Resurrecting the Engineering Model Mercury Laser Altimeter to Improve the Flight Data Calibration

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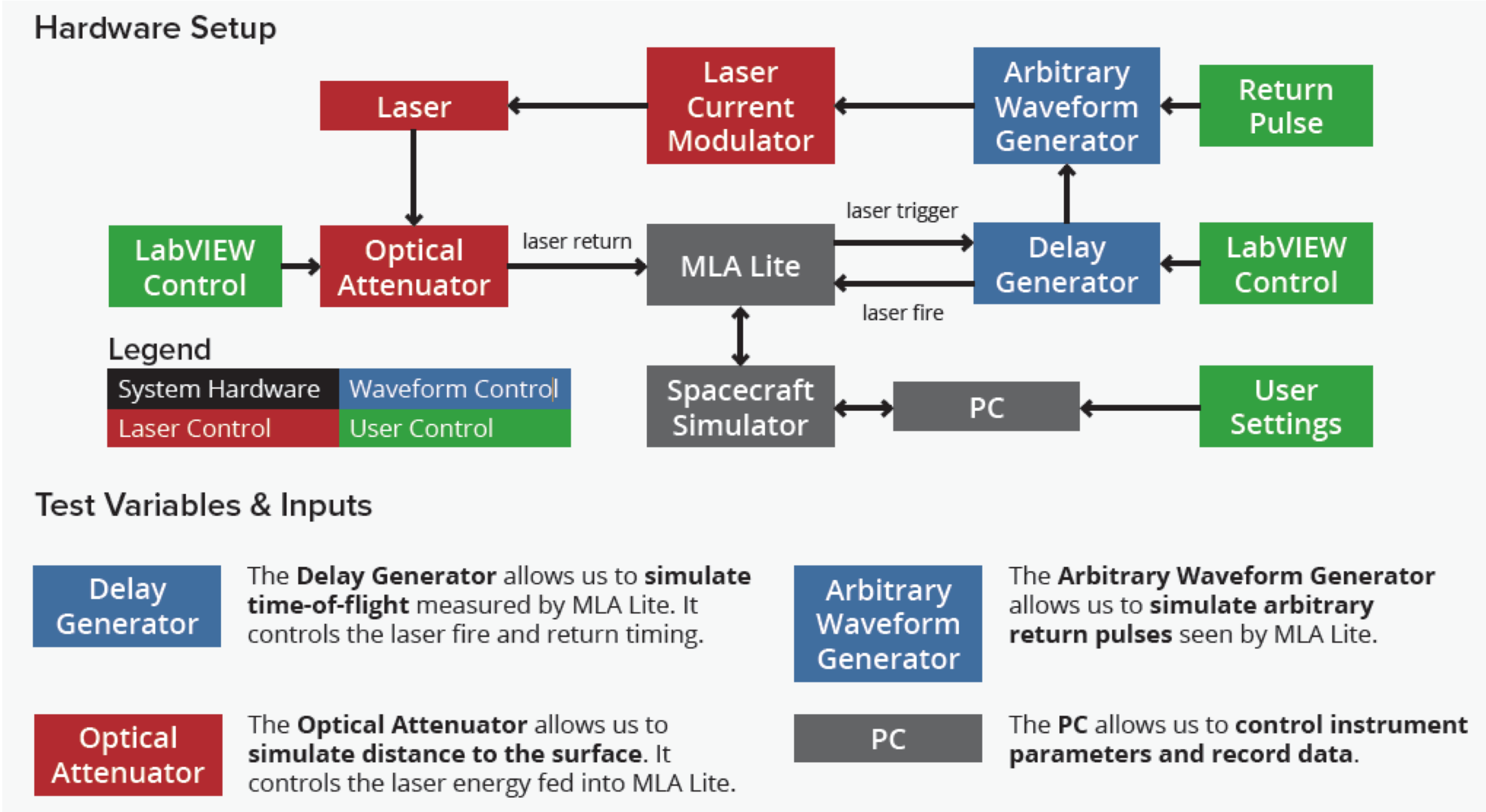
Introduction

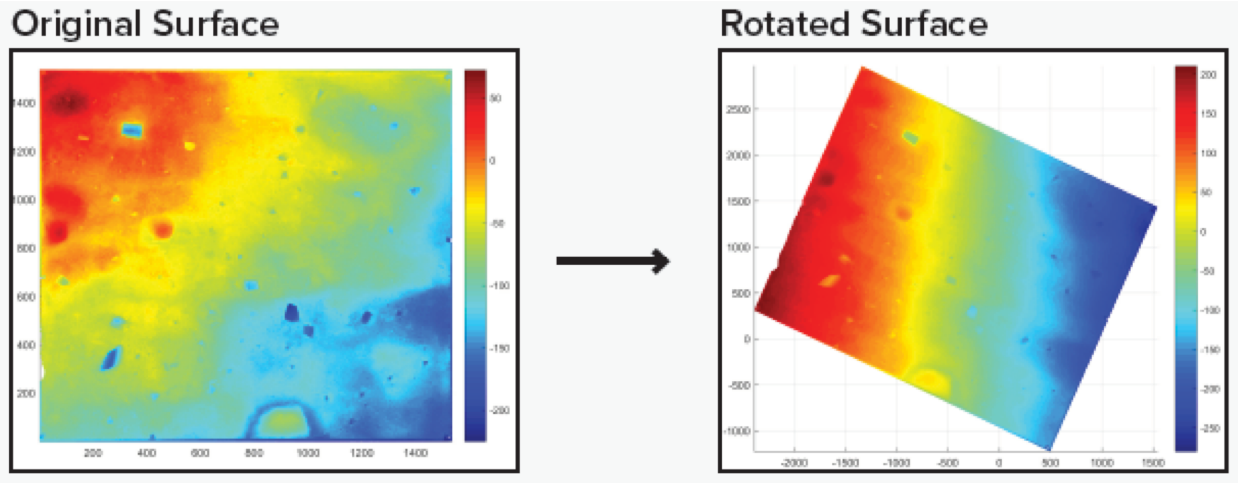
The engineering model unit of the Mercury Laser Altimeter (MLA) on the MESSENGER mission, known as MLA-Lite, has been resurrected under ISFM support, as a testbed to refine the data calibration and to develop new measurement techniques for future space lidar. It was also used as a test platform for interns to gain experience with flight hardware. The engineering model unit and residual flight spare hardware of the Lunar Orbiter Laser Altimeter (LOLA) have also been maintained in the lab under the ISFM funding for future use.



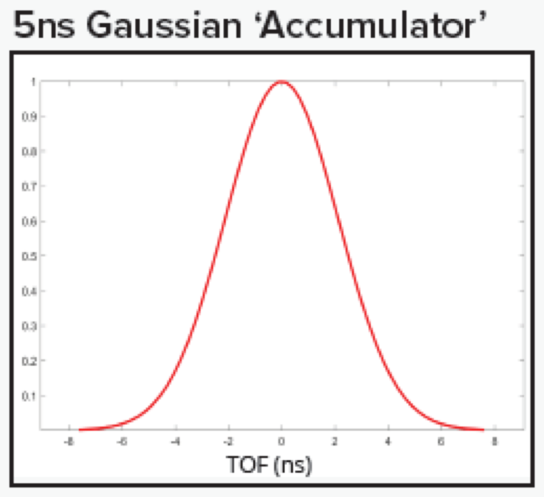
A laser diode driven by an arbitrary waveform generator and a delay generator was used to simulate the return signals under various measurement environments

Lidar return signal simulations

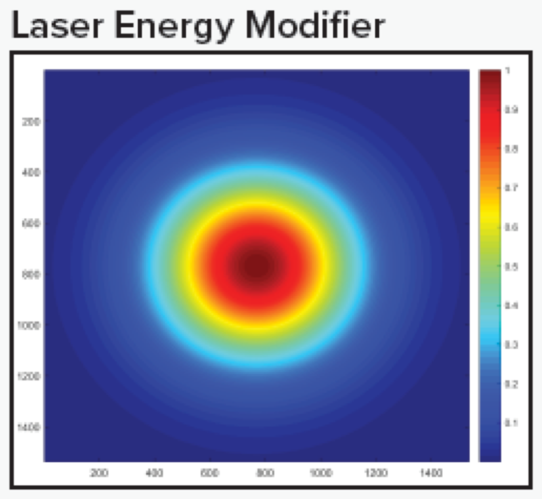
A lidar return signal simulator was built using a laser diode, a delay generator, and an arbitrary waveform generator. A Matlab script has been developed to calculate the return pulse shape from a given planetary surface, laser beam temporal and spatial profile and pointing angle.



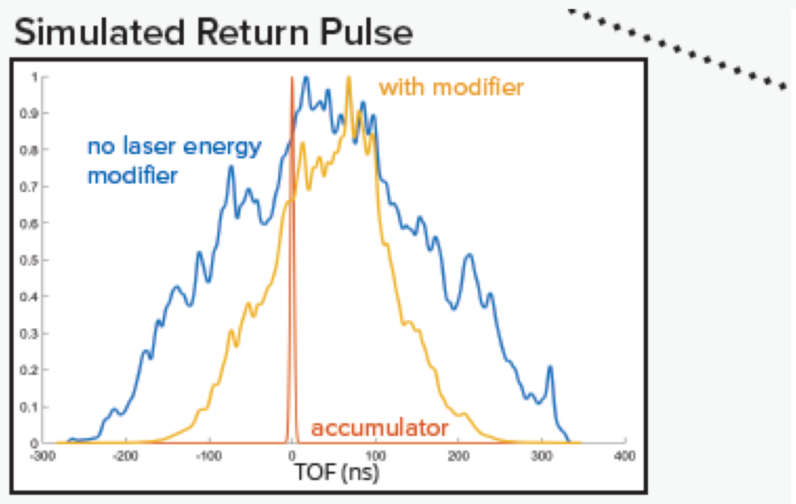
1 Surface data is optionally rotated in two axes via linear transformation simulating **laser position** and **surface slope**



2 Each point of surface data contributes a laser pulse of identical shape, but offset in time by its time-of-flight (calculated from its height)



3 Each point's contribution is weighted by a Gaussian filter simulating laser energy on a surface

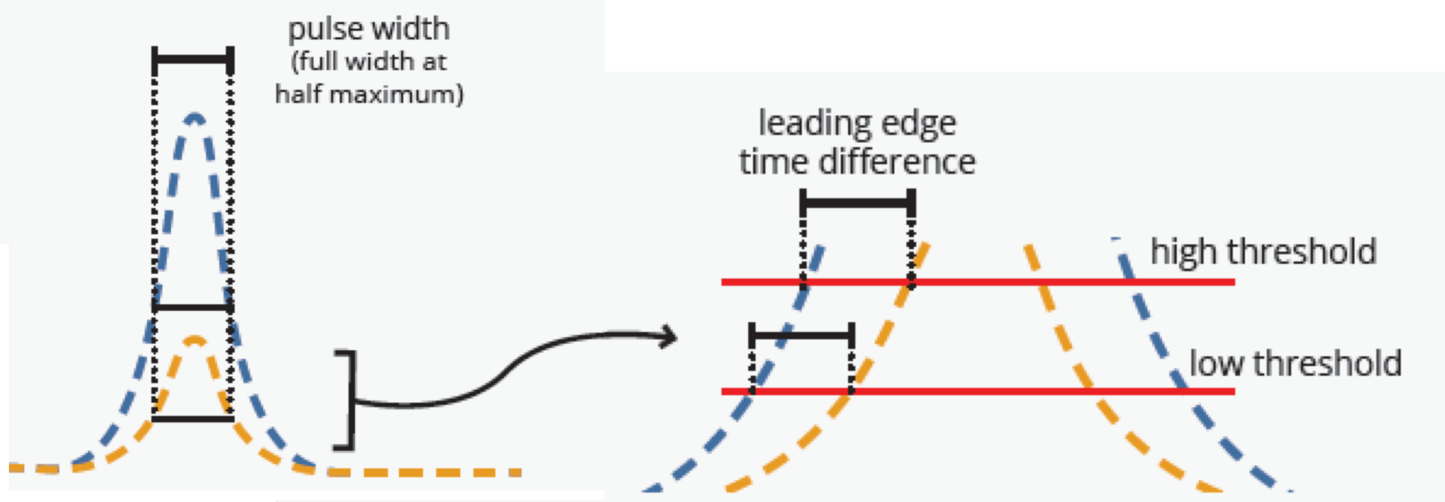


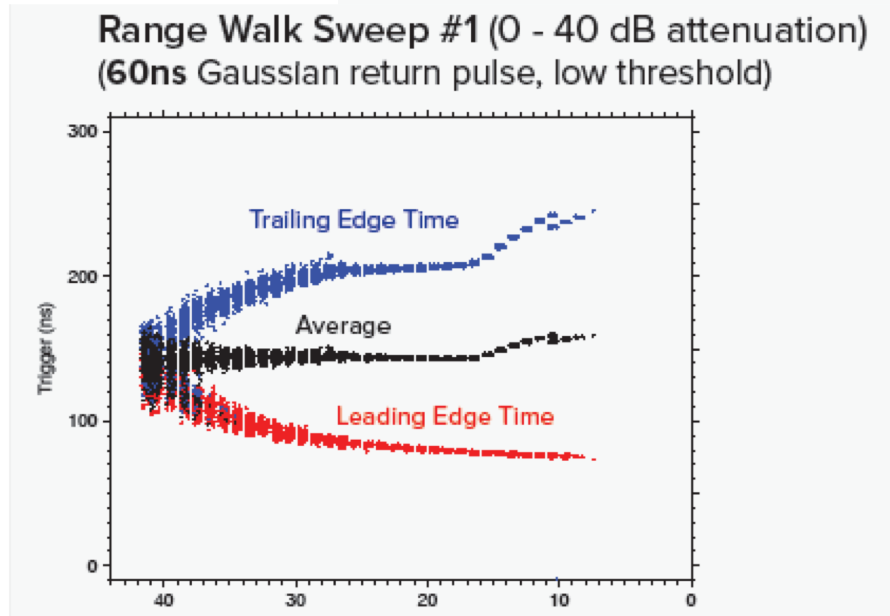
4 The weighted contributions are accumulated and normalized to form a return pulse representing the rotated surface data

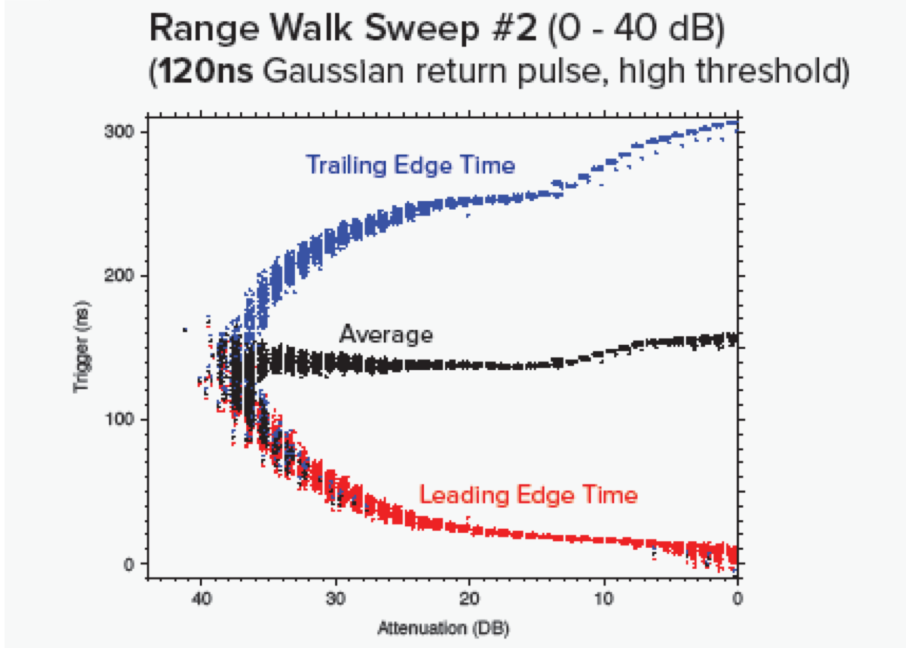
Use of the MLA-Lite and the Signal Simulator

MLA-Lite and the return signal simulator were used to refine the calibration of the MLA data to improve the measurement precision. The simulator was also used to extend the MLA calibration model to cover the data taken at extremely low altitude near the end of the MESSENGER mission.

Range walk simulation and correction

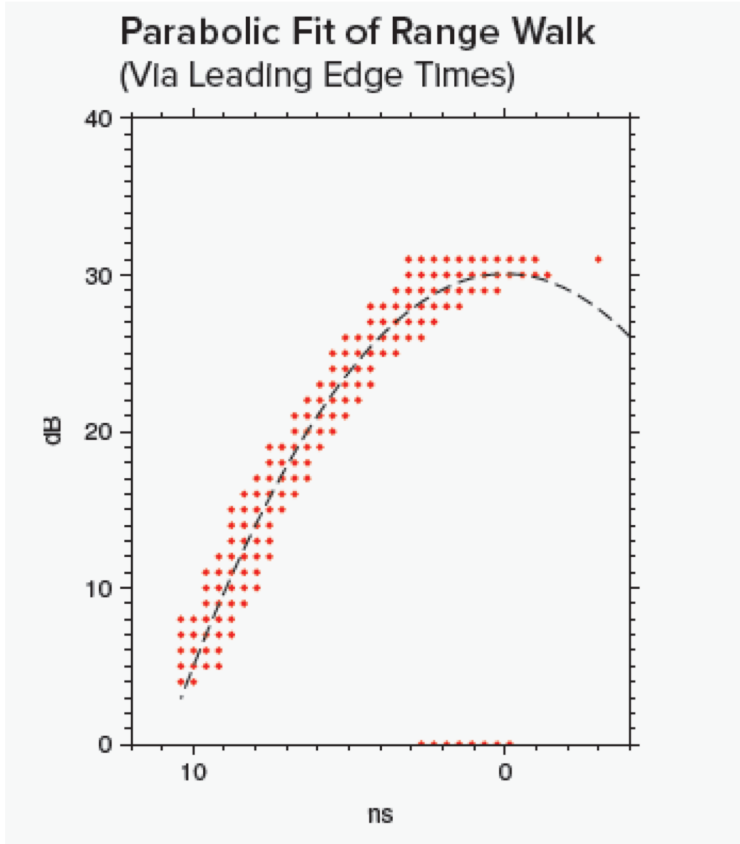






Range walk correction

For very strong signal at low altitude, the pulse trailing edge became distorted and the fourth threshold crossing point was no longer useful. A leading edge time-walk correction had to be used to calibrate these data.



Future work

- Continue simulation with the testbed to improve the MLA reflectance calibration data
- Continue to maintain the engineering model instruments to support data calibration of MLA and LOLA and as testbeds for future space lidar development