Recent Progress in Photon-counting 3D Imaging Lidars

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Planetary scientists have long expressed interest in obtaining globally contiguous, high resolution (few meter horizontal, decimeter vertical) 3D topographic maps of planets and moons. For example, the goal of NASA′s LIST mission, scheduled for launch in the 2016-2020 time frame, is a globally contiguous, 5 meter resolution, topographic map of the Earth. Unfortunately, achieving such a capability through a simple scaling of the laser power and/or telescope aperture from prior art NASA laser altimeters (e.g. MOLA, GLAS, and MLA) is not practical. This is especially true of laser altimeters destined for orbit about distant planets or moons where instrument mass and prime power usage is severely constrained. Photon counting receivers permit each range measurement to be made with a single received photon, even in daylight, and the surface sampling rate of an orbiting altimeter can be increased by three to four orders of magnitude by emitting the available laser photons in a high frequency train of low energy pulses instead of allow frequency train of high energy pulses typical of past spaceborne lidars.

We report on recent rooftop and flight testing of our second-generation 3D imaging lidar system. A recently completed study for NASA′s Jupiter Icy Moons Orbiter (JIMO) mission concluded that the three primary Jovian moons (Ganymede, Callisto, and Europa) could be contiguously and globally mapped, at few-meter horizontal resolutions, by a photon-counting lidar in a matter of months from orbital altitudes of 100 km. Work is underway to include a photon-counting lidar (‟Swath Mapper″) as a precursor to LIST on NASA′s ICESat-II mission, which is scheduled for a 2011 launch into a 600 km orbit. Swath Mapper would use a single low energy, high repetition rate laser (nominally 1 mJ@ 10 kHz = 10W) to measure surface topography over 16 uniformly spaced ground tracks spread over roughly 2.1 km.