Development of a New Testing Capability for Future Mars Technologies. I. G. Clark[1], [1]Jet Propsulsion Laboratory, California Institute of Technology, 4800 Oak Grove Dr. M/S 321, Pasadena, CA 91109, ian.g.clark@jpl.nasa.gov.

Introduction: NASA, through the Space Technology Program, has begun the Low-Density Supersonic Decelerator project (LDSD) to mature the next generation of decelerator technologies. These include several types of supersonic inflatable aerodynamic decelerators (SIADs) and a new type of supersonic parachute. To mature these technologies several new test capabilities are being developed. Chief among these is the reemergence and expansion of a test infrastructure last tried 40 years ago, a balloon dropped powered flight test vehicle.

Supersonic Flight Dynamics Test (SFDT): Flexible aerodynamic decelerators typically do not scale well due in part to increased rigidity as they decrease in size. Thus, qualification in the past has generally required testing at full-scale and in aerodynamically relevant conditions. To perform this qualification on a variety of decelerators, the LDSD project investigated a number of possible solutions. These included a number of suborbital sounding rockets (could not achieve appropriate test article size), modified ballistic missiles (limited in size and cost prohibitive), and orbital launch vehicles (cost prohibitive). The final test approach selected was a technique last used to qualify the supersonic parachutes for the Viking Mars landers. This technique consists of suspending a ~3600 kg full-scale test vehicle, similar in shape to a Mars entry vehicle and 4.7m in diameter, beneath a large high-altitude balloon. The balloon lofts the test vehicle to an altitude of ~35 km before the test vehilce is released. Upon release, a series of small solid motors are used to spin the vehicle up and a large, Star 48B rocket motor is ignited to accelerate the test vehicle to an altitude of ~50km and a velocity of Mach 4+ (Figure 1). This velocity and altitude are specifically targeted to achieve similarity with conditions typical of supersonic flight at Mars.

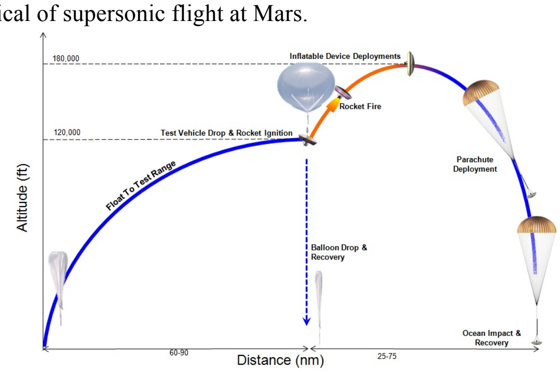

Figure 1. Basic concept of the Supersonic Flight Dynamics Test architecture.

Figure 2. SFDT Test Vehicle.

Additional Test Architecture Applications: Though designed to test and qualify a variety of SIADs and parachutes, the SFDT architecture developed by the LDSD project has a number of potential applications for testing other technologies relevant to future Mars missions.

Supersonic Retropulsion (SRP). Though small scale wind tunnel testing has been conducted on a variety of potential SRP configurations, this testing has been limited to models 12.7 cm in diameter or less and using air as a simulated rocket exhaust product. Furthermore, these tests have focused on the aerodynamic aspects of SRP. To mature SRP as a viable technology, a large scale flight test of SRP is necessary. The test conditions achieved by SFDT are very similar to those expected for SRP and the size, shape, and payload capability of the test vehicle would allow for a variety of SRP systems to be evaluated. Testing at theses scales would address a number of vital SRP issues including the effect of engine start-up transients on vehicle dynamics, the effect of real combustion products on the flowfield, and the controllability of a vehicle utilizing SRP.

Mars Ascent Vehicles (MAVs). A difficult though necessary component for a future Mars Sample Return mission is the Mars Ascent Vehicle used to carry a sample from the surface to orbit. Though Earth's gravity is nearly 3x that of Mars', a properly scaled test may still be possible. The SFDT test architecture would be capable of lofting a full size MAV to altitudes simulating the atmospheric conditions near the surface of Mars for testing of either a first-stage of complete MAV. Additionally, testing of upperstages could be possible by staging them off of the LDSD test vehicle.

Rigid Deployable Decelerators. LDSD is maturing a number of flexible aerodynamic decelerators, but rigid deployable decelerators have a number of similar applications as well as applications well beyond Mars. In as much as these deveices are envisioned to be used with blunt bodies, relatively minor modifications to the test vehicle could be made to allow for their testing and qualification.