Langston University
LUNAR-BC
Critical Design Review

Langston University
12/7/2018
CDR Presentation Contents

• **Section 1: Mission Overview**
  – Mission Overview
  – Theory and Concepts
  – Minimum Success Criteria
  – Mission Requirements (detailed)
  – Expected Results
  – Concept of Operations

• **Section 2: System Overview**
  – Subsystem Definitions
  – System Level Block Diagram
  – Critical Interfaces (ICDs)
  – Ports (if applicable)
  – User Guide Compliance
  – Sharing Logistics (if applicable)
CDR Presentation Contents

- Section 3: Subsystem Design
  - Subsystem A (SSA) (i.e. EPS)
    - SSA Block Diagram
    - SSA Key Trade Studies (1 – 2?)
    - Subsystem Risks/Mitigation
  - Subsystem B (SSB) (i.e. STR)
    - SSA Block Diagram
    - SSA Key Trade Studies (1 – 2?)
    - Subsystem Risks/Mitigation
  - Etc., Etc...
CDR Presentation Contents

• Section 4: Prototyping Plan
  – Item “A” to be Prototyped
  – Item “B” to be Prototyped
  – Etc., Etc…

• Section 5: Project Management Plan
  – Org Chart
  – Schedule
  – Budget
  – Team Contact Matrix
  – Team Availability Matrix
Mission Overview

Kaci Craft
Project Manager
Biological Samples Engineer
NASA Advanced Research In Biology Center
Scholar
Mission Overview – Mission Statement

• Mission statement

► The purpose of participating in RockSat-C is to answer our question of suborbital micro gravity effects on immune cell regulation.

► This project is in conjunction with our existing NASA project investigating natural countermeasures to Astronaut’s immune system dysregulation that is of current interest to NASA.

► The mission is to provide natural supplements (plants and probiotics metabolites extraction) testing in suborbital space to show the effects at a molecular level of gene expression change in activated immune cells.
Mission Overview: Mission Objectives

• Project requirements
  – Building a sounding payload-electronic system
  – Integrate the biological experiment-human immune cells subject to microgravity in space and on the ground and spin in a clinostat for 6 minutes
Theory and Concepts Continued

• Biological Space Payload Experiment
  – The research experiment will involve the exposure of human immune cells to natural supplements that include medicinal plants and probiotics. The products mentioned previously will be used as a countermeasure against immune dysregulation. The sounding rocket will allow for us to test the effects of microgravity on the human immune cells.
What other research has been performed in the past?

Fig. 6 Operational Payload Design

Final CAD Payload Design
Theory and Concepts Continued

- Samples after shipping back to LU (previous year)
Theory and Concepts Continued

Altitude

- $T = -3$
  - G switch triggered
  - All systems on
  - Begin data collection

- $t \approx 1.3$ min
  - Altitude: 75 km
  - Arduino Activates Centrifuge

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

- End of Orion Burn
  - $t \approx 0.6$ min
  - Altitude: 52 km

- $t \approx 5.5$ min
  - Chute Deploys

- $T \approx 7.3$ min
  - Centrifuge is deactivated

- $t \approx 15$ min
  - Splash Down
System Overview

James Harding Jr.

Biological Samples Engineer

NASA Advanced Research In Biology Center Scholar
System Definitions

- **GC**: Geiger Counter
  - Gas filled radiation detectors that operate by using ionizing nature alpha, beta, and gamma radiation.
- **ADMC**: Arduino Microcomputer
  - The brain behind the SHIELD
- **CDH**: Command and Data Handling
  - Commands the subsystems
- **SHD**: SHIELD
  - Integrated components into the five circuits.
- **Elec**: Electronic
  - 8 GB SD card Memory
- **STR**: Structure
  - The Payload Structural Kit
- **8-Channel pressure switch, PS-V8P**
  - Used to insert Phytohaemagglutinin (PHA-L) into biological samples.
- **Mech**: Mechanical
  - Applied mathematics dealing with motion and forces producing motion.
Alterations

- Double Plated SHIELD
  - Space and electronic arrangement
  - The first level on the plate will hold the original payload.
  - The second level is excluded to the centrifuge, speed controller, battery, and the second Arduino board.
  - The changes made to the plate were made to attribute more space in order to conduct our experiment
- PHA-L Injection Valve
  - We will insert capillary tubes into our cryovials in order to inject PHA-L into our cells.
  - The system will be operated by a pressure switch that will be open/closed via Arduino board.
  - The system will use a very small amount of CO2 to operate (~less than 1 PSI).
System Design – Physical Model

2018 Heritage System to be modified
Injection Apparatus (example idea)

The entire apparatus will spin with the centrifuge so the cables don’t tangle.
System Design – Physical Model (example idea)

Closed System (secondary container)

Addition to previous design

8-Channel pressure switch, PS-V8P
Schematics Arduino Mega
Geiger Schematic
Shield Schematic
System Level Block Diagram

Legend
- Sensors
- High Voltage
- Sensors

- G-Switch/CDH
- Brushless Motor
- Temperature Sensor
- Pressure Sensor
- Speed Controller
- Humidity Sensor
- Geiger Counter
- 1 and 2-Axis Accelerometers
- 3-Axis Gyroscope
- WFF Power Interface
- Arduino

RockSat-C 2019
PDR
### Power Budget (previous year)

<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>
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<tbody>
<tr>
<td>STR</td>
<td>0.0</td>
<td>0.00</td>
<td>0</td>
<td>0.00</td>
<td>0.00</td>
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<tr>
<td>DEP</td>
<td>12.0</td>
<td>0.40</td>
<td>2</td>
<td>4.80</td>
<td>0.01</td>
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<tr>
<td>EPS</td>
<td>28.0</td>
<td>0.30</td>
<td>20</td>
<td>8.40</td>
<td>0.10</td>
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<tr>
<td>PM</td>
<td>28.0</td>
<td>0.90</td>
<td>8</td>
<td>25.20</td>
<td>0.12</td>
</tr>
<tr>
<td>...</td>
<td></td>
<td></td>
<td></td>
<td>0.00</td>
<td>0.00</td>
</tr>
</tbody>
</table>

Total: 1.60 Watts, 0.23 Ah

- Total Power Capacity: 1.00
- Over (+)/Under (-): 0.77

# of Flights Margin: 4.3
## RockSat-C 2018 User’s Guide Compliance Example

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Status/Reason (if needed)</th>
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<tbody>
<tr>
<td>Center of gravity in 1&quot; mid-can?</td>
<td>1.2&quot; currently</td>
</tr>
<tr>
<td>Contained in can</td>
<td></td>
</tr>
<tr>
<td>Connected to can by 4/5 bulkheads on top and bottom only</td>
<td></td>
</tr>
<tr>
<td>Mass at 20±0.2lbs</td>
<td>19lb (Currently making 1lb ballast)</td>
</tr>
<tr>
<td>Shared canister clearance</td>
<td>No shared canister (whole canister used)</td>
</tr>
<tr>
<td>No voltage on the can</td>
<td>Checked integrated bottom plate; need top plate still</td>
</tr>
<tr>
<td>Activation wires at least 4 ft and Teflon coated</td>
<td></td>
</tr>
<tr>
<td>Activation wire at least 24 gauge</td>
<td>22 gauge</td>
</tr>
<tr>
<td>Early Activation: current &lt; 1 A</td>
<td>Working on this</td>
</tr>
<tr>
<td>T-0 Activation: current &lt; .1 A</td>
<td>Working on this</td>
</tr>
<tr>
<td>Battery Type</td>
<td>(9) 1.5Volt batteries</td>
</tr>
</tbody>
</table>
Design Overview: Ports

- We will not be using a port
Subsystem Design

Charles Thomas, Jr.
Systems Engineer
Organization chart

All outer hexagon will be integrated into the structure to complete the payload.
Research requirements

• Structure and electronic sounding system will be coming from a heritage Rockon payload project from the previous year.
• ESC (Electronic Speed Controller) - regulates the voltage that is needed to the motor for the centrifuge.
• Brushless Motor – Provides out experiment with centripetal force to mimic gravity.
• Li-On battery – Used to supply power to ESC which limits the power to the motor.
• Arduino – Upload code to start an end the experiment based on
Design decisions in each subsystem

- Each of the 10 subsystem components best fit this application, for the fact of its user friendly capability.
- Integration of components meet space requirements and easy for installation.
Subsystem Design Section

- Geiger counter
- Arduino Microcomputer
- Shield
- 8 GB SD Card
- Pressure sensor
- Temperature Sensor
- LI-On battery
- 8-Channel pressure switch, PS-V8P
- Structure
- Humidity Sensor
- 1-Axis Accelerometer
- 3-Axis Accelerometer
- 3-Axis Gyroscope
- Brushless motor
- Speed controller
Subsystem Design – Subsystem Name

Rotor to Centrifuge

Top View

Isometric View in shades of grey

Side view
Subsystem Design – Subsystem Name

Geiger Counter: Gas filled radiation detectors that operate by using the ionizing nature alpha, beta, and gamma radiation.

Geiger counter was assembled with 54 components and tested.
Subsystem Design – Subsystem Name

- Shield
- Dark green is the shield where certain components will go.

- Pressure sensor
- Temperature sensor
- 3 axis gyro
- 3 axis accel low and med rang
- 1 axis accel in high
Subsystem Design – Subsystem Name

Side View

The plate is where all subsystem components will come together and get mounted.

Top View
Risk Matrix – Subsystem Name

- Risks for the subsystem
- The horizontal represents the likelihood of a risk, the vertical is the corresponding consequence
- Risks placement should help drive mitigation priority

EPS.RSK.1: Mission objectives are not met IF a suitable motor controller cannot be procured
EPS.RSK.2: Mission objectives are not met IF microcontroller fails in-flight
EPS.RSK.3: The EPS system can’t survive launch conditions, and the mission objectives aren’t met
Test/Prototyping Plan

Quiana Mcknight
Biological Sample Engineer
Prototype

We are using the same module which we used in the last years RockOn program.

Our system consists of the following modules:
- Gieger Counter
- Arduino Microcomputer
- SHIELD
- Centrifuge
- 8-Channel pressure switch, PS-V8P

We will be conducting two experiments while in space. One is static and the other we will spin the centrifuge to 189 RPM to mimic 1G of gravity.
Mechanical Elements

- Manufactured parts: Rotor head to the centrifuge will be printed out on a high resolution resin 3D printer.
- Procured: Handling of assembly after transportation.
- testing plan/schedule: Testing plan to start March 1st
Electrical Elements

- Manufactured/soldered: Soldering of Geiger counter of all 54 components.
- Revisions of electronics: 3
- Procured: All printed circuit boards that are attached to the plate.
- Testing plan/schedule: Testing plan to start March 1st
Flight Code Testing

- Centrifuge
  - Flight code Verifications
  - Connection Verifications

- Sounding System
  - Flight code Verifications
  - Connection Verifications
  - Accelerometer
  - Pressure
  - Temperature
  - Gyro
  - Geiger Counter
  - Humidity
  - Retrieve Data
Electrical Testing

• We will use multimeter to test for shorts in the electrical system, this will measure the potential between metallic body of the payload and the battery.
  – We will know if the system passed if we didn’t find any shorts and if the lithium battery has sufficient charge remaining
  – This test will be performed before the end of the semester

• Power Regulation from SSR Pin
• Pull Data
• Input Voltage
  – Battery 1
  – Battery 2

• Grounding
• Flash Memory
• SD Memory
Project Management

Kaci Craft
Project Manager
Biological Samples Engineer
NASA Advanced Research In Biology Center
Scholar
## Management

<table>
<thead>
<tr>
<th>Name</th>
<th>Department</th>
<th>Position</th>
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</thead>
<tbody>
<tr>
<td>James Harding Jr, student</td>
<td>Biology</td>
<td>Biological Sample Engineer</td>
</tr>
<tr>
<td>Kaci Craft, student</td>
<td>Biology</td>
<td>Project Manager, Biological Sample Engineer</td>
</tr>
<tr>
<td>Charles Thomas, student</td>
<td>Technology, CAD</td>
<td>System Engineer</td>
</tr>
<tr>
<td>Quiana Mcknight, student</td>
<td>Biology</td>
<td>Biological Sample Engineer</td>
</tr>
<tr>
<td>Byron Quinn, PhD</td>
<td>Biology</td>
<td>Faculty Advisory</td>
</tr>
<tr>
<td>Christianna Howard, PhD</td>
<td>Biology</td>
<td>Faculty Advisory</td>
</tr>
<tr>
<td>Cari Quick Campbell, MS</td>
<td>Biology</td>
<td>Staff Advisory, CFO</td>
</tr>
</tbody>
</table>

*Subject to change*
Schedule

MWF 5:00 – 6:00 PM

• Working as a group to get a concrete schedule prior to the STR and for spring semester.
• Additional modifications of the design completed
• Experiments with the biological samples will be tested in house
• Test the activation and deactivation of biological samples that will be integrated with subsystems
Budget

• Currently working on a budget for the Geiger Counter and Shield
• We are creating another budget for the centrifuge rotor and the ground experiment
• In addition to the heritage systems an $1000.00 earnest deposit, full canister 12,000.00 canister fee, $4000.00 for supplies, and $4000.00 for travel expenses.
## Team Contact Matrix

<table>
<thead>
<tr>
<th>Name</th>
<th>Email</th>
<th>Department</th>
<th>Position</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kaci Craft, student</td>
<td><a href="mailto:kaci_craft@ymail.com">kaci_craft@ymail.com</a></td>
<td>Biology</td>
<td>Project Manager</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Biological Sample Engineer</td>
</tr>
<tr>
<td>James Harding Jr, student</td>
<td><a href="mailto:jwhardingjr@att.net">jwhardingjr@att.net</a></td>
<td>Biology</td>
<td>Biological Sample Engineer</td>
</tr>
<tr>
<td>Quiiana McKnight, student</td>
<td><a href="mailto:mcknightquiana@yahoo.com">mcknightquiana@yahoo.com</a></td>
<td>Biology</td>
<td>Biological Sample Engineer</td>
</tr>
<tr>
<td>Charles Thomas, student</td>
<td><a href="mailto:cdtjr619@yahoo.com">cdtjr619@yahoo.com</a></td>
<td>Technology, CAD</td>
<td>System Engineer</td>
</tr>
<tr>
<td>Byron Quinn, PhD</td>
<td><a href="mailto:bquinn@Langston.edu">bquinn@Langston.edu</a></td>
<td>Biology</td>
<td>Faculty Support</td>
</tr>
<tr>
<td>Christianna Howard, PhD</td>
<td><a href="mailto:cahoward@Langston.edu">cahoward@Langston.edu</a></td>
<td>Biology</td>
<td>Faculty Support</td>
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<tr>
<td>Cari Quick Campbell, MS</td>
<td><a href="mailto:Cari.quick@Langston.edu">Cari.quick@Langston.edu</a></td>
<td>Biology</td>
<td>Staff Support</td>
</tr>
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</table>
Team Availability Matrix

- Matrix of times during the week when the TEAM is available
  - Team members are available at 4pm/5pm CST

<table>
<thead>
<tr>
<th>MST</th>
<th>MON</th>
<th>TUES</th>
<th>WED</th>
<th>THUR</th>
<th>FRI</th>
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<tr>
<td>5:00</td>
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</tbody>
</table>
Risks and Worries

• What are your biggest worries or potential failure points with your conceptual design?
  – Data Collection
  – Arc Flash
  – Chance of Fire
  – Shortage
  – Biological Samples
  – Vibrations
  – Sample Shipping
Conclusion

LUNARBC is interested in RockSat-C to answer our question of suborbital micro gravity effects on immune cell regulation. This project is in conjunction with our existing NASA project investigating natural countermeasures to Astronaut’s immune system dysregulation that is of current interest to NASA. The mission is to provide natural supplements (plants and probiotics metabolites extraction) testing in suborbital space to show the effects at a molecular level of gene expression change in activated immune cells.