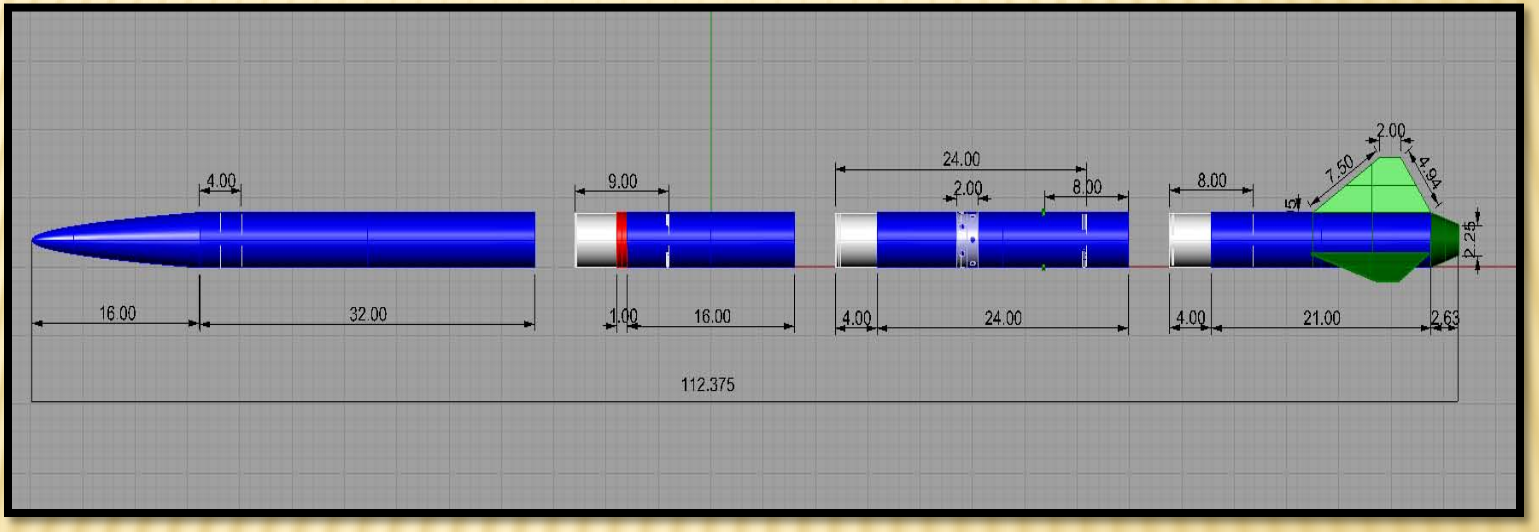
NORTHWEST INDIAN COLLEGE SPACE CENTER

Team SkyWalkers

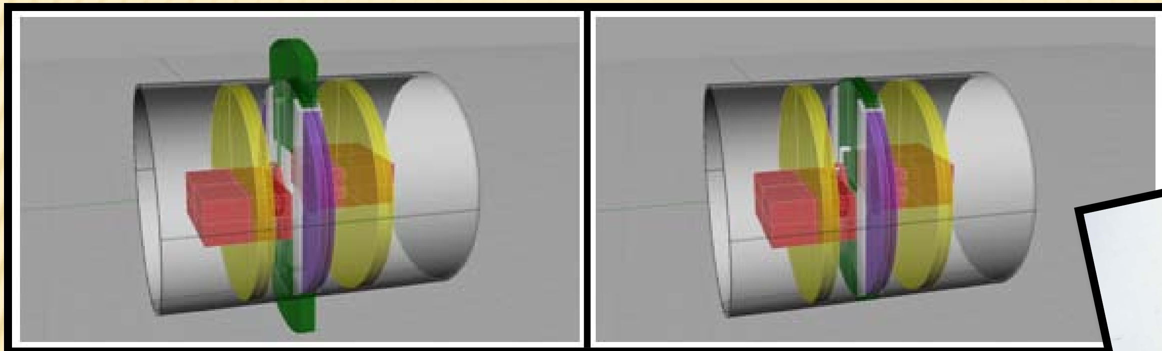
Critical Design Review

VEHICLE DIMENSIONS

Length	112.625	Diameter	4.025
Weight	23.906 lbs	Fin Span	12.025
Center of Gravity	63.424	Center of Pressure	76.287
Static Stability	3.2 (1.91 w/CTI L640 motor)		

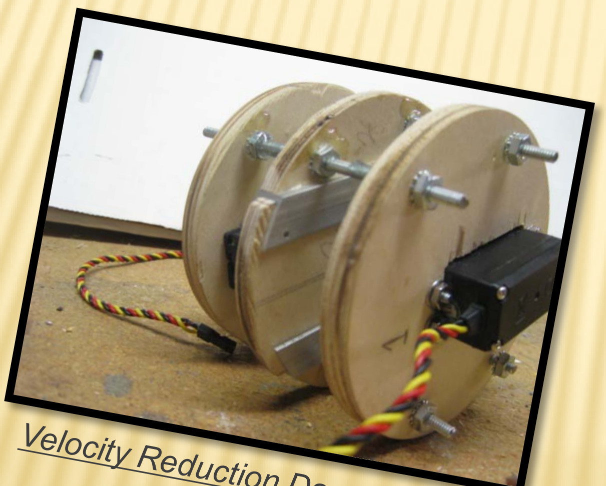


KEY DESIGN FEATURES (POWER MANAGEMENT)

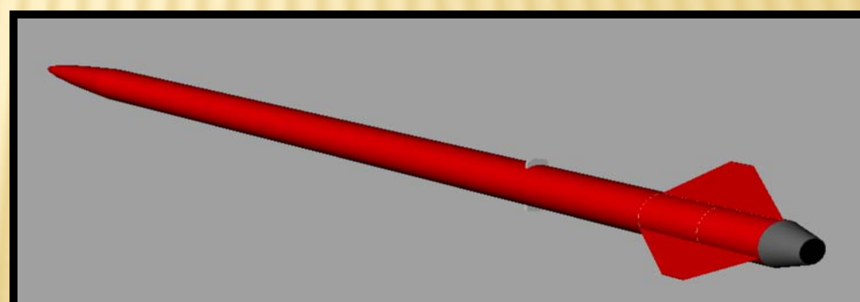


Velocity Reduction System Air Dams (L) Extended and (R) Retracted

Velocity Reduction Dams Extended

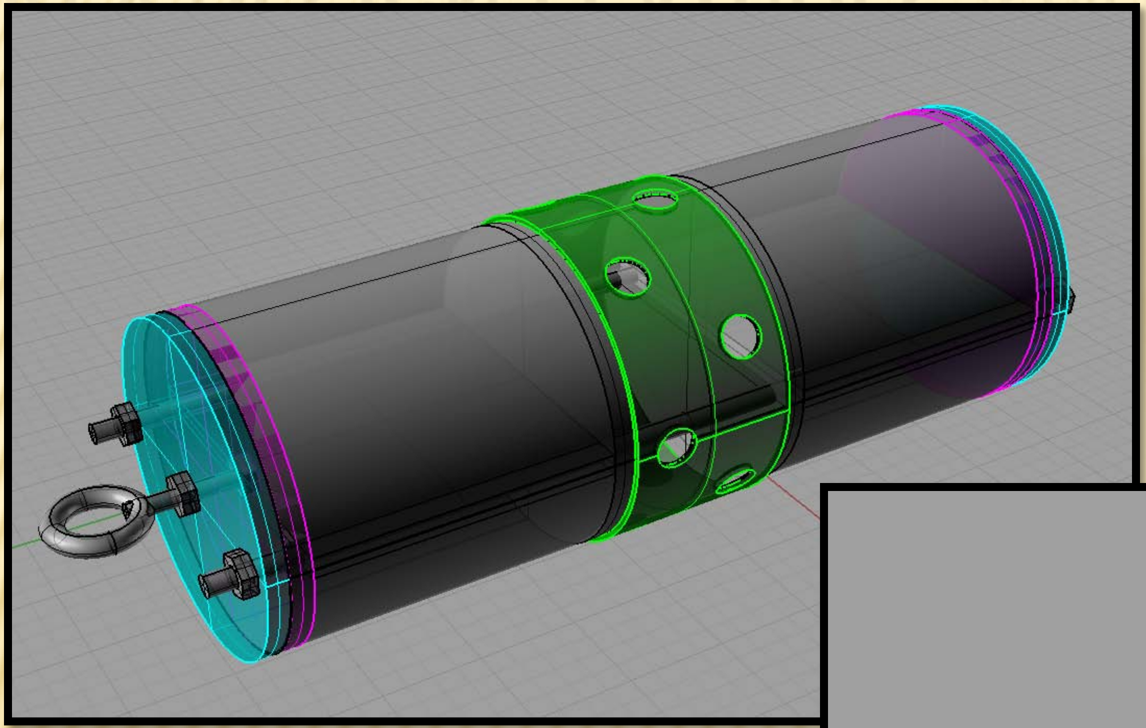


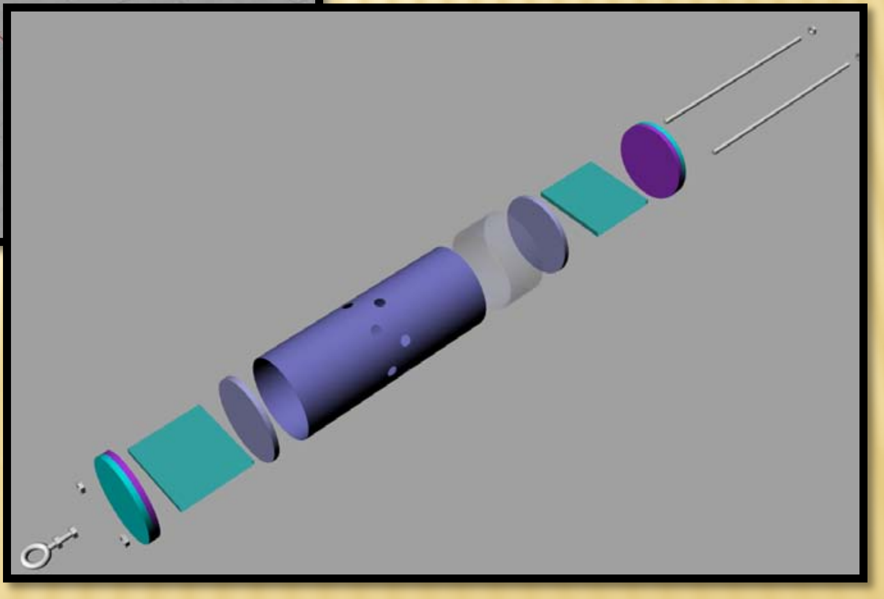
Velocity Reduction Dams Retracted



Position of the Velocity Reduction System

KEY DESIGN FEATURES (SCIENCE PAYLOAD BAY)



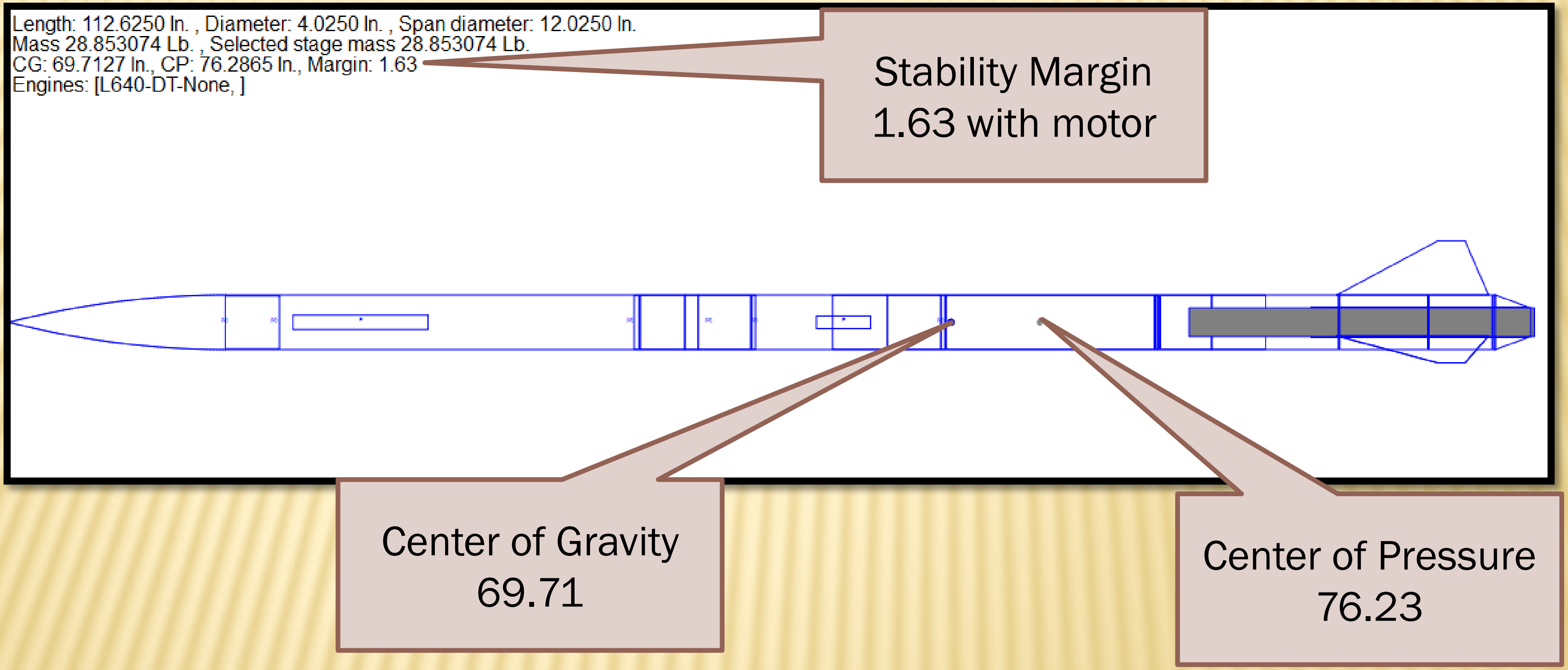


FINAL MOTOR CHOICE

Skybolt Rocket Thrust-to-Weight Ratios for Selected Motors									
Selection	Manufacturer	Motor	Maximum Thrust		Loaded Weight (lbs)	Ratio	RocSim Altitude	Case	Lift Off (fps)
			Newtons	Pounds					
	CTI	K300	561.80	126.298	27.27	4.631	4303	6GXL	35.12
	CTI	K660	1078.90	242.546	27.00	8.983	4991	6G	54.13
	CTI	L1030	1223.00	274.941	27.87	9.865	6161	6GXL	56.71
Competition	CTI	L640	1590.00	357.446	27.67	12.918	5937	6GXL	64.80
	CTI	L730	1214.90	273.120	27.67	9.871	5968	6GXL	56.71
	CTI	L935	1585.60	356.457	28.32	12.587	7133	6GXL	60.35
	CTI	L990	1702.70	382.782	27.65	13.844	6112	6GXL	59.92
	Aerotech	K375	1371.80	308.393	27.36	11.272	3962	54/2560	51.52
Practice	Aerotech	K828	1510.99	339.685	27.62	12.299	4032	54/2560	49.88
Practice	Aerotech	K1275	1554.00	349.353	27.26	12.816	4112	54/1760	60.97

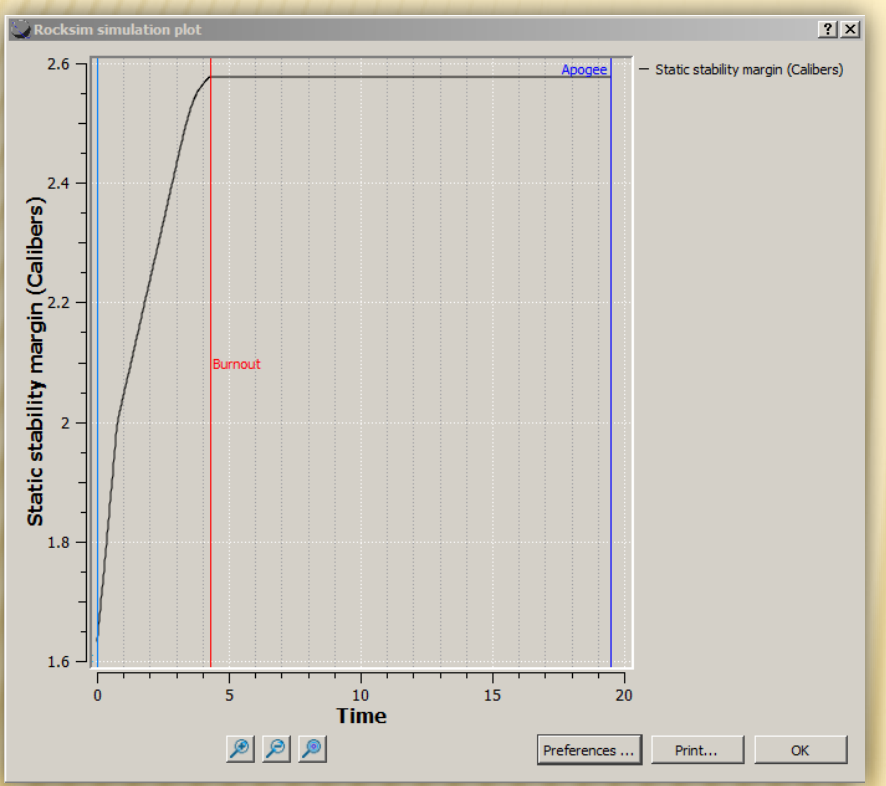
- Motor has enough thrust to get the rocket safely off the launch rail.
- Motor has enough thrust to achieve the predicted altitude.

STATIC STABILITY MARGIN

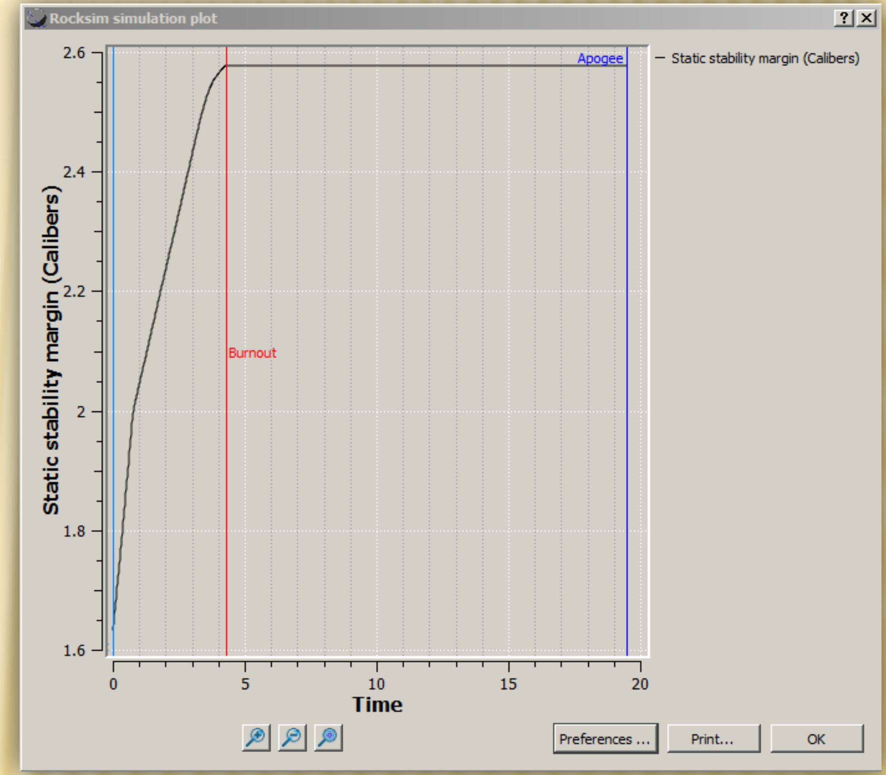


Stability Margin = (CP-CG)/Diameter

STATIC STABILITY FROM LIFTOFF TO APOGEE



Static Stability with Air Dams Retracted



Static Stability with Air Dams Extended

THRUST-TO-WEIGHT RATIO

Thrust to Weight Ratio = Pounds of Thrust/Weight of Skybolt

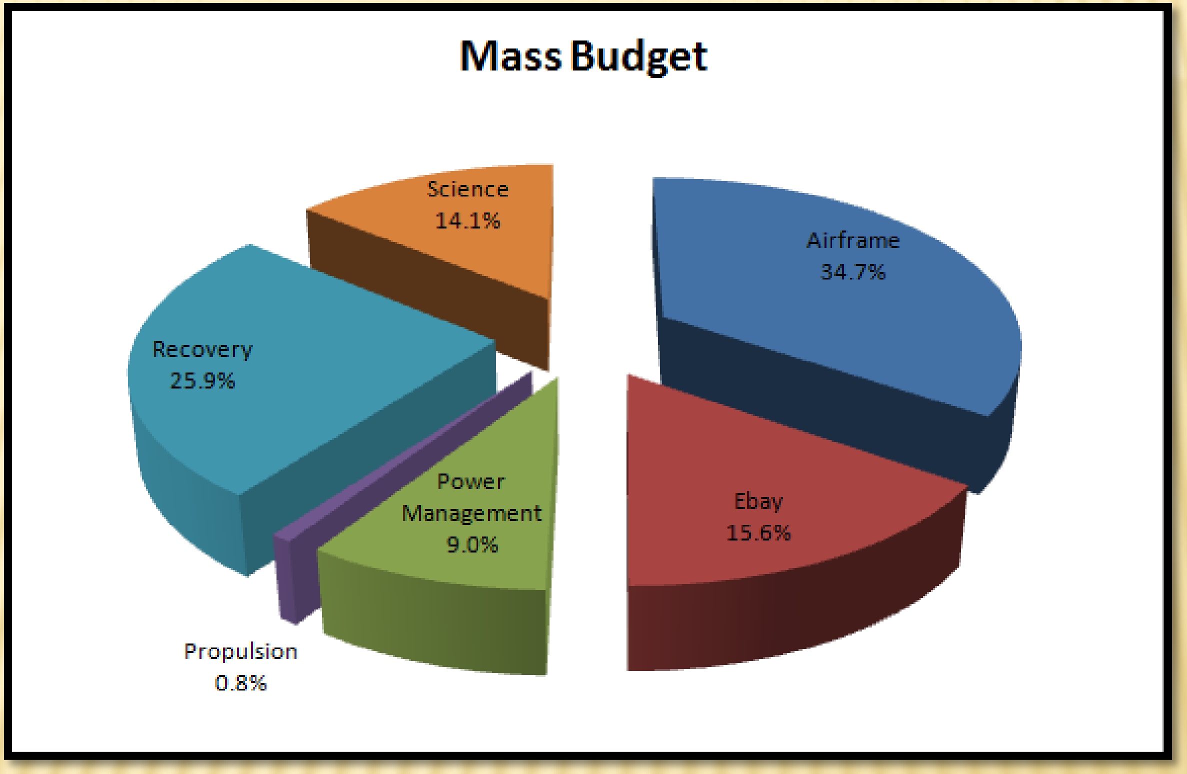
Selection	Manufacturer	Motor	Maximum Thrust		Loaded Weight (lbs)	Ratio	RocSim Altitude	Case	Lift Off (fps)
			Newtons	Pounds					
Competition	**CTI**	L640	1590.00	357.446	27.67	12.918	5937	6GXL	64.80

Rail Exit Velocity
64.8 fps

MASS STATEMENT

Mass Statement		
Material	**Component**	**Mass (lb)**
Aluminum	Tail Cone	0.170
G10 Fiberglass	Fin Can	1.125
G10 Fiberglass	Aft Airframe	0.857
G10 Fiberglass	Fwd Airframe	1.714
G10 Fiberglass	Nose Cone	0.823
G10 Fiberglass	Science Payload Bay	0.750
G10 Fiberglass	Ebay Ring	0.071
G10 Fiberglass	Fin Can Tube Coupler	0.478
G10 Fiberglass	Science Bay Tube Coupler	0.478
G10 Fiberglass	Ebay Coupler	0.478
Steel	Threaded Rod	0.375
Steel	Nose Cone Eyebolt	0.125
Steel	Fwd Ebay Eyebolt	0.125
Steel	Aft Ebay Eyebolt	0.125
Steel	Fwd Science Bay Eyebolt	0.125
Steel	Aft Science Bay Eyebolt	0.125
Steel	Fin Can Eyebolt	0.125
Nylon	Main Parachute	1.813
Nylon	Drogue Parachute	0.375
	Avionics (altimeters, batteries)	2.000
	Science Payload (sensors, transmitter, cameras	2.500
Tubular Nylon	Main Recovery Harness	1.500
Tubular Nylon	Drogue Recovery Harness	1.000
	GPS Unit	1.000
G10 Fiberglass	Nose Cone Bulkhead	0.077
G10 Fiberglass	Fwd Ebay Bulkhead	0.077
G10 Fiberglass	Aft Ebay Bulkhead	0.077
G10 Fiberglass	Fwd Science Bay Bulkhead	0.077
G10 Fiberglass	Aft Science Bay Bulkhead	0.077
G10 Fiberglass	Fwd Motor Mount Center Ring	0.075
G10 Fiberglass	Mid Motor Mount Center Ring	0.075
G10 Fiberglass	Aft Motor Mount Center Ring	0.075
	Power Management System	2.500
G10 Fiberglass	Fin Set	0.902
	Epoxy	1.000
	Paint	1.000
	Total Mass=	**23.906**

MASS BUDGET AND MASS MARGIN



The selected motor has reserve power for six extra pounds, which is about 25% of the designed weight. This extra weight will not adversely affect the stability margin or the target altitude. It moves the CG 2” forward.

PARACHUTE & HARNESS INFORMATION

Drogue

- 20 foot 9/16" tubular nylon harness connected to ¼" solid eyebolts with quick lines at either end.
- 24" B2Rocketry Skyangle Cert 3 Drogue

Main

- 30 foot 9/16" tubular nylon harness connected to ¼" solid eyebolts with quick lines at either end.
- 52" B2Rocketry Skyangle Classic

KINETIC ENERGY COMPUTATIONS

	Section 1	Section 2	Section 3
	Nose/Main	Ebay	Science/Fin Can
Wgt	6.44	2.26	13.37
V	78.82	78.82	78.82
v^2	40009.10	14040.46	83062.36
1/2	20004.55	7020.23	41531.18
KE	621.26	218.02	1289.79

KE Drogue Calculations

	Section 1	Section 2	Section 3
	Nose/Main	Ebay	Science/Fin Can
Wgt	6.44	2.26	13.37
V	78.82	78.82	78.82
v^2	40009.10	14040.46	83062.36
1/2	20004.55	7020.23	41531.18
KE	621.26	218.02	1289.79

KE Main Calculations

DRIFT PREDICTIONS

Latitude: 34° 38' 50" N

Longitude: 86° 33' 11" W

Elevation: 827 feet

Location: Braggs Farm, Toney, AL

Relative humidity: 77 %

Temperature: 65 Deg. F

Pressure: 30.27 In.

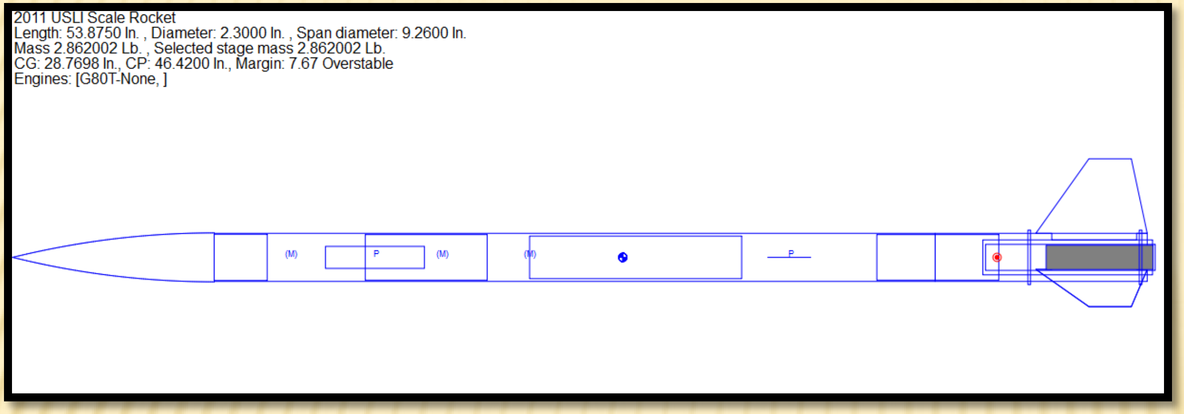
Drift Distance in Various Wind Speeds and Guide Rail Angle

	Wind Speed (Kts)				
Guide Rail Angle	0	5	10	15	20
0	0	295	1022	1517	2918
5	-1068	-756	257	917	2398
10	-2086	-1278	-1193	250	1592
15	-3014	-2167	-2157	-618	-868
20	-3819	-3108	-2870	-1287	-269

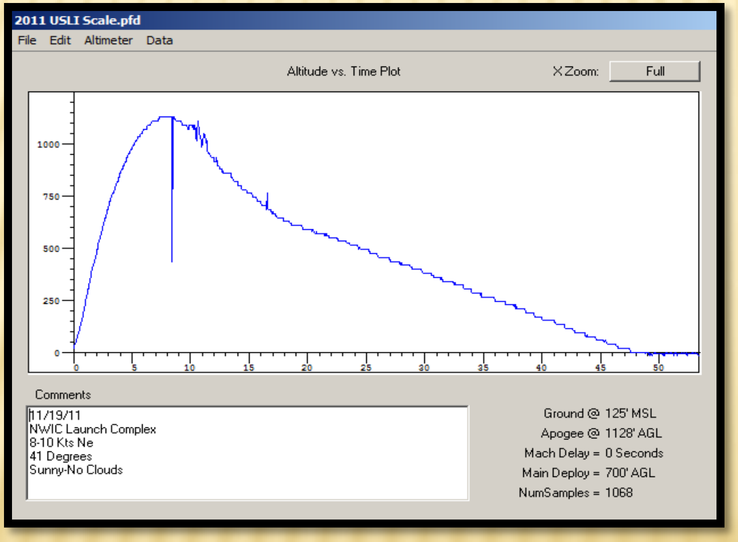
TEST PLANS & PROCEDURES

Team Sky Walkers Major Milestone Schedule		
Proposal Submitted	**Completed**	**9/6/11**
Scale Rocket	**Design Complete**	**10/5/11**
Scale Rocket	Construction Complete	10/17/11
	Completed Flight Test	11/12/11
Selection Notification	**Selected!**	**10/17/11**
USLI Team Teleconference	**Completed**	**10/21/11**
Web Presence Established	**Completed**	**11/4/11**
Competition Rocket	**Initial Design Considerations**	**9/9/11**
Competition Rocket	Design Finalized	10/20/11
	Construction Started	10/28/11
	Construction Complete	11/22/11
Competition Rocket	Recovery System Ground Test-Completed	11/23/11
	Test Flights as needed	1/28/12
		2/4/12
		2/18/12
		3/3/12
		3/17/30
		3/31/30
Science Payload	**Initial Design Considerations**	**9/6/11**
Science Payload	Design Finalized (Completed)	10/31/11
	Construction Started	11/1/11
	Construction Complete	2/15/12
	Operational Testing	2/15/12
	Testing Complete	3/20/12
	Test Flight	3/31/12
Preliminary Design Review Submitted	**Completed**	**11/27/11**
Preliminary Design Review Presentation	**Completed**	**12/6/11**
Critical Design Review Submitted	**Completed**	**1/25/12**
Critical Design Review Presentation		**2/7/12**
Flight Readiness Review Submitted		**4/21/12**
Flight Readiness Review Presentation		**4/11/12**
Launch		**4/21/12**
Post flight Analysis Review		**5/7/12**
Announcement of Winning USLI Team		**5/18/12**

SCALE MODEL FLIGHT TEST



The Rocksim data for the subscale model indicates that all desirable parameters are well within requirements. Launch conditions in Rocksim were set to match the conditions at the time of launch.

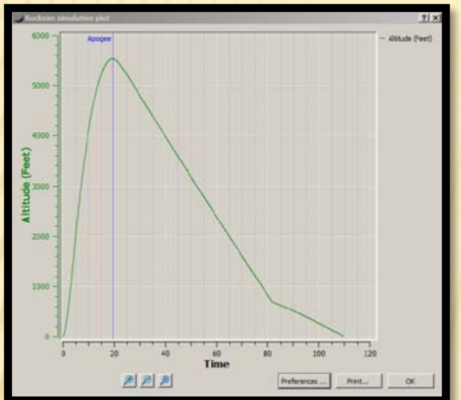


The altitude data from the PerfectFlite MAWD matches with the predicted altitude at 94%, 1194 feet predicted, 1128 feet reported.

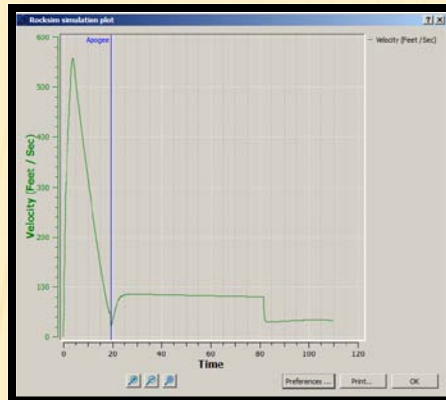
One other impact learned from the actual flight data is that there appears to be leak in the ebay which caused the spike shortly after apogee. We hypothesis that the spike was caused by the drogue ejection charge. A smaller spike about the time and altitude of the main ejection charge is possibly also from a small leak where the ejection gasses enter the electronic bay.

Both leaks may be the result of our design. In our scale rocket the ebay did not separate from the airframe as is traditional. The ebay was fastened near the middle of the airframe and the parachutes were ejected from either end of the airframe with the planned result that the parachutes would support the airframe horizontally. Having the ebay exposed to the ejection charge in a confined space may have made the necessity for air tightness more prominent.

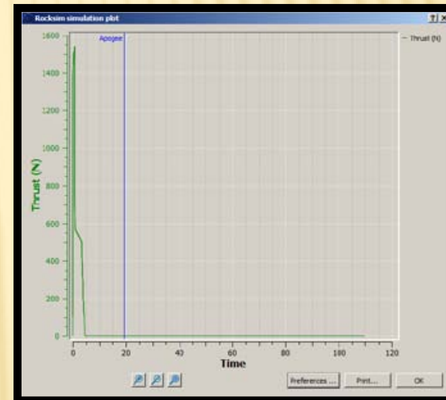
STAGED RECOVERY SYSTEM TESTS



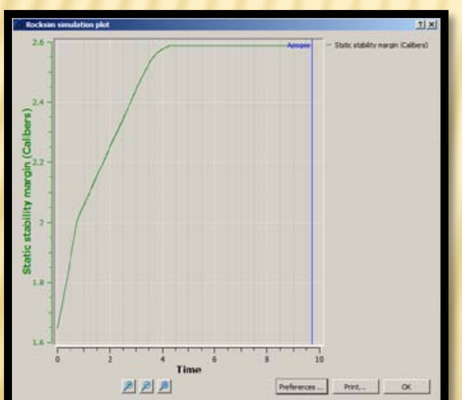
Altitude



Velocity

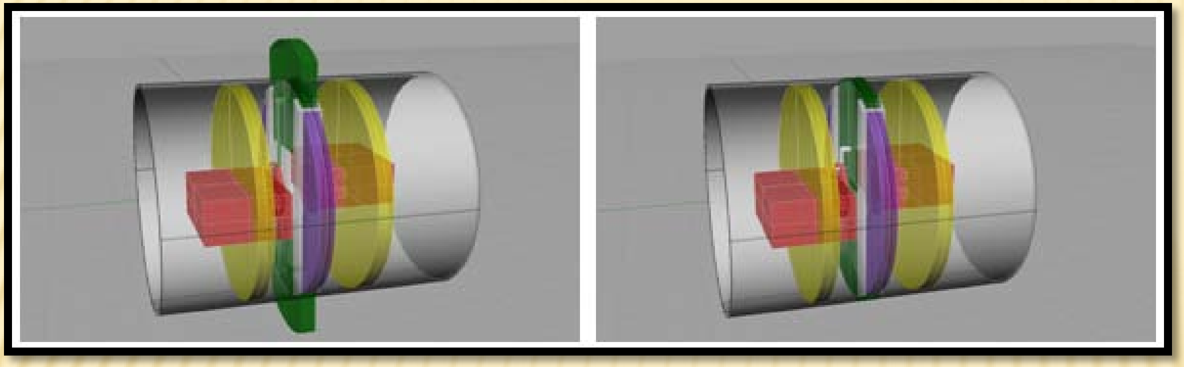


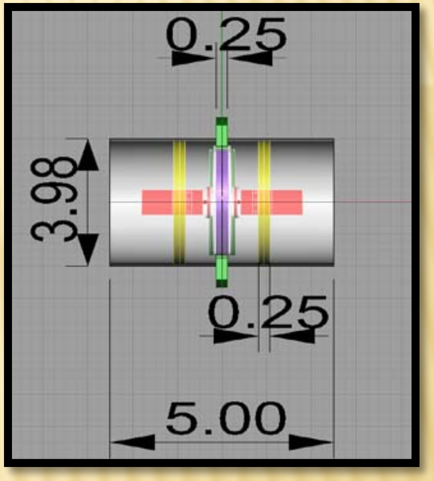
Simulated CTI L640-DT Motor Thrust Curve



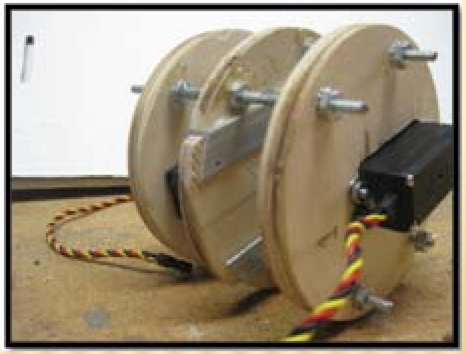
Path of Static Stability Margin from liftoff to 1 second after apogee. It’s the same for when the air dams are extended or retracted.

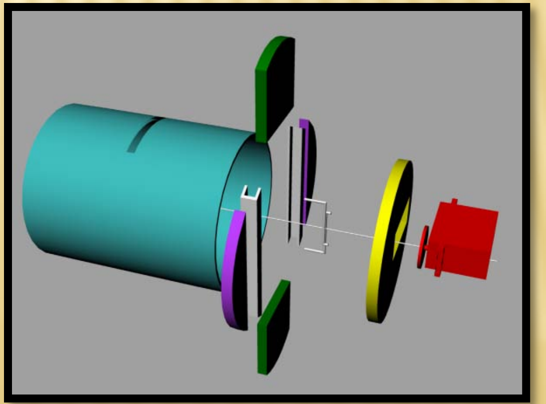
POWER MANAGEMENT SYSTEM



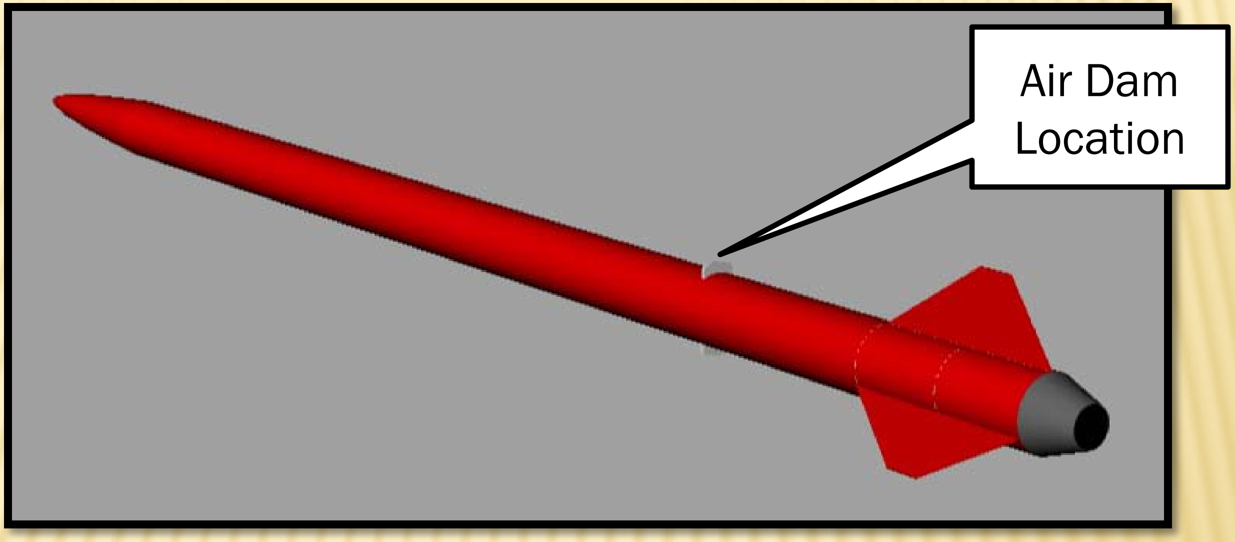


Velocity Reduction System





POWER MANAGEMENT SYSTEM



Power Management System Concept with Arduino-Controlled Hi Torque Servo Controlled Velocity Reduction System

Rocksim indicates that the CP moves 0.25 inches forward with the dams extended. The CD increases from 0.52 to 7.0. There is no measureable difference in static stability with the dams extended or retracted.

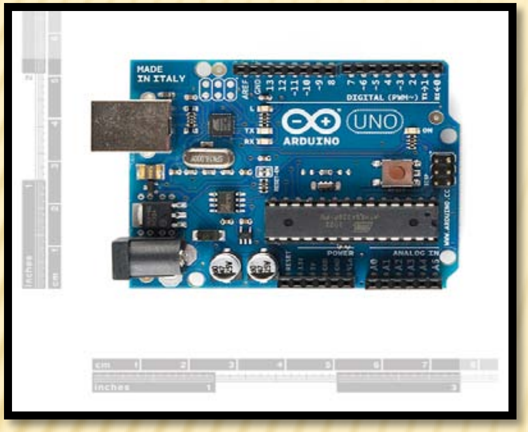
TRAJECTORY NUMERICAL SIMULATION PROGRAM

Rocket	USLI			Chute diam	Dc	2				
Rckt Mass (empty)	Mr	10.99		Time Incr	dt	0.1				
Eng. Case mass	Me	0.772		Mass Decr (propellant burned)	dm	0.31897019		Avg. Thrust		
Propellant mass	Mp	1.177		Grav. Const	gc	9.8		650.59		
Diameter, rocket	Dr	0.10244		Area, (widest part)	A	0.008241932				
Impulse, motor(N-sec)	Im	2437		Chute area	A_2	3.141592654		True Impulse		
Thrust (Newtons)	Ta	659		Burn Time	tb	3.69		2400.66		
Air Density (kg/m^3)	rho	1.2		Eject time	te	17.97	Peak kph	Peak (m)	Peak (ft)	Peak mph
Drag coef	Cd	0.52					148.26	1192.41	3911.10	331.66

Flight Time	Drag Force	Thrust	Net Force	Mass	Acceleration	Velocity (m/s)	Altitude (m)	Rocket Area		Air Density
t	Fd	Ft	F	M	Acc	V	Y	Area	mph	rho
0.0	0.00	0.00	-126.80	12.94	0.00	0.00	0.00	0.01	0.00	1.22
0.1	0.00	1065.32	938.83	12.91	72.74	7.27	1.09	0.01	16.27	1.22
0.2	0.19	1020.05	893.69	12.88	69.41	14.21	2.86	0.01	31.80	1.22
0.3	0.71	990.12	863.54	12.84	67.24	20.94	5.29	0.01	46.84	1.22
0.4	1.54	966.76	839.67	12.81	65.54	27.49	8.37	0.01	61.50	1.22
0.5	2.66	949.45	821.55	12.78	64.29	33.92	12.08	0.01	75.88	1.22
0.6	4.04	932.14	803.17	12.75	63.01	40.22	16.42	0.01	89.98	1.22
0.7	5.68	914.83	784.53	12.72	61.70	46.39	21.37	0.01	103.78	1.22
0.8	7.56	897.52	765.66	12.68	60.37	52.43	26.91	0.01	117.28	1.22

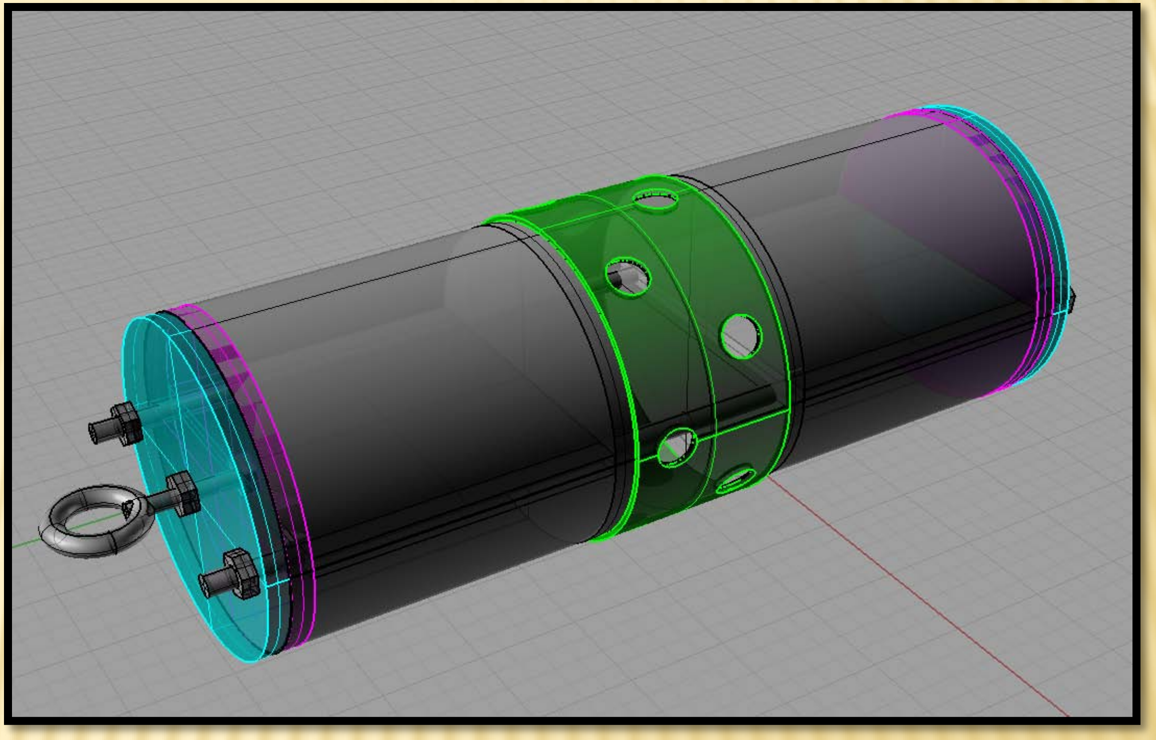
Sample data with CTI L640 motor

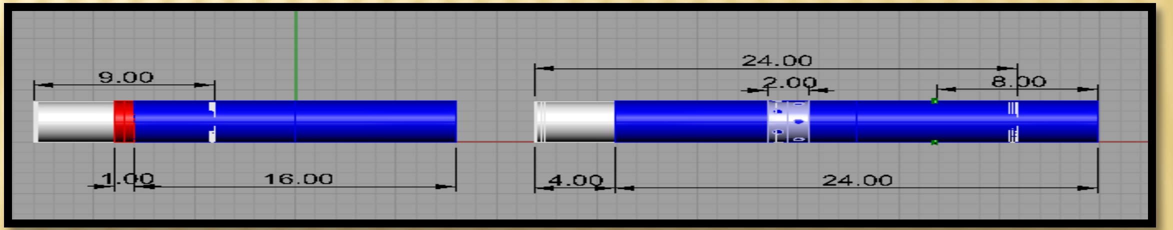
FINAL PAYLOAD DESIGN OVERVIEW



Arduino Uno

Adafruit Data Logger installed on Uno

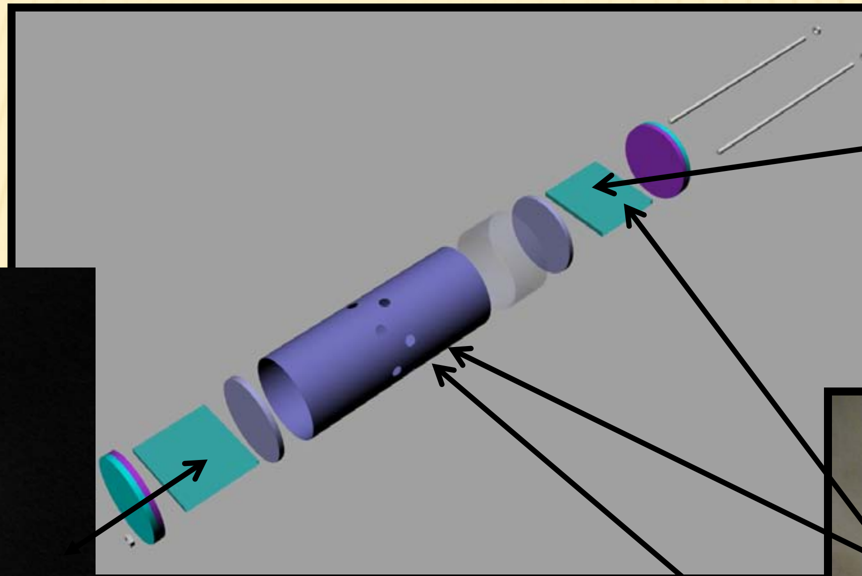


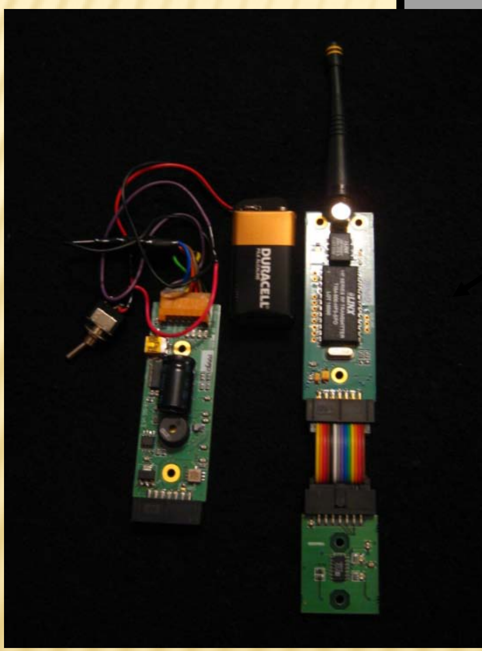


Ebay, Drogue Parachute Bay, and Science Payload Bay

FINAL PAYLOAD DESIGN OVERVIEW

Arduino

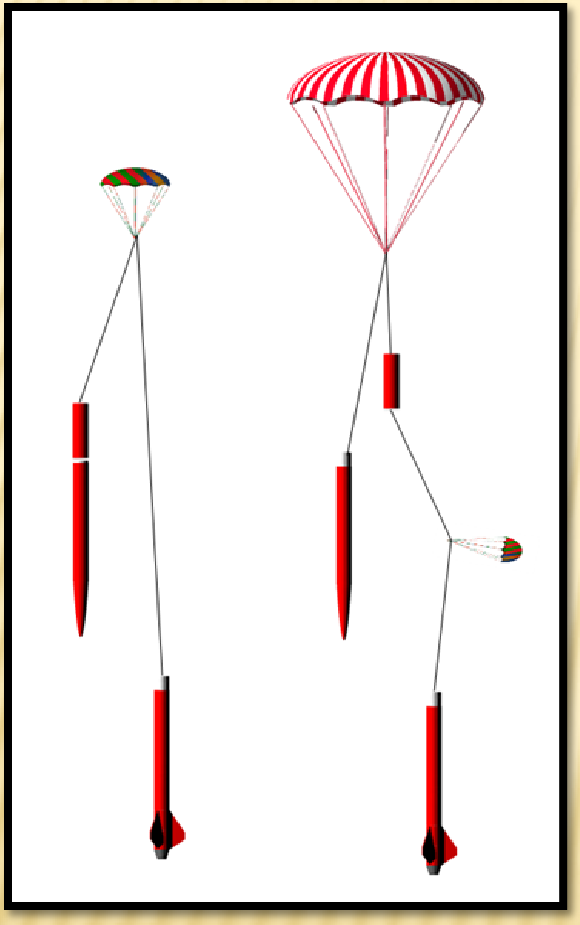




TR74UI

900 MHz Transmitter

RECOVERY SYSTEM



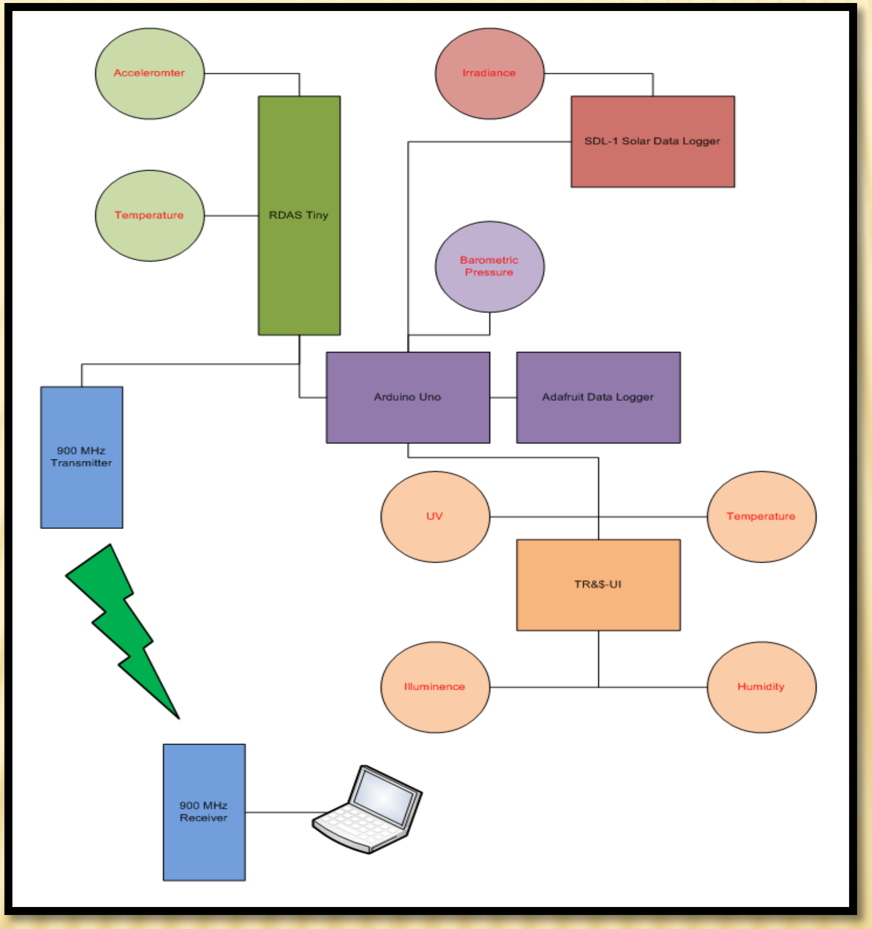
- Recovery harnesses - 9/16’ tubular nylon.
- Drogue harness - 20 feet long.
- Main harness - 30 feet long.
- Each harness end is connected to a 3/8” closed eyebolt with quick links.

RECOVERY SYSTEM PROPERTIES

Recovery System Properties				
Drogue Parachute				
Manufacturer/Model	Sky Angle Cert3			
Size	24"			
Altitude at Deployment (ft)	5,280			
Velocity at Deployment (ft/s)	34.5			
Terminal Velocity (ft/s)	72.42			
Recovery Harness Material	Tubular Nylon			
Harness Size/Thickness (in)	9/16"			
Recovery Harness Length (ft)	30			
Harness/Airframe Interfaces	3/8' closed steel eyebolt			
Kinetic Energy During Descent (ft-lb)	Section 1	Section 2	Section 3	Section 4
	162.88	977.23	1140.14	

Recovery System Properties				
Main Parachute				
Manufacturer/Model	Sky Angle Cert3 Xlarge			
Size	89 sq ft			
Altitude at Deployment (ft)	700			
Velocity at Deployment (ft/s)	72.42			
Landing Velocity (ft/s)	12.11			
Recovery Harness Material	Tubular Nylon			
Harness Size/Thickness (in)	9/16"			
Recovery Harness Length (ft)	20			
Harness/Airframe Interfaces	3/8" closed steel eyebolt			
Kinetic Energy Upon Landing (ft-lb)	Section 1	Section 2	Section 3	Section 4
	6.31	37.84	44.14	

PAYLOAD INTEGRATION



Preliminary Instrumentation Block Diagram

PAYLOAD SUBSYSTEMS

Sensors	silicon photo detector	These will be used to take readings on descent and after landing.
	temperature/humidity sensor	
	UV sensor	
	pressure sensor	
Controllers	Arduino Uno Microcontroller	This will be used to activate the devices and integrate the data collected.
Data Logger	Adafruit Data Logger	The data logger collects the data directed through the micro controller from the sensors. It stores this data for retrieval after landing.
Power Management	Arduino Pro Mini	This takes the readings from the barometric sensor and velocity and calculates when to deploy the velocity reduction system flaps.
	HiTec HS 645MG Ultra Torque Servo	This controls the velocity reduction system flaps.
	BMP 085 Barometric Sensor	

PAYLOAD VERIFICATION

<table>
<tr><th>Requirement</th><th>Design Feature</th><th>Verification</th><th>Status</th></tr>
<tr><td>The payload shall gather data for studying the atmosphere during descent and after landing. Measurements shall include pressure, temperature, relative humidity, solar irradiance and ultraviolet radiation. Measurements shall be made at least every 5 seconds during descent and every 60 seconds after landing. Surface data collection operations will terminate 10 minutes after landing.</td><td>Arduino microcontroller-based sensors</td><td>Test</td><td>Work in Progress</td></tr>
<tr><td>The payload shall take at least 2 pictures during descent and 3 after landing.</td><td rowspan="2">Multiple Cameras oriented appropriately</td><td rowspan="2">Test</td><td>Cameras purchased</td></tr>
<tr><td>The payload shall remain in an orientation during descent and after landing such that the pictures taken portray the sky toward the top of the frame and the ground toward the bottom of the frame.</td><td>Work in Progress</td></tr>
<tr><td>The data from the payload shall be stored onboard and transmitted wirelessly to the team's ground station at the time of completion of all surface operations.</td><td>900 MHz transmitter &receiver</td><td>Test</td><td>Work in Progress</td></tr>
</table>

PAYLOAD TEST PLAN

- Test each component as it's built
- Gather baseline data for each component
- Integrate one component at a time and verify it's functioning satisfactorily
- Ground test entire system
- Flight test payload

INTERNAL & EXTERNAL INTERFACES

Connecting the Components

Three different connection methods are used:

1. Those that need intermittent access use #6, #8, or #10 T-nuts and screws.
2. Temporary connections between the ebay and the two parachute compartments use nylon shear pins. The shear pins prevent the rocket from premature separation due a combination of drag, inertia, and momentum. The shear pins are, however, designed to fail when the black powder ejection charge is ignited.
3. Permanent connections use West System epoxy.

Bulkheads and Centering Rings

The bulkheads provide recovery harness mounts, confine the different components, and protect the components and electronics from black powder charges ignited during recovery system deployment. Eye-bolts are used on the bulkheads to provide a connection point for the recovery harnesses. The material for all bulkheads is 3/16 inch G10 fiberglass.

REQUIREMENTS VERIFICATION STATUS

Requirement	Design Feature	Verification	Status
1. Option 2: The Science Mission Directorate (SMD) at NASA HQ will provide a $3,000 sponsorship to any team that chooses to build and fly a deployable science payload meeting the following criteria:	SMD Payload	Inspection	Work in Progress
The payload shall gather data for studying the atmosphere during descent and after landing. Measurements shall include pressure, temperature, relative humidity, solar irradiance and ultraviolet radiation. Measurements shall be made at least every 5 seconds during descent and every 60 seconds after landing. Surface data collection operations will terminate 10 minutes after landing.	Arduino microcontroller-based sensors	Test	Work in Progress
The payload shall take at least 2 pictures during descent and 3 after landing.	Multiple Cameras oriented appropriately	Test	Cameras purchased
The payload shall remain in an orientation during descent and after landing such that the pictures taken portray the sky toward the top of the frame and the ground toward the bottom of the frame.			Work in Progress
The data from the payload shall be stored onboard and transmitted wirelessly to the team's ground station at the time of completion of all surface operations.	RDAS-Tiny transmitter & receiver	Test	Work in Progress
Separation of payload components at apogee will be allowed, but not advised. Separating at apogee increases the risk of drifting outside of the recovery area. The payload shall carry a GPS tracking unit. Minimum separation altitude shall be 2,500 ft.	Not Applicable	Not Applicable	Not Applicable

Requirement	Design Feature	Verification	Status
5. The recovery system electronics shall be shielded from all onboard transmitting devices, to avoid inadvertent excitation of the recovery system by the transmitting device(s).	Ebay lined with aluminum foil	Inspection	Completed
6. The launch vehicle and science or engineering payload shall remain subsonic from launch until landing.	Designed with Rocksim 9 to stay subsonic	Simulation	Work in Progress
7. The launch vehicle and science or engineering payload shall be designed to be recoverable and reusable. Reusable is defined as being able to be launched again on the same day without repairs or modifications.	Designed with Rocksim 9	Simulation	Work in Progress
8. The launch vehicle shall stage the deployment of its recovery devices, where a drogue parachute is deployed at apogee and a main parachute is deployed at a much lower altitude. Tumble recovery from apogee to main parachute deployment is permissible, provided that the kinetic energy is reasonable.	Designed with Rocksim 9, using drogue at apogee and main at 700 feet	Simulation	Work in Progress
9. Removable shear pins shall be used for both the main parachute compartment and the drogue parachute compartment.	6 (3 each on main and drogue end of ebay) - #2-56 nylon screws will be shear pins	Ground Testing	Completed
10. The launch vehicle shall have a maximum of four (4) independent or tethered sections.	Designed with three	Inspection	Completed
a. At landing, each independent or tethered sections of the launch vehicle shall have a maximum kinetic energy of 75 ft-lbf.	Designed via calculations	Simulation	Complete
b. All independent or tethered sections of the launch vehicle shall be designed to recover with 2,500 feet of the launch pad, assuming a 15 mph wind.	Designed with Rocksim 9	Simulation analysis	Complete
11. The launch vehicle shall be capable of being prepared for flight at the launch site within 2 hours, from the time the waiver opens.	Designed as required	Check lists	Completed

Requirement	Design Feature	Verification	Status
12. The launch vehicle shall be capable of remaining in launch-ready configuration at the pad for a minimum of 1 hour without losing the functionality of any onboard component.	Battery power calculated to last at least 2 hrs for each device using a battery	Simulation analysis	Work in Progress
13. The launch vehicle shall be launched from a standard firing system (provided by the Range) using a standard 10 - second countdown	Designed as required	Test	Work in Progress
14. The launch vehicle shall require no external circuitry or special ground support equipment to initiate the launch (other than what is provided by the Range).	None are necessary as designed	Inspection	Completed
15. Data from the science or engineering payload shall be collected, analyzed, and reported by the team following the scientific method.	Data analysis will be examined post flight	Testing will follow payload completion prior to the competition flight	Work in Progress
16. An electronic tracking device shall be installed in each independent section of the launch vehicle and shall junction with an electronic, transmitting device, but shall not replace the transmitting tracking device.	Garmin GPS unit in nose cone	Ground tested complete. Flight test to follow	Completed
17. The launch vehicle shall use a commercially available solid motor propulsion system using ammonium perchlorate composite propellant (APCP) which is approved and certified by the National Association of Rocketry (NAR), Tripoli Rocketry Association (TRA) and/or the Canadian Association of Rocketry (CAR).	Designed to use CTI/Aerotech reloadable motor	Inspection	Completed
18. The total impulse provided by the launch vehicle shall not exceed 5,120 Newton-seconds (L-class). This total impulse constraint is applicable to any combination of one or more motors.	Designed as required, L motor largest permissible	Inspection	Completed

Requirement	Design Feature	Verification	Status
19. All teams shall successfully launch and recover their full scale rocket prior to FRR in its final flight configuration.			
a. The purpose of the full scale demonstration flight is to demonstrate the launch vehicle's stability, structural integrity, recovery systems, and the team's ability to prepare the launch vehicle for flight.	Test flights scheduled prior to FRR	Test flight	Work in Progress
b. The vehicle and recovery system shall have functioned as designed.	Extensive ground testing where possible, test flights for the vehicle	Test flight	Work in Progress
c. The payload does not have to be flown during the full-scale test flight.			
▪ If the payload is not flown, mass simulators shall be used to simulate the payload mass.	Measured mass of actual payload will be either substituted or the payload will be flown	Test flight	Work in Progress
▪ If the payload changes the external surfaces of the launch vehicle (such as with camera housings and/or external probes), those devices must be flown during the full scale demonstration flight.	Test flight will be with rocket as its designed		Work in Progress
d. The full scale motor does not have to be flown during the full scale test flight. However, it is recommended that the full scale motor be used to demonstrate full flight readiness and altitude verification.	Both smaller and a full scale motor will be used in test flights	Test flight	Work in Progress
e. The success of the full scale demonstration flight shall be documented on the flight certification form, by a Level 2 NAR/TRA observer.	Our mentor and 3 other NAR L2 individuals are available		Work in Progress
f. After successfully completing the full-scale demonstration flight, the launch vehicle or any of its components shall not be modified without the concurrence of the NASA Range Safety Officer.	No changes will be made.		Work in Progress

Requirement	Design Feature	Verification	Status
20. The following items are prohibited from use in the launch vehicle:			
a. Flashbulbs. The recovery system must use commercially available low-current electric matches.	None of these have been included in the rocket design	Inspection	Complete
b. Forward canards.			
c. Forward firing motors.			
d. Rear ejection parachute designs.			
e. Motors which expel titanium sponges (Sparky, Skidmark, MetalStorm, etc.).			
f. Hybrid motors.			
21. Each team shall use a launch and safety checklist. The final checklist shall be included in the FRR report and used during the flight hardware and safety inspection and launch day.	Check lists are designed	Inspection and actual testing	Complete
22. Students on the team shall do 100% of the work on the project, including design, construction, written reports, presentations, and flight preparation with the exception of assembling the motors and handling black powder charges.	Implemented as required	Inspection	Work in Progress
23. The rocketry mentor supporting the team shall have been certified by NAR or TRA for the motor impulse of the launch vehicle, and the rocketeer shall have flown and successfully recovered (using electronic, staged recovery) a minimum of 15 flights in this or a higher impulse class, prior to PDR.	Implemented as required	Inspection	Complete

Requirement	Design Feature	Verification	Status
24. The maximum amount teams may spend on the rocket and payload is $5000 total. The cost is for the competition rocket as it sits on the pad, including all purchased components and materials and the fair market value of all donated components and materials. The following items may be omitted from the total cost of the vehicle:			
a. Shipping costs.	Implemented as required	Inspection	Complete
b. Ground Support Equipment.			
c. Team labor.			