**A Combined Chemical-Electric Propulsion Architecture for Lunar and Planetary Exploration.** T. W. Glover, A. V. Ilin[1], R. Wilks[2], R. Vondra[3] [1]Ad Astra Rocket Company, 141 W. Bay Area Blvd., Webster, TX 77598 tim.glover@adastrarocket.com, andrew.ilin@adastrarocket.com [2] rodney.wilks@atk.com , [3] P. O. Box 596, Wrightwood, CA 92397 bob.vondra@gmail.com

**Abstract:** ATK and Ad Astra Rocket Company have examined the use of an advanced space propulsion system for use in lunar and planetary exploration missions. Ad Astra's Variable Specific Impulse Magnetoplasma Rocket (VASIMR®) plasma rocket technology, currently under development, when integrated into an Orbital Transfer Vehicle (OTV), offers the ability to transfer large payloads using much less propellant than chemical rockets and significantly reduced transit times for high Δv missions. The combined system results in a highly flexible architecture that can be scaled easily to meet a range of payload and program needs.

Low-power (less than 10 kW) electric propulsion has been successfully used to enhance chemical propulsion for lunar (SMART-1) and planetary (DAWN) exploration missions. Ad Astra Rocket Company is developing a 200 kW thruster that could provide significantly more performance than previous electric propulsion systems. This new capability could play a significant role in enhancing near-term lunar exploration capabilities and longer term planetary missions. The VASIMR® engine differs from ion engines and Hall thrusters in that it uses abundant (and hence inexpensive) argon as its propellant, and places no solid components in contact with energized plasma, thereby mitigating most erosion mechanisms. Under a NASA Space Act Agreement, Ad Astra is planning a space test of the VASIMR® engine on the International Space Station in 2013, to verify the engine's performance in the space environment.

Anticipating a wide range of lunar and planetary exploration programs undertaken by both NASA and international agencies, Ad Astra and ATK have examined the utility of a reusable OTV that can enable lower cost missions. By using argon, Ad Astra's VASIMR® engine reduces propellant costs for its electric propulsion by a factor of 100 relative to xenon-based thrusters. With continuous thrust from the VASIMR® engine during a cis-lunar or planetary transit, a continuous trade between payload mass and transit time is available to mission designers. The high specific impulse (greater than 500 seconds) employed on such trajectories dramatically reduces the vehicle mass fraction required for propellant. Not only will this enable larger payloads but, for sample return, this can significantly raise the return payload mass as well.