AN OVERVIEW OF THE OSIRIS REX LASER ALTIMETER - OLA. C. S. Dickinson[1], M. Daly[2], O. Barnouin[3], B. Bierhaus[4], D. Gaudreau[5], J. Tripp[6], M. Ilnicki[7] and A. Hildebrand[8]. [1]MacDonald Dettwiler & Associates (9445 Airport Road, Brampton, ON, CANADA, L6S 4J3, cameron.dickinson@mdacorporation.com), [2]York University (dalym@yorku.ca), [3]John Hopkins University Applied Physics Laboratory (Olivier.Barnouin@jhuapl.edu), [4]Lockheed Martin Corporation (edward.b.bierhaus@lmco.com), [5]Canadian Space Agency (Daniel.Gaudreau@asc-csa.gc.ca), [6]Optech Inc. (jeff.tripp@optech.com), [7]York University (ilnicki@yorku.ca), [8]University of Calgary (ahildebr@ucalgary.ca).

Introduction: The NASA New Frontiers **O**rigins **S**pectral **I**nterpretation **R**esource **I**dentification **S**ecurity-**R**egolith **Ex**plorer (OSIRIS-REx) mission is scheduled to launch in September, 2016, arriving three years later at carbonaceous asteroid (101955) 1999 RQ_{36} [see 1 for more details]. The Canadian Space Agency is contributing a scanning lidar system known as the **O**SIRIS-REx **L**aser **A**ltimeter, or OLA, to the OSIRIS REx Mission. The spacecraft will first characterize the surface using cameras, a visible and near-infrared spectrometer, a thermal emission spectrometer, and X-ray imaging spectrometer and the OLA system, before descending to the surface to acquire a sample and return it to earth in 2023.

OLA will deliver high density 3D point cloud data, enabling reconstruction of an asteroid shape model at the highest density yet recorded on any small body, and providing much needed slope information (Figure 1) at the sample site leading up to acquisition. These data will be important for determing the geological context of the samples obtained by the OSIRIS-REx mission, as well as help minimizing the risk of encountering hazards during sampling. In addition, OLA will be important for the accurate determination of the gravity field of RQ_{36} by providing an accurate measure of the distance between the spacecraft and asteroid in support of radio science. Finally, OLA will provide ranging in support of other instruments and navigation.

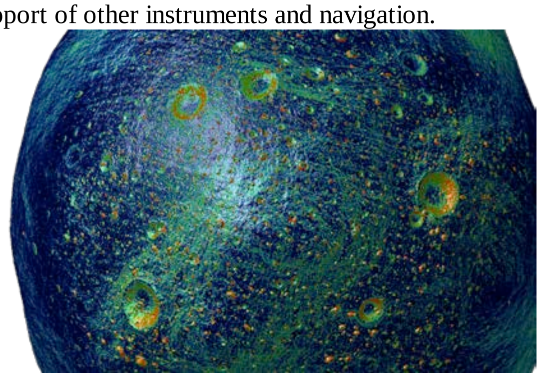

Figure 1. Slope distribution on simulated 1999RQ_{36}.

Background: RQ_{36} was discovered on September 11, 1999 by the Lincoln Laboratory Near Earth Research (LINEAR) survey with a 1.0-meter telescope located near Socorro, New Mexico. Nolan et al. [2] observed RQ_{36}, using the Arecibo Observatory and determined that it has a polar diameter of 513 m, an equatorial diameter that varies between 533 – 562 m, and a rotational period of ~4.3 hours. This B-Class Near Earth asteroid (NEA) has a geometric albedo at 0.54 µm of 0.03 ± 0.01, making it a challenging target for optical remote sensing.

Spectral analysis suggests that the most likely meteorite analogs for RQ36 are the CI and/or CM meteorites [3]. The best guess of the surface roughness, boulder size distribution, spatial distribution that will be encountered comes from estimates of the thermal inertia of the asteroid and from radar circular polarization ratio measurements. For RQ_{36} the former has been estimated at $\Gamma = 600\ J/m^2/s^{0.5}/K$ [4], with this value lying almost exactly between those measured for the boulder-strewn surface of Itokawa ($\Gamma = 750$) [5] and that estimated for 'coarse gravel' on the surface of Mars ($\Gamma = 400$) [6]. This would seem to indicate a fairly smooth surface, with further evidence to support this coming from radar polarization ratio measurements [2,7], in which the ratio of transmitted (SC) to return (OC) polarization serves as a measure of surface roughness near the radar wavelength (here either 3.5 or 13 centimeters). The measured value of RQ_{36} is SC/OC = 0.18 ± 0.01, which is midway between Asteroid Itokawa (SC/OC = 0.27 ± 0.04) and the Moon (SC/OC ≈ 0.10).

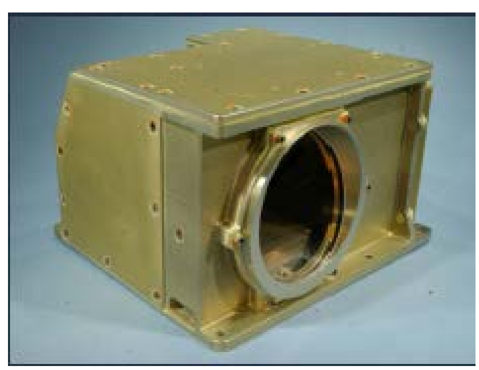

Figure 2: XSS-11 Scanning Lidar system

Technical Specifications: The OLA system is based on a heritage design of the scanning lidar system built by MDA for the US Air Force Research Laboratories XSS-11 mission (see Figure 2).

The base system will be augmented with a second higher energy laser transmitter for increased range capability (see Figure 3) that is based on the heritage of the MDA built 2008 Phoenix Mars Lidar.

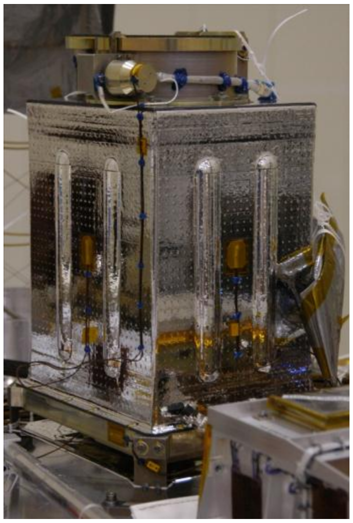

Figure 3: Phoenix Mars Lidar system

The completed system is expected to have the following specifications, based on the characteristics of asteroid RQ_{36} and operational considerations:

Maximum Operational Range	7.5 km
Minimum Operational Range*	0.5 km
Range Accuracy	5 – 30 cm
Range Resolution	1 cm
Scanner Field of Regard	$\pm 10^{o}$ (each axis)
Laser Spot Size (on surface)	0.05 - 2 m

*Operational limit only

Operations: In order to achieve its science objective, as well support sampling, the OLA sytem will be employed during four phases of the mission. It will begin with acquisition of the asteroid at approximately 7 km range from the asteroid surface, provide support for the other instrument during a detailed survey at 5km from the surface of the asteroid, range to the surface of RQ_{36} in support of the radio science experiment at 1 km and undertake a very high resolution global survey at ~700m from the surface. During this phase, individual OLA footprint sizes and their separation on the surface will allow determining slopes commensurate with the scale of the OSIRIS-REx sampling system. Finally, the OLA instrument will map out at very high resolution from 500m of the surface, any final downselected sampling sites, significantly subsampling the scale of the sampling device used by the OSIRIS-REx spacecraft to help ensure that there are no siginifacnt hazards and asure mission success.

References: [1] Lauretta et at. (2012), *LPS XLIII*. [2] Nolan, M.C. et al (2007), *American Astronomical Society*, *DPS meeting #39*, Abstract #13.06. [3] Clark, B. E., et al. (2011), *Icarus*, *216(2)*, 462-475. [4] Emery. J.P., et al (2010) *LPS XLI*, Abstract #1533. [5] Fujiwara1, A., et al. (2006) *Science*, *312*, 5778, 1330-1334. [6] Christensen, P.R., et al. (2003) *Science*, *300*, 2056. [7] Benner, L. A. M., et al. (2008) *Icarus*, *198*, 294-304.