

Northwest Indian College Space Center
**Team RezRiders and rocket,
Frankenstein II**



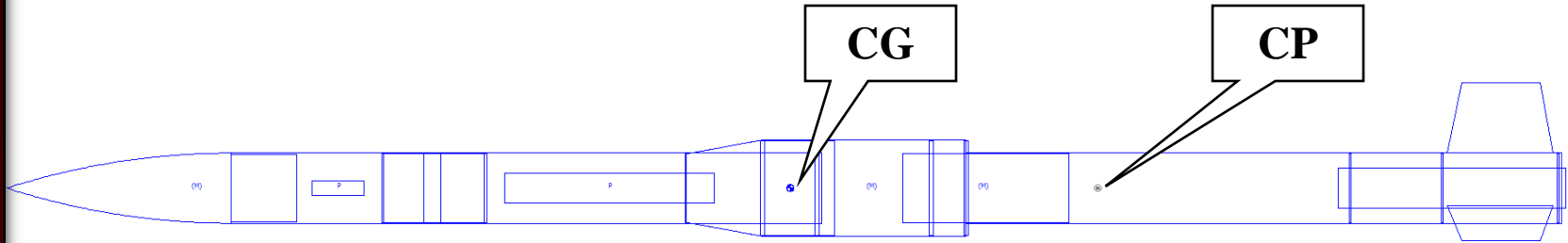
Flight Readiness Review – March 21, 2011

Motor Selection

Cesaroni Technology			
Brand Name	Pro54 K660 Classic	Total Impulse	2437.00 Ns (548.33 lb/s)
Motor Dimensions	54.00 x 572.00 mm (2.13 x 22.52 in)	Maximum Thrust	1078.90 N (242.75 lb)
Loaded Weight	1949.00 g (68.22 oz)	Avg Thrust	659.00 N (148.28 lb)
Propellant Weight	1177.00 g (41.20 oz)	I_{SP}	211.10 sec
Burnout Weight	734.00 g (25.69 oz)	Burn Time	3.69 sec

Rocket Flight Stability Diagram

Length: 89.0500 In., Diameter: 5.5400 In., Span diameter: 12.0000 In.
Mass 10,849318 Lb., Selected stage mass 10,849318 Lb.
CG: 44.7557 In., CP: 62.3155 In., Margin: 3.17 Overstable
Shown without engines.



Stability is determined by the relationship between a rocket's center of gravity (CG) and its center of pressure (CP). For proper stability, the CG should be located forward of the CP (or closer to the nose).

Static margin is a dimensionless number found by dividing the distance between the Center of Gravity (CG) and the Center of Pressure (CP) by the maximum frontal area to give the most conservative static margin.

Frankenstein II: CG=44.7557, CP=62.3155 Diameter=5.54

Static margin $(62.3155 - 44.7557) / 5.54 = 3.17$

Thrust to Weight Motor Selection for CTI K660-17A

Average Thrust		Vehicle Weight	Ratio	Motor
Newtons	Pounds			
659	148.15	10.85 lbs	13.65:1	K660-17A

Thrust-to-weight ratio is a ratio of thrust to weight of a rocket

$$148.15 \text{ lbs} / 10.85 \text{ lbs} = 13.65:1$$

Launch Guide Data

CTI K660

Launch guide length	72.0000 In.
Velocity at launch guide departure	74.6722 ft/s
The launch guide was cleared at	0.194 Seconds
User specified minimum velocity for stable flight	43.9881 ft/s
Minimum velocity for stable flight reached at	25.9856 In.

Parachute Sizes / Descent Rates

The drogue parachute is an 18” in diameter which results in a calculated 82-85 feet per second descent rate. The main parachute is 52” in diameter. The descent rate after the main is deployed is calculated to be 21 feet per second.

PARACHUTE SIZE CALCULATION		
Rocket Weight: 10.85 pounds		
Parachute Drag Coefficient: 1.5		
Vastsas Chute Calculator Program		
	Drogue (50-100 f/s)	Main (17-22 f/s)
Descent Rate	85 f/s	21.3 fps
Diameter	18.01 inches	53 inches
Shroud line length	12 inches	50 inches

SkyAngle 52"	
Tested Load Capacity for 17-25 fps descent (lbs)	6.8 -14.8
Surface Area (sq. ft.)	29.5
Suspension Line Length (inches)	52"
Cd at seal level	1.46
Net Weight (oz.)	13.32

Test Plans and Procedures

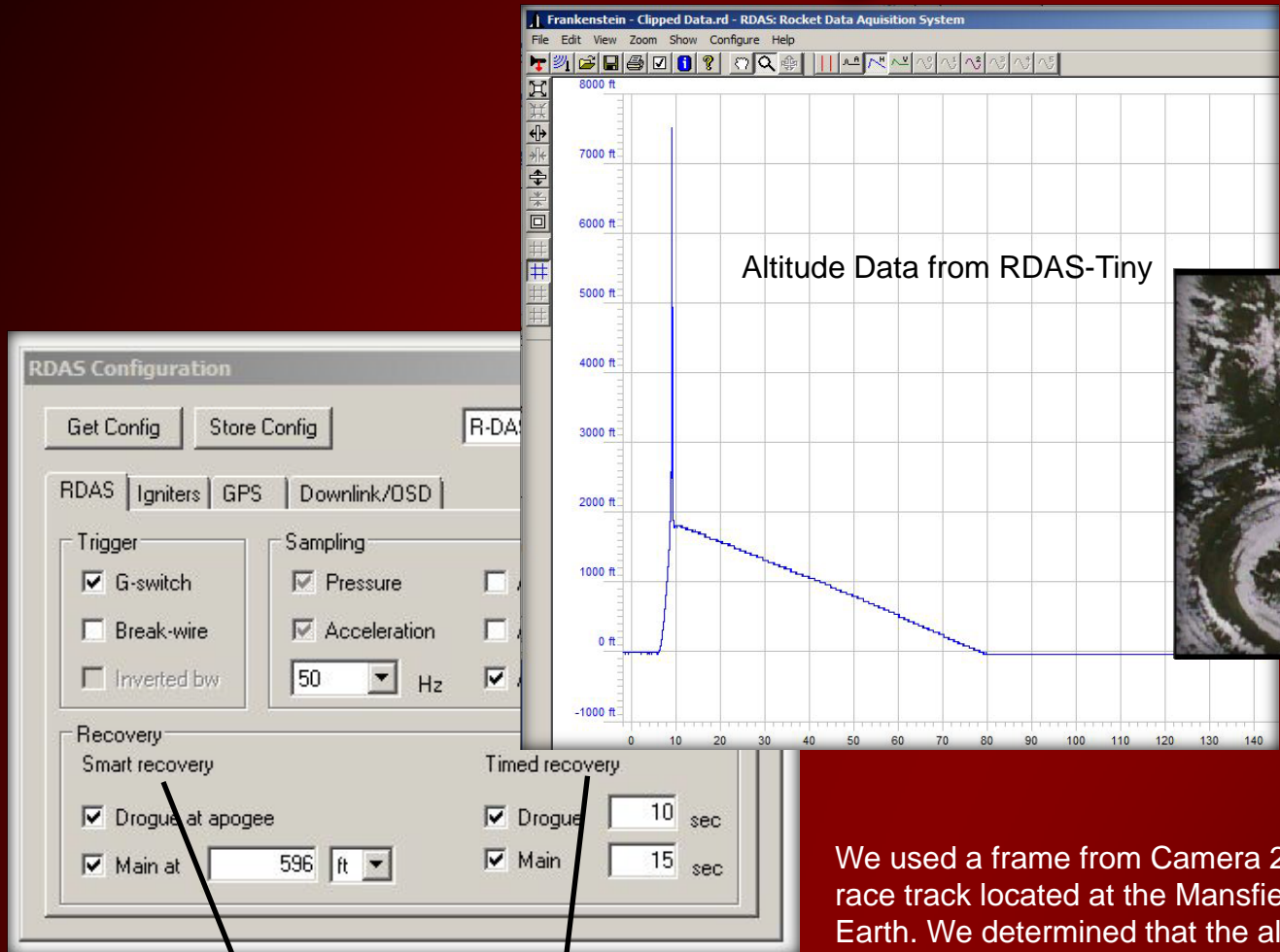
- March 5 - Full scale (CTI K660) motor flight test
 - Frankenstein disintegrated 4 seconds into flight
- March 6-19 - Frankenstein II re-constructed with additional strengthening
- March 20 – Flight scale flight with CTI J330
 - Successful launch, flight, and recovery
- March 26 – Full scale (CTI K660) motor flight test

Full Scale Flight Test

- March 5, 2010
- Mansfield, WA
- Sunny, patchy fog & low clouds, 40-45 degrees F, 0-2 Kts NE
- CTI K660
- RDAS – Tiny, drogue 1 and main 1
- PerfectFlite MAWD, drogue 2 and main 2
- 52" SkyAngle parachute wrapped in blue fire blanket
- 18" Blue parachute wrapped in red fire blanket
- Lifted off straight and flew very stably until shortly into the flight when Frankenstein came apart. The Ebay and parachutes tumbled down, the fin continued upward out of sight.



Full Scale Flight Test (cont)

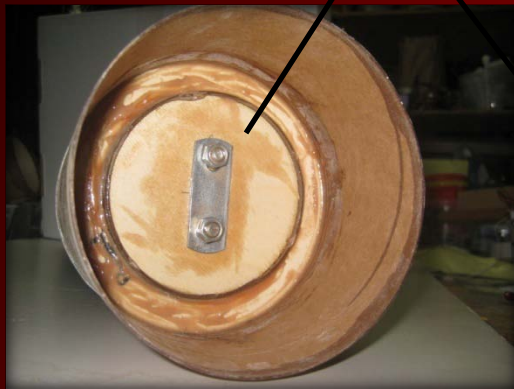


Potential Conflict & Problem

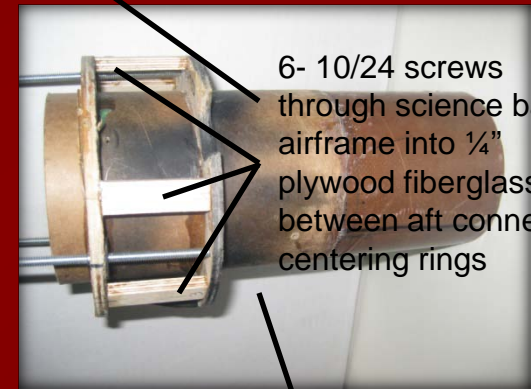
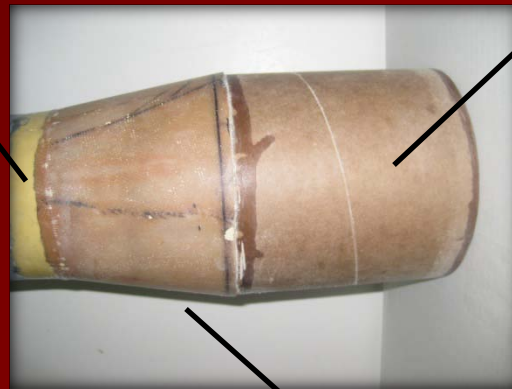
We used a frame from Camera 2 and matched the size of the race track located at the Mansfield site to one from Google Earth. We determined that the altitude was approximately 1700 feet agl at the time that that frame (camera still pointing down) was recorded and that the altitude was approximately 1800 feet agl when the rocket started to breakup.

Design Changes to Increase Structural Integrity

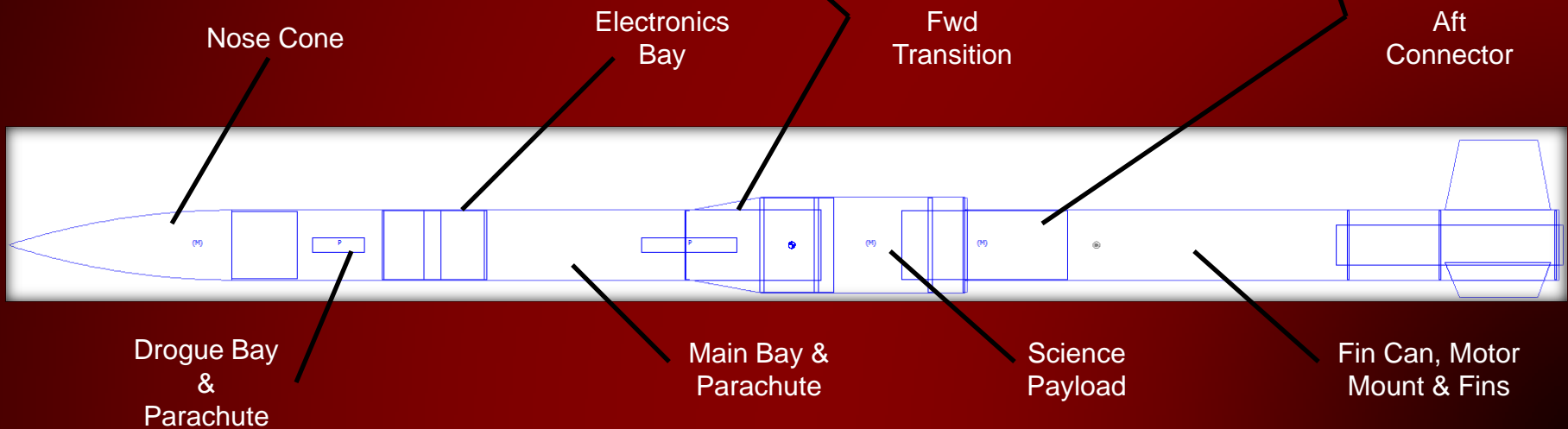
Fastened Main Bay through fwd transition



Increased length of tube couplers into science bay & Fin can



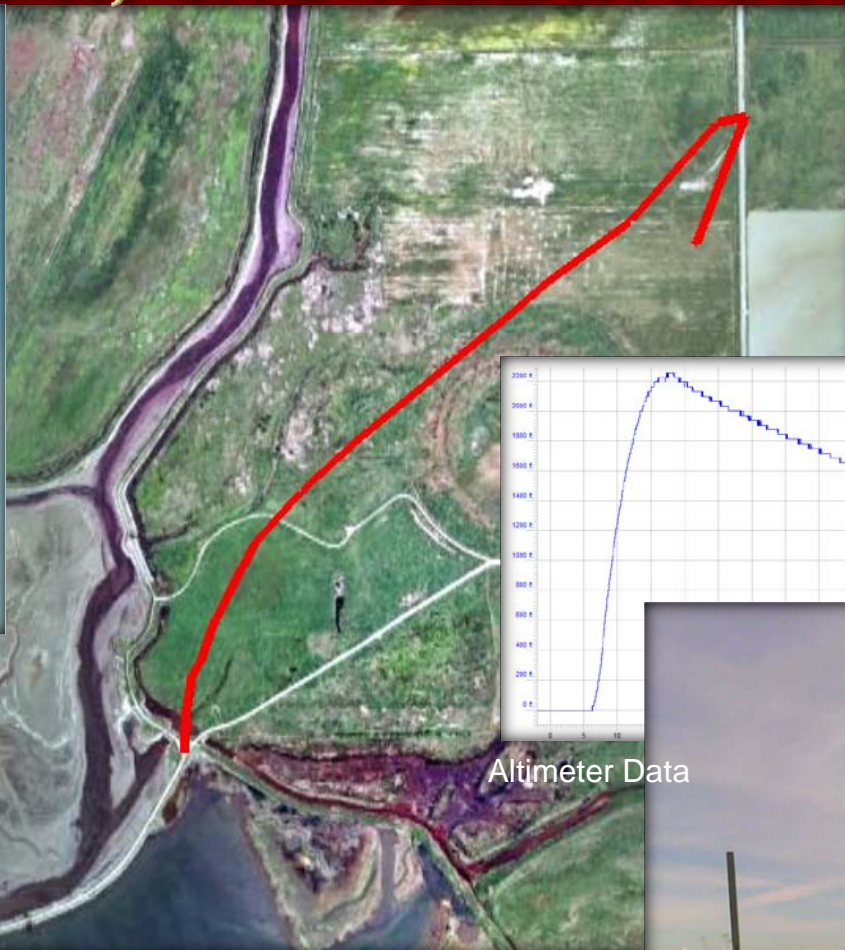
6- 10/24 screws through science bay airframe into 1/4" plywood fibreglassed between aft connector centering rings



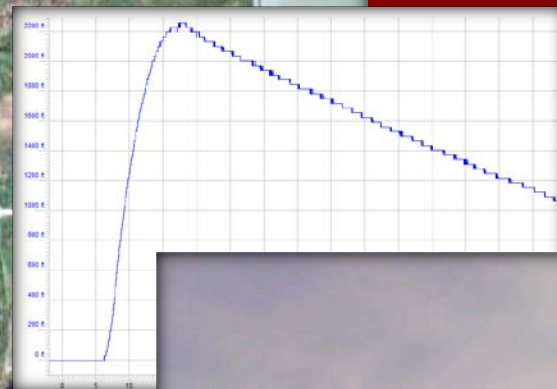
Full Scale Flight Test Frankenstein II, the REZurrection



Landing & Recovery



Ground Track



Altimeter Data

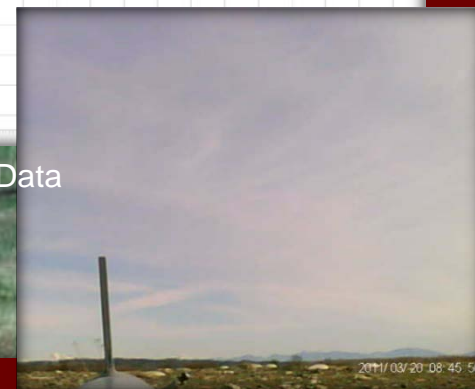


Photo from aft-facing camera

March 20, 2011
Lummi Nation Reservation
CTI J330
Alt: 2389

Launch guide data:

- Launch guide length: 72.0000 In.
- Velocity at launch guide departure: 52.4646 ft/s
- The launch guide was cleared at : 0.253 Seconds
- Minimum velocity for stable flight reached at: 50.9232 In.

Dual Deployment Avionics Test

- **Altimeters tested in a Bell jar with a vacuum equivalent to 6000 feet**
 - ✓ RDAS-Tiny Altimeter: mini Christmas tree lights were connected to the ejection charge circuitry to simulate a black powder charge – successful
 - ✓ Perfectflite MAWD: built in altimeter test via the computer interface – successful
- **Ground tested both altimeters separately with calculated amounts of black powder to test drogue and main deployment.**
 - ✓ RDAS-Tiny Altimeter: drogue and main can be set to ignite ejection charges via a time delay; charges fired successfully
 - ✓ Perfectflite MAWD: connected a 20 foot long piece of tubing to electronics bay which had been sealed. Assistant advisor inhaled and then released his breath simulating a decrease in altitude; charges fired successfully



Ejection Charge Test

Desired Pressure = 15 psi		
mass BP = 1.1 grams		
Ejection F = 188.5 lbf		
Drogue Parachute		
Drogue Bay Vol	138.23 cubic inches	
Drogue Bay Dia	4 inches	
Drogue Bay Len	11 inches	
Mass BP =	1.1 grams primary	1.3 grams secondary
Main Parachute		
Main Bay Vol	251.33 cubic inches	
Main Bay Dia	4 inches	
Main Bay Len	20 inches	
Mass BP =	2.3 grams primary	2.5 grams secondary

4Fg Black Powder Gas Properties

$$R = 22.16 \text{ ft} \cdot \text{lbf} / \text{lbm} / \text{R}$$

$$T_c = 3307 \text{ R}$$

$$m = PV / R / T \quad F = P \cdot (\pi / 4) \cdot d^2$$

Conversions: 1 lb = 454 grams

1 oz = 28.3 grams

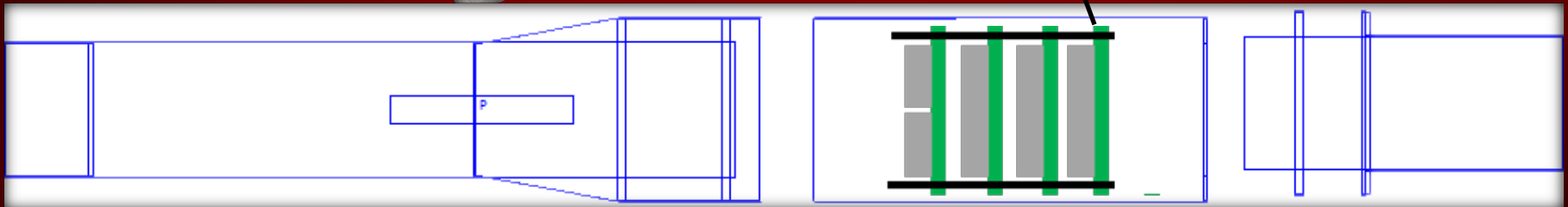
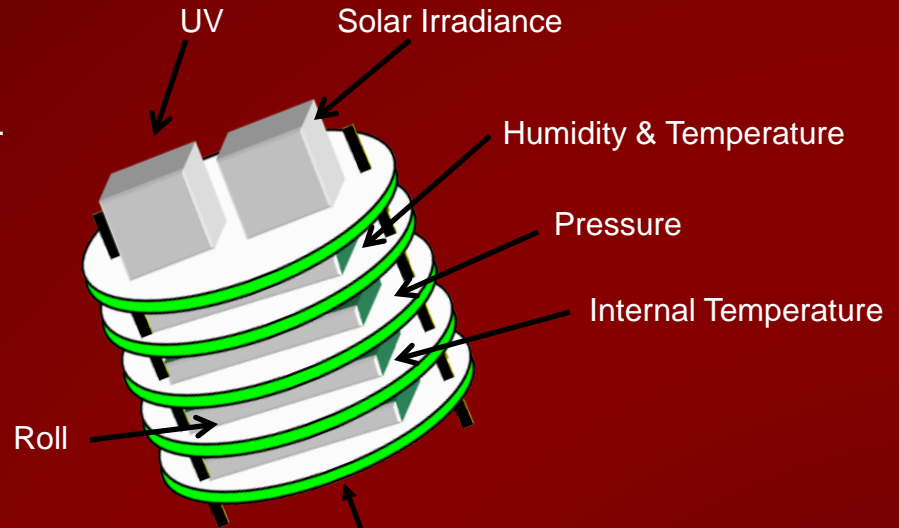
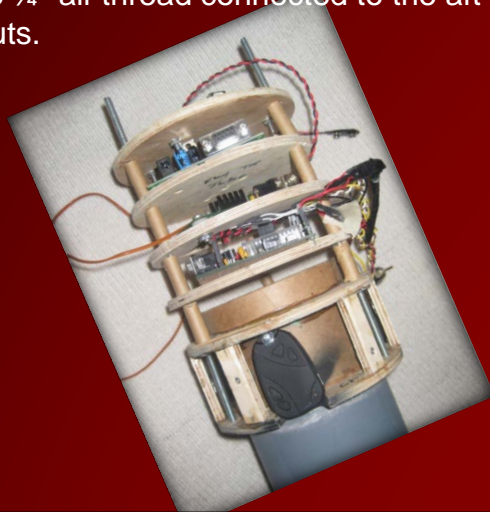
Black Powder Ejection Charge Calculator

by Chuck Pierce

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Payload Integration Feasibility

- Experiments fastened to $\frac{1}{4}$ " aircraft plywood and then stacked upon one another with $\frac{1}{2}$ " spacers.
- Stacking rods are $\frac{1}{4}$ " all-thread connected to the aft coupler via tee nuts.



Educational Engagement Plan and Status

- Climate Change Workshop:
November 11, 2010
- Northwest Indian College Science
Department High School students:
February 5, 2011
- Lummi Nations School Grades 9-12
Demonstration: February 10, 2011
- Demonstration to Northwest Indian
College students: February 24, 2011
- NAR Convention in Seattle, WA:
March 12-13, 2011
- Lummi Tribal School, Grades 4 & 5,
April 11, 2011

Schedule Updates

Key Vehicle Dates

- 10/01 – Proposal Submitted
- 10/13 – Scale rocket construction
- 11/03 – recovery ejection test
- 11/02 – Dual deployment & L2 Certification
- 11/06 – Scale rocket flight test
- 11/29 – Full scale construction complete
- 12/05 – Full scale flight test
- 03/05 – Full scale, full motor flight test (failed)
- 03/06 – Vehicle reconstructed
- 03/19 – Flight test, successful
- 3/26 – Flight test, full motor

Key Payload Dates

- 10/14 – Components ordered
- 12/05 – Prototypes complete and 50% tested
- 01/28 – Science experiments completely built
- 02/15 – Science experiments tested
- 03/26 – Flight test with ½ of experiments
- 04/03 – Flight test with full complement of experiments