WV Rocketeers

Critical Design Review

WVU WVU-TECH FSC SU
MU WVWC JFFL NASA IV&V

Steven Hard, Zack Dixon, Greg Lusk, Rachelle Huff, Seth Baker, Andrew Tiffin

12/4/2014

CDR Presentation Content

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    - Interpretation to requirements
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CDR Presentation Contents

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Mission Overview

Steven Hard

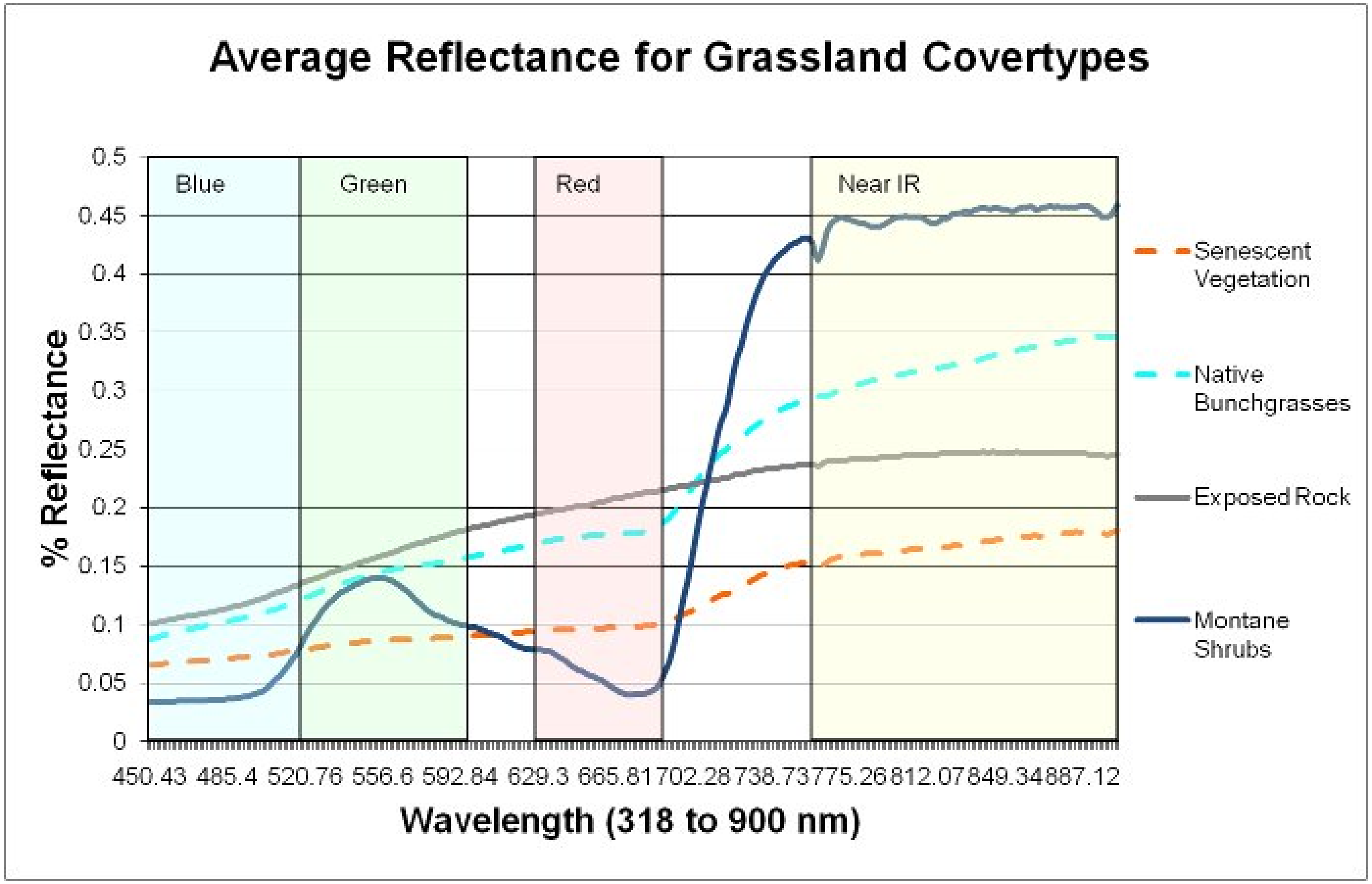
Mission Overview

- The objective of the WV RSC'15 mission will be to develop and test several science and engineering experiments for space operations
- Shall capture NIR Earth images from space, measure magnetic field of Earth, gather redundant flight dynamics data, & detect ionized particles
  - Need access to optics port
- Expect to validate the NOAA magnetic field model using data taken during the flight and to assess vegetation health with Earth images
- Benefits SmallSat community – COTS orientation estimation
- Elementary school systems – promote STEM careers

Expected Results: WVU-CAM

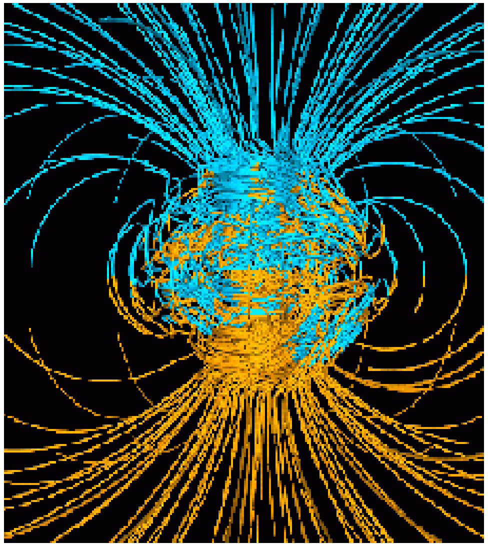
- Sequence of 60 second video clips throughout entire flight and payload recovery
- Extraction of “good” images from video data during flight
  - Good: visibly distinguishable land mass or NIR source
- Expect to create a Normalized Difference Vegetation Index (NDVI) of reflected NIR light intensities (from 0.7 to 1.1 µm) for each good image
  - Index of plant “greenness” or photosynthetic activity
- Visual telemetry showing evidence of any faults experienced during flight

Expected Results: NIR-NDVI



Expected Results: SPACE (4x)

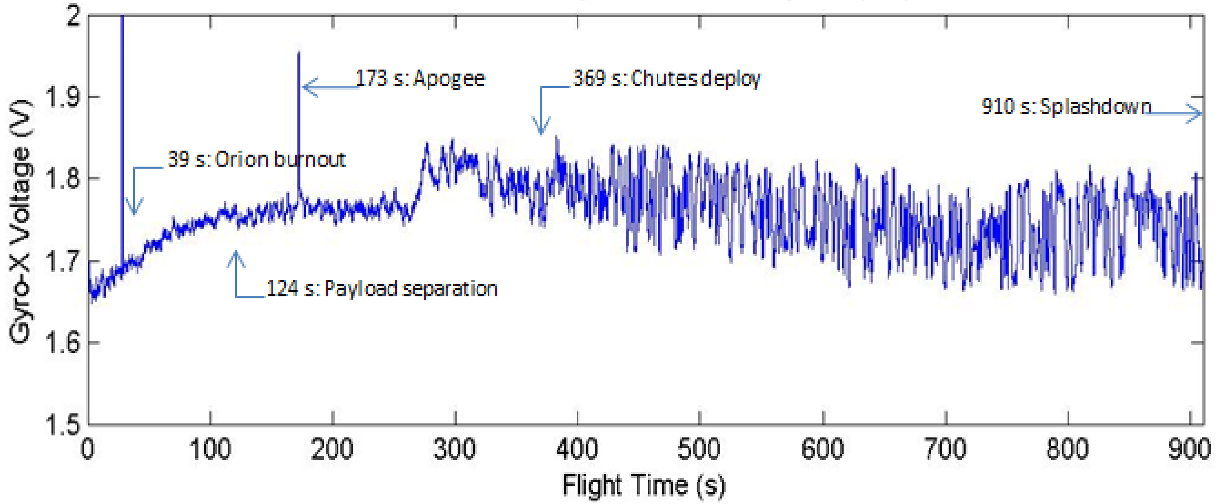
- Predict to detect slight deviations in the mapping of Earth's magnetic field since NOAA's previous mapping
  - Prove that the magnetic field is moving
- Also look to see fluctuations in magnitude of Earth's magnetic field in relation to altitude
  - 2010 NOA WMM data indicates the total field at 38'N 75' W is just over 50,000 nT, while at 150 km elevation, this value is about 47,000 nT.
  - Expect to verify this data



G.A. Glatzmaier and P.H. Roberts, "A Three-Dimensional Self-Consistent Computer Simulation of a Geomagnetic Field Reversal," Nature, 377, 203-209 (1995).

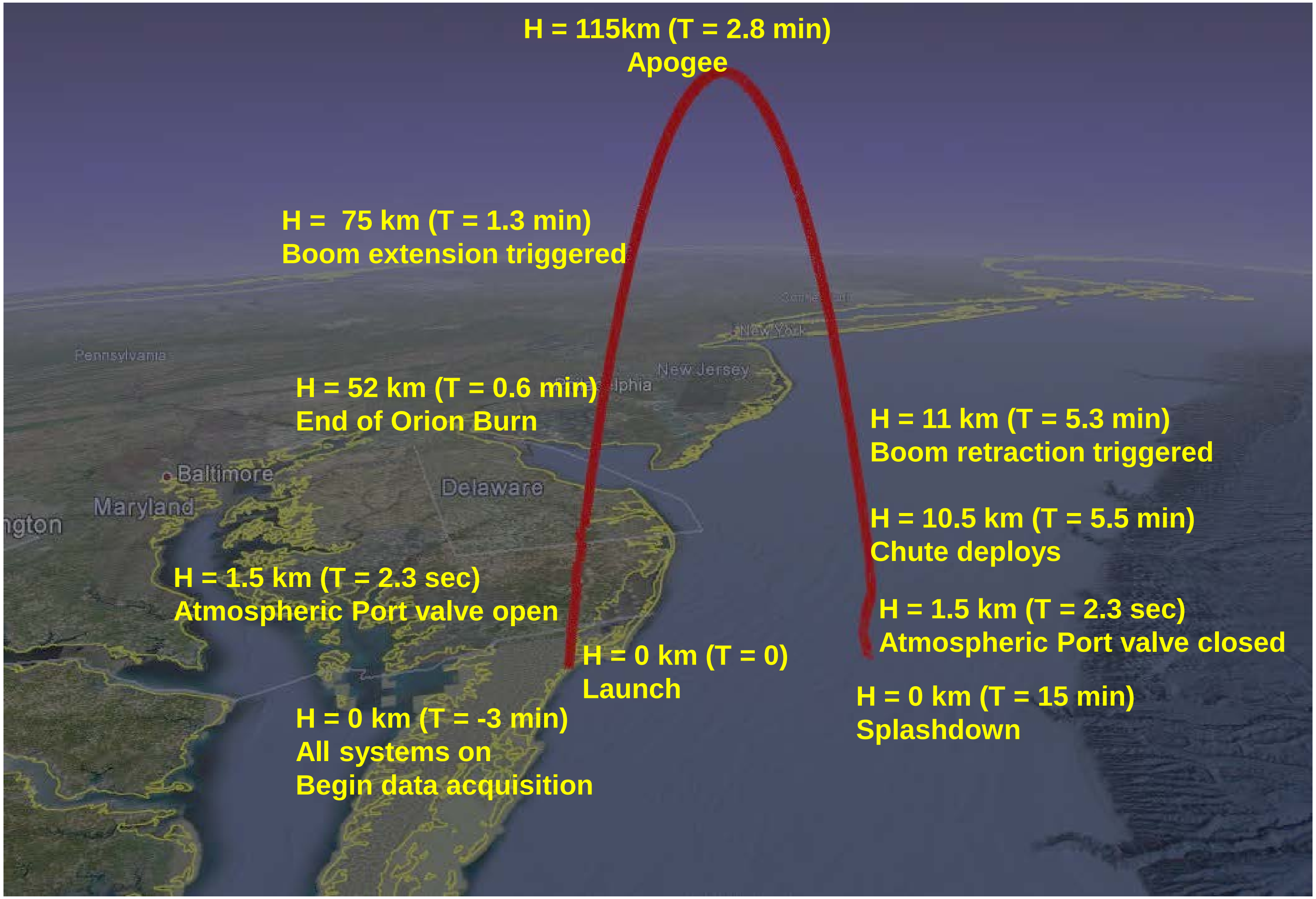
Expected Results: SPACE (4x)

- Comparison of COTS IMU performance with high resolution IMU

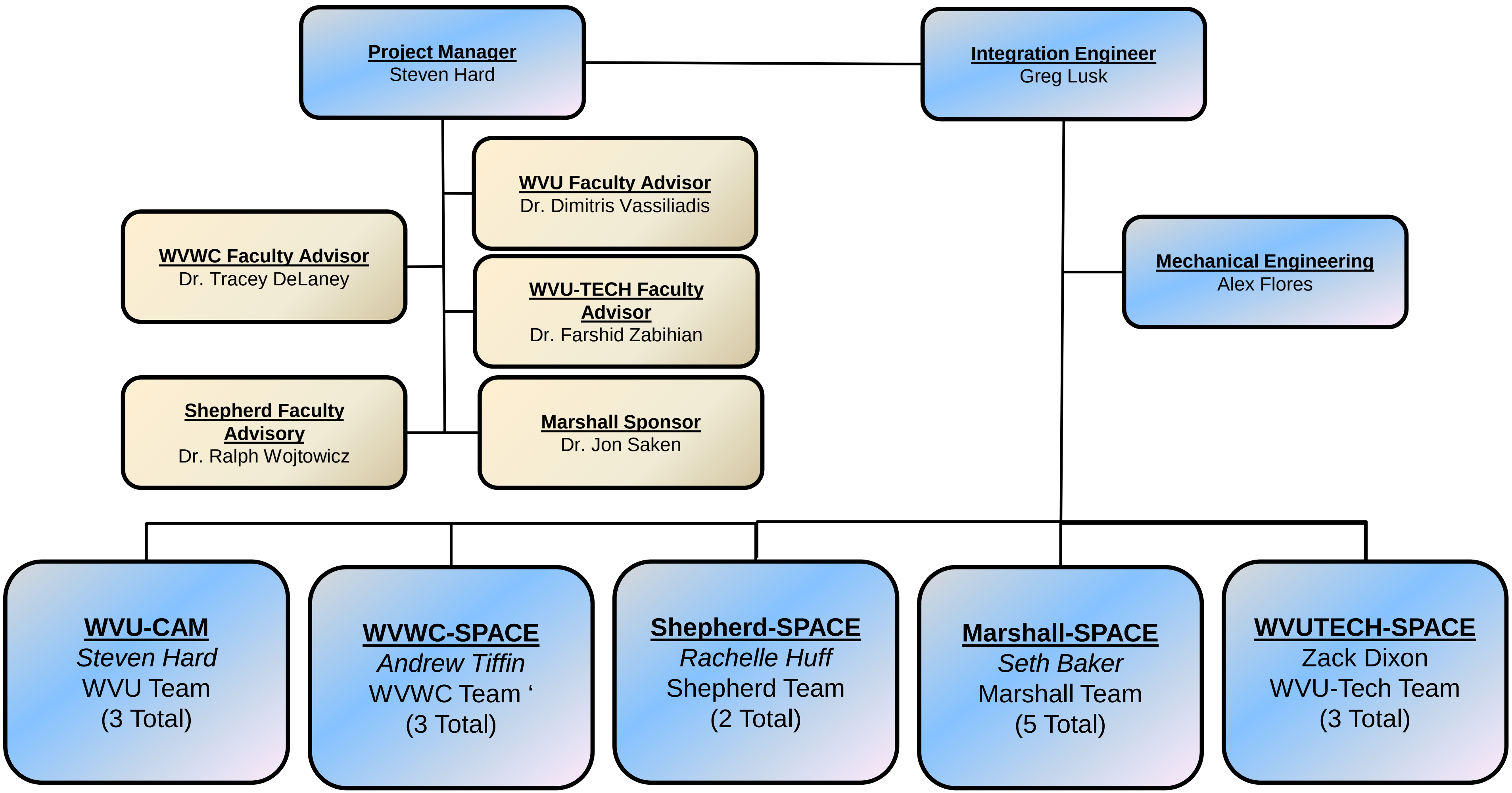


- Increased radiation levels with altitude
  - This radiation will be measured in terms of keV (kilo electron volts)
  - Expect that the radiation will be between .09-2.5 KeV in the E layer and 1-20 KeV in the D layer
- Detection of cosmic rays near apogee

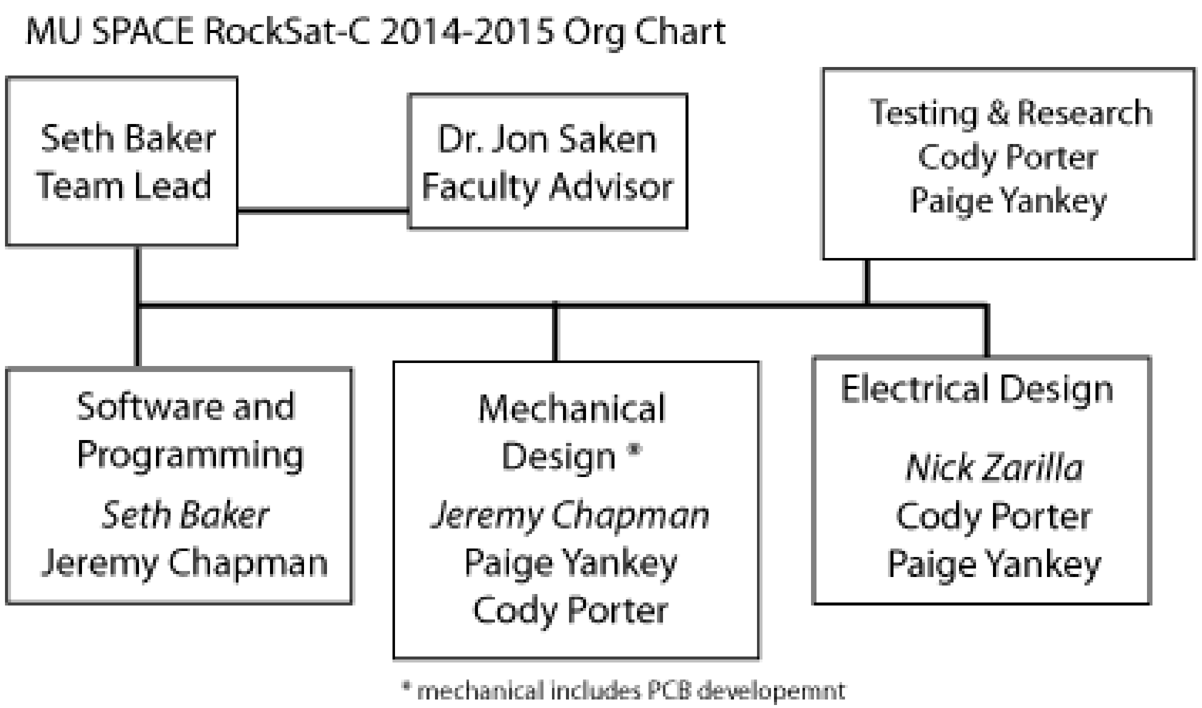
Concept of Operations



Organizational Chart



Project Management: Marshall U



WVWC-SPACE Design Description

Andrew Tiffin
Eric Kramer

WVWC-SPACE: Design Modifications

- We will be removing the altimeter from our project, due to limitations of our sensor.

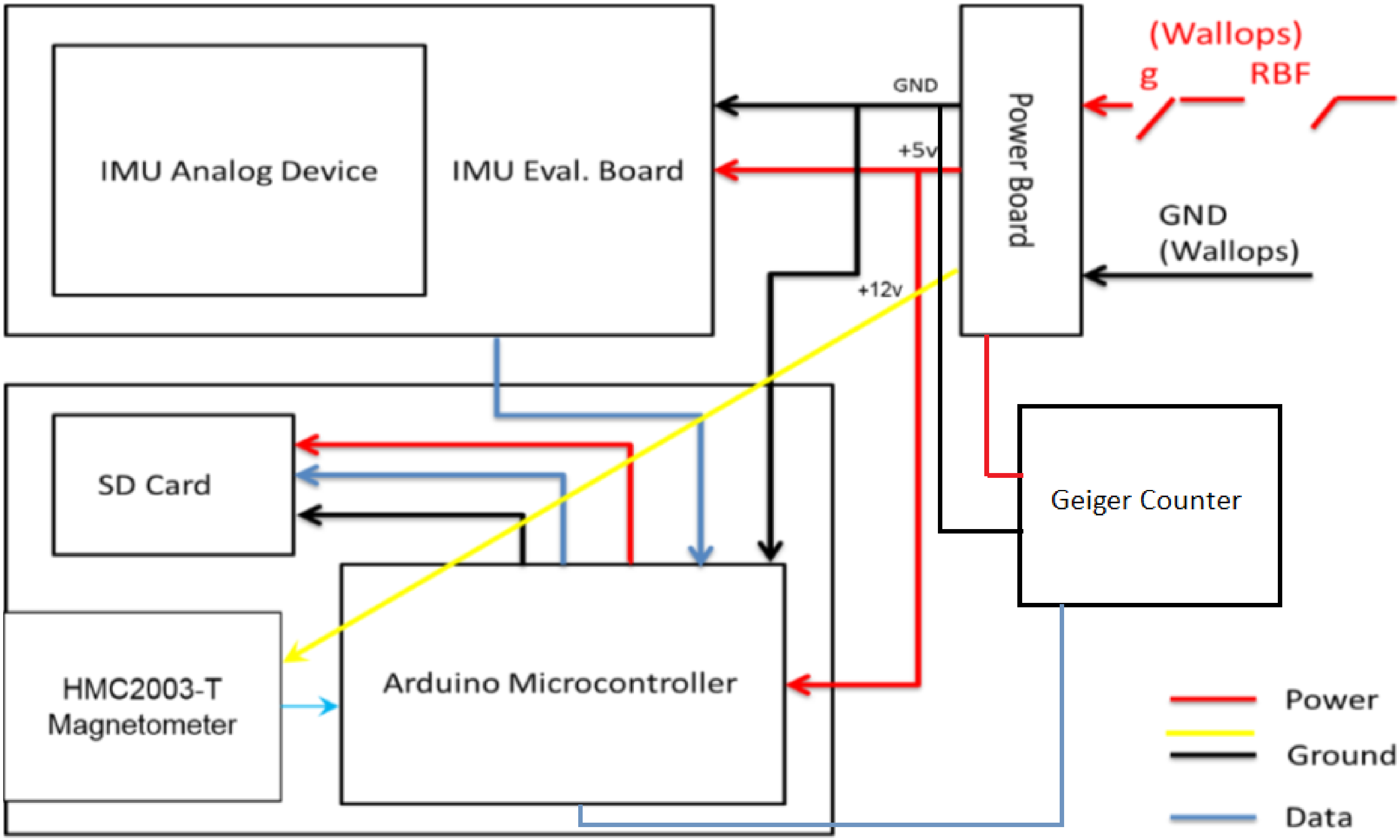
WVWC-SPACE: De-Scopes and Off-Ramps

- We have decided that the altitude sensor we were planning to use will not work at such extreme altitudes, because it is designed to be used at ground level altitudes (<28000 feet)
- Final PCB design to fit CubeSat specs is an off-ramp in case development is behind schedule

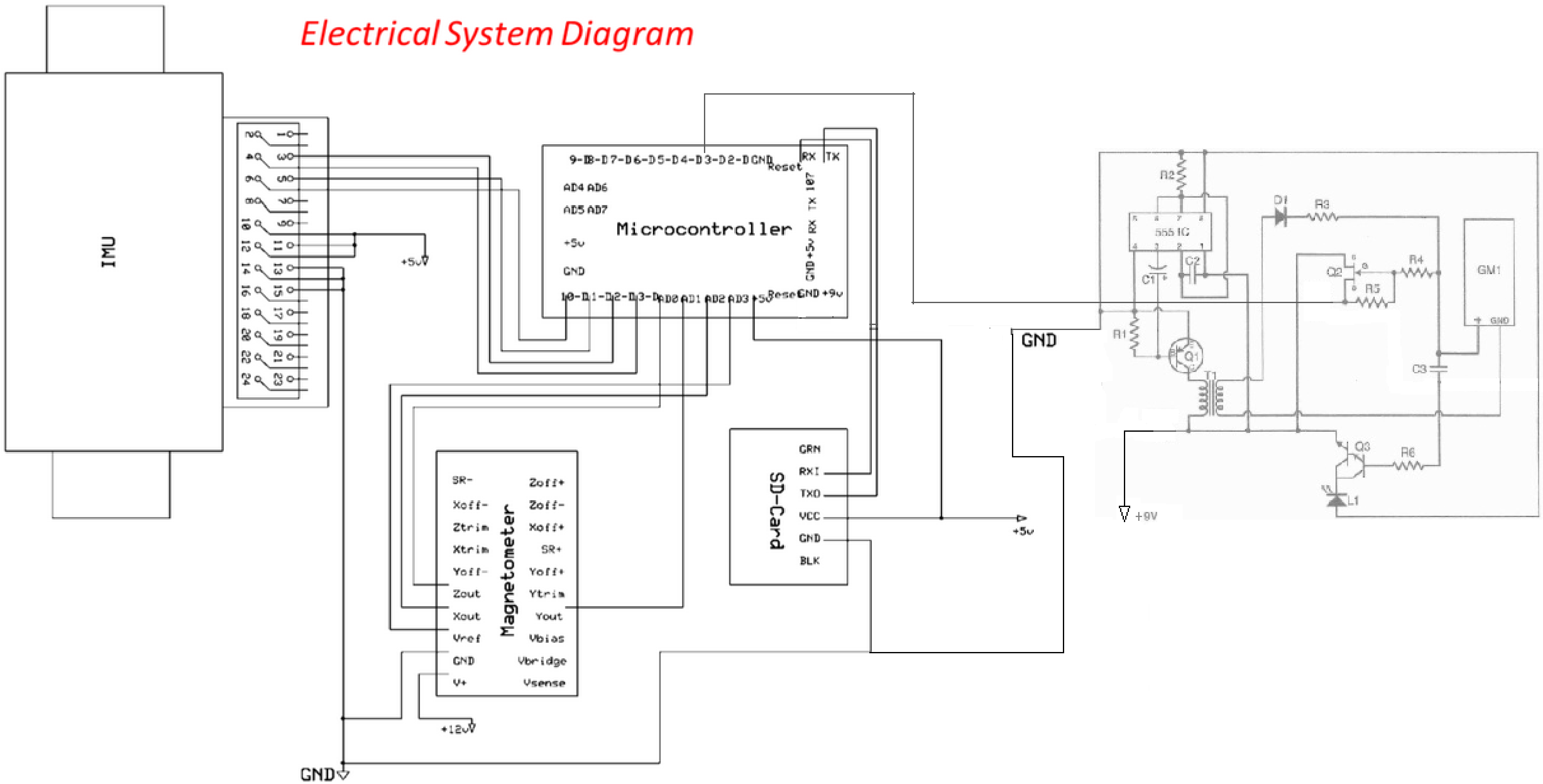
WVWC-SPACE: Electrical Design Elements

- We plan to use two PCB boards; one for our magnetometer and one for our Geiger counter.
- We will use stand-off tabs to mount the Geiger counter PCB above the magnetometer on the main PCB.

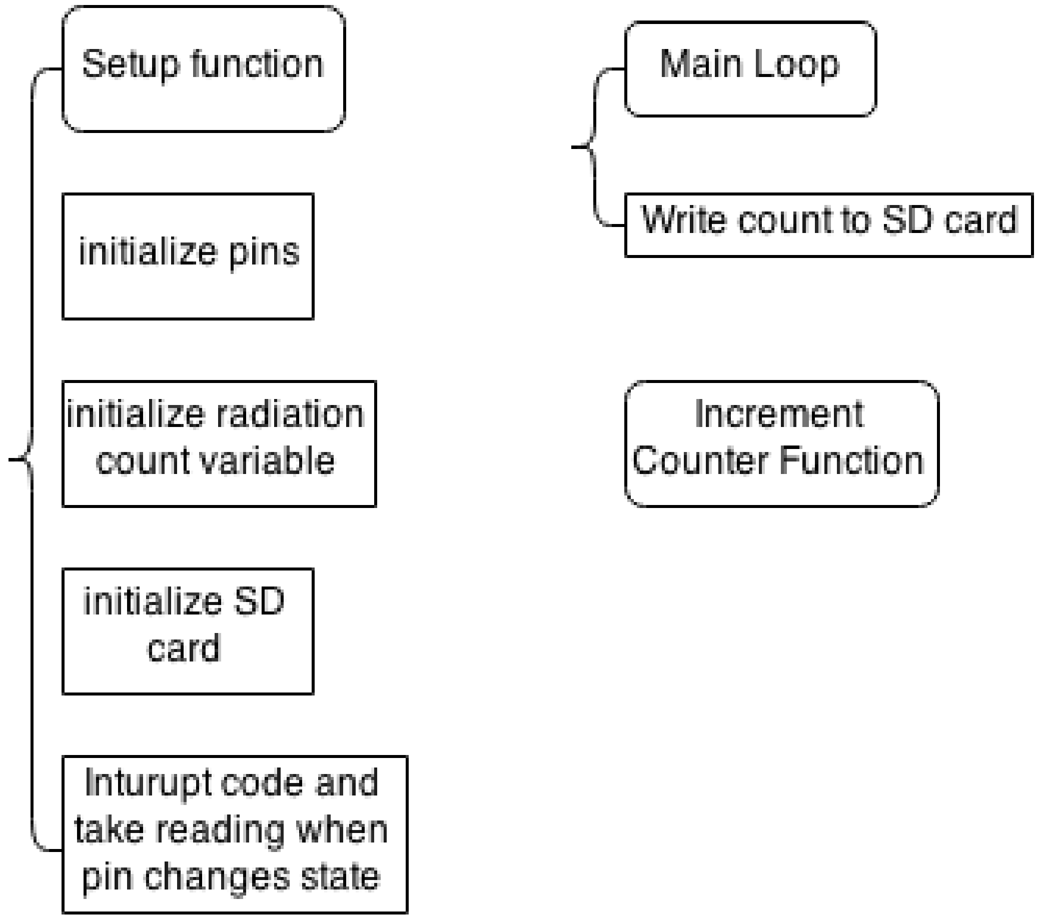
WVWC-SPACE: Electrical Diagram



WVWC-SPACE: Electrical Schematic



WVWC-SPACE: Software Design Elements



WVWC-SPACE: Magnetometer Code

magnetometerTestCode §

```
int sensorPin0 = A0; // X out
int sensorPin1 = A1; // Y out
int sensorPin2 = A2; // Z out
int sensorPin3 = A3; // Vref
float sensorValue[3];
void setup() {
  //initialize 9600 baud serial communications for arduino serial monitor
  Serial.begin(9600);
}
void loop() {
  //Read sensors using analogRead() function.
  //Mag Field (Gauss) = (OutputVoltage-ReferenceVoltage)*(conversion factor = 2.5/512)
  // 1/512 is Arduino ADC resolution
  // +-2.5 is HMC2003 max voltage.
  sensorValue[0] = (analogRead(sensorPin0)-analogRead(sensorPin3))*2.5/512;
  sensorValue[1] = (analogRead(sensorPin1)-analogRead(sensorPin3))*2.5/512;
  sensorValue[2] = (analogRead(sensorPin2)-analogRead(sensorPin3))*2.5/512;
  sensorValue[3] = (analogRead(sensorPin3)-analogRead(sensorPin3))*2.5/512;
  Serial.print( "x = ");
  Serial.print(sensorValue[0]);
  Serial.print(" y = ");
  Serial.print(sensorValue[1]);
  Serial.print(" z = ");
  Serial.print(sensorValue[2]);
  Serial.print(" sensorRefrence =");
  Serial.print(sensorValue[3]);
  Serial.print('\n');
  delay(1000);
}
```

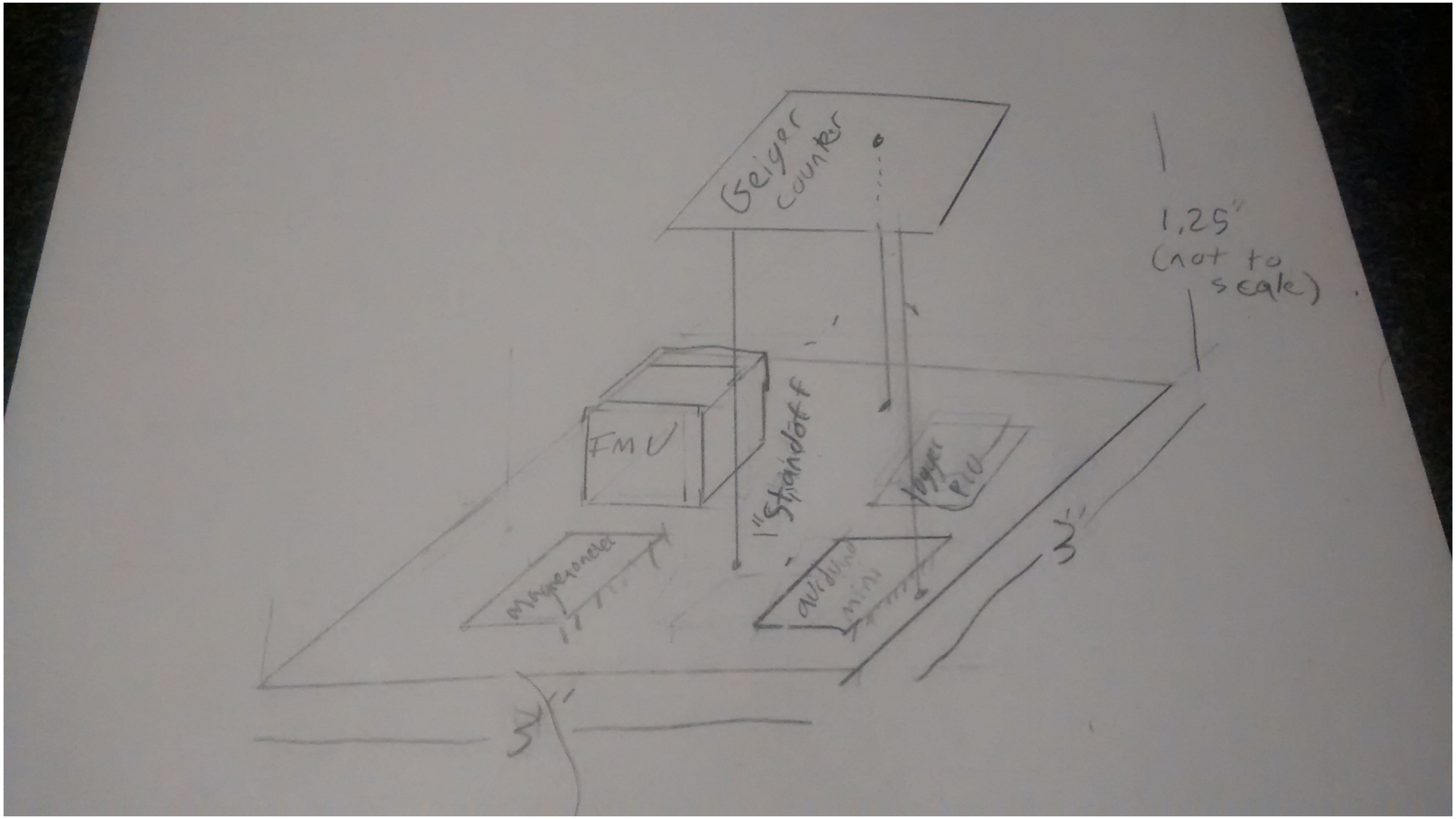
WVWC-SPACE Prototyping/Analysis

Andrew Tiffin

WVWC-SPACE: Analysis Results

- We have decided that the Geiger counter will be mounted above the magnetometer.
- We also are planning to build a new PCB for the magnetometer which will be 4”X 4” and will cut notches into board so it will be design ready for IOS CubeSat orbital launch.

WVWC-SPACE: Prototyping Results



WVWC-SPACE Manufacturing Plan

Eric Kramer

WVWC-SPACE: Mechanical Elements

- Stand-off mounting hardware still needs to be built.
- This can be built in the first few weeks after returning to school in January.

WVWC-SPACE: Electrical Elements

- Leads from the Geiger counter still need to be connected to the Arduino Mini on the PCB.
- We will also be designing a new PCB board with larger dimensions and traces for Geiger counter connection.

WVWC-SPACE: Software Elements

- The code for the Geiger counter still needs to be written to record the short pulses, which is the count rate.
- This will be worked on over Christmas break.

WVWC-SPACE
Testing Plan

Steven Hard

WVWC-SPACE: Electrical Testing

- The Geiger counter will be tested against another calibrated Geiger counter that is already on hand.
- Magnetometer will be tested using the known magnetic field in our region.
- Results will verify functional requirements of each subsystem
- Sensor Calibration: 1/19/15 – 2/6/15

WVWC-SPACE: Software Testing

- Testing the Geiger counter will involve recording the count rate with our sensor and then comparing to a calibrated Geiger counter.
- Testing the Magnetometer will involve measuring the output magnetic readings and comparing to the known magnetic field in our region.
- Software Verification: 12/20/15 – 1/23/15

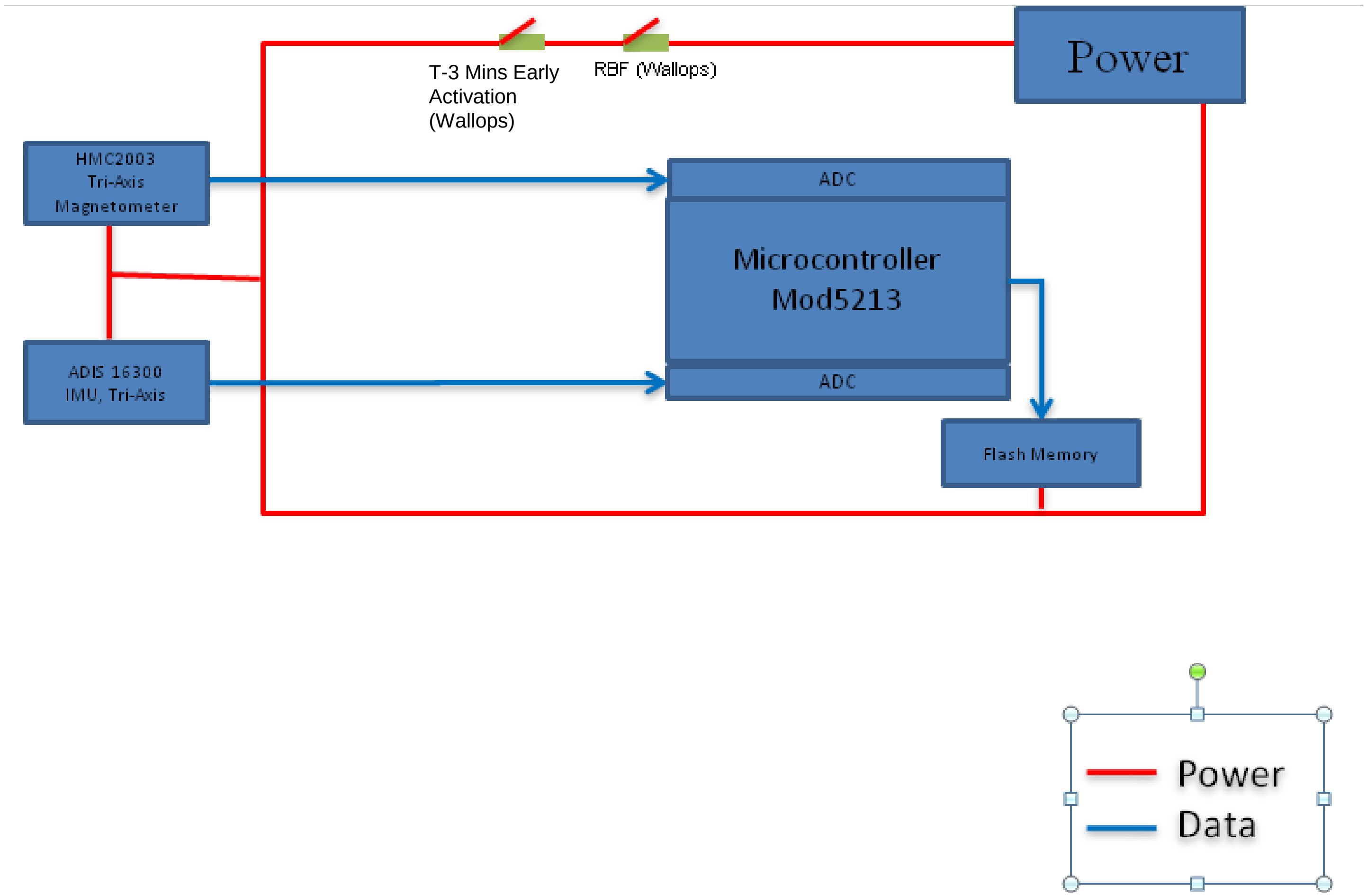
WVUTech-SPACE Design Description

Zack Dixon

WVUTech-SPACE: Off-Ramps and De-scopes

- High risk design parameter is PCB implementation
- Plan is to order PCB early enough to have revisions made
- Off-ramp is to design functional PCB first and modify to fit CubeSat specs for final revision

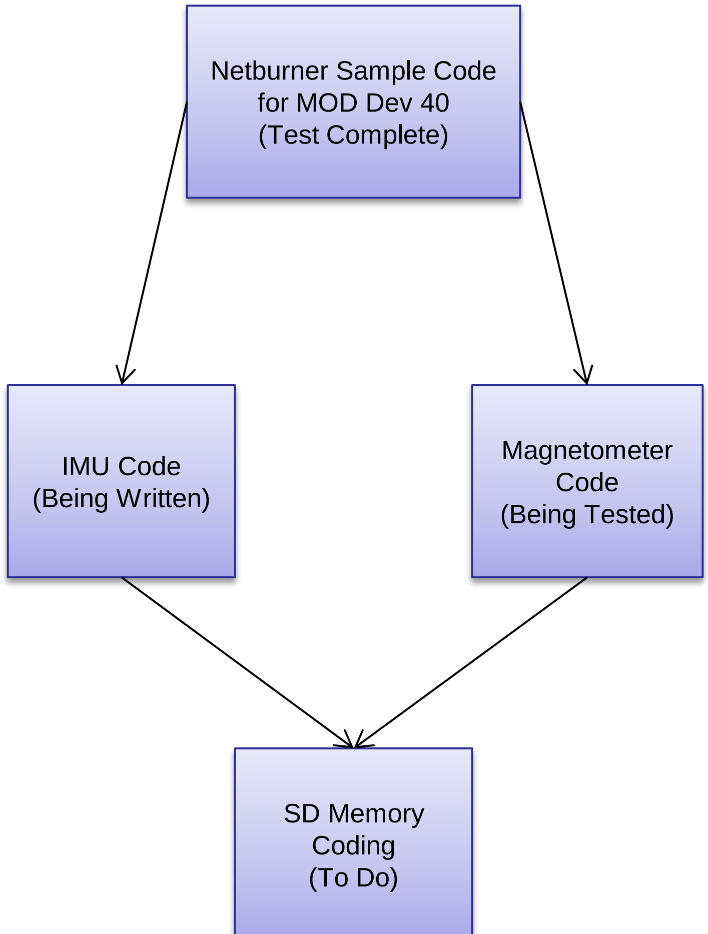
WVUTech-SPACE: Electrical Design Elements



WVUTech-SPACE: Electrical Design Elements

- One 4x4 inch PCB board will be used containing all of the components.
  - Schematics are in the works
- Command line activated at T-3mins

WVUTech-SPACE: Software Design Elements



WVUTech-SPACE: Magnetometer Code

- Sample Code used to ensure working knowledge of Netburner software.
- Magnetometer code developed and being tested shown below.

```
for (i=0; i<1 ; i++){
        int countsx = ReadA2DResult(5) >> 3;
        Xvolts = ( ( float ) countsx / ( 4095.0 ) ) * 3.3;
        int countsy = ReadA2DResult(7) >> 3;
        Yvolts = ( ( float ) countsy / ( 4095.0 ) ) * 3.3;
        int countsz = ReadA2DResult(6) >> 3;
        Zvolts = ( ( float ) countsz / ( 4095.0 ) ) * 3.3;
        float XGauss = Xvolts * 2 / 4.5;
        float YGauss = Yvolts * 2 / 4.5;
        float ZGauss = Zvolts * 2 / 4.5;
        printf("%f Xvolts \n ", Xvolts);
        printf("%f Yvolts \n ", Yvolts);
        printf("%f Zvolts \n ", Zvolts);
        printf("%f Xgauss \n ", XGauss);
        printf("%f Ygauss \n ", YGauss);
        printf("%f Zgauss \n ", ZGauss);
        iprintf( "\r\n" );
}
```

WVUTech-SPACE Prototyping/Analysis

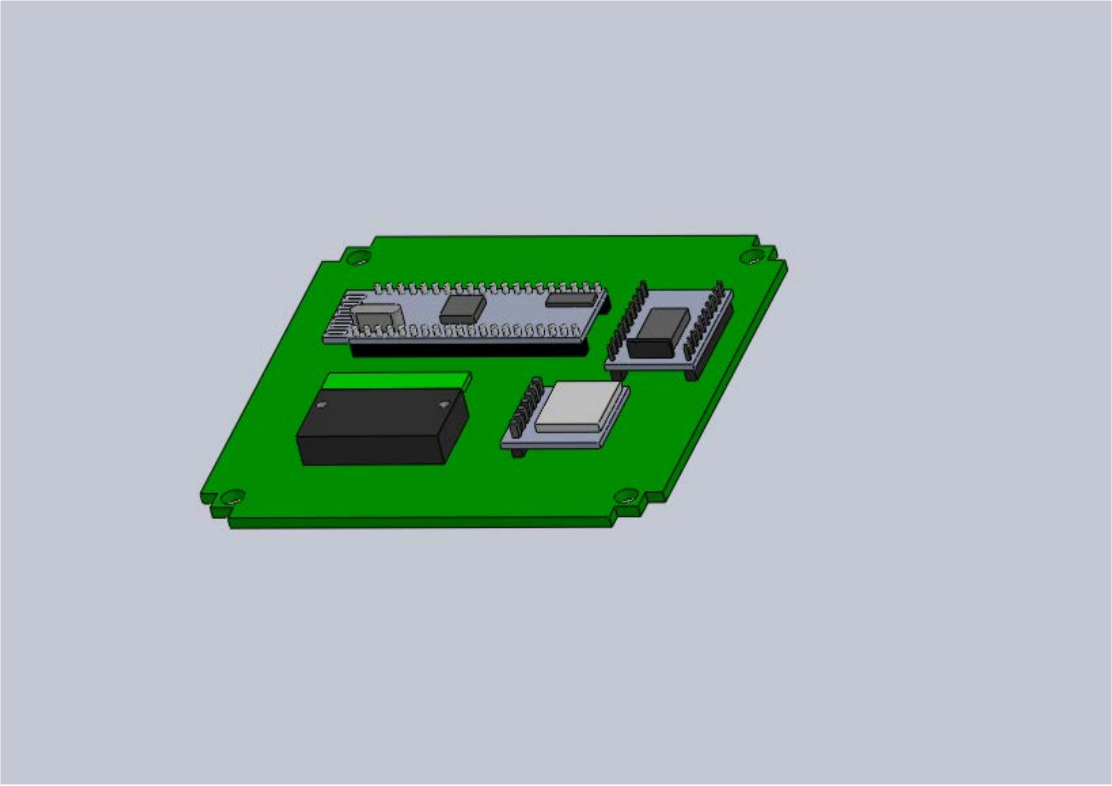
Zack Dixon

WVUTech-SPACE: Analysis Results

- Payload configuration analyzed and layout specified
  - Hardware fits within allotted space
- Limited hardware testing was performed given the holiday break

WVUTech-SPACE: Prototyping Results

- PCB board layout designed and modeled with all components



WVUTech-SPACE Manufacturing Plan

Zack Dixon

WVUTech-SPACE: Mechanical Elements

- PCB will be only manufactured part
- Electrical schematic and schematic testing needs to be done before manufacturing
- PCB will be designed by 2/16/14

WVUTech-SPACE: Electrical Elements

- No Manufacturing beyond PCB
- May need up to 3 revisions
- Will be designed by 2/16/14 to allow for order, testing, then revisions if needed

WVUTech-SPACE: Software Elements

- IMU code needs to be created. Plan to use some existing coding and test it on the MOD DEV 40 Board.
- This and the magnetometer need to be programmed to store their data on the Micro SD card.
- Should be completed by design of PCB but can be done after PCB is received.
- Complete by the 1st week of March

WVUTech-SPACE Testing Plan

Zack Dixon

WVUTech-SPACE: Electrical and Software Testing

- Each component must be tested at a regular interval. Magnetometer is being tested with assumption of earths magnetic field strength.
- Magnetometer will be compared with previous groups data to ensure proper function.
- IMU will need each axis accelerometer tested, which can be shown with earth's gravitational acceleration, the IMU should read 1g on the axis pointing toward the ground.
- These two will be tested along with SD card to ensure data storage.
- Continuous test will be conducted throughout the following months.

WVUTech-SPACE: Testing Schedule

- Payload device testing: 1/19/15 – 2/5/15
- Schematic verification: 2/8/15 – 2/15/15
- PCB testing: 3/1/15- 3/13/15
- Software verification: 3/22/15 – 4/2/15

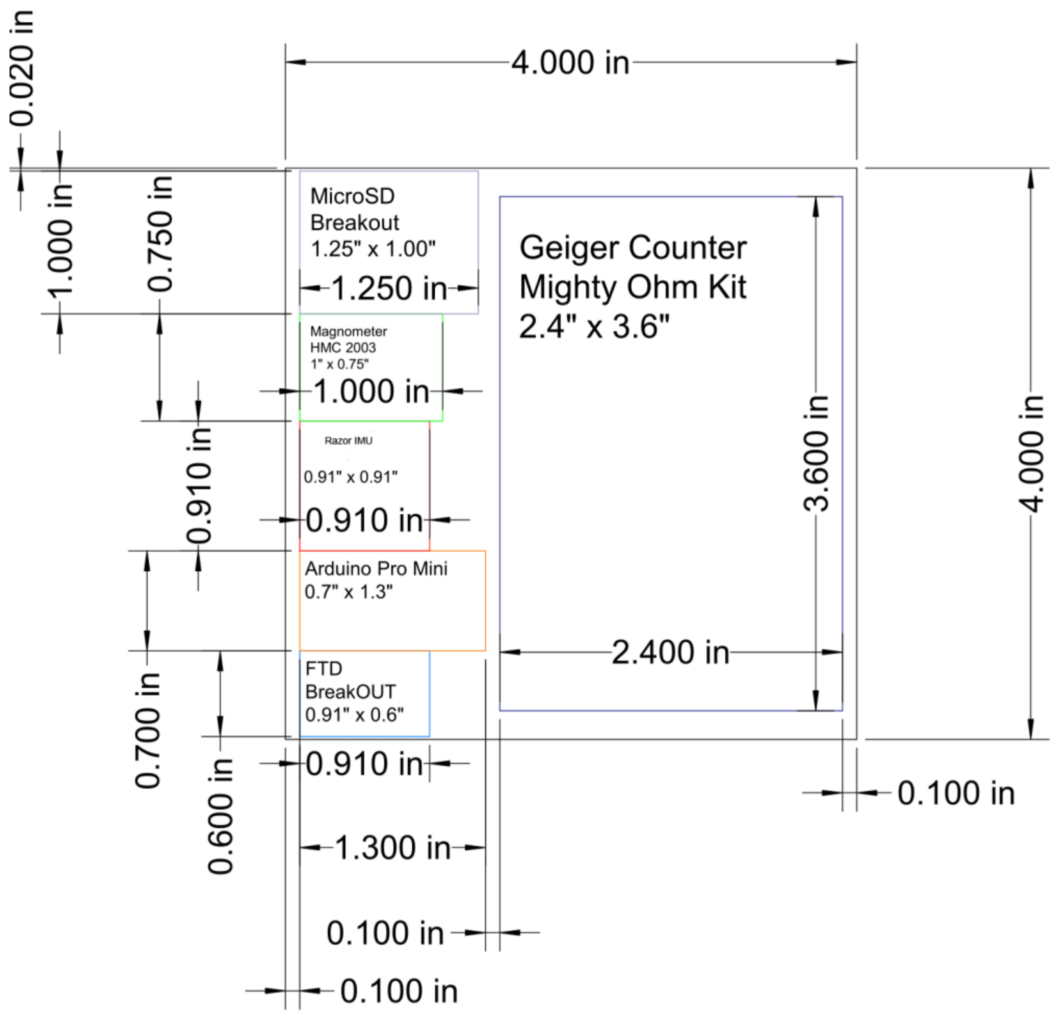
Marshall-SPACE Design Description

Seth Baker

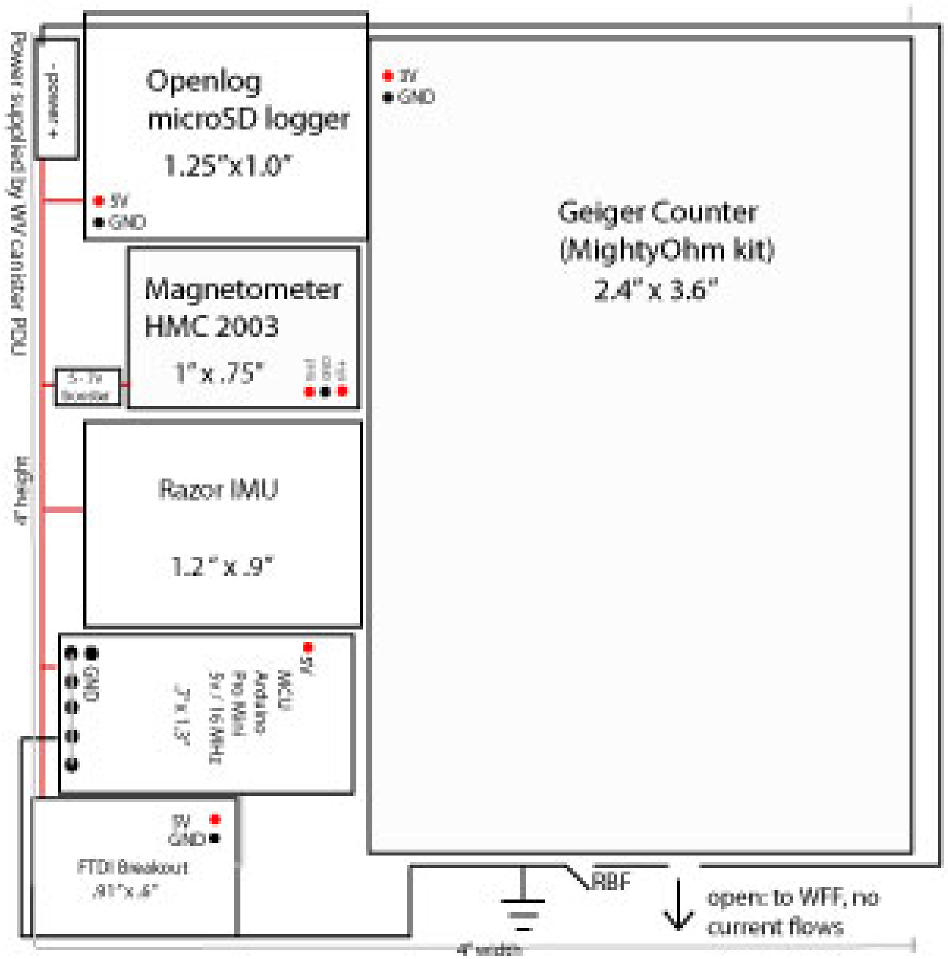
Marshall-SPACE: Off-Ramps and De-scopes

- Our payload may not include the ADIS16300 due to space constraints.
- The Geiger counter is a high-risk item. Should it prove unreliable, this item will be removed and replaced with ballast.
- The final PCB design configuration for CubeSat specs is also an off-ramp.

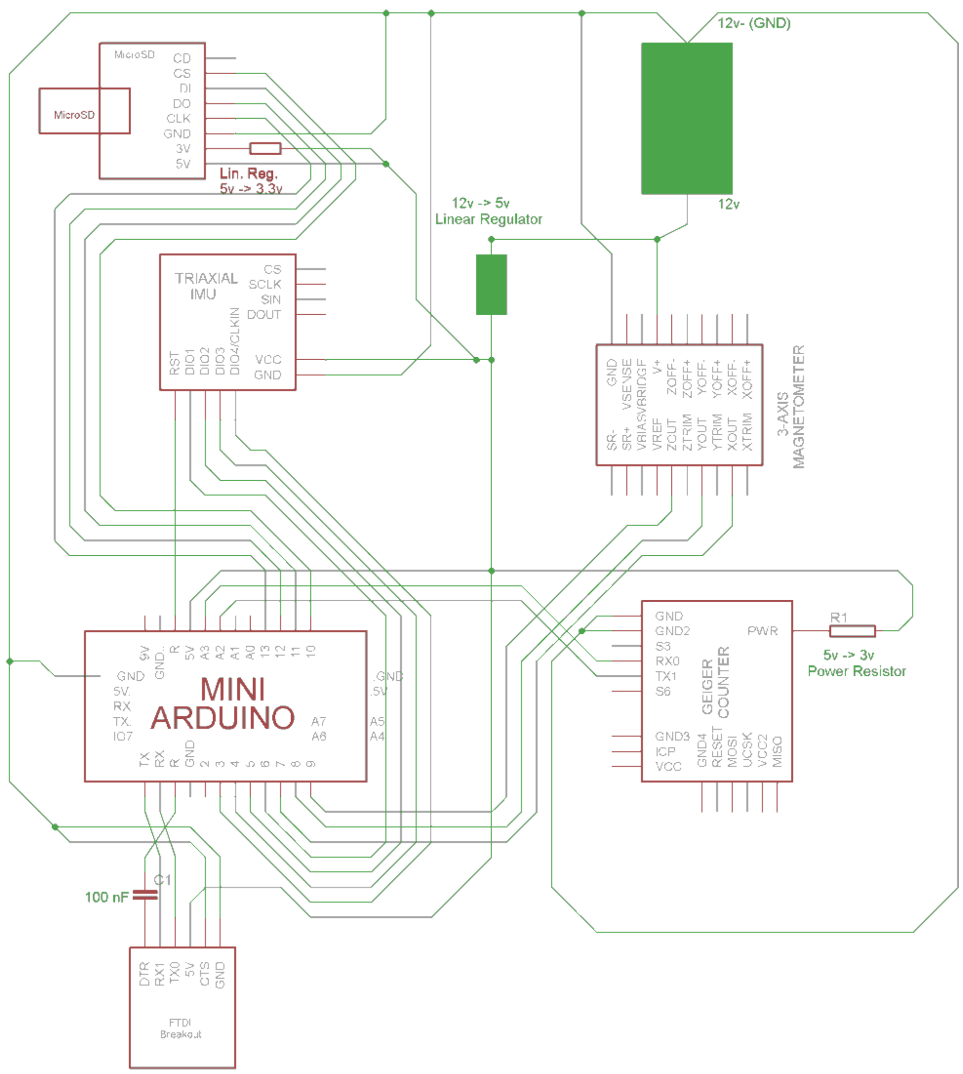
Marshall-SPACE: Mechanical Schematic



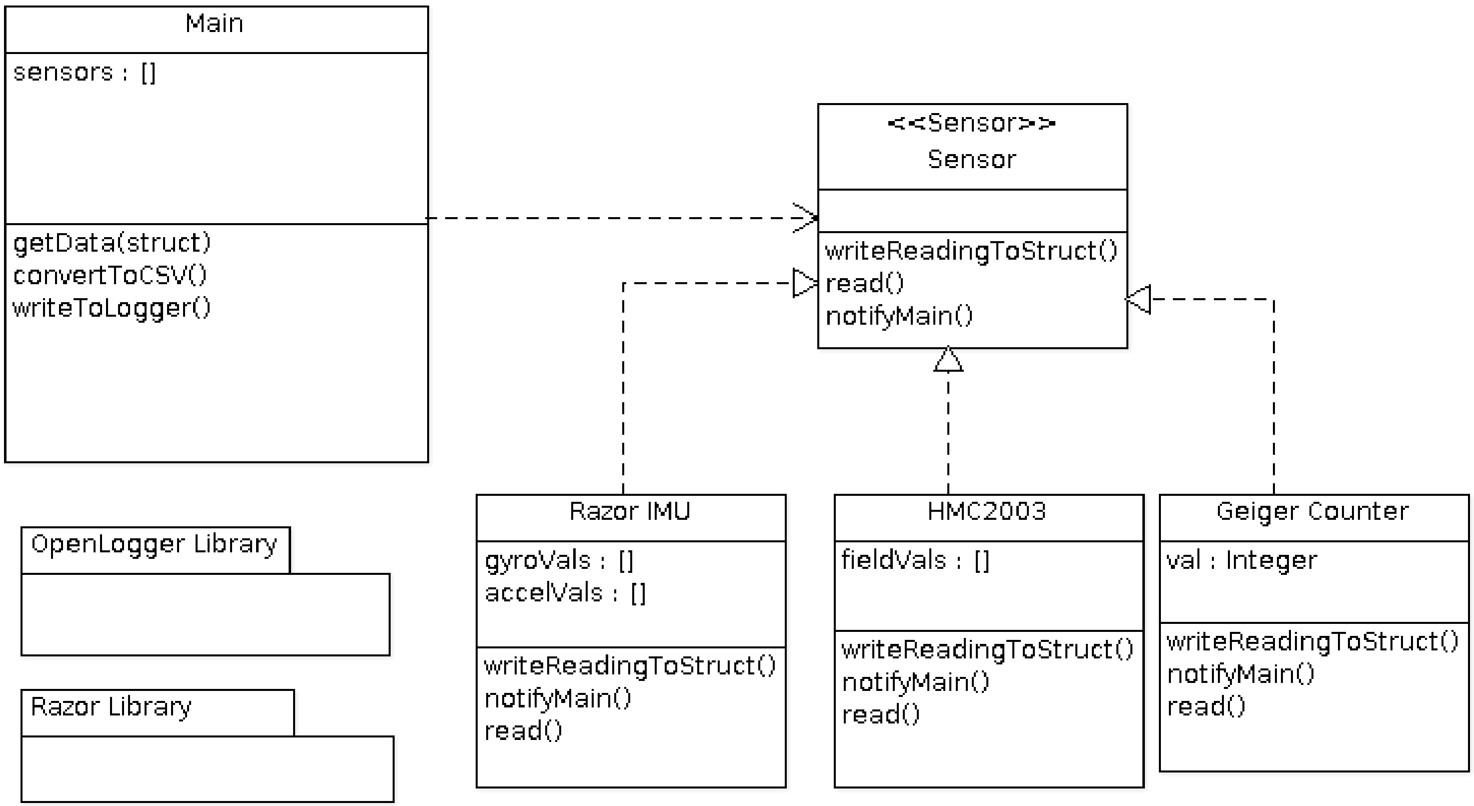
Marshall-SPACE: Electrical Overview



Marshall-SPACE: Electrical Schematic



Marshall-SPACE: Software Design Elements



Marshall-SPACE: Working Razor IMU Code

```
#include <SoftwareSerial.h>

SoftwareSerial mySerial(10,11);
String dataString;
int time = 0;

void setup(){
  Serial.begin(4800); // start serial for output
  mySerial.begin(4800);
}

void loop(){
  time = millis();
  mySerial.print("Time: ");
  mySerial.println(time);
  dataString = "";
  if(Serial.available() > 0){
    dataString = Serial.readStringUntil('\n');
  }
  if(dataString != ""){
    mySerial.println(dataString);
  }
}
```

Flight tested 11/22

*does not include the 6 configuration files used.

Marshall-SPACE: Sample Test Results

Time: 2793
Altitude (m): 0.00 , Temperature (c) : 0.00
Time: 3019
Altitude (m): 0.00 , Temperature (c) : 0.00
#A-C=-35.81,-249.94,16.88,#M-C=-27.92,-123.86,-68.16,#G-C=-4.50C=-27.57,-124.04,-68.73,#G-C=0.50,33.94,-15.77
Time: 3430
Altitude (m): 0.00 , Temperature (c) : 0.00
#A-C=-29.62,-250.80,5.63,#M-C=-28.10,-124.04,-68.92,#G-C=-4.50,,41.94,-1.77
Time: 3724
Altitude (m): 0.00 , Temperature (c) : 0.00
#A-C=-15.47,-254.27,14.07,#M-C=-28.45,-124.79,-68.16,#G-C=-2.50C=-28.10,-123.49,-68.35,#G-C=-12.50,31.94,-6.77
Time: 4139
Altitude (m): 0.00 , Temperature (c) : 0.00
#A-C=-18.13,-252.53,15.00,#M-C=-27.92,-124.04,-68.92,#G-C=8.50,,39.94,6.23
Time: 4434
Altitude (m): 0.00 , Temperature (c) : 0.00
#A-C=-17.24,-254.27,8.44,#M-C=-28.27,-124.79,-68.16,#G-C=-1.50,C=-27.92,-123.67,-68.73,#G-C=-10.50,-2.06,-19.77
Time: 4852
Altitude (m): 0.00 , Temperature (c) : 0.00
#A-C=-30.51,-251.67,12.19,#M-C=-27.92,-123.67,-67.97,#G-C=-11.529.94,-3.77
Time: 5144
Altitude (m): 0.00 , Temperature (c) : 0.00
#A-C=-17.24,-254.27,9.38,#M-C=-27.92,-124.42,-68.92,#G-C=-2.50,=-27.92,-124.23,-69.11,#G-C=-1.50,18.94,-11.77
Time: 5558
Altitude (m): 0.00 , Temperature (c) : 0.00
#A-C=-19.90,-253.40,9.38,#M-C=-27.92,-124.42,-69.49,#G-C=-3.50,0,12.94,-7.77
Time: 5860
Altitude (m): 0.00 , Temperature (c) : 0.00
#A-C=-27.85,-252.53,22.51,#M-C=-28.10,-124.60,-68.35,#G-C=16.50-C=-27.40,-124.04,-69.11,#G-C=-4.50,-37.06,-11.77
Time: 6280
Altitude (m): 0.00 , Temperature (c) : 0.00
#A-C=-18.13,-254.27,8.44,#M-C=-28.10,-123.67,-69.11,#G-C=7.50,4.06,4.23
Time: 6559
Altitude (m): 0.00 , Temperature (c) : 0.00
#A-C=-10.17,-254.27,15.00,#M-C=-27.40,-124.23,-68.35,#G-C=-0.5013,#M-C=-27.75,-124.79,-68.92,#G-C=2.50,7.94,8.23

Discussion:
-Faulty altimeter.
-Time should be measured using float, not int (Arduino int size rolls over around 32,000)
-Requires significant post-processing
-Human-friendly data can be redesigned to reduce processing operations

Marshall-SPACE: Prototyping/Analysis

Seth Baker

Marshall-SPACE: Mechanical Elements

- We are waiting on budget money to be released to order standoffs and other hardware.

Marshall-SPACE: Electrical Elements

- We have access to an Arduino mini (not pro) and a Razor IMU.
- We are waiting on money to be released to purchase the Arduino Pro, magnetometer, Geiger counter, FTDI breakout, SD logger, PCB board, and other electrical components.

Marshall-SPACE: Software Elements

- Classes required: Main, <<Sensor>>, HMCReader, GeigerReader.
- Development of Main and <<Sensor>> should run from mid-December to year's end, and will include integration with existing Razor code.
- HMCReader and GeigerReader can begin 1st week of January.
- Development of data analysis processes should begin in February.

Marshall-SPACE Testing Plan

Seth Baker

Marshall-SPACE: Electrical and Software Testing

- Magnetometer tests: compare values against existing NOAA values.
- Geiger counter tests: procure measurement equipment and specimens from MU College of Science to calibrate counter.
- Razor tests: continue low-altitude rocket launch tests.
- Software tests: Razor IMU and logger tests should begin in January. Tests of remaining components can only commence upon procurement and integration of components.

Marshall-SPACE: Testing Schedule

- Begin bread boarding and additional software unit testing of Arduino, SD logger, and Razor IMU in mid-December.
- Full prototype payload assembly completed by end of February; ongoing software and subsystem tests.
- Data post-processing system development begins Feb. 15.
- March left open for full-system testing and move from prototype to final assembly.

Shepherd-SPACE Design Description

Rachelle Huff

Shepherd-SPACE: Design Modifications

- There have been no significant changes since the PDR except taking off the second Arduino.
  - Design for orbital payload using second Arduino modified for suborbital application
- This does not change any mission objectives.

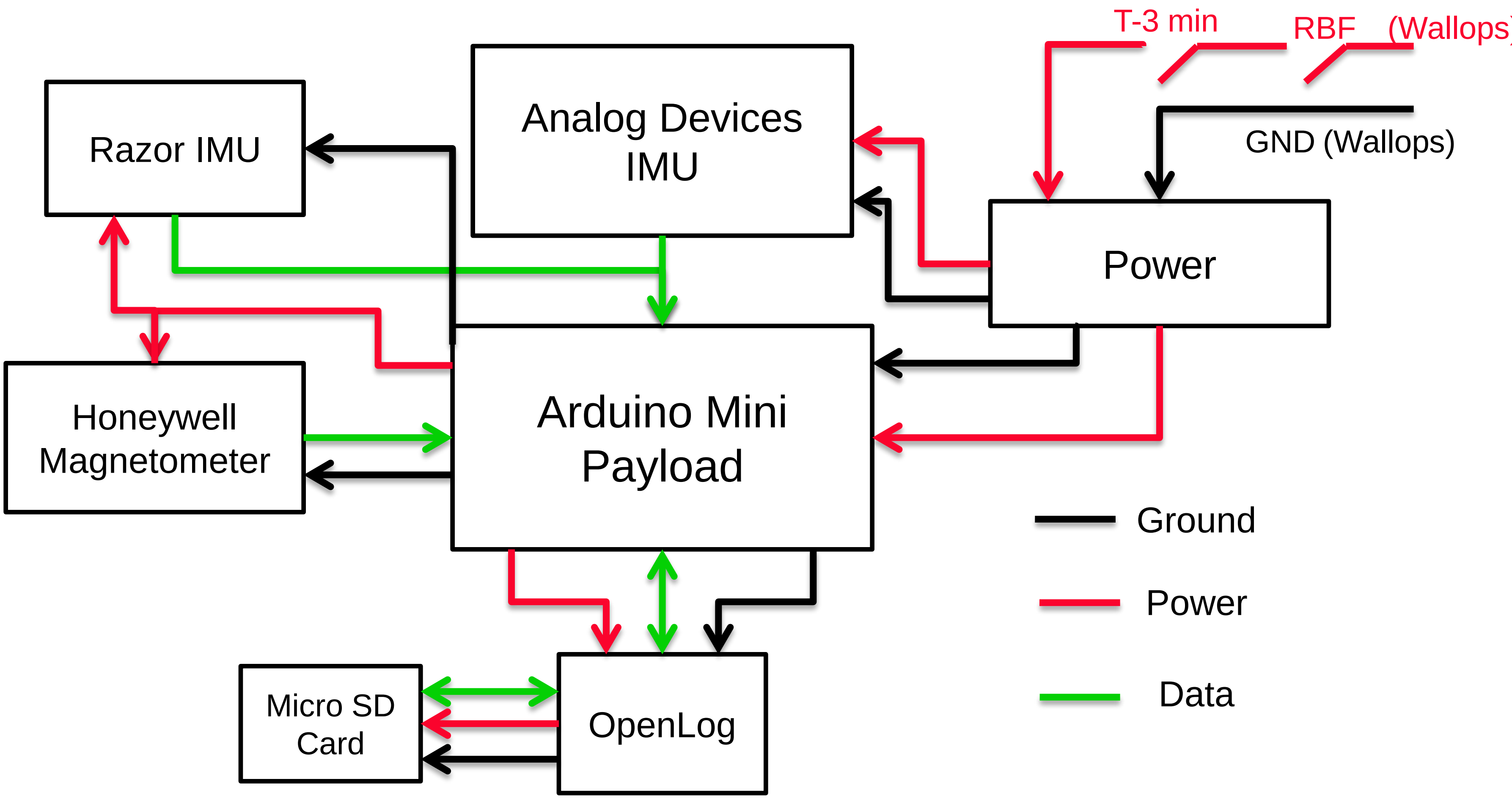
Shepherd-SPACE: De-Scopes and Off-Ramps

- We have not significantly changed our payload or the mission objectives.
  - Only change was the Arduino and that did not affect the mission.
- Off-ramp includes final PCB design modifications to fit to CubeSat specs.
  - The mission objectives did not include anything too complex and all of the devices seem to be working, further testing can validate that.

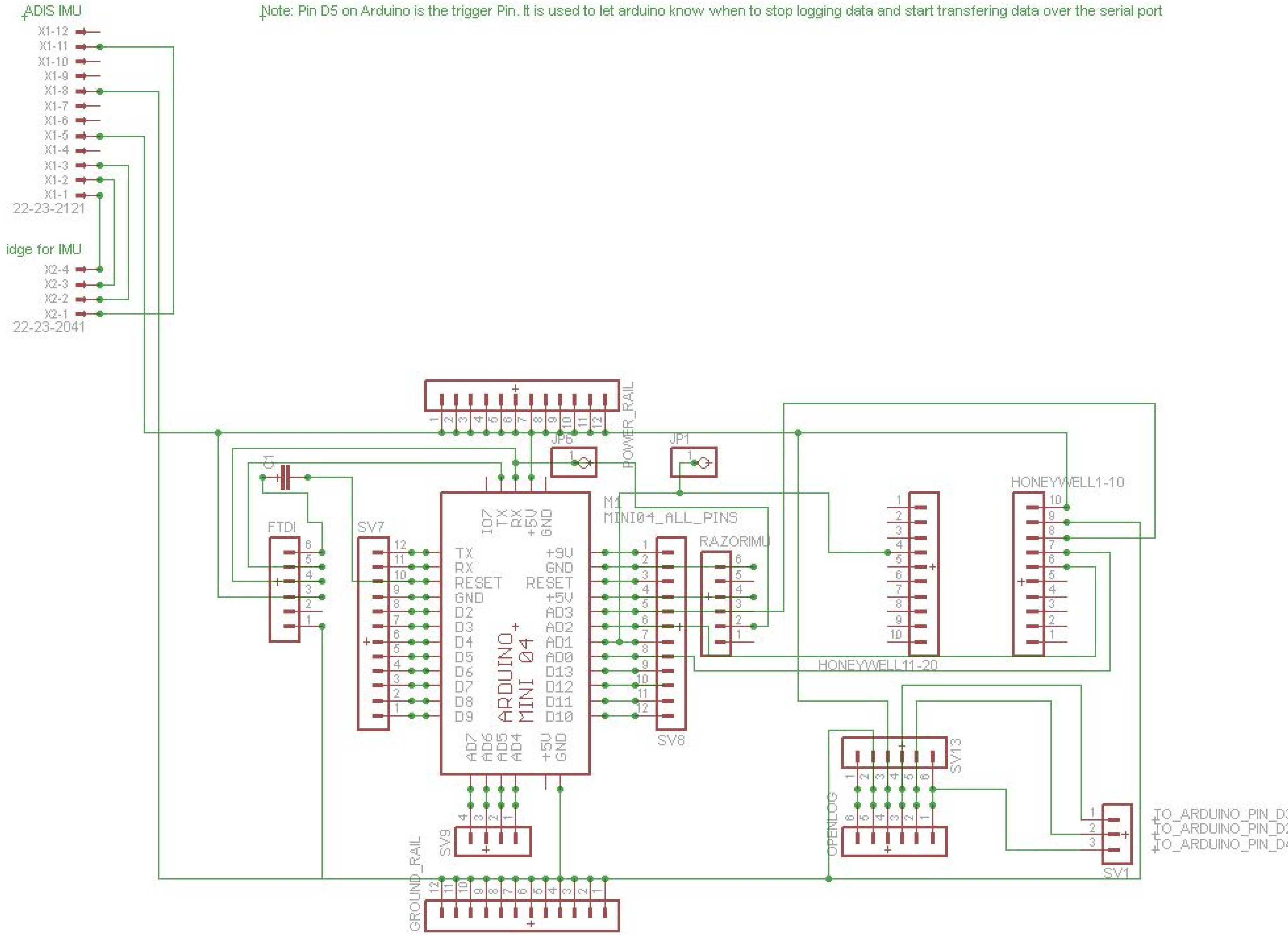
Shepherd-SPACE: Electrical Design Elements

- We plan on using a double sided PCB for our payload.
  - The schematics can be seen with in the next few slides.
- There have been a few changes to the block diagram.
  - Changed the g-switch to T-3 mins early activation
  - The second Arduino has been removed
- We will be using T-3 mins early activation as seen in the block diagram shown in the next slide.

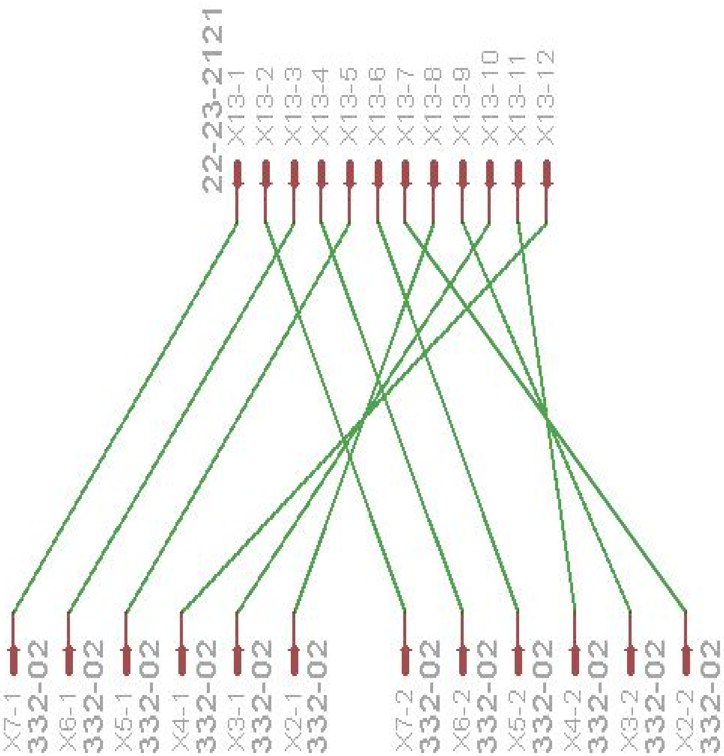
Shepherd-SPACE: Electrical Block Diagram

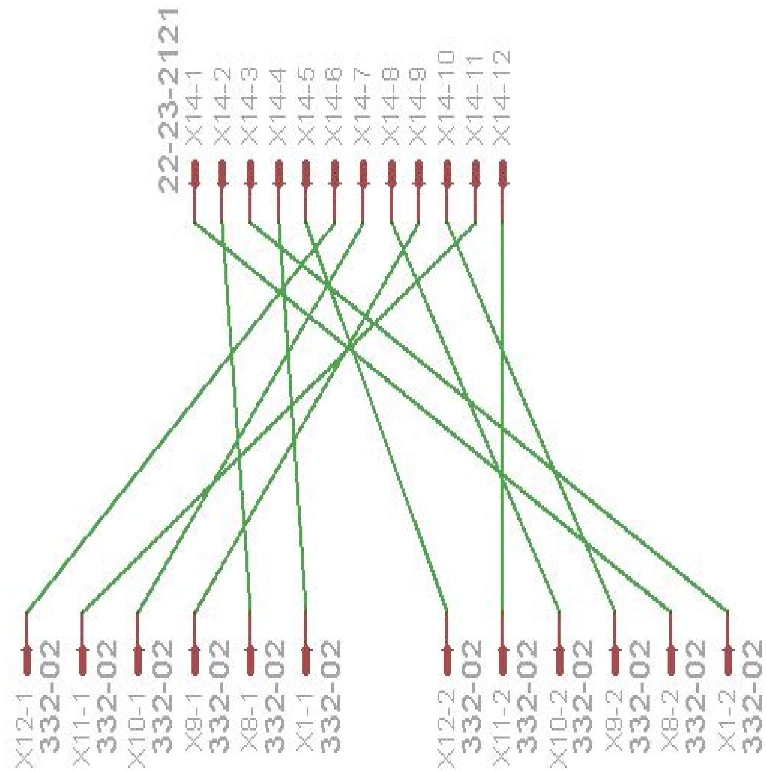


Shepherd-SPACE: Microcontroller Schematic



Shepherd-SPACE: Adaptor Schematic

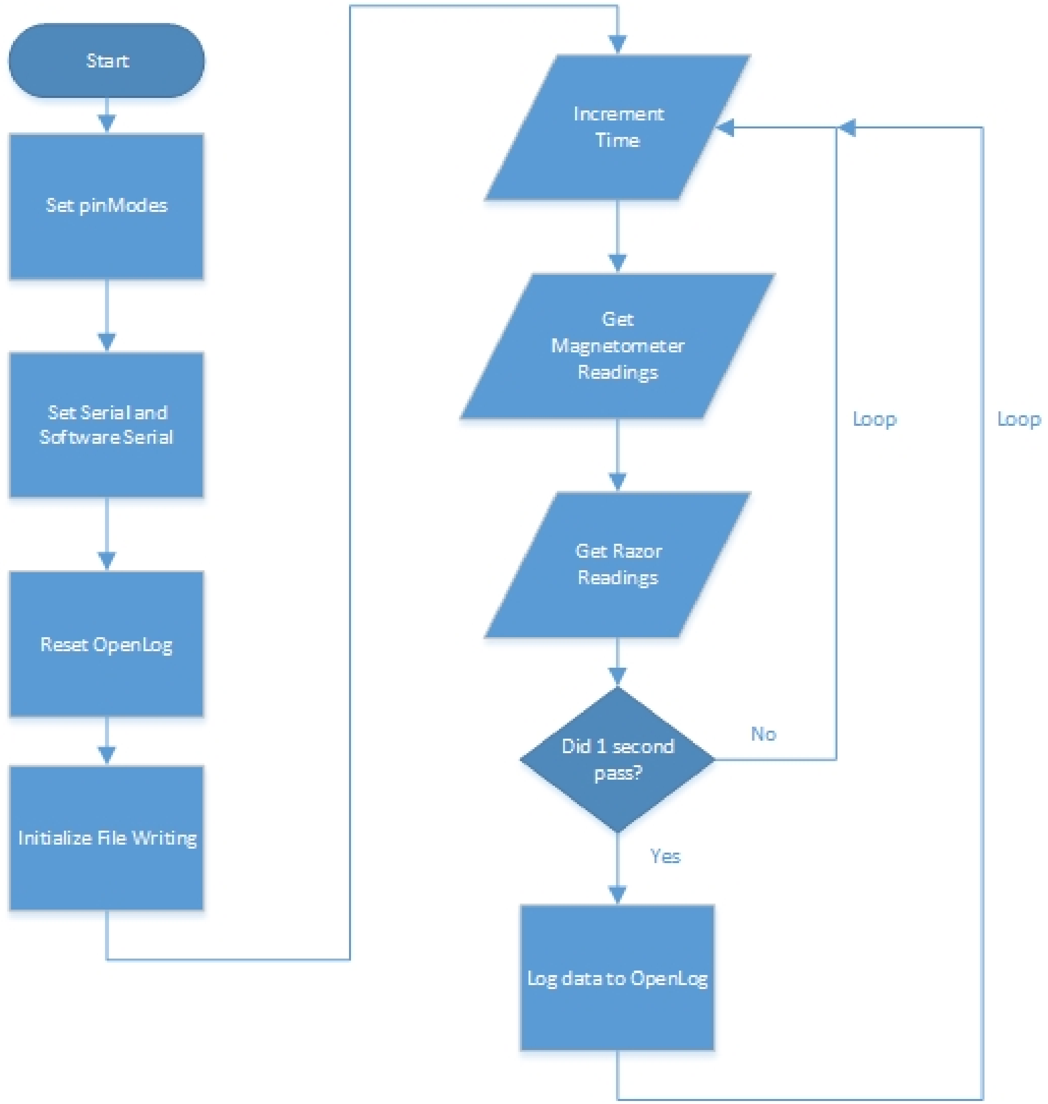




Shepherd-SPACE: Software Design Elements

- The programming for the payload is complete
  - We actually had to take out a chunk due to our removing the second Arduino.
- The payload will be receiving data from the IMUs and the magnetometer while storing said data.

Shepherd-SPACE: Program Flow Chart



Shepherd-SPACE Prototyping/Analysis

Rachelle Huff

Shepherd-SPACE: Analysis Results

- We have not done any testing since the PDR.
  - Given the recent break we were unable to test it at all the past week.
- We do plan on doing a good amount of testing in the future.
- ***We need to collect more data so that we can be sure that the payload will work for the flight.***

Shepherd-SPACE: Prototyping Results

- We have the entire payload prototyped and on a bread board.
  - This is how we are able to test everything in our payload and see if it all works together.
- ***This testing will further us in our progression towards completing a successful payload.***

Shepherd-SPACE Manufacturing Plan

Rachelle Huff

Shepherd-SPACE: Mechanical Elements

- The final microcontroller PCB, IMU adaptor PCB need to be manufactured.
- Mounting hardware for final payload needs to be procured.
- First we plan to create the PCB, and then assemble the payload.

Shepherd-SPACE: Electrical Elements

- Sensors, power connectors, Arduino, open log, and pin headers needs to be manufactured or soldered.
- A couple revisions in terms of simplifying power circuits and reducing budget need.
- Power connectors, solder, testing equipment need to be procured.
- We plan to solder everything as it should and connect the power connections.

Shepherd-SPACE: Software Elements

- The coding is already complete and further modifications are expected to be minimal.
- The main Arduino code depends on individual pieces for each sensor.
- Once we have all the hardware and software assembled on the PCB we will continue software verification

Shepherd-SPACE Testing Plan

Rachelle Huff

Shepherd-SPACE: Electrical Testing

- PCB design verification and function testing
- Verify Razor IMU works reliably in upper atmosphere conditions
  - Test payload on high altitude balloon
- Functional testing: 3/2/15 – 3/20/15
- Balloon launch: 4/4/15

Shepherd-SPACE: Software Testing

- Test each software component independently on breadboard setup
- Test each component working together and verify data saved to microSD card properly
- Software testing: 12/29/15 – 2/6/15

WVU-CAM
Design Description

Steven Hard

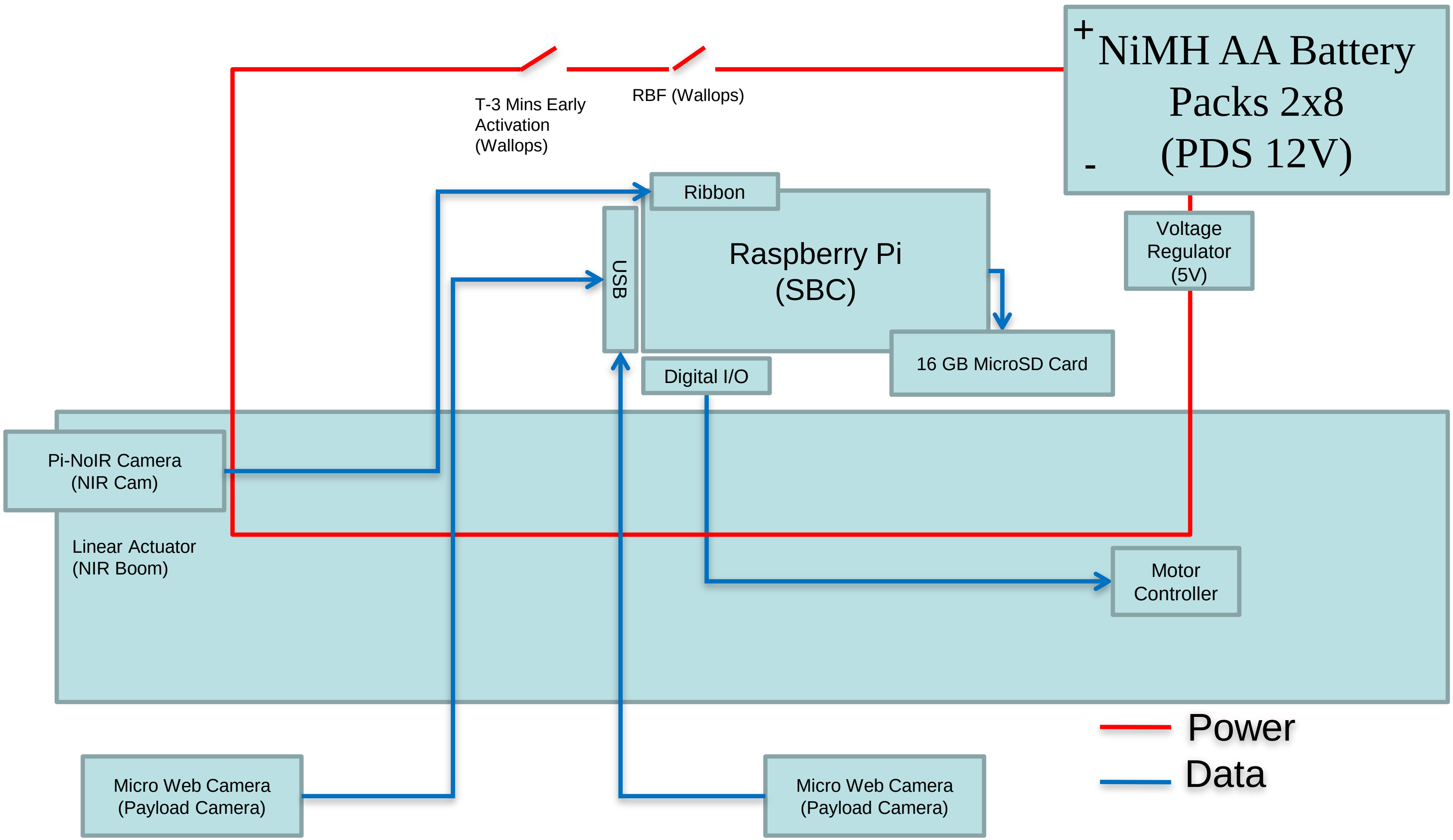
WVU-CAM: Design Modifications

- Added an additional payload camera
  - SPACE (4x) stack split into 2 stacks to fit into half-canister
  - Two cameras eliminates need for pan/tilt action
  - One focusing on NIR boom, one on SPACE
- No change to mission objectives

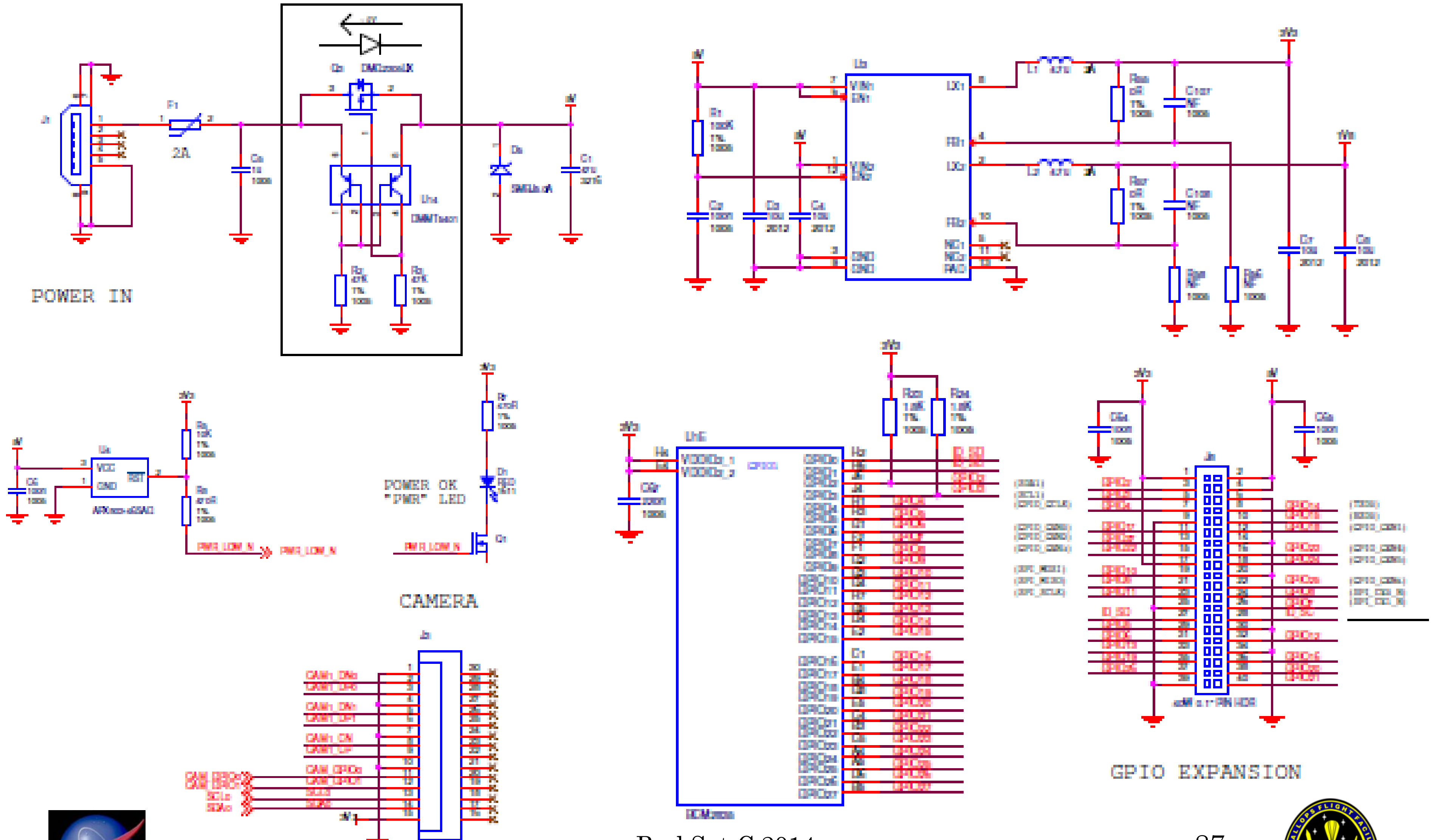
WVU-CAM: De-Scopes and Off-Ramps

- No change in scope of project
- Off-ramp includes rigid mount for NIR lens
  - This eliminates the linear actuating boom altogether
  - Also eliminates payload camera for boom actuation
  - Would cause image degradations
  - Mission objectives could potentially still be achieved

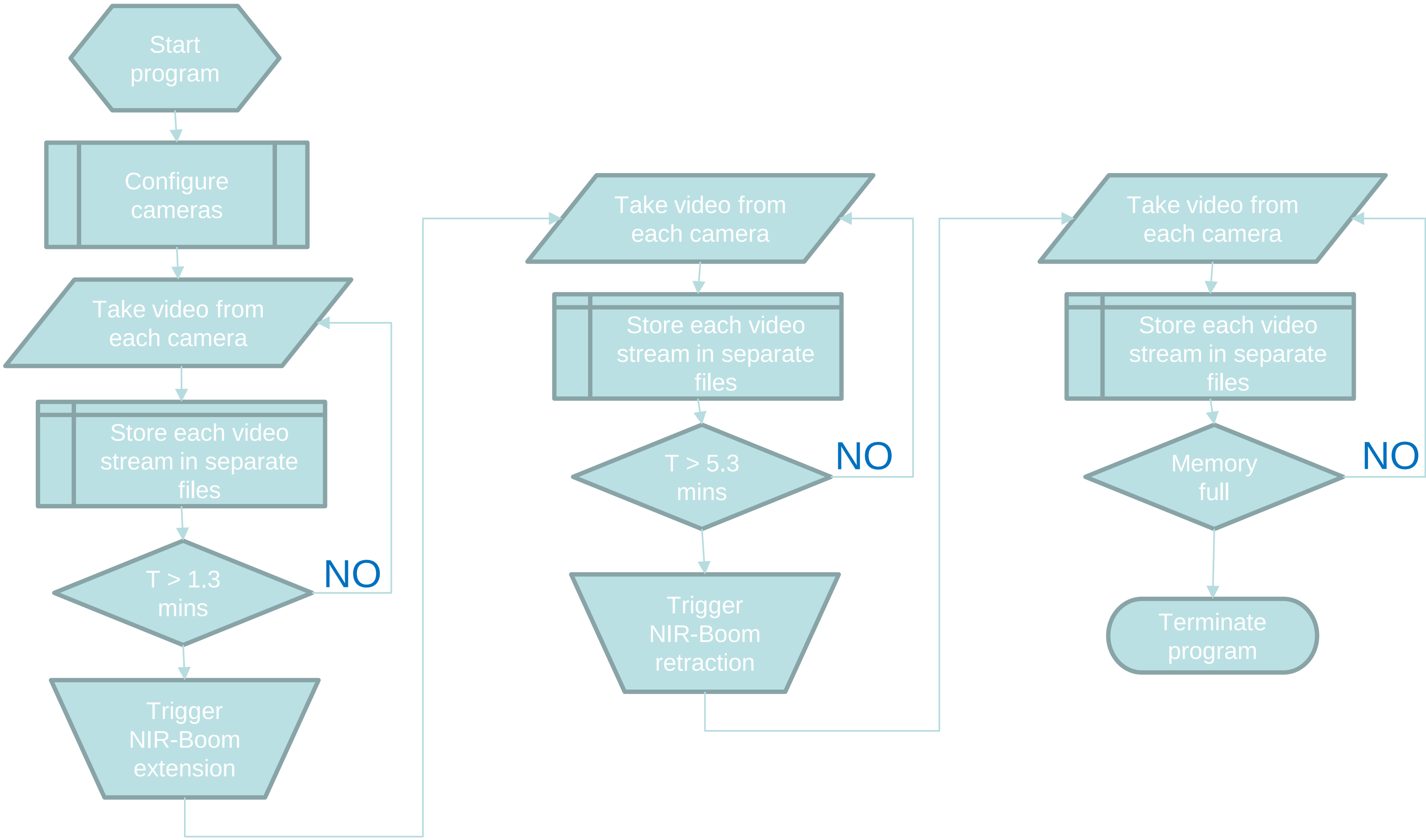
WVU-CAM: Electrical Diagram



WVU-CAM: Electrical Schematic (SBC)



WVU-CAM: Software Design Elements



WVU-CAM: Prototyping/Analysis

Steven Hard

WVU-CAM: Analysis Results

- L12 30mm boom extension analyzed using CAD modeling
  - Optimal positioning of linear actuator determined
- Optimal payload camera positioning also determined
- ***Allows capability to maximize potential for satisfying requirements***

WVU-CAM: Prototyping Results

- Raspberry Pi (SBC) operating system installed and camera code compiled
  - Configurable frame rate verified
  - Assessed physical limitations of ribbon cable on NIR camera board
- ***Verified that the requirement for video frame rate can be satisfied***

WVU-CAM Manufacturing Plan

Steven Hard

WVU-CAM: Mechanical Elements

- To be manufactured:
  – Camera mounts
- To be procured:
  – Cameras
  – Linear Actuator
- Procure remaining components: 1/17/15
- Camera mounts designed: 2/28/15
- Camera mounts fabricated: 3/15/15
- Subsystem integration: 3/16/15 – 4/15/15

WVU-CAM: Electrical Elements

- No electronics manufacturing required
- COTS SBS for main PCB
- To be procured:
  - Raspberry Pi B+
- Procure remaining components: 1/17/15

WVU-CAM: Software Elements

- Camera configuration
  - Configure frame rate and image quality
- Video capture
  - Loop for images to capture in regular intervals
- Save video files separately
  - Switch to a new file name every iteration
- Each block of code depends on the next
- Camera software testing: 1/18/15 – 3/10/15

WVU-CAM
Testing Plan

Steven Hard

WVU-CAM: Electrical Testing

- Verify NIR camera boom moves lens to optimal position when linear actuation is triggered
  - Mount linear actuator to Makrolon plate and check against design spec (Wallops)
- Subsystem integration: 3/16/15 – 4/15/15

WVU-CAM: Software Testing

- Camera configuration and video capture software elements must be development first
- Analyze NDVI method with control elements
  - Image of wood plank and insulation material against grassy backdrop
  - Check NDVI against reference
- Data processing: 3/1/15 – 4/1/15

System Level Design

Steven Hard

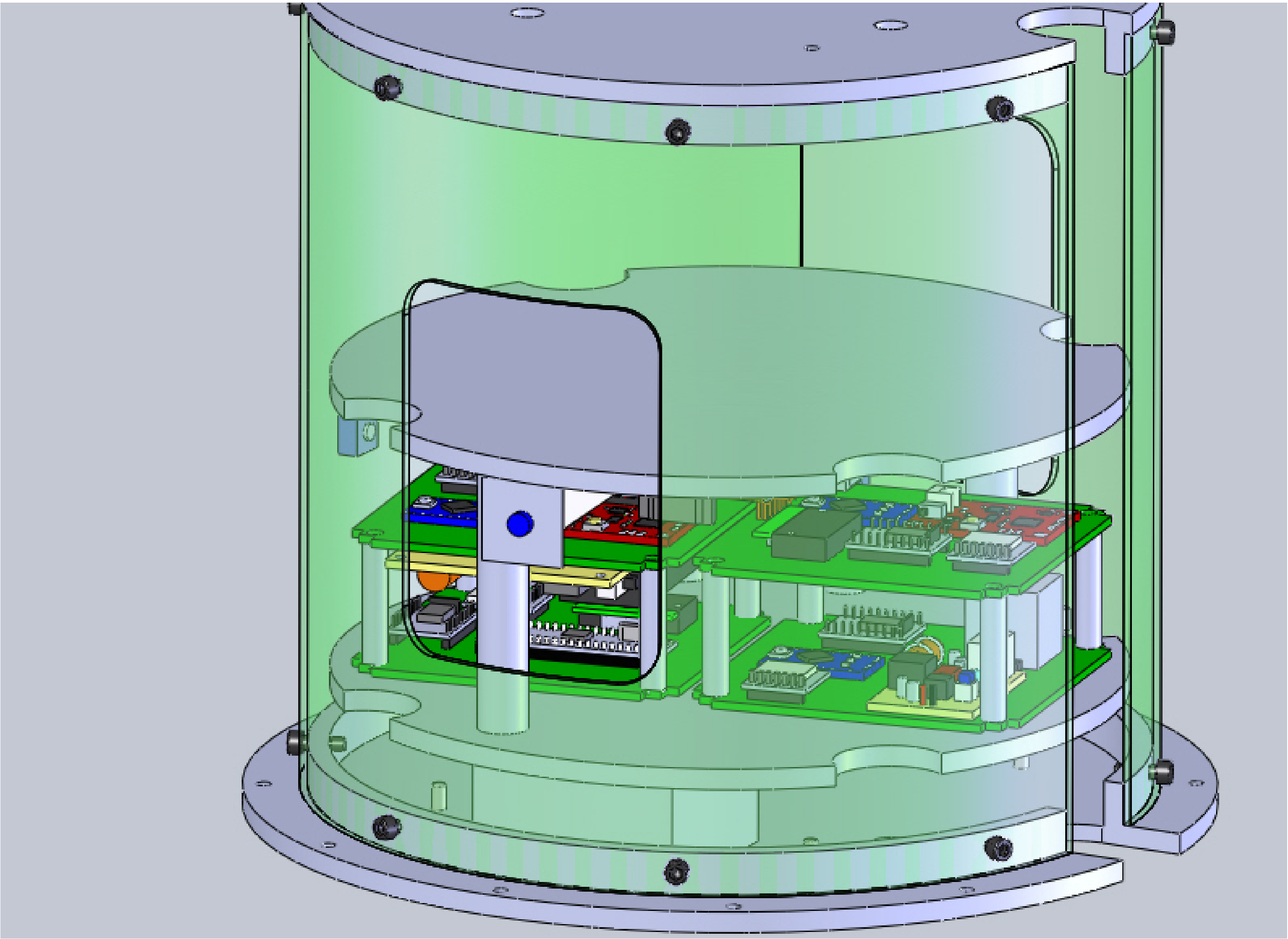
Detailed Mass Budget

WV Rocketeers		
RSC 2015 Mass Budget		
Subsystem	**Component**	**Total Mass (lbf)**
WVWC-SPACE	PCB	0.1
	Sensors/DAQ	0.1
WVUTech-SPACE	PCB	0.1
	Sensors/DAQ	0.05
Marshall-SPACE	PCB	0.1
	Sensors/DAQ	0.12
Shepherd-SPACE	PCB	0.1
	Sensors/DAQ	0.7
WVU-CAM	Sensors	0.3
	Container	0.2
	Single Board Computer	0.3
	Actuators	0.2
PDS	Batteries	0.4
	Battery Holders	0.1
	PCB	0.1
SIS	Makrolon plates	1.4
	Standoffs/Mounts	1
Target Weight (lbf)		10
Total		5.37
Over(+)/Under(-)		-4.63

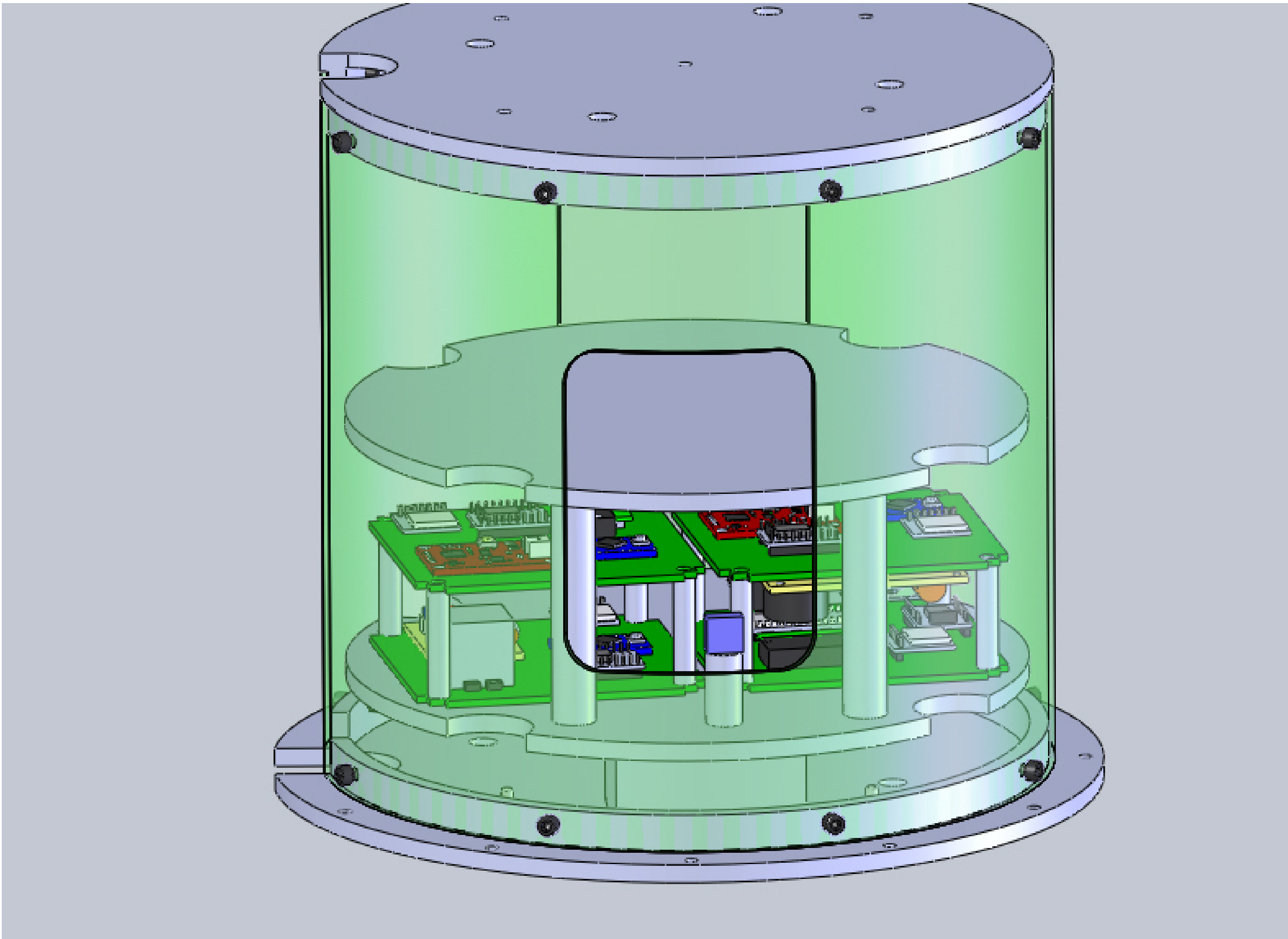
Power Discussion

WV Rocketeers - RSC2015 Power Budget					
12/1/2014					
Subsystem	**Voltage (V)**	**Max Current (A)**	**Time On (min)**	**Watts**	**Ah**
WVWC-SPACE	12.0	0.15	30	1.80	0.08
WVU-TECH SPACE	12.0	0.18	30	2.18	0.09
Marshall-SPACE	12.0	0.10	30	1.20	0.05
Shepherd-SPACE	12.0	0.10	30	1.20	0.05
WVU-CAM	12.0	0.35	30	4.20	0.18
	Total	0.88		10.58	0.44
	Total Power Capacity				4.80
	Over (+)/Under (-)				4.36
				# of Flights Margin	**2.3**

Mechanical Model: Isometric Front



Mechanical Model: Isometric Back



Risks

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High Risk Items

R1: WVWC-SPACE.RSK.1 - The high frequency spinning of the rocket will saturate the gyroscope

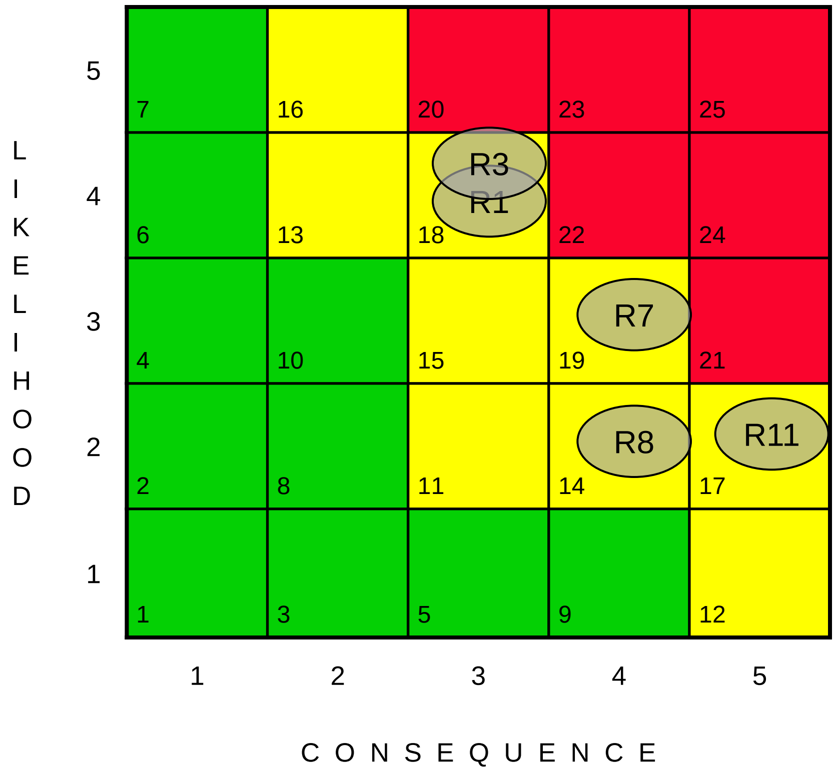
R3: Marshall-SPACE.RSK.1 - The MightyOhm Geiger kit has not been verified for aerospace applications and could potentially malfunction during flight

R7:Shepherd-SPACE.RSK.2 - Mission objectives are not met IF the Razor IMU malfunctions as it is not certain if it is flight worthy so we will no longer have redundancy in FD data when/if it dies

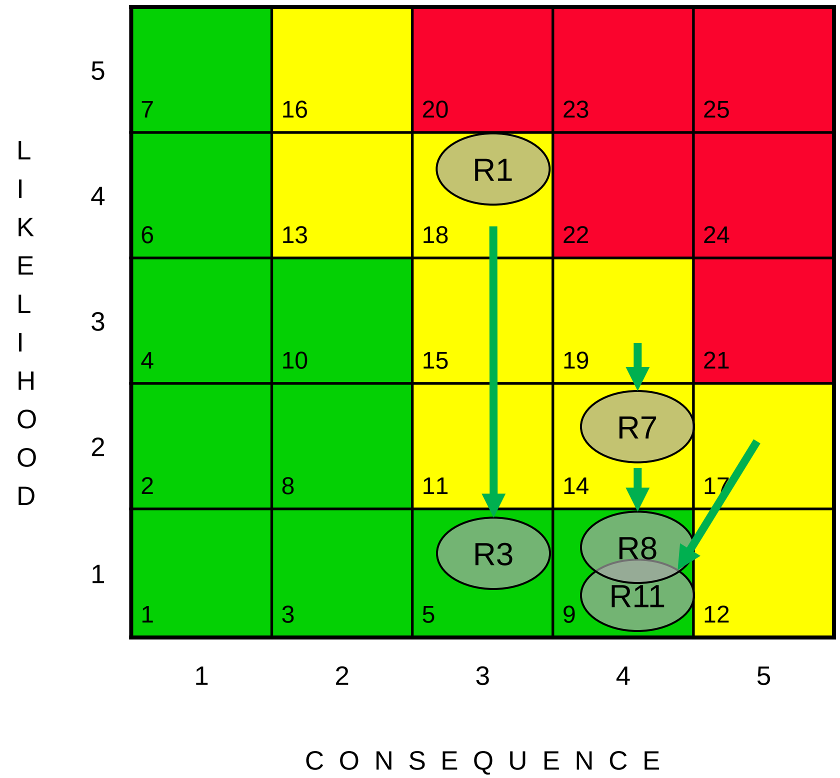
R8: WVU-CAM.RSK.1 - Mission objectives are not met IF the linear actuator boom causes damage to the NIR camera lens

R11: STR.RSK.2 - Mission objectives are not met IF mounting bracket(s) fails in-flight

Risk Matrix: Pre-CDR



Risk Matrix: Walk-down



- R3: Balloon test
- R7: Balloon test
- R8: Physical layout
- R11: Added camera and structural supports

User Guide Compliance

Steven Hard

User Guide Compliance

- Mass – 5.37 lb + mass of canister
- CG within 1"x1"x1" envelope
  - SolidWorks verification to be performed once material properties are specified
  - Ballasts will be placed strategically to ensure CG compliance
- Batteries: Rechargeable AA NiMH
- RESTATE: T-3min activation type

Design Overview: Shared Can Logistics

- Partners:
  - West Virginia University Team: WVU-CAM
  - NASA IV&V/Junior FIRST Lego League: NIR-CAM Boom
  - West Virginia Wesleyan College: WVWC-SPACE
  - Shepherd University: Shepherd-SPACE
  - Marshall University: Marshall-SPACE
  - West Virginia University Institute of Technology: WVUTECH-SPACE
  - Fairmont State University: Canister Integration

Design Overview: Shared Can Logistics

- Plan for collaboration
  - Weekly/Monthly Telecon session
  - Share designs using Google drive
  - Will fit check before June
- Mounting to bottom plate and mid plate
- Structural interfacing:
  - Aluminum standoffs
- Ports:
  - Optical port
  - ~~Atmospheric port~~

Project Management Plan

Steven Hard

Schedule

- Major Milestones
  - CDR (12/4/14)
  - Prototype high risk items (11/28/15)
  - Flight award announcement (1/16/2015)
  - Procure remaining components (1/17/2015)
  - Design PCBs (Week of 2/16/15)
  - STR (Week of 2/23/15)
  - High Altitude Balloon Launch (4/4/15)
  - ISTR (Week of 4/6/15)
  - Receive canister (Week of 4/20/15)
  - FMSR (Week of 5/20/15)
  - Deliver preliminary check-in document (Week of 6/4/15)
  - LRR (6/17/15)
  - Travel to Wallops (6/18/15)
  - Launch (6/25/15)*

  * Tentative, no guarantee – small chance launch could get cancelled due to weather or other unforeseen delays

Budget

- Most of experimental components have been procured/delivered
  - Lead time not anticipated to be a factor

Margin:	0.25	Budget:	$3,000.00	Last Update:	11/17/2014 11:15
Item	**Supplier**	**Estimated, Specific Cost**	**Number Required**	**Toal Cost**	**Notes**
Motor Controller	DigiKey	$150.00	2	$300.00	1 for testing
Linear Actuator	Firgelli	$120.00	1	$120.00	1 mini tracked linear actuator
Raspberry Pi	DigiKey	$35.00	2	$70.00	1 for testing
Pi NoIR Cam	Adafruit	$25.00	2	$50.00	1 for testing
Mini WebCam	Amazon	$90.00	2	$180.00	1 for testing
Magnetometer	Honeywell	$220.00	1	$220.00	Marshall Payload
Inertial Measurement Unit (s)	Analog Devices Sparkfun	$150.00	2	$300.00	Marshall Payload
Microcontroller	DigiKey	$25.00	1	$25.00	Marshall Payload
Printed Circuit Boards	Advanced Circuits	$33.00	4	$132.00	1 board/SPACE
Misc. Electronics (R,L,C)	DigiKey	$50.00	4	$200.00	4 misc/SPACE
Testing Materials	Various	$75.00	4	$300.00	Testing equipment for each team
Total (no margin):					$1,897.00
Total (w/ margin):					$2,371.25

Project Summary

- No critical severity issues currently identified
- Areas of concern
  - NDVI data processing
  - NIR camera mount
  - PCB design

Team Contact Matrix

Team Member	Email Address	Phone Number	US Person? (Y/N)
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Greg Lusk (Fairmont State)	grglusk@gmail.com		Y
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Andy Shtanko (Shepherd U)	iqvasya@gmail.com		Y

- Please re-verify participants US Person Status

Conclusion

- Plan of action:
  - Procure remaining components
  - Finish prototyping of subsystem configurations
  - Finalize PCB designs
- Before break:
  - Place components order
  - Norm on electronics software