Tripoli Advisory Panel Documentation for

“PHOTON”

<u>A note about Releases 2+ of this document:</u>
This article was originally intended to serve as my Level 3 construction documentation. Now that this purpose has been served, the article will also be used to document subsequent flights and the results obtained. The sections on construction details will remain unchanged so that the article may serve as an example for those who wish to attempt their Level 3 certification. Best of luck to you all!
SDR – 7/2000

The latest version of this and my other articles and videos should be available at:

www.rocstock.org
www.winroc.org

And on the Winroc CDROM.

Level 3 Data Capture Form

Tripoli Advisor Panel PRE-FLIGHT DATA CAPTURE

NAME: Stephen D. Roberson	**ADDRESS**: P. O. Box 238, Mesa, AZ 85201	**PHONE** #
TRA # 1158	**LAUNCH LOCATION**: Rainbow Valley, AZ	**DATE**: June 26, 1999
ROCKET SOURCE: Hawk Mountain **KIT** **SCRATCH** x	**ROCKET NAME**: Photon	**COLORS**: OSHA Orange
ROCKET DIAMETER: 6"	**ROCKET LENGTH**: 118"	**ROCKET WEIGHT LOADED**: 45 lbs
AVIONICS DESCRIPTION: Two BSR AltAcc, rigged for dual deployment.	**MOTOR TYPE**: Aerotech M1315, Dr. Rocket case.	**THRUST TO WEIGHT RATIO**: 11:1
LAUNCHER REQUIREMENTS: BSR rail or Unistrut rail	**LENGTH**: 10 feet minimum	
CENTER OF PRESSURE: 99.5"	**HOW CALCULATED**: Winroc	
CENTER OF GRAVITY: 84”	**HOW CALCULATED**: Balanced	
MAXIMUM VELOCITY: 887 fps	**HOW CALCULATED**: Winroc	
MAXIMUM ALTITUDE: 9380 feet	**HOW CALCULATED**: Winroc	
WAS FLIGHT SUCCESSFUL:	**YES**: X	**NO**:
TAP NAME: Mark Clark, TRA #414		
TAP NAME: Jim Cornwell, TRA #1102		
TAP NAME:		

PROJECT DESCRIPTION

Photon is an unguided, single staged sounding rocket intended for subsonic flights. The mission is to loft either a still-camera or camcorder to maximum altitudes of 2 to 3 miles. The design is based on my highly successful series of EZ-EYE camera rockets, scaled up 1.5 times. EZ-EYE rockets have made many flights in the 1 to 1.5 mile range; recently released motor products will be able to push this design to nearly two miles high. Photon is intended to extend my photographic projects beyond this altitude.

SPECIFICATIONS

Length:	118”
Diameter:	6.125”
Fin span:	24”
Empty weight:	25 pounds
Prepped weight:	32 pounds
Liftoff weight:	45 pounds
Motor:	Aerotech RMS M1319

MATERIALS

Nose cone	PML 24” fiberglass
Airframe	Hawk Mountain G12 fiberglass, 6” ID
Motor tube	Hawk Mountain G12 fiberglass, 3.875” ID
Coupler tubes	Hawk Mountain G10 fiberglass
Fins	G10-FR4, 3/16” thickness
Bulkheads	G10-FR4, 3/16” thickness, lathe turned
Centering rings	G10-FR4, 3/16” thickness, lathe turned
Adhesive	Devcon 5 and 30 minute epoxy, mixed with milled fiberglass or micro balloons where appropriate.
Recovery attachment	5/16” forged steel eyebolts 5/16” steel triangular quick links
Parachute harness	1x1/8” nylon synthetic webbing with bolted loops
Parachutes	Rocketman R3C and R14C

FLIGHT SCHEDULE

Flight	Motor	Location (Prefecture)	Payload	Purpose
1	L850	Springfest 1999 (LTR)	None	Initial test flight
2	M1315	Rainbow Valley, AZ (AHPRA)	None	Level 3 certification
3	M1419	Roc Stock X (ROC)	8mm camcorder	First video flight
4	M1315	Rainbow Valley, AZ (AHPRA)	8mm camcorder	2nd video flight
5	M1939	Beat the Heat 2000 (AHPRA)	8mm camcorder	Video from 2 miles up

Other possible flights include lower altitude video flights using new Blue Thunder 98mm reloads, or substituting a still camera for the camcorder.

CONSTRUCTION DETAILS

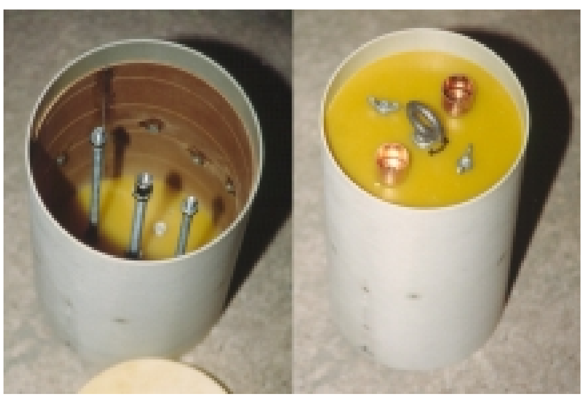
Fin root:

Fins are mounted through the wall to the motor tube. Four strands of 200 lb-test steel braided cable are threaded through holes drilled in the fin root, around the motor tube and crimped. Glass-filled epoxy fillets link the cable strands, fins, and motor tube into a solid unit. At the airframe surface, glass-filled epoxy was used to fill the gaps in the fin slots. A cosmetic fillet of epoxy and micro balloons completes the fin attachment.

The single G10 stringer is pinned in place, and is intended to provide a hard point to attach the lower rail guide.

Bulkhead & C-ring joints:

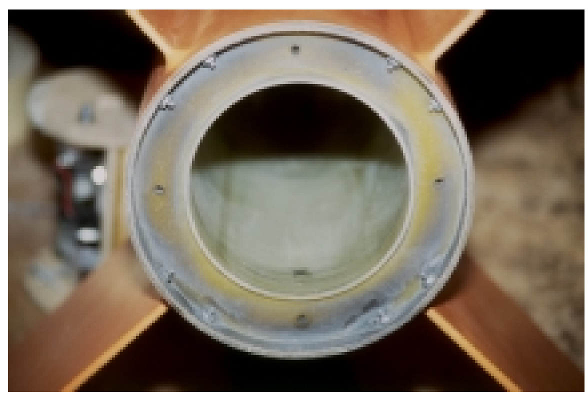
Each bulkhead is backed up fore and aft by a retaining ring made from a narrow segment of either airframe tube or coupler. The retaining rings and bulkhead are bonded with a minimum amount of epoxy. Six 4-40 steel bolts and nuts, equally spaced around the circumference, further secure each retaining ring. This method was used on the payload section bulkhead, forward fin-can centering ring, and aft of the rear fin-can centering ring.



Electronics Bay:

The electronics bay is constructed of a full-length G10 coupler tube with G10 bulkheads. An insert of phenolic tube is epoxied in place for the bulkheads to bear against. A single piece of 5/16” all-thread connects the two eyebolts, while two ¼”all-thread rods add additional links between the bulkheads. Aircraft nuts secure all.

The aft bulkhead is removed by unscrewing two wing nuts and then the eyebolt. Holes are provided for safety wire, to prevent unscrewing in flight.

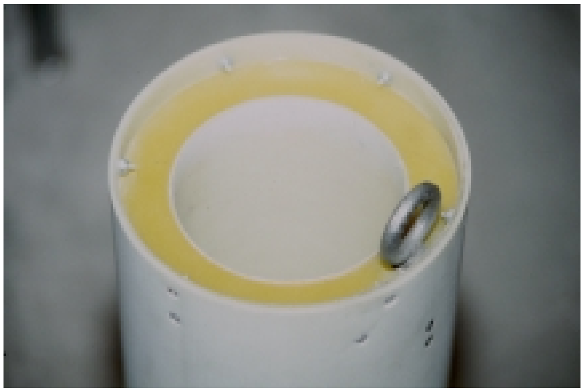


Motor retainer:

The aft centering ring is threaded with four 8-32 holes, backed up by star nuts. Four steel clips extend over the thrust ring of the motor and are bolted into these holes.

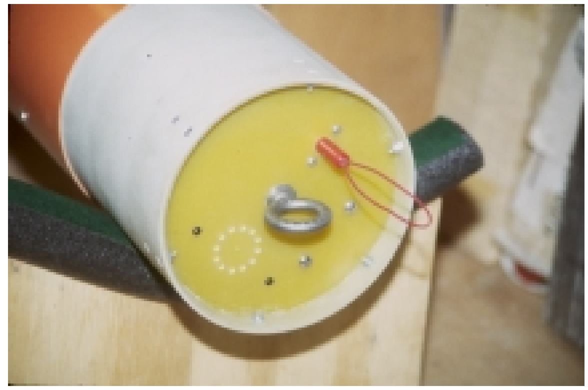
Note the 8 bolts securing the aft G10 retaining ring to the airframe tube. In this photo, the aft centering ring is lightly toasted from the White Lightning exhaust of the test flight motor.

CONSTRUCTION DETAILS 2



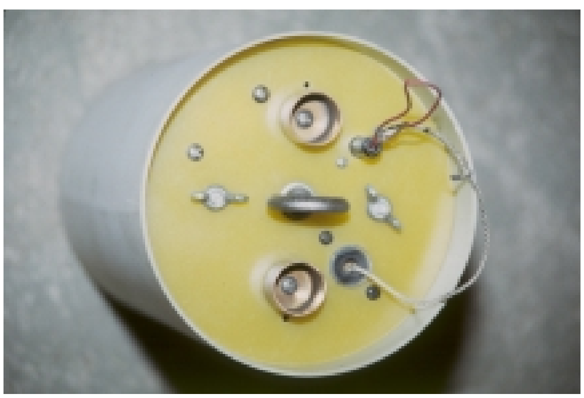
This is the forward end of the fin can showing the G10 coupler and centering ring. Note the 12 bolts holding the fore and aft retaining rings, which provide a sturdy attachment for the centering ring.

Six 8-32 stainless steel bolts backed up by star nuts, equally spaced around the circumference secure the coupler, and all other airframe joints. This coupler is removable for maintenance or for installing a future "stretch" section for using longer motors.



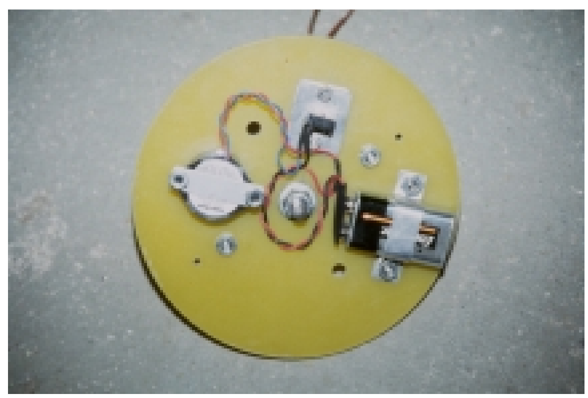
The payload bulkhead is attached to the coupler in the same fashion, with 12 bolts holding fore and aft retaining rings. The coupler is attached to the payload airframe by the standard 8-32 bolt pattern.

Built into the bulkhead is a 100db miniature siren. Powered by a 9 volt battery and activated by the main ejection, this siren is intended to warn inattentive spectators that 40 pounds of rocket is about to land on their heads. It also may prove useful if Photon were to land out of sight in trees or scrub.



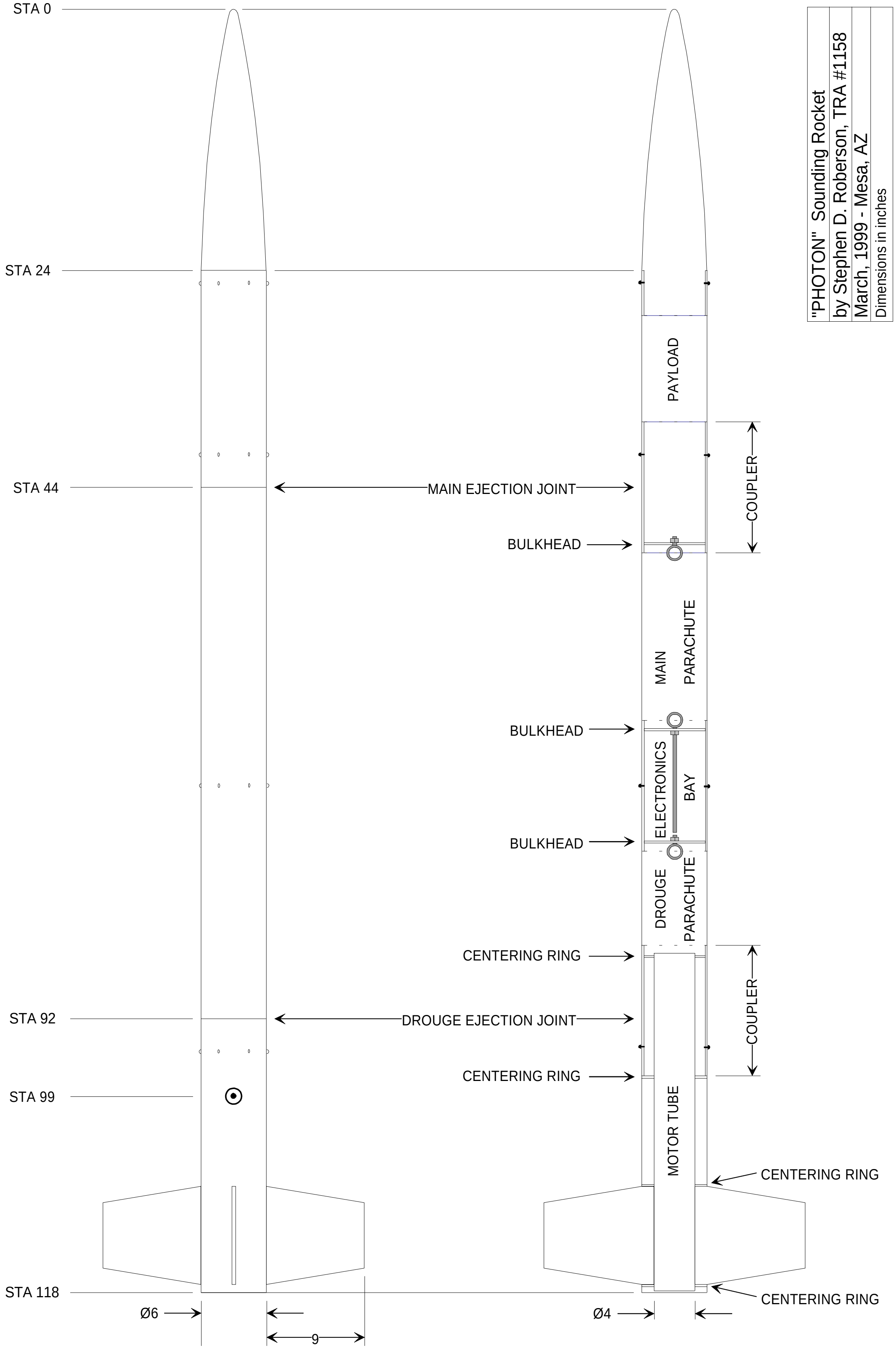
A close up of the aft end of the electronics bay shows another recovery beeper, which is activated on drogue deployment. A clear plastic cap on a string protects the beeper from ejection gasses.

Note the small hole next to each copper ejection charge holder; this is where the electric match passes into the electronics bay.



Details of the back of the electronics bay bulkhead show the mounting and wiring of the recovery beeper. The simple circuit is activated when a headphone plug is pulled out of it's jack on ejection.

These devices are sealed into the electronics bay, along with the AltAcc altimeters, to protect them from the ejection gasses. This beeper was later replaced by a siren, like the one in the payload section.



"PHOTON" Sounding Rocket
by Stephen D. Roberson, TRA #1158
March, 1999 - Mesa, AZ
Dimensions in inches
STA 0
STA 24
STA 44
STA 92
STA 99
STA 118
PAYLOAD
COUPLER
MAIN EJECTION JOINT
BULKHEAD
MAIN
PARACHUTE
BULKHEAD
ELECTRONICS
BAY
BULKHEAD
DROUGE
PARACHUTE
CENTERING RING
DROUGE EJECTION JOINT
COUPLER
CENTERING RING
MOTOR TUBE
CENTERING RING
CENTERING RING
Ø6
9
Ø4

RECOVERY SYSTEM

The dual-deployment method is employed. The vehicle is composed of 3 major sections: the fin can, main airframe, and payload section. An electronics bay is situated in the center of the main airframe. Composed of a coupler tube with ends sealed by bulkheads, this single unit contains all on-board electronics and ejection charges. Upon reaching apogee, the drogue charges will be fired, blowing the fin-can off the rear of the airframe and deploying the drogue parachute. After drifting to within 600 feet AGL, the main charges will be fired, ejecting the payload section from the front of the airframe and deploying the main parachute for final descent.

The main electronic control for recovery is a Black Sky Research AltAcc, which uses an accelerometer for determining drogue deployment, and a pressure transducer to determine the proper altitude for main parachute deployment. Backup electronic control is via second AltAcc or a BSR timer. The timer will be programmed with deployment times determined by computer simulation, and will control it's own separate ejection charges.

This photo shows the two AltAcc's bolted in place in the electronics bay. Countersunk screws are used so the bay can slide into the main airframe. Only two small holes for each unit are needed at the outside surface of the airframe, eliminating the complications of an external hatch.

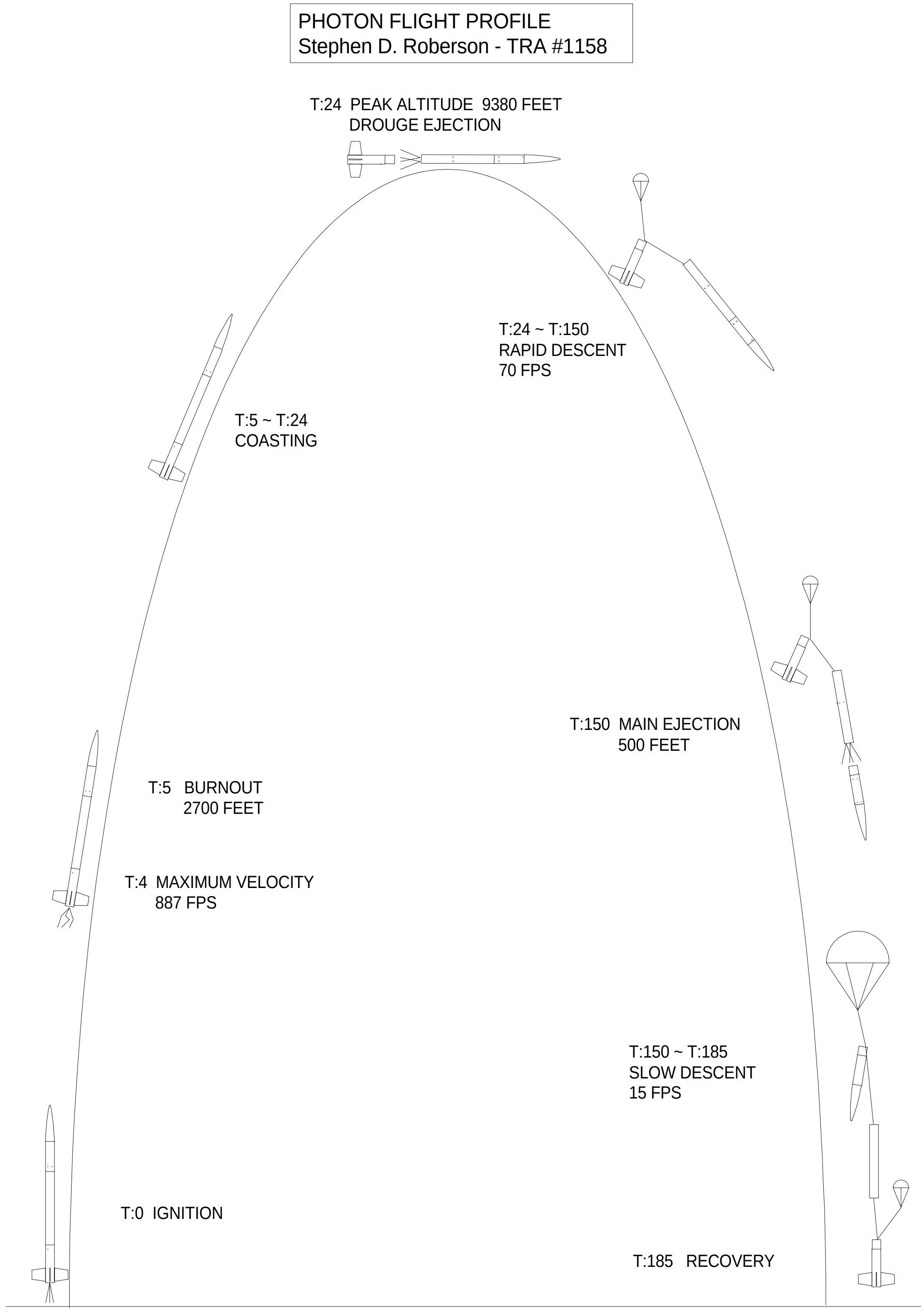
The four ejection charges are each composed of 10 grains of 4FG black powder. They are contained in a ½" copper pipe cap, bolted to the bulkhead, and sealed with masking tape. Activation is by Davyfire electric match.

Recovery attachment is by 5/16" forged steel eyebolts. These eyebolts have a solid ring. They are secured by an aircraft lock nut backed up by flat washers. The two eyebolts in the electronics bay are further joined by a length of 5/16" all-thread, creating a solid connection through the center of the electronics bay. The eyebolt on the front of the fin can is additionally backed up by an aluminum angle bracket, which is bolted to the inside of the coupler tube.

The two recovery harnesses are each 12' long, with 6' secondary parachute bridles. They are constructed of new 1" by 1/8" nylon synthetic webbing. The breaking strength is rated at 1000 pounds. Loops in the ends of the straps are bonded with epoxy and then bolted with two 8-32 stainless steel screws, washers, and lock nuts. The straps are joined to the eyebolts by 5/16" steel "Delta" quick links. Nomex cloth shields provide protection from the ejection gasses.

The drogue parachute is an R3C by Rocketman, with extra heavy shroud lines. It will provide a full-loaded descent rate of about 70 fps. The main parachute is an R14C Rocketman with nomex bag deployment system. When both parachutes are deployed, they will provide a fully loaded descent rate of about 15 fps. The nomex bag is attached by bridle to the peak of the main parachute canopy.

Couplers at each end of the main airframe are prevented from separating before ejection by a single shear pin in each joint. The shear pin is a 4-40 nylon screw, threaded into a hole in the airframe and coupler. Ground and flight tests with the EZ-EYE have demonstrated that this method will hold the payload section in place upon drogue deployment, and will shear cleanly when the ejection charge is fired.

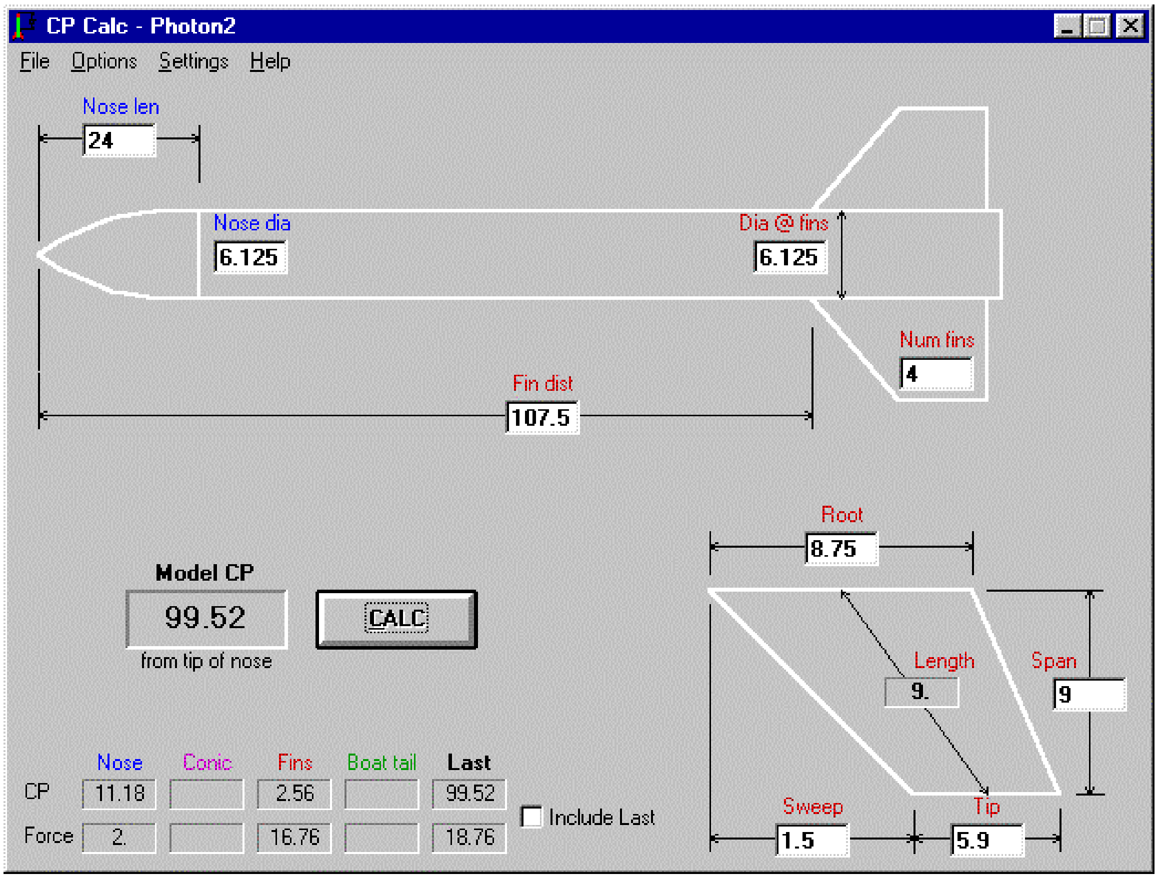


PHOTON FLIGHT PROFILE
Stephen D. Roberson - TRA #1158
T:24 PEAK ALTITUDE 9380 FEET
DROUGE EJECTION
T:24 ~ T:150
RAPID DESCENT
70 FPS
T:5 ~ T:24
COASTING
T:150 MAIN EJECTION
500 FEET
T:5 BURNOUT
2700 FEET
T:4 MAXIMUM VELOCITY
887 FPS
T:150 ~ T:185
SLOW DESCENT
15 FPS
T:0 IGNITION
T:185 RECOVERY

PREFLIGHT CALCULATIONS

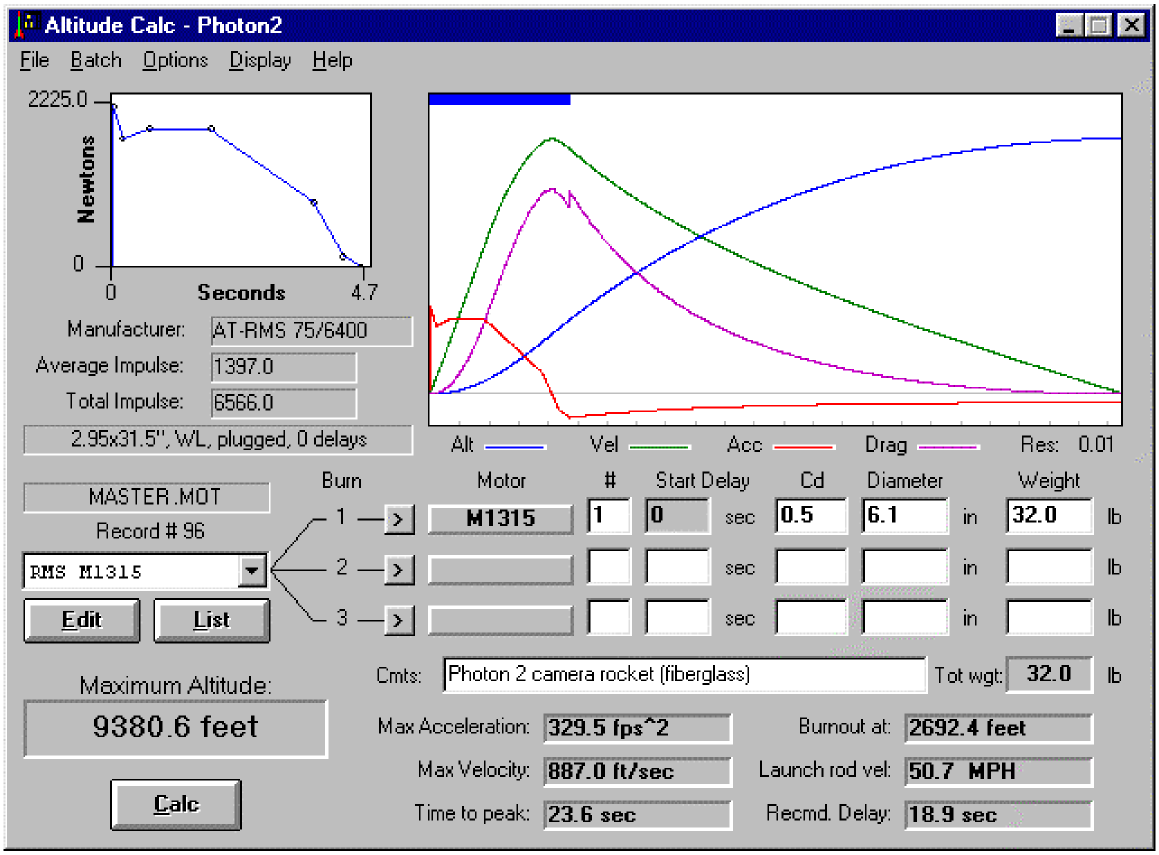
As the author of the Winroc suite of rocketry software, I have naturally used this package for all my computer simulations. Hundreds of flyers from every continent except Antarctica have thoroughly tested the accuracy of the calculations. If I did not trust this software, I would not offer it to the rocket community.

CP-CG relationship: After construction was completed, the rocket was fully assembled with all hardware and recovery systems put in place. A dummy motor was built using lead weights wrapped in cardboard. This placed the exact weight of a loaded motor at the correct distance inside the motor tube. The rocket was then balanced in it's assembly cradle and the CG point noted at 84" from the nose. The CPCALC program from Winroc was used to determine the CP position at 99.5" from the nose. Thus the CG lies 15.5" ahead of the CP. Changes in payload and motor type will no doubt alter this relationship, requiring new calculations. The CP is marked on the airframe by a custom decal.

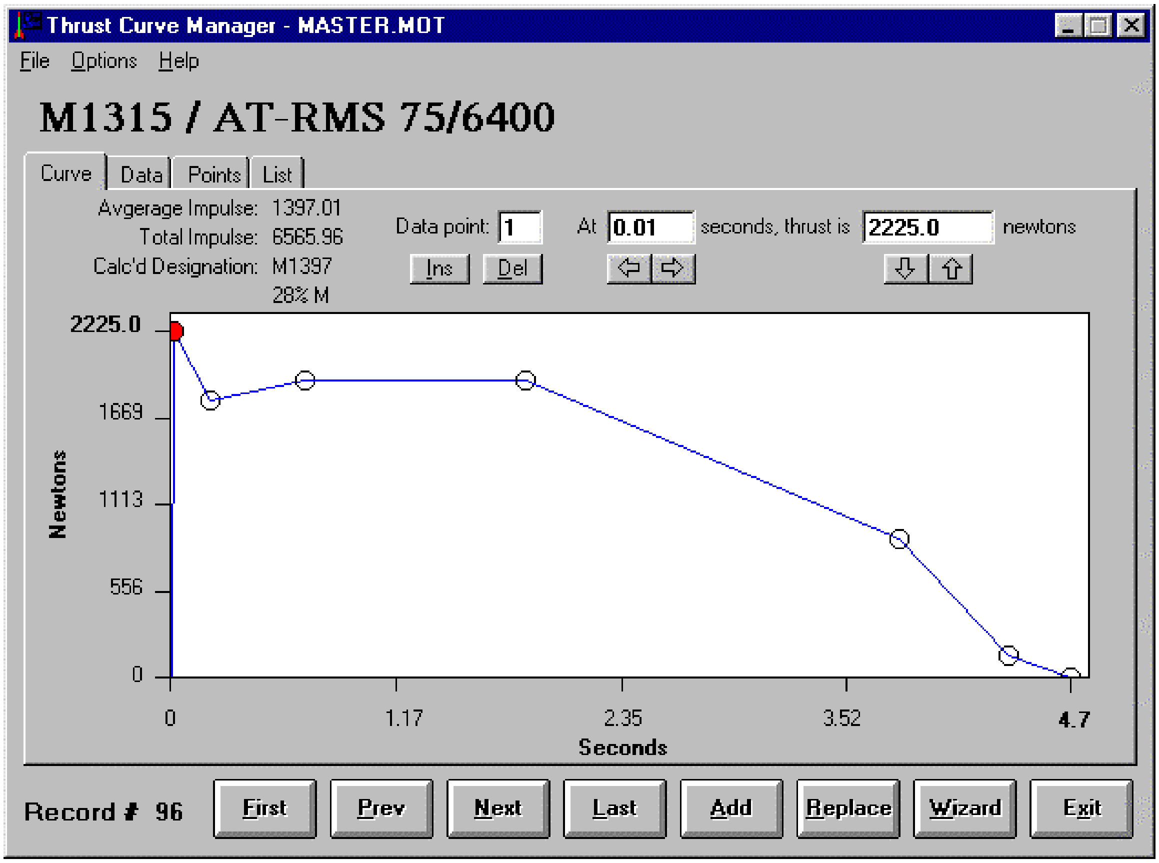


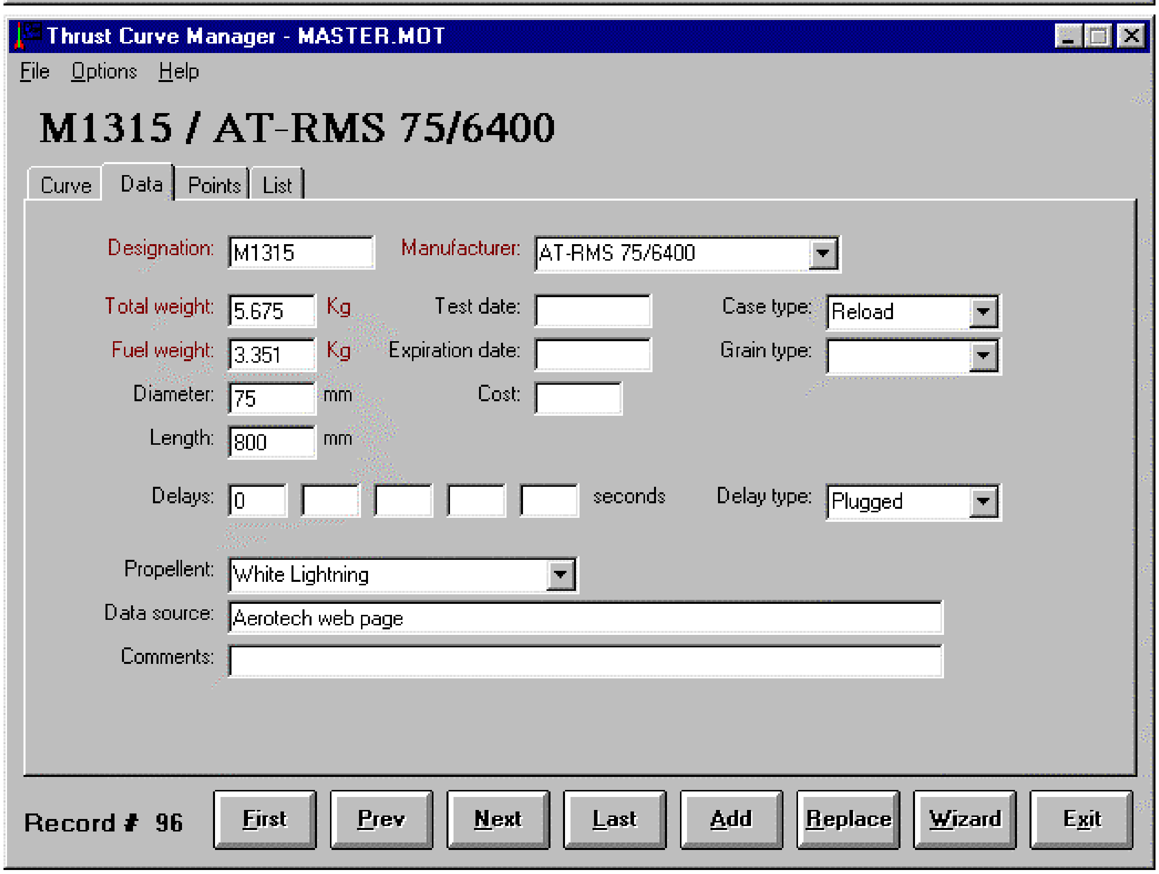
Flight Simulation: The Alticalc program from the Winroc package was used to predict the flight performance. The Coefficient of drag was predicted using flight data from the EZ-EYE, which has a similar shape, and from the successful test flight using an L850 motor.

For the L850 test flight, Alticalc predicted an altitude of 4381 feet using thrust data from Tripoli Motor Testing. Barometric data from the two AltAcc units returned altitudes of 4277' and 4324' indicating an accurate simulation is possible.



Thrust Curve: Motor data for the Photon Alticalc simulation was obtained from Aerotech.





ASSEMBLY AREA

_ Inspect airframe integrity
_ Inspect harness for damage
_ Inspect parachutes for damage
_ Motor assembled per instructions
_ Igniter assembled & not installed

_ Electronics installed with fresh batteries
Ejection charges installed
  _ Drogue   _ Main   _ Backup
Ejection charges connected to electronics
  _ Drogue   _ Main   _ Backup
Ejection charges in SAFE condition
  _ Drogue   _ Main   _ Backup
Harness attached to airframe
  _ Drogue   _ Main
Parachute attached to harness
  _ Drogue   _ Main
Ejection shields in place
  _ Drogue   _ Main
Parachutes packed and loaded properly
  _ Drogue   _ Main
Shear pins installed
  _ Drogue   _ Main

_ Payload prepared and installed
_ Airframe screws tight
_ Motor installed
_ Motor retainers installed

_ Final check: assembly completed
_ Balance check: CG ahead of CP by 1 caliber

LAUNCH AREA

_ Notify RSO rocket is moving to pad
_ Inspect pad and launch rail integrity
_ Mount rocket on rail - check for unobstructed movement
_ Tail supported at least 6" above blast deflector
_ Set launch rail angle to 80^{o} ±5^{o} away from flight line
_ Hold for photographs
_ Ask unneeded personnel to clear area

_ Attach igniter to leads and test continuity
_ Prepare payload for flight
_ Activate on board electronics
_ Ejection charges armed
_ Insert igniter & check continuity

_ Final check: ready to fire
_ Notify LCO rocket is ready to fire
_ Move to safe zone and observe flight
_ Note compass heading of landing area ________

LANDING AREA

Observe rocket before approaching:

  _ Motor has completely burned out?
  _ Motor was retained?
  _ All ejection charges expended?
  Parachutes deployed correctly?
    _ Drogue   _ Main

_ Deactivate payload
_ Deactivate on board electronics
_ Gather parachutes and bag for inspection
_ Gather harnesses and place inside tube
_ Police landing area for trash and/or broken parts
_ Reassemble rocket and carry back in triumph!

POST FLIGHT ANALISYS: Flight 1

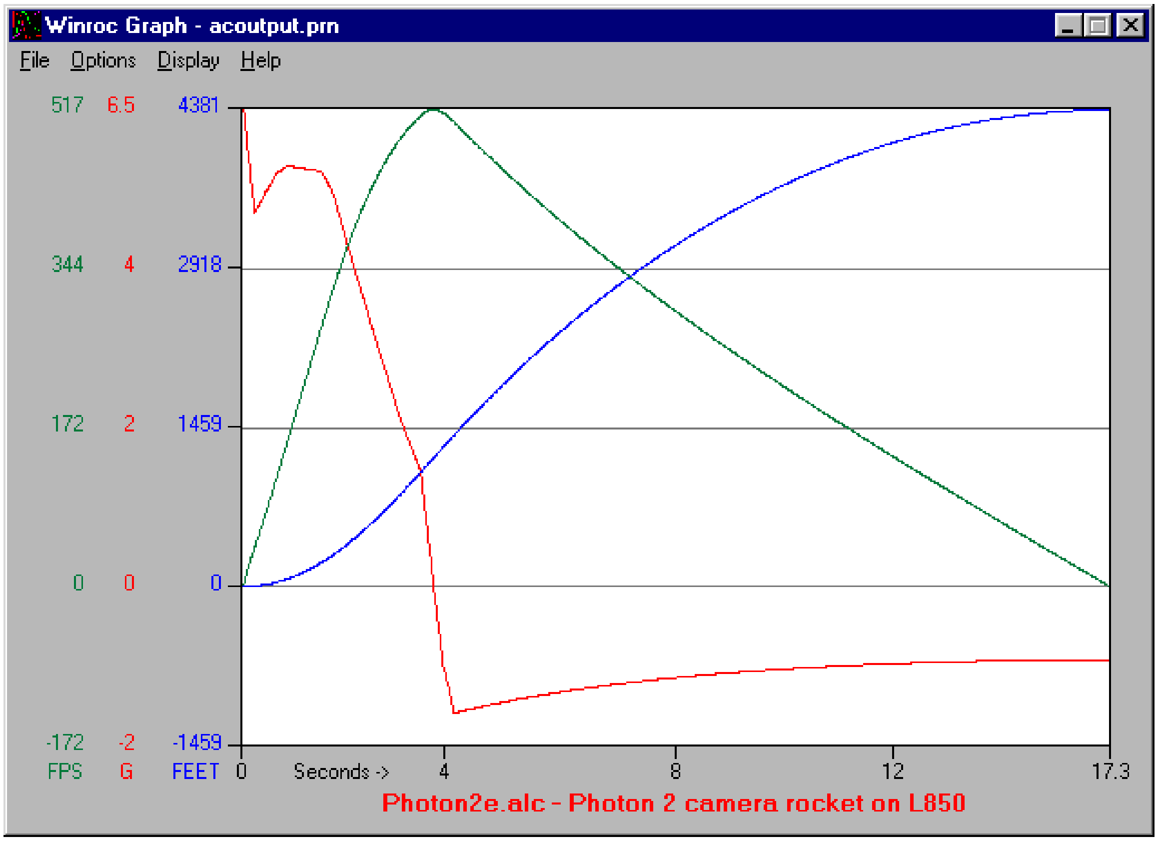
The launch rail was Bill Seiders' excellent custom built rail, which matches the cross section of the BSR rail system. Ignition of the L850 motor was accomplished via Davyfire electric match with two thermalight boosters about 4" long. The motor ignited on the first attempt. Liftoff was rapid and boost was straight up. The AltAcc units both actuated their drogue ejection charges at peak. The shear pin retained the payload section on the main airframe. The drogue parachute deployed correctly. A stable attitude was attained for the rapid descent phase. Main ejection seemed to come at a low altitude; however, the recorded AltAcc data indicates it was within the normal range. The main chute remained inside the deployment bag for a second or two and then inflated, inverting the entire assembly for landing. There was no damage to the rocket aside from minor pain dings and scratches.

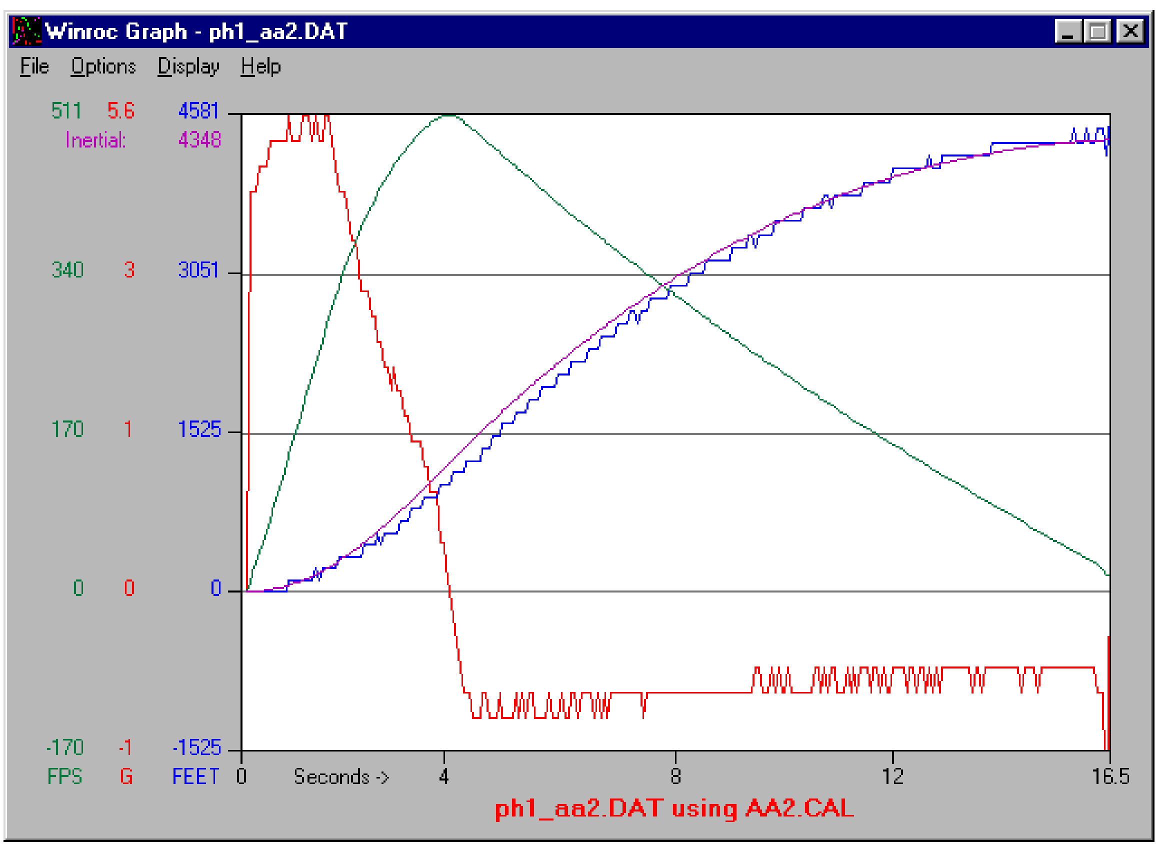
```
# Flight Mode:              Drogue to Main Mode
# AltAcc Data file:         ph1_aa1.dat
# Calibration file:         aa1.cal
#
# AltAcc Gain Factor:         3.4941
# AltAcc Minus One Gee:     130.0118
# AltAcc Zero Gee:          133.5059
# AltAcc Plus One Gee:      137.0000
# Launch Site Pressure:     197
# Launch Site Altitude:    1499 ft
#
# Drogue Fired at Time:      18.68750 sec    (   4277 ft AGL )
# Main Fired at Time:        72.50000 sec    (    634 ft AGL )
#
# Max Pressure Altitude:      4277    ft         (  18.68750 sec )
# Max Inertial Altitude:      4129    ft         (  18.68750 sec )
# Maximum Velocity:            473.0  ft / sec   (   4.25000 sec )
# Maximum Acceleration:        429.27 ft / sec^2 (  16.50000 sec,  13.3 G's )
# Minimum Acceleration:       -151.15 ft / sec^2 (  17.06250 sec,  -4.7 G's )


# Flight Mode:              Drogue to Main Mode
# AltAcc Data file:         ph1_aa2.dat
# Calibration file:         aa2.cal
#
# AltAcc Gain Factor:         3.3784
# AltAcc Minus One Gee:     122.7432
# AltAcc Zero Gee:          126.1216
# AltAcc Plus One Gee:      129.5000
# Launch Site Pressure:     222
# Launch Site Altitude:    1794 ft
#
# Drogue Fired at Time:      16.43750 sec    (   4324 ft AGL )
# Main Fired at Time:        72.37500 sec    (    454 ft AGL )
#
# Max Pressure Altitude:      4324    ft         (  16.43750 sec )
# Max Inertial Altitude:      4054    ft         (  16.31250 sec )
# Maximum Velocity:            491.1  ft / sec   (   4.18750 sec )
# Maximum Acceleration:        176.96 ft / sec^2 (   1.50000 sec,   5.5 G's )
# Minimum Acceleration:        -53.17 ft / sec^2 (   4.75000 sec,  -1.7 G's )
```

These printouts were generated by the original "produce" program by Konrad Hambrick. Differences between the two AltAcc results are no doubt due to problems in calibration, and may be resolved by more work in this area. It also appears that Unit #2 sensed liftoff later than Unit #1.

Comparison of Winroc Alticalc simulation and AltAcc flight data from first flight. Actual L850 test data from TMT was used in this simulation. It made a surprisingly close prediction.





POST FLIGHT ANALISYS: Flight 2

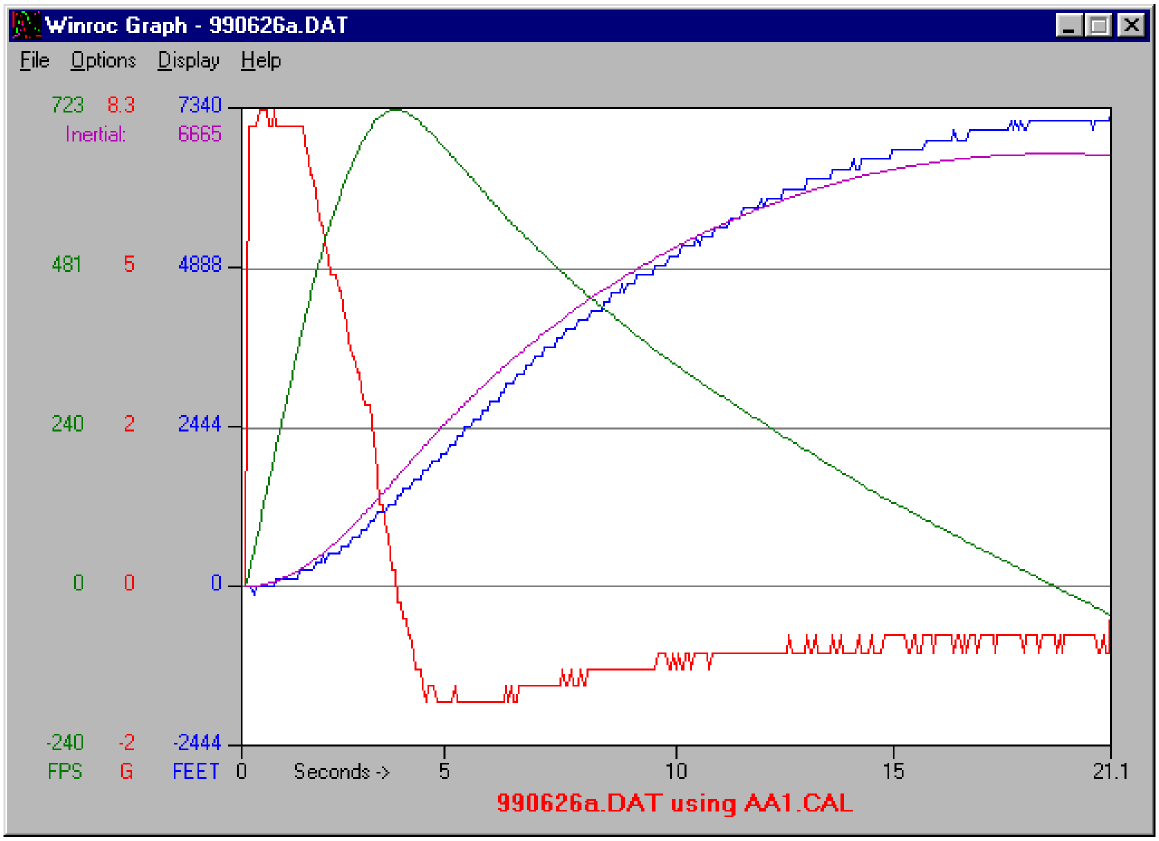
This was my TRA Level 3 certification flight. The launch rail was provided by Mark Clark of AHPRA, and utilized a common Uni-Strut for the rail. This required the fabrication of a pair of special larger launch lugs, made from HDPE, which were bolted in the same place as the BSR guides. Ignition of the M1315 motor was accomplished via Davyfire electric match with 4 thermalight boosters about 4" long. The igniter was inserted with the aid of a 1/8" pine dowel, which was left in place. The motor ignited on the first attempt. Liftoff was very rapid and boost was not straight up because of a slight angle on the rail. The AltAcc units both actuated their drogue ejection charges at peak. The shear pin retained the payload section on the main airframe. The drogue parachute deployed correctly. Main ejection again seemed to come at a low altitude. The main chute remained inside the deployment bag for a very long time but did inflate in time to slow the rocket for landing. This may indicate the need for an additional drogue to strip away the bag. There were more minor pain dings and scratches, mainly from the rail. Also, the motor exhaust charred the aft bulkhead more severely than on the first flight (despite being made from fire resistant G10), indicating the need for heat shielding of some kind.

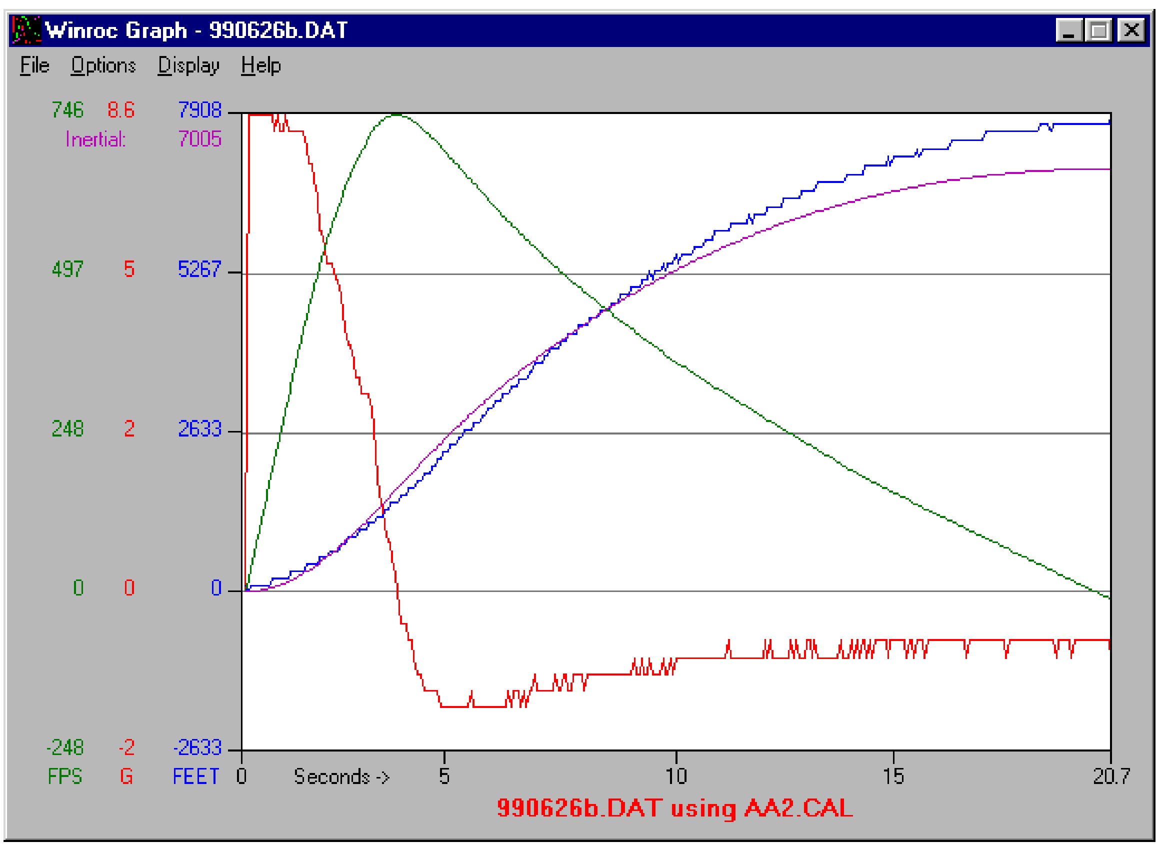
```
# Flight Mode:              Drogue to Main Mode
# AltAcc Data file:         990626a.dat
# Calibration file:         aa1.cal
#
# AltAcc Gain Factor:         3.4941
# AltAcc Minus One Gee:     132.2618
# AltAcc Zero Gee:          135.7559
# AltAcc Plus One Gee:      139.2500
# Launch Site Pressure:     200
# Launch Site Altitude:    1129 ft
#
# Drogue Fired at Time:      21.31250 sec    (   7304 ft AGL )
# Main Fired at Time:       124.25000 sec    (    625 ft AGL )
#
# Max Pressure Altitude:      7304    ft         (  21.31250 sec )
# Max Inertial Altitude:      7333    ft         (  21.25000 sec )
# Maximum Velocity:            734.6  ft / sec   (   4.00000 sec )
# Maximum Acceleration:        273.52 ft / sec^2 (   0.18750 sec,   8.5 G's )
# Minimum Acceleration:        -67.13 ft / sec^2 (   5.06250 sec,  -2.1 G's )


# Flight Mode:              Drogue to Main Mode
# AltAcc Data file:         990626b.dat
# Calibration file:         aa2.cal
#
# AltAcc Gain Factor:         3.3784
# AltAcc Minus One Gee:     121.7432
# AltAcc Zero Gee:          125.1216
# AltAcc Plus One Gee:      128.5000
# Launch Site Pressure:     224
# Launch Site Altitude:    1568 ft
#
# Drogue Fired at Time:      20.75000 sec    (   7767 ft AGL )
# Main Fired at Time:       125.18750 sec    (    564 ft AGL )
#
# Max Pressure Altitude:      7767    ft         (  20.75000 sec )
# Max Inertial Altitude:      7423    ft         (  20.68750 sec )
# Maximum Velocity:            760.7  ft / sec   (   3.93750 sec )
# Maximum Acceleration:        272.18 ft / sec^2 (   0.25000 sec,   8.5 G's )
# Minimum Acceleration:        -71.81 ft / sec^2 (   5.87500 sec,  -2.2 G's )
```

AltAcc data again indicates differences between the calibrations of the two units, in about the same magnitude and direction as the first flight. The altitude achieved was much shorter than the 9300' predicted. This was probably due to the angled flight and an optimistic manufacturer's thrust curve used in the simulation.

These graphs plot the data from the two AltAcc units on the Level 3 certification flight. Differences between this and the "produce" data indicate a slight difference in the method of smoothing the acceleration data.





POST FLIGHT ANALISYS: Flight 3

This was the first flight with the 8mm video camera payload. The launch rail was provided by Ron McGough, president of ROC. It utilized an enlarged version of the BSR rail, requiring me to borrow a set of special rail guides. These were bolted in the usual places. Ignition of the M1419 motor was accomplished via Davyfire electric match with 4 thermalight boosters about 4” long. The igniter was inserted with the aid of a 1/8” pine dowel, which was left in place. The motor ignited on the first attempt. Liftoff was very rapid and boost was straight up. The AltAcc units both actuated their drogue ejection charges at peak. The shear pin failed to retain the heavier payload section on the main airframe. Thus both the drogue and main parachutes deployed at apogee. Fortunately there was little or no wind, so the landing point was less than ½ mile away. Main ejection was not observed but the data below indicates it took place normally. Video from the flight was excellent and showed that Photon exhibited a very slow roll to the left, making 1.5 turns before apogee. The video also showed a slightly early ejection, about 2 seconds before actual peak was achieved. The camcorder project is the subject of a separate article, located in the same directory as this file.

```
# Flight Mode:              Drogue to Main Mode
# AltAcc Data file:         991113a.dat
# Calibration file:         aa1.cal
#
# AltAcc Gain Factor:         3.4941
# AltAcc Minus One Gee:     130.0118
# AltAcc Zero Gee:          133.5059
# AltAcc Plus One Gee:      137.0000
# Launch Site Pressure:     189
# Launch Site Altitude:    2509 ft
#
# Drogue Fired at Time:      17.06250 sec    (   8779 ft AGL )
# Main Fired at Time:        86.81250 sec    (    620 ft AGL )
#
# Max Pressure Altitude:      8779    ft         (  17.06250 sec )
# Max Inertial Altitude:      8203    ft         (  17.06250 sec )
# Maximum Velocity:            743.5  ft / sec   (   5.87500 sec )
# Maximum Acceleration:        194.11 ft / sec^2 (   1.81250 sec,   6.0 G's )
# Minimum Acceleration:        -60.23 ft / sec^2 (   7.50000 sec,  -1.9 G's )


# Flight Mode:              Drogue to Main Mode
# AltAcc Data file:         991113b.dat
# Calibration file:         aa2.cal
#
# AltAcc Gain Factor:         3.3784
# AltAcc Minus One Gee:     121.2432
# AltAcc Zero Gee:          124.6216
# AltAcc Plus One Gee:      128.0000
# Launch Site Pressure:     213
# Launch Site Altitude:    2833 ft
#
# Drogue Fired at Time:      22.43750 sec    (   9243 ft AGL )
# Main Fired at Time:        92.43750 sec    (    590 ft AGL )
#
# Max Pressure Altitude:      9243    ft         (  22.43750 sec )
# Max Inertial Altitude:      8502    ft         (  22.43750 sec )
# Maximum Velocity:            759.4  ft / sec   (   5.87500 sec )
# Maximum Acceleration:        200.76 ft / sec^2 (   2.56250 sec,   6.2 G's )
# Minimum Acceleration:        -72.21 ft / sec^2 (   7.31250 sec,  -2.2 G's )
```

POST FLIGHT ANALISYS: Flight 4

This was my second video flight, and as far as I know the first such flight at the AHPRA Rainbow Valley launch site. The loss of my still camera rocket, EZ-EYE, to a crash in January required me to replace the electronics used in Photon. A new AltAcc version 2 was used, with a Missile Works WRC^2 radio control unit acting as backup. The dual deployment recovery was neglected in favor of placing a 70" backup parachute in the drogue compartment. An R7C chute was used on the payload section, while an R9C was attached to the booster section.

The launch pad used was my own trailer-mounted launch rail, with Unistrut for the rail. This was my first Level 3 flight utilizing all my own equipment. Ignition of the M1315 motor was accomplished via Davyfire electric match with 3 thermalight boosters about 4" long. The igniter was inserted with the aid of a 1/8" pine dowel, which was left in place. The motor ignited on the first attempt. Liftoff was rapid and boost was straight up. The AltAcc deployed the main parachutes just after peak. After seeing the chutes had successfully deployed, I activated the first channel of the R/C backup while I observed through binoculars. I did not see any puff of smoke. A post flight examination showed that the charge had fired, although it may have been set off by the adjacent AltAcc charge. When the booster section was within 500 feet of the ground I activated the second channel of the R/C backup. This charge fired, deploying the backup parachute successfully. Video from the flight was excellent and showed that Photon again exhibited a very slow roll to the left, making about 1 turn before apogee.

This will probably be the final flight of Photon in this configuration. Before the next flight with an M1939 motor I plan to rebuild the payload and parachute sections to place 3 equal parachutes above the camera and booster. This method will provide an upright, stable camera platform, as proven by flights of Kurt Gugisberg's rocket "Big Purple". Imitation is the most sincere form of flattery.

```
# Flight Mode:              Main Only Mode
# AltAcc Data file:         062400.dat
# Calibration file:         prodata.cal
#
# AltAcc Gain Factor:         3.5586
# AltAcc Minus One Gee:     111.1328
# AltAcc Zero Gee:          114.6914
# AltAcc Plus One Gee:      118.2500
# Launch Site Pressure:     227
# Launch Site Altitude:     766 ft
#
# Main Fired at Time:        21.75000 sec    (   6974 ft AGL )
#
# Max Pressure Altitude:      6974    ft         (  21.75000 sec )
# Max Inertial Altitude:      7750    ft         (  21.68750 sec )
# Maximum Velocity:            723.4  ft / sec   (   4.43750 sec )
# Maximum Acceleration:        325.73 ft / sec^2 (   0.12500 sec,  10.1 G's )
# Minimum Acceleration:        -64.79 ft / sec^2 (   6.75000 sec,  -2.0 G's )
```

POST FLIGHT ANALISYS: Flight 5

Much construction work was done before this flight. As discussed above, Photon was modified to place 3 smaller parachutes in a compartment above the camera payload. The intent was to provide a more stable, upright platform for the camera while under chute. The rocket was lengthened by about 20” to make room for the new configuration. The main body was joined to the payload section by a coupler containing the electronics bay. The camera sat above this, and a new bulkhead with the main ejection charges and recovery harness attach points was placed above the camera. A new tube section above the camera held 3 Rocketman R7 chutes along with a smaller parachute for the nose cone, which would drift down alone on a single chute. The original R12 chute was placed in the old drogue compartment below the electronics bay to act as a backup. Room for dual altimeters and the Missile Works R/C backup controller was made in the electronics bay. Use of the radio controlled ejection saved Photon from total destruction on it’s fifth flight.

The 3rd video flight, fifth overall, was made at the AHPRA Flagstaff launch “Beat the Heat 2000”. Using an Aerotech M1939 motor and my trailer mounted launch rail, Photon was in it’s ultimate configuration for a flight to 12,000 feet. A perfect boost was followed by a less than perfect recovery. The apogee was not visible but it seems certain that the altimeters did not eject the 3 main parachutes. I activated the emergency main ejection but it was too late; Photon was traveling too fast and stripped the chutes. We did not see the rocket but heard it; the jet-plane sound of a rocket streaming in fast. I was already hitting the button for the emergency chute. We then saw the rocket, with the big chute torn but still attached, heading down fast about a half mile away.

Upon recovery the rocket was found surprisingly intact, only scratched. The nosecone and stripped main chutes were never seen again. Internally, though, there was much damage. A battery had broken loose in the electronics bay and bounced off of the delicate parts, causing damage to both the AltAcc and R/C units. The video camera took a fatal blow and suffered enough internal damage that it would not work. An operation was performed on site to extract the video tape. Unfortunately when the tape was played, it was discovered that the camera had shut down about 2 seconds into the flight, right at the predicted maximum acceleration. So there was no video from this very damaging flight.

Photon was repaired. The broken electronics were repaired or replaced and new parachutes were obtained. In the time since then, however, circumstances for our hobby changed dramatically. The AP lawsuit against the ATF, the fire at Aerotech, and the events of 9/11/2001 have made our hobby more difficult to pursue. Add to that my own marriage and adoption of a new family and you have a recipe for reduced rocket activities. Photon has not flown again, but it is ready when the time is right.

PERSONAL NOTES

The rocket described here is named “Photon 2” which implies that there was a “Photon 1”. It was a big yellow rocket that I built around 1990 out of 6” PML phenolic tubing. I built it to carry a full-sized SLR camera, in order to make use of the faster shutter speed and get better pictures than my little point-and-shoot cameras. The tubing proved to be rather fragile; there was major damage in 4 out of 7 flights with up to a K550 motor. I got some good pictures and learned a lot, but retired Photon. Now, the booster and nosecone are a conversation piece in my brother’s rec-room.

I refer to this as “my” Level 3 flight, but no one does a project of this size alone. I may wear the Rocket Scientist hat, but there were lots of family and friends who were supportive if not directly involved. I really appreciated all the help. Thanks in particular go to:

My son Christopher, who stood by and watched me spend lots of time and money on something that did not involve entertainment as he saw it, yet he accompanied me to far away places in an old truck with no AC, where we were baked alive and sand blasted, and managed to take a very nice set of photographs of the first flight. These appear on the title page.

Dave Moore, who came along for the ride and took some good photos of the second flight. He just got his Level 1 so I guess he is infected, too.

My good friend George Blair, who risked his table saw and death by fiberglass dust to help me cut up the fins and tubes.

Fellow rocketeers in Rocketry Organization of California, Lucerne Test Range, Arizona High Power Rocketry Association and Tripoli Coastal Georgia, for encouragement, ideas, and camaraderie.

And especially Kurt Gugisburg, for beating me to it. Envy is the mother of motivation.

I do wonder sometimes if it was all worth it. I enjoyed the construction phase immensely, and also writing this article. But there were some frustrations, mainly stemming from suppliers. I started this project in April 1998 by placing my first order for parts. It seemed like every single piece was slow or delayed for some reason. The best advice I can give is don’t set a deadline; just let it come in it’s own sweet time.

Sooner or later, though, you come to the point of putting it on the pad and pressing the button. If you were like me, maybe the costs crept up on you until you had $1000 worth of hardware out there ready to take off. To say I was nervous the first time is an understatement. Only the presence of Ky Michealson standing right behind me kept me from hurling all over the RSO table. The second time was only a little better, but it was my Level 3 flight and I had a reputation to uphold, so I lost a bit of sleep over it.

When the big moment came, I had the button in my hand and someone behind me shouting out a short count. There was a roar and then it was over and done with before I knew it, and then I was watching through my binoculars as Photon peaked out and ejected. I didn’t have much of a chance to enjoy it. Everything worked; afterward I was excited and pleased, and babbled on and on the entire trip home. So it must have been satisfying. Wasn’t it?

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