(527 m) and velocities (25+ m/s) than were achievable with prior NASA VTB tests, including Morpheus. The flight campaigns will expand the NDL's current flight test envelope, plus test the performance of a new navigation filter that blends NDL and LVS TRN measurements. The open-loop flights will characterize COBALT navigation filter performance and verify system components and interfaces in a passive manner without risk to the Xodiac vehicle, which will utilize GPS for navigation. The closed-loop flights will make COBALT active within the Xodiac GN&C subsystem, and the vehicle will perform guidance and control planning and maneuvers based on the precise COBALT navigation knowledge. Xodiac GPS will provide a backup/monitor during the flights to minimize risk to the commercial VTB, and it will also be used for auto-landing the vehicle below the final 20 meters of descent.

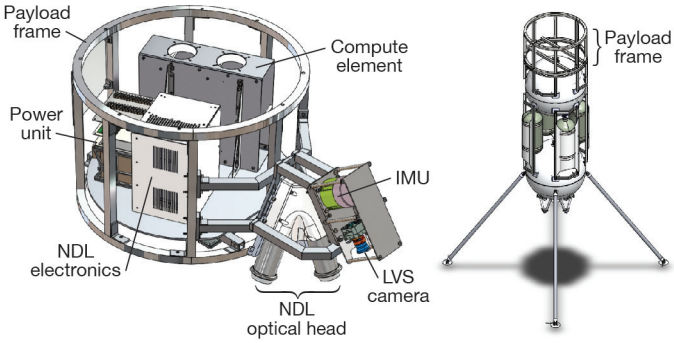
Innovation and Infusion

The COBALT project will mature precision-landing GN&C technologies for infusion into near-term robotic science and future human exploration missions. The NDL is a prime candidate sensor for Mars, moon or other planetary missions because of the high resolution velocity and range measurements. One of the key deliverables of the COBALT project is to mature NDL technology in preparation for the development of a space-qualified unit. In addition to the hardware, the COBALT navigation algorithms for blending and flight testing LVS TRN and NDL together provide a compelling new solution for future precise landing missions.

Navigation Doppler Lidar (NDL)

The third-generation NDL provides both velocity and range measurements. The sensor hardware consists of a custom optical head and electronics box. The electronics includes a seed laser, fiber amplifier, synthesizer, wide-band receiver and a NASA-developed command and data handling (C&DH) board. The NDL is designed for a velocity envelope of 200 m/s per telescope line-of-site (LOS), and an LOS range of 4+ km. The NDL will achieve TRL6 in 2019 and could be infused on-board a robotic moon or Mars lander mission in the 2020s.

Navigation Doppler lidar.



COBALT hardware (left) and Xodiac vehicle.

Lander Vision System (LVS)

The JPL-developed LVS provides an estimate of global position relative to a reconnaissance map. Its TRN function uses a passive-optical camera to take images during descent and compare them to reconnaissance maps (that are stored onboard) to determine landmark matches and to estimate the spacecraft position relative to the map. LVS has already been baselined for flight infusion onboard the Mars 2020 mission.

Partnerships and Collaborations

COBALT is a collaboration between multiple NASA centers: Johnson Space Center (JSC), JPL and LaRC. JSC provides project management, technical planning and operations support. JPL provides systems engineering, navigation filter, development, integration and testing of the COBALT payload and LVS. LaRC provides development, integration and testing of the NDL. The COBALT project derives funding from multiple NASA directorates: HEOMD-AES, STMD-GCD and STMD-FO. The LVS technology was developed with funding from SMD and STMD. The Flight Opportunities program provides access to space-relevant environments through the use of commercial suborbital space vehicles to test technologies. Masten Space Systems is one of the program's vendors.

The Game Changing Development (GCD) Program investigates ideas and approaches that could solve significant technological problems and revolutionize future space endeavors. GCD projects develop technologies through component and subsystem testing on Earth to prepare them for future use in space. GCD is part of NASA's Space Technology Mission Directorate.

For more information about GCD, please visit http://gameon.nasa.gov/

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