

## ***Lunar Night Survivability of Cryocooled Instruments Using PALETTE Thermally-Switched Enclosures***

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The Planetary and Lunar Environment Thermal Toolbox Elements (PALETTE) project is developing four new thermal management techniques that will allow cryocooled and/or ambient temperature science payloads to survive multiple lunar day/night cycles. The targeted science payloads are those slated to fly on upcoming commercial lunar payload services (CLPS) landers, none of which will likely be able to survive the first lunar night. This paper will provide a status update on those four techniques, which include: (1) thermally-switched enclosures, featuring a nested pair of Vectran tension cable supported cube-shaped enclosures, which are thermally-switched using a reverse-operation DTE thermal switch (ROD-TSW) in series with a propylene miniature loop heat pipe (mini-LHP); (2) 3D-printable parabolic reflector radiators (PRRs), which can be very affordably produced and enable side-facing, low sink temperature radiators at low-latitude lunar sites; (3) spacerless MLI, which is a new concept with a tested  $e^*$  value  $< 0.002$  that hangs 8-10 layers of double aluminized Mylar from the Vectran tension cables between the enclosures; and (4) advanced thermal isolators using optimized Ti64 and polymeric designs. These techniques are already being used in the upcoming JPL Farside Seismic Suite (FSS), which will put two seismometers on the lunar farside in 2025. FSS, which has its own C&DH, batteries, radio, and solar panel, is expected to operate for at least four months on the lunar surface with communications provided by a relay satellite. One application for PALETTE technology described in the paper is a concept for using lunar night cryogenic temperatures and a thermal storage unit (TSU) to augment the cooling capacity of cryocooled science payloads. The paper will include the latest test data from the PALETTE project, which is a 3-year effort initiated in April 2020 and is funded by the NASA Space Technology Mission Directorate (STMD) Game Changing Development (GCD) program.