Monarch 4 “MapSat”
Conceptual Design Review

Old Dominion University
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09/29/2019
CoDR Presentation Contents

• Section 1: Mission Overview
  – Mission Overview
  – Theory and Concepts
  – Mission Requirements (top level)
  – Expected Results
  – Concept of Operations

• Section 2: Conceptual Design Overview
  – Design Overview
  – Functional Block Diagrams
  – Payload Layout
  – Ports (if applicable)
  – Shared Can Logistics (if applicable)
CoDR Presentation Contents

• Section 3: Management
  – Team Organization
  – Schedule
  – Budget
  – Mentors (Faculty, industry)
  – Team Contact Matrix
  – Team Availability Matrix

• Section 4: Conclusions
  – Risks and Worries
  – Conclusion
Mission Overview

Samuel Jensen, Jacob Greenberg
• Mission Statement
  – The goal of Monarch 4 is to measure radio noise/interference during flight using a software defined radio while also collecting telemetry data to create a “noise map” post flight.
  – Experiment with electroplating material to prevent passage of gamma/beta radiation to a system.
Mission Objective

- Objectives:
  - Take accurate measurements of different radio bands during flight using a USRP and specialized antenna.
  - Telemetry data collected during flight will be used to make a model of the radio noise experienced during the flight using STK.
  - Build a simple device for blocking gamma/beta radiation using an electroplating process.
Mission Objectives

• Requirements:
  - Geiger Tubes
  - Sensors for Telemetry
  - Computing Systems
  - USRP and Antenna

• Minimum Success Statement:
  - Measurements taken of various radio bands during flight
  - Considerable change in gamma/beta propagation through electroplated material
Mission Overview: Theory and Concepts

- **Properties of EM Waves**
  - Can travel through empty space
  - Speed of light is always constant
  - Different types: radio, micro, IR, visible light, UV, X-rays, gamma
Mission Overview: Theory and Concepts

- Measuring Electromagnetic Waves
  - Using a software defined radio to “listen”
  - Scanning radio bands

- Measurable Environment
  - Earth originating radio bands (Terrestrial)
  - Common space communication bands
  - Cosmic noise noise present
Mission Overview: Theory and Concepts

• **Known Research**
  - Different materials filter EM radiation.
  - Electromagnetic Interference (EMI).
  - Effects of EMI on electrical systems.

• **EMI Qualification in Space**
  - Little amounts of research available regarding the RockSat payload.
  - Research could possibly be used for Small Sat and further RockSat projects.
Mission Overview: Expected Results

- **Expected Results**
  - A wide spectrum of EMF ranges with the elimination or reduction in the magnitude of the filtered waves.
  - Although we will be spinning, we hope to estimate the sources of such radiation by modeling the flight using Systems Tool Kit.
  - IMU data, such as a gyroscope, accelerometer, etc, will be a good fit to make the basics of the flight model.
  - Large amounts of terrestrial electromagnetic radiation on the ground.
  - Large amounts of space faring electromagnetic radiation after exiting the atmosphere.
## CONOPS

<table>
<thead>
<tr>
<th>Event</th>
<th>Description</th>
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| Launch \[t=0\]                             | Payload power up  
Data collection begins  
Terrestrial signals present |
| Exiting Earth’s atmosphere ≈ +100km       | Expected increase in EMF bombardment  
Reduction in Terrestrial Signals |
| Apogee \[t = 2.8 \text{ min}\]            | Highest measurements of EMF for space  
farin bands |
| Re-entering Earth’s atmosphere ≈ -100km    | Rapid Decline in EMF  
Increase in terrestrial bands |
| Splash Down \[t = 15 \text{ min}\]        | Significant decrease in EMF detection  
Only terrestrial signals present |
Design Overview

Shane Phipps, Jack Drescher, Connor Hetman, Aaron Easter, Samuel Jensen
Design Overview

- **Structural Requirements**
  - **Material:**
    - Aluminum plate connectors (stand offs)
    - 3D Printed chassis components
    - Makrolon Plates
  - **Design Considerations**
    - Maximize experimentation area

- **Plate Design**
  - **Layer Cake Method**
    - Two plates stacked
Design Overview

• Centralized Component Layout
  - Mitigate mass displacement issues
  - Organize payload
  - Simplify Wiring

• Sensor Layout Considerations
  - “Experiment Bay” sitting below main electronics
  - Houses all experimental equipment (acc. gyr. geiger)
Design Overview

• Electrical Requirements
  - Power Systems
  - Computing Systems (Arduino and Ras. Pi)
  - Storage systems (Possibly for both)
  - USRP (Software Defined Radio)

• Telemetry Requirements
  - 3 Accelerometers
  - 1 Gyroscope
  - 2 Gamma Ray detectors
Electrical FBD

- Accelerometer 3
- Accelerometer 2
- Accelerometer 1
- Gyroscope
- IMU
- Microcontroller
- Raspberry Pi
- USRP
- Antenna
- Port
- Storage 1
- Storage 2
- Flash Memory
- Power
- G-Switch
- RBF (Wallops)
- Shield
- Gamma 1
- Gamma 2

Red lines indicate Power, blue lines indicate Data.
Mechanical FBD

- Geiger Tube Setup
- PCB/USRP Stack
- Telemetry Sensor Stack

Connected to each other with standoffs

Mounts to base of canister

Gamma/Beta Blocking Material
Design Overview: Payload Layout

Current CAD Models

- 2 inch spacing between the two plates
- Sensor Placement and Electrical housing (bottom plate)
- Standoff supporting structures
Design Overview: Payload Layout

Top Plate Design

- Spaced out electronics for better centralized mass
- Drop Wiring points for sensor placement
Design Overview: Ports

- **Port Request:** Radio Port
- **Use:** Radio Receiving for the USRP
  - Will use specialized antenna
- **Connector Type:** Dual SMA
  - Cable routing to payload through the dedicated wiring routes from COSGC
  - Connects directly to payload USRP through an interfacing board

- **Predicted mass**
  - Expect to use 2 plates
  - unknown mass expectations (past experience being researched)

- **Predicted volume**
  - Half canister design

- **Activation Methods**
  - G-Switch

- **Special requests**
  - Radio Port
Design Overview: Shared Can Logistics

Canister Sharing: Need Pairing w/ Partner Collaboration:

- Holding a short meeting after CDR to ensure proper requirements are met.
- Second meeting during February/March timeframe to update on any changes.
- Email/Call as general collab. method
Project Management

Samuel Jensen, Josh Dobersztyn
Management
Management

• Preliminary schedule for the semester

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<th>Timeframe</th>
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<tbody>
<tr>
<td>Design Review Planning</td>
<td>Now - November</td>
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<tr>
<td>USRP Sourcing, Antenna Design</td>
<td>Now - December</td>
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<tr>
<td>Project Task List Overview</td>
<td>Now - December/January</td>
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<tr>
<td>Design Drawings/Power Budget</td>
<td>Late October - December</td>
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<tr>
<td>Critical Design Review</td>
<td>November - December</td>
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Management

• Monetary budget
  – ESPEX Research Funding (ODU Research Fd.)
  – VSGC Project Funding
• Team mentors (industry, faculty)?
  – Dr. Popescu (Electrical Engineering Faculty)
  – Jason Harris (EE PhD Student)
Team Contact Matrix

DropBox Access:
- Samuel Jensen
- Dr. Popescu

<table>
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<tr>
<th>Team Member</th>
<th>Role/Position</th>
<th>Email Address</th>
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<tbody>
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Document Changes: No expected change
## Team Availability Matrix

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Note: Times in MDT
Risks and Worries

Main Project Worries:

• Antenna Design
  – Working to multiple frequencies

• Power Draw of USRP and Ras. PI
  – No active charging methods
  – Large W/hr consumption

• USRP
  – Obtaining a usable USRP for mission
Conclusion

Mission:

• The goal of Monarch 4 is to measure radio noise/interference during flight using a software defined radio while also collecting telemetry data to great a “noise map” post flight.
• Experiment with electroplating material to prevent passage of gamma/beta radiation to a system.

Project Plan:

• Define key objectives, work backwards from there.
  – Start to finish task list