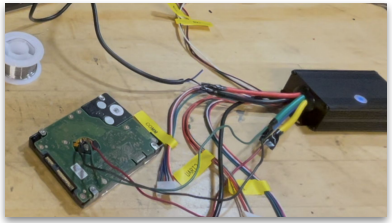
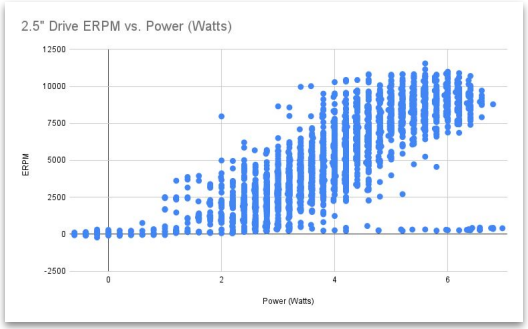
GNC Quad Chart

25 September 2024





ERPM vs Power for 2.5” Hard Drive 1000➔10K ERPM Sweep

External Tools Needed:

1. STK access - either on a lab PC / academic license
2. Pre-existing ground-truth simulation

Nadir pointing with 3dof Attitude Control - getting nadir and orbital plane w/o GPS

Progress:

1. Implemented more-accurate dynamics simulator (incorporated Brahe) and built out core simulation structure.
2. Implemented basic sensors, actuator models, and correspondence generation in simulation.
3. Measured hard drive power consumption with VESC (**~5W** for 2.5” HDD). Projecting **~2W** for a 1.8” drive.
4. Further definition/discussion of the GNC configurations

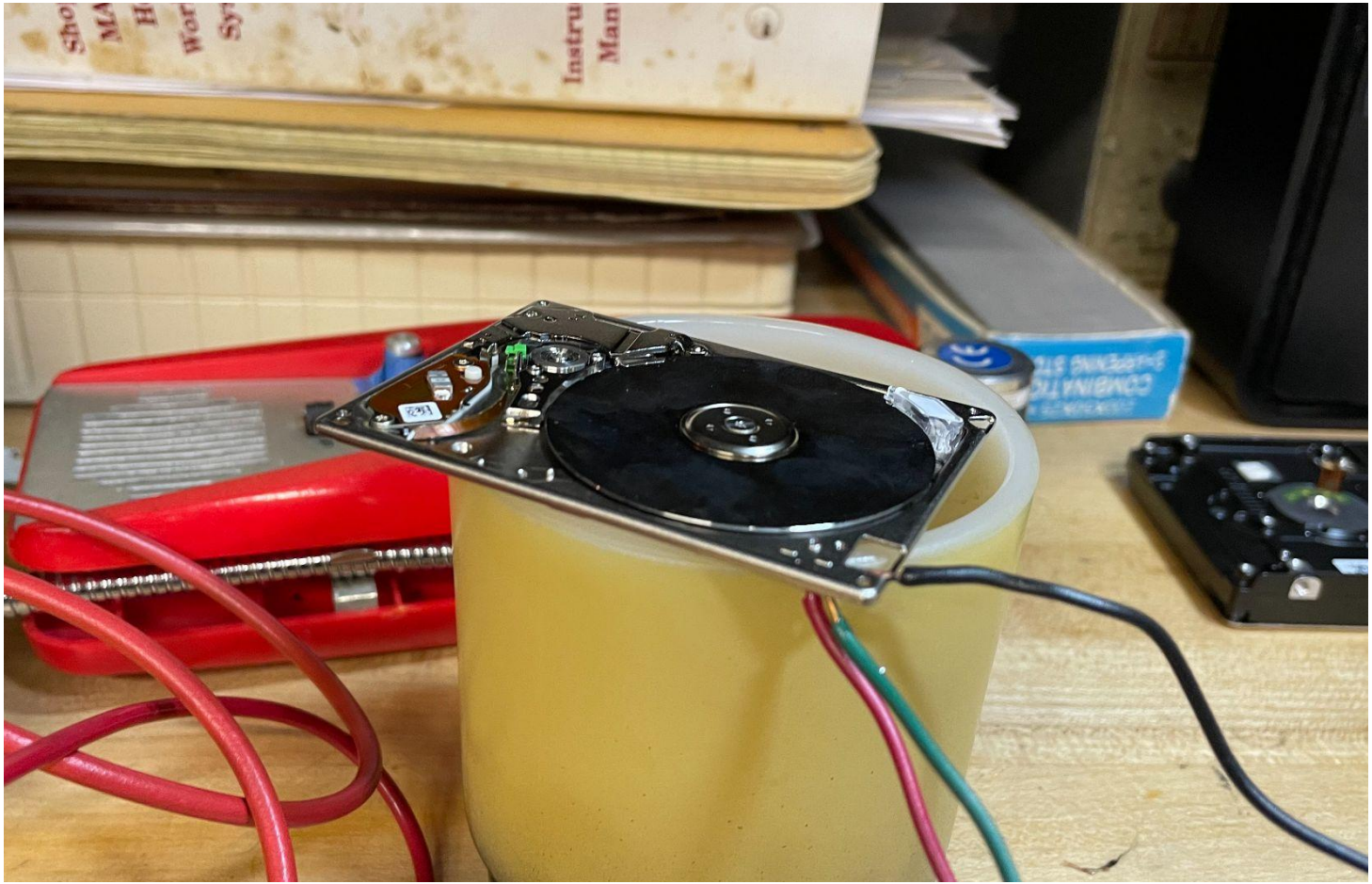
Plan for the Upcoming Week:

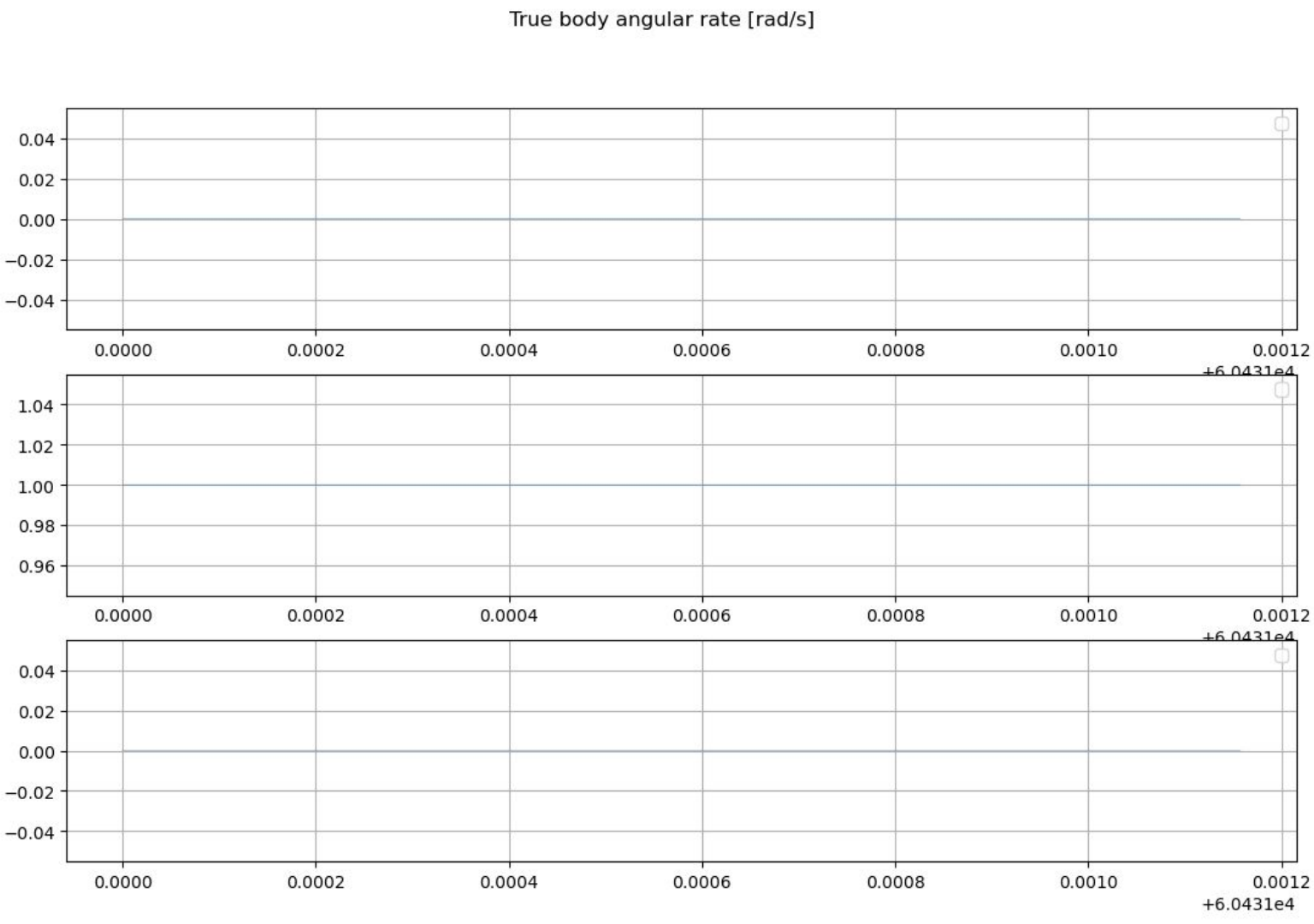
1. Design and simulate different spacecraft configurations.
2. Refine camera sensor model interface for vision to implement with landsat images.
3. Optimize / debug sluggish components/models.

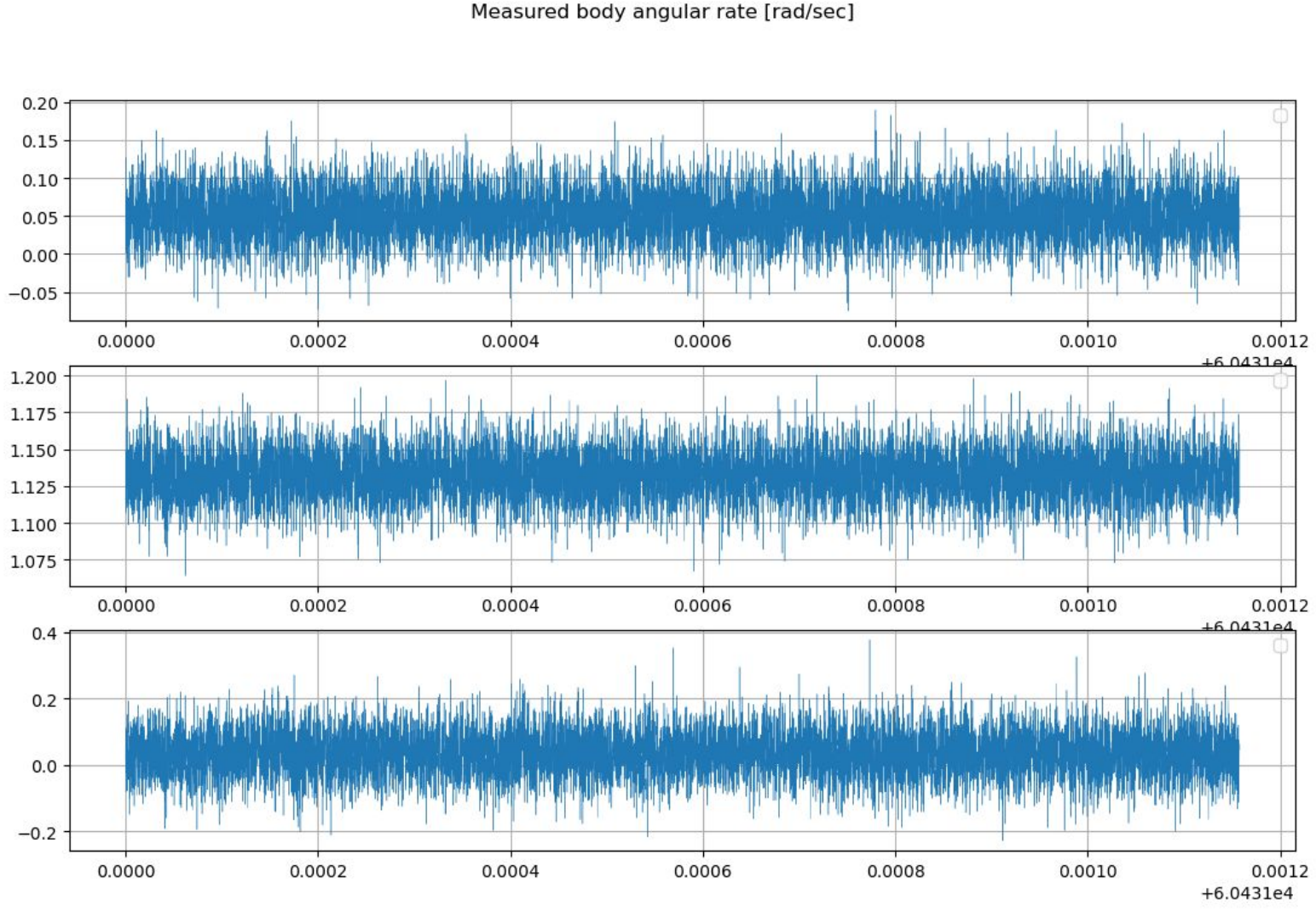
Interfaces:

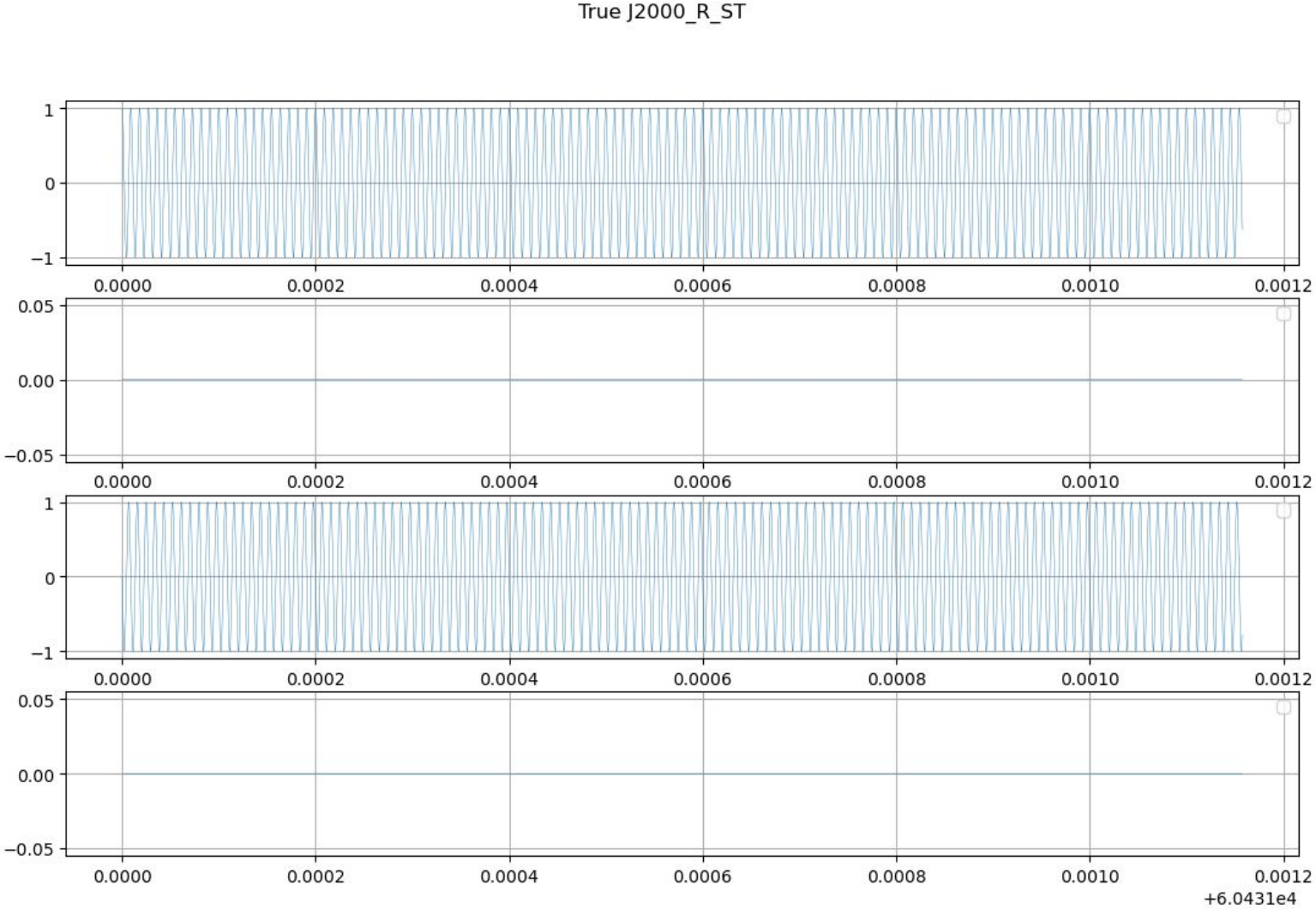
1. Mechanical: Custom reaction wheel design with more inertia?
2. Avionics: Can we afford a reaction wheel in our energy budget?
3. Vision: Camera specs and additional parameters for accurate correspondence generation and OD development?

Sensors: IMU, star tracker, light sensors (mech)
Actuators: RW, magnetorquer

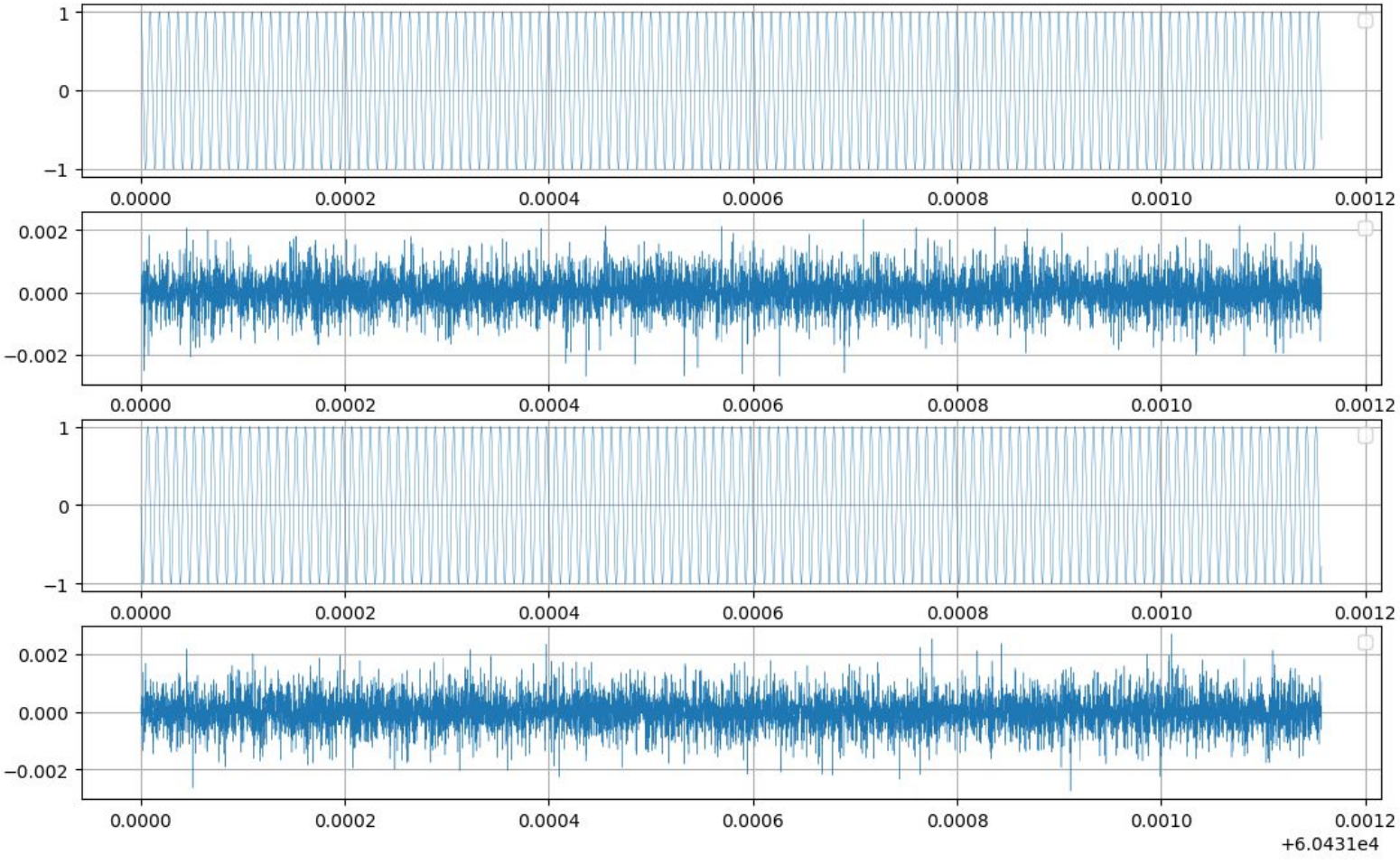


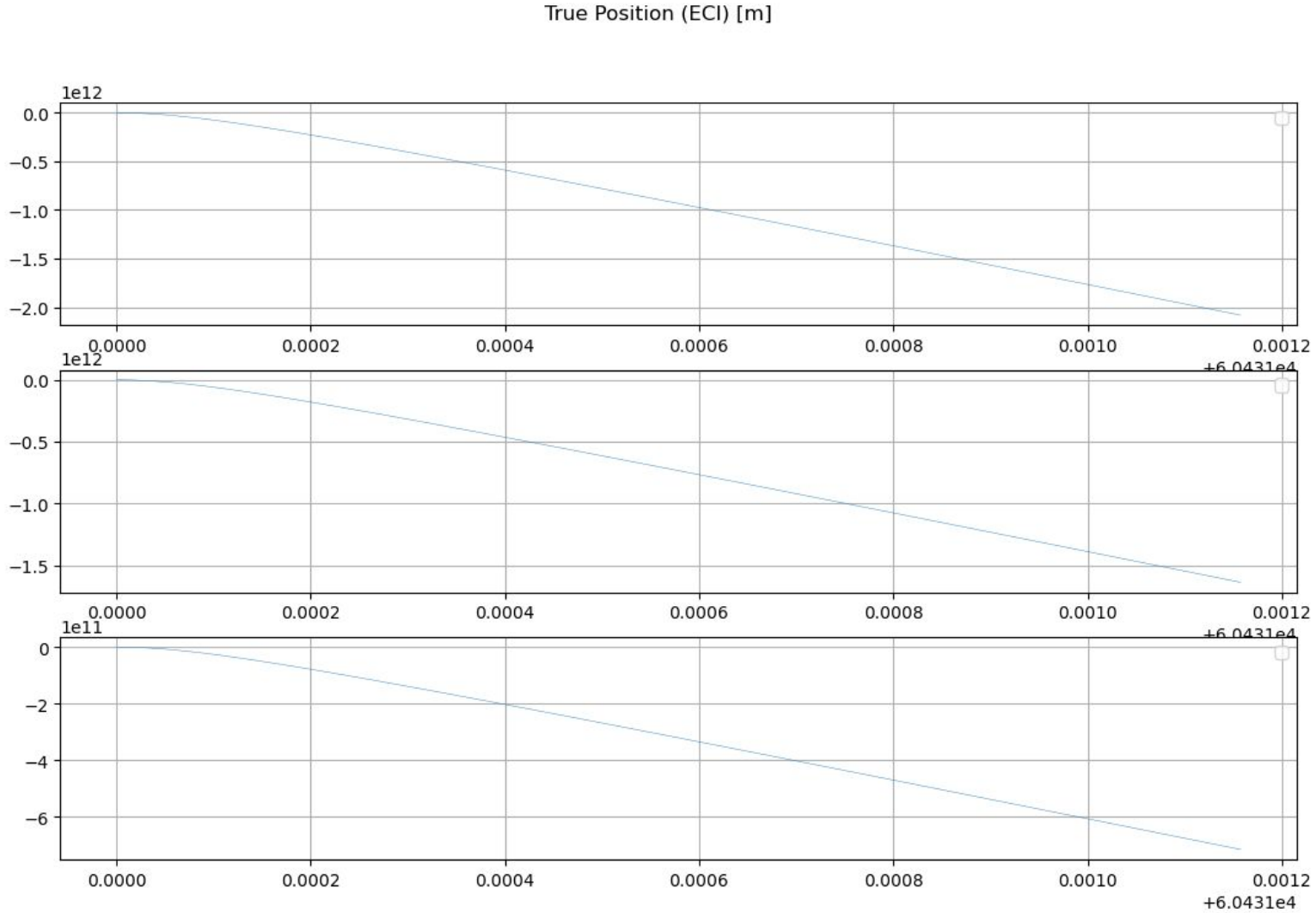

True body angular rate [rad/s]
0.04
0.02
0.00
−0.02
−0.04
0.0000
0.0002
0.0004
0.0006
0.0008
0.0010
0.0012
+6.0431e4
1.04
1.02
1.00
0.98
0.96
0.0000
0.0002
0.0004
0.0006
0.0008
0.0010
0.0012
+6.0431e4
0.04
0.02
0.00
−0.02
−0.04
0.0000
0.0002
0.0004
0.0006
0.0008
0.0010
0.0012
+6.0431e4

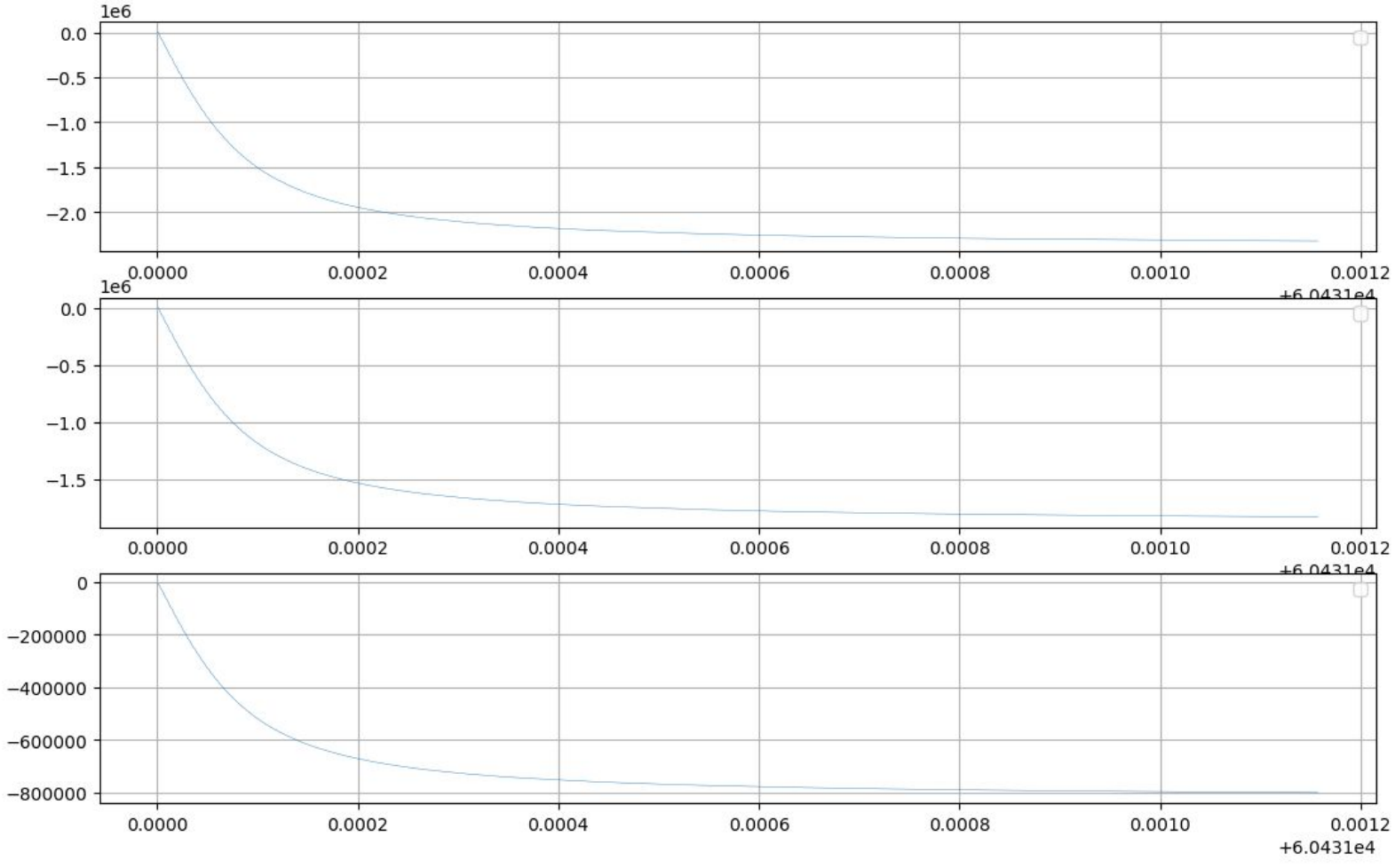

Measured body angular rate [rad/sec]
0.20
0.15
0.10
0.05
0.00
−0.05
0.0000
0.0002
0.0004
0.0006
0.0008
0.0010
0.0012
+6.0431e4
1.200
1.175
1.150
1.125
1.100
1.075
0.0000
0.0002
0.0004
0.0006
0.0008
0.0010
0.0012
+6.0431e4
0.4
0.2
0.0
−0.2
0.0000
0.0002
0.0004
0.0006
0.0008
0.0010
0.0012
+6.0431e4


True J2000_R_ST
1
0
−1
0.0000
0.0002
0.0004
0.0006
0.0008
0.0010
0.0012
0.05
0.00
−0.05
+6.0431e4

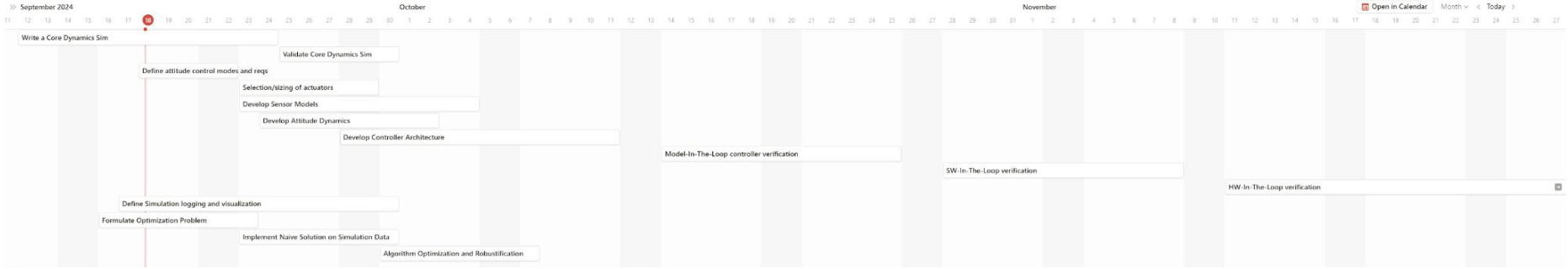
Measured J2000_R_ST




True Position (ECI) [m]
1e12
0.0
−0.5
−1.0
−1.5
−2.0
0.0000
0.0002
0.0004
0.0006
0.0008
0.0010
0.0012
1e12
0.0
−0.5
−1.0
−1.5
+6.0431e4
1e11
0
−2
−4
−6


True Velocity (ECI) [m/s]
1e6
0.0
−0.5
−1.0
−1.5
−2.0
0.0000
0.0002
0.0004
0.0006
0.0008
0.0010
0.0012
1e6
+6.0431e4
0.0
−0.5
−1.0
−1.5
0.0000
0.0002
0.0004
0.0006
0.0008
0.0010
0.0012
+6.0431e4
0
−200000
−400000
−600000
−800000
0.0000
0.0002
0.0004
0.0006
0.0008
0.0010
0.0012
+6.0431e4

Timeline



Name	Date	Sub-team
Implement GPS model in sim	October 12, 2024 → October 16, 2024	Simulation
Spec GPS	October 12, 2024 → October 16, 2024	Orbit Determination
Orbit Determination Ground Truth Alg (GPS)	September 23, 2024 → September 27, 2024	Orbit Determination
Spec AD sensors	October 7, 2024 → October 12, 2024	Attitude Determination
Implement AD sensor models in sim	October 7, 2024 → October 12, 2024	Attitude Determination, Simulation
Spec star tracker	September 28, 2024 → October 3, 2024	Attitude Determination
Star Tracker - Develop (find existing?) & test algorith	October 7, 2024 → October 12, 2024	Attitude Determination
Star Tracker - Develop Star Sim	September 28, 2024 → October 5, 2024	Attitude Determination, Simulation
Implement Attitude Determination Alg	October 7, 2024 → October 12, 2024	Attitude Determination
Derive & Formulate the Attitude Determination Alg	September 28, 2024 → October 5, 2024	Attitude Determination
Algorithm Optimization and Robustification	September 30, 2024 → October 7, 2024	Orbit Determination
Implement Naive Solution on Simulation Data	September 23, 2024 → September 30, 2024	Orbit Determination
Formulate Optimization Problem	September 16, 2024 → September 23, 2024	Orbit Determination
Selection/sizing of actuators	September 23, 2024 → September 29, 2024	Attitude Control, Attitude Dynamics
SW-In-The-Loop verification	October 28, 2024 → November 8, 2024	Entire Team
HW-In-The-Loop verification	November 11, 2024 → November 29, 2024	Entire Team
Model-In-The-Loop controller verification	October 14, 2024 → October 25, 2024	Entire Team
Define Simulation logging and visualization	September 17, 2024 → September 30, 2024	Simulation
Validate Core Dynamics Sim	September 25, 2024 → September 30, 2024	Simulation
Develop Actuator Models	September 23, 2024 → October 4, 2024	Simulation, Attitude Dynamics
Define attitude control modes and reqs	September 18, 2024 → September 22, 2024	Attitude Control, Mode Management
Develop Attitude Dynamics	September 24, 2024 → October 2, 2024	Attitude Dynamics
Write a Core Dynamics Sim	September 12, 2024 → September 24, 2024	Simulation, Attitude Determination
Develop Controller Architecture	September 28, 2024 → October 11, 2024	Simulation, Attitude Control

General Task Flow:

1. Problem Definition
2. Model-in-loop simulations - Mid October
3. Software-in-loop simulations - November
4. Hardware-in-loop simulations - Mid November