UC Berkeley Space Technologies and Rocketry Preliminary Design Review Presentation

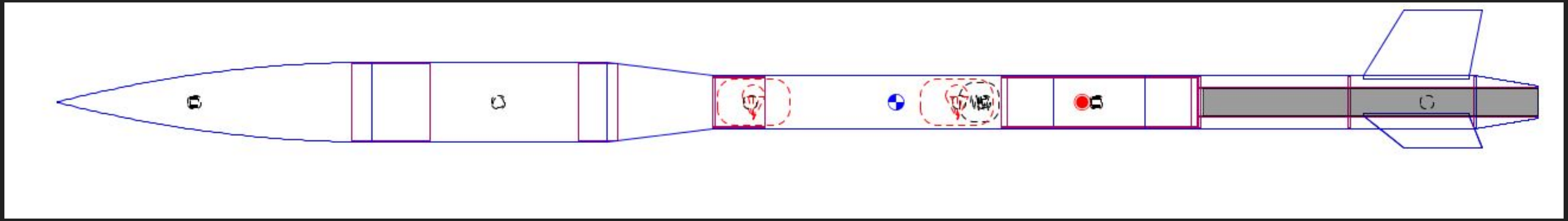
Access Control: CalSTAR Public Access

Agenda

- Airframe
- Propulsion
- Payload
- Recovery
- Safety
- Outreach
- Project Plan

Airframe

- Macros- **Length:** 9.42 ft, **Weight:** 27.125 lbs, **Apogee:** 5555 ft, **Max Vel:** 0.54 Mach, **Max Accel:** 8.95 g, **Stability:** 2.41 cal



Airframe cont.

- Weights (Wet Total: 27.125 lbs. Dry Total: 22.19 lbs.)
  - Electrical - 2 lbs. (allocated) Nose Cone
  - Payload - 6 lbs. (allocated) Payload Tube
  - Recovery -
    - Recovery Tube
      - 0.811 lbs. Main Parachute
      - 0.134 lbs. Drogue Parachute
      - 0.623 lbs. Shock Cord
      - + ~ ⅓ lb. misc
    - Booster +
      - 2 lbs Avionics
  - Propulsion - 4.9 lbs. (Wet only) Booster Section
  - Airframe - Rest of it Throughout the Rocket

Airframe cont.

- Lengths (Total: 9.42 ft)
    - Nose Cone - 24 in. (4:1 Length:Diameter)
        - Payload/Electronics can use
    - Payload Tube - 18 in.
    - Payload - Transition Coupler - 3 in.
    - Transition - 8 in.
        - 6 - 4 in. change.
    - Transition - Recovery coupler - 4 in.
    - Recovery Tube - 26 in.
    - Recovery - Av Bay Coupler - 15 in. (Runs through the entire Av Bay tube)
    - Av Bay Tube - 7 in.
    - Booster - 26 in.
    - Boat Tail - 4.7 in.

Agenda

- Airframe
- Propulsion
- Payload
- Recovery
- Safety
- Outreach
- Project Plan

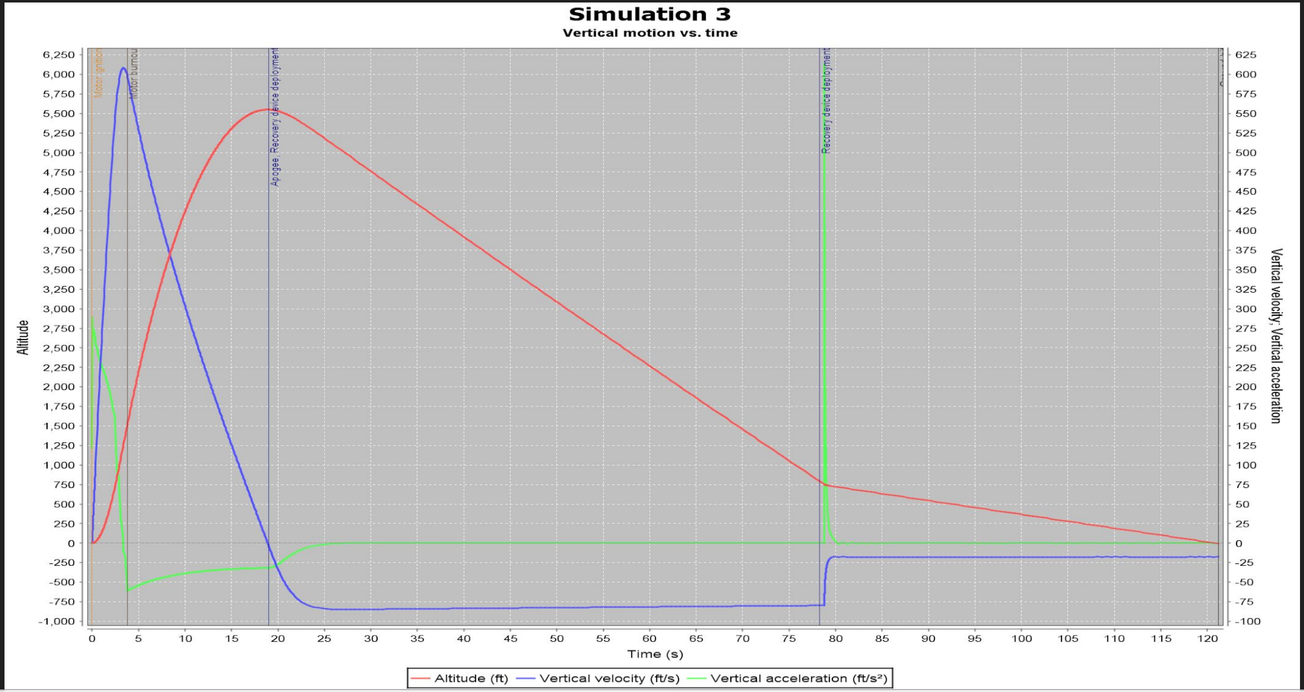
Propulsion

- Projected apogee - ~5555 ft
- Max velocity - Mach 0.54
- Max acceleration - 8.95 Gs

	Name	Configuration	Velocity off rod	Apogee	Velocity at deployment	Optimum delay	Max. velocity	Max. acceleration	Time to apogee	Flight time	Ground hit velocity
	Simulation 3	[L730-P]	82.8 ft/s	5549 ft	79.8 ft/s	15.2 s	609 ft/s	288 ft/s²	18.9 s	121 s	17.7 ft/s

Propulsion

- Current motor - Cesaroni L730
- Flight curves



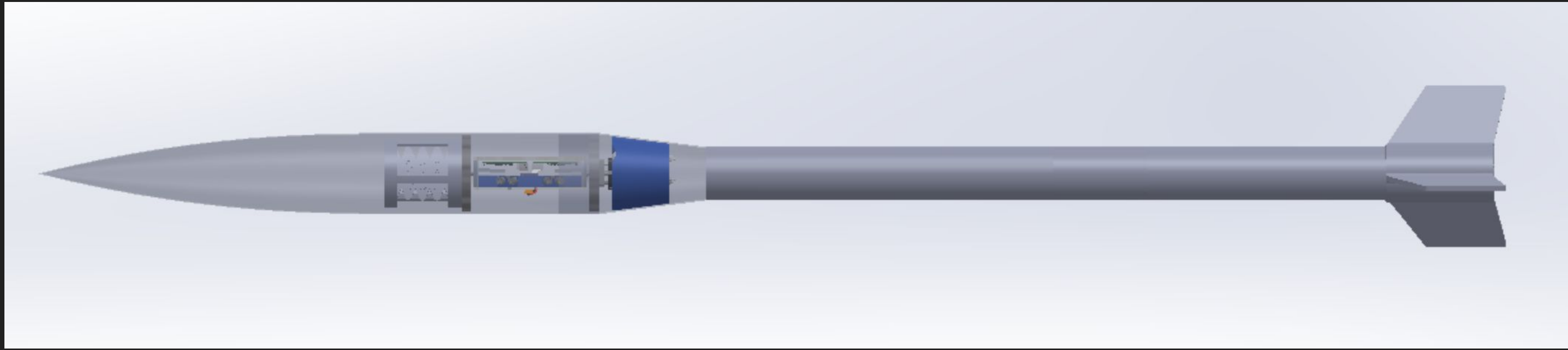
CalSTAR PA

Agenda

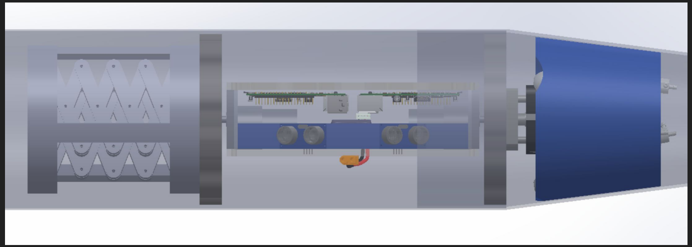
- Airframe
- Propulsion
- Payload
- Recovery
- Safety
- Outreach
- Project Plan

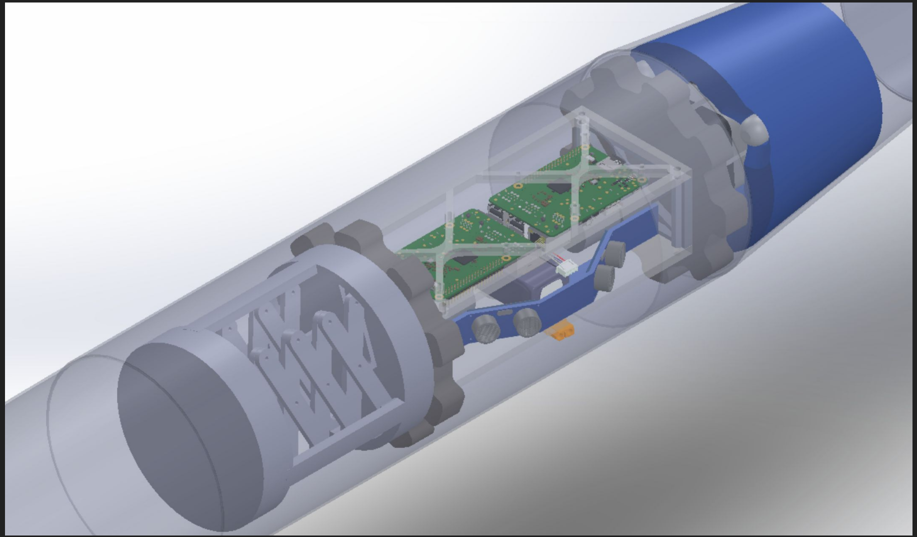
Payload - Brief Overview

- After vehicle lands, airframe is separated by a radio-triggered pneumatic deployment system
- Rover pushed out of airframe by a scissor-lift ejection system
- Rover detects ejection and drives away from airframe
  - Distance verification using encoders + inertial measurement unit (accelerometer + gyroscope) data



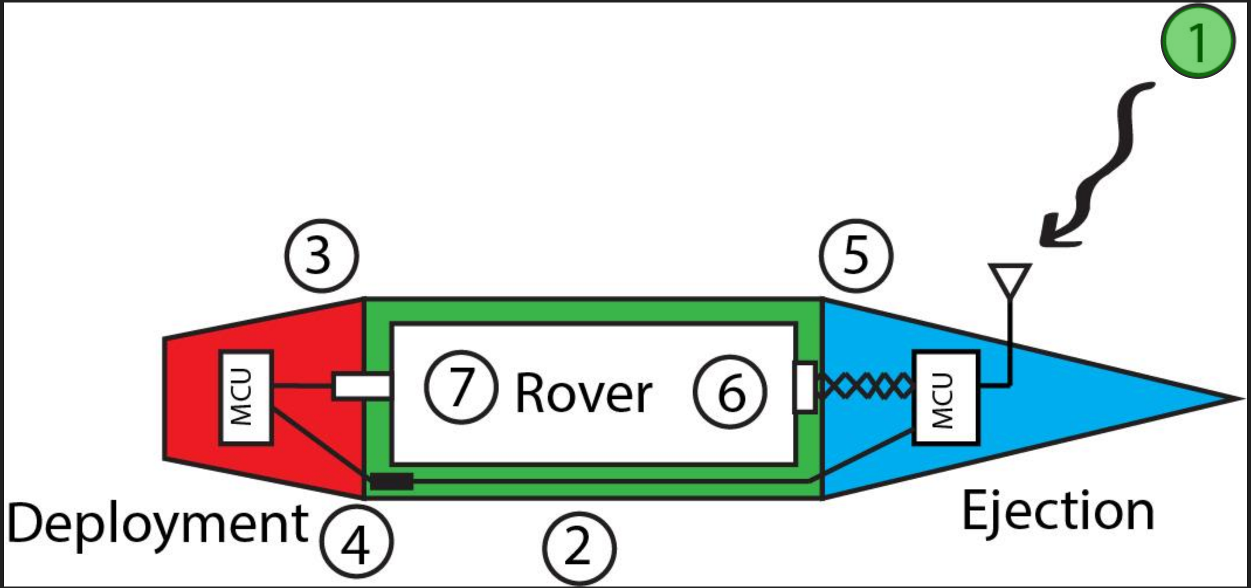
Payload - Brief Overview





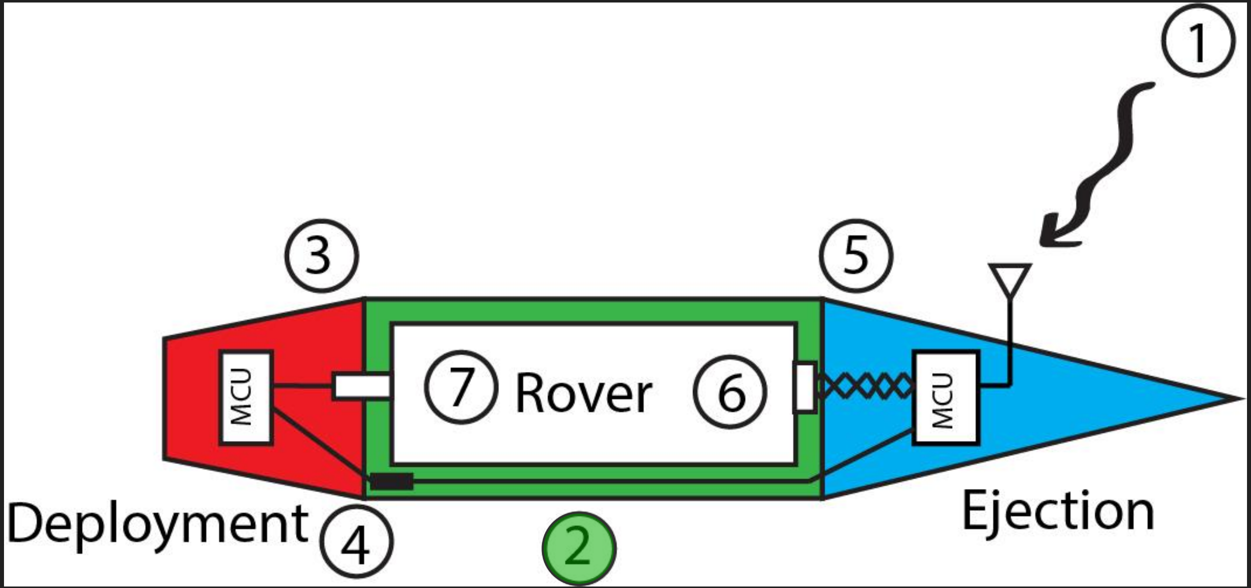
- Deployment
  - Pneumatic separation system
- Ejection
  - Scissor lift shove-out
- Movement
  - Rectangular two-wheeled rover capable of obstacle avoidance and traversing rough terrain
- Solar
  - Deployment system and panel functionality verification

Payload - Deployment/Ejection Overview



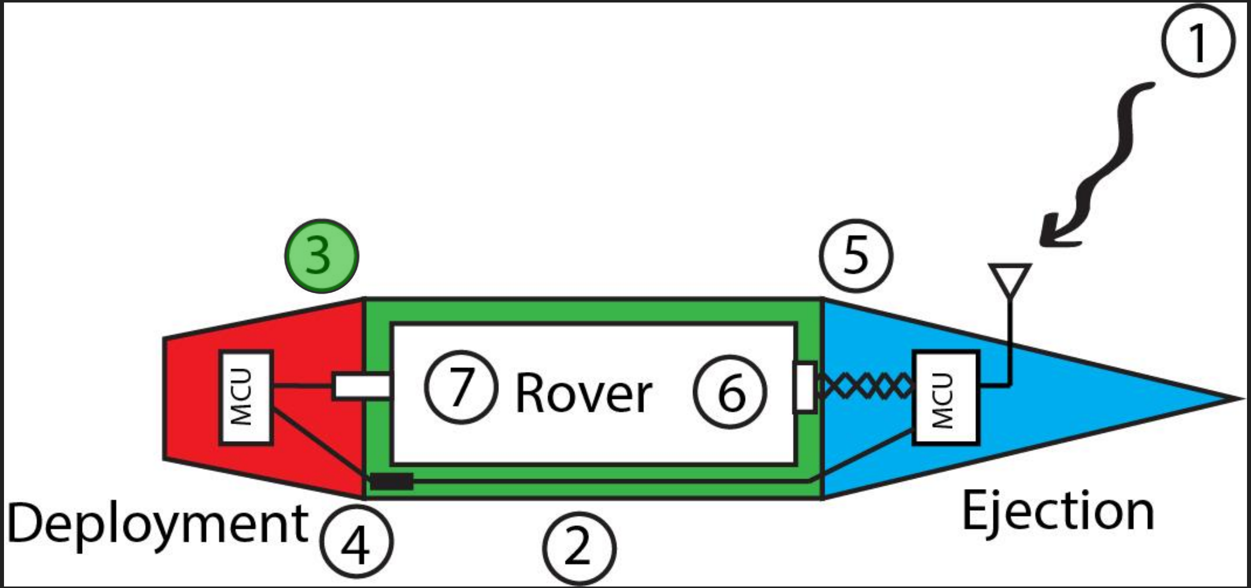
1. Ejection computer receives remote signal to begin payload process.

Payload - Deployment/Ejection Overview



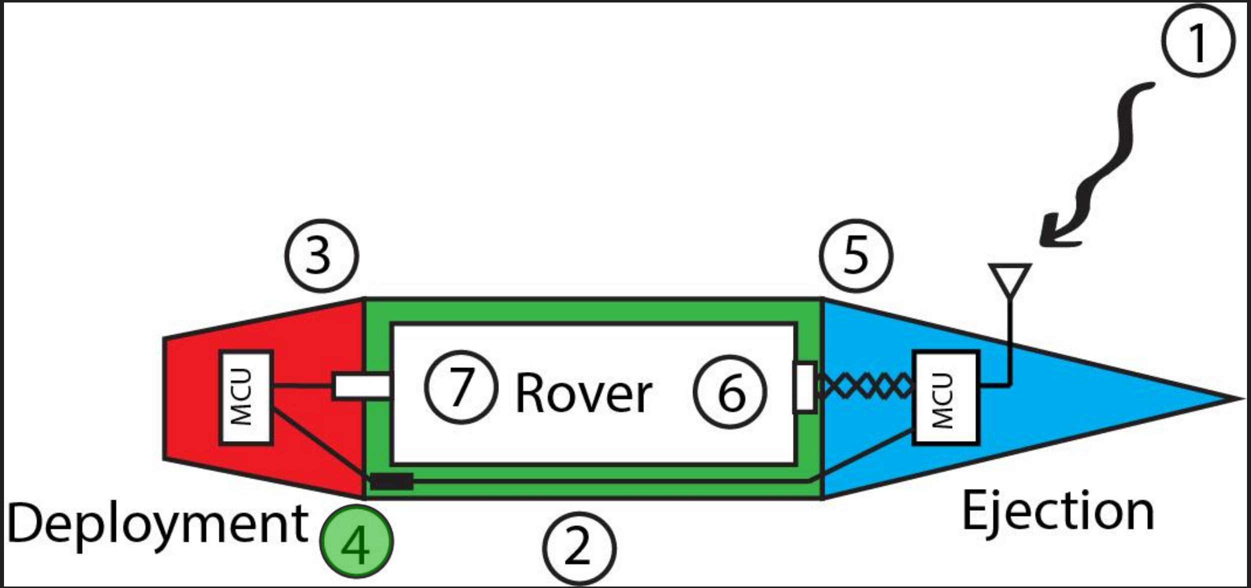
2. Ejection computer sends a signal via breakaway wires to deployment computer.

Payload - Deployment/Ejection Overview



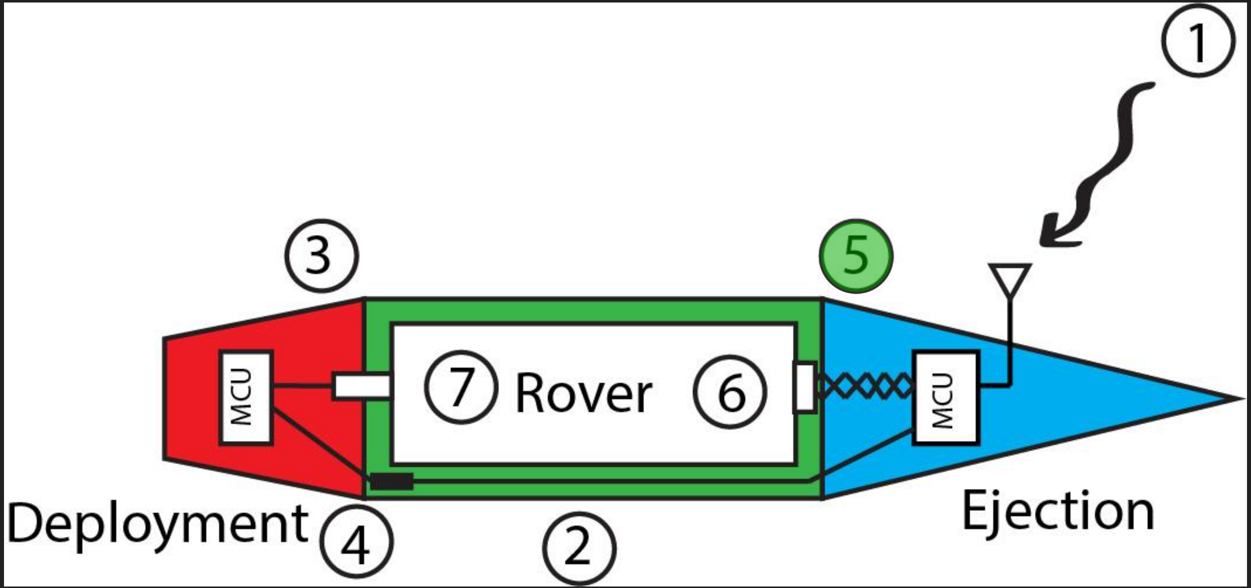
3. Deployment computer initiates pneumatic deployment.

Payload - Deployment/Ejection Overview



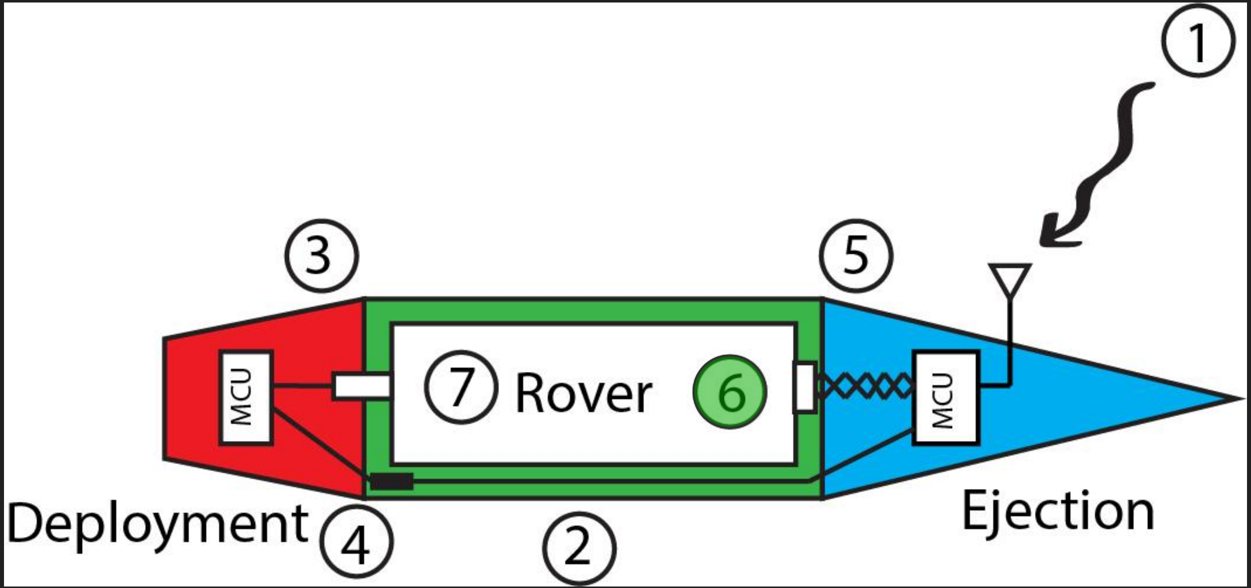
4. Deployment process disconnects breakaway wires.

Payload - Deployment/Ejection Overview



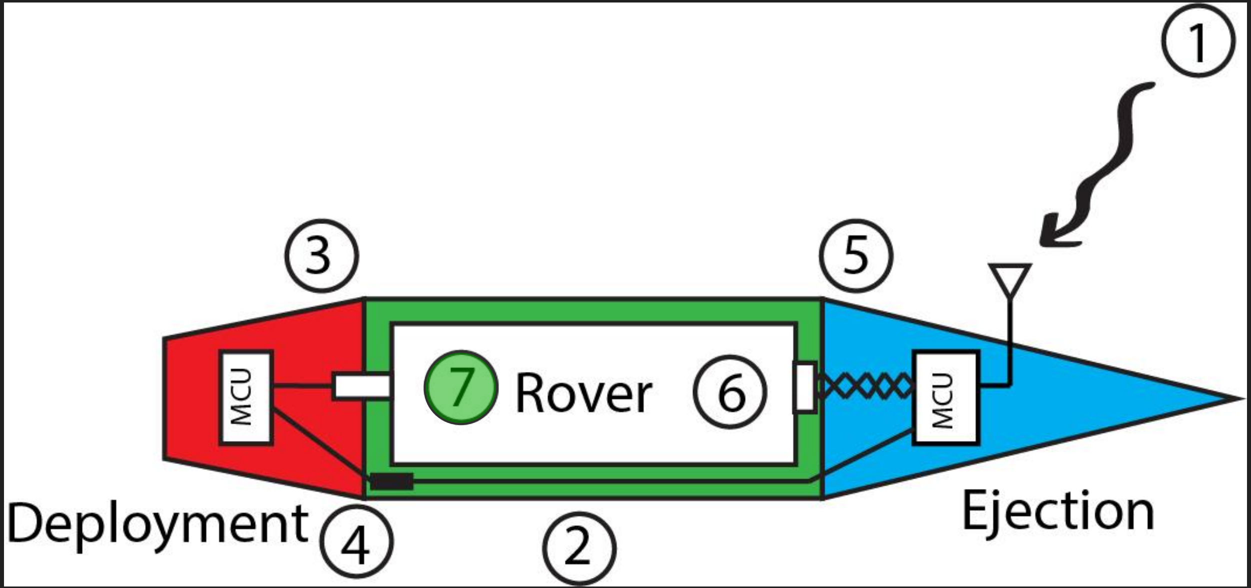
5. Ejection computer detects disconnection of breakaway wires and initiates rover ejection.

Payload - Deployment/Ejection Overview



6. Rover detects successful ejection by monitoring a switch, accelerometer, and gyroscope.

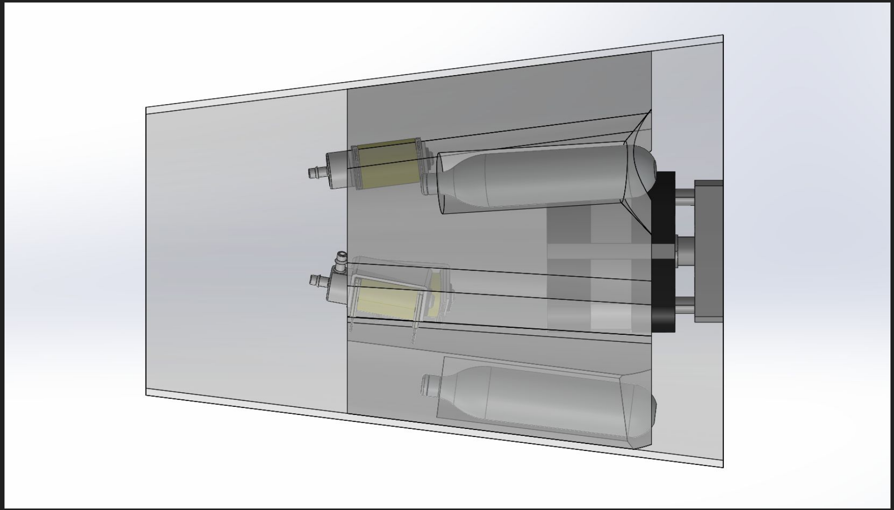
Payload - Deployment/Ejection Overview

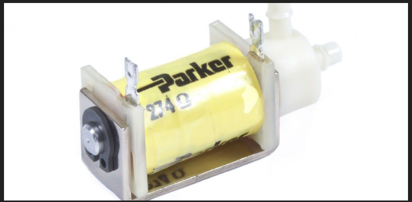


7. Rover begins moving.

Payload Deployment

- Pneumatic ejection system
  - 16g CO2 Cartridges (Threaded)
- Short Throw Pneumatic Pistons & Solenoid Valves
- Breakaway wire connector from ejection electronics



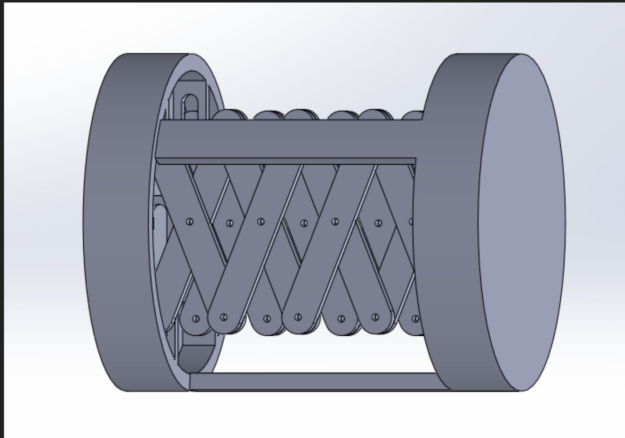


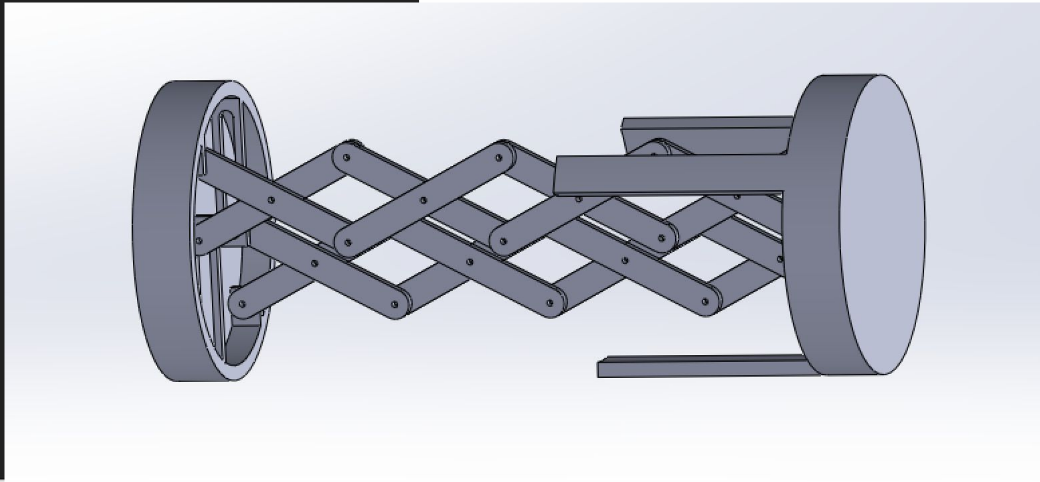
Payload Deployment: Separation

- Verification of successful landing using altimeter and accelerometer data
  - Waits for confirmation from main flight computer prior to deployment
  - Data is transferred through breakaway wire connection
- Deployment frame section is self contained
  - Section of airframe contains logic board, battery, and all hardware necessary for deployment
  - Deployment section receives command from main flight computer to deploy. Opening the NC solenoids and using a short throw pneumatic piston to shear airframe pins
- Separation confirmed with main flight computer
  - The rover and the main flight computer will be made aware of a successful separation through the disconnection of the breakaway wire connection.
- Ejection handoff

Payload - Ejection

- Horizontal scissor lift will be used to push the rover out of the payload section and onto the ground.
- Uses two redundant servos to power lift, each pushing one side of the lift.
- Minimum extension: ~6 inches
- Maximum extension: ~18 inches
    - Difference between minimum and maximum extension must be at least the length of the rover (10 inches).
- Weight estimate:
    - Currently 1.36 lb

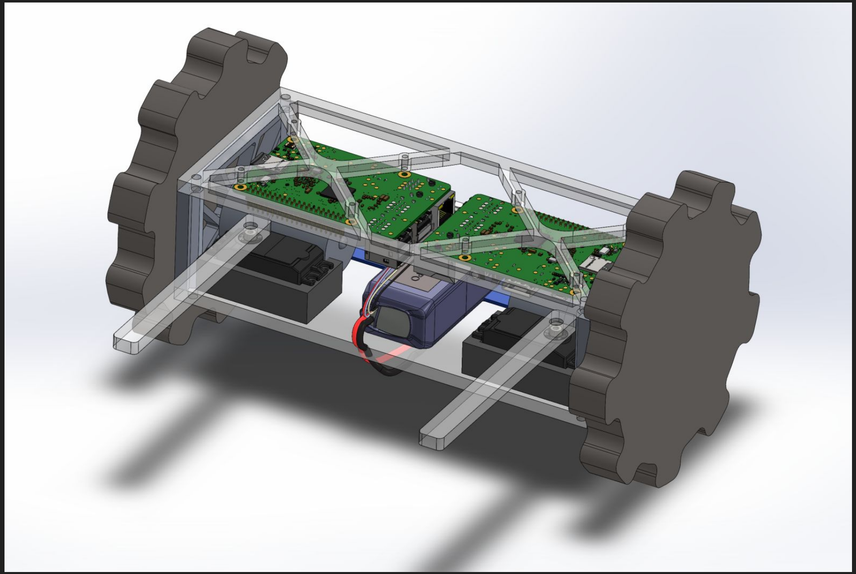


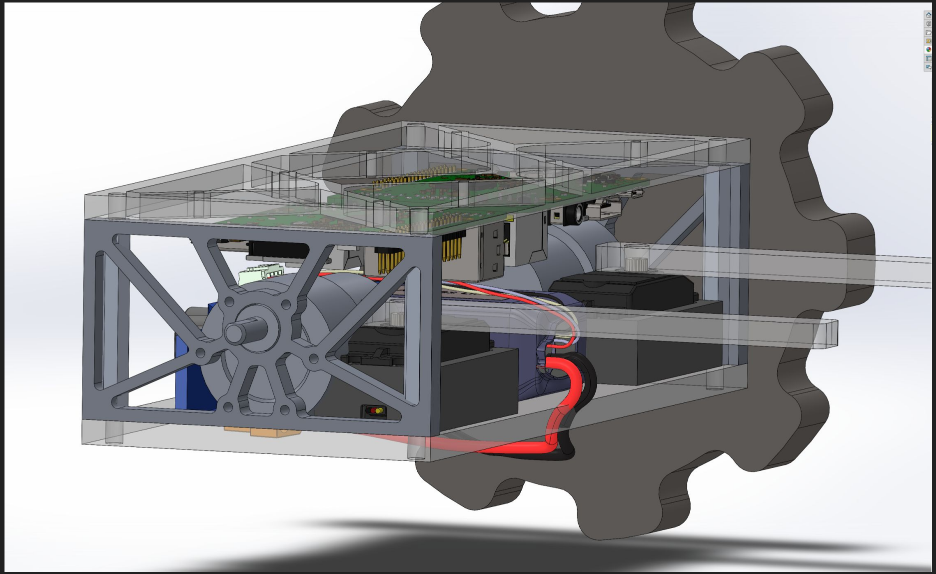


Payload - Movement - Mechanical

- Chassis: enclosed ABS plastic box
  - Rectangular with smoothed edges
  - Aluminum L-brackets for structural support
- Wheels: Solid polymer wheels, toothed tread design
  - Cross-linked polyethylene
  - Lightweight, deformable
  - Uniform material, Solid hub / soft treads
- Skid: Aluminum arms that rotate out from bottom of rover
  - Servo does not have to resist mechanical stresses
  - 2 skids

Payload - Movement - Mechanical

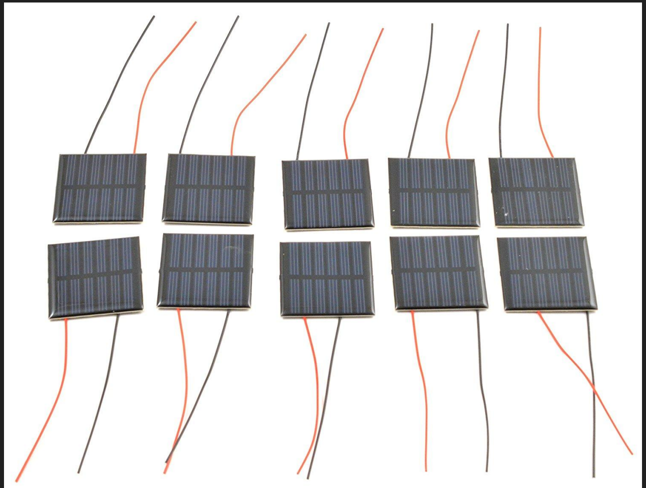




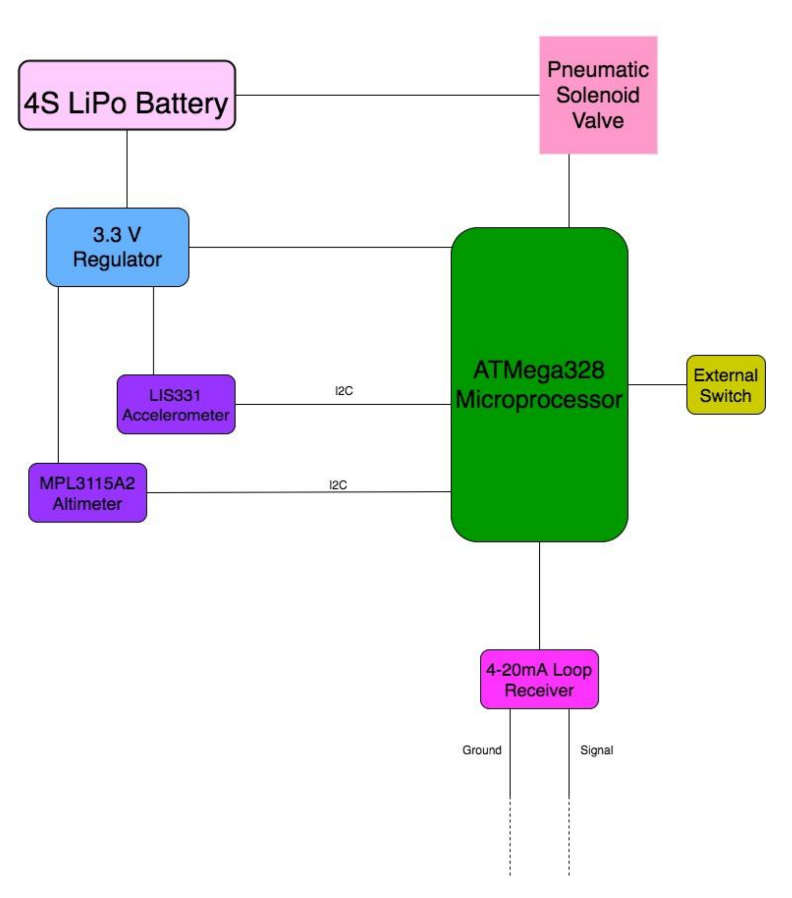
Payload - Movement - Electrical

- Motors: 12V Brushed DC Spur Gear motor with encoders
  - 38 rated RPM, 83.26 oz-in rated torque, 316 oz-in stall torque at 1.8A
  - Electronic Speed controllers
- Battery: 1300mAh 4S 45C LiPo battery
  - Small form factor: 2.8 x 1.4 x 1.4”
  - Sufficient discharge rate and capacity
- Collision sensors: 2x forward mounted ultrasonic sensors
  - Light, cheap and reliable outdoors
- Distance measurement / navigation
  - Encoders for primary navigation
  - Accelerometer and gyroscope to check movement
- Stepper motor for skid deployment
  - 28 oz-in, 350 mA

Payload - Solar

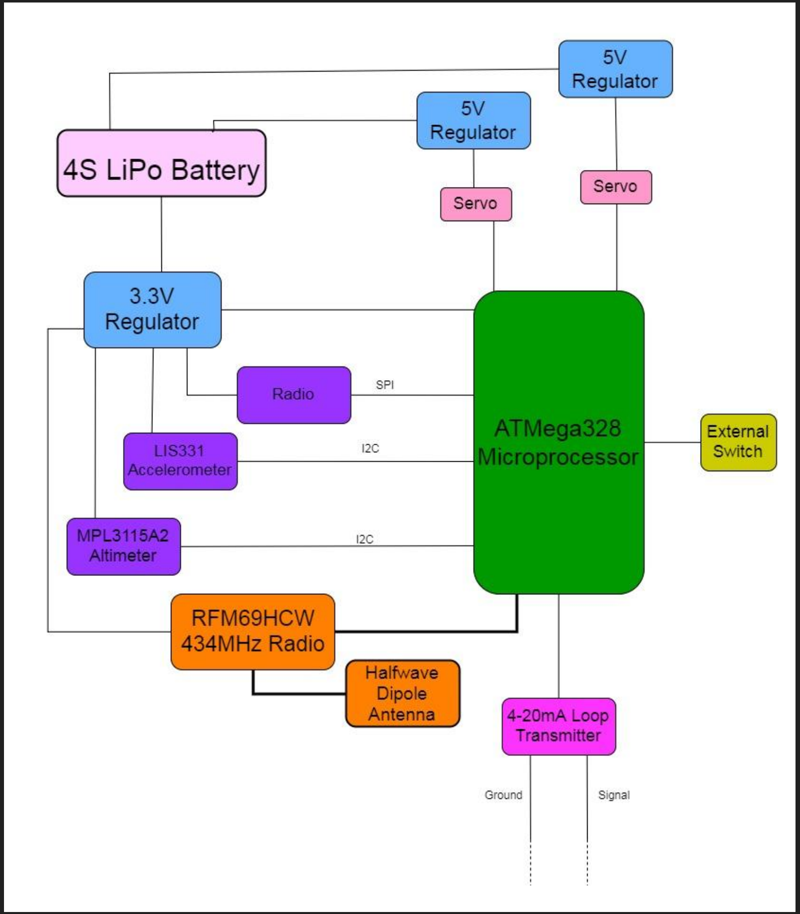


- 1” x 1” solar cells chained together on two panels
- One panel mounted above rover electronics
- Second panel mounted on hood of rover body
- Hood attached to body with hinge
- Hinge actuated with two servos whose fins are attached to hood
- Potentiometer shaft attached to hood to verify deployment position
- Electrical output of solar panels input to ADC which is passed to rover computer
- Possibly need a resistive load attached to solar panel output to dissipate current
- Magnets on hood and body to prevent unintended deployment



Payload Electronics - Deployment Board

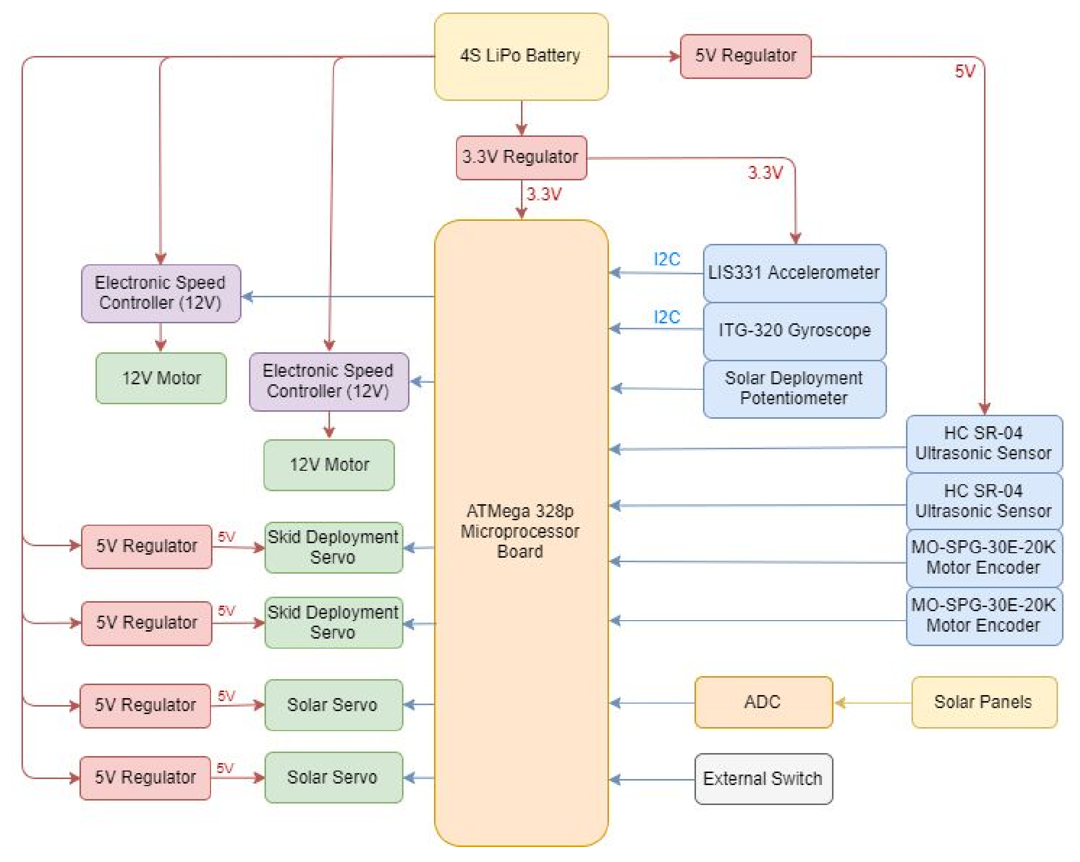
- 4S LiPo Battery in series with external switch
- Microprocessor for custom code
- Accelerometer and altimeter for verification that the rocket is on the ground
- Pneumatic solenoid valve for deployment, powered directly from battery
- 4-20mA loop receiver for signaling from ejection computer



Payload Electronics - Ejection Board

- 4S LiPo Battery in series with external switch
- Microprocessor for custom code
- 434MHz Radio with half-wave dipole antenna for remote signal reception
- Accelerometer and altimeter for verification that the rocket is on the ground
- Two servos for scissor lift activation
- 4-20mA loop transmitter for signalling to deployment computer and for detecting breakaway wire disconnection

Payload Electronics - Rover Board



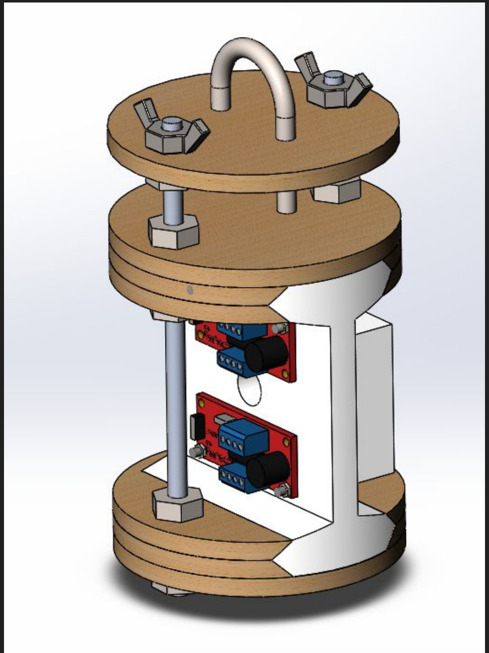
- 4S LiPo Battery
- Microprocessor for custom code
- Tactile touch switch on wheel
- Accelerometer, gyroscope, ultrasonic sensors, and motor encoders
- Two motors with ESCs
- Two servos for skid deployment
- Two servos for solar deployment
- Potentiometer and ADC for verification of solar deployment

Agenda

- Airframe
- Propulsion
- Payload
- Recovery
- Safety
- Outreach
- Project Plan

Recovery

AVIONICS BAY



DEPLOYMENT SYSTEM

Recovery - General Specs

Airframe Size

- Airframe - 33”
  - Avionics Bay - 7”
  - Parachutes - 26”
- Coupler - 15”

Weights

- Parachutes - 2.3 lb
- Avionics Bay - 1 lb

Parachute Sizes

- Drogue Chute: 24” Elliptical parachute from Fruity Chutes; the red and white one

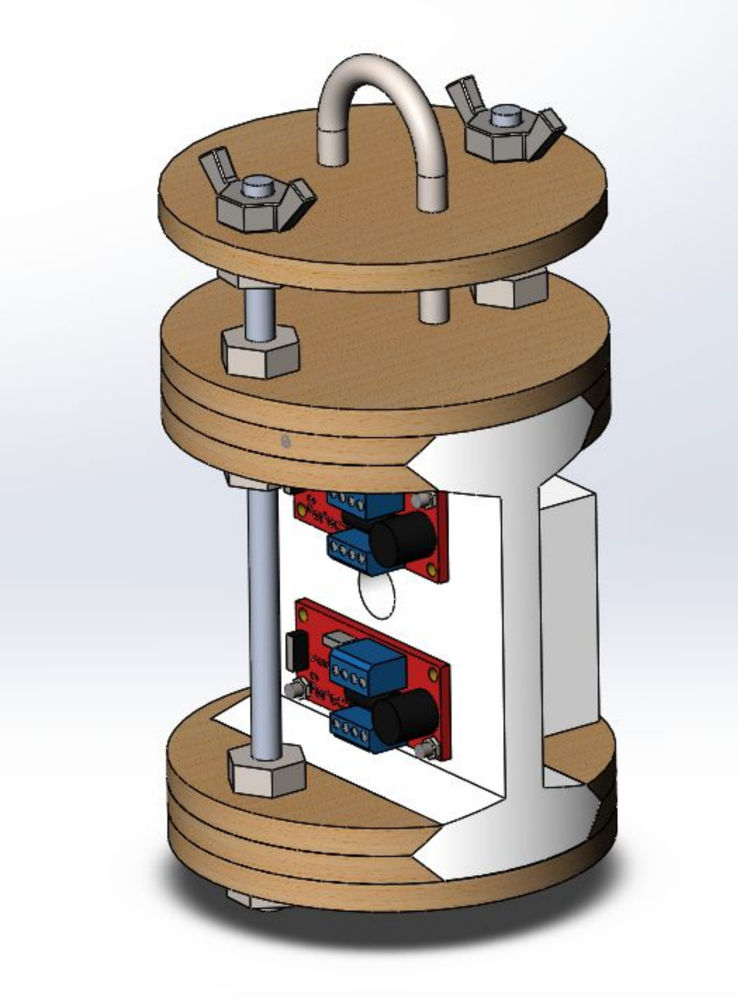
- Main Chute: 72” Toroidal parachute from Fruity Chutes; the orange and black one

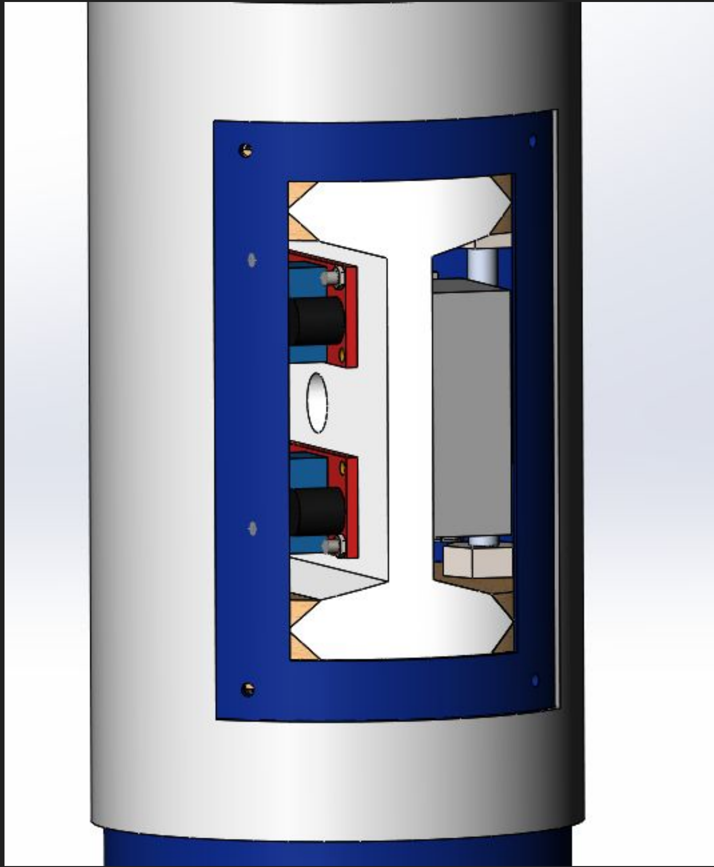
Deployment System

- Same side Dual Deployment
- L2 Tender Descenders
- Black Powder

Recovery - SLED DESIGN

- Design focus on accessibility and compactness
- Went through several iterations
- Altimeters and batteries mounted on either side
- Houses 2 PerfectFlite Stratologger CFs & 2 9V batteries
- Sled slot fits into pre-cut rails in bulkhead
- Made of 3D printed plastic

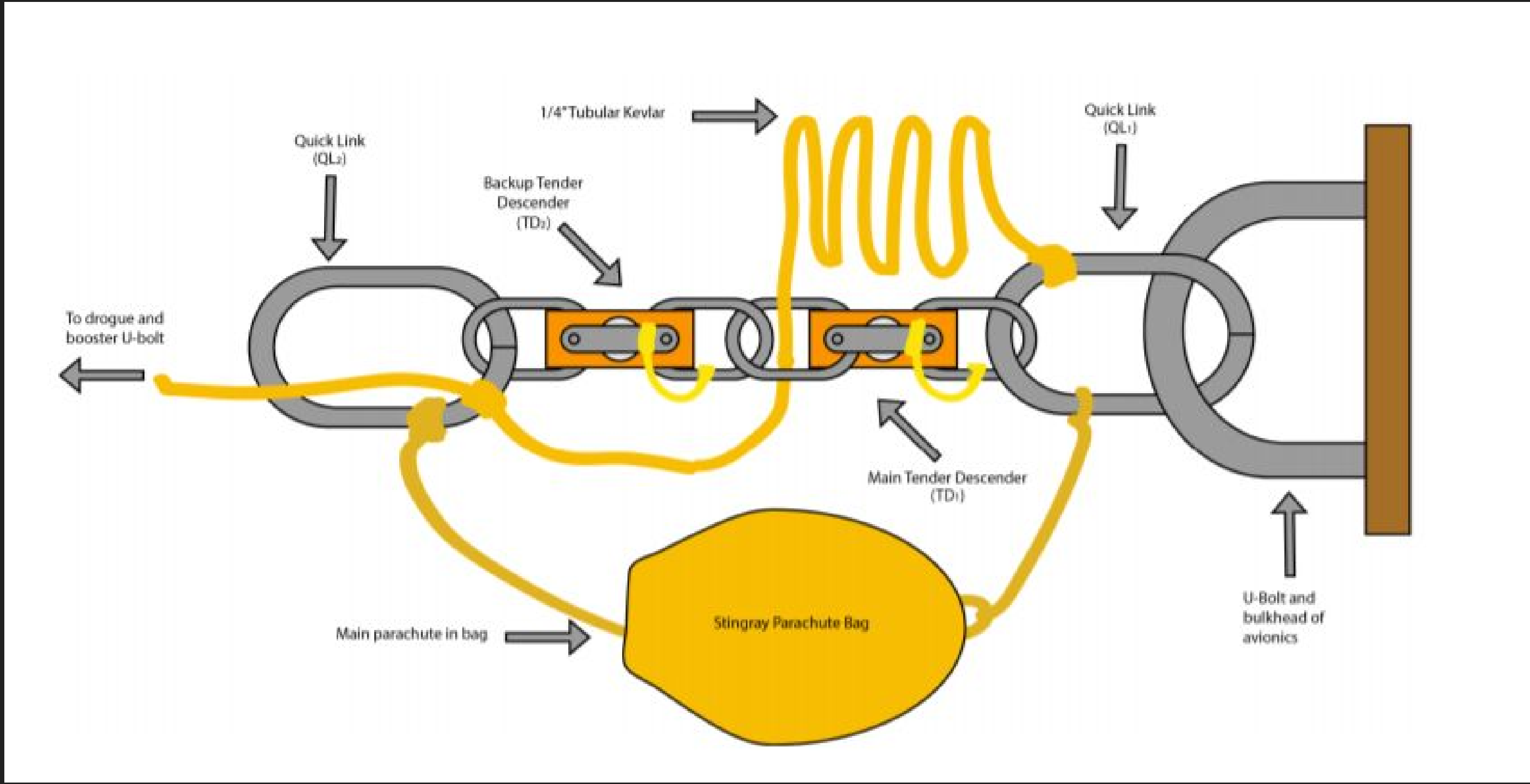




Recovery - DEPLOYMENT SYSTEM

- Using same deployment system as URSA Major
  - Parachutes will be in the front of the Av-bay
- Black Powder Ejection Charges w/ e-matches
- Redundancy

Recovery - DEPLOYMENT SYSTEM



Agenda

- Airframe
- Propulsion
- Payload
- Recovery
- Safety
- Outreach
- Project Plan

Safety

Safety Officer: Grant Posner

Team mentor: David Raimondi

Personnel safety is maintained throughout all construction over multiple sites:

- Jacobs Hall: university training required
- Etcheverry Hall: university training required
- Richmond Field Station: MSDS and safety procedure information is available, and PPE is provided (and required) for any build days

Agenda

- Airframe
- Propulsion
- Payload
- Recovery
- Safety
- Outreach
- Project Plan

Outreach

- Completed Events:
  - Ohlone College Night of Science (Oct 7, 2017)
  - Parent Education Program (Oct 14, 2017)
  - High School Engineering Program (Oct 21, 2017)
  - Discovery Days, CSU East Bay (Oct 28, 2017)
- Current Outreach Numbers:
  - 932 direct interactions with students
  - 789 indirect interactions with community members (not including students above)
- Planned Events:
  - Discovery Days, AT&T Park (November 11, 2017)
  - First Friday at Chabot Space & Science Center (November 5, 2018)
  - Space Day (TBD)

Agenda

- Airframe
- Propulsion
- Payload
- Recovery
- Safety
- Outreach
- Project Plan

Project Plan - Tests

Subscale Test Plans:

- Payload - DEMS Subsystems Tests
  - Deployment: Radio Link Test, Shear Pin Break Test
  - Ejection: Scissor Lift Force Testing
  - Movement: Rover Terrain Traversability Test
  - Solar: Solar Panel Unfolding Verification and Functionality Test
- Payload - Electronics Sequencing Test
  - Deployment/Ejection Computer Breakaway Wire Connection Test
  - Rover Physical Switch Ejection Confirmation Test
- Payload - Full Payload Sequence Test
- Recovery - Apogee Black Powder Separation Test
  - At subscale launch

Project Plan

Timeline:

- December 2nd, 2017: Subscale Launch
- December 2nd, 2017: Functional Fullscale Rover
- February 3rd, 2017: Fullscale Launch

Budget:

- Projected budget $24,000.
- Acquired $20,000, $7,000 pending, $2,000 spent

STAR

Questions?