High Altitude Shuttle System (HASS): Low-Vibration Microgravity Environment

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Abstract
The microgravity aspect of the space environment remains a difficult environment to properly simulate outside of the International Space Station (ISS). Various options exist, which trade cost and capability. NSC's High Altitude Shuttle System (HASS), when coupled with work to incorporate autopilot modifications which allow optimized parabolic trajectory generation, results in a unique capability that is offered through NASA's Flight Opportunities Program (FOP).

Unique Capabilities
HASS is a glider which starts its flights in the upper stratosphere after being lofted by a balloon. The stable air of the upper stratospheric region, where HASS can operate, coupled with the low vibration nature of an (engineless) gliding airframe allows HASS to provide a microgravity environment with lower-g (RMS) vibration than other aircraft-based options such as NASA's heritage "Vomit Comet" or current commercially-available options.
The small size of the HASS platform means that experiments can be run for relatively low cost when compared with full-airframe costs of manned aircraft or long-duration experiments on the ISS.
Payloads which are sensitive to high G loading can also be accommodated, differentiating from rocket or accelerated-launch freefall methods.
Finally, the precision inherent in a semi-autonomous flight under an autopilot tuned to the specific HASS airframe offers precision in maintenance of the microgravity environment which is not matched by manually-flown aircraft.

Applications
The HASS-based microgravity environment can be used to support a wide variety of commercial and scientific applications, based upon its physical and operational characteristics:

- Payload volume: 41,492 cm^3
- Payload mass: 10kg
- Total flight (descent) time: 45 minutes
- Microgravity periods: 11-12
- Period duration: 10-20 seconds
- Total microgravity time: 137 seconds

Operational Accomplishments To-Date
The HASS platform has completed numerous successfully flights to-date, including returns from 72,000' and 92,000' under the NASA FOP program as a Suborbital Reusable Launch Vehicle (SRLV) Surrogate. These flights have not, due to their SRLV surrogate requirement, included parabolas to generate a microgravity environment. They have however confirmed the HASS platform's continued readiness to operate in the upper-stratospheric environment where the microgravity experiment mission would be executed.

Conclusions
HASS is a multi-purpose high-altitude capable gliding platform which has been adapted via autopilot modifications and optimization-supported dynamic modeling to support experimenters requiring a high-quality (low vibration) microgravity environment while limiting cost and maximizing capability/duration of on-condition periods. It stands ready for NASA FOP and other programs requiring such capabilities.

Figure 1: HASS airframe in ascent under balloon