Team Members & Roles

Student Members:
- Anthony Zerkow (Mechanical)
  - Team Leader, Design Modeler
- Lisa Antoine (Electrical, Independent Study)
  - Coding and Hardware Technician
- Samantha Nicoletti (Civil)
  - Structural Analyst, Data Researcher
- Margaret Taylor (Environmental)
  - Filtration System Specialist, Webmaster
- Johanna Wiley (Mechanical)
  - Fluid Flow Analyst, Pumping System Coordinator
- Kaleb Barrett (Electrical, Independent Study)
  - Coding and Hardware Specialist

Faulty Members:
- Dr. John Helferty (Team Advisor)
- Dr. Shriram Pillapakkum (Team Coordinator)
- Dr. William Miller (Team Consultant)
Outline of Presentation

Section 1: Mission Overview
- Mission Statement
- Overview of Concepts & Theory
- Concept of Operations
- Expected Results
- Success Criteria
- Function & Design Requirements

Section 2: System Overview
- Changes in PDR
- Mechanical Assembly
- Design Overview
- Mechanical Dimensional Drawing
- Electrical Design Elements
- Software Design Elements
Outline of Presentation

Section 3: Subsystem Design
  ◦ Subsystem Organization Chart
  ◦ Filtration System
  ◦ Pump/Tubing/Manifold System
  ◦ Valves & Electronics System
  ◦ Weight Budget
  ◦ Power Budget

Section 4: Prototyping/Testing

Section 5: Manufacturing Plan
  ◦ Mechanical & Electrical Elements

Section 6: Risk
  ◦ Risk Walk Down

Section 7- Simulation Slides
  ◦ Matlab
  ◦ Ansys
  ◦ Solidworks

Section 8: Project Management Plan
  ◦ Organization Chart
  ◦ Baseline Project Schedule
  ◦ Monetary Budget
  ◦ Team Contact Matrix
  ◦ Tram Availability Matrix
  ◦ Project Summary

Section 9: Conclusion
Mission Overview

MARGARET TAYLOR AND SAMANTHA NICOLETTI
Mission Statement

The goal of this project is to determine the concentration of sulfate based aerosols in the troposphere and stratosphere using a series of filters and valves that are designed to open/close between 0km-50km of altitude during the descent of the flight.
Overview of Concepts & Theory

**SULFURIC ACID FORMATION**

\[ S(s) + O_2(g) \rightarrow SO_2(g) \]

Burning sulfur results into sulfur dioxide

\[ 2SO_2(g) + O_2(g) \rightarrow 2SO_3(g) \]

Sulfur dioxide is oxidized to sulfur trioxide

\[ SO_3(g) + H_2O(l) \rightarrow H_2SO_4(l) \]

Sulfur trioxide reacts with water to form sulfuric acid

[7]
Overview of Concepts & Theory

Sulfate Aerosols:
- Reflect sunlight, reducing the amount of sunlight reaching the Earth’s surface resulting in a cooling effect [2]
- Short life span: 3-5 days [2]
- Produced from the burning of coal and oil [2]

Greenhouse Gases:
- Absorb infrared solar radiation resulting in a warming effect [3]
- Long life span: 10-100 years [3]
- Produced from the burning of fossil fuels, solid waste, trees, etc. [3]
- Examples: CO₂, CH₄, water vapor, N₂O [6]
Expected Results

Expect to find higher levels of sulfate aerosols in the stratosphere and lower levels in the troposphere [2].
Concept of Operations
Success Criteria

Minimum Success
- Have 2 filters collects samples of sulfate aerosols at the lower layers of the atmosphere

Comprehensive Success
- System timing allows for multiple test samples to ensure a statistical balance in data collection
- All contamination concerns are properly addressed and filter system is easily removed from overall payload upon launch
## Functional & Design Requirements

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Verification Method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valves must be open at proper times throughout the atmosphere</td>
<td>Test</td>
<td>One, assembled, system will be tested to ensure values are open and closed at proper times</td>
</tr>
<tr>
<td>System must be activated by a G-load switch</td>
<td>Test</td>
<td>G-load will be triggered to ensure it activates upon launch</td>
</tr>
<tr>
<td>Filter System must be easily removed from canister and free from contamination</td>
<td>Test/Inspection</td>
<td>System will be inspected to ensure filter cassettes are removable. Testing will be done to simulate removal of filter from cassette</td>
</tr>
</tbody>
</table>
System Overview

ANTHONY ZERKOW
Changes Since PDR

Additions:
- Redundant Valve
- Micro Diaphragm Pump
- G-switch
- Aluminum/Brass tube fittings

Changes:
- Overall Design
  - To ensure clearance and since testing period was altered
- Number of Filter Cartridges
  - Due to the change in testing period
- Reduced number of plates for canister frame
  - Increase space
- Manifold Design
  - Due to overall design change
Mechanical Assembly

System Definitions:
- Pumping/Tubing/Manifold System (PTM)
  - The veins of the overall system
- Filtration System (FS)
- Valve/Electronics System (VE)
Design Overview

Major Components:

◦ One Electronic Vacuum Pump
◦ 6 Polytetrafluoroethylene (PTFE) Filter Disks
  ◦ Stored in filter cassettes
  ◦ One filter canister will travel with the others but not fly
◦ Five Solenoid Valves
◦ 12V Batteries (x3)*
◦ One Arduino Mega 2560 Board
◦ Two Tubing Manifolds
◦ G-Switch

*Might need to reconsider
Mechanical Dimensional Drawing

User’s Guide Compliance:
- Weight must not exceed: 10±0.2 lb_f (Half of a canister)
- Volume is limited to:
  - Diameter: 9.3 in
  - Height: 4.75 in
- Activation must happen after launch
- Center of gravity must lie within a 1x1x1 inch envelope of the filter frame’s centroid
Electrical Design Elements

Tropo-Filter Set

Micro-diaphragm Pump
Redundant Valve (R1)

Arduino Board

Strato-Filter Set

TV1(Inlet)
TV2(Outlet)

Batteries

SV1(Inlet)
SV2(Outlet)
Software Design Elements

- System is closed until rocket reaches Stratosphere. Pump will be set to turn on, and valves will be triggered to open.
- Once rocket enters the Troposphere, SV1 and SV2 will be triggered to close and TV1 and TV2 will open.
- Prior to landing, all valves will close and Pump will be turned off.
Subsystem Design
Subsystem Organization Chart

- Power
- PTM
- FS
- VE
Filtration System

Polytetrafluoroethylene (PTFE) Filter:
- Hydrophobic
- Capable of collecting particulate of 0.2 microns
- Laminated

Filter Cassettes (Polypropylene):
- Filter Storage
- Prevents Contamination

Filter Frame:
- Machined
  - Multipurpose 6061 Aluminum
Pumping/Tubing/Manifold System

Tubing:
- Polypropylene/Polyethylene tubing
- Aluminum Tube Fittings
- Brass T Tube Fitting
- Brass 90 degree Tube Fitting

Manifold:
- Machined
  - Multipurpose 6061 Aluminum
  - Aluminum NPT ¼ Tube Fittings

Pumping:
- Micro Diaphragm Pump
Valves & Electronics Systems

Electronic Valve:
- Solenoid Valve-Normally Closed
- 12VDC

Arduino Mega 2560
- 5V

G-Switch Activation
## Weight Budget

### Detailed Weight Budget

<table>
<thead>
<tr>
<th>Units</th>
<th>Quantity</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thickness of Plate (t)</td>
<td>in 0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>Diameter of Plate (d)</td>
<td>in 9.3</td>
<td>9.3</td>
</tr>
<tr>
<td>Total Volume (V)</td>
<td>in³ 43.245</td>
<td>43.245</td>
</tr>
<tr>
<td>Density of Acrylic</td>
<td>lb/in³ 0.04</td>
<td>0.04</td>
</tr>
<tr>
<td>Holes (Bottom) Diameter</td>
<td>in 0.125</td>
<td>10</td>
</tr>
<tr>
<td>Holes (Top) Diameter</td>
<td>in 0.125</td>
<td>2</td>
</tr>
<tr>
<td>Volume of Bottom Holes</td>
<td>in³ 0.0078125</td>
<td>0.0078125</td>
</tr>
<tr>
<td>Volume of Top Holes</td>
<td>in³ 0.0078125</td>
<td>0.0078125</td>
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<tr>
<td>Total Volume of Holes</td>
<td>in³ 0.0078125</td>
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<tr>
<td>Net Volume of Holes</td>
<td>in³ 43.245</td>
<td>43.245</td>
</tr>
<tr>
<td>Mass of Acrylic Needed</td>
<td>lb 1.72975</td>
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<tr>
<td>Mass of Manifolds</td>
<td>lb 0.87</td>
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<tr>
<td>Filter Frame Mass</td>
<td>lb 0.61</td>
<td>0.61</td>
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<tr>
<td>Summation of Mass of Tube Fittings</td>
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<td>0.37</td>
</tr>
<tr>
<td>12 Volt Batteries (Mass)</td>
<td>lb 0.09</td>
<td>0.27</td>
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<tr>
<td>Arduino Board (Mass)</td>
<td>lb 0.08157</td>
<td>0.08157</td>
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<tr>
<td>D10K 0-11 LPM Micro Diaphragm Gas Pump (Mass)</td>
<td>lb 0.60229</td>
<td>0.60229</td>
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<tr>
<td>Cassettes Mass</td>
<td>lb 0.0628</td>
<td>0.3768</td>
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<tr>
<td>Total Mass</td>
<td>lb 5.78041</td>
<td>5.78041</td>
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</tbody>
</table>

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**Note:** The table above lists the weight budget for various components, including thickness, diameter, total volume, density, and mass for various parts of the system. The table is structured to show the units, quantities, and totals for each component, with specific calculations for volumes and densities to determine the total mass.
### Detailed 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>
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<tbody>
<tr>
<td>Valves*</td>
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<td>0.30</td>
<td>4</td>
<td>3.60</td>
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<tr>
<td>Pump</td>
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<td>2.50</td>
<td>4</td>
<td>20.00</td>
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<tr>
<td>Arduino Board</td>
<td>5.0</td>
<td>0.04</td>
<td>10</td>
<td>0.20</td>
<td>0.01</td>
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<table>
<thead>
<tr>
<th></th>
<th>Total</th>
<th>Watts</th>
<th>Ah</th>
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<td>23.80</td>
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<tr>
<td>Total Power Capacity</td>
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<tr>
<td>Over (+)/Under (-)</td>
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<td>0.81</td>
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</table>

# of Flights Margin: 5.2
Prototyping/Testing

ANTHONY ZERKOW & JOHANNA WILEY
Prototyping/Testing

We have not been able to prototype at this time. Once we clear CDR we will purchase equipment and begin prototyping.

PTM System:
- System will be attached to vacuum pump when all valves are closed to ensure functionality during flight.

Filter System:
- Flow at a known velocity will be passed through a PTFE filter and measured at the outlet to determine the loss of flow through each filter.
- A strategic procedure will be created to handle the filters when entering and removing them from the system.
  - 6 Filters will be entered and removed from the system following the procedure and will be tested and compared to the filters that are implemented during launch.

VE System:
- Timing will be tested numerous times to ensure the filters are open at correct layers of the atmosphere.
- G-Switch will be placed under a G-Load to ensure activation occurs upon launch.
Prototyping/Testing

Mechanical Testing (Next few weeks, Johanna and Anthony):
- We are looking into putting our system through a spin/vibration test to ensure it can withstand the forces and loading during flight.
- Loading and center of gravity analysis can be analyzed using SolidWorks Modeler
- Vibration table at Temple University’s College of Engineering

Electrical Testing (Spring Semester, VE Team):
- Electrical system will be connected and tested once valves, Arduino Board, G-switch, and pump are purchased

Software Testing (Spring Semester, VE Team):
- Software system is intertwined with the VE system and will be tested at the same time
Matlab Configurations
Fluent Analysis

Velocity Contour Map of Inlet in the Stratosphere
Fluent Analysis

Static Pressure Contour Map of Inlet in the Stratosphere

Static Pressure Contour Map of Inlet in the Troposphere
Fluent Analysis

Velocity Contour Map of Inlet in the Stratosphere

Velocity Contour Map of Inlet in the Troposphere
SolidWorks Analysis

Von Mises Stresses

\[ \sigma_z \]

\[ \delta Z \]
Manufacturing Plan

ANTHONY ZERKOW
Mechanical & Electrical Elements

Mechanical Elements:
- Machined
  - Filter Frame
  - Manifolds (x2)
- Laser Cut
  - Top and Bottom Plate
- We will be machining the parts over the winter break

Electrical Elements:
- Soldering will take place once entire system is assembled and checked for functionality
Risks

MARGARET TAYLOR
Risk Walk Down

Biggest Risks during the time of the PDR:
- Clearance of the system inside the frame
  - Changed design to accommodate for clearance. No longer a risk since system fits in frame
- Timing and ensuring valves open at proper times
  - Still considered a risk and will take action to ensure the risk is addressed once VE system is assembled
- Ensuring System activates during launch
  - Still the process of addressing this

Top Risks (Current):
- Ensuring proper thickness of manifolds to ensure threads are not presenting a barrier to flow. Making the manifolds too thick presents a challenge with clearance

Risks we have to accept:
- Tubing coming detached from barbed fittings
  - More reliable fittings are too large to be used in this system
Project Management Plan

SAMANTHA NICOLETTI
Organization Chart

Rocksat-C

Program Manager
Becca Lidvall

PTM System
Johanna, Anthony

Filtration System
Samantha, Margaret

Temple University

Faculty Advisor
Dr. John Helferty

VE System
Johanna, Anthony, Lisa, Kaleb

Faculty Coordinator
Dr. Shriram Pillapakkam

Research Team
Johanna, Margaret, Samantha, Anthony
## Baseline Project Schedule

<table>
<thead>
<tr>
<th>Task Mode</th>
<th>Task Name</th>
<th>Duration</th>
<th>Start</th>
<th>Finish</th>
<th>Predecessors</th>
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<tbody>
<tr>
<td></td>
<td>Rocksat-C Intent to F</td>
<td>20 days</td>
<td>Mon 8/24/15</td>
<td>Fri 9/18/15</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SD 1 - Web. V 1</td>
<td>8 days</td>
<td>Mon 8/24/15</td>
<td>Wed 9/2/15</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rocksat-C Team Availability</td>
<td>9 days</td>
<td>Sat 9/19/15</td>
<td>Wed 9/30/15</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SD 1 - Web. V 2</td>
<td>24 days</td>
<td>Thu 9/3/15</td>
<td>Tue 10/6/15</td>
<td></td>
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<tr>
<td></td>
<td>Rocksat-C CoDR Review</td>
<td>38 days</td>
<td>Mon 8/24/15</td>
<td>Wed 10/14/15</td>
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<tr>
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<td>SD 1 - Preliminary Overview</td>
<td>45 days</td>
<td>Mon 8/24/15</td>
<td>Fri 10/23/15</td>
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<td>SD 1 - PDR Presentation</td>
<td>14 days</td>
<td>Wed 10/14/15</td>
<td>Mon 11/2/15</td>
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<tr>
<td></td>
<td>Rocksat-C PDR</td>
<td>18 days</td>
<td>Wed 10/14/15</td>
<td>Fri 11/6/15</td>
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<tr>
<td></td>
<td>SD 1 - Web. V 3</td>
<td>22 days</td>
<td>Tue 10/6/15</td>
<td>Wed 11/4/15</td>
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<tr>
<td></td>
<td>Rocksat-C Critical Design Review</td>
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<td>Mon 11/23/15</td>
<td>5,1,8,3</td>
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<td>Mon 11/2/15</td>
<td>Mon 11/30/15</td>
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<td>SD 1 - Project Poster</td>
<td>2 days</td>
<td>Mon 11/30/15</td>
<td>Tue 12/1/15</td>
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<td></td>
<td>SD 1 - Senior Design Day Preparation</td>
<td>5 days</td>
<td>Wed 12/2/15</td>
<td>Tue 12/8/15</td>
<td>11,7,12,2,4,9,6</td>
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# Monetary Budget

<table>
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<tr>
<th>Equipment/Service</th>
<th>Supplier</th>
<th>Price per Unit ($)</th>
<th>Number of Units</th>
<th>Price ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vacuum Pump</td>
<td>Servo-Flo</td>
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<td>1</td>
<td>330.00</td>
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<td>Valves</td>
<td>Monster Guts</td>
<td>19.00</td>
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<td>95.00</td>
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<td>Battery (9V)</td>
<td>RiteAid</td>
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<td>3</td>
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<td>PTFE Filters</td>
<td>Sterlitech</td>
<td>4.00</td>
<td>20</td>
<td>80.00</td>
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<td>Filter Cassettes</td>
<td>Sterlitech</td>
<td>18.00</td>
<td>6</td>
<td>108.00</td>
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<td>Manifold</td>
<td>McMaster</td>
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<td>Arduino</td>
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<td>46.00</td>
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<td>Tubing/Fittings</td>
<td>McMaster</td>
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<td></td>
<td></td>
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<tr>
<td>G-Switch</td>
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<td>Canister</td>
<td>RockSat-C</td>
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<td>3,000.00</td>
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<table>
<thead>
<tr>
<th>Tubing/Fitting</th>
<th>Supplier</th>
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<th>Number of Units</th>
<th>Price ($)</th>
</tr>
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<tr>
<td>Aluminum 1/4 NPT Male to Barbed Fittings</td>
<td>McMaster</td>
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<td>21</td>
<td>101.64</td>
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<tr>
<td>Aluminum 1/4 NPT 90 Barbed to Barbed Fittings</td>
<td>McMaster</td>
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<td>McMaster</td>
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<td>McMaster</td>
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<td>1</td>
<td>7.40</td>
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<td><strong>Total</strong></td>
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<td></td>
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# Team Contact Matrix

## RSC 2016 Contact List for Temple University

<table>
<thead>
<tr>
<th>Team Member</th>
<th>Email Address</th>
<th>Phone Number</th>
<th>US Person (Y/N)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Students</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anthony Zerkow</td>
<td><a href="mailto:tud20856@temple.edu">tud20856@temple.edu</a></td>
<td>267-315-1516</td>
<td>Y</td>
</tr>
<tr>
<td>Johanna Wiley</td>
<td><a href="mailto:tud16137@temple.edu">tud16137@temple.edu</a></td>
<td>215-756-1057</td>
<td>Y</td>
</tr>
<tr>
<td>Margaret Taylor</td>
<td><a href="mailto:tud19409@temple.edu">tud19409@temple.edu</a></td>
<td>267-432-6642</td>
<td>Y</td>
</tr>
<tr>
<td>Samantha Nicoletti</td>
<td><a href="mailto:snicolet@temple.edu">snicolet@temple.edu</a></td>
<td>267-229-8785</td>
<td>Y</td>
</tr>
<tr>
<td>Kaleb Barrett</td>
<td><a href="mailto:tue67907@temple.edu">tue67907@temple.edu</a></td>
<td></td>
<td></td>
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<tr>
<td>Lisa Antoine</td>
<td><a href="mailto:tuf89455@temple.edu">tuf89455@temple.edu</a></td>
<td></td>
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</tr>
<tr>
<td><strong>Faculty</strong></td>
<td></td>
<td></td>
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<tr>
<td>John Helferty</td>
<td><a href="mailto:helferty@temple.edu">helferty@temple.edu</a></td>
<td>215-204-8089</td>
<td>Y</td>
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<tr>
<td>Shriram Pillapakkum</td>
<td><a href="mailto:sbp2n@temple.edu">sbp2n@temple.edu</a></td>
<td>215-204-4306</td>
<td>Y</td>
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<tr>
<td>William Miller</td>
<td><a href="mailto:wcsmith@temple.edu">wcsmith@temple.edu</a></td>
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# Team Availability Matrix

**Temple University: The Rocketeers**  
Spring 2016 RS-C Team Availability Matrix

<table>
<thead>
<tr>
<th></th>
<th>Monday</th>
<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday</th>
<th>Friday</th>
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<tbody>
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<td>8:00</td>
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Conclusion

ANTHONY ZERKOW
Project Summary

Remaining issues/Areas of Concern

• It is important that we know the volume of air going through each filter, so we are looking into using an anemometer to measure volumetric flow during the flight
References

Author(s): Joyce E. Penner, Robert E. Dickinson and Christine A. O'Neill


[4] Perturbation of the northern hemisphere radiative balance by backscattering from anthropogenic sulfate aerosols...


[7] “Chemical of the Week: Sulfuric Acid”