PongSat Launch System

Small experiments flown to space at no cost to students.

The PongSat Launch (PSL) System consists of a small reusable sounding rocket launched from an airship.

This is an extremely small system designed for the bulk carrying of extremely small payloads. This is an expansion of the existing small payload launched program operated by JP Aerospace. This program is called PongSat for "Ping Pong Ball Satellite" . PongSat provides a payload standard in the same manner as Cubesat but on a smaller scale.

The forty-foot long airship carries a seven-and-a-half foot rocket. The rocket is launch at the top of the atmosphere and flies to space.

At dawn, the balloons of the Tandem airship are inflated inside balloon launch bags. At launch runners pull open the balloon tear panels. The airship does a 'hands off' takeoff and climbs at 18.3 km per hour. The winds aloft balloon launched earlier shows the airship operator exactly how to maneuver the airship so it arrives in the launch corridor at 30 km.

The rocket is stowed in an insulated launch box. At launch altitude the launch box is lowered by a reel 180 meters below the airship. This allows the rocket to be fired two degrees off vertical and clear the sides of the airship's balloons. The launch box is rotated to the required azimuth. The system status is verified both with sensors and visually with on-board cameras. (Note: there is an on board interlock tied to a GPS that prevents launching outside the launch corridor).

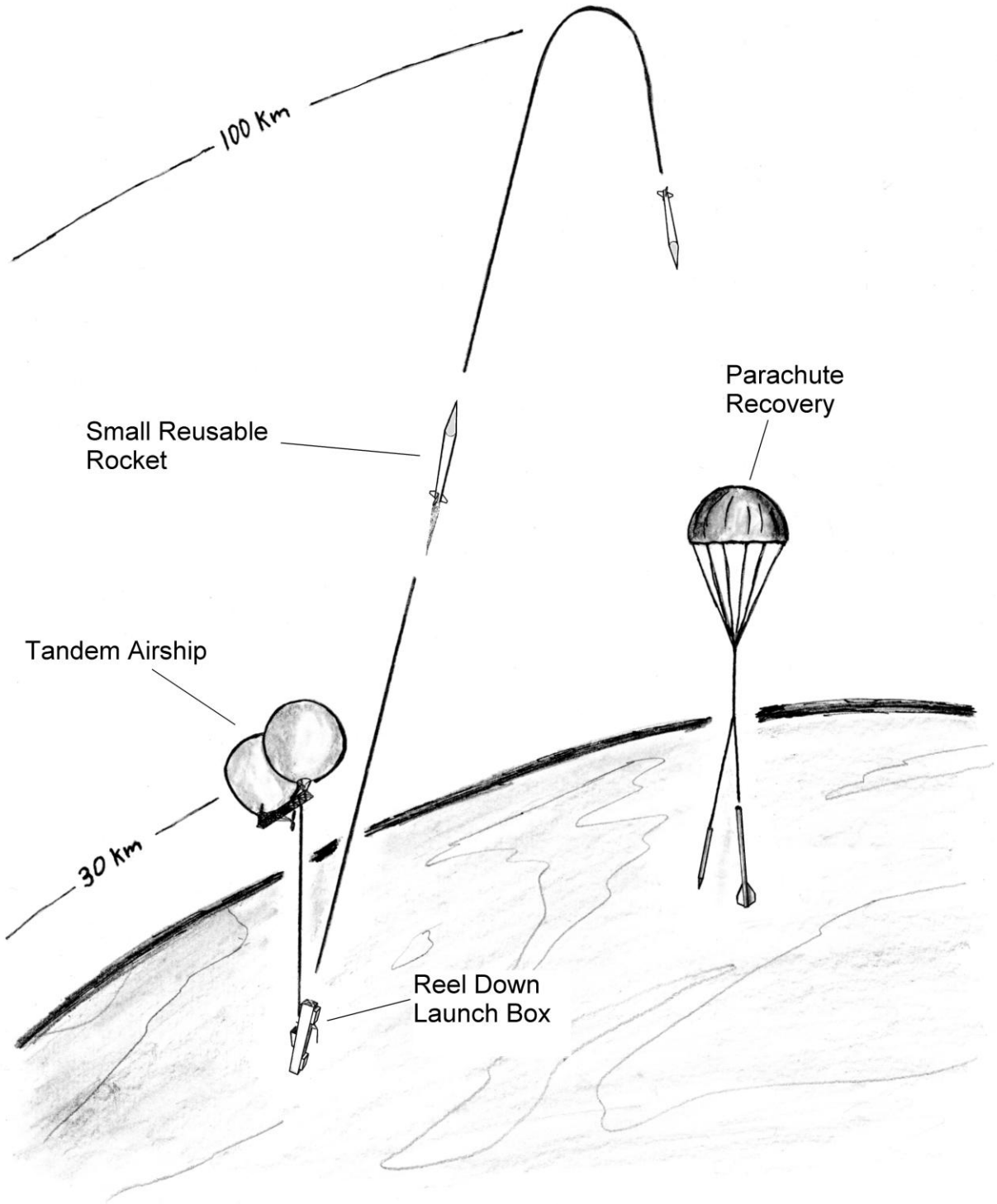
The rocket is launched by ground command. After a five second burn of the rocket motor, the rocket coasts to 100km. Apogee is detected on board by GPS and verified by accelerators. A cold gas charge separates the rocket into two pieces held together with webbing. This is to break up the aerodynamics and slow the descent. When the rocket has descended to twenty km a parachute is deployed. The rocket descends before being separated in two. The descent can be extended for long microgravity duration.

During the flight of the rocket the airship acts as a telecommunication "satellite". Primary communications are direct from the rocket to the ground, and the backup link goes through the airship. All telemetry is handled through JP Aerospace's existing mobile communication equipment.

The recovery team receives data from both the rocket and the airship. After the rocket has landed the balloons are released from the airship which also descends on parachute. Both the rocket and airship are retrieved by the recovery team.

Both the airship and rocket are fully reusable.

JP Aerospace 2530 Mercantile Dr. Suite I, Rancho Cordova, CA 95742 916-858-0185
www.jpaerospace.com jpowell@jpaerospace.com



PongSat Launch System

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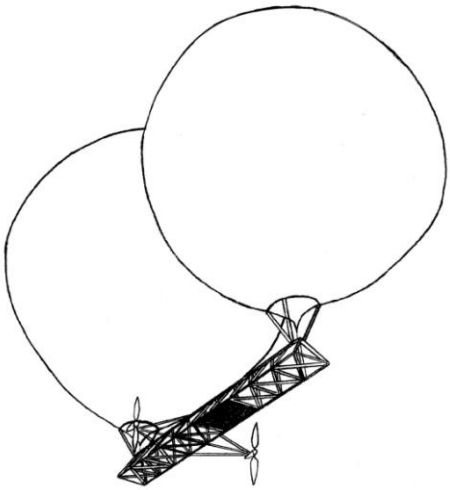
Flight Details Typical Mission:

Total Airship Launch Weight:	30 kg
Airship Climb Rate:	304.8 meters/min
Time to Launch Altitude:	100 min
Rocket launch Altitude:	30.48km
Rocket Motor Burn Time:	5 sec
Rocket Empty Weight:	3.6 kg
Total Rocket launch weight	8.2 lbs
Motor Burn Time:	5 sec
Burnout Velocity:	1175 m/sec (3.46 mach)
Time to Apogee:	125 seconds
Total Payload mass to 100 km:	1 kg
Total Number of Payloads 100 km:	20

Components

The Tandem Airship



The Tandem is a simple unmanned high altitude vehicle designed to fill the gap between free balloons and complex high altitude airships. It consists of two weather balloons separated by a carbon fiber truss. The Tandem will fly to 30km. The airship is driven by two electric motors spinning advanced carbon fiber propellers.

The Tandem provides maneuverability, altitude hold, payload infrastructure support and other benefits while being low cost and easy to operate like balloons.

The Tandem achieves high altitude operation at a fraction of the price of other high altitude vehicles. The low cost is the result of simplicity and the use of off-the-shelf components. The Tandem is designed entirely from existing parts that have all been tested at high altitude.

The Tandem's bag launching system means: a small ground crew, all weather operations, and no hanger.

The balloons are Kaymont 4000g latex weather balloons. For larger Tandems, polyethylene balloons on a roller deployment system will be used. The balloons are mounted on large carbon cradles. The cradles pivot and allow the balloons to move fore and aft. Side to side motion of the balloons is restricted.

The hollow carbon/Kevlar propeller were specifically designed for operations at 30km.

At the end of the operation the balloons are released and the airship descends by parachute.

The Tandem prototype is complete. The first test flight to 30km is scheduled for summer 2011.

Tandem Propeller being tested at 80,000 feet.

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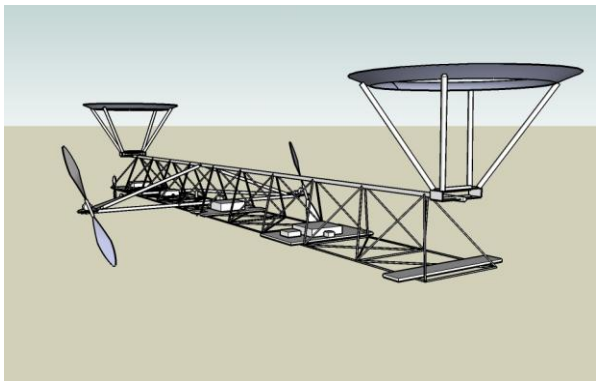
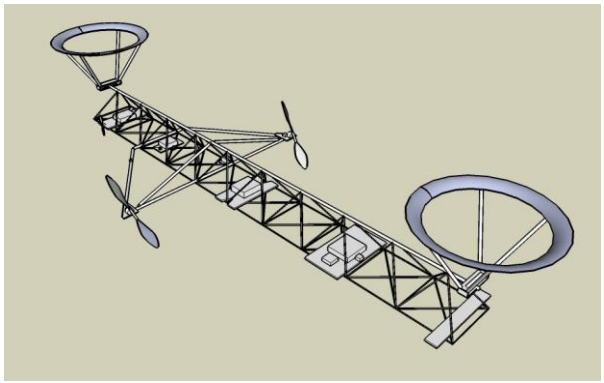
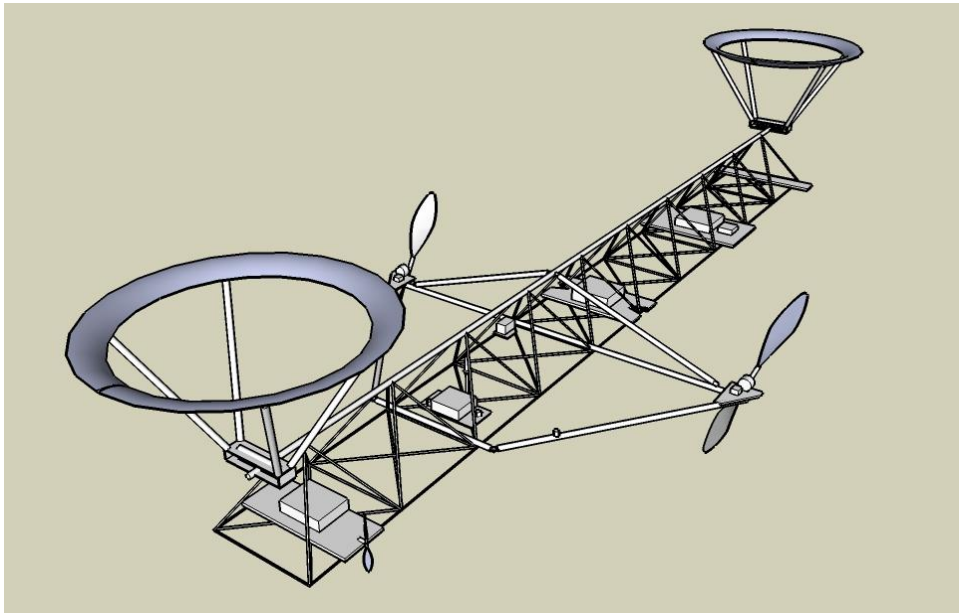
Tandem Prototype Data

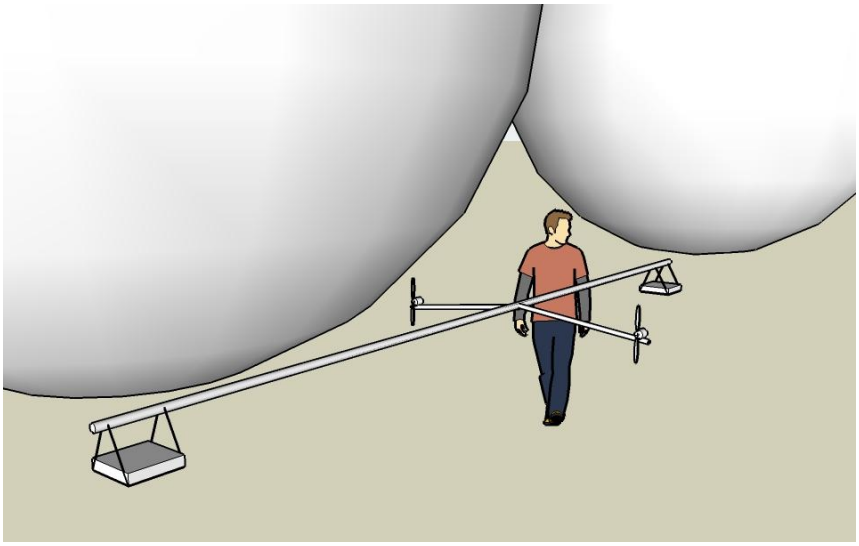
Launch weight:	67 lbs
Maximum Altitude:	110,000 feet
Duration:	6 hours
Velocity	5 knots
Winds aloft mitigation:	The Tandem can stop at any desired altitude in favorable wind conditions
Recovery:	Parachute
Maximum winds at launch:	25 knots, no ground facilities required
Command/Control:	900 mhz spread spectrum
Ground Station:	Radio and laptop

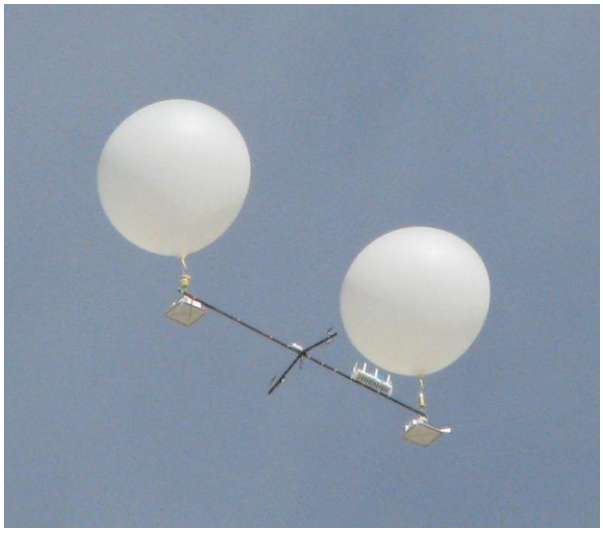






Micro Tandem



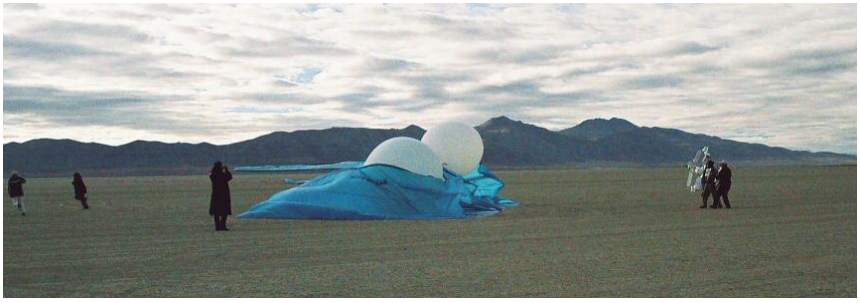


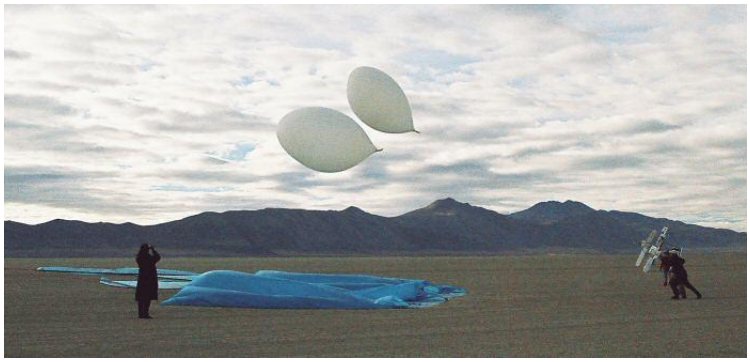
We built and flew a fourteen foot long version of the Tandem to test the general configuration. The vehicle was flown to an altitude of 12km. In flight the vehicle performed turns and other basic Tandem operations.

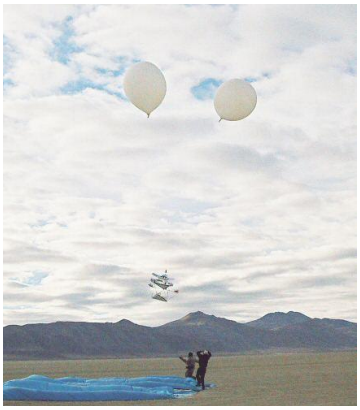
High Wind Launch Capability

One of the drawbacks of a lighter-than-air based launch system is the susceptibility to delays due to surface winds. The Tandem's unique configuration allows for all weather launch capabilities.

In the past the problem of high winds had been addressed by either always flying out of a hanger or by using a large number of ground personnel. The Tandem uses a bagged balloon launch. This technique has been used for decades by weather service personnel and researchers to launch balloon in windy conditions. The balloon is placed inside a large cloth bag secured flat to the ground. The balloon is filled inside the bag. To launch, a Velcro strip is rapidly pulled across the top of the bag. This opens the top of the bag, releasing the balloon. The Tandem's configuration of a balloon on each end allows the bagged balloon launch method to be used.







During preparation and balloon fill, the Tandem will lie flat on the ground. The balloon cradles will be tipped outward and downward. Each balloon will be mounted to the vehicle and then placed inside a fill bag. The balloons are filled while firmly secured to the ground inside the bag. To launch, one person at each bag pulls a large Velcro strip across the top of the bags. We've successfully tested this technique in twenty knot winds.

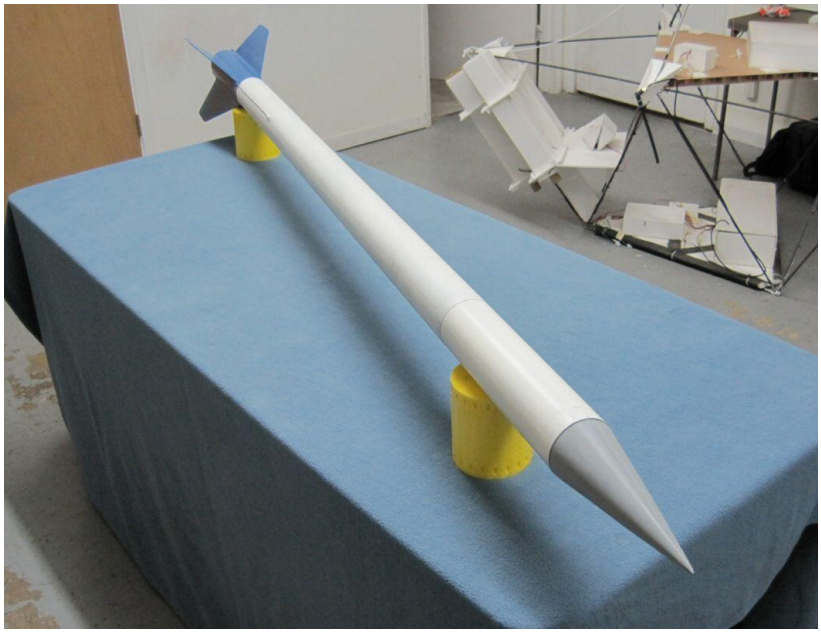
Three-quarter scale Tandem test article launch test.

The Tandem airship for this program will be 20% larger than the existing Tandem. This larger airship is expected to fly in the fall of 2011.

The PongSat Launcher Rocket

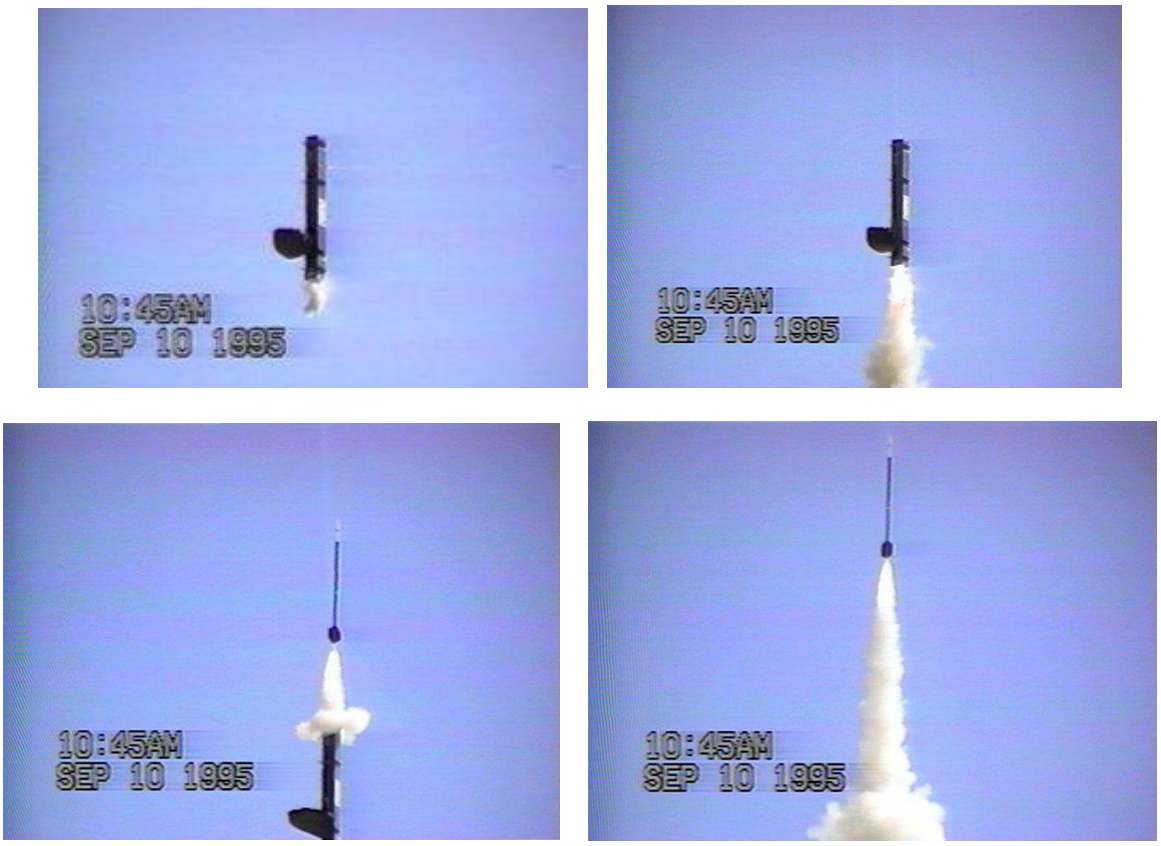
The rocket is 89 inches long and three inches in diameter. It utilizes a phenolic airframe with a Kevlar nosecone. It is powered by a commercial, off-the-shelf, reloadable solid rocket motor. The rocket can use motors from 6,800 to 8,000 newton/sec of total impulse.

This rocket was specifically designed for high altitude launch. This rocket design has flown five times. We have one rocket in stock. We have a production capacity to produce one vehicle a week although the rocket is fully reusable.



Rocket is carried aloft inside a foam and paper launch box. The box is protected from the rocket exhaust by layers of aluminum foil. This box provides both insulation to protect the rocket from the low temperatures found in near space and to act as a launch rail in the first moments of launch.

Rocket launch boxes for balloon launch.



Rocket launching from the launch box while suspended by balloon. Note: The balloons are located off camera 180 meters above the launch box.

Carbon Reel

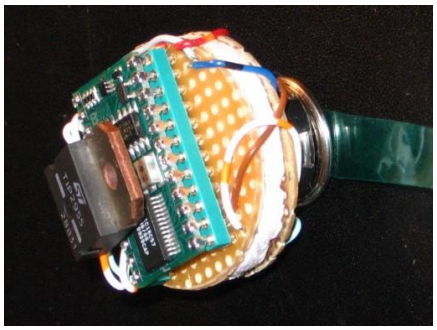
The carbon fiber reel mechanism lowers the rocket launch box from its stowed position on the Tandem to its launch location 180 meters below the vehicle.

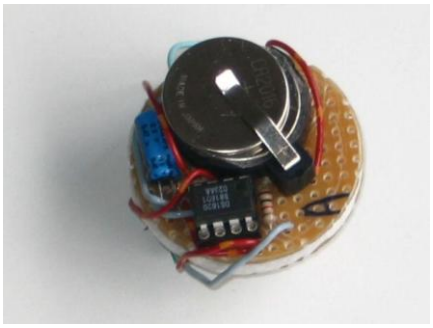
JP Aerospace has in-house carbon fiber manufacturing capability. Propellers, tubing, reels, rocket airframes and other composite components are made in-house.

Payload

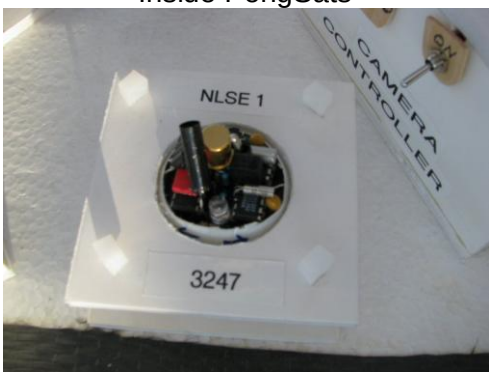
This system will be used to fly PongSat class payloads. A PongSat is an experiment that fits inside of a ping pong ball. Experimenters cut a ping pong ball in half, place their experiment inside, tape it back together and mail it to us.

We are always surprised by the amazing variety and sophistication of the experiments that can take advantage of such a small space. The experiments range from plant seeds to complete upper atmosphere labs with over a dozen sensors and a data logger. PongSats have been used for both basic science inspiration and literacy and for university class research.





Inside PongSats



We had a first grade class participate in the program. They each flew a PongSat with a gummy bear candy inside. The school was just an hour away from the JP Aerospace office, so after the flight I returned the PongSats to the class personally and gave a talk to the students. During the talk, one of the students asked why his gummy bear was rough; it wasn't rough before. I then proceeded to have a sophisticated discussion about material outgassing with a class of six-year-olds. I know many engineers that don't have the gut level understanding of this phenomena that these children now had.

Standardizing the payload has a powerful impact on a flight program. This is seen in the Cubesat satellite standard. Standardization allows for a greater number of payloads to be flown by dramatically simplifying the integration process.

The One Minute Program Interface

The single most important key to the success of the PongSat program has been the simple integration to the user. In these times of budget cuts and strictly controlled test-focused curriculum, most educators do not have the ability to participate in any external science programs. In order to make their participation possible the paperwork and time needed to be involved in the program must be kept to an absolute minimum. The entire process to become involved in PongSats and have payloads approved for flight takes less than one minute.

The user fills out the form found on the PongSat webpage. They state their contact information, how many PongSats they wish to fly and when they would like to fly. They email the page to JP Aerospace and that's it. We assign ID numbers (thousands of ping pong ball all start to look alike after a while), manifest them on a flight and send the information back to the user.

Two weeks before the flight, the user mails the PongSats to JP Aerospace along with a list of the contents of each PongSats. The list is reviewed and the PongSats are placed in the payload container. After the flight the PongSats are sent back to the user along with a data sheet of the flight details, a photoset from the flight and a DVD of video from the mission.

The significance is huge. No payload is turned down due to lack of space. Every researcher, student or educator who wants to fly a payload can do so.

The following is from the PongSat Teacher Guide, by JP Aerospace:

PongSat Requirements

No insects or other animals.
Anything that sticks out of a PongSat must be preapproved.
No volatile chemicals.
No combustion
No heavier than 3 oz
Any device the emits a radio signal must be preapproved.
Any liquids must be carefully contained.

Experiments Ideas

What can you do inside something as small ping pong ball? Plenty!!
Here are just a few ideas:

Plant seeds: Compare the growth of plants grown from seeds flown at the edge of space with those left behind.

Would a bubble wrap bubble pop? Is the drop in pressure enough to do the job?

Small electronics

Film cosmic ray experiment. Undeveloped camera film will often contain white streaks when developed after be exposed to cosmic rays at high altitude.

Two PongSats, one beeps and the other listens. Sound can be used to determine altitude.

Put in a mini-marshmallow; after the flight, see that it expanded and freeze dried.

Get two matching inexpensive digital clocks (the type found in $2 to $6 dollar watches). Put one watch in the PongSat. Use the other as a control.
After the flight, compare the time on clocks. See if the cold temperature affected the clock.

Stamp computer controlled wind flow measurement.

Paper that changes color with temperature.

PongCam

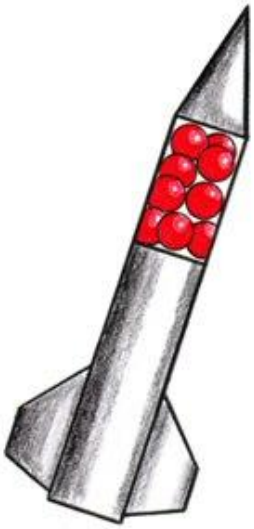
Solar power battery charging. Charge a small battery with a small solar panel.
Is an MP3 strip affected by the cosmic ray strikes at 100,000 feet?

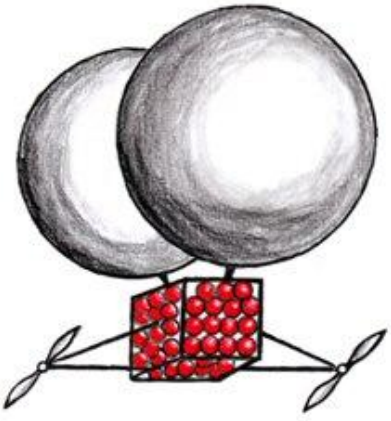
Temperature and pressure measurement.

Before and after bounce test of the ping pong itself.

One Flight, Two Sets of Payloads

20 PongSats to 100km





500 PongSats to 30km

This launch system provides two groups of payloads on each flight. Twenty payloads will be carried on the rocket to 100 km; 500 additional payloads are carried on board the airship to 30km.

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Standard Service

The PongSats program provides flight only. No power or other support is provided to the PongSat in flight. The standard services includes:

- Flight Operation
- Return of the PongSat to the user
- Flight Data Pack that includes:
  - Flight information, (how high, how cold and complete flight data logs)
  - Flight Report
  - Flight Photo Set
  - DVD with on board flight video.
  - Certificate of Participation

There is no change for any PongSats. The one exception is PongSat payloads flown for resale. Those are charged at a flat rate of $500 for PongSats flown to 30km and $3,000 for PongSats flown to 100km.

There is no selection process for payloads in the PongSat program. We fly all payloads that meet the safety requirement in the order that the users send in their request.

Non-Standard Service

Approximately two hundred of the 3475 PongSats flown have been non-standard. They typically fall into two categories; they need to be turned on prior to flight or some part of the payload extends beyond the ping pong ball.

Non-standard PongSats have included:

- Solar panels requiring exposure to sunlight
- Requiring power on checklists
- PongSats that require external mounting

Users must notify JP Aerospace when their PongSats are manifested on a flight if any are non-standard. This usually results in two to three e-mails to finalize the need and how it will be met.

History of PongSat

The first flight of the PongSat payload program was flown on March 9th, 2002. Over the next nine years we flew 3475 PongSat payloads. These have involved over 10,000 experimenters.

Preparing PongSats for return to users.

The thousandth PongSat

These experiments have ranged from marshmallows that expand in vacuum to complex sensor/datalogging systems.

History of JP Aerospace

JP Aerospace was founded in 1977. We have conducted 110 flight tests. These include high altitude balloons and platforms, airships and sounding rockets.

Example JP Aerospace Projects with unique payloads:

Cubesat Deployment Test

JP Aerospace conducted a small satellite sounding rocket ejection test for an SBIR grant funded by AFRL Edward propulsion directorate. In this project a Cubesat provided by Stanford University was carried aloft by the upper stage our twenty-foot MicroSat Launcher Rocket launched from the ground. The Cubesat was ejected at apogee and descended by parachute. This purpose of the project was to test Cubesat deployment from a sounding rocket in real world conditions.

This flight was conducted from the West Texas Space Port in Fort Stockton, Texas.

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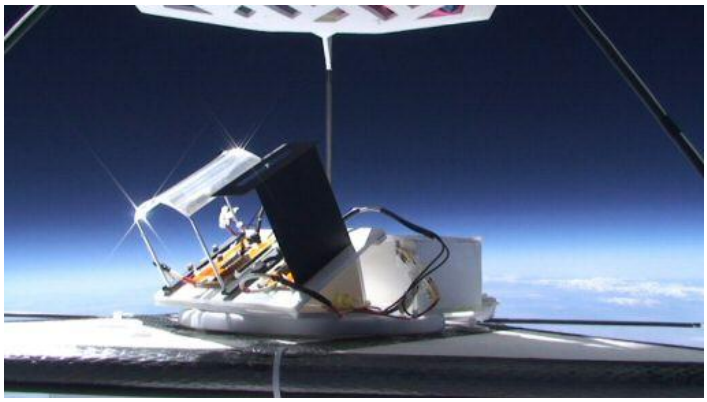
Discovery Channel Solar Power Experiments



JP Aerospace was contracted to conduct a series of photovoltaic experiments at 30km for the Discovery Channel. The project consisted of two balloon flights. Each flight carried a sun scanning platform with two separate photovoltaic experiments. In addition to the experiments each flight carried HD cameras. The result were made into a Discovery Channel episode.

The Toshiba Chair Commercial

In September 2009 JP Aerospace flew four unique payloads for the Toshiba Corporation. Four full-sized chair mock-ups were carried to 30km suspended beneath a film studio balloon platform . This was to film a Toshiba television commercial that appeared across Europe and Japan. This series of flights was an experience builder in both flying a unique payload and in managing a diverse group of directors, film crews and constantly changing requirements.

Note: This mission also carried PongSats.

Education

This program aims to change the nature of space education payloads. Currently a student or researcher flying an experiment is a rarity. Our goal is make flying a payload a part of every students learning experience.

In the middle of the last century dissecting a frog in biology class was the common experience for high school students in the entire country. It would be a sea change in space education if every high school student in the country made and flew a PongSat.

This means millions of payloads. We have already started down this path. This program will expand the number of total payloads and begin sending a significant number of payloads to 100km. We see this program going from most payloads going to near space and a handful to 100km, to most payloads going to orbit and a handful going to the moon and beyond.

PongSat at the Science Fair

This program creates a low to no cost hands-on flight experience for students.

The program fits a wide swath of the education user community. Both university level engineering professors and Kindergarten teachers have found great benefits to their classroom through the existing version of this program. The proposed expansion of the program from flight the current 30km to 100km will give greater opportunities for researchers and greater inspiration to student participants. Future engineers can begin running their own space programs in Kindergarten.

School Class with their PongSats

San Antonio College PongSats

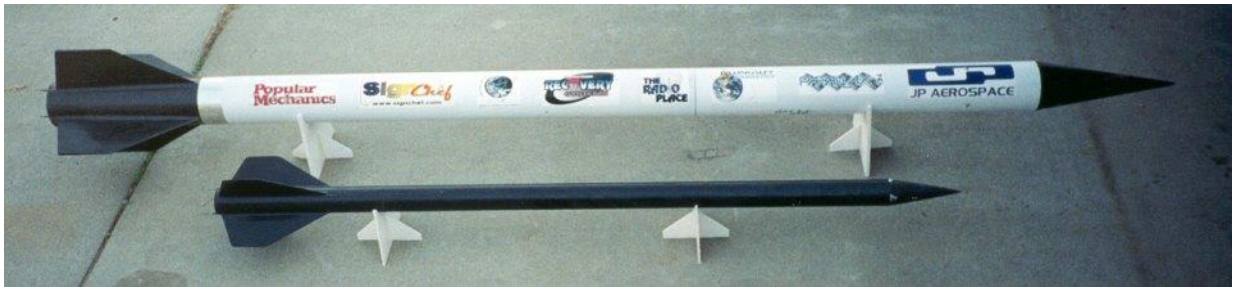
Summary

- ✓ **Small Sounding Rocket Launched from Airship**
- ✓ **Existing Rocket**
- ✓ **Existing Airship**
- ✓ **PongSat Class Payloads**
- ✓ **Payloads to 30 and 100km on Each launch**

Current Status of the System

The rocket is undergoing an instrumentation upgrade to include wireless payload support. A fourteen-foot long version of the Tandem airship has been flown to 12km. A thirty-five foot long Tandem airship has been completed and is scheduled to fly to 30km in the summer of 2011 (Note: it will be carrying 100 PongSats).

After building up a base of experience with suborbital flight we intend to expand the system into a small orbital launch system. This will require a larger Tandem airship and a six-inch diameter, twenty-foot long two stage rocket. We have built and conducted four test flights of this latter vehicle (including one flight for the AFRL Edwards Propulsion Directorate).



Upper stage of orbital rocket above, PongSats Launcher rocket below.

The first person to walk on Mars will have flown a PongSat. Join us on our journey to space.

Appendix: PongSat Senator letter
Midland College letter
Spaceflight Rocket Sideview drawing
AIAA PongSat Flyer

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California State Senate

SENATOR
BOB MARGETT
TWENTY-NINTH SENATORIAL DISTRICT

COMMITTEES:

NATURAL RESOURCES & WATER
VICE CHAIR

BUDGET SUBCOMMITTEE ON EDUCATION

PUBLIC SAFETY

GOVERNMENTAL ORGANIZATION

TRANSPORTATION & HOUSING

August 10, 2005

Mr. John Powell
JP Aerospace
2530 Mercantile Drive, Suite I
Rancho Cordova, CA 95742

Dear Mr. Powell:

Thank you for meeting with my office on August 8, 2005. Since our first meeting over three years ago, the educational programs provided by your business have been of great interest to me.

When we first met, you explained a student payload program experiment that your company was working on named PongSat. I was particularly intrigued by this program and how your aerospace company branched out to California students by sharing its scientific and engineering expertise. Since then, your company has conducted over 12 PongSat flights and given thousands of students an education initiative that has brought excitement and hands-on experience to the classroom.

PongSat has shown that the space industry in California can play an important role in motivating students in science, math and engineering. I hope other companies and organizations in the space industry will support this program in the future.

I look forward to continuing to work with JP Aerospace and the PongSat program to further enhance education for the students of California. You have my ongoing support and best wishes for this program.

With Kind Regards,

Bob Margett

BOB MARGETT
State Senator, 29th District

Midland College

Regional Technical Training Center

Mr. John Powell, July 22, 2004

I whish to complement you on your PongSat program, this has proven to be an outstanding and inexpensive way to educate our K-12 students. We have had great responses from all of our participating schools across the state of Texas, and are currently signing schools up for this year's PongSat launches.

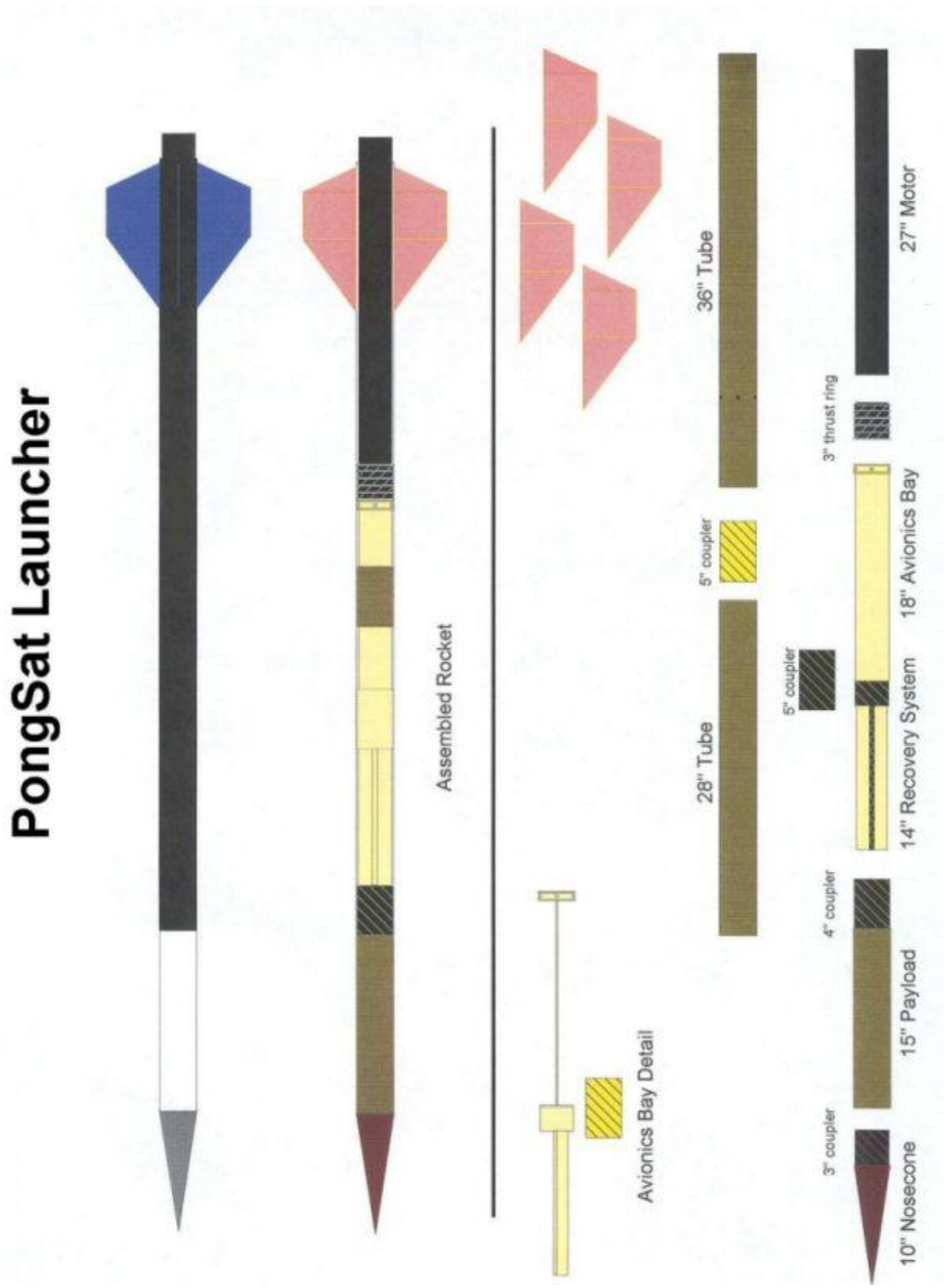
In the past two years we have seen this program grow from 700 PongSats to over 3,000; this program has grown from the West Texas region to schools across the state. While increasing the level of interest in Science in all of our participating students, one of these students took his PongSat experiment all the way to the State Science Fair. Furthermore, we have developed other programs based off the PongSats. We now have high schools that not only send their own PongSat experiments up, but also go to their local elementary schools to assist in creating experiments designed for lower levels of science. We have created the Texas CanSat program, based off the Stanford University ARLISS, in which high school students that participate in the PongSat program can also build satellites that fit inside soda cans, which are then flown in rockets to ten thousand feet, and returned to them for a final analysis.

We have seen a growth in the interest of science and engineering, and we must accredit some of this to you and your PongSat program. I have enjoyed working with you in this adventure, and hope to continue on with our partnership and growth.

Sincerely,

Amber K McNew
Aero-Science Coordinator

1201 W. IH-10 Ft. Stockton, Texas 79735 Phone: 915-336-7882 Fax: 915-336-7745


PongSat Launcher
Assembled Rocket
Avionics Bay Detail
36" Tube
5" coupler
28" Tube
5" coupler
3" thrust ring
27" Motor
18" Avionics Bay
14" Recovery System
4" coupler
15" Payload
3" coupler
10" Nosecone

2011 PongSat Event with AIAA

ATTENTION 7TH AND 8TH GRADE SCIENCE CLASSES IN THE SACRAMENTO AREA

Don't pass up this exciting launch!

Send your class in space and win a field trip to the Aerospace Museum of California. This year the Sacramento Chapter of AIAA is going to sponsor field trip, transportation included, to the Aerospace Museum of California at McClellan Park. If you have not participated in a PongSat launch, you are missing a wonderful educational, free activity.

Hurry . . . the launch is in March 2011 and prep is needed!

This contest is open to all Sacramento area public, private, and charter middle schools, and middle school science or math academies or clubs. To enter your class or club in the competition, simply fill out the form on the next page, then get your ping pong balls and start brainstorming with your class about the cargo they will put inside of their PongSat. In the Sacramento area, Linda Swan will pick up and deliver your class's PongSats to JP Aerospace before the launch. **Note: PONG BALLS are due March 2011 although PROJECT is not due till April 11, 2011.**

Check out the links below for more information.

AEROSPACE MUSEUM OF CALIFORNIA

The Museum boasts "the finest collection of aircraft and aviation memorabilia in the west". It has a strong education program that is based on providing hands-on, practical state-of-the-art experiences related to math and science. The Aerospace Learning Center within the museum gives students an appreciation for how math and science can be used in aviation. The students fly a no-motion flight simulator as part of the Learning Center experience. Please visit http://www.aerospacemuseumofcalifornia.org for more information.

A PongSat is an experiment that fits inside of a ping pong ball. These ping pong ball 'satellites' are flown to the edge of space by balloon or launched in sounding rockets. The PongSats are then returned to the student. The experience is a unique, creative, and exciting way to interest students in science and math. Visit http://www.jpaerospace.com/pongsat/index.htm to learn more.

JP Aerospace 2530 Mercantile Dr. Suite I, Rancho Cordova, CA 95742 916-858-0185
www.jpaerospace.com jpowell@jpaerospace.com

PongSat Middle School Competition Guidelines and Entry Form

Sponsored by the American Institute of Aeronautics and Astronautics. AIAA offers and sponsors a wealth of resources to support educators at both the university level and K-12: publications & online tools, classroom grants, our Educator Associate Program, informative aerospace links. The list goes on and on. Membership is entirely FREE to educators!!

Guidelines: This contest is for 7th and 8th grade classes in the Sacramento Area. Teachers will provide each student with a ping pong ball. The teacher will need to cut each ball in half. Each student will determine an experiment or item to be placed inside their ball, which is then taped back together. The PongSats will be sent to JP Aerospace for the launch in March 2011.

The class will prepare a Summary Project consisting of:

1. An electronic presentation such as a power point, summarizing the PongSat experience **and**

2. A class book which consists of the original or a copy of each student's Scientific Process Worksheet which is teacher provided. This two-part "Summary Project" will become a contest entry and will be presented to Sacramento AIAA council members and Pong Sat entrepreneur John Powell for judging. All entries become the property of AIAA.

Contest entries will be due no later than April 11, 2011. Deliver to the Aerospace Museum, 3200 Freedom Park Dr., McClellan, CA 95652-2432 OR Linda Swan 9271 Linda Rio Drive, Sacramento, CA 95826.

Winner(s) will be judged on creativity of the electronic presentation and thoroughness of Scientific Process worksheets. PowerPoints will be limited to 15 slides and Class Books limited to one page per student. Neatness and originality may become deciding factors.

Winners will be notified by April 18, 2011. Winning classes will receive a field trip to the Aerospace Museum of California. Transportation and admission are included in this prize. Field trips can be scheduled any time after winners are announced. All teachers are encouraged to become members of AIAA (membership is FREE to educators), thus enhancing our local membership while providing valuable educational AIAA resources to these new members!

For questions or more information, PLEASE contact Linda Swan at lswan@att.net.

The following pre-entry form is due as soon as you decide to enter. PongSat spaces on the January launch are limited to 300 ping pong balls. Reserve your spot TODAY by mailing to above Contest entry locations or emailing to lswan@att.net.

Date: _____

Teacher's name:_____ Teacher's email:_____

Teacher's AIAA # _____ **Go to http://AIAA.org to join. It's FREE to Educators.**

School: _____
District:_____

School address:
_____

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www.jpaerospace.com jpowell@jpaerospace.com

School phone: _____ Teacher's phone:_____

Name of class, club, or group_____ # of students participating _____

Pong Sat ID #s _____ (These will be assigned by JPAerospace)