Project Imua
Mission 10

Preliminary Design Review

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- Section 1: Mission Overview
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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 cameras (HonCC)

Secondary Experiment

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

  (Assets School/WinCC/HSFL)

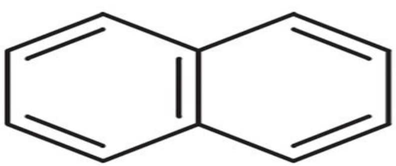
Theory & Concepts: Sublimating Material

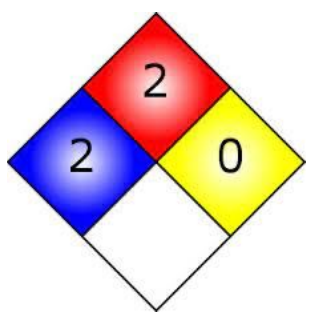
Naphthalene

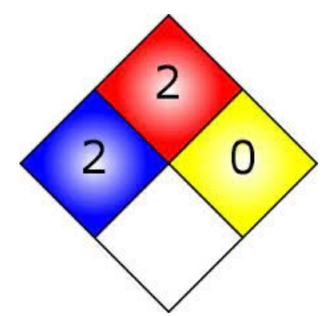
- Formula: $C_{10}H_8$
- Sublimates at: 0.338 Pa
- Molar Mass: 128.1 g/mol
- Density: 1.14 g/cm^3
- Boiling Pt: 218° C
- Melting Pt: 80.3° C

Camphor

- Formula: $C_{10}H_{16}O$
- Sublimates at: 166 Pa
- Molar Mass: 152.2 g/mol
- Density: 0.99 g/cm^3
- Boiling Pt: 209° C
- Melting Pt: 175° C





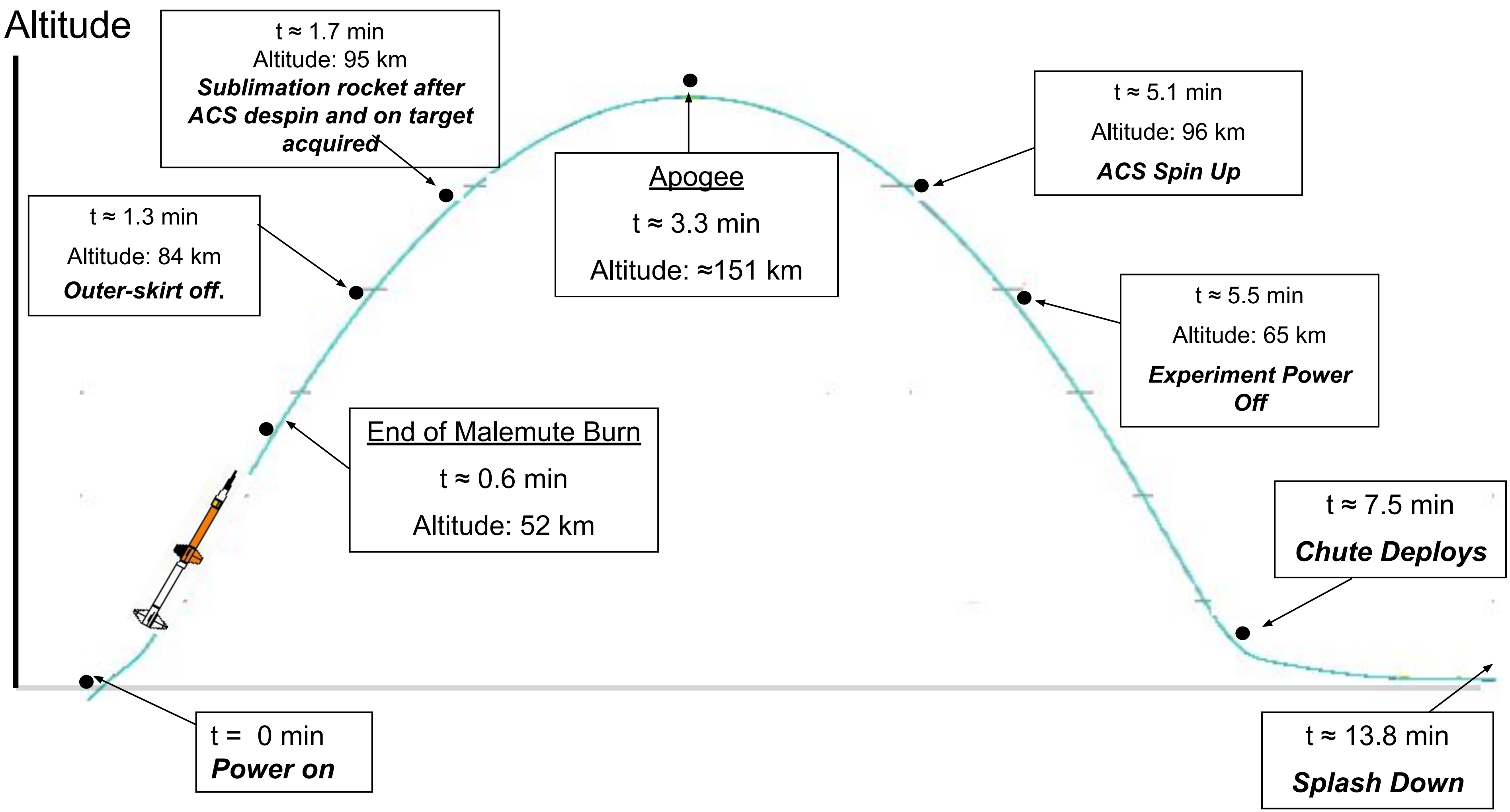


Theory & Concepts Artemis CubeSat Kit

- 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 be the most basic functionality of a small spacecraft.
- https://www.hsfl.hawaii.edu/artemis-cubesat-kit-2/

Concept of Operations

Jared



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

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 then 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, $\dot{R}$.

$$P = \frac{Nk_BT}{V} = (\dot{R}\frac{N_A}{\mathfrak{M}}\Delta t)(\frac{k_BT}{V})$$

Where $\mathfrak{M}$ is the molar mass of the sublimating mass, N_A is Avogadro's number, and Δt is the elapsed time from ScubeR release. The rate of mass loss is the ratio of the throat area A_{th}, to the total surface area of the sublimation chamber $\dot{m} = \left(\frac{A_{th}}{A}\right)\dot{R}$.

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

Using the current design dimensions for ScubeR, the first term is effectively zero and the second term yields an increase in thrust of 4.5 mN per second from deploy.

Expected Results (On-board Camera Systems)

Capture & Store Imagery of ScubeR Deployment

- Determine ScubeR Distance versus Time

- Determine ScubeR Acceleration

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 by ScubeR deployment
    - Monitor small rotations (±245 dps)

Minimum Success Criteria

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 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 & receive data at Wallops Ground Station.
Demonstrate operation of 3-axis accelerometer.	Save data to SD card on deck plate & receive data at Wallops Ground Station.
Proof of Concept flight for modified Artemis CubeSat Kit.	Demonstrate Artemis CubeSat onboard utilities

Top Level Requirements (ScubeR)

Nikki

Requirement	Verification Method	Description
Scuber shall be oriented along the eastern edge of the hoizon	**Test**	Orientation will be confirmed using our visual capture devices
Raspberry Pi shall start up on T = -180 using GSE connections for pre flight	**Test**	Preliminary testing will be done to confirm Raspberry Pi‘s 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 week.

Nikki

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.

Nikki

Top Level Requirements (Data Controller)

Requirement	Verification Method	Description
IMU and Accelerometer shall power on and save files to SD card and send data to Wallops Ground Station before shutdown.	**Test**	The IMU will measure small vibrations as well as small rotations created by ScubeRs deployment. The additional Accelerometer will measure high vibrations.
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 (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.

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 power requirements are overburdened, an Arduino Nano can be used to supply H-Bridge control instead of the Raspberry Pi

2.0 System Overview

PDR Presentation Content

- Section 2: System Overview
  - Science Design Overview
  - Engineering Design Overview
  - Top Level Requirements
  - Functional Block Diagram
  - Description of Partnerships – with sponsors/collaborators (i.e. NASA or company)
  - User Guide Compliance
  - Special Requests from Rocket/Wallops

Top Level Requirements

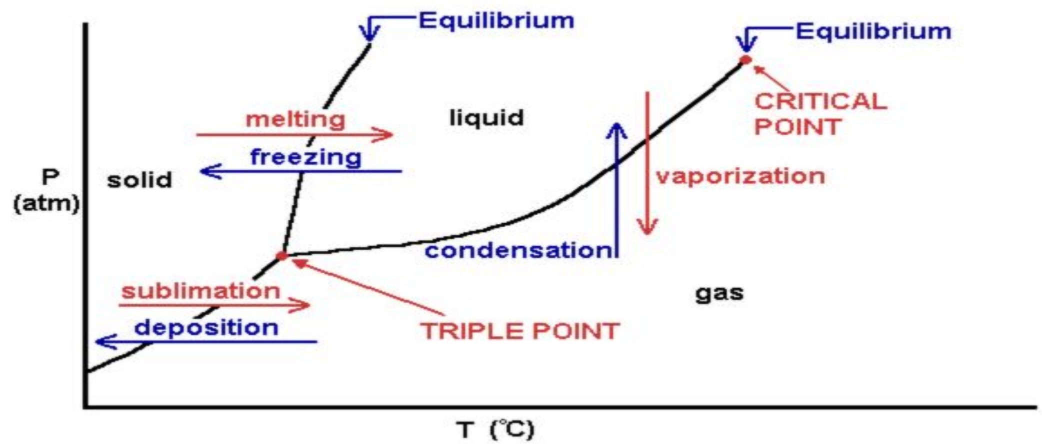
- For launch we require an orientation for our sublimation rocket that is along the eastern edge of the horizon.
- Our visual capture systems functions successfully.
- Stepper Motor must execute its script successfully.
- ScubeR must be released with a minimum velocity of approximately 0.4 inch/s (~1 cm/s) in order to clear the CarRoLL section before ACS spin up commences.
- Our power conditioning board must be fully functional in order to supply appropriate voltages to each subsystem.
- Our launch trigger, TE-1, must be triggered accurately.

Science Design Overview (ScubeR)

Super Simple Sublimation rocket, ScubeR

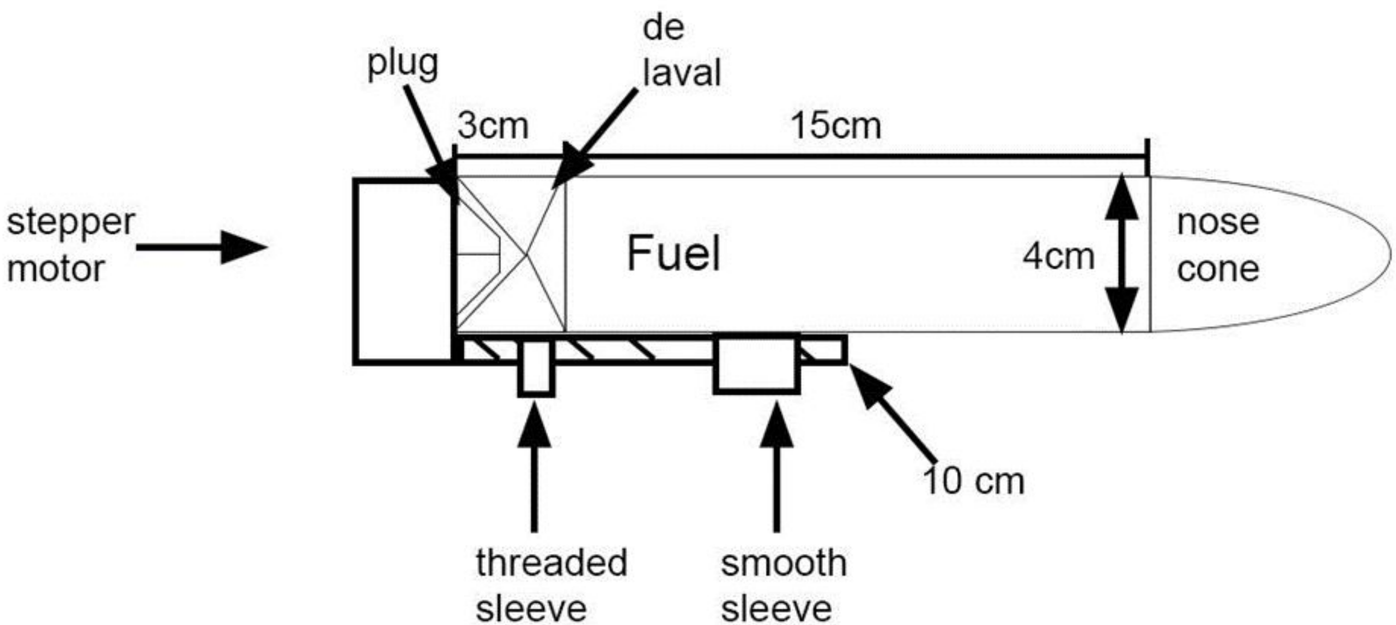
Sublimation Fueled Rocket:

The sublimation of camphor at low pressure will act as propellant for the rocket, ScubeR. When the camphor 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)

Engineering Design Overview (ScubeR)

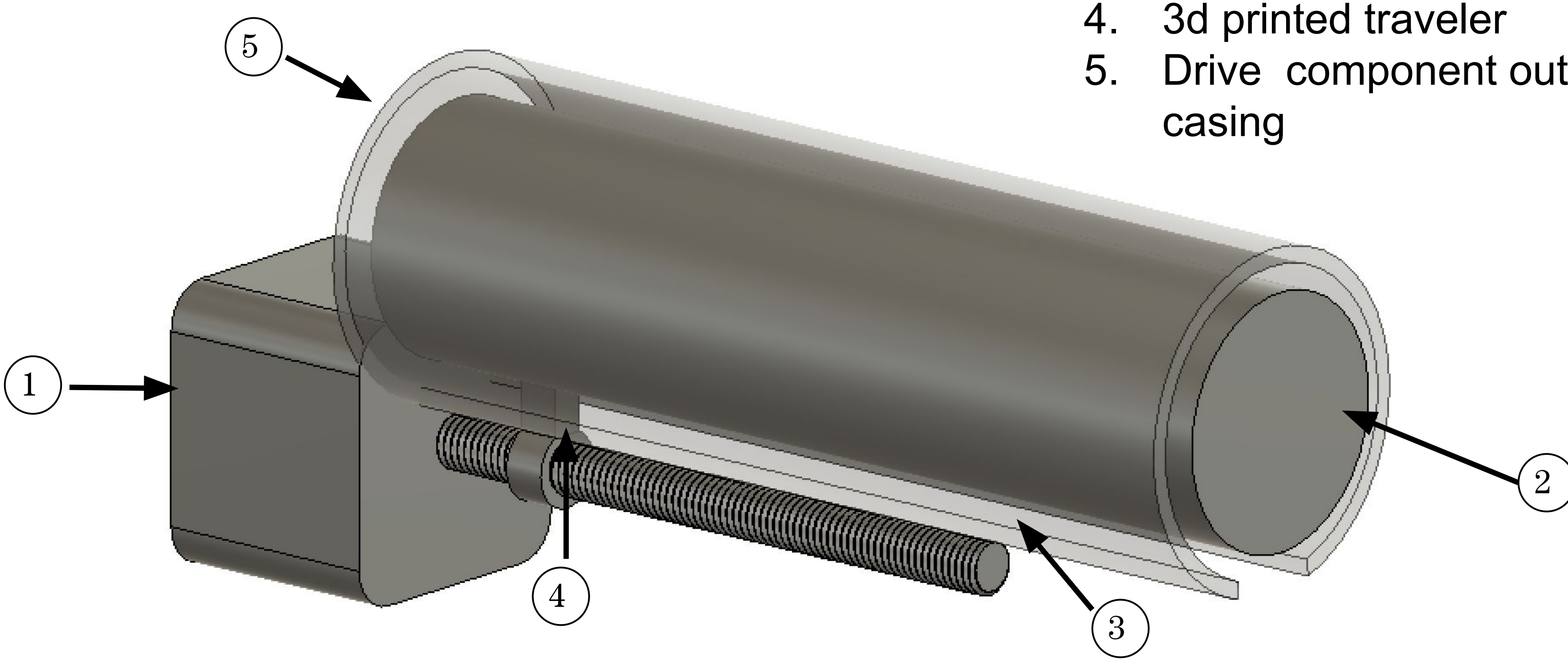


- Lulzbot Taz 5 (3D Printer): Fabrication of rocket (ScubeR)
- NEMA 17 Stepper Motor
- Compressed Solid Camphor

Engineering Design Overview (ScubeR)

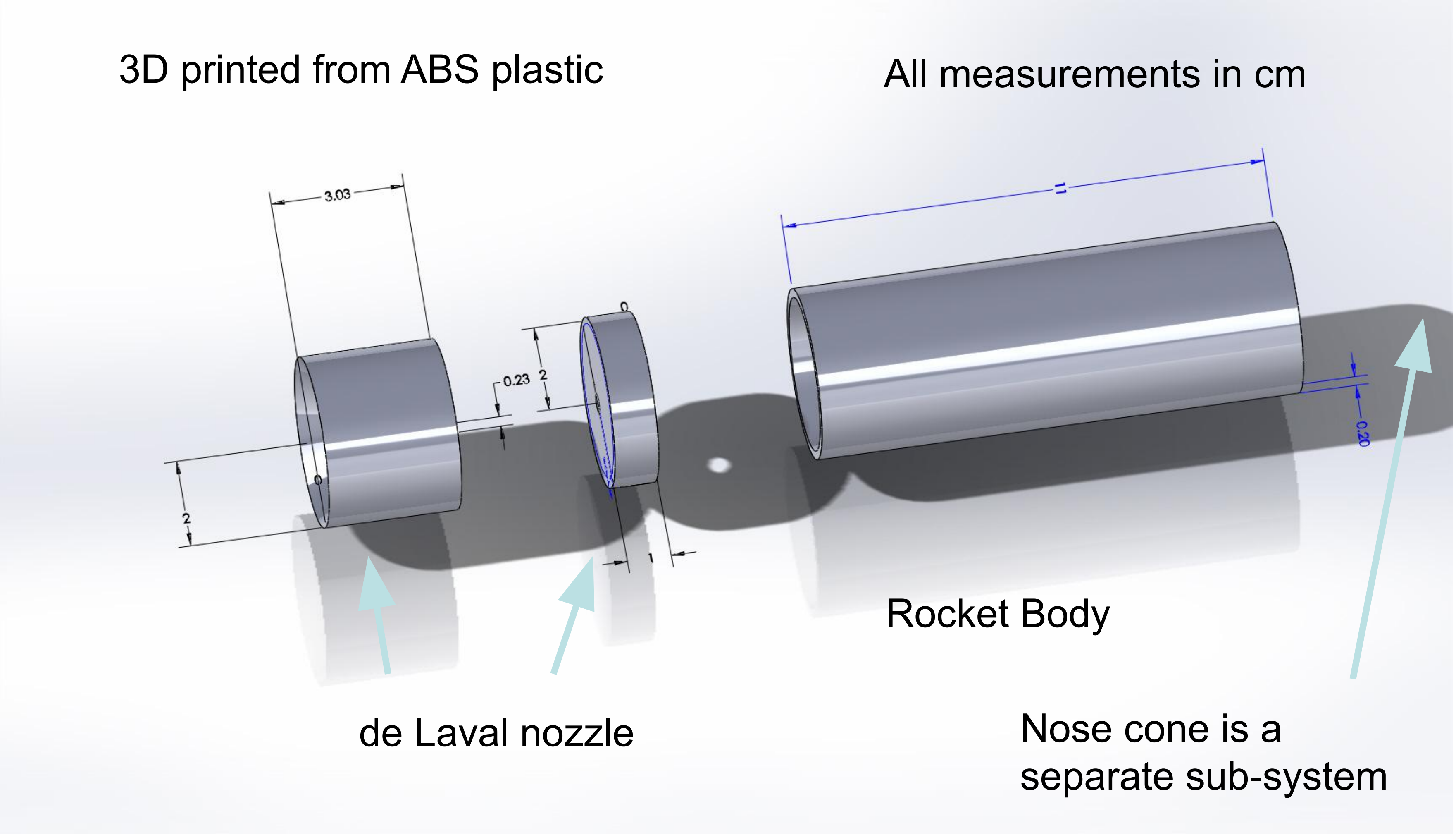
Nikki

1. Stepper motor
2. ScubeR
3. Helical Lead Screw
4. 3d printed traveler
5. Drive component outer casing



Engineering Design Overview (ScubeR)

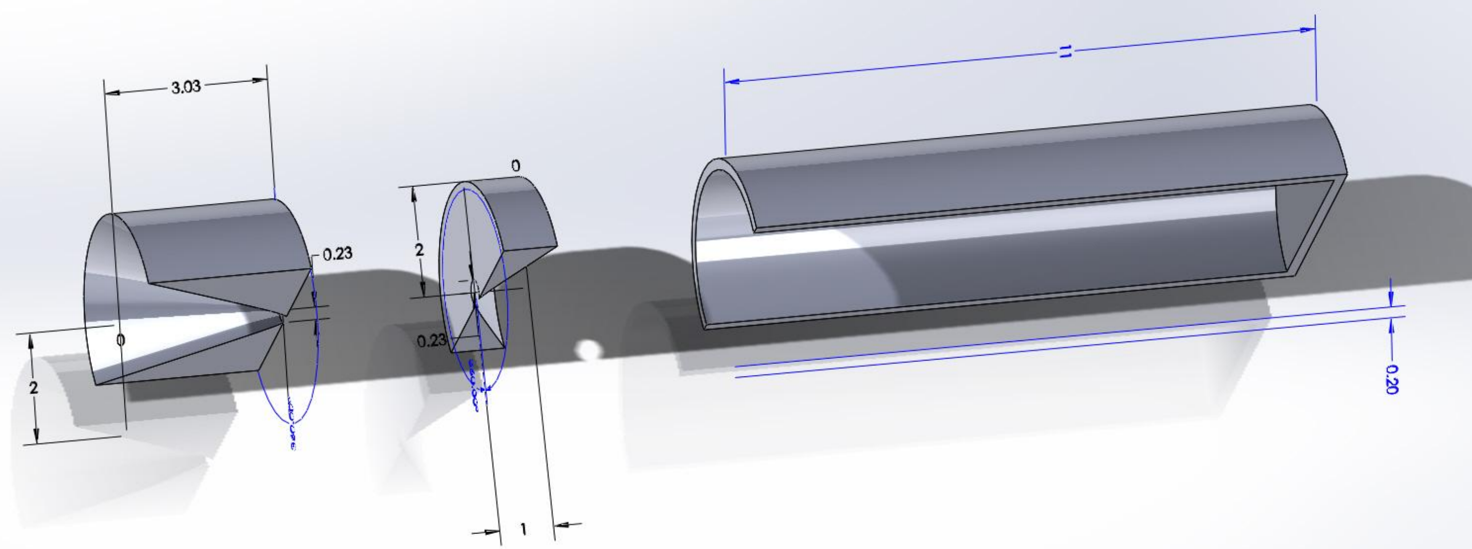
Nikki



Engineering Design Overview (ScubeR)

Nikki

Cross section view of ScubeR



Engineering Design Overview (ScubeR)

Nikki

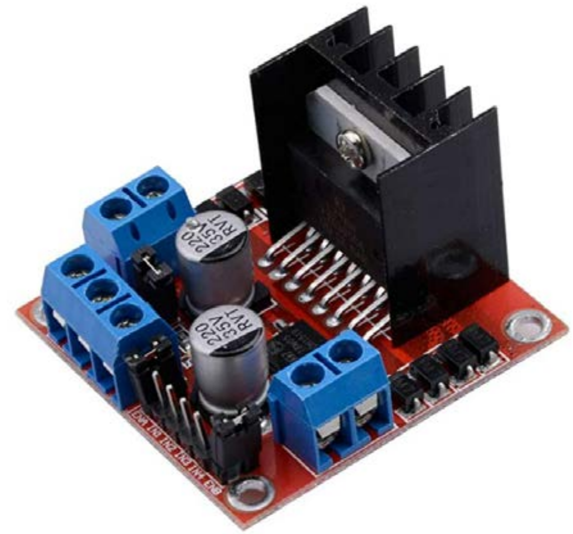
- NEMA 17, 2 Phase stepper motor
- 2 Phase, 1.9V per phase, 4 wire
- Lead screw to drive scuber out of CarRoLL
- Driven by H bridge

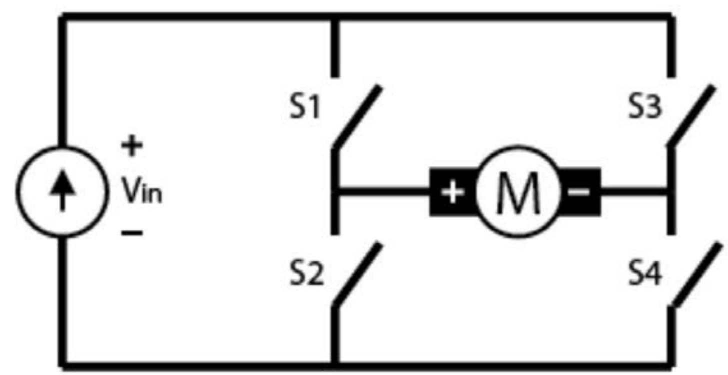
Nikki

Engineering Design Overview (H-Bridge)

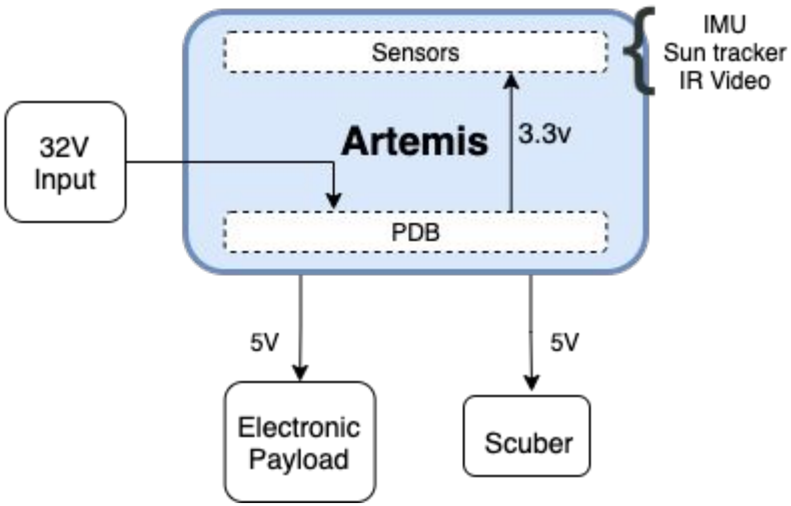
- Power
  - 5V DC
- Size
  - Dimensions - 1.75” x 1.75” x 1”
  - Weight - 1.06 oz
- Motor Drive Capacity
  - 12V max
  - 2A max single bridge

Needs motor control commands from Raspberry pi.





Engineering Design Overview (Artemis/PDB)



- Power
  - 32V input from main input
- Size
  - Dimensions - 10cm x 10cm x 11cm
- Internal Component
  - Artemis sensor components
  - PDB
  - Distribute power

Science Design Overview (Mobius Cameras)

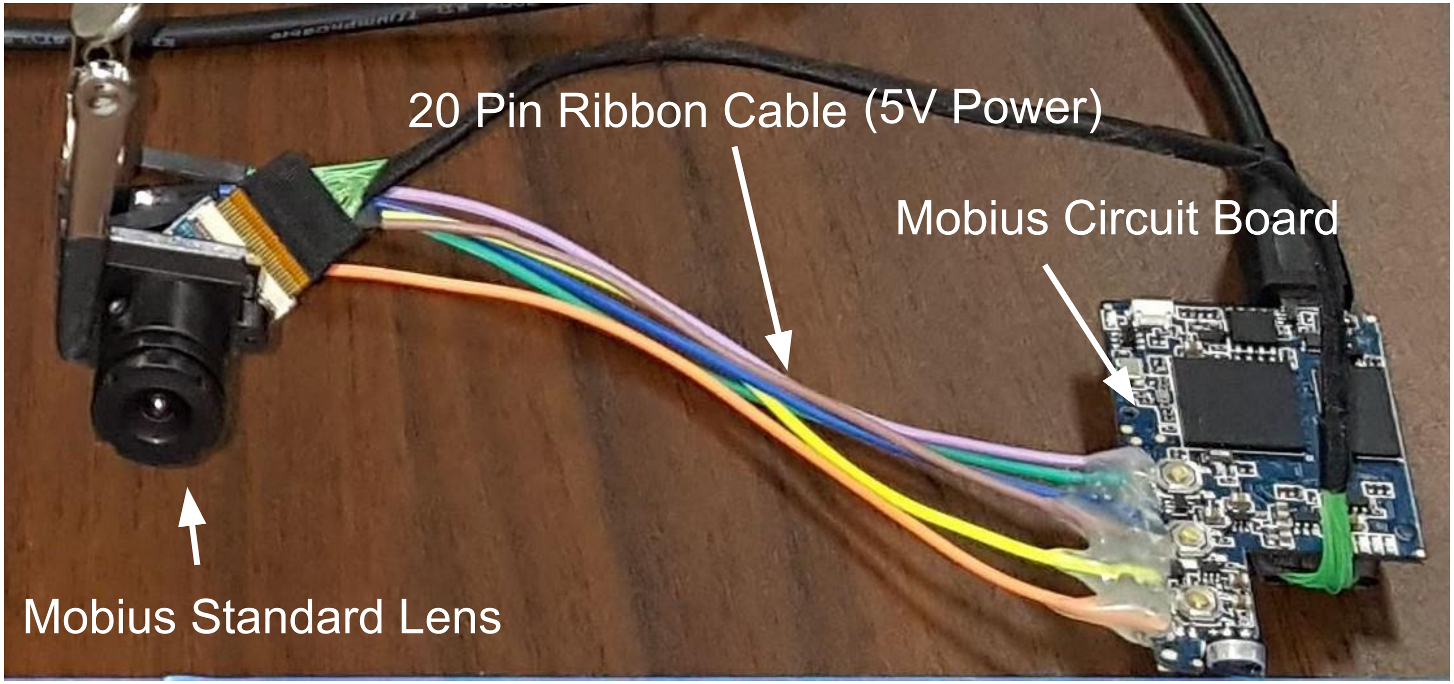
Caleb

- Two onboard Mobius cameras will record imagery of ScubeR deployment.
  - Camera 1 will record time-lapse photos.
  - Camera 2 will record video.
- Data from each camera will be stored on SD cards on Mobius circuit boards.
- Cameras will be housed in a Hammond Box.
- Imagery will be used to calculate the distance and velocity of ScubeR deployment.

Engineering Design Overview (Onboard Cameras)

Caleb

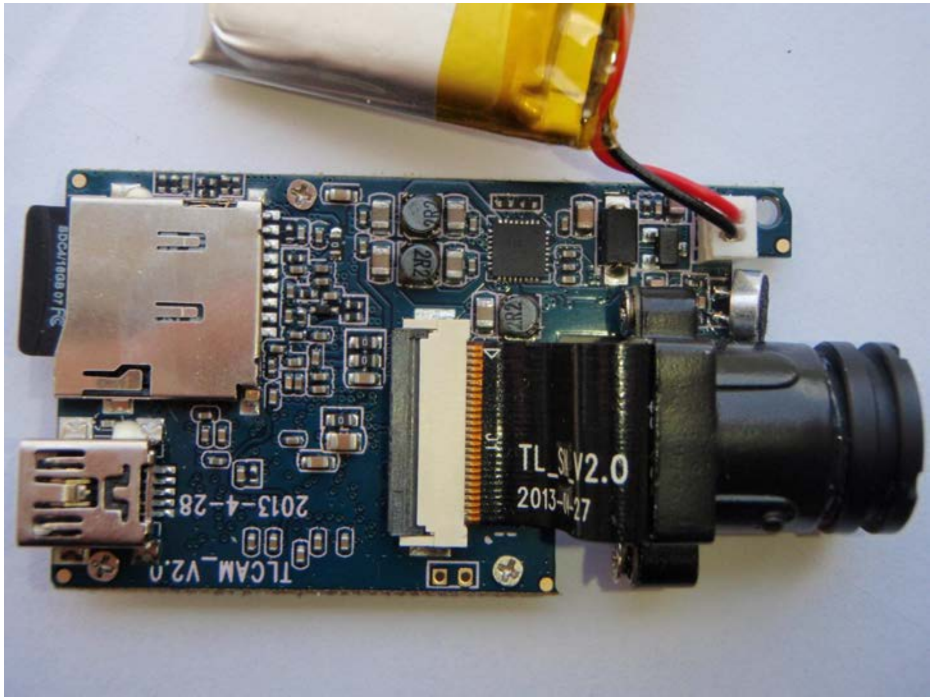
Pictured: one of two Mobius camera systems outside of housing



Mobius Pro Mini Action Camera Full HD

Caleb

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



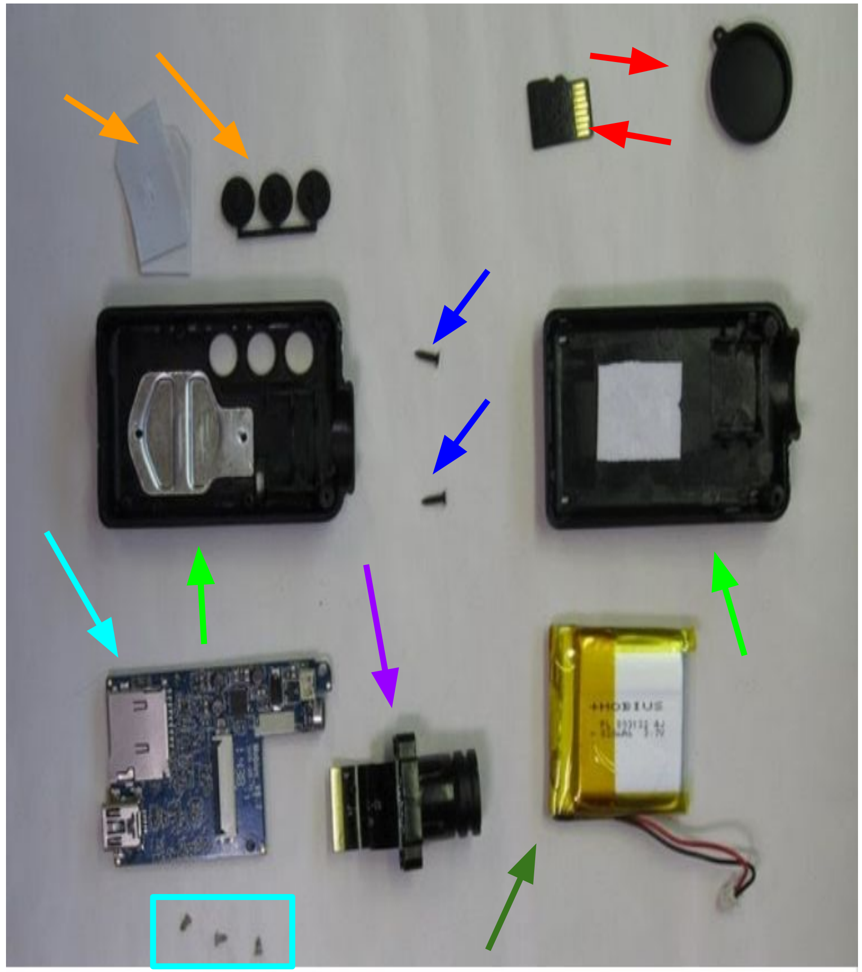
Teardown of Mobius Pro Mini Action Camera

Caleb

Step 7: Remove the interface buttons & the circuit board backing material.

Step 6: Remove 3 screws securing the circuit board to the casing.

Step 5: Remove the battery plug with a pair of small needle nose pliers



Step 1: Removing Exterior Peripherals

Step 2: Remove both screws on the bottom of the case.

Step 3: Pull the casing apart near the lens.

Step 4: Removing the Camera Module

Science Design Overview (Data Controller)

- IMU & Accelerometer
  - IMU Accelerometer set to ±2g to monitor low vibrations
  - 2^{nd} Accelerometer set at ±16g to monitor high vibrations
  - IMU gyroscope set to ±245 dps to monitor low rotations
- Acceleration data will be used to see if ScubeR was deployed at total zero acceleration
- Data from each sensor will be stored on MicroSD & be sent to Wallops Ground Station
- Housed in Hammond Box

Engineering Design Overview (Onboard IMU & Accelerometer)

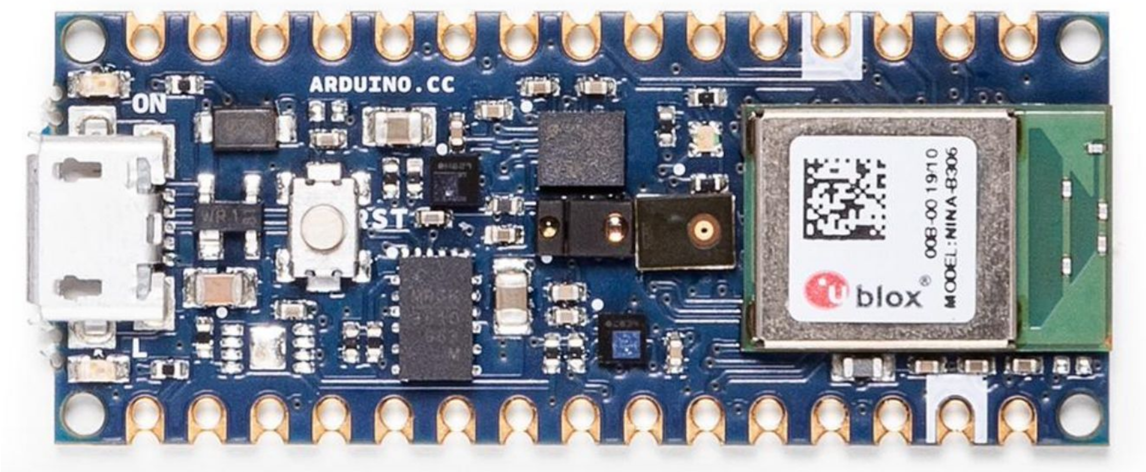
D'Elle

Adafruit LSM9DS1 IMU & LIS3DH Accelerometer

- Power - 3.3-5V 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 IMU & Accelerometer)

D'Elle



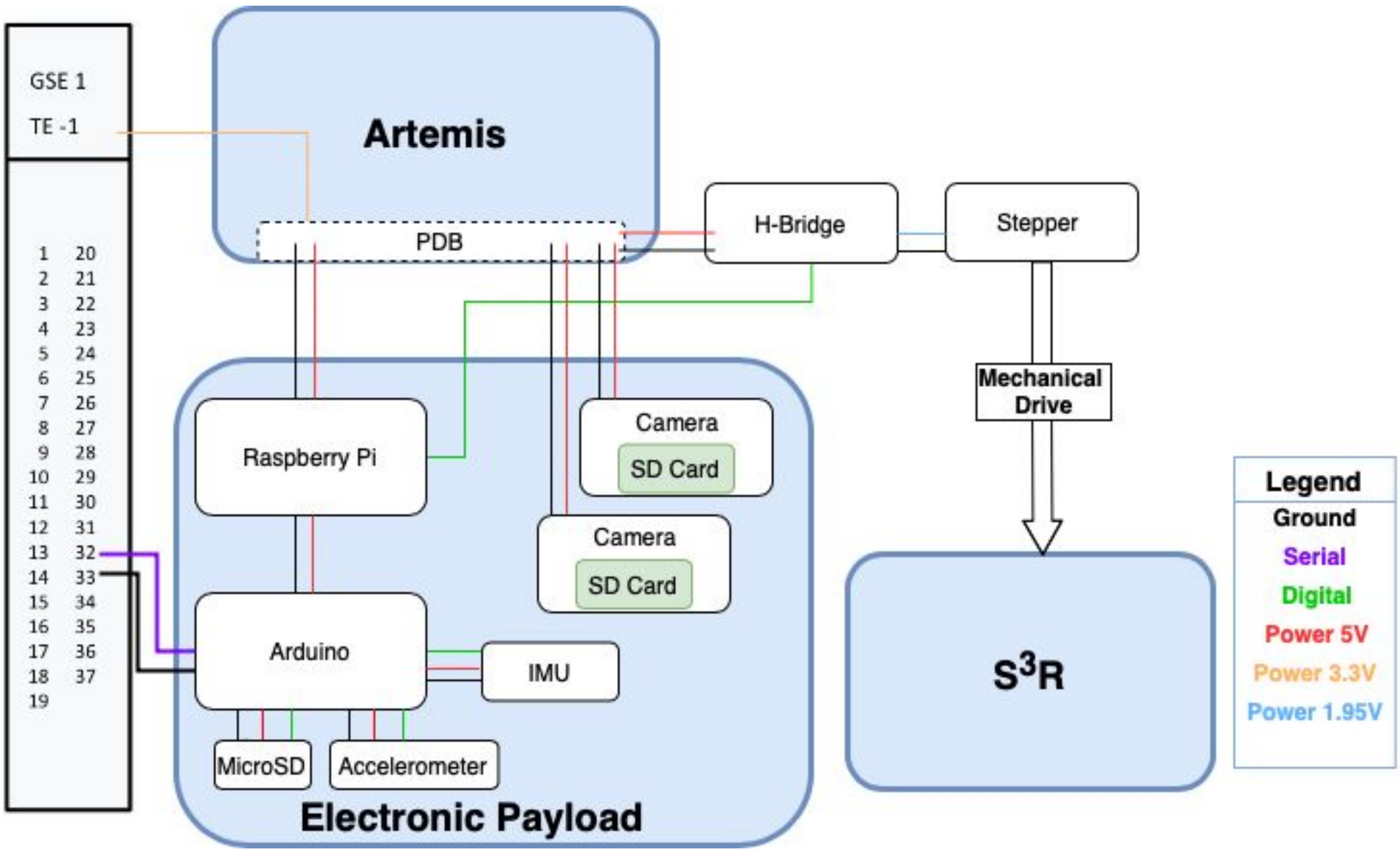
5 Sensors

1. IMU
2. Humidity/Temperature
3. Barometer
4. Microphone
5. Proximity

Arduino Nano 33 BLE Sense

- **Power** - 3.3V DC
- **Dimensions** - 45 x 18mm
- **Weight** - 5g (with headers)

Functional Block Diagram



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:

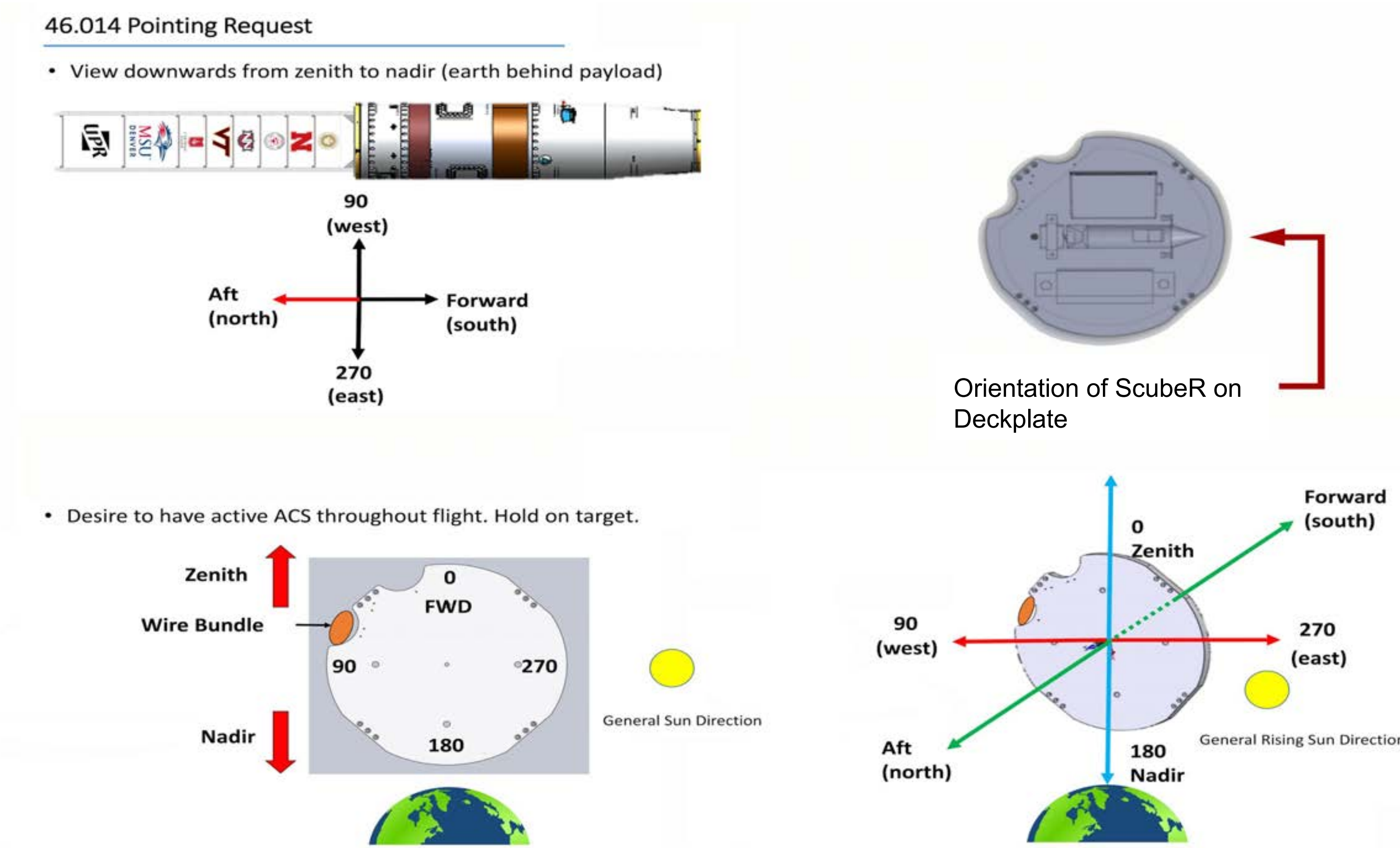
Hawaii Space Grant Consortium (HSGC) for the funding of Project Imua.

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

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

System Overview: Special Requests

Our only special request for WFF is to have an orientation of the release of ScubeR along the eastern edge of the horizon.



Jared

User Guide Compliance: Summary

	Assets	Honolulu	Windward	Total
Weight?	800g	53.5g-Mobius Cam ~200g-data controller	~ 700 g.	~1753.5g excluding mounting hardware
Dimensions?	Height = 110 mm Area 100 x 100 mm	H=17mm x 85mm x 56mm Unknown for data controller at this time	Height = 40mm Base = 250 x 40mm	Within space
Within 1 inch keep out zone?	yes	yes	yes	yes
Deployments?	No	No	Yes	Yes
ADC Lines?	No	No	No	0
Async/Parallel?	No	Yes/No	No/No	No/Yes/No
GSE Lines?	No	No	No	0
Power/Timer Events?	No	TE-1 @ T= 0.1+	TE-1 @ T= 0.1+	TE-1 @ T= 0.1+
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	No	Yes	No
ITAR? Export Control Hardware?	Compliant,none	Compliant, none	Compliant, none	Compliant, none

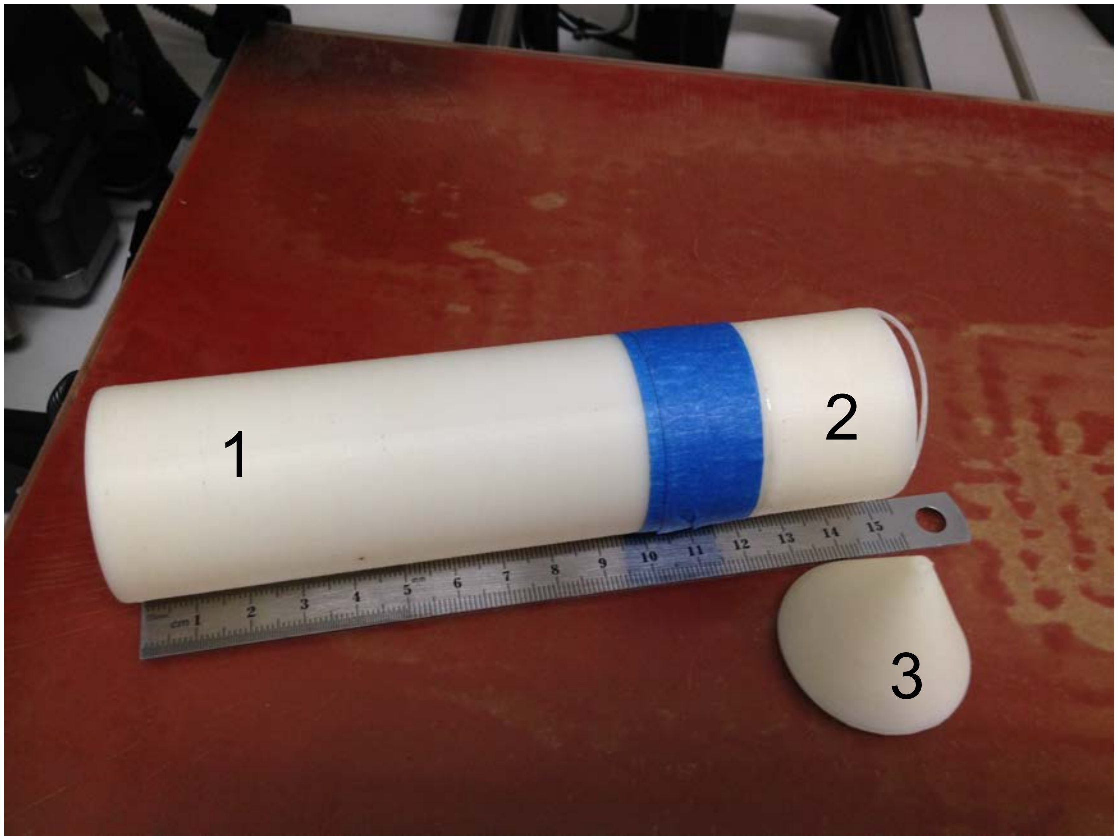
3.0 Subsystem Design

PDR Presentation Contents

- Section 3: Subsystem Design
  - Structures
  - Power
  - Science
  - Command and Data Handling
  - Software
  - Other

Subsystem Design: Structure (ScubeR)

Nikki



ScubeR is 3D printed with ABS plastic.

ScubeR consists of 4 parts

1. Fuselage
2. de Laval Nozzle
3. Plug
4. Fuel: Camphor

$C_{10}H_{16}O$

Subsystem Design: Structure - Mechanical Interface (ScubeR)

Nikki

Stepper Motor

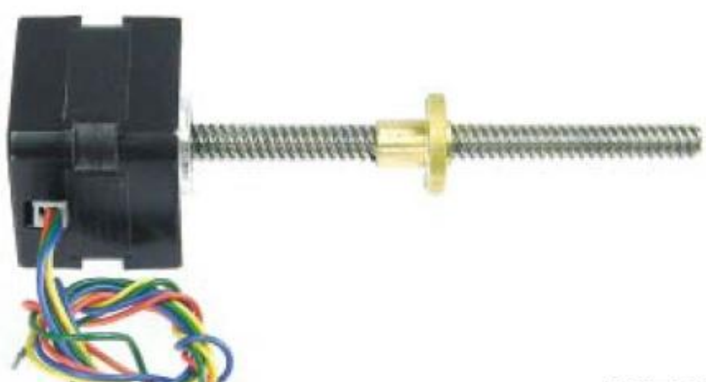
31564-MS

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

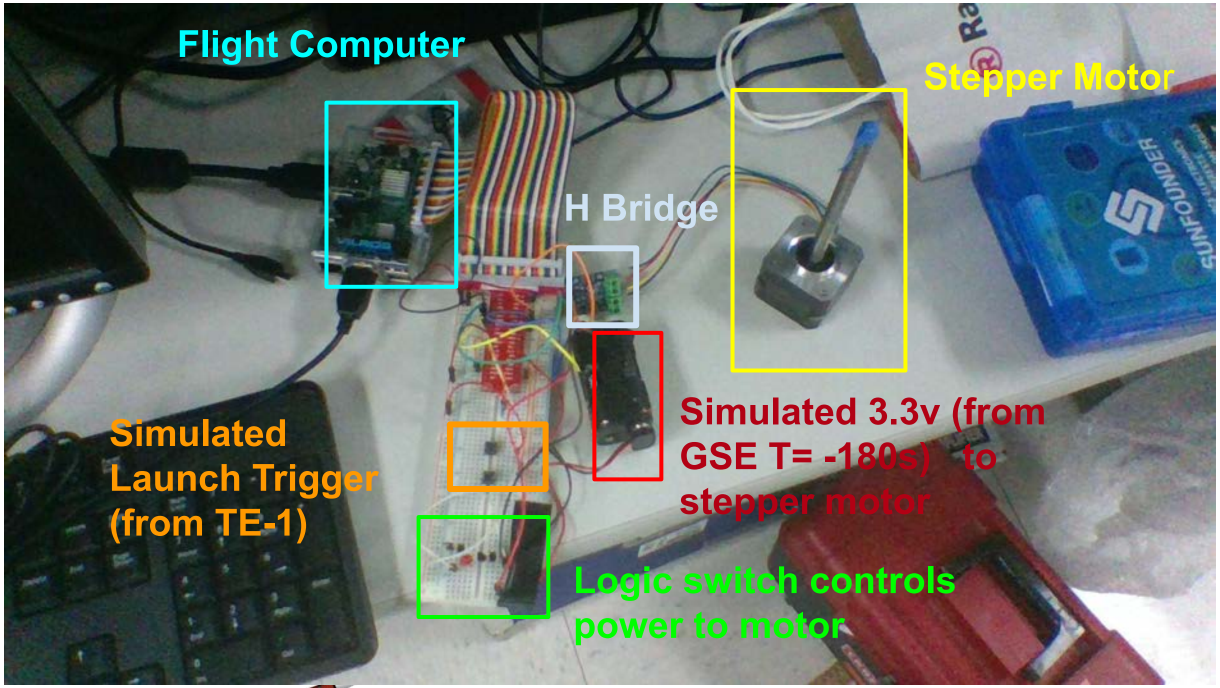


Subsystem Design: Structure - PDB (ScubeR)

- 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:
  - 0.396 oz
- Physically adjustable power limitation

Subsystem Design: Structure (Flight Computer)

- Microcontroller: Raspberry Pi 2 model B
  - size: 85.5mm x 55mm X 15mm
  - weight: 45g (1.6 oz)
  - power: 5v from GSE @ T= -180s



Subsystem Design: Science (ScubeR)

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 Naphthalene

- Triple Point at 202 K and 51.44 kPa
- Expected to sublimate at 166 Pa at 66 kM

ABS plastic rocket

- 3D printed

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.

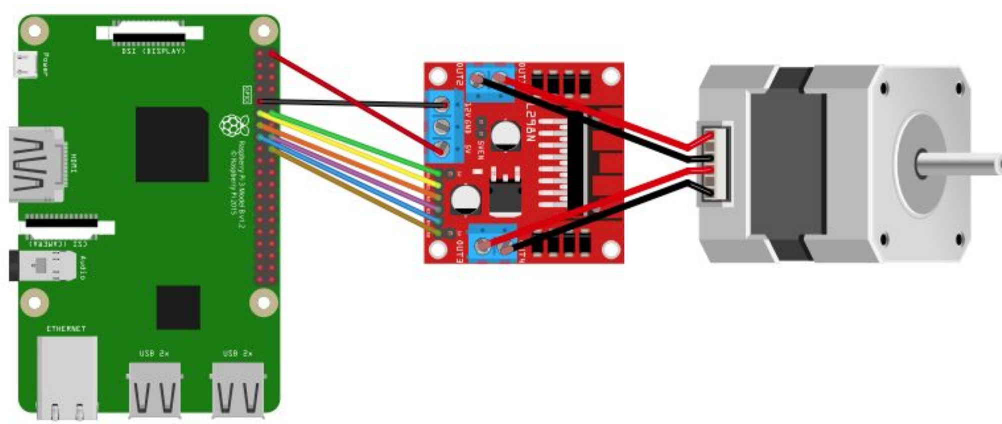
Subsystem Design: Command and Data Handling Mechanical Interface (ScubeR)

Nikki

Motor Rotation Truth Tables

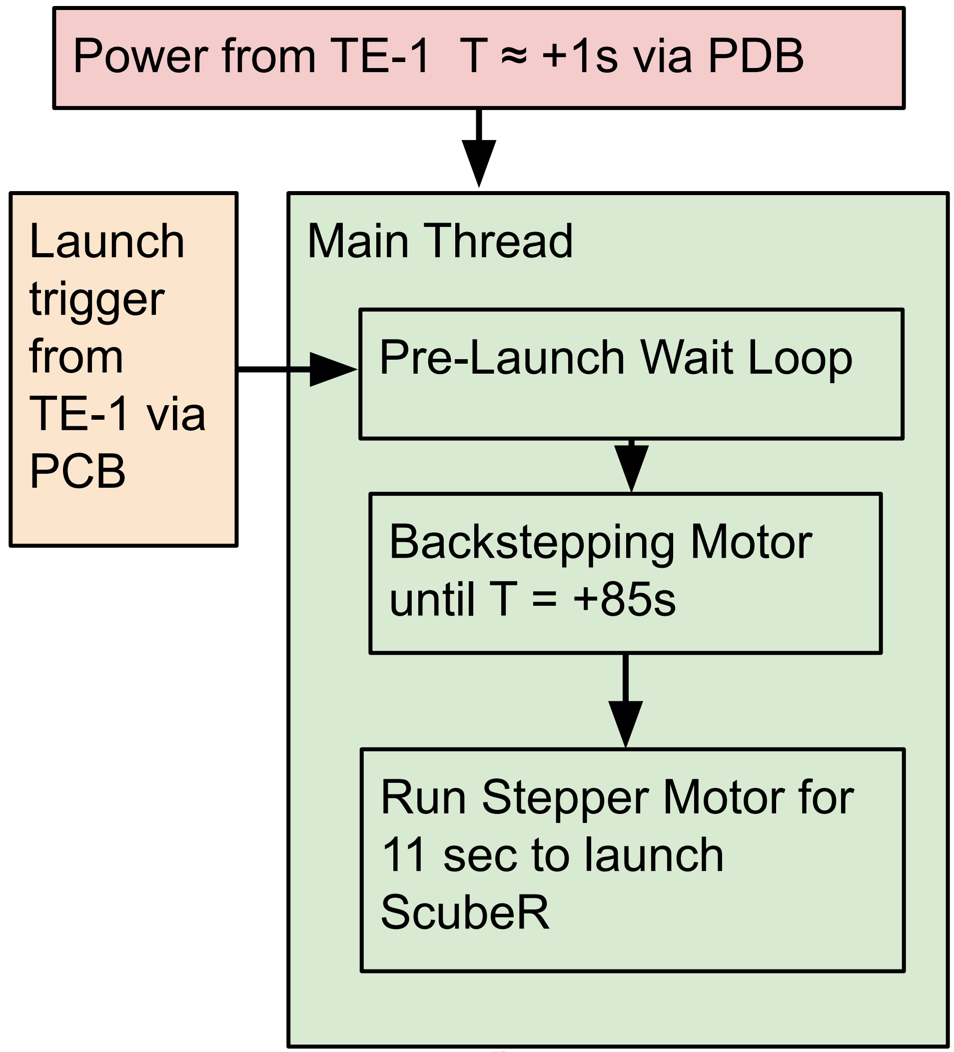
Phase 1		
Input1	Input2	Phase rotation
0	0	Stop Rotate
0	1	Clockwise
1	0	Anti-clockwise
1	1	Stop Rotate

Phase 2		
Input3	Input4	Phase rotation
0	0	Stop Rotate
0	1	Clockwise
1	0	Anti-clockwise
1	1	Stop Rotate



Subsystem Design: Software (Flight Computer)

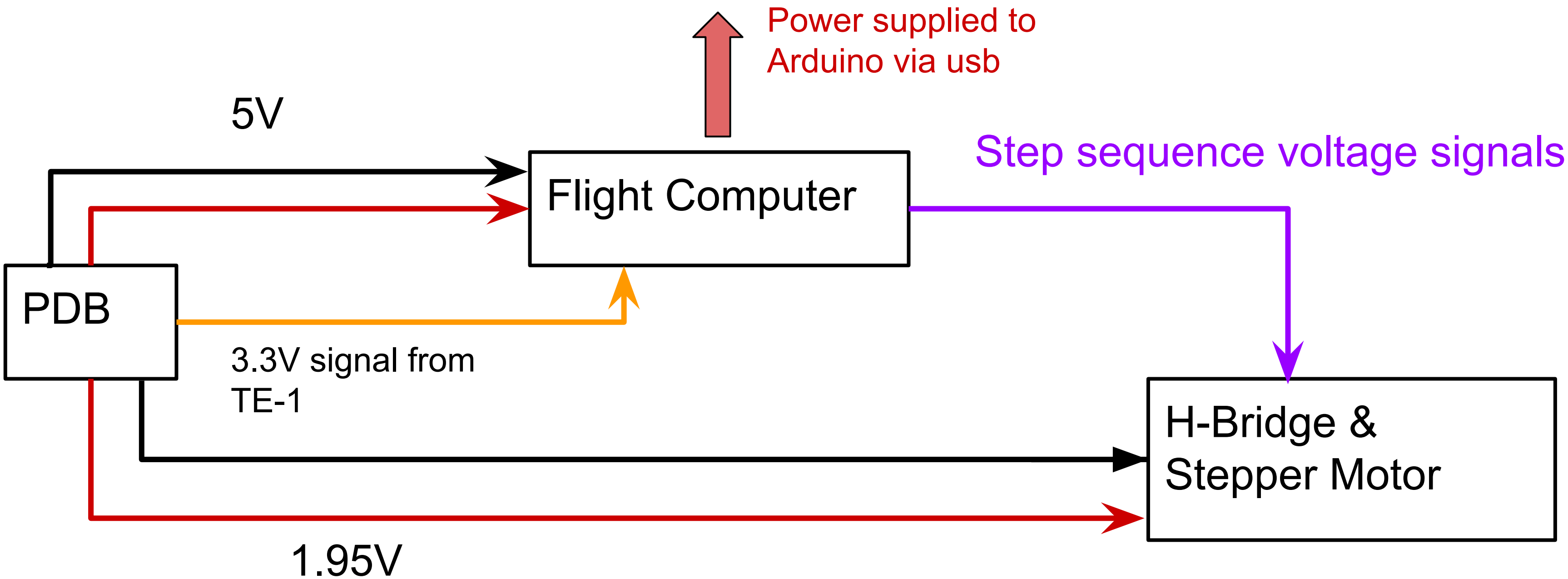
Nikki



Subsystem Design: Power (Raspberry Pi)

Nikki

- Flight Computer: Receives 5V via PDB (@ T≈+0.1)
- H-Bridge sends commands to Stepper Motor: Motor start backstepping from T≈+0.1s to T≈+100s and forward stepping for 11 sec at T≈+100s.



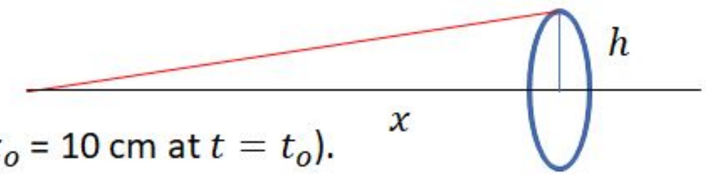
Caleb

Subsystem Design: Science (Mobius Camera)

- Imagery will be used to calculate the distance and velocity of ScubeR deployment using the apparent image height.
- ScubeR distance is found by;

$$x = \frac{x_o}{m} = \frac{x_o h_o}{h}$$

where h_o is the nozzle diameter at the end of the thread (at x_o = 10 cm at $t = t_o$).



- ScubeR speed (relative to the payload section) is determined by;

$$v = x_o\left[\frac{2}{t}\left(\frac{h_o}{h}\right) - \frac{1}{t_o}\right]$$

- Uncertainty in the ScubeR distance and speed can also be found…

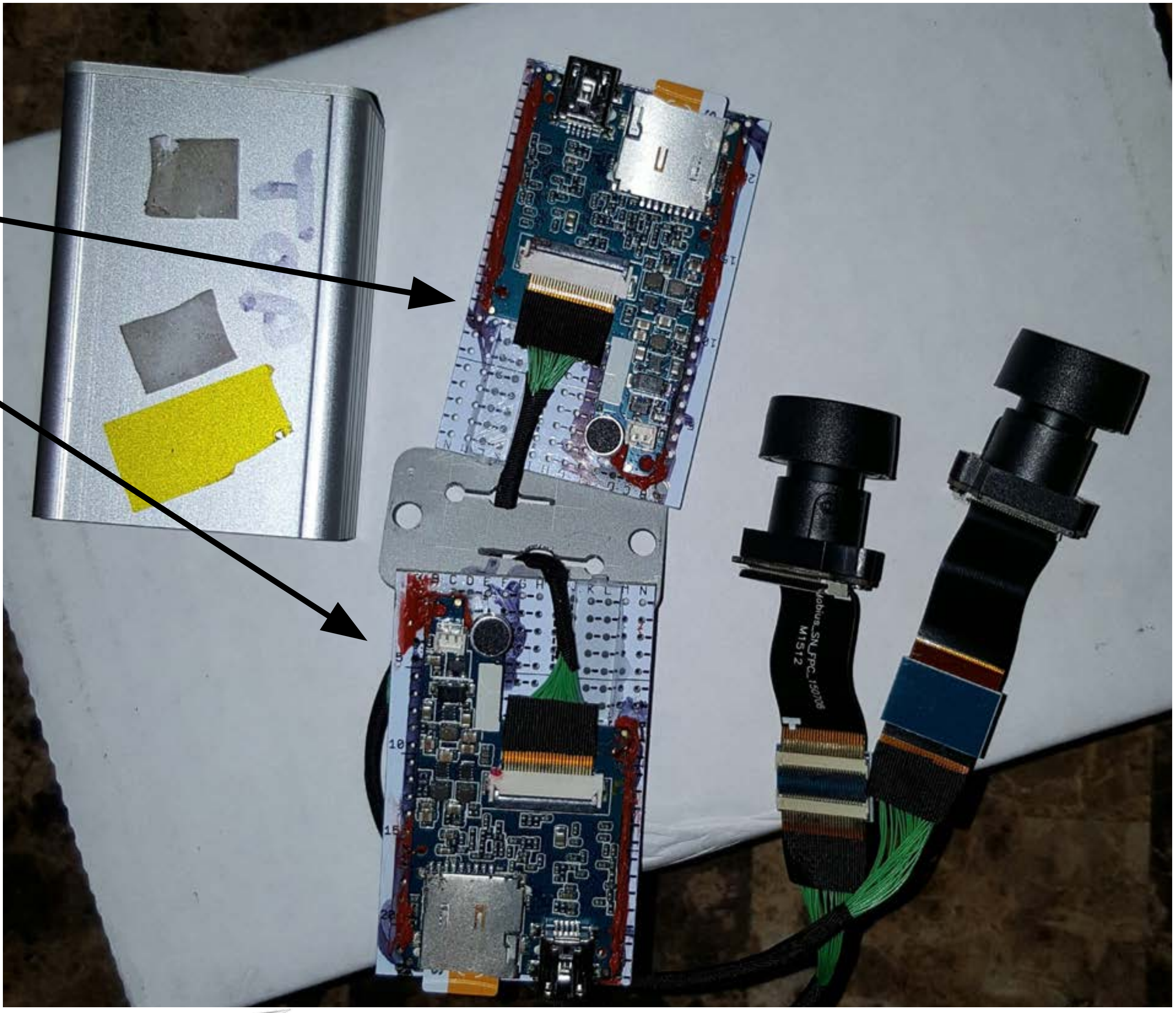
$$\delta x = \left(\frac{x}{h}\right)\delta h \qquad \delta v = \sqrt{\left(\frac{\delta h}{h}\right)^2 + \left(\frac{\delta t}{t}\right)^2}$$

Subsystem Design: Structure (Mobius Cameras)

Onboard Mobius camera circuit boards outside of housing

Camera 1 (time-lapse) and Camera 2 (video)

Lenses at right



Size: 60mm x 80mm x 15mm

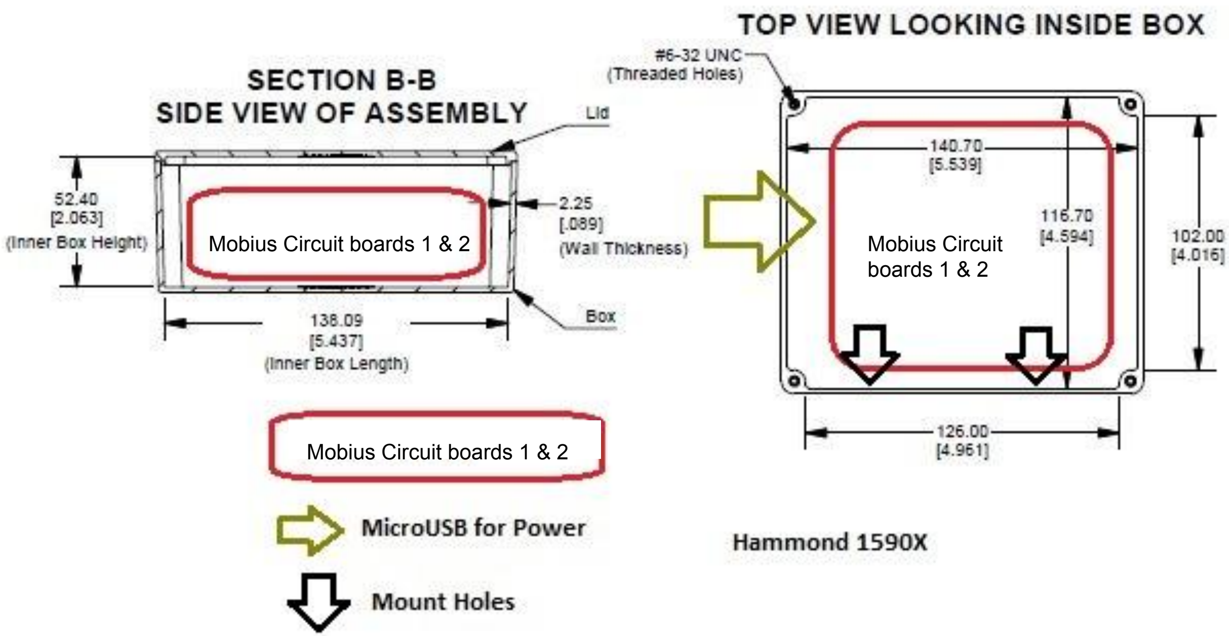
Power: 450mA at 5V for each camera

Mass: 0.29 lbs

Caleb

Subsystem Design: Structure (Mobius Cameras)

- Camera Housing-Hammond Box
  - Diecast Aluminum Alloy
    - Weight ~454g
    - Silicone Gasket
    - Stainless Steel Screws

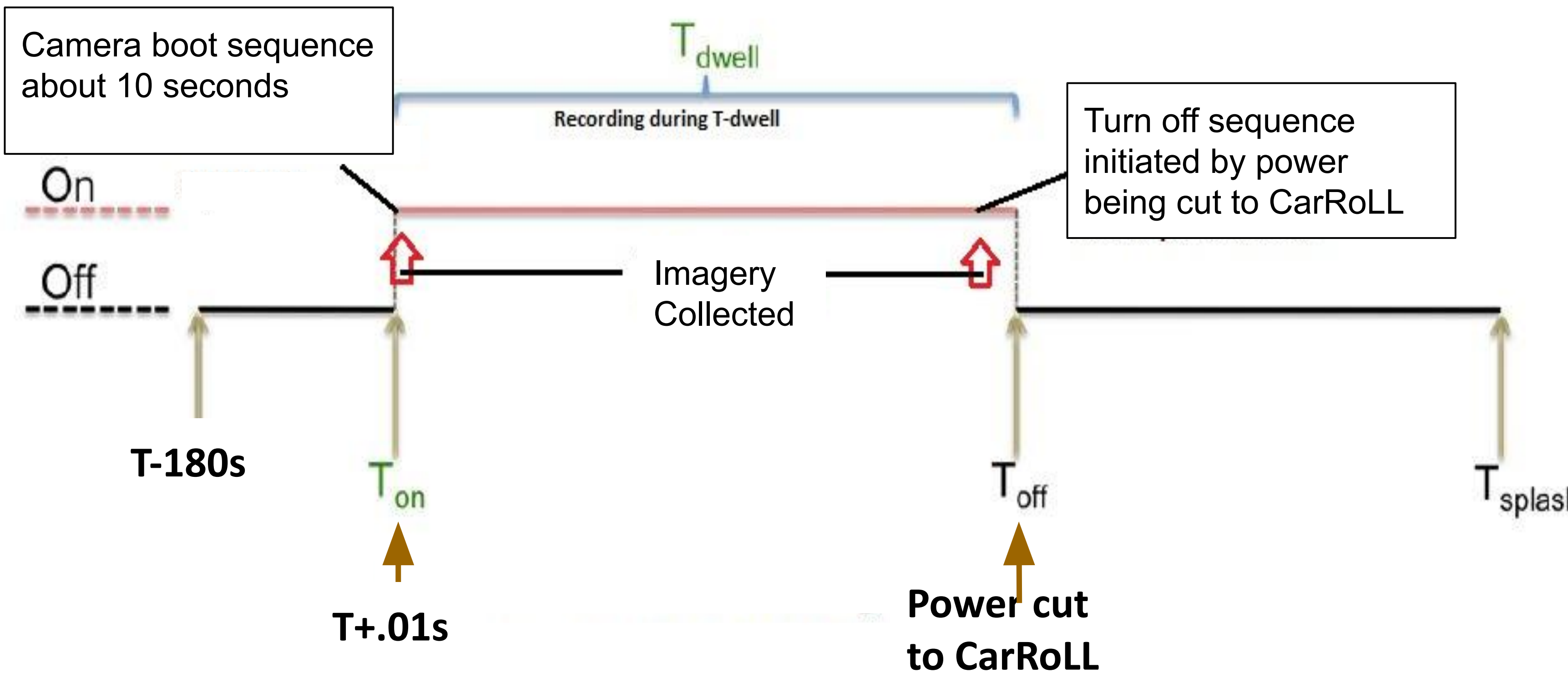


Subsystem Design: Power (Mobius Camera)

Caleb

Power on / off sequence

- (T_{on}) Photos and video will start recording to SD cards on Mobius Circuit Boards about 10 seconds after power is applied at T+ 0.1 seconds.
- (T_{off}) Power to onboard cameras will cutoff when WFF power to CarRoLL is cut at T+ 336 seconds.



Caleb

Subsystem Design: Software (Mobius Cameras)

Mobius Camera_1:

- Embedded firmware enables stand-alone operation
- Operates in Video mode
- Captures and stores 5-min video clips of ScubeR release
- Data is stored locally to micro SD-card contained within camera PCB enclosure

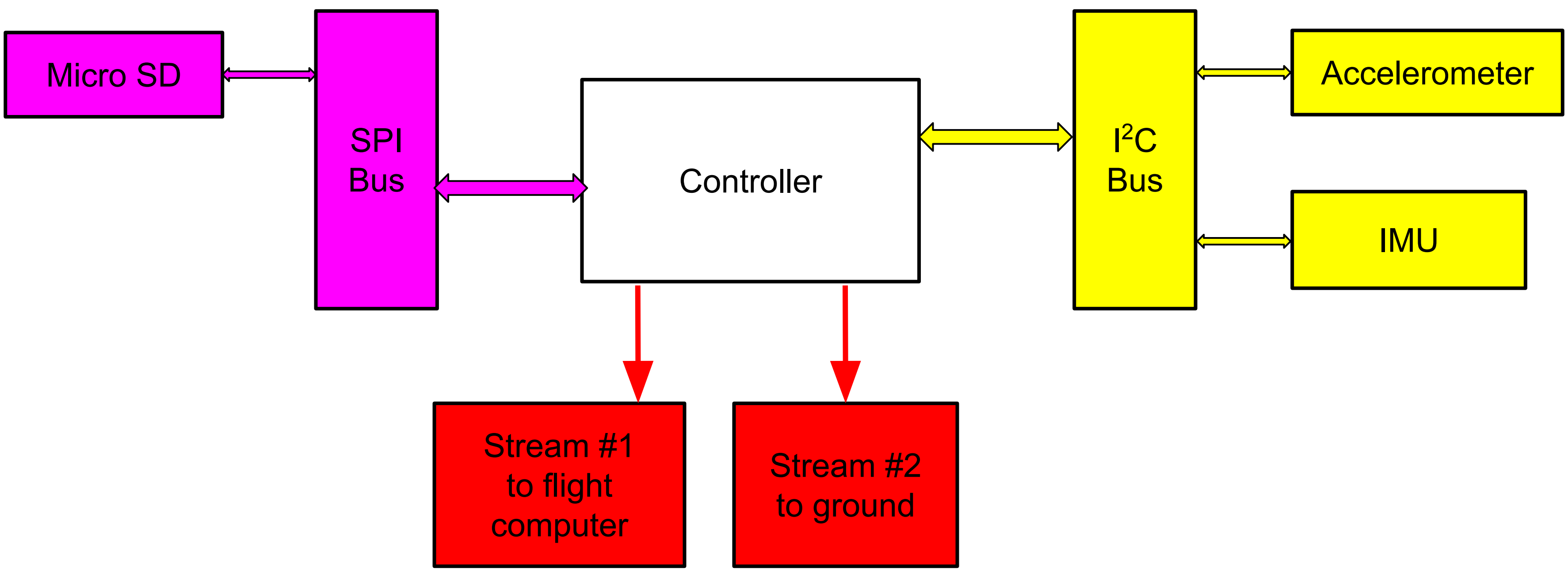
Mobius Camera_2:

- Embedded firmware enables stand-alone operation
- Operates in Photo mode
- Captures and stores time-lapse photos of ScubeR release
- Data is stored locally to micro SD-card contained within camera PCB enclosure

Subsystem Design: Structure (Data Controller)

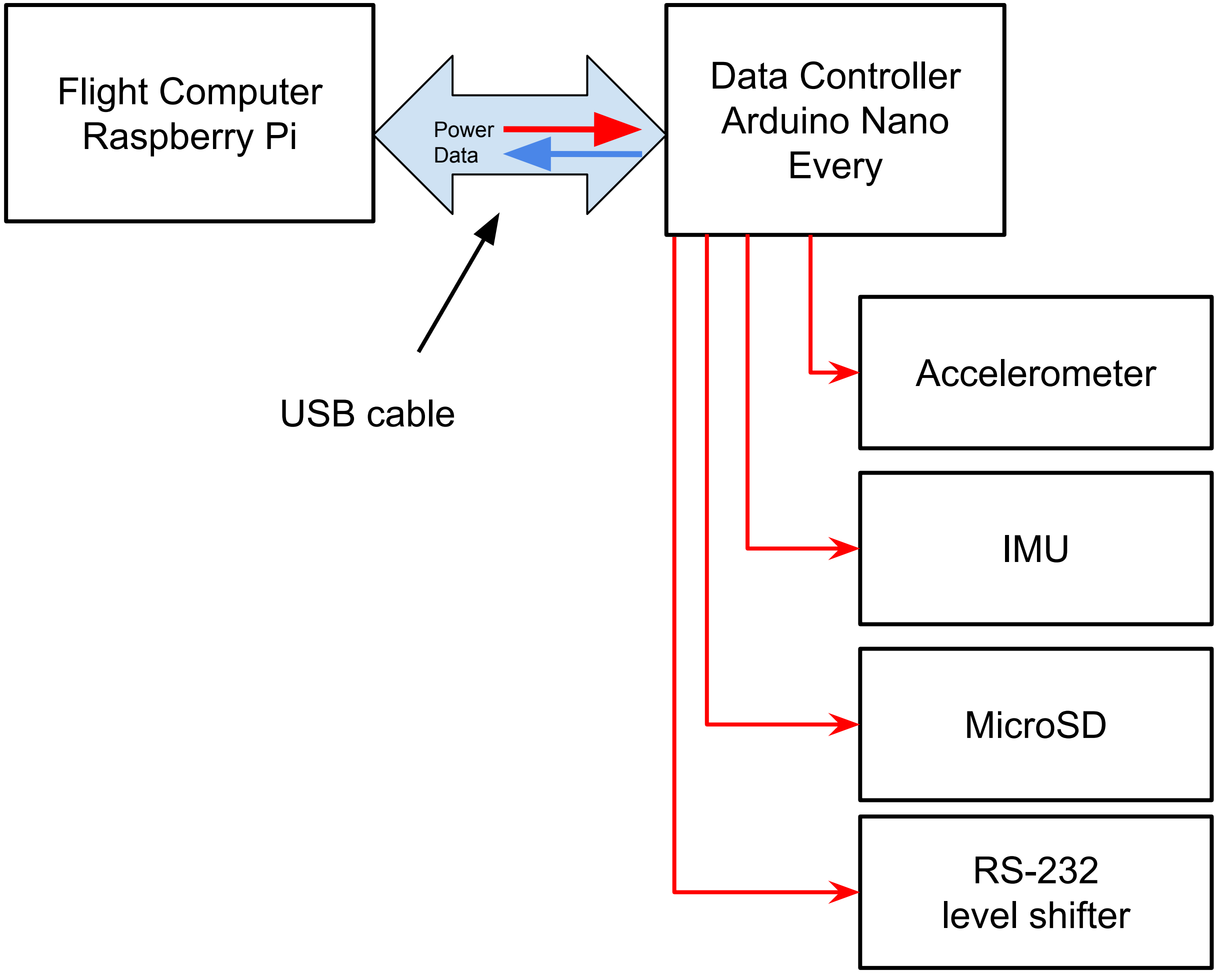
Controller: Arduino Nano Every (5 grams - 5 Volts)
Accelerometer: Adafruit LIS3DH (1.5 grams - 3.3-5 Volts)
IMU: Adafruit LSM9DS1 (2.5g - 3.3-5 Volts)
MicroSD: Adafruit MicroSD Card Breakout Board+ (0.81oz - 3.3-5 Volts)

The mass would be around 20 to 30 grams, plus another 30 to 50 grams for the circuit board and wiring



Subsystem Design: Power (Data Controller)

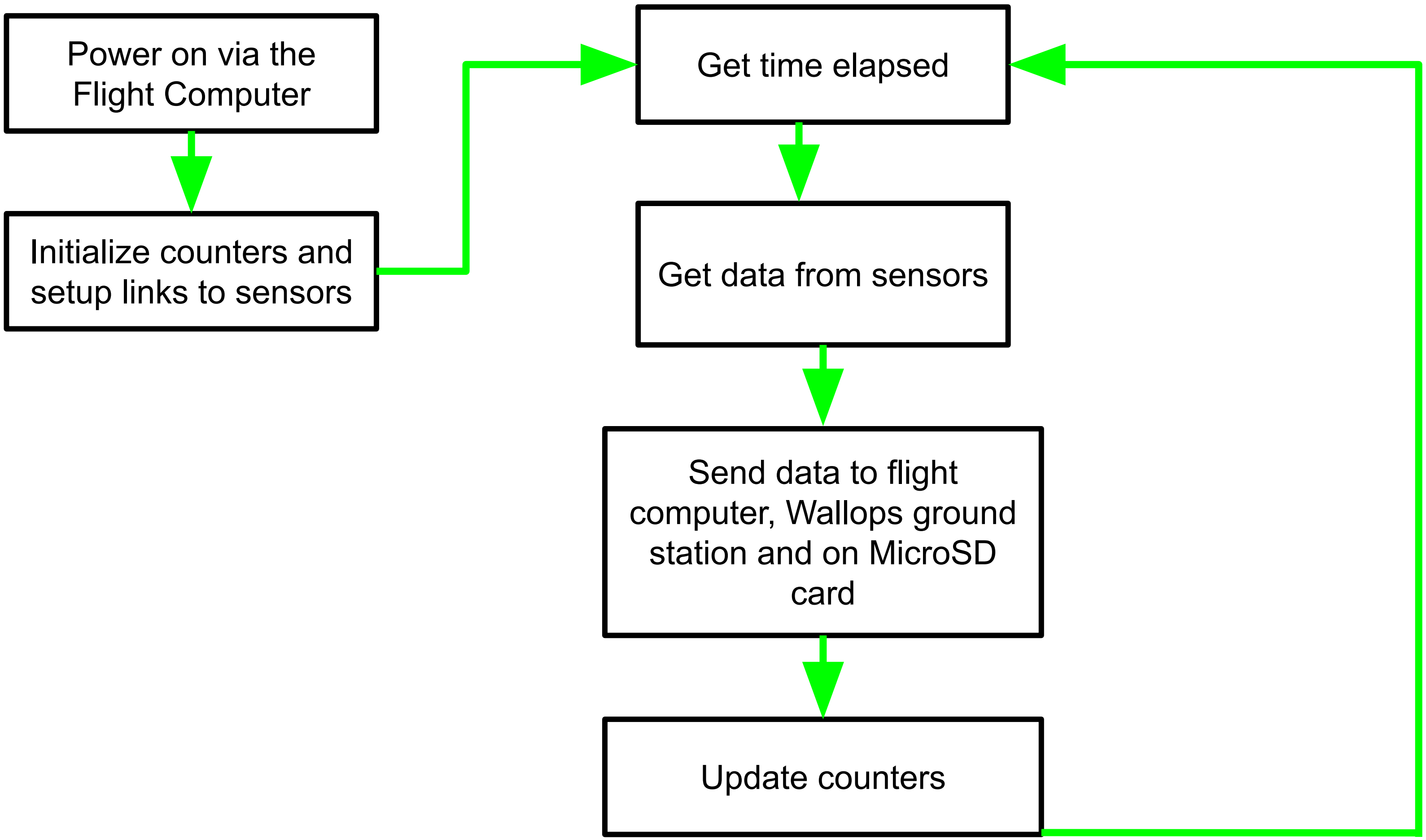
D'Elle



The Arduino Nano Every is at 5 Volts (20 mA).

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

Subsystem Design: Software (Data Controller)



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	Raspberry Pi	5.0	0.8	4.0	2.00	26.7
	Stepper Motor	1.95	2.12	4.13	1.30	53.0
	Onboard Camera (Mobius)	5.0	0.80	4.0	5.53	78.4
	Artemis CubeSat	5.0	2.0	10.0	2.00	67.0
	H Bridge	5.0	2.0	10.0	1.30	50.0
New	LSM9DS1 (IMU)	5.0	0.004	0.02	15	1
	LIS3DH	5.0	0.01	0.5	15	2.5
	MicroSD Reader	5.0	0.15	0.75	15	37.5
	Arduino 33 BLE Sense	3.3	0.015	0.0495	15	3.75
	Arduino Nano Every	5.0	0.02	0.1	15	5.0
					Total Current (A)	Total Capacity (Ah)
					7.919 A	0.3211 Ah

*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.

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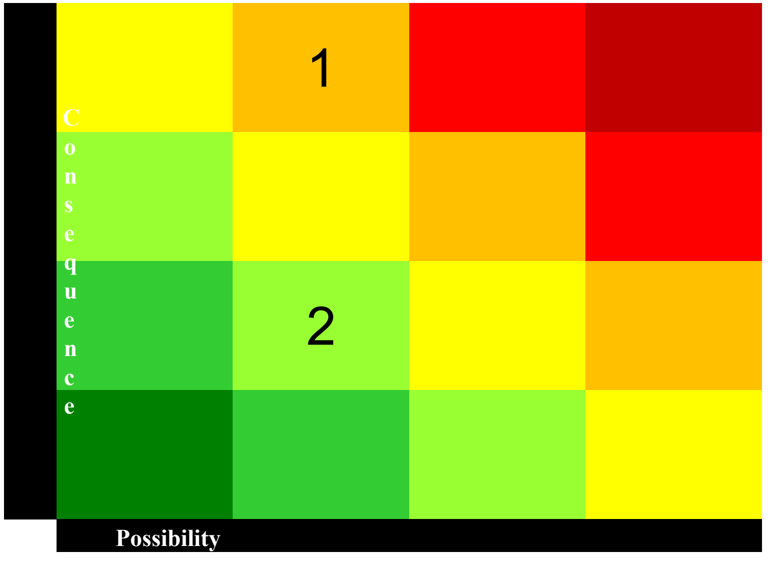
4.0 Risk Matrices

PDR Presentation Contents

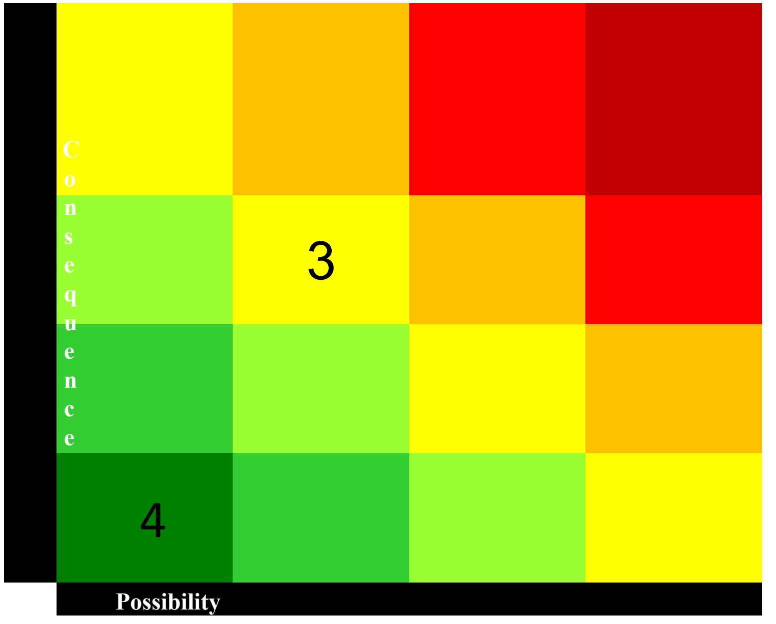
- Section 4: Risk Matrices
  - ScubeR
  - Power Distribution Board
  - Mobius Cameras
  - Data Controller
  - Command and Data Handling
  - Summery

Risk Matrix (ScubeR)



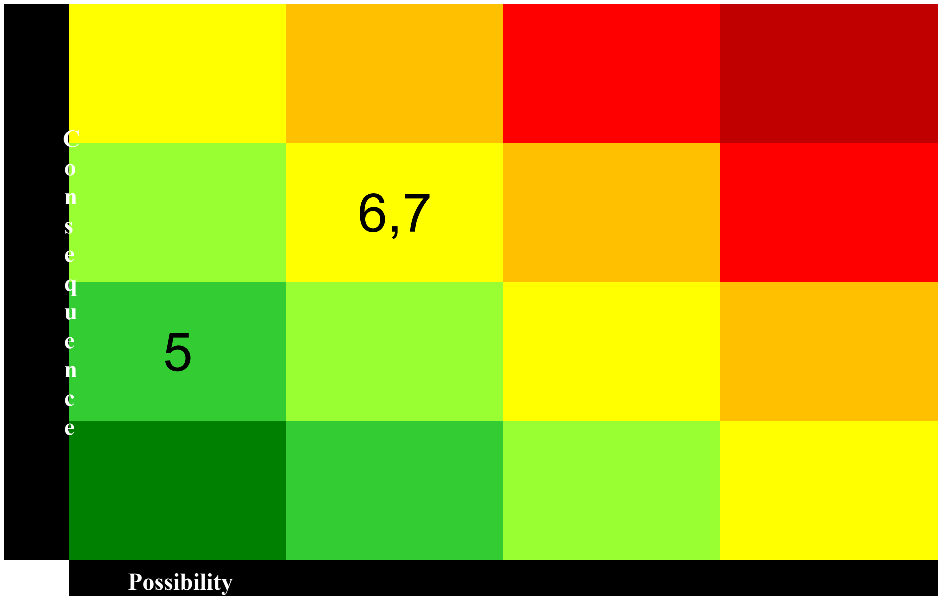
1. ScubeR will not clear the CarRoLL before re-entry because of a delay in sublimation.
2. Stepper Motor might not work.

Risk Matrix (Power Conditioning Board)



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.

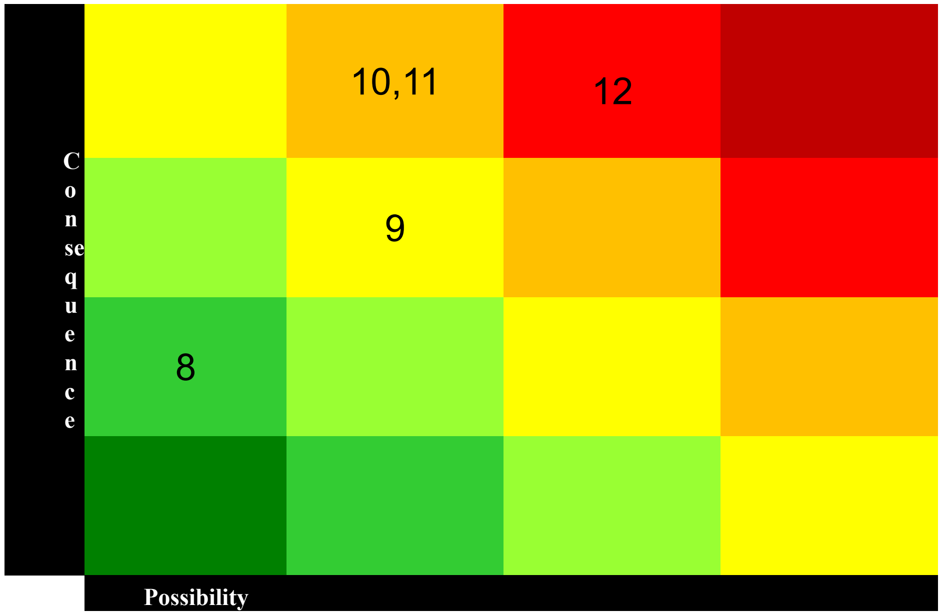
Risk Matrix (Mobius Cameras)



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.
5. Video images will not be stored if power to unit is removed before five-minutes from power on.

Jared

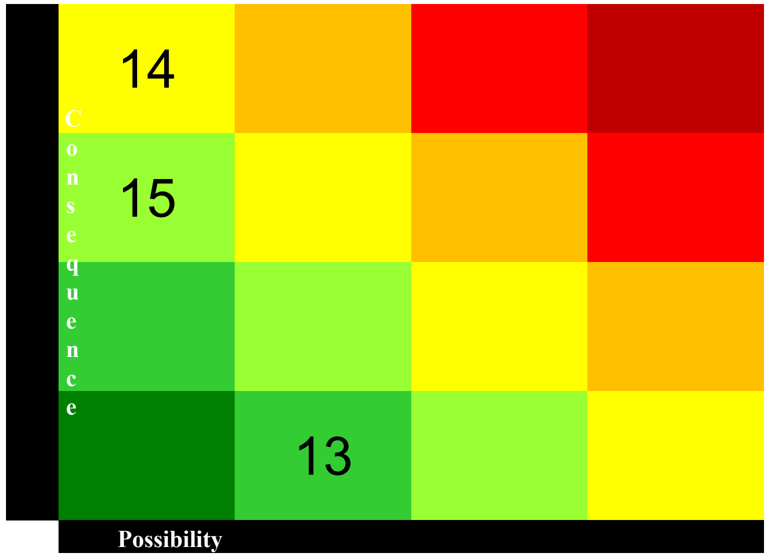
Risk Matrix (Data Controller)



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
11. Data loss from telemetry failure
12. If flight computer is not on, the data controller will not work

Jared

Risk Matrix (Command and Data Handling)



13. Too much processing may slow down the Raspberry Pi 2 to the point that it fails to initiate a controlled timing event.
14. Data Loss from re-entry.
15. Raspberry Pi 2 failure.

Jared

Risk Matrix (Summary)

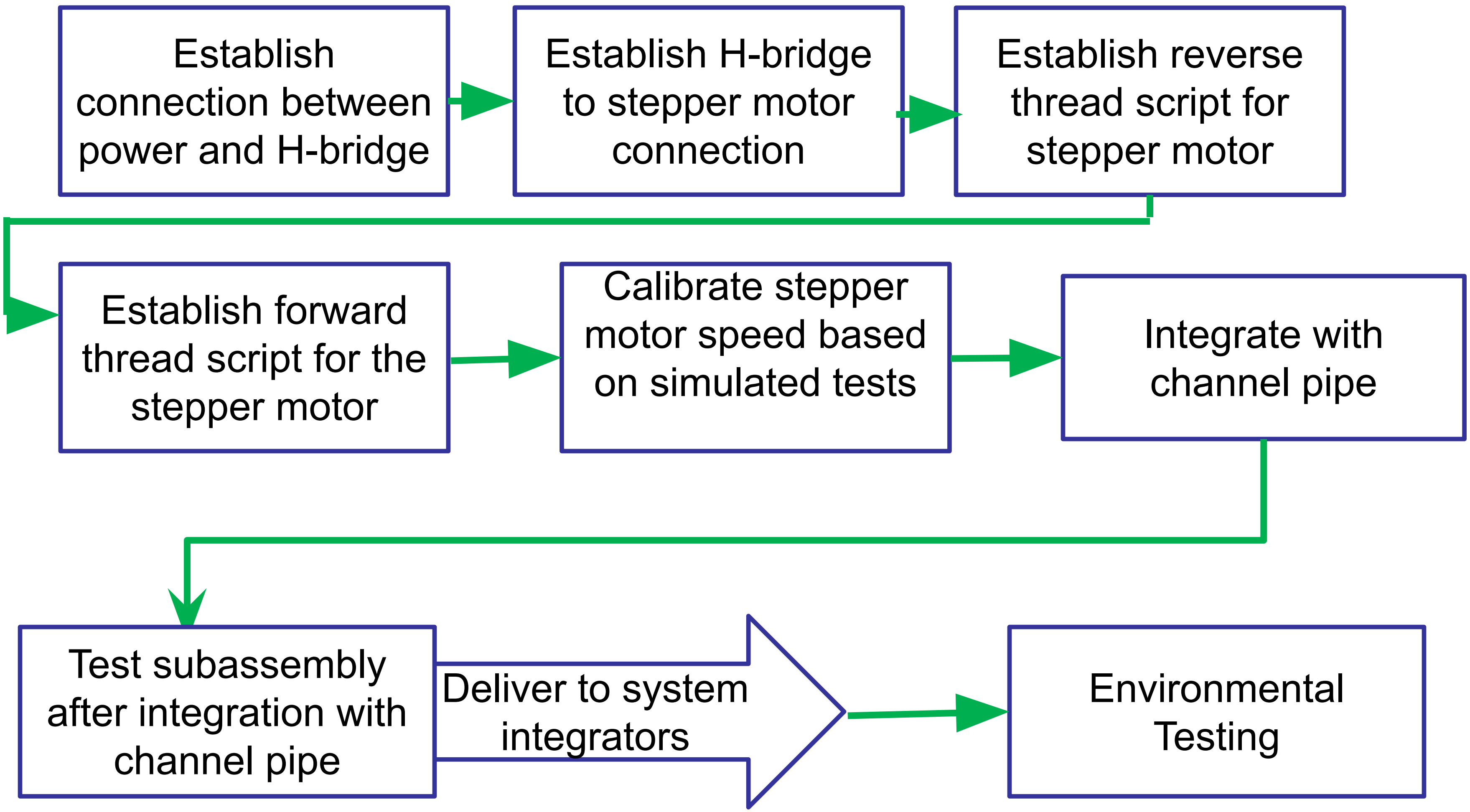
Consequence				
	14	1,10,11	12	
	15	3,6,7,9		
	5,8	2		
	4	13		
	Possibility			

5.0 Test/Prototyping Plan

PDR Presentation Contents

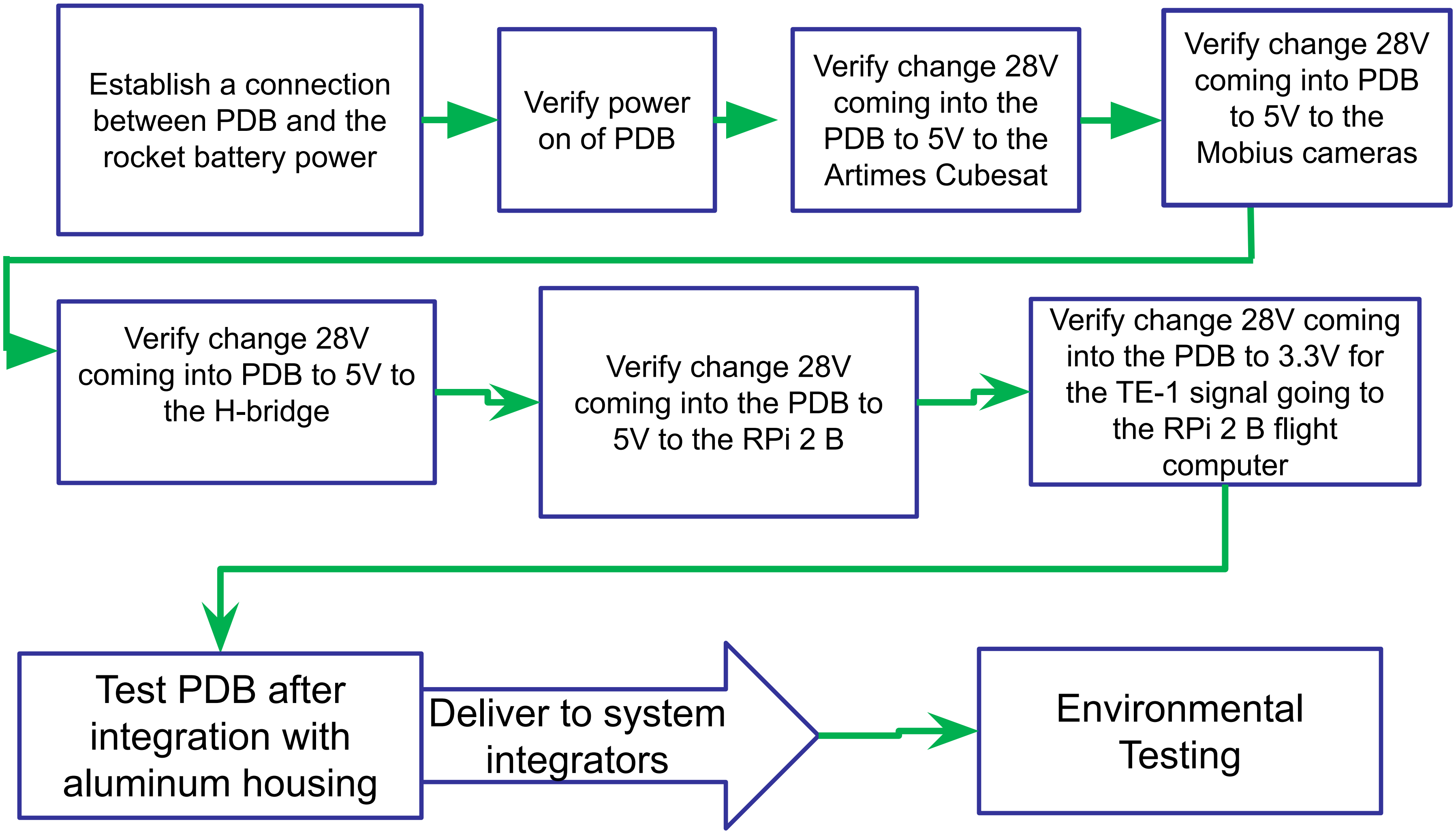
- Section 5: Initial Test Plan
  - ScubeR
  - Mobius
  - Power Distribution Board (PDB)
  - Flight Computer
  - Data Controller

Test/Prototyping Plan (ScubeR)

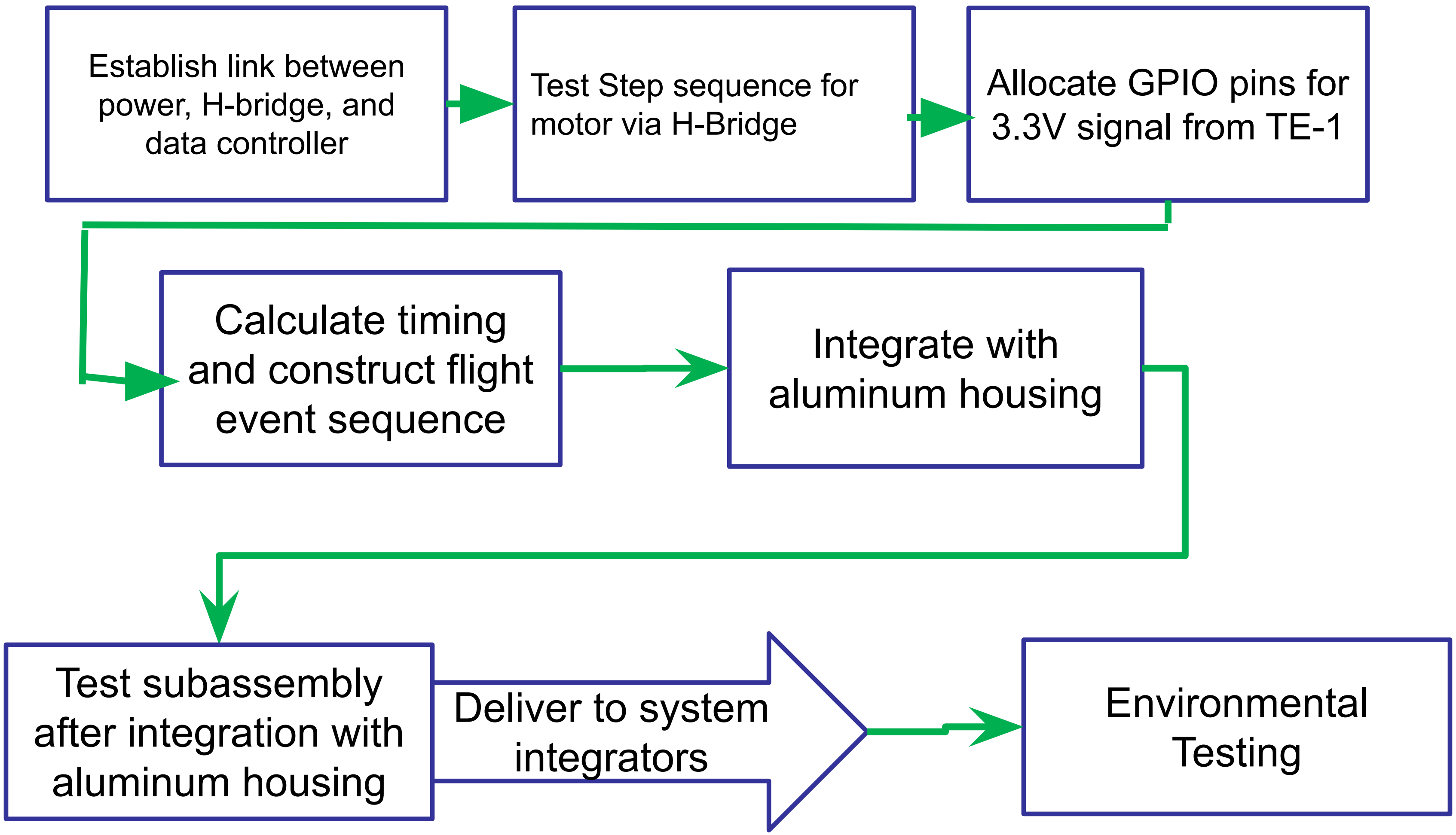


D’Elle

Test/Prototyping Plan (Power Distribution Board)

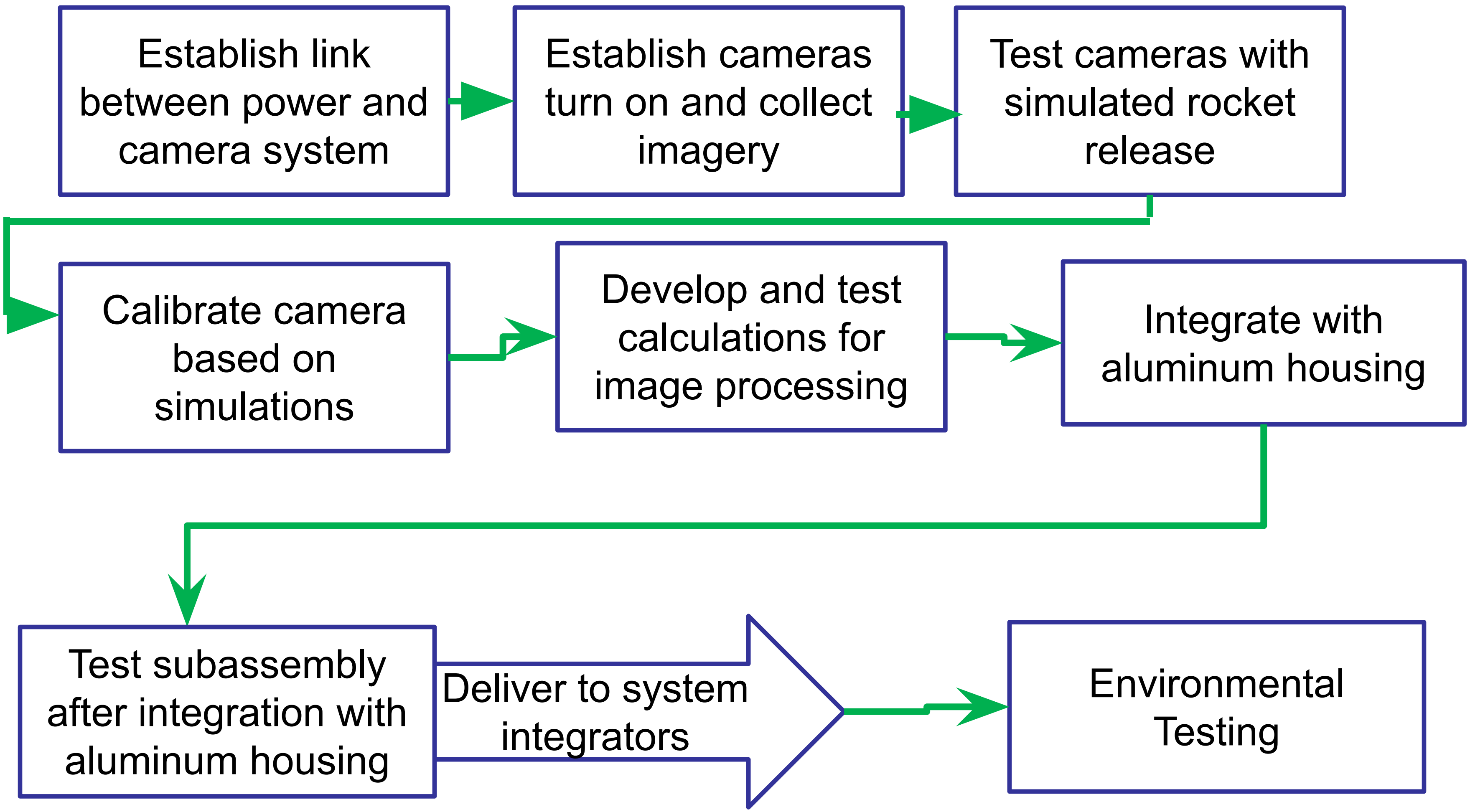


Test/Prototyping Plan (Flight Computer)



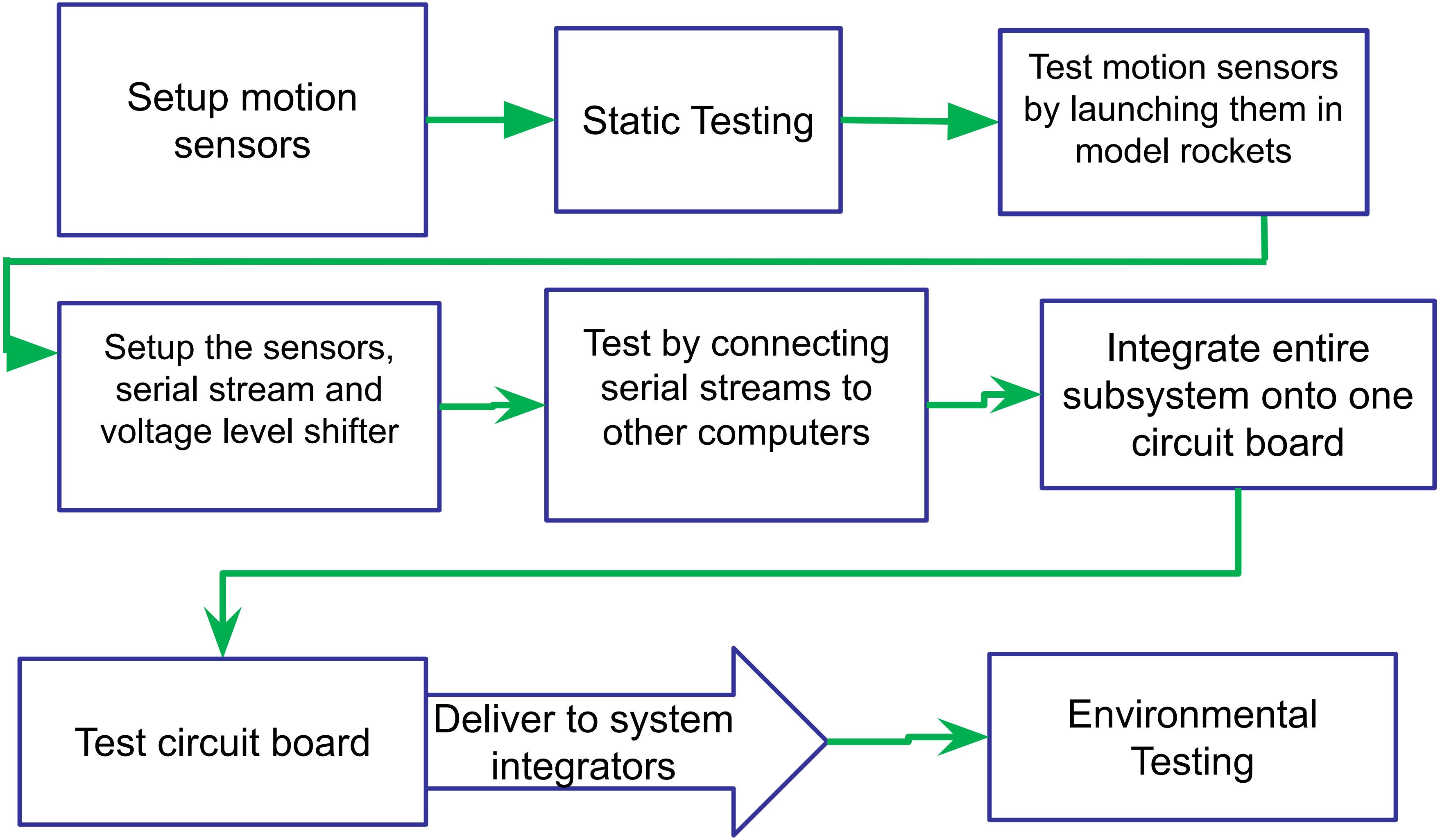
D'Elle

Test/Prototyping Plan (Mobius Cameras)



D’Elle

Test/Prototyping Plan (Data Controller)



Jared

6.0 Project Management Plan (PMP)

PDR Presentation Contents

- Section 6: Project Management Plan (PMP)
  - Schedule
  - Budget (Labor, launch fee, travel, hardware, etc)
  - Mentors (faculty, industry)
  - Latest Availability Matrix
  - Latest Team Contact Matrix
  - Status of deposit
  - Worries

Project Imua Budget: Mission 10

Jared

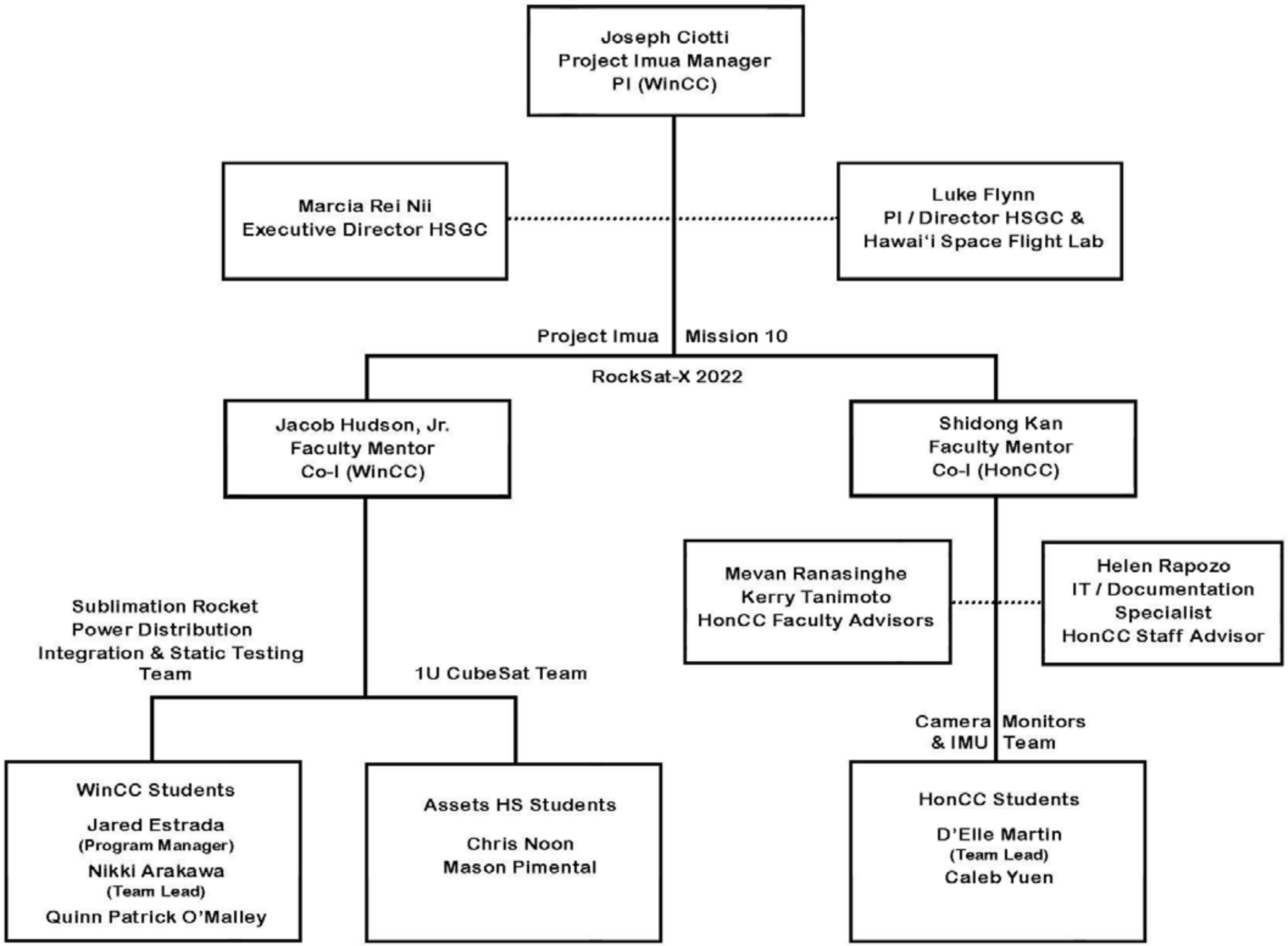
rev 10-24-21			
UHCC Project Imua Mission 10: RS-X 2022			
Item	**Budgeted**	**Expended/ Encumbered**	**Balance**
Student Fellowships (Fall/Spring/Summer)	37,500	7,500	30,000
Student Summer Travel Stipend	12,330	0	12,330
Mentor Summer Travel	10,357	0	10,357
Supplies	7,000	0	7,000
RockSat-X 2022 launch 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

Team Mentors

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

Jared

Team Organization



Schedule

Timeline — 2016 - 2017

Gantt Chart UHCC RockSat-X 2022

Tasks	October	November	December	January	February	March	April	May	June	July	August
PCB											
ScubeR											
Mobius Camera development											
Mobius Camera fabrication											
Data Controller/IMU development											
Data Controller/IMU fabrication											
Artimes Cubesat development											
Artimes Cubesat fabrication											
Flight Computer											
Sub-System test											
Integration											
Full Mission Simulation											
Review/Telecon	CoDR	PDR	CDR	Manifested?	STR	ISTR	FMSR	IRR	ETS	LRR	Launch
WinCC											
HonCC											

Wincc
HonCC
Assets
Everyone

Team Availability

	Team Name/School: UHCC Project Imua 1(					
	Fall RS-X Team Availability Matrix. CoDR Week of Oct 11					
	PLEASE USE MOUNTAIN TIME ZONE TIMES					
HST	MDT	Monday	Tuesday	Wednesday	Thursday	Friday
3:00 AM	7:00 AM	4	4	4	4	4
4:00 AM	8:00 AM	3	4	3	4	4
5:00 AM	9:00 AM	2	4	2	1	1
6:00 AM	10:00 AM	1	4	4	4	3
7:00 AM	11:00 AM	2	1	1	4	1
8:00 AM	12:00 PM	2	1	1	4	1
9:00 AM	1:00 PM	4	4	4	4	4
10:00 AM	2:00 PM	4	4	4	4	4
11:00 AM	3:00 PM	4	4	4	4	4
12 noon	4:00 PM	4	4	4	4	4
1:00 PM	5:00 PM	4	4	4	4	4

Team Contact Matrix

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
Assets High School (Mentor: Jacob Hudson)							
Student	Mason Pimental	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.

Conclusions

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 CDR:
  - Continue online and face-to-face meetings between campuses.
  - Begin research and development of all critical systems and subsystems.