ARLISS M S4 PocketQube Deployer

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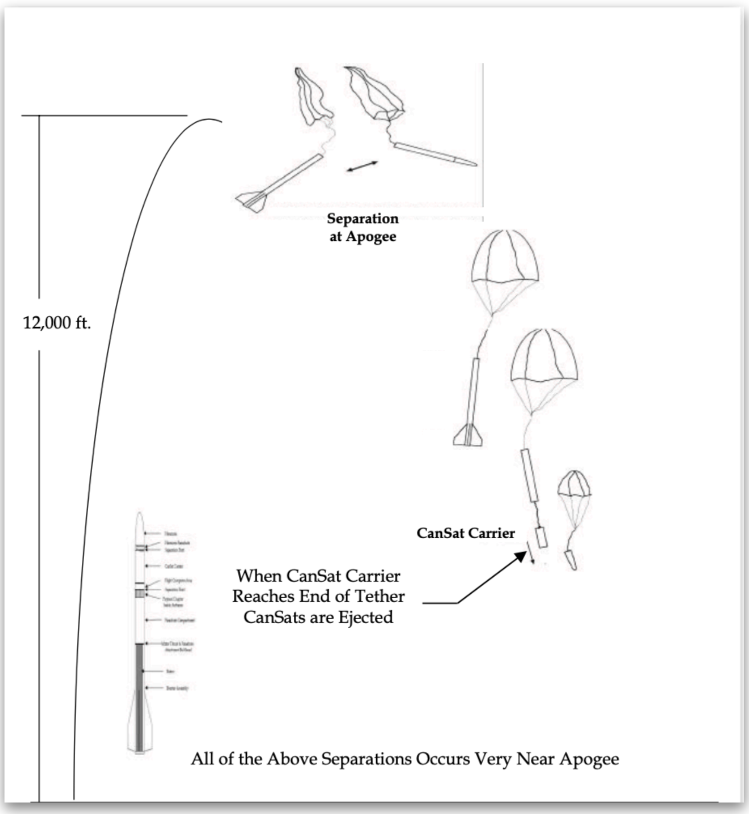
ARLISS[1,2] - A Rocket Launch for International Student Satellites - is a 20 year old STEM program begun by Professor Bob Twiggs and the AeroPac[3] rocketry education organization. It began looking at a unique partnership of highly experienced amateur rocketeers flying reliable, reusable sounding rockets, carrying sophisticated student robotic satellite payloads on a number of missions. ARLISS's first satellites were size of soft drink cans, and became the first instance of we know today as CanSats.

Today ARLISS remains a major STEM competition event in September of each year in the Black Rock Desert of northwestern Nevada but CanSats have spread to many events throughout the world. Launchers at ARLISS put student satellites up to ~10,000' and deploy student satellites to perform a STEM mission in a hostile environment and challenge them to find their own autonomous way home. Two classes of high power launchers - the 75mm ARLISS K on 54mm K motors and the 150mm ARLISS M on 98mm M motors - fly these missions at major rocket launches.



ARLISS has evolved over its 20 year history to support a wide range of missions and launchers.

The most common ARLISS missions today - use larger CubeSat sized satellites that typically deployed to fly an autonomous mission to return to their launch site - by crawling, flying or whatever method the mission designer chooses. Recent designs incorporate AI deep learning tools to improve mission accuracy all the while retaining basic mechanical robustness necessary for a successful mission.

In 2014, a new form of ARLISS satellite and mission was also invented by Professor Twiggs - PocketQubes - 5 cm cubic satellites, 1/8th the volume of a typical 10cm CubeSat - that can fit in your pocket. These pico satellites, enabled by Moore's Law, have now reached LEO, but are of a size, cost and capability that allow them not only to do their own missions, but to totally replace the legacy soda can format and challenge the CubeSat sized sats. The author's S4 project[4]- Small Satellites for Secondary Students - has created an Arduino based platform of software, 3D printed packaging, wireless telemetry and sensors to

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[1] https://www.dropbox.com/s/9cqc000bp0jwlfp/Sport%20Rocketry%20ARLISS%201.2014.pdf?dl=0

[2] https://www.dropbox.com/s/0ghdfftph07d6di/ARLISS%20Podcast%20TRS_90B.mp3?dl=0

[3] www.arliss.org

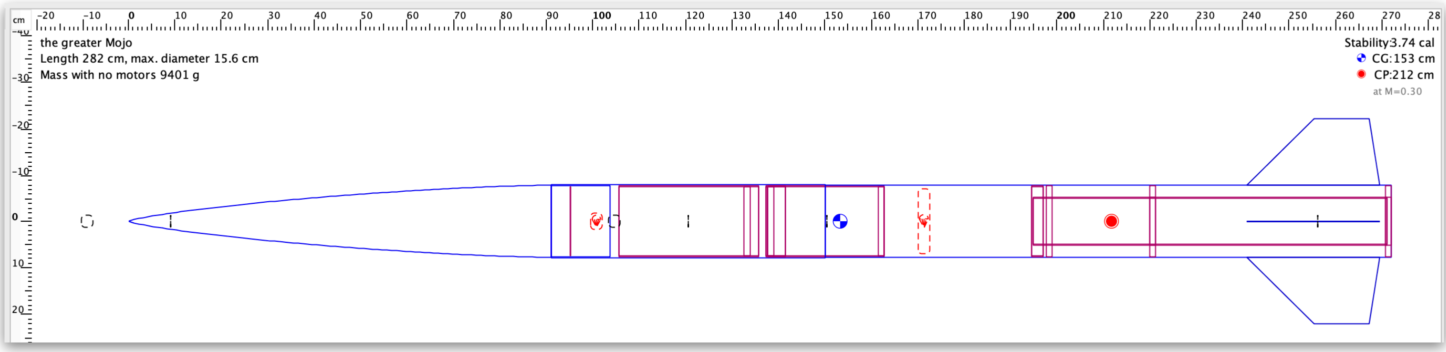
[4] https://www.dropbox.com/s/4i4729zyfppuny6/PocketQubes%20are%20the%20New%20CanSats.pdf?dl=0

construct STEM missions in this new, smaller pico satellite size. A 5x5x5cm basic S4 PocketQube quantum is called the 1P size, and a 5x5x10cm package is a 2P and so on.

For student STEM missions, a new family of small launchers, ARLISS Lite[5], allow flying missions with these new small payloads not just a major rocket launches on high power rocket motors, but also on 24mm E motors at local parks or 29mm or 38mm motors at larger venues. This widens the scope and accessibility of these STEM adventures to more students, in more places at lower cost.

But that does not mean that the classic ARLISS missions are obsolete - rather more missions can be flown with greater sophistication in more places and lower cost. S4 PocketQubes naturally fit the legacy 75mm deployment carriers for ARLISS K - tripling the capacity by allowing 3-4x the sats per flight as before, using the same carrier in the same airframe.

ARLISS M is the workhorse launcher for ARLISS today. It is typically a six inch airframe launched on an M1419 to ~10,000'. Satellite deployment is just after apogee and the satellite finds it own independent way as the airframe is recovered separately. An ARLISS M has a 6"x11" payload bay for deployable missions but typically has a large nosecone that is usually empty … space that could be used for payloads not independently deployed but recovered with the airframe.



A modular deployer, that fits both the existing payload carrier, as well as the nosecone, could carry potentially many S4 PocketQubes - some to be deployed from the carrier and some to recovered with the nosecone as captive payloads. 3D printing lets us be creative with the design.

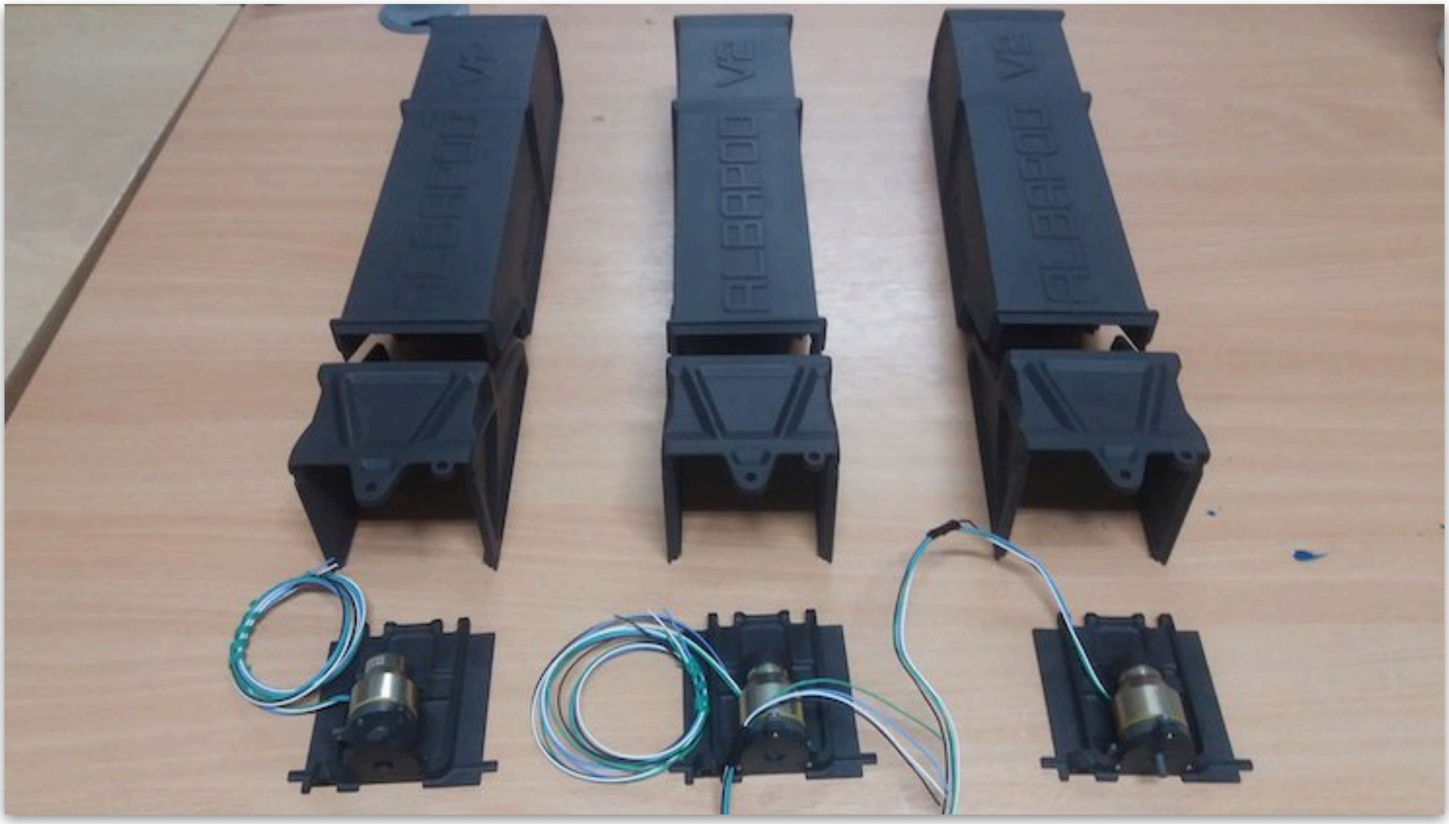
As we shall see, this enables an ARLISS to carry up to 28 S4 1P pico satellites, less if deployed and volume is needed for recovery gear, but a huge increase in mission capacity. We can now think about not just an independent one satellite mission, but experiments with swarms of pico satellites, in local radio communication, using a distributed portfolio of redundant sensors to execute a sophisticated mission.

CubeSat and PocketQube deployers for orbit are typically rectangular tubes, loaded with a sequence of cube shaped pico satellites, spring loaded with a door, that when opened - lets the spring push the satellites out from the deployer. A classic CubeSat deployer.

And these have now been size reduced for PocketQubes - as illustrated here by Alba Orbital's[6] 3D printed PocketQube deployers.

[5] https://www.dropbox.com/s/j09eha9id0ugav9/ARLISS%20Lite.pdf?dl=0

[6] https://www.tctmagazine.com/3d-printing-news/crp-technology-3d-print-pocketqube-satellite-deployer/



The S4 ARLISS M Deployer emulates that same behavior, but since we have more room, and the pyro deployment event itself gives the energy to push the picosatellites from the deployer, the design can be both simplified and expanded.   And is well suited to implementation via 3D printing.

Expanded, since rather than one single string of satellites, we can fit parallel strings of satellites in a 6” airframe - in fact, four parallel strings in a six inch diameter airframe enabling deployer volume for up to 28P of S4 pico satellites.

Simplified, since a mechanical door and spring are not longer necessary since we can use the energy from the deployment event to release the S4 pico satellites in the same way that current payloads are deployed.

It is made up of three components, each 3D printable in a modest hobbyist printer. I choose to use a translucent PETG for this version.

- A base unit of 8P capacity.   This can be used for the nosecone as well - adding 8P of captive carry capacity.
- A middle unit of 8P capacity that stacks on the base unit.
- A top unit of 4P capacity that stacks on either the base or middle unit.

From these three components we can construct payload deployers for as little of four S4 sats up to 20 or more.   They can be any combination of 1P, 2P or 3P S4 sats.

Illustrated to the right is a 20P capacity deployer (in captive carry configuration), that fits into a standard ARLISS M payload carrier as an insert.   Capacity is reduced when in deployed carry mode - allowing room for each sats recovery method.

Since it fits into a standard fiberglass coupler, the base unit can also fit inside the nosecone coupler adding another 8P of captive carry S4 payload capacity.