KRUPS Deployment and Communication System (KUDOS)  
Critical Design Review  

Devin Sparks, Evan Whitmer, Courtney Montague, Gabriel Myers, Suzanne Smith, Alexandre Martin  
University of Kentucky  
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PDR Presentation Content

- Section 1: Mission Overview
- Section 2: System Overview
- Section 3: Subsystem Design
- Section 4: Prototyping/Analysis
- Section 5: Manufacturing Plan
- Section 6: Testing Plan
- Section 7: User Guide Compliance
- Section 8: Project Management Plan (PMP)
1.0 Mission Overview

Devin Sparks
Mission Overview: Mission Statement

• Increase the TRL of a small entry spacecraft to TRL 9 by demonstrating data acquisition, communication, and TPS designs

Mission Objectives

• Test and demonstrate communication system, release mechanism, and TPS design for application in future research
• Obtain data for the TPS, which will be used to help ongoing scientific investigations on protection for entry conditions
• A rocket is a cost effective way to collect data at high altitude and high speed in order to test the TPS
Mission Overview: Theory and Concepts

- Ablative Thermal Protection Systems (TPS)
  - Used/Developed from 1950’s - (e.g. AVCOAT on Apollo missions)
- Significant advances have been made in the last 15 years
  - Development of low-density materials such as PICA, used on MSL, Stardust and Dragon
- Many improvements due to high-fidelity numerical methods

*Micro-CT scan of FiberForm*
Mission Overview: Theory and Concepts

• Ablative TPS relies on the phase-change of the material to mitigate high heat flux
  – Phenolic resin and carbon matrix

Micrographs of PICA at different magnifications. (Agrawal et al., 2013)
Mission Overview: Theory and Concepts

• No ground facility can reproduce atmospheric entry flows
• TPS designed using numerical modeling tools and ground test campaigns
• Problems validating models
  – Limited flight data
    • MSL and Orion EFT-1 have provided data
• Similar concepts are being developed in:
  – Belgium
  – Germany
  – Private Sector
Mission Overview: Expected Results

Thermocouple trace of the MISP 1 instrument over the Mars entry of MSL
Mission Overview: ConOps
**Mission Overview: ConOps**

**Team Name:** KUDOS  
**Date:** December 3, 2016

<table>
<thead>
<tr>
<th>Event</th>
<th>Time On</th>
<th>Units</th>
<th>Dwell Time</th>
<th>Units</th>
<th>Event Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>GSE 1</td>
<td>T-180 (sec)</td>
<td>540 (sec)</td>
<td>Minutes before launch. Start on the computer for the experiments.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GSE 2</td>
<td>T-180 (sec)</td>
<td>540 (sec)</td>
<td>Minutes before launch. Start on the computer for the experiments.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TE-1</td>
<td>T+120 (sec)</td>
<td>5 (sec)</td>
<td>Bring power to the electronic deadbolt</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TE-2</td>
<td>T+125 (sec)</td>
<td>60 (sec)</td>
<td>Bring power to the solenoid</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TE-3</td>
<td>N/A (sec)</td>
<td>N/A (sec)</td>
<td>N/A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TE-R</td>
<td>N/A (sec)</td>
<td>N/A (sec)</td>
<td>N/A</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Mission Overview: Top Level Requirements

#### Table 1. Top Level Requirements

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Verification Method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum of 50% of all data transmissions shall be received by radio transceiver or via Iridium network</td>
<td>Test</td>
<td>Iridium and ISM band radio will be tested on a balloon launch</td>
</tr>
<tr>
<td>Payload and all subsystems shall withstand three-axis loading at 25 G, and longitudinal impulse loading of 50 G for 200 seconds</td>
<td>Test</td>
<td>The payload and all subsystems will be subjected to these vibration loads in our vibration testing</td>
</tr>
<tr>
<td>The combined structure shall have a center of gravity (CG) that is within 1 inch square in the plane of the RockSat-X deck in a latitudinal direction</td>
<td>Test</td>
<td>The CG of each subsystem will be collected, then the subsystems will be placed on the payload to get the correct overall CG.</td>
</tr>
</tbody>
</table>
Mission Overview: Success Criteria

- Test the communication system at high altitude and velocities
  - >50% of data collected by sensors shall be received for analysis
- Release mechanism reliability in space environment
  - Mechanism shall eject KRUPS from rocket, without damaging KRUPS or striking longerons
- Test the sensors for thermocouple data acquisition
  - >50% of data retrieved from the thermocouple sensors shall be stored on KRUPS
2.0 System Overview
System Overview: Science Design

Model material response and gas surface interactions at the macro-scale level

Extract material, chemical and transport properties at the micro-scale level

Application to atmospheric entry spacecraft
System Overview: Science Design

- The mission will result in a better understanding of material, chemical and transport properties.
- Heat flux is the main measurement that is modeled in computational research.
- Placement and design of thermocouples are key factors in the design of KRUPS.

3D material response modeling
System Overview: Science Design

Thermocouples

• 12 total thermocouples integrated with KRUPS.
  – Via three (3) thermo-plugs embedded in heat shield
• Thermocouples are spaced 0.10, 0.23, 0.35, and 0.48-inches from heat shield surface
System Overview: Science Design

- Heat Shield
  - Glued to housing
- Thermocouple locations
System Overview: Engineering Design

- **KRUPS** is structured similarly to REBR
  - REBR - A data re-entry breakup recorder designed by Aerospace Corp.,
  - 3 successful mission in re-supply vehicles (HTV, ATV, etc.)
- The computational research data will be compared with data recorded from:
  - Thermocouples
  - Accelerometers
  - Gyrometers
  - Pressure gauges
- Iridium Satellite Network will receive data from KRUPS
  - Global satellite coverage
- Release mechanism
  - Solenoid
System Overview: Payload Layout
Systems Overview: System Changes Since PDR

**PDR Action List**
- Finalize designs
- Engineering analysis completed
- Drawings completed

**Major Changes**
- ISM Radio RF is 915MHz
- Position of KRUPS for ejection
- Scaled KRUPS from 7 to 7.5-in diameter
- Including a camera on the Payload deck
System Overview: Functional Block Diagram

PAYLOAD AREA

Payload Control Unit

Lid

Electronic Dead bolt

Remove pin

Electronic Dead bolt

DC to DC 24-32V to 5V Converter

GSE-1
GSE-2
TE-R
TE-NR1
TE-NR2
TE-NR3

RS232 Parallel bits 1-8

Payload Control Unit

Micro-controller

Controller 1

Controller 2

Remove connector

Launch sensor

Deployable Arm 1

Solenoid

Remove pin

Solenoid

Gain 5 Accelerometer

Orientator

High-G Accelerometer

Sensor

Thermo Couple to Digital

Battery Pack

microcontroller

Radio Transceiver

KRUPS

Legend

Red - Power
Green - ADC
Orange - PWM
Black - Digital
System Overview: Mechanical Design

Solenoid

Electronic Dead bolt
System Overview: Mechanical Design

KRUPS

Filler material
System Overview: Electrical Design
System Overview: Electrical Design
## System Overview: Electrical Design

<table>
<thead>
<tr>
<th>Component Name</th>
<th>Specifications</th>
<th>Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADXL377</td>
<td>± 200G accelerometer in X, Y, and Z orientations</td>
<td>Detection of splashdown</td>
</tr>
<tr>
<td>L3GD20H</td>
<td>3 axis gyroscope</td>
<td>Measure changes in orientation during descent</td>
</tr>
<tr>
<td>LSM303DLHC</td>
<td>± 8G accelerometer ± 4 gauss magnetometer</td>
<td>Magnetometer, re-entry detection</td>
</tr>
<tr>
<td>MAX31855</td>
<td>14bit, .25C resolution</td>
<td>Thermo-couple measurement of TPS material</td>
</tr>
</tbody>
</table>
System Overview: Software Design
System Overview: De-Scopes and Off-Ramps

- Off-ramp if necessary
  - Payload camera
  - Only use one radio in KRUPS
- Impact
  - No impact on objectives
  - Decreased redundancy of data transmission
System Overview: Special Requests

- Transmit Frequencies:
  - Iridium network on 1616-1625Mhz
  - Transmit to ground station frequencies 915MHz
3.0 Subsystem Design

Courtney Montague
Subsystem Design

• Thermal Protection System
  – Location of thermocouples
  – Shape / Dimensions

• Release Mechanism
  – KRUPS pre-ejection restraint and deployment

• Communication
  – Iridium network & KRUPS transmissions

• Embedded Control
  – Data collection & storage

• Electrical
  – Capsule power system
Subsystem Design: Thermal Protection System

- Weight not to exceed 1 lb.
- TPS Material:
  - Norcoat-Liege
    - Hot Pressed Cork particles & Phenolic Resin
    - $\rho = 480 \text{ kg/m}^3$
- Glued to housing using RTV
### RISKS

1. **TPS.RSK.1**; **Consequence:** 4; **Likelihood:** 2
   Thermal Protection System failure IF the release mechanism penetrates the TPS outer layer

2. **TPS.RSK.2**; **Consequence:** 4; **Likelihood:** 1
   Thermal Protection System failure IF the outer layer of the TPS gets damaged during the shipping processes
Subsystem Design: Release Mechanism

- Weight not to exceed 15 lbs
- Power: Wallops supplied 28V stepped down to 5V
- Solenoid controlled release mechanism
Subsystem Design: Release Mechanism

RISKS

1. MD.RSK.1; Consequence: 5; Likelihood: 1
   Mechanical Deployment failure IF thermal expansion differs from design expectations

2. MD.RSK.2; Consequence: 2; Likelihood: 2
   Mechanical Deployment failure IF vibration during launch engages the release mechanism early

3. MD.RSK.3; Consequence: 3; Likelihood: 2
   Mechanical Deployment failure IF temperature range exposed to the release mechanism differs from design expectations
Subsystem Design: Communication

- Weight to not exceed 1.5 lbs
- Power: 4.5V
- NAL Research Iridium Modem
- Custom designed 900MHz radio transceiver
### Subsystem Design: Communication

#### RISKS

1. **COM.RSK.1**: Consequence: 4; Likelihood: 4
   Communication failure IF we cannot receive more than 50% of data transmitted via Iridium or ISM band radio.

2. **COM.RSK.2**: Consequence: 4; Likelihood: 1
   Communication failure IF the power source to KRUPS becomes disconnected during the launch.

3. **COM.RSK.3**: Consequence: 4; Likelihood: 2
   Communication failure IF the power source to KRUPS does not activate from the preset timer.

4. **COM.RSK.4**: Consequence: 3; Likelihood: 3
   Communication failure IF the radio transceivers inside of KRUPS overheat due to TPS insulation.
Subsystem Design: Embedded Control

- Weight to not exceed .5 lbs
- PJRC Teensy 3.2 micro-controller
- Custom designed instrument board
  - High and Low G Accelerometer
  - Gyroscope, and Magnetic Compass
  - Thermocouple to Digital Convertor
  - Surface Pressure Sensor
  - Micro-SD card
Subsystem Design: Electrical

- **Weight**: ~0.3-0.46 lbs
- **Power**: 4.5V nominal
  - Arranged in a series-parallel connection
- **Power source**: 9 AA batteries
- **Yields**: 7-9Ah of capacity
1. ELE.RSK.1; Consequence: 5; Likelihood: 2
Electrical failure IF the vibration during launch causes the wire connections to disconnect

2. ELE.RSK.2; Consequence: 5; Likelihood: 2
Electrical failure IF wire insulation degrades in the temperature range during flight
KUDOS - Detailed Weight Budget

Date: December 3, 2016

<table>
<thead>
<tr>
<th>Sub-system</th>
<th>Weight (lbs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TPS</td>
<td>2</td>
</tr>
<tr>
<td>KREM</td>
<td>15</td>
</tr>
<tr>
<td>Payload Platform</td>
<td>3.5</td>
</tr>
<tr>
<td>Housing</td>
<td>1</td>
</tr>
<tr>
<td>Electronics</td>
<td>1.5</td>
</tr>
<tr>
<td>Communications</td>
<td>2</td>
</tr>
<tr>
<td>Extra</td>
<td>5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>30</strong></td>
</tr>
</tbody>
</table>

**Over/Under** 0.00
## KOREVET - Power Budget for KREM (powered by Wallops)

**Date 12/03/2016**

<table>
<thead>
<tr>
<th>Subsystem</th>
<th>Voltage (V)</th>
<th>Max Current (A)</th>
<th>Start Time (min)</th>
<th>Time On (min)</th>
<th>Watts</th>
<th>Ah</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teensy 3.2</td>
<td>3.3</td>
<td>0.1000000</td>
<td>9</td>
<td>0.33</td>
<td>0.01500000</td>
<td></td>
</tr>
<tr>
<td>Solenoid</td>
<td>12.0</td>
<td>0.4030000</td>
<td>1</td>
<td>4.84</td>
<td>0.00671667</td>
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</tr>
<tr>
<td>Electronic Dead bolt</td>
<td>12.0</td>
<td>0.9000000</td>
<td>0.0833333333</td>
<td>10.80</td>
<td>0.00125000</td>
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</tr>
<tr>
<td></td>
<td>3.3</td>
<td>0.0000000</td>
<td></td>
<td>0.00</td>
<td>0.00000000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3.3</td>
<td>0.0000000</td>
<td></td>
<td>0.00</td>
<td>0.00000000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3.3</td>
<td>0.0000000</td>
<td></td>
<td>0.00</td>
<td>0.00000000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3.3</td>
<td>0.0000000</td>
<td></td>
<td>0.00</td>
<td>0.00000000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3.3</td>
<td>0.0000000</td>
<td></td>
<td>0.00</td>
<td>0.00000000</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1.40</td>
<td></td>
<td></td>
<td>15.97</td>
<td>0.02296667</td>
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</tbody>
</table>

| Total Power Capacity       | 1.00        |
| Over/Under                 | 0.98        |

# of Flights Margin: 43.5
# Subsystem Design: Detailed Power Budget

## KUDOS - Power Budget for KRUPS (not powered by Wallops)

<table>
<thead>
<tr>
<th>Subsystem</th>
<th>Voltage (V)</th>
<th>Max Current (A)</th>
<th>Start Time (min)</th>
<th>Time On (min)</th>
<th>Watts</th>
<th>Ah</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gyro</td>
<td>3.3</td>
<td>0.0050000</td>
<td>5</td>
<td>0.02</td>
<td>0.0041667</td>
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</tr>
<tr>
<td>Analog Multiplexers</td>
<td>3.3</td>
<td>0.0000002</td>
<td>5</td>
<td>0.00</td>
<td>0.0000002</td>
<td></td>
</tr>
<tr>
<td>Hi-G Accel</td>
<td>3.3</td>
<td>0.0003000</td>
<td>5</td>
<td>0.00</td>
<td>0.0003000</td>
<td></td>
</tr>
<tr>
<td>Pressure Sensor</td>
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<td>0.0020000</td>
<td>5</td>
<td>0.01</td>
<td>0.0016667</td>
<td></td>
</tr>
<tr>
<td>Compass, Lo-G Accel</td>
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<td>0.0001100</td>
<td>5</td>
<td>0.00</td>
<td>0.0000917</td>
<td></td>
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<tr>
<td>Thermo</td>
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<td>0.0030000</td>
<td>5</td>
<td>0.01</td>
<td>0.0002500</td>
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<tr>
<td>Teensy 3.2</td>
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<td>0.1000000</td>
<td>8</td>
<td>0.33</td>
<td>0.0133333</td>
<td></td>
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<tr>
<td>Iridium</td>
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<td>0.5000000</td>
<td>8</td>
<td>2.50</td>
<td>0.0666667</td>
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<tr>
<td>ISM Radio</td>
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<td>0.4000000</td>
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<td>1.32</td>
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</tr>
<tr>
<td></td>
<td>3.3</td>
<td>0.0000000</td>
<td></td>
<td>0.00</td>
<td>0.0000000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3.3</td>
<td>0.0000000</td>
<td></td>
<td>0.00</td>
<td>0.0000000</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>0.01</strong></td>
<td></td>
<td><strong>4.18</strong></td>
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<td><strong>0.13420085</strong></td>
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</tr>
<tr>
<td><strong>Total Power Capacity</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>1.00</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Over/Under</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>0.87</strong></td>
<td></td>
</tr>
</tbody>
</table>

# of Flights Margin: 7.5
4.0 Prototyping/Analysis Results/Plans

Gabriel Myers
Prototyping Results/Plan:

- **Housing**
  - 3D Printed with PLA using FDM
  - 20% Fill

- **Findings:**
  - Need tighter tolerances
  - Add screw bosses for temporary assembly before applying adhesive
    - Size & Location dependent on final communication system dimensions
Analysis Results/Plans:

• Finite Element Analysis
  – Deformation of TPS due to solenoid arm
  – Deformation of TPS due to 25 and 50 G
  – Stress and deformation on electronic dead bolt pin

• Key results
  – TPS will not be deformed due to solenoid arm or the 25 and 50 G’s during launch
    • Agrees that the requirement to not damage the TPS will be met
  – Dead bolt pin will not experience stress or deformation that will cause the door not to open.
    • Agrees that the requirement to have a reliable release will be met

• Plans for other analysis
  – Natural frequencies and mode shapes caused by the vibrations
  – Deformation of the internal housing due to 25 and 50 G
Analysis Results/Plans:

- Finite Element Analysis Example
  - Deformation of TPS due to solenoid arm
5.0 Manufacturing Plan

Gabriel Myers
Manufacturing Plan: Mechanical Elements

• What will be manufactured
  – Filler material mold
  – Rectangular tube
  – Internal housing

• What will be purchased
  – Vibration dampers
  – Solenoid
  – Electronic dead bolt
Manufacturing Plan: Electrical Elements

• What will be manufactured
  – Printed Circuit Boards
  – Final launch circuit board will be professionally manufactured

• What will be purchased
  – Sensors
  – Battery packs

• Schedule
  – New prototype every 1.5-2 months until design is fully functional and satisfies requirements
Manufacturing Plan: Software Elements

- Object oriented design
  - C++ based functions with Arduino extensions

- All sensor oriented functions finished by early March
- Communication software fully implemented by February and field tested by early April
- Data archival, and compression software finished by March
6.0 Testing Plan

Gabriel Myers
Testing Plan: Mechanical Testing

- **Weigh overall system**
  - Using a scale, we will weigh the overall system.
  - This test can be done when all parts are delivered. Projected timeline is around February or March.

- **Center of Gravity (balance test)**
  - Finding the balance point.
  - This test can be done when all parts are delivered. Projected timeline is around February or March.

- **Vibration testing**
  - Shaker test.
  - This test can be done when all parts are delivered. Projected timeline is around March.

- **Deployment testing**
  - Water release testing
  - This test can be done when all parts are delivered. Projected timeline is around March.
Testing Plan: Electrical Testing

- **Thermo-Vacuum Chamber**
  - Test functionality during defined temperature profile
  - Check the pressure sensors against the Chamber’s calibrated pressure gauge

- **Electrical Continuity Test**
- Test each sensor’s interface independently
  - Check both functionality, and accuracy of all sensors
Testing Plan: Software Testing

• Test communication system during balloon launch, March-April time frame

• Ensure functionality of:
  – Launch activation of hardware
  – Sensor measurements at intervals
  – Data archival
  – Data reordering, and transmission to radios
7.0 User Guide Compliance

Devin Sparks
## User Guide Compliance: Summary

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Status</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Center of gravity in 1” plane of plate?</td>
<td>Yes</td>
<td>Final design in progress</td>
</tr>
<tr>
<td>Weight 30.0+/- 1.0 lbs.</td>
<td>Yes</td>
<td>Final design in progress</td>
</tr>
<tr>
<td>Max Height &lt; 10.75” (5.13”)</td>
<td>Yes</td>
<td>Final design in progress</td>
</tr>
<tr>
<td>Bottom of deck has flush mount hardware?</td>
<td>Yes</td>
<td>Final design in progress</td>
</tr>
<tr>
<td>Within Keep-Out Zone</td>
<td>Yes</td>
<td>Final design in progress</td>
</tr>
<tr>
<td>Using &lt; 10 A/D Lines</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Using/Understand Parallel Line</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Using/Understand Asynchronous Line</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Using X GSE Line(s)</td>
<td>Yes</td>
<td>GSE-1</td>
</tr>
<tr>
<td>Using X Non-Redundant PWR Lines (TE-1, TE-2, TE-3)</td>
<td>Yes</td>
<td>TE-1, TE-2</td>
</tr>
<tr>
<td>Using X Redundant Power Lines (TE-R)</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Using &lt; 1 Ah</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Using &lt;= 28 V</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Using RF (If yes, list frequency and TX Power)</td>
<td>Yes</td>
<td>Frequency is 915 MHz. Only TX on ejected capsule!</td>
</tr>
<tr>
<td>Using deployable?</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Whole team consists of US Persons</td>
<td>No</td>
<td>Non-US persons are part of the senior design teams, but <strong>will not</strong> be on site at Wallops</td>
</tr>
<tr>
<td>Using ITAR and/or Export Controlled hardware</td>
<td>No</td>
<td>There is a possibility to get an ITAR restricted heat-shield, but it would add too many constraints</td>
</tr>
</tbody>
</table>
## User Guide Compliance: Power Interface

<table>
<thead>
<tr>
<th>Power Pin</th>
<th>Function</th>
<th>Intended Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>GSE 1</td>
<td>Ejector power</td>
</tr>
<tr>
<td>2</td>
<td>Timer Event Redundant (TE-RA)</td>
<td></td>
</tr>
<tr>
<td>3</td>
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</table>
8.0 Project Management Plan (PMP)

Courtney Montague
PMP: Management

Faculty Advisor
Dr. A. Martin
Dr. S. Smith

Systems Engineering & Integration

Devin Sparks (ME)

Courtney Montague (ME)
Gabriel Myers (ME)
Evan Whitmer (COE)

Senior Design Teams & Leads

Thermal Protection System (TPS)
Olivia Schroeder
- Ausencio Fuentes
- Joseph Galloway
- Anastasia Marcum
- Loril Smith

Communication System (KRUPSComm)
Ajin Sunny
- Abdul Abu-Taha
- Zach Davis
- Tanbir Gill
- Evan Whitmer
- Guo Yuanzhen

Rocket Ejection Mechanism (KREM)
Gregory Avina
- Mason Boggs
- Shaun Kim
- Liz Miller
- Brandon West

AIAA
UK Student Chapter

SEDS
UK Student Chapter
# PMP: Management

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PMP: Management

- **Budget:** $34,000
  - Status of Deposit: Paid
- **Faculty:** Dr. A. Martin, & Dr. S.W. Smith

### KUDOS/University of Kentucky

#### Fall 2016 RS-X Contact Matrix

<table>
<thead>
<tr>
<th>Role</th>
<th>Name</th>
<th>Day Phone</th>
<th>Cell Phone</th>
<th>Receive Texts?</th>
<th>Email</th>
<th>Citizenship</th>
<th>Add to mailing list?</th>
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</thead>
<tbody>
<tr>
<td>Faculty Advisor</td>
<td>Alexandre Martin</td>
<td>859-317-9184</td>
<td>734-474-4383</td>
<td>Yes</td>
<td><a href="mailto:alexandre.martin@uky.edu">alexandre.martin@uky.edu</a></td>
<td>Canada/US Perm. Res.</td>
<td>yes</td>
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<tr>
<td>Leadership Team (Undergraduate)</td>
<td>Evan Whitmer</td>
<td>270-977-5498</td>
<td>270-977-5498</td>
<td>Yes</td>
<td><a href="mailto:evancw@gmail.com">evancw@gmail.com</a></td>
<td>United States</td>
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<tr>
<td>Leadership Team (Undergraduate)</td>
<td>Courtney Montague</td>
<td>859-753-0931</td>
<td>859-753-0931</td>
<td>Yes</td>
<td><a href="mailto:ccmontague@yahoo.com">ccmontague@yahoo.com</a></td>
<td>United States</td>
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<tr>
<td>Leadership Team (Undergraduate)</td>
<td>Gabriel Myers</td>
<td>859-324-6191</td>
<td>859-324-6191</td>
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<td><a href="mailto:gimy222@g.uky.edu">gimy222@g.uky.edu</a></td>
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<tr>
<td>Leadership Team (Undergraduate)</td>
<td>Devin Sparks</td>
<td>405-482-9680</td>
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<td><a href="mailto:devin.sparks@uky.edu">devin.sparks@uky.edu</a></td>
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**KUDOS/University of Kentucky**

**RS-X Team Availability Matrix**

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Please Place priority levels for times you are available. This is done by simply typing a 1, 2, 3, or 4 in each clear box. Hashed boxes are not available.

**Example**

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PMP: Worries

• Communication failure
  – A balloon launch will test:
    • Antennas
    • Communication System at ~30.5km altitude
• Mechanical deployment failure
  – Vibration testing
  – Thermo-Vacuum chamber tests
• Electrical failure
  – Thermo-Vacuum chamber tests wire connections in high altitude conditions
PMP: Conclusion

• This mission is a cost effective method for validating computational models and experimental ground tests
  – Directly compare numerical models with flight data
  – Result in improved design of Thermal Protection Systems

• Next steps toward the STR
  – All parts ordered and delivered
  – Start testing subsystems