quantum SPATIAL

Small UAS-based LiDAR Acquisition and Processing Considerations for Natural Resource Management

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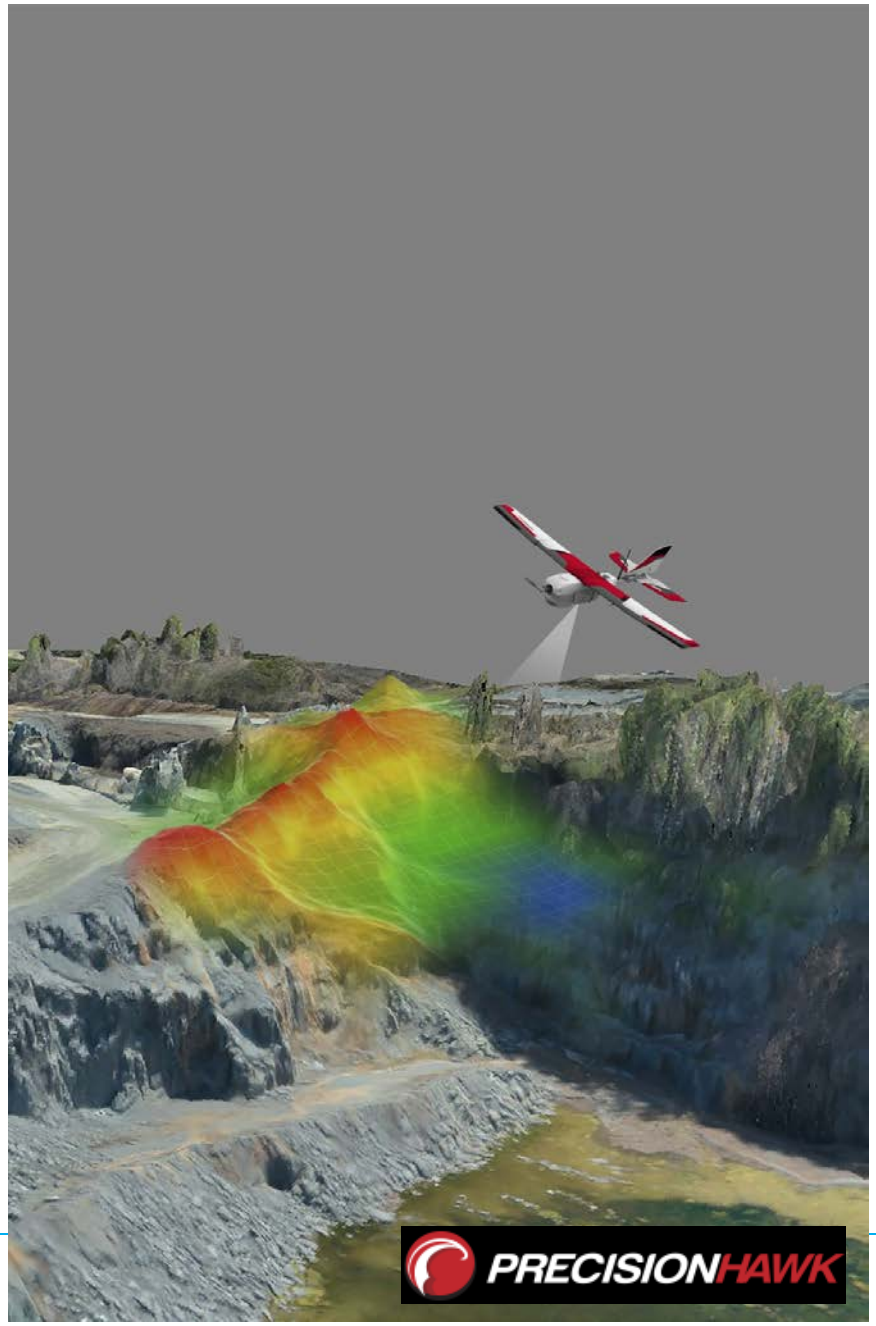
Matt Coleman, Precision Hawk

Coastal GeoTools 2017
Thursday, 2/9/17

Outline

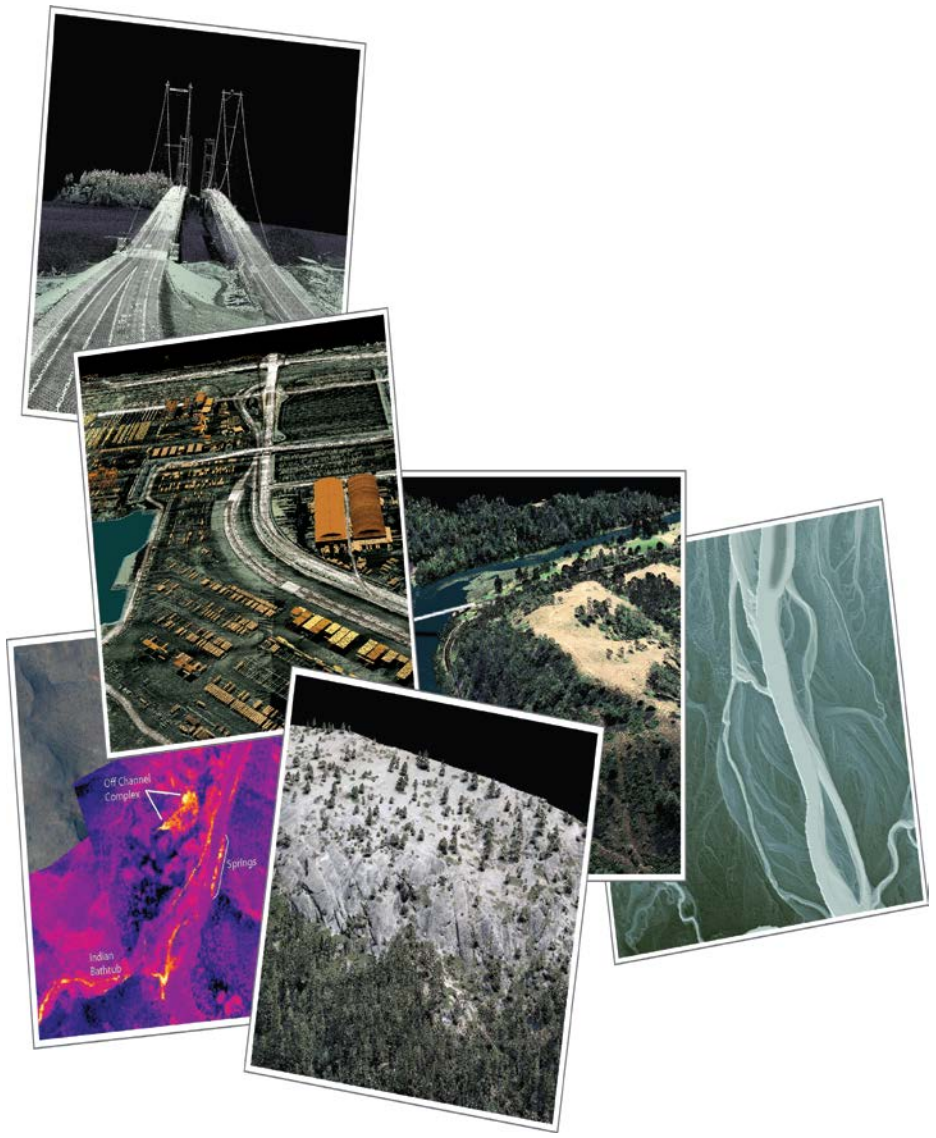
- Introduction
- NOAA Natural Resource Interests
- UAS-Based Lidar
- Test Results



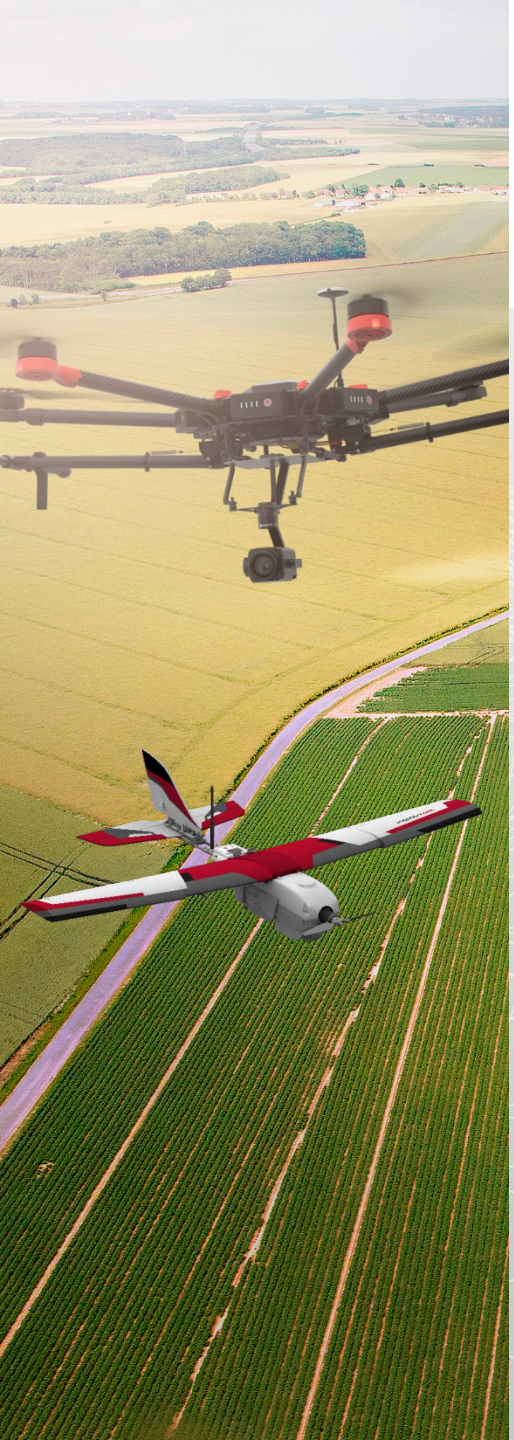
Quantum Spatial

- Full service geospatial firm
  - Data acquisition & processing
  - Solutions & product development
  - Custom analytics & applications development
  - Enterprise GIS

- Airborne LiDAR (2017)
  - 70,804 sq mi of topographic LiDAR
  - 1,500 sq miles of topo-bathy LiDAR
  - Data collected in 45 states



Mapping & Engineering Clients



PRECISIONHAWK

- PrecisionHawk provides an enterprise platform that uses advanced drone technology to collect and analyze data to improve business intelligence. The platform includes automated flight planning, data collection, analytics as well as tracking and safety.
- PrecisionHawk also serves as a key leader in shaping regulations and policies that promote the safe and rapid adoption of drones both through its work under the FAA Pathfinder program and development of its LATAS drone safety platform.
- The company is privately held and located in Raleigh, NC and Toronto, Canada. The company has nearly 200 employees around the globe.

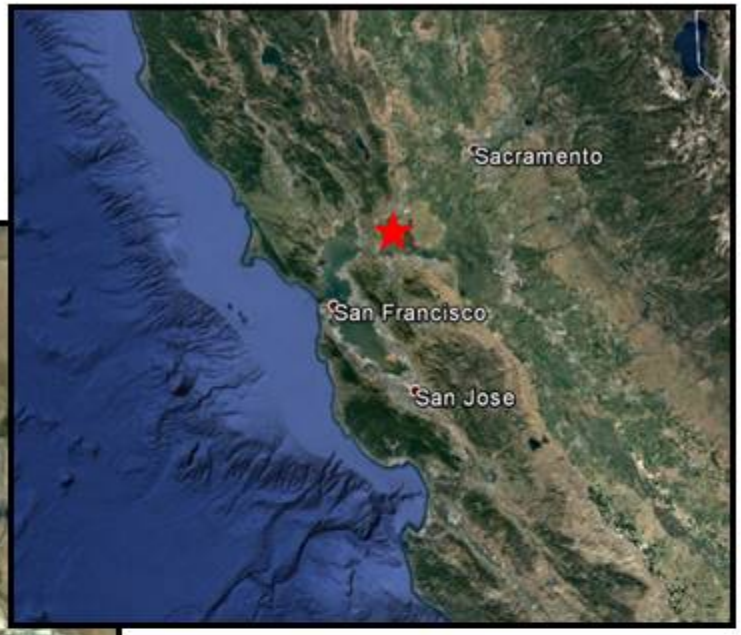
UAS Lidar

NOAA RESEARCH INTERESTS

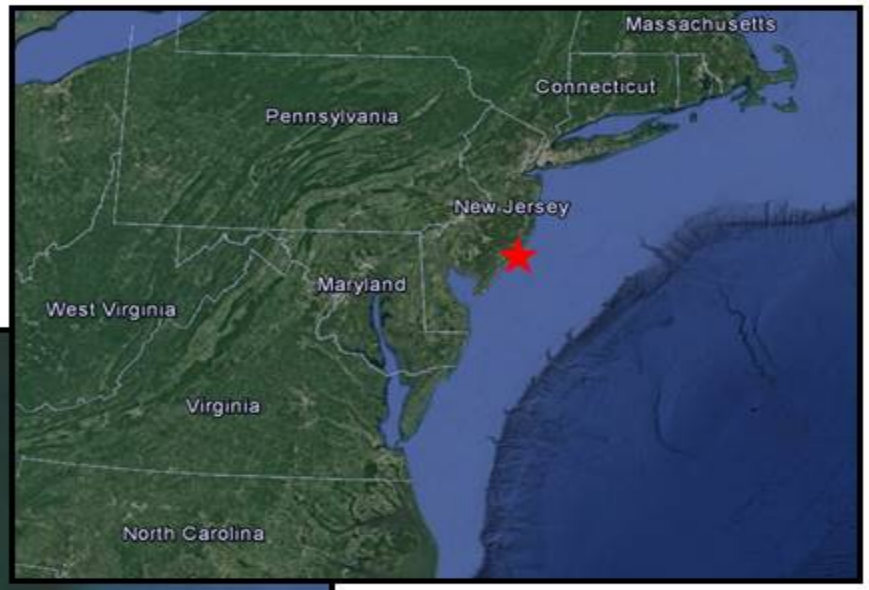
NOAA NERRs Project

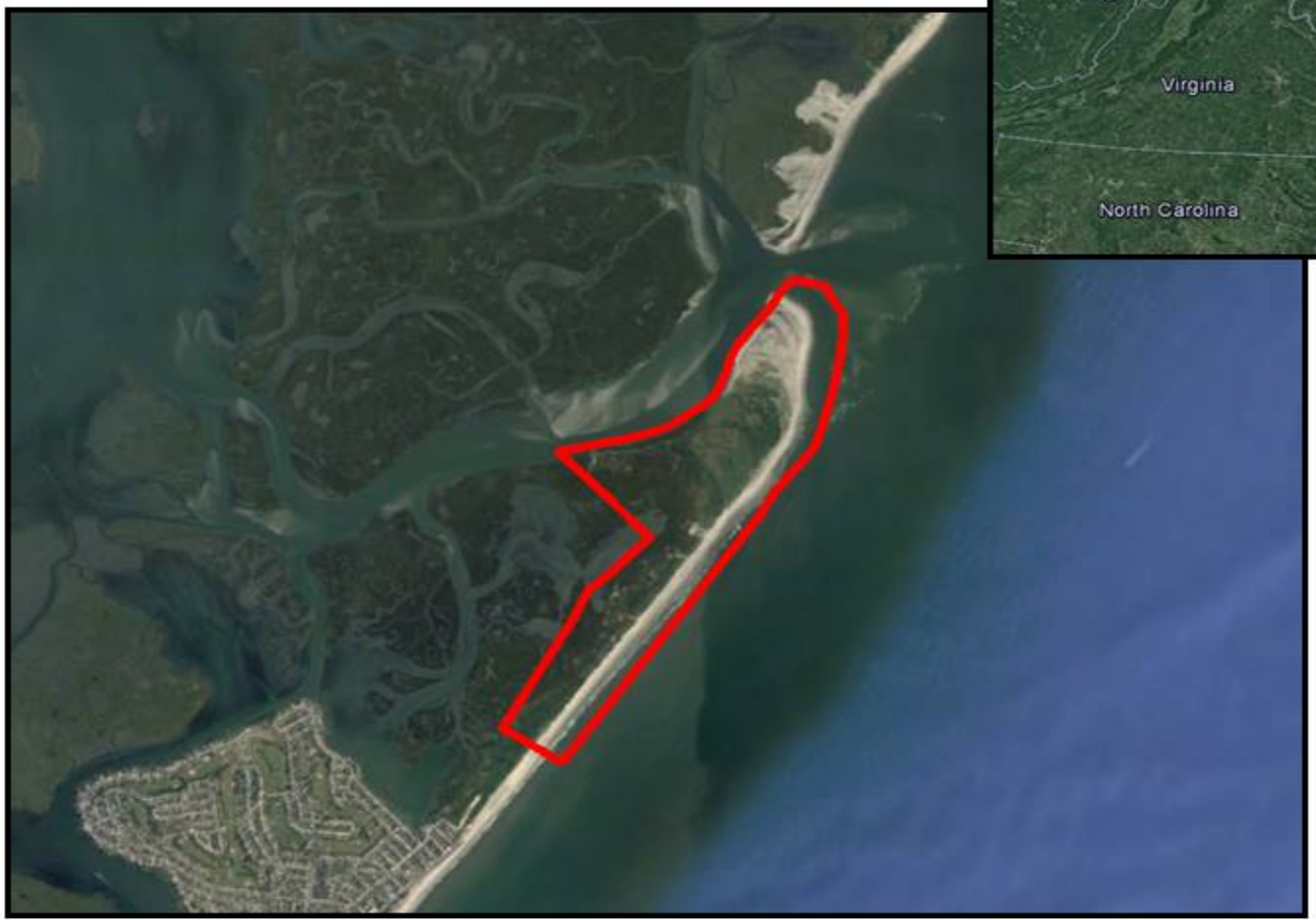
- Objective: Collect LiDAR data from a UAS, to evaluate its capabilities in management and monitoring within the National Estuarine Research Reserves System (NERRs).
  - NERRs are jointly managed and funded by NOAA's Office for Coastal Management (OCS) and pertinent States
- Evaluating flexibility and cost-efficiency
- Three NERR Sites (two-time periods at one site)
  - Range of ecosystems
- Each <= ~1 sq. mile

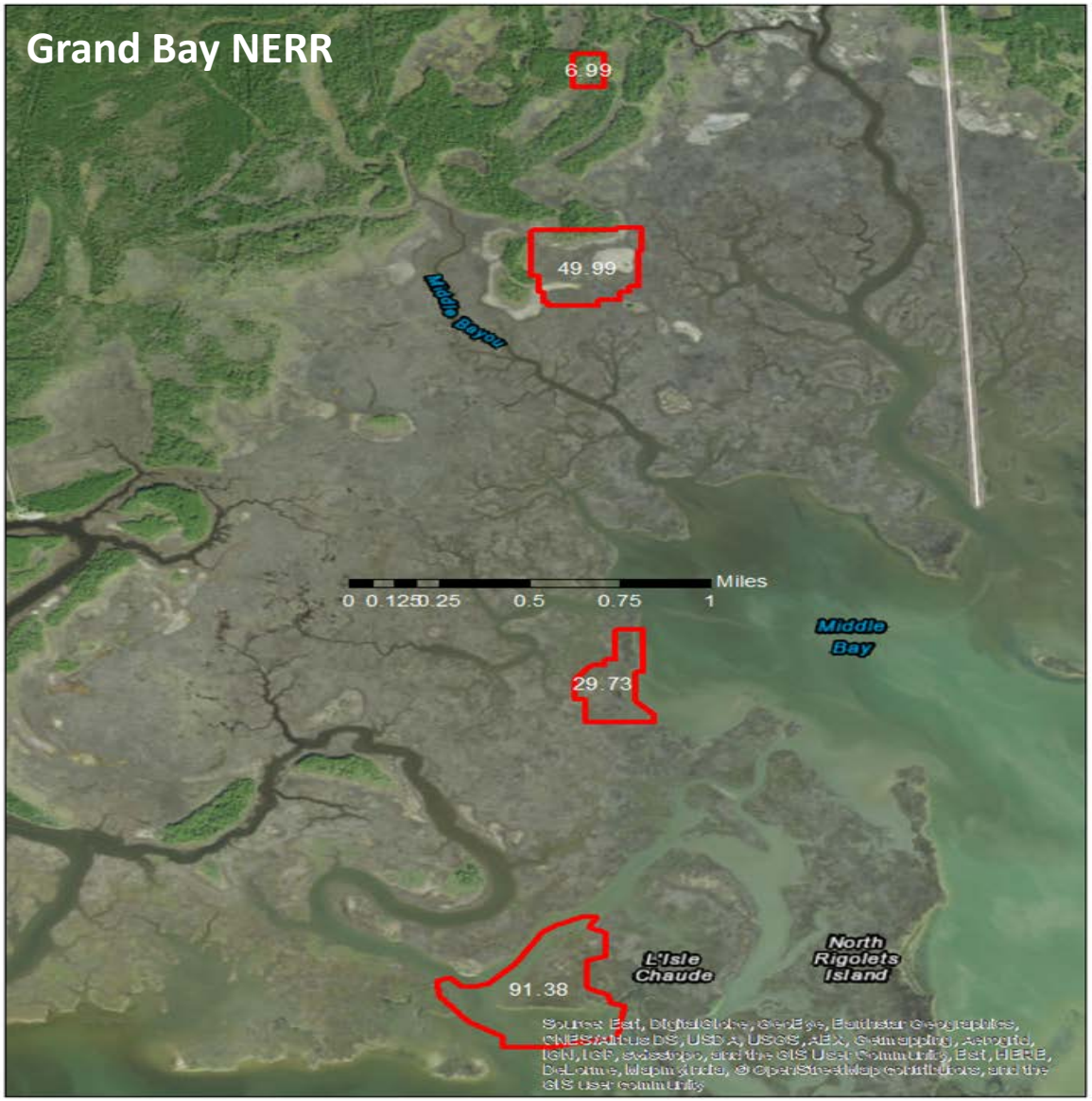
Rush Ranch



Brigantine Area

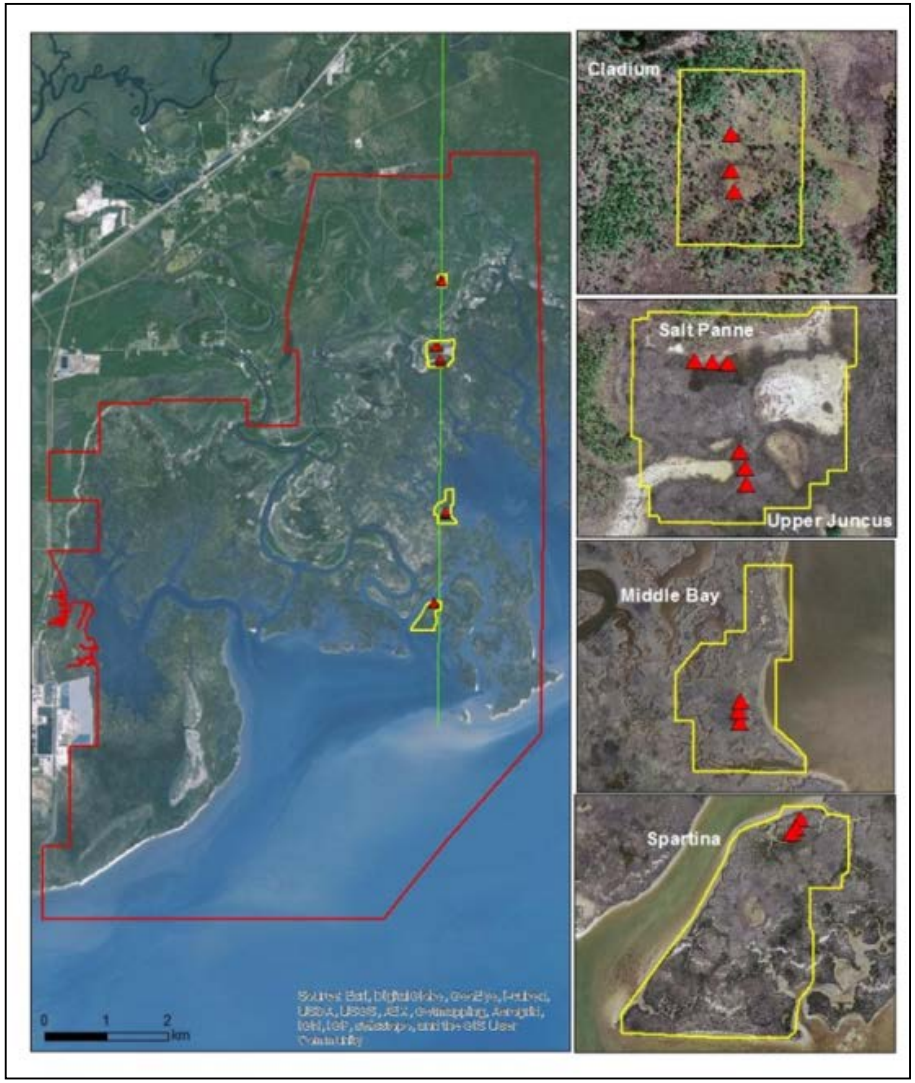





Grand Bay NERR
6.99
49.99
Middle Bayou
Miles
0 0.125 0.25 0.5 0.75 1
Middle Bay
29.73
L'Isle Chaude
North Rigolets Island
91.38

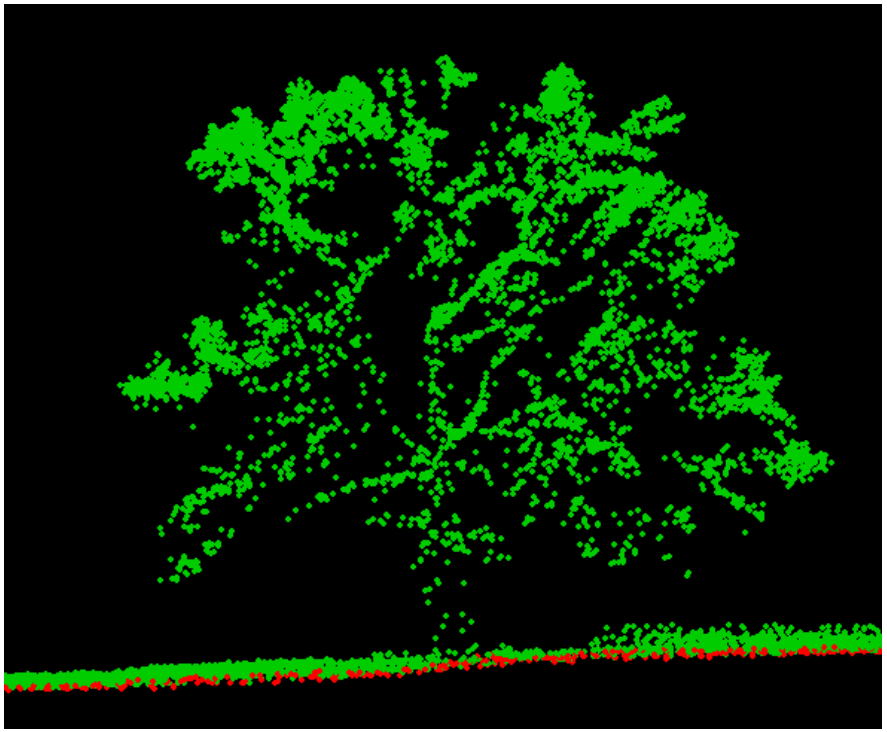
NERRS LiDAR Requirements

- Lidar nominal pulse spacing <=20 cm.
- Lidar vertical accuracy 10 cm RMSEz
- Classified to ASPRS LAS specs (min: ground, water, unclassified).



Objectives

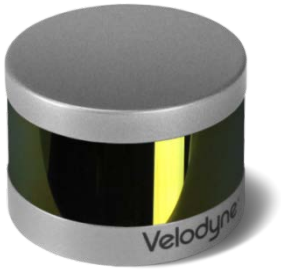
- Achieve traditional mapping grade accuracy w/ low-cost UAS LiDAR
- Develop best practices for mission planning and data processing
- Determine trade-offs



UAS Lidar

UAS-BASED LIDAR

Commercial UAS LiDAR Sensors



Velodyne Puck
VLP-16

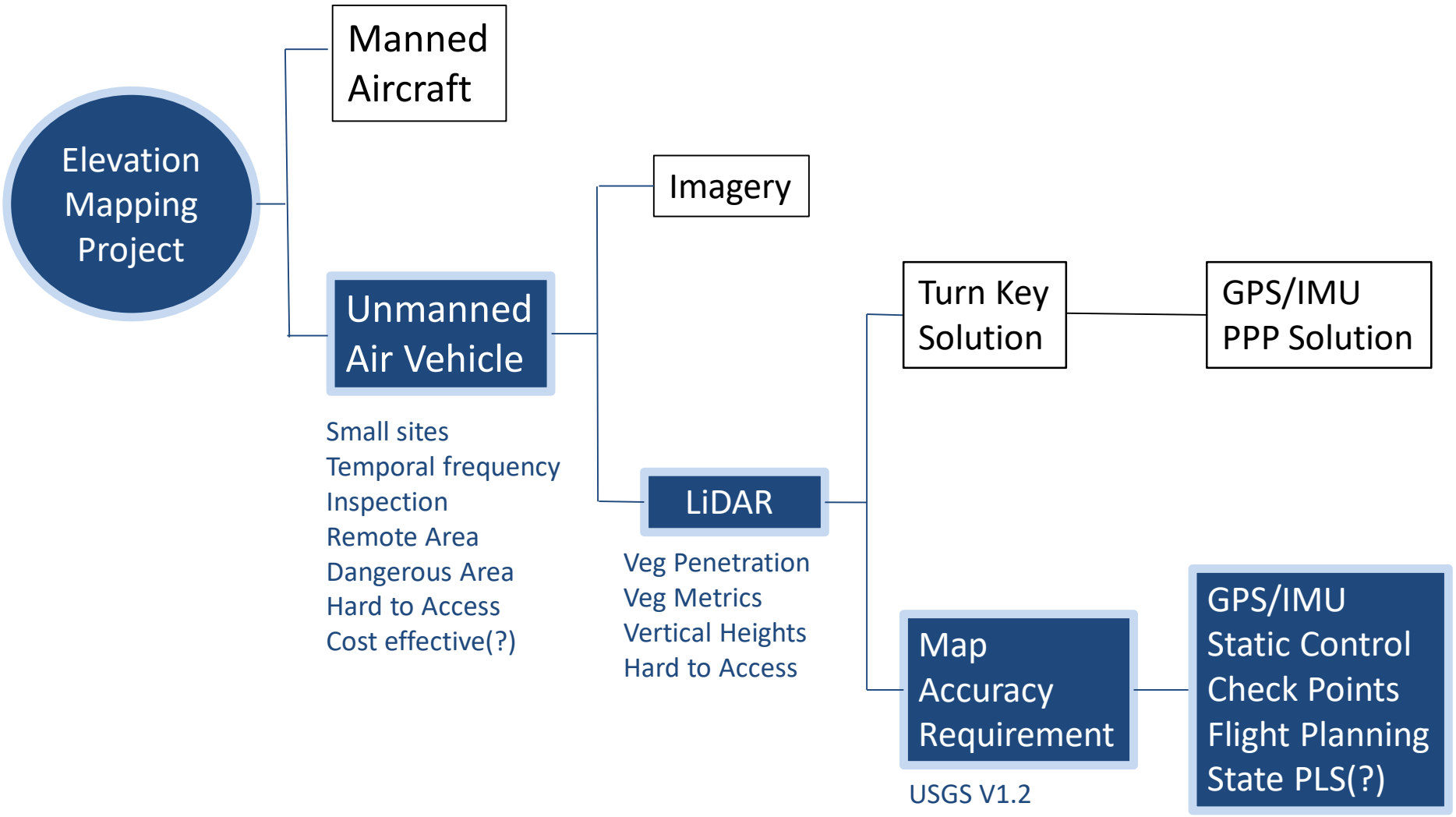
Riegl VUX-1UAV

Geodetics

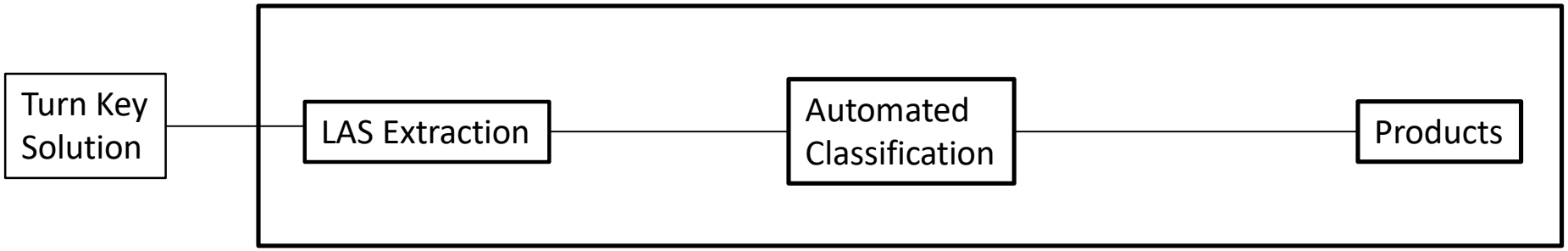
Routescene LiDAR Pod

YellowScan
Surveyor

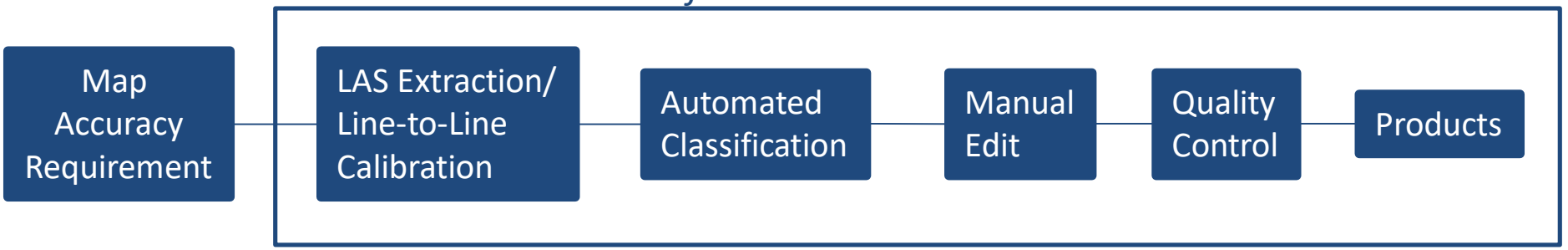
Images Not to Scale!

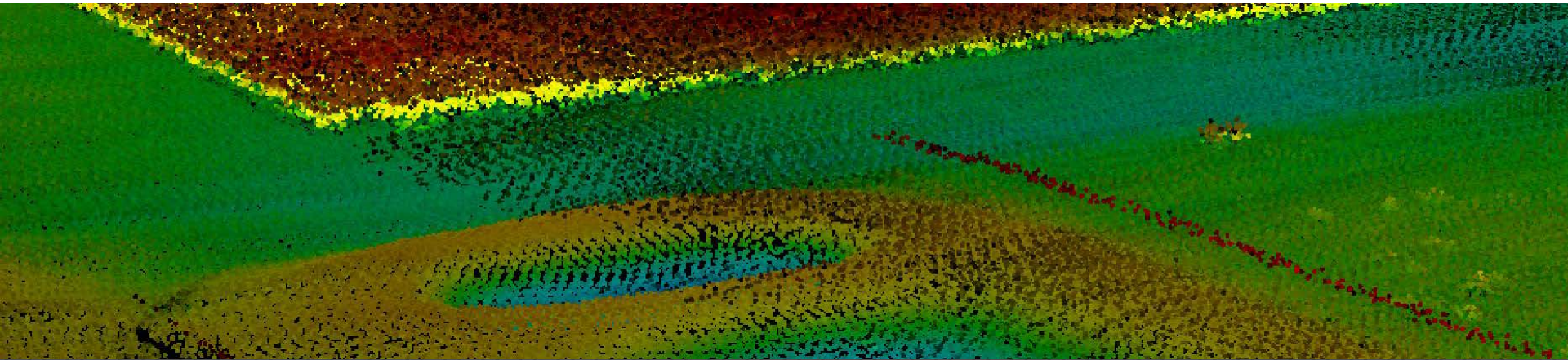

Elevation Mapping Project
Manned Aircraft
Unmanned Air Vehicle
Small sites
Temporal frequency
Inspection
Remote Area
Dangerous Area
Hard to Access
Cost effective(?)
Imagery
LiDAR
Veg Penetration
Veg Metrics
Vertical Heights
Hard to Access
Turn Key Solution
GPS/IMU PPP Solution
Map Accuracy Requirement
USGS V1.2
GPS/IMU
Static Control
Check Points
Flight Planning
State PLS(?)

Rapid Assessment LiDAR Workflow



Traditional LiDAR Workflow





UAS Lidar

TESTING

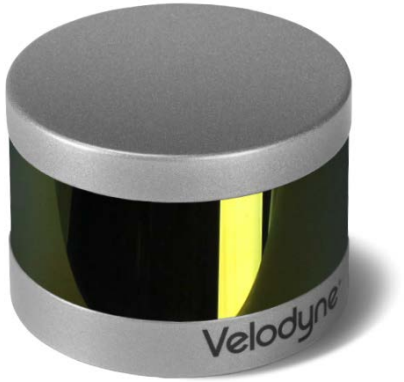
UAS & Sensor

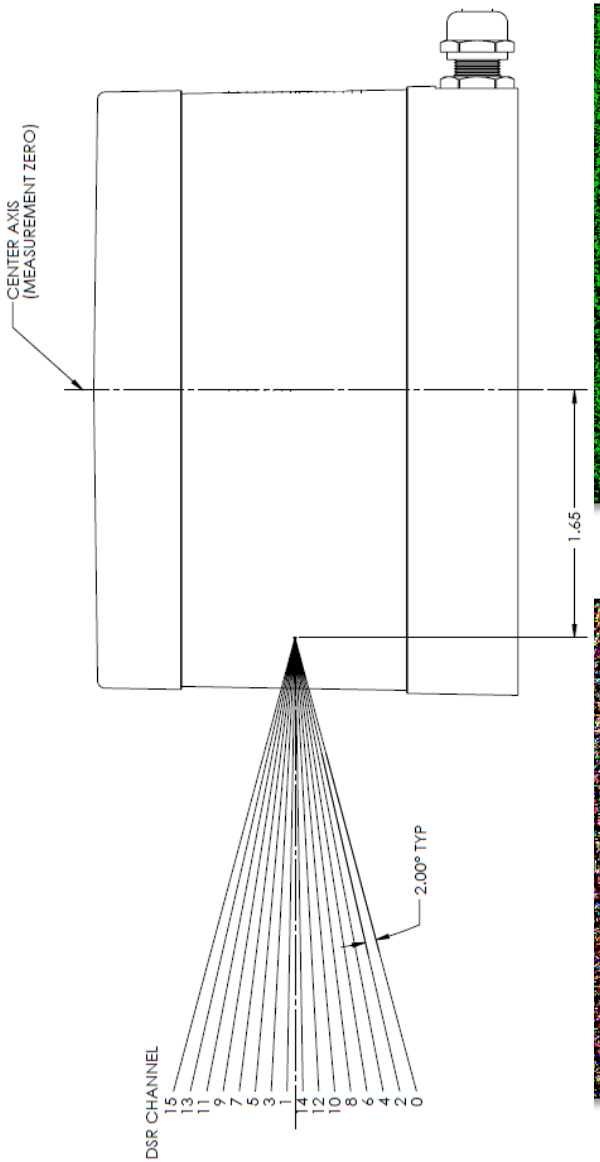
- Precision Hawk Lancaster 5
- Interchangeable/swappable sensors

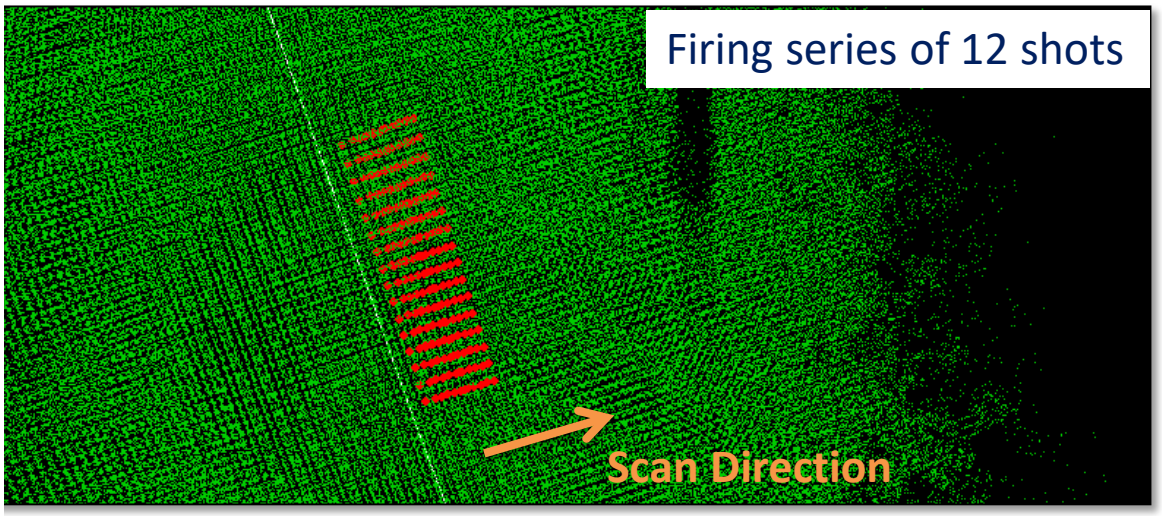
Sensor Characteristics

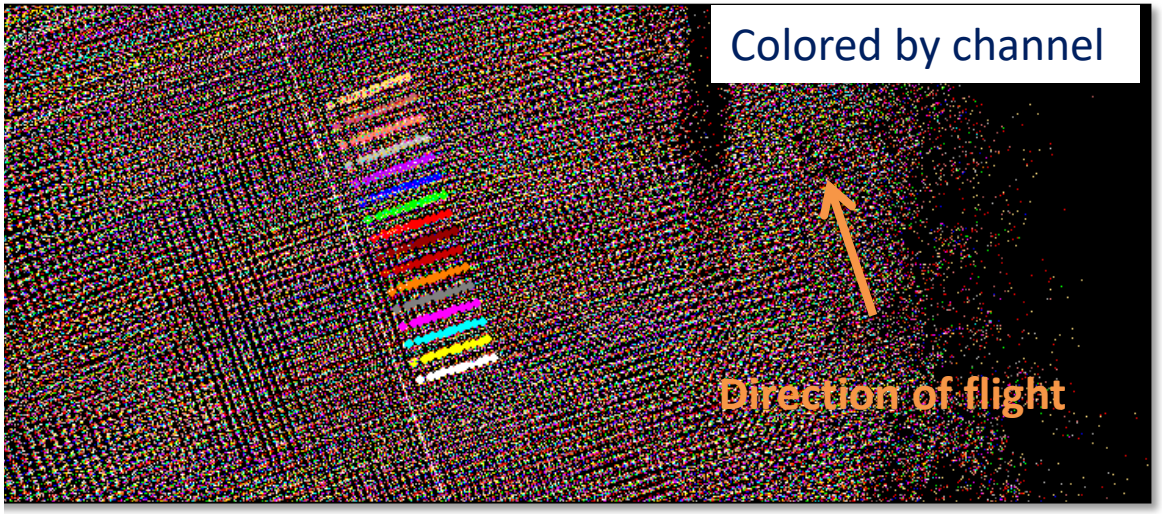
- 16 fixed channels
  - 30 degree FOV (+15 to -15); orthogonal to sensor rotation
- ~300kHz PR (50kHz effective PR @ 60 deg FOV)

- 903nm wavelength
- 6ns pulse duration
- Up to 2 returns per pulse (strongest/last returns)
- Effective range: 100m (40-60m typical)
- Discrete point distance of 1m (min)
- 3mrad beam divergence
- (~15cm spot size @50m AGL)

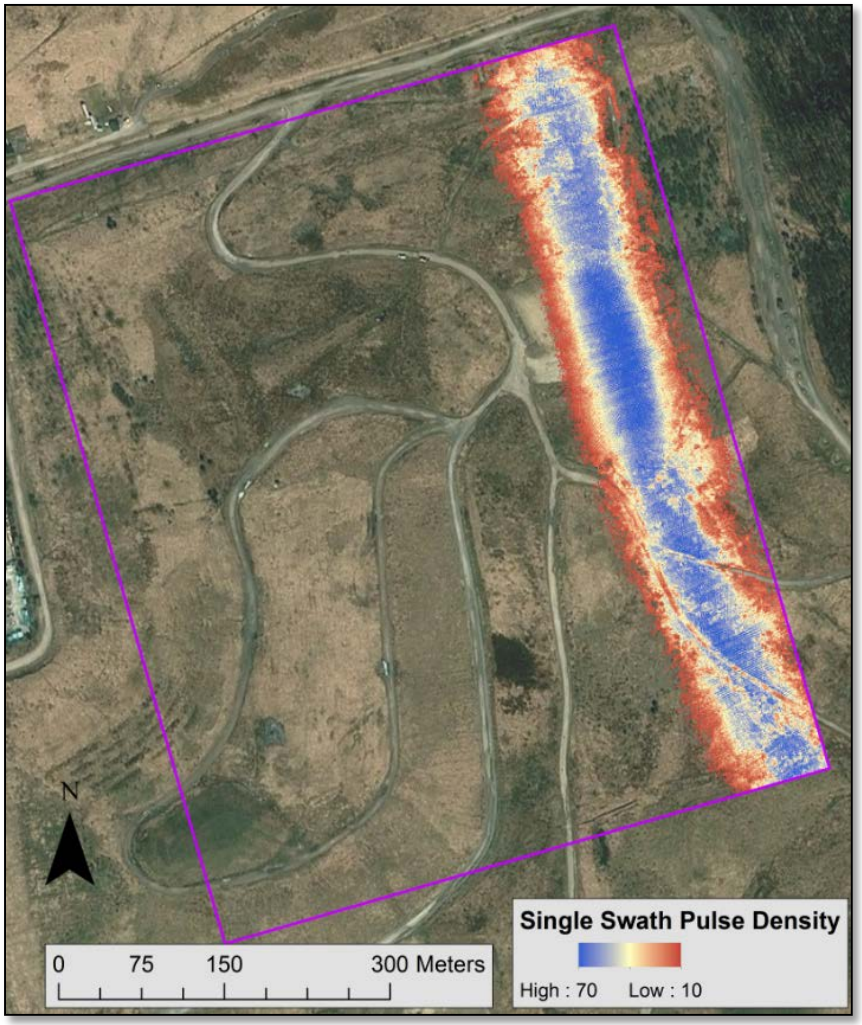


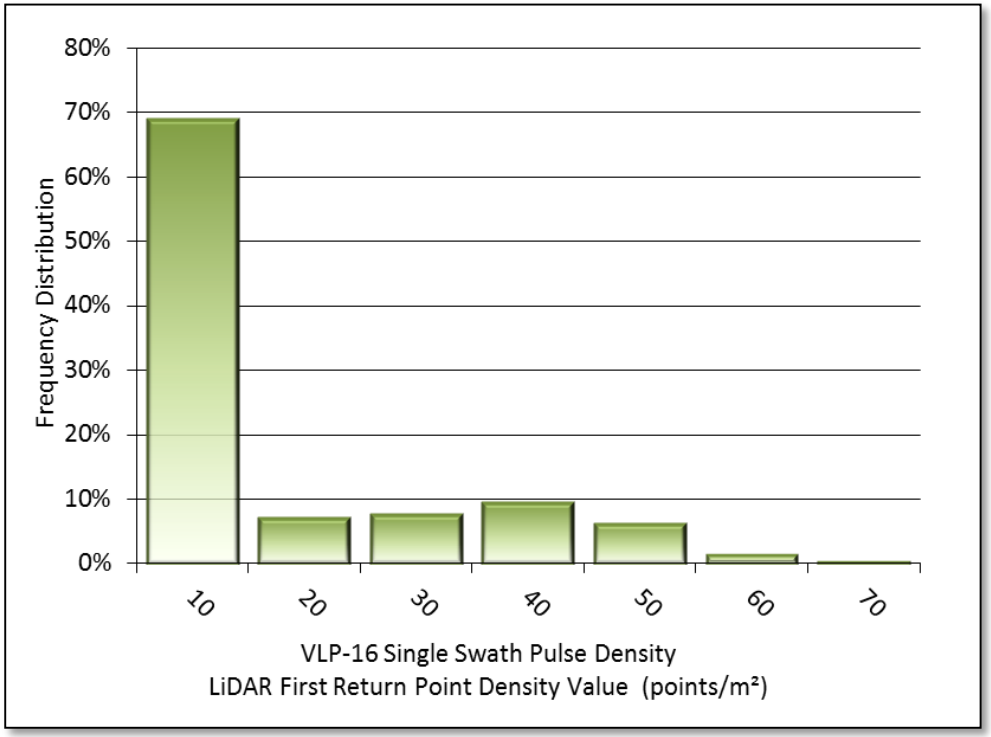

CENTER AXIS
(MEASUREMENT ZERO)
1.65
2.00° TYP
DSR CHANNEL
15
13
11
9
7
5
3
1
14
12
10
8
6
4
2
0


Firing series of 12 shots
Scan Direction

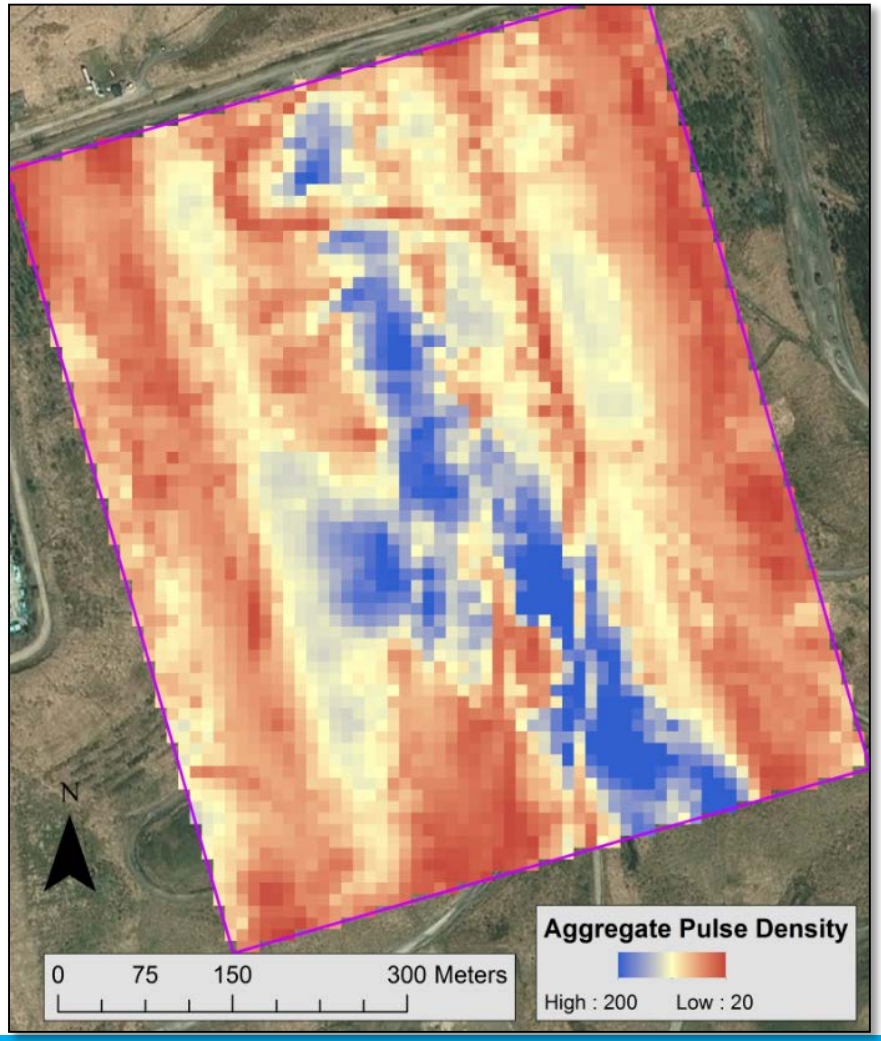

Colored by channel
Direction of flight

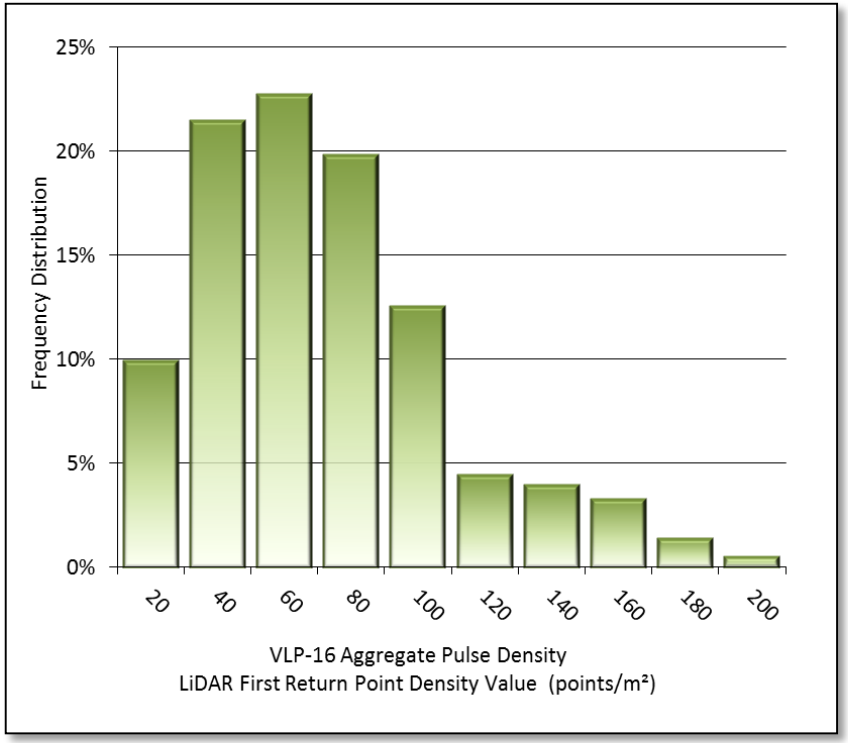
Single Swath Return Density



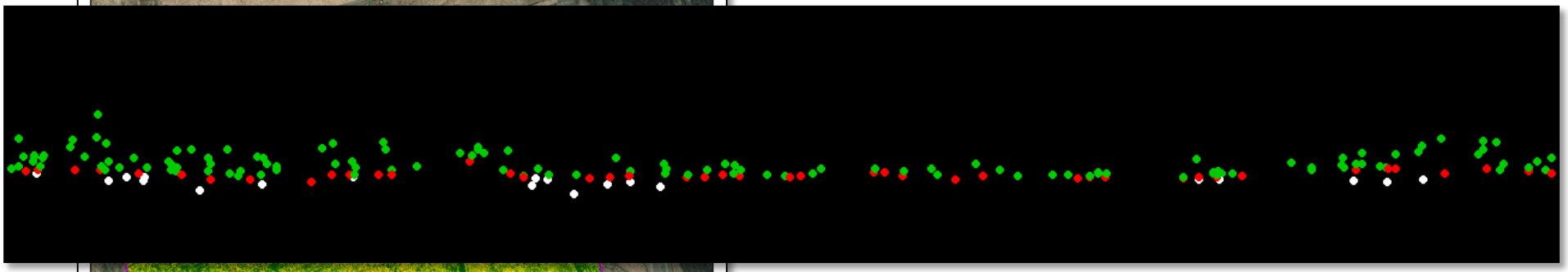


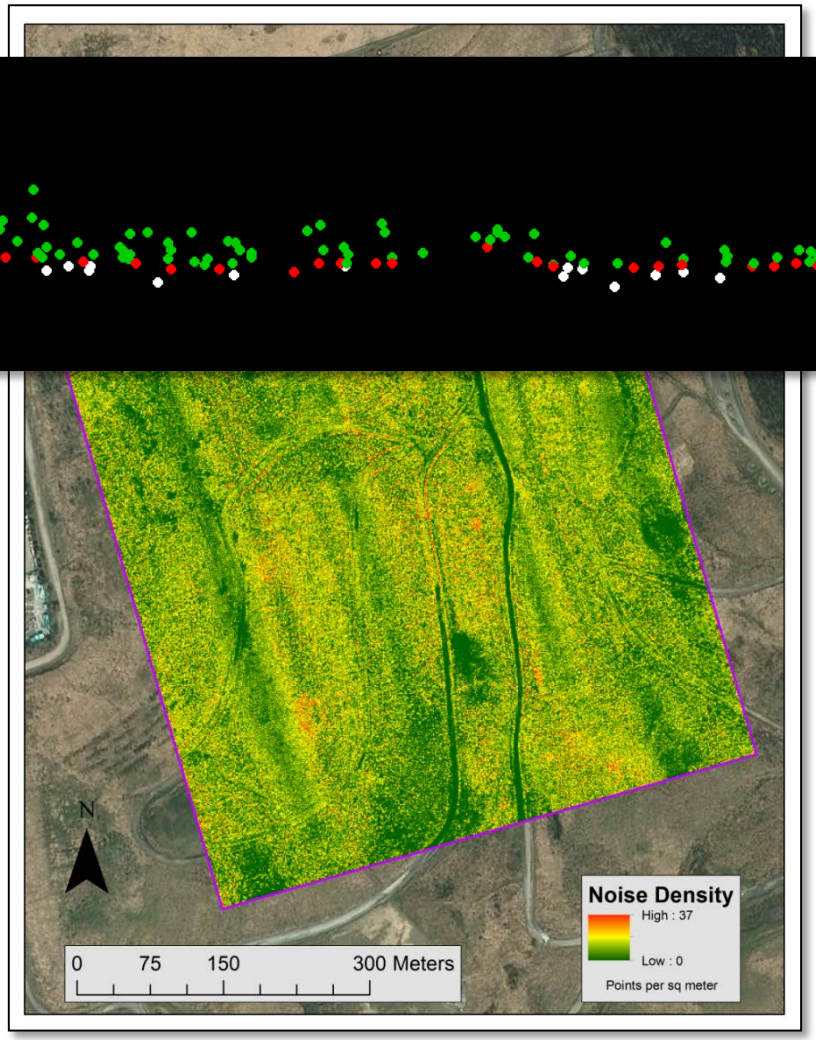
Aggregate Return Density

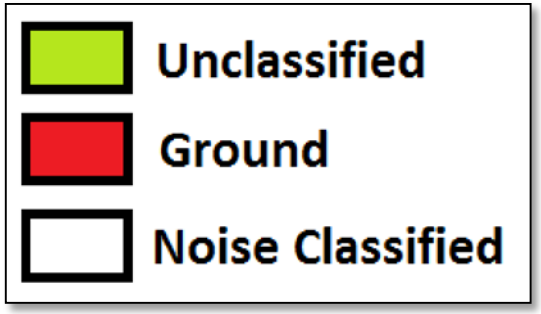




Filtered Noise

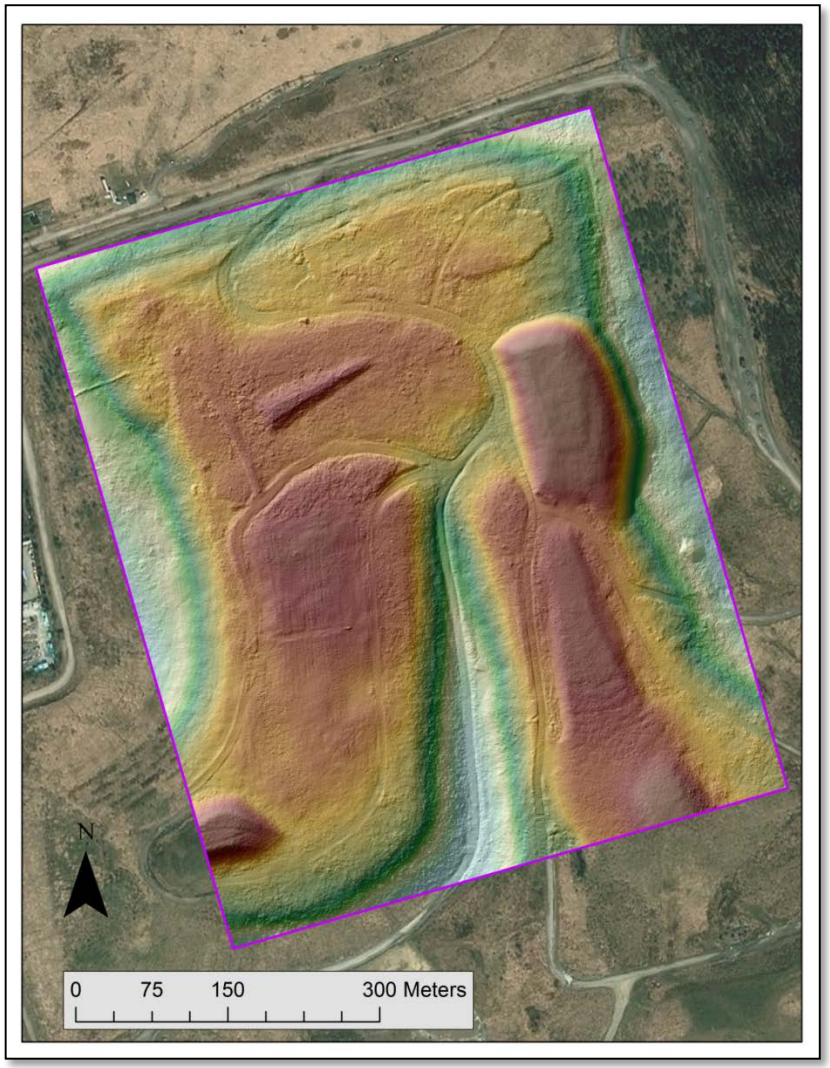






Noise Filtered Points	
Total number of points	29,283,095 points
Noise classified	4,340,588 points
Percentage Valid Returns	90.9%

Toronto Ground Model

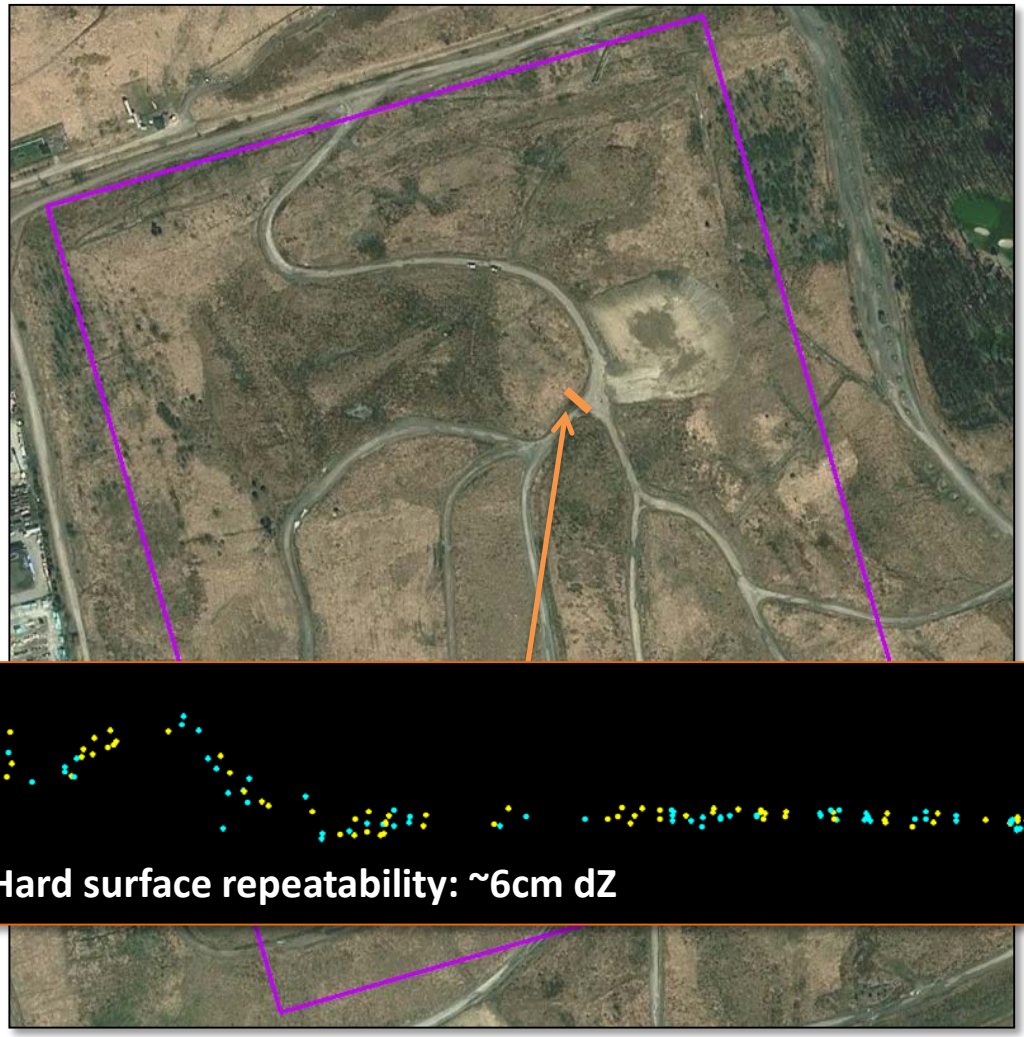


Toronto Absolute Accuracy

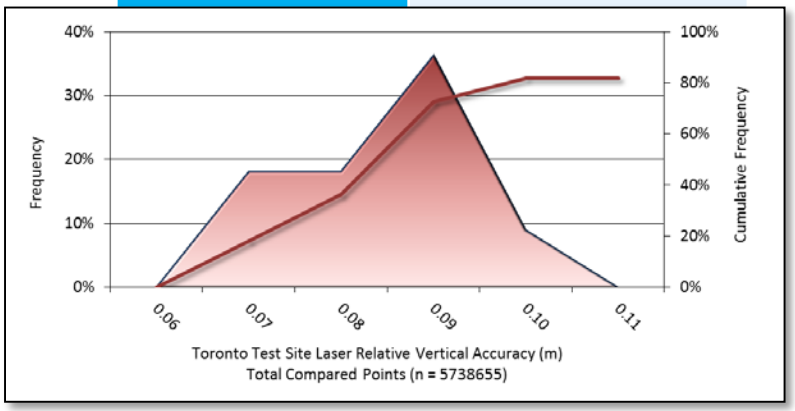
Absolute Accuracy	
	Ground Check Points
Sample	14 points
NVA (1.96*RMSE)	0.326 m
Average	-0.002 m
Median	0.032 m
RMSEz	0.166 m
Standard Deviation (1σ)	0.166 m

Systematic shift applied to LiDAR dataset

Toronto Relative Accuracy



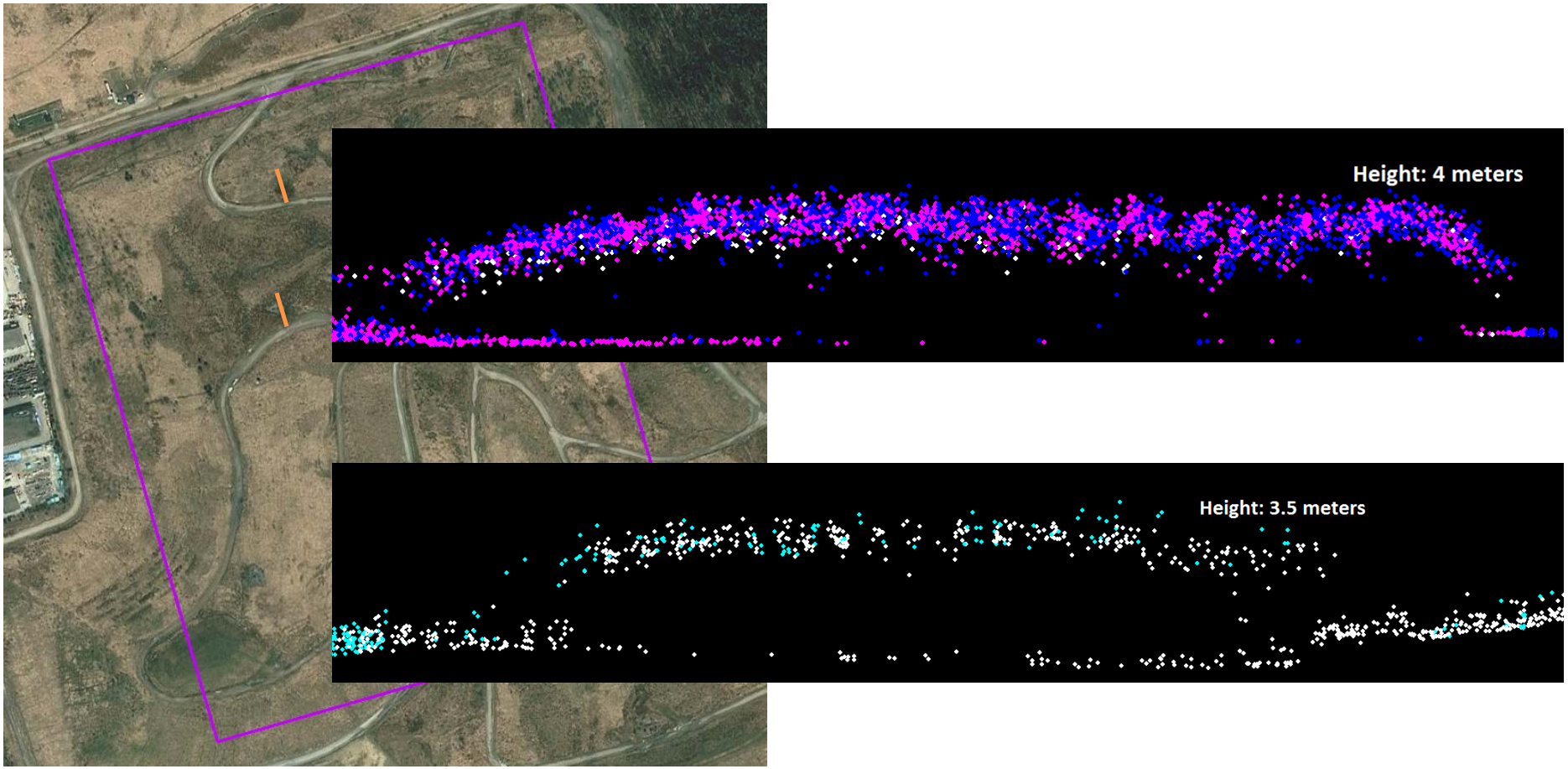
Relative Accuracy	
Sample	11 surfaces
Average	0.089 m



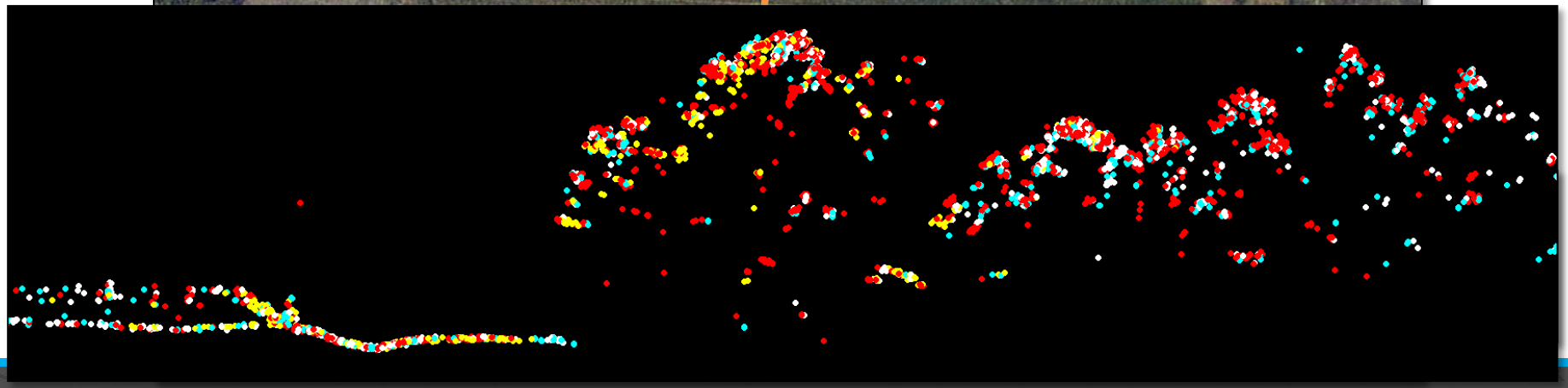
Cross section depth: 10cm
Colored by Flightline

Hard surface repeatability: ~6cm dZ

Vegetation



Vegetation

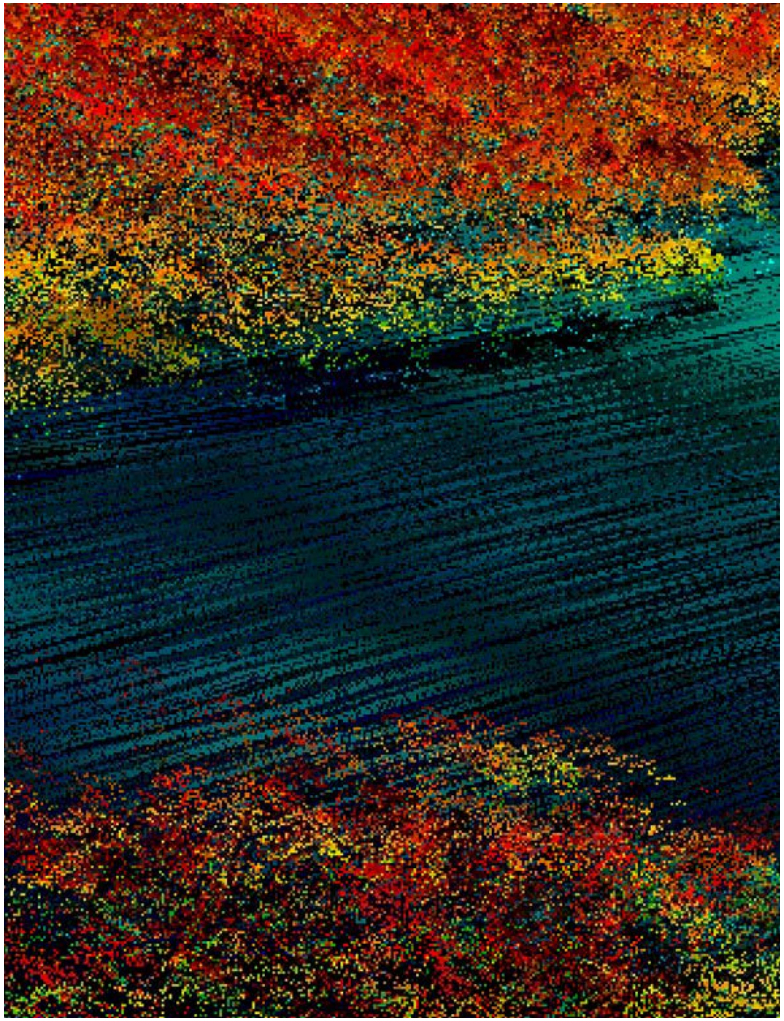


UAS Lidar

SUMMARY

Summary

- Fully understand and plan the project based on the use case
- UAS LiDAR technology is continually improving
- Upcoming flight tests in Corvallis, OR and Raleigh, NC



Thank You

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