PSP High Altitude

System Requirements Review and Conceptual Design Review

December 2022

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1 Introduction

1.1 Purdue Space Program High Altitude

High Altitude (HA) is a project team within Purdue Space Program (PSP) that was formed in May 2021. High Altitude's objective is to fly a two stage, student developed rocket to the Kármán Line: 100 kilometers above mean sea level. The team was formed with the experience and leadership from the now-defunct PSP Solids team, which competed annually in the Spaceport America Cup. Over the course of the past year, High Altitude has continued to develop skills across the team in design iterations and flights as the team continues to move into more detailed work on the spaceshot rocket.

Since its formation, High Altitude has been involved in rapid iteration and prototyping of many smaller-scale rockets. Last year, the team conducted three launches that began developing experience for our team. This started with an initial L2 kit rocket, the Wildman Darkstar Extreme, and its launch in September 2021. The team's next launch was in December; it was fully designed and constructed by our team and made primarily out of carbon fiber. The third and most recent launch was a reflight of the Darkstar. After these launches, the team began work on the spaceshot project; this Design Review will conclude the first phase of that work.

1.2 Budget

The High Altitude team receives funding each semester from Purdue organizations including Purdue Engineering Student Council (PESC) and the Purdue Engineering President's Council (PEPC). These merit funds total up to $6,000 per semester. The team launched a successful crowdfunding campaign in the Spring of 2022 to raise over $3,000 and also participates in fundraising events through Purdue Athletics. In addition, we have applied for scientific research grants through organizations such as NASA to support the project's development. These research grants are limited by the type of research being completed by HA as there is not an experimental payload included onboard the rockets.

These funds are reallocated each semester to each technical team based on the current projects of each team. Currently, HA has about $8,000 with an expected addition of $3,000 from the PESC Merit Fund before the end of the year. For the Spring 2023 semester, the Avionics team will receive $2,000 for the research and development of a flight computer as well as the purchase of a commercial avionics board to be tested on an L1 kit rocket. The Mechanisms team will receive $500 to construct and test the de-spin mechanism as well as the recovery system. The Propulsion team will be designing and building a test stand at Zucrow Laboratories to characterize solid rocket motors; the cost of this project is dependent upon the involvement of other research groups. Structures will continue to finalize the design for spaceshot; prototyping, manufacturing, and testing the airframe is estimated to cost between $4,000 - $10,000 which will be allocated incrementally during the next few semesters. Future budgeting will involve attempting to obtain funding from companies, institutions, and foundations.

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To satisfy our stakeholder requirements (SR.5), the spaceshot vehicle will have a payload, which will not be essential to the successful flight of the vehicle. The payload will include a camera, but if there is more available mass and volume, we hope to include additional items. To support additional payload mass, as well as general overruns in component design, the vehicle is being sized with an apogee of 150km, well above our true target.

The camera system will, at a minimum, consist of a single camera looking radially out of the second stage. The detailed design of the camera bay is beyond the scope of this review, but we expect the hole cut in the rocket to remain uncovered, as opposed to being blocked by a transparent window. The specific model of camera to be used will be based primarily on reliability and flight heritage; based on a brief study of comparable-performance amateur rockets, GoPro cameras seem to be the leading candidate.

If the payload subsystem is allocated more mass and volume than a single camera requires, we plan to add additional components to the payload. Ideas under consideration include

- A camera inside the recovery bay, watching the deployment of the parachute
- A thermal camera inside the nosecone, to characterize the thermal loading
- A collection of COTS avionics boards, so we can later publish their performance on such an extreme flight
- A biological experiment, as minimal as a Petri dish, to explore the effects of a zero-g environment

The specific components of the payload subsystem will be determined by PDR, once the actual mass and volume constraints are solidified.

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