RESOLVE-A Payload to Groundtruth the Presence of Volatiles on the Moon. J.W.Quinn (NE-S, Kennedy Space Center, FL 32899, Jacqueline.W.Quinn@nasa.gov) , W.E. Larson (NE-I, Kennedy Space Center, FL 32899, William.Larson@nasa.gov) G. B. Sanders (JSC-EP111, Johnson Space Center, Houston, TX77058, Gerald.Sanders@nasa.gov), R. S. Baird (JSC-EP111, Johnson Space Center, Houston, TX 77058, R.S. Baird@nasa.gov), A. Colaprete (SST, Ames Research Center, Moffitt Field, CA 94035, Anthony.Colaprete-1@nasa.gov), Martin Picard (Candian Space Center, 6767, route de l'Aéroport, Saint-Hubert (Québec) J3Y 8Y9, Martin.Picard@asc-csa.gc.ca)

Introduction: Data from remote sensing missions to the Moon such as the Clementine (1994), Lunar Prospector(1998) and the Lunar Reconnisance Orbiter (2009) the later, indicated the presence of potentially significant quantities of hydrogen bearing molecules in permanently shadowed craters near the lunar poles. The LCROSS mission in 2009 provided our first look at the compounds found in the craters. These hydrogen bearing volatiles along with any other possibly co-located volatiles would be extremely useful resources whatever their form. The extraction and processing of space resources (whether from Lunar, near earth asteroid, comet, or Mars sources) into useful products is known as In-Situ Resource Utilization (ISRU) and can have a substantial impact on individual missions and mission architecture concepts. In particular, the ability to make propellants, life support consumables, and fuel cell reagents can significantly 1) reduce mission cost by reducing launch mass, providing affordable pre-positioning of consumables, and enabling hardware reusability; 2) reduce risk by providing backup life support consumables and reduced dependence on Earth; and 3) enable extended surface operations by providing an energy rich environment and affordable access to multiple surface targets.

Knowing that useful resources, such as hydrogen and water ice, are available on the lunar surface and other locations around the solar system is important; however, questions remain to be answered before ISRU development of these resources is practical. What are the constituents and distribution of the hydrogen rich volatiles located by the previous probes/missions? What other volatiles are also available? What are the environments and physical properties of the source materials that could drive ISRU extraction and processing hardware design?

In cooperation with the Canadian Space Agency, NASA has undertaken the development of the payload Regolith and Environment Science & Oxygen and Lunar Volatiles Extraction (RESOLVE) which will be designed to answer these questions as the next logical step toward human exploration and expansion out into the solar system.

Science Goal: The overall long-term objectives of the RESOLVE Project are to verify the presence of water ice and other volatiles on the lunar surface, determine resource distribution and extraction characteristics, and serve as a precursor for future prospecting missions to a variety of locations around the solar system including Mars, asteroids, and comets by direct, ground truth measurements of the materials at those locations. For the purpose of the initial demonstration and development phases of the RESOLVE Project, work shall focus on analyzing lunar regolith in and around permanently shadowed Polar Regions. These focused objectives have been defined by the Exploration Technology Development and Demonstration (ETDD) and ISRU Domain customers to include:

- Determination of the form, concentration, and spatial distribution of hydrogen and other volatiles inside and outside of shadowed lunar Polar Regions to a depth of at least 1 m.
- Determination of bulk properties of lunar material inside and outside of shadowed lunar Polar Regions.
- Demonstration of regolith prospecting, extraction, and processing operations in the lunar environment.
- Demonstration of oxygen (water) extraction from regolith via hydrogen reduction in the lunar environment.

Presentation Focus: This presentation will review the overall system architecture from software to onboard instrumentation planned for RESOLVE. It will also highlight previous RESOLVE field demonstrations and how the current architecture will morph to meet the new challenges of working with the volatiles now known to exist on the lunar poles. The presentation will also highlight three mission scenarios for RESOLVE and the impact to technology and operations based upon those architectures:

- All operations occur in sunlight near permanently shawdowed regions.
- Dash and grab with short duration excursions into shadowed areas and processing in the sunlight.
- Full permanently shadowed crater mission.