Detection and timing of laser pulses from Lunar Reconnaissance Orbiter

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Abstract

In space calibration of optical instruments such as laser altimeters is currently being investigated at many research facilities such as NASA Goddard Space Flight Center. The calibration requires very precise aperture for detecting and time tagging the laser pulses emitted by space born Lidar on the ground. This study presents a method of detecting and time tagging laser pulses emitted by Lunar Reconnaissance Orbiter using the GuideTech GT668PCI-2 CTIA (Continuous Time Interval Analyzer) card for instrument calibration and validation purposes.

Methodology

Figure 1 depicts the block diagram of experiment setup deployed at the roof of one of NASA GSFC buildings. The first (and thus far) only experiment has been conducted during LRO active raster scan. The detector installed in Vixen Telescope has been used for detecting the LRO laser pulses. The signal from the detector has been time tagged using GuideTech GT668PCI-2 CTIA card installed in computer 4, signal waveform was recorded HP Infinium oscilloscope and Dell 4200 machine.

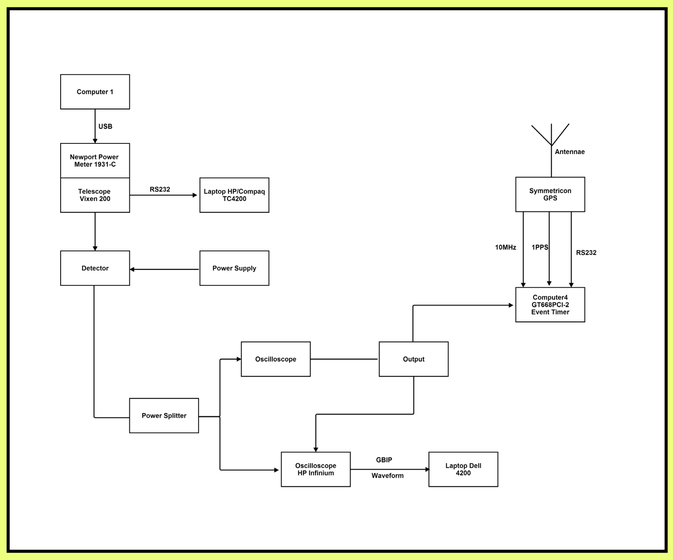


Figure 1 Block diagram of LROActive Scan Ground Station Setup.

LRO Laser Pulses Time Tagging with GT668PCI-2 CTIA

In order to confirm that the laser altimeter is pointing in the right direction it's necessary to record the times at which the pulse was emitted by the instrument and later on detected on the ground. The time tagging of the signal was performed by GuideTech GT668PCI-2 CTIA. In order to reference the time to absolute UTC time a custom application has been developed. Figure 2 presents a modular architecture of the application.

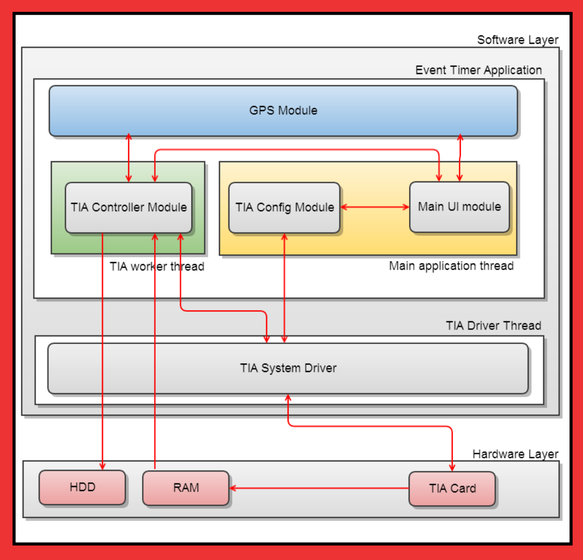


Figure 2 Event Timer application architecture.

Referencing to UTC time

The GT668PCI-2 card is characterized by very high accuracy (1 Pico second), however it outputs relative time of an event, meaning the time between the start of the measurements (indicated as the blue line on Figure 3) and event occurrence (pulses). It is crucial to know the exact time at which the laser pulses were recorded. To reference the time tagged signal to absolute UTC time, the event timer application exploits the GPS 1 pulse per second (PPS) signal. The pulses always occur at equal second, however it's impossible to derive the absolute time directly from the 1 PPS signal, hence the application queries the GPS receiver just before starting the measurements (time T1) and right after registering the first pulse (time T2) on channel B where GPS signal is connected. The absolute UTC time of first pulse is equivalent to the T2 time rounded to the nearest second.

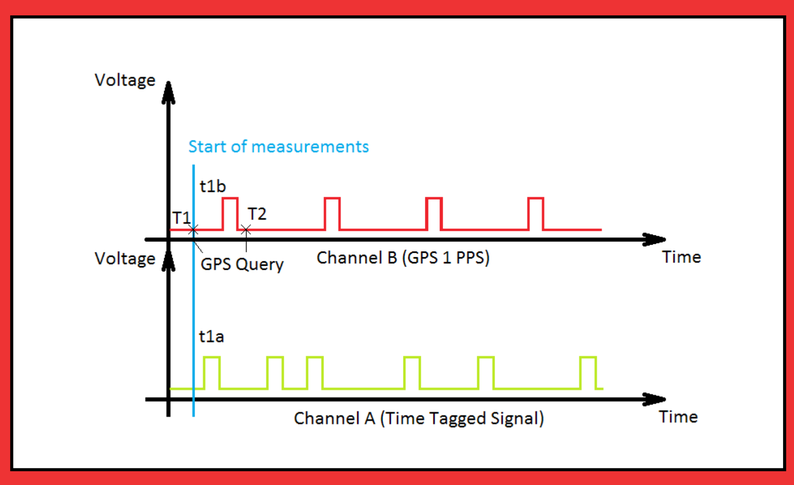
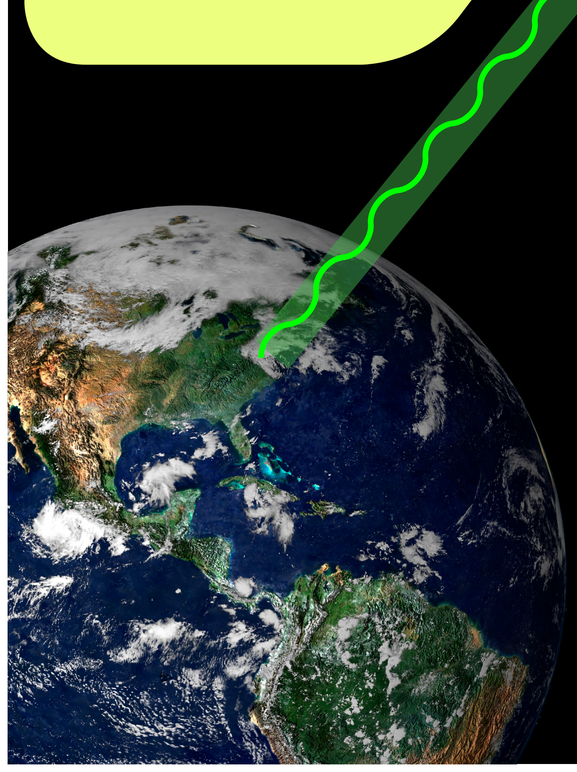


Figure 3 Event Timer referencing to absolute UTC method.



Conclusions and Future Work

During first experiment no pulses were detected hence any further data processing and analysis were impossible. Prior to the second attempt improvements were introduced in the telescope tracking system. Due to bad weather conditions and changes in LRO operations schedule second attempt has been postponed. Next attempt is expected before the end of November 2013. Latest data from LRO indicates that LOLA laser energy has decreased more than anticipated hence the experiment will require more resources in order to be accomplished successfully, however the method and software developed for the purpose of detecting laser pulses emitted by in space laser are very promising.

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