
VRSE
VIRTUAL REALITY SPACE EXPERIENCE
Team Check-In and Milestone Timeline
4 / 2 / 2021

Community Colleges of Colorado

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ACC

RED ROCKS COMMUNITY COLLEGE

COSGC COLORADO SPACE GRANT CONSORTIUM

ROCKSAT-X

WFF

Presentation Outline

- Section 1: Mission Concept and Interfaces
- Section 2: Design Overview
- Section 3: Subsystem Testing Status
- Section 4: Integrated Subsystem Testing Status
- Section 5: Plan for FMSR
- Section 6: Project Schedule
- Section 7: Project Management
- Section 8: Conclusion

1.0 Mission Concept and Interfaces

Stacie

Mission Overview: Mission Statement

- Create a virtual reality camera apparatus and record 360° video of the RockSat-X 2020 sub-orbital flight for NASA's Education and Outreach program

Success Criteria

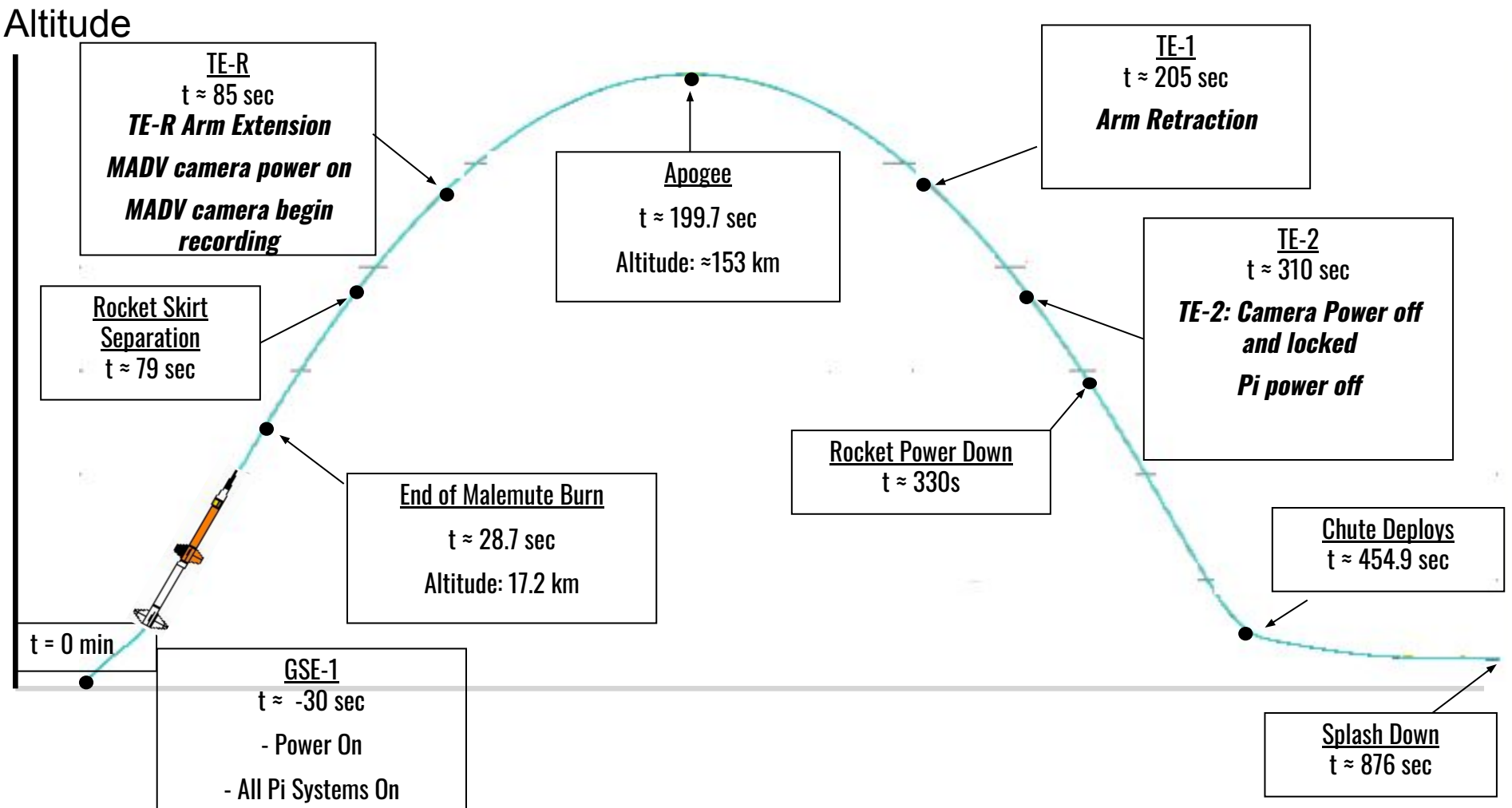
Minimum Success Criteria:

- Record footage from inside the payload in the event that the arm does not extend
- Receive telemetry data
- Recovery of virtual reality video

Comprehensive Success Criteria:

- Full extension and retraction of arm
- Recovery of camera and full quality video from both cameras

ConOps


Altitude
TE-R
t ≈ 85 sec
TE-R Arm Extension
MADV camera power on
MADV camera begin recording
Apogee
t ≈ 199.7 sec
Altitude: ≈153 km
TE-1
t ≈ 205 sec
Arm Retraction
Rocket Skirt Separation
t ≈ 79 sec
TE-2
t ≈ 310 sec
TE-2: Camera Power off and locked
Pi power off
End of Malemute Burn
t ≈ 28.7 sec
Altitude: 17.2 km
Rocket Power Down
t ≈ 330s
Chute Deploys
t ≈ 454.9 sec
t = 0 min
GSE-1
t ≈ -30 sec
- Power On
- All Pi Systems On
- Pi camera recording
Splash Down
t ≈ 876 sec

Activation Sequence: CC of CO and WV

	School	Start (sec only)	Start (min, sec)	Dwell (sec)	End (sec only)	End (min, sec)	Comments
GSE-1	CCofCO	T-30s	T-0min, 30 s	Flight	Flight	Flight	Power to Pi and Pi cam power up and begin recording, power to sensors
GSE-2	WV	T-180s	T-3min	Flight	Flight	Flight	Power On
TE-R	CCofCO	T+85s	T+1min, 25s	Flight	Flight	Flight	Power to motor hat, arm extension and primary camera turns on and begin recording
TE-1	CCofCO	T+205s	T+3min, 25s	Flight	Flight	Flight	Arm Retraction, recording stopped
TE-2	CCofCO	T+310s	T+5min, 10s	Flight	Flight	Flight	Lock Camera Power Off Data Loss Prevention
TE-3	WV	T+321s	T+5min, 21s	Flight	Flight	Flight	Latch of Internal Battery

2020 Mission Timeline

Mission Time Line
46.030/Koehler

Weight: 872.9 lbs QE: 84.0 deg. AZ: 110.0 deg.

4/13/2020
Rev B

Event	Time (sec)	2 Sigma Low Altitude (km)	Nom. Alt. (km)	2 Sigma High Altitude (km)	Nominal Range (km)	Nominal Mach Number	Nominal Vel. (m/s)	2 Sigma Low Q (psf)	Nominal Q (psf)	2 Sigma High Q (psf)	Nominal Flight Elevation (deg)	Event Control	Dwell Time (sec)
Exp GSE Backup Event	0.1	0.0	0.0	0.0	0.0	0.0	-	-	0.0	-	84.0	TM DIRT Timer 2	34.9
UPR (Exp5 TE-1) - More Power	0.1	0.0	0.0	0.0	0.0	0.0	-	-	0.0	-	84.0	TM DIRT Timer 2	336.0
Rail Release	0.5	-	0.0	-	0.0	0.1	44.2	-	25.1	-	84.0		
Terrier Burnout	5.2	-	1.5	-	0.2	1.6	559.0	-	3448.1	-	82.9		
CoC (Exp4 TE-1) - System Power	10.0	3.8	3.9	3.9	0.5	1.3	434.4	1630.0	1638.1	1653.5	82.2	TM DIRT Timer 1	326.0
Imp. Malemute IGN	18.0	-	6.7	-	0.9	0.9	288.7	-	532.3	-	80.3	CDI DIRT Timer	1.0
CSoM (Exp3 TE-1) - Comp. Pwr On	20.0	7.3	7.4	7.5	1.0	1.4	449.5	1188.9	1189.6	1199.4	79.8	TM DIRT Timer 1	316.0
Imp. Malemute Burnout	29.7	-	17.2	-	2.9	5.7	1666.0	-	4075.3	-	78.8		
UoC (Exp4 TE-R) - GoPro & Lighting On	65.0	64.7	67.2	69.5	13.8	4.3	1276.2	3.0	2.2	1.7	76.1	TM DIRT Timer 1	360.0
Heat Shield Enable	66.0	65.8	68.4	70.8	14.1	4.3	1266.9	2.5	1.8	1.4	76.0	TM DIRT Timer 1	600.0
Despin to 0 hz	68.0	-	70.8	-	14.7	4.3	1248.3	-	1.2	-	75.9	CDI DIRT Timer	1.0
UPR (Exp5 TE-2) - Detect Skirt Deploy	70.0	70.4	73.2	75.9	15.3	4.2	1229.7	1.2	0.9	0.6	75.7	TM DIRT Timer 2	266.0
Motor Sep	72.0	-	75.6	-	15.9	4.2	1211.2	-	0.6	-	75.4	CDI DIRT Timer	1.0
ACS, Rate Damping	72.0	72.7	75.6	78.4	15.9	4.2	1211.2	0.9	0.6	0.4	75.4	ACS Timer	6.0
Aft Skirt Sep	79.0	-	86.8	-	18.0	4.2	1146.5	-	0.1	-	74.7	TM DIRT Timer 1	1.0
Kaulda (Exp2 TE-1) - Start Deploy & Bluetooth	81.0	82.3	85.8	89.1	18.6	4.1	1128.1	0.2	0.1	0.1	74.4	TM DIRT Timer 1	255.0
Nose Sep	82.0	-	86.8	-	18.9	4.1	1118.9	-	0.1	-	74.3	TM DIRT Timer 1	1.0
ACS. Align to and Maintain Target	83.0	84.4	87.9	91.3	19.2	4.1	1109.7	0.1	0.1	0.0	74.2	ACS Timer	224.0
CCoC (Exp1 TE-1) - Arm Extension	85.0	86.4	90.0	93.6	19.8	4.1	1091.4	0.1	0.1	0.0	73.9	TM DIRT Timer 1	251.0
CSoM (Exp3 TE-2) - Actuators Enabled	85.0	86.4	90.0	93.6	19.8	4.1	1091.4	0.1	0.1	0.0	73.9	TM DIRT Timer 1	251.0
UoC (Exp4 TE-3) - Deploy Seq. Setup	85.0	86.4	90.0	93.6	19.8	4.1	1091.4	0.1	0.1	0.0	73.9	TM DIRT Timer 1	265.0
300 kFt Upleg	86.4	-	91.4	-	20.2	4.0	1078.9	-	0.0	-	73.7		
VT (Exp5 TE-R) - Sig Deployment Seq.	115.0	111.8	117.2	122.5	28.7	2.2	821.5	0.0	0.0	0.0	68.7	TM DIRT Timer 1	160.0
Apogee (nominal)	196.9	-	148.5	-	52.3	0.7	293.3	-	0.0	-	0.0		
CoC (Exp4 TE-2) - Ejection	198.0	138.3	148.5	158.5	52.6	0.7	293.4	0.0	0.0	0.0	-1.9	TM DIRT Timer 1	138.0
CCoC (Exp1 TE-R) - Arm Retraction	270.0	109.1	123.7	137.7	73.4	1.9	744.0	0.0	0.0	0.0	-66.5	TM DIRT Timer 1	66.0
UPR (Exp5 TE-3) - Pwr Off Flag	305.0	77.4	94.0	110.1	83.7	4.0	1055.9	0.4	0.0	0.0	-73.4	TM DIRT Timer 2	31.0
ACS Spin Up	307.0	75.3	92.0	108.2	84.3	4.0	1074.2	0.6	0.0	0.0	-73.7	ACS Timer	40.0
300 kFt Downleg	307.5	-	91.4	-	84.4	4.0	1079.0	-	0.0	-	-73.7		
WVC (Exp1 TE-3) - Latch Int battery	321.0	59.1	76.6	93.7	88.5	4.2	1202.3	6.6	0.5	0.0	-75.4	TM DIRT Timer 1	15.0
All Experiment Power Off	336.0	39.9	58.1	76.0	93.0	4.3	1333.4	87.9	7.9	0.6	-76.9	TM DIRT Timer 2	1.0
ACS Vent	348.0	24.3	42.0	60.4	96.6	4.4	1410.3	756.7	67.5	6.3	-77.8	ACS Timer	40.0
ACS Valves Off	388.0	4.0	7.1	11.9	103.3	0.9	295.3	433.7	530.5	946.2	-83.0	ACS Timer	End Dwell
Ballistic Impact (nominal)	420.5	-	0.0	-	103.8	0.5	174.8	-	390.5	-	-88.2		
Parachute Deploy (nominal)	477.5	-	4.9	-	103.8	0.3	90.0	-	63.1	-	-88.3		
ACS Control Off	790.0	-	0.4	-	103.8	0.0	9.7	-	1.2	-	-90.0	ACS Timer	
ACS Power Off	800.0	-	0.3	-	103.8	0.0	9.7	-	1.2	-	-90.0	ACS Timer	
Payload Impact	839.7	-	0.0	-	103.8	0.0	9.7	-	1.2	-	-90.0		

Experiment Events
ACS Events

Pin Assignments: Power

Power Connector--Customer Side	
Pin	**Function**
1	+28 Volts (GSE-1)
2	Timer Event Redundant (TE-RA)
3	WV
4	Timer Event 1(TE-1)
5	GND
6	GND
7	GND
8	GND
9	WV
10	Timer Event 2 (TE-2)
11	WV
12	WV
13	WV
14	WV
15	WV

Pin Assignments: Telemetry

Telemetry Connector--Customer Side			
Pin	**Function**	**Pin**	**Function**
1		20	
2		21	
3		22	
4		23	
5		24	
6		25	
7		26	
8		27	
9		28	
10		29	
11		30	
12		31	
13		32	RS-232 Data (TP1)
14		33	RS-232 GND (TP2)
15		34	
16		35	
17		36	
18		37	
19			

Updated Power Budget

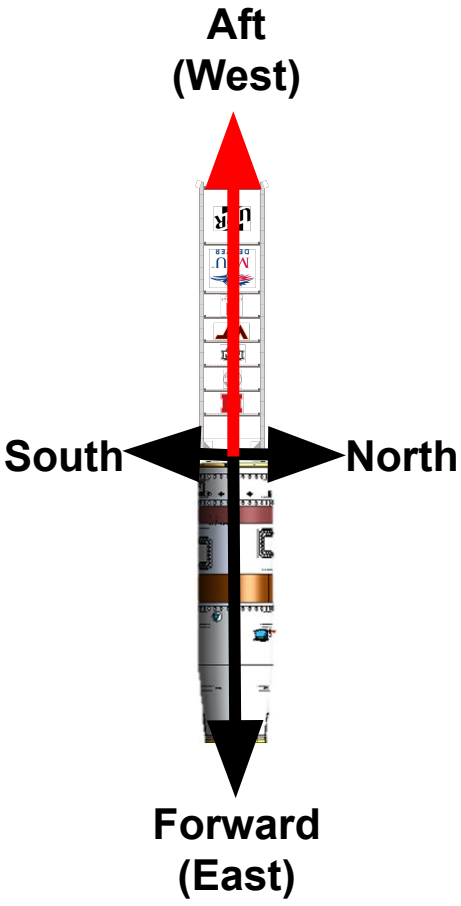
CCofCO (VRSE)- Power Budget							
Date - 11/17/2020							
Wallops Power Line	Subsystem	Voltage (V)	Max Current (A)	Start Time (min)	Time On (min)	Watts	Ah
GSE1	Raspberry Pi, Sensors	5.0	0.20	T-5	10	1.00	0.03
	DC Motor	12.0	0.50	1min 25 seconds	2	6.00	0.02
TE1/2/3/R	Signal Arm retraction	1.8	0.01	3min 25 seconds	2	0.02	0.00
	Signal System shutdown	1.8	0.01	5min 25 seconds	0.083	0.02	0.00
						0.00	0.00
TER	Signal Arm Extension	1.8	0.01	1min 25 seconds	2	0.02	0.00
		GSE 1/2 Total	0.70				
		TE1/2/3/R Total	0.03				
		Total	0.73			7.05	0.05
		Total Power Capacity	1.85				0.50
		Over/Under	1.12				0.45
					# of Flights Margin		19.7

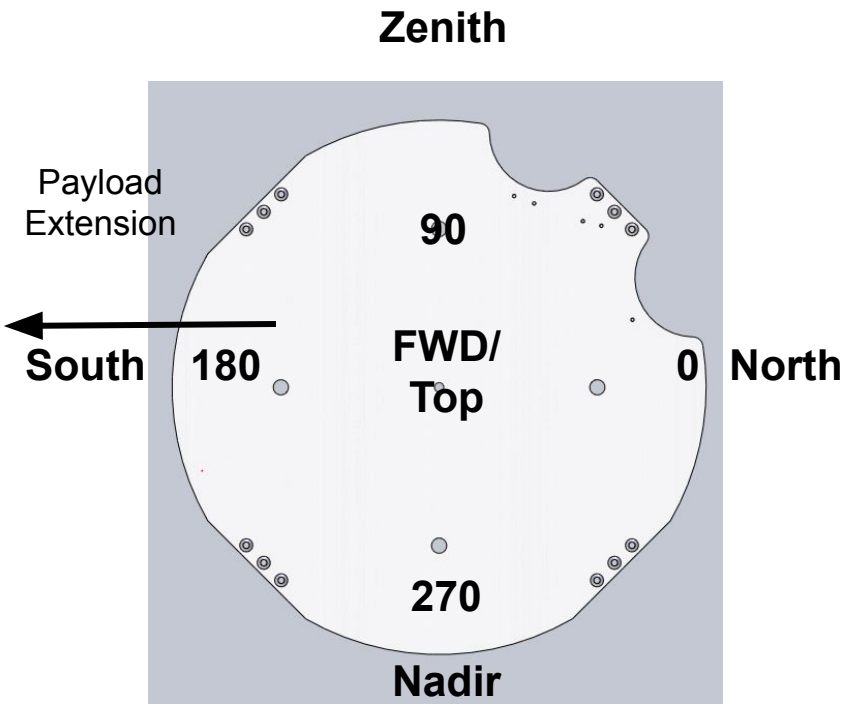
For half payload, change Total Power Capacity to 0.5

Payload Location

Final Positions

Pointing


Aft
(West)
South
North
Forward
(East)


Zenith
Payload
Extension
90
South
180
FWD/
Top
0
North
270
Nadir

Detailed Weight Budget

Approximate Total Mass Calculated in CAD:

- 11.208 Lbs

  *** Includes the base plate ***

Estimated Hardware and Electrical weight

- ~ 1.338 lbs

Total Weight:

- ~ 12.546 Lbs

2.0 Design Overview

Anton

System Changes Since Last ISTR

Arm Members
- Added flanged bearings to arm members for increased structural integrity

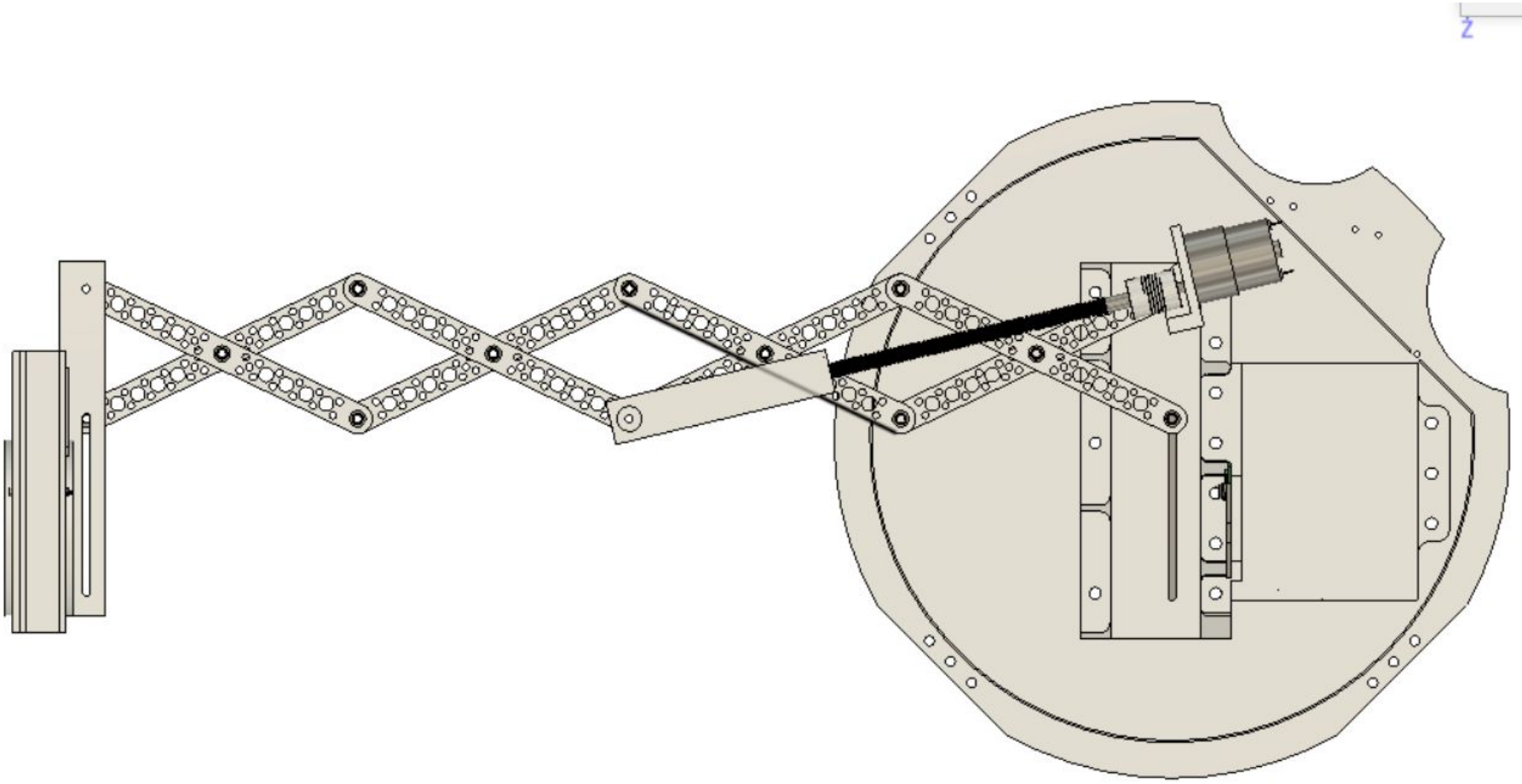
Camera Case
- Changed the internal CAD design to the Camera Case to fit into the keep out zone and to hold selfie-stick adaptor for a solid connection for communication to the camera.

EBox
- Flipped the Ebox to where the opening is facing the other direction
- Added Sleeve for electronics mounting in EBox

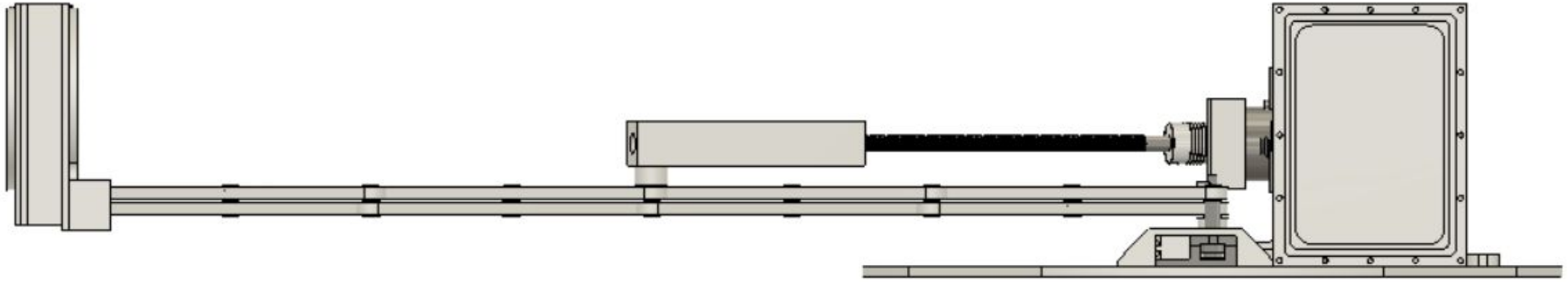
Descoped
- Descoped the Pi Camera mount and added pi camera to the sensor mount
- Descoped the electronics card for a sleeve to optimize surface area for mounting electronics in the EBox

Fabricated
- Milled Arm Base Plate (Xometry)
- Milled Undertrack that holds limit switches (Xometry)
- Milled Custom spacers and Clevis Pins (Bri at Mines)

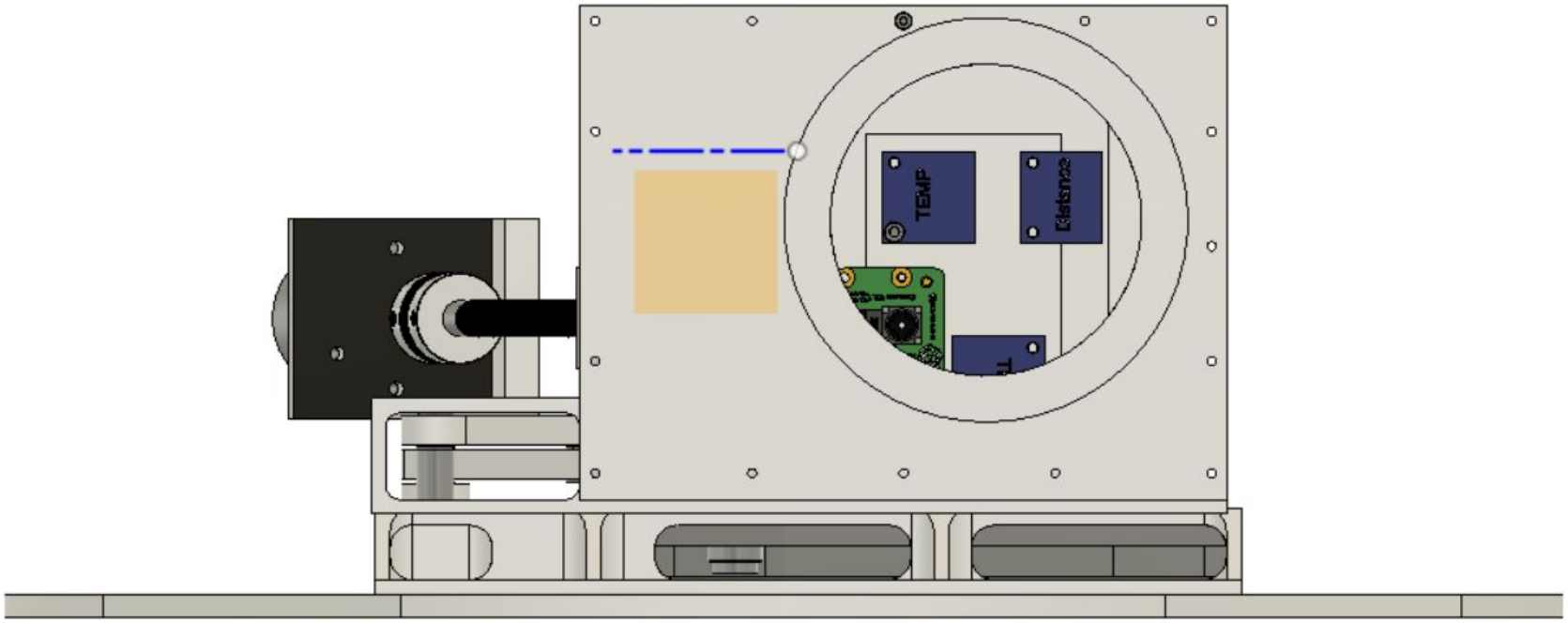
Design Overview



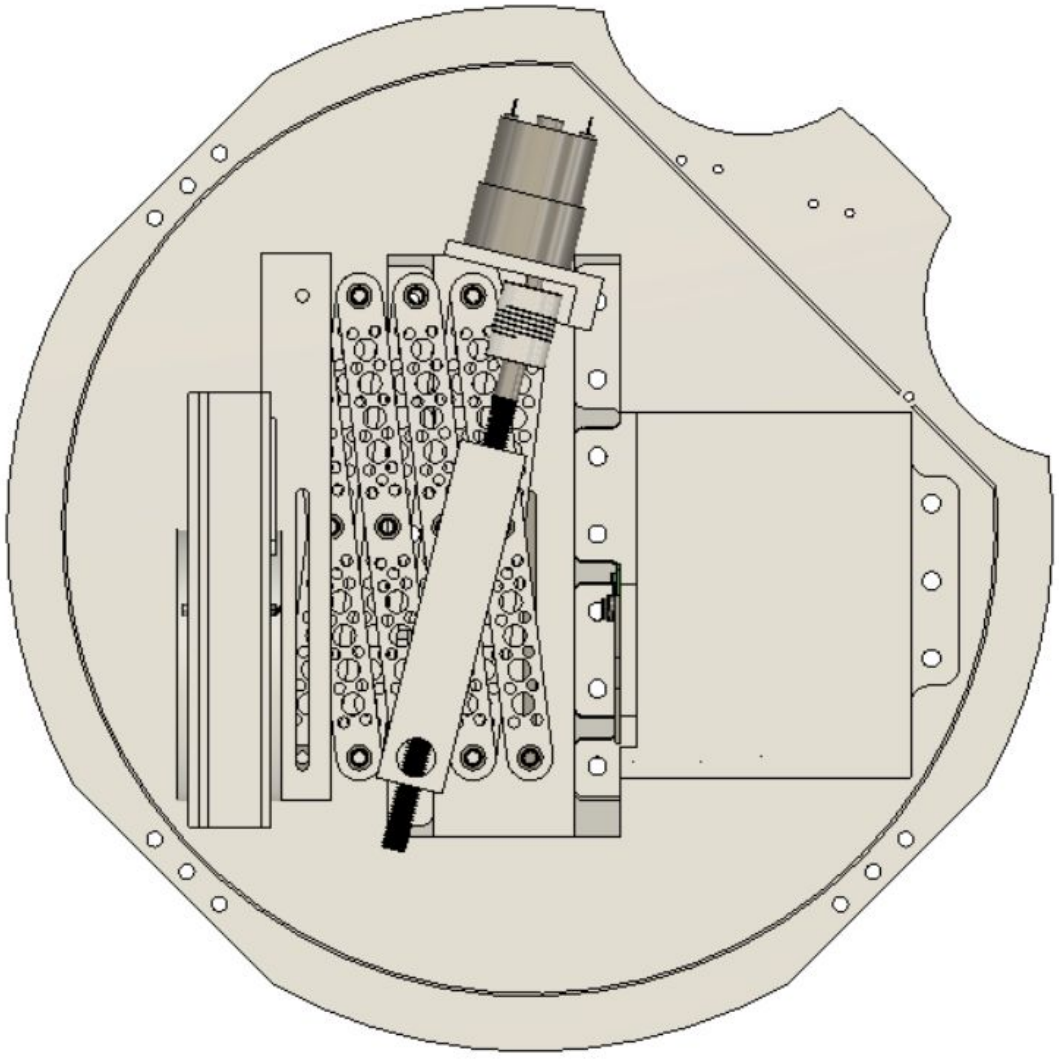
Design Overview



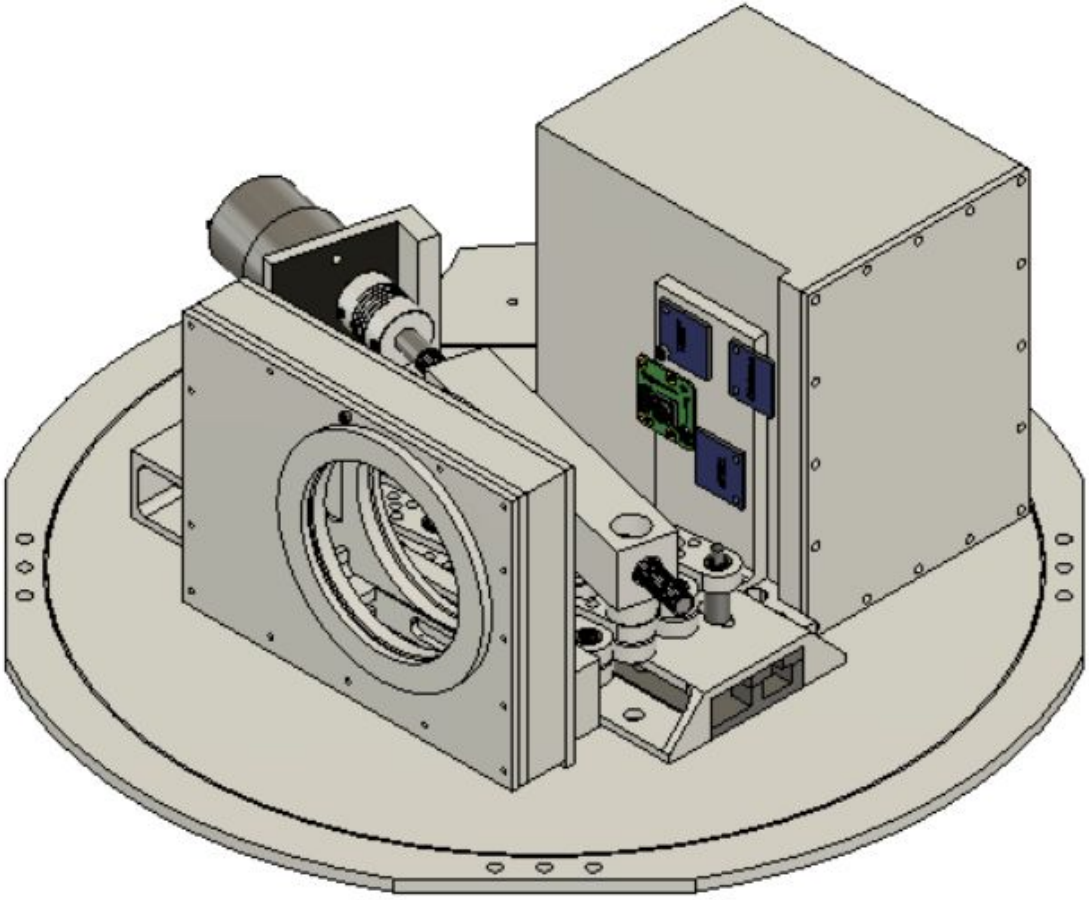
Design Overview



Design Overview



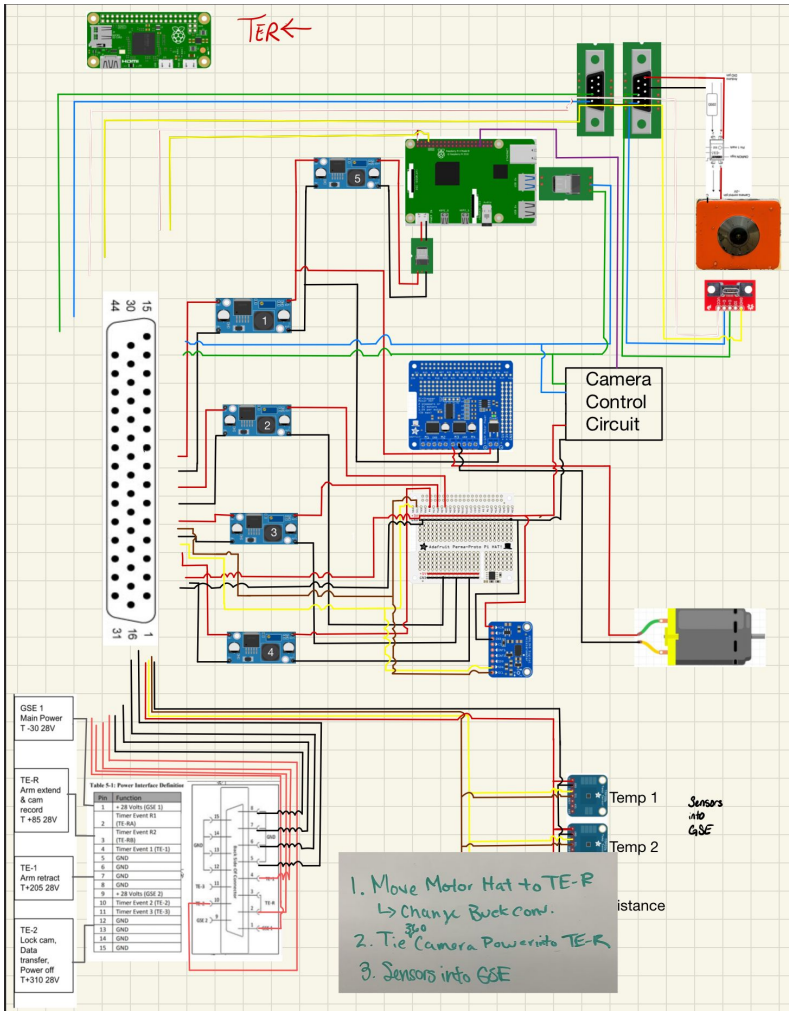
Design Overview



Design Overview

Extension and retraction of arm video

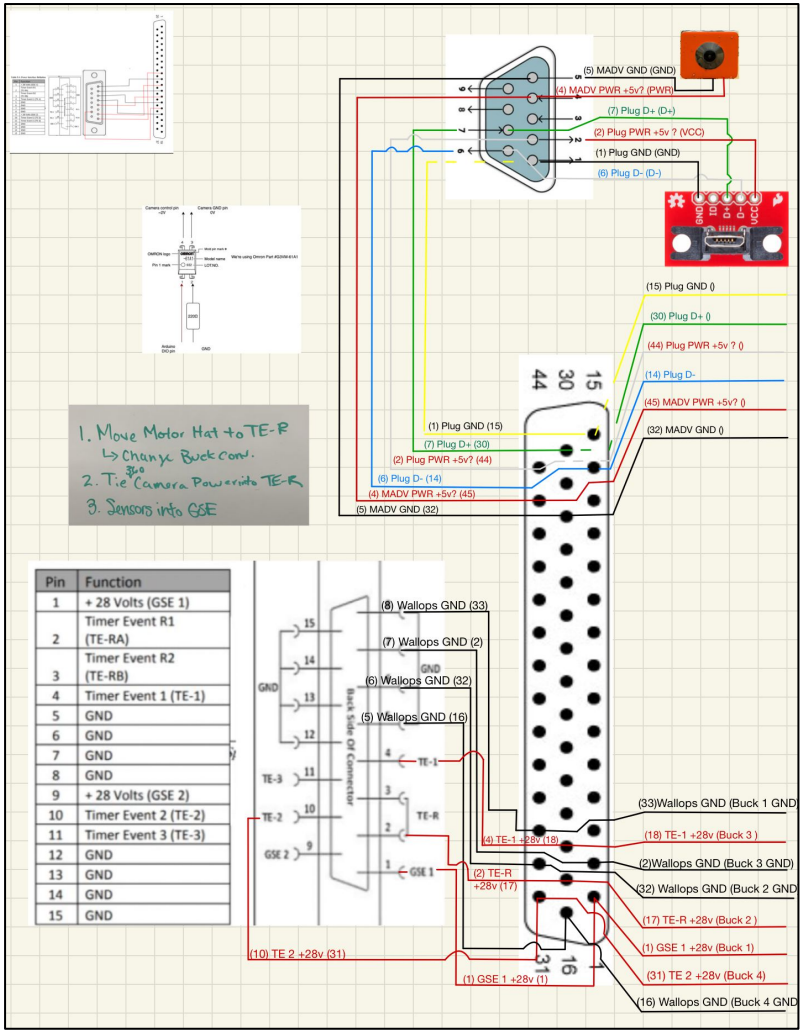
Functional Electrical Diagram



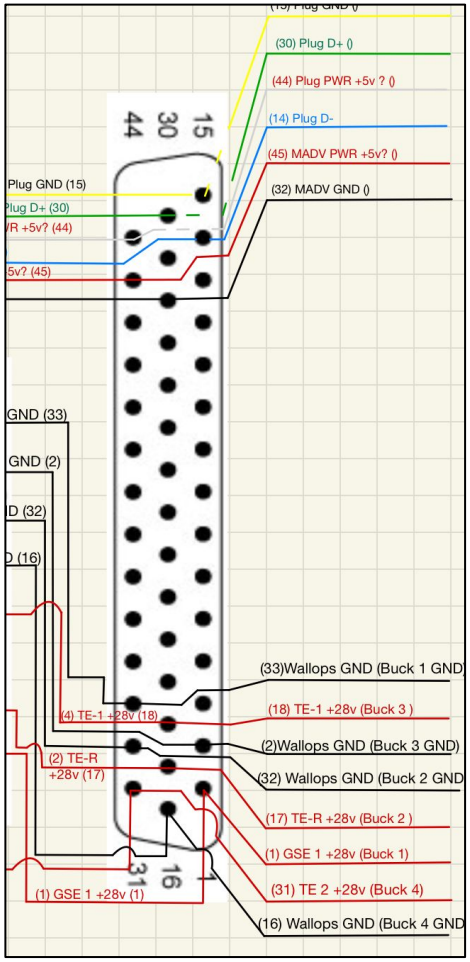
Changes made:

- Motor hat/motor power will come from TE-R line to prevent potential early deployment of arm if tied to GSE line.
- Pi camera will be wired directly to the pi 4, so not Pi Zero will be needed
- Sensors and Raspberry Pi are tied to GSE-1 line instead of TE-R.
- Using a 44 pin dsub instead of 37 pin dsub to accommodate Pi Cam ribbon line pins.

Wiring Harness Diagram



Pin	Function
1	+ 28 Volts (GSE 1)
2	Timer Event R1 (TE-RA)
3	Timer Event R2 (TE-RB)
4	Timer Event 1 (TE-1)
5	GND
6	GND
7	GND
8	GND
9	+ 28 Volts (GSE 2)
10	Timer Event 2 (TE-2)
11	Timer Event 3 (TE-3)
12	GND
13	GND
14	GND
15	GND



- Wiring harnesses are ~75% mapped
- Using IC circuit for MADV control signals
- Using a 44 pin dsub instead of 37 pin dsub to accommodate Pi Cam ribbon line pins.

Hazardous Mechanical Items

Materials

- Sealant - Potting Compound → Used around D-sub connectors

Mechanical Operations

- Arm Extension
  - Extension : 34.5 seconds to fully extend
  - Full extension: 16 in from edge of plate

- Arm Retraction
  - Retraction : 36 seconds to fully retract
  - Arm does not completely retract to starting position, but is within our bounds

Mechanical Interference

- Arm deployment will change the payload CG and MOI

Hazardous Electrical Items

- High voltage items/components
  - None

- Operational hazards
  - MadV Camera has Lithium ion battery (non removable)

De-scopes and Off-ramps

- If we must sacrifice the main camera for any reason, we have planned for the TE-2 timer to schedule a lower-quality video transfer and power down of the system.
- Secondary camera and all sensors can potentially be descoped.
- Our priority will be getting the main camera and arm system working to scope, and then we will incorporate secondary systems if possible

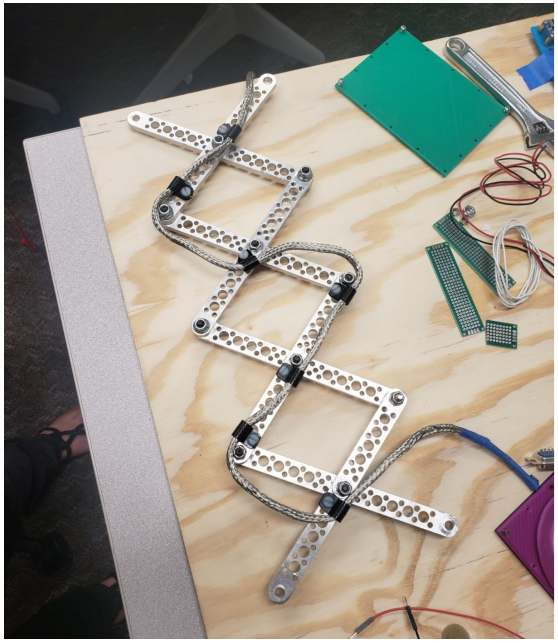
3.0 Subsystem Testing Status

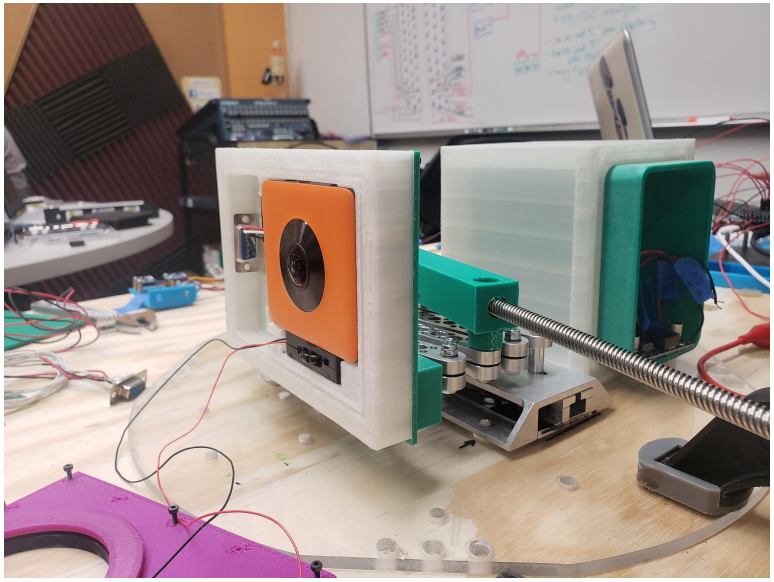
Stacie & Cass

Subsystem Testing Status: Arm

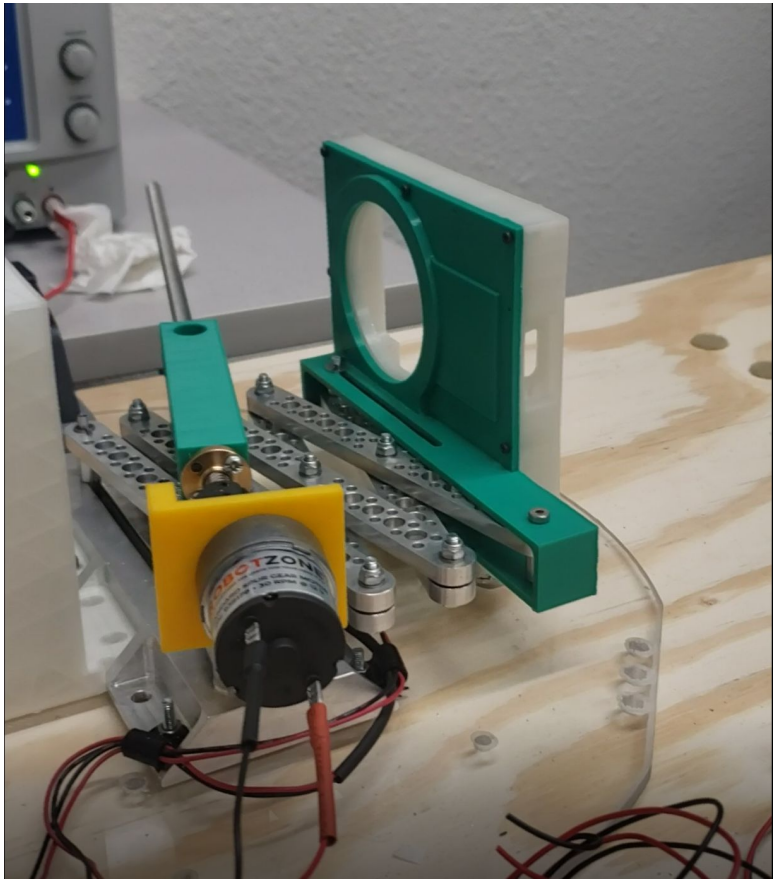
Arm with Motor:

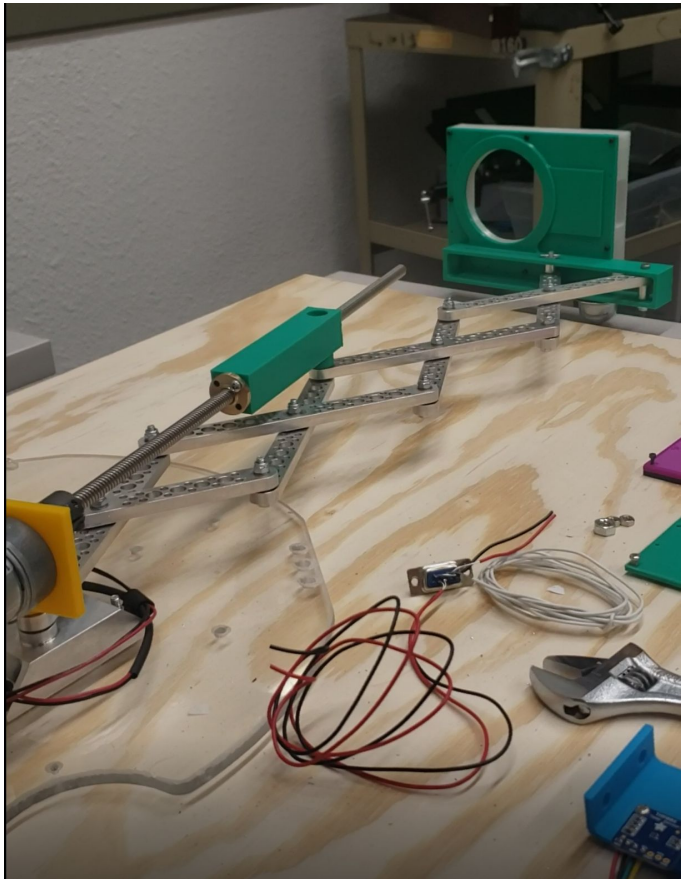
- Arm is moving with 30 rpm motor
- Needs to test with camera mounted and wired down the arm
- Wire management along arm has been tested but not integrated





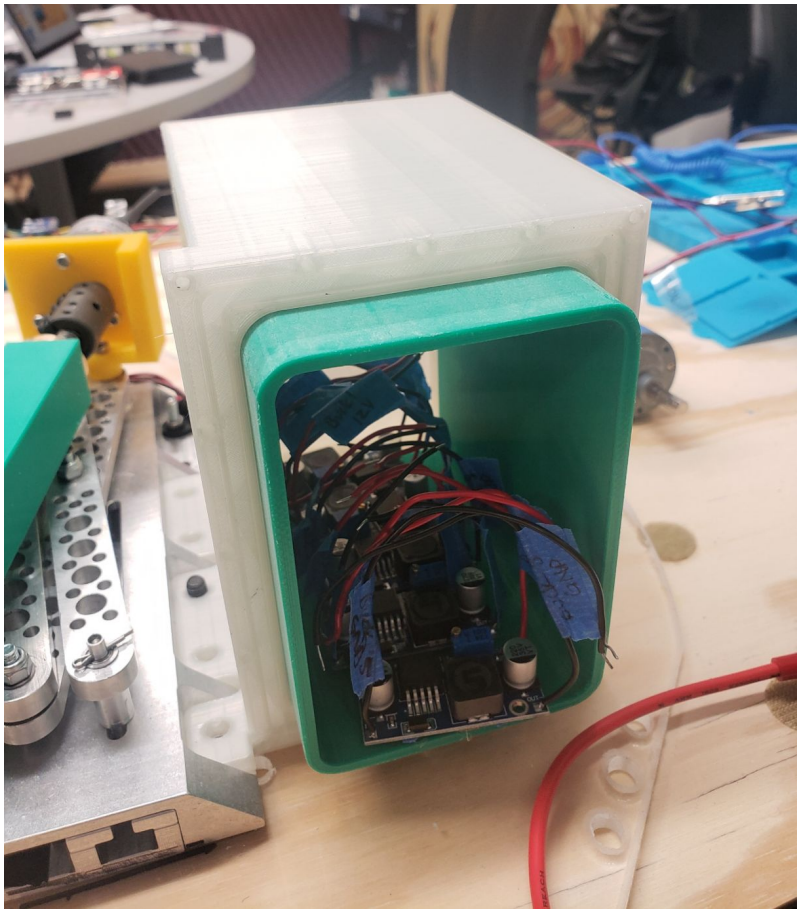
Subsystem Testing Status: Arm





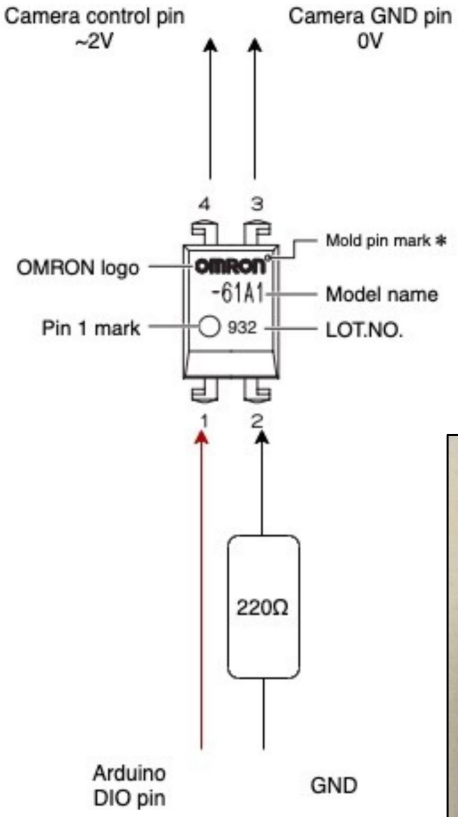
Subsystem Testing Status: Electronics

- Able to fit and mount all needed electronics on E-box sleeve
- Need to verify ESD safety of the proximity of components



Subsystem Testing Status: Camera Circuit

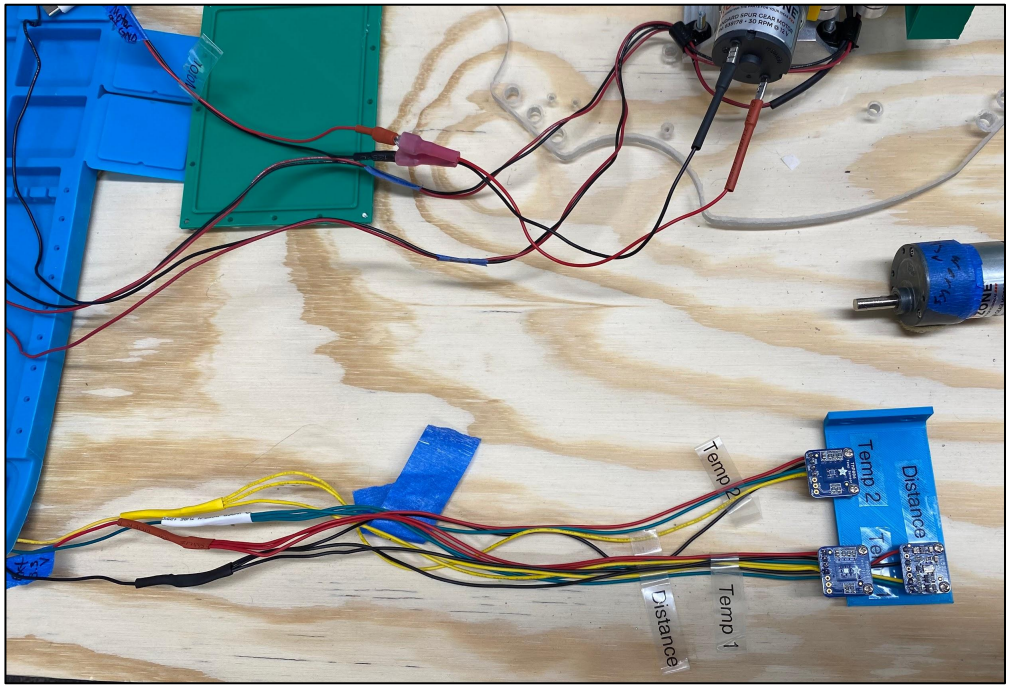
- Able to control MADV with IC circuit, wiring simple
- Not able to download low res video to Pi after integration



We're using Omron Part #G3VM-61A1

Subsystem Testing Status: Sensors/Pi cam

- Code finished and tested and integrated onto flat sat
- Untested on entire system



Subsystem Testing Status: Timing Events

Timing Events

- Implemented Save State
  - Checks for a value 1 -4 on reboot
  - Controlled by buttons - simulates events

Save Functions

```
def dump(): #Save state
    data = [] #data array
    raw = current_state #holder value
    data.append(raw) #add current_state to data array
    file = open ('save_state', 'wb') #open file for writing
    pickle.dump(data,file) #dump information to file
    file.close #close file

def load(): #Load State
    file = open('save_state', 'rb') #open file
    global data #global decleration for other functions
    data = pickle.load(file) #dump infomration to function
    file.close() #close file

def counter():
    cnt = 0 #iteration variable
    global item
    for item in data: #parshing loop
        print('The save state is :', item)
        cnt += 1

def stater():
    dump()
    load()
    counter()
```

State Functions

```
def state1():
        print ("Button 1 Pressed")
        print ("Arm Extension")
        sleep (.1)
        if GPIO.input(limit_2)==1: #Listen for button press
            kit.motor3.throttle = 1 #Throttle forward
            sleep (1) #Pause for limit to set
            while kit.motor3.throttle == 1:
                if GPIO.input(limit_2)==0: #Listen for LIMIT_1 press
                    kit.motor3.throttle = 0 #Stop throttle
                    print ("Starting Camera Script RECORD")
                    sleep (.5)
                    subprocess.call("./camera_scripts/camera_control_on.sh", shell=True)
                    print ("Event 1 End") #call other script
                elif kit.motor3.throttle == 0:
                    break

def state2():
        print ("Button 2 Pressed")
        print ("Arm Retraction")
        sleep (.1)
        if GPIO.input(limit_1)==1: #Listen for button press
                kit.motor3.throttle = -1 #Reverse motor
                sleep(1) #Pause for limit to set
                print ("Camera data script TRANSFER")
                while kit.motor3.throttle == -1:
                    if GPIO.input(limit_1)==0: #Listen for LIMIT_2 press
                        kit.motor3.throttle = 0 #Stop throttle
                        print ("Arm Closesd")
                        print ("Starting Camera Scripts")
                        subprocess.call("./camera_scripts/camera_control_off.sh", shell=True)
                        print ("Event 2 End")
                    elif kit.motor3.throttle == 0:
                        break

def state3():
    print ("Button 3 Pressed")
    print ("simulation shutdown event")
    kit.motor3.throttle = 0 #Set throttle to zero
    #Turn off raspberry pi
    sleep(.5)
    exit
```

Event Logic

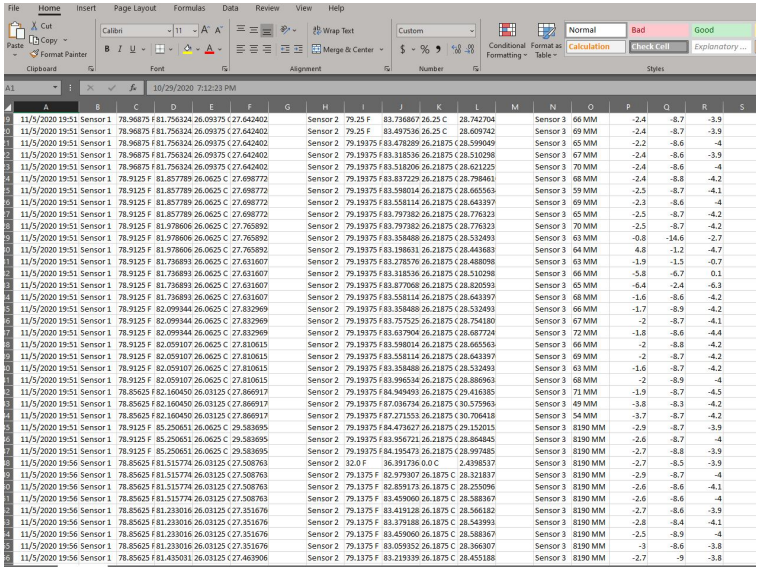
```
while (1):
    if item == 0:
        while (1):
            if (GPIO.input(button1)==0):
                current_state = 1
                stater()
                state1()
            if (GPIO.input(button2)==0):
                current_state = 2
                stater()
                state2()
            if (GPIO.input(button3)==0):
                current_state = 3
                stater()
                state3()
                current_state = 4
                stater()
                break
    elif item == 1:
        while (1):
            if (item == 1):
                current_state = 2
                stater()
                state1()
            if (GPIO.input(button2)==0):
                current_state = 2
                stater()
                state2()
            if (GPIO.input(button3)==0):
                current_state = 3
                stater()
                state3()
                current_state = 4
                stater()
                break
    elif item == 2:
        while (1):
            if (item == 2):
                current_state = 3
                stater()
                state2()
            if (GPIO.input(button3)==0):
                current_state = 3
                stater()
                state3()
                current_state = 4
                stater()
                break
```

Subsystem Testing Status: Programming

Telemetry Module

- Completed code for all the sensors.
- Create storage array for all data.
- Made it possible to transmit data over serial port
- Test it with the yellow box

```
# Function to convert celsius (c) to fahrenhiet.
def TempConversion(c):
    return c * 9.0 / 5.0 + 32

# Function to write data to a .csv file for graphing
def write_sensors(die_1):
    with open("/home/pi/data/Telemetry.csv", "a") as log:
        log.write("{0},{1},{2},{3},{4},{5},{6},{7},{8},{9},{10},{11},{12},{13},{14},{15},{16},{17}\n"
        .format(strftime("%Y-%m-%d %H:%M:%S"),"Sensor 1",str(die_1)+" F",str(obj_1)+" F",str(die_temp)+" C",str(obj_temp)+" C",
        " ","Sensor 2",str(die_2)+" F",str(obj_2)+" F",str(die_temp2)+" C",str(obj_temp2)+" C"," ","Sensor 3",str(distance)+" MM"
        ,str(xAxis),str(yAxis),str(zAxis)))

# Define both Temp Sensors
sensor = TMP006.TMP006()
sensor_2 = TMP006.TMP006()
# Address both Temp Sensors
sensor = TMP006.TMP006(address=0x40, busnum=1) # Default i2C address is 0x40 and bus is 1.
sensor_2 = TMP006.TMP006(address=0x41, busnum =1) # change 3v to ad0

# Default rate is 16 samples per loop.
# Initilize both Temp Sensors
sensor.begin()
sensor_2.begin()

# Loop printing measurements every second.
# Tell where stuff is being stored
print ('Press Ctrl-C to quit.')
print ('Storing data /home/pi/data')
print ('Temperature is in Fahrenheit')
print ('Distance is in MM')
```



Subsystem Testing Status: Primary Camera

Primary Camera

- Full integrated
  - Split script into three parts on, record, data-dump/off

Old Test

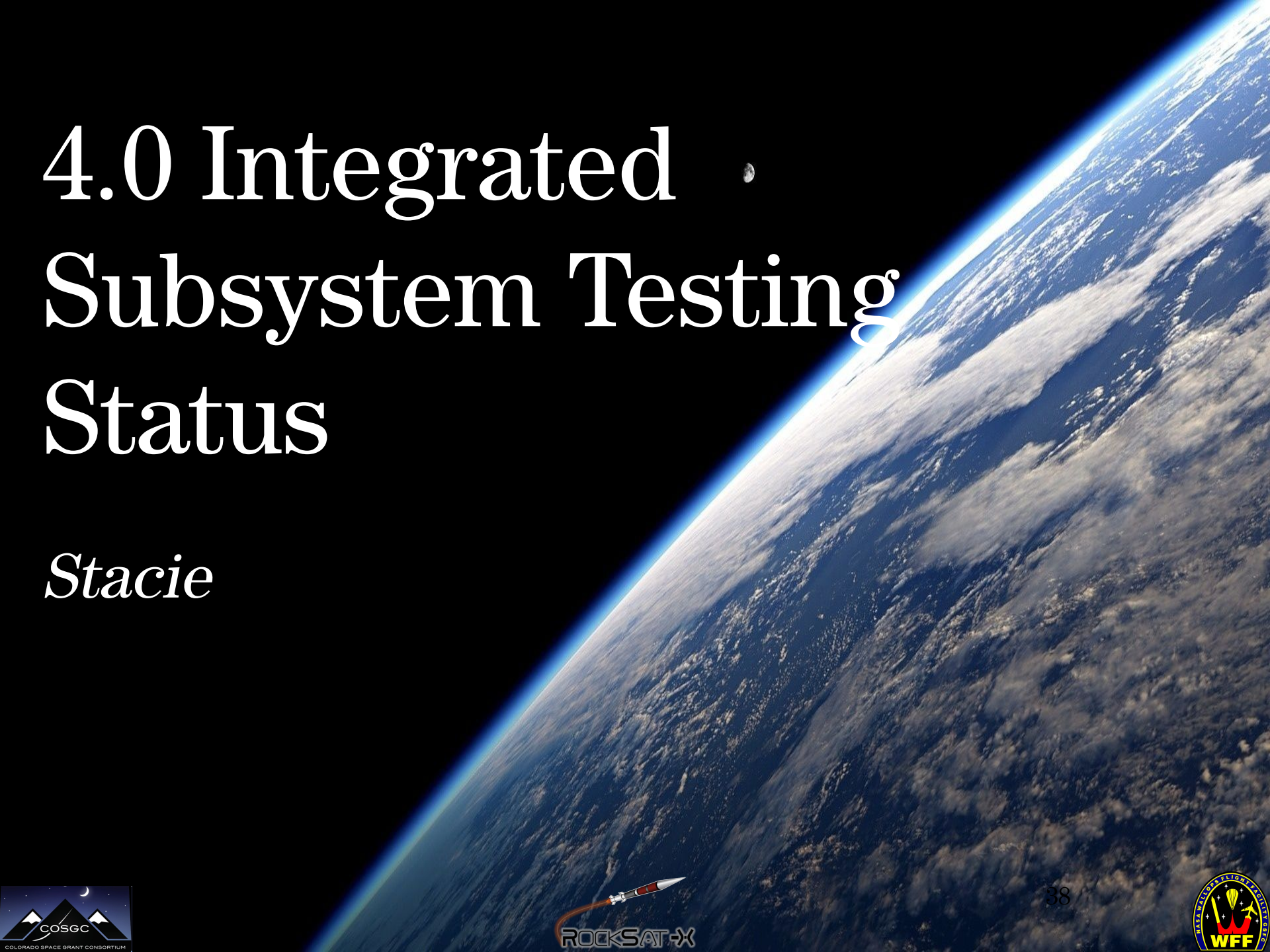
```python
import RPi.GPIO as GPIO
import time

pin = 33
power_on_seconds = 2
set_mode_seconds = 1
record_on_seconds = .5
power_off_seconds = 4
record_time_seconds = 10

time_delay1 = 3
time_delay2 = 8

GPIO.setmode(GPIO.BOARD)
GPIO.setwarnings(False)
GPIO.setup(pin, GPIO.OUT)

print("Powering On.")
GPIO.output(pin, GPIO.HIGH)
time.sleep(power_on_seconds)
GPIO.output(pin, GPIO.LOW)

time.sleep(time_delay2)

print("Setting to Record.")
GPIO.output(pin, GPIO.HIGH)
time.sleep(set_mode_seconds)
GPIO.output(pin, GPIO.LOW)

time.sleep(time_delay1)

print("Recording On.")
GPIO.output(pin, GPIO.HIGH)
time.sleep(record_on_seconds)
GPIO.output(pin, GPIO.LOW)

#Time to record:
time.sleep(record_time_seconds)

print("Turning Off.")
GPIO.output(pin, GPIO.HIGH)
time.sleep(power_off_seconds)
GPIO.output(pin, GPIO.LOW)

#time.sleep(time_delay)

print("Complete.")
```

Power On module

```python
# Uses modifed selfie stick circut
# Turns on power to 360 camera
import RPi.GPIO as GPIO
import time

pin = 33
power_on_seconds = 2
set_mode_seconds = 1
record_on_seconds = .5
power_off_seconds = 4
record_time_seconds = 10

time_delay1 = 3
time_delay2 = 8

GPIO.setmode(GPIO.BOARD)
GPIO.setwarnings(False)
GPIO.setup(pin, GPIO.OUT)

print("Powering On.")
GPIO.output(pin, GPIO.HIGH)
time.sleep(power_on_seconds)
GPIO.output(pin, GPIO.LOW)

#Might not be needed
time.sleep(time_delay2)
```

4.0 Integrated Subsystem Testing Status

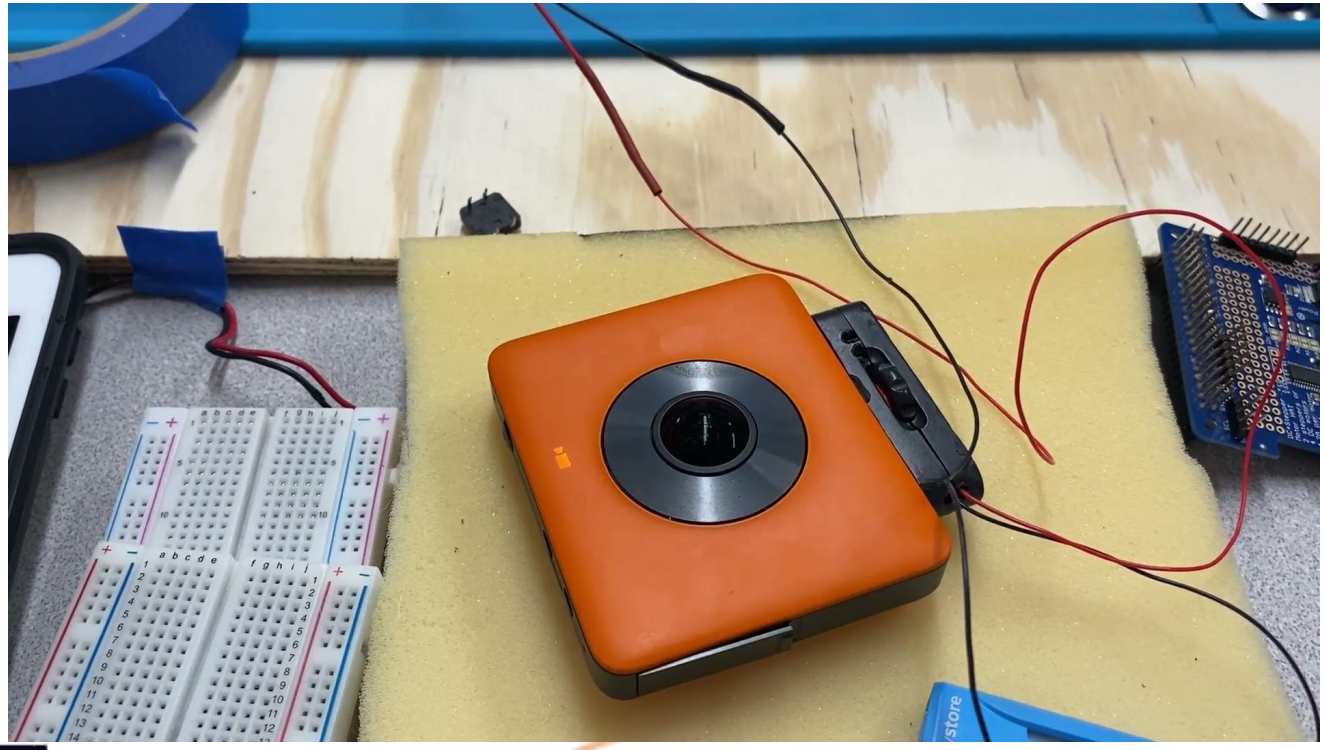
Stacie



Integrated Subsystem Testing Status

Motor, Camera, Programming

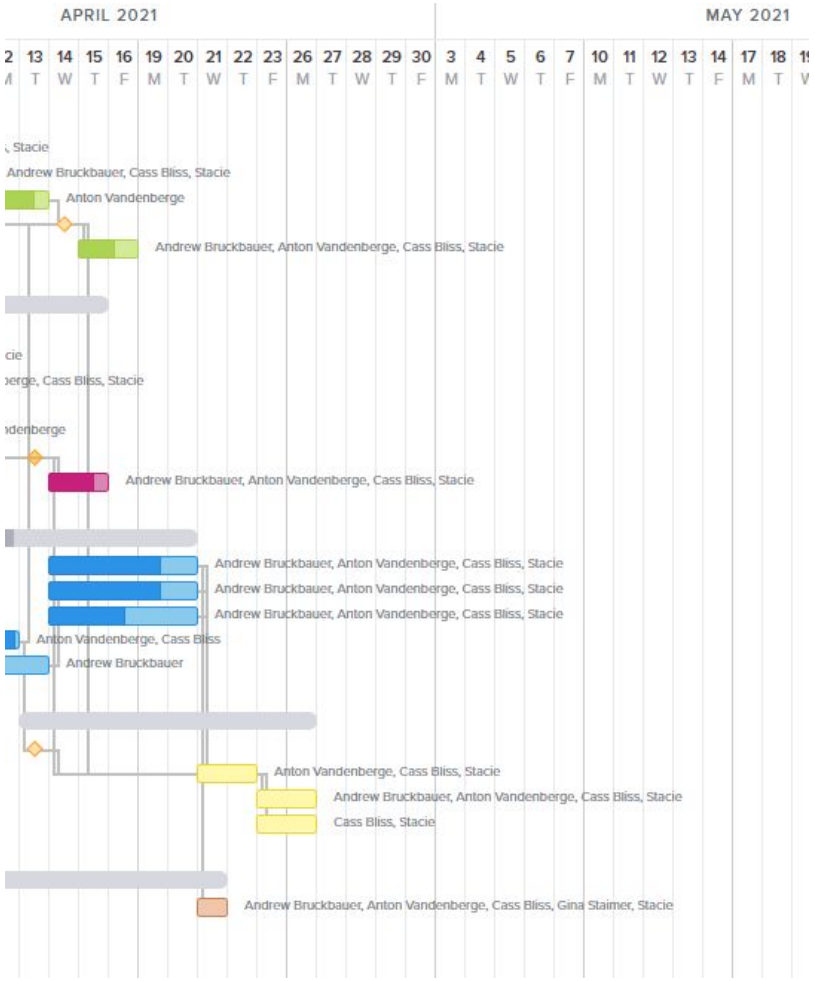
Tested arm extension and retraction, with limit switches. Programming turns on camera after extension, begins recording, arm retracts, camera turns off. We were able to view video captured on app.



5.0 Plan for Full Mission Simulation Review

Stacie

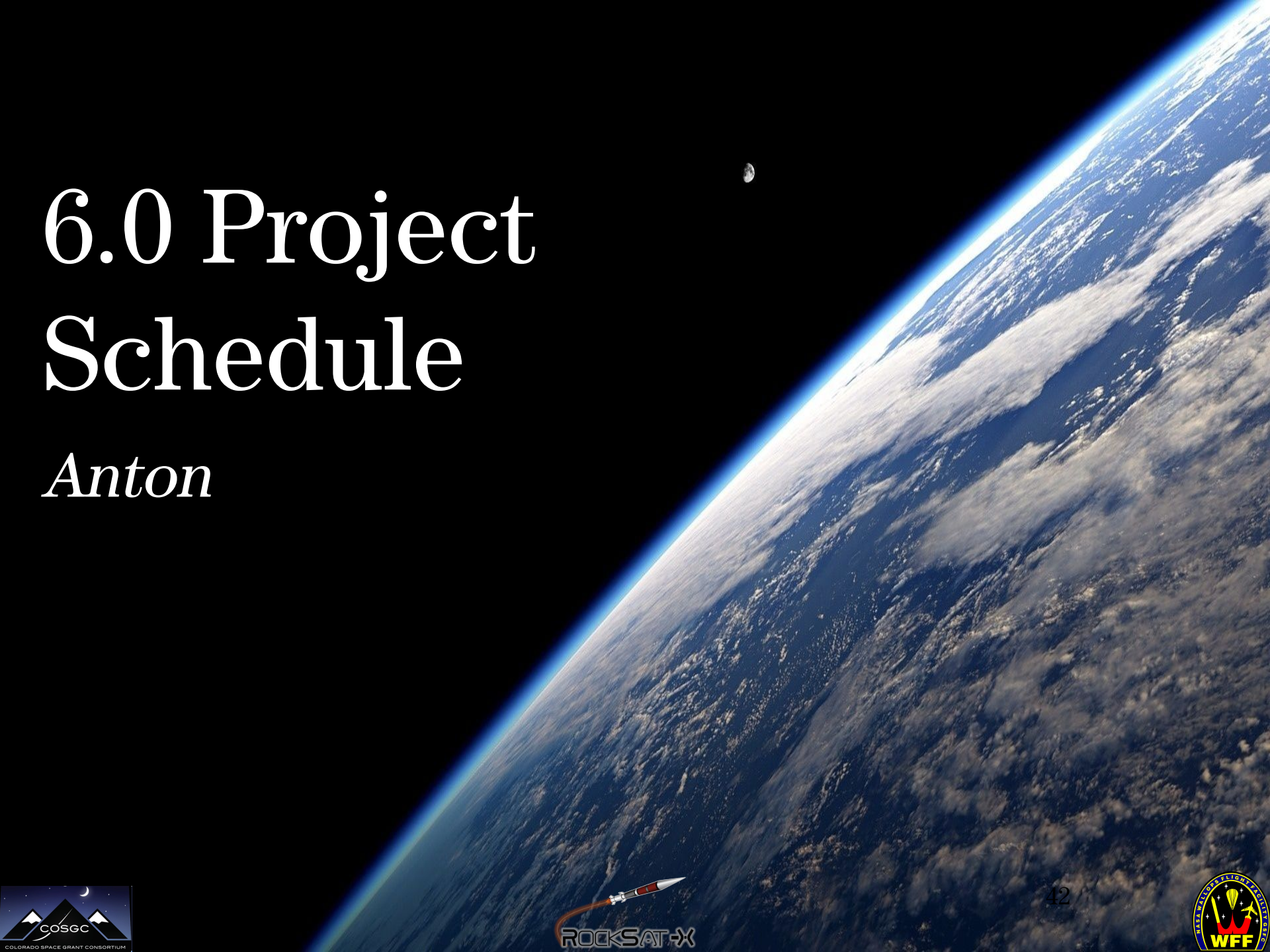
Full Mission Simulation



- Dates will vary based when milled components arrive.
- We are budgeting one week for actual plate integration, but all integrated subsystems will have been repeatedly tested by the time they arrive.

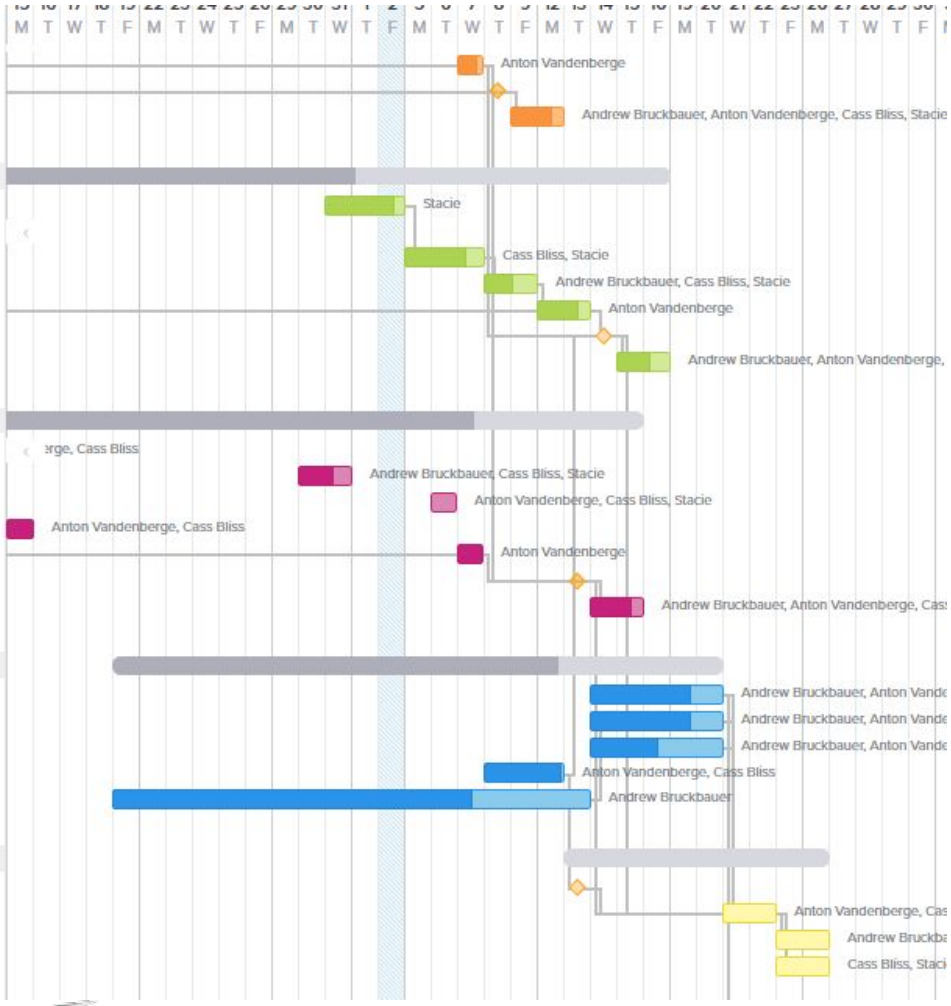
6.0 Project Schedule

Anton



Schedule

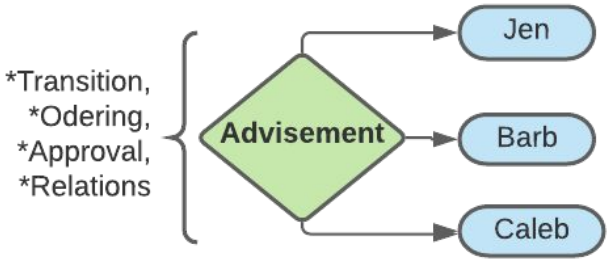
Test w/ 3D Printed Parts	Anton Vandenberge, Cass Bli	100%
Finalize Arm CAD	Anton Vandenberge	100%
Send CAD files for quote	Anton Vandenberge	70%
Get Arm Components Milled		☑
Build and Test Arm mechanism	Andrew Bruckbauer, Anton Va	75%
Electronics Wiring/Box		68%
Pin Out for electrical system	Stacie	85%
Determine D-subs	Stacie	100%
Wire electrical components by system	Cass Bliss, Stacie	75%
Verify sensor/camera functionality	Andrew Bruckbauer, Cass Blis	50%
Complete E-box CAD with wired components	Anton Vandenberge	75%
Get E-box milled		☐
Build and test system	Andrew Bruckbauer, Anton Va	60%
Camera		78%
Print updated camera case	Anton Vandenberge, Cass Bli	100%
Test camera functionality in case	Andrew Bruckbauer, Cass Blis	65%
Test gasket functionality with glass/case	Anton Vandenberge, Cass Bli	0%
Verify camera case mounts on milled arm system	Anton Vandenberge, Cass Bli	100%
Make any changes to camera CAD	Anton Vandenberge	95%
Get camera case milled		☑
Test Camera Case on arm	Andrew Bruckbauer, Anton Va	75%
System Testing		73%
Verify main camera system functionality	Andrew Bruckbauer, Anton Va	75%
Verify Motor and sensor system	Andrew Bruckbauer, Anton Va	75%
Verify secondary camera system	Andrew Bruckbauer, Anton Va	50%
Finalize all CAD	Anton Vandenberge, Cass Bli	95%
Complete Final Programing	Andrew Bruckbauer	75%
Integrated System Testing		0%
Mill Plate		☐
Fit plate with all electronics and components	Anton Vandenberge, Cass Bli	0%
Test entire system with timer events	Andrew Bruckbauer, Anton Va	0%
Complete testing documentation for Integration	Cass Bliss, Stacie	0%

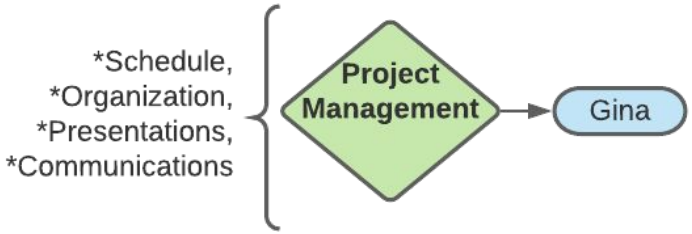


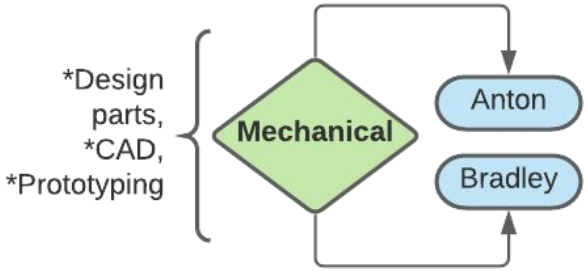
7.0 Project Management

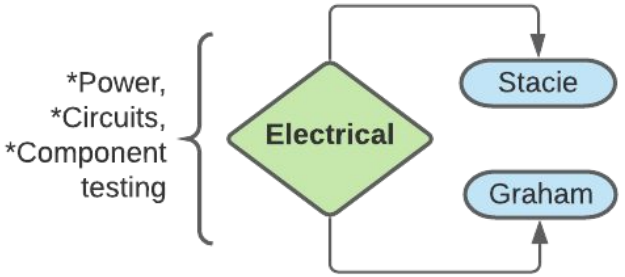
Anton

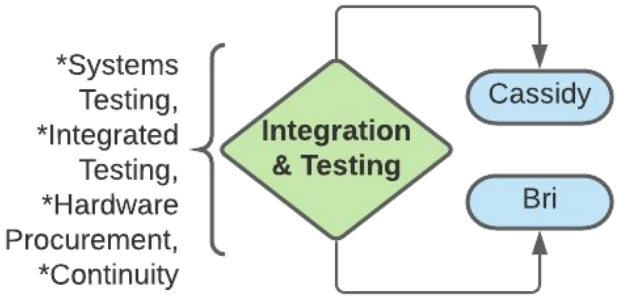
Team Structure

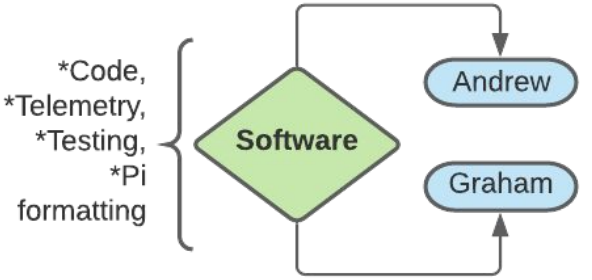












Hardware and Parts Orders

Item #	Name	Cost per unit	Quantity required	Cost total	Link	Notes	Arrived
1	Hardware Organizer	15.97	1	15.97	DEWALT 20-Compartment Pro Small Parts Organizer-DWST14830 - The Home Depot		no
2	Flange Bearings	3.54	70	247.8	MF74ZZ Miniature Ball Bearing Flange RF740-ZZ (onlinebearingstore.com)		no
5	Joint Bolts (inside)	6.83	1	6.83	Medium-Strength Class 8.8 Steel Hex Head Screw, Zinc-Plated, M4 x 0.7 mm Thread, 22 mm Long | McMaster-Carr		yes
6	Joint Bolt nuts	1.41	1	1.41	Steel Hex Nut, Medium-Strength, Class 8, M4 x 0.7 mm Thread | McMaster-Carr		yes
7	Joint Washers	6.29	1	6.29	Steel Oversized Washer, for M4 Screw Size, 4 mm ID, 8 mm OD | McMaster-Carr		no
8	Joint Bolts (ends)	10.35	1	10.35	18-8 Stainless Steel Low-Profile Socket Head Screws, with Hex Drive, M4 x 0.7 mm Thread, 35 mm Long | McMaster-Carr		yes
9	Cotter Pins	7.48	1	7.48	Cotter Pin, 18-8 Stainless Steel, 1.600 mm Diameter, 10 mm Long | McMaster-Carr		yes
10	Ball Bearing	7.49	4	29.96	Stainless Steel Ball Bearing, Shielded, Trade No. 604-2Z, for 4 mm Shaft Diameter | McMaster-Carr		yes
11	Brass Punch Set	24.9	1	24.9	Brass Punch Set, Hammer Bench Block Kit | Gunsmithing, Gun Repair Tools Kit With Steel, Plastic for Armorers, Watch, Jewelry, and Craft - - Amazon.com		no

Hardware and Parts Orders

Item #	Name	Cost per unit	Quantity requir	Cost total	Link	Notes	Arrived
1	DC Motors	34.99	2	69.98	30 RPM Gear Motor - ServoCity	needed spares. one missing and one not working	yes
2	44 Dsub for Ebox Female connector	22.26	2	44.52	A-HDF 44 LL-WP Assmann WSW Components | Connectors, Interconnects | DigiKey	waterproof - for flight	yes
3	44 Dsub for Ebox Male Connector	22.26	2	44.52	A-HDS44LL-WP-R Assmann WSW Components | Connectors, Interconnects | DigiKey	waterproof - for flight	yes
4	44 Dsub practice female connector	7.99	1	7.99	Amazon.com: uxcell D-sub Connector DB44 Female Socket 44-pin 3-Row High Density Port Terminal Breakout for Mechanical Equipment CNC Computers Pack of 4: Industrial & Scientific	for testing and soldering practice	no
5	44 Dsub practice male connector	9.99	1	9.99	Amazon.com: uxcell D-sub Connector Male Plug 44-pin 3-Row Port Terminal Breakout Solder Type for Mechanical Equipment CNC Computers Black Pack of 8: Computers & Accessories	for testing and soldering practice	no
6	15 Dsub practice	7.95	1	7.95	Amazon.com: Pc Accessories - Connectors Pro 10 Pairs DB9 Male and Female D-Sub Solder Type Connector, 20-Pack (10 Male + 10 Female): Electronics	for testing and soldering practice	no
7	Wheels	11.99	1	11.99	Amazon.com: bayite 4 Pack 1" Low Profile Casters Wheels Soft Rubber Swivel Caster with 360 Degree Top Plate 100 lb Total Capacity for Set of 4 (2 with Brakes & 2 Without): Home Improvement	for testing- simulate conditions without weight	no
8	Limit Switch mount bolts	10.42	1	10.42	Black-Oxide 18-8 Stainless Steel Phillips Flat Head Screws, M2.5 x 0.45 mm Thread, 14 mm Long | McMaster-Carr	these are very specific and needed to mount limit switches properly	no
9	Limit Switch mount nuts	1.94	1	1.94	Steel Hex Nut, Medium-Strength, Class 8, M2.5 x 0.45 mm Thread | McMaster-Carr	these are very specific and needed to mount limit switches properly	no
10	Track mounting bolts	11.93	1	11.93	Black-Oxide Alloy Steel Hex Drive Flat Head Screw	holes were not a standard size originally	no
11	Track mounting nuts	11.36	1	11.36	Extreme-Strength Steel Hex Nut, Class 12, M6 x 1	holes were not a standard size originally	no
12	22 G wire - Black	10.99	1	10.99	Solid Hook Up Wire - 22 Gauge, 100 Foot Spool - Black (Shade May Vary) by EX ELECTRONIX EXPRESS - Electrical Wires - Amazon.com	for flat sat and systems wiring	no
13	22 G wire - Red	10.99	1	10.99	Solid Hook Up Wire - 22 Gauge, 100 Foot Spool - Red (Shade May Vary) by EX ELECTRONIX EXPRESS - Electrical Wires - Amazon.com	for flat sat and systems wiring	no
14	Mounting screws for base plate and Ebox	5.65	1	5.65	Black-Oxide Alloy Steel Hex Drive Flat Head Screw, 90 Degree Countersink, M6 x 1.00 mm Thread, 25 mm Long | McMaster-Carr	holes were not a standard size originally	no
15	Sensor mounting screws	4.97	1	4.97	18-8 Stainless Steel Socket Head Screw, M2.5 x 0.45 mm Thread, 5 mm Long | McMaster-Carr	holes were not a standard size originally	no

Hardware and Parts Orders

Item #	Name	Cost per unit	Quantity requir	Cost total	Link	Notes	Arrived	Notes
1	Black-Oxide Allo	7.51	1	7.51	Black-Oxide Alloy Steel Hex Drive Flat Head Screw, 90 Degree Countersink, M2 x 0.40 mm Thread, 10 mm Long | McMaster-Carr	needed spares. one missing and one not working	yes	
2	Coupler	47.13	2	94.26	Machinable-Bore Clamping Shaft Coupling, Steel, for 8 mm x 8.000 mm-6.000 mm Keyed Shaft Diameter | McMaster-Carr	need one for bestter fit no woble	yes	
3	flange bearings	3.54	70	247.8	MF74ZZ Miniature Ball Bearing Flange RF740-ZZ (onlinebearingstore.com)	need extras	yes	
4	linear rod	13.99	1	13.99	HAWKUNG 2pcs 350mm 8mm T8 Stainless Steel Threaded Rod Lead Screw with T8 Nut for 3D Printer Machine Z Axis: Amazon.com: Industrial & Scientific	need extras	n/a	**need to reorder**
5	Flight Wire	56.72	2	113.44	Remington Industries 22STRPTFEKIT 22 AWG Gauge PTFE Wire Kit, Stranded Hook Up Wire, 25' Length Each, 0.0253" Diameter, 600 Volts: Amazon.com: Industrial & Scientific	ran out of PTFE	yes	
6	drill tap countersink	14.5	1	14.5	HAWKUNG 2pcs 350mm 8mm T8 Stainless Steel Threaded Rod Lead Screw with T8 Nut for 3D Printer Machine Z Axis: Amazon.com: Industrial & Scientific	for drilling holes	n/a	**need to reorder**
7	wire conduit	34.84	1	34.84	Amazon.com: Electriduct 1/4" Tinned Copper Metal Braid Sleeving Flexible EMI RFI Shielding Wire Mesh (0.16" Diameter) - 50 Feet: Home Improvement	protect wiring	yes	
8	heat shrink	9.49	1	9.49	https://www.amazon.com/dp/B07QM8249H/ref=sspa_dk_detail_6?psc=1&pd_rd_i=B07QM8249H&pd_rd_w=rpE8d&pf_rd_p=cbc856ed-1371-4f23-b89d-d3fb30edf66d&pd_rd_wg=vDt0G&pf_rd_r=KE8QF2NV8KED5V5D3V1R&pd_rd_r=bff2f883-95b5-4adf-9f1f-d2ff28c5c1f9&spLa=ZW5jcnlwdGVkUXVhbGlmaWVyPUExUUc5TEFNWVBRSlRXJmVuY3J5cHRlZElkPUEwNDY5OTEzMkM0T1ZYRk5FUUk0MCZlbmNyeXB0ZWRBZElkPUEwNTc0NDgwMkc0TDU3MUxXV0dZVCZ3aWRnZXROYW1lPXNwX2RldGFpbF90aGVtYXRpYyZhY3Rpb249Y2xpY2tSZWRpcmVjdCZkb05vdExvZ0NsaWNrPXRydWU=	protect wiring	no	

8.0 Conclusions

Stacie

Conclusion

- Concerned about the camera not being able to focus on the earth (not the rocket)
- Concerned with the code being able to shutdown power the usb so it can record.
- How to get image over serial connection, data transfer solution
- Make sure we can save high quality and low quality simultaneously

Worries and Concerns

Greatest potential failure points with final design

- Waterproofing failure in electrical box or primary camera case
- Raspberry Pi failure
- Inability to change focus on camera FOV after camera has been turned off.

Potential failure mitigation plan

- Extensive testing of waterproofing components upon exposure of payload to extreme conditions
- Repeated testing and Raspberry pi, SD card backups along with extreme safety measures (anti-static transport, grounded mats, etc)