



AEROPAC Newsletter 2013 Year End Edition

Photo by Ken Adams

President's Pad

Tony Alcocer

I hear this newsletter is jam-packed with a bunch of cool rocketry info, so I'll keep my 'report' short. I'd like to start off by thanking Jonathan DuBose for stepping up and taking over the job of putting together 'our' newsletter. I'd also like to thank Ken Biba for organizing 'our' End of Year Party. The more people that step up and volunteer to help the better AEROPAC can be! I'd like to thank those that stepped up this past season and made it possible for all of us to fly this year! I'm really looking forward to next season!



Photo: R. Jackson

Tony making the rounds at MUDROCK

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A word from your Newsletter Manager

Jonathan DuBose

I decided to volunteer for this role when President Tony Alcocer made a plea for more member participation in running the club during the membership meeting at XPRS. For those you who don't know me I have been involved in AEROPAC since 2008. I enjoy flying ARLISS and building and launching two stage rockets. I am also a member of LUNAR and a founding member of the Sacramento Area Rocketry Group (SARG). I am a Hewlett Packard retiree and live in Sacramento. I usually hang out on the east end of the flight line.

This is your newsletter so please contact me your articles and photos at:

newsletter-AT-aeropac.org



Photo: Ken Adams



Photo: Ken Adams

Volunteer(s) Wanted

Right now, AEROPAC equipment management seems to be a club-wide function. We seem to be able to keep things running with only minor issues. However, it is clear that we need someone to step up and take ownership of this important role.

The Equipment Manager is responsible for the organization of getting the equipment trailer from Empire out to the launch site on the afternoon before a launch; setting up the range; returning the trailer back to Empire after the launch and ensuring that our equipment is maintained and is in good working order.



AERO-PAC Officers

President / Prefect - Tony Alcocer

Vice President - Richard Hagen

Secretary— Bill Kellerman

CFO - Eric Kleinschmidt

Launch Director - Gene Engelgau

Assistant Launch Director - OPEN

Equipment Manager—OPEN

Webmaster - Jamie Clay

Contest Director - Darryl Paris

Membership - Don Duncan

Newsletter—Jonathan DuBose

Contact: officers@aeropac.org

AEROPAC Board of Directors

Seth Wallace (chairman)

Karl Bauman

Gary Rosenfield

Tony Alcocer

Ken Biba

Jim Green

William Walby

Jake Hudson

Eric Kleinschmidt

Contact: bod@aeropac.org

In Memoriam — Laura Hagen

by Seth Wallace

AEROPAC lost a long time friend and member in September when Laura Hagen passed away after battling health issues for several years. She could almost always be found anchoring the East End of the flight line with Richard in their El Monte RV. Laura was amazing with kids and always had little trinkets, games and crafts for her grandkids and the kids from neighboring camps to keep them busy. She endured scooter wrecks (Richard), motorcycle wrecks (Shannon) and hundreds of dollars of rocket wrecks (Richard again) all with a smile and a band aid. She was loved by all and will be missed greatly.

Our thoughts and sympathy are with Richard and the Hagen family.

Those wishing to remember a loved one or rocketry friend may submit your articles to:

newsletter-AT-aeropac.org



AEROPAC's New Launch Rail

By Casey Barker

Back in 2012, "Team AEROPAC" set out to break the 100k' mark. We were successful and won the Carmack Prize, but the project taught us a lot about the importance of launch trajectory for high-altitude flights. Our existing club launch rails are great, but our pad video showed they could flex 5+ degrees as the 60-pound stack took off. We think reliable recovery from 100k'+ will need an order-of-magnitude improvement in rigidity and precision.

As most folks know, Google got involved with our 100k project from the beginning, and helped us build our first science payload using a Nexus smartphone. So back in the spring, my team at Google considered having a rocket launch display at our annual developer convention. We contacted a manufacturing partner, Shane Roberts at RMI in Blountville, Tennessee, for help. I showed Shane the launch videos, and he was immediately hooked. I also talked about what we learned and how much trouble we had with the launch rail. So Shane started sketching a new launch pad that would double as our convention display.

Unfortunately, there wasn't room for our display in Google's convention plans. However, Shane understood how critical the launcher was, and he generously offered to build it and donate it to Team AEROPAC. Shane coordinated with us to sort out the design, and then built it in his shop over the summer. Ken Biba flew out to meet Shane's team in Tennessee, and got to hang out with them for the final assembly.

Team AEROPAC used a portion of the Carmack Prize proceeds to purchase a trailer for the launcher, and Shane's crew drove it across country, all the way from Tennessee to Nevada, to deliver it to us at the ARLISS launch.

This launcher is a serious piece of hardware. The rail is 30 feet of 15/15 rail, secured to a tower constructed of powder-coated chromoly steel. The base is built to house network-controlled servo motors that can precisely pitch the tower 5 degrees in any direction, and a lift motor to raise and lower the tower.

This is a major leap in our effort to make high-altitude amateur flights reliable and repeatable. Team AEROPAC is already making plans for this launcher, and we intend to make it available for others, too. If you'd like to use it for your project, contact Ken Biba for details. details.



Left: Shane Roberts operates the lift motor for the rail's first flight.

End



ARLISS 2014

By Jonathan DuBose

The 15th year of ARLISS promised to be another in a long line of great events. Throughout the year a number of new teams from countries who hadn't previously participated made plans to attend. Teams from Egypt, Turkey and Costa Rica were building projects and raising funds to attend. The usual strong Japanese presence was expected. Georgia Tech had collaborated with students from Budapest University of



Technology and Economics (Hungary), University of Patras (Greece), Kumoh National Institute of Technology (a new team from Korea), and the Indian Institute of Technology Madras (India). Students from India and Korea would join them on the playa.

During the offseason, Becky and Jim Green traveled to Costa Rica to judge an intra country competition to determine which team would travel to the USA for the event. When the proper permits did not arrive in time to allow a launch, a hook and ladder fire engine was pressed into service. Projects were tossed from the top of the 100 meter ladder and a winner was determined. The ingenuity shown by the Costa Ricans was shown again when they arrived at the event. The Costa Ricans, our first Latin American team, showed a lot of

Creative Costa Rican ARLISS Qualification

camaraderie with other teams and were a big hit with everyone on the playa.

In the off season, the ARLISS team had investigated the need to decrease the force with which payloads were being deployed. The objective was to give the students the best chance possible for their projects to deploy safely. ARLISS flyer Bob Feretich assembled a team and created a data logging device which would be flown in the deployment carriers during the event to try and capture enough data to make some good decisions. See Bob Feretich's article on page 23.

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ARLISS 2014

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Although some of the teams who had hoped to attend couldn't for a variety of reasons, by Monday morning the playa was buzzing with activity. 17 teams from Japan, many arriving before dawn, were set up and ready to rock. Several other teams, including Costa Rica, Nevada Reno, Hawaii and Georgia Tech would arrive throughout the week. The flight board showed that 24 teams were preparing projects to fly.

An early Monday morning meeting, led by Ken Biba and Becky Green kicked off the event. Guidelines for taking care of the playa were emphasized; the ARLISS flyers were introduced and the Japanese teams expressed their team spirit with school chants and songs. Time to fly!

Soon ARLISS rockets were lifting off regularly, students chasing down their projects, rocketeers were recovering and both students and flyers were preparing to fly again.



Photo: R. Jackson

Not all projects are rovers

Left: A U. of Tokyo student holding their glider. Its wingspan and fuselage are both about 18".

Right: Student preparing folded up glider to fit in the standard 10" deep by 5.75" ARLISS payload carrier.

This project deployed successfully but eventually lost GPS lock.



Photo :R. Jackson

Windy weather can have a severely negative impact creating problems for both the rockets and the payloads. This year, however, with the exception of the cloudburst on Thursday afternoon we enjoyed near perfect flying weather. The playa however was problematic. The BLM assigned us a location that had extremely soft playa. This made it difficult for rover projects to navigate. Several projects were observed struggling out of deep, sandy ruts only to encounter another rut only feet away. Many batteries were depleted fighting through this harsh terrain.

Part of the excitement of ARLISS is seeing the competition among the teams, especially the Japanese teams for their corporate sponsored "Mission" and "Come Back" contests. The "Mission" contest is somewhat subtle and understated (at least to this ARLISS flyer). However, the "Come Back" competition – successfully deploying the payload, landing it safely and autonomously navigating across the playa for long distances to the target, can have the excitement of a soccer goal, a football touchdown or a baseball home run!

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ARLISS 2013

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This year the Mission Competition was won by TITANIKU (Tokyo Institute of Technology) and the Comeback Competition by Chosa-heidan (The University of Electro-Communications).

Normally ARLISS flights end on Thursday afternoon but several flights were scrubbed late Thursday due to the deluge and a number of flights occurred on Friday.



Photo: K. Adams

In total, there were 43 "M" or open class flights and for the first time in memory there were no "K" class flights.

End

Left: Optimistic Costa Rican team at the work bench



Photo: R. Jackson

Signing the rockets

ARLISS Traditions



Photo: R. Jackson

Token of appreciation.



Photo: R. Jackson

The kids carry the rockets!



Photo: K. Adams

Left: Pre-flight photo (and calisthenics?)

Right: Pre-flight payload description by students



Photo: J. DuBose



Three Miles High — Scoutcraft Meets STEM in the Black Rock Desert

By William Kellerman

Father's Day weekend, 2013 saw the scouts of Troop 29, Pacifica, California traveling to Nevada's Black Rock desert. The purpose of the trip was to attend MUDROCK, launch their troop rocket and enjoy a primitive camping experience. But our story really begins one year earlier with the troop's first trip to Black Rock.

Watching extreme rockets launch from the playa, including test launches for the Carmack Prize attempt, inspired the scouts. Most of the scouts had built model rockets in Cub Scouts or to meet Space Exploration Merit Badge requirements. They wanted to build a rocket, but not just any rocket. Scouters in the troop and other adults were somewhat taken aback by the rocket they wanted to build: a 75mm minimum diameter, high-speed, high-altitude, high-power rocket, similar to the sustainer rocket used by the 100K team. And they wanted to fly it one year later at the MUDROCK 2013 launch. The challenge was on!

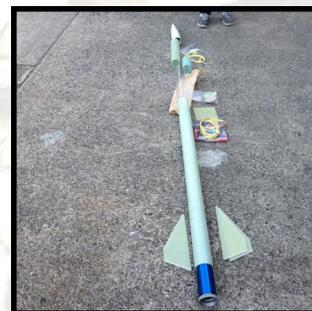
Designing the Project

Beginning in late fall, 2012, a portion of troop meetings was dedicated to setting goals and designing the rocket. Many ideas were discussed: big rocket, small rocket, through-the wall fin design, surface mount fin design, high altitude, high speed, higher speed, really high speed, fat rocket, skinny rocket, etc. before the final rough design was established. Using RockSim software, various configurations of length, diameter, fin number and shape, as well as rocket 'finess' – the ratio of length to width - were simulated in the software. The computer was connected to a projector, so rocket design and flight simulations could be shared. A long, thin rocket with clipped delta fin shape was chosen over the next-best candidate, because it simulated an extra 580' closer to the goal altitude. The goal? To fly as close to three miles high above the ground, 15,840 feet (AGL) as they could, without going over.

Additional goals included exceeding MACH 1, dual-redundant flight computer systems for safety, a GPS tracking radio to insure recovery and installing a HD video camera as the science payload. The scouts wanted see if they could capture the curve of the horizon on video at the target altitude.

Unassembled Rocket

Photo: B. Kellerman



Building The Rocket

The scouts settled on an all-fiberglass airframe with tip-to-tip fiberglass layup on the fin can. Scouts viewed, many times over the YouTube how-to videos provided by AEROPAC Prefect Tony Alcocer, to learn how to install the fins and layer the fiberglass and epoxy resin to build the rocket's booster section. Several meetings and Saturday mornings were dedicated to build sessions sandwiched between service projects, Eagle projects, camping trips and other typical scout activities.

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Three Miles High

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The scouts also sold Imagine Chocolate assortments as a fundraiser to purchase the myriad parts needed to assemble the rocket as well as the motor to fly it. Fins were epoxied onto the tube and bonded with fiberglass, the altimeter bay was designed and assembled and the payload camera bay was also put together. As with many Scout projects, final assembly happened in camp on the playa – more on that later.

Good shop safety rules were emphasized and observed during all build sessions. Scouts wore appropriate clothing, aprons, appropriate gloves, safety glasses and masks during various construction activities. Fiberglass dust from cutting and sanding is dangerous. Handling epoxy resin and hardener plus the final epoxy mix can burn skin and just make a mess. Care must be taken when handling such materials. Adults handled all controlled materials, such as motor grains and recovery charges, where necessary to comply with laws, regulations and TRA rules.

The Adventure

We arrived on site mid-afternoon in time to watch several high power and many mid and low power flights. Tents were setup, gear was stowed, dinner was cooked and eaten, and dishes were washed just in time for the night launch and campfire. The titanium sponge laced streaks of Skidmark and Metalstorm motors alternating with the green and red laser-streak glow of Redline and Mojave Green motors set the stage for what was to come.



Photo: B. Kellerman

Saturday morning dawned clear and cool. The calm serenity of dawns on the playa are a mystical experience, soon cut short by the blast of the first high power launch.

After breakfast it was time to go to work. Final fitting and assembly was finished. The Airframe and Payload teams, mimicking a NASA launch, finalized launch checklists and set-up steps. The motor was assembled and loaded. Charges were filled and wired to the flight computer. Chutes and harnesses were connected and packed. Switch wires and batteries were connected and the AV bay was buttoned up. The GPS was switched on, wrapped in bubble wrap, and installed in the nose cone. Last, the camera was installed and the payload bay assembled and attached to the AV bay and booster section. The rocket was ready, final photos were taken and it was time to go to the pads.

The Flight

RSO Charlie Whitman performed the safety check on the rocket and cleared us for pad assignment. We were assigned Pad A. The rocket was installed on the rail and the video camera was set to 'record.' The

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Three Miles High

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motor igniter was installed and altimeters switched on, generating an R2D2-esque song of happy beeps and chirps, indicating the rocket was ready to go. The 'look-up' GoPro camera was switched on and placed on the ground close to the pad to get a video of the rocket at launch. It was now or never.

At launch time, just before noon, the sky was clear and the wind was nil. After a 10 count, we were off. Three Mile High rose on a column of smoke and flame with nary a shake and hardly a roll. She continued on straight and true, encouraged by a cacophony of cheers, whoops and hollers and the smacks of high-fives all around.

At apogee, instead of arcing over, she stopped dead in the sky and then back-slid onto a flat spin. For some reason the apogee charges failed, holding the drogue chute in. But the rocket was well balanced and the fall was slow. At 1100', the main chute popped and settled the rocket gently down to the playa. The GPS tracker worked as planned and the telemetry provided a touchdown waypoint. We were able to follow the handheld GPS right to our rocket approximately one mile away from its launch point. The altimeters chirped out our max altitude: 1 pause 1, 2, 3, 4, pause, 1, 2, 3, pause, 1, 2, 3, 4, 5, 6, 7, pause, 1, 2, 3, 4. A second round of cheers ensued as the scouts realized they'd hit their goal – 14,374 feet AGL or roughly 2.72 miles high!

Lessons Learned



Photo: B. Kellerman

The scouts learned many aspects of STEM (Science, Technology, Engineering & Mathematics) education in addition to the Scout-craft of primitive camping in an extreme location. Three specific system failures occurred, which luckily did not affect the outcome. For example, the rocket was not finished in time to conduct ground testing of the ejection charges before flight. Consults with rocketeers flying similar rockets, as well as ejection charge calculators, proved invaluable, and worked for the main chute, but not the drogue. The tight coupler and two shear pins proved too tough for the primary charge and for some reason the secondary charge never kicked off. The rocket was made true and conditions were perfect for a straight flight and back slide, instead of a more parabolic and ballistic trajectory. This avoided a high-speed deployment of the main with a possible stripped chute and crash landing.

In addition, one ply of fiberglass was delaminated by the heat of transonic friction. When laying up that section, the scouts failed to mix enough epoxy for all three layers. A second batch quickly mixed did not have enough hardener to create a permanent bond that would withstand the

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Three Miles High

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the heat. While unsightly, the delaminated fins still held together and can fly again with simple repair.

The combination of careful construction (for the most part) redundant systems and luck led to a successful flight. All mission goals were accomplished!

Rocket Details

Airframe: 75mm G-10 fiberglass tube with 3 surface-mount G10 fins laminated tip-to-tip. Fiberglass and acrylic camera bay, molded fiberglass nose cone.

Avionics: Primary deployment altimeter: GWIZ LCX, Backup altimeter: Adept Rocketry Adept 22
GPS: Big Red Bee BRB900 transmitter with LCD Receiver

Payload: Canon HD Camera

Recovery: Fruity Chutes 48" IRIS main, Military surplus 18" drogue, Kevlar chute protectors
¼" Kevlar webbing recovery harness

Charges: 1.7 gr. 4F black powder - two 2/64 nylon screw shear pins per bay

Motor: Aerotech L-1120 W Total Impulse: 4,928 Newton's Burn time: 4.4 seconds

Length: 91" **Weight:** 21.5 lbs. loaded with motor

Flight Data: Altimeter Apogee: 14,374' AGL GPS Apogee: 14,780 AGL Speed: 1.08 Mach

Acknowledgements: The Troop would like to thank AEROPAC for hosting the launch, and all the advice and encouragement from members and flyers attending the launch. The troop would also like to express special recognition to Gene from Fruity Chutes, Jack from What's Up Hobbies and fellow Scouters Mike and Marcus from Bay Area Rocketry for materials and advice during build, assembly and flight. Last but not least, thanks to Tony for his invaluable how-to videos.

About Troop 29. Pacifica Troop 29 is a member of the Discovery District, Pacific Skyline Council of the Boy Scouts of America. Chartered in 1938, Troop 29 is the oldest scout unit in Pacifica, California. Our Chartered Organization is the Pacifica Moose Lodge with meetings in the lodge's Family Fun Center. The author is an Assistant Scoutmaster and Scout-Parent Coordinator for Troop 29. He is also corporate counsel for AERO-PAC and a Tripoli certified rocketeer.

End

Saturn IV / IVB Testing in Sacramento

Jonathan DuBose

Recently at Sacramento's Discovery Museum and Space Center a number of former employees of Douglas Aircraft gathered to share their memories of testing the S-IV and S-IVB. The S-IV was the 2nd stage of the Saturn 1 and S-IVB was the 3rd stage of the Saturn V moon rocket. From 1964 to 1971, the mighty J2 engines in the S-IV and S-IVB roared to life in what is now Rancho Cordova and let everyone in the area know that Sacramento was involved in the race to the moon.

The S-IVB was 18.5' in diameter, 40' long and 20,000 lbs. with no fuel. It was assembled in Huntington Beach incorporating the J2s built by Rocketdyne. The first models were transported by ship to SF and then barge up the Sacramento River and then by truck to the test site. After that those first models "Pregnant Guppy" aircraft were used to transport the stage to the test site and to Kennedy Space Center after testing.

During a Lunar mission, the S-IVB fired its single J2 engine for a short time to obtain optimal Earth orbit and then for 4 to 5 minutes to put it on a course for Lunar orbit. Here, the motor fired once, for "several minutes". Don Brincka, who was test director for the test site, says that 19 S-IVBs were tested here from a setup which been converted from a Thor rocket motor test site.



Left: An S-IVB is hoisted onto the test stand prior to fueling and firing.



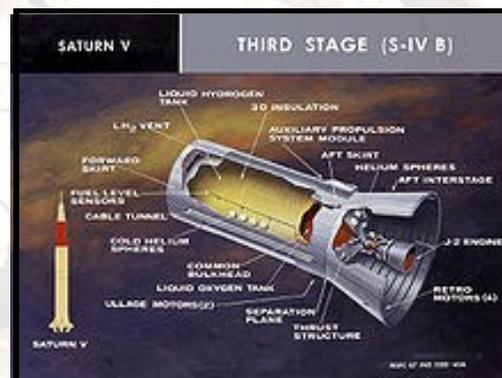
Right: At least 2 motors exploded

Photos by Douglas technician Jim Porter courtesy of Terri Penellos whose father was a NASA engineer at the site.



Left: An S-IVB after testing and prior to being loaded to a "Pregnant Guppy" at Mather Field for flight to Cape Canaveral

Right: Depiction of the S-IVB as 3rd stage of the Saturn V





XPRS Contest Winners

Darryl Paris

This year we had great participation in the two contests: Loft duration and Extreme Altitude!

Loft Duration is a contest for the younger crowd testing their chute packing skills into the lightest rocket possible while timing the flight from lift off to landing. Loft Duration this year was sponsored by Bay Area Rocketry "BAR".

Contest winners in motor categories:

- B class Zoe P. 1min 12sec.
- C class Jack W. 2min 11sec.
- D class Will S. 48sec.
- E class Jack W. 5min 7sec.
- F class Andrew B. 2min 2sec.
- G class Keanu P. 3min 31sec.



Photo: D. Paris

Young winners in loft duration contest

Extreme Altitude is a contest for adults to get the highest altitude they can in a motor class.

This year Extreme Altitude was sponsored by "What's Up Hobbies."

Contest winners in motor categories:

- H class Rob Tashsian 4017'
- I class Aiden Sojourner 3940'
- J class Bryce Chames 7783'
- K class Ryan Catanesi 29,998'
- L class Ryan Catanesi 28,041'
- M class Kurt Gugisberg 43,637'
- O class Derek Jameson 27,364'

ARLISS / XPRS Total Flights		379
Low Power	129	
H	45	
I	52	
J	37	
K	37	
L	10	
M	20 + 43 ARLISS "M" Class	
N	4	
O	1	
Q	1	
Total Certifications	16	
Total Bad Flights	32	

Kurt Gugisberg also received recognition as being the highest flyer of the contest and receiving an awesome prize from Jack at What's Up Hobbies. It's worth mentioning that Ryan Catanesi received his level 1 the day before the contest and on day of contest reached 29,998' for his level 2, Great job Ryan!

As the contest director it is very pleasing to get great participation in the contests and this year was excellent. It was fun to watch the last minute extreme flights with flyers frantically filling out contest forms to get submitted in time before cut off. Cool rocket trophies for next year are in the works!

End



Senza Confini (!)54

Ryan Catanesi

My name is Ryan Catanesi. I am a college student, a pizza boy, and an avid rocketeer. I have been making the trek out to Black Rock for many years now, watching and flying high power rockets alongside my dad, John. After being out so long out in this prime rocketry environment, I wanted to start pushing the envelope. Thus, the questions came about - Can you break 30,000 feet on K power without building a flying casing? Will composites hold together at Mach 3 with a two layer tip-tip? And what happens when you take a 3147ns L motor with a three second burn, and stuff it in a rocket that weighs less than two pounds?

Senza Confini, my latest 54mm minimum diameter design answered those questions this year. The rocket was very short and extremely light. Built entirely from high end composites, the structure was very strong, yet even in its heaviest configuration, weighed only 1.8lbs with everything loaded except for the motor case and propellant. An interchangeable forward airframe setup allowed me to extend its length to accommodate either the Aerotech 54/2800 motor or the Cesaroni Pro 54-6Gxl, and still be minimum length either way. In each configuration, the nose cone would always rest on the forward end of the corresponding motor case that was loaded. This super short design was made possible by some avbay tricks I discovered, and quite a few clever recovery system hacks, pioneered by AEROPAC's Tony Alcocer a few years back, such as surgical tubing encased BP charges and a reefed parachute setup, that minimized space needed for recovery.

The rocket's first flight was at XPRS 2012, on the Aerotech K250W. It took off beautifully and stayed straight and true all the way to an apogee altitude of 27,938 feet AGL, pushing around 1200 mph to get there. From this we can conclude the K250W available today, producing around 2300ns and a 9.5 second burn, is a good candidate for high altitude flight.

The next three flights occurred at XPRS 2013. The first to go up was the Cesaroni K300-CL. This 2546ns C slot burned for over 8 seconds. Saturday morning winds were nil, and the rocket took off straight and true and somewhat faster than the K250 flight. A slight bit of coning could be seen between 1,000 and 2,000 AGL, but aside from that, the rocket stayed perfect to an apogee altitude of 29,998 feet AGL, a mere 2 feet short of 30K, and a top speed of over 1400 mph. About 15 minutes later, it was recovered perfectly 1.5 miles away.

Later that evening, I flew the Cesaroni L640Dt. This 2772ns motor produced a 1400N jolt off the pad for just over half a second, and then throttled back to around 420ns for an additional 3 seconds. It took off incredibly fast and straight up into the windless, dusky Black Rock sky.

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Senza Confini (!)54

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However, after another perfect recovery, again exactly 1.5 miles away, I was quite intrigued to find that even though the rocket had reached an impressive 1700 mph, the apogee altitude was only 28,091 feet AGL.

The third and final flight for the weekend came on a beautiful windless Sunday morning, and was by far the one that I had anticipated most. To my knowledge, Senza Confini was the smallest, lightest and most aerodynamic rocket to have flown a CTI L935 Imax yet. This motor was the strongest commercially available 54mm motor, pushing out a rated 3147ns in just 3.4 seconds. Everything worked flawlessly. The rocket bolted out of the tower, climbing up to a top speed of Mach 2.9, and then coasting smoothly up to apogee at 28,889 feet AGL. It was recovered 100% and ready to fly again. Only some paint on the nose had been scorched and some of the epoxy in my tip-tip application had bubbled from the intense aerodynamic heating. West Systems epoxy is not the best to use for a high temp flight. I would suggest Aeropoxy or Cotronics instead.

Conclusions: With the use of innovative recovery techniques that minimize space, a conventional minimum diameter rocket can be built to pump out some extreme performance without needing extreme amounts of power. Composites work fine at Mach 3 and a properly built structure could probably work reliably above Mach 4. We can also confirm again that high speed yields much higher energy loss due to drag. Previously, we had argued that the N altitude records were set only because of Aerotech's 14 second burning N1000W. This claim was refuted however when an Australian team hit around 51,000 AGL with a 3.5 second burning CTI N5800 Cstar. Furthermore, the full potential of the N5800 has yet to be put to the test, with an optimized rocket. So the idea is simple – you can get out of that thick atmosphere and still have reasonable amount of coast if you're going insanely fast to start with, but you need 98mm power to do so.



End



AEROPAC 2013 Launch Director Report

Gene Engलगau

Hi all! I hope you are having a good vacation from Black Rock over the next months. If you're like me you're mostly repairing my rockets, plus, I have a couple of projects I'd like to bring to the next season. Anyway this year was my debut as launch director and I think it went pretty well. For the most part I enjoyed it and didn't find it overwhelming. I really like helping out folks at the launch!

This was a position I had been thinking about helping with for some time. Also, I now have more vacation time available through work so I have more time both before and after the launch to help. Anyway, here are my brief reports for this years three launches.

MUDROCK 2013 – First let me say that the weather for MUDROCK was amazing, even perfect. Throughout the entire launch the winds were below 10mph and we could fly all day! Temp max might have hit 95 at the most. Evenings were very nice.

I got there Thursday about 3 PM and as I stepped out of my car folks were ready to get going. Darryl had retrieved the trailer from Empire that morning - thanks Darryl! The range was pretty much set up in 1.5 hrs or so I'm guessing.

After that it was time to see if all this stuff actually worked. At the top of the list we had a bunch of problems with batteries . Most batteries were in pretty bad shape. With some testing I was able to get probably a bare minimum of batteries working for the launch. At the end of the launch Tony Alcocer took all the batteries home for a checkup.

The launch equipment also had issues, mostly with bad cabling connectors. That took a few hours of fiddling to get all that working. Jonathan DuBose set up the way away cell, but we did not have enough batteries to power it. Fortunately Tony had a wireless launch controller that worked great - thanks, Tony! There were a number of N flights from those pads.

Friday, when we were getting ready to do the AM meeting we tried to get the PA to work. No one quite knew how it was supposed to be powered, and finally we figured out it is via two batteries in series, or 28v. But it still would not work and we traced it to a bad battery connector. We cleaned that and it worked!



Dick Jackson and his night launch rocket at MUDROCK

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AEROPAC 2013 Launch Director Report

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Through the rest of the launch there were minimal launch equipment issues, maybe some leads that needed cleaning. But my ohm meter, and sand paper took care of these.

On Saturday we had a nice day of flying. The winds stayed low all day.

On Sunday before the morning meeting I was able to recruit a volunteer with an empty hitch to take the equipment trailer to Empire - that was Mike Mota who drives the Hummer - thanks Mike!!

At the Sunday fliers meeting we took a poll at the AM meeting and were able to find out who wanted to fly, and let folks know that we would start staging breakdown around 10 starting at the away cell so they needed to fly early. Also it was Fathers Day and those of us who are dads would like to try and get home at a somewhat reasonable time. Before load out we had some good flights including a few M motor away cell flights that were great!

For load out I was able to get quite a few folks to help each doing a few specific things, and we got it all buttoned up by about 11:30. Becky helped head up the LCO / RCO area. I rode around with Darryl pulling the trailer and we had a nice crew following us from area to area and quickly loading up. While others were finishing up the trailer I finished up the last of my load out so I could accompany Mike M to Empire. We rolled out shortly after, got the key and parked the trailer. I got home about 7:30PM which was great.



Photo: K. Adams

Matt Sikkink's M1315 to M650 lifts off

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AEROPAC 2013 Launch Director Report

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AERONAUT 2013 – First I want to say that AERONAUT again had phenomenal weather, low winds, no dust, and lots of help!

For this launch I was tasked with hauling out the equipment trailer. Sam Fineberg and I caravanned together from the Bay area and arrived at Empire around 1:30 PM. I picked up the AEROPAC Trailer (and Sam was nice enough to tow my little trailer) and headed over to Bruno's. A group of us met about 2 PM at Bruno's. After waiting a bit for others to show up we decided to head out about 3 PM. We had a group of about a half dozen cars caravan out to the Playa to a location 0.5 mile N of the MUDROCK location. I had hoped that the playa there would be good and I was not disappointed. It was very hard and our tires didn't even break the surface.

We had good help for setup and we did it quickly. We set up about half the pads which worked well for this launch.

During the launch we again had a few equipment issues. Batteries were better, but I found at least a few bad ones. Also the club generator quit due to a really weird issue. It seemed that gas was somehow in the oil and that filled up the crank case so the starter cord could not be pulled. Eric Kleinschmidt and I looked at it and it seems like a serious problem. We used Eric's as a backup.

For load out Sunday we had an entire troop of Boy Scouts for tear down so that was done in record time. They completely took down the away cell and huffed all the gear back to the trailer. They also took down the low power pads and walked the grounds. We drove off the playa around 1:00 PM. I want to thank Marcus Krause who accompanied me to Empire to help store the trailer. He towed my little trailer so I could avoid a trip back to get it.

ARLISS and XPRS 2013 – ARLISS / XPRS may go down in the books as MUDROCK II - The Revenge! It was a real adventure and one I won't forget. For the most part the weather was good, except for a "little" rain storm on Thursday.

I arrived at ARLISS about 4 PM on Tuesday. Everything was already running so I was able to relax a little and get camp set up.

Wednesday was nice with great weather. I got a few flights in. Lots of cool ARLISS flights. On Thursday the day started off nice, but it was a little humid with broken clouds. Over the course of the afternoon the weather thickened up and black clouds formed on the edges of the Playa. I felt like we were in a shooting gallery with lightning strikes in the hills around us! Eventually around 4PM, a black cloud

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AEROPAC 2013 Launch Director Report

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came barreling down on us from the northeast and was moving fast. I was helping Ari Krupnic recover his successful L3 project and the wall was getting close fast. We raced back to my camp and I threw my Fruity Chutes boxes and other gear into the trailer. Then the EZ-UP top went in, and the new cleared the rest of the camp as fast as possible. Rockets went into the back of the SUV. Rain started coming in sideways and by the time I finally got into my car I was soaking wet! It rained for about an hour and soaked everything. The Playa was a mucky mess. It seemed like everywhere we walked had packed down and become a pool of mud. I ventured out a little and my shoes quickly became platform shoes (fortunately they are high top hiking boots and are waterproof).



Photo: R. Jackson

Launch Director Gene Engelgau performing one of his many duties

Later on Thursday night we noticed headlights would appear on the Playa, and then suddenly turn around and we would see red lights. A few folks stuck it out trying to get to the launch. Few actually made it to us, but I think most eventually got stuck and a few like Steve Kendal walked into camp after getting stuck. Not much we could really do until Friday.

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AEROPAC 2013 Launch Director Report

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Photo: R. Jackson

**ARLISS teams
were stranded
until 8pm or
so**

On Friday we woke up and the playa was better, but not great. Over the course of the day it did dry out quite a bit. So XPRS was supposed to get started Friday early but that was delayed due to muddy soaked equipment. I helped pull a few folks out of the muddy playa while we waited. Finally, around 10:30 AM XPRS got started with a fliers meeting and we were off!

I introduced the idea of a theme day for XPRS. It was not a contest with prizes but really just a day set aside to fly your theme rocket and get some bragging points. For Friday we had “Big and Fat Friday” – where your fat overpowered rocket ruled! Saturday was “Super Sonic Saturday” and sleek overpowered rockets ruled. Sunday was “Easy Rider Sunday Flyer,” which really means I was too busy to really keep track of anything so just have fun. It seemed the flyers liked the idea and I had quite a few fill out my score card. Later I applied a score to the flight and arrive at the points for that flight.

Otherwise Friday went well once we got going and we had some great flights.

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AEROPAC 2013 Launch Director Report

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Saturday was much busier than Friday and it seemed like we had double the number of flyers! At some points the day I felt almost manic just trying to keep up with stuff. Tony Alcocer spent much of the day helping with the way-away cell. I was running all over doing in-camp RSO checks, filling in for LCO when needed, and generally helping keep stuff going. It calmed down around 4 PM and I managed to fly my rocket I now call Full Yellow Jacket on a M2480 75%M Alumaflame motor. For me that was the last flight.

Later that day we had the AEROPAC members meeting, and then the night launch.

Sunday was load out day and I went pretty much full tilt until we had everything done. We had good help to tear down so that was nice to see. I rolled off the playa around 2:30PM.

In summary, there were quite a few issues for the equipment because the normal technical get together to fix the equipment pre-season did not happen. Regardless, we managed. I'm an electrical engineer by trade and I know how to use a volt meter, so that helps! I can say that we have a lot of flaky relay boxes at this point, and the equipment needs some work over the winter break. The generator needs serious work! The PA is a little wonky sometimes. I did notice that it is sensitive to battery voltage.

For the flyers I think there were pretty minimal issues. MUDROCK, and ARLISS seemed easy and I didn't really have any issues with any folks.

At XPRS, however, there were a few issues that centered on noise, and fast motor cycles or scooters. Thursday night one camp decided it was a good thing to sing drunken songs at 2 AM in the morning – they got yelled at by someone and stopped. One guy showed up with a very loud generator he had rented. He completely understood the issue and agreed to limit its running to the bare minimum. During ARLISS we seemed to have a few folks that thought it was a good idea to ride motorcycles very fast through camp. One guy crashed and really hurt his shoulder and was very close to having to leave. He toughed it out somehow.

One idea I think will help is remind everyone at the flyers meeting about the basic do's and don'ts. I think there are more XPRS flyers showing up during later ARLISS and it would help to have the XPRS talk earlier.

To close I look forward to 2014 and it was really fun being able to help!

End



Mudding It on the Playa

The Paris Crew

While participating in other playa activities out beyond the "Black Rock", the Paris crew watched the thunderstorm blacken the sky and the playa with heavy rain and wind. Our comrades back at camp were getting slammed by the storm and we knew it.

Previously we had notified our friendly neighbors at camp where we were headed and when we would return. Having plenty of food / water / fuel / TP & a shovel we could have easily crashed out for the night high and dry up behind "Black Rock" but we knew if we didn't return our camp neighbors would come looking for us through the mud possibly getting themselves stuck. We couldn't let that happen. We knew we would either make it back to camp or get ourselves stuck, we had a shovel & supplies and the warm cozy beds back at camp made the risk worth it!

We crept down out of the foothills onto the Playa. It was damp and mud flinged easily, so I knew the wheel wells would soon fill up with mud and bog the truck down. We putted at 10mph so as to not fling mud up. One mile onto the playa it got really wet and with ten miles to go the only option making sense was to floor it! At 65 mph on the muddy playa the adrenalin was pumping! We attempted to go straight but ended up mostly slide-ways across ten miles of playa, 8 miles... & mud flinging off the tires high in the air all around us; 6 miles...with mud all over the windshield sloshing around in the wipers; 4 miles... steering was getting difficult with mud clogging the wheel wells; 2 miles... hard to see out the front but our camp was now in view, the speed was dropping quickly with sticky goo clogging up the works! Even though we had the 345HP Hemi at our disposal it was no match against the sticky goo!! 40, 30, 20, 15mph it was time to give in and let the Mopar drop to her knees in defeat. I got out the laser range finder: 228 yds from camp!!! So close!!

After kicking it for a few and watching many others get stuck (it was quite entertaining! We counted 7 other vehicles) I ventured out of my clean interior to dig the mud out from the wheel wells. The playa was soaking up the water but not fast enough as night was quickly approaching, so there was nothing left to do except floor the Mopar back to camp! We skidded into camp with a small applause from our neighbors!

Home at last, we made it!



Photo: D. Paris

End

ARLISS Data Logger Project

Bob Feretich

For the last few years, there have been continuing discussions regarding the increased number of student payloads that seem to have been damaged while being deployed from ARLISS rockets. (ARLISS is an annual international launch event sponsored by AEROPAC. For more information see www.ARLISS.org.) Following the 2012 ARLISS event, a team was assembled to create a device that could be used to instrument the current fleet of AEROPAC ARLISS rockets and measure the forces that the rockets were inflicting upon their payloads. The team consisted of Jeff Stutzman, Grant Saviers, James Dougherty, James Prior, and myself. The ARLISS Data Logger that we created is a combination of hardware, firmware, data analysis software and web presentation software.

The objectives of the ARLISS Data Logger are to:

- Measure the forces to which student payloads are subjected while inside the rocket.
- Provide failure analysis data to help determine the causes of satellite damage.
- Permit ARLISS Rocket designs to be improved to provide a more consistent and less stressful flight for their payloads.
- Help ARLISS Satellite Teams to better understand the environment for which their satellites must be designed.

The ARLISS Data Logger is an electronics module that resides in the bottom bulkhead of the ARLISS payload carrier. Both the carrier internal payload compartment space and the carrier external dimensions were maintained so that these instrumented carriers were compatible with existing payloads and rockets. This made it possible to deploy the instrumented carriers widely across the fleet and collect sufficient data to begin to profile AEROPAC's ARLISS fleet.



Figure 1: Looking down inside an instrumented carrier with the protective cover plate removed. An ARLISS Data Logger (Version 1) and battery are visible.

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ARLISS Data Logger Project

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Logger Sensors and Features

The Logger's sensors measure tri-axis acceleration forces, rotational movement, and detect the instant of payload deployment.

The Logger electronics module contains the below sensors and feature components:

- A STMicroelectronics LSM330DLC inertial module (IMU). The LSM330 has a 3D accelerometer that is configured to measure up to ± 16 g and a 3D gyroscope that is configured to measure angular rates of up to ± 500 deg/sec. The LSM330 also contains a temperature sensor that measures temperature of the MEMS gyroscope in a range of -40 to +85 deg C. (The temperature sensor does not seem to measure accurately.)
- An Analog Devices ADXL377 3D accelerometer and amplifier/filter circuit that measure up to ± 50 g. This sensor was installed to measure High-G events, such as ejection charge and collision shocks.
- A photo-transistor that monitors the light level inside the payload carrier and is used to detect the time at which the payload is deployed.
- A SDHC MicroSD-card socket. The MicroSD-card is used to hold recorded flight data.
- A high performance PIC18 microcontroller able to sustain a 1.3 kHz data sample and record rate.

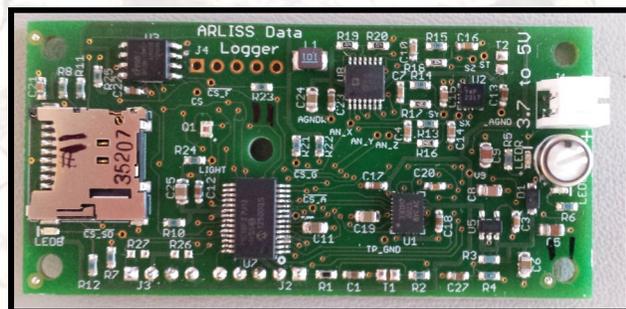


Figure 2: ARLISS Data Logger (Version 2) Shown actual size.

- Red, Green, and Blue LEDs that are used to communicate the Logger's activity and launch readiness status. A serial port can be connected to a terminal (or terminal emulator). The serial port is used to perform Logger calibration.

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ARLISS Data Logger Project

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Logger Use Scenario

At the beginning of the ARLISS Launch Event, instrumented payload carriers are distributed to flyers. Each Logger is powered-on, contains a MicroSD-card, and is ready for flight when the carrier is provided to the flyer. The battery use is managed by the Logger and the Logger will remain powered-on for the entire multiday launch event. At rest, the Logger resides in a low power utilization state called "sleeping." While sleeping, a subset of the IMU accelerometers remain active and they will wake the Logger when movement is detected. Within 2 milliseconds of detected movement, the full sensor cluster is operational and the Logger is monitoring for launch. If 15 seconds elapse without a launch being detected, the Logger will resume sleeping. Assuming that the Logger will be allowed to sleep between flights, the battery is expected to last six days or more.

Just before the flyer loads the payload carrier for flight, the flyer can give the carrier a gentle shake (a nudge) and to make it run a flight readiness and battery test. The result of this test will be blinked out using the Red and Green LEDs. If the Logger reports that it is ready for flight, the flyer loads the payload and proceeds to fly the rocket. No special actions need be taken after a flight. The Logger will reset itself and be ready for another flight within 20 minutes of the previous launch. Each flight recording is a sequentially numbered file the MicroSD-card and the recording contains a date/time stamp to help identify the flight to which the file corresponds.

After the last flight of the event, the flyer returns the instrumented carrier to an ARLISS coordinator. ARLISS coordinators match recorded data to flight cards. (ARLISS flight cards collect substantial amount of information from both the flyer and the student team.) This data is fed into a post-processing program that analyzes the flights and generates a collection of web pages for the event's flights.

Flight Analysis

The processed flight data for the September 2013 ARLISS Event can be found at <http://www.arliss.org/data> Eight instrumented carriers were distributed for this event and 17 flights were recorded. This web page is the "event summary." It contains a summary of key flight characteristics and a link to the detailed data for each launch. Unfortunately much of the flight card data for these launches was lost in a mini-tornado that ran through camp and sucked up a box of flight cards. Only some of this lost flight card data was able to be reconstructed.

For ARLISS flights, the Data Loggers are set to the first ~45 seconds of the flight. Each of the sensors is sampled every 744 microseconds. (The gyroscopes supply data at about half this rate.) The high sample rate provides excellent resolution for examining the shocks that are delivered to the payload. Windows are analyzed, key results are extracted, and flight anomalies are reported.

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ARLISS Data Logger Project

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An example of the flight data can be seen by selecting any of the links on the event summary page. It's possible to view the sample by sample data in spreadsheet format by clicking on the "Flight.xls" link. Data for a flight is divided into four windows; launch, coast, deployment, and recovery. The first three windows are analyzed, key results are extracted, and flight anomalies are reported.

Launch Window

The launch window is from first movement to motor burn out.

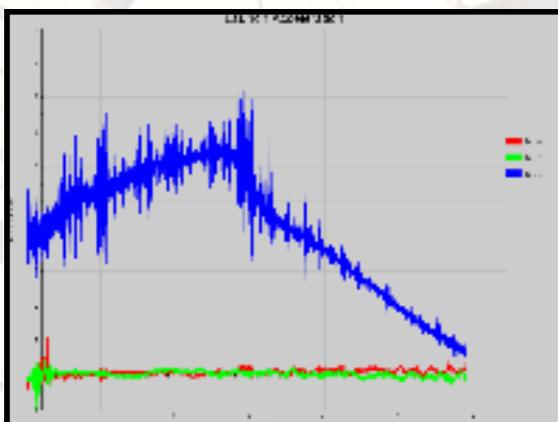


Figure 3 is an example of an acceleration chart generated from the data in this window. The "blue" series of the chart is acceleration in the vertical axis. (Clicking on any thumbnail chart on the web page displays a high resolution version of the chart.) Motor characteristics (thrust and impulse) are analyzed during this window.

Figure 3

Deployment Window

The deployment window is the time interval from the firing of the first ejection charge until the payload deploys and deployment forces quiesce. For ARLISS flights, the first ejection charge is programmed to occur at apogee. This charge splits the rocket in two and deploys the main parachute(s).

A second ejection charge, for payload deployment is programmed to occur six seconds later (See Figure 4). This delay interval is to permit the main parachute to deploy and orient the payload compartment downward. (The payload carrier is located just behind the nose cone.)

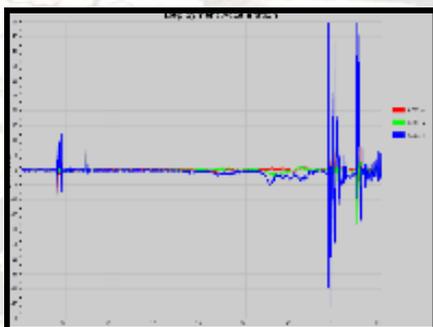


Figure 4

The payload is typically subjected to the highest magnitude shock forces during this window. This is due to close proximity of the ejection charge, the relatively low mass of the loaded payload carrier, and the breaking of the nosecone shear pins that are used to prevent premature deployment. This window is analyzed to determine the magnitude of the acceleration shocks and the time at which the payload becomes free of the carrier.

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ARLISS Data Logger Project

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Results

Figure 5 shows an acceleration profile of a typical flight.

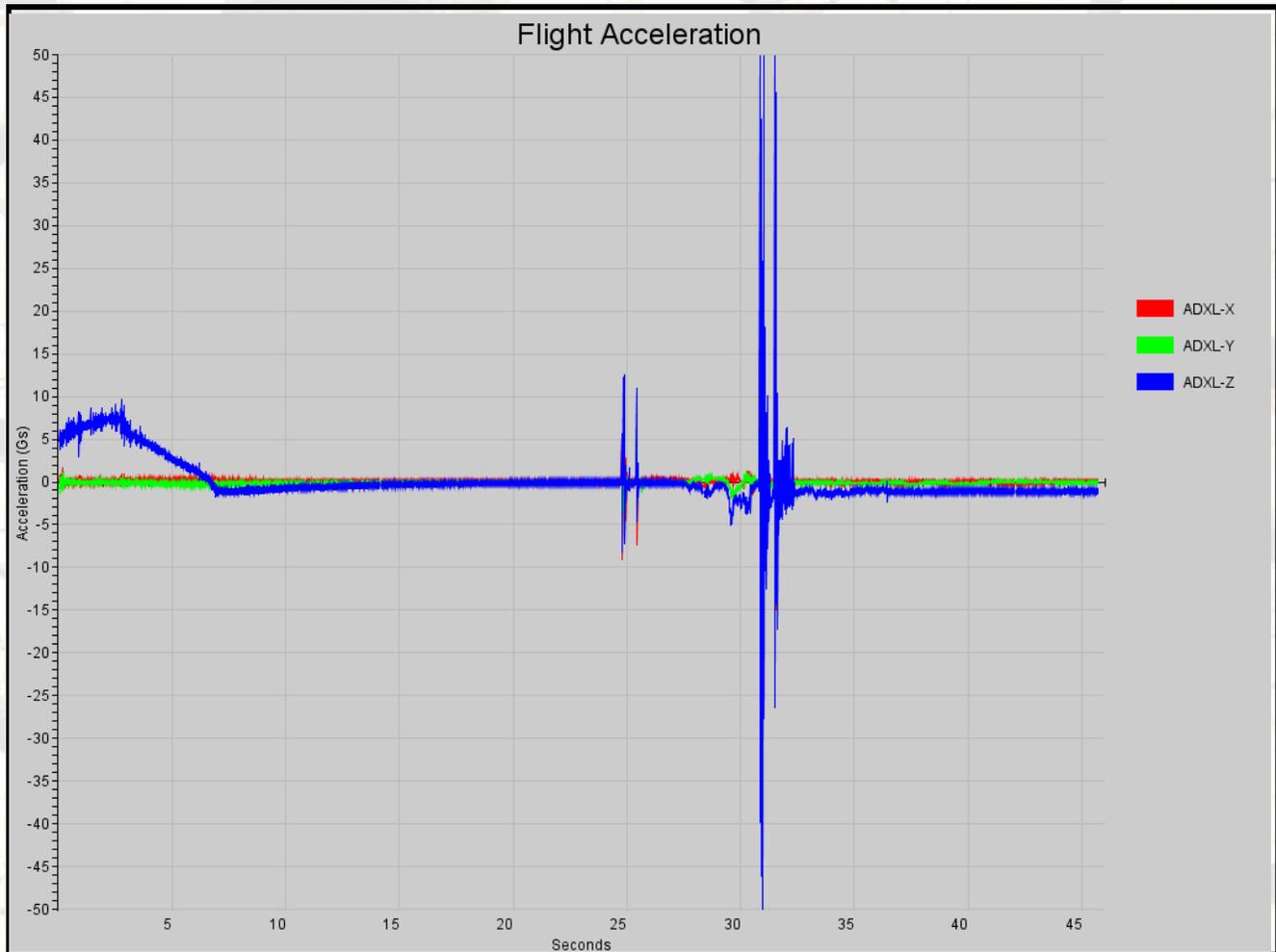


Figure 5

The most noticeable characteristic is the magnitude of the payload deployment shocks occurring at about 31 seconds into the flight. Since the Hi-G accelerometer circuit saturated at approximately 50 Gs, we do not know the real magnitude of these shocks. We had expected them to be no larger than 30 Gs.

Generally gyroscopic rates throughout the fleet were well behaved, but external pods and cameras did cause interesting roll and wobble. The roll (blue series) on this flight saturated the gyroscope

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sensor. Even the pitch and yaw (red and green series) gyroscopes show an interesting wobble. (see figure 6).

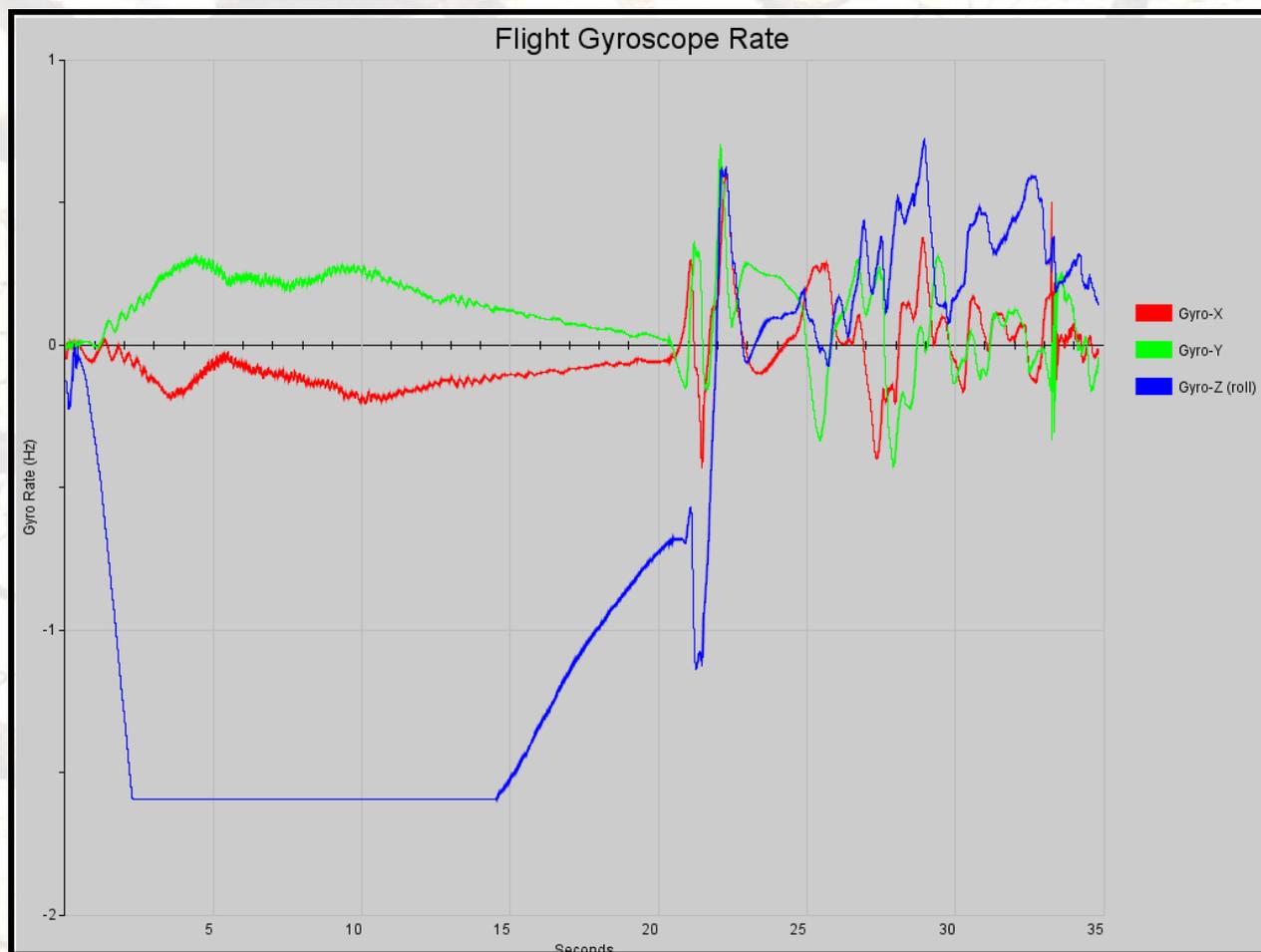


Figure 6

This rocket (Gumby) had an asymmetrical cross section profile due to an external pod.

Also typical of rockets with external pods and cameras was earlier occurrences of apogee, which was probably due to the additional drag.

Another surprise was that the measured motor thrust and impulse were lower than expected. In previous ARLISS events, a significant number of flights performed a “wobble dance” just above the launch rail and/or exhibited significant wind-cocking. I didn’t observe as much of it this year. The

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ARLISS Data Logger Project

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weather/winds were very calm for most of the event and many of the launches occurred from a 30-foot rail rather than from the usual 10-foot rails. However, the measured initial thrust was less than 5 Gs for several flights. The motors were expected to deliver about 8 Gs of initial thrust. We don't have an explanation for this difference. We are speculating that we may be losing significant thrust due to launch rail/button friction.

Conclusions

The data loggers succeeded in collecting a pool of data for ARLISS flyers to analyze. The mining of the pool of data has just begun. Our initial analysis indicates that...

- student payloads are being subjected to shocks that are larger than we expected
- rockets are leaving the rail at slower velocities than expected



Photo: R. Jackson

Most importantly, the ARLISS Data Logger has provided a measurement capability that is expected to enable ARLISS flyers to better understand what is occurring during the flights, to formulate experiments, and ultimately to improve our ability to provide a more consistent and less stressful flight for payloads.

End

Field analysis of preliminary flight data by ARLISS flyers