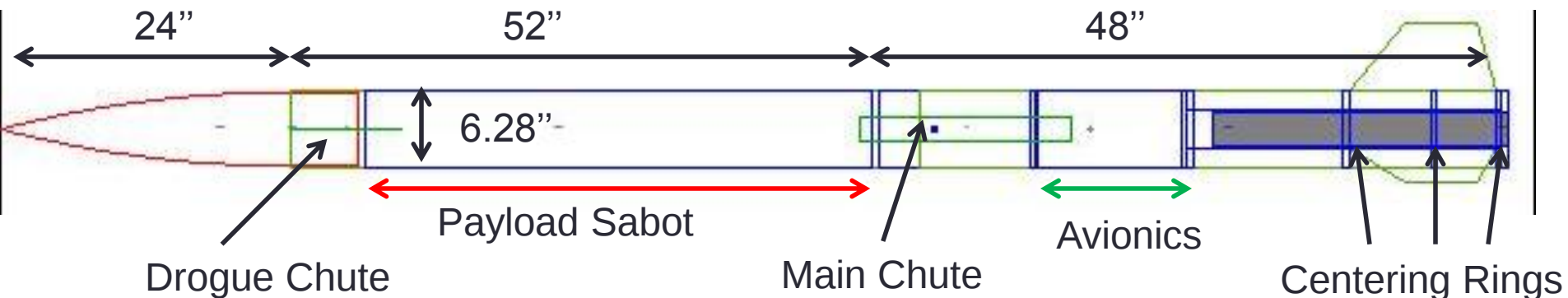


MIT ROCKET TEAM

NASA ULSI 2012-2013 PDR

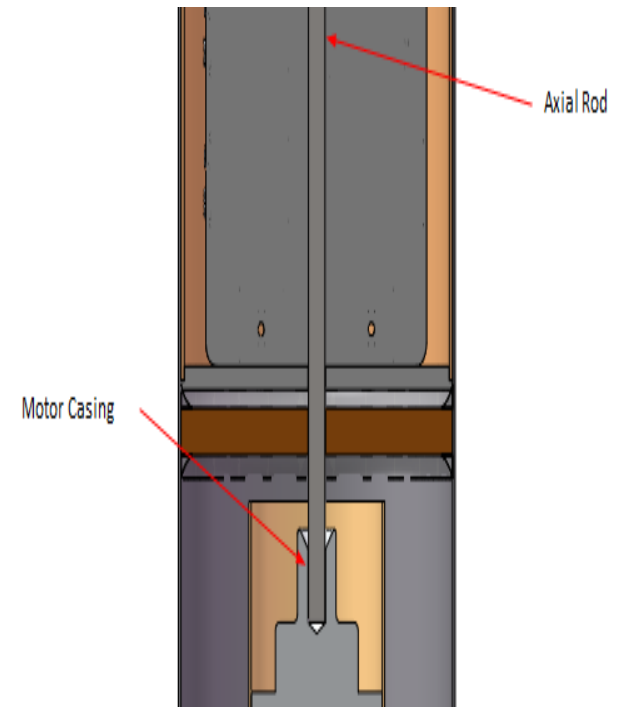
Rocket Overview (1)

- Requirements:
 - Launch rocket to 5280 ft
 - Deploy Quadrotor Sabot at 3000 ft
- Concept
 - Solid Rocket Motor
 - Carbon Fiber Airframe
 - Redundant Flight Computers
 - Sabot Deployment
 - Dual Deployment Recovery
- Launch Vehicle Dimensions
 - 10.375 feet Tall
 - 6.28 inch
 - 46.27 Pound liftoff weight



Rocket Overview (2)

- Key Design Features
 - Motor retention via threaded rod to recovery eye bolt
 - Full Carbon Fiber Airframe
 - Avionics package inside coupler tube above motor
 - Recovery package consisting of dual deployment via Tender Descender with sabot/ quadrotor deployment



Rocket Airframe and Materials

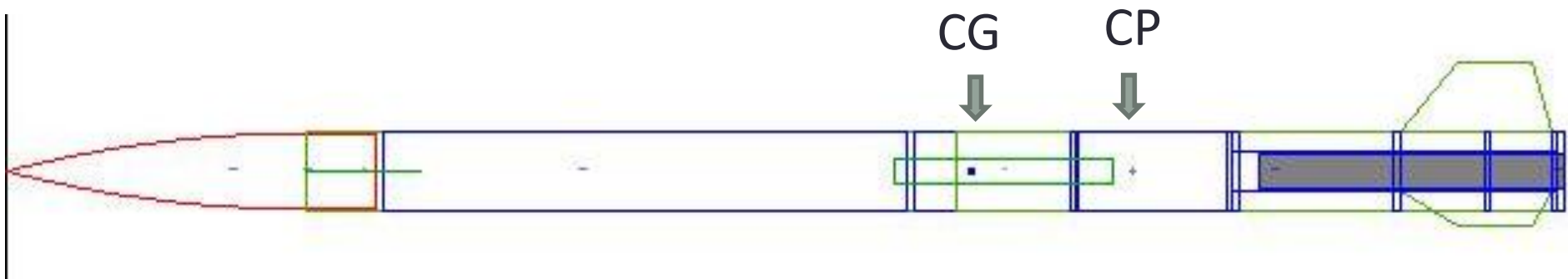
- Airframe
 - Carbon fiber: 11oz Soller Composites Sleeve
 - Aeropoxy 2032/3660
- Bulkheads & Centering Rings
 - 1/2" Plywood
- Fins
 - Plywood/Carbon Fiber Sandwich
 - Tip-to-tip carbon sheets
- Various
 - Phenolic tubing: motor mount, avionics package
 - Nylon: avionics assembly components
 - Stainless steel: quick links, eye bolts
 - Nomex: chute protectors, deployment bags

Rocket Propulsion Design

- Rocket Motor – Cesaroni L1115
 - 4996N-s impulse - more than enough to reach target altitude given mass estimates
 - Proven track record and simple assembly
 - Cheaper and more reliable than Aerotech alternative
- Full-scale Test Motor – Cesaroni K661
 - Will provide nearly identical flight profile to verify launch vehicle design

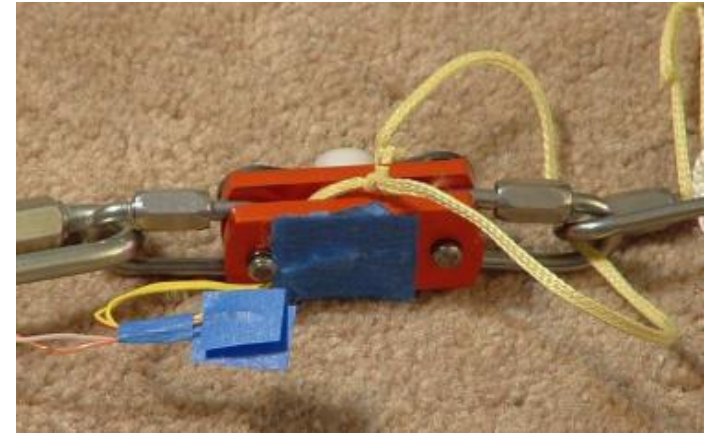
Static stability margin

- Center of Pressure
 - 90" from nose tip
- Center of Gravity
 - 77" from nose tip at launch
- Stability Margin
 - ~2.11 Calibers



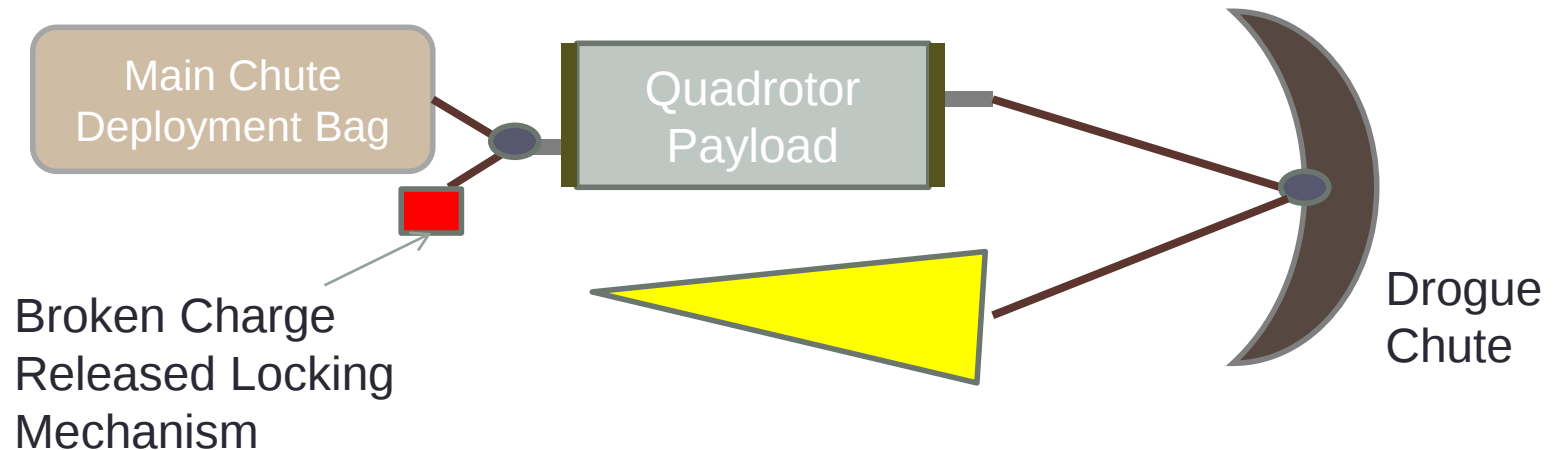
Rocket Recovery System

- 5 ft drogue parachute
 - Deployment at apogee
 - Shear 2x 2-56 screws
 - 3.5 g black power charge
 - 16' x 1" tubular nylon webbing harness
- 16 ft main parachute
 - Deployment at 3000 feet
 - Pulled out by Quadrotor and sabot
 - Sabot released by Tender Descender
 - Deployment Bag used
 - 3.25' x 1" tubular nylon webbing harness



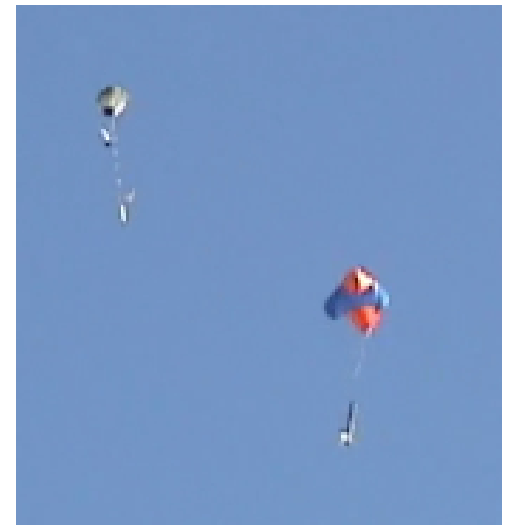
Payload Deployment

- Tube-stores payload during flight
- Charge released locking mechanism - releases sabot at 3000 ft
- Chute Bag – ensures clean main parachute opening
- Separation of rocket and nose cone prevents parachute entanglement



Staged Recovery System

- Proven Recovery Method
- 6 Successful Flights



Descent Rates and Drift Calculations

Final Descent Rate & Energy		
Nose/Sabot Final Descent Rate	13.9 ft/s	70.7ft-lbf
Rocket Body Under Main	13.9 ft/s	19.8ft-lbf
Quadrotor Under Chute	21.2 ft/s	69.7 ft-lbf

Payload Design

- Sprite
 - **Specialized Rotorcraft for IR Communications, Object Tracking and On-board Experiments**
- Halo
 - **High Altitude Lightning Observatory**



Payload Goals

- Decrease deployment time for quadrotor high altitude missions
- Improve information acquisition, processing, and transmission on and between mobile targets in a dynamic environment
- Validate high altitude lightning models via direct measurements

Payload Requirements (SPRITE)

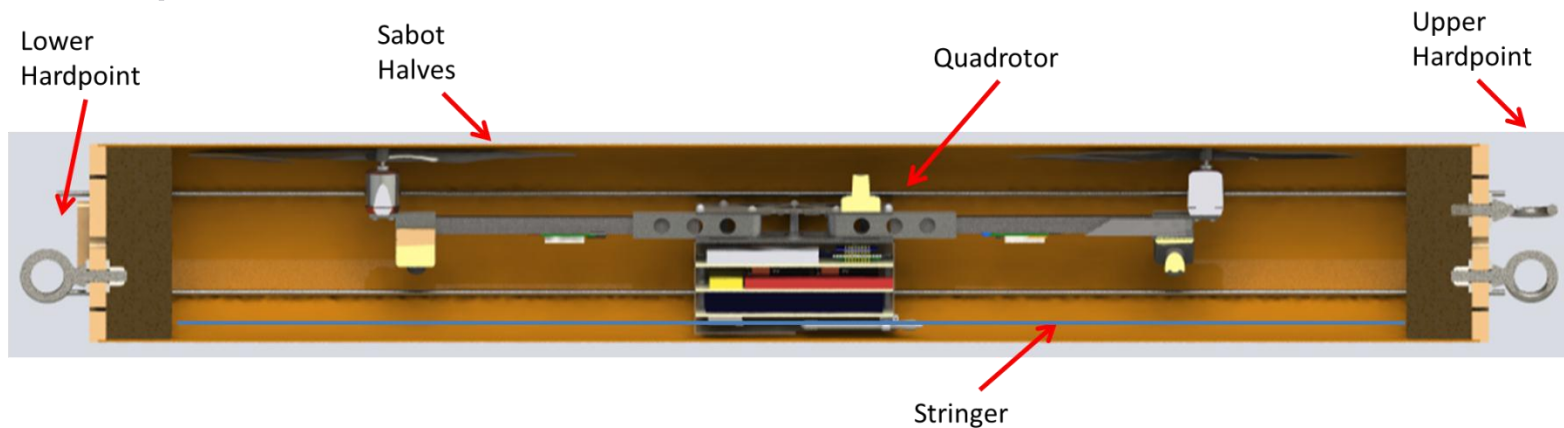
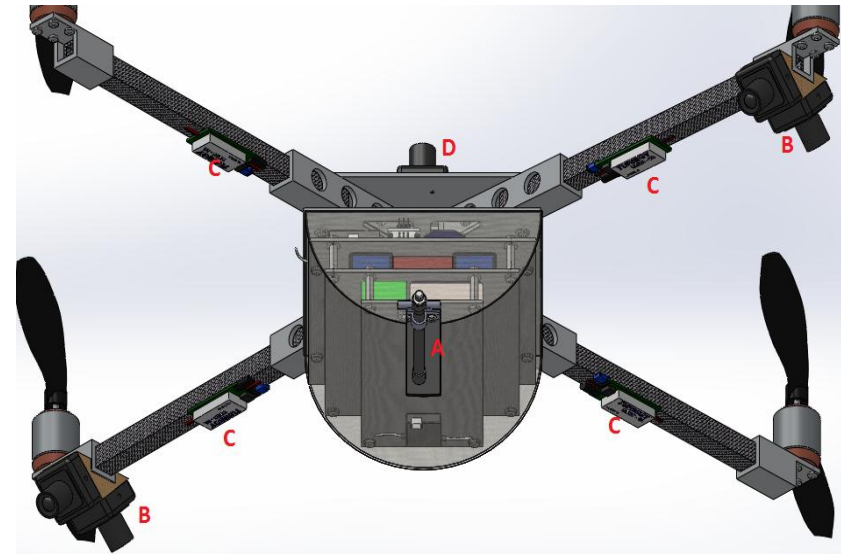
- Safely house all hardware and electronics during all phases of the mission: launch, normal operations, and recovery
- Relay telemetry and video to the ground station
- Track the nose cone and ground station

Main Payload Requirements (HALO)

- Demonstrate the ability to detect high altitude “lightning” events
- Gather atmospheric measurements of: the magnetic field, EMF radiation, ULF/VLF waves, and the local electric field.
- Gather atmospheric measurements of: pressure and temperature at a frequency no less than once every 5 seconds upon decent, and no less than once every minute after landing.

Structures and Propulsion

- Composite and aluminum structure
- Avionics housed in covered “trays” below the central platform
- Fits in a 3.5ft sabot
- Mass of ~10lbs with a 24lb thrust
- 13in propeller and 830W motor per arm



Avionics Hardware and Software

- Ardupilot – Flight computer
 - Controls attitude/position determination and correction
- Cameras – Captures images of rocket and ground
 - Five LinkSprite JPEG cameras (TTL interface with BeagleBone)
 - One up and four 45 degrees down
- BeagleBone – Embedded processor running a Linux OS
 - Collects, processes, stores, transmits camera and science data
 - Communicates relative rocket location to Ardupilot
- OpenCV – Realtime image processing
 - Runs object tracking and recognition algorithms

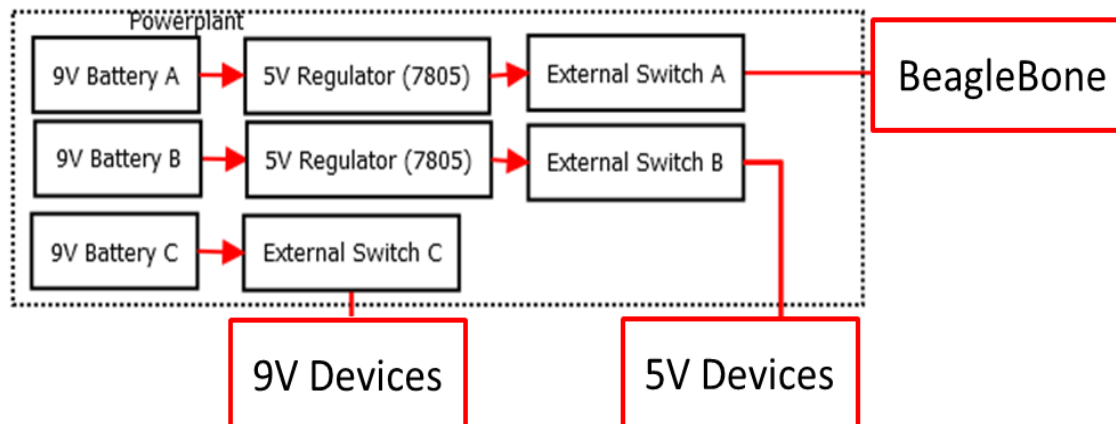
Communications and Power

Redundant TX/RX

- Transceivers
 - Xbee Pro (UART)
 - 3DR Radio (SPI)
 - Spektrum RC Transmitter (Ground)
 - Spektrum RC Receiver (Airborne)

Separate Battery Lines

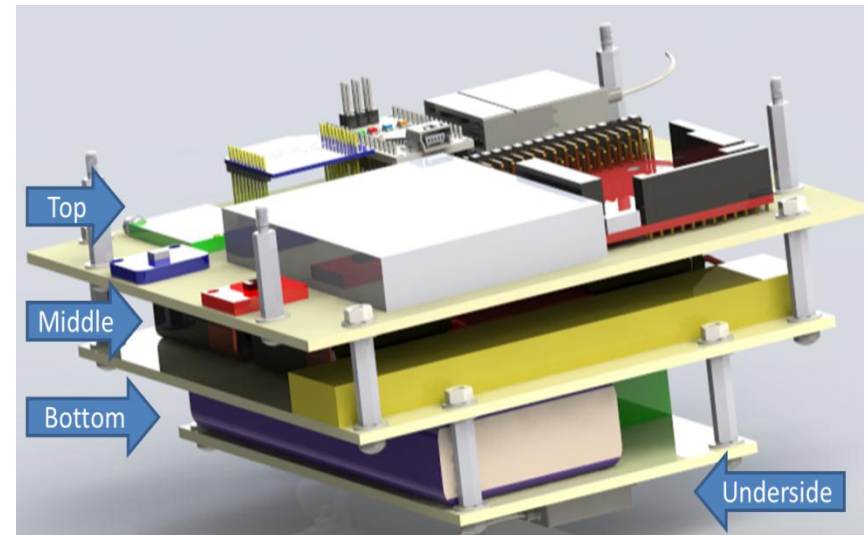
- Four 9 volt batteries power the science sensors, processor, and secondary chute
- Motors and flight computer are powered by a Turnigy 2650mAh LiPo Battery (with ESC regulators)



HALO Overview

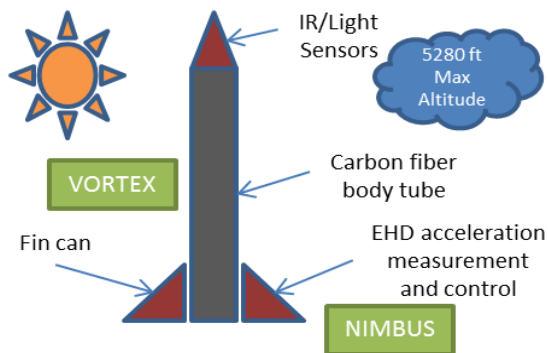
- Science Computer
 - BeagleBone
- Sensors
 - Pressure and Temperature
 - VLF Receiver
 - Magnetic Field Strength
 - Lightning Detector
- Sensors (Custom)
 - Electric Potential

“a payload to study the cause of high altitude lightning discharges and their effect on the surrounding environment, with the goal of validating existing mathematical models that lack in situ data”

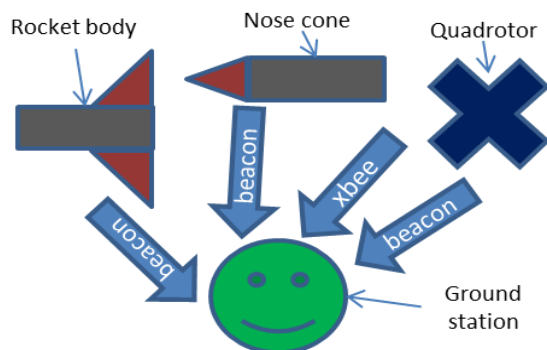


Flight Operations

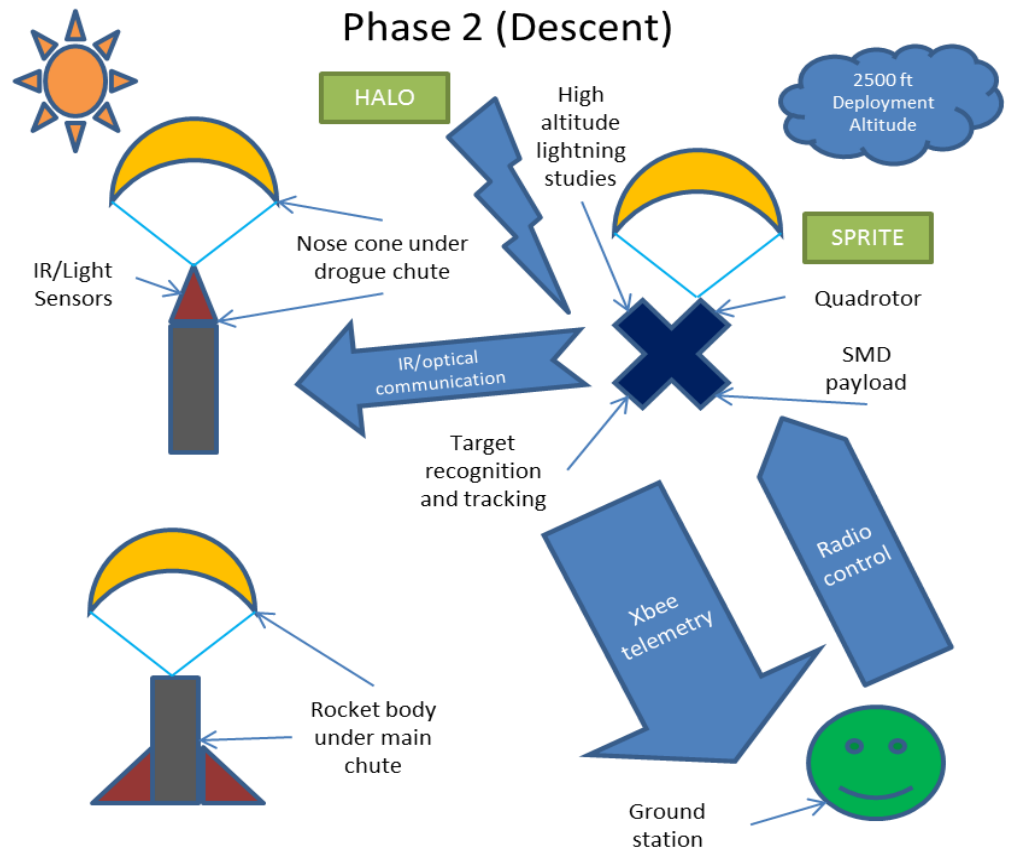
Phase 1 (Launch/Ascent)



Phase 3 (Recovery)



Phase 2 (Descent)



Milestones, Testing, and Outreach

- ~~9/29: Project initiation~~
- ~~10/29: PDR materials due~~
- 11/18: Scaled test launch
- 1/14: CDR materials due
- Jan: Scale quadrotor test
- Jan: Avionics sensors test
- Feb: Deployment test
- Feb: Full-scale test launch
- 3/18: FRR materials due
- 4/17: Travel to Huntsville
- 4/20: Competition launch
- 5/6: PLAR due

11/17: MIT Splash Weekend

Winter:

- MIT Museum
- Boston Museum
- Science on the Streets

Spring:

- Rocket Day @ MIT
- MIT Spark Weekend
- MIT Museum

QUESTIONS?

