Team H.E.L.I.O.S.

Helium Exhaust Liberating Inflation Optimization System

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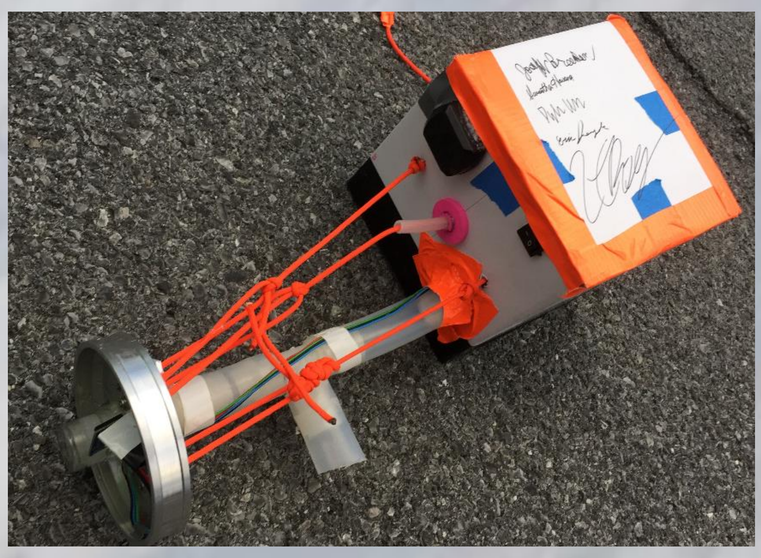
Abstract

The goal of HELIOS was to prove the feasibility of a valve system to vent helium from a weather balloon mid-flight. It consisted of a custom valve and sensors for judging the success of the valve, as well as for collecting other useful data. The mission's primary accomplishment was a successful flight and retrieval that demonstrated functionality without damage to the balloon or other payloads.



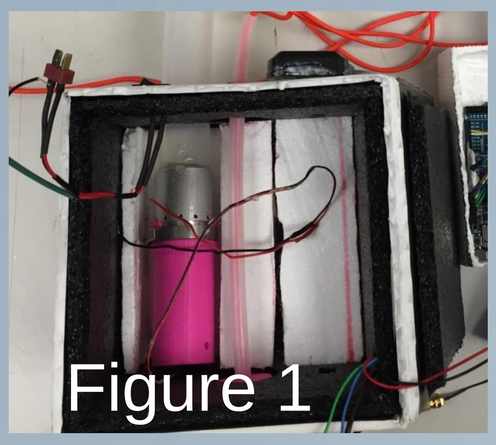


Figure 1

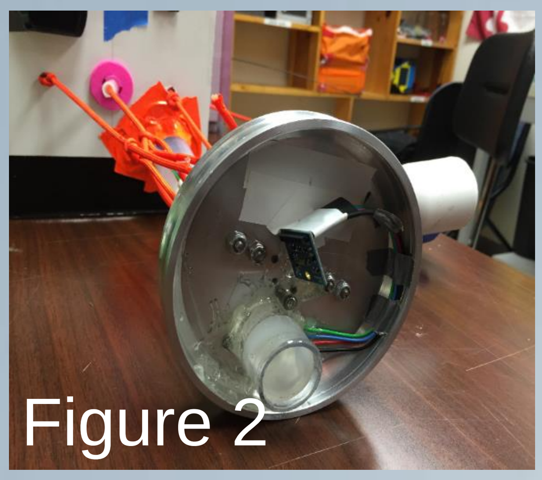


Figure 2

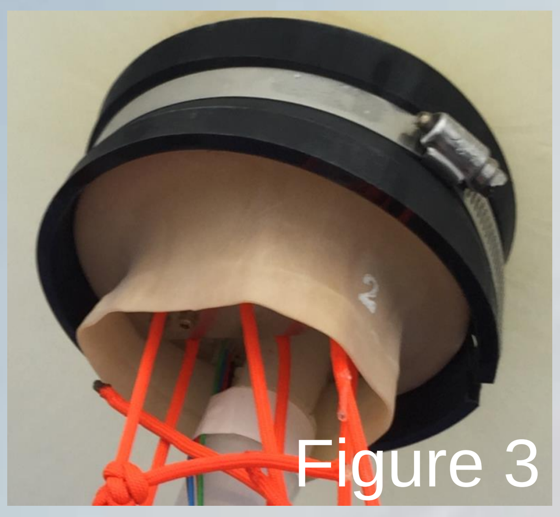


Figure 3

Methodology

HELIOS was designed, constructed, and tested over the course of 9 weeks in preparation for launch on November 14, 2015. The payload housing was constructed of a 7.0" insulated cube (Fig. 1). The box housed all sensors and the custom-made valve (Fig. 4) controlled by an H-bridge and programmed via Arduino to open for one minute at 60,000 ft. HELIOS interfaced with the balloon via a custom plug (Fig. 2) within the balloon neck connected via tubing to the box and secured by a Ninjaflex 3D-printed sleeve and a hose clamp (Fig. 3).

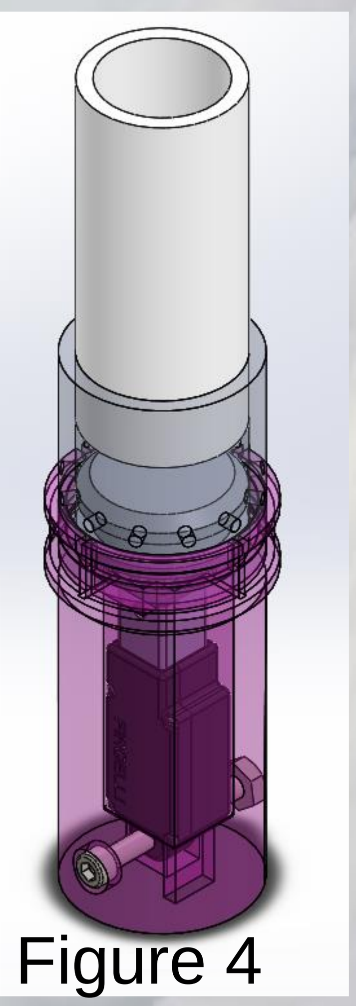


Figure 4

Components above made by William Gilbert, Steven Lentine, and Camden Miller

One of the easiest retrievals in Maryland Nearspace Program history (HELIOS in the center)

The successful liftoff of HELIOS

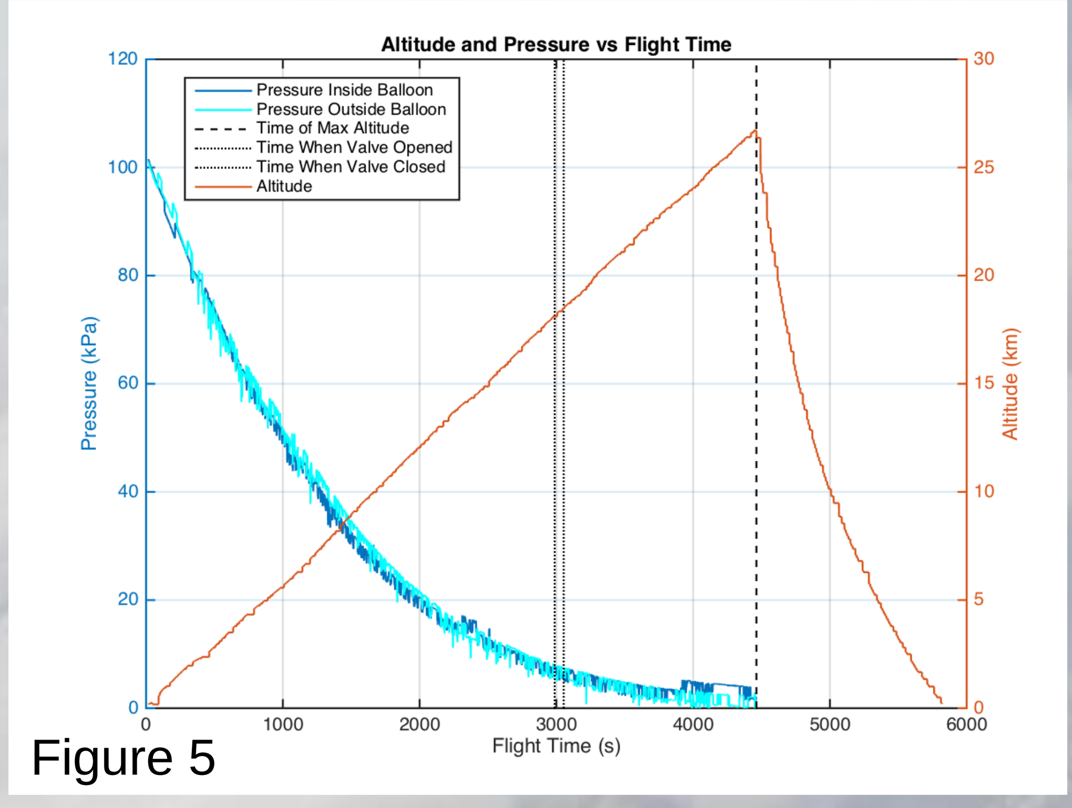


Figure 5

Data – Figure 5

This is a complete graph of pressure and altitude versus time. The pressure generally follows an exponential curve, but is very noisy, while altitude increases linearly.

A change in internal pressure was expected to accompany the valve opening, but rather internal pressure consistently matched external pressure.

Data – Figure 6

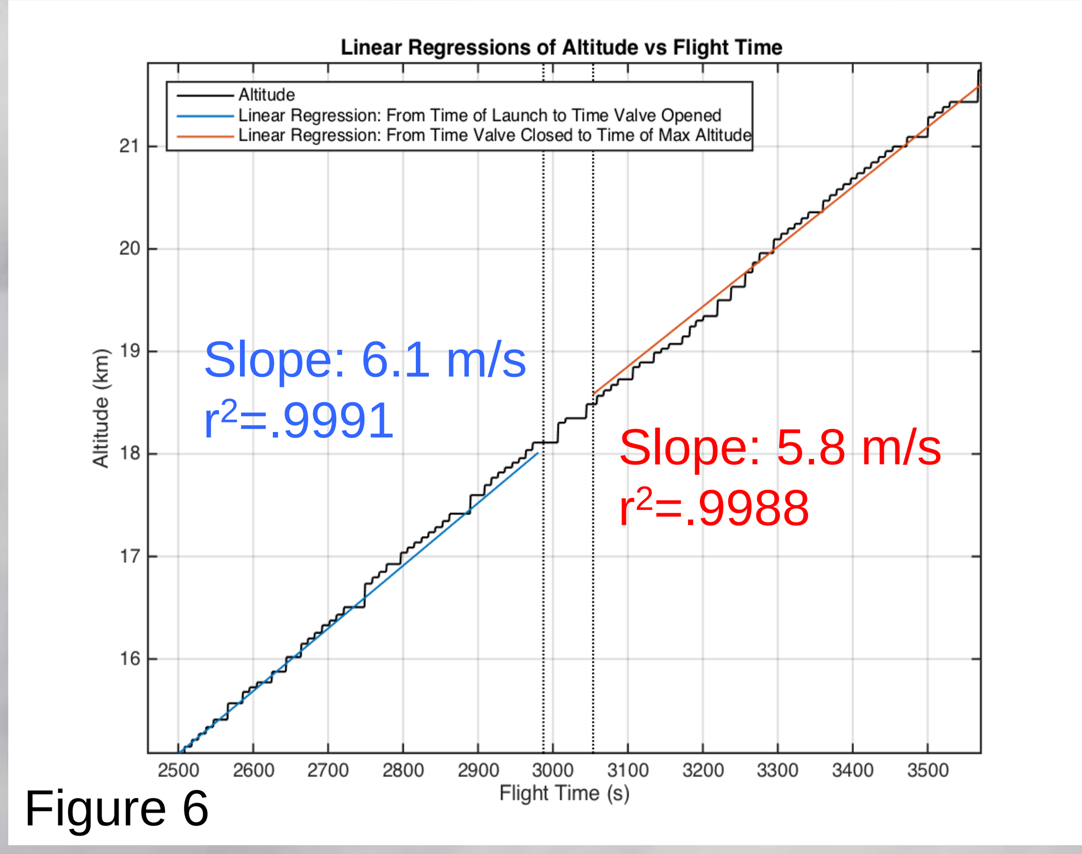


Figure 6

This is a zoomed-in view of altitude versus time near the valve open period. While not visibly obvious, the best fit lines do show a 4.9% decrease in the rate of ascent, highly suggesting the proper functionality of the valve mid-flight. Other measurements also indicate some change occurring during the open period, but cannot specifically confirm the desired outcome.

Implications

HELIOS is the first UMD payload to fly within the neck of a balloon, and the first to take internal pressure readings. By venting helium to slow balloon expansion, it will be used to delay bursting and set altitude and distance records in future launches.

Conclusion

Testing and sensors would suggest the proper performance of the valve in flight. That said, there was certainly error and unexplained anomalies, so the data cannot absolutely confirm or deny that the valve actually vented. This is partly a result of the choice to conservatively limit release time to reduce the likelihood of over-venting or drifting. Regardless, the presence of HELIOS in the balloon neck did not impair the balloon's function, as initially feared, so this is a viable altitude control system for future launches.

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Background image taken by Bach's Box Payload