TALON

Level 3 Certification Project
Talon-6 (Giant Leap Rocketry kit)

Michael J. Mangieri

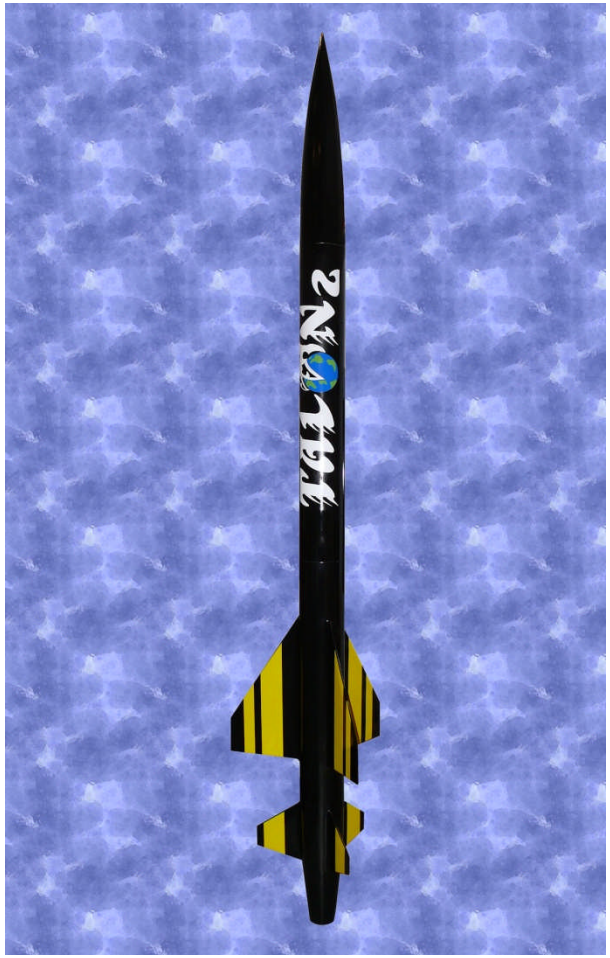
April 12, 2010

V2.0

Part I

INTRODUCTION

OVERVIEW



- Giant Leap Talon-6
  - Length: 10 ft 3.375 in
  - Diameter: 6.16 in
  - Weight (est.): 34.26 lbs.
    45.95 lbs loaded.
  - Motor: Cesaroni M-1400

DESCRIPTION

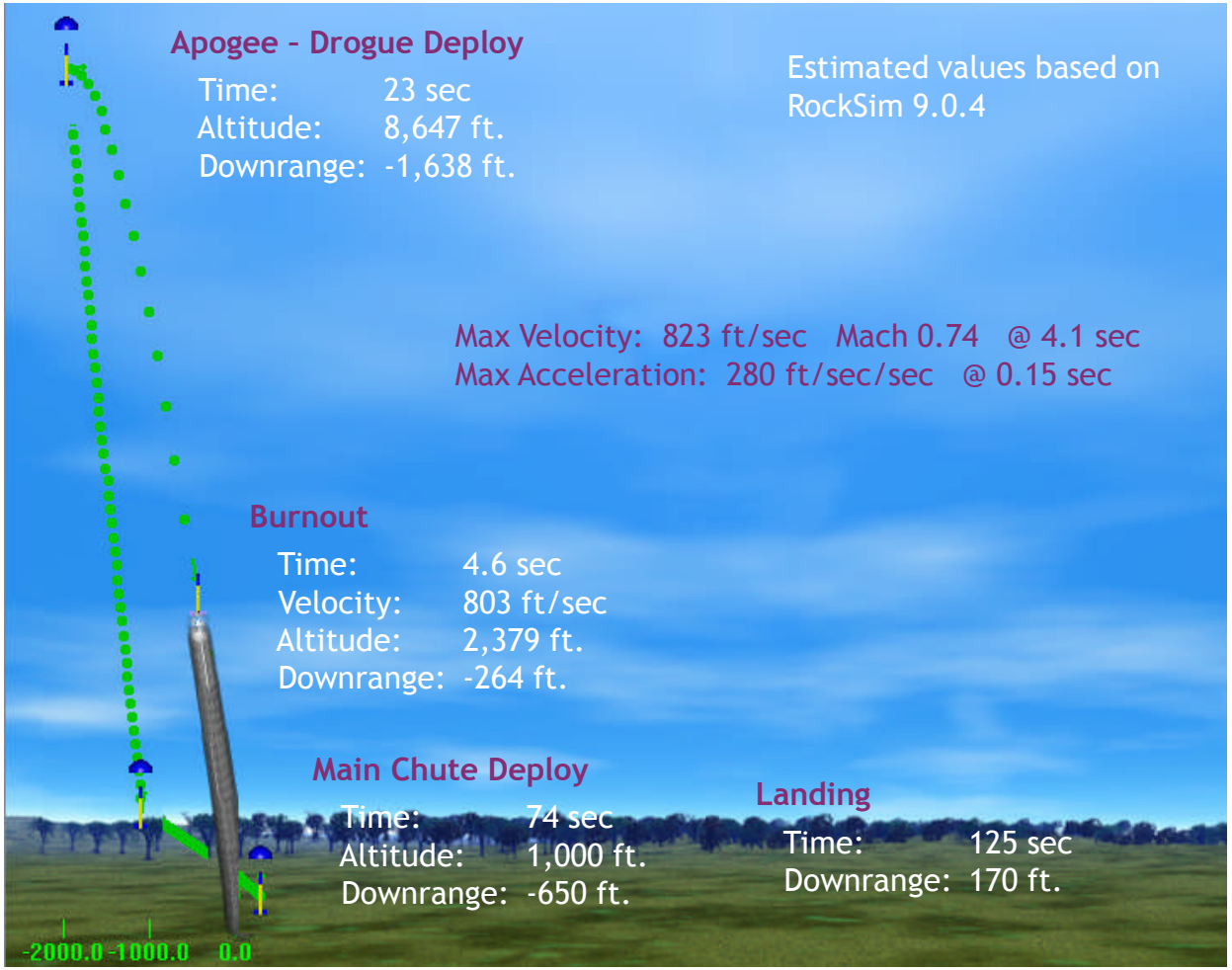
- The Talon is basically the Talon-6 kit from Giant Leap Rocketry with some slight modifications*
  - Length: 123.375 inches
  - Diameter: 6.16 inches
  - Launch Weight: estimated at around 46 lbs.
    - Final value will be determined after all components are completed
- Planned motor:
  - Cesaroni M-1400 Classic
  - Motor Case: Cesaroni Pro75 5 grain case

* Detailed later

FLIGHT DETAILS

- Estimated altitude: 8600 feet
  - Based on initial weight estimates of ~46 lbs
  - Wind conditions of 7-15MPH
- Recovery
  - Drouge chute at apogee
    - Giant Leap Rocketry TAC-Drogue 24” (1.9 oz cloth)
  - Main chute at 1000 feet
    - b_2 Rocketry SkyAngle, Cert 3 XL, (1.9 oz cloth)

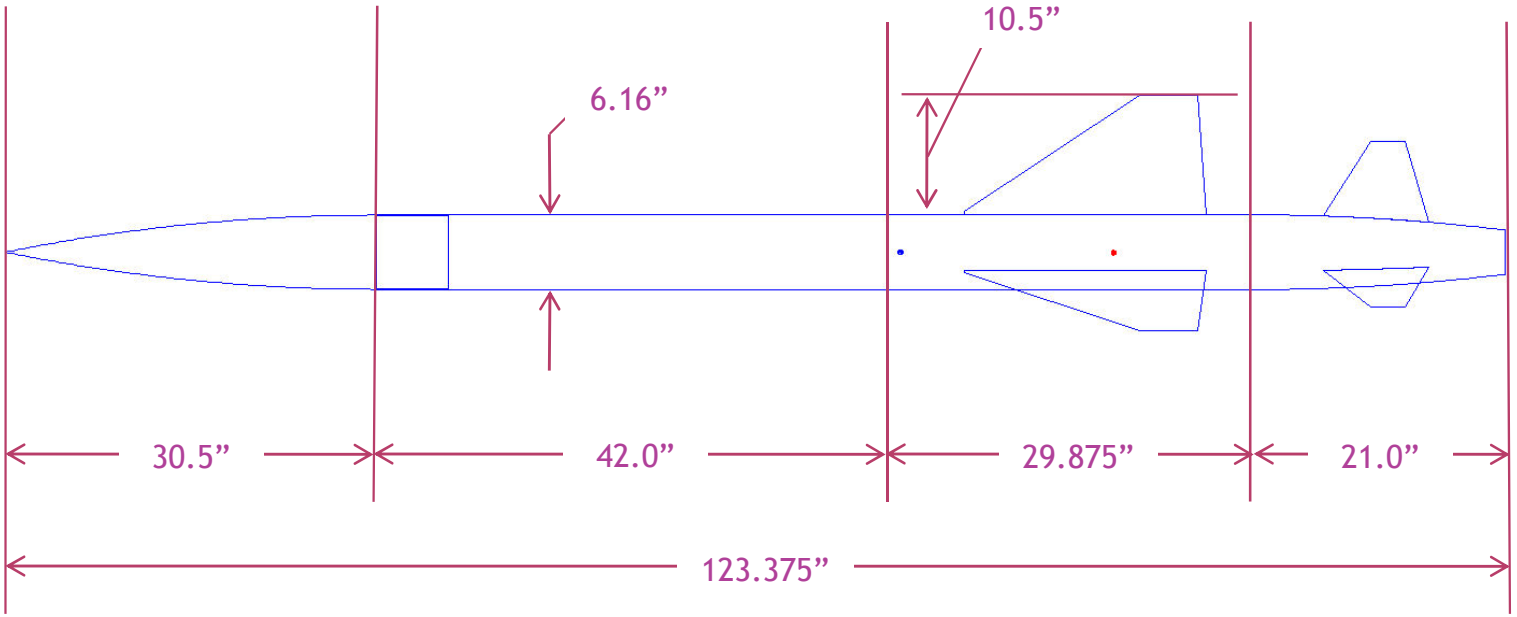
FLIGHT PATH


Apogee - Drogue Deploy
Time: 23 sec
Altitude: 8,647 ft.
Downrange: -1,638 ft.
Estimated values based on RockSim 9.0.4
Max Velocity: 823 ft/sec Mach 0.74 @ 4.1 sec
Max Acceleration: 280 ft/sec/sec @ 0.15 sec
Burnout
Time: 4.6 sec
Velocity: 803 ft/sec
Altitude: 2,379 ft.
Downrange: -264 ft.
Main Chute Deploy
Time: 74 sec
Altitude: 1,000 ft.
Downrange: -650 ft.
Landing
Time: 125 sec
Downrange: 170 ft.
-2000.0 -1000.0 0.0

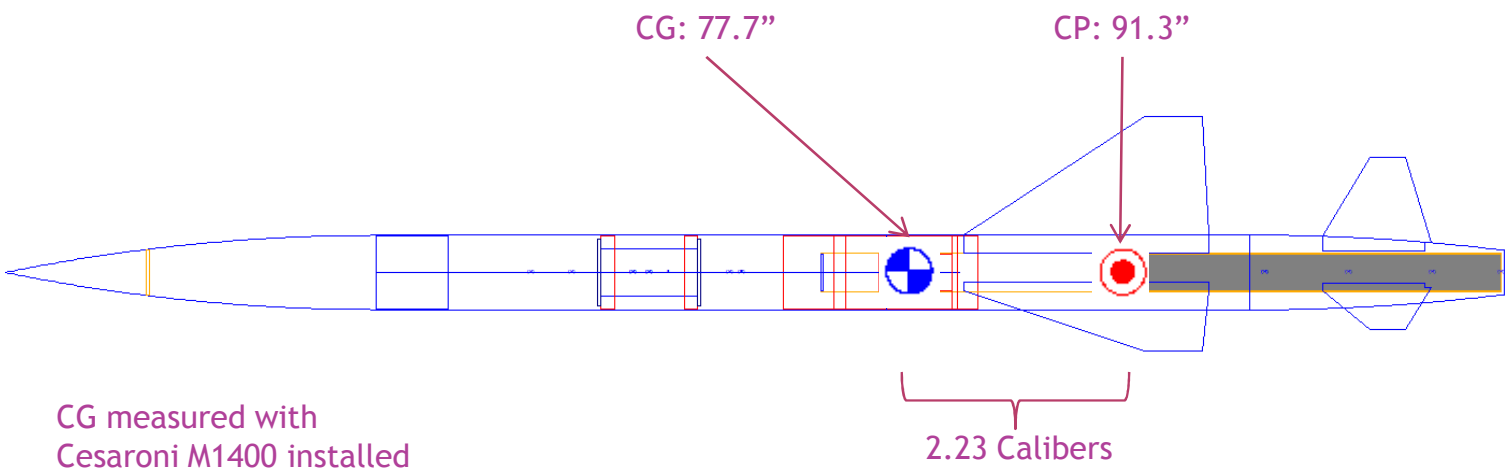
Part II

DRAWINGS

OUTSIDE DIMENSIONS



CP AND CG



CG measured with
Cesaroni M1400 installed

Part III

CONSTRUCTION

SPECIFICATIONS

- Nosecone: 5-to-1 Ogive; Epoxy-based figerglass
- Tailcone: Epoxy-based fiberglass; preslotted for lower fins
- Airframe: Filament-wound fiberglass; preslotted
- Motortube: 75mm X 48“; phenolic (extended to 52”)
- Recovery system
  - Booster:
    - 22 ft 5/8” Tubular Kevlar™ (external)
    - 18 ft 5/8” Tubular Kevlar™ (internal)
  - Upper Section:
    - 25 ft 5/8” Tubular Kevlar™
- Fins: 3 upper fins, 3 lower fins finished edges; 1/4" composite honeycomb with glass sandwich. Reinforced with one layer of 10 oz fiberglass followed by one layer 3 oz fiberglass.
- Bulkheads and Rings: 1/2" thick 9-ply Russian Birch
- Motor Retention: 75mm Threaded Slimline
- Delrin Rail buttons (attached through to bulkheads)

AIRFRAME AND CENTERING RINGS

Nosecone

Fiberglass
Length: 30.5”
Thickness: ~0.125”

Fore Airframe

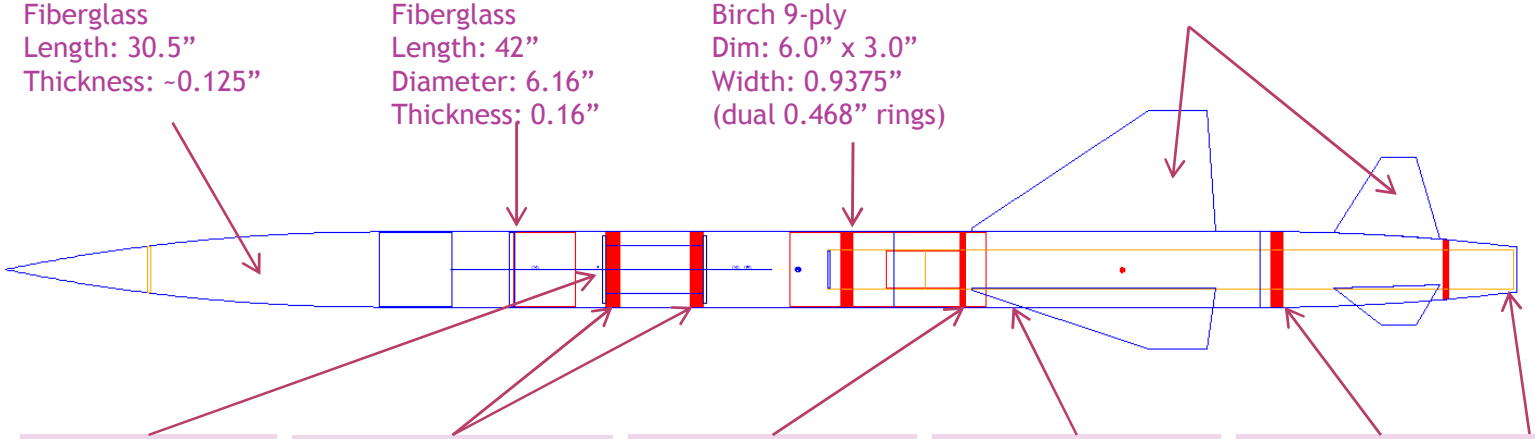
Fiberglass
Length: 42”
Diameter: 6.16”
Thickness: 0.16”

Forward Ring

Birch 9-ply
Dim: 6.0” x 3.0”
Width: 0.9375”
(dual 0.468” rings)

Fins

Composite with
Fiberglass Layer
Thickness: 0.25”



eBay

Phenolic
Length: 8”
ID: 3.76”

eBay Mounting Collar Rings

Birch 9-ply
Dim: 6.0” x 3.9”
Width: 0.9375”
(dual 0.468” rings)

Aft Ring

Birch 9-ply
Dim: 6.0” x 3.0”
Width: 0.468”

Aft Airframe

Fiberglass
Length: 29.875”
Diameter: 6.16”
Thickness: 0.16”
Slotted for fins

Fore Tail Ring

Birch 9-ply
Dim: 5.8125” x 3.0”
Width: 0.9375”
(dual 0.468” rings)
Slotted for fins

Tailcone

Fiberglass
Length: 21”
Diameter: 6.16” to 3.625”
Thickness: ~0.125”

ADHESIVES

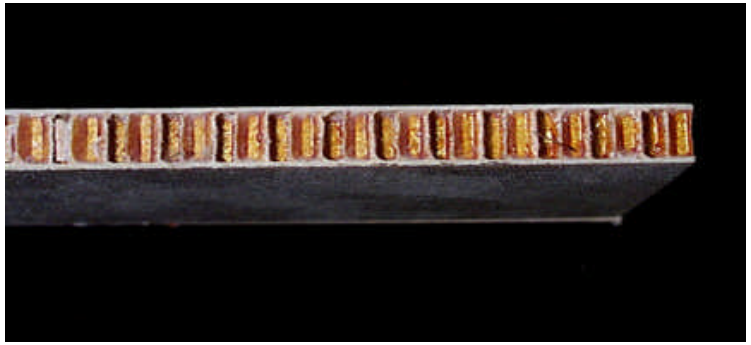
- Rings and bulkheads mounted with West System® epoxy 105 Resin and 205 Fast Hardener
- Motor retainer mounted with J-B WELD (8265-S)
- All other parts were assembled using 15min Epoxy
- Fillets on all key mating points (rings to airframe, rings to motor tube, bulkheads to airframes and nosecose and fins to surface of airframe) made using West System® 105 thickened with 404 High-Density Filler
- Aeropoxy for applying the fiberglass

REINFORCEMENTS

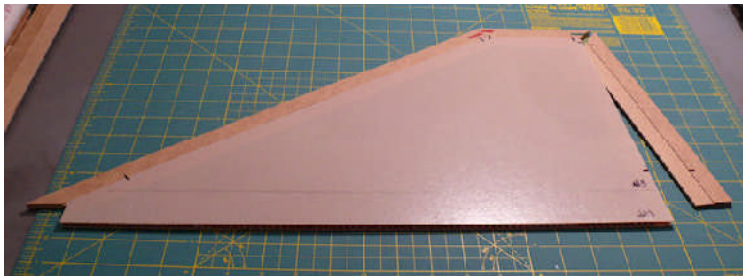
- Fin anchor points were fashioned out of 3/8x3/8 hardwood providing a ‘slot’ for the root edge of the fins to slide into. This also reinforced the centering rings.
- The fins are covered with one layer of 10 oz fiberglass fabric laminated with Aeropoxy followed by one layer of 3 oz fiberglass fabric extending out to provide fin-to-body tube reinforcement.

COMPOSITE FINS

- Aerospace Composite Fins
  - Giant Leap's new fin material
  - It is much stronger than wood, more rigid than G-10 (for equivalent thickness). Lighter than wood, 1/3 the weight of G-10.
- Each fin covered with one layer of 10 oz. fiberglass followed by one layer of 3 oz fiberglass.



An inner layer of NOMEX(TM) honeycomb, sandwiched between thin G-10 Fiberglass!



Fiberboard edging provided with kit is glued to the fins using polyurethane glue.

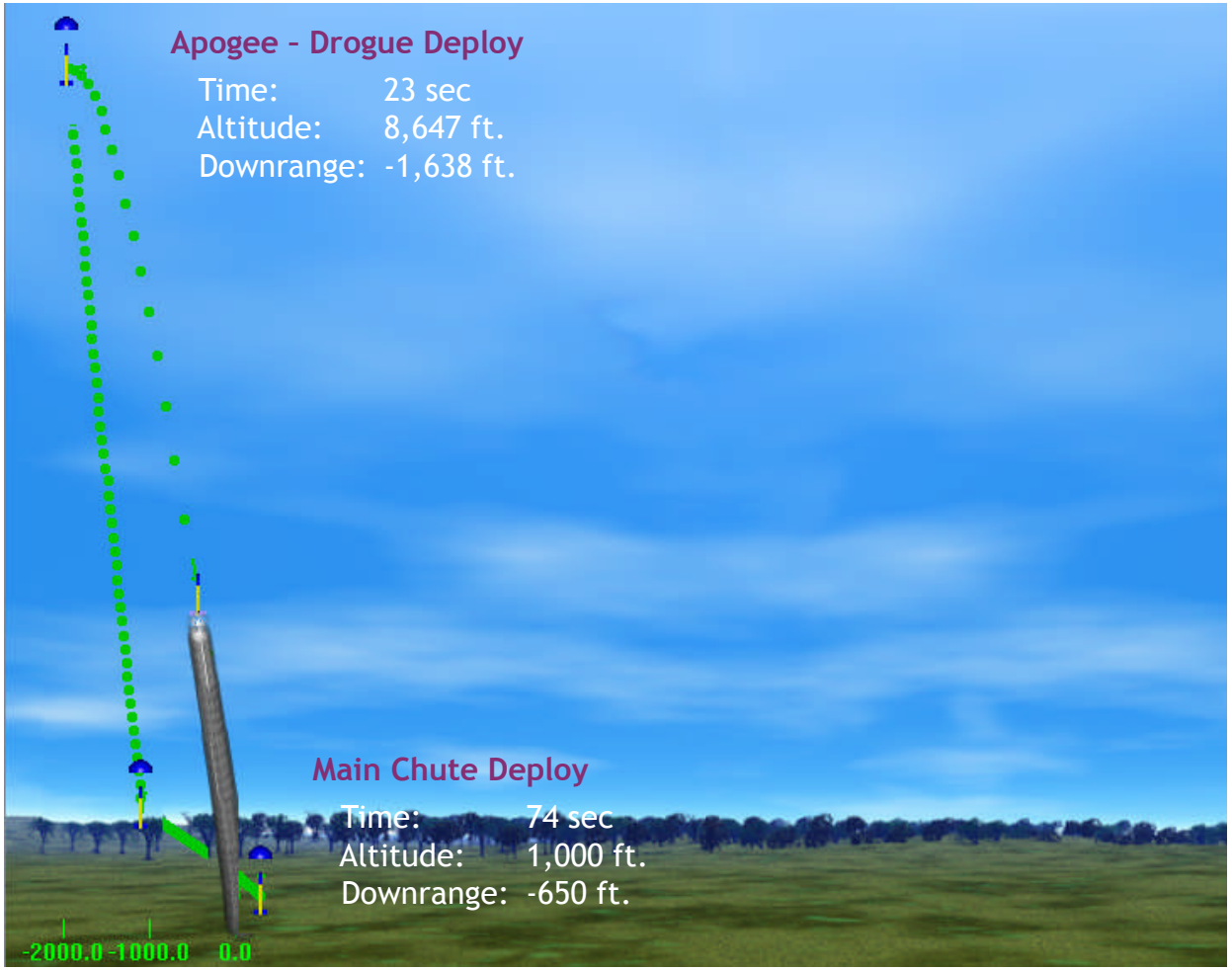
DETAILED CONSTRUCTION

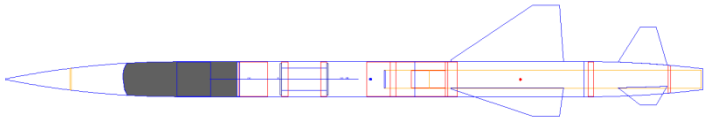
- Details on the construction of the Talon (with photographs) can be found at:
  - http://xcalrockets.net/html/l3details.html

Part IV

RECOVERY SYSTEMS

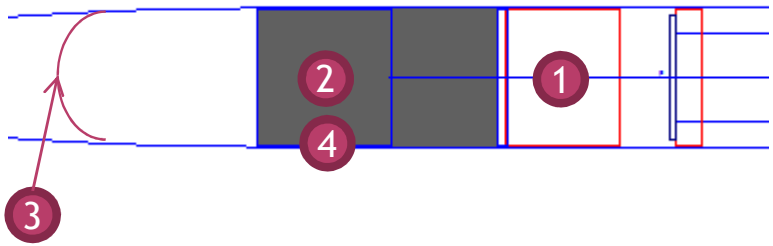
DEPLOYMENT SEQUENCE

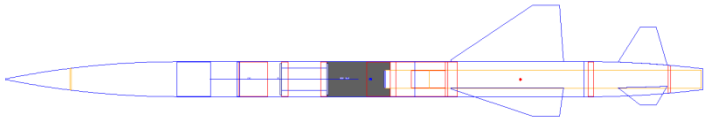




PARACHUTE COMPARTMENTS

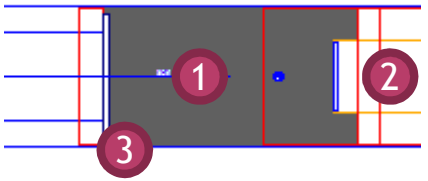
- The Main parachute will reside in the upper portion of the forward airframe (and the nosecone). The parachute will be protected by a large Kevlar™ chute protector (2)
- Because of the size of the parachute and the short space in the airframe the parachute will extend into the nosecone
- 2” elastic supports the parachute and aids in its deployment by providing force against the chute (3)
- Four nylon shear pins retain the nosecone to the airframe (4)





PARACHUTE COMPARTMENTS

- The Drogue parachute will reside in the lower portion of the forward airframe protected by a large Kevlar™ chute protector (1)
- The motor tube extension was reduced in overall length by 4” to provide additional space for the drogue and associated elements (2)
- A 3/16” hole is located in the upper portion of the airframe to relieve pressure as the rocket gains altitude preventing premature separation of the two airframes (3)



DESCENT RATES

- b2 Rocketry Manufacturer ratings for CERT-3 XL
  - CD = 2.59
  - 20 fps @ 45 lb load
- Rocksim 9.0.4 estimates:
  - Drogue parachute descent rate: 165 – 155 ft/sec
  - Main parachute descent rate: 24 - 25 ft/sec

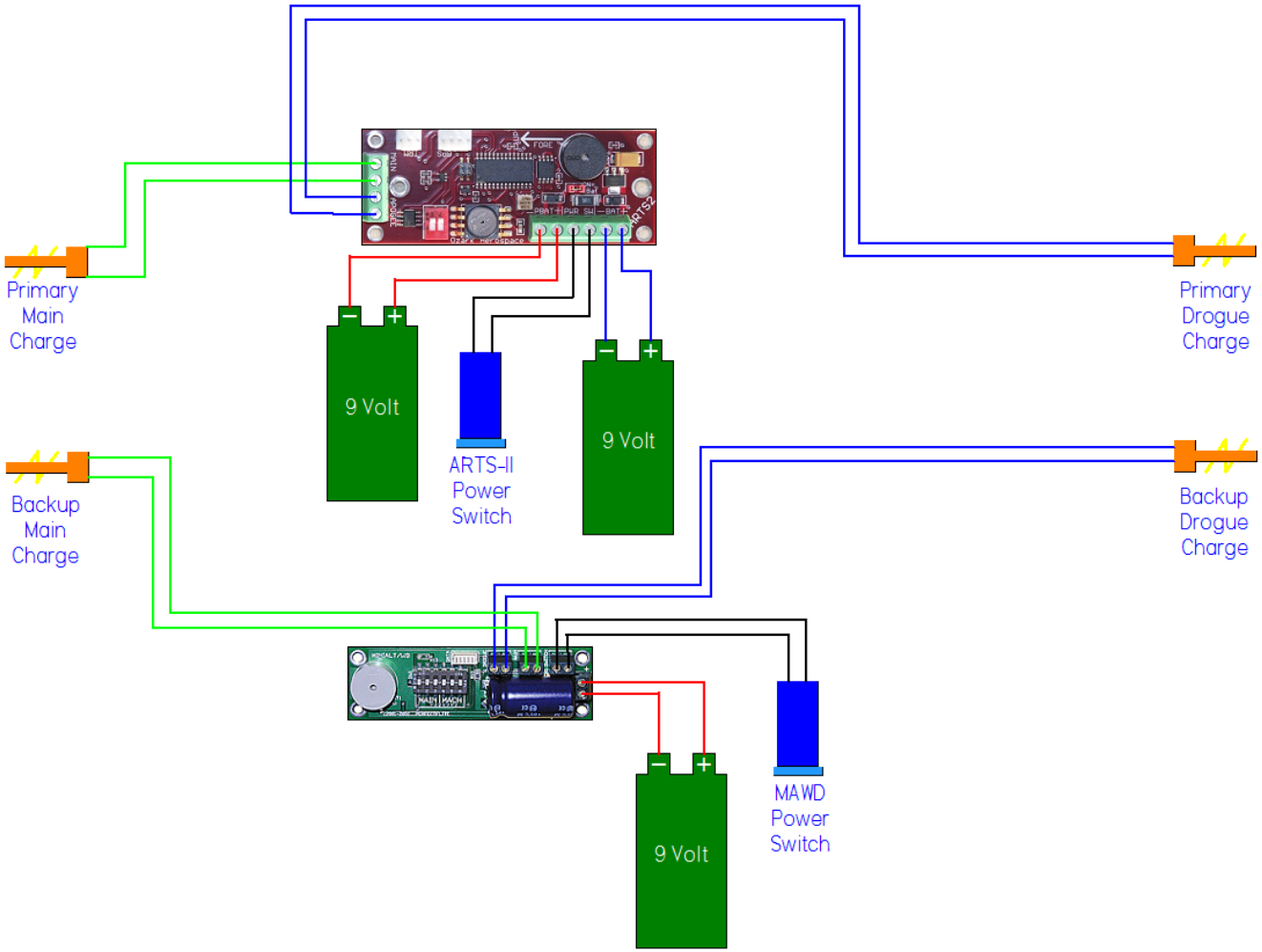
CONTROL DEVICES – ARTS-II

- Main Altimeter
  - Ozark ARTS2
    - 2 fully programmable pyro channels for chute deployments, air start, staging, etc.
    - Accelerometer as well as Barometric operation (immune to mach effects)
    - Recording sample frequency selectable: 200Hz, 100Hz, 50Hz, 20Hz, 10Hz
    - 26 min (max) recording time, 10 Samples/Sec
    - 82 sec recording time at 200 Samples/Sec
    - Terminal port for connection to a computer for data download
    - Field-reprogramable firmware
    - Two mounting options: four .125" mounting holes (#4 screw) or two #6 screws
    - Use a single 9v battery (or any 9V-25V DC power source)
    - The ARTS 2 now offers the option to use a second power source to provide extra power for the outputs.
  - Second battery option used

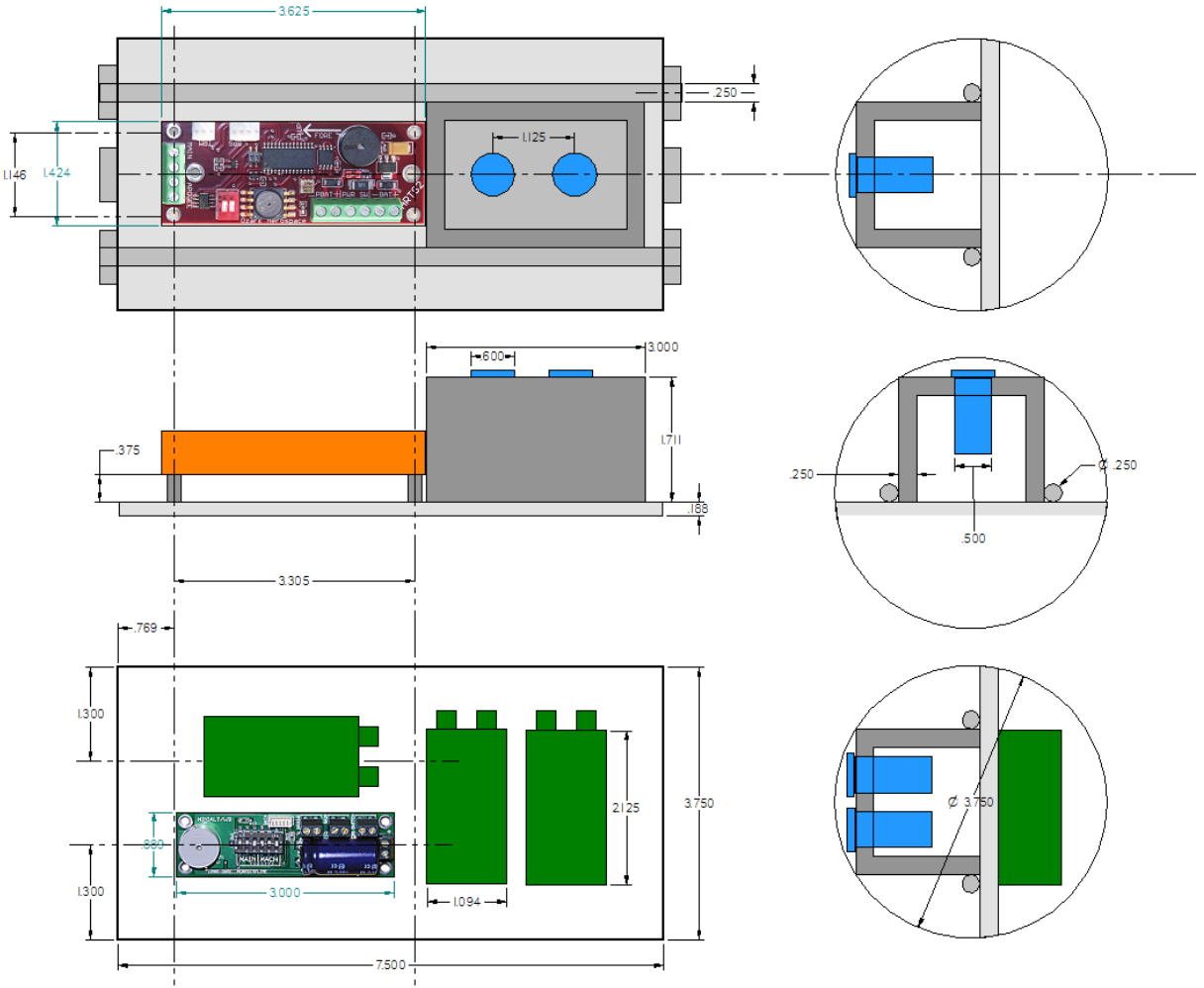
CONTROL DEVICES – MAWD

- Backup Altimeter
  - PerfectFlite miniAlt/WD logging dual event altimeter
    - Precision sensor works to 25,000 feet MSL
    - All data is stored in nonvolatile memory and is preserved even if power is lost
    - Deploys drogue and main chutes with audible igniter continuity check
    - Main chute deployment altitude is adjustable from 300’ to 1,700’ in 200’ steps
    - Mach delay is adjustable from 0 to 14 seconds for high performance flights
    - Robust power supply is not affected by up to two seconds loss of power in flight
    - High accuracy A/D and precise factory calibration yields +/- 0.5% typical accuracy
    - Rugged SMD construction, stringent QC testing, and internal self-diagnostics assure reliability
    - Measures just 3.0” L * 0.9”W * 0.7”H, fits in 24mm tube, weighs 0.7 oz.

CONTROL DEVICES - WIRING



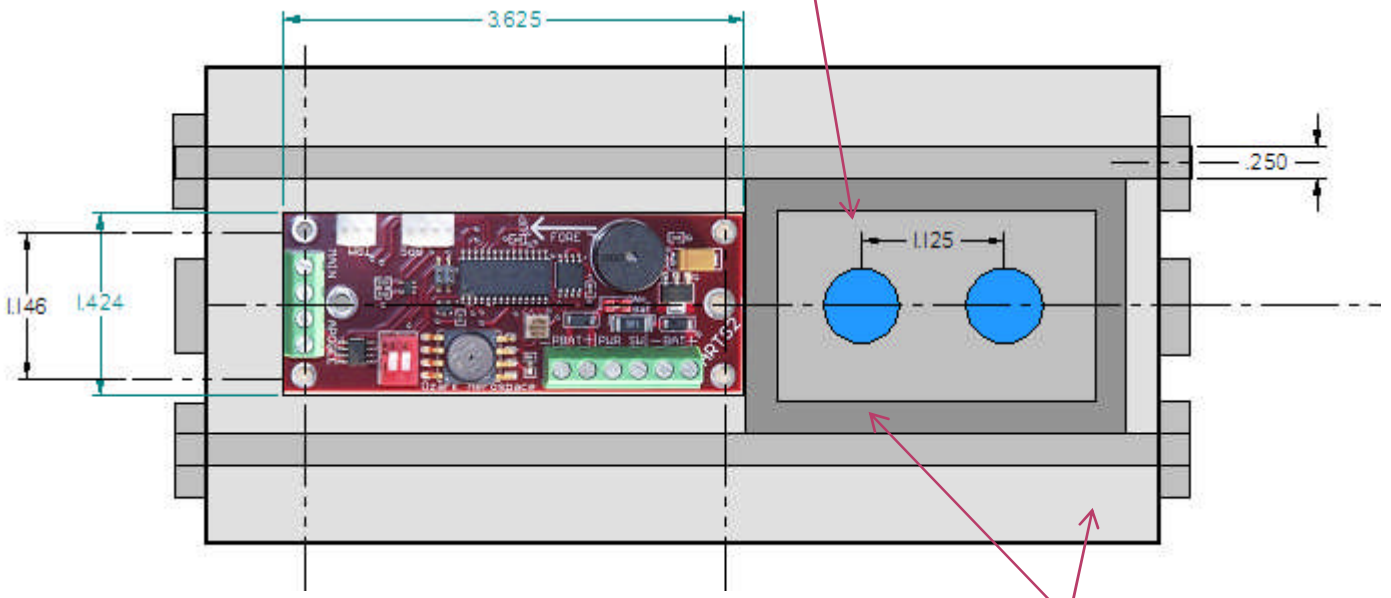
ELECTRONICS SLED - OVERVIEW



ELECTRONICS SLED – TOP VIEW

Switches

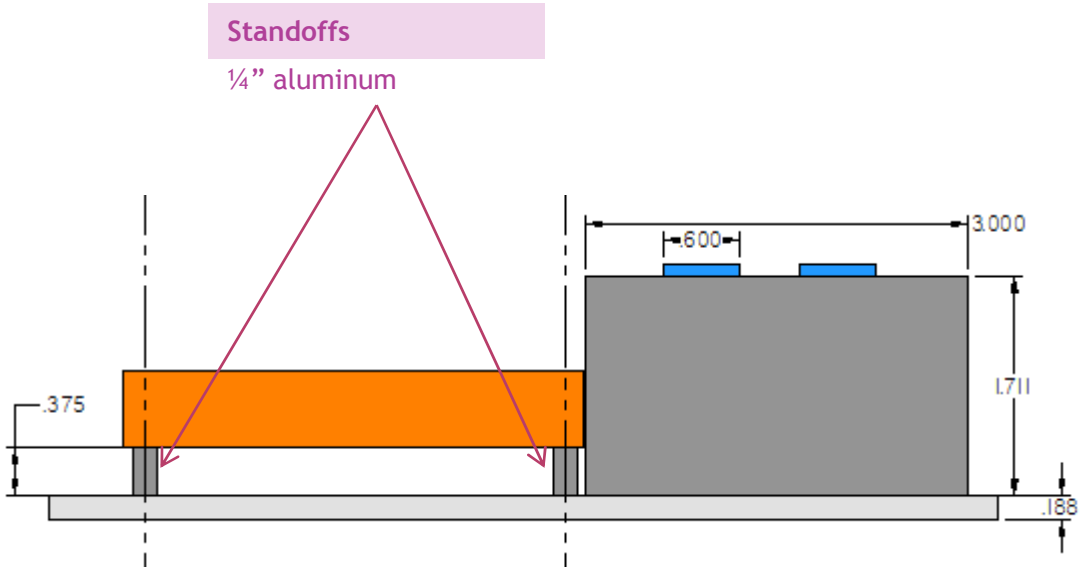
Missile Works
2 pole rotary



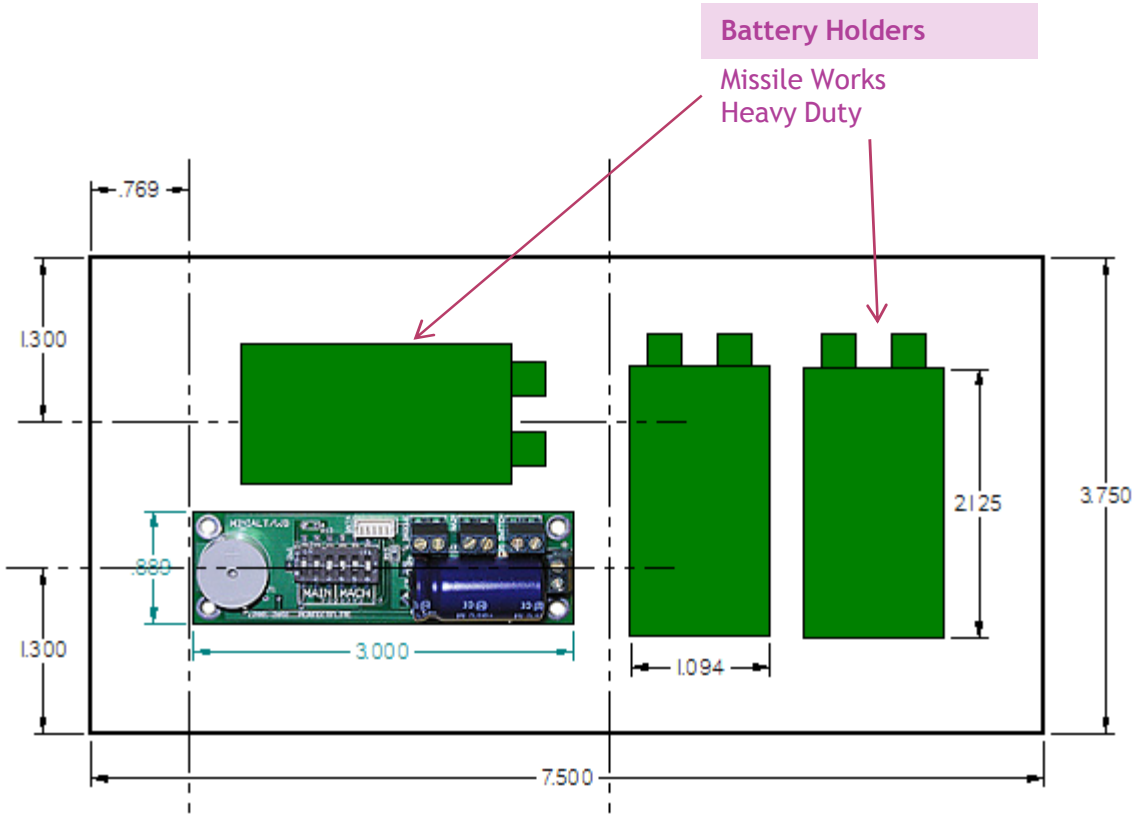
Sled and Switch Bay

3/16” plywood coated in finishing epoxy

ELECTRONICS SLED – SIDE VIEW

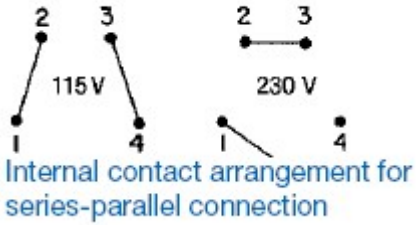


ELECTRONICS SLED - BOTTOM



ELECTRONICS SLED

- Switches
  - Missile Works SW-2
  - 2 pole rotary



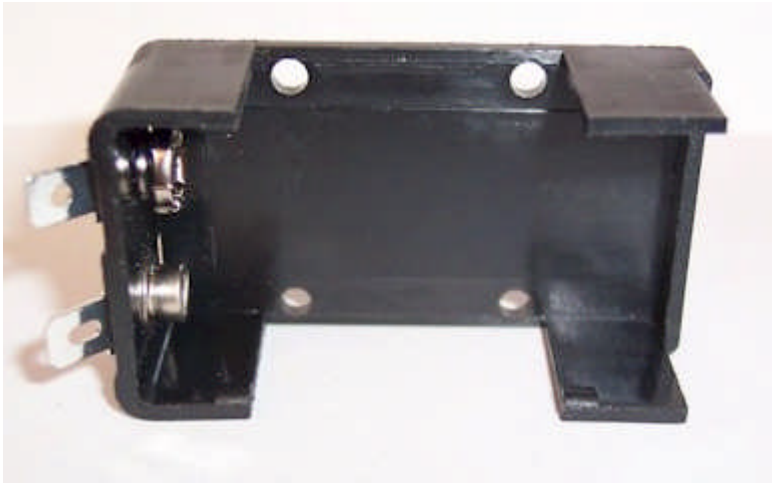
Internal contact arrangement for series-parallel connection

- *Features:*
  - High detent spring loaded cams for bobble-free operation.
  - Easy operation by flat-blade screwdriver in or out of the airframe.
  - Use for switching or shunting applications.
  - SPST or DPST operation. Rated for 6.3A at 250V.

Dimensions:
Length - 1.05"
Head - 0.6" D x 0.1" L
Body - 0.5" D

ELECTRONICS SLED

- Battery Holder
  - Missile Works
  - BH-9
  - Batteries will be held in place via electrical tape wrap completely around the holder



- *Features:*
  - High-impact glass-filled Nylon body.
  - Nickel plated steel battery contacts.
  - Tin plated brass solder terminals.
  - Accommodates ALL 9V batteries.
  - 4 hole rigid mounting.

MAIN PARACHUTE

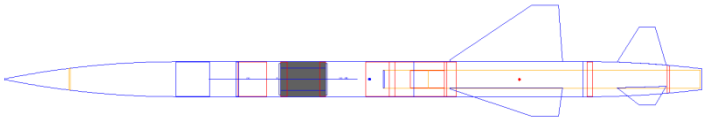
- b_2 Rocketry CERT-3 XL
  - CERT-3 series manufactured with zero-porosity 1.9 oz. silicone-coated balloon cloth
  - 5/8" mil-spec tubular nylon (2,250 lbs.) suspension lines sewn around outside canopy
  - UV-resistant polyester sail-maker's thread used throughout
  - CERT-3 series lines attach to a heavy-duty 1,500 lb. 12/0 nickel-plated swivel

DROGUE PARACHUTE

- Giant Leap Rocketry TAC-Drogue
  - 24” Diameter
  - Extra strength 1.9oz coated, low porosity ripstop nylon

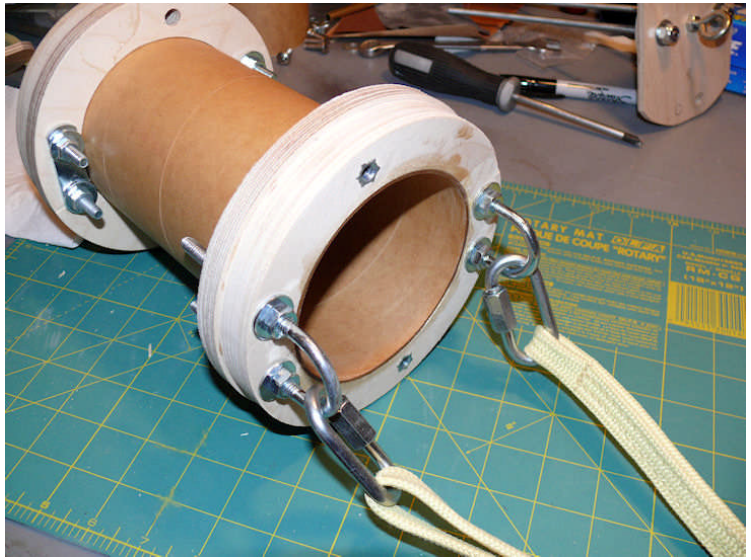
RISERS

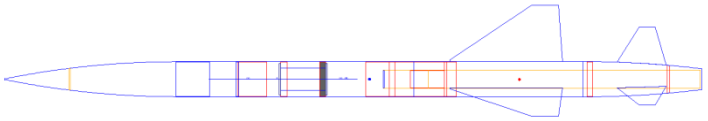
- ½” Tubular Kevlar™ throughout
- Anchored to aft ring by knot and tape wrap
- Other anchor points sewn and attached with QuikLinks
- (See Mounting Hardware section for photos)



MOUNTING HARDWARE - 1

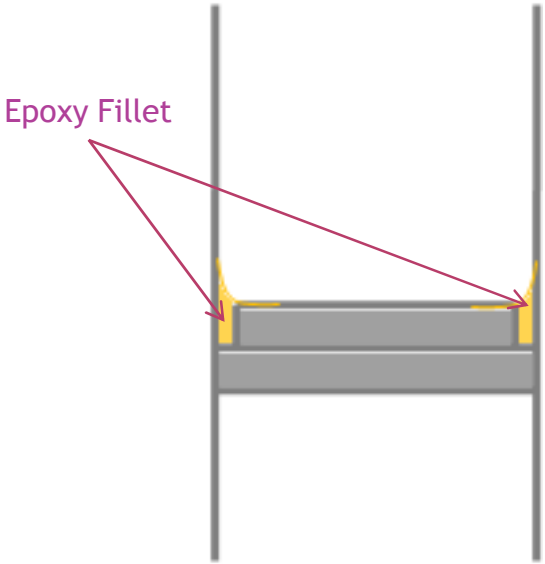
- Electronics Bay and Collar Assembly
  - Modified to use ¼” Quik-links
  - Fore and Aft

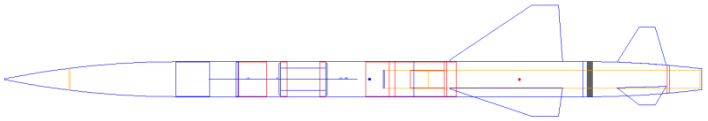




MOUNTING HARDWARE - 2

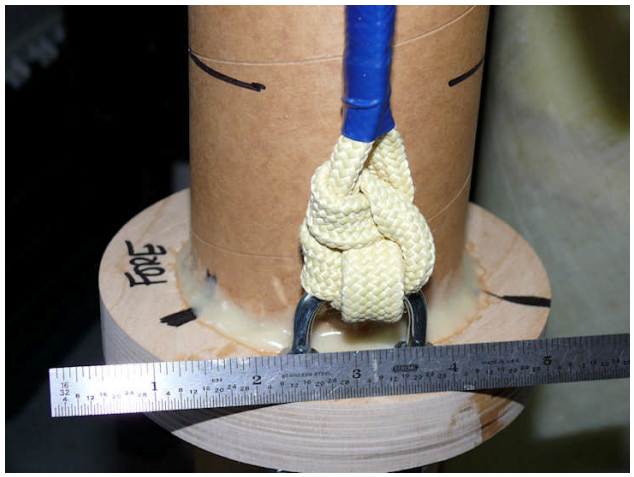
- View of eBay and Collar assembly from inside forward airframe.
  - West System epoxy used to attach to airframe
- Top ring is slightly smaller to allow epoxy to fill in and provide extra strong bond at the ring to airframe junction

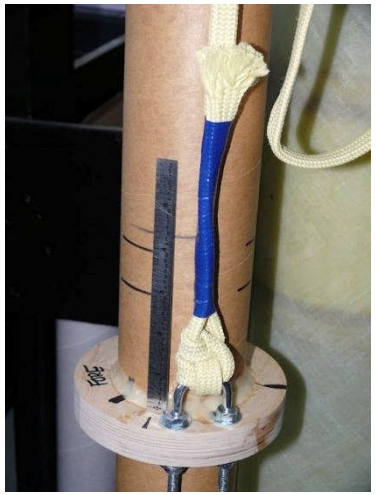


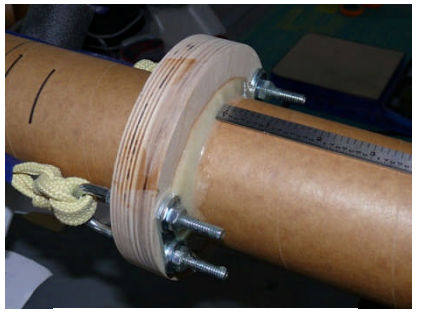


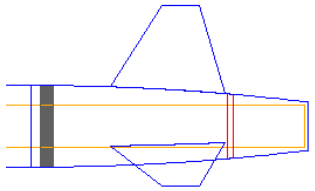
MOUNTING HARDWARE - 3

- Aft centering ring
  - ¼” U-Bolts
  - ½” Tubular Kevlar™ tied with anchor knot.
  - 6” of cord wrapped in electrical tape
  - Mounted to motor tube with West System epoxy thickened with 404 filler



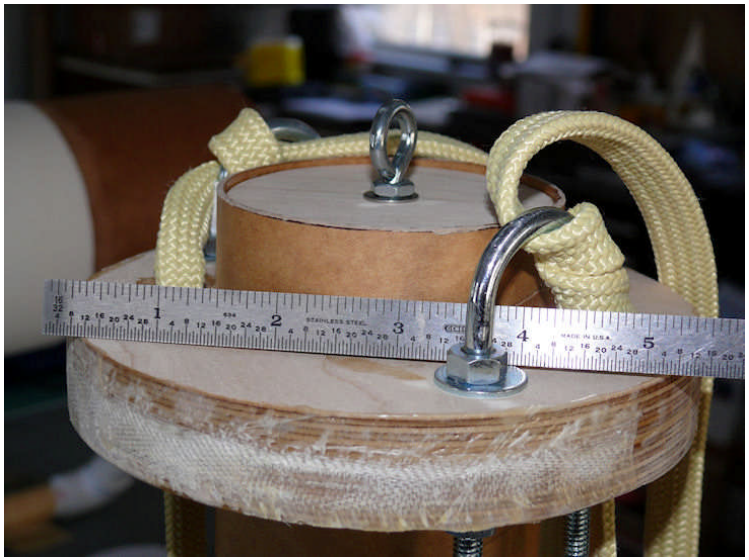






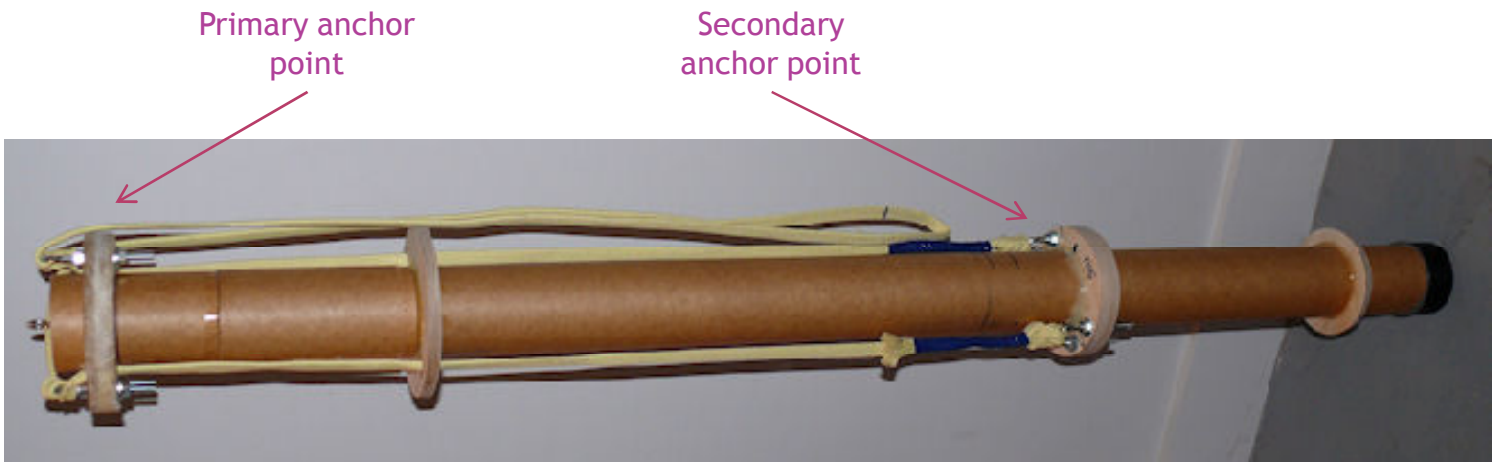
MOUNTING HARDWARE - 4

- Forward motor tube ring
  - ¼” U-Bolts
  - 5/8” Tubular Kevlar™ cord (up from the aft ring) wrapped and then extended about 14”



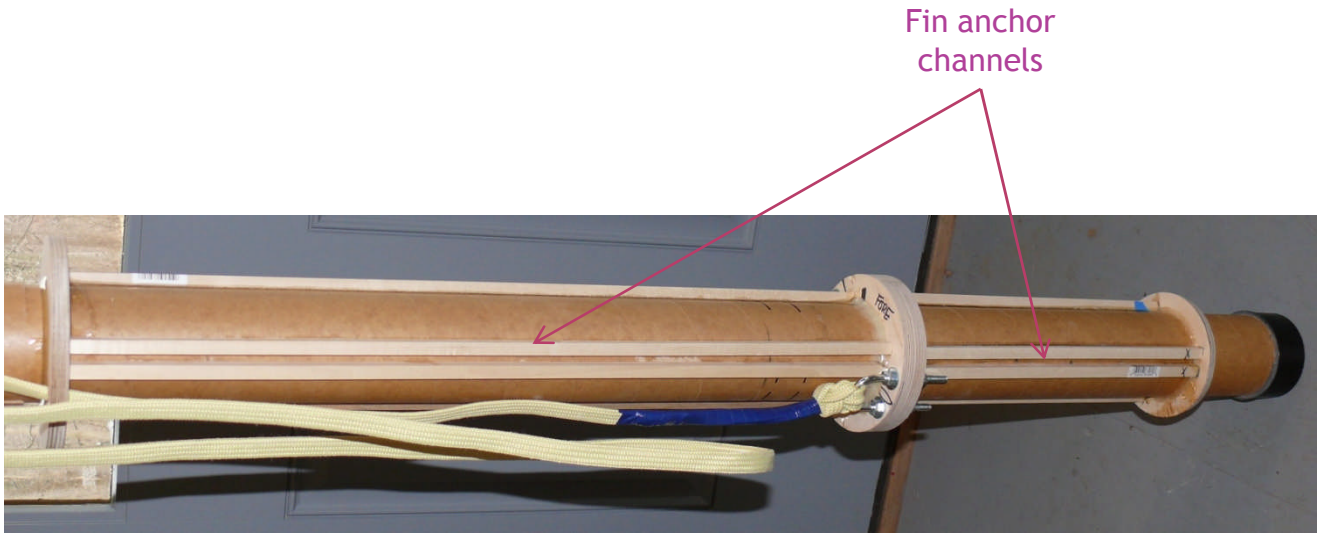
MOUNTING HARDWARE - 5

- The recovery system features a redundant anchoring system so that in the unlikely event that one attachment point fails, there's a back up anchor
- The aft centering ring provides secondary anchoring for the forward motor tube ring (not included in rebuild)



MOUNTING HARDWARE - 6

- Another modification to the original plans was the addition of fin anchor channels which provide a stronger attachment for the fin's root edge and also provides added strength to the centering rings.



PYROTECHNIC DEVICES

- MJG Technologies J-Tek3B eMatches
  - Resistance: 1 Ohm +/- 0.2 Ohms
  - Maximum no fire current: 0.3 Amps
  - Minimum All fire Current: 0.75 Amps
  - Recommended Min. Firing current: 1.00 Amps
  - Recommended Nominal Firing Current: 1.25 Amps
  - Maximum Test Current: 0.04 Amps
- Four eMatches (one in each ejection canister)

EJECTION DATA - MAIN

- Data from Chuck Pierce's Black Powder Ejection Charge Calculator
- Length of 25" was a conservative value based on length of forward section main airframe and the interior of the nosecone.
- BP needed = 5 grams

Volume =	706.9	in^3		4Fg Black Powder Gas Properties		
Dia =	6	inch		R =	22.16	ft*lbf/lbm/R
Lengh =	25	inch		Tc =	3307	R
				Conversions:	1 lbm = 454 grams	
					1 oz = 28.3 grams	
Calculation Mass of Black Powder for a desired Ejection Pressure						
Desired Pressure =	14	psi				
mass BP =	5.11	grams		m=PV/R/T		
Ejection F =	395.8	lbf		F=P*(pi/4)*d^2		

EJECTION DATA - DROGUE

- Data from Chuck Pierce's Black Powder Ejection Charge Calculator
- Drogue compartment length = 12"
- BP needed = 2.5 grams

Volume =	339.3	in^3		4Fg Black Powder Gas Properties		
Dia =	6	inch		R =	22.16	ft*lbf/lbm/R
Lengh =	12	inch		Tc =	3307	R
				Conversions:	1 lbm = 454 grams	
					1 oz = 28.3 grams	
Calculation Mass of Black Powder for a desired Ejection Pressure						
Desired Pressure =	14	psi				
mass BP =	2.45	grams		m=PV/R/T		
Ejection F =	395.8	lbf		F=P*(pi/4)*d^2		

GROUND TEST DETAILS

- Using 4 grams of BP and 4 2-56 nylon screws as shear pins
  - 5 grams was a bit excessive for the smaller chute
- Ground Test successful

Part V

STABILITY

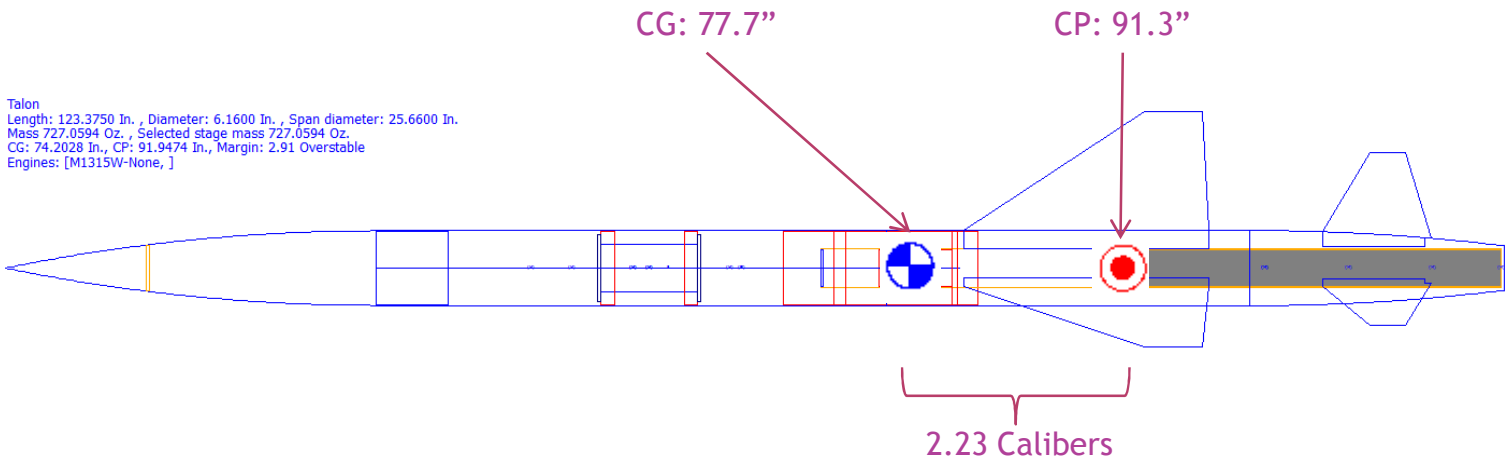
LAUNCH PAD

- Available system at MDRA site
  - Either 1500 or 1550 rails T-Slot rails on C-Rack or
  - 1 5/8” Unistrut on the hydraulic towers

CG AND CP

- Calculated by RockSim 9.0.4

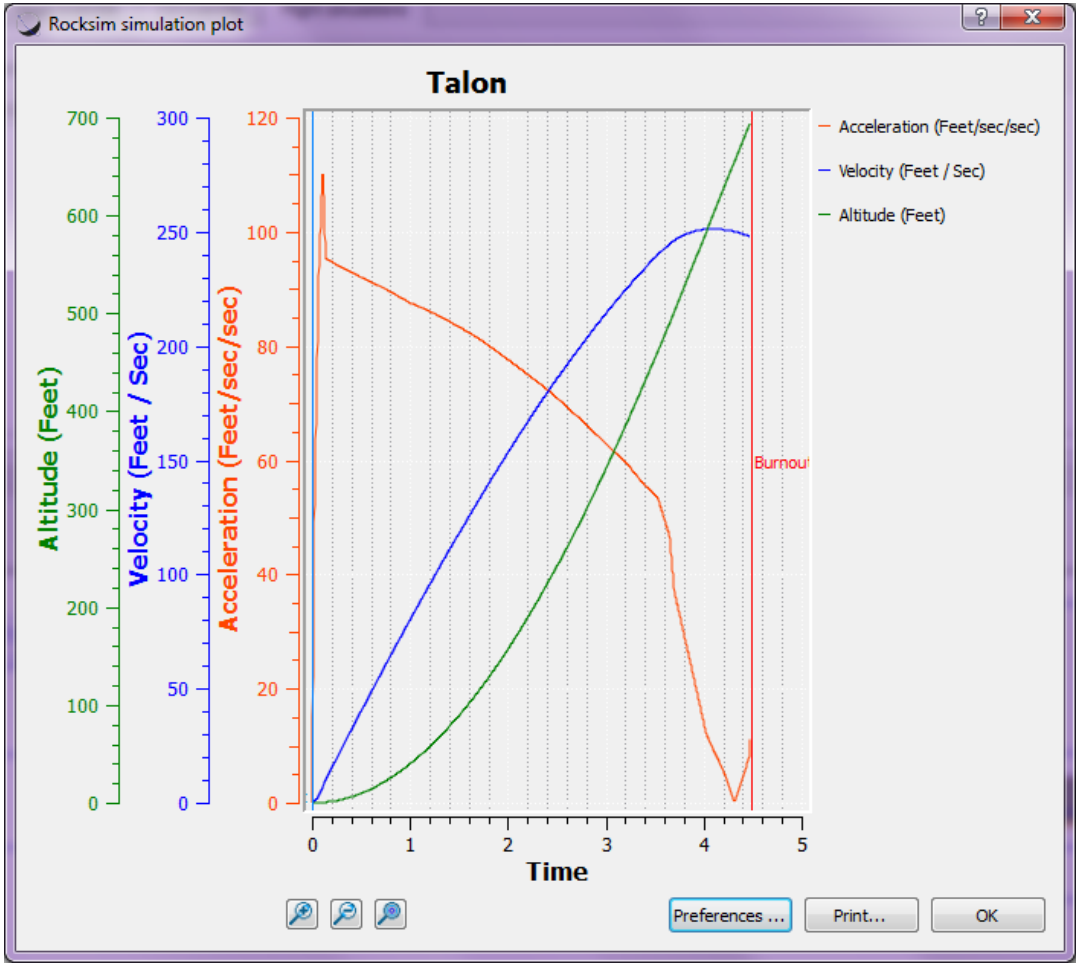
Talon
Length: 123.7500 In. , Diameter: 6.1600 In. , Span diameter: 25.6600 In.
Mass 735.2703 Oz. , Selected stage mass 735.2703 Oz.
CG: 77.7302 In., CP: 91.3354 In., Margin: 2.23
Engines: [M1400-Classic-None,]



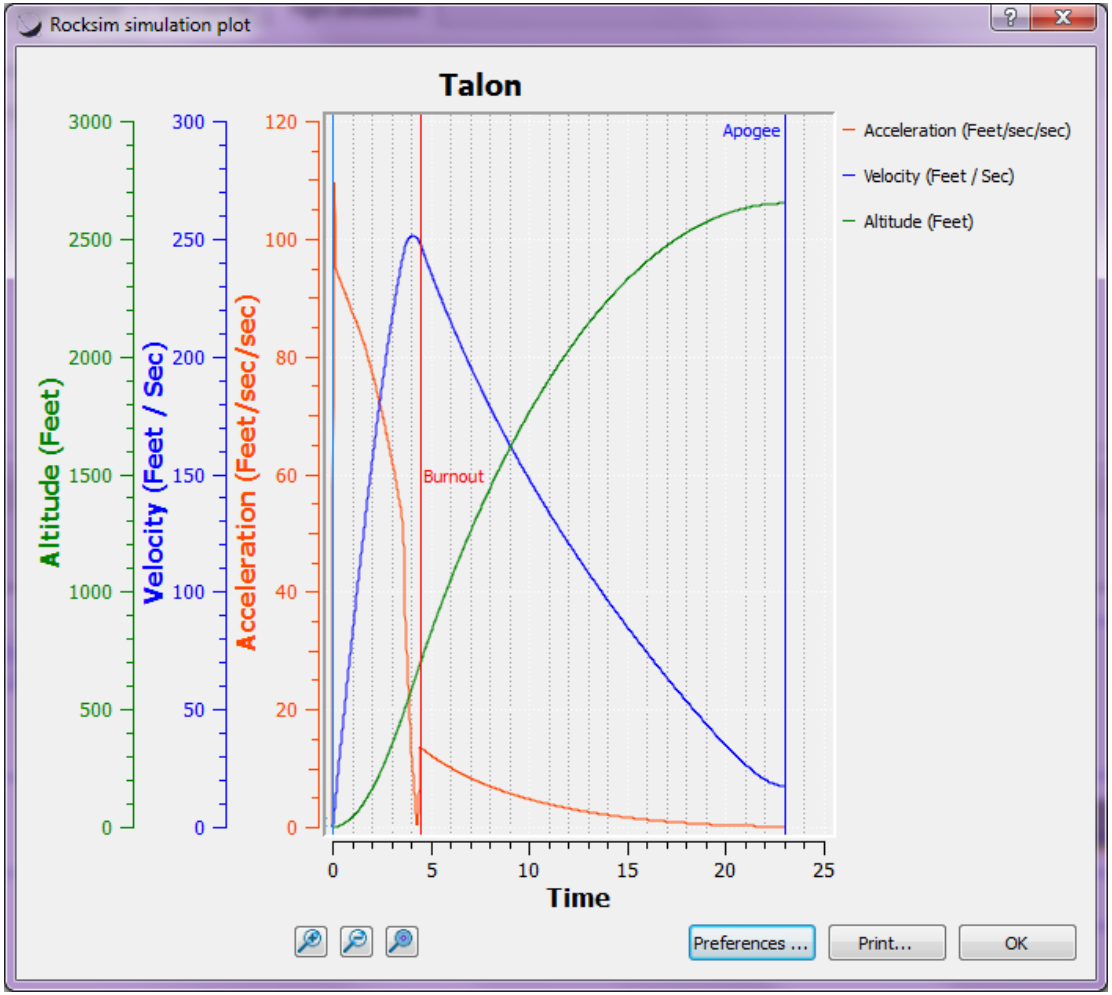
Part VI

TECHNICAL PERFORMANCE MEASURES

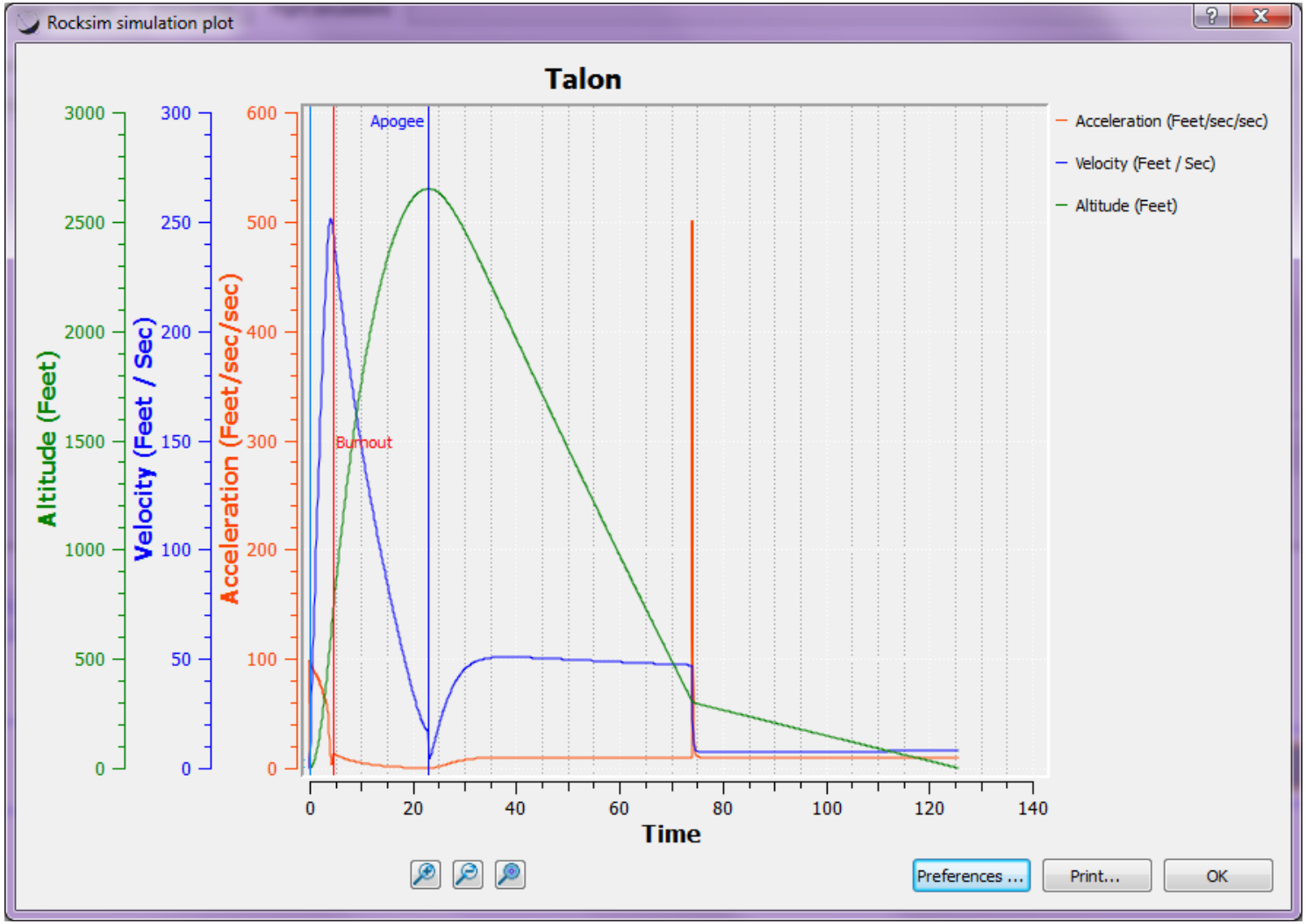
LAUNCH TO BURNOUT



LAUNCH TO APOGEE



LAUNCH TO LANDING



MOTOR

- Motor Reload
  - Cesaroni M1400
    - Average Thrust: 1389 N
    - Peak Thrust: 2206 N
    - Burn Time: 4.5 sec
    - Total Impulse: 6251 N-S
- Motor
  - Pro75 P75-5G-HS

LAUNCH GUIDE DATA

- Launch guide length: 120.0000 In.
- Velocity at launch guide departure: 75 ft/s
- The launch guide was cleared at : 0.29 Seconds
- User specified minimum velocity for stable flight: 44 ft/s
- Minimum velocity for stable flight reached at: 41 in.

MAX DATA VALUES

- Est. Drag Coefficient: 0.35 – 0.78 (Calculated by RockSim 9)
- Maximum acceleration:*
  - Vertical (y): 2020 Ft./s/s
  - Horizontal (x): 8.4 Ft./s/s
  - Magnitude: 2020 Ft./s/s
- Maximum velocity:
  - Vertical (y): 809 ft/s
  - Horizontal (x): 21.8 ft/s
  - Magnitude: 823 ft/s
- Maximum range from launch site: 2258 Ft.
- Maximum altitude: 8647 Ft.

* Large values are calculated at Chute Deployment: actual Max accel(magnitude): 280 Ft./s/s at 0.15 sec.

LANDING DATA

- Time to landing: 125 Sec.
- Range at landing: 170 feet
- Velocity at landing: Vertical: -18.9 ft/s , Horizontal: 17.2 ft/s , Magnitude: 25.6 ft/s

Part VII-X

CHECKLISTS

PLANNING CHECKLIST

- Planning Checklist
  - 1 Paperwork and Planning Materials
    - Check weather for wind and temperature conditions
    - Has the NAR L3CC approved the launch?
    - Have appropriate MDRA officers been notified of the flight?
    - Has all paperwork been completed and submitted?
  - 2 Flight profile predictions
    - Rocksim's predicted altitude below the waiver
    - Motor and reload ordered for flight date
  - 3 Pre-Launch (at home activities)
    - PerfectFlite MiniAlt/WD tested and operational
    - ARTS-II tested and operational
    - avBay parts accounted for and any pre-assembly completed
    - New 9v batteries purchased (8)
    - Inventory
      - Nosecone
      - Forward airframe
      - Aft airframe
      - avBay
      - Upper shock cord assembly
      - Lower shock cord assembly
      - QuikLinks
      - Chute protectors (2)
      - Shear pins
      - Main Parachute
      - Drogue Parachute
      - miniAlt/WD Altimeter
      - ARTS-II Altimeter
      - Motor preparation tools and materials
      - Motor retainer ring
      - Tools for airframe assembly and inspection
      - Stands and tie downs
      - Electronic test gear
      - eMatches
      - FFFF BP
      - Tissue wadding
      - Cellulose insulation
      - General at-field equipment (shade, chairs, flight kits, computer, GPS, etc.)
      - Manuals (Altimeters)
      - NAR Certification Forms
      - Certification package (copy)
      - NAR Membership Card
      - MDRA Membership Card

PRE-FLIGHT CHECKLIST

Pre-Flight Checklist

- [ ] 1 Damage Check
  - [ ] Check Nosecone for damage
  - [ ] Check upper airframe for damage
  - [ ] Check lower airframe for damage
  - [ ] Verify all linkage points are secure
  - [ ] Check harness(es) for damage or weak points
- [ ] 2 Motor Assembly
  - [ ] Assemble motor per manufacturer's instructions
- [ ] 3 Electronics
  - [ ] Verify all units are in safe mode
  - [ ] Check batteries for condition
  - [ ] Inspect electronics for damage
  - [ ] Conduct altimeter checks
    - [ ] Verify miniAlt is set for 900' main deployment (Switch settings: 0 1 1 0 0 0)
    - [ ] Conduct ARTS-II diagnostic tests
    - [ ] Program ARTS-II for 1000' main deployment
  - [ ] Verify safe status after all tests complete
  - [ ] Mount altimeters in avBay
  - [ ] Install all batteries (secure with electrical tape)
  - [ ] Connect batteries to altimeters
  - [ ] Verify safe status of altimeters
- [ ] 4 Pyrotechnics
  - [ ] Test all eMatches for continuity and resistance (1 +/- 0.2 ohm nominal)
  - [ ] Load eMatches into ejection canisters
  - [ ] Connect eMatches to altimeters
  - [ ] Verify Main and Drogue leads are routed properly
  - [ ] Plug eMatch lead routing holes to seal against ejection pressure
  - [ ] For all four ejection charge cannisters:
    - [ ] Load specified amount of black powder into ejection charge cannister
    - [ ] Install tissue wadding or cellulose insulation into canister
    - [ ] Tape end of cannister to secure charge
  - [ ] Final check of wiring
- [ ] 5 avBay
  - [ ] Mount avBay into upper airframe
  - [ ] Verify forward end is toward nosecone
  - [ ] Verify switch holes are in alignment with airframe access holes
  - [ ] Bolt on cover place and verify seal
- [ ] 6 Recovery System
  - [ ] Connect aft "Y" harness to aft avBay collar assembly
  - [ ] Fasten aft shockcord
  - [ ] Verify secure connections to both booster section and aft collar assembly
  - [ ] Attach drogue chute to QuikLink
  - [ ] Add cellulose insulation to aft end of main airframe
  - [ ] Pack shockcord, drogue and chute protector into aft section of main airframe
  - [ ] Attach metal repair tape to coupler
  - [ ] Couple booster and main airframe
  - [ ] Verify friction fit
  - [ ] Connect upper "Y" harness to upper avBay collar assembly
  - [ ] Fasten forward shockcord
  - [ ] Verify secure connections to both nosecone and forward collar assembly
  - [ ] Pack cellulose insulation into forward end of main airframe against forward collar assembly
  - [ ] Attach main chute to Quiklink
  - [ ] Pack shockcord, main and chute protector into forward section of main airframe
  - [ ] Verify main chute is not too tight in airframe (forward end will extend about 12" into nosecone)
  - [ ] Couple nosecone and main airframe (chute should compress the elastic in the nosecone)
  - [ ] Verify fit is clean with no parachute material wedged between airframe wall and nosecone shoulder
  - [ ] Install shear pins
- [ ] 7 Final Assembly
  - [ ] Verify electronics are in safe condition
  - [ ] Verify ignitor is available (not installed)
  - [ ] Verify CG location
  - [ ] Check launch lugs for alignment

LAUNCH CHECKLIST

Launch Checklist		
☐	1	Equipment List
☐		Launch site equipment available
		Launch pad tools (knife, wrenches, tape)
		Radios
☐	2	Mount rocket on launcher
☐	3	Verify launch angle and trajectory
☐	4	Install ignitor
☐	5	Arm Electronics
☐		Arm ARTS-II
☐		Verify ready (3 short beeps followed by high tone)
☐		Arm PerfectFlite
☐		Verify ready (3 short beeps - continuous)
☐	5	Connect ignitor to launch system
☐	6	Verify all flight witnesses are ready
☐	7	Contact LCO with Flight Ready Status

POST-FLIGHT CHECKLIST

Post-Flight Checklist		
☐	1	Verify pyro-charges are discharged
	☐	Safe any unfired charge
	☐	Attempt to identify reason for un-fired charge(s)
☐	2	Record Flight Data

CONTINGENCY CHECKLIST

Contingency Checklist		
☐	1	Determine misfire, lauch abort, or crash
☐	2	Safe all pyro charges
☐	3	Disconnect/remove ignitor
☐	4	Note operating time (flight batteries need replacement)