Bacteriological Mutation by Cosmic Radiation

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AND GUSTAVO SANTOS
The 6th Mission Idea Contest

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Introduction

Since the arrival of the first human to the moon, 50 years ago, we are beginning to live a new era in space exploration, one that puts Mars as the next major objective. Achieving this goal will require the joint effort of people around the world, both to develop new and improved technologies and to better understand the environment to which astronauts will be exposed.
Mission Objectives

1. Determine if bacteria exposed to the ISS environment suffers some behavioral change.

2. Determine the bacteriological growth change by comparing sequential images of two bacterial lawn, one in the ISS and another on ground.

3. Determine the effectiveness of antibiotics in the space environment.

4. Record the intensity, time and cumulative dose of cosmic radiation and the temperature to which the bacteria will be exposed during all the experiment operation time.

5. Expose samples of lyophilized bacteria to the space environment for further analysis on land.
Platform Selection

The ICE Cube service was selected to carry out this experiment since it is located in the Columbus module, which offers the following advantages:

- It is pressurized, avoiding the thermal control of the experiment. It also eliminates the possibility of outgassing happening.
- It is an environment almost identical to the one inhabited by the ISS astronauts on a daily basis.
Experiment Concept

Mission Payload

- Main experiment
- Lyophilized bacteria samples
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Experiment Concept – Main Experiment

Cosmic Radiation

International Space Station

Space Segment Sample

Bacteria on regular nutrient agar + Cosmic rays

Bacteria + antibiotics + Cosmic rays

Higher concentration antibiotic

Lower concentration antibiotic

Plate divider

400 Km (approx.)

Ground Laboratory

Control Sample
Experiment Concept – Lyophilized samples

- **Freezing (Solidification)**
- **Primary Drying (Ice sublimation)**
- **Secondary Drying (Desorption)**

- Vacuum at 5-10% water
- 1-2% water
- 95-99% water
Bacteria Selection

- Pathogenic properties
- Temperature ranges
- Typical growth curves
- Survival capacity
- Possible antibiotics

Lactobacillus acidophilus

Staphylococcus aureus
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Space Segment Description

References:
- Data
- Power

ICE Cube Standard Box

- Data Collection System
  - SD Card
  - Processing Unit
- Temperature & Humidity Sensor
- Cosmic Ray Detector
- Light Source
- Petri Dish

Lyophilized Samples

DB13W3P Male Connector
Concept of Operations

<table>
<thead>
<tr>
<th>Sample</th>
<th>Flight without antibiotics</th>
<th>Flight with antibiotics</th>
<th>Ground without antibiotics</th>
<th>Ground with antibiotics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observations</td>
<td>40 colonies</td>
<td>16 colonies</td>
<td>30 colonies</td>
<td>4 colonies</td>
</tr>
</tbody>
</table>
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Implementation Plan

- Project Organization
- Schedule
- Infrastructure
- Cost estimation and Budget plan
- Risk analysis
Project Organization

- Project Leader
- Experiment Responsible
- Mechanical Responsible
- Electrical/Electronic Responsible
- Software Responsible
- Technology Linking Unit
## Schedule

<table>
<thead>
<tr>
<th>Task</th>
<th>Months</th>
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<tbody>
<tr>
<td></td>
<td>1 2 3 4 5 6 7 8 9 10 11 12 13 14</td>
</tr>
<tr>
<td>Experiment design and revision</td>
<td></td>
</tr>
<tr>
<td>Purchase components</td>
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</tr>
<tr>
<td>Software development and testing</td>
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<tr>
<td>Prototype development and functional testing</td>
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<tr>
<td>Final product integration and testing</td>
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<tr>
<td>Space segment delivery and launch (*)</td>
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<tr>
<td>Experiment operations</td>
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<tr>
<td>Environment data collection</td>
<td></td>
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<tr>
<td>Space segment return (*)</td>
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<tr>
<td>Science data analysis and results</td>
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<tr>
<td>Documentation</td>
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</table>

* This times are responsibility of the ICE Cube service.
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Infrastructure

Office
- Project management
- Software development
- Ground Operations

Workshop
- Integration
- Testing

Laboratory
- Samples preparation
- On ground experimentation

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Cost analysis

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity</th>
<th>Cost ($USD)</th>
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<tbody>
<tr>
<td>Petri dish + bacteria sample + antibiotic</td>
<td>2</td>
<td>500</td>
</tr>
<tr>
<td>ICE cube standard structure</td>
<td>1</td>
<td>1000</td>
</tr>
<tr>
<td>Data collection system + light source + temperature &amp; humidity sensor</td>
<td>1</td>
<td>1500</td>
</tr>
<tr>
<td>Camera</td>
<td>1</td>
<td>1000</td>
</tr>
<tr>
<td>Cosmic ray detector</td>
<td>1</td>
<td>4000</td>
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<tr>
<td>Transportation and Pre-launch campaign</td>
<td>1</td>
<td>3000</td>
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<tr>
<td>End-to-end ICE Cube service package (for a 1U / 1kg payload)</td>
<td>1</td>
<td>55000</td>
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<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>66000</strong></td>
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# Risk Analysis

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<tr>
<th></th>
<th>Negligible</th>
<th>Minor</th>
<th>Moderate</th>
<th>Significant</th>
<th>Severe</th>
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<tr>
<td>Very likely</td>
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<tr>
<td>Likely</td>
<td>C</td>
<td></td>
<td>B</td>
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<tr>
<td>Possible</td>
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<td></td>
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</tr>
<tr>
<td>Unlikely</td>
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<td>A</td>
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<tr>
<td>Very unlikely</td>
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</table>
Conclusions

✓ Simple and robust design.
✓ Relative low cost.
✓ High scientific value.
✓ Feasible project.
✓ It is a way to introduce high students to the space activity.
Acknowledgments

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All the UNISEC-Global Staff
Thank you!