Newsletter
Association of Experimental Rocketry Of the Pacific

Volume 20 Issue 1
Spring 2014

President's Pad

Tony Alcocer

Vendor News: What's Up Hobbies will not be vending at any of AeroPac's launches this year. Jack is doing some traveling. Mike at Bay Area Rocketry will be at our launches. Mike says if you really need something for a certain launch to order it **NOW**! STOP reading this newsletter and go order the items you need NOW!

Location Location Location: AeroPac will be moving its launch site location. The FAA and BLM have gotten together and are now allowing rockets to be flown from 2 different locations on the playa. The FAA's concerns are roads, buildings and people inside the waivered recovery area. BLM's concerns were rockets "misplaced" in Wilderness Areas and motorized vehicle use in restricted areas. I have a supply of BLM maps and can point out these areas for those that may need to look for their misplaced rocket

(continued next page)

What's Inside

Editor's Note: A new feature this edition is advertisements from the vendors who come to our launches.

We also hope to include product reviews in the future.

Any other ideas that could enhance this newsletter are welcomed. Send your ideas to: newsletter(AT) aeropac.org

President's Pad

in these restricted areas. Each launch location comes with its own predetermined altitudes and radius. For now I'm guessing we will be 2-3 miles North and a tad to the East. We will be posting GPS numbers of the new location on our website before MUDROCK.

BLM Permits: BLM and Tripoli leaders also had some meetings. The outcome of these meeting was that Tripoli now obtains the 'rocket launch permit' for everyone that is launching out at Black Rock. I just received our copy of the permit yesterday. All looks good and less paper work for me. I will be very vigilant to make sure AeroPac retains our long-standing launch dates.

Q's @ XPRS: Q's as in motor size not Q's as in Questions. At this point it looks like there will be 3 Q flights at XPRS this year!

Me: What have I been up to? Awhile back I kitted up some model rocket kits to go along with a program called the Small Satellites for Secondary Student program. The program is funded by NASA and put on by Lynn Cominsky and crew at Sonoma State University. AeroPac has been "helping" out with the program when we can. Putting these kits together was interesting, hard, fun, challenging and a lot of work! I did get help from the following vendors: LOC Precision Rocketry, Aerocon System and Evan Curtis at FX Cutting in Novato. I now know why kits cost what they do! And they are worth it!

I'm looking forward to flying this year and seeing what everyone else has built.

I wish I had a catchy sign off. Let's try this one:

Fly high and straight and keep out of the Wilderness Areas!

Tony

Photo: J. DuBose

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Photo by Ken Adams

Photograph by Patrick Wagner

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AEROTECH 2014 Engineering Party **Jonathan DuBose**

On January 25, 2014 AEROPAC members and supporters from far and wide came together to inspect, repair / rework and test our equipment. Richard Hagen opened his shop in Oakland and supplied tools, equipment and sage advice. The usual donuts and coffee appeared and got things rolling.

The equipment trailer was emptied, tasks assigned and with 20 rocketeers working diligently we "got 'er done" in 4 hours or so.

Those pesky launch system batteries were tested. Some were 86'd and others designated for charging. All the igniter leads were inspected and repaired as needed, controller boxes were reburbished, the cabling laid out and tested for continuity. All identified problems were either corrected or assigned

A small team assembled to discuss options to eliminate "rail whip" in the high power launch rails

for further action. The trailer was unburdened of about 30 lbs of playa.

A lengthy discussion occurred over the high power launch rails with the objective of creating more stable launch platforms. Significant rail "whip" has been observed often sending rockets off on a less than optimal trajectory.

A large lunch spread was enjoyed by all except Peter Clay who found wire insulation in his salad.

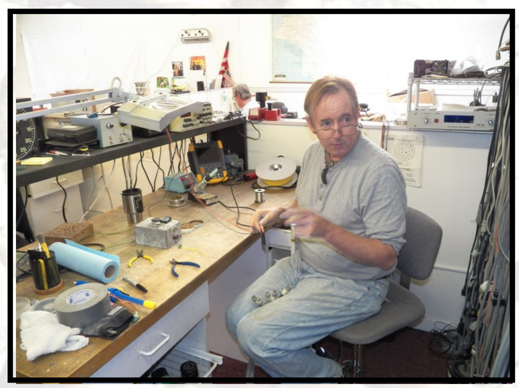
By 2:00 pm or so the trailer was repacked and AEROPAC'ers on their way home knowing that the equipment was (almost) ready for the 2014 flying season.

So for those of you who couldn't make it, when you are out on the Playa this year and you see one of these folks shake their hand and tell them "thanks":

Ken Adams (all the way from Carson City), Tony Alcocer, Ken Biba, Peter Clay, Evan Curtis, Jonathan DuBose, Eric Ebert, Gene Engelgau, Bob Feretich, Becky Green, Jim Green, Alan Palmer, Richard Hagen, Paul Hopkins, Dick Jackson, Steve Kendall , Darryl Paris, Robert Tashjian, Steve Wigfield, Charlie Wittman. Apologies if any names were missed. End

Eric did the igniters leads and clips

Gene did the junction boxes



Jim did the big cables

Tony kept an eye on it all

Rail Cleaning Party

On Sunday, May 18 a rail cleaning party was held at Richard Hagen's shop in Oakland.

The rails got an acid bath and good scrubbing.

This looks like it is pretty nasty work.

Special thanks to Richard Hagen, Darryl Paris, Bill Kellerman, Peter Clay and Evan Curtis.

Photos courtesy of Darryl Paris

PHOENIX EX PROJECT

Curt von Delius

Design

In pushing for the highest possible altitudes for a relatively low total impulse, two stages with minimum velocity, length, weight and diameter are my primary design criteria.

The PHOENIX EX Project is loosely based on the successful and enduring Black Brant 8 Sounding Rocket. This two year project has been extensively researched and incorporates several of the BB8 design features including Nozzle, Interstage and Fin design.

All components and assemblies were completely designed in Solidworks CAD. CNC and manual machining was used to manufacture almost every component.

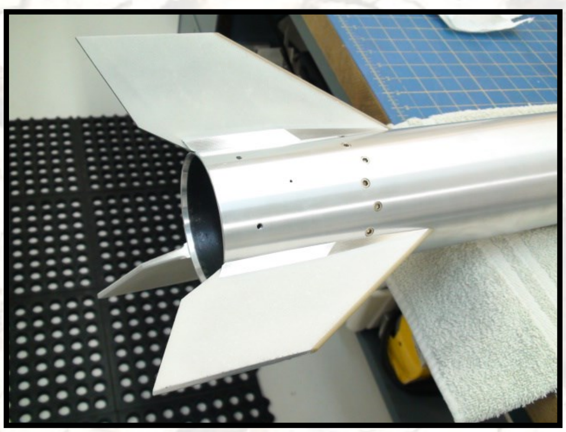
Structure

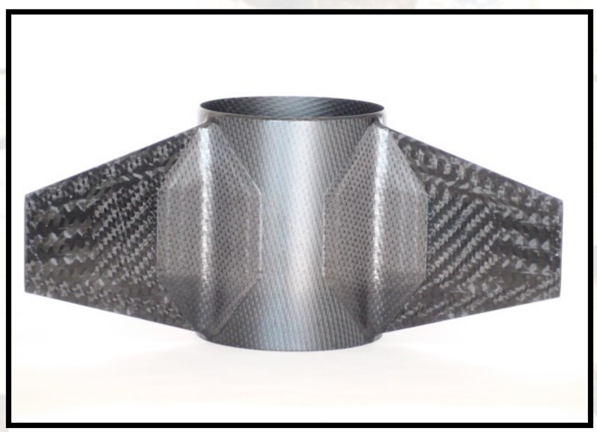
The Cesaroni custom N1100 and standard M 3400 Motor Cases serve as the Sustainer and Booster Airframes.

Fins: The Sustainer Fins are CNC machined from .500” 7075-T651 plate and form a shoulder where they meet the Airframe. They are attached with Mil Spec 180,000 psi high strength alloy fasteners. For thermal protection, the leading edges are fabricated of high temperature Phenolic G-11

PHOENIX EX PROJECT

Garolite. Also a thin sheet of Firex 2376 low temperature ablative is vacuum bonded to each side of the fins.

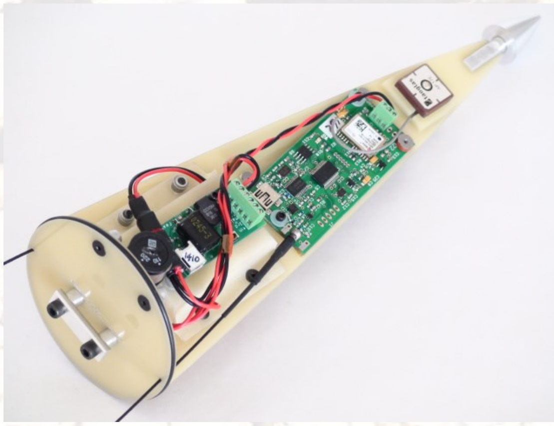




The Booster Fins share the Nike scaled profile, bevels and tapers and are fabricated using .250” rigid carbon fiber plate and traditional carbon fiber composite construction.

PHOENIX EX PROJECT

The Nose Cone is .090" Kevlar and high temperature epoxy composite, layed up on a CNC machined mandrel. A .100" layer of Firex 2390 intumescing ablative is bonded to the Nose Cone and then CNC machined to the correct profile. The Nose Cone houses the twin GPS module, Beacon and Drogue.



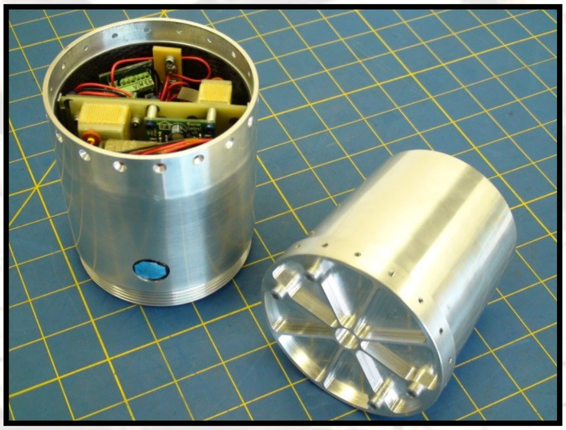
The conical Interstage houses the Booster Avionics Bay and Deployment and is constructed of 7075-T651 aluminum. While under boost, the Sustainer motor case nestles in a curved groove at the base of the Interstage. The forward end of the Interstage contacts the Nozzle just aft of the throat. The combination of these interfaces creates a very rigid stack while under boost, and a low friction release during drag separation.

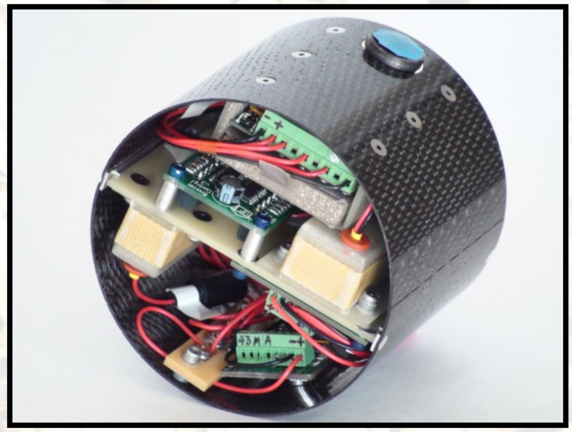
Recovery

Standard Dual Deploy. The Drogue is a custom built, scale 3.5% Viking Disc-Gap-Band constructed of MIL-C-7020 Type III high porosity fabric with 24 Kevlar shrouds. The DGB was chosen for the descent as the vehicle will reach very high speeds under Drogue and scale models of identical construction have been

PHOENIX EX Project

sucessfully deployed in NASA wind tunnel tests to Mach 2.5. The main is a custom, 66 inch 1.3oz. F-111 cruciform with 20 Kevlar shrouds. Deployment will utilize sealed BP charges. Charges were extensively tested in scientific vacuum chamber to 260,000' with a 100% success rate and only a slight loss of force.





Electronics

Rocket Tiltometer 2 (RTOM2), Gyro Attitude-Based Air-Start Ignition Control System, Mission Control Flight Computer v3.0 (Deployment/Air-Start), RDAS Tiny Flight Computer v 4.2 (Deployment), Raven 2 Flight Computers (Deployment Booster), (2) Beeline GPS 70 cm v A23 (Telemetry/Tracking), Marshal RT Plus Beacon (Tracking), Hack HD 1080p Video Camera

Tower

It seemed to me that several important factors play into a straight boost and subsequent staging, so a custom Tower was constructed to meet the following criteria:

1) The launcher guide surface must be rigid along its entire length.

2) The launcher must be straight.

PHOENIX EX PROJECT

3) The launcher must have the ability to be precisely adjusted.

4) The launcher must be long enough for the project to reach an adequate velocity before departing.

5) The Initial stability of the Two Stage rocket design must be adequate for straight flight.

6) The Sustainer Ignition must be inhibited if the Sustainer is appreciably off-axis.

The 20 foot Tower is constructed of .125 wall 1x3 aluminum box tubing and laser cut rings. It is stabilized at the top and middle rings by 3/32" stainless steel cable. Highly tensioned thin cables mounted along the back side of each guide rail serve as straight edge references to adjust the middle guy cable tension and assure the rails are straight.

A pivot on the top ring and removable plate on the middle ring and bolts at the base allow one of the rails to swing out. The Booster and Sustainer can then be simply loaded into the Tower at ground level, and the head-end initiator installed. The rail is then swung into position and the bolts and plate re-secured. This process also allows the Tower to remain in adjustment.

Performance

The Booster motor produces 895 lbs. peak thrust for 2.9 sec. The Sustainer with 609 lbs. peak thrust burns for 12.5 seconds. Maximum velocity will be Mach 3.4. Total vehicle weight is 50 lbs and 92 inches long.

Many thanks to all that have participated in this project including Edward Dye who contributed the much needed CNC expertise, my brother Christian von Delius for helping me learn Solidworks and my wife Monica Daniels for her continuing patience, wisdom and support.

Editor's Note: Curt says "we will be looking for optimal winds for a launch in the summer of 2014."

ARLISS Extreme: An Amateur Educational Sounding Rocket to the Edge of Space

Ken Biba

ARLISS Xtreme is an amateur sounding rocket program sponsored by AeroPac to take CanSat[1] sized payloads to the edge of space. It is based on the philosophies of the very successful 15 year old ARLISS (A Rocket Launch for International Student Satellites) program[2,3] - a unique partnership between highly skilled amateur AeroPac rocketeers that fly ingenious student robot experiments as experimental rocket payloads. Classic ARLISS flights typically go to 3.3 km, carry a 1 Kg student robotic sub-orbital satellite, have an outstanding reliability record of 99.6% success in payload deployment (over the 600+ flights since 1999) and are based a highly reusable airframe design with over 20 flights on an airframe being typical. ARLISS is a non-profit, all volunteer program, in which ARLISS team members build airframes on their own and fly student payloads for the cost of the propellant.

Photo Courtesy Ken Adams

ARLISS Xtreme takes the next big step and tackles the challenge of suborbital flights with a CanSat or PocketQube[4] to the 30-70 km range. Balloons do very well in the lower and middle of the stratosphere up to about 30 km. ARLISS Xtreme reaches above balloons to explore the complete stratosphere and large parts of the mesosphere on the edge of space. It fills the gap between balloons and small LEO CubeSats and PocketQubes.

And it is a lot of fun.

Like ARLISS, ARLISS Xtreme airframes are open source, made with commonly available amateur rocketry composite components and assembly techniques. Capital cost per airframe (including avionics) is under $2k and about $1-$1.5k in per flight propellant and expendables. Flight duration above 30 km is a few minutes. Airframe design is open source.

ARLISS Xtreme is very efficient, matching the efficiency of post WW II commercial sounding rockets with airframes typically flying Mach 3-4 on 20 to 30k Nsec of commercially available solid propellant

ARLISS Extreme

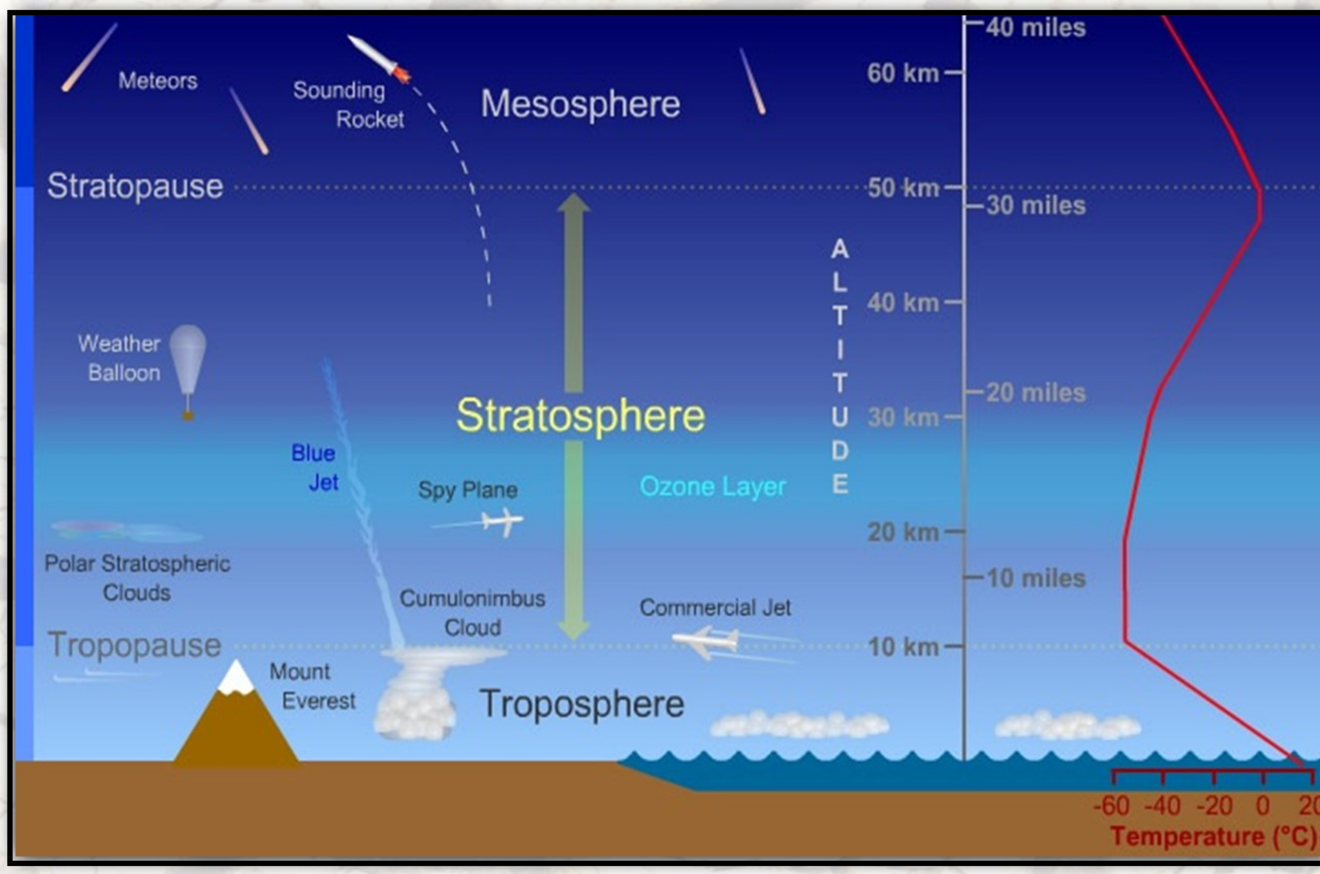


Image courtesy of Windows to the Universe (www.windows2universe.org)

A Bit of History

ARLISS Xtreme comes from a two AeroPac/LUNAR group projects on high altitude amateur air-frames from the 2005-7 time frame: to100K and 99k. While neither project succeeded in their common goal of exceeding 100k' AGL at their Black Rock, NV range, both taught valuable lessons about airframe design, flight profile and avionics that led to the AeroPac 100k project of 2012. That project won the Carmack Prize - created by John Carmack to recognize the first amateur rocketry team to exceed 100k' AGL, document the altitude with GPS and publish a complete analysis of the project and the system. That flight was in September 2012 to 104k' AGL - but one of a series that the team flew with this airframe - characterizing its performance.

ARLISS Extreme

That project, and more importantly the team[5], created a high performance sounding rocket system:

- that is highly efficient in its use of propellant, dramatically decreasing flight cost to high altitude;
- can be constructed from common HPR materials and techniques;
- that is explicitly designed to carry an educational student payload, as does ARLISS Classic;
- that is highly reliable, reusable and precise on recovery;
- that can explore the limits of the atmosphere using commercial motors of less than 40k Nsec of total impulse.

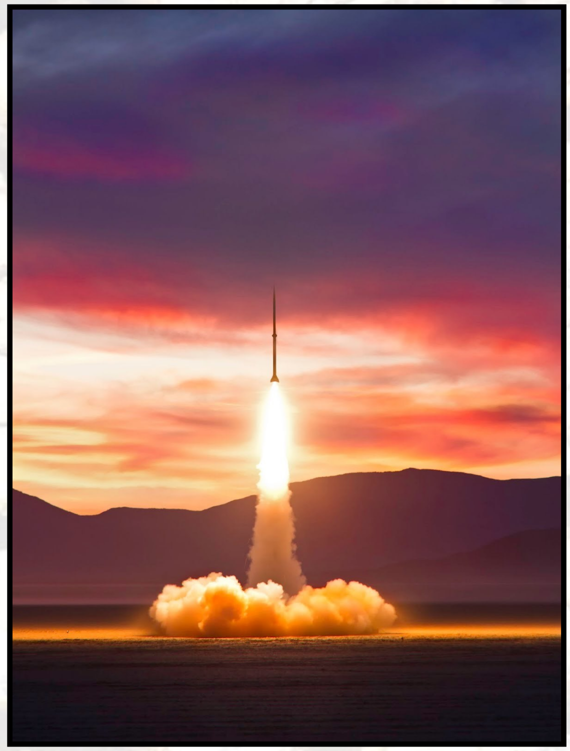


Photo courtesy of Tom Rouse

The ARLISS Xtreme system is the result. It consists of a proven, flight characterized airframe; a mission profile that optimizes recovery; and launch system and telemetry system designed to deliver .3 Kg, soda can sized (550 cm^3) payloads to 30-70 km in altitude and recover them.

And fly again the next day with a new payload.

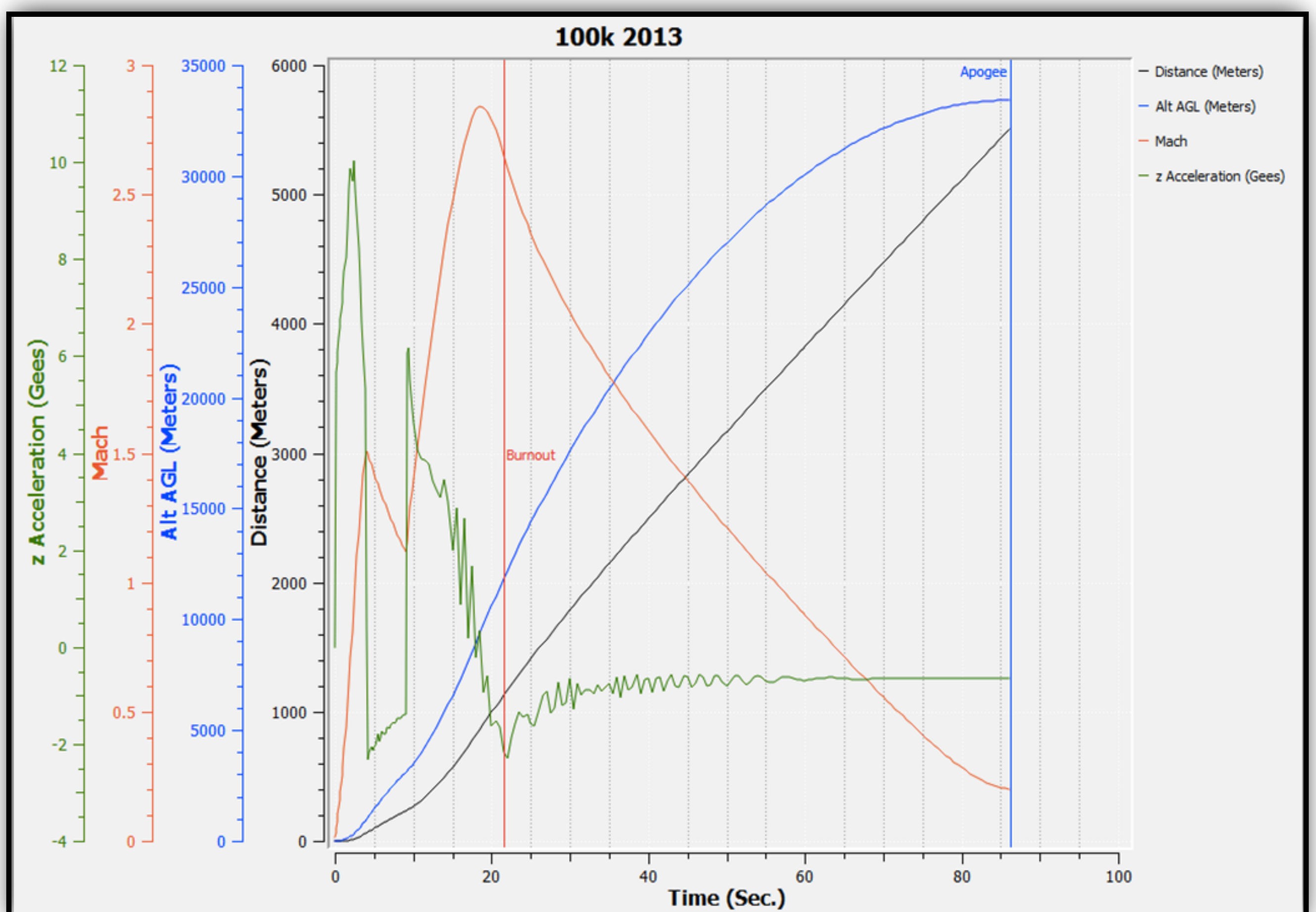
<u>Mission Profile</u>

The ARLISS Xtreme airframe is a two stage (4” booster to 3” sustainer) rocket. It can be configured with a range of commercial solid fuel motor configurations in booster (98mm) and sustainer (75mm) totaling between 20-30k Nsec of propellant.

ARLISS Xtreme is launched from a 30’ pointable rail that can be adjusted in azimuth and elevation to compensate for upper atmosphere winds to increase the precision of recovery. Standard procedure is to fly a small pilot weather balloon with a GPS tracker prior to flight to characterize the local high altitude wind column. Data from the wind column is used in Monte Carlo simulations to determine the best launcher attitude.

ARLISS Extreme

Both sustainer and booster have 70cm GPS beacons based on the HAM standard APRS protocol for tracking and recovery. Both sustainer and booster have HD cameras for recording the flight.
Staging occurs at between 3k and 7k meters AGL depending on the booster motor selected.



The Booster motor is focused on getting sufficient velocity off the launch rail to ensure accurate flight while not being too energetic to waste too much energy in friction in the lower atmosphere. Staging is either passive drag separation or an active piston is used to push out the sustainer from the interstage to ensure staging.

The booster avionics barometrically determine apogee and deploy a drogue at booster apogee to slow and orient recovery of the booster. At about 1k meters AGL, the booster avionics deploy the main booster parachute.

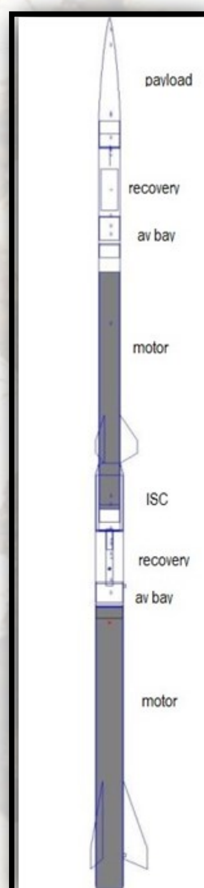
ARLISS Extreme

Sustainer avionics light the sustainer motor shortly after stage separation. There is a short staging delay before sustainer ignition with sustainer avionics overriding sustainer ignition if the airframe is not in a sufficiently vertical profile for effective recovery. Sustainer motor selection is biased towards longer burn motors to optimize altitude and minimize energy lost to drag. Sustainer avionics are redundant and are primarily based on accelerometer apogee detection above 30 km about 80-90 seconds into the flight.

The sustainer (and payload) spends about 60-100 seconds above 30km during the flight.

A drogue chute is deployed at sustainer apogee to align and to minimize tangling of the recovery harness. At about 1k meters AGL, the sustainer avionics will deploy a main sustainer parachute. Total flight time from launch to recovery is on the order of 5 minutes.

AeroPac provides four critical components of infrastructure to enable these sounding rocket missions: a standard, well characterized, proven airframe; a mission profile to maximize recovery near the launch site; a highly capable launcher; and the Virtual Classroom for sharing these missions throughout the Internet.



Airframe

The 2014 airframe is the third ARLISS Xtreme airframe constructed, the first two having been retired - still flight capable. Airframe A, the Carmack Prize winner, has been promised a long-term home at the Boeing/Seattle Museum of Flight's amateur rocketry exhibit currently under construction. Airframe A had four flights. Airframe B had 1 flight.

Airframe C incorporates minor updates in design from the first two - reflecting the experience of the 2012 flight program. C has changes in avionics, recovery, interstage, motor selection and payload organization. It also, sadly, remains unpainted!

Airframe C retains the same basic planform and structure as its predecessors … and thus inherits its well-characterized drag and stability profile. The exterior profile is the same.

Airframe C moves the Beeline GPS telemetry from the avionics bay to the nosecone. The nosecone has two bays … an upper bay with the main sustainer Beeline GPS telemetry and a lower payload bay. The new payload bay occupies space formerly used by the CO2 recovery system in airframes A and B.

ARLISS Extreme

Avionics. The booster avionics remain the same, dual Featherweight Ravens for recovery deployment and staging, a GoPro Hero camera and a Beeline 70cm GPS for tracking and telemetry.

The sustainer avionics have been upgraded. The RDAS Tiny[6] remains but the Featherweight Raven has been replaced with an Altus Metrum TeleMega[7], the GoPro camera has been upgraded to the new, smaller Hero3 model and the Beeline GPS tracker has been moved to the tip of the nosecone above the payload bay.

The TeleMega, while a very new product, offers two new capabilities. First, the integrated IMU offers measurement of airframe attitude potentially allowing control of sustainer ignition based on airframe attitude, minimizing dispersion and maximizing altitude. Second, it includes a second, 70cm telemetry and tracking system … as a backup to the primary Beeline GPS. Spectrum analysis of the two operating 70 cm transmitters shows that with the movement of the Beeline to the nosecone, there is sufficient separation that the two trackers will have only minimal, if any, interference.

Interstage. Airframes A and B used a milled Delrin interstage - the thinking being to minimize friction with the extended part of the sustainer motor and encourage drag separation. The difference in expansion coefficients between Delrin and aluminum (while not significant on paper) seemed to matter a lot (and required much hand sanding before launch) in practice at the hot Black Rock launch site. Airframe C moves to an interstage based on a custom fitted fiberglass tube set in a milled aluminum frame. The combination of passive separation from drag separation and active separation with a BP activated piston remains.

Motor selection. The off vertical 2012 results spurred the team to cover every base to ensure vertical flight. The new launch system is a core piece of that, complemented by an updated motor selection. A higher initial impulse, but shorter burn motor, has been chosen for the baseline booster motor. This higher impulse motor, combined with the longer, stiffer launch rail should ensure a 2x higher full stack velocity when leaving the rail.

We retained the use of long burn motors in the sustainer.

Payload. Airframe C formally establishes a well defined nosecone payload bay that is CanSat sized - 6.6 cm by 15 cm cylinder designed for 350 gram payload. It sits at the based of the nosecone assembly with the Beeline GPS tracker mounted directly forward. A small hole is provided at the base of the nosecone shoulder for the payload to have direct contact with the outside world either for a camera or other sensor .

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Recovery

Both sustainer and booster retain two phase recovery, with a drogue deployed at apogee and a main parachute deployed at ~1km AGL. We have a continuing team internal debate about the value of the sustainer drogue and for the moment the drogue remains.

We learned that surgical tubing wrapped BP charges worked well at over 100k' MSL and that our CO2 recovery system, while it worked, was prone to failure modes with its increased complexity. We decided to remove the CO2 system and rely entirely on the BP charges for recovery deployment.

Payload Profile

ARLISS Xtreme flies small payloads … but those payloads today can be as complex as orbiting satellites. ARLISS Xtreme has the volume and weight constraints of roughly classic CanSats and of 1 and 2p PocketQubes.

What missions can we do? The most interesting missions explore the Earth's stratosphere and mesosphere. While balloons can do a great job of doing science in the stratosphere, much less is known about the mesosphere, since only sounding rockets - like ARLISS Xtreme - are well-prepared to do missions at that altitude.

A bit about the science in the stratosphere from Windows to the Universe (Windows to the Universe (www.windows2universe.org).

> The stratosphere is a layer of Earth's atmosphere. The stratosphere is the second layer, as one moves upward from Earth's surface, of the atmosphere. The stratosphere is above the troposphereand below the mesosphere.
>
> The top of the stratosphere occurs at 50 km (31 miles) altitude. The boundary between the stratosphere and the mesosphere above is called the stratopause. The altitude of the bottom of the stratosphere varies with latitude and with the seasons, occurring between about 8 and 16 km (5 and 10 miles, or 26,000 to 53,000 feet). The bottom of the stratosphere is around 16 km (10 miles or 53,000 feet) above Earth's surface near the equator, around 10 km (6 miles) at mid-latitudes, and around 8 km (5 miles) near the poles. It is slightly lower in winter at mid- and high-latitudes, and slightly higher in the summer. The boundary between the stratosphere and the troposphere below is called the tropopause.
>
> Ozone, an unusual type of oxygen molecule that is relatively abundant in the stratosphere, heats this layer as it absorbs energy from incoming ultraviolet radiationfrom the Sun. Temperatures rise as one moves upward through the stratosphere. This is exactly the opposite of the

ARLISS Extreme

behavior in the troposphere in which we live, where temperatures drop with increasing altitude. Because of this temperature stratification, there is little convection and mixing in the stratosphere, so the layers of air there are quite stable. Commercial jet aircraft fly in the lower stratosphere to avoid the turbulence that is common in the troposphere below.

The stratosphere is very dry; air there contains little water vapor. Because of this, few clouds are found in this layer; almost all clouds occur in the lower, more humid troposphere. Polar stratospheric clouds (PSCs) are the exception. PSCs appear in the lower stratosphere near the poles in winter. They are found at altitudes of 15 to 25 km (9.3 to 15.5 miles) and form only when temperatures at those heights dip below -78° C. They appear to help cause the formation of the infamous holes in the ozone layer by "encouraging" certain chemical reactions that destroy ozone. PSCs are also called nacreous clouds.

Air is roughly a thousand times thinner at the top of the stratosphere than it is at sea level. Because of this, jet aircraft and weather balloons reach their maximum operational altitudes within the stratosphere.

Due to the lack of vertical convection in the stratosphere, materials that get into the stratosphere can stay there for long times. Such is the case for the ozone-destroying chemicals called CFCs (chlorofluorocarbons). Large volcanic eruptions and major meteorite impacts can fling aerosol particles up into the stratosphere where they may linger for months or years, sometimes altering Earth's global climate. Rocket launches inject exhaust gases into the stratosphere, producing uncertain consequences.

Various types of waves and tides in the atmosphere influence the stratosphere. Some of these waves and tides carry energy from the troposphere upward into the stratosphere; others convey energy from the stratosphere up into the mesosphere. The waves and tides influence the flows of air in the stratosphere and can also cause regional heating of this layer of the atmosphere.

A rare type of electrical discharge, somewhat akin to lightning, occurs in the stratosphere. These "blue jets" appear above thunderstorms, and extend from the bottom of the stratosphere up to altitudes of 40 or 50 km (25 to 31 miles).

A bit about the mesosphere from the same source.

The mesosphere is a layer of Earth's atmosphere. It starts about 50 km (31 miles) above the ground and goes all the way up to 85 km (53 miles) high. The layer below it is called the stratosphere. The layer above it is the thermosphere. The border between the mesosphere and the thermosphere is called the mesopause. Most meteors burn up in the mesosphere. A type of lightning called sprites sometimes appears in

ARLISS Extreme

the mesosphere above thunderstorms. Strange, high-altitude clouds called noctilucent clouds sometimes form in this layer near the North and South Poles. It is not easy to study the mesosphere directly. Weather balloons can't fly high enough and satellites can't orbit low enough. Scientists use sounding rockets to study the mesosphere. The top of the mesosphere is the coldest part of the atmosphere. It can get down to -90° C (-130° F) there! As you go higher in the mesosphere, the air gets colder. The top of the mesosphere is the coldest part of Earth's atmosphere. The temperature there is around -90° C (-130° F)!

The boundaries between layers in the atmosphere have special names. The mesopause is the boundary between the mesosphere and the thermosphere above it. The stratopause is the boundary between the mesosphere and the stratosphere below it.

Scientists know less about the mesosphere than about other layers of the atmosphere. The mesosphere is hard to study. Weather balloons and jet planes cannot fly high enough to reach the mesosphere. The orbits of satellites are above the mesosphere. There are not many ways other than sounding rockets to get scientific instruments to the mesosphere to take measurements there. Sounding rockets make short flights that don't go into orbit. Overall, there's a lot that is unknown about the mesosphere because it is hard to measure and study.

What is known about the mesosphere? Most meteors from space burn up in this layer. A special type of clouds, called "noctilucent clouds", sometimes forms in the mesosphere near the North and South Poles. These clouds are strange because they form much, much higher up than any other type of cloud. There are also odd types of lightning in the mesosphere. These types of lightning, called "sprites" and "ELVES", appear dozens of miles above thunderclouds in the troposphere below.

In the mesosphere and below, different kinds of gases are all mixed together in the air. Above the mesosphere, the air is so thin that atoms and molecules of gases hardly ever run into each other. The gases get separated some, depending on the kinds of elements (like nitrogen or oxygen) that are in them.

There are waves of air in the atmosphere. Some of these waves start in the lower atmosphere, the troposphere and stratosphere, and move upward into the mesosphere. The waves carry energy to the mesosphere. Most of the movement of air in the mesosphere is caused by these waves.

Launch System

The launcher is as an important part of the ARLISS Xtreme system as the airframe and that was a core lesson learned from the 2012 flight program. Stability and rigidity of the launcher is key and the launch system used for the first program left something to be desired.

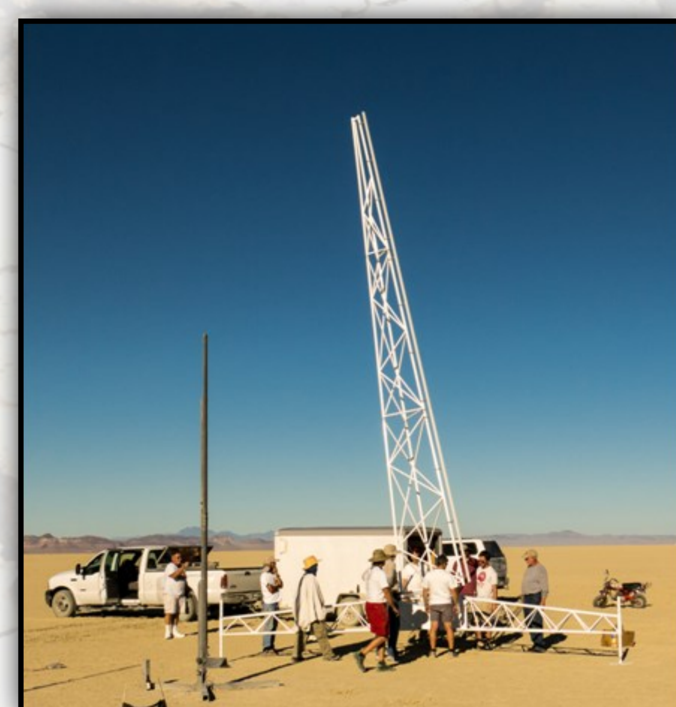
ARLISS Extreme

Secondly, the actions of upper atmosphere winds have a dramatic effect on both the ascent and descent of the sustainer. A test weather balloon launch at 2013 ARLISS suggested that local upper atmosphere winds at Black Rock were not well predicted by NOAA radiosonde measurements at Reno or Lovelock - the closest radiosonde locations.

Extensive Monte Carlo flight simulations suggested that good knowledge of the current wind column would allow pointing a well characterized airframe at launch to compensate for the wind column and allow launch and recovery of the airframe close to launch location. To do this required three parts: accurate wind column knowledge, a method to reverse simulate from the wind column to determine proper launcher attitude, and a launcher rigid enough and pointable enough. We had the methodology … now we needed the tools. The ARLISS Xtreme 2014 program will test this methodology.

The 2013 balloon experiment strongly suggested that local balloons flown at the launch site close in time to the proposed launch were important. But classic weather balloons are unwieldy and require large crews. Smaller 1m pilot balloons with miniaturized 70cm APRS GPS trackers were the solution.

Fillable with small quantities of helium, they will give a good track through the troposphere to the tropopause where the most important wind effects are located.



ARLISS 2013 saw the introduction of the new "UberRail", a 30' modular, chrome-moly 1515 tower that is pointable. The tower is brought horizontal with a motor and winch, the airframe is loaded onto the rail, and then the tower is erected to vertical via motorized winch. The tower can then be adjusted small amounts in azimuth and altitude via computerized stepper motors to point to the attitude the current wind data plus flight simulations indicate will result in minimizing landing distance of the sustainer from the launcher.

ARLISS Extreme

Virtual Classroom

AeroPac's Virtual Classroom is a state-of-the-art communications infrastructure for remote rocketry at such sites as such as Black Rock where there is effectively none. It is based in a converted remote TV reporting van. The VC provides five critical services for high altitude rocketry:

1. Radio telemetry downlink and uplink capability with good antennas to radio packages in the airframe. Radios are currently available for several different protocols at the 70cm and 2m HAM bands, at 900 MHz, 2.4 GHz and 5 GHz.
2. Internet backbone access via either satellite Internet or 4G cellular connection.
3. WiFi 802.11n hotspot service over a wide area (a few km^2) surrounding the VC van.
4. HAM radio capability for voice and APRS at 2m and 70cm.
5. Mapping capabilities uniting the tracking capabilities of the radio telemetry with the mapping capabilities of the Internet.
6. Streaming video from multiple VC cameras to uStream.

Each ARLISS Xtreme flight is tracked by the VC in real time and can (optionally) be forwarded to real time maps on the Internet.

Program Plans for 2014

ARLISS Xtreme plans three flights in 2014 to further move the system from development into full deployment. The major goal of the 2014 flight program is to move the system from a one time event to a consistent reliable ARLISS quality payload flier with consistent, reliable flight and recovery performance.

The first flight in June 2014 will be a low powered flight with about 15k Nsec of propellant and targets an apogee of about 20 km AGL at Black Rock (1.2 km MSL launch site). It will be carrying an AeroPac experimental payload.

The second flight is scheduled for August 2014 at AeroPac's Aeronaut launch. It increases the motor total impulse to 20k Nsec with a target apogee of 35 km. It will be carrying an AeroPac experimental payload.

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The third flight is scheduled during ARLISS 2014 in September 2014. It increases motor total impulse to about 28k Nsec with a target apogee of 50 km. A noted Japanese university has a student team building a payload for this flight.

If these flights go well ARLISS Xtreme will likely be a mainstream event in 2015 at ARLISS and we will be soliciting other student payloads for the ARLISS 2015 event and other fliers to build more airframes Our simulations say that the airframe can be further upmotored to fly to 70 km with about 30k Nsec of commercial motors. While all multi-stage airframes have higher dispersion than single stage, getting to this altitude with only two stages increases the reliability (and lowers the cost!) of the system over solutions with more stages.

<u>Opportunities</u>

ARLISS Xtreme is an opportunity for AeroPac volunteers to help with prep and launch and to learn about very high performance systems. The team will likely be building additional airframes for the 2015 season. Now is a great time to learn about high performance airframes, stagings, telemetry and all the tools necessary to fly to the edge of space.

And interested student teams, particularly for the 2015 season interested in building payloads to explore - now is the time to think about the science that can be done at the edge of space.

<u>Contact</u>

Contact a member of the ARLISS team for more information.

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S4 Program Updates

Lynn Cominsky

The NASA-funded "Small Satellites for Secondary Schools" program is continuing in its third year. Last summer, 18 educators were trained to build the payloads, and flew them with ROC at Lucerne Dry Lake Bed in July 2013. We had 18 successful launches before our final attempt failed and became a lawn dart. Ken Biba helped with the launch and lectured about WiFi connectivity, and Tony Alcocer lectured about rockets and helped the teachers construct the payloads. The week-long training session was held at NASA Dryden's Aero Institute in Palmdale, CA, and was organized by the Sonoma State University Education and Public Outreach group, under the leadership of Lynn Cominsky. Kevin John, Logan Hill and student Kevin Zack , who also gave lectures to the 14 teachers and 4 Girl Scout leaders in attendance.

This past year, the educators have received their payload kits, and are building and flying them in a wide variety of ways. Some of the teachers have purchased rocket kits developed by Tony Alcocer that can use G- or H-motors to fly the payloads to around 800-1000 feet. Tony also put together a series of instructional videos (which are available on YouTube) to show the teachers and students how to build the rockets. He has been supporting launches by different teams during the spring, including DairyAire in mid May, 2014.

Meanwhile, Ken has continued to support the S4 program by attending TARC, doing a demo table with the S4 payload, flyers and a poster, and advertising a new opportunity for the top 25 TARC teams to build S4 payloads, that will then be launched by AeroPac members, probably in conjunction with ARLISS in 2015. This new partnership is a great opportunity to get more publicity for S4, in the hopes that we can turn it into a West Coast version of NASA's Student Launch Initiative (which was cancelled this year due to all the budget turmoil regarding NASA Education).

Photos of the teachers and the summer 2013 training can be found in the media gallery on the s4.sonoma.edu website.

Tony Alcocer and students at Dairyaire 2014

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