THERMAL VACUUM TESTING OF A LUNAR RATED SAMPLE DRILL. S. L. Schmidt[1] and D. Boucher1, [1]Deltion Innovations Ltd 26 Meehan St. Capreol, ON P0M 1H0 sschmidt@detlion.ca.

Introduction: Deltion Innovations has developed a low power, lunar rated sample drill system called VDCU. It is a TRL6 thermal vacuum rated drill. The system builds on the previously developed DESTIN drill. The focus of this development effort was mechanical adaptations of the cryocable DESTIN design so that it was also vacuum capable. VDCU utilizes the first lunar-rated Maxon Motors. These motors were developed in cooperation with Deltion Innovations specifically for this development effort. The motors are lightweight brushless DC units. Sensors utilized in the system are vacuum rated. Adaptations from the DESTIN drill design were made to improve sensor isolation and dust and noise immunity. Materials of construction were selected with consideration to embrittlement, coefficient of thermal expansion (CTE) issues and vacuum welding. Three different tools were developed for the system. The push tube is a 1m tool designed to penetrate and collect a sample in unconsolidated material. The 1m coring auger was developed for drilling and capturing sample in consolidated media. The push tube and coring auger maintain sample stratigraphy during formation and capture of a core. The 50cm auger tool propagates a hole and augers cuttings to surface in consolidated (or unconsolidated) media. The auger tool includes a bit temperature sensor for monitoring the temperature close to the communition point. The system is rugged and durable.

Extensive laboratory testing was conducted to assess the capabilities of the system. Drilling media included frozen CHENOBI lunar simulant with moisture concentrations ranging from 0-7.5% and ice. More than 26m were drilled with the VDCU system. The tools were utilized on another test bed for more than 12m of additional drilling. The VDCU system can drill in moisture bearing frozen CHENOBI lunar regolith. It operates under vacuum and temperatures as low as -150C. Coring operations resulted in a high degree of sample integrity. Coloured layers of simulant in a media bed were used to show that the coloured layers in the sample captured correlate with depth drilled. The bit temperature sensor was able to report the temperature of the media bed. Thermal tests were conducted on the system to ensure heater adequacy and functionality at -150C. Separate vacuum tests conducted showed the system to be functional at 10^{-2} Torr and verified aspects of the thermal model.

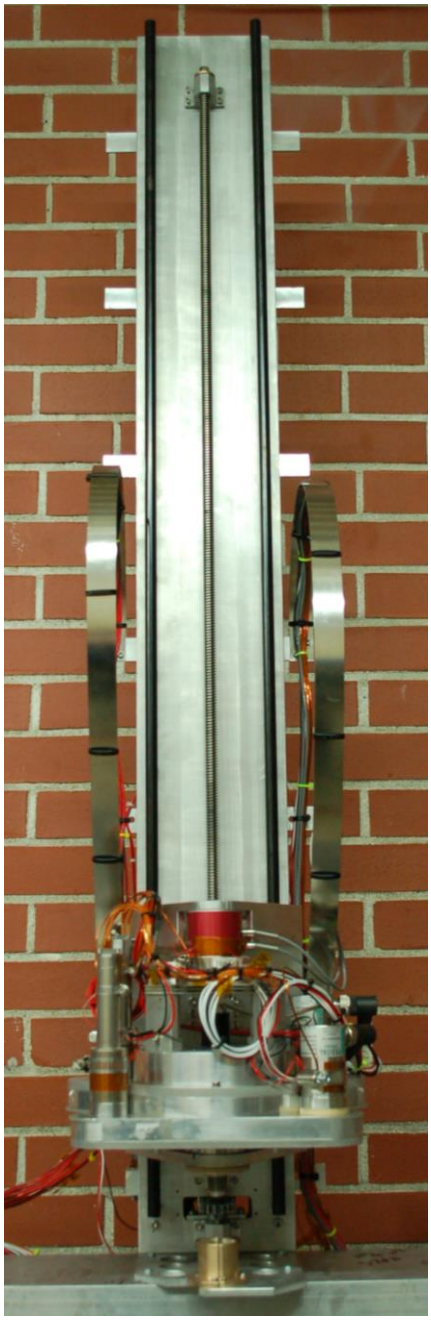

Figure 1: VDCU Unit in Deltion Lab

The unit was also tested in NASA Glen Research Center's VF13 dirty thermal vacuum chamber. Testing exposed the operating system to vacuum, a temperature of 100K and dust generated by drawing vacuum on the chamber with the CHENOBI media bed installed. With the auger tool installed, the VDCU successfully augered to depth in frozen 5% moisture CHENOBI

simulant. The coring auger tool drilled and collected sample in both 2% and 5% frozen moisture CHENOBI. Simple volatile capture devices were employed to qualitatively compare volatile loss with different tools. Results suggest that volatile retention is possible with a coring auger but not with an auger where cuttings are augered to surface. Average power consumption, including heaters in the thermal vacuum chamber, was less than 55Watts.

Figure 2: VDCU drill at NASA GRC VF13