A SECOND GENERATION SUBORBITAL RESEARCH PLATFORM FOR LARGE SCALE MICROGRAVITY FLIGHT EXPERIMENTS

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Rocketplane Global, Inc.(RGL) is continuing its preliminary engineering and development effort for its Mach 12 spaceplane design, based on a 20 year legacy of systems engineering for a variety of high Mach suborbital spaceplanes. The first stage reusable launch system is capable of delivering up to 2,000 kg to a 800 km polar orbit and can deliver over 2,500 kg to the ISS orbit. A key enabling technology for this system is the use of a KDC-10 tanker aircraft to transfer the majority of the propellant load to the spaceplane once the vehicle is in the air and flying at normal subsonic jet speed. The tanker carries the 64,000 kg of LOX plus the kerosene fuel. By taking off "light" with only a small fraction of the fuel and oxidizer required to pre-chill and condition the tanks and lines, and then transferring this propellant load in flight, the vehicle dry mass fraction challenges are greatly reduced. This in turn enables the disruptive reduction in launch price to less than $20 million for a 2 ton LEO satellite or deployment of multiple 150 kg microsats from a dispenser. The system is shown in Figure 1 below.

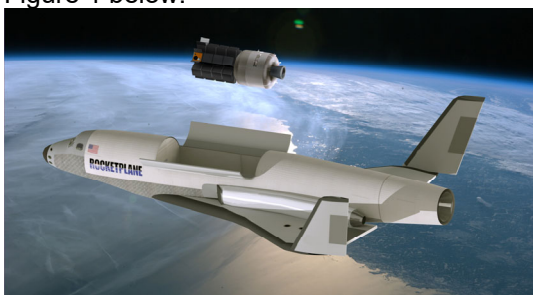

Fig. 1. Phoenix Spaceplane with upper stage stack.

While the first stage spaceplane is 100% reusable and designed for daily flight operations, the second stage needed to get payloads to orbit is expendable. Consequently, the internal payload bay of the Phoenix spaceplane is quite large at 3m diameter x 9m long – about the same size as a large business jet interior. This size is necessary because the upper stage takes up about 50% of the total payload bay volume, and the dispenser required to carry multiple 15kg class microsats requires the 3m diameter configuration.

The key enabler for low cost orbital launch is getting as much of the energy to orbit as possible provided by the reusable first stage. The Phoenix launch system stages at Mach 12 (half orbital velocity) and about 150km altitude. Therefore, the Phoenix spaceplane has the ability to greatly expand the microgravity operating environment with this high Mach flight profile and more than double the duration of high quality microgravity flight time. Preliminary estimates are between 6 and 7 minutes of 10^{-3} or better microgravity.

The large payload bay will be configured with a reusable pressurized payload bay laboratory module which would be equipped with standard ISS rack systems and experiment hardware. Researchers will be able to fly tended experiments inside the research module, since the spaceplane is piloted and therefore human rated from the beginning. The total volume of the lab module will approach the size of the ISS Columbus module and be available for daily flight operations should customer demand support this. Because of the large volume and payload mass capabilities of the system and 100% reusability, ROM pricing for a 6+ minute high quality human tended microgravity could be as low as $200/kg for large volume customers, with service beginning in 2024 o4 2025. The biggest question at this point is whether the microgravity research market will grow large enough to be able to support high throughput systems such as the proposed Phoenix microgravity research lab, or become part of a coupled research / tourism business model using a common pressurized payload bay module and jointly supported suborbital flight operations.