First Nations Launch RECOVERY Webinar 2025

Presented by:
Frank Nobile WSGC TECH TEAM – Tripoli Rocketry
February 11, 2025

ARTEMIS STUDENT CHALLENGES
nasa.gov/stem/artemis.html

NASA Partner

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Meet the FNL Team

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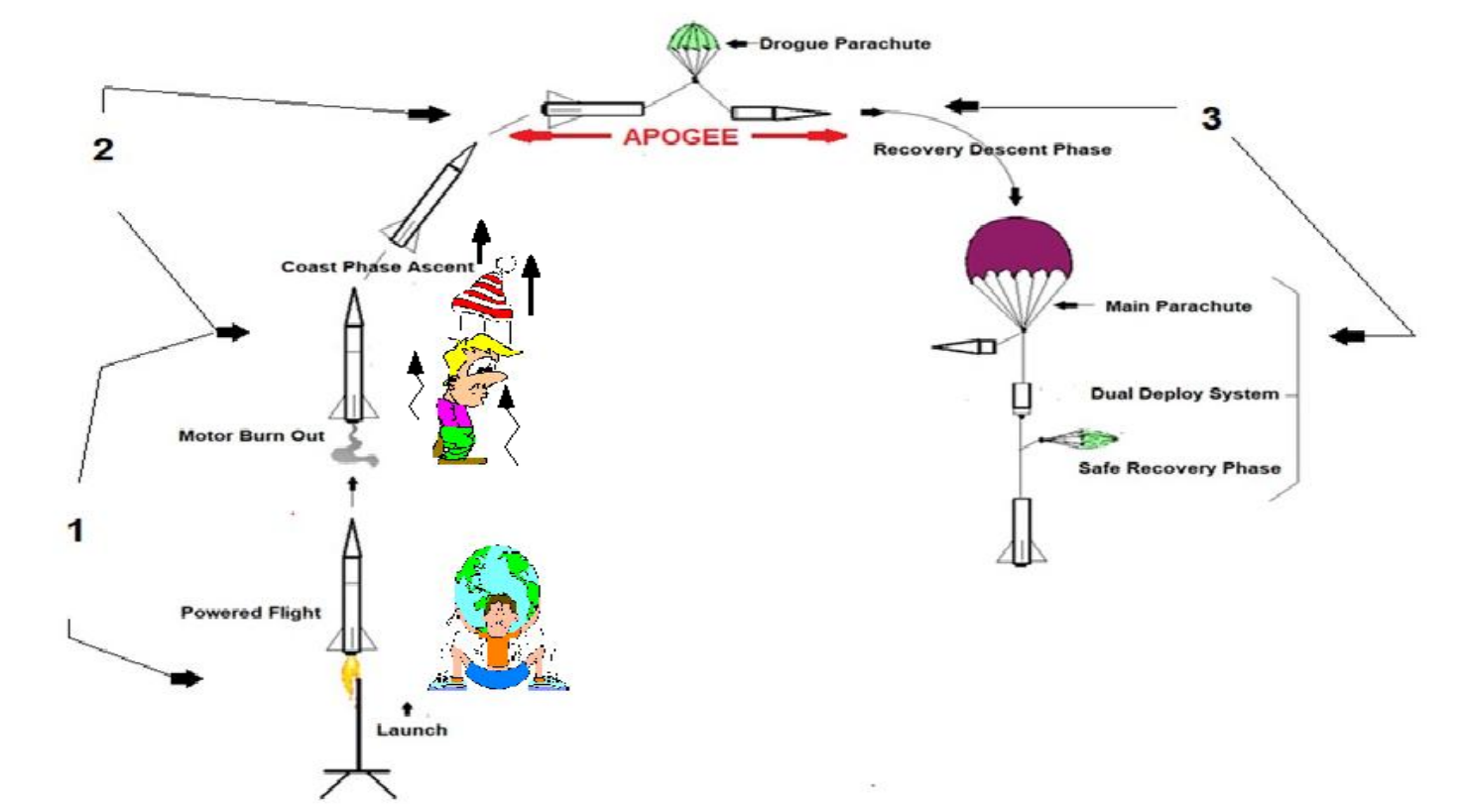
ROCKET RECOVERY

SUMMARY

- RECOVERY PROFILE
- IT ALL STARTS IN THE AVIONICS BAY
- TYPES OF HARDWARE, ANCHOR POINTS AND CONNECTIONS
- DEPLOYMENT HARDWARE AND TECHNIQUES
- HOW TO ACHIEVE A SAFE RECOVERY
- LOCATING THE ROCKET

Recovery Flight Profile

Laws of Motion are Prevalent



AVIONIC CHECK

The use of recommended fresh/charged batteries will optimize operating voltages, that is vital for altimeter performance.
All redundant recovery systems must have a separate independent altimeter, power supply and energetics.
Securing batteries to the deck of the avionic sled is essential.
Primary battery connections should be doubled down securely.

Figure 1

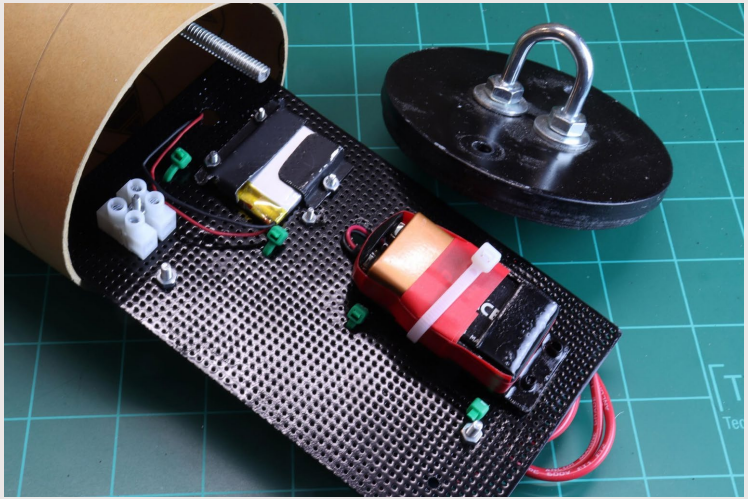
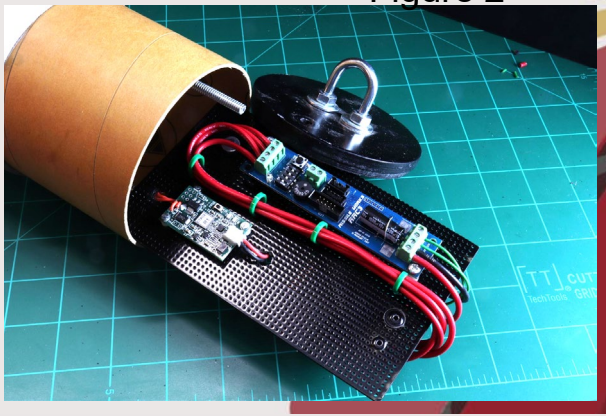


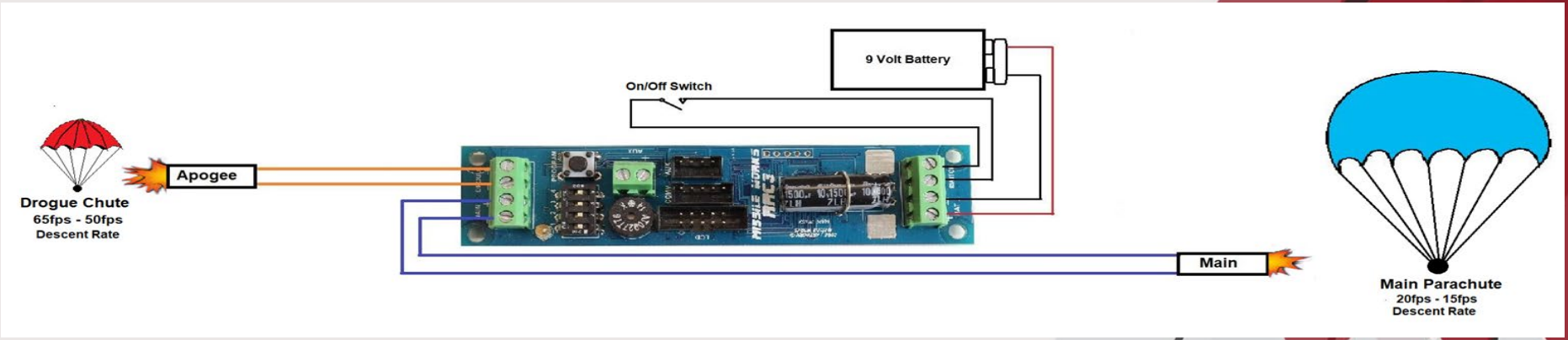
Figure 2



Always mount altimeters, using non-metallic stand-offs to avoid damaging delicate components on the underside from being crushed.
Assure wires are secured to the altimeter (Phoenix) terminals. (perform a gentle tug test).
Understand the programed audible sequence of the altimeter.

WIRE IT RIGHT

Typical Missile Works RRC3 altimeter wired correctly for dual deployment recovery



Review owners manual for proper function and wiring of all electronic devices in your rocket

RESTRAINT HARDWARE

Restraint recovery hardware is available at most hardware stores, outdoor sporting shops and rocketry vendors.

Some quick links are stamped rated with a (WLL) Weight Limit Load or a (SWL) Strength Working Load.
Stainless Steel restraint hardware are rated almost double the strength of the basic zinc coated steel quick links.
Basic WLL/SWL of 400lbs for high-power rockets weighing below 25 lbs. is plenty sufficient for a fully loaded rocket.
U-Bolts 7&8 have a SWL of 1500-2000 lbs. rating. #9 the forged galvanized eye bolt has a rating of 650 lbs.
#10 - Stainless Steel Eye to Eye swivel should only be used for parachute attachments to recovery harness. Avoid attaching to bulk plates that bare the weight of the rocket. # 6 – Avoid using open eye bolts. Their ratings are only 70-100 lbs.

Material: Stainless Steel

Chain Size	Work Load Limit	Diameter	Finish
1/4"	875 lb	1/4"	
3/8"	2300 lb	11/32"	
3/8"	9920 lb	3/8"	

Material: Steel

Chain Size	Work Load Limit	Diameter	Finish
1/8"	400 lb	1/8"	Zinc
1/4"	1250 lb	1/4"	Zinc
5/16"	1525 lb	5/16"	Zinc
3/8"	1900 lb	3/8"	Zinc
3/8"	2300 lb	3/8"	Zinc

BASIC ROCKET PARACHUTES

Safety codes of both NAR and Tripoli (and the NFPA) require that a high-power rocket may be flown only if it contains a recovery system that will return all parts of the rocket safely to the ground so that it may be flown again.

For most high-power rockets, this goal is achieved using a parachute that is deployed when ejection charges in the rocket separate the rocket into multiple parts.

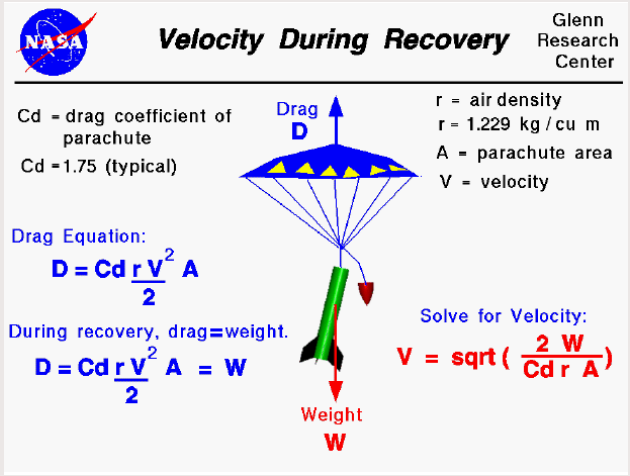
ELLIPTICAL PARACHUTE

PARABOLIC PARACHUTE

X-FORM

Parachute Descent Rate

A rocket at apogee under a small drogue parachute (using dual deployment) requires a descent rate of about 50-70 fps. (34-47mph).
Deployment of the main parachute at any altitude should have a descent rate of 15-25 fps (10-17 mph).
Observe the Velocity formulas below (left) to calculate the size chute to use or simply estimate your recovery descent rate using the RockSim program.



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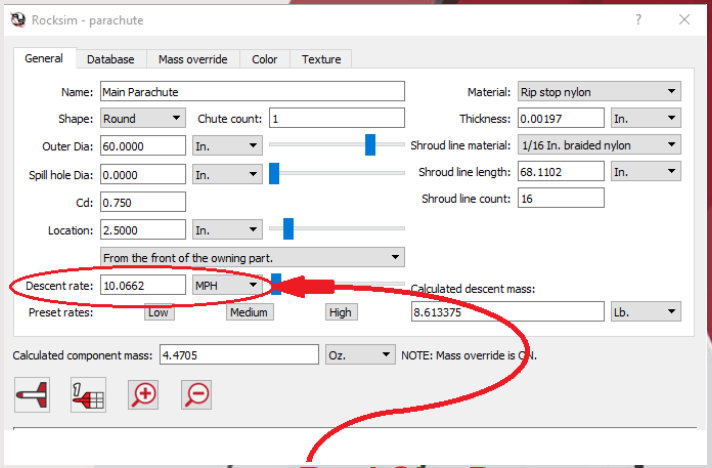
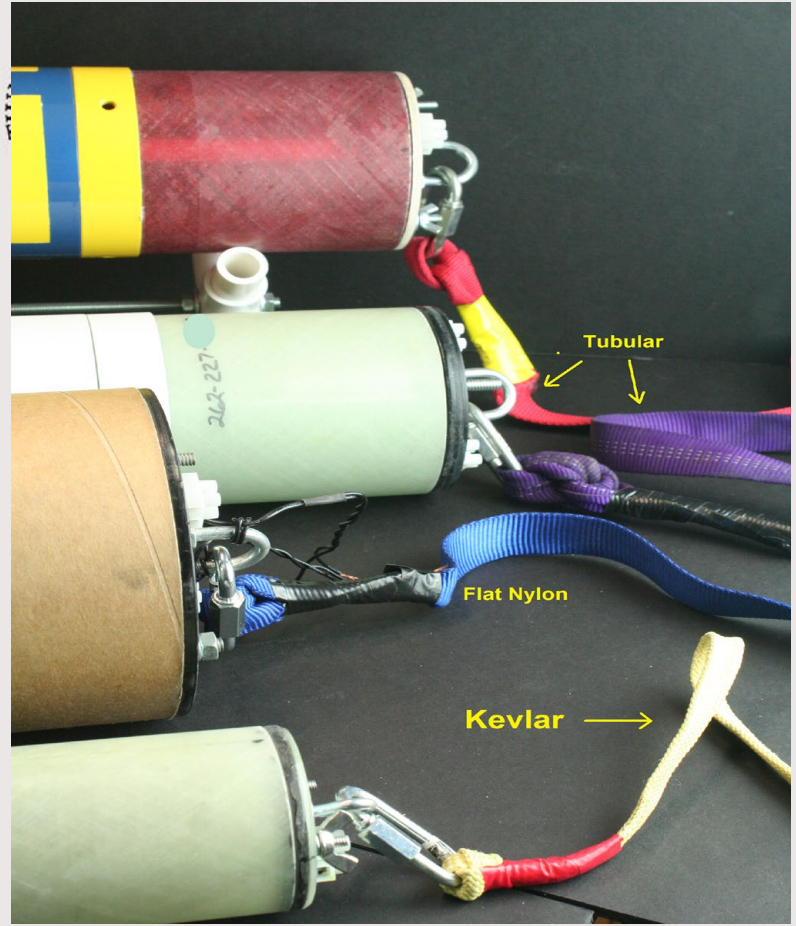


RockSim Descent Calculation



Types of Rocket Recovery Harnesses

Tubular Nylon Facts

- 1 inch wide breaking strength is 4000 lbs
- Military grade
- Melting point 380 degrees Fahrenheit
- Easy to tie and untie bluewater tubular nylon webbing - Google Search

Kevlar Strap Facts

- Heat resistant strong synthetic fiber
- Related to other aramids such as Nomex
- .05” wide has a 1500 lb. breaking strength
- Created by Stephanie Kwolek, DuPont™ Kevlar® is a heat-resistant para-aramid synthetic fiber with a molecular structure of many inter-chain bonds that make Kevlar® incredibly strong. Best known for its use in ballistic body armor, Kevlar® also has many other applications because of its high tensile strength-to-weight ratio.

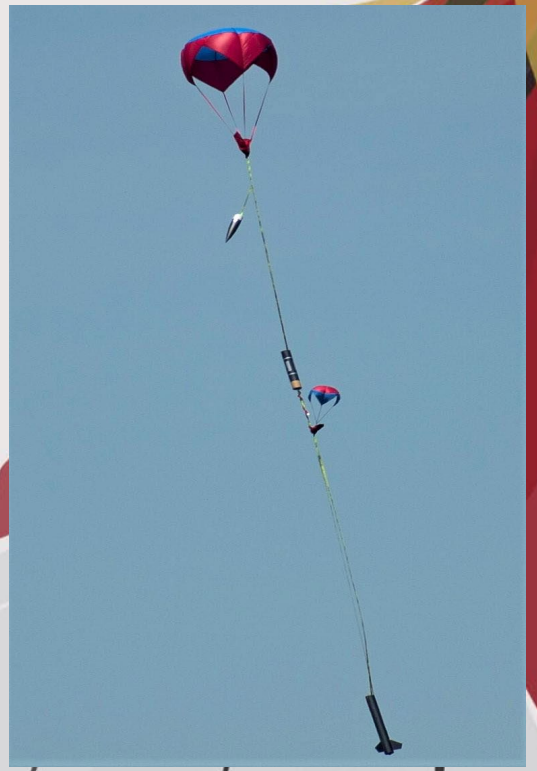
Nylon Flat Webbing

- .075” wide with a tensile strength of 3800 lbs
- Moderately heat resistant but should be inspected after each use

HARNESS LENGTH

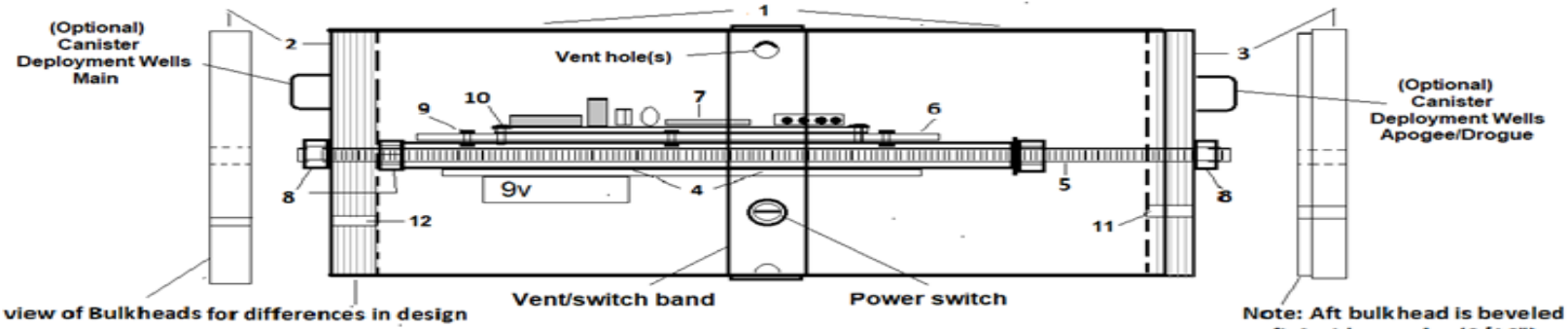
Length of the recovery harness, especially during the apogee deployment phase, should be 3 – 5 times the length of the rocket.

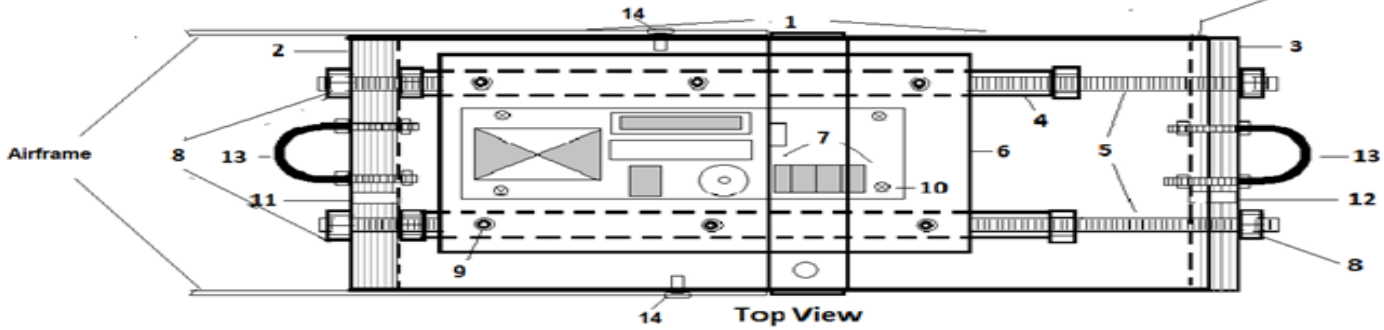
Providing this length, will ultimately cause drag as the harness unravels out of the airframe, reducing the velocity of the rocket during deployment.



Simple Avionic Bay
(Not to Scale)

Side View





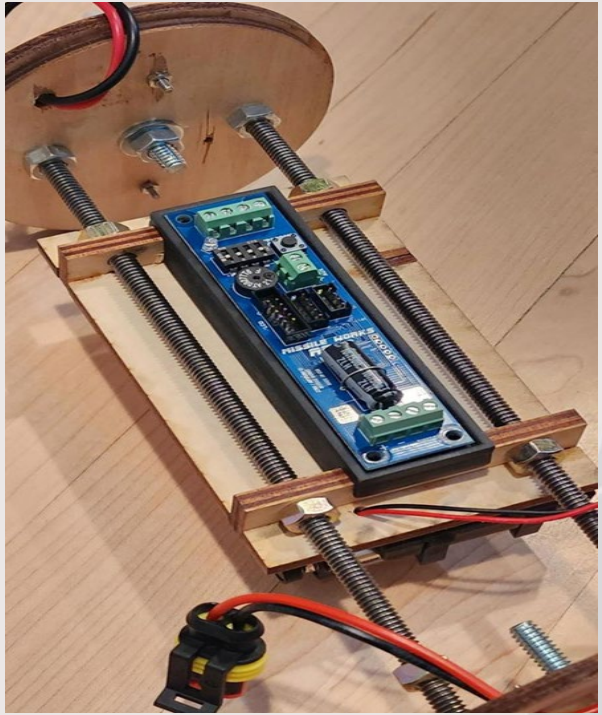
1. Avionics Bay/Coupler
2. Forward coupler 7 ply 1/2" Birch bulk plate
3. Aft coupler 7 ply 1/2" Birch bulk plate
4. Payload mounting tube 1/2" Plumbing CPVC pipe (or equivalent)
5. Threaded rod stock 1/4" #20 or 5/16" dia #18
6. Avionic mounting board. (PVC,Wood,G10 fiberglass)
7. Electronics, Altimeter, Recording devices.
8. Bulkhead mounting nuts
9. Aluminum rivets (optional) or Epoxy board to tube
10. Electronics/Altimeter mounting bolts
11. 3/16" Hole for Apogee Ejection Wire
12. 3/16 Hole for Main Ejection Wire
13. Recovery U bolt
14. Removable Rivet

FJN 012

3D printed Ebay sleds

[Free 3D file RRC3 Altimeter Mount ・Object to download and to 3D print・Cults (cults3d.com)]

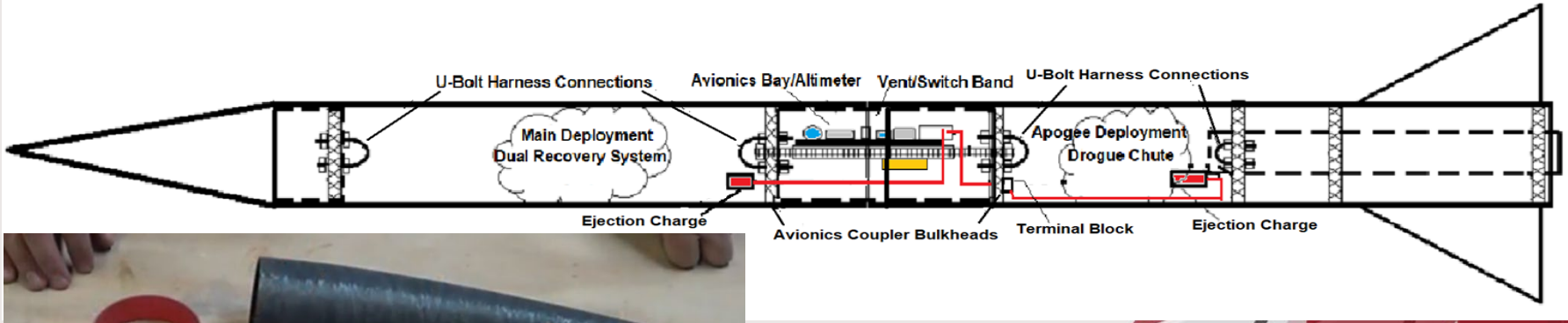
[Altimeter Sleds – Additive Aerospace]

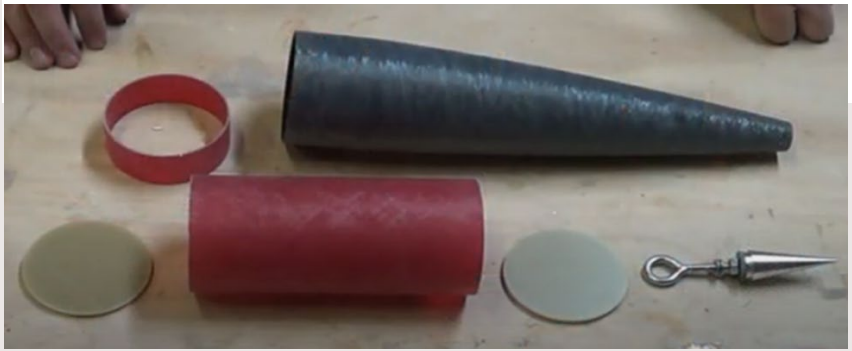


DEPLOYMENTS

Typical Dual Deployment Rocket

Using Satellite Deployment Canisters





[Head-End Dual Deployment Explained | High Power Rocketry Basic HED Packing Tutorial (How I do it) - YouTube]

RECOVERY IDEAS

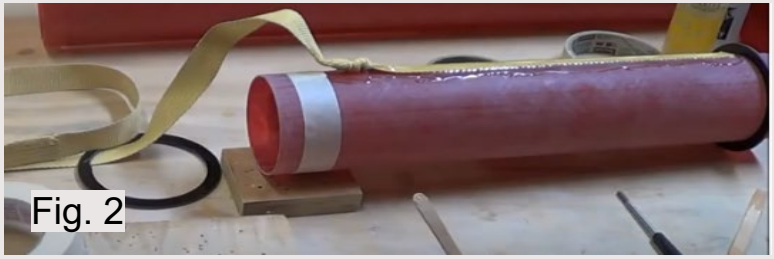
Fig. 1 - The Y-harness design connected to the motor centering rings is very useful to avoid airframe damage such as zippering the airframe

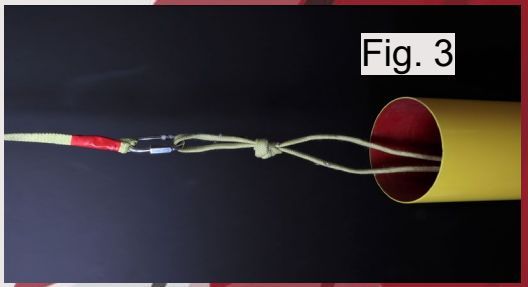
Fig. 2 - Harnesses epoxied to the booster motor tube with the Y – harness application

Fig. 3 - Shows the Y – harness accompanied with a bowline or a figure eight loop knot to secure the remaining harness connection

Fig. 4 - Standard use of a single harness connected to a U-bolt is sufficient for fiberglass airframes

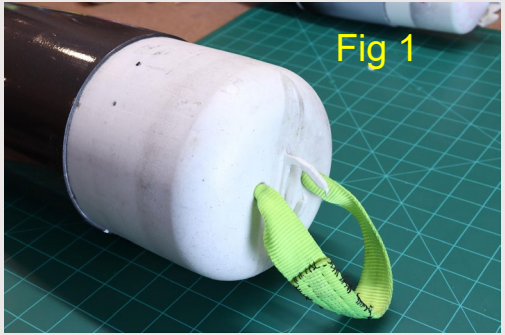
Fig. 5 - Recovery Y – harness comes through the notched-out centering ring. Both ends are epoxied to the motor tube



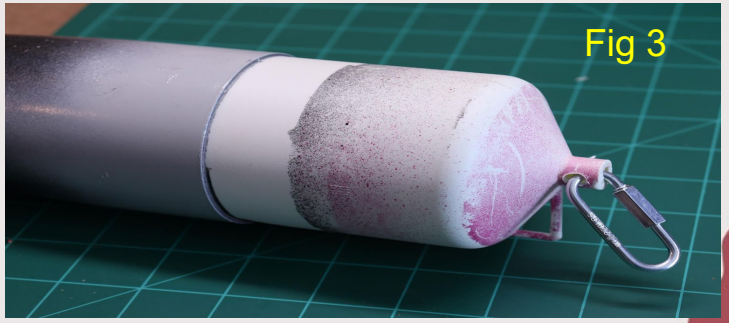


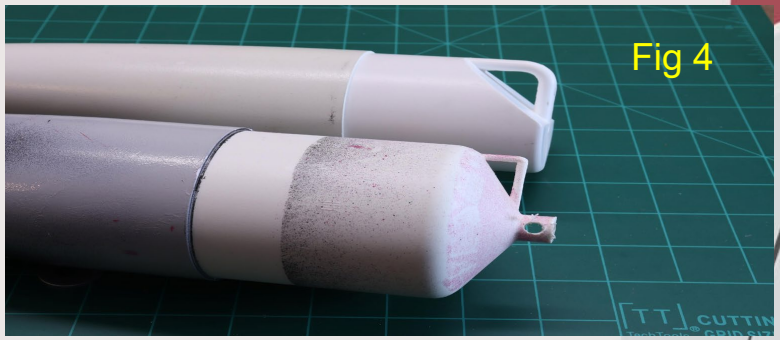
SUSTAINERS, PAYLOADS AND NOSE CONES

Improvising a good connection with a polystyrene (plastic) molded nose cones may need extra attention. The recovery tabs can become brittle and subject to failure under moderate/high velocity deployments.



Uni-knot/Bowline knot





Bowline Knot | How to tie a Bowline Knot using Step-by-Step Animations | Animated Knots by Grog

Figure 8 Knot | How to tie a Figure 8 Knot using Step-by-Step Animations | Animated Knots by Grog

Securing the tail end of the knot is beneficial to keeping it connected

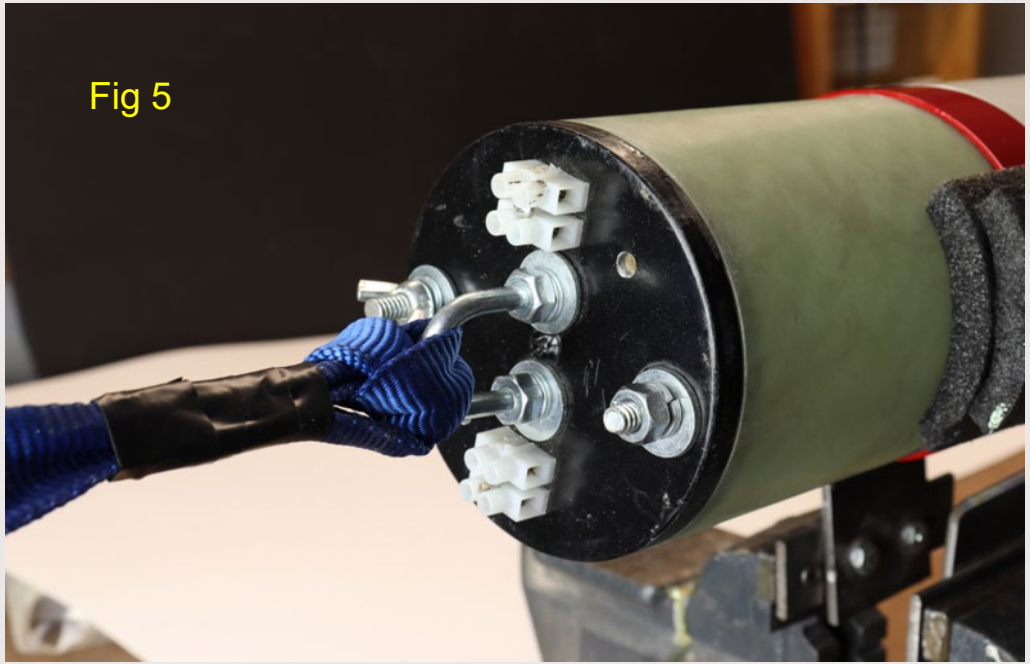
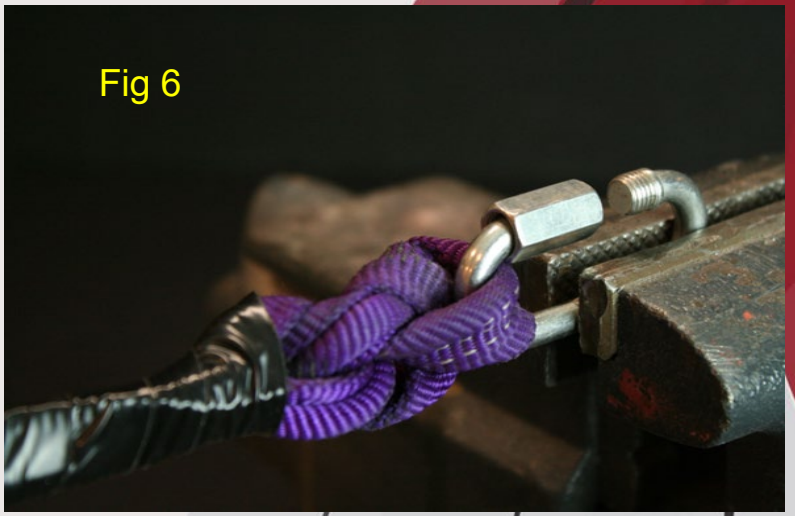


Figure eight knot



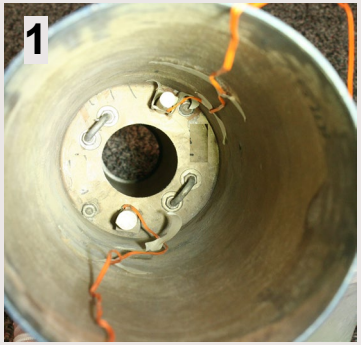
Single half hitch knot

RECOVERY

1. Deployment canister(s) positioned directionally forward in booster section. (Forward motor centering ring).
2. E-Bay module with ejection well (canister) These canisters can be mounted on both aft and forward bulkheads.
3. Severe airframe zipper due to deployment/separation at high velocities during flight.

4a-b. Always mount recovery bulk plate above shoulder of a Polystyrene Nose cone.

1



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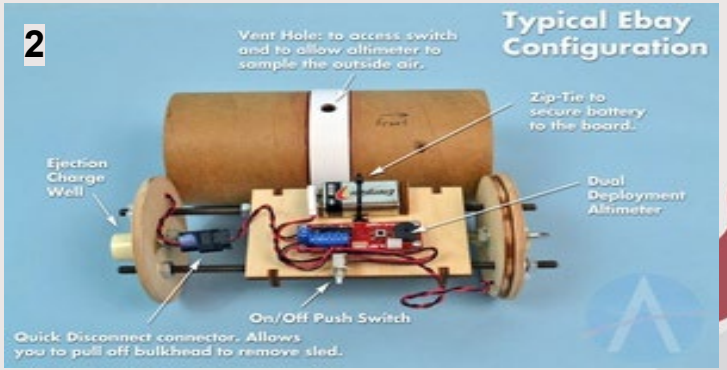
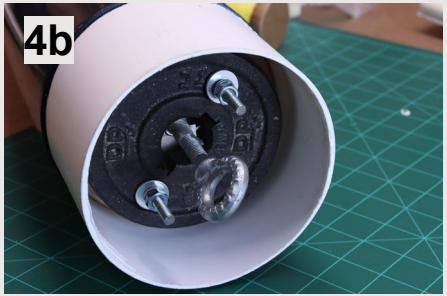


3

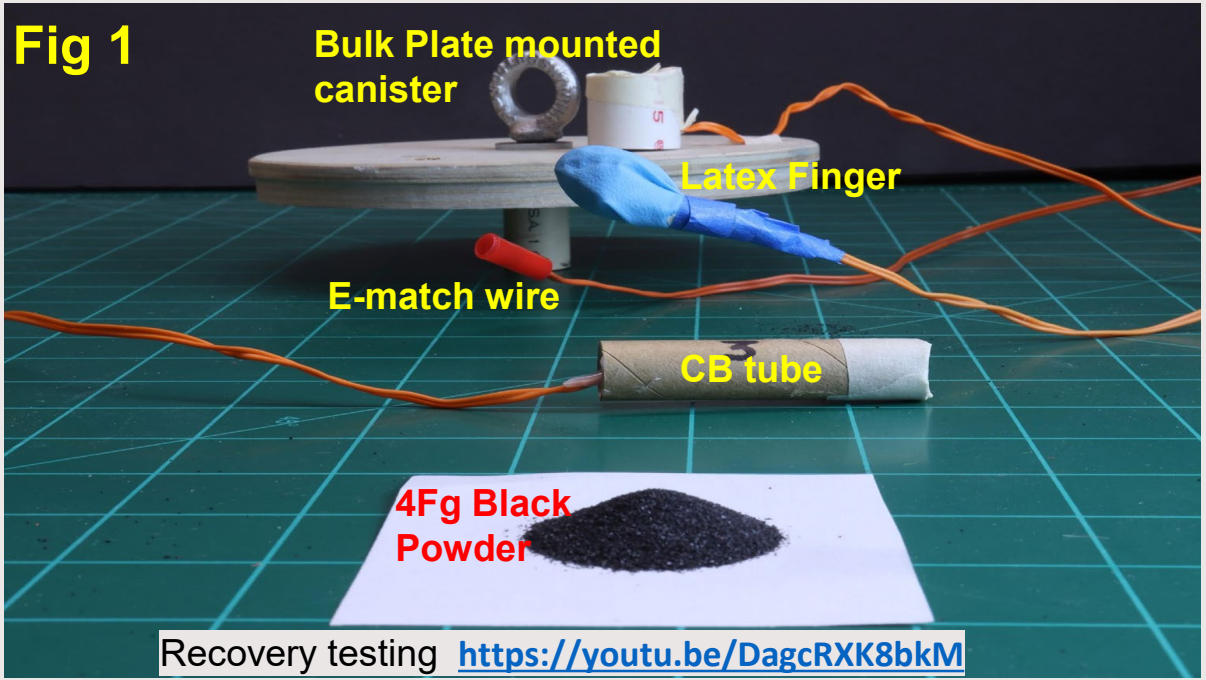
4a

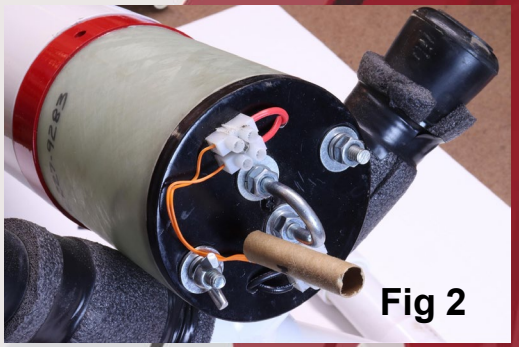
4b

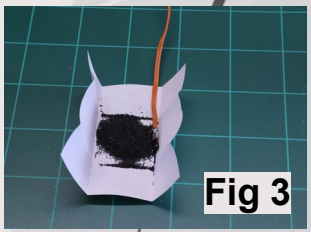


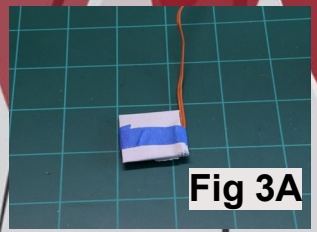
ENERGETICS AND DEPLOYMENT STANDARDS

Fig. 1 FFFFg black powder provides peak performance during deployment.
Fig. 2 Shows an E-match/w cardboard tube wired to a (European) terminal block that is inline connected to the altimeter inside the avionics bay.
Fig. 3-3a Is an example of a simple deployment paper-pack that provides adequate ejection reliability for 4" or less diameter rockets.







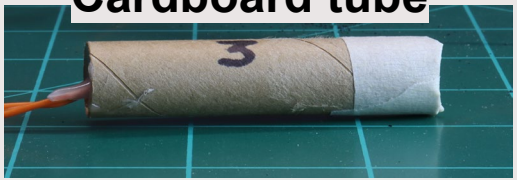


Internal Deployment Devices

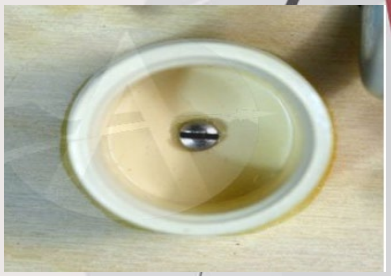
These devices are controlled by the altimeter in the avionics bay. Deployment activation occurs inside a designated airframe to deploy recovery hardware.

https://youtu.be/ibEwm-nd0UU

Cardboard tube



Deployment Vials



Deployment well (canister) mounted to avionic bulk Plate(s)

External Main Deployment

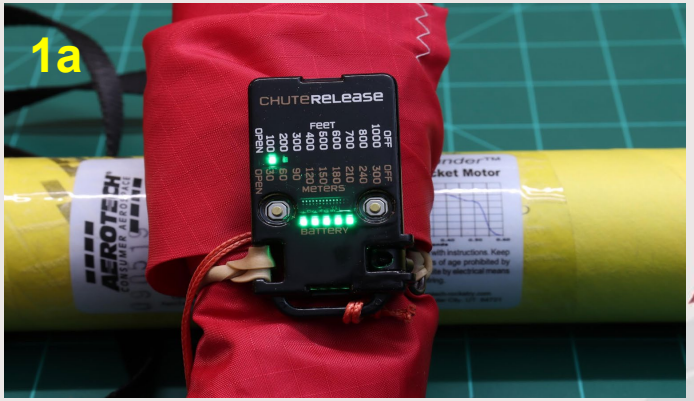
Some Operating Altimeters are attached externally tagged to the harness and parachutes after partial descent from apogee.

https://jollylogic.com/

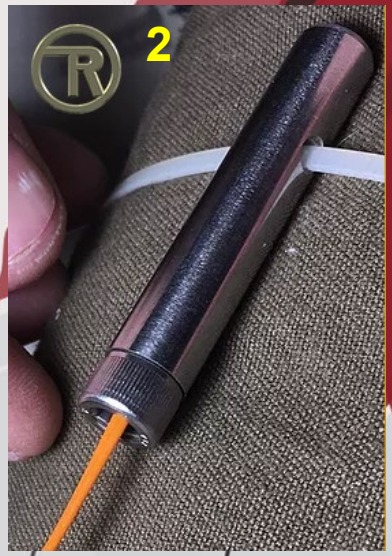
Jolly Logic Altimeter

1

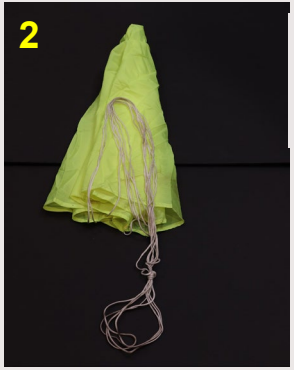
Tender Descender

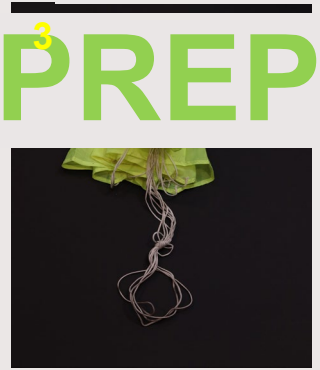


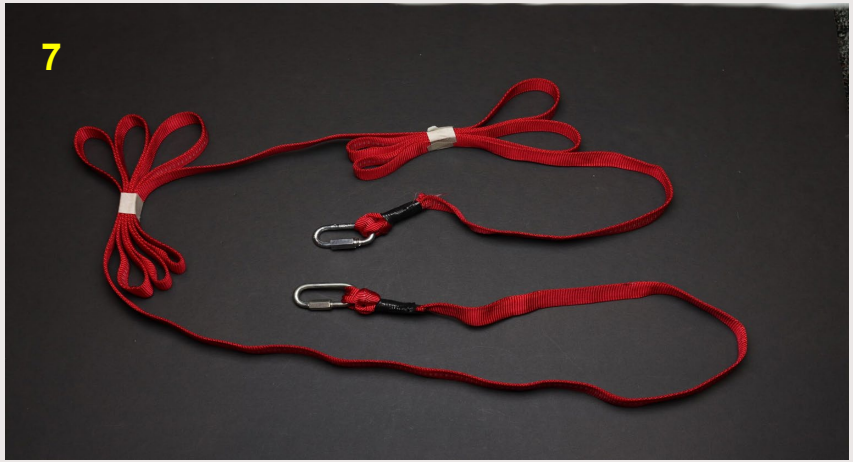
Cable Cutter



PARACHUTE PREPARATION







Straighten shroud lines. Spread and flatten parachute and fold in half twice. Position shroud lines in an “S” or hook shape atop of chute.

Fold in half, firmly roll parachute. Attach shroud lines to the recovery harness quick link.

Open chute protector cloth and connect protector to same quick link. Hold parachute above chute protector and lower the remaining shrouds and parachute in the center of chute protector.

Carefully fold and roll chute protector around parachute. Install the booster end harness into airframe followed with the packed parachute and remaining forward harness that’s connected to the sustainer (or nose cone).

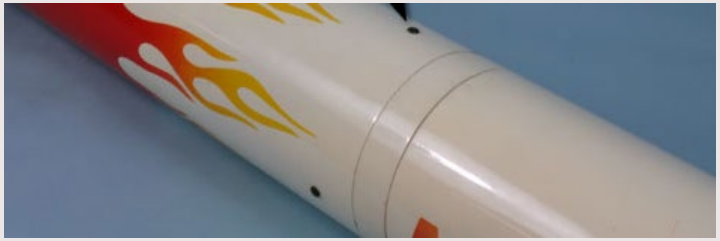
KEEP YOUR ROCKET TOGETHER

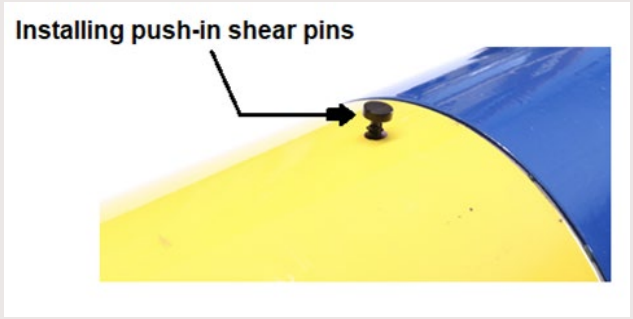
During the rockets flight profile, inertia will greatly affect all friction coupled components after motor burn out, recovery deployment and descent

2/56 shear Pins

[2-56 Nylon Shear Pins (alwaysreadyrocketry.com)]

Removable Rivets to secure avionic bay



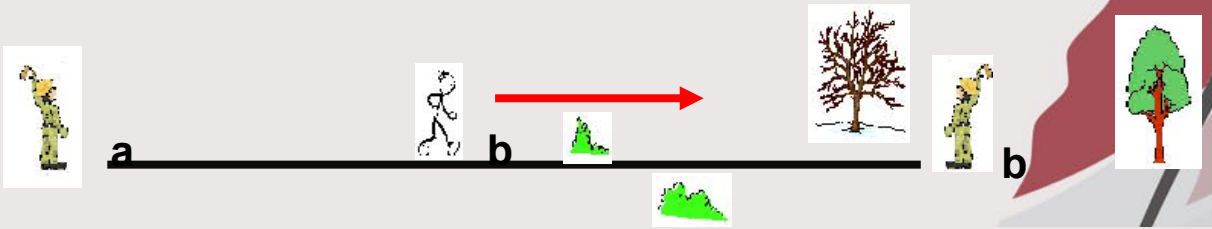


Shear pin is fully inserted to secure nose cone to the airframe during flight

Locating Your Rocket Without a Tracking System

You or a team member should watch the direction where the rocket lands. Mark a line in the gravel or lay a straight long object on the ground pointed in the general area the rocket landed. Pick a landmark where the rocket landed (i.e, tree, pole line) and pick a landmark inline directly behind you.

To enhance this manual technique, have person (a) who has the line on the rocket, stay at that location. Send another person (b) to retrieve the rocket, walking in line with directions from person (a). If the terrain is obstructed with brush or small ditch lines, have person (b) carry a small marker flag or a 6' white PVC I" pipe so person (a) can see person (b's) location.

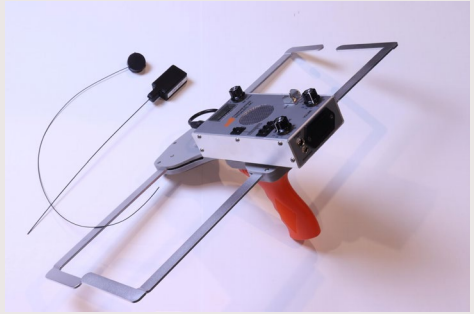


Taking a video or picture of the descending rocket before it lands will assist defining where the rocket lands. A small audible sonic beacon will aid the location of the rocket as you approach the landing area.

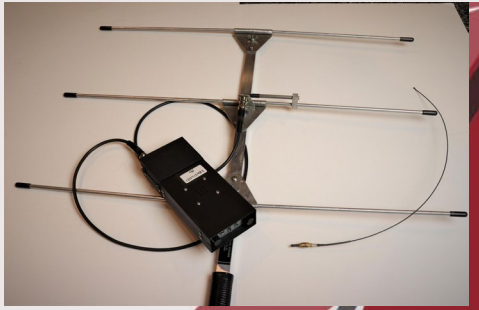
Using a smart phone with a compass app works great too. Open compass app before flight, following rocket as it lands, point phone toward the landing area and click on the compass heading. Walk in a straight line to the landing area keeping a look out for obstacles and maintain a straight heading with land marks observed when rocket landed. Always assume the rocket may have landed farther then you perceived.

Transmitters, Receivers & GPS Systems

Communication Specialist, Inc.



Yagi Directional Transceivers



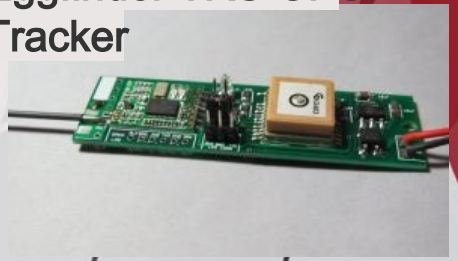
RF Devices

Featherweight GPS Tracker

https://www.featherweightaltimeters.com/

GPS Devices

Eggfinder TRS GPS Tracker



http://eggtimerrocketry.com/

SAFE RECOVERY

Sometimes locating or recovering your rocket can be a challenge. Be patient, take your time, stay focused where the rocket landed. Avoid hazardous obstacles.
Taking a buddy with you on a rocket recovery adventure is encouraged.
Wearing the proper attire, hiking shoes, leg coverings (pants), water, communication device, tools to turn off altimeter(s) or harness removal. Do not attempt to recover your rocket that will result you, being in a unsafe situation, by climbing a tree or water recovery. Call the head launch range coordinator for assistance. Write your contact information on rocket in case someone else locates it.

The Perfect Recovery

Failures can happen

Ask For Help

Not a Perfect Recovery

Any Questions?