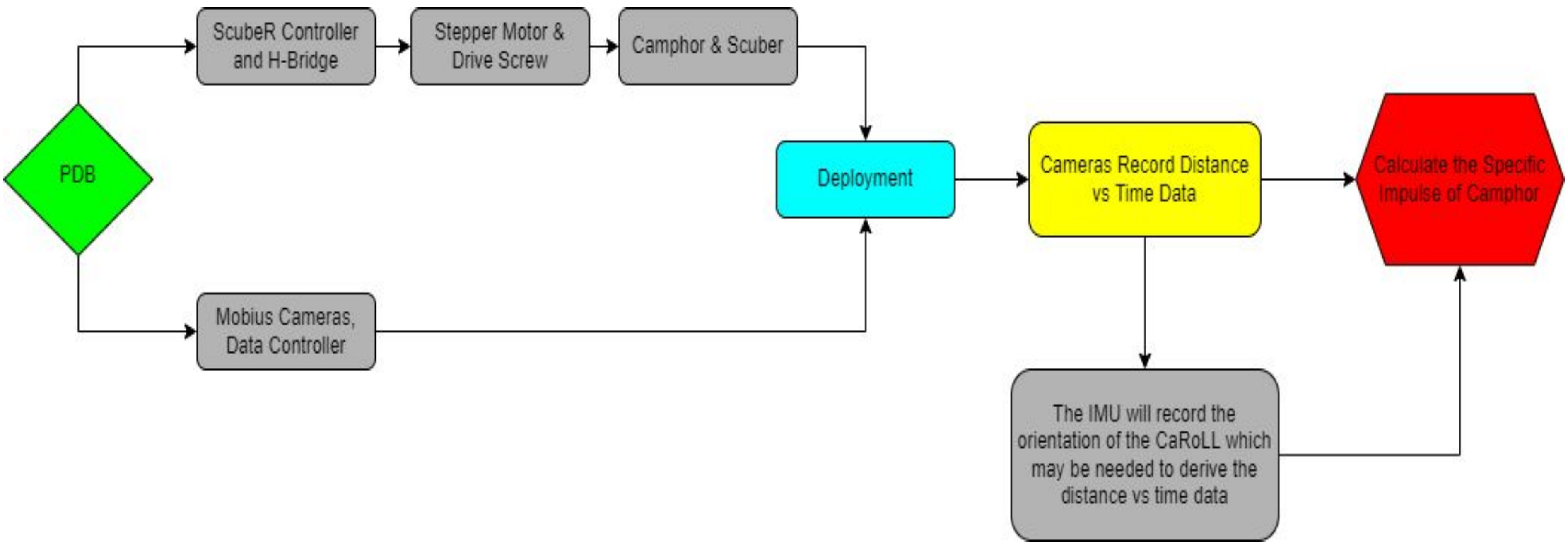
Top Level Requirements (Artemis)

Requirement	Verification Method	Description
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.
A single GSE line shall be required to activate the Artemis CubeSat through the PDB at T = -200 seconds.	**Test**	Preliminary testing will be done to confirm that the IMU will be powered on and functioning correctly.
The Power Distribution Board shall deliver power at T=+0.1 seconds.	**Test**	Test on/off capabilities of PDB through a series of power tests.

2.0 System Overview

Nikki

Science Overview: General Outline

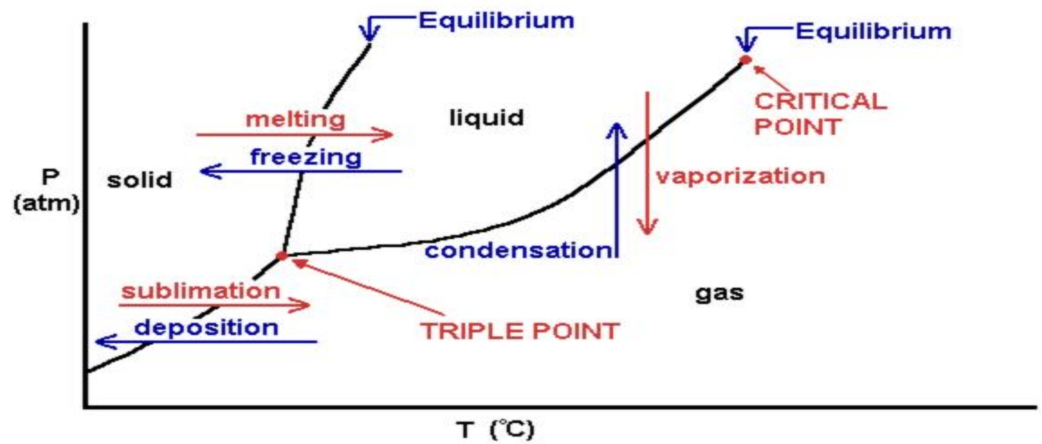


System Overview: Science Design Overview Sublimate

Super Simple Sublimation Rocket — ScubeR

Sublimation Fueled Rocket:

The sublimation of camphor at low pressure will act as propellant for the rocket, ScubeR. When the camphor sublimation vapor is expanding within its container during the sublimation process, the vaporized camphor will act as a reaction mass for ScubeR.



Phase diagram P (atm) vs T (celsius)

System Overview: Science Design Overview Sublimate

Nikki

Pressure (Pa)	Temp (K)	Altitude (km)
101.3k	300	Launch
28k	230	10
5.6k	210	20
1.3k	235	30
0.32k	260	40
0.1k	270	50
0.03k	260	60
7	210	70
1.3	190	80
0.25	210	90
0.056	240	100
0.016	270	110
0.005	330	120
0.002	390	130

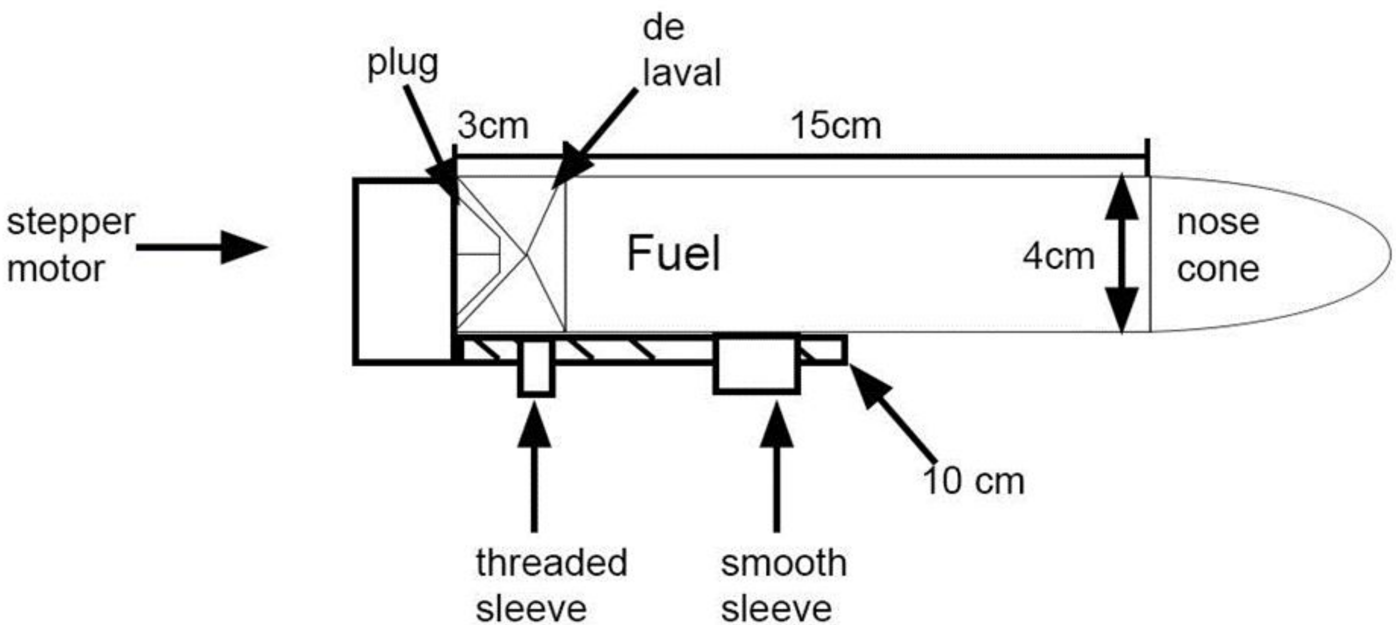
Compressed Camphor

- Triple Point at 202 K and 51.44 kPa
- Expected to sublimate at 166 Pa at 45 km
- Expected sublimation start time between end of Malemute burn and outer skirt off
- ScubeR released at T=+96s
- Once ScubeR released, minimum velocity is 0.4 in/sec

Lide, David R. "Chapter 14; Section 20." *CRC Handbook of Chemistry and Physics: A Ready-reference Book of Chemical and Physical Data*. 92nd ed. Boca Raton, FL: CRC, 2010-2011. N. pag. Print. Special Student Edition.

System Overview: Science Design Overview ScubeR

Nikki



- ABS 3D printed body
- Compressed Solid Camphor sublimate

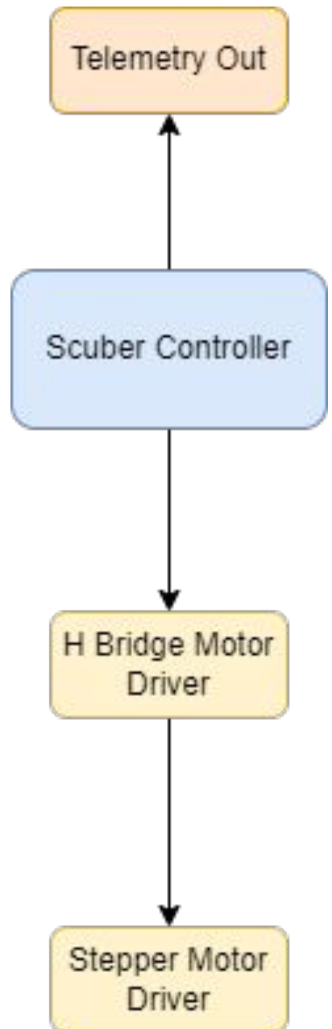
System Overview: Science Design Overview
ScubeR Mechanical Drive system

Nikki

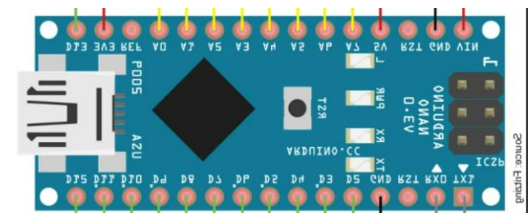
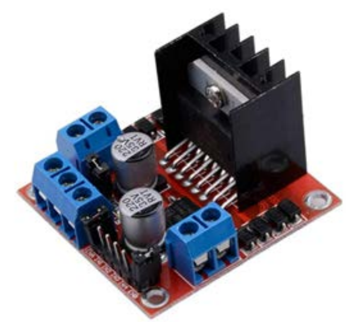
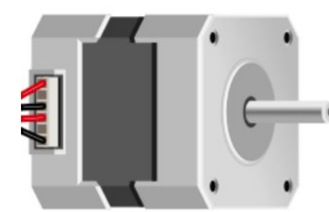
ScubeR Controller
- Arduino Nano
- Send motor commands to H bridge motor driver
- Send motor status update to Asych. telemetry lines

H Bridge
- L298 H Bridge motor driver

Mechanical Drive
- NEMA 17 stepper motor

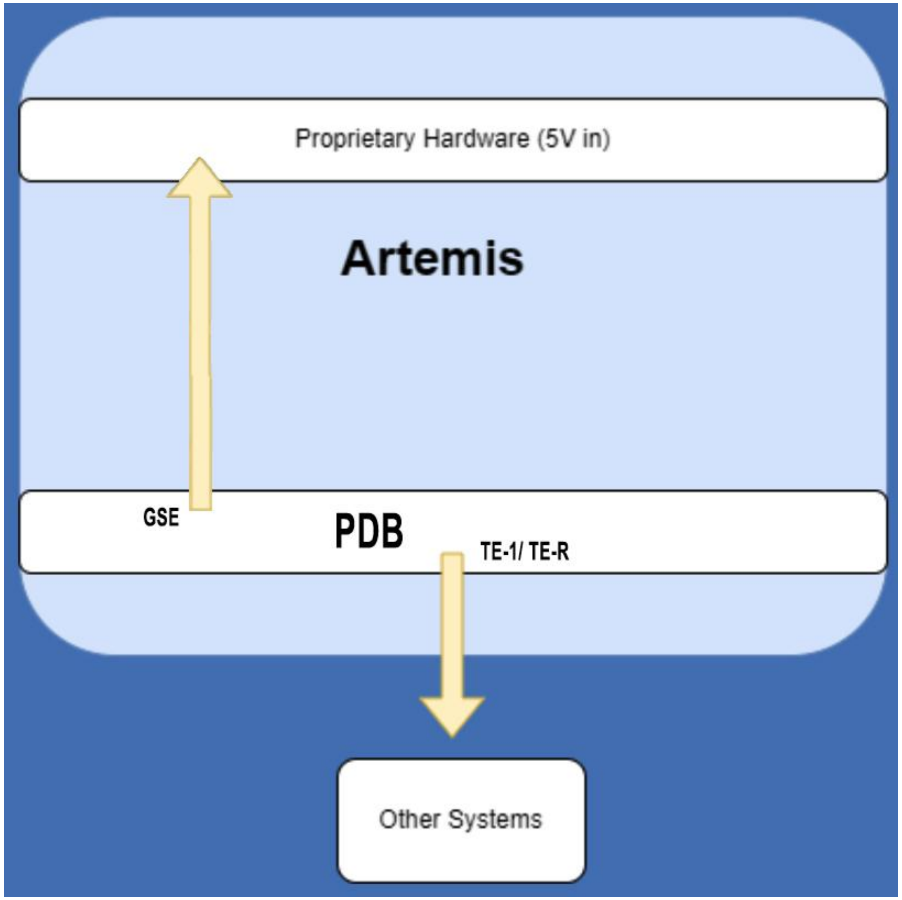




Science Design Overview: Artemis and PDB

Nikki



Artemis -

- Has existing proprietary hardware
- Houses PDB
  - PDB provides power for Artemis through GSE line
  - PDB provides power for ScubeR Controller, Motor and Data Controller via TE-1 and TE-R lines

Caleb

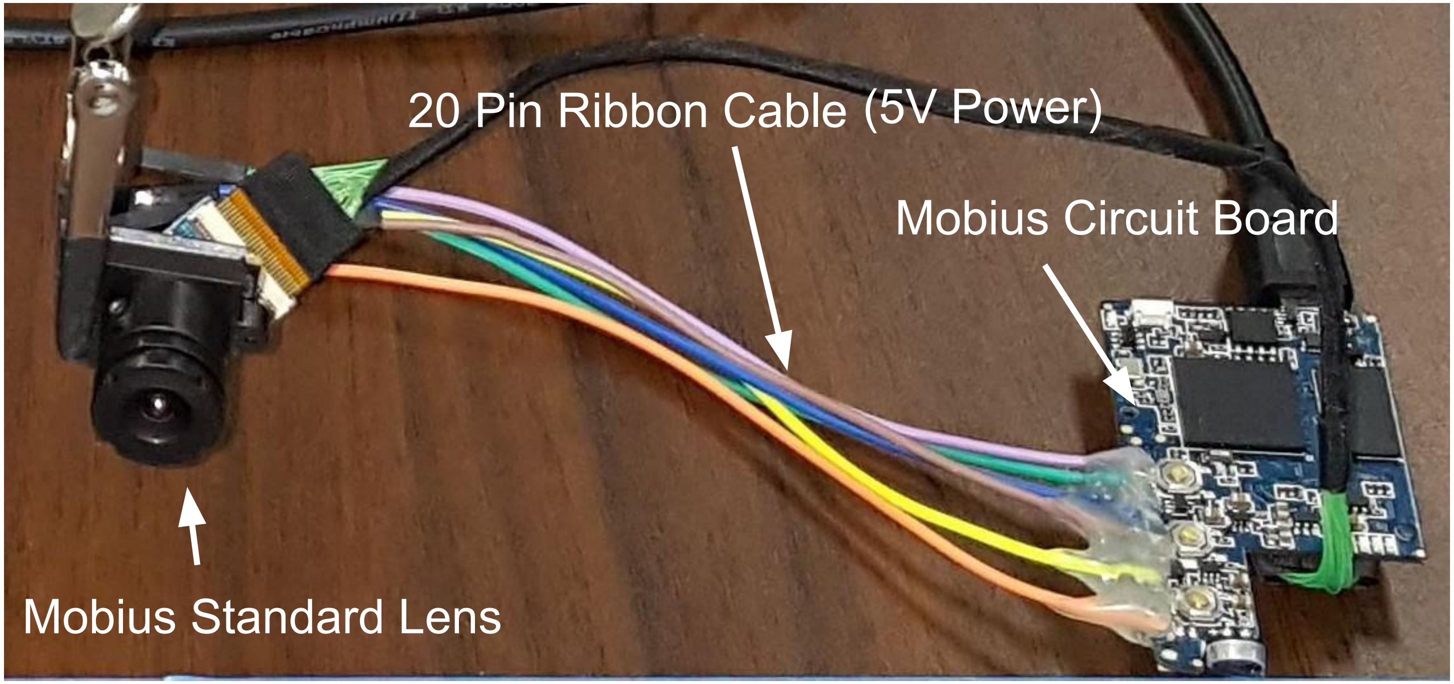
Science Design Overview (On-board Cameras)

- Two onboard Mobius ActionCams will record imagery of ScubeR deployment.
  - Photo Camera will record time-lapse photos
  - Video Camera will record video
- Imagery will be used to calculate the distance of ScubeR deployment
  - Consecutive multiple images used to calculate velocity & acceleration
- Data will be stored on MicroSD cards on Mobius circuit boards
- Cameras will be housed in a 1590K Hammond Box

Engineering Design Overview (On-board Cameras)

Caleb

Pictured: one of two Mobius Action Cameras systems outside of housing



Mobius Action Camera Full HD

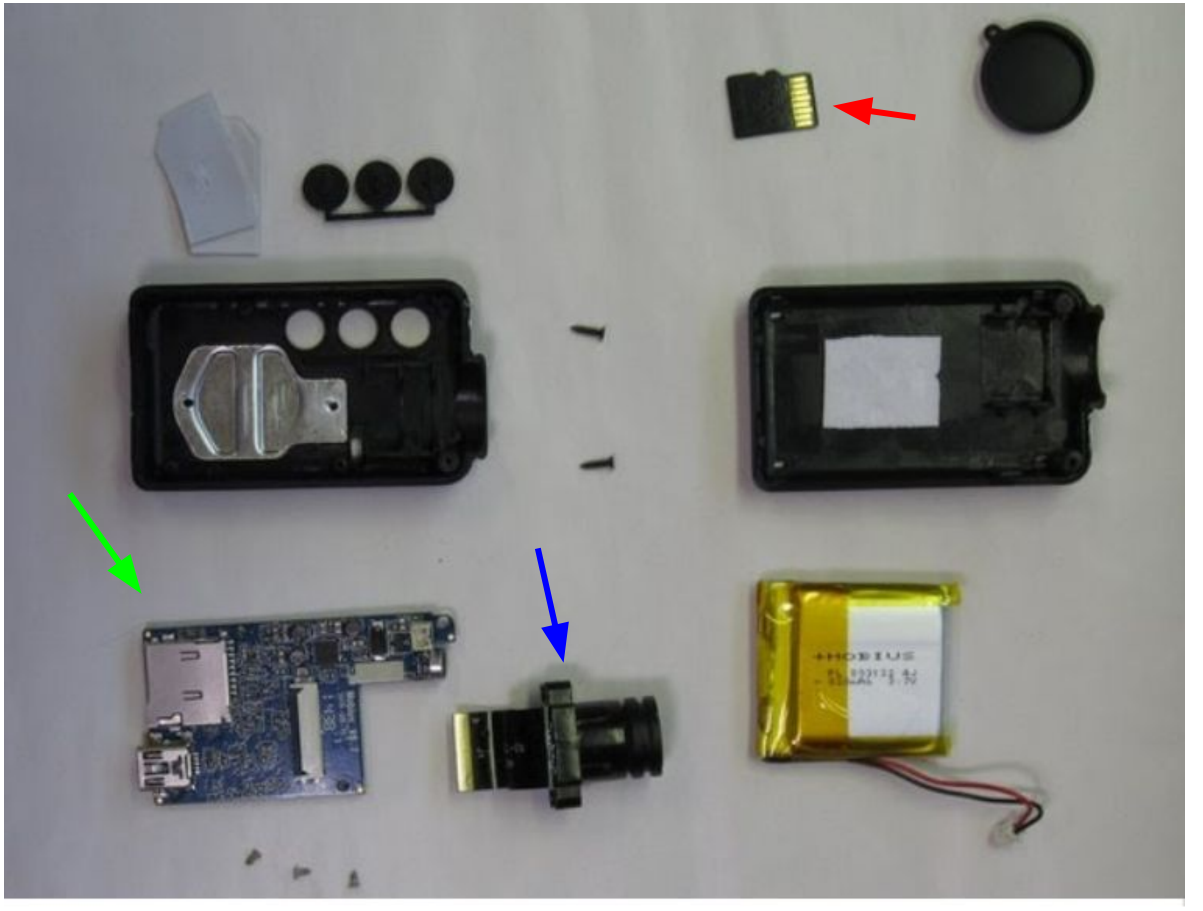
Caleb

- Power
  - 5V DC
- Size
  - Dimensions - 2” x 1” x 1”
  - Weight - 1.00 oz (28.35g)
- Data Storage
  - Capacity up to 32GB
- Video & Pictures
  - Video Capture Resolution 1080p
  - Takes pictures & time-lapse photos

Caleb

Teardown of Mobius ActionCam

- Green
  - Circuit Board
- Blue
  - Camera Module
- Red
  - MicroSD Card



Science Design Overview (Data Controller)

D'Elle

- IMU & Accelerometer
  - IMU Accelerometer set to ±2g to monitor low vibrations
  - 2nd Accelerometer set at ±16g to monitor high vibrations
  - IMU gyroscope set to ±245 dps to monitor low rotations
  - Magnetometer set to ±4 gauss
- Acceleration data will be used to see if ScubeR was deployed at total zero acceleration
- Data from each sensor will be stored on MicroSD
- Housed in Hammond Box (1590)

Engineering Design Overview (Onboard IMU & Accelerometer)

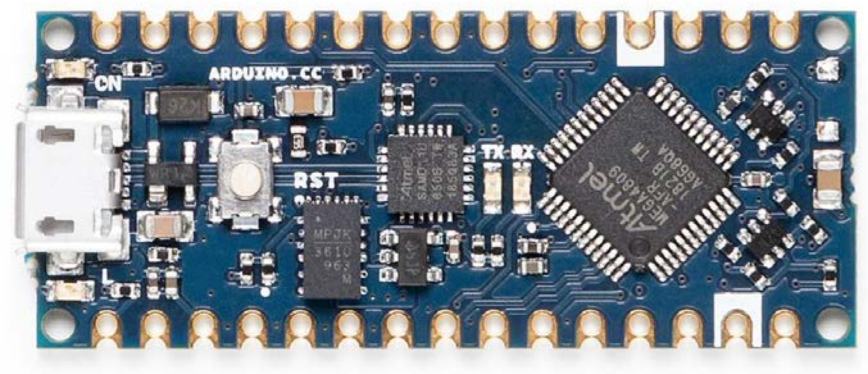
D’Elle

Adafruit LSM9DS1 IMU & LIS3DH Accelerometer

- Power - 5V DC
- LSM9DS1
  - Dimensions - 1.3” x 0.8” x 0.1”
  - Weight - 2.5g
- LIS3DH
  - Dimensions - 3.74” x 2.56” x 0.2”
  - Weight - 1.5g

Engineering Design Overview (Onboard Controller & Data Storage)

D’Elle



Arduino Nano Every

Power - 5V DC

- Dimensions - 1.77” x 0.7”
- Weight - 5g

Adafruit MicroSD Breakout Board+

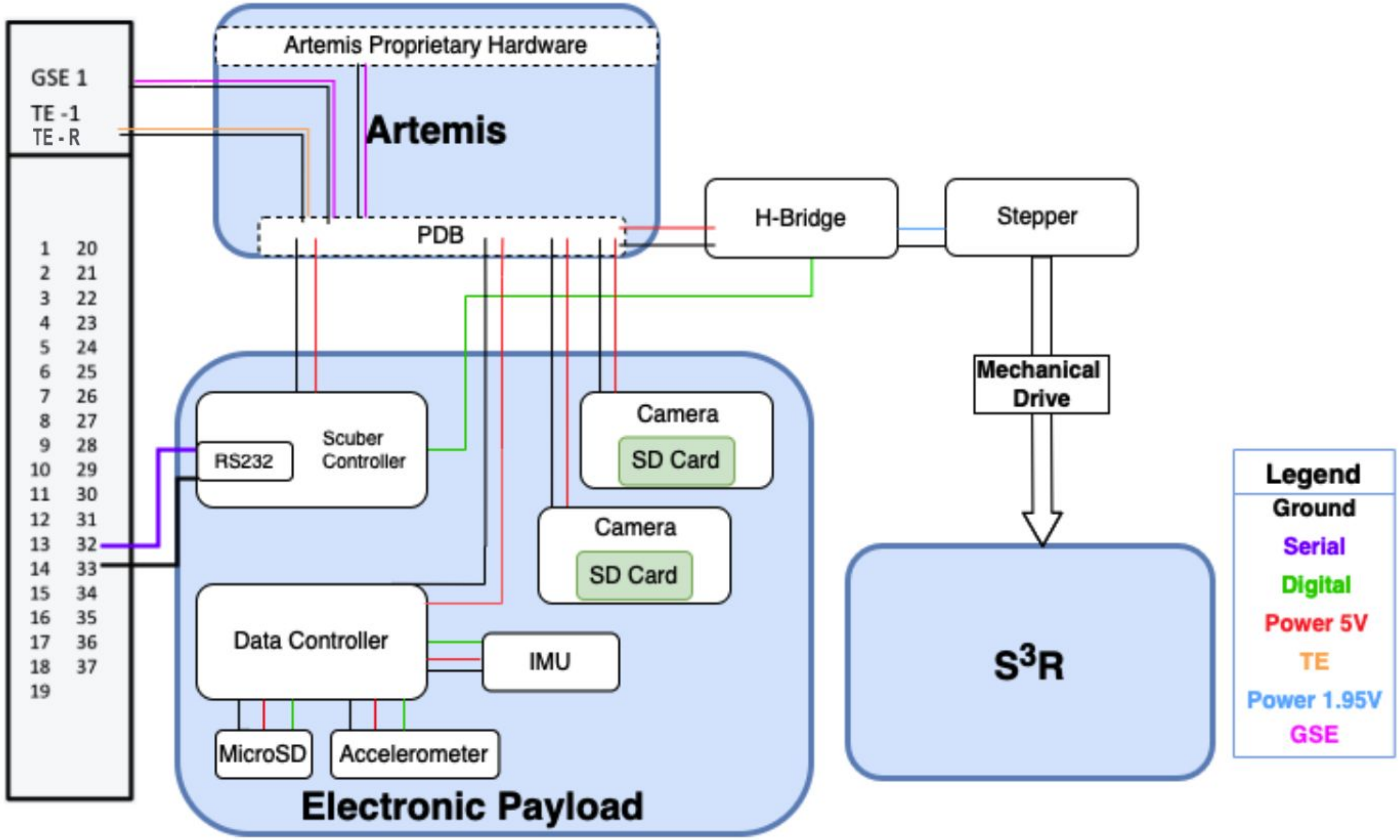
Power - 5V DC

- Dimensions - 1.5” x 1” x 0.15”
- Weight - 3.43g

Changes and Updates

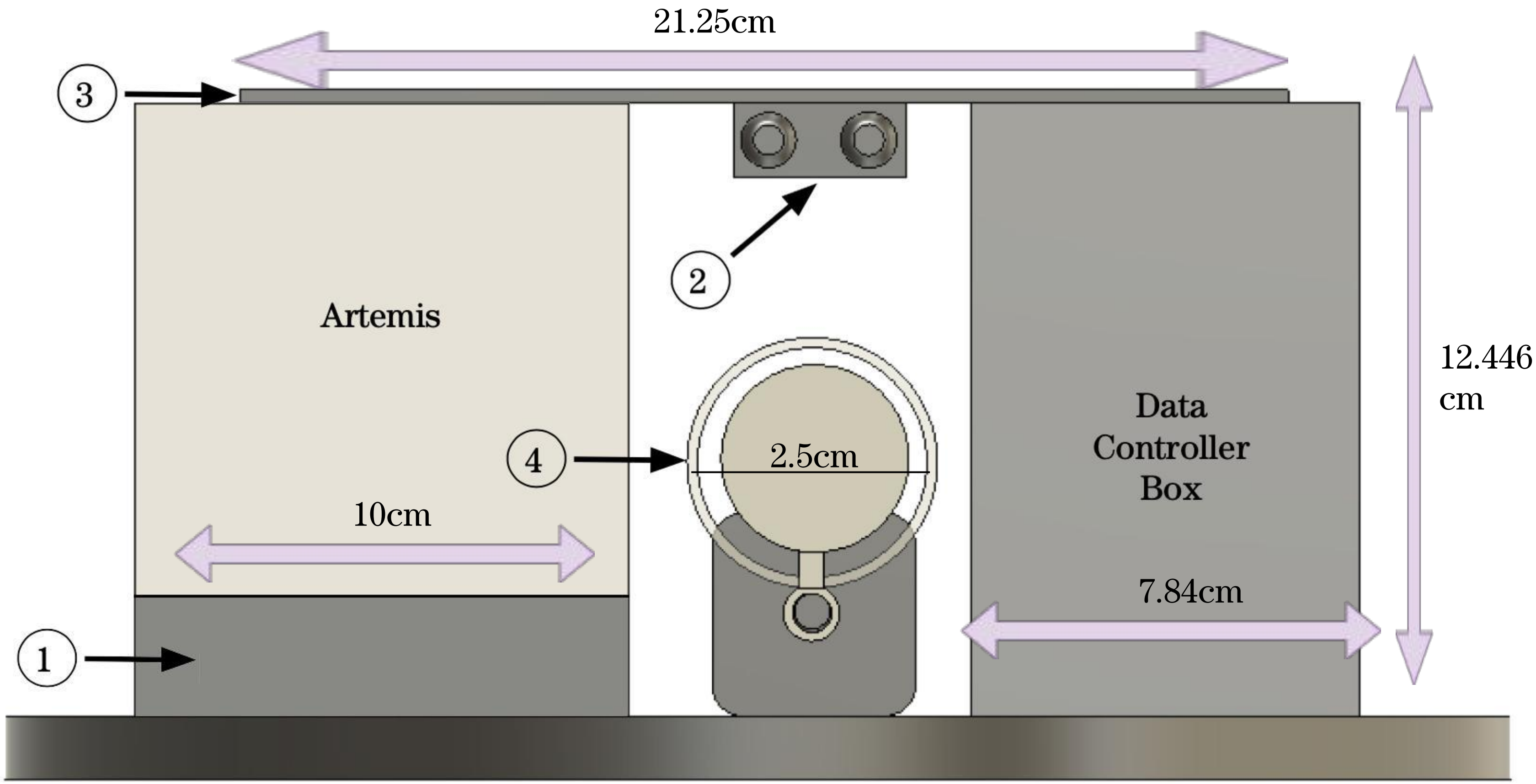
- Updates Since PDR:
  - Since PDR we have stated our top level requirement to be "shall" statements.
  - Additionally, our CONOPS has been updated to reflect the implementation of a GSE line.
  - We added a TE-R line to TE-1 for redundancy.
- Changes
  - We have switched out our flight controller from a Raspberry Pi to an Arduino Nano.
    - The Raspberry Pi drew too much current from our allocated 0.5 Ah capacity, as such the Arduino Nano was implemented to resolve this.
    - This change has **not** resulted in a change in any of our mission objectives or requirements.
  - We have added the Artemis cubesat electronics system to add to the justification of proof of concept flight
    - This has **not** resulted in a change of our mission objectives.
  - We have changed our GSE line to power on the Artemis CubeSat as the GSE line is no longer needed to power the IMU.
    - Power will be supplied to the Artemis CubeSat via GSE
    - This has **not** resulted in a change of our mission objectives.

System Overview: Functional Block Diagram



System Overview: Mechanical Design

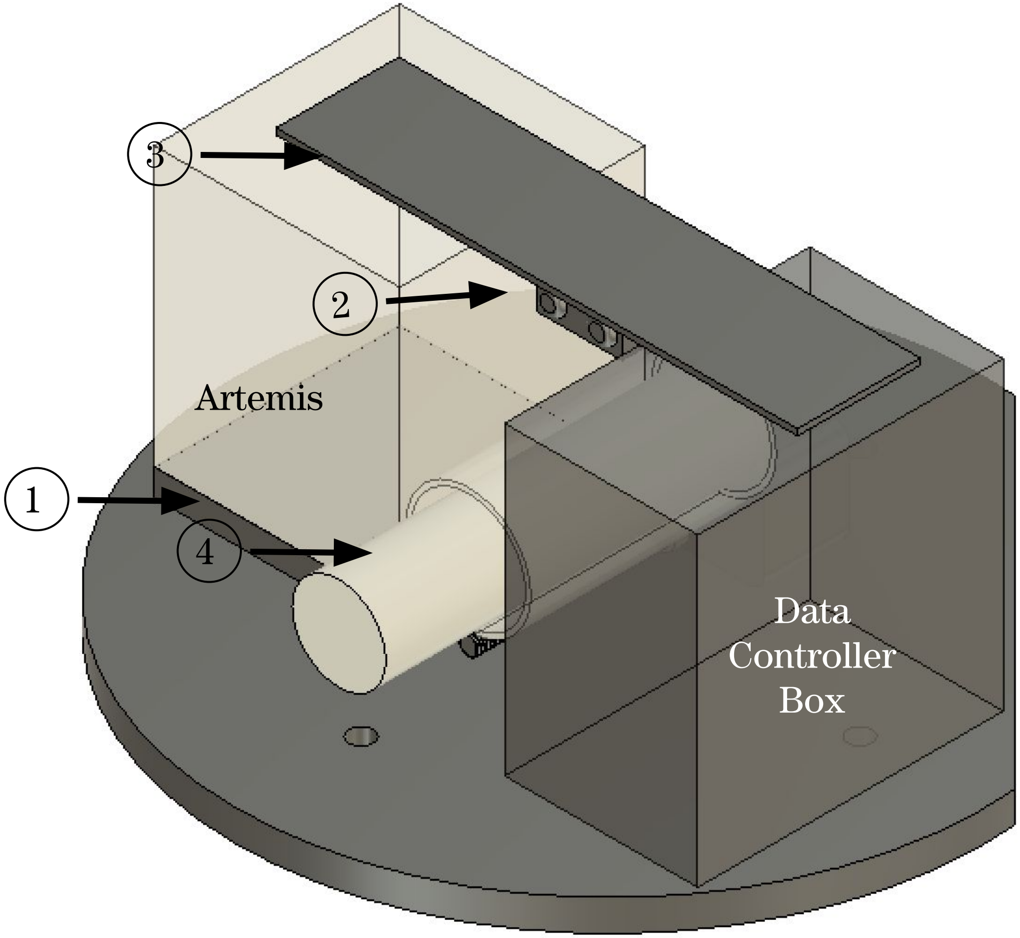
D'Elle



1. Dead Mass Base Plate
2. Camera Lense Housing
3. Lens Bridge
4. ScubeR Assembly

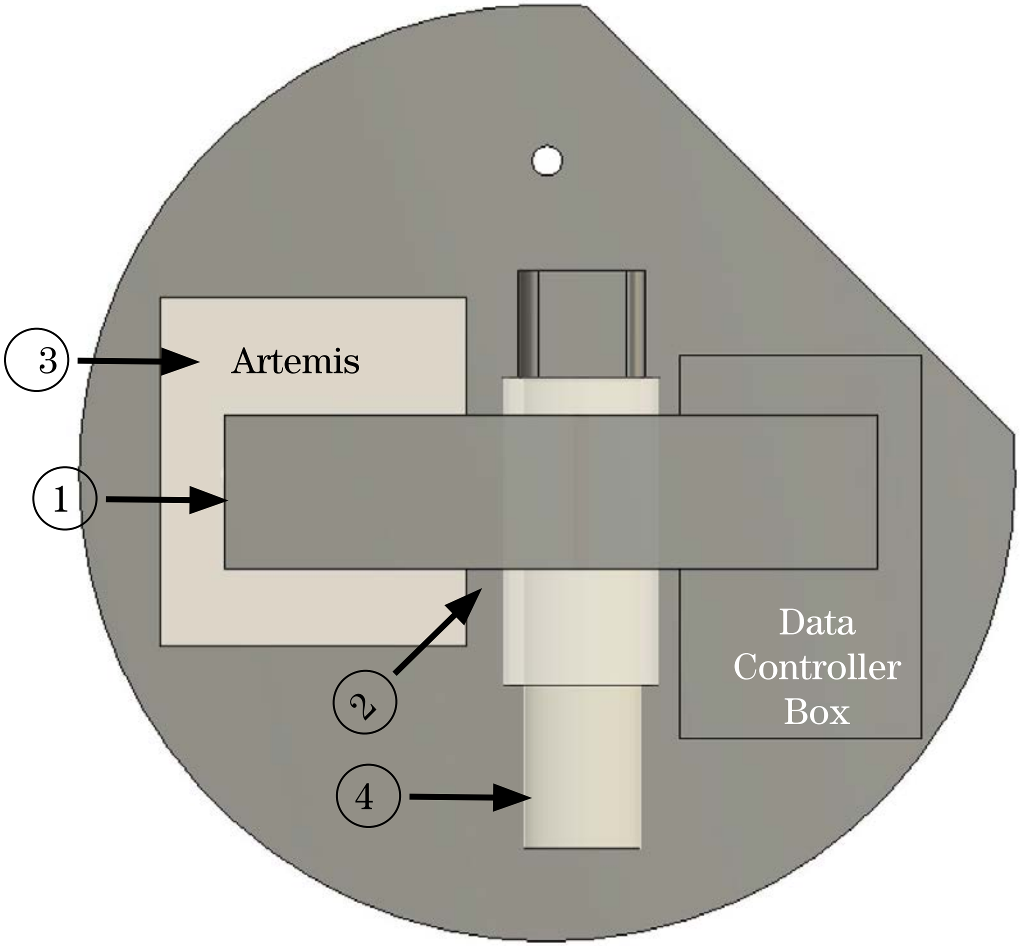
System Overview: Mechanical Design

D'Elle



1. Dead Mass Base Plate
2. Camera Lense Housing
3. Lens Bridge
4. ScubeR Assembly

System Overview: Mechanical Design



1. Lens Bridge
2. Camera Lense Housing
3. Artemis
4. ScubeR Assembly

System Overview: Mechanical Design Materials

D'Elle

ScubeR - 3d printed ABS Plastic

Artemis - main structure supports 3D printed with ABS or PLA plastic with metal hardware

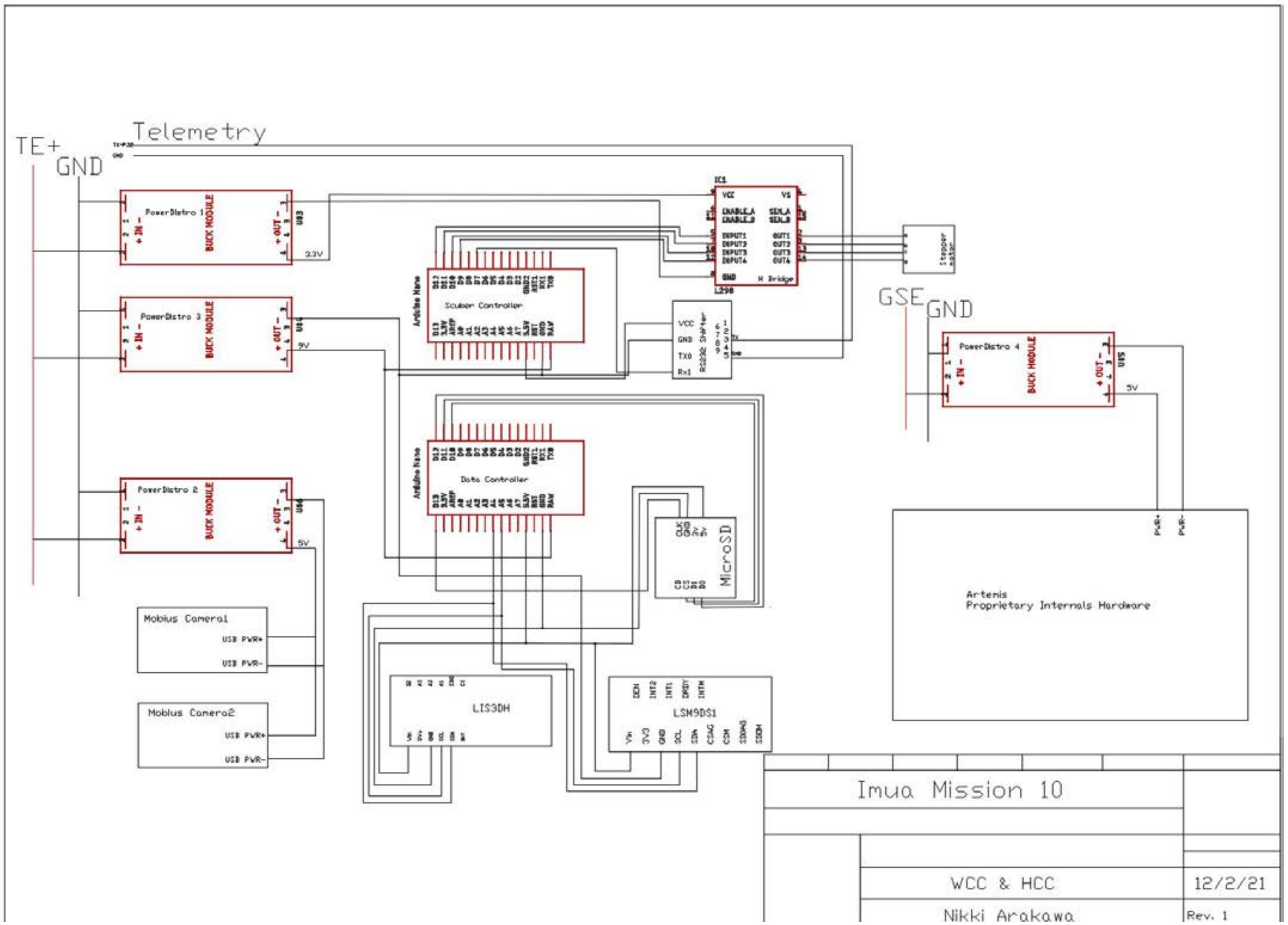
Data Controller housing - 1590K Aluminum Hammond Box

Camera Lens housing - Aluminum Box

Camera Lens bridge - 20 gauge aluminum bar

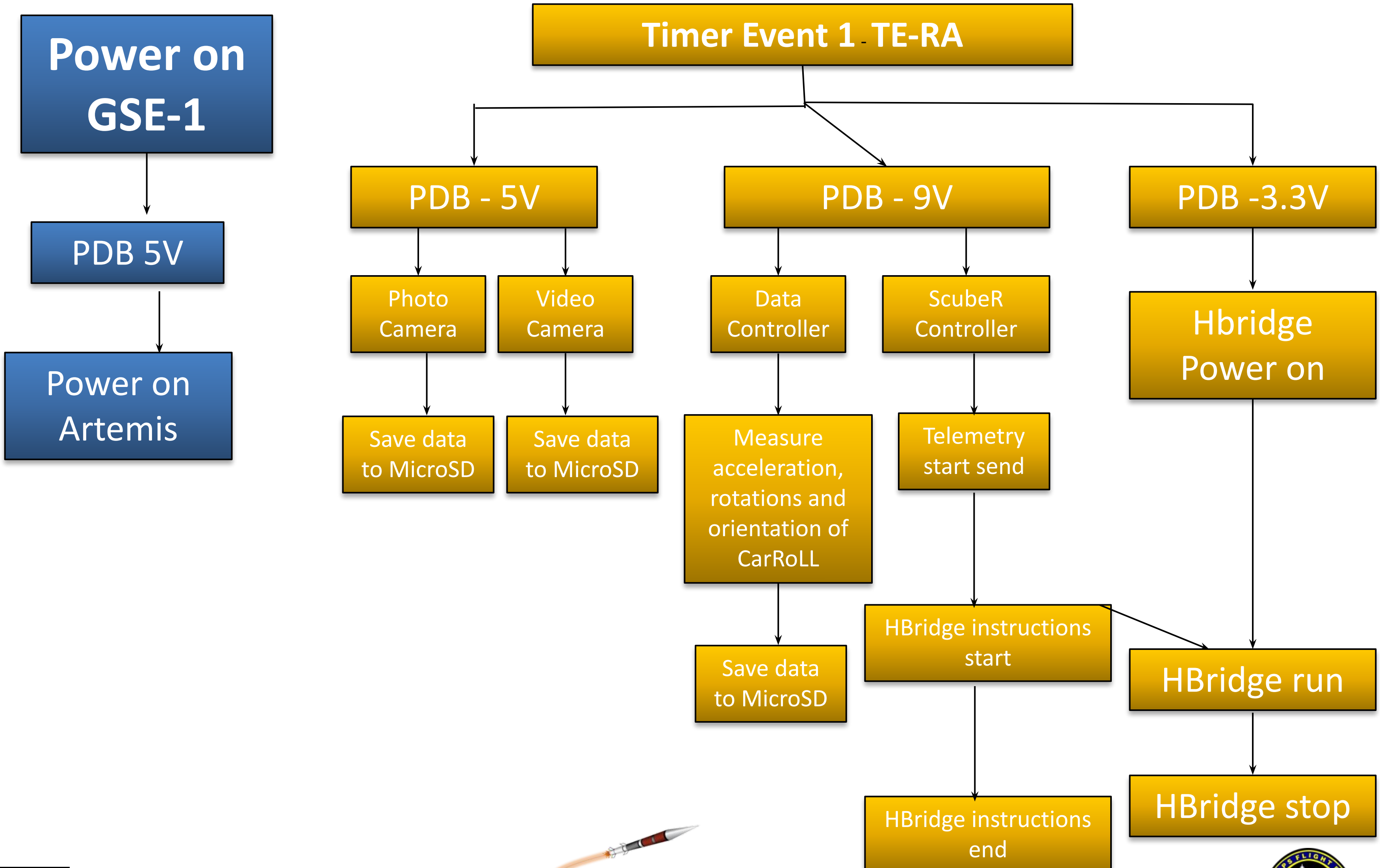
Stepper Motor - metal with metal gears

System Overview: Electrical Design



Nikki

System Overview: Software Design



System Overview: Description of Partnerships

Build Teams:

Project Imua Mission 10 currently consists of three student teams from Windward Community College, Honolulu Community College, and Assets High School.

Sponsors:

Hawaii Space Grant Consortium (HSGC) for the funding of Project Imua.

Hawaii Space Flight Lab (HSFL) for vacuum testing of ScubeR reactant sublimation.

NASA for deck space within their 2-stage suborbital sounding rocket.

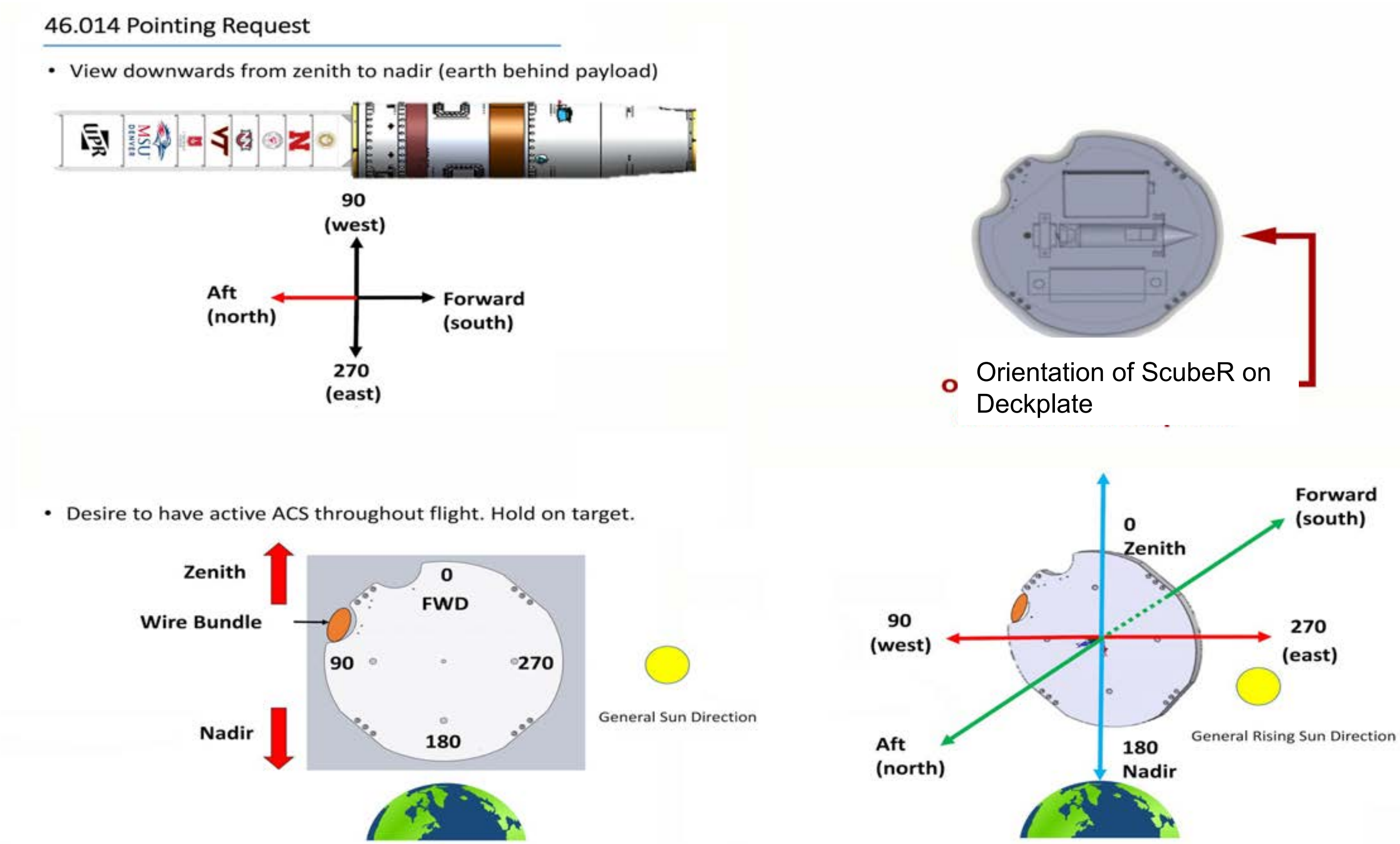
De-Scopes and Off-Ramps (Contingency Plans)

- If Artemis unit cannot be manufactured by February 1st, a separate storage compartment for the power distribution board will be built by the end of February
- If fabrication for ScubeR cannot be printed in house by February 9th, it can be printed using a predetermined alternate vendor
- If the Stepper motor can not be purchased by December 30th we have a contingent and similar stepper motor we can purchase

3.0 Subsystem Design

System Overview: Special Requests

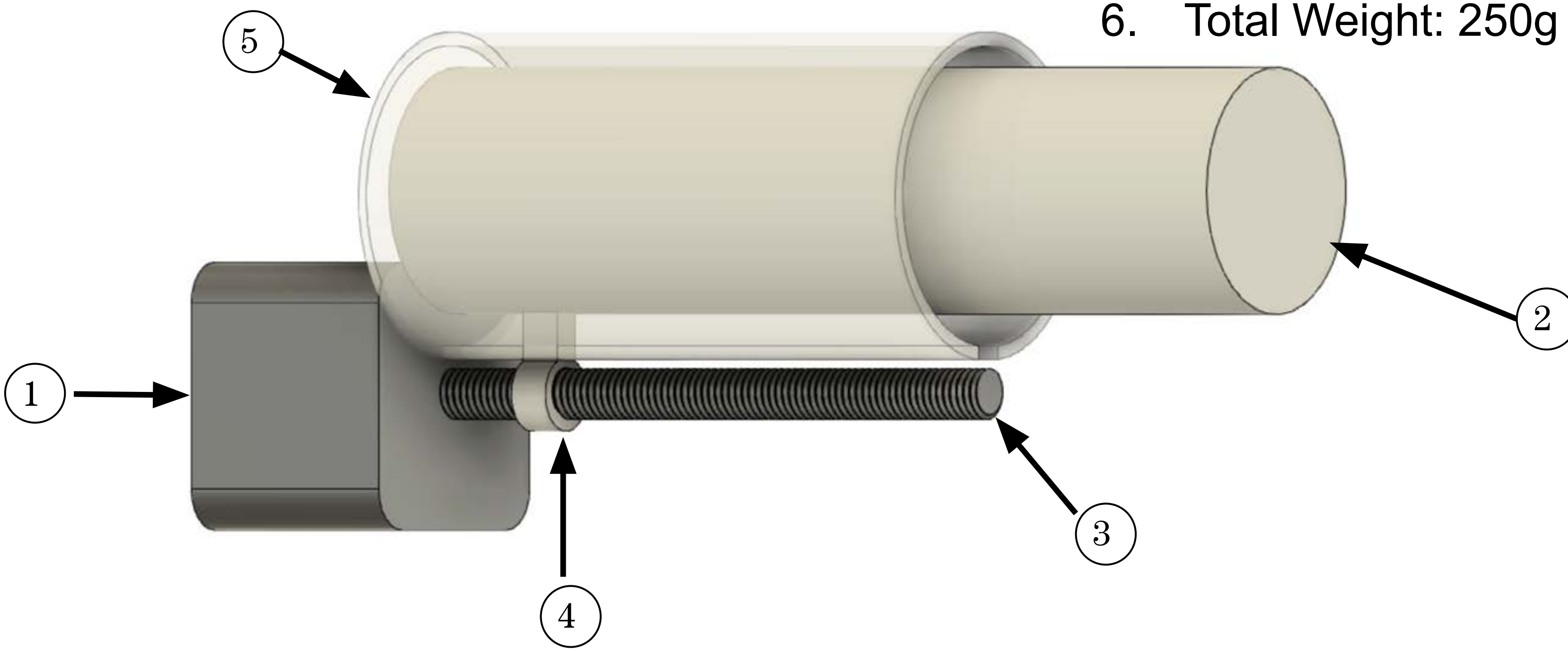
Our only special request for WFF is to have an orientation of the release of ScubeR in direct sunlight—the preferred direction is along the eastern edge of the horizon.



Subsystem Design: Mechanical Design ScubeR

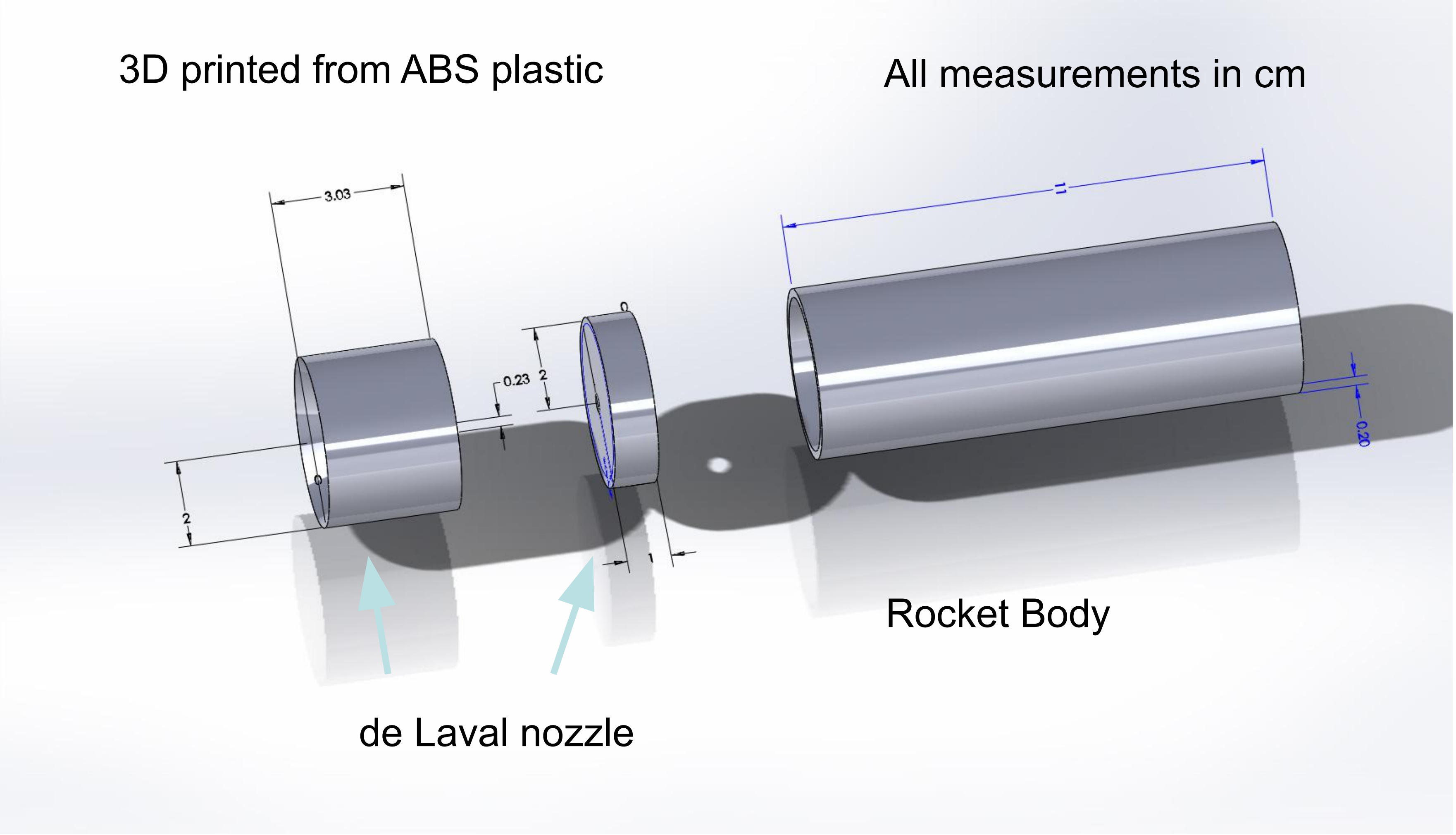
Nikki

1. Stepper motor
2. ScubeR
3. Helical Lead Screw
4. 3d printed traveler
5. Drive component outer casing
6. Total Weight: 250g (0.55lbs)



Subsystem Design: Mechanical Design ScubeR

Nikki

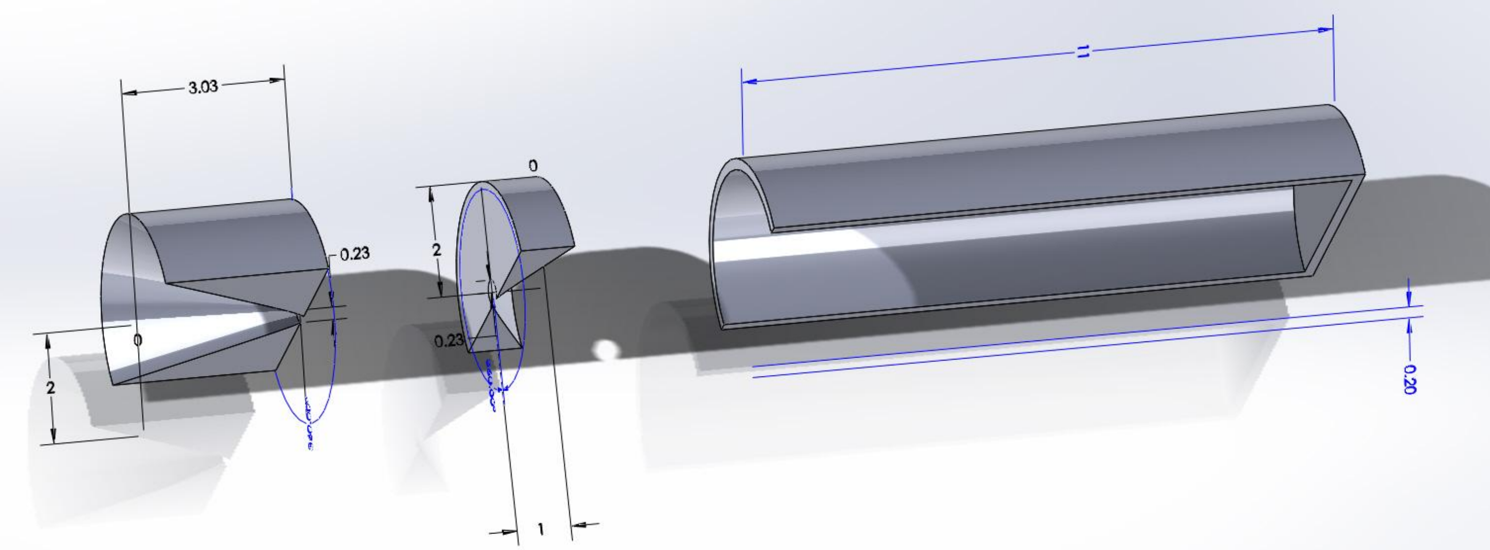


Subsystem Design: Mechanical Design ScubeR

Nikki

Cross section view of ScubeR

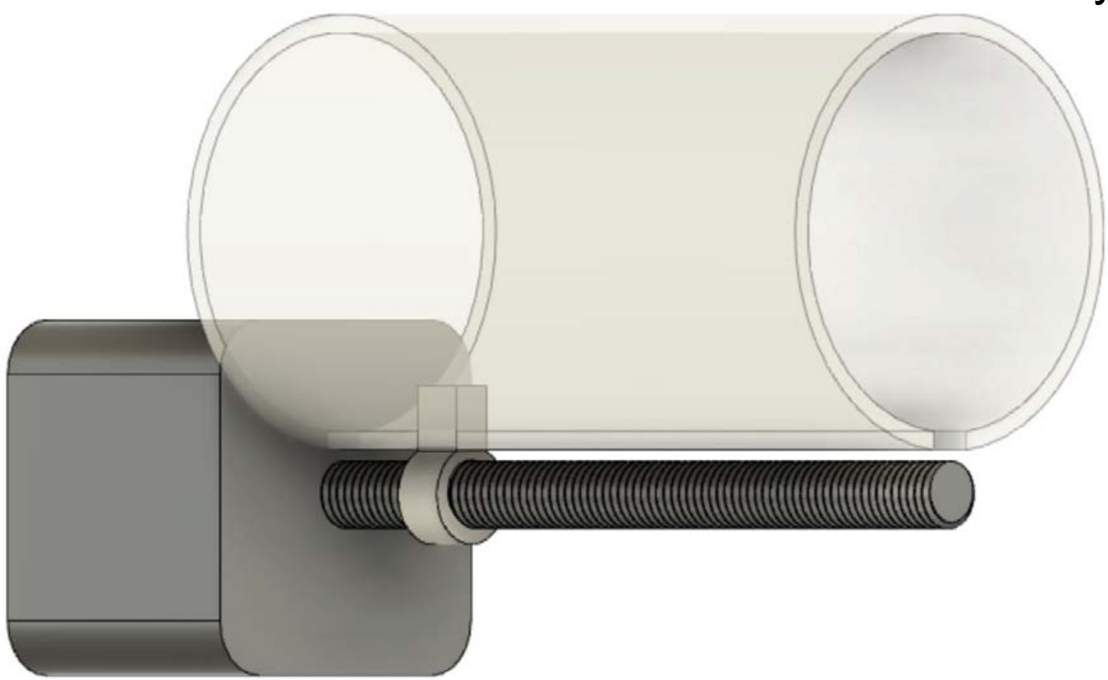
All measurements in cm



Subsystem Design: Mechanical Design ScubeR

Nikki

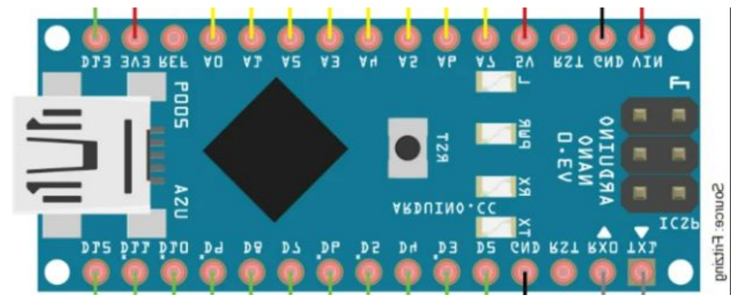
- NEMA 17, 2 Phase stepper motor
- 2 Phase, 1.9V per phase, 4 wire
- Lead screw to drive ScubeR out of CarRoLL
- Driven by H bridge



Subsystem Design: Mechanical Design ScubeR Controler

Nikki

ScubeR Controller Arduino Nano



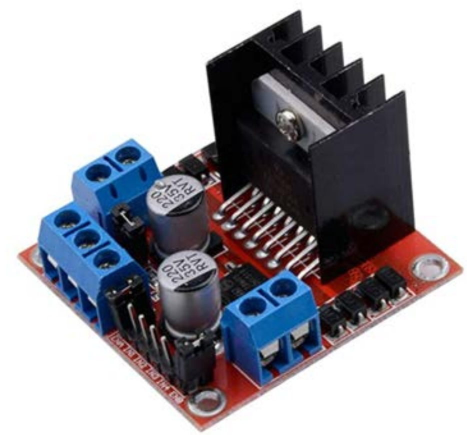
Dimensions - L = 45 mm, W = 18 mm

Weight - 0.18 oz

Digital Pin Amax

- 40mA per pin in use

HBridge motor Driver



Dimensions - 1.75” x 1.75” x 1”

Weight - 1.06 oz

Driving Capacity

- 5V - 12V max
- 2A max single bridge

Subsystem Design: Mechanical Design ScubeR Controler Motor

Nikki

Stepper Motor

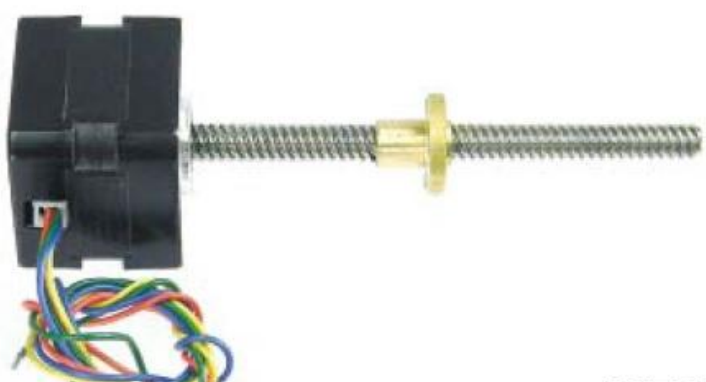
31564-MS

NEMA 17 STEPPER with LEADSCREW

P/N: 42HD0403-100L
NEMA: 17
COIL: 1.5A/1.3 ohm
TYPE: 2 Phase 4 Lead Bi-Polar or H Drive
1.8 Degree stepper motor with a 8mm Dia./2mm Pitch 4 Start Helical leadscrew
100mm steel long with brass traveler. 8mm/turn or .04mm/step.
4 corner M3X 0.5 metric mounting holes. 13" leads.
SQ.: 1-5/8" **L:** 1-3/8" (Body)

WT: 0.2 lbs

P/N	Step Angle	phase V	phase I	phase Res.	phase Ind.	Inerta	Leads	WT.	Body L.	Shaft L.
	Deg.	Volts	Amps	Ohms	mH	kg cm^2	#	lbs.	mm	mm
42HD0403	1.8	1.95	1.5	1.3	1.5	2.2	4	0.2	33	100



Subsystem Design: Mechanical Design ScubeR Controler Telemetry

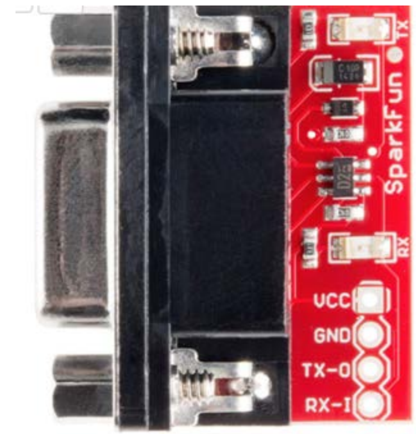
Nikki

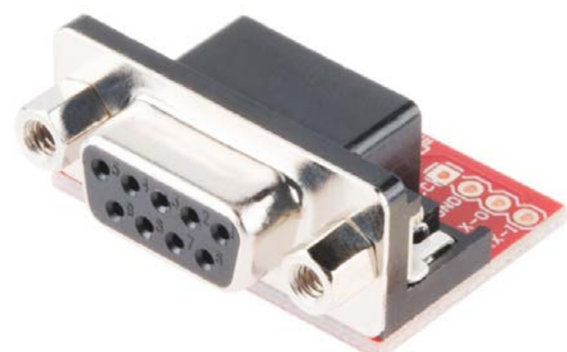
Sparkfun RS232 Level Shifter

Power - 5V DC

- Dimensions - 1.22” x 1.08” x 0.62”
- Weight - 35g

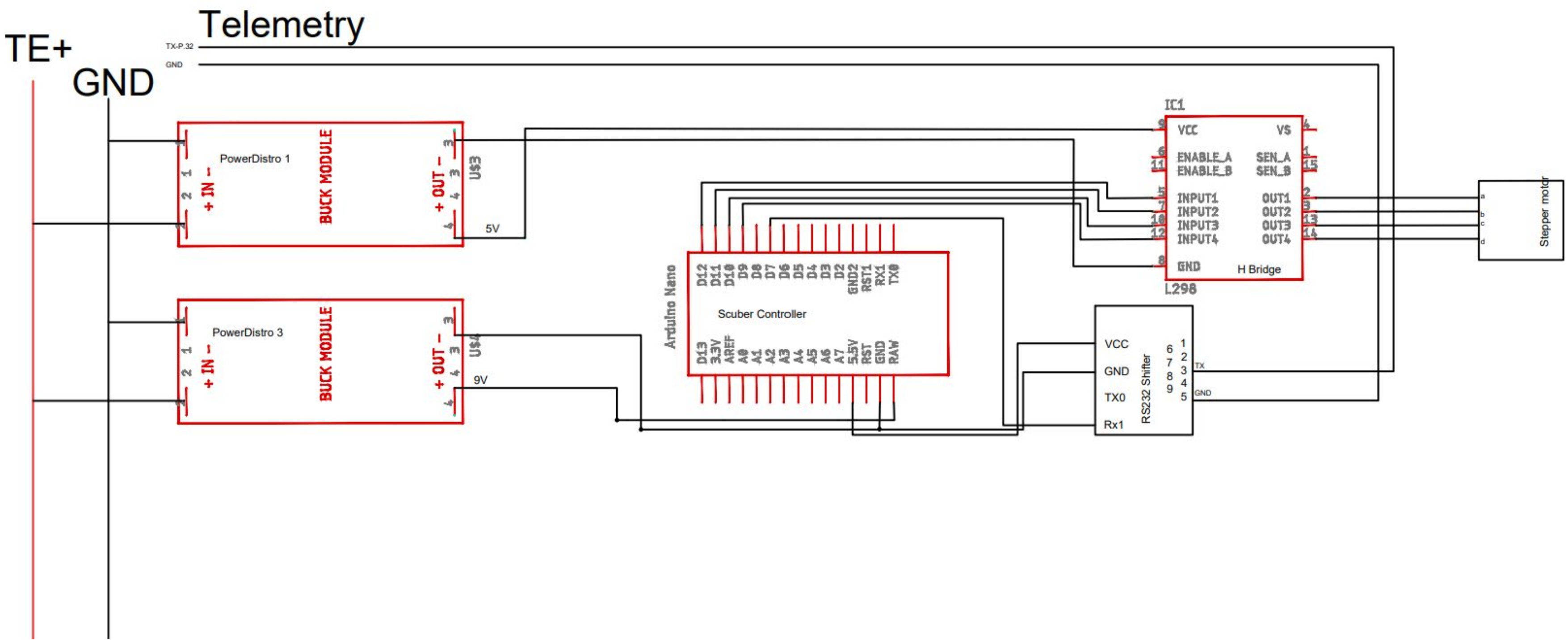
Device to send ScubeR deployment updates via telemetry





Subsystem Design: Mechanical Design ScubeR Electrical Interfaces

Nikki

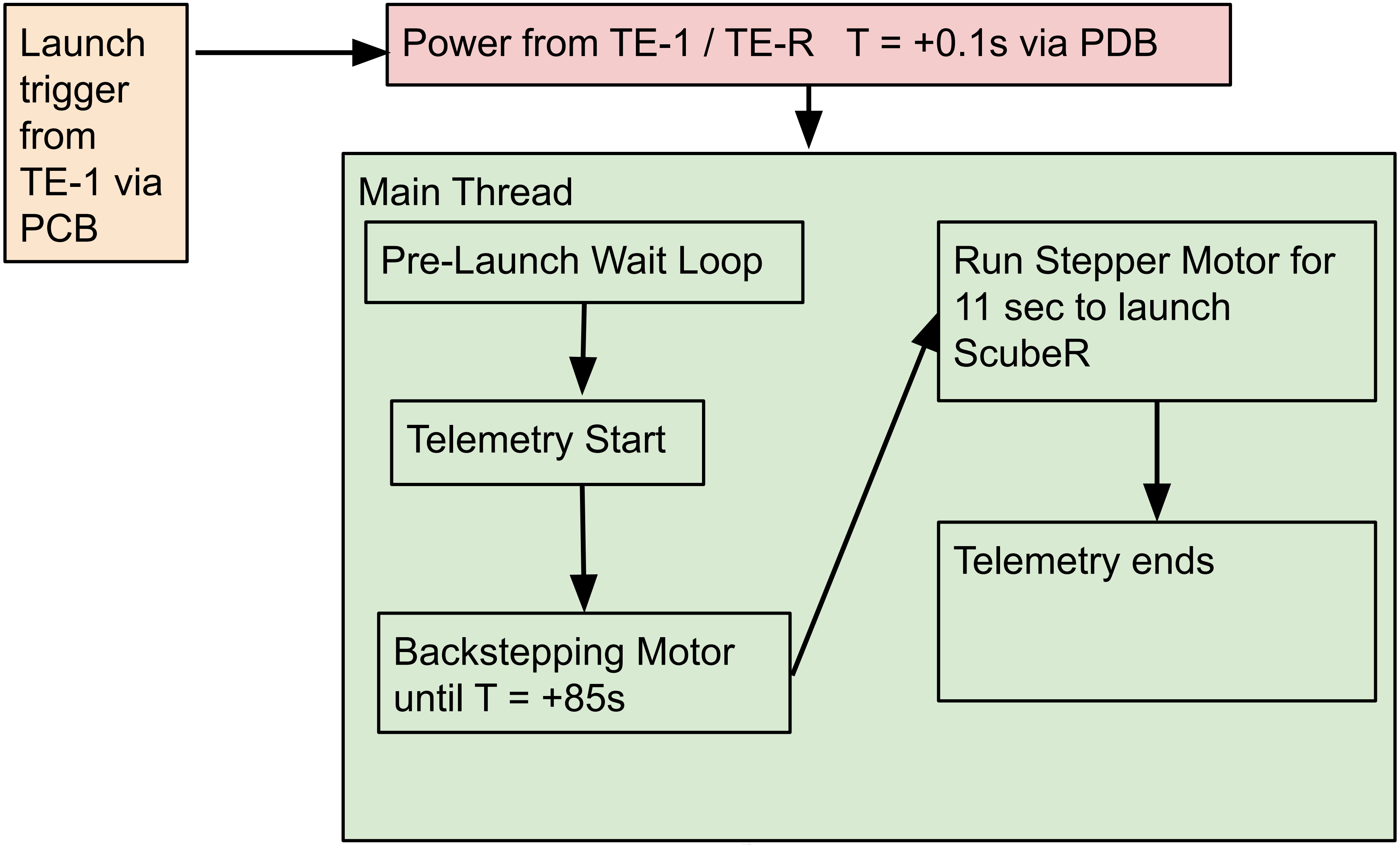


ScubeR to be deployed by ScubeR Controller

Stepper to be controlled by H bridge that will receive directions from ScubeR Controller

Subsystem Design: ScubeR Controller

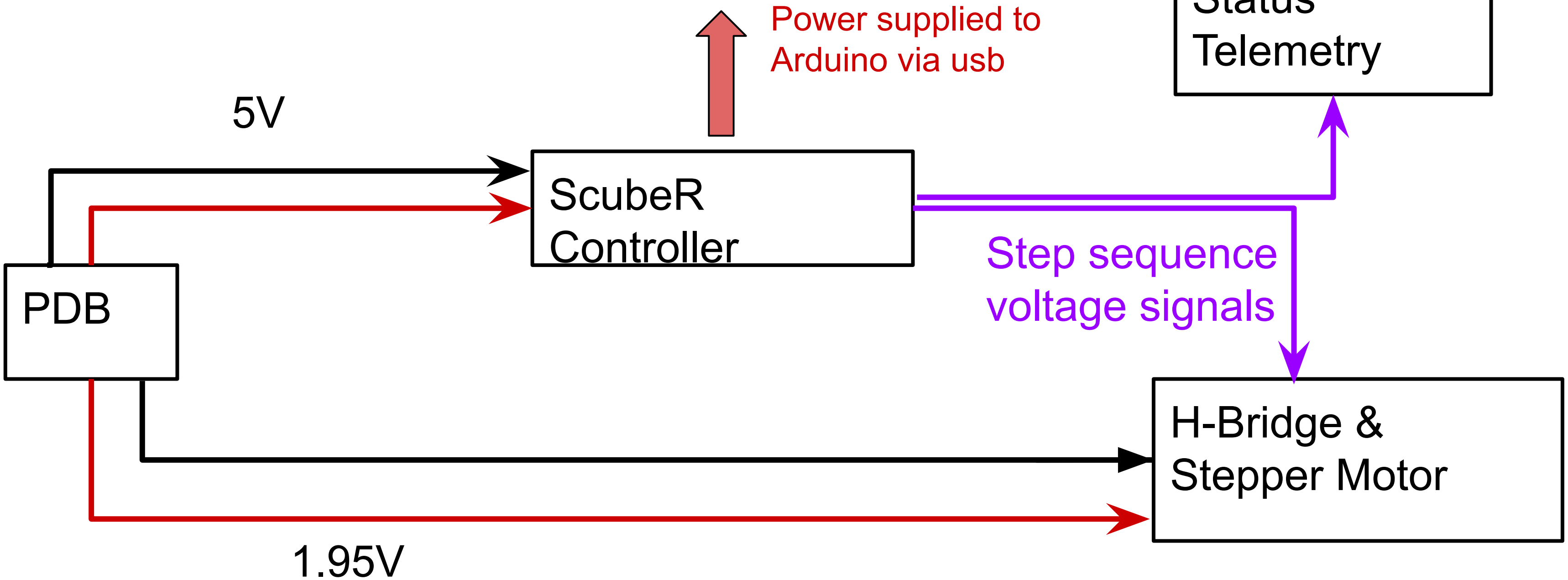
Nikki



Nikki

Subsystem Design: Power ScubeR Controller

- ScubeR Controller: Receives 9V via PDB (@ T≈+0.1)
- H-Bridge sends commands to Stepper Motor: Motor starts backstepping from T≈+0.1s to T≈+85s and forward stepping for 11 sec until T≈+96s when ScubeR is released. Stepper Motor continues forward stepping until T=+100s.



Subsystem Design: Mechanical Design ScubeR Final Design

Nikki

Not Final Design

- May make some minor design changes to the sublimate rocket features since the fuselage and design on nozzle and tip are pending modeling analysis.

Subsystem Design: Power Distribution Board in detail

Nikki

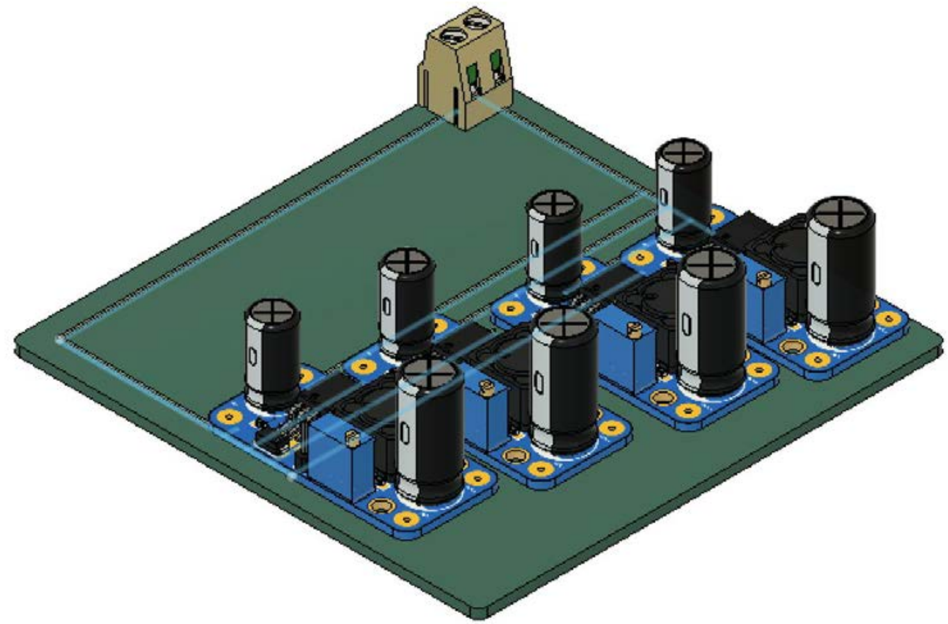
- LM2596 Step Down Module
- Input Voltage Range: DC 3 - 40 V
- Output Voltage Range: DC 1.5 - 35 V
- The input must be 1.5 V higher then the output voltage.
- The 2A max without heatsink
- Dimensions:
  - 1.071” x 0.827” x 0.551”
- Weight per converter:
  - 11.23g
  - Weight total = 44.92g
- Physically adjustable power limitation
- Voltage Regulators on hand

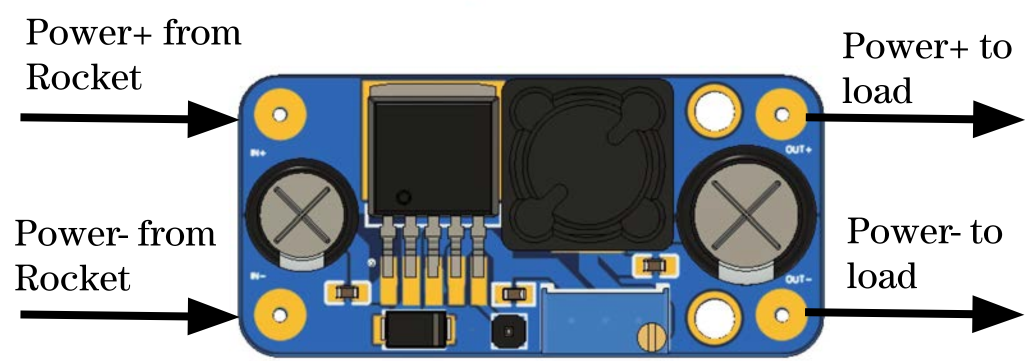
Subsystem Design: Power Distribution Board in detail

Nikki

PDB board to be housed in Artemis

- 4 LM2596 Step Down Module total
- GSE Line power to power 1 LM2596
    - To be connected to Artemis directly
- All other LM2596 units to receive power from TE and TE-R lines





Power

- 0.008775Ah total
- power dissipation loss

Subsystem Design: Power Distribution board in detail

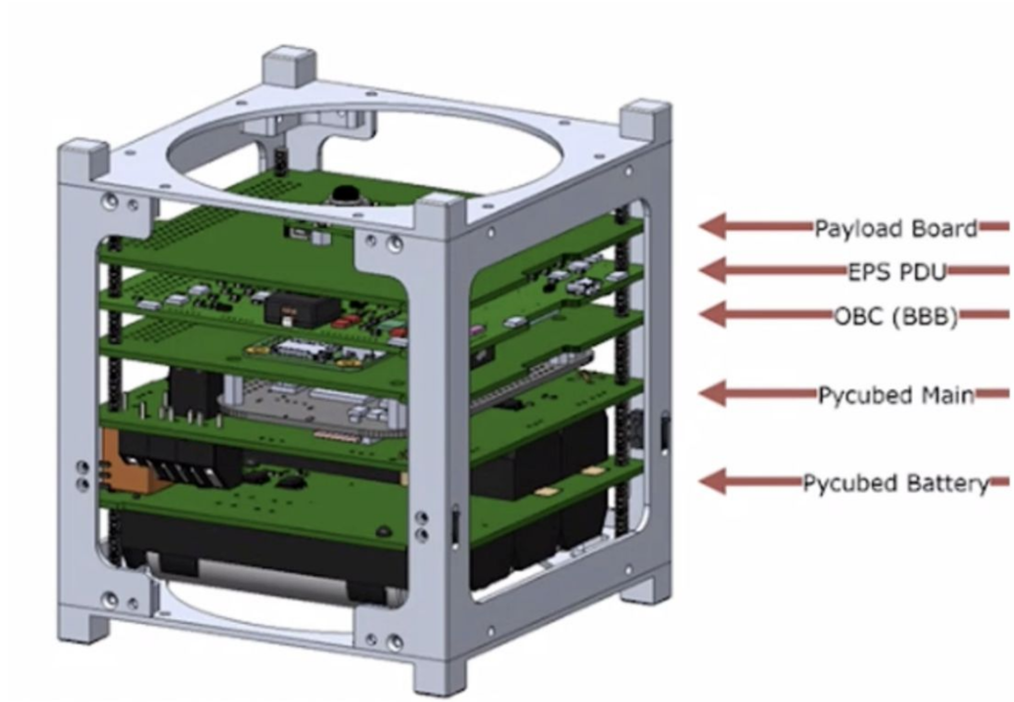
Not Final design.

- Other electronics might be added to the same electronic deck as the PDB because of space constraints for the existing ScubeR controller.
    - Devices to potentially be added are the ScubeR controller and RS232 Level Shifter
- If more physical space is needed for controller hardware, space will be made on the PDB to accommodate existing electronics

Subsystem Design: Artemis

Cubesat kit with existing electronics

- Lower bays, depending on space requirements, have modular feature and will be emptied to make room for the PDB and ScubeR controller electronics.
- Screwed to deck plate
- 1.31 lbs
- 10cm x 10cm x 11cm
- 5v input from voltage converter
- Final Design



Subsystem Design: Data Controller

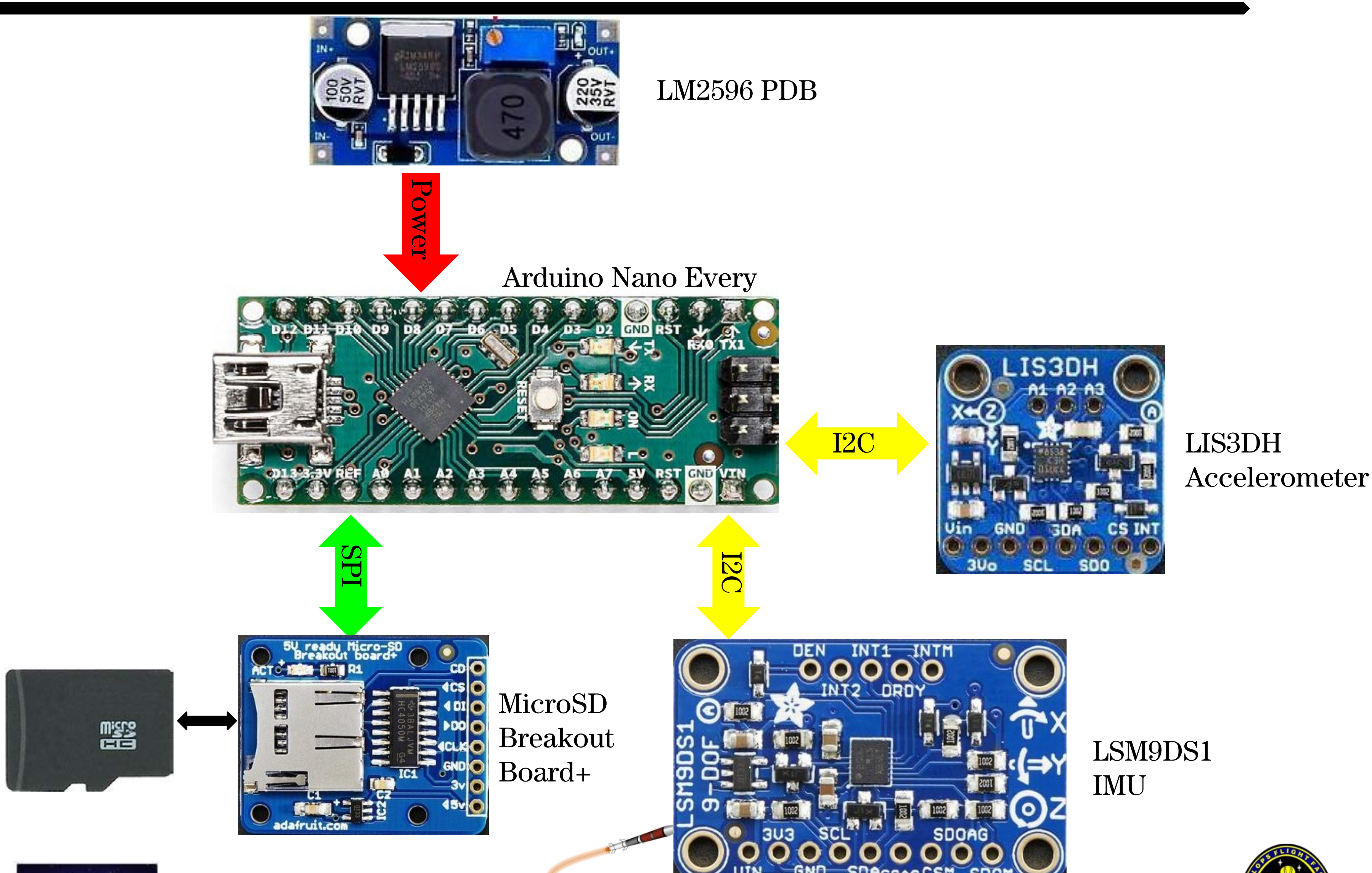
The Data Controller Subsystem will be based off the Arduino Nano Every microcontroller. The microcontroller will receive data from the LSM9DS1 IMU and the LIS3DH Accelerometer, and save it to a microSD card through the Adafruit MicroSD Breakout board.

The Data Controller Subsystem Design is **not final**, and needs to undergo assembly and lab testing.

- Measurement parameters
  - Acceleration in the X, Y and Z axis from Accelerometer and IMU
    - Selectable scaling of ±2 or ±4 or ±8 or ±16 g for both Accelerometer and IMU
  - Gyroscope in the X, Y and Z axis from the IMU
    - Selectable scaling of ±245 or ±500 or ±2000 dps
  - Magnetometer in the X, Y, and Z axis from the IMU
    - Selectable scaling of ±4 or ±8 or ±12 or ±16 gauss

Subsystem Design: Data Controller

D'Elle



Subsystem Design: Data Controller

Power Usage and Subsystem Weight

Power Board Output (Nominal Component Ratings)				Battery Usage		Mass
Component	Voltage (V)	Current (mA)	Power (W)	Time On (min)	mAh	Mass (g)
LSM9DS1 (IMU)	5.0	4	0.02	5.6	0.37	2.5
LIS3DH	5.0	10	0.5	5.6	0.93	1.5
MicroSD Reader	5.0	150	0.75	5.6	14	2.5
Arduino Nano Every	9.0	100	0.925	5.6	9.4	23
				Total Current (mA)	Total Capacity (mAh)	Total Mass (g)
				264.0	24.7	29.5

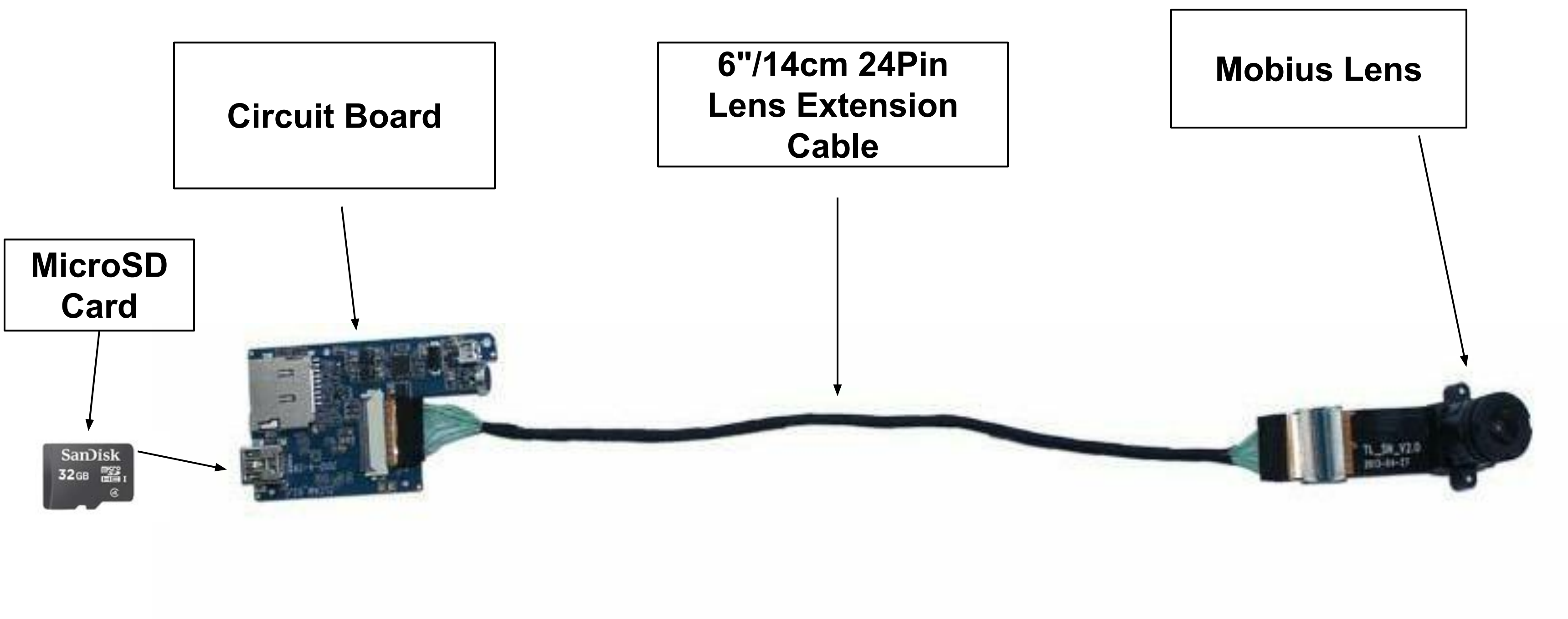
*Note: A fabricated Power distribution board will be taking the incoming voltage supplied by the rocket and it will be facilitating the power needs of the components listed above.

plus approximately 30g for wiring and unit mounting board for 59.5g total.

Subsystem Design: Camera

Caleb

- Mobius Action Camera
  - Dimensions - 2” x 1” x 1”
  - Weight: 0.29 lbs (131.54 g)
  - Power: 450mA at 5V for each camera



Subsystem Design: Onboard Camera

Caleb

The Mobius Action Cameras will be used to take photo and video of the ScubeR deployment which we will use to measure the distance vs time and acceleration.

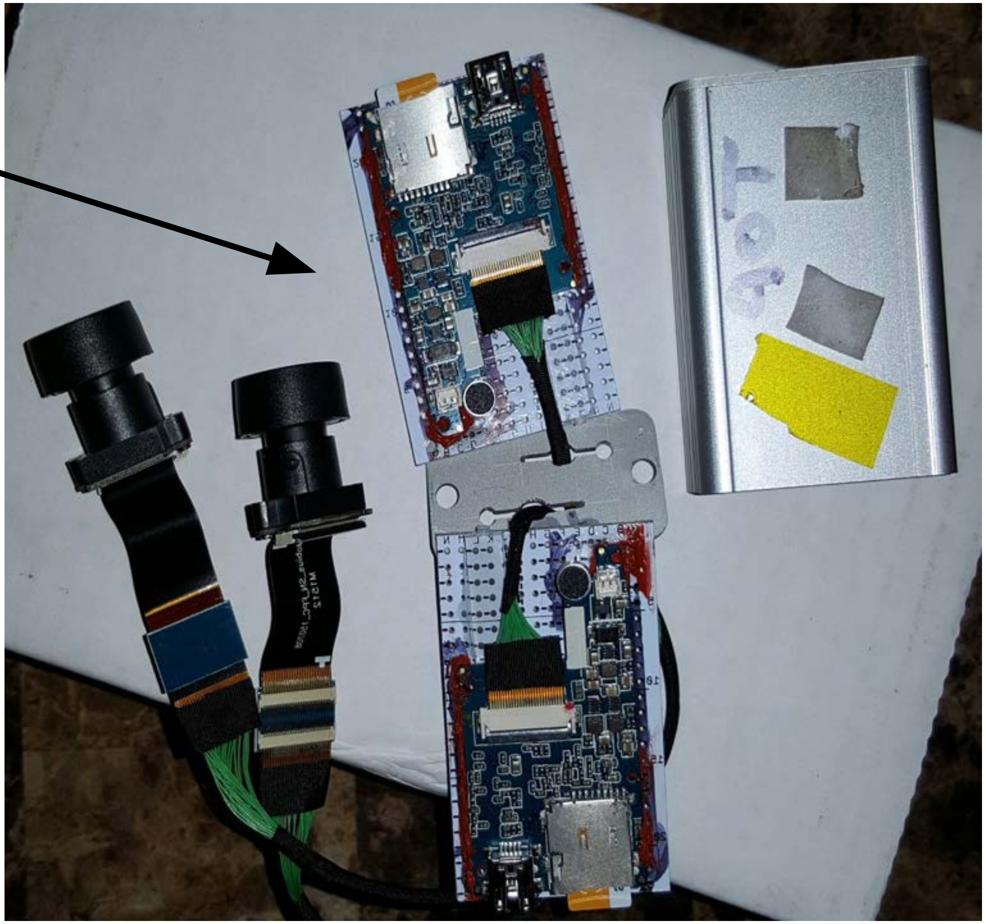
The Camera Subsystem Design is not final, and needs to undergo assembly and lab testing.

- Specifics of video & photo
  - Video Camera
    - Records the entire flight from launch until the power cuts off
  - Photo Camera
    - Measure ScubeR's speed from at least 3 pictures

Subsystem Design: Structure (Cameras)

Onboard Mobius Action Cameras circuit boards outside of housing

Photo Camera (time-lapse) and Video Camera (video)



Size: 2” x 1” x 1”

Power: 450mA at 5V for each camera

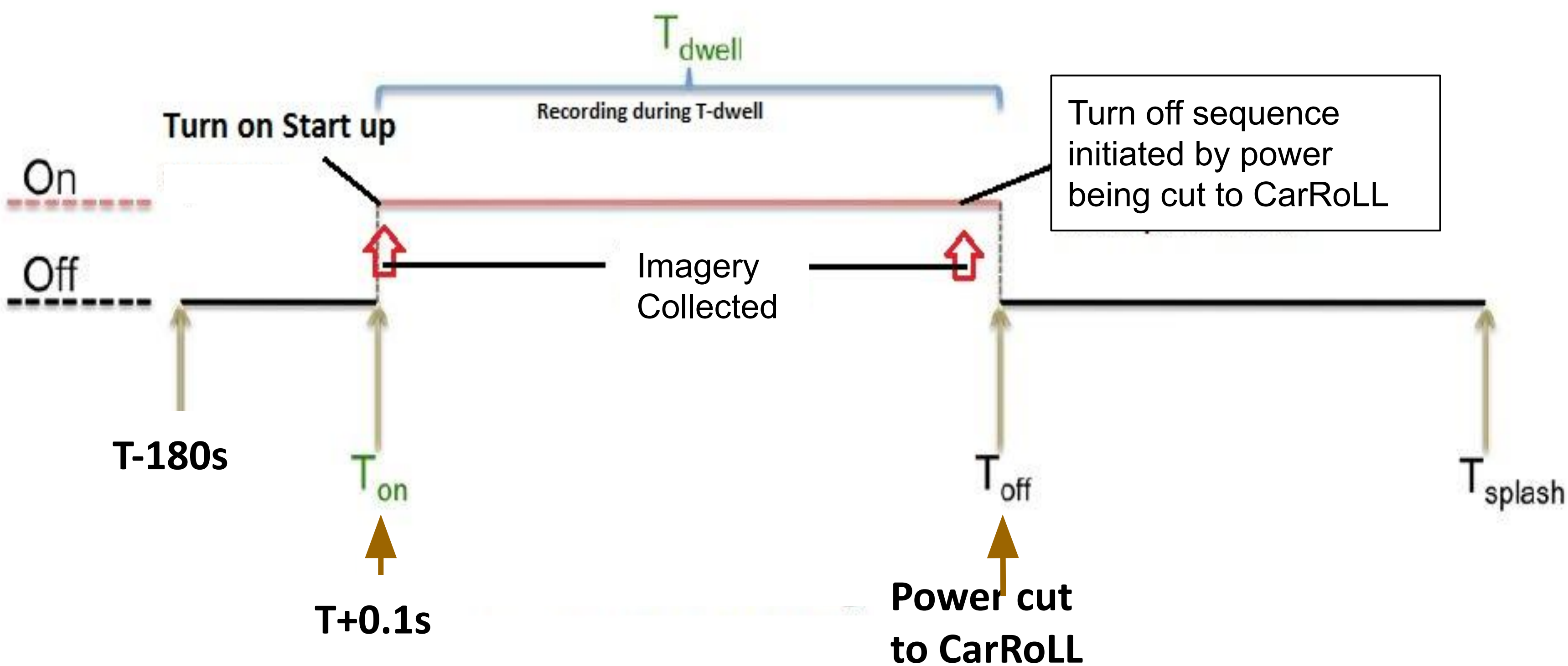
Weight: 0.29 lbs (131.54 g)

Subsystem Design: Power (On-board Camera)

Caleb

Power on / off sequence

- (T_{on}) Photos and video will start recording to the MicroSD cards that are on the Mobius Action Cameras after power is applied at T=+0.1 seconds.
- (T_{off}) Power to Mobius Action Cameras will cutoff when WFF power to CarRoLL is cut at T+ 336 seconds.



Caleb

Subsystem Design: Software (On-board Cameras)

Video Camera:

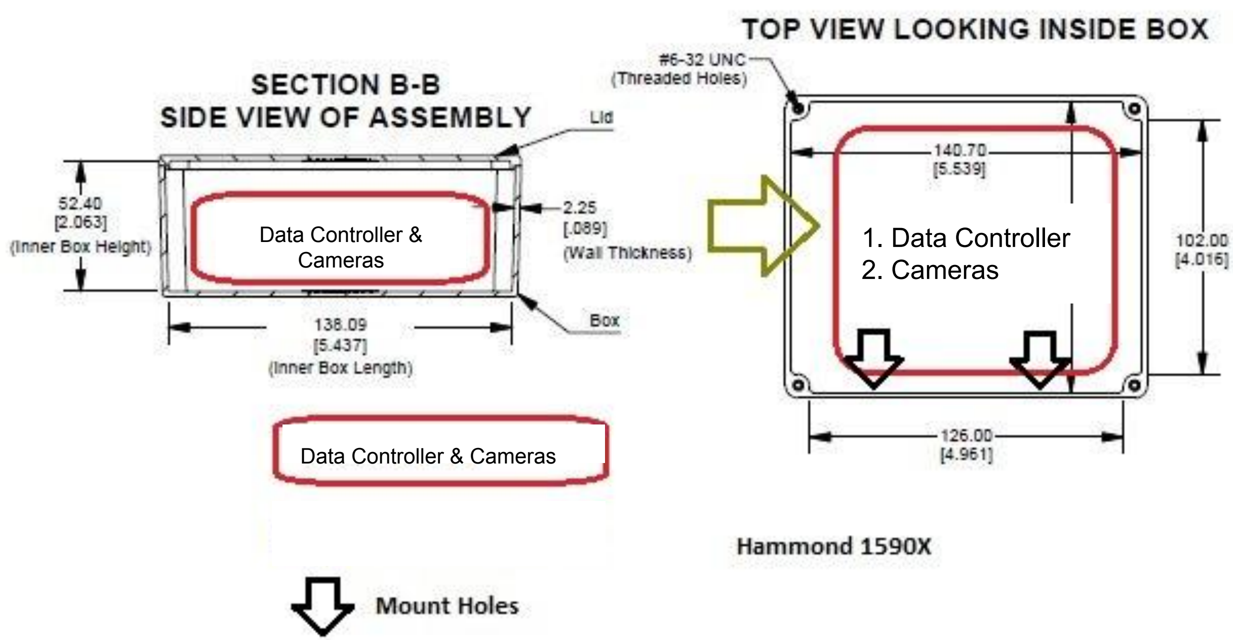
- Enable video mode
- Taking a 5 minute video clip
- Data is stored locally to MicroSD card contained within camera enclosure

Photo Camera:

- Enable photo mode
- Taking 1 photo every 2 seconds
- Data is stored locally to MicroSD card contained within camera enclosure

Subsystem Design: Structure

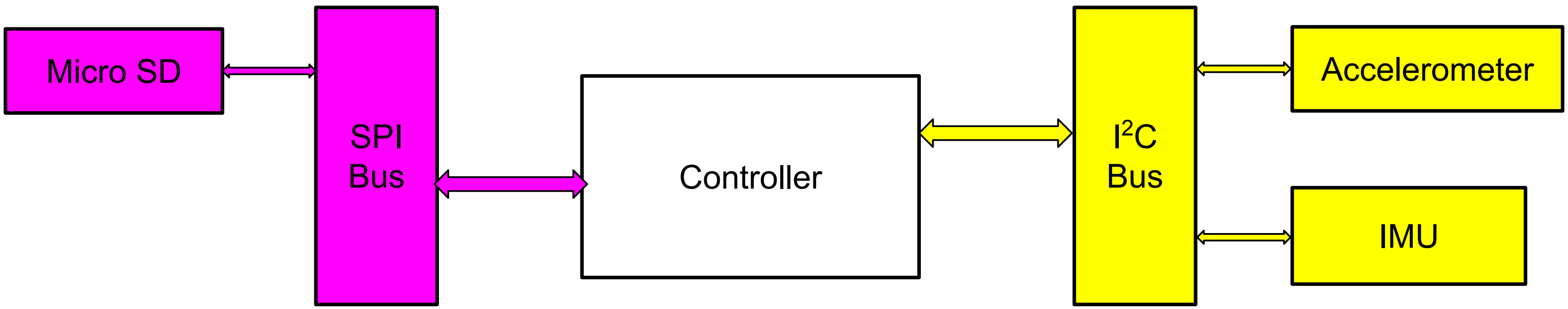
- Housing-Hammond Box
  - Diecast Aluminum Alloy (4.92” x 4.49” x 3.11”)
    - Weight 0.994lbs (450.87g)
    - Silicone Gasket
    - Stainless Steel Screws



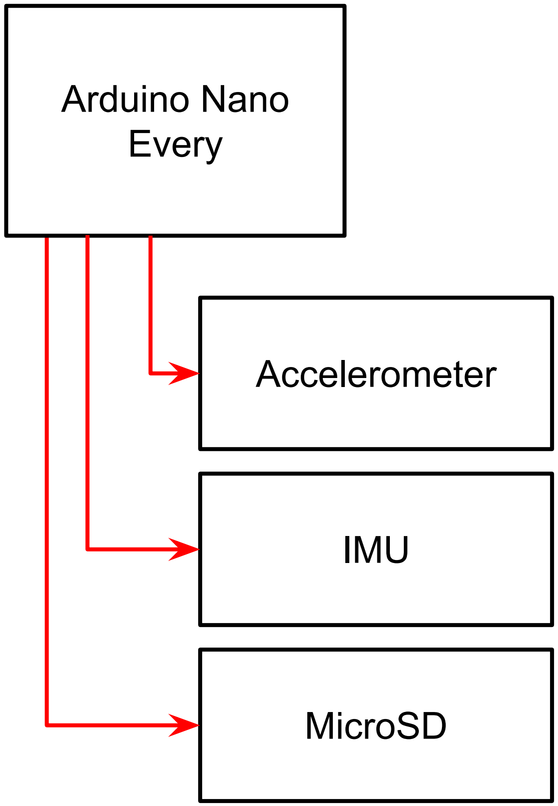
Subsystem Design: Structure (Data Controller)

Controller: Arduino Nano Every (5 grams - 5 Volts)
Accelerometer: Adafruit LIS3DH (1.5 grams - 3.3-5 Volts)
IMU: Adafruit LSM9DS1 (2.5g - 3.3-5 Volts)
MicroSD: Adafruit MicroSD Card Breakout Board+ (0.81oz - 3.3-5 Volts)

The mass would be around 11 grams, plus another 30 to 50 grams for the circuit board and wiring



Subsystem Design: Power (Data Controller)

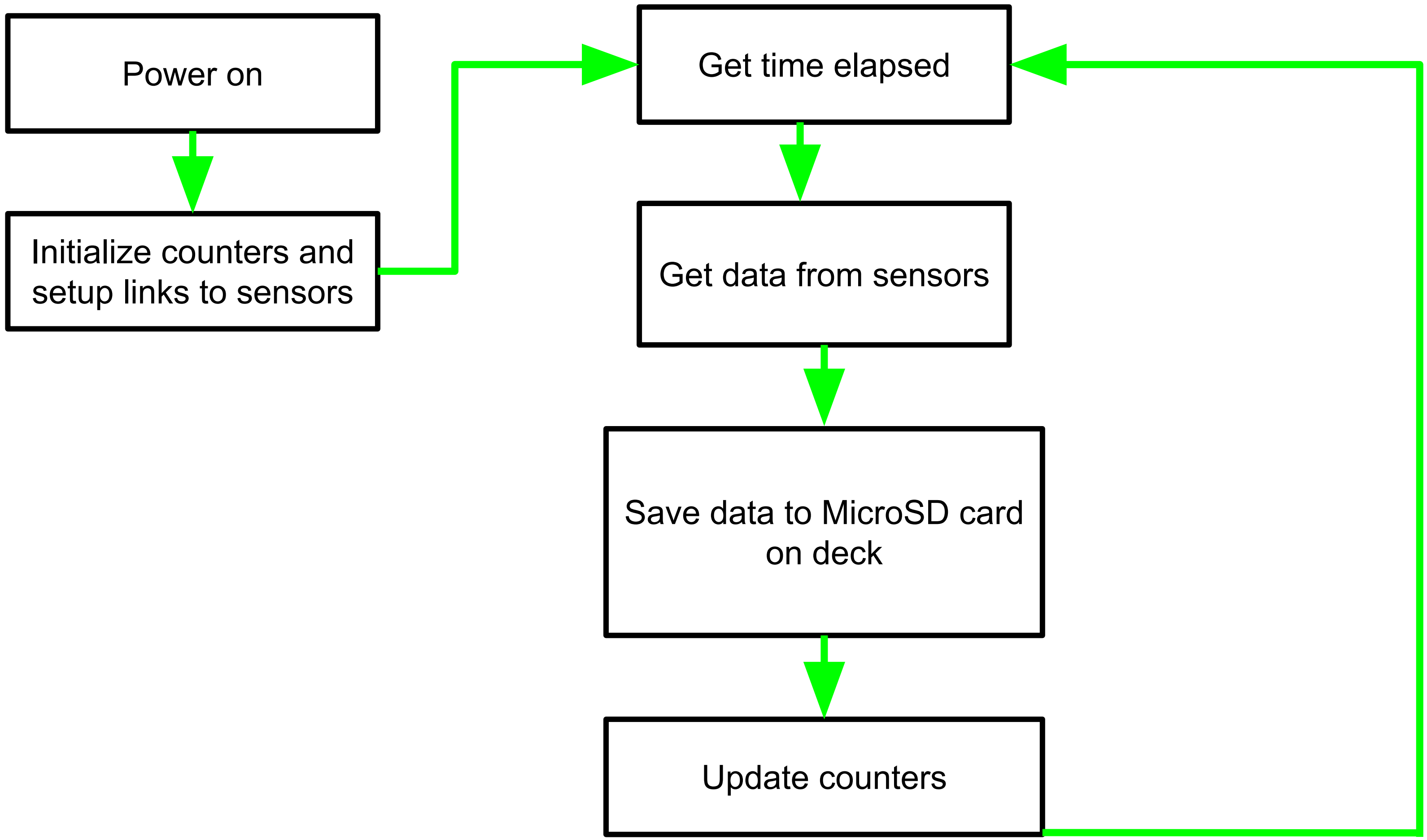


Input to the Arduino Nano Every is at 9 Volts.

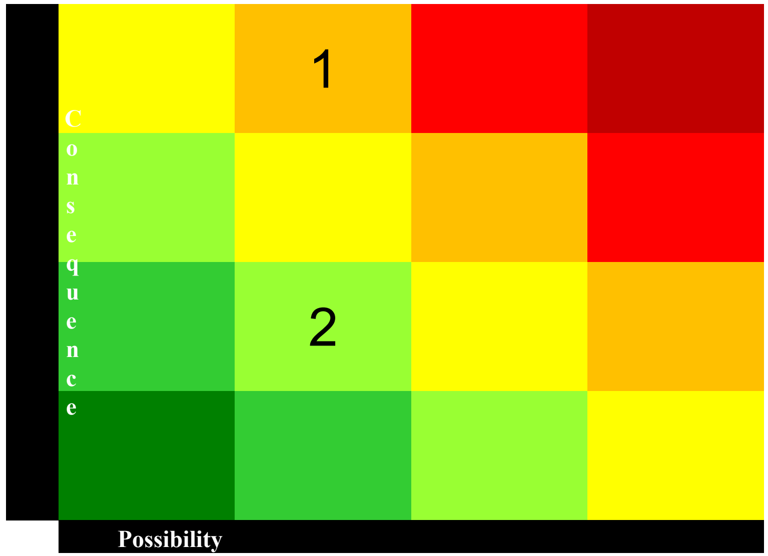
Output to the rest of components is at 5 Volts.

- (T_{on}) Data Controller will start at T=+ 0.1 seconds.
- (T_{off}) Power will cutoff when WFF power to CarRoLL is shut off at T=+ 336 seconds.

Subsystem Design: Software (Data Controller)

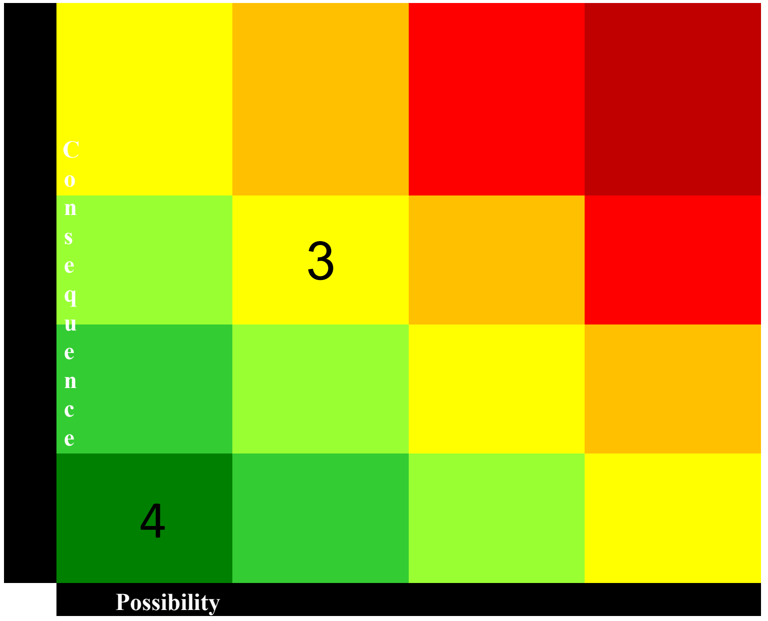


Risk Matrix (ScubeR)



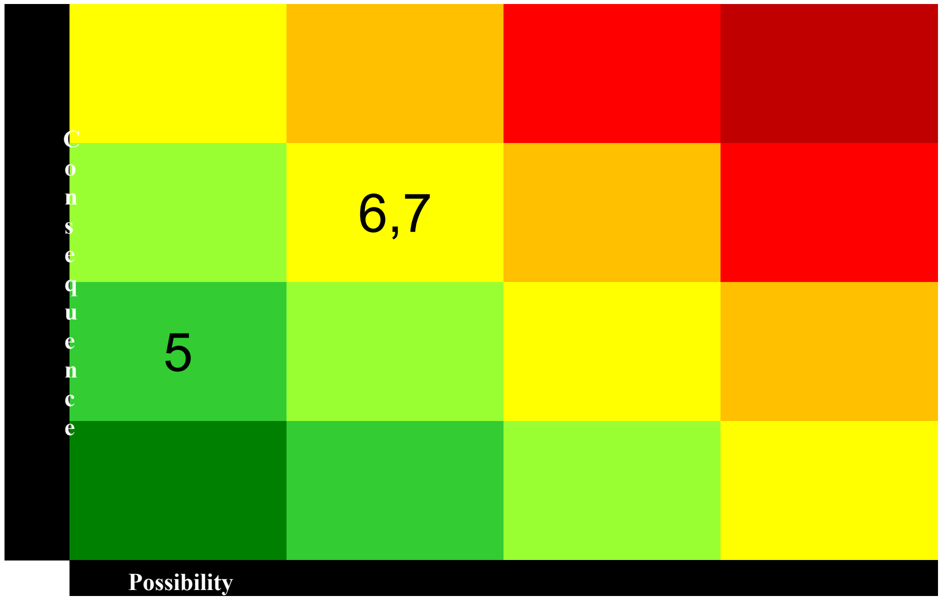
1. ScubeR will not clear the CarRoLL before re-entry because of a delay in sublimation.
2. Stepper Motor might not work.

Risk Matrix (Power Conditioning Board & Artemis)



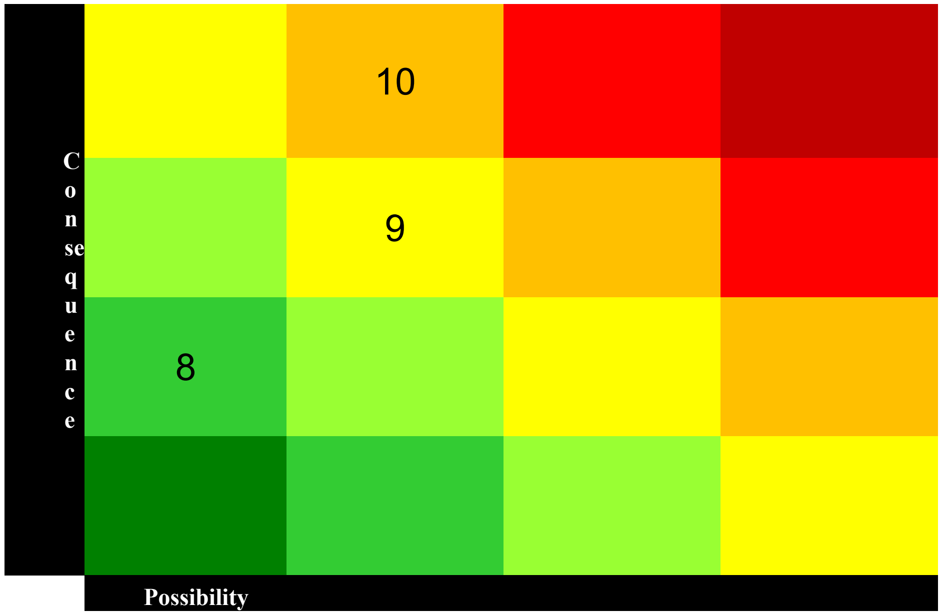
3. Testing the integrated subsystem will be delayed if the PDB board isn't delivered on time.
4. If the Artemis Cubesat fails our primary mission remains unchanged and unaffected.

Risk Matrix (Onboard Cameras)



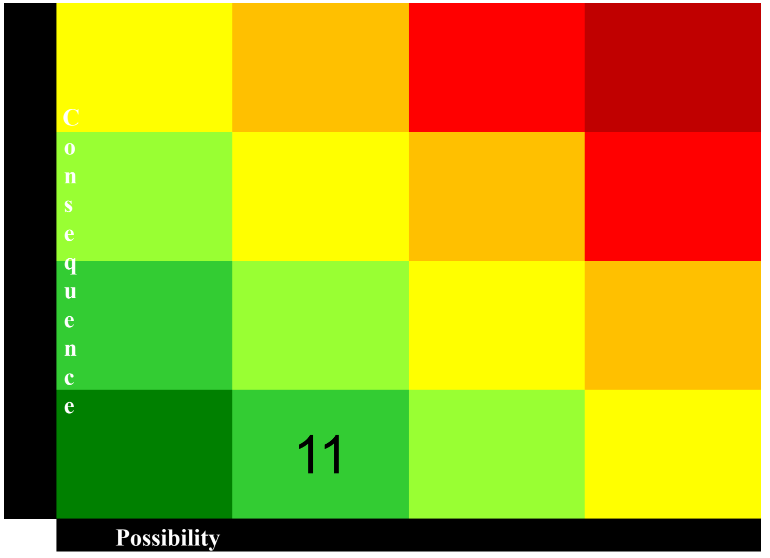
5. Images may become distorted if fog/outgassing gets on camera lens.
6. Camera may fail to capture images if the ribbon cable interface is damaged during launch.
7. Video images will not be stored if power to unit is removed before five-minutes from power on.

Risk Matrix (Data Controller)



8. Units undergoing test on model rockets might get lost during the flight. There might be delays in getting replacement parts.
9. IMU breakout board availability
10. Data loss from SD card damage

Risk Matrix (ScubeR Controller)



11. Too much processing may slow down the Arduino Nano Every (ScubeR Controller) to the point that it fails to initiate a controlled timing event.

Jared

Risk Matrix (Summary)

Consequence	Possibility			
		1,10,		
		3,6,7,9		
	5,8	2		
	4	11		

Subsystem Design: Weight Budget

UHCC - Weight Budget	
Date: 12/2/21	
Subsystem	Total Weight (lbs)
ScubeR	0.55
Artemis	1.31
Data Controller	0.11
Mobius Cameras (2)	0.13
Hammond Box	0.99
Payload Deck	3.425
Total	6.52
Over/Under (15 lbs)	Under by 8.48

Subsystem Design (Power Usage Table)

	Power Board Output (Nominal Component Ratings)				Battery Usage	
	Component	Voltage (V)	Current (A)	Power (W)	Time On (min)	mAh
Experiment	ScubeR Controller	5.0	0.099	0.45	5.6	9.2
	Stepper Motor	3.3	0.290	0.96	0.033	0.2
	Video Camera	5.0	0.80	4.0	5.6	74.7
	Photo Camera	5.0	0.80	4.0	5.6	74.7
	Artemis CubeSat	5.0	1.0	5.0	8.9	148.0
	H Bridge	5.0	1.4	10.0	1.30	30.0
	Data Controller	9.0	0.1	0.925	5.6	9.4
					Total Current (A)	Total Capacity (Ah)
					5.1 A	0.35 Ah

*Note I: 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.
*Note II: No high voltage sources are being used. the DC converters on the PDB will run in parallel where needed to supply the necessary voltage.

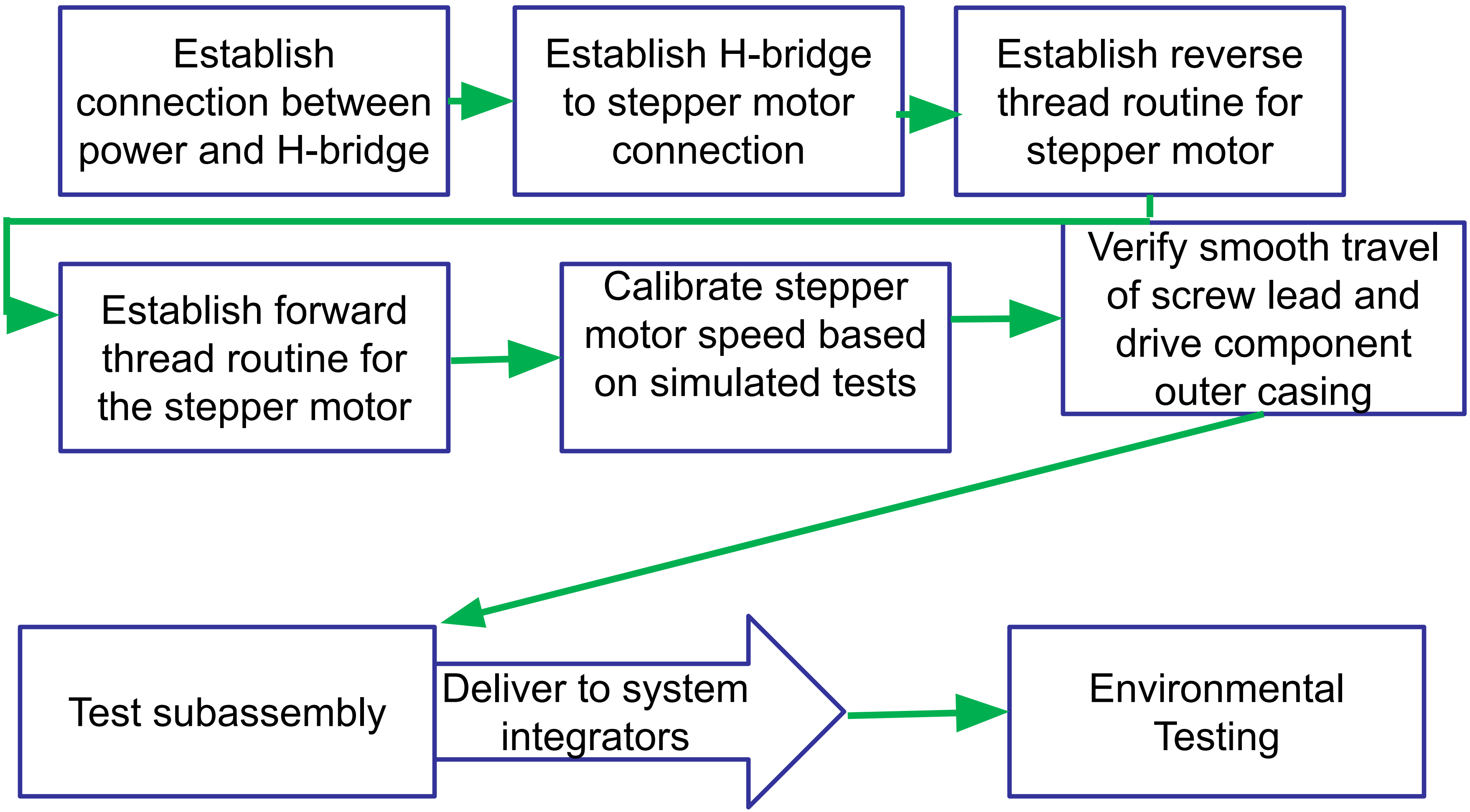
Jared

Power Budget Deliverable

UHCC - Power Budget							
Date: 12/1/21							
Wallops Power Line	Subsystem	Voltage (V)	Max Current (A)	Start Time (min)	Time On (min)	Watts	Ah
GSE1/2	PDB (Artemis)	5.0	1.00	t = -3.3 min	8.9	5.00	0.15
						0.00	0.00
TE1/2/3/R	PDB (Cameras - 2)	5.0	1.60	t = +0.01 min	5.6	8.00	0.15
	PDB (Data and ScubeR Controllers)	9.0	0.16	t = +0.01 min	5.6	1.43	0.01
	PDB (Stepper)	3.3	0.29	t = +0.01 min	5.6	0.96	0.03
						0.00	0.00
		GSE 1/2 Total					
		TE1/2/3/R Total					
		Total	3.05			15.39	0.34
		Total Power Capacity					0.50
		Over/Under					0.16
					# of Flights Margin		2.9

4.0 Prototyping/Analysis Results/Pans

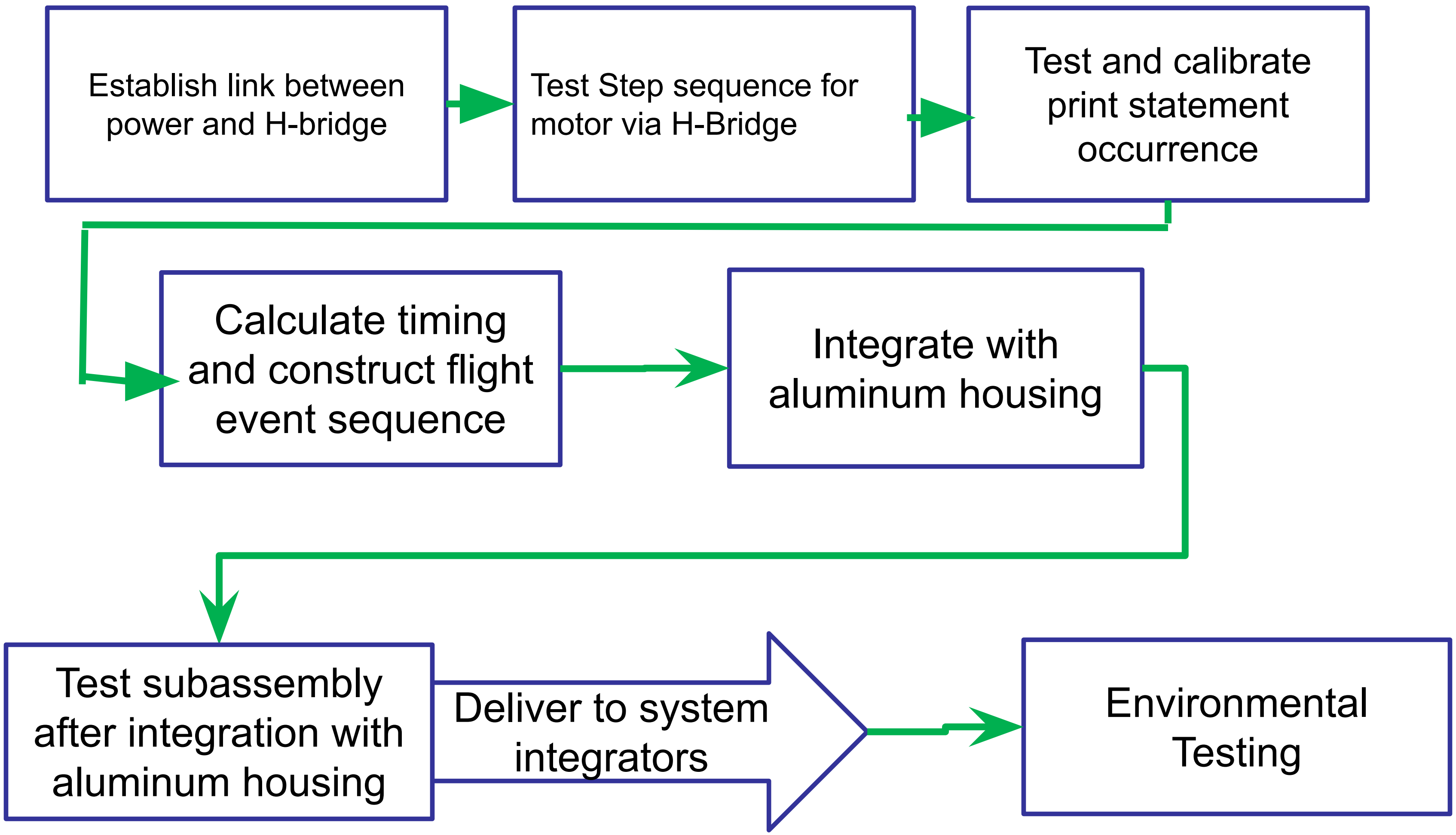
Test/Prototyping Plan (ScubeR)



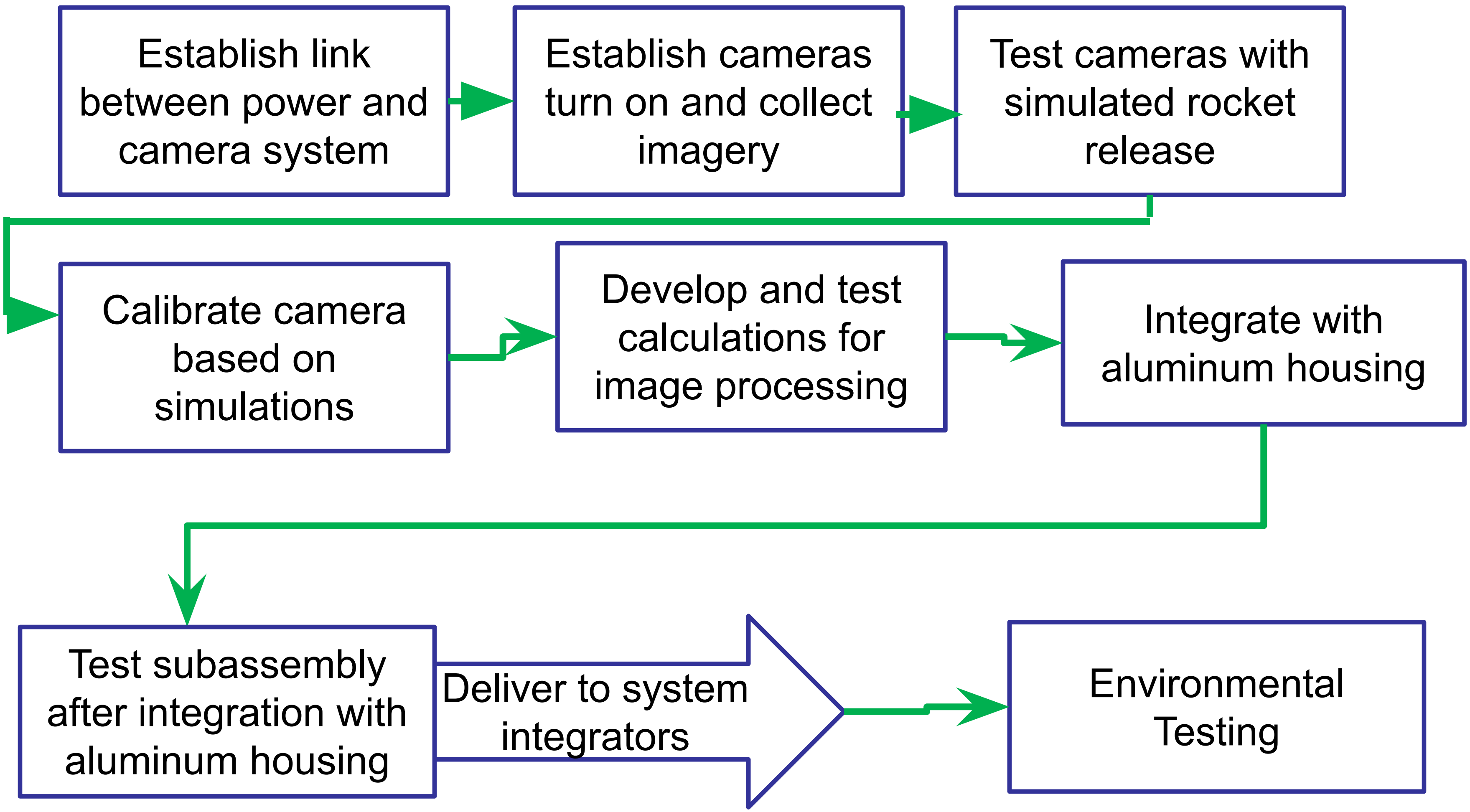
Test/Prototyping Plan (Power Distribution Board)

1. Establish a connection between PDB and the rocket battery power
2. Verify power on of PDB
3. Verify change 32V coming into the PDB to 5V to the Artimes Cubesat
4. Verify change 28V coming into the PDB to 5V after T = 0.1 Artimes Cubesat
5. Verify change 28V coming into PDB to 5V to the Mobius cameras
6. Verify change 28V coming into PDB to 3.3V to the H-bridge
7. Verify change 28V coming into the PDB to 9V to Data Controller and ScubeR Controller
8. Test PDB after integration with aluminum housing
9. Deliver to system integrators
10. Environmental Testing

Test/Prototyping Plan (ScubeR Controller)

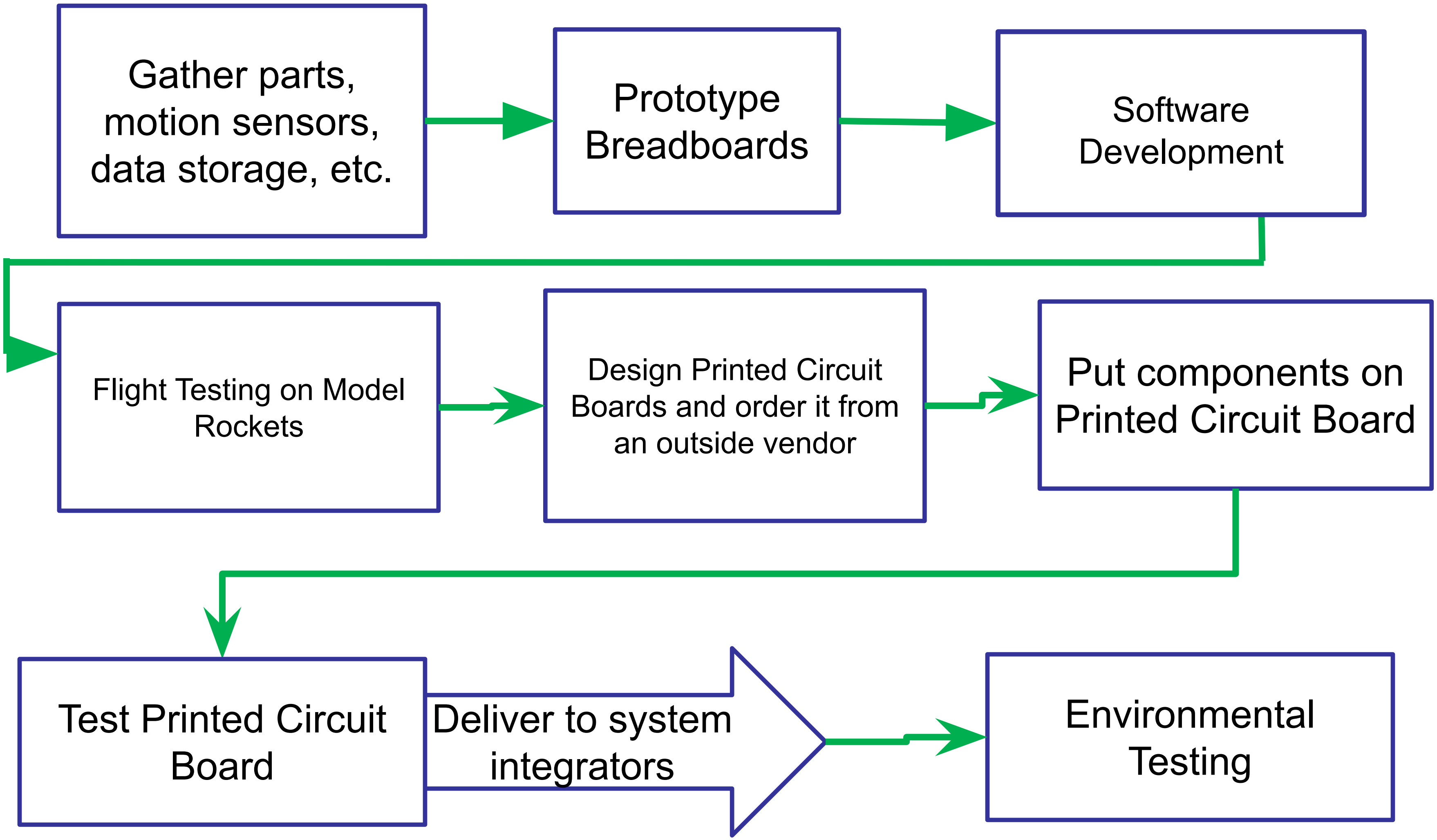


Test/Prototyping Plan (Onboard Cameras)



D'Elle

Test/Prototyping Plan (Data Controller)



5.0 Manufacturing Plan

Caleb

Mechanical Elements (Onboard Cameras)

- What will be manufactured?
  - The Mobius Action Cameras will be using an 6 inch extension cable connecting from Circuit Board to Mobius Lens.
- What will be purchased?
  - 6” extension cable, MicroSD Card, Replacement lens, Circuit Board
- Manufacturing plan/schedule
  - Start beginning January through March

Caleb

Mechanical Elements (Data Controller)

- **What will be manufactured?**
  - The Data Controller will be mounted on a printed circuit board and housed inside a 1590K Hammond Box.
- **What will be purchased?**
  - MicroSD card, Circuit Board, 1590K Hammond Box
- **Manufacturing plan/schedule**
  - Start beginning January through March

Caleb

Electrical Elements (On-board Camera)

- What needs to be manufactured/soldered?
  - Printed circuit board to mount Data Controller: including IMU, Accelerometer, Controller and MicroSD Breakout Board+
- How many revisions of the electronic boards do you anticipate?
  - At least 2 revisions
- What needs to be procured?
  - Need to order the board and mounting hardware to mount the Data Controller on top the circuit board
- Present a plan/schedule that supports your testing/prototyping schedule
  - December 2021 to January 2022

Manufacturing Plan: Mechanical Elements

Mechanical Fabrication flow:

In house fabrication of subsystems in process. All components have been received or in acquisition.

2021 Dec => 2022 Feb.

Subsystem Level Fabrication:
- ScubeR + stepper motor + Power Distribution Board
- Onboard Camera assembly
- Data Controller
- Artemis CubeSat

Subsystem Testing Review: FEB

Subsystem fabrication complete for ISTR

2022 Feb => 2022 Mar.

Integrated Systems Assembly:
- Assemble subsystems on payload deckplate
- Fabricate all electrical interfaces
- Verify center of Grav., weight and dimensions.

Integrated Systems Testing Review: Mar.

2022 Jun <= 2022 Mar.

Verify size, weight, center of gravity before IRR

Environmental Testing:
- Mechanical stress test
- Vacuum chamber.
- Verify Release velocity of Rocket

Integration Readiness Review: Jun.

2022 Aug <= 2022 Jun

Contingency for Action Items and potentially fatal failures.

Mechanical Components

- ScubeR Controller
  - NEMA 17 stepper motor mount
- Onboard cameras
- Power Distribution Board
- Data Controller
  - Circuit Board
  - 1590K Hammond Box
- Artemis CubeSat

Manufacturing Plan: Electrical Elements

Electrical Integration flow:

PCB finalized and printed by Feb 1st. First PCB’S assembled for STR

2021 Dec => 2022 Feb.

Subsystem Level Fabrication:

- Power Distribution Board
- Data Controller
- ScubeR Controller
- Cameras

Subsystem Testing Review: FEB

PCB boards tested and operational for ISTR

2022 Feb => 2022 Mar.

Integrated Systems Assembly:

- Assemble interfaces for Payloads.
- Perform open bench testing, verify integrated operations
- Verify power budget
- Troubleshoot electrical failures

Integrated Systems Testing Review: Mar.

2022 Jun <= 2022 Mar.

Closed bench testing/ troubleshooting

Full Mission Simulations:

- Verify deployments(ScubeR release)
- Verify Limit Switch Operation
- Verify electrical integrity before/after environmental testing

Integration Readiness Review: Jun.

2022 Aug. <= 2022 Jun

Contingency for Action Items and potentially fatal failures.

Electrical Components

- Power Distribution Board
  - 4x L298 Voltage Regulator (H-Bridge)
- Data Controller
  - IMU
  - Accelerometer
  - Controller
  - MicroSD Breakout Board
- ScubeR Controller
  - H Bridge
- Cameras

Manufacturing Plan: Software Elements

Software Development flow:

Currently developing software internal to subsystems. Primary focus is on Flight Board and Data Controller.

2021 Dec => 2022 Feb.

Subsystem Level Development:

- ScubeR Controller
- Data Controller

Subsystem Testing Review: FEB

Subsystem software tested and calibrated prior to ISTR.

2022 Feb => 2022 Mar.

Integrated Systems Development :

- Establish power link between PDB and subsystems.
- Create data structure for storage of flight data.

Integrated Systems Testing Review: Mar.

2022 Jun. <= 2022 Mar.

Integrated systems operational for full missions simulation

Testing/Debugging:

- Run Full flight simulations
- Collect and analyze data from simulations to verify integrity of operations.

Integration Readiness Review: Jun.

2022 Aug. <= 2022 Jun.

Contingency for Action Items and potentially fatal failures.

Manufacturing Plan Overview:

Subsystem:	Components :	Status:
ScubeR	--Rocket body --stepper motor release	--De Laval nozzle - **To be printed** --Fuselage and plug - **To be printed** --stepper motor in-house - **To be purchased**
On-board Camera	--Mobius ActionCam (2) --Camera mounting brackets	--Mobius ActionCam - **purchased** --Camera mounting brackets - **to be printed**
Power distribution Board	--(1) 9.0V 1312 DC-DC converters --(2) 5.0V 1312 DC-DC converters --(1) 3.3V 1314 DC-DC converters --Printed Circuit Board	--5.0V and 3.3V DC-DC converters - **purchased** --power & telemetry boards - **to be fabricated and assembled** --Printed Circuit Board - **Not designed yet**
ScubeR Controller	-Arduino Nano	-Arduino Nano in-house - to be **purchased**

Manufacturing Plan Overview (Continued):

Subsystem:	Components :	Status:
Data Controller	-- Arduino Nano Every -- LIS3DH accelerometer -- LSM9DS1 IMU -- MicroSD breakout board -- Printed Circuit Board	--Arduino Nano Every - **purchased** --LIS3DH accelerometer - **in stock** --LSM9DS1 - **in stock** --MicroSD breakout board - **in stock** --Printed Circuit Board - Not designed yet
Artemis	--CubeSat Kit	--Artemis CubeSat Kit - **order to be received by January**

6.0 Testing Plan

Testing Plan: Mechanical Testing

D'Elle

Mechanical Testing flow:

At present WinCC has prototyped ScubeR and HonCC has prototyped Onboard Camera

2021 Dec => 2022 Feb.

Subsystem Critical Testing:

- Characterize Rocket Thrust in vacuum
- Demonstrate operation of ScubeR Release(photogate+ramp)
- Operation of stepper motor functions
- Perform stress analysis simulation for ScubeR
- Verify Release Velocity of Rocket
- Verify performance of cameras via simulated SubeR deployment

Subsystem Testing Review: FEB

Complete fabrication and assembly of ScubeR and Subsystems for ISTR

2022 Feb => 2022 Mar.

Integrated Systems Critical Testing:

- Open bench test
- Verify payload dimensions, weight, and Center of Gravity are within constraints.

Integrated Systems Testing Review: Mar.

2022 Jun <= 2022 Mar.

Make necessary modifications to mechanical layout. Complete payload assembly for testing

Environmental Testing:

- Closed bench test
- Weight and Balance test
- Shake/spin test
- No mechanical inhibits

Integration Readiness Review: Jun.

2022 Aug <= 2022 Jun.

Contingency for Action Items and potentially fatal failures.

Testing Plan: Electrical Testing

D'Elle

Electrical Testing flow:

Boards to be fabricated during winter

2021 Dec => 2022 Feb.

Subsystem Critical Testing:
- Verify the operation of PDB's provides correct voltages
- Verify operation of H-Bridge and Stepper Motor and Artemis
- Verify operation Cameras and Data Controller.

Subsystem Testing Review: FEB

Each subsystem verified and functional for ISTR

2022 Feb => 2022 Mar.

Integrated Systems Critical Testing:
--Open bench testing: Verify the assembly of electrical interfaces
--Collect data from each of sub-systems
--Simulate ScubeR release sequence

Integrated Systems Testing Review: Mar.

2017 Jun <= 2022 Mar.

Closed Bench testing prior to Envr. testing: Electrical testing with full payload assembly

Environmental Testing:
- Verify the integrity of electrical interfaces after each phase of environmental testing
- No electrical inhibits

Integration Readiness Review: Jun.

2022 Aug <= 2022 Jun.

Contingency for Action Items and system failures.

Testing Plan: Software Elements

Software Development flow:

Currently developing software internal to subsystems. Primary focus is on Flight CPU and Data Controller.

2021 Dec => 2022 Feb.

Subsystem Level Development:

- Data Controller
- ScubeR Controller (determines operation of stepper motor)

Subsystem Testing Review: FEB

Subsystem software tested and calibrated prior to ISTR.

2022 Feb => 2022 Mar.

Integrated Systems Development :

- Not Applicable (No data transfer between subsystem)

Integrated Systems Testing Review: Mar.

2022 Jun. <= 2022 Mar.

Integrated systems operational for full missions simulation

Testing/Debugging:

- Run Full flight simulations
- Collect and analyze data from simulations to verify integrity of operations.

Integration Readiness Review: Jun.

2022 Aug. <= 2022 Jun.

Contingency for Action Items and potentially fatal failures.

7.0 User Guide Compliance

User Guide Compliance: Summary

	Assets	Honolulu	Windward	Total
Weight?	~1.13 lbs	~ 1.14 lbs	~ 1.86 lbs.	~6.52 lbs excluding mounting hardware and including the pyaload deck
Dimensions?	Height = 110 mm Area 100 x 100 mm	4.92" x 4.49" X 3.11"	Height = 40mm Base = 250 x 40mm	Within space
Within 1 inch keep out zone?	yes	yes	yes	yes
Deployments?	No	No	Yes	Yes, speed is under 1 inch/sec
ADC Lines?	No	No	No	0
Async/Parallel?	No/No	No/No	Yes/No	Yes/No
GSE Lines?	No	No	Yes	1
Power/Timer Events?	Yes, GSE-1 @ T= -200	TE-1 @ T= 0.1+	TE-1 @ T= 0.1+ TE-R @ T=0.1 +	TE-1 @ T= 0.1+ TE-R @ T=0.1+ GSE-1 @ T = -200
Understand CG Requirement?	Yes	Yes	Yes	Yes
High Voltage?	No	No	No	No
Using < 0.5 Ah	Yes	Yes	Yes	Yes
Hazardous Procedures?	No	No	No	No
RF?	No	No	No	None
Bottom of Deck Plate Flush?	Yes	Yes	Yes	Yes
US Persons for whole team?	Yes	Yes	Yes	Yes
ITAR? Export Control Hardware?	Compliant,none	Compliant, none	Compliant, none	Compliant, none

Telemetry Pin Assignment

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)	Status Update for controllers
33	RS-232 GND (TP2)	Status Update for controllers
34	N/C	N/C
35	N/C	N/C
36	Ground	N/C
37	Ground	N/C

Power Pin Assignment

Power Pin	Function	Intended Use
1	GSE 1	Turn on Artemis Raspberry Pi at T = -200 sec
2	Timer Event Redundant (TE-RA)	Failsafe for turning on Power Distribution Board at T = 0.1 sec
3	Timer Event Redundant (TE-RB)	N/C
4	Timer Event 1 (TE-1)	Turn on Power Distribution Board at T = 0.1 sec
5	GND	GSE 1
6	GND	TE-1
7	GND	TE-RA
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

8.0 Project Management Plan (PMP)

Project Imua Budget: Mission 10

rev 12-3-21			
UHCC Project Imua Mission 10: RS-X 2022			
Item	**Budgeted**	**Expended/ Encumbered**	**Balance**
Student Fellowships (Fall/Spring/Summer)	37,500	7,500	30,000
Student Summer Travel Stipend	12,330	0	12,330
Mentor Summer Travel	10,357	0	10,357
Supplies	7,000	0	7,000
RockSat-X 2022 launch fee deposit	2,000	2,000	0
RockSat-X 2022 launch fee 1st Install	6,000	0	6,000
RockSat-X 2022 launch fee 2nd Install	6,000	0	6,000
Total	81,187	9,500	71,687

Jared

Team Mentors

revised 10-30-21

University of Hawai'i Community College (UHCC) Project Imua Mission 10		
RS-X 2022 Team Mentors & Advisors		
Institution	**Mentor/Advisor**	**Cell Phone**
Windward CC		
Project Manager (PI)	Joseph Ciotti	808-225-5637
Faculty Mentor (Co-I)	Jacob Hudson	808-347-8246
Honolulu CC		
Faculty Mentor (Co-I)	Shidong Kan	808-724-1533
Faculty Advisor	Mevan Ranasinghe	862-803-0760
Faculty Advisor	Kerry Tanimoto	808-295-3475
Staff Advisor	Helen Rapozo	808-367-3684
Assets High School		
Faculty Mentor	Jacob Hudson	808-347-8246
UH Manoa		
Advisor—HSGC/HSFL Director	Luke Flynn	808-277-7218
Advisor—HSGC/ Program Coordinator/ Executive Director	Marcia Rei Nii	808-384-4684

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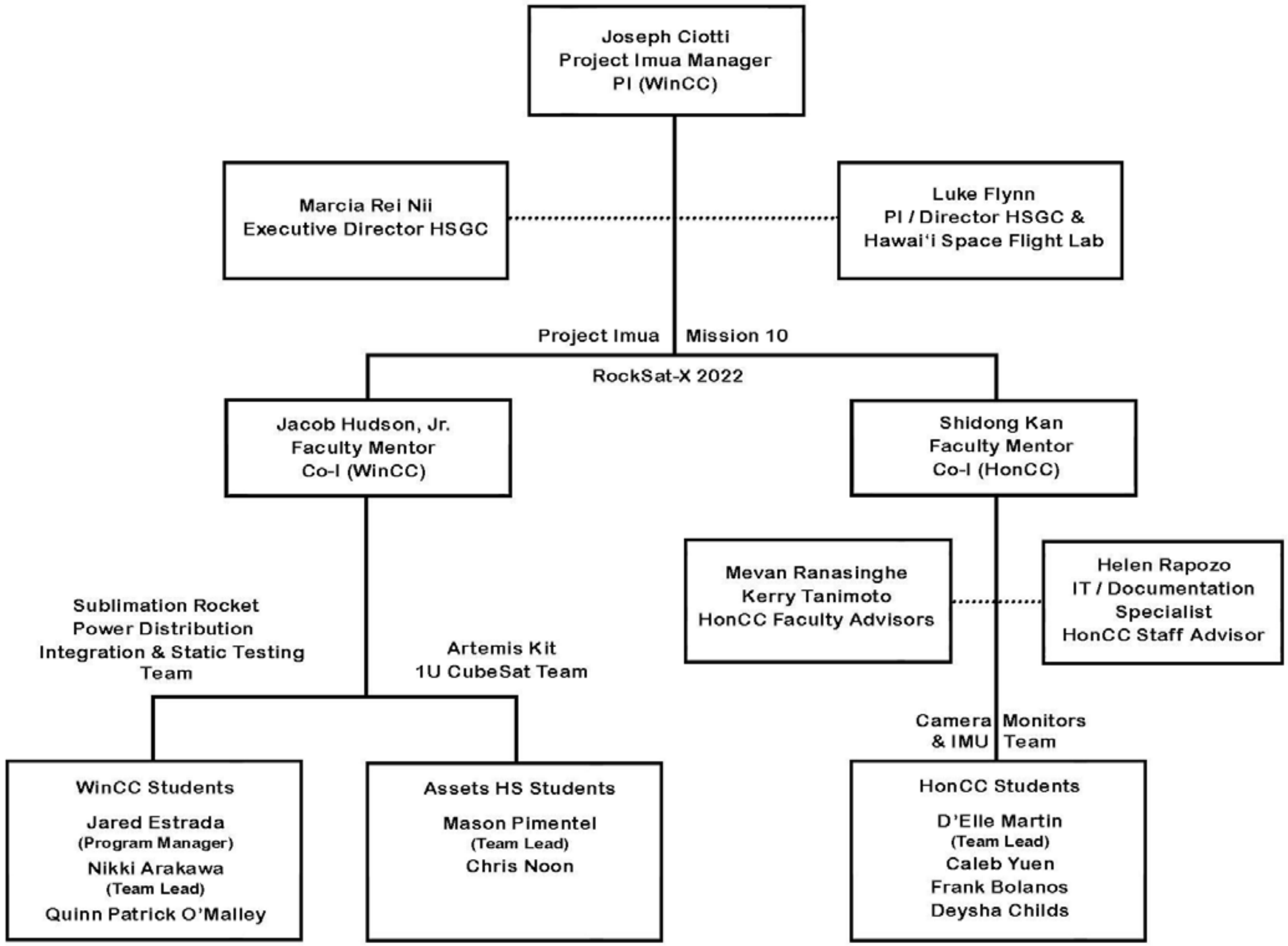
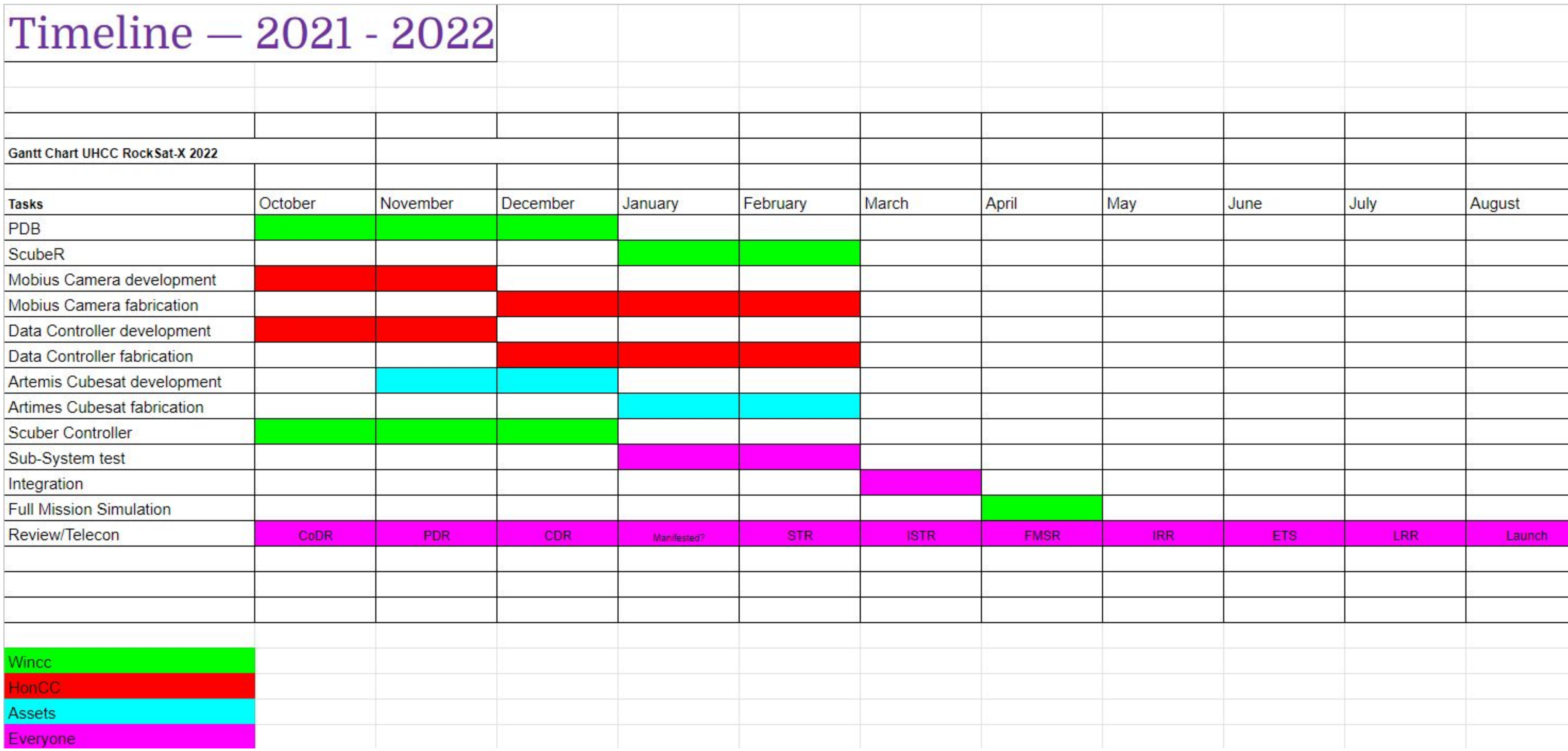
Team Organization



Schedule



Timeline — 2021 - 2022
Gantt Chart UHCC RockSat-X 2022
Tasks
October
November
December
January
February
March
April
May
June
July
August
PDB
ScubeR
Mobius Camera development
Mobius Camera fabrication
Data Controller development
Data Controller fabrication
Artemis Cubesat development
Artimes Cubesat fabrication
Scuber Controller
Sub-System test
Integration
Full Mission Simulation
Review/Telecon
CoDR
PDR
CDR
Manifested?
STR
ISTR
FMSR
IRR
ETS
LRR
Launch
Wincc
HonCC
Assets
Everyone

Jared

Team Availability

HST	MST	Monday	Tuesday	Wednesday	Thursday	Friday
4:00 AM	7:00 AM	3	4	3	4	4
5:00 AM	8:00 AM	2	4	2	1	1
6:00 AM	9:00 AM	1	4	4	4	3
7:00 AM	10:00 AM	2	1	1	4	1
8:00 AM	11:00 AM	2	1	1	4	1
9:00 AM	12:00 PM	4	4	4	4	4
10:00 AM	1:00 PM	4	4	4	4	4
11:00 AM	2:00 PM	4	4	4	4	4
12 noon	3:00 PM	4	4	4	4	4
1:00 PM	4:00 PM	4	4	4	4	4
2:00 PM	5:00 PM	4	4	4	4	4

Team Name/School: UHCC Project Imua 10

Fall RS-X Team Availability Matrix. CDR Week of Dec 6 [CDR: Dec 7]

PLEASE USE MOUNTAIN TIME ZONE TIMES

Please Place priority levels for times you are availible. This is done by simply typing a 1,2,3, or 4 in each clear box.

Example	1	2	3	4
	Highest Priority			Lowest Priority

NOTE: Mainland ends Daylight Saving Time on **November 7, 2021**. Time listed in the second column is **MDT.**
HST is currently 4 hours behind MDT.

Team Contact Matrix

revised 12/3/21

Team Name/School: UHCC Project Imua Mission 10							
Fall 2021 RS-X Contact Matrix							
Role	**Name**	**Day Phone**	**Cell Phone**	**Receive Texts?**	**Email**	**Citizenship**	**Add to mailing list?**
Project Manager (PI)	Joseph Ciotti	808-236-9111	808-225-5637	yes	ciotti@hawaii.edu	U.S.	yes
Windward CC							
Faculty Mentor (Co-I)	Jacob Hudson	808-347-8246	808-347-8246	yes	jacobh@hawaii.edu	U.S.	yes
Student (Program Manager)	Jared Estrada	719-440-0941	719-440-0941	yes	jestrada7125@gmail.com	U.S.	yes
Student (Team Lead)	Nikki Arakawa	808-450-4294	808-450-4294	yes	nikkia@hawaii.edu	U.S.	yes
Student	Quinn Patrick O'Malley	808-738-2618	808-738-2618	yes	qomalley@hawaii.edu	U.S.	yes
Honolulu CC							
Faculty Mentor (Co-I)	Shidong Kan	808-845-9499	808-724-1533	yes	shidong@hawaii.edu	U.S.	yes
Faculty Advisor	Mevan Ranasinghe	862-803-0760	862-803-0760	yes	mevanr@hawaii.edu	U.S. green card	yes
Faculty Advisor	Kerry Tanimoto	808-845-9154	808-295-3475	yes	kerryt@hawaii.edu	U.S.	yes
Staff Advisor	Helen Rapozo	808-845-9202	808-367-3684	yes	rapozo@hawaii.edu	U.S.	yes
Student (Team Lead)	D'Elle Martin	808-358-5743	808-358-5743	yes	dellej@hawaii.edu	U.S.	yes
Student	Caleb Yuen	808-476-8018	808-476-8018	yes	yuenc734@hawaii.edu	U.S.	yes
Student	Frank Bolanos	808-271-3405	808-271-3405	yes	fbolanos@hawaii.edu	U.S.	yes
Student	Deysha Childs	808-375-3331	808-375-3331	yes	dchilds7@hawaii.edu	U.S.	yes
Assets High School (Mentor: Jacob Hudson)							
Student (Team Lead)	Mason Pimentel	808-726-1616	808-726-1616	no	mason_pimentel@assets-school.org	U.S.	yes
Student	Christopher Noon	808-423-1356		no	christopher_noon@assets-school.org	U.S.	yes

Risks/Concerns

- **Concern 1:** Sublimation Rocket may not clear CarRoLL before re-entry.
  - **Mitigation:** Use of worm gear will guarantee clearing of CarRoLL section.
  - Additional vacuum pressure test planned.

- **Concern 2:** The Specific Impulse of the sublimation propellant is unknown, resulting in an uncertainty of rocket's maximum reaction mass.
  - **Mitigation:** Once a prototype ScubeR is constructed, it will be loaded with varying concentrations of different sublimation propellant and tested inside a vacuum chamber at the Center for Aerospace Education.

- **Concern 3:** Mobius camera data retrieval damage (Still Pictures & Video)
  - **Mitigation:** Hammond box for heat & water proofing.

Conclusion

- Mission deserves to fly because:
  - Provides proof-of-concept and baseline measurements for innovative low-thrust venier rockets.
  - Provides early college students with high-tech NASA-focused design and production experience
  - Proof of Concept Flight for Artemis CubeSat Kit

- Next steps for your team to get to STR:
  - Begin assembly of **ScubeR** body.
  - **Mobius camera system:** Take apart the cameras, Mount circuit boards in Hammond box, configure settings.
  - Complete arrangement, construction, testing of **Power Distribution Board**.
  - Complete construction and testing of **Artemis CubeSat**.
  - **Flight Board**: integrate driver code and test stepper motor execution.
  - Connect and integrate **Mobius camera system** with data controller.
  - **Data controller:** Build flying units to test on model rockets.

Acronyms

HonCC – Honolulu Community College

WinCC – Windward Community College

UHCC – University of Hawai‘i Community Colleges

HSGC – Hawai‘i Space Grant Consortium

HSFL – Hawai‘i Space Flight Lab

ScubeR – Super Simple Sublimation Rocket (S^3R)

PDB - Power Distribution Board

Special Names

Mobius ActionCam – On-board cameras

ScubeR Controller - Arduino Nano Every controlling the Stepper Motor

Data Controller - Contains Motion Sensors and Data Storage