GALLOGLY COLLEGE OF ENGINEERING
SCHOOL OF AEROSPACE AND MECHANICAL ENGINEERING
The UNIVERSITY *of* OKLAHOMA

Constellation Asteroid Measurement Project

Faculty Sponsor:
Dr. Diogo Merguizo Sanchez

Faculty Advisor:
Dr. Srikanth Bashetty

Project Overview

Team Members



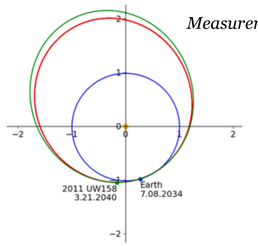
Back (L-R): Jordan Ayers, Bo Russell, Jacob Cohen

Front (L-R): Kierra Teer, Maddie Bollinger, Grant Swimelar

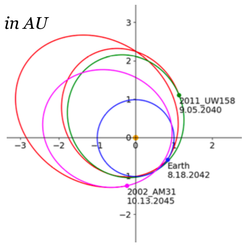
Team Lead: Maddie Bollinger

Mission Architecture[1]

- Explore Near-Earth Asteroids (NEAs):
  - Primary target: 2011 UW158 (PHA)
  - Secondary target: 202 AM32 (NEA)
- Deploy nine 6U CubeSat probes for remote sensing and sample collection
- Retrieve three probes carrying asteroid samples
- Return samples to Earth via spin-stabilized aeroshell



Transfer (red) from Earth orbit (blue) to 2011 UW158 (green)



Transfer (red) from 2011 UW158 (green) to 2002 AM31 (magenta) via Earth (blue) flyby.

Project Timeline

2023
- Spacecraft Team: *Identified targets; Initial spacecraft design*
- Probe Team: *Initial probe design; Selected 6U CubeSat spec.*

2024
- Spacecraft Team: *Iterated probe release/docking mechanism*
- Probe Team: *Designed attitude determination and control*
- Collector Team: *Designed sample collector mechanism*

2025
- Spacecraft Team: *Iterated probe release/docking mechanism*
- Probe Team: *Implemented reaction wheels and control algorithm*

2026

Objectives

- Update spacecraft to house new CubeSat bays
- Design re-entry capsule for sample collection probes
- Update electrical and mechanical systems of release/docking mechanism
- Produce 3D-printed scale model of updated spacecraft for demonstration

Constraints

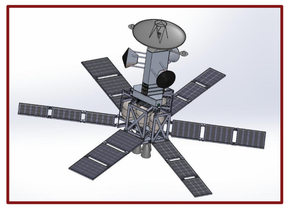
- Release/docking mechanism should be compatible with existing CubeSat probe design (6U CubeSat)
- Orbit configuration is fixed
- Compliant with NASA standards for space systems
- Prototyping budget: $1500

Spacecraft

Design Iterations

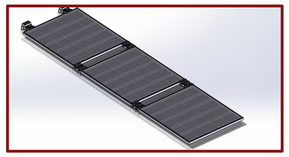


2023 → 2026

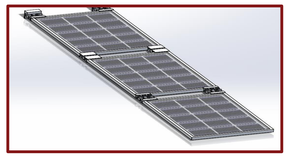


- Redesigned solar panels
- Elongated central structure
- Relocated CubeSat bays
- Improved compactness

Solar Panels

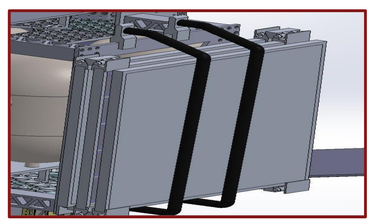


1.07 m x 1.1 m
[340. 25 Watts]



0.7 m x 1.1 m
[261.31 Watts]

- Panels fold inward and are secured with nylon rope, storing tension in spring-loaded hinges
- Burn wires cut rope on command, releasing panels
- Stored spring tension unfolds panels automatically
- Hinge pins lock panels in place at full extension

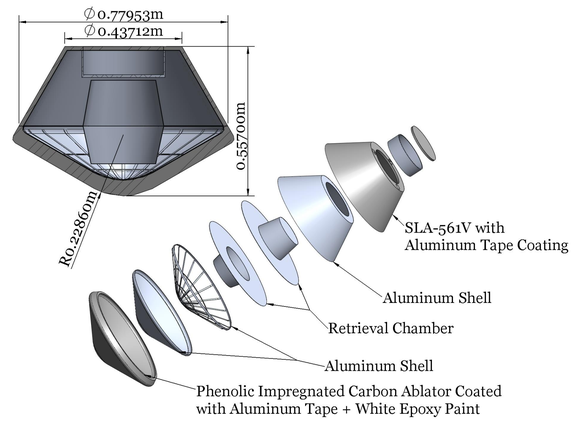


Standards

Standard	Application
NASA/SP-2016-6105	NASA Systems Engineering Handbook
NASA/SP-20220010761	Planetary Mission Entry Vehicle
NASA-STD-5017B	Tolerances and interface-fit requirements
NASA-HDBK-1005	Mission architecture traceability
NASA-HDBK-7009A	Modeling and simulation requirements
Specification	**Description**
Cal-Poly CP-CDS-R14.1	CubeSat Design Specification Rev.14.1
Rocketlab 2002337G	CSD Data Sheet Rev. G
GomSpace DS 1060779 1.2	Nanostructure 6U Datasheet Rev. 1.2

Aeroshell

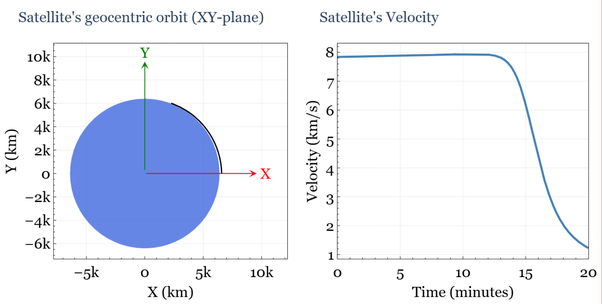
Design



Geometry	
Shape	Blunt nose cone
Nose Radius	0.22848 m
Dry vehicle mass	45.61 kg
Structure material	Aluminum 6061-T6

Astrodynamics

Trajectory



Properties

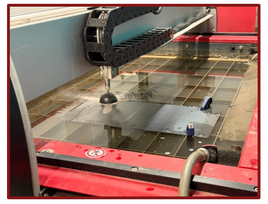
Trajectory		Thermal	
Testing entry angles	-1° to -8° at altitude of 200,000 m	Velocity at peak heat	6.633 km/s
Entry velocity	Relative 7,840 m/s	Peak heating rate	48.854 W/cm^2 at -1°entry angle
Control method	Ballistic, spin stabilized	Dynamic Pressure	0.00567 atm at -1° entry angle
Ballistic co-efficient	56.069 kg/m^2	Forebody material & thickness	PICA 0.0582m
Peak Deceleration	1.5076 g at -1° entry angle	Aftbody material & thickness	SLA-561V 0.01396 m

Release/Docking

Decision Logic

1-5 (best)	FACTOR	Traction Wheel	Rack and Pinion	Spring + Latch	Conveyor Belt
Manufacture time	2x	3	3	4	2
Power consumption	3x	3	3	4	2
Reliability	3x	3	3	4	2
Cost	2x	4	3	3	2
Integration difficulty	3x	4	3	4	1
Weight	1x	3	2	5	1
Total		**48**	**42**	**56**	**25**

Manufacturing

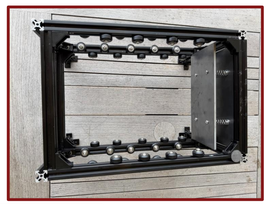


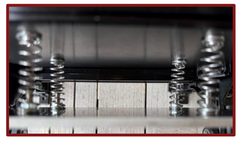


Manufactured at OU FabLab

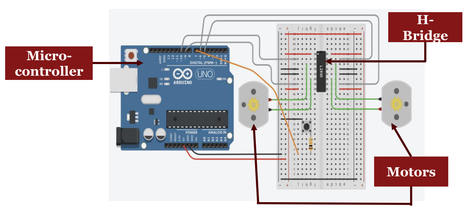
Prototype







Electrical Design



Part Name	Material	Quantity	Price
Spring	Stainless Steel	6	$8.63
Back/Front Plate	A36 Steel	1	$39.86
U-brackets	Carbon Steel	1	$14.99
		Total	**$106.63**

[1] Sanchez, D.M., "On the exploration of the asteroid 2011 UW158," AAS/AIAA Astrodynamics Specialist Conference, August 2024, Broomfield, CO, USA, AAS 24-235