

Exposing a COTS LiDAR Sensor to the Rigors of the Space Environment: Proof of Function and Thermal Balance Testing. W. E. King¹, E. G. Hayward¹, M. R. Zanetti¹, F. L. Wilson¹, ¹NASA Marshall Space Flight Center (MSFC), 4600 Rideout Road, Huntsville, AL 35812, United States. (Contact: walter.e.king@nasa.gov)

Introduction: LiDAR offers unique capabilities for exploration and operations in the lunar environment [1,2,3]. LiDAR enabled Terrain Relative Navigation (TRN) and GPS-denied mapping have the potential to enhance situational awareness and hazard identification, mission planning and LTV/EVA path planning, lunar construction, asset tracking, infrastructure projects, and science. Low-SWaP-C (Size, Weight, Power, and Cost) LiDAR units are becoming increasingly prevalent due to advances driven by the automotive industry. Sensors of this type are well suited for integration with Lunar Terrain Vehicles (LTVs), EVA suits, landers, or rovers. However, these sensors are not designed or qualified for use in space.

Objectives: This work aims to investigate the feasibility of adapting a low-cost COTS automotive LiDAR sensor for use in space applications. The objectives are to (1) confirm proof of function at vacuum and extreme temperatures, and (2) evaluate the thermal response of the sensor when subjected to relevant conditions.

Methods: A COTS scanning ToF (Time of Flight) LiDAR sensor was exposed to vacuum and temperature extremes within a thermal vacuum chamber.

Proof of Function. The sensor was exposed to rough vacuum for 5 days followed by hard vacuum for 3 days. The unit was subsequently powered on and the temperature of the unit modulated using a cold plate during operation.

Thermal Balance. The sensor was placed in vacuum and allowed to reach thermal quasi-equilibrium under a variety of conditions. A thermal shroud, xenon lamp, and cold plate were used to replicate relevant environments. A series of five calibrated reflective panels were installed in the chamber within view of the sensor. Data from the sensor was logged under a variety of conditions. Customized mounts and heat straps were designed and installed to promote heat transfer from the top of the sensor.

Results: Detailed results will be presented in an associated poster pending approval for public release.

Conclusion: The successful proof of function under space-relevant conditions indicates that space qualification of LiDAR units of this

architecture may be possible. Thermal balance characterizations performed will serve as a starting point to inform possible integration of such sensors into lunar surface systems. Future work should focus on understanding long-term reliability and sensor performance, as well as optimizing thermal management strategies for specific mission profiles. LiDAR as a tool to enhance autonomy, construction, and exploration on the Moon and other planetary bodies may be just on the horizon.

References: [1] Zanetti M. R. et al. (2022) LPSC LIII, Abstract #2660. [2] Miller K. A. et al. (2022) LPSC LIII, Abstract #2808 [3] King W. E. et al. (2023) IPCC IV, Abstract #1075.