Spaceflight Design Challenge
Subsystem Testing Review

FSU, BRCTC, NASA PAXC, WVU-ARC, & WVU NSBE
Jeffrey Moe, Jeff Reynolds, Ronald Willis, Morgan Cassels, Nicholas Bense, Emily Certain, & Sebastian Reger
February 15th, 2017
Presentation Outline

• Section 1: Mission Overview
• Section 2: Final Design Description
• Section 3: Project Management Update
• Section 4: Hardware Procurement Status
• Section 5: Subsystem Testing Results
• Section 6: Integrated Subsystem Testing Plan
• Section 7: User Guide Compliance
Mission Overview
Mission Overview

● Expected Results
  ○ Real-time tracking of RockSat

● Who will this benefit/what will your data be used for?
  ○ Our data will be verified with NASA’s own telemetry data in order to verify that our system provided coherent and accurate data
  ○ Tracking of propagation data will further knowledge of how RF signals move through our atmosphere
Concept of Operations (Updated)

- t = 2.8 min
  Apogee 72 miles

- t = -30 sec
  All systems on
  transmission & data
collection begin

- t = 15 min
  Turn systems off
  end transmission
Success Criteria (Updated)

• Minimum Success Criteria:
  – Capture of at least one valid (readable) data point for every 10 seconds of flight time.

• Comprehensive Success Criteria:
  – Capture of at least one valid (readable) data point for every second of flight time
Final Design Description

William Howard, Jeffrey Moe, Troy Pallay
Detailed Mass Budget (Update)

- Present your subsystem masses and total mass similar to what is given at right.

<table>
<thead>
<tr>
<th>Subsystem</th>
<th>Total Mass (lb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Novatel OEM729</td>
<td>0.1058</td>
</tr>
<tr>
<td>Rasperry Pi Zero W</td>
<td>0.0198</td>
</tr>
<tr>
<td>GPS Receive Antenna</td>
<td>0.5625</td>
</tr>
<tr>
<td>Transmit Antenna</td>
<td>0.02</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>20</strong></td>
</tr>
<tr>
<td><strong>Over/Under</strong></td>
<td><strong>(0.00)</strong></td>
</tr>
</tbody>
</table>
Hazardous Mechanical Items

• Identify all mechanical components that may hazardous or interfere with other payloads or rocket systems (magnets, transmitters, items that change your CG or MOI during the flight) (if any)
  ○ Transmission antenna, GPS antenna
Updated Power Budget

- Voltages and currents should be included

<table>
<thead>
<tr>
<th>Subsystem</th>
<th>Voltage(V)</th>
<th>Max Current(A)</th>
<th>Time on(min)</th>
<th>Power(W)</th>
<th>Ah</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transmission</td>
<td>3.3</td>
<td>.2</td>
<td>15</td>
<td>.9</td>
<td>.18</td>
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<tr>
<td>GPS</td>
<td>3.3</td>
<td>.17</td>
<td>15</td>
<td>.561</td>
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<tr>
<td>Data Processing</td>
<td>3.3</td>
<td>.17</td>
<td>15</td>
<td>.561</td>
<td>.0425</td>
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<td>Total</td>
<td>.37</td>
<td></td>
<td></td>
<td>1.461</td>
<td>.2225</td>
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<tr>
<td>Total Power Capacity</td>
<td></td>
<td></td>
<td></td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>Over(+)/under(-)</td>
<td></td>
<td></td>
<td></td>
<td>-.7775</td>
<td></td>
</tr>
</tbody>
</table>
Hazardous Electrical Items

• Identify any operational hazards with your electrical design (if any)
  ○ RF Hazards in regards to transmission.
Software Design

• A software terminal node controller called Dire Wolf installed on RPi
• GPS unit will pass telemetry data to RPi and Dire Wolf
  • Data will be recorded and transmitted only during flight
• Data is packetized and transmitted through radio

Dire Wolf github repository
GPS unit turned on and is receiving signal → Flight Timer Initiated → Position and velocity data from GPS unit is passed to RPI → All data logged to disk → Flight Timer expired AND below Flight Altitude

Packet from software TNC is transmitted → Data sent to Dire Wolf software TNC → Data Collection Halted → END
De-Scopes and Off-Ramps

- The scope of the project is still the same.
  - Receive data from GPS Module.
  - Process telemetry information with raspberry pi
  - Transmit information to the base station.
  - Receive information at the base station
  - Receive transmission from other amateur radio clubs.
De-Scopes and Off-Ramps

- The Primary goal of the mission is to process telemetry.
- The secondary mission is to have other radio stations other than the base station also receive transmission data.
- If not enough volunteers want to receive data from the transmission, the secondary mission will not be possible.
- If an adequate GPS module is not available for the project, data could be incorrect.
3.0 Hardware Procurement Status

Jeffrey Moe, William Howard
Mechanical Elements

• What has been manufactured/purchased?
  ○ Raspberry Pi Zero W

• What has not been manufactured or purchased?
  ○ Novatel GPS
  ○ Transmission/Receive antennas
  ○ Multipurpose port solution
Mechanical Elements

- Do you need to make a purchase request?
- Novatel GPS
  - GPS antenna
- Transmission/Receive antennas
Electrical Elements

- What has been manufactured/soldered?
- Custom connectors may need created
- In house materials include test equipment and a complement of radios
- Two antennas need procured: GPS receiver and telemetry transmission
4.0 Subsystem Testing Results

Jeffrey Moe, William Howard, Troy Pallay
Subsystem Overview

- What are your subsystems? (list)
- Receiving - Cameron Hale
- Transmission - William Howard
- Software & Signal Processing - Troy Pallay
Receive

- Quick Status
  - Direwolf correctly processes APRS packets
  - System can receive with a Baofeng radio
  - The RSP1A SDR has not been tested with the system.

- Pictures!😊
Receive

A computer with Direwolf TNC software was used with a dual band amateur radio transceiver to decode ARPS packets in real time.

Next stage is testing with RSP1A and designing ground antennas.

hardware photo
Receive

The tests using the Baofeng with Direwolf were successful.

• direwolf screenshot
Transmission

• Quick Status
  – Direwolf system outputs correctly
  – System can transmit successfully via Baofeng radio
  – Issues may arise while breaking down Baofeng

Progress: 70%
Transmission

- Tests have been completed using a full Baofeng radio
- Next stage is to use as little of the Baofeng as possible
Transmission

- Positive results from Direwolf tests
Software & Signal Processing

Quick Status

- Direwolf software and supporting packages have been installed and are functioning on RPi
- Packets can be received when RPi is connected to Baofeng transceiver
- Packets can be constructed and transmitted from RPi using Direwolf

Progress: 70%
Software & Signal Processing

An RPi unit that has Direwolf TNC software installed has successfully received APRS packets transmitted from another source and can construct packets for transmission. The packets are audible signals travelling through an external USB audio card. A Baofeng transceiver was used as a radio.

*Photo of setup*
System Level Testing

• Present an overview of the tests you need to conduct at the full system level

• Will you test power & mechanical structures in a way that simulate the duration of the flight?
  ○ Run system on the ground for 15 min.
  ○ Physical test of system in canister.

• When will these tests be performed?
  ○ Rocketry Testing in Kansas March 9-11
Project Management Update

Jeffrey Moe
Program Management and Team Updates

- The Team roster is as follows
  - Cameron Hale - Receive
  - William Howard - Transmission
  - Jeffrey Moe - Team Lead
  - Troy Pallay - Software & Interfacing
Organizational Chart
Schedule Update

<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>2/14 - 2/22</td>
<td>Mechanical Design</td>
</tr>
<tr>
<td>2/28</td>
<td>System testing</td>
</tr>
<tr>
<td>3/9-3/11</td>
<td>Rocketry Test</td>
</tr>
</tbody>
</table>

- Are you on schedule?
  - Mechanical Design, delayed due to availability

- Has anything been shifted? Why?

- How will you resolve changes?

- What are your main concerns?
Schedule Update

• Has anything been shifted? Why?

• How will you resolve changes?

• What are your main concerns?
  ○ Mechanical design, GPS unit
Conclusion

• Mechanical design has had setbacks
• GPS unit, antennas, ready to be ordered.

• Recap: Issues, concerns, any questions?
  • Range of rocket?
Mission Overview

Zachary Buchman
Mission Overview

• Our mission is to design and test our systems and payload within the capabilities of this sounding rocket in order to gather scientific results and troubleshoot the package for a longer duration cubesat experiment.

• Our mission requires access to the central power line, and if available, an antenna system for data telemetry.

• Our experiment has three fold potential for significant results, including a microfluidics experiment designed to observe channel occlusion due to protein aggregation, an RNA folding experiment, and synthetic protocell gene expression experiment.

• This data has the potential to benefit NASA’s mission goals of sustained space flight, medical/pharmaceutical research and development, and the field of astrobiology research.
Success Criteria

- Minimum Success Criteria:
  - Functional subsystems for an operational payload and continuous video record of experiments

- Comprehensive Success Criteria:
  - Significant/observable scientific results from all 3 experiments
ConOps

- **High Concentration of N2**
  - $t \approx 1.3$ min
  - Altitude: 75 km

- Systems engaged
  - Camera triggered
  - LED light triggered

- **Microfluidics pumps triggered**
  - RNA and Protocell pumps triggered
  - $t \approx 2.05$ min

- **Apogee**
  - $t \approx 2.8$ min
  - Altitude: $\approx 115$ km

- **End of Orion Burn – Spin Rate Largest**
  - $t \approx 0.6$ min
  - Altitude: 52 km

- **High Tumble Rate**
  - $t \approx 4.0$ min
  - Altitude: 95 km

- Microfluidics pumps stopped
  - RNA and Protocell pumps stopped
  - $t \approx 3.05$ min

- **Low N2, Low spin**
  - $t \approx 5.5$ min
  - Chute Deploys

- **t = 0 min**

- **t = 15 min**
  - Splash Down
  - Camera stopped
  - LED Light stopped
Final Design Description

Zachary Buchman
Changes since the CDR

- The major changes we have implemented since the PDR include the revision of the science payload experiment mechanisms of observation
  - The mini-microscope has been removed from the experiment and replaced with a raspberry pi camera to de-risk the experiment
  - The RNA folding and synthetic protocell experiments will rely upon the camera in conjunction with an LED light source to observe a fluorescence reaction
  - The microfluidics experiment will rely upon payload retrieval to observe if the device has encountered occlusion during flight
- The selection of pumps for the experiments have been refined and narrowed down
- Materials have been selected for the construction of the chassis and containment of the reagents
- The amount of fluid contained in the experiment payload has been reduced
Functional Block Diagram

**Red**: 5VDC power supply for Raspberry Pi

**Orange**: Circuit with 3VDC to be simultaneously powered on at a desired T+

**Maroon**: GPIO connections to supply 3.3V at roughly 15mA to LED

**Yellow**: 5V connection from OBC to pump 1 motor driver at 0.024A

**Blue**: Data transfer from OBC to telemetry interface
Mechanical Design

- Microfluidics Pump 2
- RNA Pump 1
- RNA Pump 2
- RNA Reagent A
- RNA Reagent B
- Proto-cell Reagent B
- Proto-cell Reagent A
- Microfluidics Reagent A
- Microfluidics Reagent B
- Microfluidics Pump 1
- Microfluidics Pump Valve
- Microfluidics Sink
- Microfluidics Flow Lane
- Raspberry Pi and Pi Camera
- Proto-cell Pump 1

Mechanical Design

RNA Observation Tube/Sink

Proto-cell Observation Tube/Sink
Mechanical Design
Mechanical Design
Mechanical Design
## Detailed Mass Budget (Update)

<table>
<thead>
<tr>
<th>Subsystem</th>
<th>Total Mass (lb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>OBC/Camera/LED</td>
<td>0.14</td>
</tr>
<tr>
<td>Pumps/Controller</td>
<td>0.18</td>
</tr>
<tr>
<td>Reagents</td>
<td>0.15</td>
</tr>
<tr>
<td>Containment Chassis</td>
<td>0.68</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1.15</strong></td>
</tr>
<tr>
<td><strong>Under 3 Lb Target</strong></td>
<td><strong>-(1.85)</strong></td>
</tr>
</tbody>
</table>
List of Materials

1. Microcentrifuge Tubes x 7
2. Raspberry Pi Zero x 1
3. Pi Camera x 1
4. PTFE 3 mL vial x 2
5. PLA 3D Printed Containment Chassis x 1
6. Microfluidics Experiment Lane x 1
7. RP-QX Pumps x 4
8. RP-Q1 Pump x 1
9. APP-20RG Pump x 1
10. MNV Valve x 1
11. MPD Microcontroller x 1
12. Silicone Tubing
13. PPS Tubing
14. Containment Chassis Clips/O-Ring
Hazardous Mechanical Items

- This payload contains around 8 mL of fluids, thus we have designed a payload chassis which will contain the fluids in the event of a leak
Electrical Design

Present your **FINAL** Electrical Design in the next few slides.

- Include all **electrical schematics**
- Include **updated** Power Budget
- Identify any high voltage components
- Identify any hazardous electrical items in your design
# Updated Power Budget

## PAXC Power Budget

2/13/18

<table>
<thead>
<tr>
<th>Subsystem</th>
<th>Voltage (V)</th>
<th>Max Current (A)</th>
<th>Time On (min)</th>
<th>Watts</th>
<th>Ah</th>
</tr>
</thead>
<tbody>
<tr>
<td>RNA Pump 1</td>
<td>3V</td>
<td>0.04</td>
<td>1</td>
<td>0.12</td>
<td>0.00067</td>
</tr>
<tr>
<td>RNA Pump 2</td>
<td>3V</td>
<td>0.04</td>
<td>1</td>
<td>0.12</td>
<td>0.00067</td>
</tr>
<tr>
<td>Protocell Pump 1</td>
<td>3V</td>
<td>0.04</td>
<td>1</td>
<td>0.12</td>
<td>0.00067</td>
</tr>
<tr>
<td>Protocell Pump 2</td>
<td>3V</td>
<td>0.04</td>
<td>1</td>
<td>0.12</td>
<td>0.00067</td>
</tr>
<tr>
<td>Microfluidics Pump 1</td>
<td>5V</td>
<td>0.024</td>
<td>3</td>
<td>0.12</td>
<td>0.00012</td>
</tr>
<tr>
<td>Microfluidics Pump 2</td>
<td>3V</td>
<td>0.04</td>
<td>3</td>
<td>0.12</td>
<td>0.002</td>
</tr>
<tr>
<td>Pi Zero w/ Camera</td>
<td>5V</td>
<td>1A</td>
<td>15</td>
<td>5</td>
<td>0.25</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>1.224</td>
<td>25</td>
<td>5.72</td>
<td>0.2548</td>
<td></td>
</tr>
</tbody>
</table>
Hazardous Electrical Items

- Microfluidics Pump 1 is a Piezoelectric drive motor that utilizes a near-sine wave for its drive. This would require conversion of a low DC voltage to a high (30-125) VAC.
- Motor Drive board to accomplish voltage conversion and motor control will likely feature electrolytic capacitor(s) that may cause off-gassing in a vacuum.
- Due to the amount of fluid in the experiments, electrical shortages are a possibility in lieu of a leak. Self-resettable polyfuses are the desired method of isolating any electrical mishap in our equipment to a local level, not affecting any other customer.
The core flight software shall manage the following applications:

- MicroPump Application
- MicroScope Application
- DeOrbiter Application

*Application Data shall be divided based on the needs of the experiment.

Total Disk Space shall be **128GB**

- CFS 65 Mb
- MISC tools (Git, etc.) ~2 GB
- Operative System (Raspbian) 4.5 Gb
- *Application Data ~8 GB*
Software Flow Diagram within cFS

1. Start the application(s)

2. MicroPump Application
   - Start pumps (123 sec)
   - Pump
   - Take picture based on interval
   - Store Data for 777 sec

3. Pi Camera Application
   - Turn on Camera (123 sec)
   - End
Software Flow Diagram within cFS

```c
void pump(int num, char* pins)
{
    gpioInitialise();
    /*Set GPIO pins High*/
    for (i=1; i<num; i++)
    {
        g = atoi(pins[i]);
        gpioSetMode(g, PI_INPUT);
        gpioSetPullUpDown(g, PI_PUD_UP);
    }
}
```
Software Flow Diagram within cFS
Software Flow Diagram within cFS

```
void storeData(int *Pointer)
{
    Input: Pointer
    Save Image
    return status bit
}

Start the application(s)

---

MicroPump Application

Start pumps (123 sec)

---

Pi Camera Application

Turn on Camera (123 sec)

---

Pump

Take picture based on interval

---

Store Data for 777 sec

---

End
```
Software Elements

• A basic program to take pictures from the Pi Zero Camera has been written and tested
• The hardware infrastructure for the Pi Zero has been configured
De-Scopes & Off-Ramps

• One or more of the experiments may be descoped if the payload requires a reduced mass, financial or electrical budget
3.0 Hardware Procurement Status

Zachary Buchman
Mechanical Elements

- The Raspberry Pi Zero Kit and camera have been purchased and assembled
- The pumps and small parts necessary to construct the payload chassis still need to be ordered
- The team has recently received a quote from Takasago Fluidics, who manufactures the pumps we are interested in, and are ready to place our order
- Once the chassis has been 3D printed, the parts to secure the payload items will be purchased
Electrical Elements

- Raspberry Pi has been purchased with a kit including the Pi Camera, protective housing, HDMI, and 5V power cable
- Theorizing and working through an additional PCB to accomplish electrical tasks at a centralized location
  - Polyfuses between WFF power source and experimental instruments
  - Circuit with resistor(s) for the LED(s)
  - Voltage regulator for OBC
  - Hub to connect to WFF power supply inlet
- Prototyping and design are still underway (finalizing and acquiring pumps) but prototyping equipment is possessed by team members and required no additional procurement thus far:
  - Breadboard
  - Digital multimeter
  - Male and Female jumper wires
  - Soldering Iron
  - Extra LEDs to test with
  - Miscellaneous circuit components
4.0 Subsystem Testing Results

Zachary Buchman
Subsystem Overview

- Subsystems
  - Onboard Computer/Camera System
  - Experiment Pump System
OBC/Camera Subsystem

Progress: [Green Check]

- Quick Status
  - The Pi Zero has been assembled and configured
  - Final code for camera has not been written yet
  - Code for pump activation has not been written yet
OBC/Camera Subsystem

- We were able to take some test photos from the Pi Zero/Camera set up
OBC/Camera Subsystem

```
pi@raspberrypi:~ $ ls
oh_the_glamour
pi@raspberrypi:~ $ cd oh_the_glamour/
pi@raspberrypi:~/oh_the_glamour $ ls
picam.py selfie133219.jpg selfie159167.jpg selfie231266.jpg selfie.jpg
pi@raspberrypi:~/oh_the_glamour $ cat picam.py
import picamera
from numpy.random import randint
camera = picamera.PiCamera()
camera.capture('selfietest%d.jpg' % randint(0,500000))
pi@raspberrypi:~/oh_the_glamour $
```
Experiment Payload

Progress: [ ]

- Quick Status
  - Prototype experiments have been conducted without microfluidics pumps
  - Still waiting to order pumps in order to test final experiment design
Experiment Payload

- Separate prototype tests for all 3 experiments were conducted with materials and equipment not specific to payload conditions
Microfluidics Experiment Prototype Test
Microfluidics Experiment Prototype Test

t = 0 min

t = 1 min

t = 2 min

t = 4 min
Microfluidics Experiment Computational Flow Model
We have visualized aptamer fluorescence using blue LED light sources and commercial cell phone cameras at concentrations spanning the range employed in folding experiments. Here, samples A-C were ca. 3 μM in aptamer, and sample D was ca. 300 nM.
Protocell Prototype Test

eGFP production

Sample 1

Sample 2
Experiment Payload

- All 3 tests were successful
- Next phase is to purchase pumps and test with these devices within payload
System Level Testing

• We will fully assemble the payload and run the experiments on the ground to ensure our systems are all running properly
• We are planning to put our payload through some preliminary vibration testing with a paint can shaker to simulate the rocket flight conditions
Project Management Update

Zachary Buchman
Program Management and Team Updates

- We have an open position for Team Lead
  - Will be holding elections on Thursday
- Additions since CDR:
  - Zachary Buchman as Electrical Systems Lead
  - Michael Borden as Computation Systems Lead
  - Calvin Robinson as Software Lead
Organizational Chart

Team Lead
TBD

Mechanical Systems Lead
Andrew Gilstrap

Electrical Systems Lead
Zach Buchman

Software Systems Lead
Calvin Robinson

Computation Systems Lead
Michael Borden

Science Payload Lead
Nicholas Bense
Schedule Update

• We are currently on schedule to have a prototype with all 3 of our experiments tested and the final package assembled by mid-to-late March

• If funding and time permits, we can then look at ways to enhance our current payload design
Worries and Concerns

- Our project is currently over budget by about $406
- We are trying to encourage our collaborators to contribute financially to the construction of the payload subsystems for their respective experiments
- We believe we have established a solid system for fluid leak containment, but still need to assemble and test our approach
Conclusion

• Our immediate action items are to:
  – Order our pumps
  – 3D print our experimental chassis
  – Determine feasibility/logistics of an additional PCB
  – Assemble a working prototype of the final experiment
  – Subject prototype to systems testing and paint can shaker
Mission Overview

Jeff Reynolds
Mission Overview

The mission is to gather flight data from the rocket and analyze post flight to ascertain a baseline for future flights.

Objective

Gather usable data during flight
Process the data post flight
Success Criteria

Minimum success Criteria:
– Collecting the trajectory on a SD card for future analysis

Comprehensive Success Criteria:
– Complete data acquisition through the full flight and relevant for VR model processing
Final Design Description

Jeff Reynolds
Changes since the CDR

• **Removal of data transmission to ground station.**
  
  – Due to time constraints and my partner who is experienced in data transmission not being able to participate, I could not meet the prototyping for the XLR.
  
  – The XLR will be pushed to next year and I will continue to try and understand how to use the device until then.
  
  – Data can still be gathered and processed post flight.
Detailed Mass Budget (Update)

- Overall mass will be less than .5 pounds
Electrical Design
**Updated Power Budget (Example)**

- Voltages and currents should be included

<table>
<thead>
<tr>
<th>Subsystem</th>
<th>Voltage (V)</th>
<th>Max Current (A)</th>
<th>Time On (min)</th>
<th>Watts</th>
<th>Ah</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pos and Trajectory</td>
<td>3.3v</td>
<td>20 mA</td>
<td>8.5</td>
<td>.066</td>
<td>0.00</td>
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<th>Watts</th>
<th>Ah</th>
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</thead>
<tbody>
<tr>
<td>Total</td>
<td>20mA</td>
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<td>2.766</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Total Power Capacity Over (+)/Under (-)</th>
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</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.00</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Date</th>
<th></th>
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<tbody>
<tr>
<td></td>
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</tr>
</tbody>
</table>
Example Software Flow Diagram

**PCB on Rocket**

- Initialize Program
  - Take readings from gyro and accelerometer
    - Take reading from ADXL377
      - Transmit Raw Data
      - Store raw data

**Post Flight**

- Read raw data
  - Plot all movement on all axis
    - Run through modeling software
      - Compare expected flight to gathered data
Software Elements

• All devices are recording data
• Further adjustments to calibrate movements is necessary
De-Scopes & Off-Ramps

- No further De-scopes and off-ramps are available
3.0 Hardware Procurement Status

Jeff Reynolds
Mechanical Elements

- N/A
Electrical Elements

- Proper power switch needs to get designed
- PCB needs to be ordered
4.0 Subsystem Testing Results
Jeff Reynolds
Position Trajectory

- Quick Status
  - System has been developed and tested
  - Yellow - Calibration Testing needs to be completed

Progress: 75%
Position Trajectory

- Testing for proper hook up and data retrieval
- All successful, however logic converters are needed and just arrived 02/11/15
- Pro Mini 3.3 V arrived 02/13/15 so they have not been integrated yet. (this should omit the need for logic converters)
Position Trajectory

- Data is shown, however it was a failure
- Logic level issue that is being worked out.
System Level Testing

- Final logic level tests will occur Friday.
- Pro Mini 3.3 V as well as Logic converters have arrived

- Calibration testing will occur within the next few weeks to fine tune the remaining devices
Project Management Update

Jeff Reynolds
Program Management and Team Updates

• New Members
  Jesse Mazzie
  Roger McDiffitt
  Trevor Schoonover
  Anthony Cardenas
New members have just expressed interest and are not up to speed yet.
Schedule Update

Timeline
• December weeks 2 and 3 – Prototype the components and begin programming
• January – Final code and have it checked by advisor
• February – Test position estimation and create backup code for projected flight path
• March – Test with Aviation department and see if it is tracked properly

• Slightly behind schedule, PCB needs to be finalized. Lack of time to complete and learn Eagle. Outside help is being sought
Worries and Concerns

- Main concern – properly regulating voltage and creating a system that will not fail.

- I am meeting with my professors weekly to design a power regulator.

- Further help in software has been found and they can finalize the software.
Conclusion

• PCB finalization. I will focus on this heavily the next upcoming week.
Space Flight Design Challenge
Subsystem Testing Review

West Virginia University
National Society of Black Engineers

Team Co-Leads: Francis Mbuyamba, Morgan Cassels
Team: Emily Certain, Selorme Agbleze, Kyle Gillis, Lunet Yifru, Ferron Campbell, Chai Smith, Temitope Agboola, Bryant Iriele, Bradlee Cruise, Albert Nunez

2/13/2018
Mission Overview
Mission Overview

• **Mission statement:** Our mission is to gather and store real-time flight data including altitude, temperature, pressure, trajectory, rotation, and speed of the rocket.

• **Mission requirements:** The mission is required to gather data consisting of: altitude, temperature, pressure, trajectory, acceleration and angular velocity.

• We plan to gather a variety of data to better understand the movement and trajectory of rockets.
Mission Overview

Mission Objectives:

• To gather altitude, temperature and pressure values, a BMP 280 Adafruit sensor will be used.

• To determine trajectory and angular rotation, a MMA8451 3-axis accelerometer coupled with a L3G20H 3D gyroscope will be used.

• To calculate the speed values, results from the gyroscope and the BMP 280 sensor will be used.
Expected Results

Final Calculations:

<table>
<thead>
<tr>
<th>Unit</th>
<th>Expected Max Value</th>
<th>Expected Min Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>altitude</td>
<td>115 km</td>
<td>0 km</td>
</tr>
<tr>
<td>temperature</td>
<td>300 K</td>
<td>260 K</td>
</tr>
<tr>
<td>pressure</td>
<td>101.325 kPa</td>
<td>0.0001 kPa</td>
</tr>
<tr>
<td>rotation</td>
<td>336 RPM</td>
<td>0 RPM</td>
</tr>
<tr>
<td>speed</td>
<td>640 m/s</td>
<td>0 m/s</td>
</tr>
<tr>
<td>camera</td>
<td>Continuous video footage of flight</td>
<td>no footage recorded</td>
</tr>
</tbody>
</table>
Success Criteria

• Comprehensive Success: to capture the altitude, temperature, pressure, trajectory, acceleration and angular velocity values that can be stored on the microsd card.
• Record video footage for the duration of the flight
• Minimum Success: to capture one data type without any malfunctions
During the entire flight, altitude data, temperature data, pressure data, trajectory data, rotation data, and speed data will be gathered.
Final Design Description
Changes since the CDR

- We decided to connect the sensors directly to the arduino instead of using a custom PCB
- We decided to add a camera to the payload, and this could require additional power
Block Diagram

Arduino Uno

MMA8451

BMP280

LG320H

SD CARD HOLDER AND SD CARD

CAMERA

external Power
# Mechanical Design – Mass Budget

<table>
<thead>
<tr>
<th>Subsystem</th>
<th>Total Mass (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arduino UNO</td>
<td>25 g</td>
</tr>
<tr>
<td>BMP280</td>
<td>1.3 g</td>
</tr>
<tr>
<td>MMA8451</td>
<td>1.3 g</td>
</tr>
<tr>
<td>L3GD20H</td>
<td>2.8 g</td>
</tr>
<tr>
<td>MicroSD board</td>
<td>3.43 g</td>
</tr>
<tr>
<td>Serv Camera</td>
<td>40.8 g</td>
</tr>
<tr>
<td><strong>Total (g)</strong></td>
<td><strong>74.63g</strong></td>
</tr>
</tbody>
</table>
Mechanical Design - Components

Arduino UNO R3

Adafruit BMP280- Pressure Sensor

Adafruit MMA8451- Accelerometer

Adafruit L3GD20H- Gyroscope

Adafruit MicroSD card breakout board+
Hazardous Mechanical Items

- No hazardous mechanical items, operations, or interferences
Electrical Design

- No high voltage components
- No hazardous electrical items in design
- No operational hazards with electrical design
## Electrical Design - Power Budget

### National Society of Black Engineers - Power Budget 2/13/2018

<table>
<thead>
<tr>
<th>Component</th>
<th>Voltage (V)</th>
<th>Max Current (A)</th>
<th>Time On (min)</th>
<th>Watts</th>
<th>Ah</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arduino UNO</td>
<td>12</td>
<td>0.2</td>
<td>60</td>
<td>2.4</td>
<td>0.2</td>
</tr>
<tr>
<td>Camera</td>
<td>3</td>
<td>0.02</td>
<td>60</td>
<td>0.06</td>
<td>0.02</td>
</tr>
<tr>
<td>BMP280</td>
<td>3.6</td>
<td>0.00000042</td>
<td>20</td>
<td>0.00000151</td>
<td>0.00000014</td>
</tr>
<tr>
<td>MMA8451</td>
<td>3.6</td>
<td>0.000165</td>
<td>25</td>
<td>0.000594</td>
<td>0.00006875</td>
</tr>
<tr>
<td>L3GD20H</td>
<td>3</td>
<td>0.0048</td>
<td>20</td>
<td>0.0144</td>
<td>0.0016</td>
</tr>
<tr>
<td>Micr SD card board</td>
<td>3</td>
<td>0.15</td>
<td>60</td>
<td>0.45</td>
<td>0.15</td>
</tr>
</tbody>
</table>

| Total Power           |             |                 |               | 0.37 Ah   |          |
| Total Power Capacity  |             |                 |               | 1.00 Ah   |          |
| Under                 |             |                 |               | 0.63 Ah   |          |
Software Design

Start

Collect Acceleration data from MMA8451

Calculate inclination

Trajectory is determined from speed and inclination

Calculate Velocity and distance

Altitude is determined from trajectory

Determine which temperature formula to use

Calculate temperature

Collect pressure data from BMP280

Collect angular velocity from L3GD20H

Store data to SD card

End
Software Elements

- We have not completed testing the code with the sensors
De-Scopes & Off-Ramps

• We have decided to not use a custom PCB to better utilize our time.
3.0 Hardware Procurement Status
Mechanical Elements

- All elements have been purchased
- Our parts have recently arrived and we plan to begin the manufacturing process in the next few weeks.
Electrical Elements

- No electrical components have been completely manufactured yet.
- We have decided to not use a custom PCB to better utilize our time.
- We will still need to purchase wires, proto board and soldering equipment.
4.0 Subsystem Testing Results
Subsystem Overview

• What are your subsystems?
  ● Sensor system
  ● Computer and Data system
  ● Structure system
Sensor System, Data System, Structure System

- We have recently received the sensors and Arduino but have not started manufacturing or testing
- We are currently working to program the Arduino

In Progress
System Level Testing

- Each sensor will be tested individually for performance, data, and power consumption.
- We will do vibration testing to test the durability of our final system.
Project Management Update
New members:

- Bryant Iriele - Industrial Engineering
- Bradlee Cruise - Computer Science
- Albert Nunez - Computer Science
Organizational Chart

Co-Lead
Francis Mbuyamba
(Mechanical Engineering)

Lunet Yifru
(Mechanical Engineering)
Ferron Campbell
(Mechanical Engineering)
Chai Smith
(Mechanical Engineering)

Bradlee Cruise
(Computer Science)
Albert Nunez
(Computer Science)
Selorme Agbleze
(Chemical Engineering)

Co-Lead
Morgan Cassels (Industrial Engineering)

Temitope Agboola
(Industrial Engineering)
Kyle Gillis
(Industrial Engineering)
Bryan Iriele
(Industrial Engineering)
Schedule Update

- We are on schedule to meet all of the deliverables deadlines
- Our full schedule is on the upcoming slides
## Schedule Update

<table>
<thead>
<tr>
<th>Start date</th>
<th>Due Date</th>
<th>Task</th>
</tr>
</thead>
<tbody>
<tr>
<td>N/A</td>
<td>3/5-9/2018</td>
<td><strong>Progress Update Telecon</strong></td>
</tr>
<tr>
<td>2/13/2018</td>
<td>3/19/2018</td>
<td>Coding/software - understand basic code syntax and find the ideal structure and flow control methods to complete tasks</td>
</tr>
<tr>
<td>2/13/2018</td>
<td>3/19/2018</td>
<td>construction/ manufacture</td>
</tr>
<tr>
<td>2/13/2018</td>
<td>3/19/2018</td>
<td>soldering</td>
</tr>
<tr>
<td>3/19/2018</td>
<td>3/26/2018</td>
<td>Power breakdown and weight breakdown</td>
</tr>
<tr>
<td>3/19/2018</td>
<td>3/26/2018</td>
<td>Hypothesize expected data</td>
</tr>
<tr>
<td>3/19/2018</td>
<td>3/26/2018</td>
<td>Subsystem Design Testing</td>
</tr>
<tr>
<td>3/19/2018</td>
<td>3/26/2018</td>
<td>Data testing</td>
</tr>
<tr>
<td>3/26-30/2018</td>
<td></td>
<td><strong>Integrated Subsystem Testing Review Teleconference</strong></td>
</tr>
<tr>
<td>3/26/2018</td>
<td>4/9/2018</td>
<td>Final Power testing</td>
</tr>
<tr>
<td>4/9-13/2018</td>
<td></td>
<td><strong>Progress Update Telecon</strong></td>
</tr>
<tr>
<td>4/9 /2018</td>
<td>4/30/2018</td>
<td>Full mission simulation</td>
</tr>
<tr>
<td>5/4/ 2018</td>
<td>5/21/2018</td>
<td>Confirm payload is ready for launch- fix issues found during full mission simulation</td>
</tr>
<tr>
<td>Start date</td>
<td>Due Date</td>
<td>Task</td>
</tr>
<tr>
<td>-------------------</td>
<td>-------------</td>
<td>------------------------------------------------</td>
</tr>
<tr>
<td>5/21-25/2018</td>
<td></td>
<td>Progress Update Telecon</td>
</tr>
<tr>
<td>5/30/2018</td>
<td></td>
<td>Possible Program Telecon</td>
</tr>
<tr>
<td>6/4/2018</td>
<td></td>
<td>Preliminary Check-In Procedure Document Due</td>
</tr>
<tr>
<td>6/4/2018</td>
<td></td>
<td>Launch Readiness Review Document Due</td>
</tr>
<tr>
<td>6/4/2018</td>
<td>6/13/2018</td>
<td>Last minute changes/travel logistics meeting</td>
</tr>
<tr>
<td>6/13/2018</td>
<td></td>
<td>Travel to Wallops Flight Facility</td>
</tr>
<tr>
<td>6/14/2018</td>
<td></td>
<td>Visual Inspections at Refuge Inn</td>
</tr>
<tr>
<td>6/(15-18)/2018</td>
<td></td>
<td>Vibration/Integration at Wallops</td>
</tr>
<tr>
<td>6/20/2018</td>
<td></td>
<td>Presentations to next year’s RockSat</td>
</tr>
<tr>
<td>6/21/2018</td>
<td></td>
<td>Launch Day!!</td>
</tr>
<tr>
<td>7/13/2018</td>
<td></td>
<td>Preliminary Launch Results Document Due</td>
</tr>
<tr>
<td>6/22/2018</td>
<td>7/27/2018</td>
<td>Final Report Due</td>
</tr>
</tbody>
</table>
Conclusion

- We are all working to program the Arduino
- All components arrived this week
- We will begin manufacturing in the near future
Blue Ridge Community & Technical College
Subsystem Testing Review

Ronald Willis, Walter Willis, Zachary Mackinder, Kevin Wilson
2/10/2018
Mission Overview
Ronald Willis
• Mission statement
  – The goal of PiGen2 is to successfully record an accurate vibration profile of the rocket in order to construct a Power Spectral Density report.
  – No special ports are needed.
  – This report will be provided to NASA and future Rock On, RockSat c/x, and CubeSat teams for payload design analysis.
  – The importance behind this research lies in the very nature of experiments onboard a rocket. The harmonic frequency of a mechanical system should never match the driving frequency. When this occurs in a mechanical system catastrophic damage can be the result.
  – We expect to finding a large variation in frequency with some hertz consistency.
• Minimum Success Criteria:
  – Retrieving usable data on one axis.

• Comprehensive Success Criteria:
  – Retrieving usable data on all three axes and retrieving gyroscopic and acceleration data.
Example ConOps

Altitude

Hertz range shrinks
- \( t \approx 1.3 \text{ min} \)
- Altitude: 75 km

Ambient Hertz of rocket at apogee
- \( t \approx 2.8 \text{ min} \)
- Altitude: \( \approx 115 \text{ km} \)

End of Orion Burn – Spin Rate Largest, Hertz range begins
- \( t \approx 0.6 \text{ min} \)
- Altitude: 52 km

High Tumble Rate
- New hertz range
- \( t \approx 4.0 \text{ min} \)
- Altitude: 95 km

Chute Deploys
- \( t \approx 5.5 \text{ min} \)
- Splash Down
- End data collection

natural hertz range of rocket (open or closed) without engine interference
- \( t \approx 0.6 \text{ min} \)
- Altitude: 52 km

Initial and second burn.
- Strongest hertz expected to be seen in this range

Initial and second burn.
- Power engaged upon NASA power up
- All systems on
- Begin data collection
- Accelerometer and Gyroscope will send data until power is turned off.

Altitude
- \( t = 0 \text{ min} \)
- Altitude: 75 km

Altitude
- Altitude: \( \approx 115 \text{ km} \)
Final Design Description

Ronald Willis
Changes since the CDR

- I am currently in the process of communicating with Steminc to find out what is the best fit for PiGen2 in regards to piezo discs.
- Also, We are experiencing 400 mA noise on the experiment that may be caused by RF, so we are going to use small Coaxial cables to shield the system from this interference.
Example Functional Block Diagram

Legend

- Digital Data/Control
- High Voltage
- Low Voltage
- AC Variable Signal

Power

RBF (Wallops)

Yeeco Boost Circuit

Raspberry Pi

Memory Card

ADC

Piezo 1

Piezo 2

Piezo 3

ADIS 6 DOF Gyroscope
Detailed Mass Budget (Update)

• Present your subsystem masses and total mass similar to what is given at right.

<table>
<thead>
<tr>
<th>Subsystem</th>
<th>Total Mass (lbs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raspberry Pi 3 B</td>
<td>0.0925942</td>
</tr>
<tr>
<td>Yeeco Boost Circuit</td>
<td>0.0187393</td>
</tr>
<tr>
<td>ADIS Gyroscope</td>
<td>0.0330693</td>
</tr>
<tr>
<td>Adafruit ADC</td>
<td>0.017637</td>
</tr>
<tr>
<td>Piezo Disc X 3</td>
<td>0.0462971</td>
</tr>
<tr>
<td>...</td>
<td></td>
</tr>
<tr>
<td>...</td>
<td></td>
</tr>
<tr>
<td>Total (lbs)</td>
<td>0.2083368</td>
</tr>
<tr>
<td>Over/Under</td>
<td>N/A</td>
</tr>
</tbody>
</table>
Hazardous Mechanical Items

• No hazardous materials exist within the system.
Electrical Design

Present your **FINAL** Electrical Design in the next few slides.

- Include all *electrical schematics*
- Include *updated* Power Budget
- Identify any high voltage components
- Identify any hazardous electrical items in your design
## BRCTC - Power Budget

<table>
<thead>
<tr>
<th>Subsystem</th>
<th>Voltage (V)</th>
<th>Max Current (A)</th>
<th>Time On (min)</th>
<th>Watts</th>
<th>Ah</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raspberry pi 3</td>
<td>5</td>
<td>.250</td>
<td>15</td>
<td>1.25</td>
<td>0.00</td>
</tr>
<tr>
<td>ADIS Gyroscope</td>
<td>3.15</td>
<td>.044</td>
<td>15</td>
<td>.139</td>
<td>0.00</td>
</tr>
<tr>
<td>Adafruit ADC</td>
<td>3.5</td>
<td>.0000015</td>
<td>15</td>
<td>.00000525</td>
<td>0.00</td>
</tr>
<tr>
<td>Piezo discs</td>
<td>Variable</td>
<td>Variable</td>
<td>Variable</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>0.00</strong></td>
<td></td>
<td></td>
<td><strong>1.38900525</strong></td>
<td><strong>.07350038</strong></td>
</tr>
</tbody>
</table>

Total Power Capacity: 0.00

Over (+)/Under (-): 0.00
Hazardous Electrical Items

- All Piezos produce less than 2 volts.
- No other items are hazardous.
The multi-threaded PiGen program.

- Main program contains shared resources, such as the amount of time the program will be running.
- A main loop controls the usage of the 2 threads.
- Piezo thread computes harmonic data during the launch.
- Gyro thread computes applied forces on the rocket.
Read RTC and use data to append date to filename

Sample hardware reference voltage
Modify software reference voltage from sample

Create current time variable.
Create a loop control variable (+30 minutes from current time)

Generate headers in file

Start

GetData()

Piezo/ADC Thread

Gyro Thread

Stop

Current Time < End Time?

Yes

Data Threads

No

Stop

Start
Software Elements

• The Main program has been cleaned up and simplified from last year.
• The Multiplexor thread has been removed and replaced with a Piezo thread. This thread is in the testing phase and handles 40k data points before writing to the disk for increased performance.
• The Gyroscope thread is still in the process of being designed. Attention has been focused on the Piezo code for the moment as it is the most important subsystem.
De-Scopes & Off-Ramps

• No risks are present. The piezo discs are working as expected. We must figure out the noise issue.
3.0 Hardware Procurement Status

Ronald Willis
Mechanical Elements

• So far we have all but a few parts. We will need a few more piezos and the Yeeco voltage regulator.

• The PCB is currently under design. We were speaking with APC international about piezo choices, so we didn’t want to finalize the shapes and sizes quite yet.

• We will need to make one more purchase request.
Electrical Elements

- Now that we have finalized the Piezos, we will order a few more and complete the PCB for fabrication. Research into the noise issue is currently being conducted.
Piezoelectric Ceramic Discs

• Quick Status – Data Collection

- Below are the piezos recorded over a minutes time. There are peaks and ebbs as I varied the speed of a back massager.

![Graph showing voltage over time]
Piezoelectric Ceramic Discs

- Back Massager Experiment success.
Piezoelectric Ceramic Discs

- The results on the excel sheet captured from the Raspberry Pi show a floating 40 mV noise, while the oscilloscope looked great. We are thinking noise from RF interference is to blame.
ADIS Gyroscope

Progress: 50%

- Data Collection
- Testing on this device is ongoing. We are running tests, but don’t have compiled graphs yet.
ADIS Gyroscope

- We are working on orientation testing and are analyzing data as we speak.
So far the Gyro seems to be reading data as expected, but further analysis will provide clearer answers.
System Level Testing

- A high powered rocket will be used to test the old gyro and raspberry Pi. This payload will launch in mid March. The new Gyro will be tested with handheld manipulation.

- The entire system will be placed on a large massager and readings will be taken. We will verify that no parts come loose.
Project Management Update
Ronald Willis
Program Management and Team Updates

• No one has switched roles.
Example Organizational Chart

- **Team Lead**: Ronald Willis
  - **Software Lead**: Walter Willis
  - **Software**: Kevin Wilson
  - **Faculty Advisor**: Gervase Willis
  - **Mentors**: Gervase Willis, David Teets
  - **Organization**: Mechatronics
  - **Mechanical/Electrical**: Zachary Mackinder
  - **Organization**: BRCTC

- **Lead Mechanical/electrical**: Ronald Willis
Schedule Update

- Testing and noise resolution expected to be completed within 2 weeks. PCB design and fabrication is scheduled to be completed by the end of March. Continuous testing will continue until launch to perfect code.
- We are on schedule to complete all tasks by the end of March.
Worries and Concerns

• The only worry we have stems from the noise we are seeing in the system. We are actively trying to resolve this.
Conclusion

- Solve noise issues and fully test the new ADIS.

- We need to prevent RF interference.
System Overview
Emily Certain
Half Can Subsystems

Our collaborative payload is comprised over several subsystems that are represented by each team’s individual payload along with standard operating subsystems.

- WVU-ARC Payload
- NASA-PAXC Payload
- WVU-NSBE Payload
- FSU Payload
- BRCTC Payload
- Power Distribution System (PDB)
System Overview: Payload Layout

Structural Integration System:
- WVU-ARC
- WVU NSBE
- FSU
- BRCTC
- PAXC

T-3 min activation switch (Wallops)

Power Distribution System:
- Low Voltage 5.0 V
- Voltage Regulation +/- 12V
Using the same mechanical layout for our payload as last year:
   Includes:
   - Makrolon Plates, standoffs, and ballasts

Changes since the CDR:
   - We will be utilizing a mid mounting plate this year
   - We’re changing the layout of payloads and battery size to optimize space and ensure fitting in the canister with the mid mounting plate
Additional Mechanical Drawings

Top Down (Top Plate)               Top down (Bottom Plate)

These outlines are a bit outdated since we have updated the PDB and battery placement, but the idea is the same as last year.
Additional Mechanical Drawings

- WVU-NSBE
- WVU-ARC
- PDB
- FSU Double Stack PCB
- Battery Pack
- PAXC/BRCTC PCB Stack
- Possible PiCam Outreach Payload to the School of the Deaf and Blind
Plan for Subsystem Integration

-To ensure that all team payloads will be able to properly function together and for the length of the flight, we plan on having them all integrated in the half can and connected to the Power Distribution Board for day in the life testing. (This is projected for mid-March depending on the progress of all the teams collectively)

-Major hurdles are going to be geographical challenges, ensuring that all teams are on track, and troubleshooting in the event that there is a malfunction during our testing
## User Guide Compliance

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Status/Reason (if needed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Center of gravity in 1&quot; mid-can</td>
<td>(ballasts to be places strategically with shared can partner to ensure we maintain this compliance)</td>
</tr>
<tr>
<td>Contained in can</td>
<td>Yes</td>
</tr>
<tr>
<td>Connected to can by 4 or 5 bulkheads on top and bottom only</td>
<td>Yes</td>
</tr>
<tr>
<td>Mass at 10±0.2lbs</td>
<td>Yes (Predicted at 5lbs without ballast)</td>
</tr>
<tr>
<td>Shared canister clearance</td>
<td>Yes</td>
</tr>
<tr>
<td>No voltage on the can</td>
<td>None (as of now)</td>
</tr>
<tr>
<td>No voltage on multipurpose port</td>
<td>None (as of now)</td>
</tr>
<tr>
<td>Activation wires at least 4 ft.</td>
<td>Yes</td>
</tr>
<tr>
<td>Activation wire at least 24 gauge</td>
<td>Yes</td>
</tr>
<tr>
<td>Early Activation: current &lt; 1 A</td>
<td>Yes</td>
</tr>
<tr>
<td>Battery Type</td>
<td>LiPo 7.4V 5000mAh (Subject to change as we look for smaller batteries)</td>
</tr>
</tbody>
</table>
Design Overview: Shared Can Logistics

-Since the CDR we have been paired with Delaware, although I have yet to hear back from them since they’re getting back to school later than us
Project Management
Emily Certain
Management: Org Chart

Emily Certain
- Project Manager

Sebastian Reger
- Deputy Project Manager

Jeff Reynolds
- FSU Lead

Jeffrey Moe
- ARC Lead

Ronald Willis
- BRCTC Lead

TBD
- PAXC Lead

Morgan Cassels
- NSBE Lead
<table>
<thead>
<tr>
<th>Date</th>
<th>Event Description</th>
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<tbody>
<tr>
<td>1/25/18</td>
<td>Progress Update Telecon</td>
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<tr>
<td>2/12/18</td>
<td>First Payment Due</td>
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<tr>
<td>2/15/18</td>
<td>Team Lead Deliverables Due</td>
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<tr>
<td>2/25/18</td>
<td>Finalization and Parts Procurement for the Mechanical Structure</td>
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<tr>
<td>3/5/18-3/9/18</td>
<td>Progress Update Telecon</td>
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<tr>
<td>3/26/18-3/30/18</td>
<td>Integrated Subsystem Testing Review</td>
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<tr>
<td>TBD (After ISTR)</td>
<td>Integration of Half Can teams for sizing and power check</td>
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<tr>
<td>4/2/18</td>
<td>Final Payment Due</td>
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<td>4/9/18-4/13/18</td>
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<td>4/30/18-5/4/18</td>
<td>Full Mission Simulation Telecon</td>
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<td>TBD (After FMSR)</td>
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Management: Monetary Budget

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<th>Item</th>
<th>Supplier</th>
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<th>Number Required</th>
<th>Total Cost</th>
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<td>Devices &amp; Components</td>
<td>Various</td>
<td>$500.00</td>
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<td>$2,500.00</td>
<td>5 experiments kept under $500 each</td>
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<tr>
<td>PCBs</td>
<td>Advanced Circuits</td>
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<td>$900.00</td>
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<td>Structural Supplies</td>
<td>McMaster-Carr</td>
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<td>$400.00</td>
<td>Only need 1 set of mechanical parts</td>
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<p>| Total (no margin):    |                  |                          |                 | $3,800.00      |
| Total (w/ margin):    |                  |                          |                 | $4,750.00      |</p>
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Risks & Worries

New:
- Hearing back from our shared canister partners
- Being able to still fulfil canister mechanical part orders on time (gov’t funding)
- Ensuring that all teams order their PCBs in time to allow for possible revisions
- Elon Musk’s Tesla Roadster surviving in space
Conclusion

Overall, the mission of the Space Flight Design Challenge is to collaborate with institutions to foster innovative advancements in space payload design.

We are on schedule despite a few possible setbacks and can’t wait for launch day at Wallops!