

Dual Deployment Recovery

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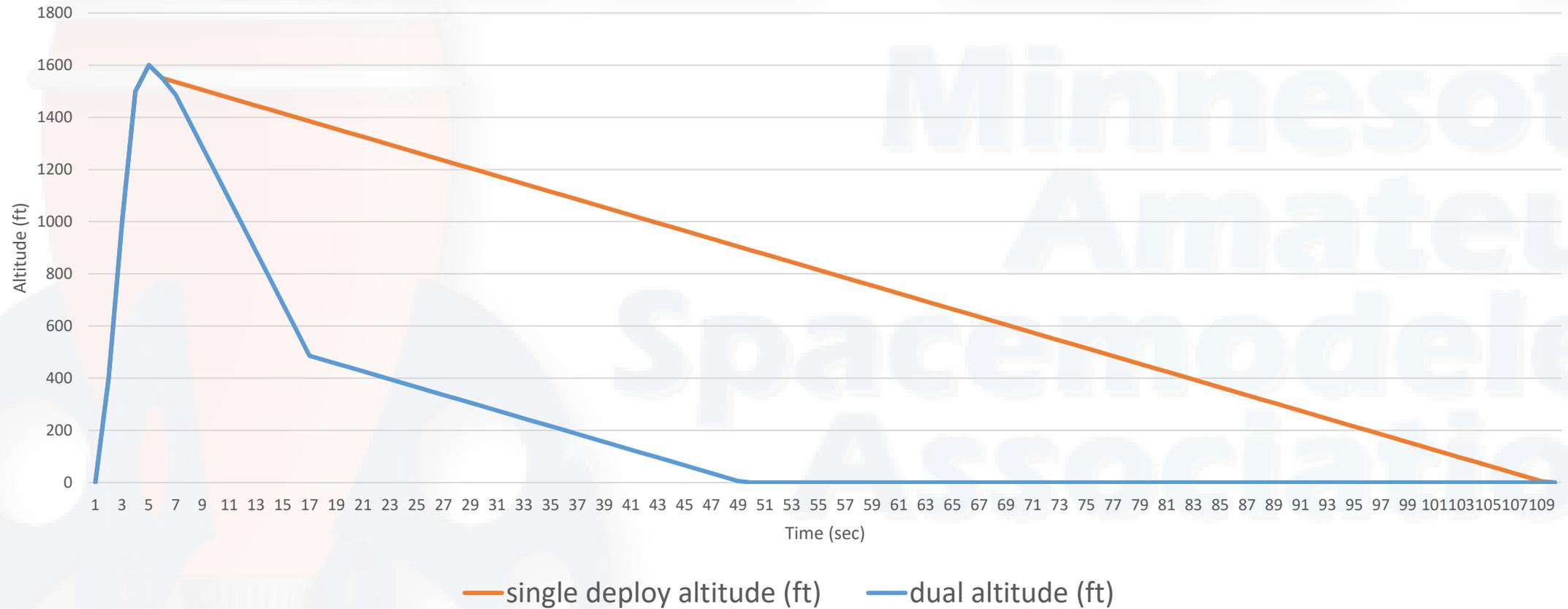
Photo credit: Aaron Sheriff

Why bother? It requires expensive electronics and it makes flight prep much more involved...

- It increases the likelihood of landing on the range – shorter walks!
- It allows for higher-powered flights under given conditions
- It encourages larger parachutes for gentler landings
- It enables deployment redundancies
- It provides finely tuned ejection timing and conditions (no more zippers!)
- It demonstrates technical rocketry accomplishment
- If you aspire to Level 3 HPR certification, it's required

Shortened drift time and recovery walks

Single v. Dual deployment recovery drift time



Shortened drift time and recovery walks

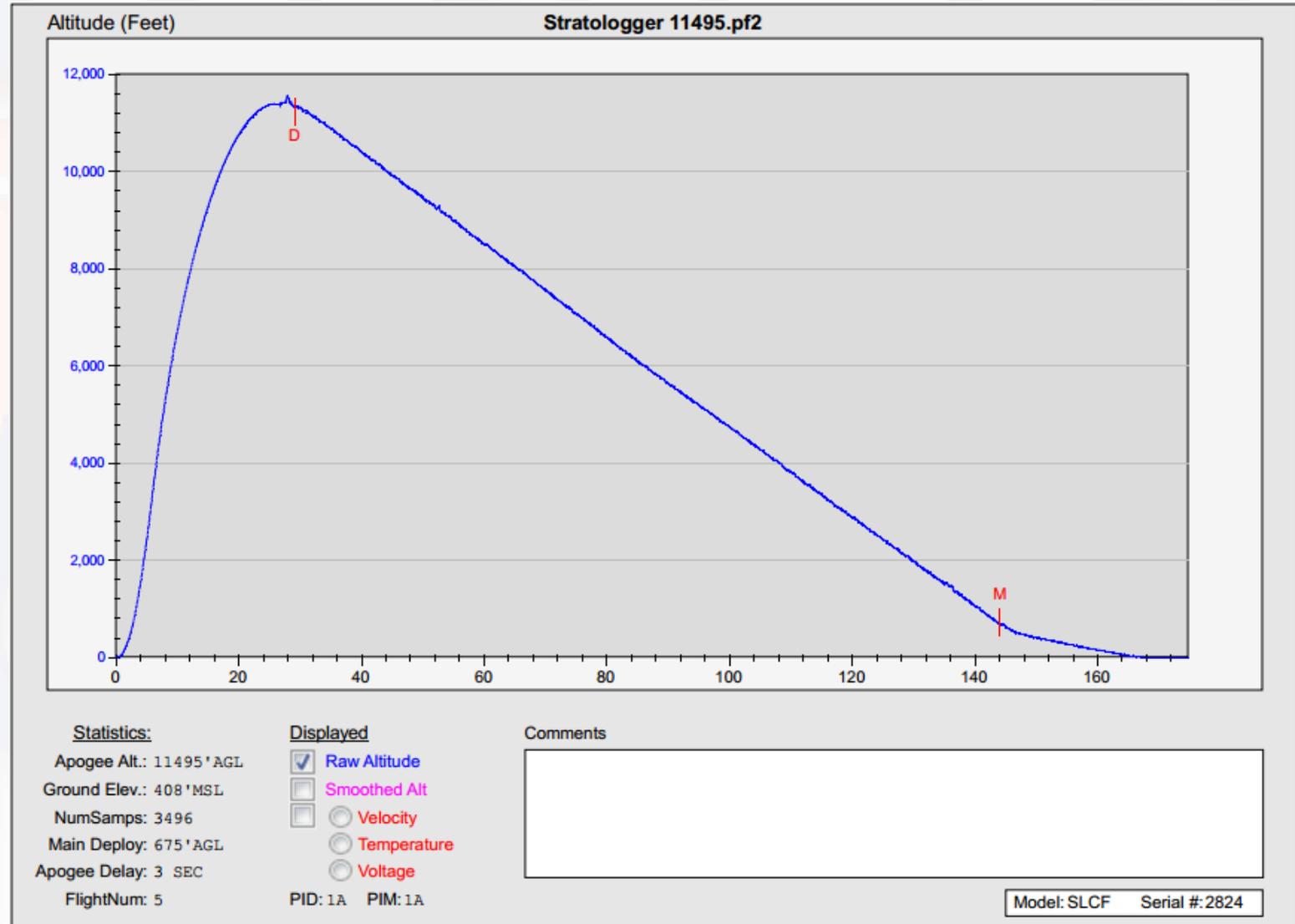
Real-world example:

Drogue (2' Rocketman Mach II Ballistic) fired at apogee of 11,495'

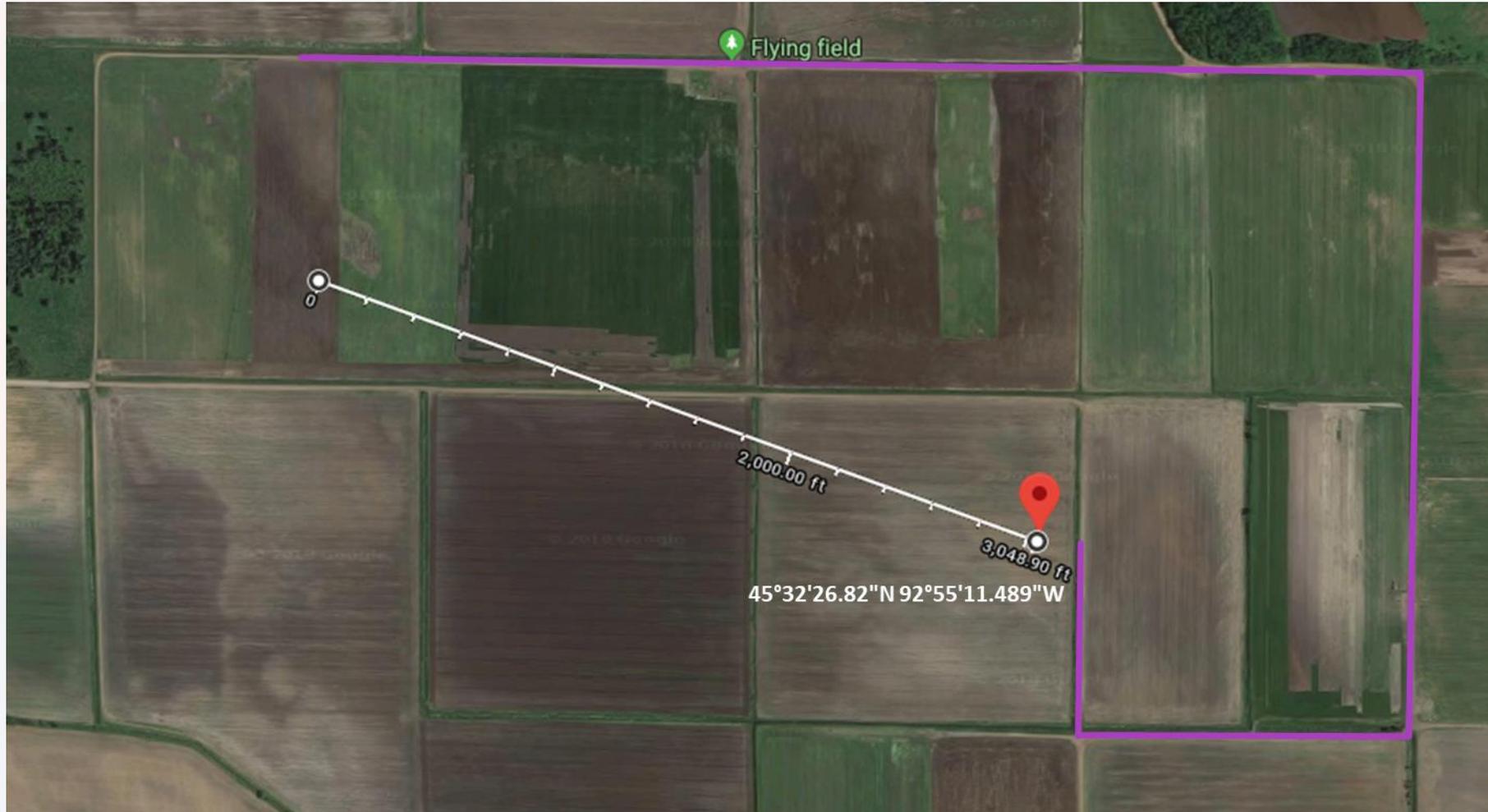
Main (12' Rocketman Standard w/1' Fruity Chutes pilot) at 675'.

Note the difference in the slopes of the lines. Drogue descent was at nearly 100 ft/sec, landed under 20ft/sec. Total drift from launch site 3,048' (came fairly straight down)

Altimeters: Missileworks RRC3 and Stratologger CF



Shortened drift time and recovery walks



The basics

- Different approaches all have the following in common -
 1. An ejection charge separates the nose cone or airframe at apogee
 2. The rocket descends rapidly from apogee tumbling under drogue or streamer
 3. An altimeter or timer deploys the main parachute at a preset altitude shortly before landing
 4. The rocket slows and gently descends the remaining distance to the ground on its main parachute for safe recovery

Apogee ejection

- Initial ejection can be motor based (delay grain timed), timer based, altimeter based, accelerometer based, or can use more than one of these
- The rocket's aerodynamic shape is spoiled to prevent ballistic descent (the precursor to the "lawn dart")
- A drogue parachute or streamer (or nothing) is deployed at the apogee separation to stabilize the descent and ease tracking
- Redundancy is smart, easy, and recommended
 - Motor ejection can serve as a failsafe for an electronically timed or altitude-based ejection, or vice versa
 - It's common to hear extra ejection reports shortly after apogee on dual deployment flights

The drogue

- Usually just a small parachute, often of reinforced build to handle higher speeds
 - Example: for a 6' long rocket 4" in diameter and weighing 6-7 pounds, a 6-12" nylon parachute is sufficient
 - Heavily reefed chute
 - Dino Chutes "Guide Chute"
 - Bama Chutes "Ballute Drogue"
 - Streamer
 - Just a separation can be enough (cable cutters)
- Descent speed under drogue @ 75-100 ft./sec.
- Intent is rapid but stable non-ballistic descent
 - Prevents lawn darts and core samples
 - Stabilization will aid main parachute deployment, avoid tangles, and keep nosecone/payload from contacting main body tube
 - Higher visibility aids visual tracking and helps LCO and spectators

The drogue



Rocketman Ballistic Mach II, Dino Chutes Drogue (L) and Guide Chute (R), Bama Chutes Ballute

Main deployment

- The main parachute is the primary recovery device
- The main achieves the desired landing descent rate for the rocket
 - Example: for the same 6' long / 4" diameter rocket, a 60" parachute works well
- Descent speed under main @ ~15 ft/sec (must be < 24 ft/sec)
- Deploys high enough to give the parachute time to unfurl, slow the rocket, and give spectators time to react

Electronics

- Altimeters & Timers
 - Work in conjunction with ejection charges, tethers, or combinations
 - With ejections charges, will energize “pyro channels” for igniters/starters/e-matches
- Timers usually “start the clock” by sensing launch with an accelerometer
- Altimeters may use an accelerometer or minimum altitude lockout logic to recognize a nominal flight
- Usually reside in an electronics or avionics bay protected from ejection gasses but vented open to the atmosphere (for the altimeter)
- Devices signal readiness once armed
 - Battery voltage and/or Continuity to ejection igniters/starters/e-matches
 - Main deployment altitude
 - Last flight max altitude, etc.
- Some electronics provide additional functionality
 - Telemetry data via voice, beeps, LCD's/LED's, USB/micro USB, and/or wireless
 - Air starts for multistaging or clustering AP motors
 - Tracking/GPS

Electronics – dual deploy examples

(not endorsements)

- Perfectflite
 - Stratologger SL100
 - Stratologger CF
- Missile Works
 - RRC3
 - RRC2+/2L
 - WRC+ (remote control!)
 - PET2+
- Altus Metrum
 - TeleMetrum
 - TeleMega
 - TeleMini
- Jolly Logic
 - Chute Release
- ENTACORE
 - AIM USB
 - AIM XTRA / BASE
- Eggtimer Rocketry (you assemble)
 - Proton
 - Quantum
 - Classic
 - Quark
 - TRS
- BigRedBee
 - Transmitters, receivers, and beacons
- PML
 - Co-Pilot v3 is designed for their CPR dual deploy kits

Electronics bays / avionics bays

- Several configurations
 - Mid airframe coupler most common
 - Reinforced bulk plates and strong attachment points
- Bay usually separates drogue from main
- Bay protects electronics from hot and corrosive ejection gases
- Bay provides access for arming
 - Safety codes require arming AFTER mounting and aiming pad/guide
 - Many arming switch styles – toggle SPDT/SPST, key, push momentary/locking, etc., magnetic
 - Wireless arming (like with Eggtimer Wifi Switch)
 - Tripoli requires separate arming of wifi system after on the field and away from crowd
 - Unsophisticated “twist and tape” arming also works
- Bay needs static ports for barometric altimeters
 - Port sizing calculators
 - Ports make handy access points for arming

Ejection charges

- Black powder
 - FFFFg, also called priming powder
 - Tip - Preserve unused powder from AeroTech RMS motor kits
 - Charge calculators online
 - May need LEUP for storing black powder, e-matches
 - Magazine for secure storage, background check, etc.
 - ATF.gov for info
- Pyrodex (“smokeless powder”)
 - Requires compression of the charge
 - Doesn’t burn as fast
 - Black powder and Pyrodex should always be firmly packed so the powder doesn’t move away from the ignition source
- Compressed gas
 - CO₂ cartridges, standard sizes
 - Best for very high altitudes

Tether/release and CO₂ systems

- Tethers and CO₂ usually need some pyro to activate
 - Jolly Logic Chute Release is notable tether exception
- Pyro triggers CO₂ canister puncture
 - Example; Peregrine / Raptor by Tinder Rocketry
- Pyro activates tether release
 - Example; Tender Descender by Tinder Rocketry
- Pyro activates cable cutters
 - Example; Cable Cutter by Prairie Twister Rocketry
 - Disposable tethers (zip ties)

Jolly Logic Chute Release

dual deploy that also works for low-mid power

- MSRP \$129 <https://www.jollylogic.com/products/chuterelease/>
- Available from Off We Go Rocketry
- Requires separate ejection, either motor or electronic
- Intended for BT-60 / 1.6" / 42mm or larger
 - Includes extra bands, pins, and lanyards
 - <https://youtu.be/ZtokOKrRwRg> - ground demo
 - <https://youtu.be/AA4tOfYKNjQ> - flight demo
 - Can use to wrap entire 'chute or reef the 'chute
 - Only does release, does not report altitude
 - JL Alt1, 2, & 3 do that!
- Make a TIGHT bundle, use the tightest band
- Don't forget to tether it to the shock cord!



Cable cutters

- Cable Cutter allows you to bundle your 'chute and cut the cable tie using your altimeter
 - <http://ptrocketry.blogspot.com/p/cable-cutter.html> - \$50 for 2 w/ accessories
 - Use to bind entire 'chute, reef 'chute, or reef shrouds
 - Tightly wrap 'chute/shrouds/extra shock cord in a flame shield
 - Secure with cable tie through two cable cutters (for redundancy)
 - The drogue charge ejects the nose and the bundled 'chute
 - Use with or without a drogue 'chute (the bundle acts like a drogue)
 - "Main" charge cuts the cable ties and chute unfurls
 - Remember to protect the wires from ejection charge
 - <https://youtu.be/Dux4M77ZoxQ> - Ground test video
 - <https://youtu.be/5QGznnvJNQc> - Setup video



Considerations and common problems

- Avoiding drag and ejection shock separation
 - Coupler e-bays may need ejection-destructible rivets
- Avoiding arming switch actuation during flight
 - Must resist high g-forces at ignition and apogee ejection
 - Orientation and/or inertial resistance
 - Toggle switches should avoid alignment with vertical axis
 - May add drag if not recessed
- Avoiding other deployment failures
 - “Blow it out or blow it up” – error on the side of too much with charges
 - Ground testing
 - Most altimeters have testing mode (or use a shop-vac and silicone tape like Brian does)
 - Fresh batteries – use of welded batteries such as Duracell encouraged
 - Batteries must be secured to prevent damage to electronics

Typical dual deploy pre-flight checklist

- ✓ Determine use of motor ejection at apogee
- ✓ Select motor and set delay, load/reload motor
 - ✓ if using motor ejection as a redundancy, allow more delay
 - ✓ If NOT using motor ejection, empty the charge well of powder)
- ✓ Install altimeter in e-bay, arm for diagnostics
- ✓ Disarm altimeter, attach ejection igniters
- ✓ Load/pack ejection charges – loose powder is not acceptable
- ✓ Pack drogue/harness, couple payload to e-bay
- ✓ Pack main/harness, couple fuselage to e-bay
- ✓ Mount rocket on assigned pad, arm deployment electronics, recheck diagnostics/POST
- ✓ Cross fingers when LCO gets to your rocket, start video recording

Enjoy the flight, the suspense of the main opening, AND the short walk to recover from the slow, majestic, nearby touchdown!

Conclusion

- Once you do it you'll never go back!

Shopping/scavenging list

- Altimeters
- Ejection charges and e-matches
- Terminal blocks, wiring, arming switches
- Ejection canisters
- Soldering kit

Resources

- Descent rate calculator
 - <http://www.rocketreviews.com/descent-rate-calculator.html>
 - RockSim will also estimate descent rates
- E bay static port sizing
 - <http://www.vernk.com/AltimeterPortSizing.htm>
- Ejection charge calculator
 - http://www.rockethead.net/black_powder_calculator.htm