MARS DARTDROP: ASSESSING CONTEMPORARY HABITABILITY AT RECURRING SLOPE LINEAE WITH A SIMPLE IN SITU MISSION.

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Introduction: Recurring slope lineae (RSL) are dark, narrow features on Mars that incrementally lengthen during warm seasons, fade away in cold seasons, and recur each year. While RSL have been widely considered to be seasonal liquid water at (or just below) the surface of Mars, other theory and evidence suggest they could be debris flows. Understanding the true nature of these features is pivotal to questions of the contemporary habitability of Mars and its impact on future robotic and human exploration, including planetary protection. We have devised DartDrop, whose principal scientific objective is to determine the habitability of martian RSL by measuring in situ the volume of liquid water and its thermodynamic activity.

Background: RSL are highly spatially heterogeneous: they occur at specific sites with dimensions of a few km or less and even within the best sites they cover only ~50% of the surface [e.g., 1–4]. Thus the principal mission challenges are both accurate targeting to an RSL site and sampling of an RSL per se. DartDrop addresses these challenges by (1) guided parawing flight to an RSL site and (2) release of multiple small penetrators: 6 darts yield a 98% probability of landing on at least one RSL. The highly periodic behavior of RSL—including visible darkening for more than half a Mars year at many sites—ensures that only spatial and not temporal targeting is critical.

Architecture: The entry and descent follows the MarsDrop architecture [5]. Deep Space 2 heritage entry vehicles achieve subsonic deceleration at 5-10 km altitude. The parawing can be autonomously navigated to the nearest RSL site up to 10s of km distant. The descent vehicle releases 6 Darts (17x4 cm) at ~100 m altitude. Drogue chutes provide aerodynamic stability and orbital imaging targets.

Conops: Measurements begin immediately after landing and continue at timed intervals for a 6-hr threshold, 30-hr baseline, or 42-hr extended mission. Data are independently uplinked at UHF to an orbiter. The Darts use Phoenix-heritage sensors to measure subsurface and air temperature (T), atmospheric relative humidity (RH), and subsurface electrical conductivity (EC). The volume of water and its solute concentration can be assessed jointly from T and EC: assessment of habitability (but not life detection) can be made solely from these quantities. Category IVc planetary protection can be easily implemented on these small spacecraft.

References: [1] McEwen, A.S. et al. (2011) *Science 333*, 740. [2] Stillman, D.E. et al. (2016) *Icarus, 265*, 125. [3] Schmidt, F. et al. (2017). *Nat. Geosci., 10*, 270. [4] Dundas, C. et al. (2017). *Nat. Geosci., 10*, 903. [5] Eby, M. (2013) 2nd Interplanet. Cubesat Conf., https://icubesat.files.wordpress.com/2013/06/icubesat-org_2013-a-1-1-marsdrop_eby_201305271621.pdf.

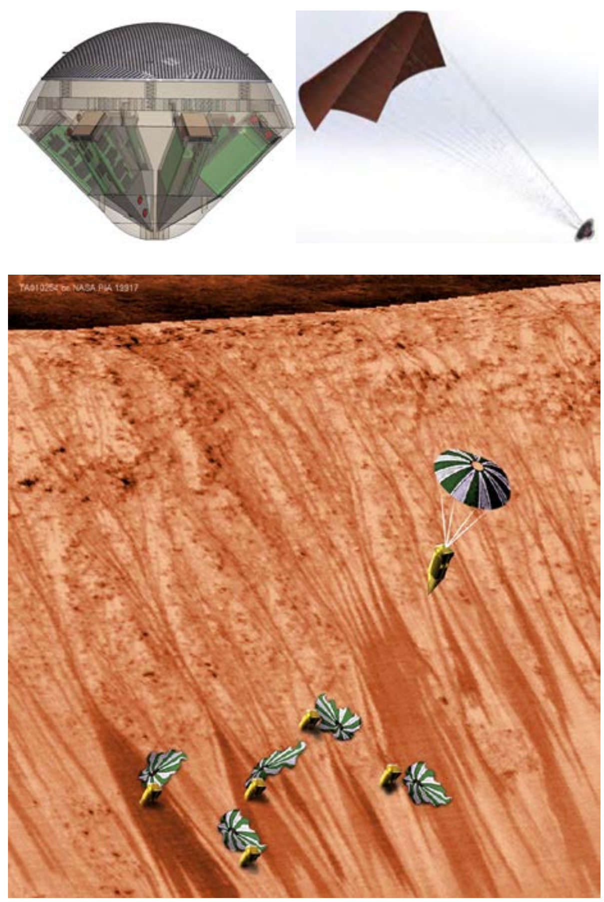

Fig. 1. DartDrop mission concept. *Top Left*: Deep Space 2 aeroshell containing parawing, descent avionics, and 6 darts. T*op Right*: Parawing desent and autonomous navigation to RSL site. *Bottom*: Artist's concept of Dart hit-and-miss among individual RSL (Dart size is exaggerated).