The Terra Nova Project

Flight Readiness Review

NASA USLI

FSU Panama City Senior Design Rocket Team:

Krieg Conrad, Case Dyer, Austin Zaal, Jonathan Serbest, Matthew Wilson, Jayden Duarte

ROCKET TEAM MEMBERS

KRIEG CONRAD

Team Lead

Oversees project schedule, subsystem integration, finances, hardware acquisition, deliverables, and overall rocket construction.

JONATHAN SERBEST

Safety Officer

Develops and enforces safety procedures, ensures compliance with NASA/NAR/TRA codes, and oversees all hazardous material handling and construction safety.

AUSTIN ZAAL

Recovery Officer

Designs, fabricates, and tests all recovery systems including parachutes, bulkheads, and avionics bay for both subscale and full-scale rockets.

ROCKET TEAM MEMBERS

CASE DYER

Payload System Officer

Leads design, fabrication, and testing of the HAUS payload system, including soil collection mechanisms, capsule integration, and airframe transitions.

MATTHEW WILSON

Electronics Officer

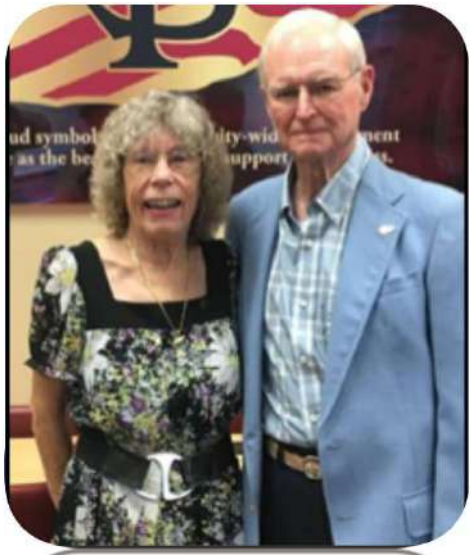
Designs and integrates avionics and payload electrical systems, ensuring redundancy, data integrity, and EMI-free operation.

JAYDEN DUARTE

Publications Officer

Manages outreach, social media, sponsor communication, and STEM engagement documentation for NASA deliverables.

A C K N O W L E D G M E N T S



Jim & Sandy Dafoe

Randy Hanna, EdD

Irvin Clark, EdD

FSU PANAMA CITY

A C K N O W L E D G M E N T S

FSU INSPIRE

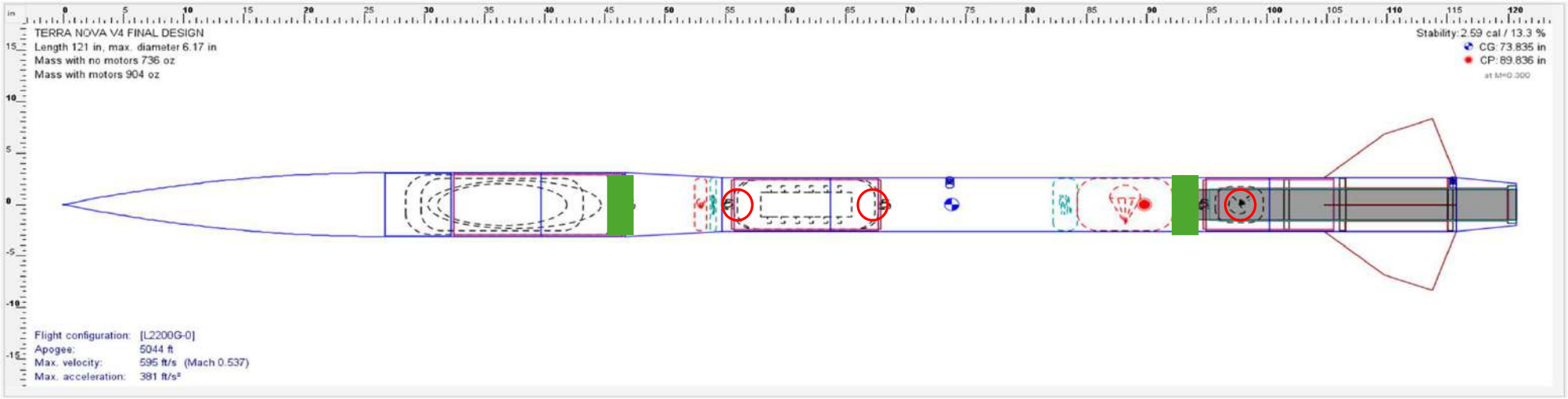
Coastal Machine & Supply, Inc.

ASTRO AMERICA

MARITECH

VEHICLE OVERVIEW

VEHICLE DIMENSIONS

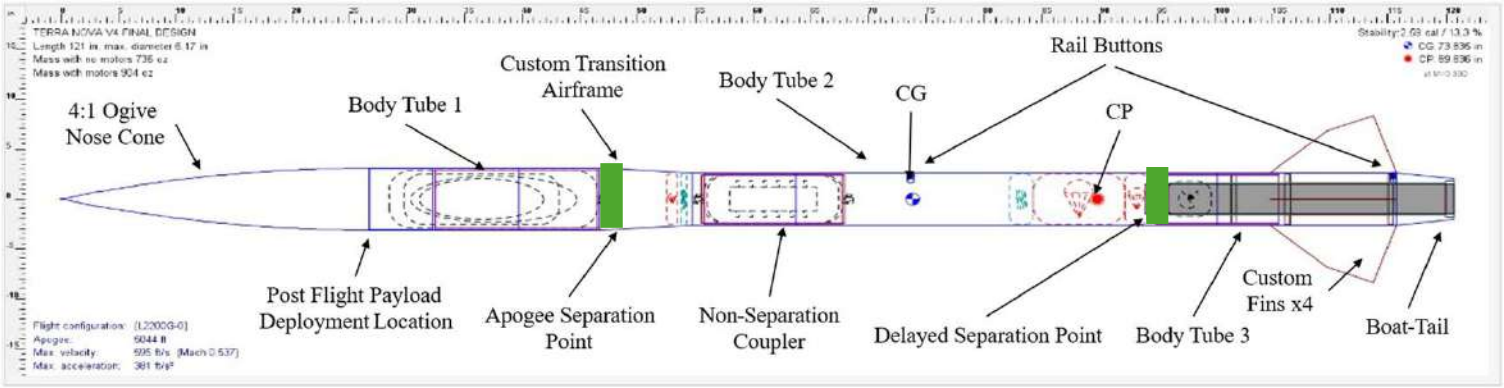


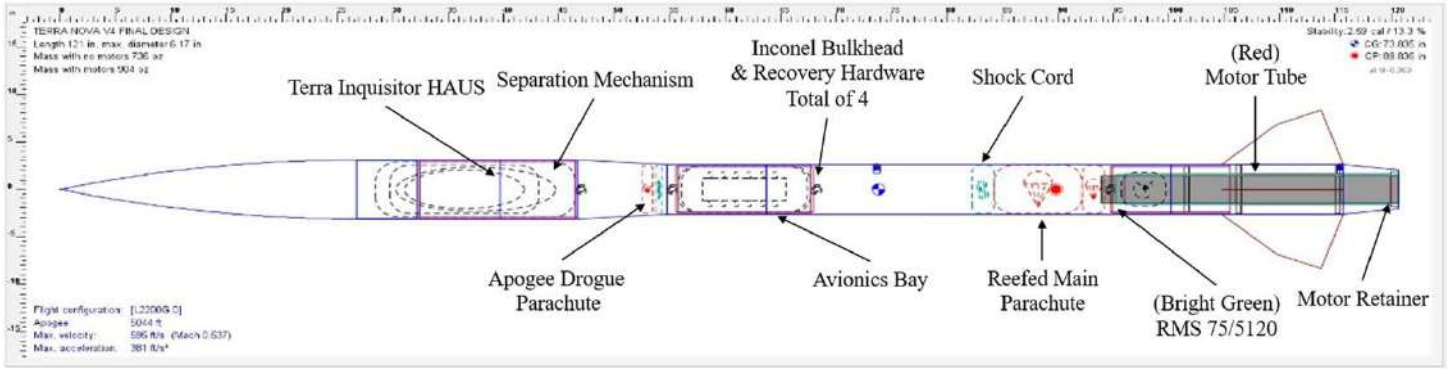
○ = Energetic Location

▮ = Separation Location

Vehicle Dimensions			
Section	**External Length**	**Landing Section Lengths**	**ID**
HAUS	39.75”	46.7”	6”
Avionics	60.5”	60.5”	6”-5”
Propulsion	20.5	26”	5”
Total	121	N/A	6” and 5”

KEY DESIGN FEATURES





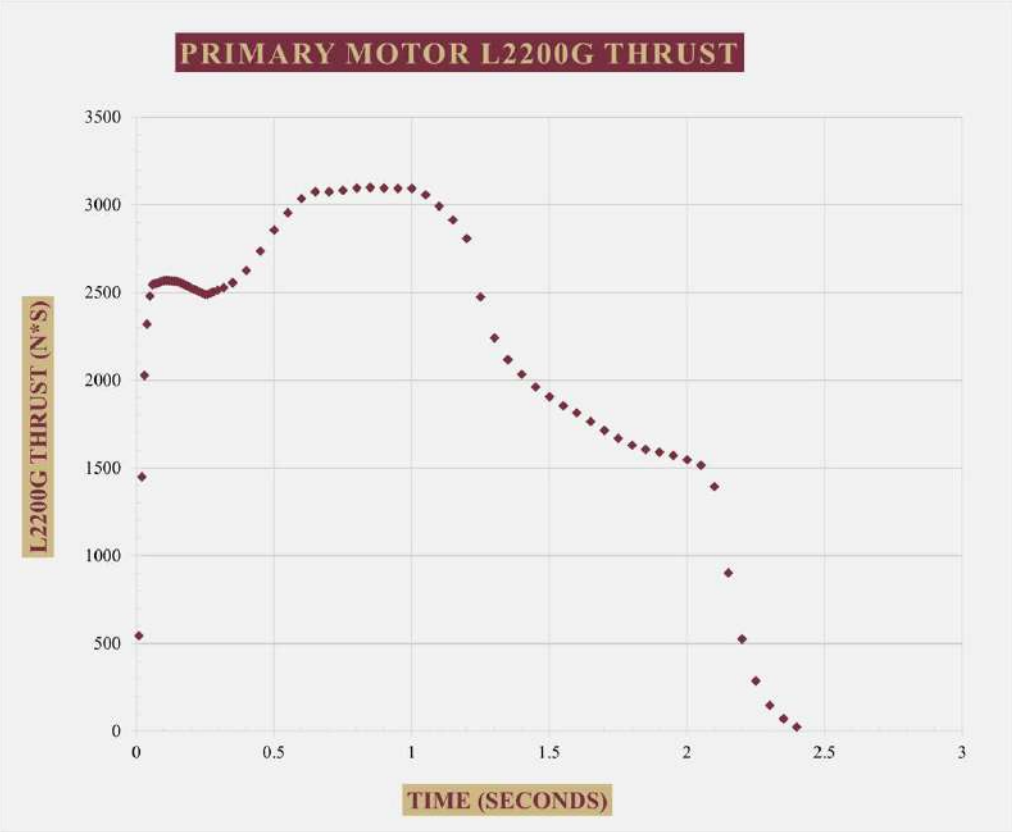
LAUNCH VEHICLE PERFORMANCE

MOTOR PERFORMANCE

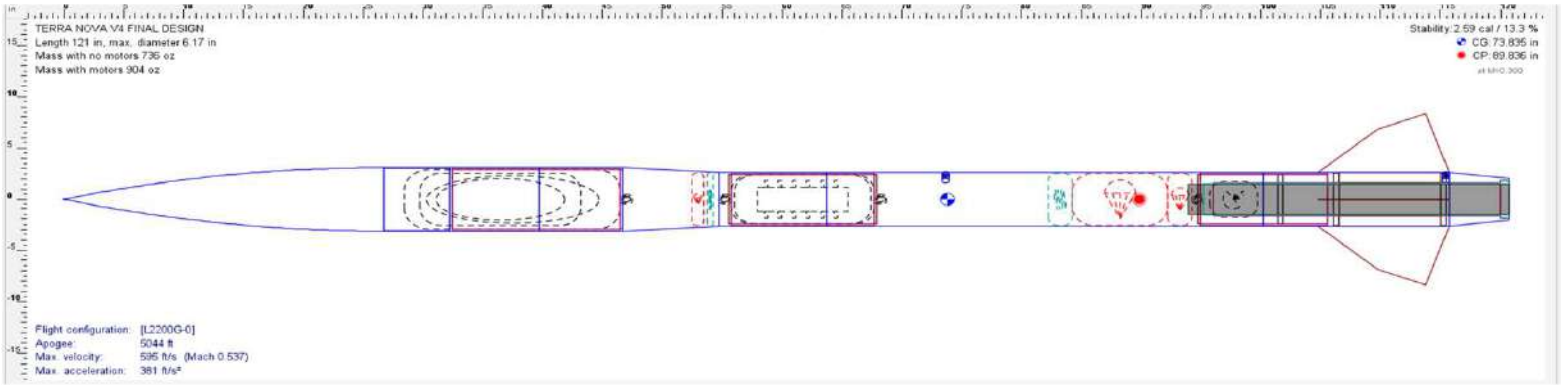
Motor Selection	
Primary Motor	**Secondary Motor**
L2200G-0	**L1420R-P**
Justification	
• Average Apogee of 4842 ft • Total Impulse: 5104Ns	• Average Apogee of 3879 ft • Total Impulse: 4585 Ns

L2200G-0:

- Thrust to weight ratio: 8.89:1.0
- Maximum Thrust: 3099 N
- Average thrust: 2243 N

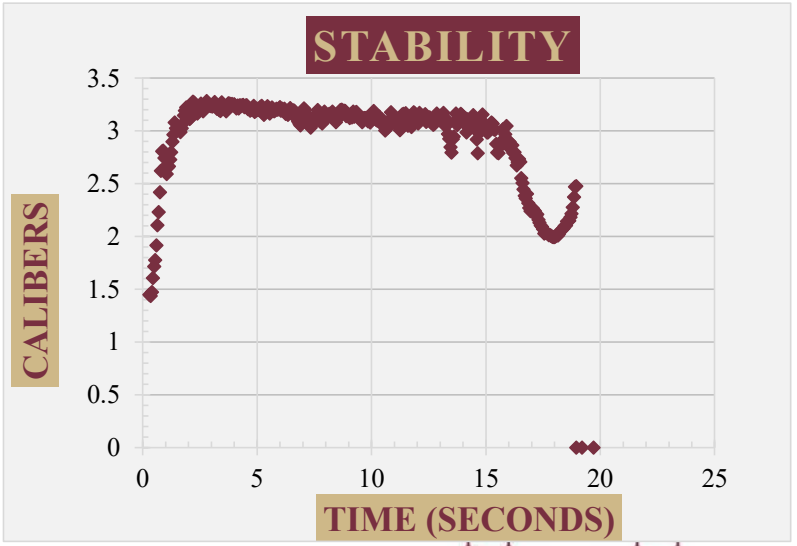


ROCKET STABILITY

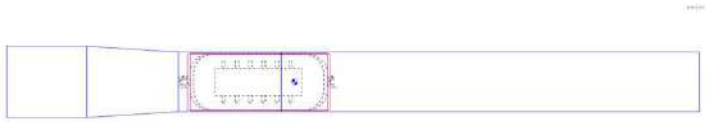
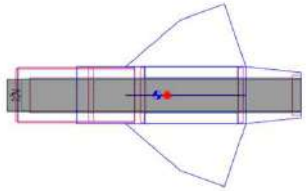


Stability (Cal)		
Minimum	Maximum	Static Stability
1.5	3.3	2.59

CG: 73.835” AFT
CP: 89.836” AFT



MASS STATEMENT

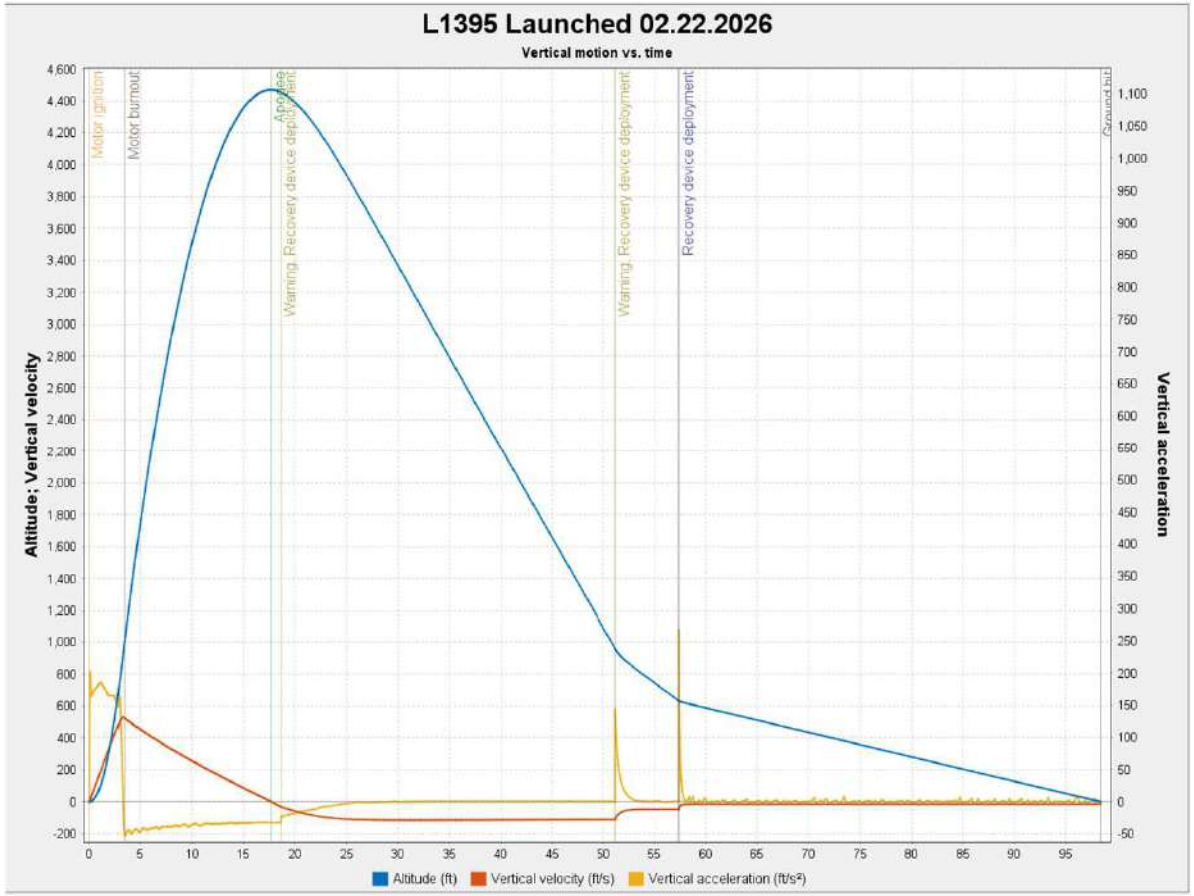
HAUS SECTION	AVIONICS SECTION	MOTOR SECTION
		
Landing Mass: 254 oz	Landing Mass: 223 oz	Landing Mass: 268 oz
Mass On Launch Pad: 254 oz	Mass On Launch Pad: 279 oz	Mass On Launch Pad: 371 oz

VDF FLIGHT 1 PREDICTED PERFORMANCE

Predicted Performance		
Apogee	**Descent Time**	**MAX Impact Energy**
4469 ft	81.3s	122.33 ft-lbs
Velocity off Rod	**Landing Vel**	**Heaviest Section**
58.9 ft/s	22.8 ft/s	19.5 lbs

Prediction Notes

- High impact prediction due to ballast weight
- Ballast weight used to account for Inconel bulkheads
- Ballast weight placed in the nosecone – high heaviest section
- Flight 2 will follow the traditional model

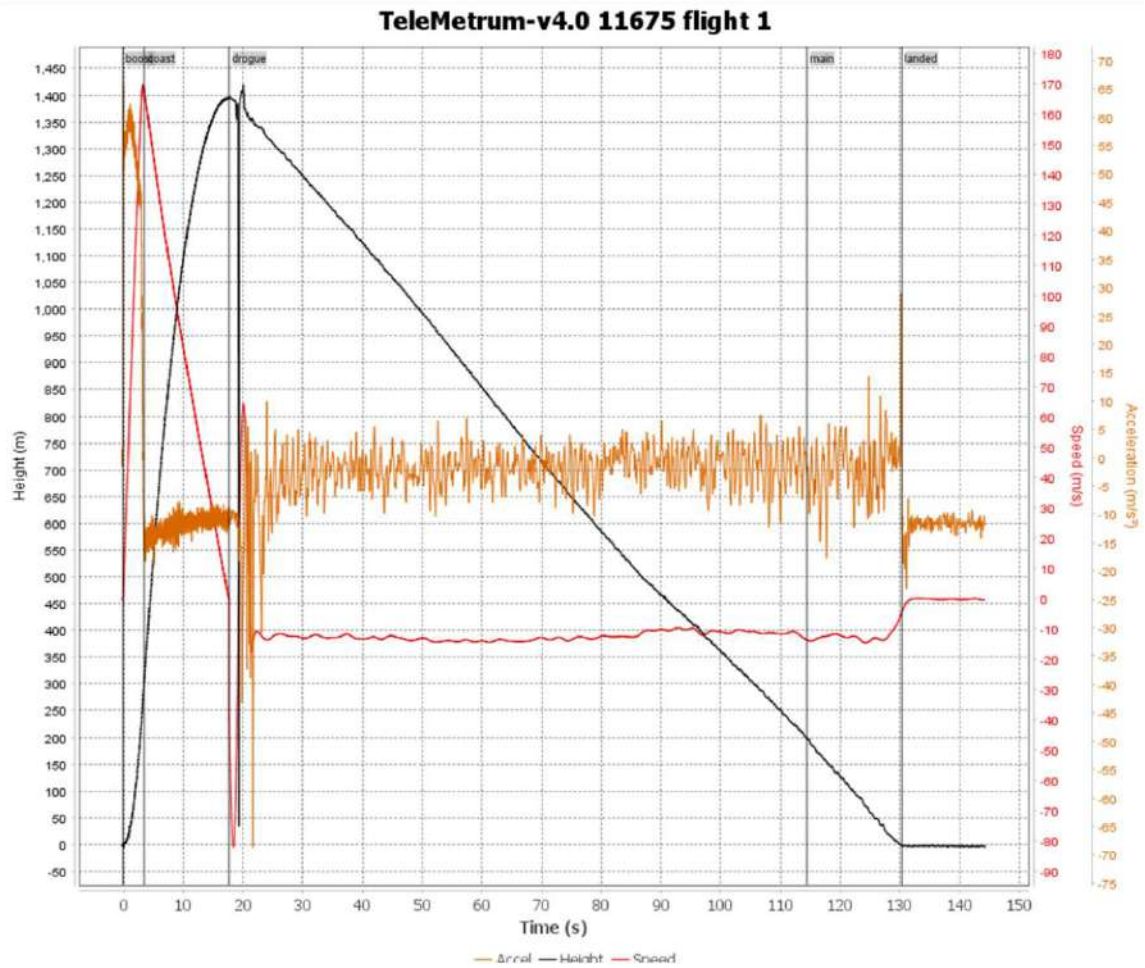


V D F F L I G H T 1

T E R R A N O V A

Key Data		
Apogee	**Descent Time**	**MAX Impact Energy**
4564 ft	111.7 s	638.76 ft-lbs
Velocity off Rod	**Landing Vel**	**Heaviest Section**
60 ft/s	45.9 ft/s	19.5 lbs
Flight Notes		

- Premature main separation
- Reef System failed to engage due to severed E-Match
  - E-match was too short – oversight
  - High section weight due to ballast



FIRST VDF ATTEMPT 2/22/2026

- Rocket flight unsuccessful due to high impact energy & low off-rod velocity
- Inconel bulkheads were not in possession – forced to use plywood
- Significant ballast in nosecone to account for Inconel bulkheads – cause for high impact
- Reefing E-Match severed – led to failed engagement

CHANGES MADE TO VEHICLE

Bulkheads
- Initially plywood bulkheads
- Sufficient for launch; did not have Inconel
- Inconel will be available for VDF Flight 2

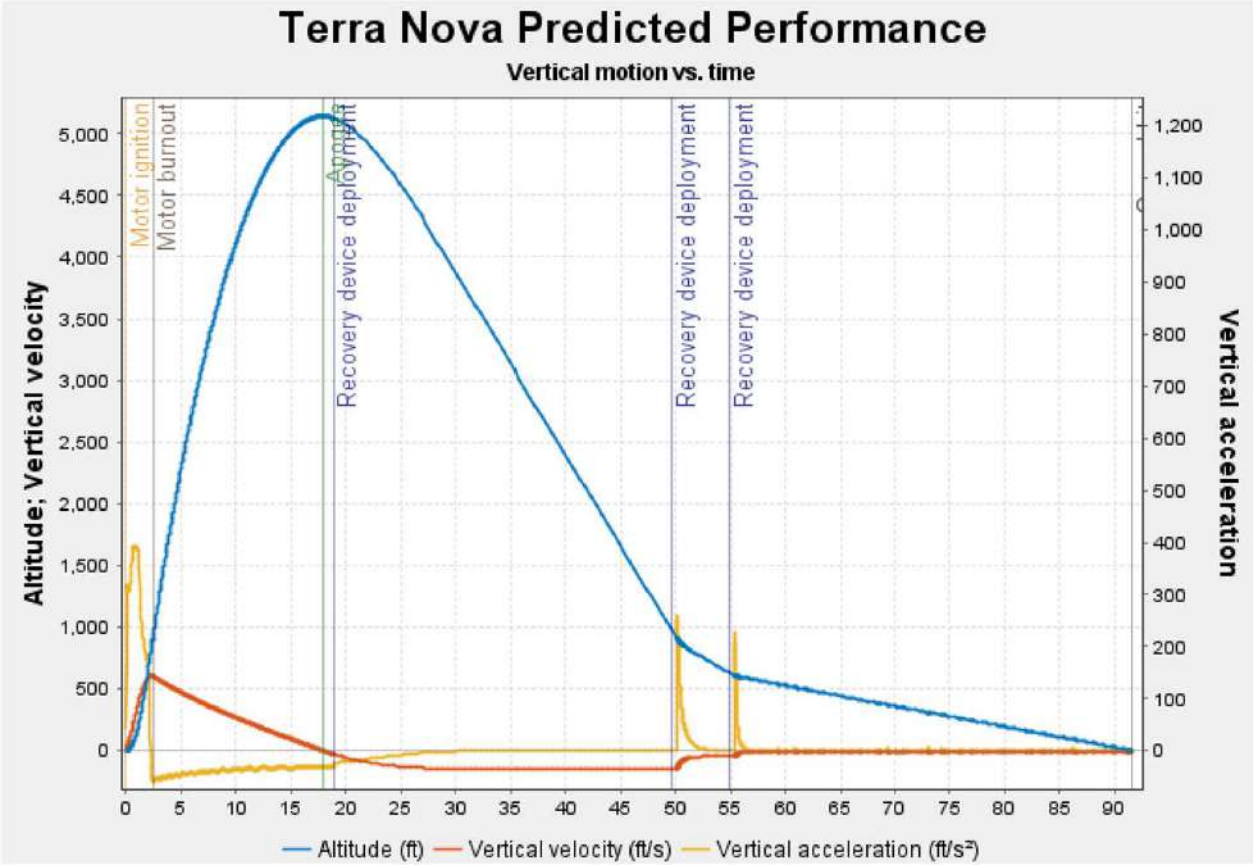
Airframe
- Camera added to AV bay to record flight
- Vehicle has been painted

Recovery
- E-Match to reef-cutter will be doubled in size
- E-Match to reef-cutter will employ better threading to device via running it up the shroud lines
- Extensive recovery testing to ensure no premature separation in VDF Flight 2

FLIGHT 2 PERFORMANCE PREDICATIONS

Predicted Performance		
Apogee	**Descent Time**	**MAX Impact Energy**
5021 ft	80.33 s	62.59 ft-lbs
Velocity off Rod	**Landing Vel**	**Heaviest Section**
77.3 ft/s	15.5 ft/s	16.76 lbs
Flight Notes		

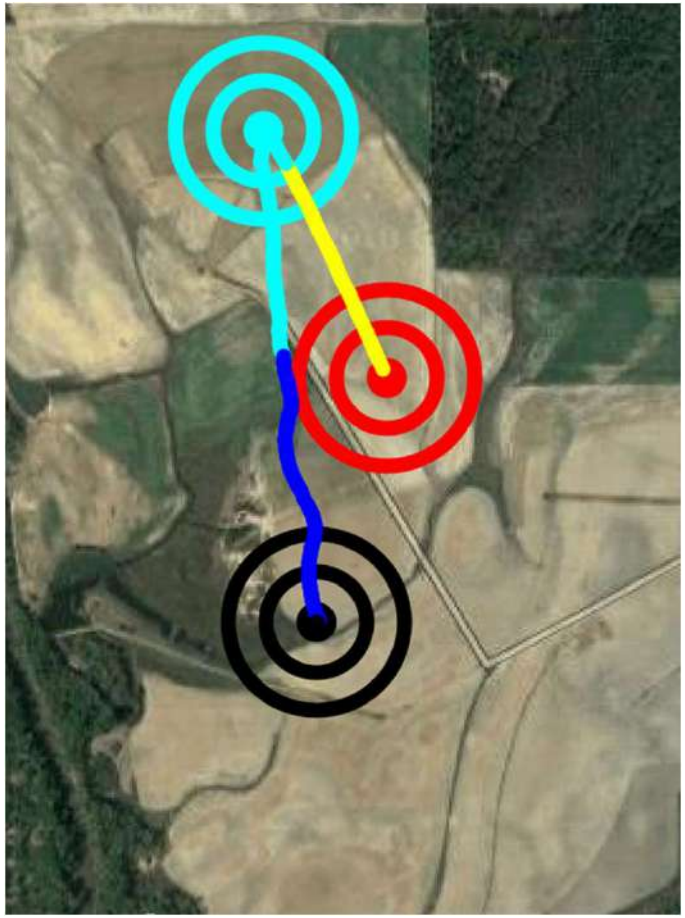
- Drogue at Apogee
- Reefed Main at 1000 ft
- Reef cut at 650 ft
- Highest Deployment Force: 315 lbs
- Wind speed: 11.7 ft/s
- Launch Angle: 5°



WIND DRIFT CALCULATIONS

Descent Drift			
5 ft/s Wind	10 ft/s Wind	15 ft/s Wind	20 ft/s Wind
402 ft	803 ft	1205 ft	1606 ft

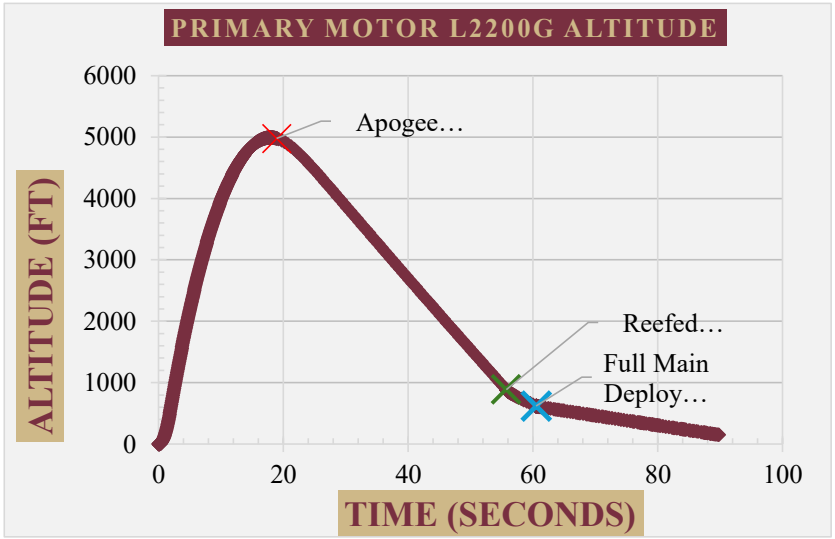
Descent Rates		
15” Drogue	36” Reef	120” Main
128 ft/s	49 ft/s	15.5 ft/s

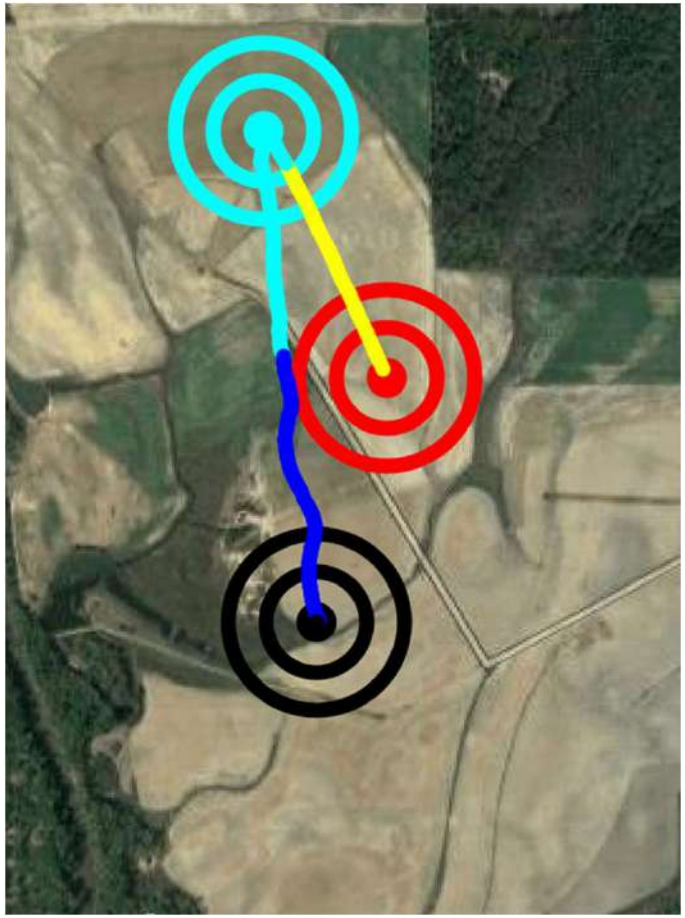


APOGEE: 5021 ft
DESCENT TIME: 80.3 s
All Descent Rates were recalculated based on VDF Flight 1;
- Cd calculated from flight data & used in calculations

APOGEE / WIND

Apogee Predictions			
5 ft/s Wind	10 ft/s Wind	15 ft/s Wind	20 ft/s Wind
5052 ft	5026 ft	5000 ft	4964 ft





R E C O V E R Y

PARACHUTE SELECTIONS

Drogue– Fruity Chutes 15” Drogue (1.5-1.6 Cd; 128 ft/s)

Main – Rocketman 120” Parachute (2.2 Cd; 15.5 ft/s)

Reefed Main – Main chute reefed to 36” (49 ft/s)

Rocketman 120” Parachute

Fruity Chutes 15” Parachute

Reefed Main Parachute

AVIONICS BAY

Flight Computer – Telemetrum & EZ Mini Computers

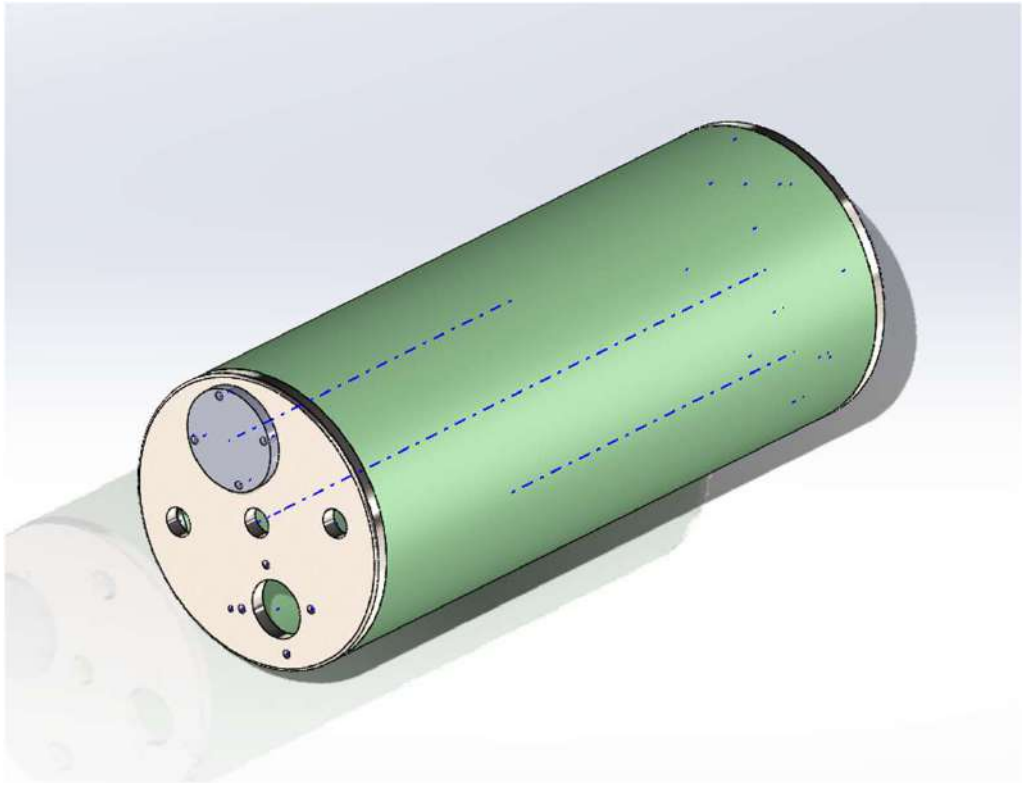
Power Supply – Energizer Ultimate Lithium 3.8V (L522)

Ejection System – TR Eagle CO_2 Ejection Device

Arming Device – Screw Switch

Material Makeup – 3D Printed Material (PETG)

Terra Nova AV Bay



AV Bay SOLIDWORKS Part

EJECTION SYSTEM

Two Stage Main Deployment
- Tinder Rocketry's Eagle CO_2 Ejection System
- 25g, 38g, 45g CO_2 canisters
- 2 each side, 1 for redundancy
- E-Matches to contained charge

Drogue Release
- Sep Body tube 1 & 2
- Event initiated at apogee +1s

Main Release
- Sep Body tube 2 & 3
- Event initiated at 1000 ft

TR Peregrine

TR Eagle

CO2 CARTRIDGE SIZING

Calculations
- 152 lbf required for separation
- Lowest ejection force estimated 483 lb
- Min 3.18 safety factor

Selected Sizes
- Primary Drogue: 25g
  - 1730 lbf
- Redundant Drogue: 38g
  - 2817 lbf
- Primary Main: 38g
  - 483 lbf
- Redundant Main: 45g
  - 620 lbf

Used 8g CO2 Canisters

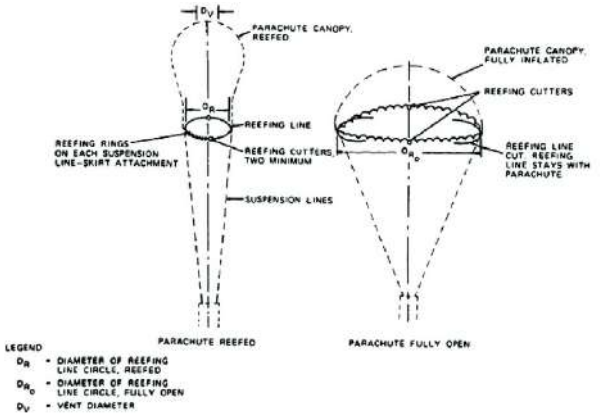
REEFING & CUTTING SYSTEM

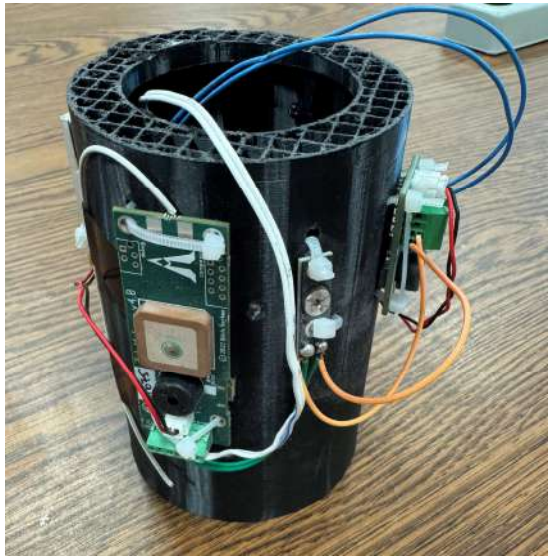
Two Stage Main Deployment

120” Parachute
- Deployed at 1000 ft
- Reefed to 36”
- Reef Cut after 650 ft

Initiation
- Isolated flight computer/power supply
- E-Matches to contained charge

Testing
- Several tests conducted to prove concept
- Successful demonstration in subscale flight 3 & VDF Attempt





RECOVERY TESTING

Several Deployment Tests Conducted

Main Separation
- 100% of tests showed success when properly conducted
- Only failures indicated when AV bay was inserted backwards FOR TESTING, & when improper cartridges were inserted
- Premature event in VDF flight 1, unknown cause

Drogue Separation
- 100% of tests showed success when properly conducted

Reef-Cutting
- All tests have seen proper device initiation & line cutting – VDF flight 1 failed

AVIONICS BAY COMPUTER CONFIGURATIONS

Flight Computer: Altus TeleMetrum

Redundant System: Altus EasyMini

Configuration Software: AltOS

Recovery Electronic Configurations			
Criteria	TeleMetrum	EasyMini	Reefing Computer
Mode	Dual Deployment	Dual Deployment	Single Deployment
Drogue	Apogee	Apogee	N/A
Main	1000 ft	1000 ft	650 ft
Location	AV Bay	AV Bay	Reef Bay
Arming	Screw Switch	Screw Switch	Screw Switch

TEST PLANS

Test ID	Objective	Variable(s)	Method	Status
LV-MAT-XX	Verify Material Properties are sufficient	Post-Processing, Load	Tension and Torsion Tests	Partially Complete
LV-DEP-XX	Verify reliable deployment	CO2 Canister sizing	Ground deployment Test	Complete
LV-AV-XX	Verify logic and wiring continuity	Arming state	Bench test & inspection	Complete
LV-SFT-XX	Identify failure modes	Flight Configuration	Flight test	Complete
LV-FFT-XX	Identify failure modes	Flight Configuration	Flight test	Partially Complete

LAUNCH VEHICLE REQUIREMENTS VERIFICATION

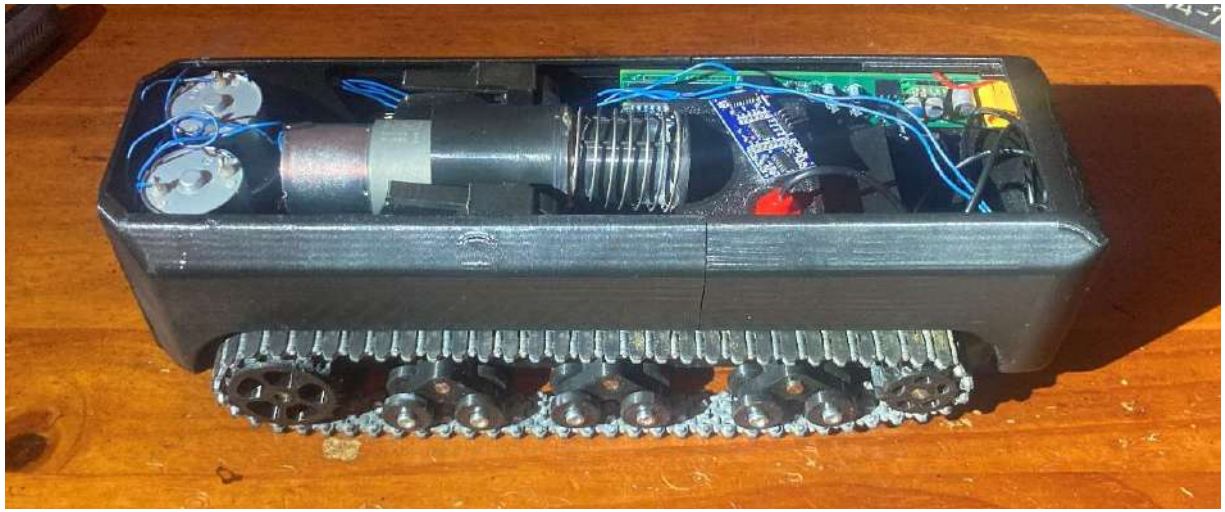
HANDBOOK DERIVED & TEAM DERIVED

Requirement	Implementation Plan	Method of Verification	Status
2.1 The vehicle shall deliver the payload to an apogee altitude between 4,000 and 6,000 feet AGL.	The vehicle was designed and simulated to achieve the declared target altitude within the required altitude band using the selected competition motor.	**Analysis + Test:** OpenRocket simulations and full-scale demonstration flight altimeter data.	Verified

Requirement	Justification	Method of Verification	Status
The Inconel 718 recovery bulkheads shall maintain a minimum factor of safety ≥ 5 against the predicted parachute deployment load of 1200 N.	The recovery bulkheads transfer parachute deployment loads to the airframe. Maintaining a sufficient safety factor ensures the structure can withstand recovery loads without failure.	**Analysis + Test:** Structural analysis combined with **Inconel material testing (LV-MAT-01)**.	In Progress

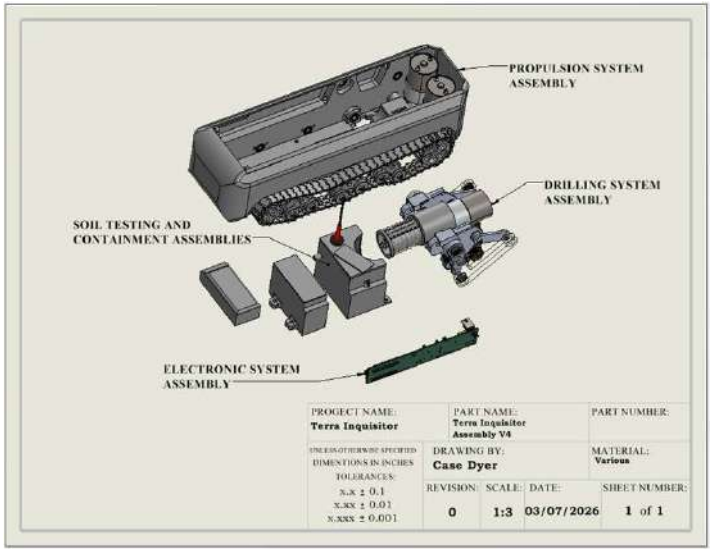
P A Y L O A D

OVERALL PAYLOAD DESIGN



Payload As Constructed

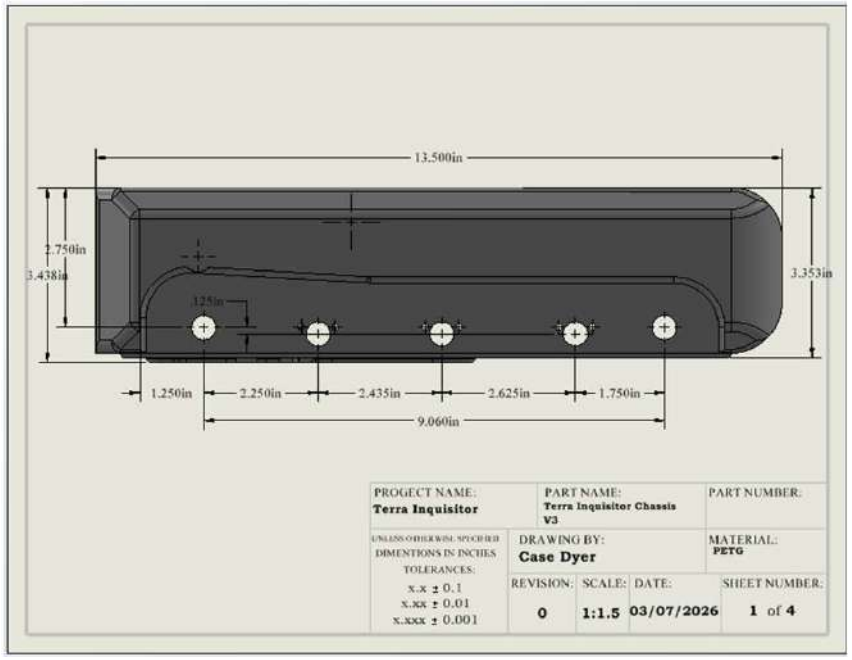
Length: 13.5”
Width: 4.92”

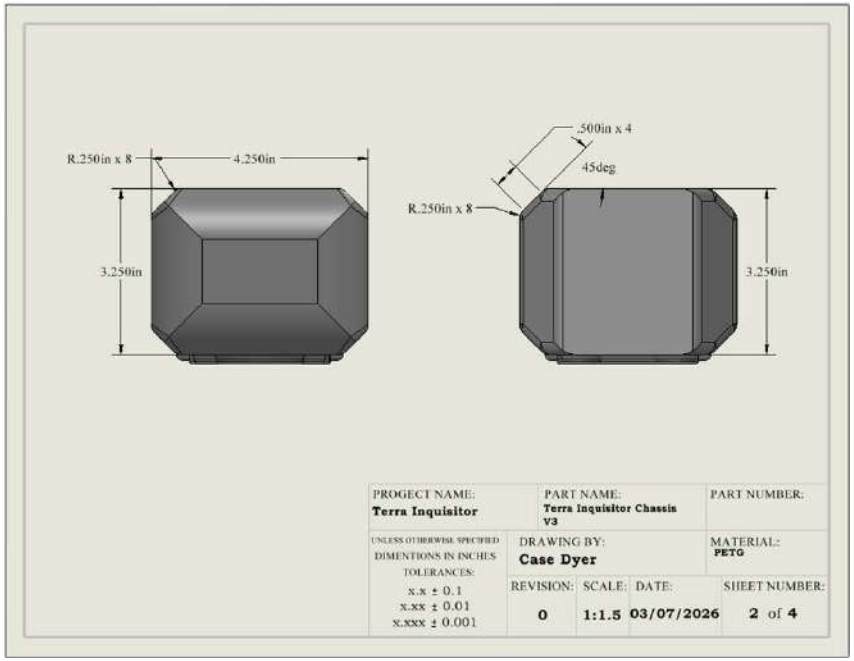


Payload Weight:

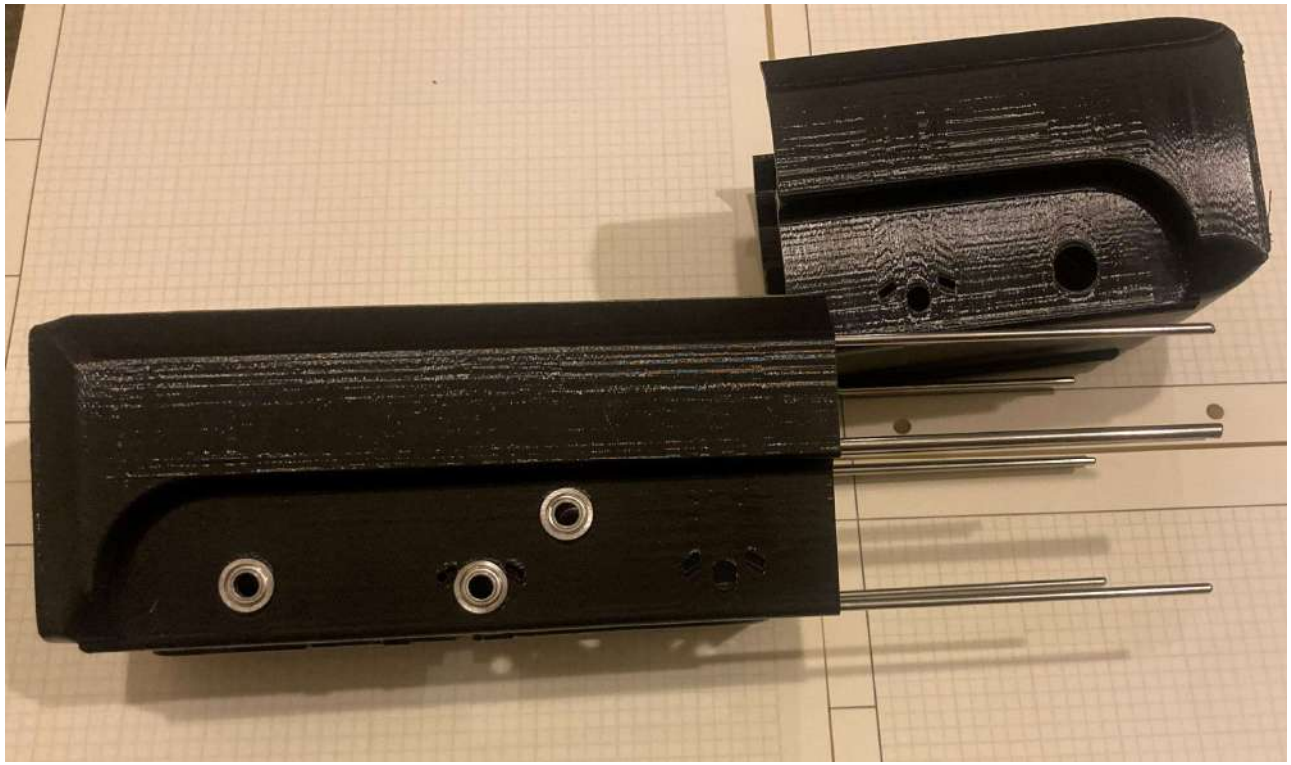
- 5.5 lb.

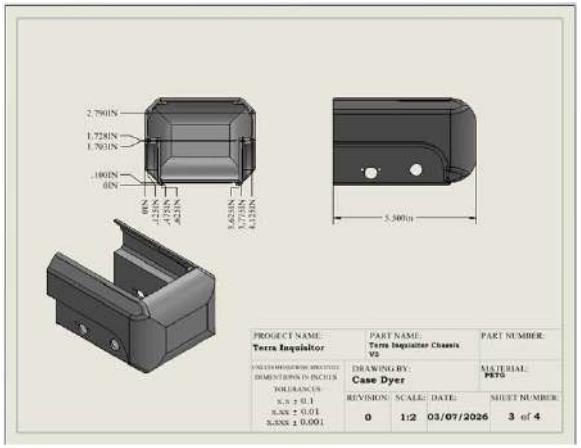
PAYLOAD CHASSIS DESIGN

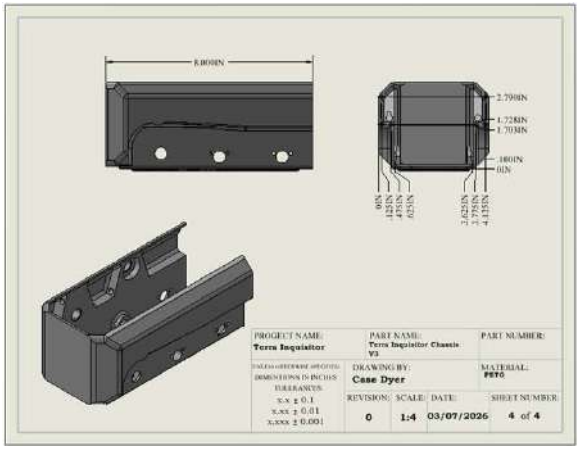




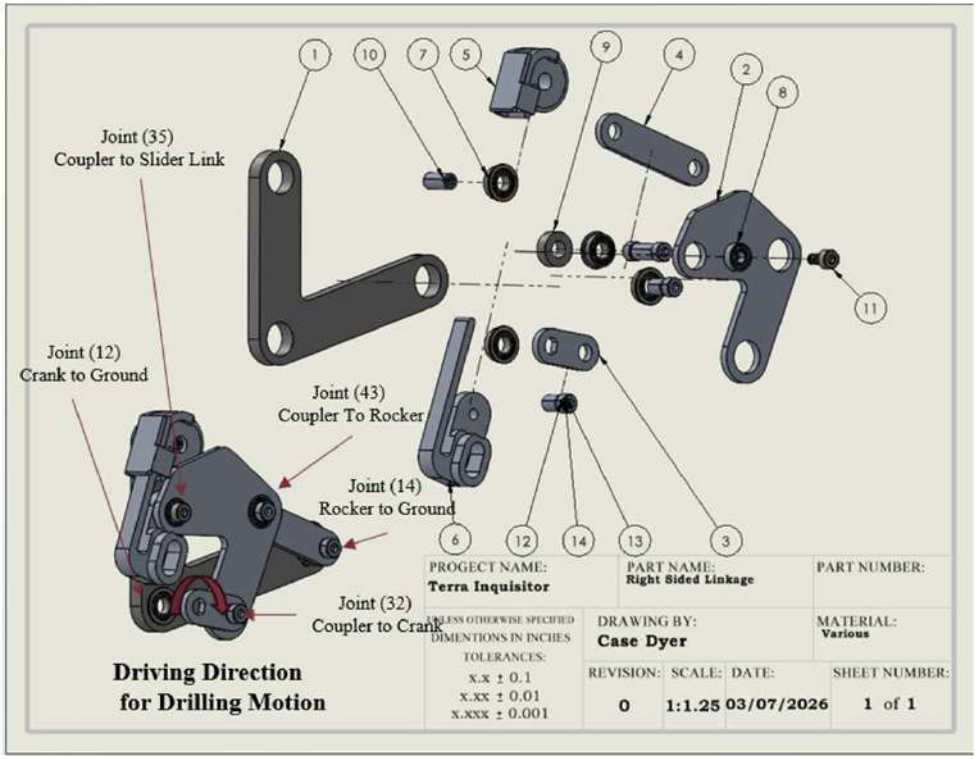
PAYLOAD CHASSIS DESIGN



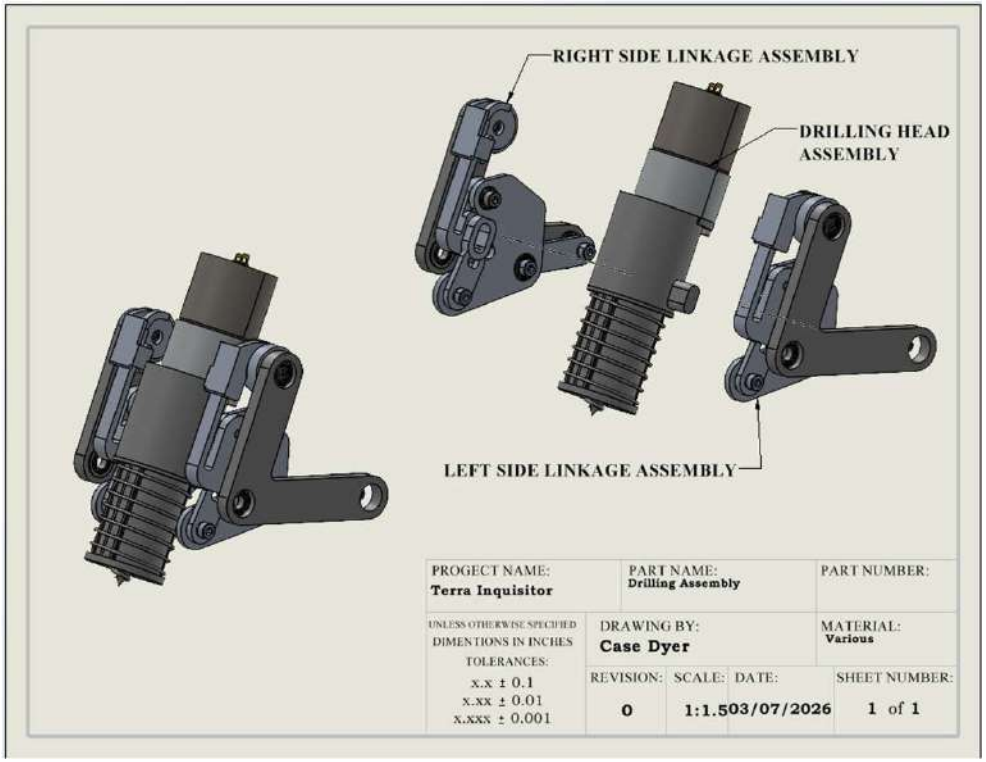




LINKAGE ASSEMBLY

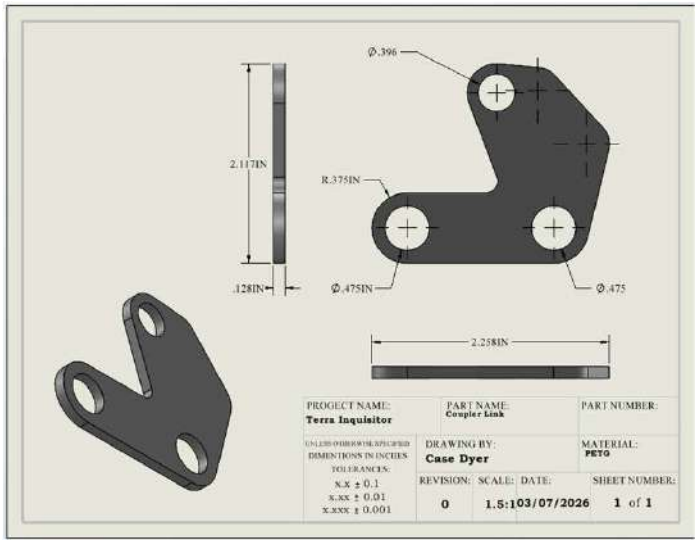


Right Side Drill Linkage Assembly



Drill Linkage Assembly

LINKAGE DIMENSIONS

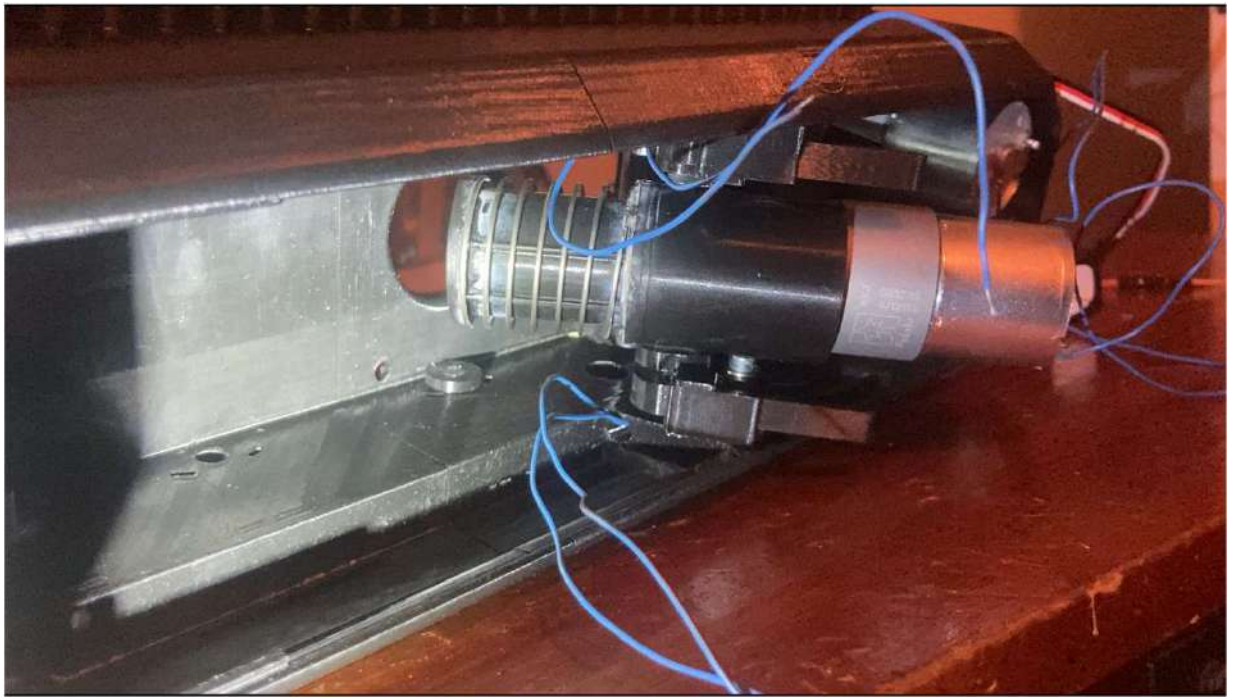


Coupler Drawing with Bearings

Gamma Angle of 67°

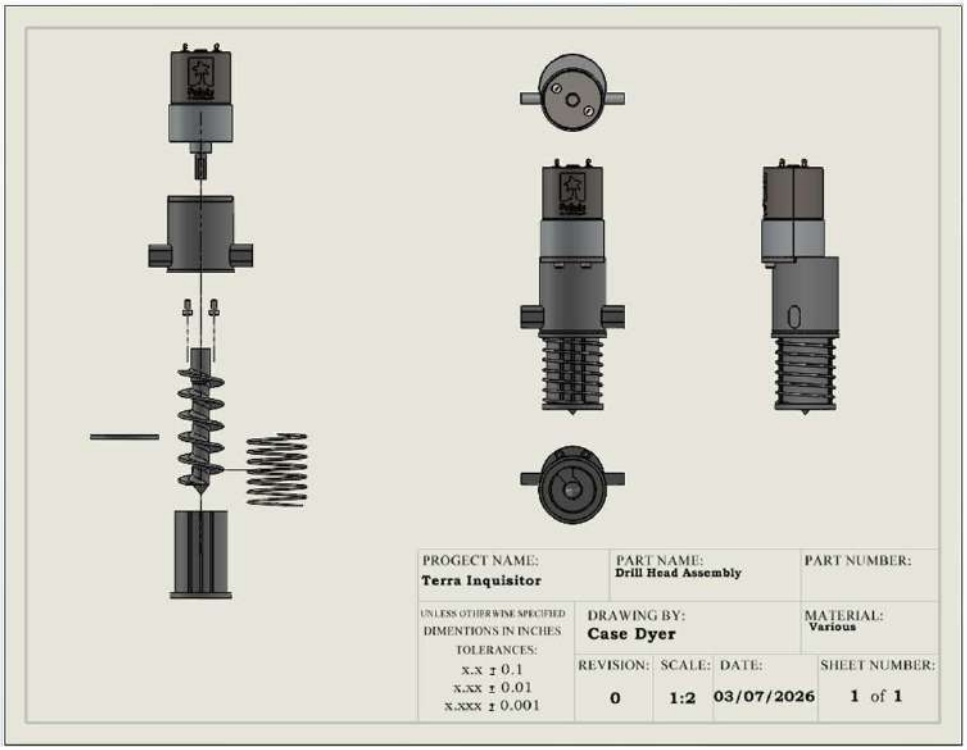
As Constructed

L I N K A G E D I M E N S I O N S

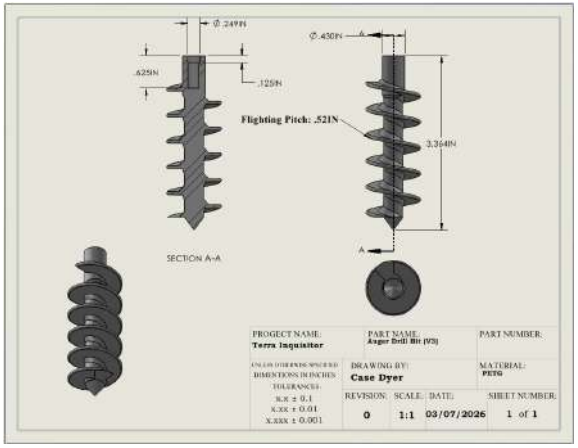


Drilling Assembly Operation Testing

DRILL ASSEMBLY

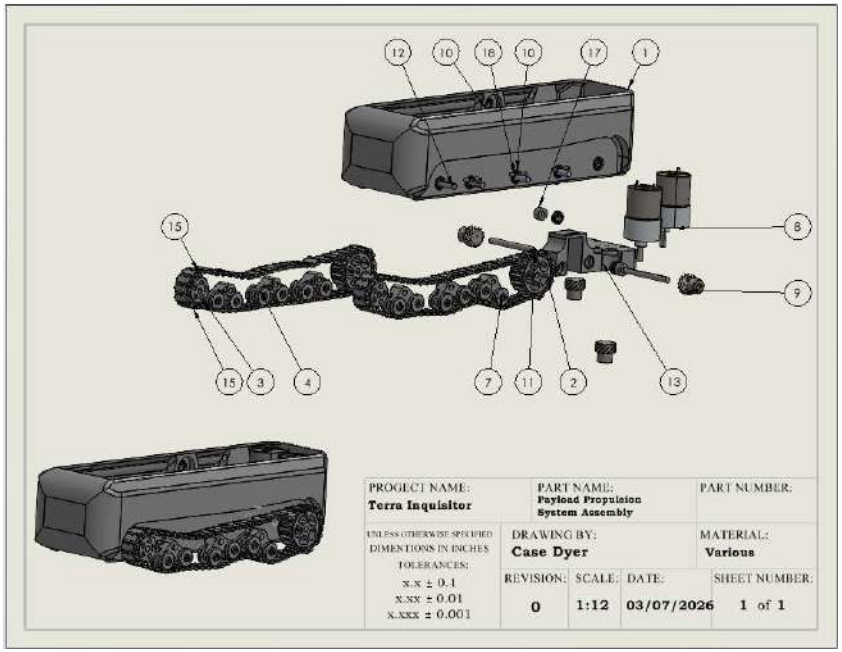


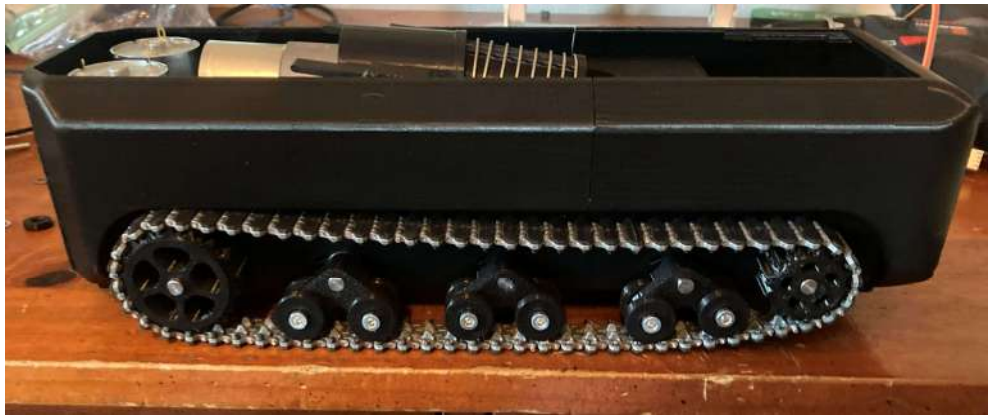
Drill Head Assembly



Terra Inquisitor Auger

PROPULSION SYSTEM

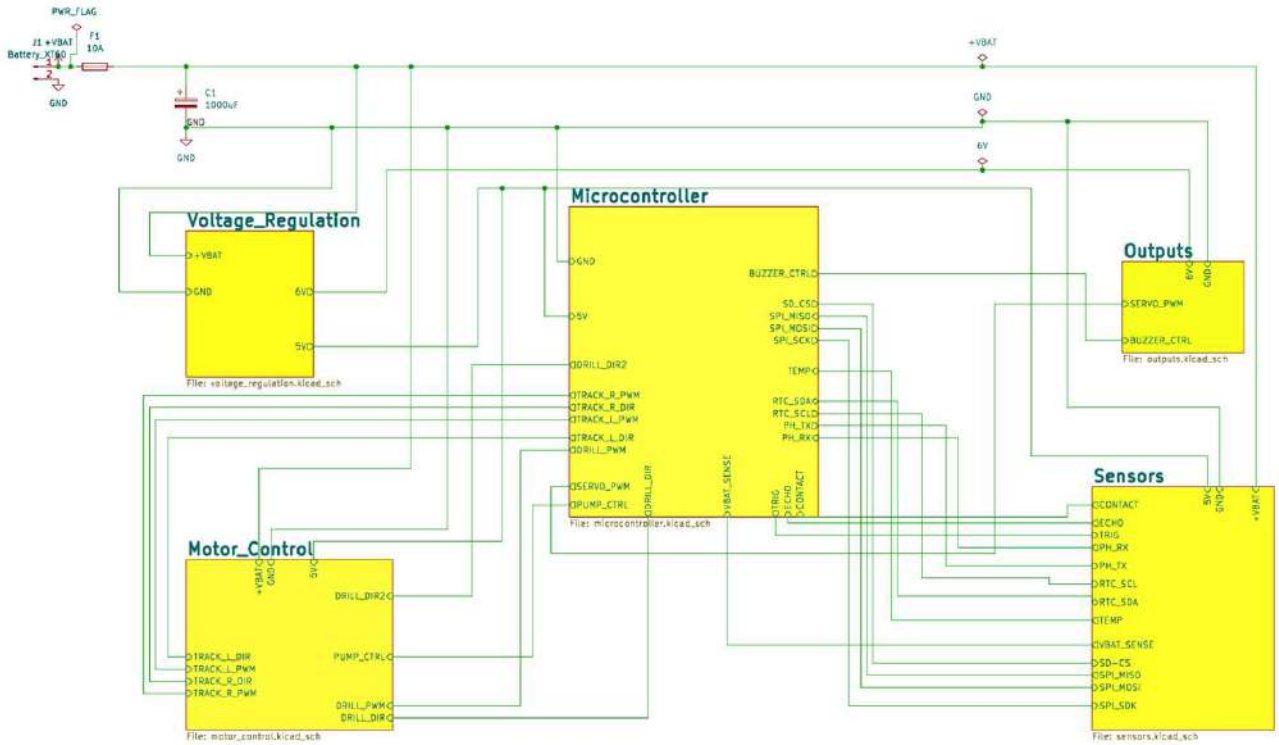




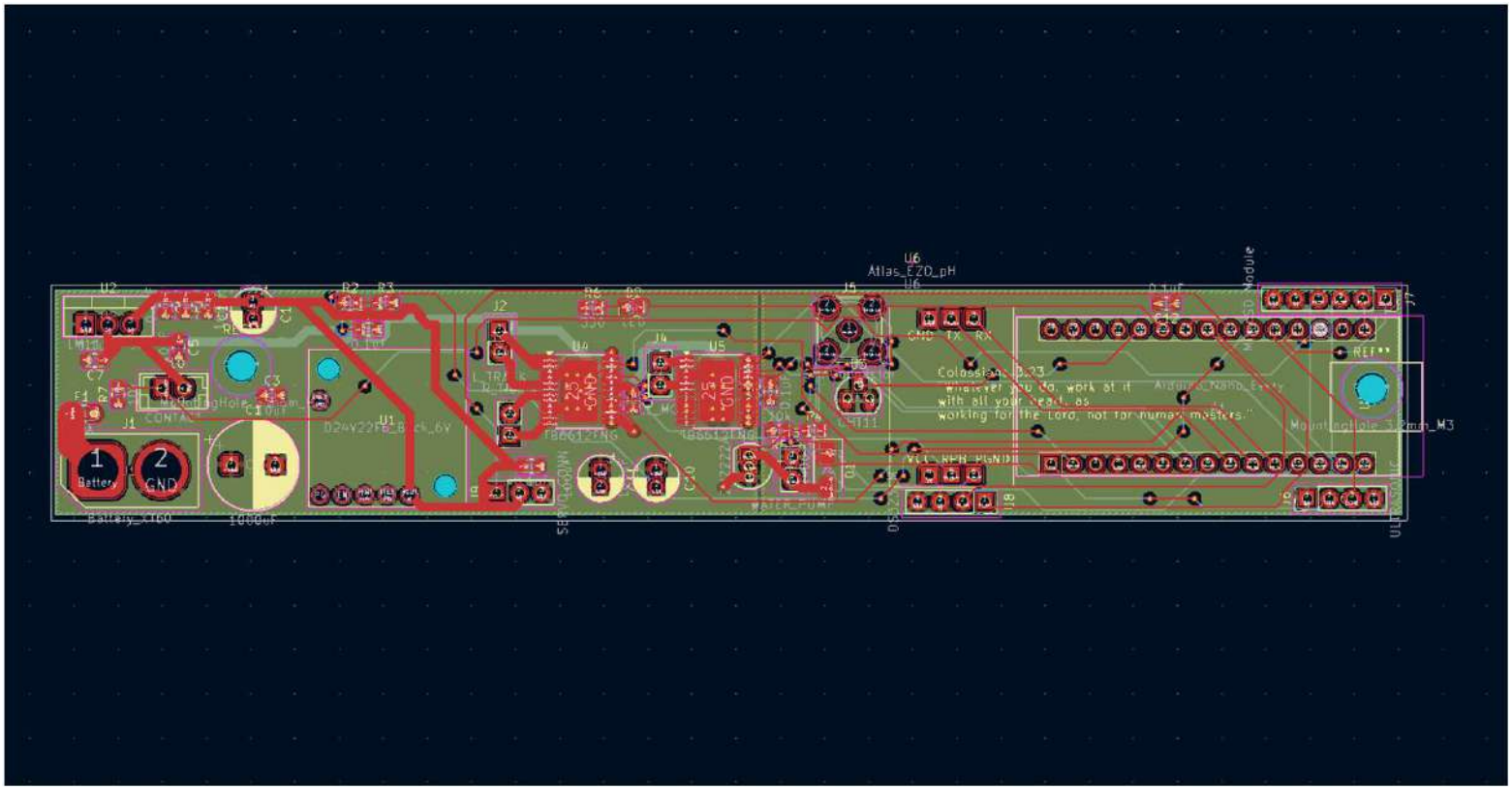
Payload Propulsion System Assembly and As Constructed Version

PAYLOAD ELECTRONIC SYSTEM

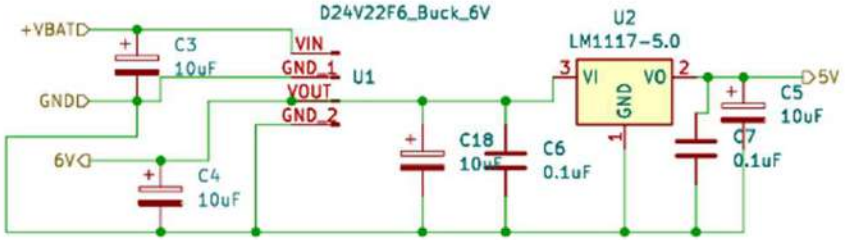
- Power System
- Development Board
- Motor Control
- Sensors
- Data Logging



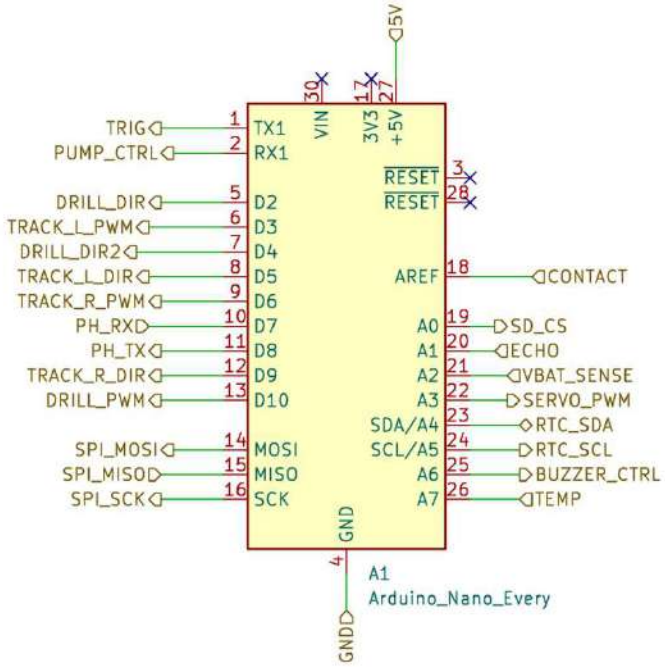
PAYLOAD ELECTRONIC PCB IMPLEMENTATION

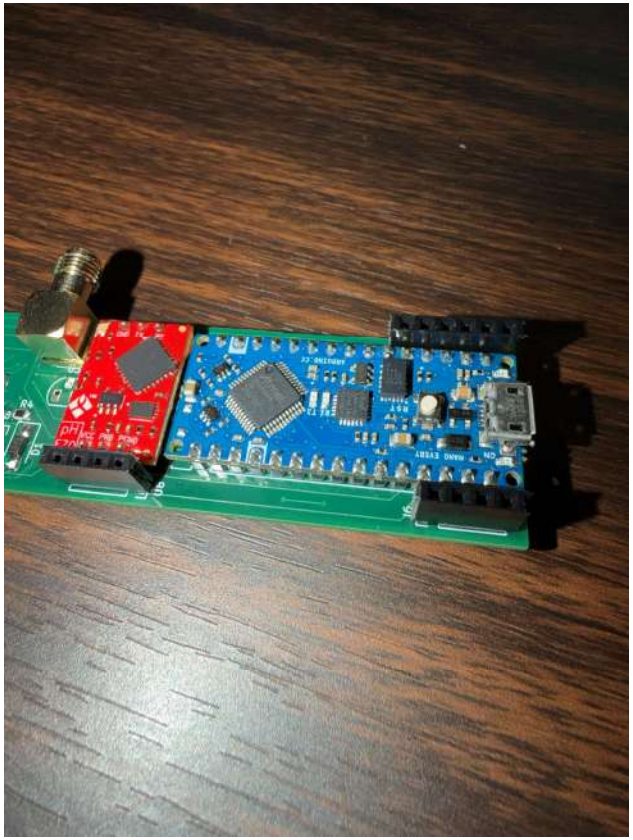


VOLTAGE REGULATION SYSTEM

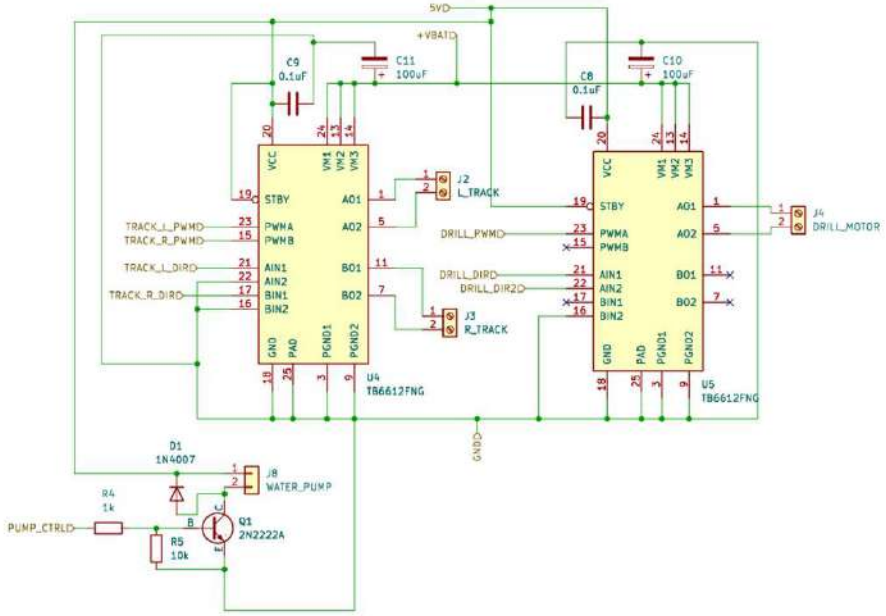


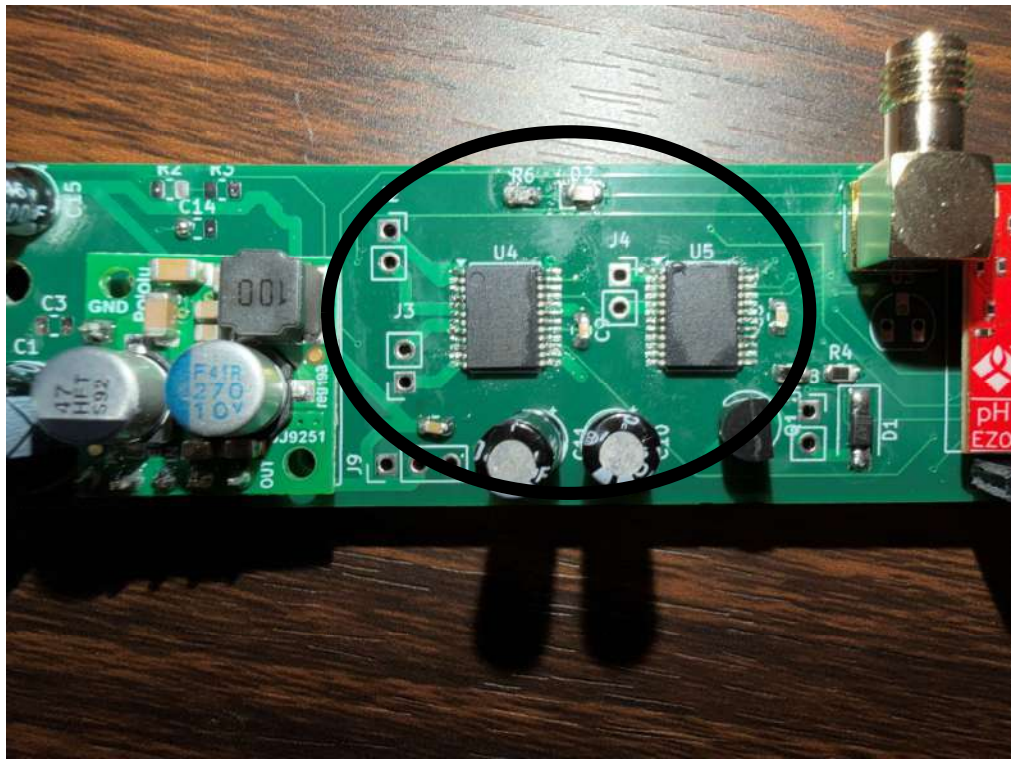
DEVELOPMENT BOARD IMPLEMENTATION



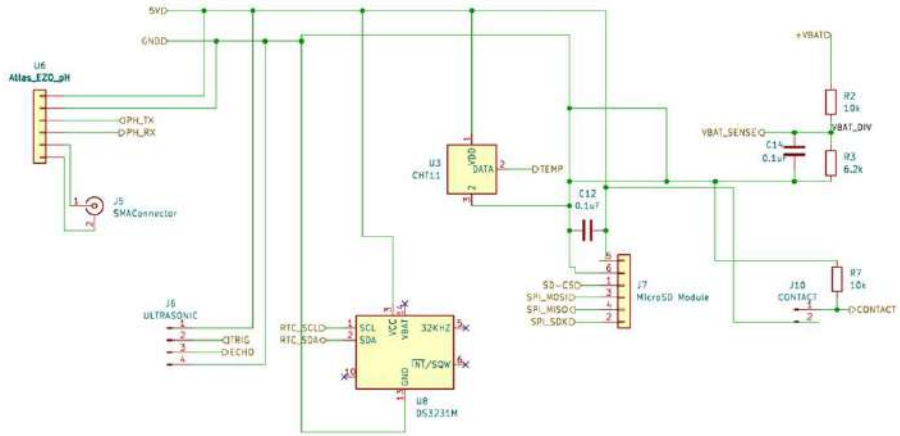


MOTOR POWER/CONTROL SYSTEM





SENSORS/PERIPHERALS



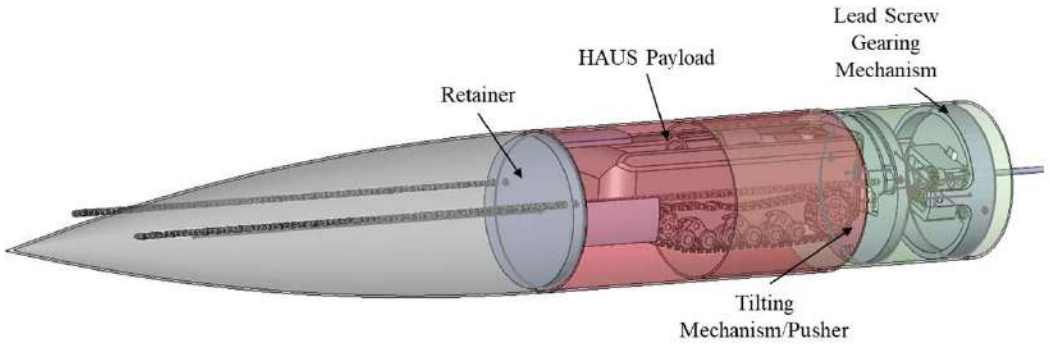
PAYLOAD SYSTEM TESTING

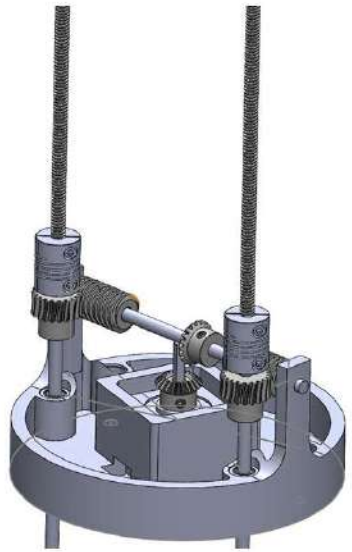
Propulsion System
• Tested motors, geartrain, tracks, and chassis on multiple terrains (grass, sand, concrete)

Soil Collection & Containment
• Linkage and drilling systems tested individually and in integration
• Requires 18–22 cycles for required soil volume(requiring 5 minutes)
• Successful soil transfer and containment with no jamming after redesign

Electrical System
• Verified PCB, power regulation, and motor drivers under load conditions
• System current draw within safe limits (up to ~1.3 A under load)
• PWM motor control validated with no signal distortion
• pH sensor calibrated and tested within ~1% error across standard solutions

PAYLOAD RETENTION SYSTEM

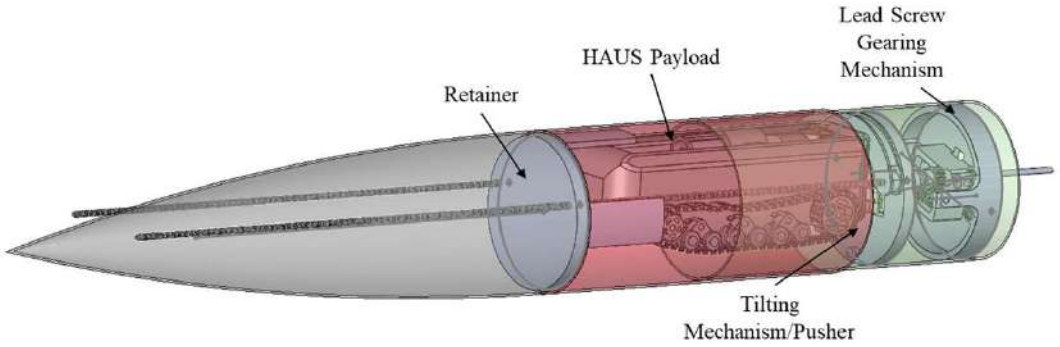


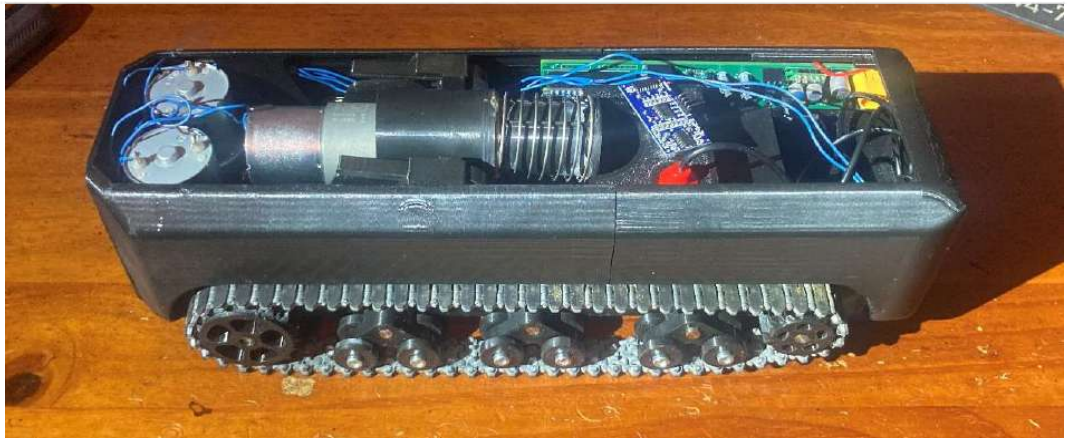


PAYLOAD DEMONSTRATION FLIGHT PLAN

Status– Planned (March 29th in Samson, Alabama)

Preparation – Currently built, ensuring reliable deployment and operation





TEST PLANS

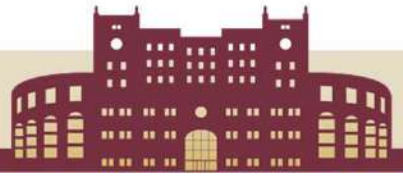
Test ID	Objective	Variable(s)	Methods	Status
PL-INT-XX	Verify separation reliability	Alignment, surface condition	Bench demo and flight	Incomplete
PL-ELEC-XX	Verify electrical reliability	-	Bench test / inspection	Complete
PL-SW-XX	Verify Software	-	Bench test	Partially Complete
PL-MECH-XX	Verify Mechanisms	-	Bench / ground demo	Partially Complete
PL-EXP-XX	Experimental Testing	-	Bench test / Ground Demo	Partially Complete
PL-SURV-XX	Testing Survivability	-	Flight-derived + inspection	Planned

PAYLOAD REQUIREMENTS VERIFICATION

HANDBOOK DERIVED & TEAM DERIVED

Requirement	Implementation Plan	Method of Verification	Status
4.1 After landing, teams shall autonomously collect and retain a soil sample of at least 50 mL.	The payload includes an autonomous soil acquisition and containment mechanism sized to collect at least 50 mL of soil.	Test + Demonstration: Soil collection testing and integrated payload demonstrations.	In Progress

Requirement	Justification	Method of Verification	Status
The payload shall successfully power on and initialize in ≥3 consecutive startup attempts in the flight configuration.	Reliable payload startup ensures that the experiment sequence begins correctly after landing.	Test: Electrical startup testing (PL-ELEC-01).	Planned



S A F E T Y

LAUNCH DAY SAFETY PLAN

Pre-Launch

•Oversee final vehicle integration and readiness

•Verify safety, arming states, and configuration compliance

•Support launch readiness and resolve discrepancies

Launch

•Support pad operations and final safety checks

•Coordinate with mentor, RSO, and range personnel

•Assist with troubleshooting and launch execution

Post-Launch

•Assist with post-flight inspection and data retrieval

•Support cleaning and disassembly

THANK YOU!

ANY QUESTIONS?

A P P E N D I X

DEPLOYMENT TESTING: DROGUE

DEPLOYMENT TESTING: DROGUE