ASEN 4018 Senior Projects, Spring 2019
Manufacturing Status Review (MSR)

VANTAGE

Visual **A**pproximation of **N**anosat **T**rajectories to **A**ugment **G**round-based **E**stimation

Team: *Aaron Aboaf, Dylan Bossie, Sean Downs, Justin Fay, Marshall Herr, Josh Kirby, Lara Lufkin, Richard Moon, Nicholas Renninger, Zach Talpas, Jerry Wang*

Customer: *Prof. Penina Axelrad (CCAR), John Gaebler (CCAR)*

Advisor: *Prof. Marcus Holzinger*

Presenters

Overview	Marshall Herr
Schedule	Nick Renninger
Manufacturing	Zach Talpas, Aaron Aboaf, Jerry Wang, Dylan Bossie
Budget	Justin Fay

Project Overview

Project Purpose

Objectives:

The **long term vision** of this project is to augment existing, ground-based CubeSat Space Situational Awareness (SSA) by observing CubeSat deployments from the perspective of the NanoRacks (NR) ISS-based deployer.

This year's VANTAGE team will produce a **proof of concept** for this mission by developing a **ground based prototype** which will be tested using a simulated CubeSat deployment in a laboratory environment.

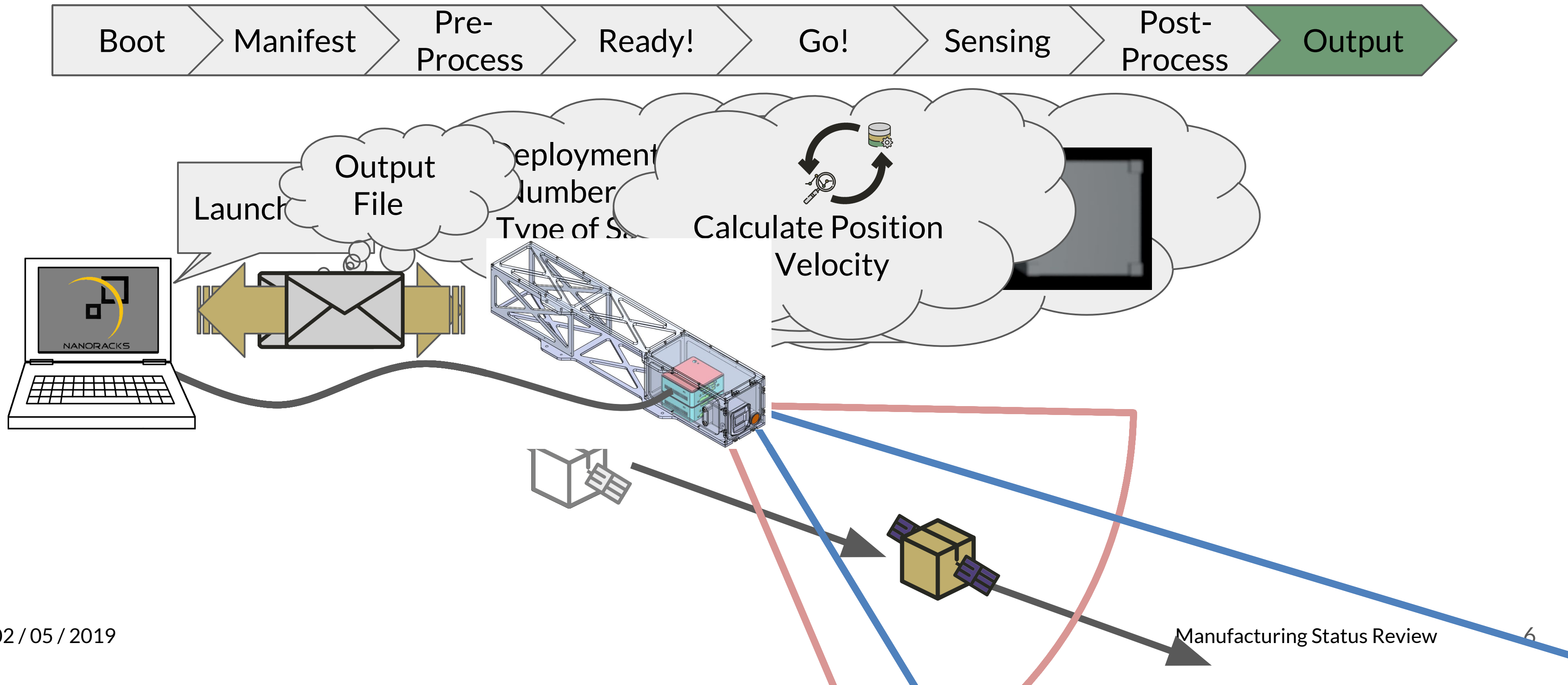
Project Stakeholders:

- Customer: Prof. Axelrad and John Gaebler
- Associated Company: NanoRacks

Specific Objectives

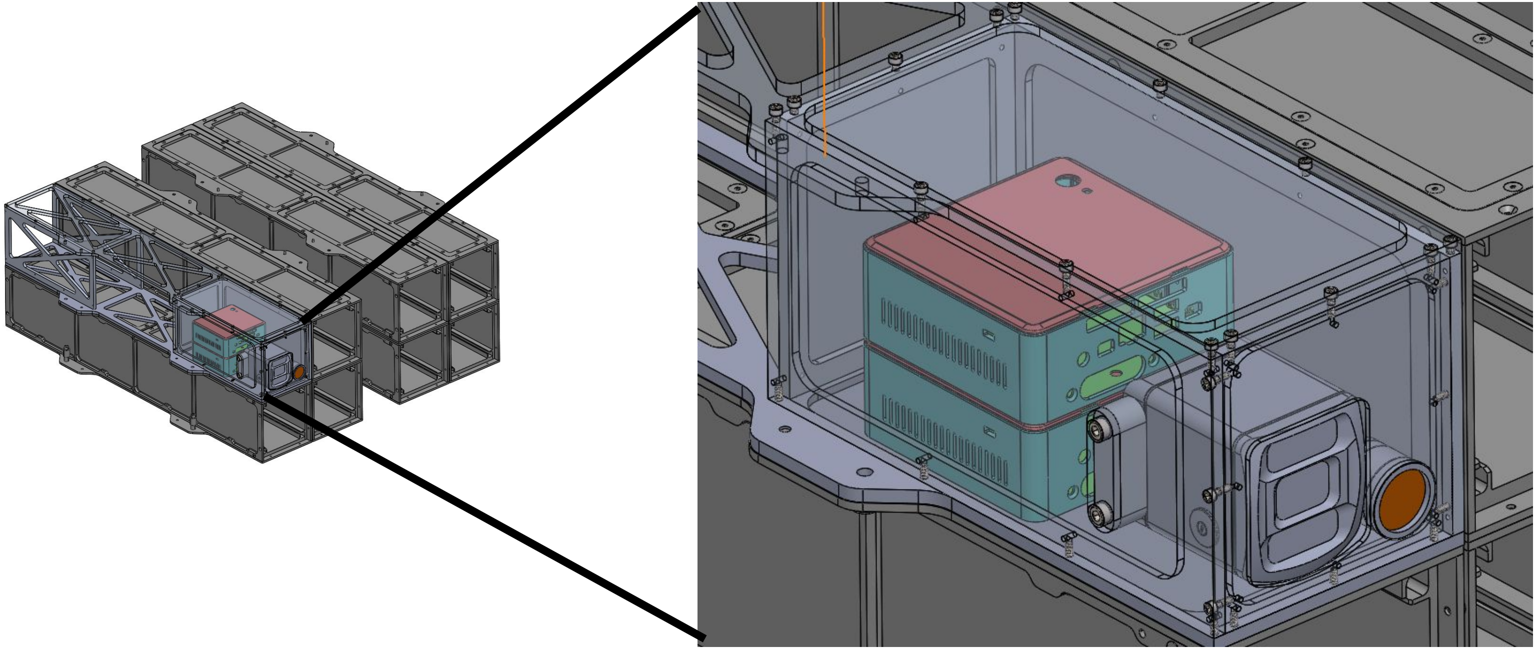
Structures - STR *(level 2)*	All key system components ***fit*** in the structure, but they only need to ***function*** as a "flat sat"
Tracking - TRK *(level 2)*	VANTAGE software will ***track the states*** of 1-6 mock CubeSats out to 100m and ***report off-nominal velocities*** of these CubeSats
Power - EPS *(level 3)*	VANTAGE's EPS will distribute power corresponding to the available power from the NR deployer
Testing - TST *(level 2)*	Test rigs can ***simulate physical deployment*** of up to six (6) mock CubeSats ***out to 100m*** and record position ***truth data***

CONOPS



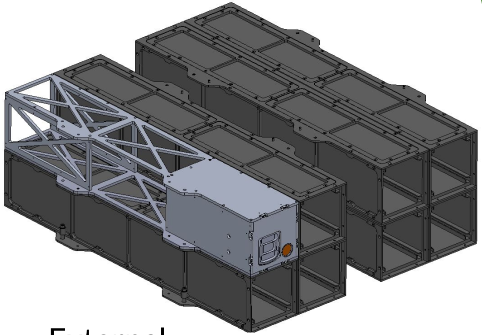
Boot
Manifest
Pre-Process
Ready!
Go!
Sensing
Post-Process
Output
Launch
Output File
Calculate Position Velocity
NANORACKS

Baseline Design Overview



Baseline Design Overview

Interface With NanoRacks Ground-based Hardware



External Mounting

Avionics and Software

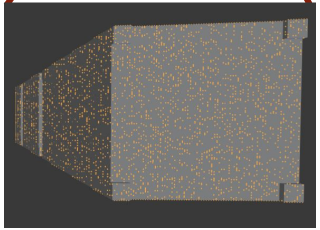
Next Unit of Computing (NUC)

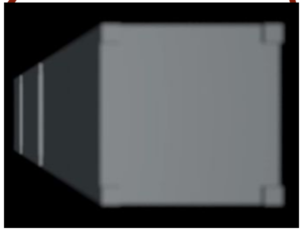
MATLAB SW

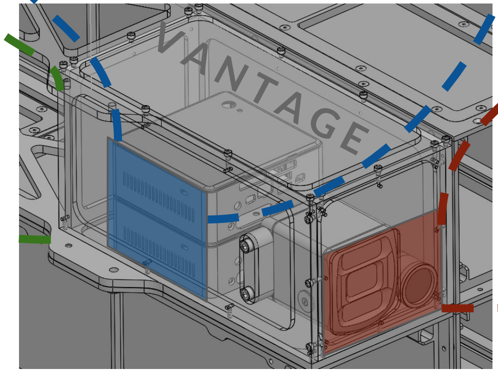
Acquire Data

Time of Flight (TOF) Camera

Monochrome Camera

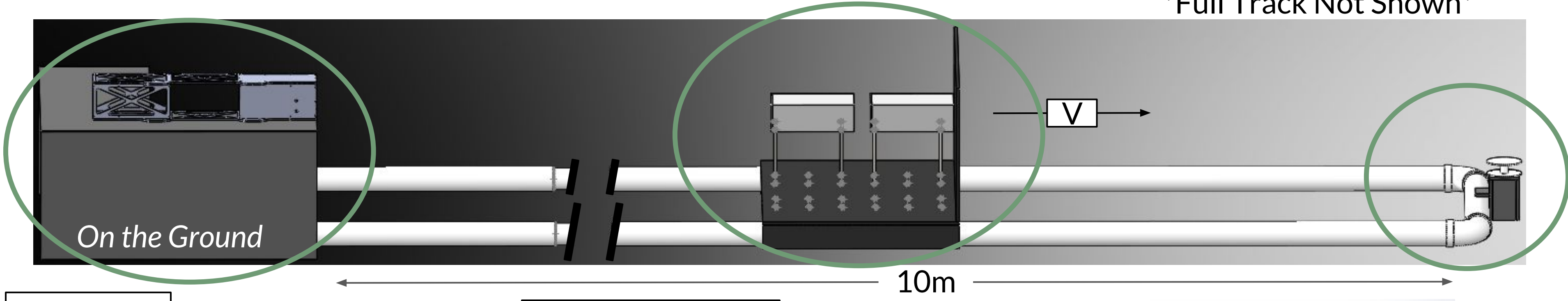


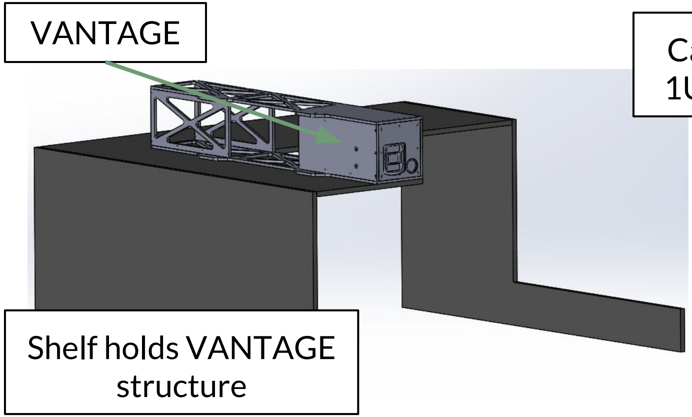


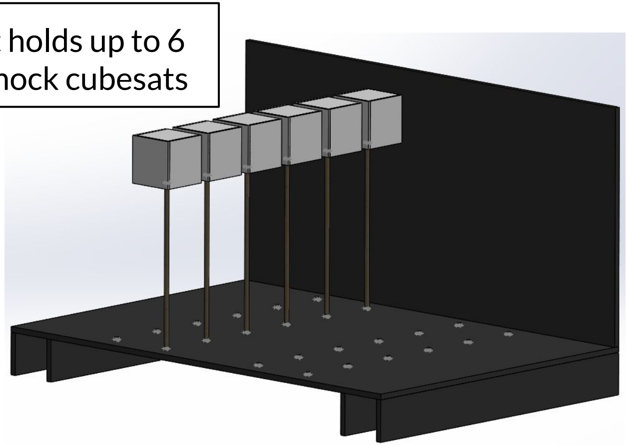


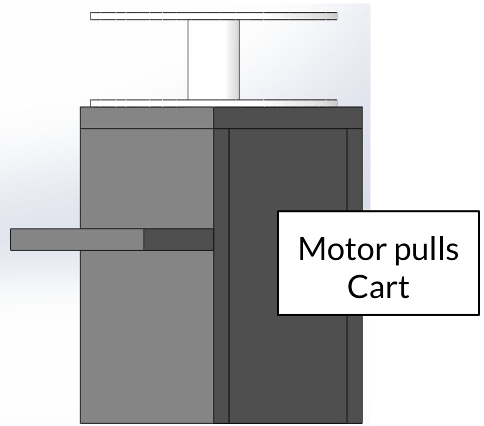
Modular Test Overview

Full Track Not Shown

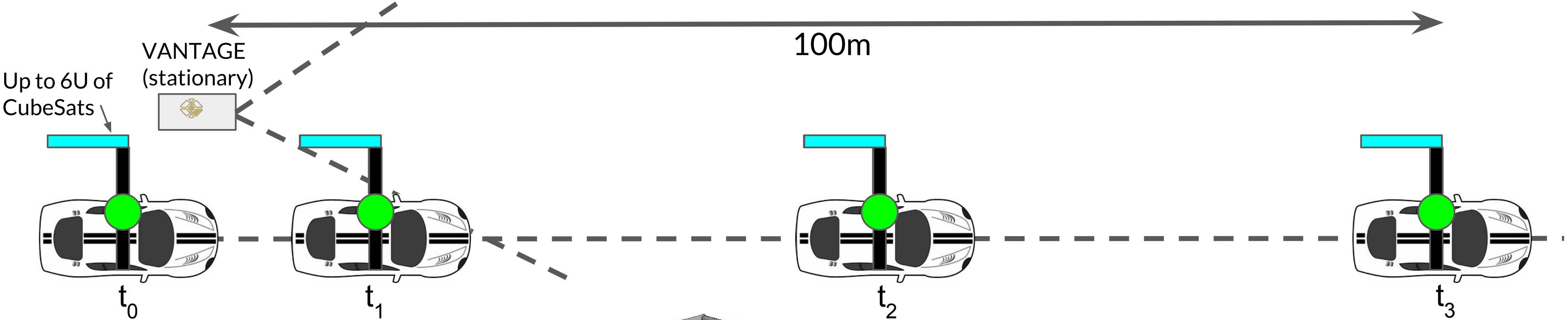




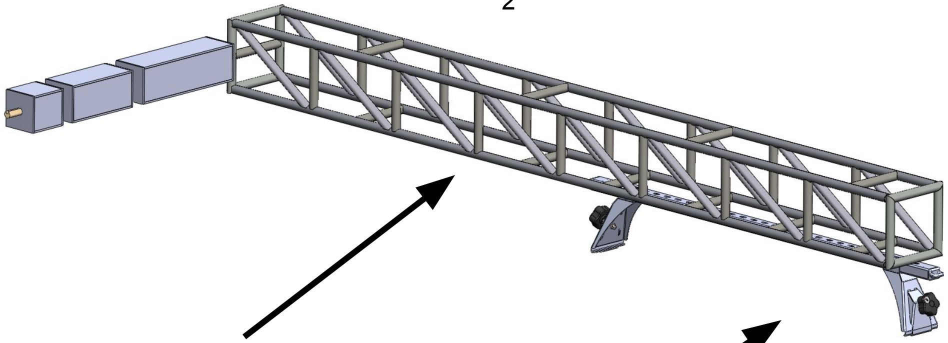




100m Test Overview



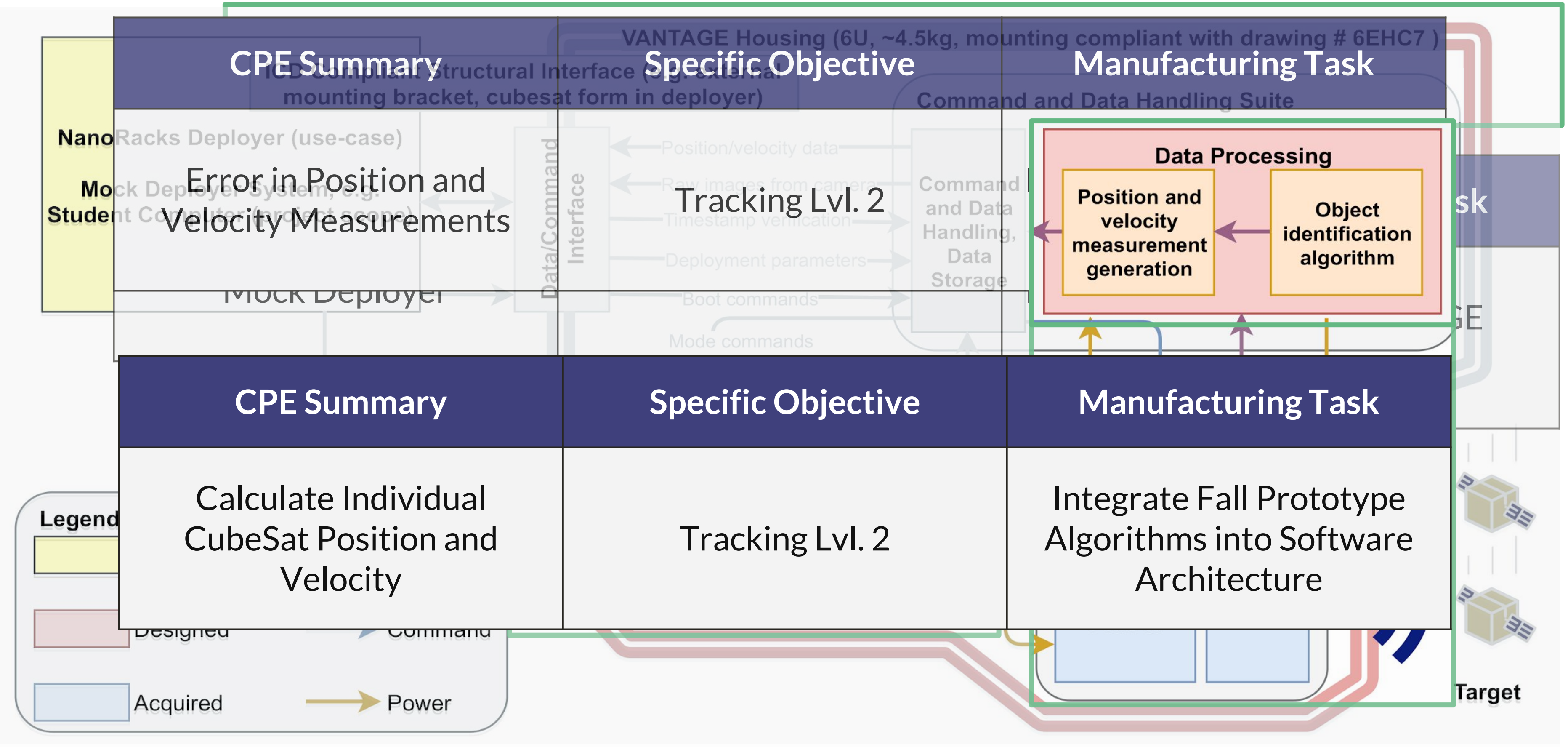
Legend
- CubeSat Kabob
- 10ft Test Boom
- GPS unit



Design Updates Since CDR

- Swapped Arduino with Raspberry Pi for low-power mode
- Testing an additional GPS system for our 100m test
- Adding stabilizing harness to our 100m test boom mount

Critical Manufacturing Elements

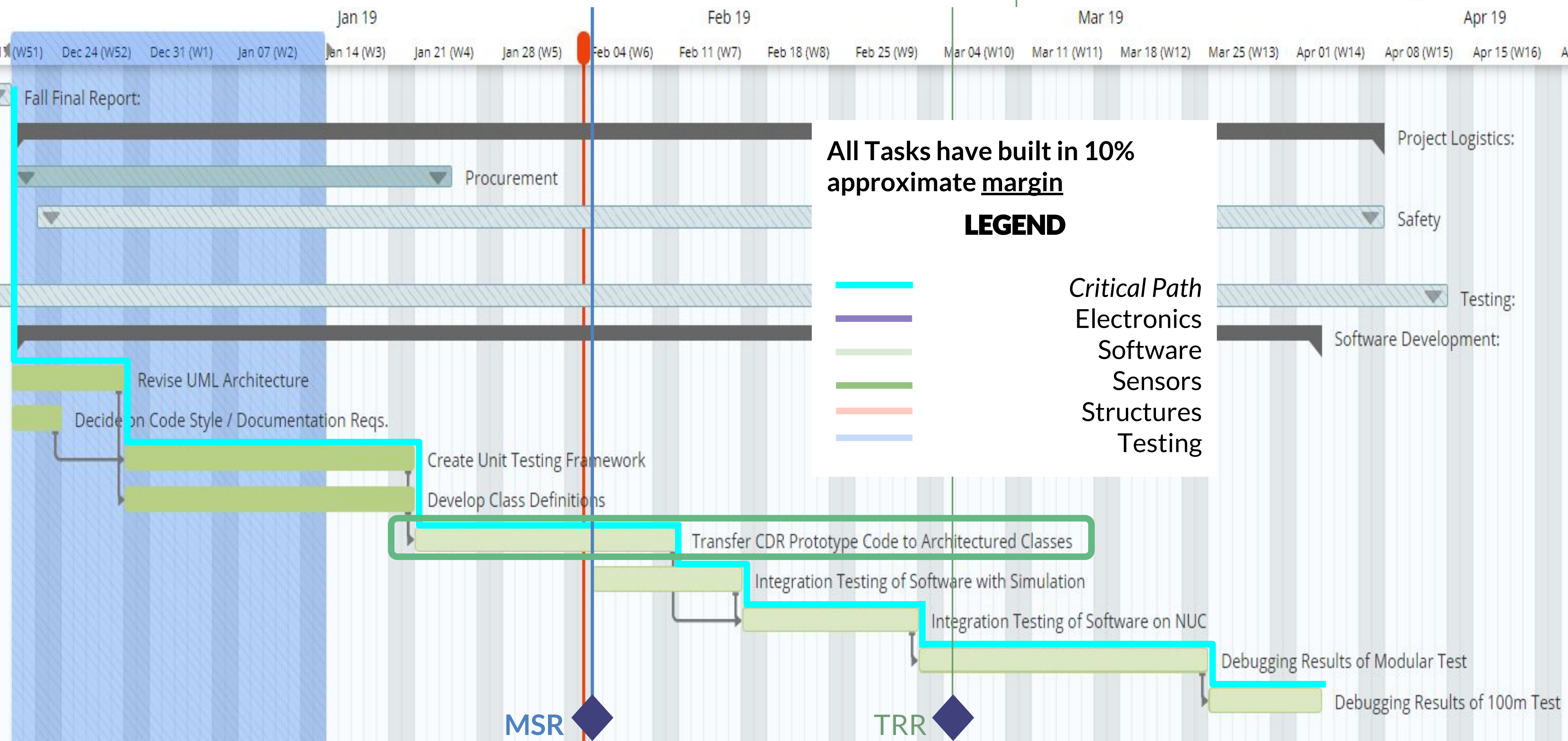


CPE Summary	Specific Objective	Manufacturing Task
Error in Position and Velocity Measurements	Tracking Lvl. 2	

CPE Summary	Specific Objective	Manufacturing Task
Calculate Individual CubeSat Position and Velocity	Tracking Lvl. 2	Integrate Fall Prototype Algorithms into Software Architecture

Schedule

Software Integration Schedule



Manufacturing

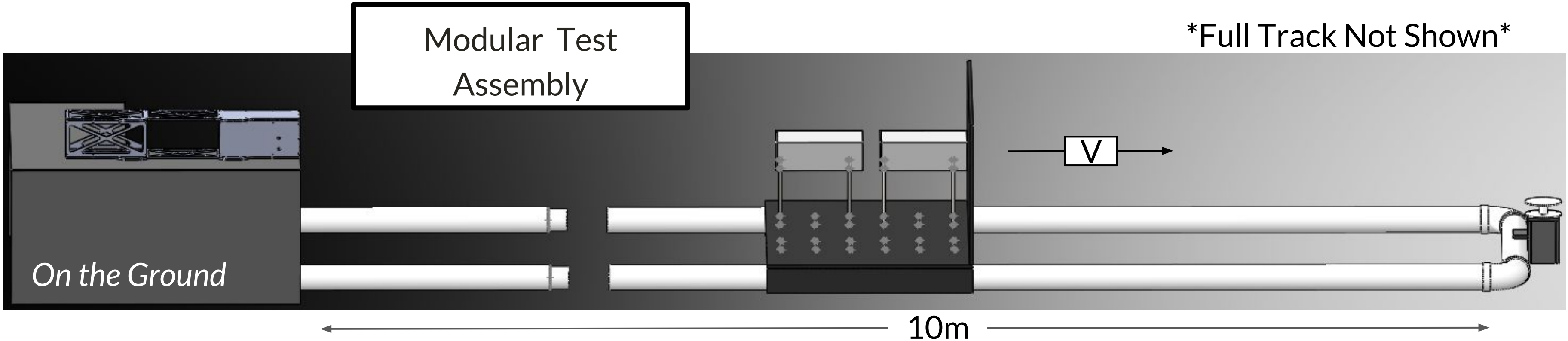
Modular Test Manufacturing Status

Work Completed:

- Cart, Motor Assembly, and Shelf manufacturing and assembly
- Assembly & Test Procedure
- Motor Qualification Test

Pending:

- Mock CubeSats printing
- VICON training - scheduled for Feb. 6 (Tomorrow)



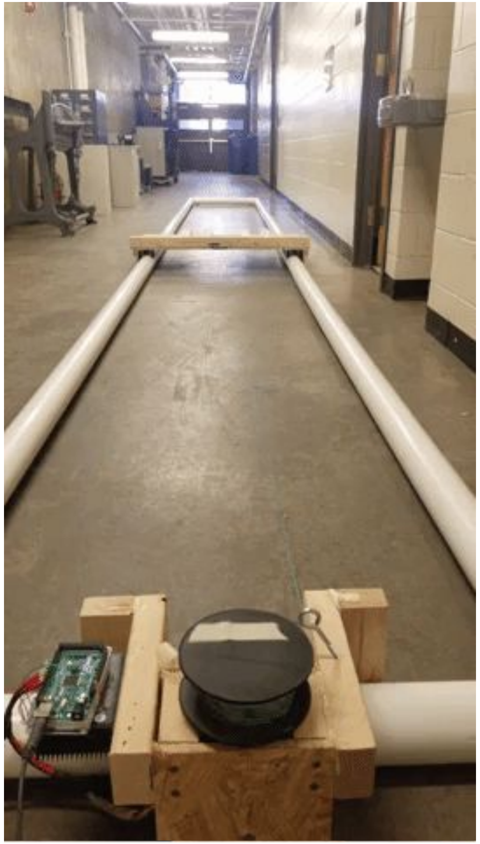
Motor Qualification Test

- Problem:
  - Current max speed is 1.3 m/s
  - Requirement: [0, 2] m/s

- Source:
  - Controller angular velocity is limited

- Mitigation Strategy:
  - Design spool with larger radius
  - Increases cart speed

- Next Steps:
  - VICON Integration
  - Sensor Interface Testing



Pending

Fit Check Planned

- Verbal permission obtained
- VANTAGE team has reached out several times to get written permission
- Airport contact has been slow to respond with written permission

VANTAGE

eSat on Kabob

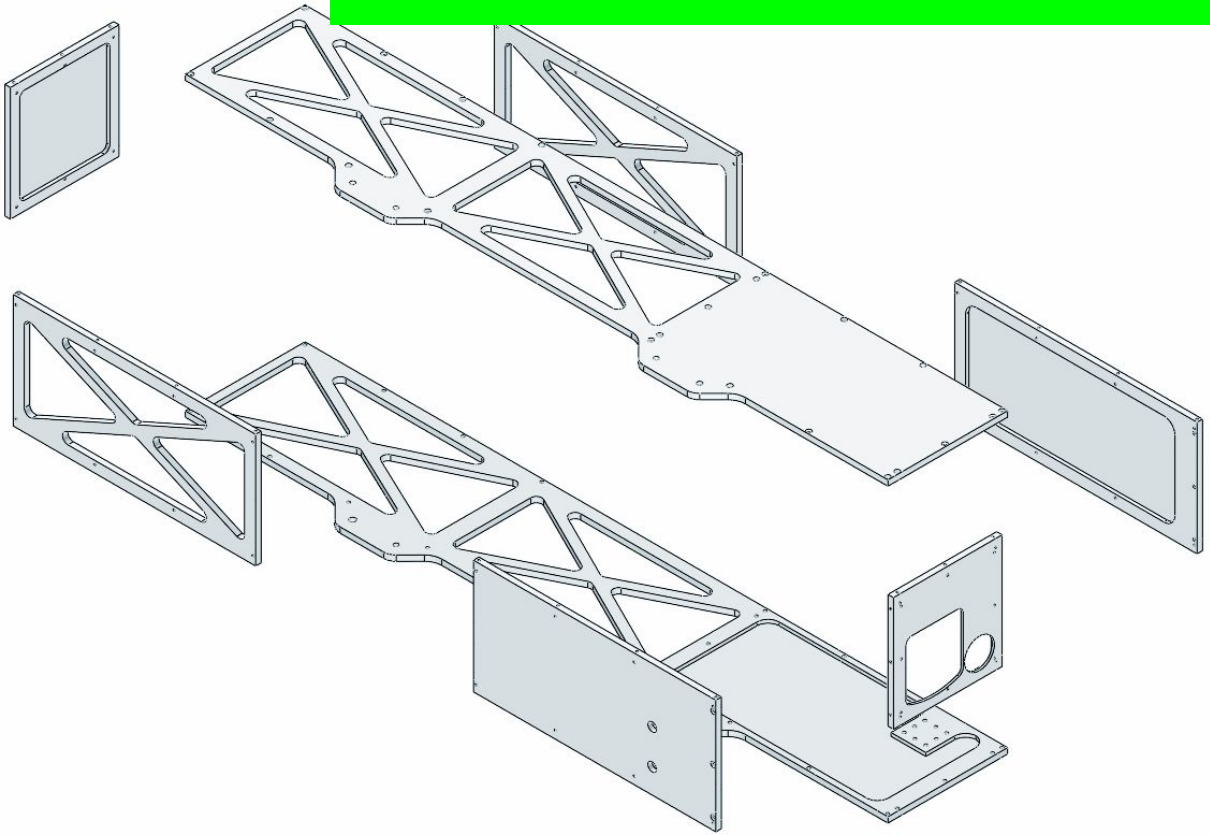
Written Approval to use Airport Location

Trimble GPS System Rigid Mount and Power

- Trimble system has battery powered receiver box which does calculations and data storage
- Cables will connect to antenna and pass through the sunroof of the car

Optical Camera in same configuration as VANTAGE

Written



Avionics Power System
Actual EPS System

- All testing before final integration will be done with provided wall adapters
- Converters demonstrated to produce desired voltage with static load

Avionics Power System Power Budget

- **CDR Predicted Power Usage**
  - *Based on Data Sheets*
  - *ToF Sensor - 10.0 W*
  - ***Total (41.6% Margin) - 81.8 W***

DC-DC Power Limit is 120W:

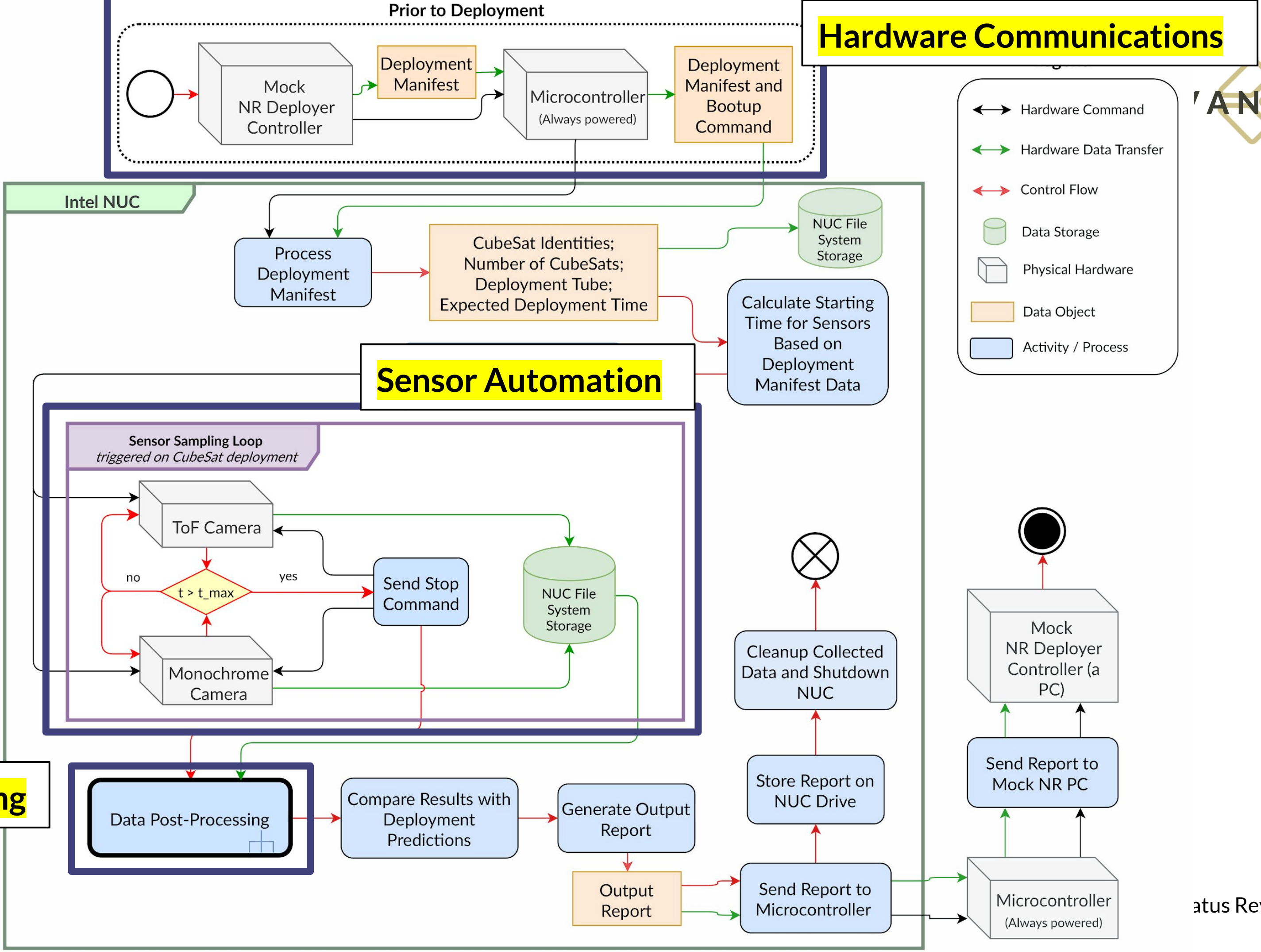
- **After Hardware Inspection**
  - *Label has discrepancy from data sheet*
  - *ToF Sensor - 62.4 W*
  - ***Total (11.6% Over) - 133.4 W***

Pending

1. Load Test ToF Sensor
2. Load Test Avionics Power System

Potential Solutions

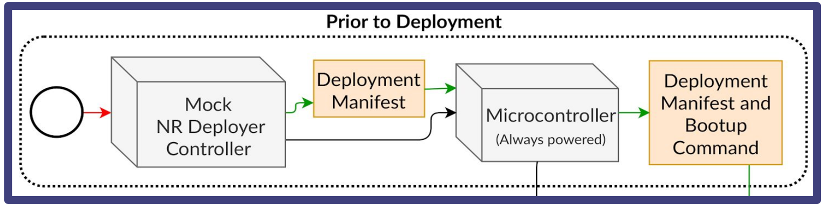
1. Underclock NUC
2. DC-DC OC mode.
3. Purchase a new power supply.


Hardware Communications
Sensor Automation
Data Processing
Prior to Deployment
Mock NR Deployer Controller
Deployment Manifest
Microcontroller (Always powered)
Deployment Manifest and Bootup Command
Intel NUC
Process Deployment Manifest
CubeSat Identities; Number of CubeSats; Deployment Tube; Expected Deployment Time
NUC File System Storage
Calculate Starting Time for Sensors Based on Deployment Manifest Data
Sensor Sampling Loop
triggered on CubeSat deployment
ToF Camera
no
yes
t > t_max
Send Stop Command
NUC File System Storage
Monochrome Camera
Data Post-Processing
Compare Results with Deployment Predictions
Generate Output Report
Output Report
Send Report to Microcontroller
Store Report on NUC Drive
Cleanup Collected Data and Shutdown NUC
Send Report to Mock NR PC
Mock NR Deployer Controller (a PC)
Microcontroller (Always powered)
Hardware Command
Hardware Data Transfer
Control Flow
Data Storage
Physical Hardware
Data Object
Activity / Process

Hardware Communications

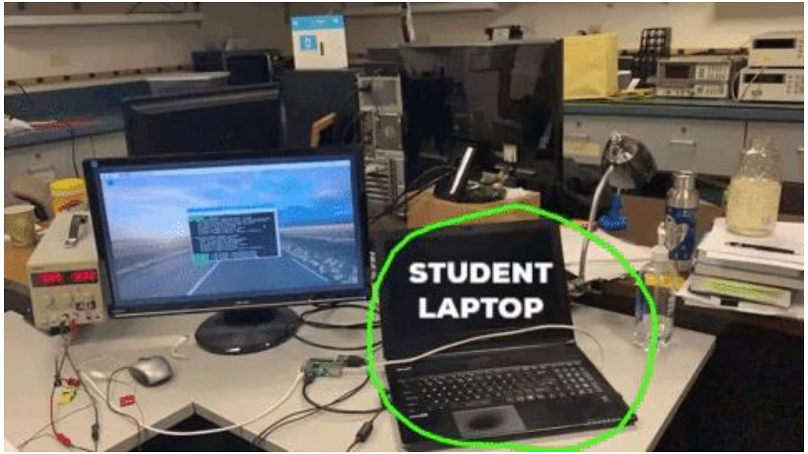
Tasks:

- Raspberry Pi boots NUC over LAN
- Data transfer from student laptop to NUC



Done:

- Raspberry Pi demonstrated to boot laptop over LAN
- See video



In Progress:

- Boot NUC over LAN with Raspberry Pi
- Set up data transfer from student laptop to NUC

Sensor Automation

Tasks:

- Manual sensor data capture on student laptop
- Automated sensor data capture on NUC

Done:

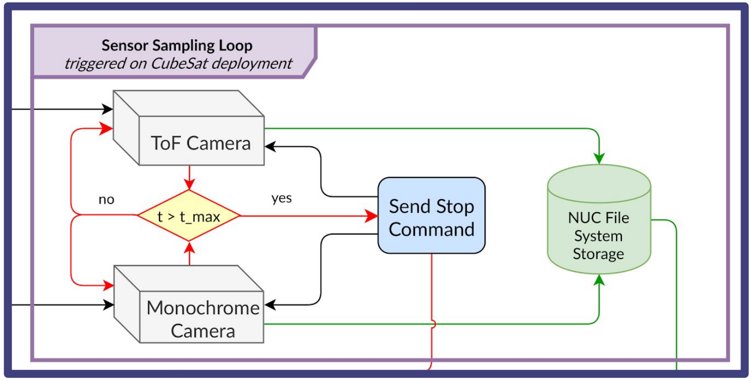
- Manual sensor data capture on student laptop
- Automated sensor data capture on student laptop

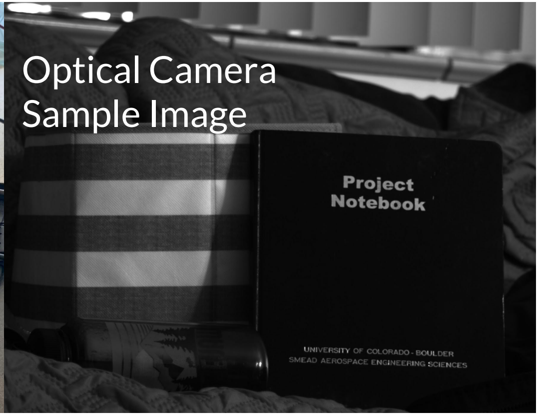
In Progress:

- Automated sensor data capture on NUC

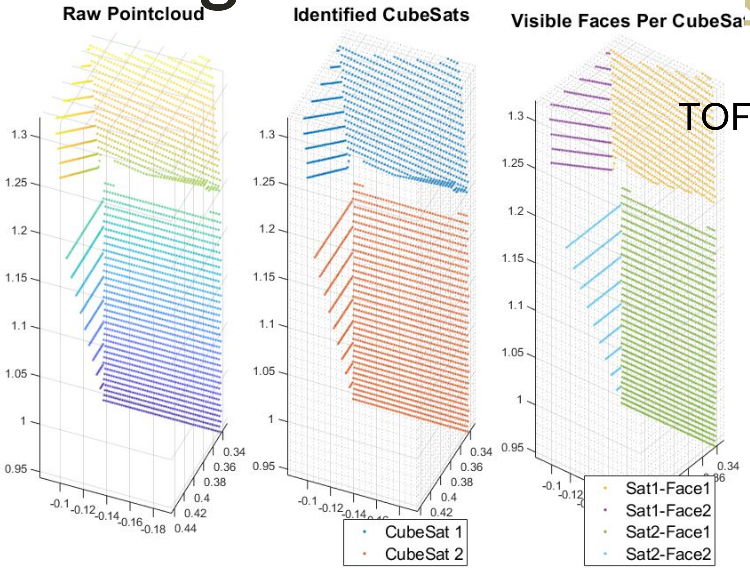
Challenges:

- Integrating sensor controls with MATLAB
- Measuring accurate sensor parameters





Data Processing



TOF Results

Tasks:

- TOF data processing and centroiding
- Optical camera data processing and centroiding
- Sensor Fusion

Done:

- TOF data processing
- Optical camera data processing
- Sensor Fusion

In Progress:

- TOF centroiding
- Optical camera data centroiding
- Further, Exhaustive Testing

Challenges:

- Solving image processing edge cases

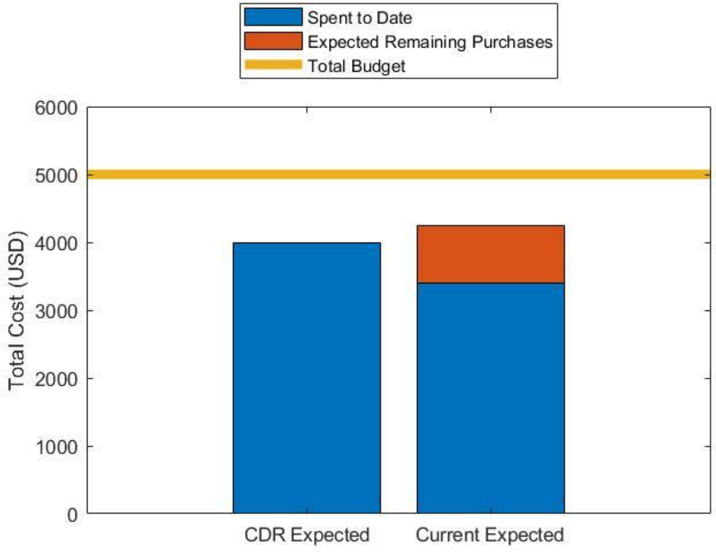
Optical Camera Results

CCAR

Budget

VANTAGE

Incomplete Procurements	Subsystem	Expected Cost	Status
INTEL® NUC KIT NUC8I7BEH	Electronics	$671.28	Pending Changes
PHYS Machine Shop Use	Structures	$170.00	Scheduled



Subsystem:	Structures	Sensors	Software	Electronics	Testing	Total
CDR Expected Total:	$365.86	$2,430.00	$0.00	$916.22	$645.85	$3,992.07
Remaining Purchases:	$170.00	$0.00	$0.00	$671.28	$0.00	$841.28
Total Spent:	$252.69	$2,589.13	$0.00	$207.44	$357.47	$3,406.73
Current Expected Total:	$422.69	$2,589.13	$0.00	$878.72	$357.47	$4,248.01