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# *Unmanned Aerial Systems (UAS) Workshop*

**Waquoit Bay National Estuarine Research Reserve**
131 Waquoit Hwy
East Falmouth, MA 02536

**Wednesday**
July 26th 2017
12:30 - 4 PM

## Eldredge Surveying & Engineering, LLC

www.ese-llc.com/airshark

# ScannerJammer

We can keep this session on the light side and have some fun while reviewing some pretty heavy topics.

Have a question? Raise your hand, cough, interrupt or even say “Hey You! What about this?” With luck we can answer the question, without luck we will be flustered and simply answer ScannerJammer!

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Has a fancy pants name; goes by Thadd.

# What is LiDAR?

Laser Radar

Light Detection and Ranging

Scanning

Lidar (also written LIDAR, **LiDAR** or LADAR) is a remote sensing technology that measures distance by **illuminating a target with a laser and analyzing the reflected light.** Although thought by some to be an acronym of Light Detection And Ranging,[1] the term lidar was actually created as a portmanteau of "light" and "radar".[2][3] Lidar is popularly used as a technology to make high-resolution maps, with applications in geomatics, archaeology, geography, geology, geomorphology, seismology, forestry, remote sensing, atmospheric physics, airborne laser swath mapping (ALSM), laser altimetry, and contour mapping. (wikipedia)

**SURVEYING!!!**

# Terms

**Scanner** – a LiDAR unit or a magic box with laser(s) and possibly camera, compensator, compass, GPS, height sensor or other options.

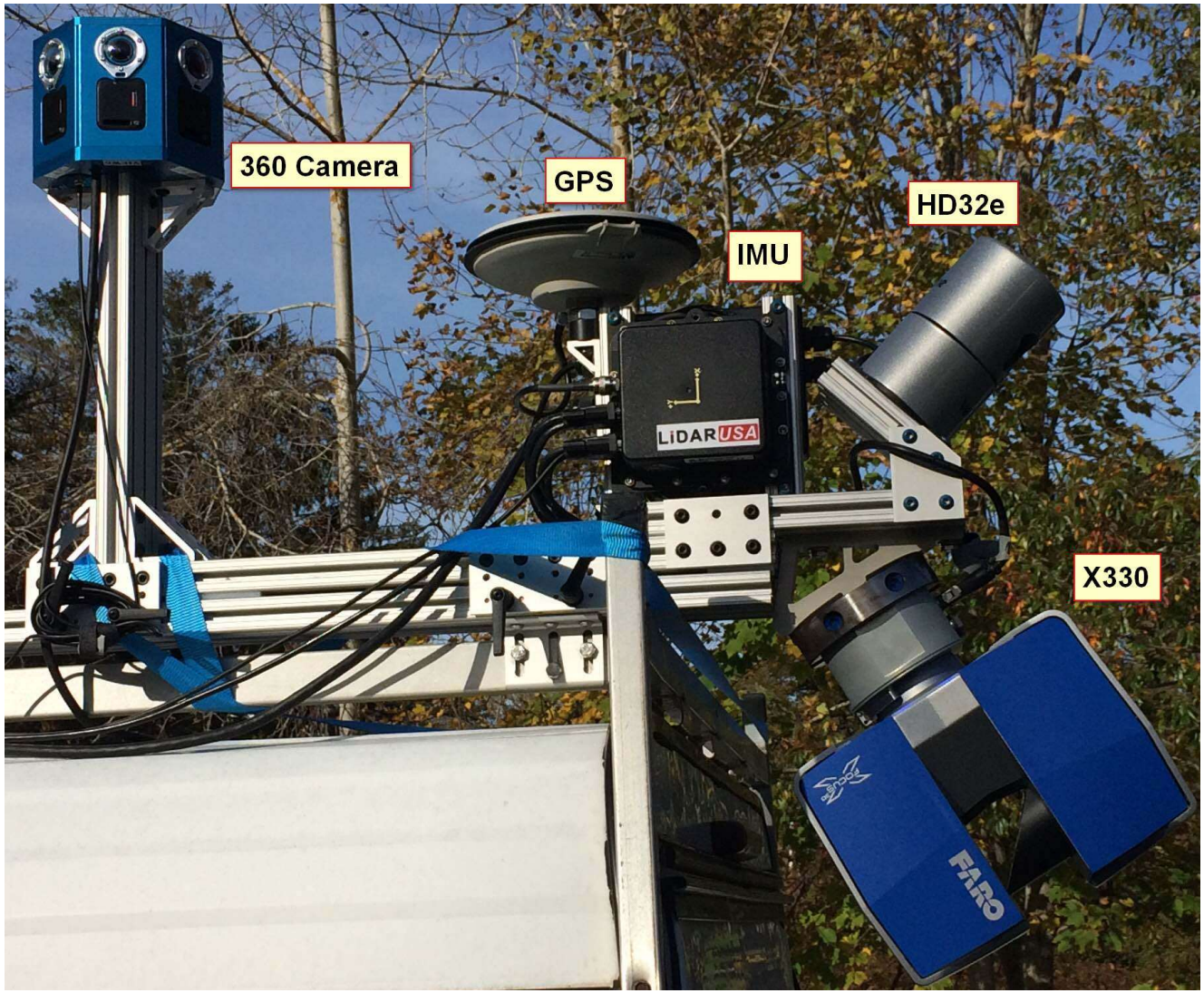
**Registration** – The adjustment of raw scan data or point clouds. This can include stitching two clouds together or adjusting clouds onto known control.

**Registration Sphere** – aka Ball. An awesome round target that is a great method for scan registration.

# Terms

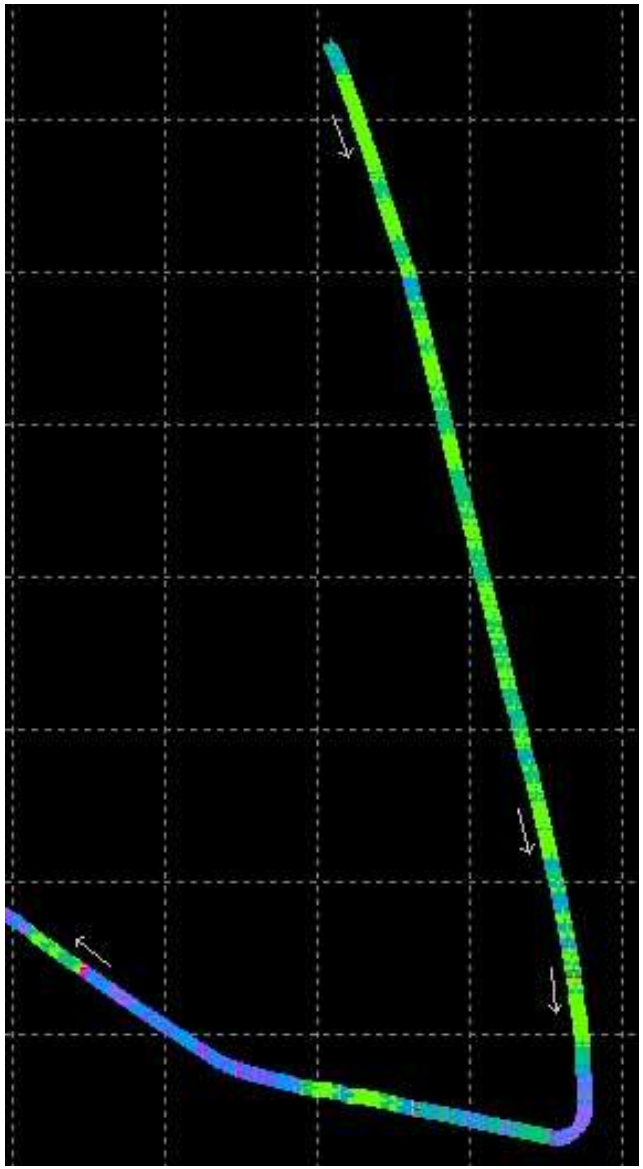
**GPS** – Geographic Positioning System or a magic box that tells you where you are based on satellite signals.

**IMU** – Intertial Measurement Unit or a magic box that calculates moving position based on the forces of motion.



# Terms

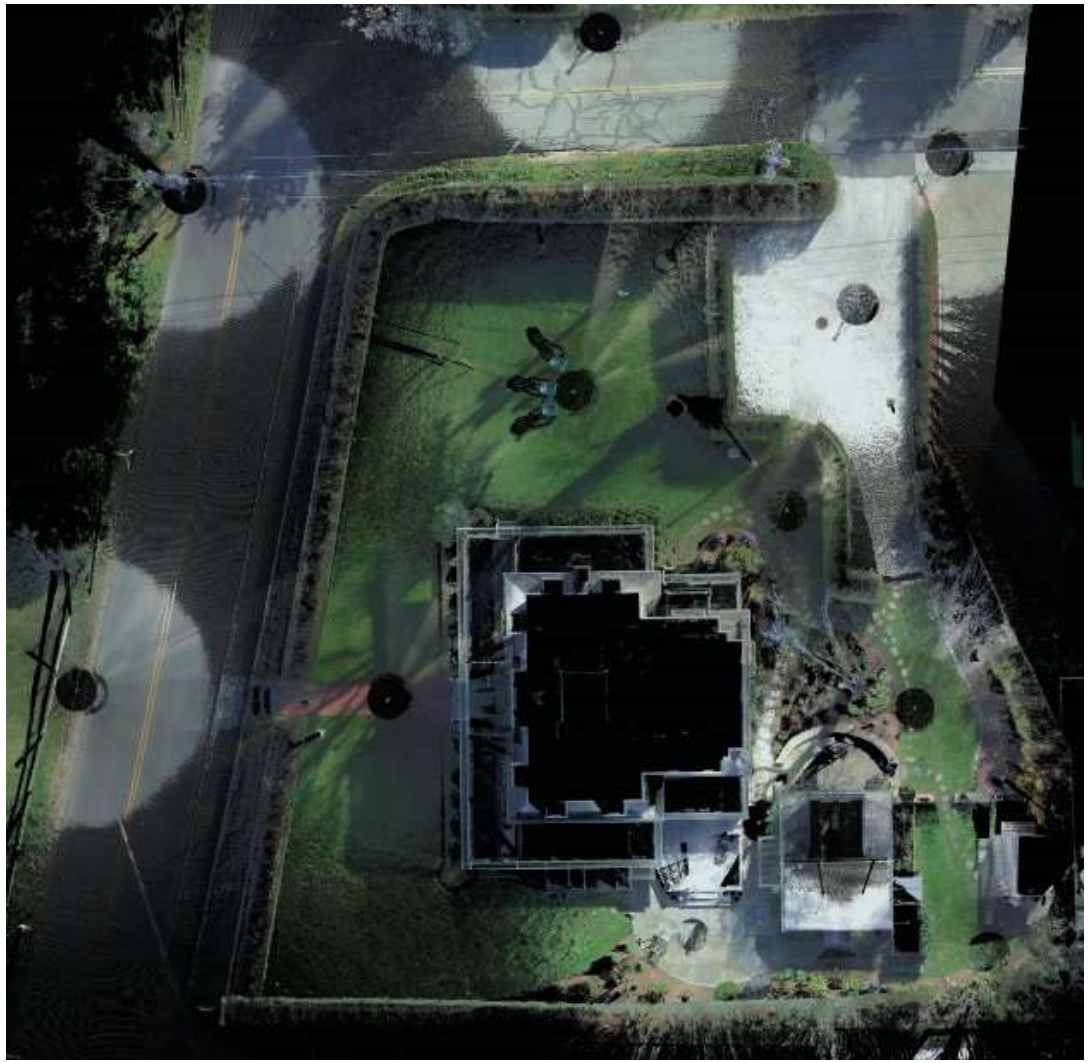
**Trajectory** – The measured path that a GPS & IMU follows. Where a typical point list has PNEZD (point, northing, easting, elevation, description), a tractory has STTXYZOPK (station, time (GPS seconds of the week), time (GPS week), easting, northing, elevation, roll, pitch, yaw. Basically it is the location and angle where the unit is situated and facing at a specific point in time. The output can also include statisitcal components associated with the measurements.



| Station | GPSTime (sec) | Week (week | Easting (usft) | Northing (usft) | H-MSL (usft) | Omega (deg) | Phi (deg) | Kappa (deg) |
|---|---|---|---|---|---|---|---|---|
| 3-K | 567070.400000 | 1851 | 1079514.209 | 2712384.789 | 51.360 | -0.9504185654 | 2.6644130045 | 301.7670569503 |
| 3-K | 567070.405000 | 1851 | 1079514.208 | 2712384.791 | 51.360 | -0.9168609802 | 2.6733211137 | 301.1019981206 |
| 3-K | 567070.410000 | 1851 | 1079514.208 | 2712384.792 | 51.360 | -0.8984867699 | 2.6780191848 | 300.7289272731 |
| 3-K | 567070.415000 | 1851 | 1079514.208 | 2712384.793 | 51.360 | -0.8804958925 | 2.6827868666 | 300.3671540414 |

# Static LiDAR

A laser scanner is mounted on something solid. The scanner rotates, spins or otherwise maneuvers its focus to send and receive laser pulses that reflect off most objects within range and view. Targets are typically set to register the clouds by rotating and translating the raw data to control points and to other raw data sets.



# Aerial LiDAR

Laser scanners are mounted to a plane with GPS and IMU units. The plane is flown, the scanner acquires data, the GPS and IMU acquire the trajectory and everything is processed into a point cloud.  Like aerial imagery, there are data overlaps and control targets on the ground that help to register the clouds.

# Mobile LiDAR

Laser scanners are mounted to a vehicle with GPS and IMU units. The vehicle is driven, the scanner acquires data, the GPS and IMU acquire the trajectory and everything is processed into a point cloud. There are data overlaps and control targets on the ground that help to register the clouds. The vehicle can be just about anything: car, truck, boat, wagon, train, golf cart, backpack, drone, shopping cart, beefy remote controlled car, lawnmower, tractor, etc...

# Point Cloud

Point Clouds are simply point files.  Text files.  They make some fancy formats to manipulate millions of points.  They can all be converted to a slow, clunky Text file.

There are many conversion programs available.

# Point Cloud

| Text | rapidlasso | ASTM |
| --- | --- | --- |
| *.txt | *.las | *.e57 |
| *.xyz | *.laz | |

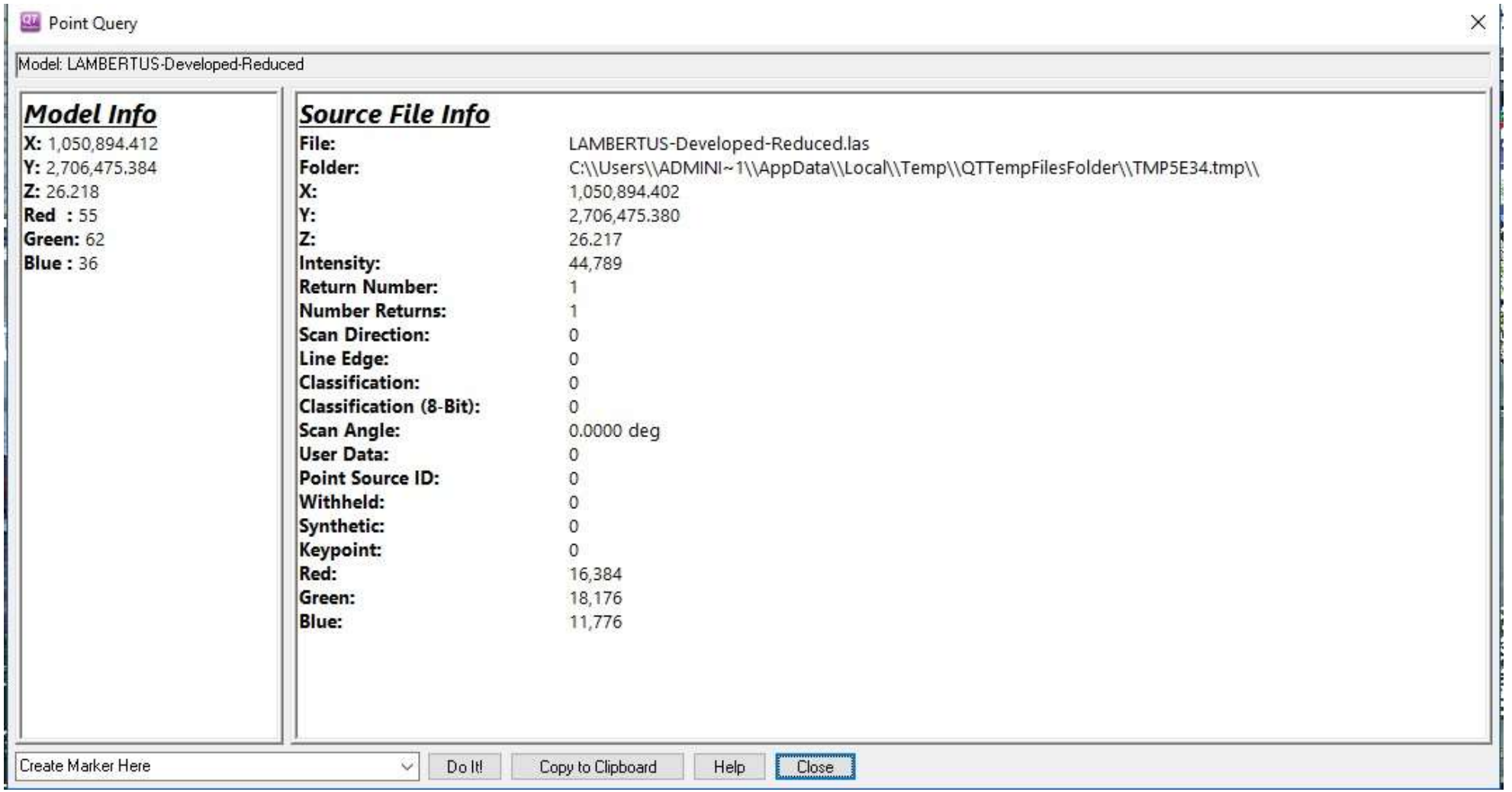
There are some proprietary formats out there as well, for example:

| Pointools | Tesseract | 3dtk | Leica |
| --- | --- | --- | --- |
| *.pod | *.bxyz | *.oct | *.pts |
| | | | *.ptx |

**There are more.**

# Point Cloud

**XYZ** – It'd be a little hard to have a point in 3-space without a 3-tuple (ie a Coordinate).

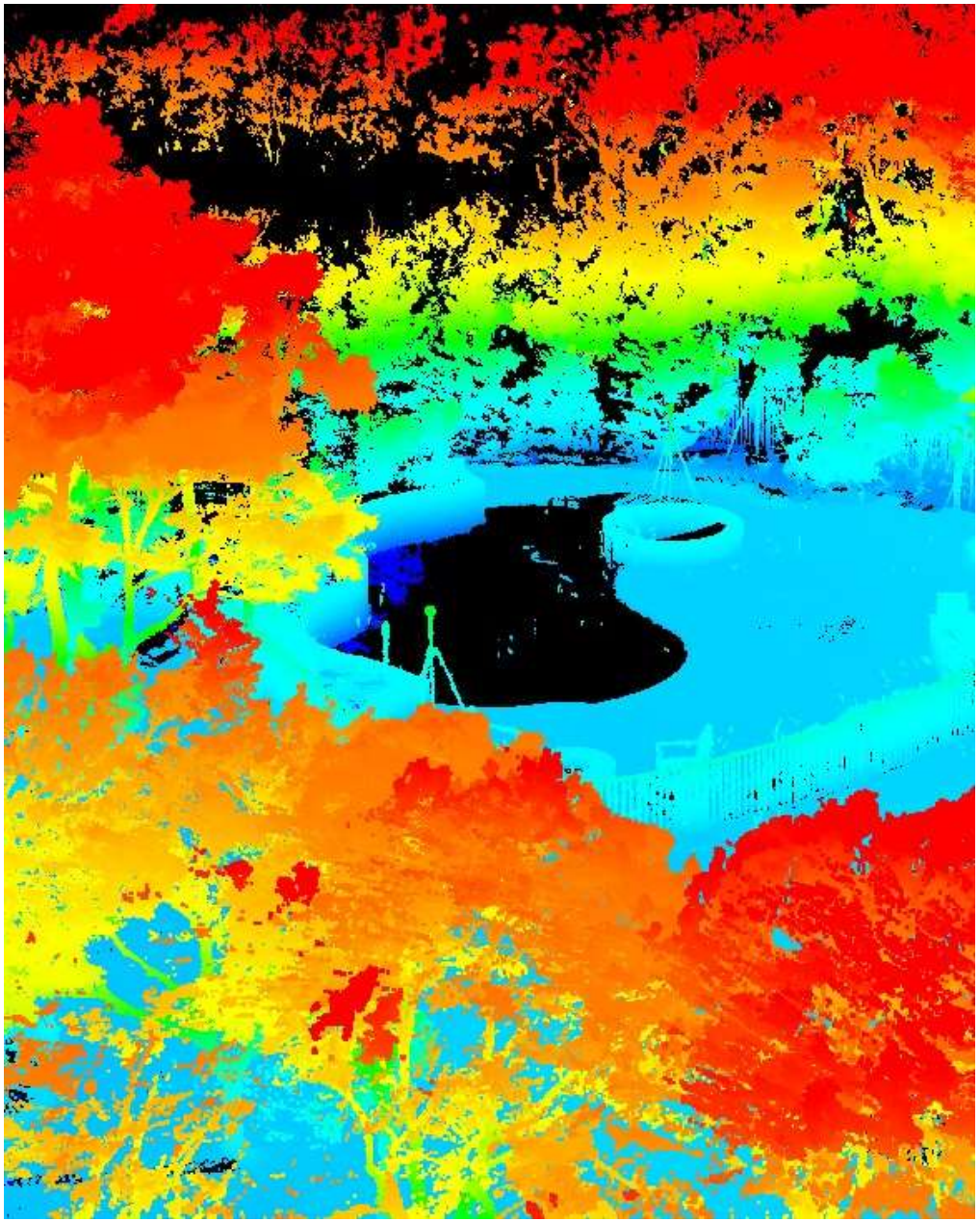


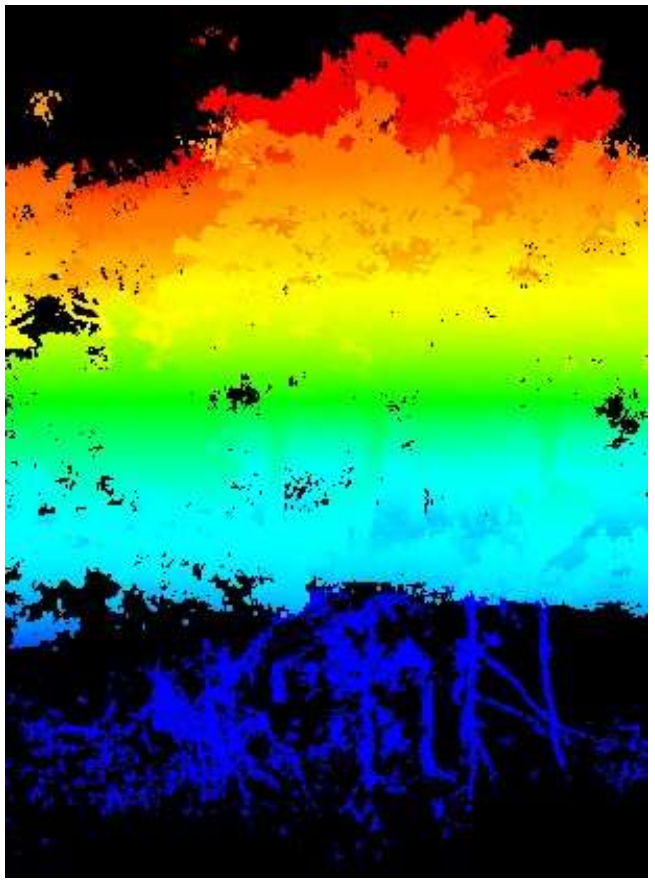
**RGB** – The points can be colorized from imagery, the color data can be stored in the cloud file.

Values can range but all are based on 2 to the power of something.  [0,1], 256 and 65,536 being fairly common.

**i** – Intensity is a common return from the scanners. How reflective is the surface? Highly reflective surfaces have the tendency to send the lasers off to space or some other object.

# **z** – The view can change based on height.





To the right is a shot of the pool and to the left are the reflected locations of the trees.

# Point Cloud

**T –** Time, usually GPS Time in seconds of the week with GPS week. The GPS Week Number count began at midnight on the evening of 05 January 1980 / morning of 06 January 1980.

**C –** Classification. There are several standard classifications: Ground, Building, Vegetation (low, med, high), Water, Utilities and so on…

**A –** Attributes. Oh yes, you can add other things. It is usually better to let the computer handle all this as the task would overwhelm any person.

# Programs

- RapidLasso Tools - https://rapidlasso.com/lastools/
  - ESRI & QGIS Toolboxes
- Quick Terrain Viewer - http://appliedimagery.com/
- Fugro Viewer - https://www.fugro.com/about-fugro/our-expertise/technology/fugroviewer
- Cloud Compare - http://www.danielgm.net/cc/
- http://www.ese-llc.com/lidar

# ⚠ CAUTION

## DO NOT STARE INTO BEAM

## LASER IN USE