THE OSIRIS-REx LASER ALTIMETER (OLA). C. S. Dickinson[1], M.G. Daly[2], O. Barnouin[3], C. Johnson[4], B. Bierhaus[5], J. Seabrook[2], T. Haltigin[6], D. Gaudreau[6], C. Brunet[6], G. Cunningham[7], D. S. Lauretta[8], E. B. Beshore[8], W. V. Boynton[8]. [1]MacDonald Dettwiler & Associates, (cameron.dickinson@mdacorporation.com), [2]York University, [3]Johns Hopkins University Applied Physics Laboratory. [4]University of British Columbia [5]Lockheed Martin Corporation, [6]Canadian Space Agency, [7]Optech Inc., [7]University of Arizona.

Introduction: The NASA New Frontiers **O**rigins **S**pectral **I**nterpretation **R**esource **I**dentification **S**ecurity-**R**egolith **Ex**plorer (OSIRIS-REx) mission will visit a carbonaceous (B-type) asteroid (101955 Bennu[1]) – with the hope of returning a sample from one of the solar system's most primitive bodies. This will broaden our understanding of both the physical and geochemical origin and evolution of carbonaceous asteroids, which are very likely related to CM and/or the even more rare CI meteorites [2].

The OSIRIS-REx spacecraft will launch in September 2016, and arrive at Bennu in 2018. The **O**SIRIS-REx **L**aser **A**ltimeter (OLA) is a contribution of the Canadian Space Agency to the OSIRIS-REx Mission. OLA is part of suite of onboard instruments [3] including cameras (OCAMS) [4], a visible and near-infrared spectrometer (OVIRS) [5], a thermal emission spectrometer (OTES), and an X-ray imaging spectrometer (REXIS) [6].

OLA Mission Objectives: The OLA instrument will provide several key data sets to the OSRISI mission. Firstly, it will be used to update the shape of Bennu. Such measurements will aid in the understanding of Bennu's bulk density, and thus, it's internal heterogeneity. This is facilitated by a campaign employing radio science data (to determine the exact position of the OSIRIS REx spacecraft during dynamic maneuvers, and thus the asteroids mass) with OLA data providing refined estimated of the relative spacecraft to Bennu positions, and OCAMS data provide broad scale, contextual data. The combination of these data sets will serve to constrain estimates of Bennu's internal density structure, and hence provide further clues to its geological origin and subsequent collisional evolution over the eons.

The OLA instrument will also provide global asteroid maps of slopes, elevation relative to the asteroid geoid. Quantitative insights on how local-regional surfaces on Bennu evolved subsequent to the formation of the asteroid will be inferred from OLA derived vertical roughness measurements.

Finally, OLA will assist in providing context for the selected sample location on Bennu. This will consist of:

- *Investigating Geological and Geophysical Processes* – OLA will provide contextual data to assess the influence of the surface regolith at scales relevant to the collected sample size.
- *Measuring Surface Topographic Slopes* - High resolution (meter-scale) spatial measurements of slopes within the sample ellipse (i.e. center-of-mass referenced elevation, and vertical roughness) will provide quantitative data on regolith processes such as surface granular flows that could have displaced the regolith sampled by OSIRIS-REx spacecraft.
- *Support to Sample Site Assessment: Safety & Mission Assurance* – The OLA system will also be provide data for assessing hazards at any proposed sample site. Specifically, the OLA system will measure the slope distribution within the sample ellipse and characterize surface roughness at or below the scale of the OSIRIS REx sample head.

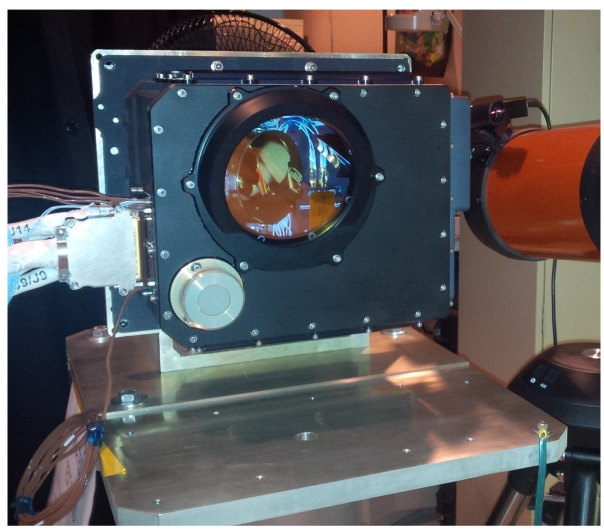

Figure 1. OLA EM during system calibration.

OLA Technical Specifications: The OLA system is comprised (See Figure 1) of two lasers: a "low energy" Nd:YAG operating at 10kHz, 10µJ and a "high energy" Nd:YAG (based on the Phoenix Mars mission lidar system [7]) operating at 100Hz, 1mJ. Both lasers operate at their fundamental frequency of 1064nm. The laser beams are directed onto a flexure mounted scanning flat mirror, driven by Electro-Magnetic Actuators, and employing high accuracy readout electronics for determination of OLA pointing knowledge on the surface of Bennu. The system performance specifications are as follows:

High Energy Laser Operational Range for Bennu (4% albedo)	1.0 - 7.5 km
Low Energy Laser Operational Range for Bennu (4% albedo)	0.150 – 1.5 km
Range Accuracy	5 – 20 cm
Range Resolution	< 4 cm
Scanner Field of Regard	±7^o (each axis)
Laser Spot Size (on surface)	0.015 - 2 m
Pointing Knowledge (Absolute)	<1.5 mrad

OLA Testing: A successful EM test campaign was conducted through spring and summer of 2014. (See Figure 2).

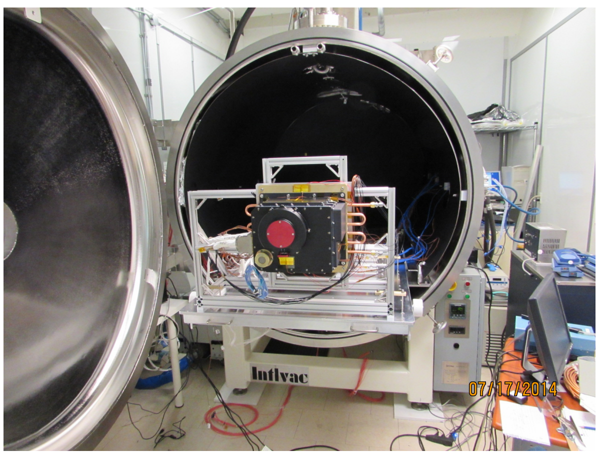

Figure 2. OLA EM during TVAC testing (Note: red laser safety cover in place over OLA window).

A sample scan illustrating the system performance is shown in Figure 3, which is a survey of the target wall at 27m distance, located at MDA's Brampton facility. For reference the targets are mounted on cinderblocks, and in the scan the faint outline of mortar between each cinderblock can be seen.

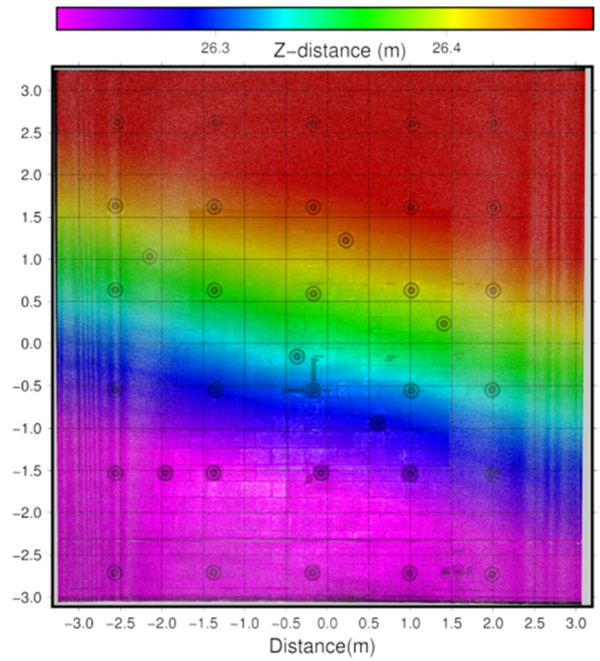

Figure 3. OLA 2D scan of test wall (>7M shots). Note visible cinderblock structure in scan. (A grid has been overlaid onto the image for reference)

A protoflight unit is currently in manufacture, and final testing will commence in the spring of 2015. Delivery to the Canadian Space Agency, and thus integration onto the OSIRIS Rex Spacecraft, is scheduled for the fall of 2015.

References: [1] Lauretta et al. (2012), LPSC 43, this issue. [2] Clark et al., Icarus, 216, 462-475.[3] Boynton et al. (2012), EPSC2012-875. [4] Smith et al. (2013), LPSC 44, #1690. [5] Simon-Miller and Reuter (2013), LPSC 44, #1100. [6] Allen et al. (2013), Proc. of SPIE Vol. 8840. [7] Whiteway et al (2008), JGR, 113, E00A08 10.1029/2007JE003002