LCROSS Science Payload Ground Development, Test and Calibration Results. K. Ennico,[1] A. Colaprete,[1] D. Wooden,[1] J. Heldmann,[1] D. Lynch,[1] G. Kojima,[1] M. Shirley.[1] [1]NASA Ames Research Center, Moffett Field, CA, 94035, kennico@mail.arc.nasa.gov.

Introduction: The LCROSS (Lunar Crater Observation and Sensing Satellite) is a lunar impactor mission designed to target and impact a permanently shadowed region at a lunar polar latitude to create and measure the characteristics of an ejecta cloud of regolith and possibly ice and water vapor [1]. The LCROSS mission is co-manifested with the Lunar Reconnaissance Orbiter (LRO) whose six science instruments will survey the Moon to prepare for and support future human exploration of the Moon [2]. LRO and LCROSS are scheduled to be launched in October 2008.

There are nine unique instruments that compose the LCROSS science payload. Their industry and laboratory development, flight unit testing and calibration are summarized in this paper.

The LCROSS mission is managed by NASA Ames Research Center (ARC) with industry partner Northrop Grumman. LCROSS is a NASA Class-D mission.

LCROSS Science Payload Design: The LCROSS payload consists of nine science instruments, their supporting electrical, mechanical and optical harnesses and a central data handling unit assembled onto one of six radiator panels on the LCROSS space vehicle as shown in Figure 1.

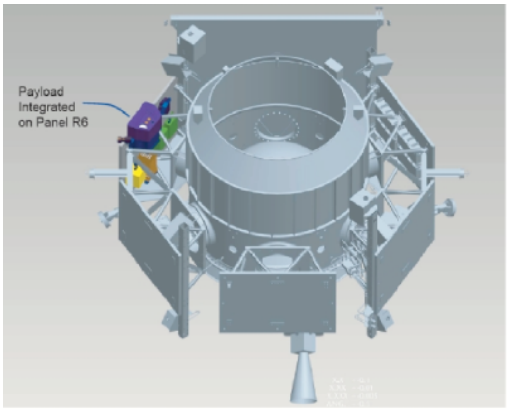

Figure 1. The LCROSS Science Payload is located on a single panel on the LCROSS space vehicle.

The nine science instruments are a visible wavelength context imager provided by Ecliptic Enterprises Corporation, two near-infrared (1.0-1.4 micron/ 1.0-1.7 micron) cameras from Goodrich Sensors Unlimited, one mid-infrared (6-9 micron) thermal imager from Thermoteknix Systems, Ltd., one mid-infrared (6-17 micron) camera from FLIR Systems/Indigo Operations, a custom-built highly sensitive total luminance photometer, a UV-visible spectrometer (260-650 nm) provided by Ocean Optics, and two compact low-power near infrared spectrometers (1.2-2.4 micron) built by Polychromix. The three spectrometers are connected via fiber optics to specially designed fore-optics provided by Aurora Design & Technology. These nine instruments are powered and controlled by a Data Handling Unit (DHU) provided by Ecliptic Enterprises. The DHU is interfaced with the space-vehicle command and data handling and power systems. Thermal control of the science payload is provided using heaters and thermostats.

The instrument specifications were designed to provide direct or indirect measurements of the total water content of the ejecta created by the initial impactor (the upper stage of the Atlas launch vehicle), as well as ancillary information about the ejecta mineralogy and the impact event. The payload itself becomes a second impactor, four minutes later. Both impact events are expected to be viewable by ground, Earth-orbit, and lunar-orbit assets, providing additional information at other wavelengths and/or timescales [3].

LCROSS Science Payload Testing: As many units of the LCROSS science payload are COTS (Commercial Off-the-Shelf) or modified-COTS, the LCROSS payload test program stressed early verification testing of Engineering Test/Development Units (ETU/EDUs) which, for the most part are identical in form and function to the vendor-proposed flight version. These ETU tests were primarily development tests in the process to bring "COTS-like to flight." Development tests were shared between NASA/ARC and the vendors to alleviate schedule burden and promote rapid turn-around for flight unit development. This proved to a be a successful paradigm to increase the robustness of this Class-D payload over the course of a few months.

The flight science instruments are tested for functionality and performance at both the unit and assembly level, the latter which is more representative of "test-as-you-fly" approach. Panel level testing is presently underway at NASA Ames Research Center as shown in Figure 2. After flight environmental acceptance testing, the payload is delivered to the spacecraft provider, Northrop Grumman, for integration at the space vehicle. Testing at the space vehicle level continues until the space vehicle is ready for transport to

Cape Canaveral for integration with the LRO in the fairing of the Atlas Centaur.

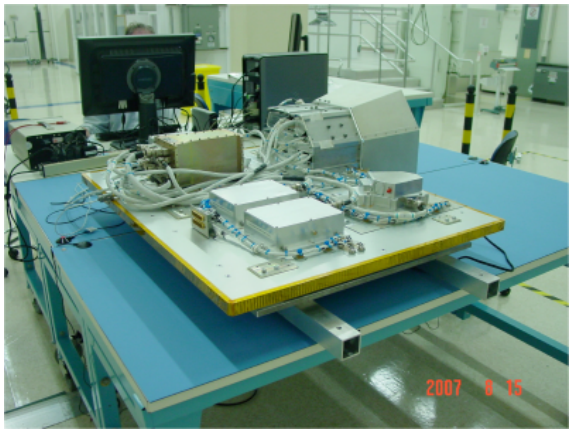

Figure 2. Complete flight LCROSS Payload on space vehicle radiator panel under test in clean room at NASA Ames Research Center.

LCROSS Science Payload Calibration Status: The calibration plan for the LCROSS science payload is a multi-faceted approach relying on 1) vendor-provided specifications, 2) in-situ radiometric and performance characterization at the NASA Ames Research Center Calibration Laboratory facilities, and 3) in-orbit calibrations.

The flight spectrometers and total luminance photometer have been radiometrically, spectrally, thermally, and temporally calibrated. This data provides a benchmark to compare against future in-orbit calibration checks. The flight cameras are being tested for image quality, responsivity and co-alignment. This paper will summarize the current ground calibration of these instruments in the context of the overall LCROSS test program.

The 3-4 month cruise phase of the LCROSS mission profile will provide a number of opportunities to obtain instrument health, performance, alignment and contamination checks, before the final descent. In particular, a lunar swing-by is planned at launch + 5 days, by which the science instruments are pointed at several places along the lunar surface and measurements along lunar limb. Additional earth and space looks are part of the in-orbit calibration plan.

References: [1] Colaprete, A., Briggs, G. et al. These proceedings. [2] Chin, G. (2007) *Space Sci Review*, in press. [3] Heldmann, J., Colaprete A. et al. These proceedings.