Astrogenomics Sequencing on the Karman-Line (ASK-L)
Subsystem Testing Review (STR)

University of Puerto Rico
Río Piedras Campus
02-18-2019
Mission Overview
Mission Overview: Mission Statement

Our goal is to collect microparticle samples at the Karman Line for post-flight analysis in Astrogenomics research. While searching for significant genetic information from the micrometeorite particles collected, we intend to certify the MinION and the VolTRAX to a TRL-9 (Technical Review Level 9) by performing the amplification and analysis of said genetic information. We intend to contribute to the scientific community by sharing possible findings regarding the genetic information and the TRL-9 certification of the MinION and VolTRAX. This mission should fly on the rocket because it is an interdisciplinary experiment that can bring valuable information in a modern developing field.
Mission Overview: Mission Objectives

• Collection of micrometeorite samples at the Karman Line for post-flight analysis.

• Record high quality 4k Sounding Rocket flight for experiment validation.

• Automated library preparation and analysis of the genetic information collected at the Karman-Line.

• VolTRAX and MinION TRL-9 Certification.
Cross Contamination – Mitigation Protocols

• Before flight mitigation procedure (UPR Remove-Insert Before Flight Procedure 2019.docx)
  – Initial background control sampling
  – OSCAR Deployment Inhibit Removal
  – Electronic Inhibit Verification
  – Background Control Sampling

• Background Lab Assessment & Astrogenomics payload sampling post-RockSat-X flight for DNA detection & Characterization (Protocol Astrogenomic Payload opening.pdf).
  – Johnson Space Center

These documents are in the folder of this presentation
Mission Overview: Relevance

• Nucleic acid sequencing in deep space and in otherwise inaccessible places.
• Highly contaminated/radioactive zones
• Exoplanets and satellite moons
Mission Overview: VolTRAX

• “Oxford Nanopore has developed VolTRAX – a small device designed to perform library preparation automatically, so that a user can get a biological sample ready for analysis, hands-free.”
Mission Overview: VolTRAX
Mission Overview: VolTRAX

• Automated sample and library preparation without human intervention.
  – Including cell lysis
  – By applying a charge, are moved in a programmed path, allowing the separate sample and library preparation processes to be performed sequentially

• Portable PCR

• Programmable
  – Variety of techniques and flexibility
Mission Overview: VolTRAX

- Range of traditional library preparation kits are available
  - Rapid, streamlined protocols
  - Sample multiplexing (multiples samples on a single flow cell)
  - Whole or targeted nucleic acid sequencing

- Reproducible results
  - Equivalent performance on VolTRAX and in tubes

- Whole-genome amplification enables low-input sequencing
  - Increasing the mass of DNA when low inputs of DNA are available.
Mission Overview: VolTRAX Development

- Microparticle collection
  - Using Aerogels deployed in OSCAR

- DNA Extraction & Amplification
  - Using VOLTRAX
  - Library Preparation

- DNA Analysis
  - Using MinION
Mission Overview: VolTRAX Integration

- Pipet up and down 5 times
- Float the rack and tubes in a 56\(^\circ\) C water bath for 10 min. At 5 mins remix by shaking or vortexing.
- Remove the tubes by shaking. Float the rack of tubes in a 100\(^\circ\) C water bath for 6 minutes.
- After the 6 minutes, remove the tubes from 100\(^\circ\) C water bath and shake. Pellet the matrix by spinning for 5 minutes at 6,000 g.
- Using a 200\(\mu\)L pipet tip, remove 170\(\mu\)L.
- Proceed to set up and perform PCR reactions.
Mission Overview: MinION

- DNA or RNA sequencing
- Weighs under 100 grams
- Runs different experiments in sequence on one flow cell
- Runs many experiments on one device
- 1D library preparation can take <10 minutes.
- Has been proven to survive Sounding Rocket Flight and Space Environments from previous flights (RockSat-X 2019).
Mission Overview: Aerogels

• Polyimide aerogels have been previously shown to be good candidates for the collection of micrometeorites due to their unique properties:
  — Extremely low density (~99.8% air)
  — Excellent thermal electrical and thermal insulator
  — Mechanically stronger than silica aerogels
• The total density of particles collected will be estimated using:
  — Trajectory of the collector
  — Density and velocity of micrometeorites at the Karman line
  — Mean free path of the particles in the aerogel
Mission Overview: Aerogels

• We wish to estimate the total mass of particles collected during the flight. The idea is to calculate the total distance \(d\) travelled by the payload while the sample collector is open. This multiplied by the surface area of the aerogels \(A\) and the density of micrometeorites at the Karman line \(\rho\) gives the total mass of particles \(M\) the collector will be in contact with:

\[ M = \rho \times d \times A \]

• The total distance is being estimated using the equations of motion for a projectile in a parabolic arc. We wish to account for the rotation of the payload.
Mission Overview: UV-C Lamps

• The light spectrum of UV Light is between 10 and 400nm.

• The range where ultraviolet radiation can eradicate any type of microorganism is between 100 and 280nm wavelengths. This is known as UV-C.

• 254nm radiation will be used on the payload before flight and during the process of decontamination to remove DNA or RNA of any microorganism.

• Specifically, UV-C decomposes the DNA and RNA of any microorganism in a way that it becomes incapable of replicating. A cell that can’t be reproduced is considered dead since it is unable to multiply.
Mission Overview: Mission Timeline

Mission Time Line
KoeHLer 46.022 Rev B WIP

Event | Time (sec) | Nominal Altitude (km) | Nominal Range (km) | Velocity (m/s) | Mach NO. | Nominal Q (psec) | Flight Elevation (deg) | Event Control | Time Type | Dwell Time (sec)
--- | --- | --- | --- | --- | --- | --- | --- | --- | --- | ---
EXP QSE, backup event | 0.1 | - | - | - | - | - | - | TM | UMF 34.9 | -
UPR TET-1 (Launch indicator) | 0.1 | - | - | - | - | - | - | TM | UMF 335 | -
UPR TET-1 (Launch indicator) | - | - | - | - | - | - | - | TM | UMF 335 | -
ULLN 1 (GEP Pro trigger) | 0.1 | - | - | - | - | - | - | TM | UMF 335 | -
Rail Release | 0.5 | 0.0 | - | 0.0 | 44.2 | 0.1 | 23.1 | 84.0 | - | -
Tenax Burnout | 5.2 | 1.5 | - | 0.2 | 555.1 | 1.6 | 349.8 | 82.9 | - | -
CO2CO2 TET-1 (power to LV) | 5.0 | 3.8 | 3.9 | 3.9 | 4.0 | 434.5 | 1.2 | 165.5 | 82.2 | TM | UMF 320
Imp. Maximum Ignition | 18.0 | 6.7 | - | 0.9 | 283.7 | 0.9 | 332.3 | 89.3 | WITC Cell | DRT 1.0
Imp. Maximum Burnout | 20.7 | 17.7 | - | 2.3 | 1066.7 | 5.2 | 407.7 | 78.8 | - | -
Umd TET-1 (Motor power) | 48.0 | 39.1 | 40.6 | 41.8 | 7.7 | 1488.7 | 4.8 | 510.0 | 77.8 | TM | UMF 200.0
Heat Shed Enable | 66.0 | 65.7 | 68.4 | 71.0 | 14.1 | 1267.5 | 4.3 | 1.8 | 76.1 | TM | UMF 600.0
Deployment (D.O.H) | 68.0 | 70.9 | - | 14.7 | 1248.0 | 4.3 | 1.2 | 73.9 | WITC Cell | DRT 1.0
Payload Separation | 72.0 | 75.6 | - | 15.9 | 1211.8 | 4.2 | 0.6 | 75.5 | WITC Cell | DRT 1.0
ACS-2 Thrust Stopping | 73.0 | 75.6 | 75.6 | 75.6 | 15.9 | 1211.8 | 4.2 | 0.6 | 75.5 | ACS | Electric 12.0
ACS-2 Valve Off | 75.0 | 78.9 | 82.5 | 85.8 | 17.7 | 1158.3 | 4.2 | 0.2 | 74.8 | ACS | Electric End Dwell
GSN Separation | 78.0 | 83.6 | - | 18.0 | 1147.1 | 4.2 | 0.1 | 74.7 | TM | UMF 1.0
UPR TET-2 (event deploy indicator) | 79.0 | 80.0 | 83.6 | 87.0 | 18.0 | 1147.1 | 4.2 | 0.1 | 74.7 | TM | UMF 256.0
Nose Cone Separation | 82.0 | 86.9 | - | 18.9 | 1119.5 | 4.1 | 0.1 | 74.4 | TM | UMF 1.0
ACS-2 Launch to End Maintain Target 1 | 83.0 | 84.1 | 89.0 | 91.6 | 19.2 | 1119.5 | 4.1 | 0.1 | 74.4 | ACS | Electric 225.0
300000 Ft Uplink | 86.3 | - | 91.4 | - | 20.2 | 1086.0 | 4.0 | 0.0 | 73.8 | - | -
CO2CO2 TET-1 (Deployment Activation) | 100.0 | 99.9 | 104.8 | 109.4 | 24.2 | 955.7 | 3.3 | 0.0 | 71.8 | TM | UMF 235.0
ULLN 1 (turn on deployer) | 110.0 | 107.1 | 113.4 | 118.7 | 27.2 | 866.2 | 2.5 | 0.0 | 69.9 | TM | UMF 200.0
ULLN 2 (Secondary MCU) | 110.0 | 107.1 | 113.4 | 118.7 | 27.2 | 866.2 | 2.5 | 0.0 | 69.9 | TM | UMF 200.0
Apogee (356.0) | 168.0 | 137.9 | - | 12.0 | 296.7 | 0.6 | 0.0 | 12.0 | - | -
WV TE-2 (Antenna Deploy) | 195.1 | 137.7 | 148.7 | 159.2 | 52.0 | 292.3 | 0.7 | 0.0 | 1.7 | TM | UMF 118.9
Apogee, Nominal | 197.1 | - | 148.7 | - | 52.2 | 292.1 | 0.7 | 0.0 | 8.6 | - | -
COC TET-1 (power on deck) | 220.0 | 133.8 | 146.2 | 158.2 | 56.8 | 362.8 | 0.9 | 0.0 | 36.1 | TM | UMF 16.0
UK TE-1 (GEP Pro cameras) | 240.0 | 126.4 | 140.1 | 153.3 | 64.5 | 496.2 | 1.1 | 0.0 | 53.7 | TM | UMF 2.0
Umd TET-1 (Ejection) | 250.0 | 126.4 | 140.1 | 153.3 | 64.5 | 496.2 | 1.1 | 0.0 | 53.7 | TM | UMF 2.0
UK TE-2 (DRM doors) | 250.0 | 126.4 | 135.6 | 149.5 | 67.4 | 574.6 | 1.5 | 0.0 | 59.2 | TM | UMF 2.0
UK TE-3 (Ejection) | 255.0 | 118.4 | 133.1 | 147.2 | 68.8 | 615.4 | 1.6 | 0.0 | 61.4 | TM | UMF 2.0
300000 Ft Diverting | 255.0 | 85.7 | 103.9 | 120.6 | 80.5 | 967.3 | 3.4 | 0.0 | 71.9 | TM | UMF 20.0
ACS Start-Up | 258.0 | 75.3 | 81.5 | 108.7 | 84.3 | 1079.9 | 4.0 | 0.0 | 73.3 | ACS | Electronic 40.0
WV TE-3 (Trigger) | 335.0 | 53.1 | 72.2 | 90.8 | 89.4 | 1236.9 | 4.2 | 1.0 | 75.5 | TM | UMF 10.0
ACS Experimental Power Off | 335.0 | 40.9 | 58.9 | 78.9 | 92.4 | 1236.9 | 4.2 | 1.0 | 75.5 | ACS | Electronic 12.0
ACS Vent | 348.0 | 23.4 | 42.4 | 62.1 | 95.3 | 1410.3 | 4.4 | 64.7 | 77.5 | ACS | Electronic 40.0
ACS Values OFF | 368.0 | 3.8 | 7.2 | 12.5 | 103.1 | 297.4 | 0.9 | 53.5 | 82.9 | ACS | Electronic End Dwell
Ballistic Impact (nominal) | 423.0 | - | 103.6 | 125.0 | 0.9 | 331.7 | 0.0 | 82.2 | ACS | Electronic 80.0
Parachute Deploy (nominal) | 479.4 | - | 4.9 | - | - | - | - | - | - | -
Payload Impact | 541.8 | - | 0.0 | - | - | - | - | - | - | -

ACS Events

ACS Events
Mission Overview: Concept of Operations

- All systems on
- Begin data collection

At time $t = 0$ min:
- UV-C Lamps Turn Off

At time $t = 1.3$ min:
- Altitude: 75 km

At time $t = 1.7$ min:
- Altitude: 95 km

Apogee
- At time $t = 3.1$ min
- Altitude: $\approx 150$ km

End of Malemute Burn
- At time $t = 0.6$ min
- Altitude: 52 km

O.S.C.A.R. Deploys
- At time $t = 4.0$ min
- Altitude: 95 km

O.S.C.A.R. Retracts
- At time $t = 4.5$ min
- Altitude: 75 km

End of Malemute Burn
- At time $t = 7.5$ min
- Chute Deploys

Splash Down
- At time $t = 15$ min
Mission Overview: Expected Results

• Confirmation of the pristine micrometeorite sample collection validated by the recording of the sounding rocket in 4k.

• Amplified genetic material from the collected micrometeorites by VolTRAX (automated library preparation).

• Analysis of the genetic material from the collected micrometeorites (automated genetic information analysis by MinION).

• Appropriate functioning of the MinION and VolTRAX as confirmed by the amplification and analysis of the positive control (TRL-9 certification).
Mission Overview: Success Criteria

• Minimum Success Criteria:
  • Video validation of O.S.C.A.R. deployment and retraction.
  • Receive proper telemetry data.

• Comprehensive Success Criteria:
  • VolTRAX survives flight.
  • Vacuum to vacuum sample transfer.
  • Samples analyzed at Johnson Space Center.
## Top Level Requirements:

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Verification Method</th>
<th>Description</th>
</tr>
</thead>
</table>
| The OSCAR collector shall deploy and retract properly sealing the collected samples. | **Demonstration**    | The prism holding the aerogels will be deployed to full length to verify that it does not exceed 3”.
| The computer systems should operate given commands controlling the components of the payload following all time events. | **Test**             | All software routines should run accordingly to the time events of the flight. For reference, see software flow chart. |
| The payload power supplies should always work during flight.                | **Test**             | The system will be subjected to sequence tests and load during full mission simulation. |
De-Scopes and Off-Ramps

• The O.S.C.A.R. subsystem, the power subsystem and the computer subsystem are the highest priority in the payload.

• In case that our newer SL-2 camera is not provided by Leica, we will use our current model SL-601.
System Overview
System Overview: Science Design

- We use a Raspberry Pi-2B as our main flight computer, it includes a 900MHz quad-core ARM Cortex-A7 CPU and 1GB RAM.
- Wi-Fi signals interfere with the rocket’s telemetry signals, for which we avoid newer models, and makes RPi2B the perfect choice.
- The board includes 40 GPIO pin for different purposes which will be programmed with Python, our language of choice. In the pins, there are two 5V & 2 3.3-volt pins which are not configurable.
System Overview: Science Design

- Custom circuit boards will be designed for expanding the Raspberry Pi and to accommodate power supply demand and challenges.
- Thermocouples will be used to monitor the temperature around the payload.
- The motors will be controlled by the Raspberry Pi-2 through the Big Easy Motor Driver connected to the Raspberry Pi board.
- 6 UV-C lamps will be used for decontaminating the surface of the payload.
System Overview: Science Design

- A proximity sensor will be used to confirm skirt separation.
- An UV Sensor will be used to confirm that the UV Lamps turned on and off at the proper time events.
- A Leica SL (Type 601) camera will be used to record high definition 4K footage of the sounding rocket flight for experiment validation.
- A Raspberry Pi Zero will control a smaller secondary camera for backup experiment validation.
- Optocouplers will be used to maintain the internal and external electrical systems separated, protecting most electrical components.
System Overview: Electrical Design

- The 28V provided by the rocket will be converted to 12V and 5V to power the instruments on the payload.
- The 12V is going to be used to power 3 motors that will open and close the collector on the payload that will collect the micrometeorites.
- The 5V conversion will be used to power the Raspberry Pi-2B Board, which will control all the equipment on the payload.
- 1 relay (5V to 12V) will be used to feed three UV boards to control and turn on or off the lights.
System Overview: Electrical Design

Sensor specification:

- Thermocouple amplifier (3V/5V) – can be adjusted for required temperate depending the input voltage. It will allow us to monitor the environment.

- Proximity Sensor (5V) – analog output. Distance to be sensed can be modified depending on the input voltage.

- UV-Light Sensor (5V) – The UV-Light Sensor can read the wavelengths of out UV-Lights in a spectrum of 240-370mm.
System Overview: Electrical Design
Systems Overview: System Changes Since PDR

• Properly defined correct measurements for both electronic enclosures, reducing their total volume and mass.

• A third enclosure has been added for the UV-C boards.

• The O.S.C.A.R. subsystem is being modified to be able to dock with the vacuum chamber at Johnson Space Center for vacuum to vacuum transfer of samples.
System Overview: Payload Design

O.S.C.A.R.
Organic Sample Collector for Astrogenomics Research

UV Enclosure
Includes:
• 3 UV-C Power Supplies

Power Enclosure
• Includes:
  • VHB100W 28V-12V DC-DC Power Converter
  • VHB100W 28V-5V DC-DC Power Converter

Computer Enclosure
• Includes:
  • Raspberry Pi 2B Computer
  • Raspberry Pi Zero Computer
  • 3 Big Easy Motor Drivers

VolTRAX Enclosure
• Includes:
  • Ofoxford Nanopore VolTRAX Sample Preparator

Camera Enclosure
• Includes:
  • Leica SL (Type 601) Camera
  • Leica Elmarit 28mm Lens
System Overview: Payload Top View
System Overview: Payload Bottom View
System Overview: Payload Back View
System Overview: Payload Left View
System Overview: Payload Right View
System Overview: Payload Isometric View
System Overview: Payload Height
System Overview: Payload Center of Mass
## User Guide Compliance: Summary

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Status/Reason (if needed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Center of gravity in 1&quot; plane of plate?</td>
<td>YES, Estimated to be .488&quot;</td>
</tr>
<tr>
<td>Weight 30.0+/- 1.0 (15.0 +/− 0.5) lbs?</td>
<td>YES, Estimated to be 30 lbs.</td>
</tr>
<tr>
<td>Max Height &lt; 10.75” (5.13”)</td>
<td>YES, Currently 8.226”</td>
</tr>
<tr>
<td>Bottom of deck has flush mount hardware?</td>
<td>NO, we request .850” bellow NASA plate</td>
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<tr>
<td>Within Keep-Out Zone</td>
<td>NO, we request to be able to use keep out zone</td>
</tr>
<tr>
<td>Using &lt; 10 A/D Lines</td>
<td>Using 3</td>
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<tr>
<td>Using/Understand Parallel Line</td>
<td>N/A</td>
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<tr>
<td>Using/Understand Asynchronous Line</td>
<td>YES, at 19200 Baud</td>
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<tr>
<td>Using X GSE Line(s)</td>
<td>YES, GSE 1 and GSE 2</td>
</tr>
<tr>
<td>Using X Non-Redundant PWR Lines (TE-1, TE-2, TE-3)</td>
<td>YES, TE-1 and TE-2</td>
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<tr>
<td>Using X Redundant Power Lines (TE-R)</td>
<td>YES, TE-R</td>
</tr>
<tr>
<td>Using &lt; 1 Ah</td>
<td>YES</td>
</tr>
<tr>
<td>Using &lt;= 28 V</td>
<td>YES</td>
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<tr>
<td>Using RF (If yes, list frequency and TX Power)</td>
<td>NO</td>
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<tr>
<td>Using deployable?</td>
<td>YES, Speed is &lt; 1in per second</td>
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<tr>
<td>Whole team consists of US Persons</td>
<td>YES</td>
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<tr>
<td>Using ITAR and/or Export Controlled hardware</td>
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## Power Connector--Customer Side

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<th>Function</th>
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<tr>
<td>1</td>
<td>GSE1</td>
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<td>TE-RA</td>
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<td>5</td>
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## Telemetry Connector--Customer Side

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<tr>
<td>3</td>
<td>UV-C Sensor</td>
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<td>4</td>
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<tr>
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<td>38</td>
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Design Overview: Special Request

• We request a Full Deck Payload.

• We request to be in the Aft position of the rocket, as obtained in previous years. After discussing with some of the scientist from JSC we determined that the aft position is crucial to reducing rocket particulates from contaminating our samples.

• We request availability to build within the keep out area as in previous years.

• We request a depth of 0.850” below the NASA Plate for the lens cover of our camera and the OSCAR collector’s bottom cover as in previous years.
Pointing Request

- Due to O.S.C.A.R. deploying from the aft position, we don’t need a particular orientation for the rocket.
System Overview: Functional Block Diagram

Computer System
- Raspberry Pi 2
- Micro SD Card
- Proximity Sensor
- Stepper Drivers
- Thermocouples
- Optocouplers

Payload Power
- 28-12 V DC-DC
- 28-5 V DC-DC
- Timer Event Voltage Sensor

Organic Sequencing
- VolTRAX

Camera Systems
- Raspberry Pi ZERO
- RP Camera V2
- Leica SL (Type 601)

Organic Collector
- Bio Sterilization
- UV-C LAMPS
- UV SENSOR
- O.S.C.A.R.
- Aerogel
- Operating Mechanism
- Sealing Mechanism
- Stepper Motors

Wallops Power
- GSE 1
- TE-RA
- TE-RB
- TE-1
- GSE 2
- TE-2
- TE-3

Wallops Telemetry
- ADC
- Serial Data

Legend
- Power 5V
- Power 12V
- Power 28V
- Digital
- Telemetry
System Overview: Software Flowchart

Wallops Power (Events)
- Power On
  - T[5]: -240
  - GSE1 and GSE2
- Rocket Launched
  - T[3]: 0
    - TE-1
- Skirt Deployment
  - T[3]: +79
    - TE-2
- Power off in 30
  - T[3]: +325
    - TE-3

Wallops Telemetry
- Serial Data
- ADC

RASPBERRY PI 0
- Program Start
- Camera
  - On
  - Off

RASPBERRY PI 2
- Program Start
  - Print Initial Program Version Info
  - Initialize Internal Clock that starts from -240
  - Turn on UVC-Lamps and VoTRAX
  - Print "Oscar Deployed" with Current Time
  - Print UV Sensor Data
  - Has TE-2 Occurred?
    - No
      - Print "Waiting to Launch" with Current Time.
      - Print UV Sensor Data
    - Yes
      - Print "Flying Time" with Current Time

HAS TE-1 Occurred?
- No
  - Print "Waiting to Launch" with Current Time.
  - Print UV Sensor Data
- Yes
  - Print "Launch" with Current Time

HAS TE-3 Occurred?
- No
  - Print UV Sensor Data
  - Print "Skirt not Cleared" with Current Time
  - Has Skirt Cleared Proximity Sensor?
    - No
      - Payload Powered Off
    - Yes
      - Retract O.S.C.A.R.

- Yes
  - Has TE-3 Occurred?
    - No
      - Payload Powered Off
    - Yes
      - Retract O.S.C.A.R.

RASPBERRY PI 2 Connection Table:
- P: For "Serial Out" from all Print Instructions in PI to Wallops.
- C: To Analog to Digital Converter.
- U: From PI to UVC-Controller.
- V: From PI to VoTRAX
  - 1: From TE-1 to Raspberry PI 0.
  - 2: From PI 2 to 3 Motors to Deploy OSCAR.
  - 3: From TE-3 to Raspberry PI 0.

Computer System
- Thermocouples
- Proximity Sensor

Biosterilization
- UVC-Lamps
- UV Sensor

O.S.C.A.R.
- Motor 1
- Motor 2
- Motor 3

VoTRAX

Time Events based on Koehler 46.022 Rev B WIP (5/15/2019)
System Overview: Software Pseudocode

START

INITIALIZE clock that starts from T(s): -240~, functions and other variables
PRINT Initial Program Version
PRINT current time
ACTIVATE UVC-Lamps and VoITRAX
PRINT UV Sensor Data
WHILE TE-1 has not occurred
   PRINT "Waiting to launch " with current time
END WHILE

PRINT "launch " with current time
PRINT UV Sensor Data
WHILE TE-2 has not occurred
   PRINT "Flying Time " with current
END WHILE

WHILE Skirt has not cleared proximity Sensor
   PRINT "Skirt not cleared " with current time
END WHILE

PRINT "Skirt cleared proximity Sensor" with current time
Wait until T(s): +197~

PRINT UV Sensor Data
DEACTIVATE UVC
PRINT UV Sensor Data
DEPLOY OSCAR
WHILE TE-3 has not occurred
   PRINT "OSCAR deployed " with current time
END WHILE

RETRACT OSCAR
PRINT "OSCAR retracted " with current time

END
Subsystem Design
Subsystem Design: Organic Collector

- The three motors are connected to 12V from the Big Easy Drivers.
- Weight: 6.67 lbs.
  ** Estimated
- Measurements:
  ** Expands up to 3 in.
Risk Matrix: Organic Collector Subsystem

- Risk #1: O.S.C.A.R. does not deploy or retract at indicated timed event.
  - If this would occur flight can be classified as unsuccessful. However, this risk does not affect other subsystems.
- Risk #2: At splash-down water infiltrates O.S.C.A.R.
  - Sample collection would be contaminated.
Subsystem Design: Organic Sequencing

- Connected to 5V from the 28V to 5V power converter.
- Weight: 0.77 lbs.
  ** includes cartridge
- Measurements:
  ** Has a height of 1.614 in.
  without the cartridge.
  We are working on acquiring this measurement.
Risk Matrix: Organic Sequencing Subsystem

- Risk #1: The VolTRAX will not survive the flight.

- If VolTRAX does not survive, no other subsystem would be affected; but it won’t be certified for TRL 9.
Subsystem Design: Computer

- Connected to 5V from the 28V to 5V power converter.
- Weight: 0.21 lbs.
  ** includes extender hats
- Measurements:
  ** has a height of 1.899 in.
  with extender hats
Risk Matrix: Computer Subsystem

- Risk #1: Computer system commands do not operate.
- Flight would be unsuccessful because timed events would not be signaled to occur.
Subsystem Design: Power

- Connected to 28V directly from Rocket.
- Weight: 0.216 lbs. (X2)
- Measurements:
Risk Matrix: Power Subsystem

- Risk #1: Power system supply fails.
- If this occurs, the flight will be unsuccessful since the payload would not have turned on.
Subsystem Design: Camera

- Weight: 2.77 lbs.
- Measurements:
Risk Matrix: Camera Subsystem

- Risk #1: No video footage evidence will be obtained to validate O.S.C.A.R. deployment and retraction.

- No other subsystems are affected if camera fails; if this happens, the experiment will not be validated.
Subsystem Design: Cross-Contamination Mitigation

- Connected to 12V from the 28V to 12V power converter.
- Measurements
Risk Matrix: Cross-Contamination Mitigation Subsystem

- Risk #1: UV lamps and UV sensors do not turn on.
- Risk #2: UV Boards create a breakdown voltage that reset the Computer
- If any of these occur, the samples collected might result in false data during genomic analysis.
Subsystems Overview

- We have a total of 5 subsystems: the Organic Sample Collector, Power and Data, the Camera System, Computer System and the Organic Sequencer better known as the Voltrax.
Subsystem #1: Organic Sample Collector

Progress:

- Quick Status
  - Vacuum-bellow with flanges has been ordered.
  - The UV-C lights and the Proximity sensors have been tested.
  - The stepper motors have been tested.
Subsystem #1: Organic Sample Collector

- Proximity Sensor tests
  - The proximity sensors were tested using an object at different distances
Subsystem #1: Organic Sample Collector

- UV-C lights testing
  - The UV-C lights were tested by turning them on and off
Subsystem #1: Organic Sample Collector

- Stepper motor tests
Subsystem #1: Organic Sample Collector

- What were the results
  - The tests conducted were successful.
    - The UV-C lights are in total function
    - The proximity sensors are proven to be in great conditions
    - The stepper motor ran properly.
Subsystem #2: Power and Data

Quick Status

- Power Supplies and Flag System have been tested.
- Telemetry has not yet been checked out.
- Integration of the power subsystem to the others has not yet been checked out.
- We expect to be ready for ISTR.

Progress: 50%
Subsystem #2: Power and Data

Power supplies tests
– Voltage conversion by power supplies
• We had the corresponding power supplies put out 12V and 5V from a feed of 28V
Subsystem #2: Power and Data

Flags System tests
Converted voltage in to 2.5V for the use of flags to the computer.
Subsystem #2: Power and Data

• Expected Results for telemetry data
  - This is the data that we expect to get from the payload telemetry.

Summary of telemetry data received of the actual Times events of the flight:

- Software UPR RockSat X 2019 Revision 7/27/19
- This software is from the August Flight
- UPR Payload Alive T(sec) = -218.69
- Checking for Inhibit at T(sec) = -218.48
- Inhibit is NOT active at T(sec) = -218.28
- UV are on at T(sec) = -218.08
- Time to Launch T(sec) = -217.88
- Time to Launch T(sec) = 0.57
- UV are off at T(sec) = 0.0
- Launch T(sec) = 0.2
- Flying Time T(sec) = 0.4
- Flying Time T(sec) = 78.76
- Skirt is not off at T(sec) = 78.96
- Skirt Off T(sec) = 79.16
- Waiting to Deploy at T(sec) = 79.36
- Waiting to Deploy at T(sec) = 196.99
- Door Opening Started at T(sec) = 197.19
- Door Open at T(sec) = 222.89
- Door still open at T(sec) = 223.09
- Door still open at T(sec) = 294.64
- Door Closing T(sec) = 294.84
- Door Closed at T(sec) = 320.57
- Going back Home T(sec) = 320.77

Data from UPR RockSat-X 2019 flight
Subsystem #2: Power and Data

What were the results

• The tests conducted were successful.
• The power supplies put out the voltages expected (12V and 5V) from a feed of 28V.
• The Flags System responded by converting voltage received to 2.5V.
Subsystem #3: Camera

Progress: 50%

Quick Status
• The Leica SL (Typ601) has been tested as the backup camera.
• The Leica SL2 has not been tested because it has not yet arrived.
## Subsystem #3: Camera

<table>
<thead>
<tr>
<th>Tests:</th>
<th>Results:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Charging the battery</td>
<td>Battery charges</td>
</tr>
<tr>
<td>Turning ”On” and “Off”</td>
<td>It works</td>
</tr>
<tr>
<td>Recording and taking Pictures</td>
<td>Reads and writes the memory card</td>
</tr>
<tr>
<td>Button presses</td>
<td>Did their correct function</td>
</tr>
</tbody>
</table>
Subsystem #4: Computer

Progress: 50%

- Quick Status
  - What has been tested
    - The Raspberry Pi Computer Start Up and Hardware.
    - Micro SD Card
  - What has not yet been checked out
    - Optocouples, Thermocouples
Subsystem #4: Computer

- Computer
  - Booting of Raspberry Pi Computer Operating System. Testing Voltage in the GPIO pins and Micro SD Card.

- Proximity Sensor
  - The proximity sensor put out the respective voltage when an object was close to it.
Subsystem #4: Computer

- **Stepper Driver**
  - Turns On, Change Reference voltage when potentiometer is turn.

- **Stepper Motor**
  - Rotates and responds to electricity pulses.
  - Still need integration with computer.
Subsystem #4: Computer

- Computer pseudocode from RockSat X 2019.
- It gives commands for each receiving flag and prints the data for the telemetry to be sent.

START

INITIALIZE clock that starts from T(s): -240°, functions and other variables
PRINT Initial Program Version
PRINT current time
ACTIVATE UVC-Lamps and VoTRAX
PRINT UV Sensor Data
WHILE TE-1 has not occurred
   PRINT "Waiting to launch " with current time
END WHILE

PRINT "launch " with current time
PRINT UV Sensor Data
WHILE TE-2 has not occurred
   PRINT "Flying Time " with current time
END WHILE

WHILE Skirt has not cleared proximity Sensor
   PRINT "Skirt not cleared " with current time
END WHILE

PRINT "Skirt cleared proximity Sensor" with current time
Wait until T(s): +197°
PRINT UV Sensor Data
DEACTIVATE UVC
PRINT UV Sensor Data
DEPLOY OSCAR
WHILE TE-3 has not occurred
   PRINT "OSCAR deployed " with current time
END WHILE

RETRACT OSCAR
PRINT "OSCAR retracted " with current time

END
Subsystem #5: Voltrax

- **Quick Status**
  - The Voltrax has ordered but has not yet arrived therefore we have not started testing.
  - As soon as it arrives, we expect to run a PCR (polymerase-chain-reaction) to evaluate that it works well.

Progress: 25%
5.0 Plan for Integrated Subsystem Testing
Plan for Subsystem Integration

- Based on where we are now, to ensure subsystems’ integration and testing we’ll be using a testbench to test software for its functionality for the Subsystem Integration and Testing Report. Custom printed circuit boards will be used to minimize wiring.

- Of the things that can go wrong:
  - If purchase orders aren’t received in time, we will use existing materials.
## System Overview: Detailed Weight Budget

<table>
<thead>
<tr>
<th>Payload</th>
<th>Aluminum Parts</th>
<th>Weight (lbs)</th>
<th>Payload</th>
<th>Electrical Components</th>
<th>Weight (lbs)</th>
<th>Payload</th>
<th>Other Components</th>
<th>Weight (lbs)</th>
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</thead>
<tbody>
<tr>
<td>Computer Subsystem</td>
<td>1.230</td>
<td></td>
<td>Computer Subsystem</td>
<td>0.224</td>
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<td>Cross-contamination Subsystem</td>
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<td>Computer Enclosure</td>
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<td>Raspberry Pi 2B</td>
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<td>UV-C Lamps (6)</td>
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<td>Raspberry Pi Zero</td>
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<td>Power Enclosure</td>
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<td>VolTrax Cartridge</td>
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<tr>
<td>Power Enclosure Lid 1</td>
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<td>Extender Hat 2</td>
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<td>Camera Subsystem</td>
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</table>
## RockSat-X UPR Power Budget 2020

**Subsystem Design: Detailed Power Budget**

**Tuesday, December 10, 2019**

<table>
<thead>
<tr>
<th>Wallops Power Line</th>
<th>Subsystem</th>
<th>Voltage(V)</th>
<th>Current(A)</th>
<th>Max Current(A) @ 28V</th>
<th>Starttime (sec)</th>
<th>Endtime (sec)</th>
<th>Time On(sec)</th>
<th>Watts</th>
<th>Ah</th>
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<tbody>
<tr>
<td>GSE 1/2</td>
<td>JV-C Lamp (1)</td>
<td>12</td>
<td>0.6</td>
<td>0.257</td>
<td>-240</td>
<td>197</td>
<td>437</td>
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<td>0.2</td>
<td>0.086</td>
<td>70</td>
<td>90</td>
<td>20</td>
<td>2.4</td>
<td>0.0009</td>
</tr>
<tr>
<td></td>
<td>Stepper drivers/motor first sequence (2)</td>
<td>12</td>
<td>0.2</td>
<td>0.086</td>
<td>70</td>
<td>90</td>
<td>20</td>
<td>2.4</td>
<td>0.0009</td>
</tr>
<tr>
<td></td>
<td>Stepper drivers/motor first sequence (3)</td>
<td>12</td>
<td>0.2</td>
<td>0.086</td>
<td>70</td>
<td>90</td>
<td>20</td>
<td>2.4</td>
<td>0.0009</td>
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<tr>
<td></td>
<td>Stepper drivers/motor second sequence (1)</td>
<td>12</td>
<td>0.2</td>
<td>0.086</td>
<td>295</td>
<td>315</td>
<td>20</td>
<td>2.4</td>
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<td>Stepper drivers/motor second sequence (2)</td>
<td>12</td>
<td>0.2</td>
<td>0.086</td>
<td>295</td>
<td>315</td>
<td>20</td>
<td>2.4</td>
<td>0.0009</td>
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<tr>
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<td>Stepper drivers/motor second sequence (3)</td>
<td>12</td>
<td>0.2</td>
<td>0.086</td>
<td>295</td>
<td>315</td>
<td>20</td>
<td>2.4</td>
<td>0.0009</td>
</tr>
<tr>
<td></td>
<td>Termocouples</td>
<td>5</td>
<td>0.002</td>
<td>0.000</td>
<td>-240</td>
<td>315</td>
<td>555</td>
<td>0.14</td>
<td>6E-05</td>
</tr>
<tr>
<td></td>
<td>VoTRAX</td>
<td>0</td>
<td>0</td>
<td>0.000</td>
<td>-240</td>
<td>315</td>
<td>555</td>
<td>0.14</td>
<td>1E-06</td>
</tr>
<tr>
<td>Time Event R</td>
<td>Time Event 1 Launch</td>
<td>28</td>
<td>0.005</td>
<td>0.005</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0.14</td>
<td>1E-06</td>
</tr>
<tr>
<td></td>
<td>Time Event 2 Skirt Deployment</td>
<td>28</td>
<td>0.005</td>
<td>0.005</td>
<td>79</td>
<td>80</td>
<td>1</td>
<td>0.14</td>
<td>1E-06</td>
</tr>
<tr>
<td></td>
<td>Time Event 3 30 seconds before power off</td>
<td>28</td>
<td>0.005</td>
<td>0.005</td>
<td>305</td>
<td>306</td>
<td>1</td>
<td>0.14</td>
<td>1E-06</td>
</tr>
</tbody>
</table>

|                     | **Total GSE 1/2**          | 1.496      | 41.88       | 0.1122               |
|                     | (Time Event 1 2 3 are signal flags and no current drain)(TE 1/2/3/R Total) | 0 | 0 | 0 |
|                     | **Total**                  | 1.496      | 41.88       | 0.1122               |
|                     | **Total Power Capacity (1.0 amp/hr)** | 1.496 | 1 |
|                     | **Over / Under**           | Under      | 0.8872      | 0.9196               |

Total Flight margin = 0.9196
Prototyping/Analysis
Results/Plans
# Prototyping Plan

<table>
<thead>
<tr>
<th>Subsystem</th>
<th>Test to be done</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organic Collector</td>
<td>Motors will receive power to test that the collector opens and closes the appropriate length.</td>
</tr>
<tr>
<td>Organic Sequencing</td>
<td>VolTRAX will be used to prepare samples to test that it is properly working before flight.</td>
</tr>
<tr>
<td>Computer</td>
<td>Computer will be powered on to verify that it is properly working.</td>
</tr>
<tr>
<td>Power</td>
<td>The power converters will receive 28V to verify that they output 12V and 5V.</td>
</tr>
<tr>
<td>Camera</td>
<td>Camera will be powered on to verify that the camera records at the proper times.</td>
</tr>
<tr>
<td>Cross-Contamination Mitigation</td>
<td>UV-C Lamps will be powered to verify that they are functional.</td>
</tr>
</tbody>
</table>
Manufacturing and Testing Plans
Manufacturing Plan: Mechanical Elements

- All Aluminum 6061 and Teflon parts will be manufactured by the students of the School of Machining. Manufacturing will begin in February.
- The Vacuum Bellow is being purchased from Kurt J. Lesker. Ordering, manufacturing, and shipping of the bellow can take up to 3 months.
Manufacturing Plan: Electrical Elements

- New Raspberry Pi 2 extension Boards and Power Supply Boards are being designed to reduce the amount of cables that need to be soldered into the boards. They will be manufactured and purchased from PCBway. Manufacturing and shipping of custom boards can take 1 or 2 months.

- New Stepper Motors, Power Converters, Relays and Optoisolators are being purchased.

- We already have in our possession the Raspberry Pi 2B, Raspberry Pi Zero, RS232, Thermocouples, UV Sensor, UV-C Lamp Boards, Proximity Sensor and Big Easy Drivers.
## Manufacturing Plan: Electrical Elements

<table>
<thead>
<tr>
<th>Components</th>
<th>Manufactured</th>
<th>Soldered</th>
</tr>
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<tbody>
<tr>
<td>Thermocouples</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Optoisolators</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>UV-C Boards</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Stepper Motors</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Big Easy Drivers (Stepper Drivers)</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Raspberry Pi 2B</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Raspberry Pi Zero</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Proximity Sensor</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Relays</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Rs232 converter</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Raspberry Pi 2B Extender Hats</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Power Supply Board</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>
Manufacturing Plan: Software Elements

• 2019 software is being adapted for this year's payload. It has been tested and has proven reliable.

• New code for the running the camera, and all other new components need to be added.
# Schedule Summary: Mechanical, Electrical and Software

<table>
<thead>
<tr>
<th>Activity</th>
<th>February-19</th>
<th>March-19</th>
<th>May-19</th>
<th>June-19</th>
<th>July-19</th>
<th>August-19</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subsystem Testing Review (STR)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Integrate Subsystem Testing Review (ISTR)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Full Mission Simulation Review (FMSR)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Full System Test</td>
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<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Integration Readiness Review (IRR)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GSE Checkouts at Refuge Inn</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Visit to WFF Environmental, Int. Test</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Launch Readiness Review Packages (LRR)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GSE Checkouts at Refuge Inn</td>
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<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Payload Integration and Testing at WFF</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Integration and Launch</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Testing Plan: Schedule
Testing Plan: Mechanical Testing

- As the design is worked, analysis of weight/volume/vibration is performed.
- Call-out any deployment tests and how they will be performed
  - Collector deployment

### Mechanical Inhibits

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
<th>Completed before Rocket Integration?</th>
<th>Need to be repeated between tests?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Remove Collector Lid Mechanical Inhibits (For June and August)</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>2</td>
<td>Connect UV-C Inhibit (For June and August)</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>3</td>
<td>Full Mission Inhibit (For August)</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>4</td>
<td>GPS Rollout (For August)</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>5</td>
<td>Insert Before Flight (For August)</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>
Testing Plan: Electrical Testing

Electrical inhibits needed for Wallops testing

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
<th>Completed before Rocket Integration?</th>
<th>Need to be repeated between tests?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Remove Collector Lid Mechanical Inhibits (For June and August)</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>2</td>
<td>Connect UV-C Inhibit (For June and August)</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>3</td>
<td>Full Mission Inhibit (For August)</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>4</td>
<td>GPS Rollout (For August)</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>5</td>
<td>Insert Before Flight (For August)</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>
Testing Plan: System Level Testing

- Test at a system level will be done according to how it’s been done for previous years as our testbed for the electronics is being developed in time for future presentations like the FMSR.
Management
Program Management and Team Updates

• Did anyone switch roles?
  – We have 6 new students joining the team!
Program Management and Team Updates

• Did anyone switch roles?
  – We have 6 new students joining the team!
### Management: Contact Matrix

#### Spring 2020 RS-X Contact Matrix

<table>
<thead>
<tr>
<th>Name</th>
<th>Day Phone</th>
<th>Receive Texts?</th>
<th>Email</th>
<th>Citizenship</th>
<th>Add to mailing list?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Genesis M. Ferrer Imbert</td>
<td>787-368-5967</td>
<td>Yes</td>
<td><a href="mailto:genesis.ferrer1@upr.edu">genesis.ferrer1@upr.edu</a></td>
<td>U.S.</td>
<td>Yes</td>
</tr>
<tr>
<td>Brikinie Baez Rodriguez</td>
<td>787-643-1208</td>
<td>Yes</td>
<td><a href="mailto:brikinie.baez@upr.edu">brikinie.baez@upr.edu</a></td>
<td>U.S.</td>
<td>Yes</td>
</tr>
<tr>
<td>Giancarlo Gonzalez Fellu</td>
<td>787-502-3361</td>
<td>Yes</td>
<td><a href="mailto:giancarlo.gonzalez2@upr.edu">giancarlo.gonzalez2@upr.edu</a></td>
<td>U.S.</td>
<td>Yes</td>
</tr>
<tr>
<td>Sergio Rodriguez Dietsch</td>
<td>787-525-1965</td>
<td>Yes</td>
<td><a href="mailto:sergio.rodriguez15@upr.edu">sergio.rodriguez15@upr.edu</a></td>
<td>U.S.</td>
<td>Yes</td>
</tr>
<tr>
<td>Delia S. Ocaña Narváez</td>
<td>787-214-9094</td>
<td>Yes</td>
<td><a href="mailto:delia_ocana@upr.edu">delia_ocana@upr.edu</a></td>
<td>U.S.</td>
<td>YES</td>
</tr>
<tr>
<td>Nyleishka Pagan Gonzalez</td>
<td>787-404-7724</td>
<td>Yes</td>
<td><a href="mailto:nyleishka.pagan@upr.edu">nyleishka.pagan@upr.edu</a></td>
<td>U.S.</td>
<td>Yes</td>
</tr>
<tr>
<td>Kevin N. Ortiz Ceballos</td>
<td>787-446-7551</td>
<td>Yes</td>
<td><a href="mailto:kevin.ortiz22@upr.edu">kevin.ortiz22@upr.edu</a></td>
<td>U.S.</td>
<td>Yes</td>
</tr>
<tr>
<td>Maria J. Sanchez Muniz</td>
<td>787-349-4593</td>
<td>Yes</td>
<td><a href="mailto:maria.sanchez17@upr.edu">maria.sanchez17@upr.edu</a></td>
<td>U.S.</td>
<td>Yes</td>
</tr>
<tr>
<td>Amaris C. Gonzalez Fuentes</td>
<td>787-370-9813</td>
<td>Yes</td>
<td><a href="mailto:amaris.gonzalez1@upr.edu">amaris.gonzalez1@upr.edu</a></td>
<td>U.S.</td>
<td>Yes</td>
</tr>
<tr>
<td>Marcos X. De Jesus Reyes</td>
<td>787-586-0413</td>
<td>Yes</td>
<td><a href="mailto:marcos.dejesus2@upr.edu">marcos.dejesus2@upr.edu</a></td>
<td>U.S.</td>
<td>YES</td>
</tr>
<tr>
<td>Arianna E. Bou Ramos</td>
<td>787-383-5853</td>
<td>Yes</td>
<td><a href="mailto:arianna_bou@upr.edu">arianna_bou@upr.edu</a></td>
<td>U.S.</td>
<td>yes</td>
</tr>
<tr>
<td>Genesis Mallol Pagan</td>
<td>787-201-4109</td>
<td>Yes</td>
<td><a href="mailto:genesis.mallol@upr.edu">genesis.mallol@upr.edu</a></td>
<td>U.S.</td>
<td>Yes</td>
</tr>
<tr>
<td>Angel Ortiz Nunez</td>
<td>787-528-4982</td>
<td>Yes</td>
<td><a href="mailto:angel.ortiz42@upr.edu">angel.ortiz42@upr.edu</a></td>
<td>U.S.</td>
<td>Yes</td>
</tr>
<tr>
<td>Marcos Valdez Cuello</td>
<td>787-365-1327</td>
<td>Yes</td>
<td><a href="mailto:marcos.valdez@upr.edu">marcos.valdez@upr.edu</a></td>
<td>U.S.</td>
<td>Yes</td>
</tr>
<tr>
<td>Lian M. Perez Sierra</td>
<td>787-627-7845</td>
<td>Yes</td>
<td><a href="mailto:lian.perez@upr.edu">lian.perez@upr.edu</a></td>
<td>U.S.</td>
<td>Yes</td>
</tr>
<tr>
<td>Jose G. Portela Gonzalez</td>
<td>787-202-5506</td>
<td>Yes</td>
<td><a href="mailto:jose.portela@upr.edu">jose.portela@upr.edu</a></td>
<td>U.S.</td>
<td>Yes</td>
</tr>
<tr>
<td>Dariel R. Ramirez Rosado</td>
<td>787-988-3867</td>
<td>Yes</td>
<td><a href="mailto:dariel.ramirez@upr.edu">dariel.ramirez@upr.edu</a></td>
<td>U.S.</td>
<td>Yes</td>
</tr>
<tr>
<td>Angely M. Candelaria Esteves</td>
<td>787-567-0054</td>
<td>Yes</td>
<td><a href="mailto:angely.candelaria@upr.edu">angely.candelaria@upr.edu</a></td>
<td>U.S.</td>
<td>Yes</td>
</tr>
<tr>
<td>Amanda Ortiz Noriega</td>
<td>7872937901</td>
<td>Yes</td>
<td><a href="mailto:amanda.ortiz6@upr.edu">amanda.ortiz6@upr.edu</a></td>
<td>U.S.</td>
<td>YES</td>
</tr>
<tr>
<td>Jorge Coppins Massanet</td>
<td>7874021470</td>
<td>Yes</td>
<td><a href="mailto:jorge.coppins@upr.edu">jorge.coppins@upr.edu</a></td>
<td>U.S.</td>
<td>yes</td>
</tr>
<tr>
<td>Francisco Rivera Emanuelli</td>
<td>7877185979</td>
<td>Yes</td>
<td><a href="mailto:francisco.rivera42@upr.edu">francisco.rivera42@upr.edu</a></td>
<td>U.S.</td>
<td>yes</td>
</tr>
<tr>
<td>Carlos A. Roig-Blay</td>
<td>787-359-1488</td>
<td>Yes</td>
<td><a href="mailto:carlos.roig@upr.edu">carlos.roig@upr.edu</a></td>
<td>U.S.</td>
<td>Yes</td>
</tr>
<tr>
<td>Jonathan M. Santiago Figueroa</td>
<td>7875671789</td>
<td>Yes</td>
<td><a href="mailto:jonathan.santiago29@upr.edu">jonathan.santiago29@upr.edu</a></td>
<td>U.S.</td>
<td>Yes</td>
</tr>
</tbody>
</table>
**ISTR teleconference window is from 3/16 to 3/20. The team therefore would be ready for March 17th as the day of our presentation.**

**The installments due for the payload. The UPR team has, for all the year’s it’s participated has always made a one-time payment of the $24,000.**

***The reviews further in the semester were not mentioned in the manifest deliverables Jan.9. Just wanted to run it by you if the FMSR has a due date, and of the IRR and GSE checkouts will be discussed later in the semester.***

<table>
<thead>
<tr>
<th>Event</th>
<th>DUE DATE</th>
<th>DATE DONE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Team Initial Meet</td>
<td></td>
<td>1/28/2020</td>
</tr>
<tr>
<td>Team Meet</td>
<td></td>
<td>2/4/2020</td>
</tr>
<tr>
<td>First Installment Due**</td>
<td>2/10/2020</td>
<td></td>
</tr>
<tr>
<td>Team Meet</td>
<td></td>
<td>2/11/2020</td>
</tr>
<tr>
<td>UPRRP team visit to UPR- Mayaguez</td>
<td></td>
<td>2/13/2020</td>
</tr>
<tr>
<td>Team Meet</td>
<td></td>
<td>2/18/2020</td>
</tr>
<tr>
<td>Subsystems Test Review (STR)</td>
<td>2/18/2020</td>
<td>2/18/2020</td>
</tr>
<tr>
<td>Team Meet</td>
<td></td>
<td>2/25/2020</td>
</tr>
<tr>
<td>Team Leads will Visit Machining team</td>
<td></td>
<td>2/28/2020</td>
</tr>
<tr>
<td>Team Meet</td>
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<td>3/3/2020</td>
</tr>
<tr>
<td>Team Meet</td>
<td></td>
<td>3/10/2020</td>
</tr>
<tr>
<td>Experiment Deck and Connectors Sent</td>
<td></td>
<td>3/17/2020</td>
</tr>
<tr>
<td>Team Meet (Cancelled - Monday classes recovery)</td>
<td></td>
<td></td>
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<tr>
<td>Integrated Subsystems Test Review (ISTR)*</td>
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</tr>
<tr>
<td>Team Meet</td>
<td></td>
<td>3/24/2020</td>
</tr>
<tr>
<td>Team Meet</td>
<td></td>
<td>3/31/2020</td>
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<tr>
<td>Team Meet</td>
<td></td>
<td>4/7/2020</td>
</tr>
<tr>
<td>Final Installment Due**</td>
<td>4/9/2020</td>
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<td>Team Meet</td>
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<td>4/14/2020</td>
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<td>4/21/2020</td>
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<td>Team Meet</td>
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<td>Full-Mission Simulation Review (FMSR)</td>
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<tr>
<td>teleconferences***</td>
<td>April - May</td>
<td></td>
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<td>Team Meet</td>
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<td>5/5/2020</td>
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<tr>
<td>Team Meet</td>
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<td>5/12/2020</td>
</tr>
<tr>
<td>Integration Readiness Review (IRR)***</td>
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</tr>
<tr>
<td>GSE Checkouts @Refuge, Testing and Envrnmtl w/ WFF***</td>
<td>JUNE</td>
<td></td>
</tr>
</tbody>
</table>

* ISTR teleconference window is from 3/16 to 3/20. The team therefore would be ready for March 17th as the day of our presentation.

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## Management: Monetary Budget

### RSX 2020 Budget

<table>
<thead>
<tr>
<th>Categories</th>
<th>Cost $</th>
<th>Travel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Materials</td>
<td>3,000</td>
<td></td>
</tr>
<tr>
<td>Equipment</td>
<td>5,000</td>
<td></td>
</tr>
<tr>
<td>Aerogel</td>
<td>0</td>
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</tr>
<tr>
<td>Piezo</td>
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<tr>
<td>Consumable Materials</td>
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</tr>
<tr>
<td>Hardware Materials</td>
<td>8,000</td>
<td></td>
</tr>
<tr>
<td>Actuators</td>
<td>2,000</td>
<td></td>
</tr>
<tr>
<td>Computer</td>
<td>2,000</td>
<td></td>
</tr>
<tr>
<td>Power Supplies</td>
<td>600</td>
<td></td>
</tr>
<tr>
<td>Teflon Cable, Vacuum Connectors</td>
<td>600</td>
<td></td>
</tr>
<tr>
<td>Payload Flight Ticket</td>
<td>24,000</td>
<td></td>
</tr>
<tr>
<td><strong>Sub-Total</strong></td>
<td><strong>46,600</strong></td>
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</table>

#### Trip to Wallops June 2020 Test

<table>
<thead>
<tr>
<th>Sum (5 participants, 10 days)</th>
<th>Cost $</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air Travel</td>
<td>2,500</td>
</tr>
<tr>
<td>Hotel</td>
<td>3,000</td>
</tr>
<tr>
<td>Car</td>
<td>1,100</td>
</tr>
<tr>
<td>Food</td>
<td>1,400</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>8,000</strong></td>
</tr>
</tbody>
</table>

#### Trip to Wallops August 2020 Launch

<table>
<thead>
<tr>
<th>Sum (10 participants, 10 days)</th>
<th>Cost $</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air Travel</td>
<td>4,000</td>
</tr>
<tr>
<td>Hotel</td>
<td>9,500</td>
</tr>
<tr>
<td>Car</td>
<td>2,400</td>
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<tr>
<td>Food</td>
<td>3,840</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>19,740</strong></td>
</tr>
</tbody>
</table>

**Total**                     | **74,340** | **$27,740.00** |
## Management: Team Availability Matrix (MDT)

<table>
<thead>
<tr>
<th>Time</th>
<th>Monday</th>
<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday</th>
<th>Friday</th>
</tr>
</thead>
<tbody>
<tr>
<td>7:00 AM</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>8:00 AM</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>9:00 AM</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>10:00 AM</td>
<td>4</td>
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<td>4</td>
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<td>12:00 PM</td>
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<td>1:00 PM</td>
<td>4</td>
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<td>4</td>
<td>4</td>
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<tr>
<td>2:00 PM</td>
<td>4</td>
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<td>4</td>
<td>4</td>
</tr>
<tr>
<td>3:00 PM</td>
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<td>4</td>
<td>4</td>
<td>4</td>
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<td>4</td>
<td>2</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
</tbody>
</table>
Management: Partnerships

NASA Wallops Flight Facility

- Fly, integration and environmental tests. Provide students the opportunity to develop a hardware project that is launched to space on a sounding rocket.

School of Machining:

- Construction of the payload’s aluminum structure.
Management: Partnerships

Evactron by XEI Scientific

- This partnership will provide science and technology transfer in regards of the Oxygen plasma decontamination subsystem.

Bifröst

- This partnership will provide high definition video footage for validation of the micrometeorite collection, and future Aurora Borealis experiments.
Management: Partnerships

UPR-Mayagüez
- UPRM Mechanical Engineering Program will be advising and designing this year’s payload.

Mary Ann B. Meador Glenn
- This partnership will provide us the aerogels.

Brookhaven National Lab
- This future partnership will provide us with instrumentation for post-flight sample analysis.
Management: Partnerships

Aaron Burton, Johnson Space Center

- This developing partnership will provide us guidance and facilities to do post-flight sample analysis of the micrometeorites with the Astromaterials Research and Exploration Sciences Department at NASA JSC.
Management: Future Partnerships

Oxford Nanopore Technologies

- Multiple meetings have been scheduled with James Brayer, who was recommended to us by Aaron Burton, to be able to acquire the VolTRAX for testing.
Risks/Worries

• Our main concern is getting our parts in time, due to having to buy all the parts by the University’s Purchase Orders, which take around 3 months.

• The risks of collecting micrometeorite samples includes cross contamination with terrestrial microorganisms upon reentry.

• If our payload fails to properly deploy during the allotted time of the spaceflight timeline, we may reduce our collection time and risk the validity, origins of our samples.

• Incorrect functioning of the motorized devices of our collector may damage the integrity of our payload and even damage any collected samples.
Future Objectives
NASAS Johnson Space Center Collaboration

As part of our visit to Johnson Space Center we:

• Developed protocols for particle extraction from Aerogels with NASA Curation Staff.
NASA Johnson Space Center Collaboration

As part of our visit to Johnson Space Center we:

• Scouted for possible facilities to open our 2019 and 2020 collectors.
• Discussed a vacuum to vacuum dock for space sample transfer of our collector.
• Did Scanning Electron Microscopy of 2013 Micrometeorite samples to determine their composition and geology.
The particle found gave a high spectral reading of aluminum. This is thought to be from either the rocket or other payloads.
Other particles found need further analysis to determine their origin. We are working on analyzing all the other extracted particles.
NASA Johnson Space Center Collaboration

As part of our visit to Johnson Space Center we:

• Studied the VolTRAX device. Discussed with Oxford Nanopore and ARES future testing for certifying VolTRAX for future ISS payload capabilities and missions to asteroids and other planets. Spoke with their sales department to speed up process of acquiring the device.

• Developed new Clean Lab protocols for opening future payloads for downstream organic analysis to avoid cross-contamination.

• Discussed the possibility of flying Silica aerogels as well as the regular Kapton aerogels to test the different properties of the aerogels in flight. Discussed baking properties for decontamination of silica aerogels.
NASA Johnson Space Center Collaboration

As part of our visit to Johnson Space Center we:

- Did CT scans of 2013 Aerogels to determine depth of Micrometeorite sample penetration into aerogel.
NASA Johnson Space Center Collaboration

As part of our visit to Johnson Space Center we:

• Discussed with Engineers and Scientists from their Particle Gun Lab the possibility of impacting bacteria at 1km/s and 6km/s into Silica and Kapton aerogels.
A downstream of future analysis of samples have been discussed and planned out.
Conclusions
Conclusion

• The chance to be part of RockSatX-2020 provides countless research insights that are unparalleled. Few institutions have access to sounding rocket technologies; therefore, it will allow us the developments of novel Astrogenomic studies. Our multidisciplinary team is composed of students from all branches of STEM, we are dedicated to run two experiments in one payload. The collector mechanism is expected to open, collect and close in record time, whereas the possibility to receive data being analyzed by Oxford Nanopore devices during flight will expand the outreach of studies under extreme conditions.

• Next steps for our team to get to STR
  – Provide preliminary designs to School of Machining for manufacturing of payload parts
  – Finalize discussions with Oxford Nanopore to obtain VolTRAX and commence experimental analysis of the DNA sample preparator to understand integration and develop the required processes for space conditions.
  – Enhance the mechanical, electrical, software, and computer engineering designs from last year’s payload.
  – Maintain communication for proper Cross-Contamination Mitigation protocols pre- and post-flight for this year’s payload under the guidance of Aaron Burton at JSC.
References


