PDR Project Luftballons

By Space Force
Team Overview

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Project Overview

○ Provide the same facilities as a ground based launch system.
○ Reach 30,000ft before rocket ignition
○ Safely Launch either an L1 rocket or Project z
○ Safely descend and be recovered
○ Be reusable

Additional Goals:

○ Prove the viability of a high altitude launch system
○ Provide a scalable model for future platforms
○ Make a platform for high altitude experimentation for both RIT Launch and Spex
Structure Overview
Proposed Design

This prototype platform will be centered around a launch silo suspended between four scientific weather balloons. By keeping the center of mass below the balloons, the platform will remain upright throughout the ascent.

Using Aluminum stock for construction, our estimates for the total weight, including the rocket and avionics is 36 lbs.
The Silo

The silo will be 1 ft diameter by 10 ft long, and constructed out of 1/8th inch aluminum sheet metal and launch rails. The launch rails allow for easy assembly/disassembly of the arms and also allows for a wide variety of rockets to launch from the silo.
Balloons

Four scientific weather balloons will provide the lifting force to the platform. These balloons will be clamped shut until launch, after which the onboard avionics will open them in conjunction with the drogue chute. For cost effectiveness they will be filled with hydrogen. 4 x 350 gram Diameter Latex weather balloons will be used. They will be attached via milled aluminum inserts, and gas will be controlled by solenoid gas valves. This will allow us to make adjustments in flight, and release gas after launch.
Recovery
Recovery Overview

The platform will begin its descent after launch with the release of the lifting gas and the deployment of a streamer by the Eggtimer Quantum. At 750 feet above ground, the main 20 in. diameter chute will deploy.
Streamer

For initial descent, a streamer will be used. This will ensure the platform will be able to safely deploy it’s main parachute, but will still fall quickly for the majority of its descent. This method will reduce drift during descent.
Active Propulsion System

In order to reduce drift, provide fine control and stabilize the platform during launch, we will integrate a set of rotors into the support arms. This system will allow us to keep the vehicle within the bounds of the launch site.
Simulations
Balloon Burst

balloon burst calculator
About | Help

Payload Mass (g)
4000

Balloon Mass (g)
Raymond - 350

Target Burst Altitude (m)
10000

Target Ascent rate (m/s)

Result
- Burst Altitude: 10000 m
- Ascent Rate: 8.51 m/s
- Time to Burst: 20 min
- Neck Lift: 9907 g
- Volume: 9198 L
- 9.20 m$^3$
- 324.6 ft$^3$

Constants (Advanced)

- Gas
  - Hydrogen
- Air Density (kg/m$^3$)
  - 1.2050
- Gas Density (kg/m$^3$)
  - 0.0999
- Air Density Model
  - 7238.3
- Burst Diameter (m)
  - 7.88
- Balloon Cd
  - 0.3
Predicted Path (unpowered)
Avionics
Primary Avionics

- Iridium Sat communication module
  - Signal anywhere in the world
  - Will allow ground control over gas system, motors and launch
Sensors

For sensory equipment, we will need:

- 4 pressure sensors for the balloon
- Temperature sensors for the avionics package
- Backup altimeter, and accelerometer for recovery systems (most likely an Eggtimer Quantum)
Flight Computer

- A custom PCB will be designed to handle the operation of the motors, gas outlets, heaters, and launch system.
- This system will be controlled primarily from the ground via satcom module.
- This board will also be responsible for the launch signal for the rocket.
Payload Enclosure

- An insulated box will be used to protect the avionics from the low temperature of high altitude.
- Will provide protection to avionics upon touchdown.
Payload Battery

- 2 batteries for redundancy
- Long battery life
- Will be responsible for powering the avionics, motors, heaters, and solenoid valves
Payload Heating

- Active heating will help protect sensitive electronics
Video Live Feed Option 1

Live-Feed camera and supporting electronics (no antenna)

- Raspberry Pi Zero
- CSI Camera
- Store local, send out over 5.8GHz
- Not pictured:
  - 1W Transmitter
  - Cloverleaf Antenna
- Max Range: 9 Miles
  - Assuming 16-turn Helix at ground
Video Live Feed Option

- If possible, we would like to get a live feed of the launch using a GoPro HeroCast or similar device.
- This will not only give us more data to assess the flight, but also would help us exhibit the project.
Rocket Overview
Rocket Payload

The goal as of now is to demonstrate the platform’s capability by launching Space Force’s Project Z or a variant of that rocket. This rocket is already designed to achieve 30,000 feet from ground based launches. In the instance that this rocket is unavailable, a simpler or pre-existing design may be used.
Primary Tracking

The Project Z rocket will have a Big Red Bee GPS, which will allow us to track the rocket. This is an independent system than the balloon platform and its satcom system.
360 Degree Camera

The Project Z rocket has a built-in camera bay that will enable the rocket to carry a 360 degree camera. This will allow the rocket to take video and photos at high altitude.
Hydrogen Gas Handling
Gas Regulator

We would like to reuse the gas regulators from the hybrid rocket engine project. These would be used to control the flow of the hydrogen gas prior to launch. This is necessary as we will need to know how much gas we are filling the balloons with.
Hydrogen Gas Calculations

Volume needed:

\[(\text{Total weight/lift}) \times 12^3 = 1,512,000 \text{ in}^3 (875 \text{ ft}^3)\]

<table>
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<tr>
<th>Weight of Balloons (lb)</th>
<th>Density of Aluminum (lb/in^3)</th>
<th>Total Volume (in^3)</th>
<th>Weight of Rocket (lb)</th>
<th>Lift of Hydrogen (lb/ft^3)</th>
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Filling Manifold Design

Since the filling manifold does not need to handle high pressure, we will make a simple “bubbler” system to prevent blowback into the tank. This system will evenly direct the flow of gas into all four balloons simultaneously. Further control over the filling process will be handled by the inline solenoid valve. The manifold will be disconnected before launch.
## Budget

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These values do not account for any sponsorships, or team discounts that may be available upon approval.
Development Timeline

Design and fabrication: Winter-Early Spring 2019

Initial Tests and Adjustments: Spring 2019

Test Launch of L1 at Potter: Late April-Early May

Launch at Spaceport America: June 2019