



# EPS DEVELOPMENT FOR THE TARGIT CUBESAT PROJECT

LOGAN BEWLEY

CREATING THE NEXT®

# TARGET



**T**ethering  
**A**nd  
**R**anging mission of the  
**G**eorgia  
**I**nstitute of  
**T**echnology

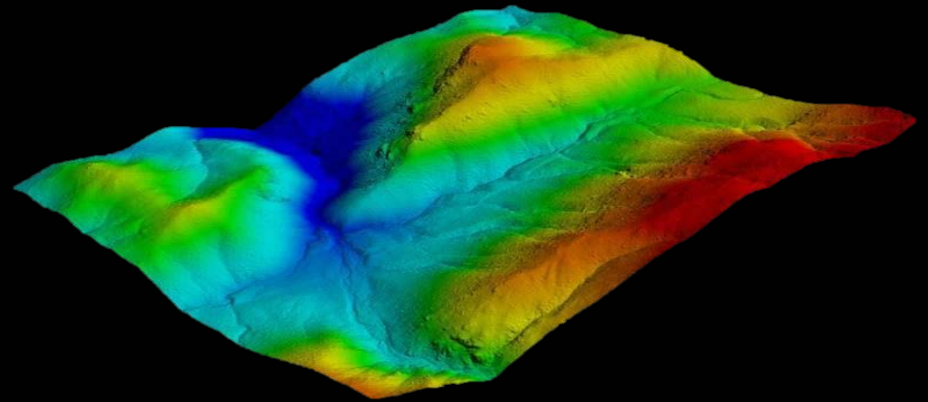
“The objective of this project is to develop, and test on-orbit, a miniaturized LiDAR imaging camera. The LiDAR will image a deployed inflatable target to verify the instrument's performance, and demonstrate cm-level altimetry valuable to numerous future planetary missions.”

# TECHNOLOGY

- LiDAR (*Light Detection and Ranging*): a remote sensing method that uses light in the form of a pulsed laser to measure ranges to the Earth
- LiDAR imaging is performed through a single laser shot and using a detector array generates precise composite 3-D images

## Some LiDAR Applications:

- Topography
- Geology
- Atmospheric Remote Sensing
- Meteorology



# APPLICATION TO CUBESATS

- Raise TRL of new silicon photomultiplier array (SiPM) capable of cm-level topographic mapping of planetary bodies
- Provide detailed landing site reconnaissance and hazard identification for future landers
- Low cost, small form factor instrument suitable for ride-share applications. Especially useful on planetary missions where high cost per kg limits space assets
- Other uses include: laser communications; navigation for approach, descent, and landing

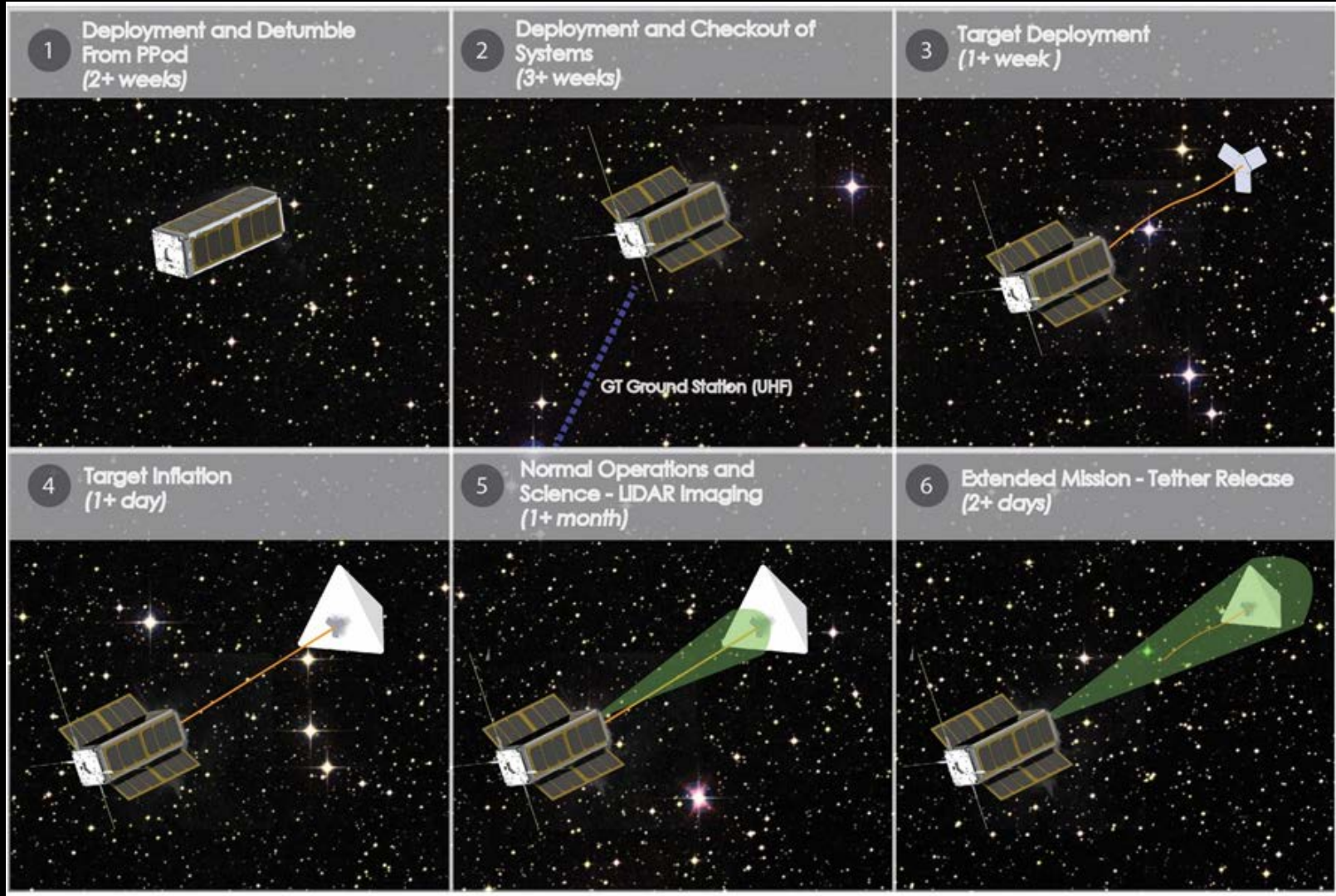


# MISSION OBJECTIVES



- Primary Objective: Develop and test on-orbit a SiPM-based LiDAR with cm-level precision
- Secondary Objective 1: Demonstrate the ability to point and track a remote object
- Secondary Objective 2: Investigate the dynamics of a CubeSat-Tether system
- Secondary Objective 3: Demonstrate a tethered target as a deployable inflatable drag device

# CONCEPT OF OPERATIONS



# IMPLICATIONS FOR EPS DESIGN



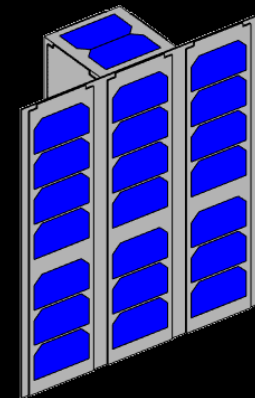
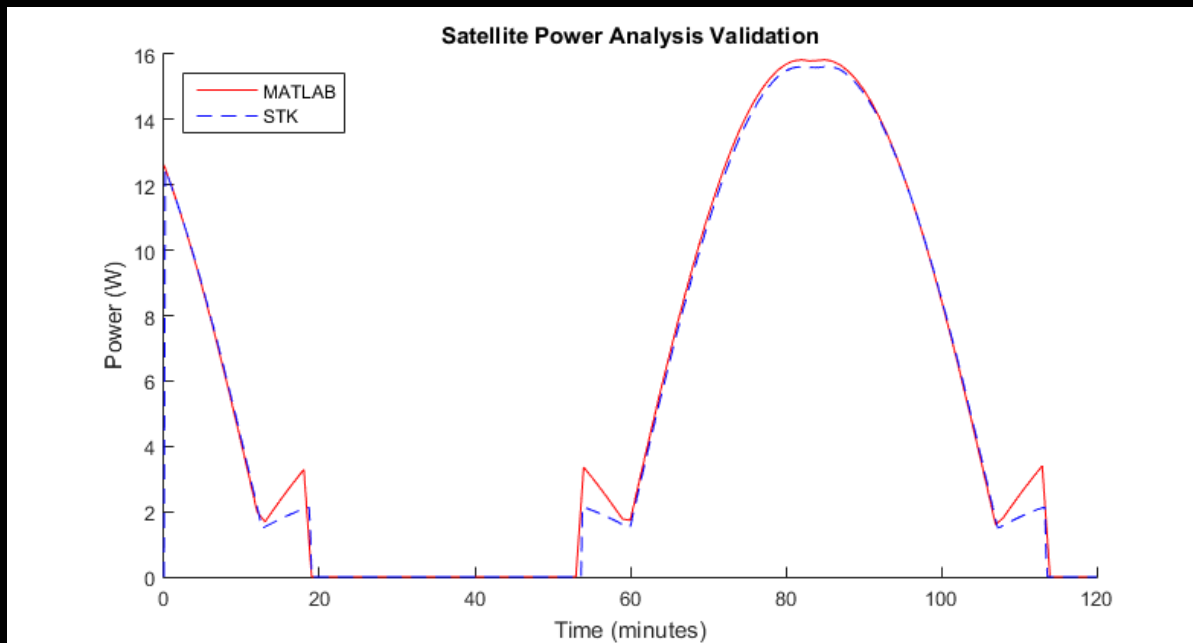
- Power usage of in development systems such LiDAR, tether deployment, target inflation are unknown
- High power usage components and mission phases
- Pointing requirements for target tracking
- Attitude stability of satellite-tether-target system as well as sun pointing capability unknown
- Orbit unknown
- These factors contributed to making both power requirement definition as well as power generation capability difficult to quantify

## Major Tasks for EPS Development

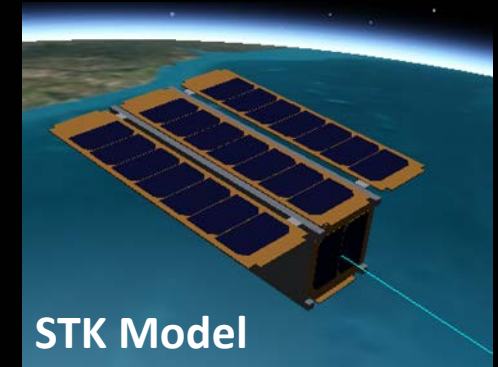
- Power Modeling
- Solar Panel Configuration Analysis
- Solar Panel Fabrication

# POWER MODELING

- MATLAB code that models power generation of a CubeSat in various configurations was developed for RANGE, but additional work and changes were needed:
- Validate using STK



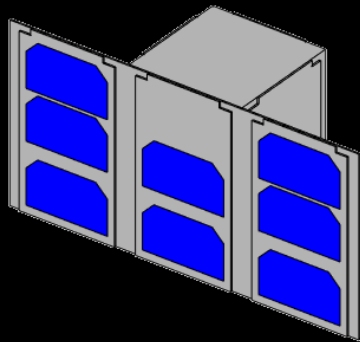
**MATLAB Model**



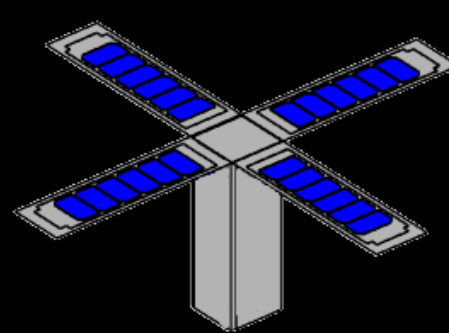
**STK Model**

# POWER MODELING

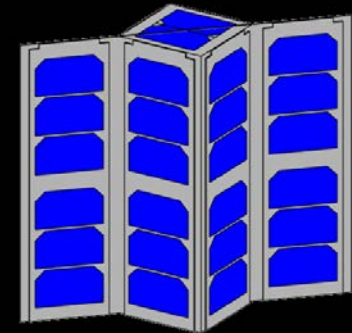
- Add capability for larger CubeSats and additional configurations



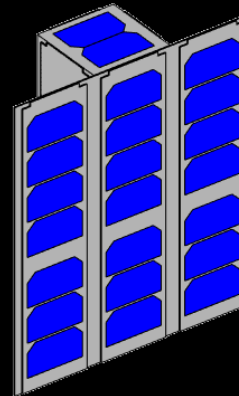
**RANGE**



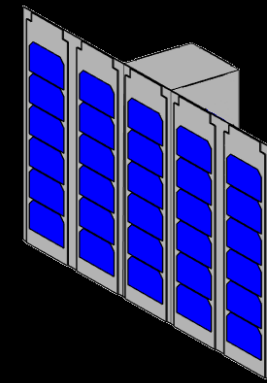
**Short Edge Deploy**



**135 Degree Deploy**



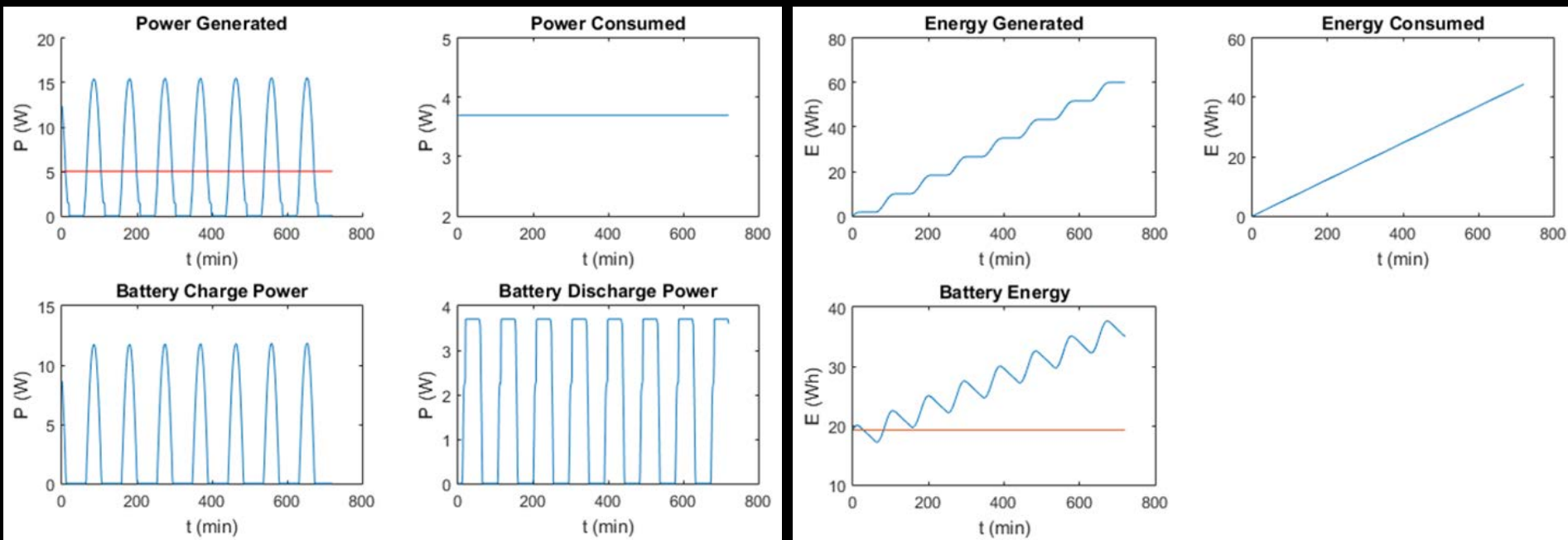
**90 Degree Deploy**



**Double Deploy**

# CONFIGURATION ANALYSIS

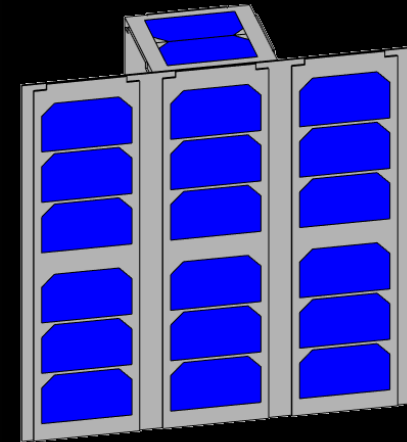
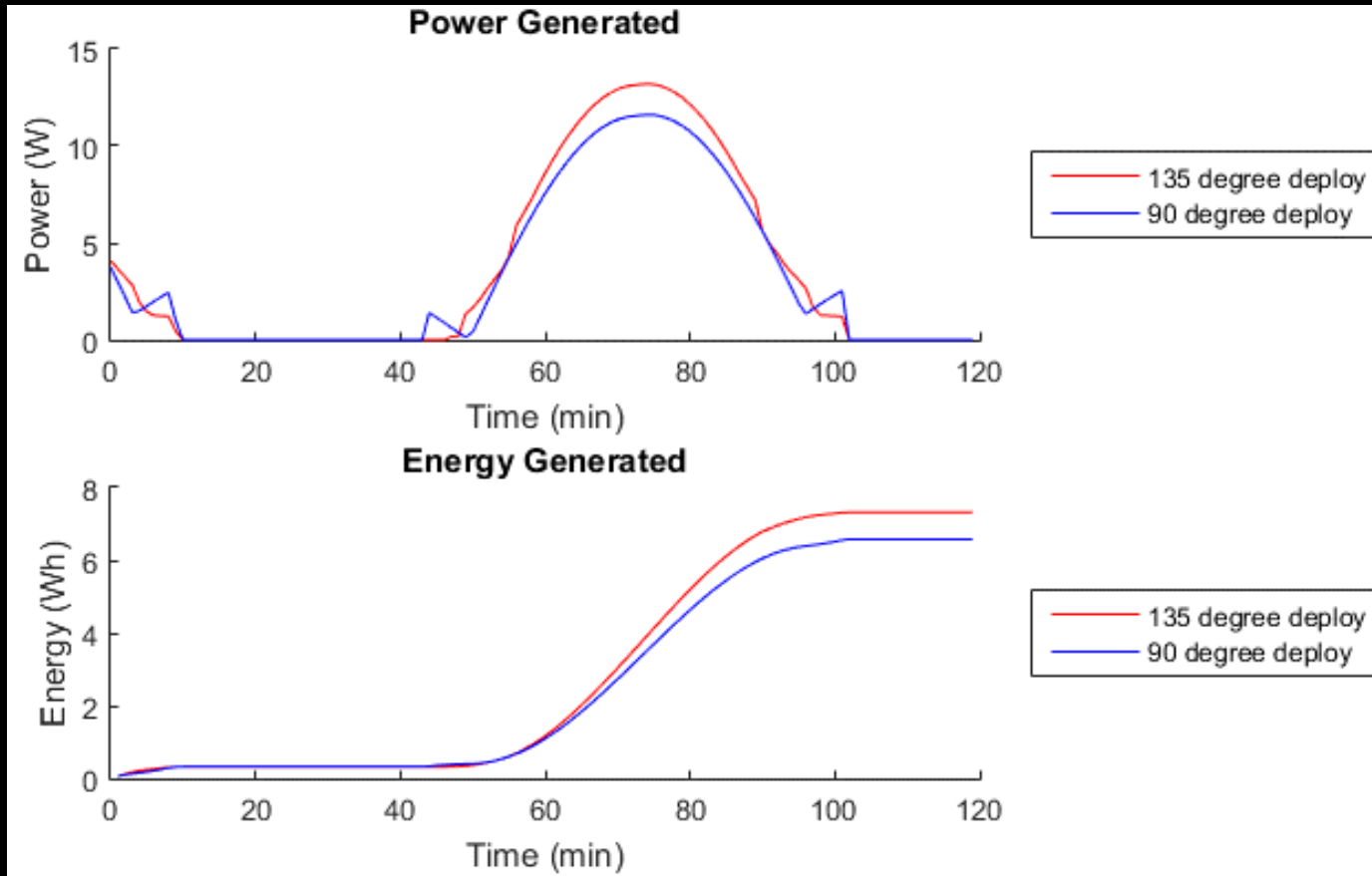
- Code outputs



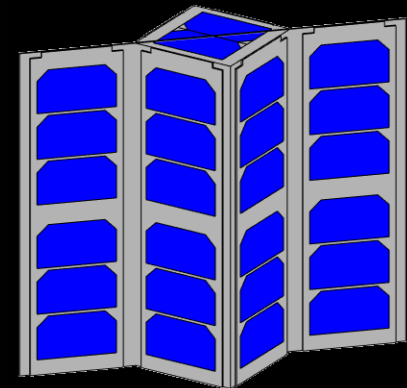
- State of charge of battery and relationship to modes
- If the battery recharges and time required for recharge

# CONFIGURATION ANALYSIS

- Configuration comparison



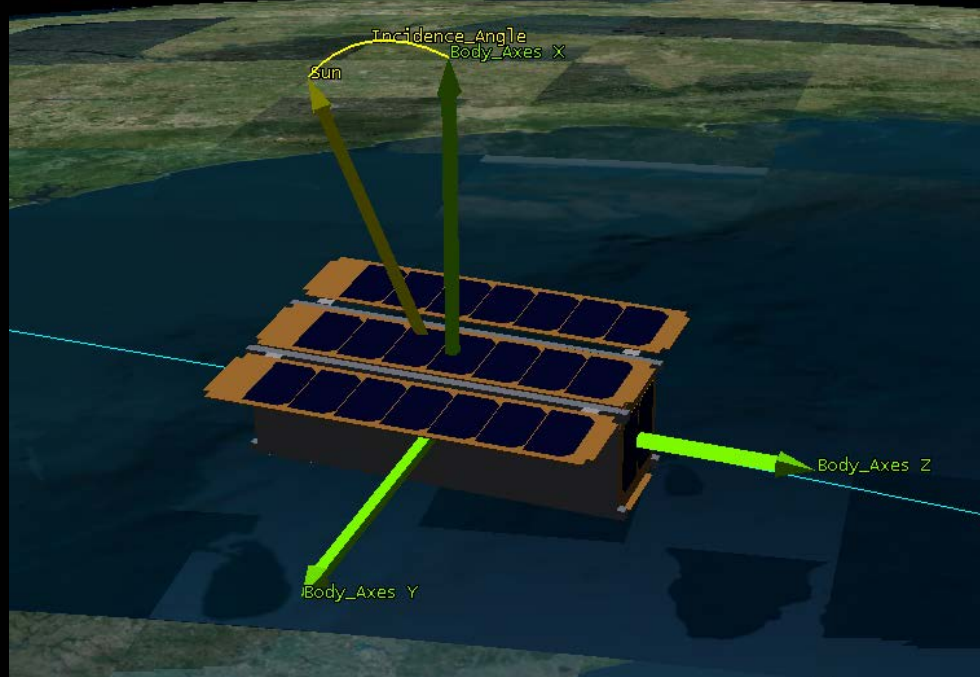
90 Degree Deploy



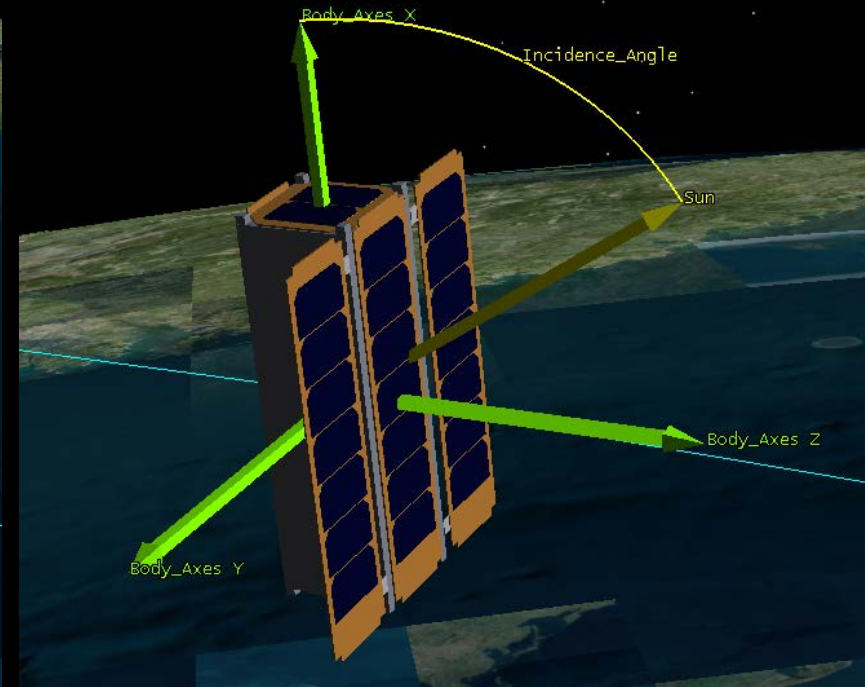
135 Degree Deploy

# CONFIGURATION ANALYSIS

- Analyze power generation with different attitudes

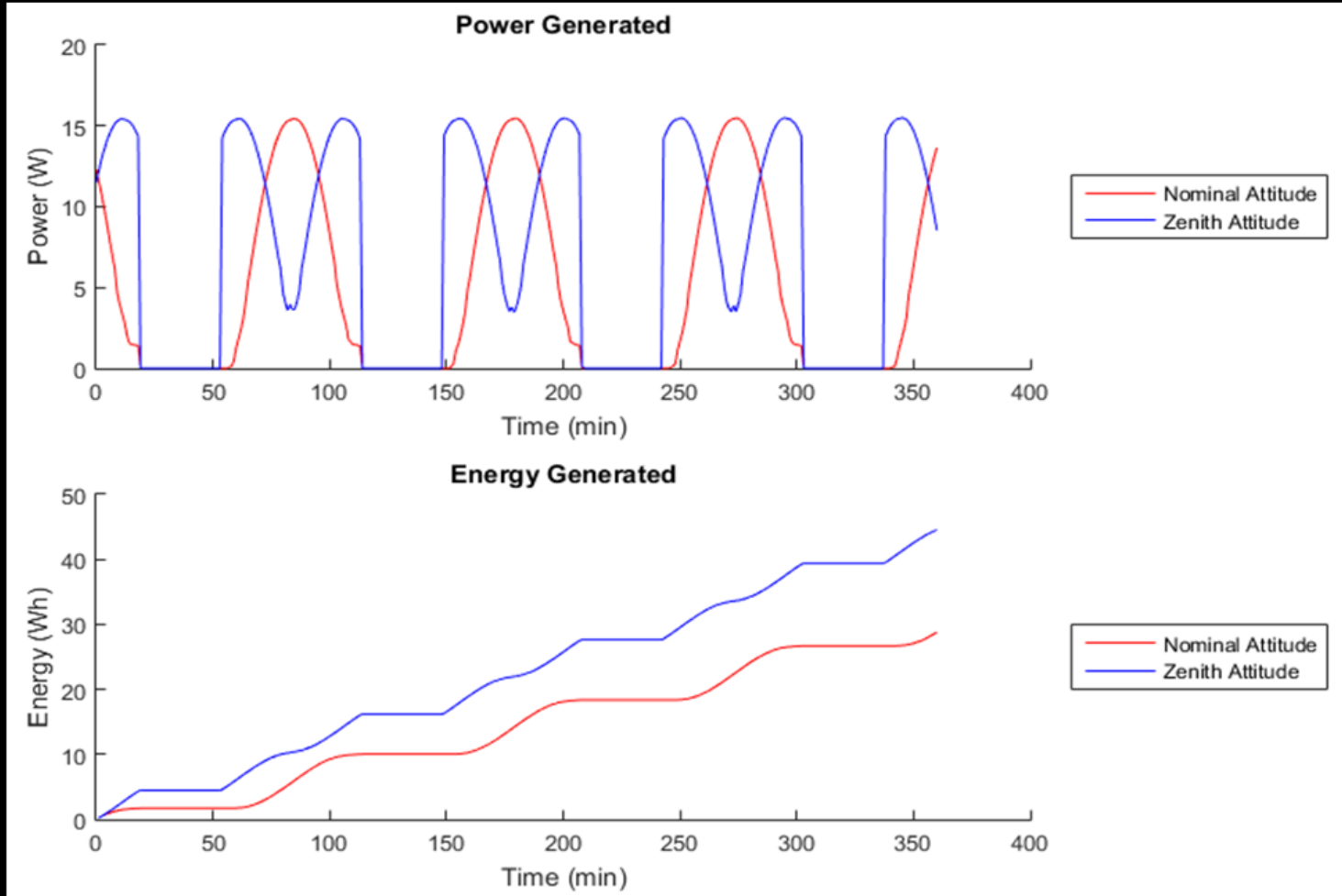


**Velocity Aligned**



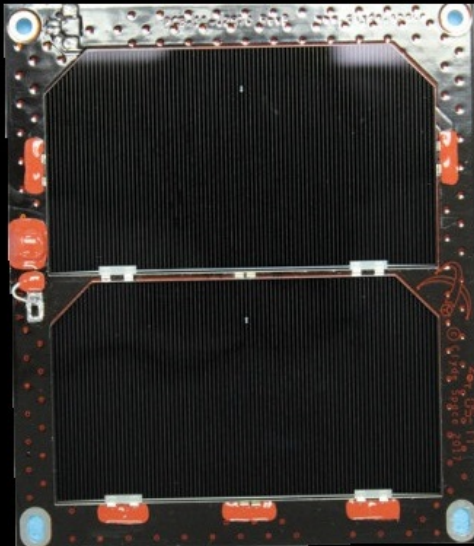
**Zenith Pointing**

# CONFIGURATION ANALYSIS

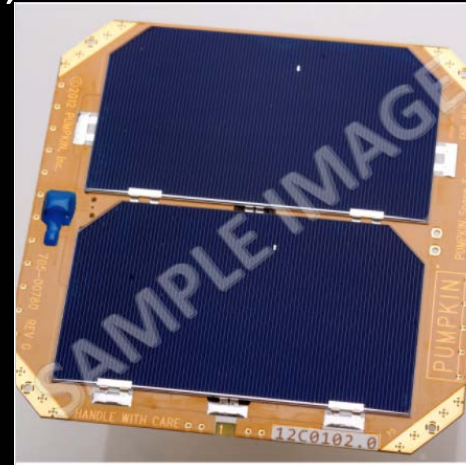


# SOLAR PANEL FABRICATION

- Trade study was conducted that determined in-house fabricated solar panel were preferable to prebuilt alternatives
  - Lower cost and customizable, but less robust and time intensive



Clyde Space



Custom PMDSAS panel, deployable, per cell  
\$1,500.00

Pumpkin Space

- Based on research, a method utilizing a PCB panel and double-sided Kapton tape for solar cell adhesion was chosen
- 1U panel would be made to test design and assembly

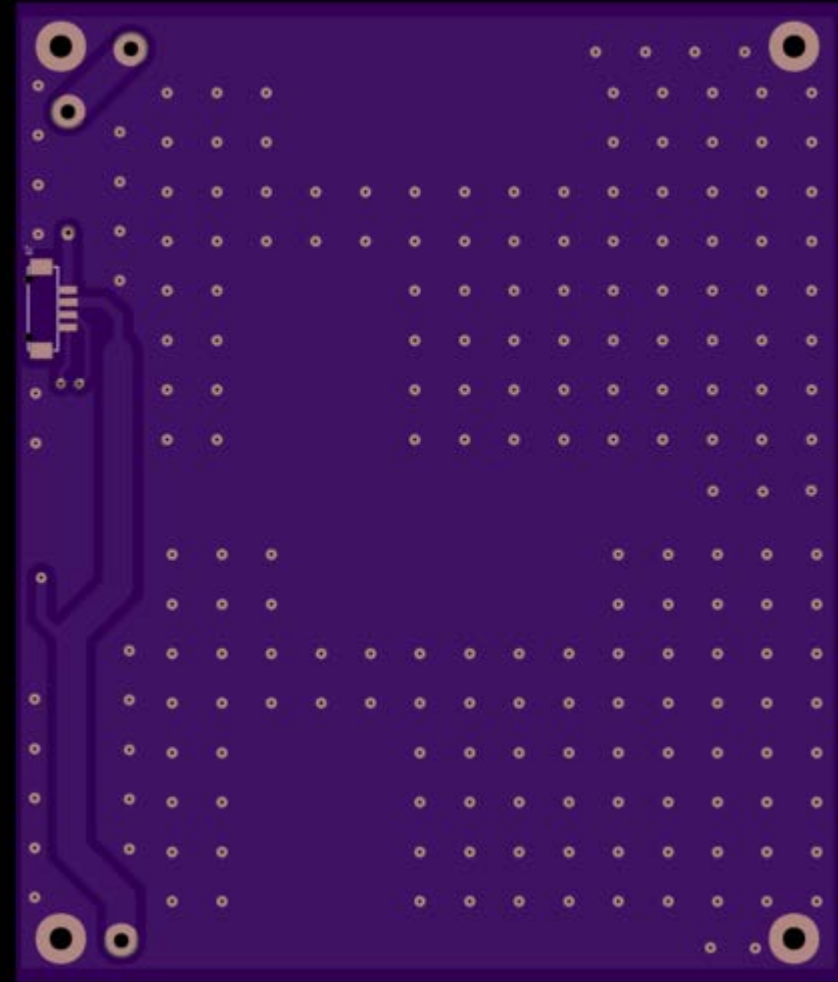
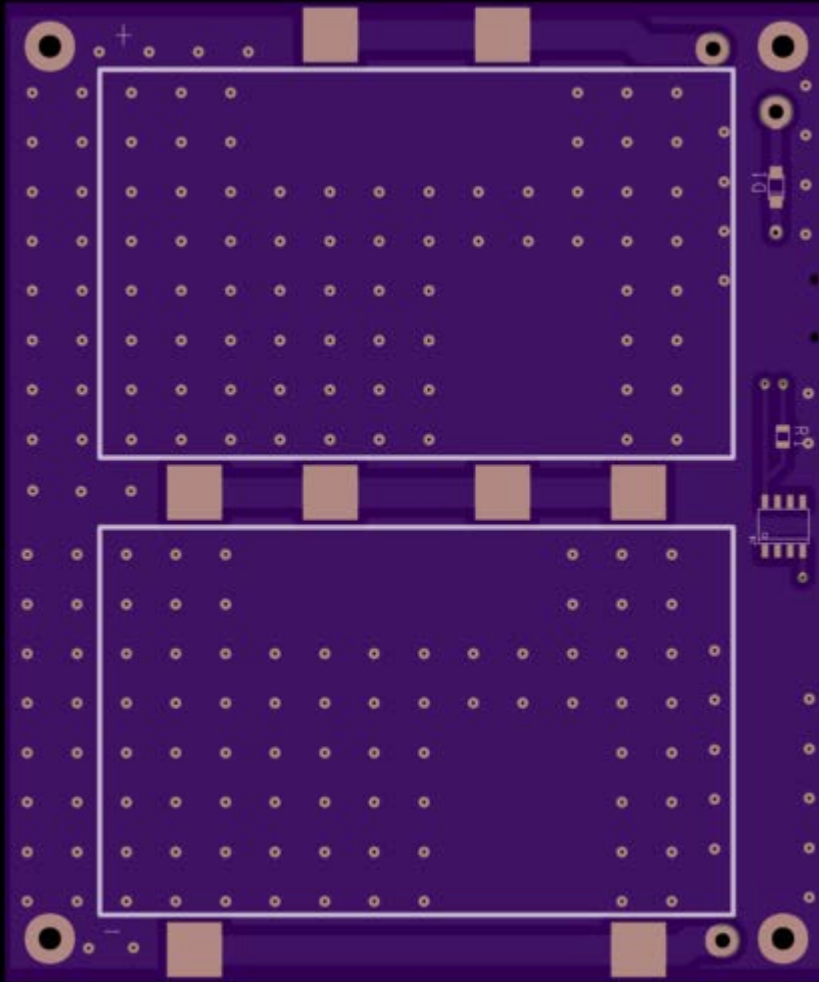
# SOLAR PANEL FABRICATION



- Having never designed a PCB, some time was spent learning Cadence OrCAD software and researching solar panel PCB design
- Design concerns
  - Board area and cell placement
  - Thermal dissipation
  - Thermistor integration
  - Bypass and blocking diodes
  - Deployment hinge and burn wire release integration
- Most of these were included in the test panel design, but some such as deployment hinges and burn wire release were excluded due to confidence in these systems being used on RANGE

# SOLAR PANEL FABRICATION

- Panel PCB design

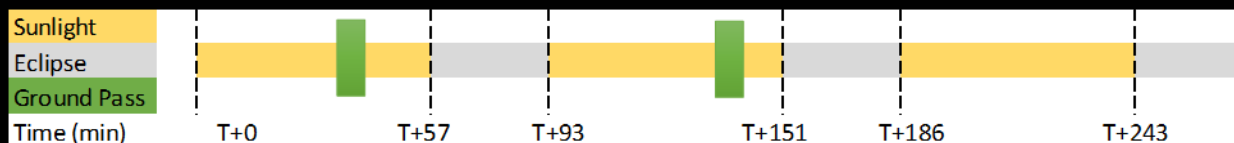
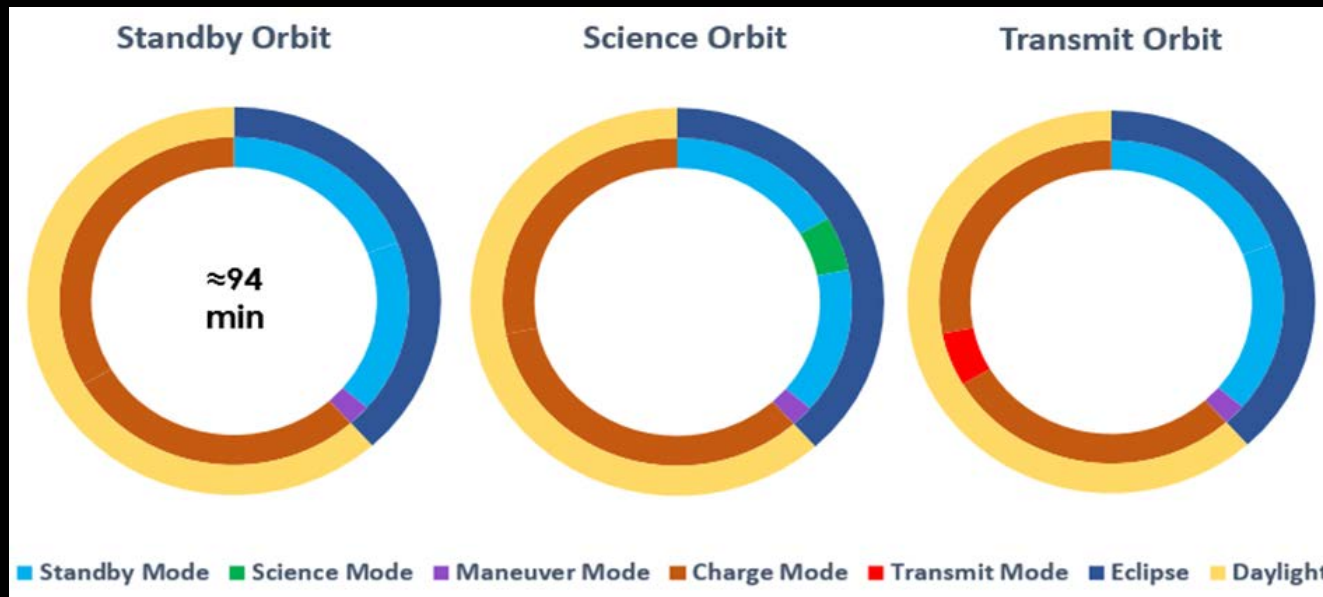


Top

Bottom

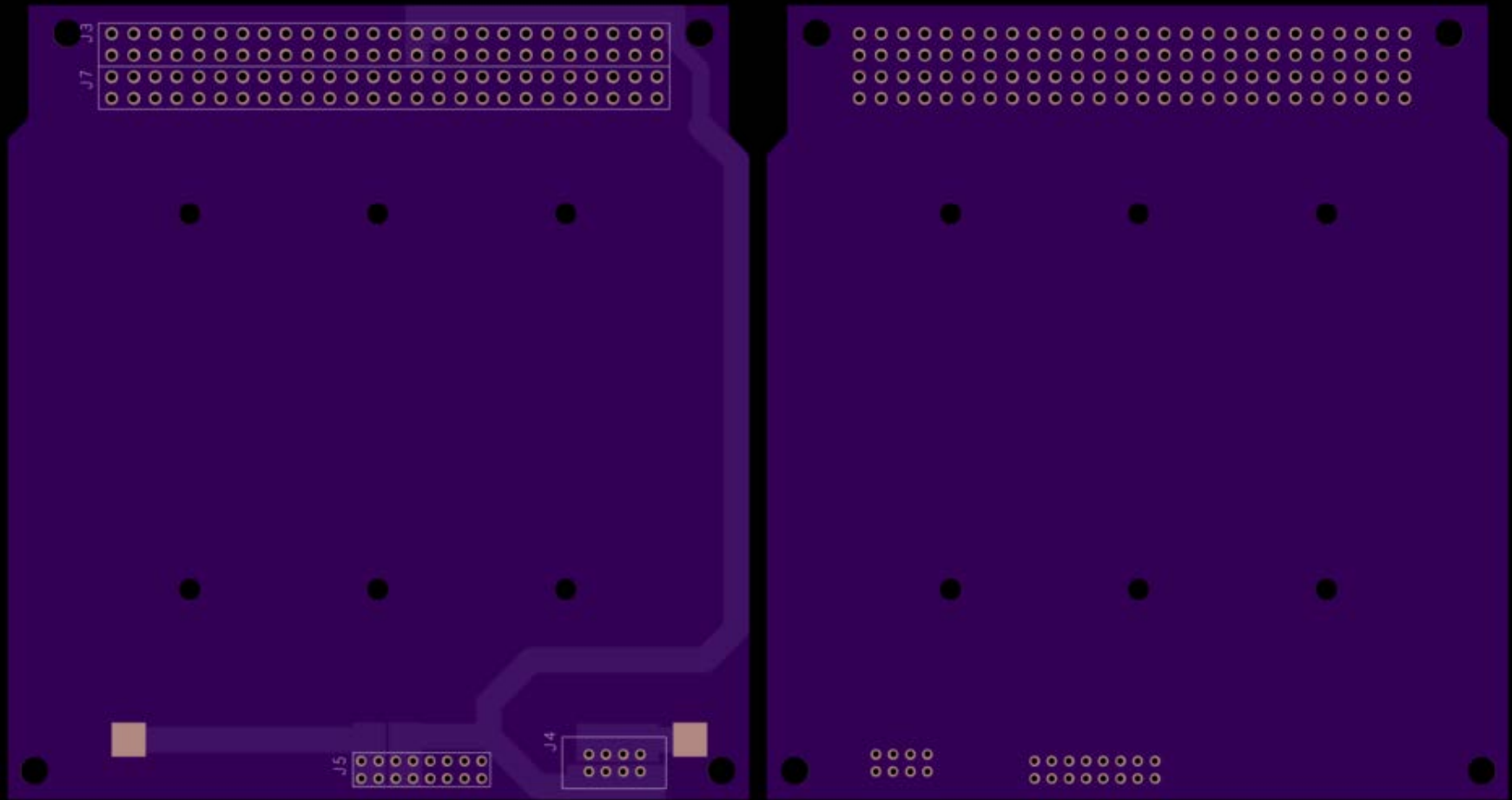
# OTHER TASKS

- Operations plan development
  - Modes definition
  - Science operations details



# OTHER TASKS

- Battery pack
  - In-house fabricated battery pack alternative to GOMSpace



# FUTURE WORK



- Power modeling
  - Develop flexibility and add more features
- Solar panel configuration analysis
  - Finalize power modeling and configuration justification
- Solar panel fabrication
  - Fabricate, test, and develop panel-body fixed and deployable for 3U
- Mission operations plan development
  - Continue modes/operations definition as systems are developed
- Battery pack
  - Fabricate, test, and develop battery pack