FLASH LIDAR SYSTEMS FOR HAZARD DETECTION, SURFACE NAVIGATION AND AUTONOMOUS RENDEZVOUS AND DOCKING.

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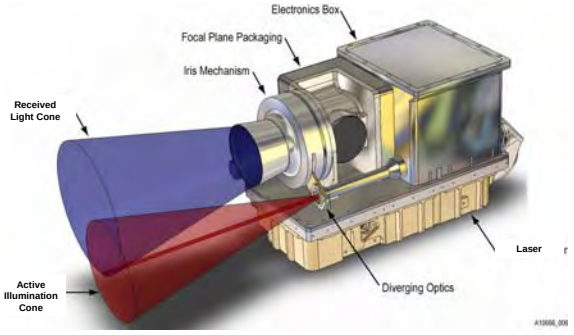
This poster will present the results of the Ball Aerospace 3D flash LIDAR field tests, including those performed at three different NASA centers. It will also provide multi-mission application information and secenarios for use in Lunar Science, Exploration and Resource Prospecting.

Background: Three dimensional flash LIDAR is an enabling technology for Lunar Science, Exploration and Resource Prospecting. For in space and on orbit **rendezvous**, the powerful flash LIDAR LASER pulse can be used to acquire and range targets from a distance of up to 10-20 km. For **docking** applications, flash LIDAR provides real-time three dimensional video of the target spacecraft under any lighting conditions. This provides six degree of freedom pose as well as velocity and spin rate data. Inclusion of a flash LIDAR system also allows for redundant video guidance capabilities. **Landing** applications for flash LIDAR include use as a supplement or replacement to conventional RADAR altimeters, providing ranging and velocimetry from 10-20 km above the surface. Additonally, flash LIDAR systems are well suited for use in **hazard detection,** offering three dimensional object and terrain mapping. The real-time nature of the system provides data at 10 to 100 times the rate of conventional scanning systems, enabling active **hazard avoidance** navigation. Therefore, flash LIDAR offers higher spatial resolution per unit time, allowing more detailed terrain information. Lastly, flash LIDAR systems offer an attractive solution for **surface navigation and terrain mapping**. These systems have the advantage that they may be used successfully under any lighting conditions – as a means to acquire a 3D topographic site survey, or as a sensor for real-time autonomous rover navigation and hazard detection.



*Ball's flash **LIDAR** is a flexible platform that supports multiple missions including docking, landing, hazard avoidance and surface navigation*

Design Heritage: Ball Aerospace has developed a highly capable, mature, multi-mission 3D flash LIDAR system for Lunar Exploration and other space-based applications. The unit leverages technology from our proven long-life space-based LASER systems. The baseline LASER, optics and key electronics are all currently in operation on a classified space mission. The LASER itself draws directly from our development of the associated LIDAR LASER aboard the NASA CALIPSO mission.

Principal Specifications

Weight:	7.72 kg (17.02 lbs)
Power:	30 Watts average (at max data rate)
Dimension:	11" x 5" x 5.9"
FOV Options:	12° (nominal)
Data Rate:	1-30Hz real-time (x,y,z, Intensity, quality)
Range Precision:	3 cm (rms)

Unique Features

Single low precision mechanism maintains image focus and optimal dynamic range and laser divergence control

TRL of Components

Modified Star-Tracker Optics:	TRL 7/8
Existing Level III qualified Laser:	TRL 9
30 Hz real-time 3D processor (FPGA):	TRL 8/9
APD Detector Assembly:	TRL 5
3U Support Electronics (heritage):	TRL 7

Options

Visible Camera for High Resolution 2D images and/or Star-tracking
FSM for Long Range Target Acquisition

Field Testing: In addition to extensive in-house testing, the Ball Aerospace 3D flash LIDAR system has been field tested at three different NASA centers. At the Marshall Space Flight Center (MSFC), Ball and NASA engineers performed two successful proximity operations and docking tests. The Ball LIDAR was the only system tested to provide real-time data and pose estimation under all lighting conditions. The system also has been tested successfully in Hazard Detection for Landing, using a laboratory developed specifically for

this type of sensor characterization at NASA'S Langley Research Center (LaRC). Ball's flash LIDAR is the first and only sensor that has been tested at this facility to date. Lastly, Surface Navigation capabiities were tested at NASA'S Ames Research Center (ARC). Both indoor hazards as well as outside longer range imaging was performed. The Ball flash lidar system performed extremely well during all three multiple mission application field tests.