



Comparison of Inertial Profiler Measurements with Leveling and 3D Laser Scanning

Abby Chin and Michael J. Olsen
Oregon State University

Road Profile Users Group
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Outline

- Research Objectives & Plan
- 3D Laser Scanning
- Field Data
- Observations & Future Work

Research Objectives

- Establish certification test site
- Determine repeatability and accuracy of reference profiler (inclinometer)
- Develop procedures and guidelines for certification of inertial profilers

Background

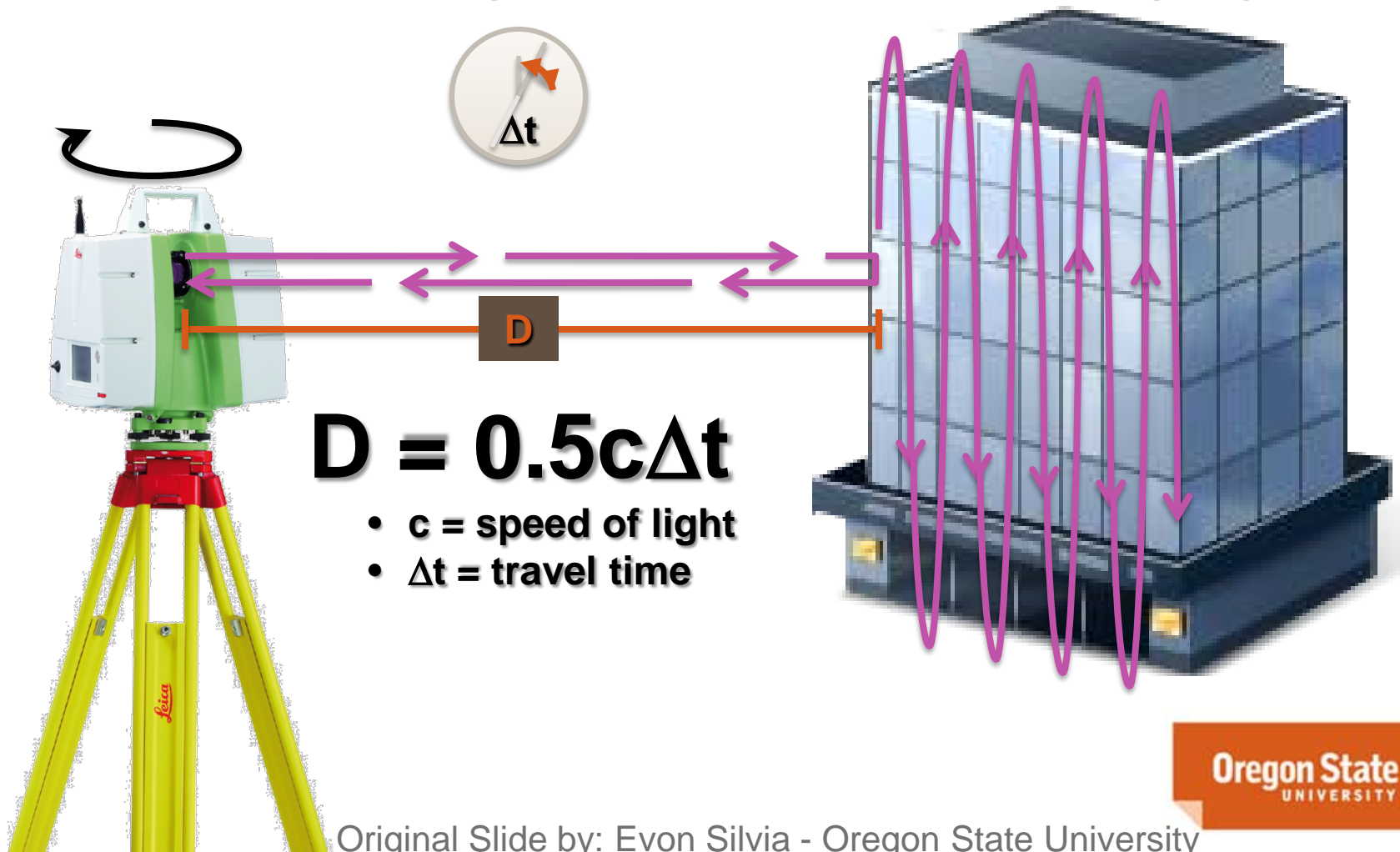
- ODOT is implementing IRI-based incentive/disincentive program
- Certification on site proved difficult
- Inertial profilers were showing great repeatability, but did not meet AASHTO criteria

Research Plan

- Compare Methods
 - Inertial Profiler
 - Terrestrial LiDAR
 - Rod and Level
 - Inclinator Profilers
- Develop Certification Procedure Guidelines
- Pavement Texture Analysis
 - Study Roughness and Aggregate Size

What is LiDAR?

LiDAR = Light Detection and Ranging



Terrestrial LiDAR

- Time of Flight System
- Produces 3D Point Cloud
- ~5 mm Accuracy at 50 m
- Data are Geo-referenced
 - Targets
 - GPS

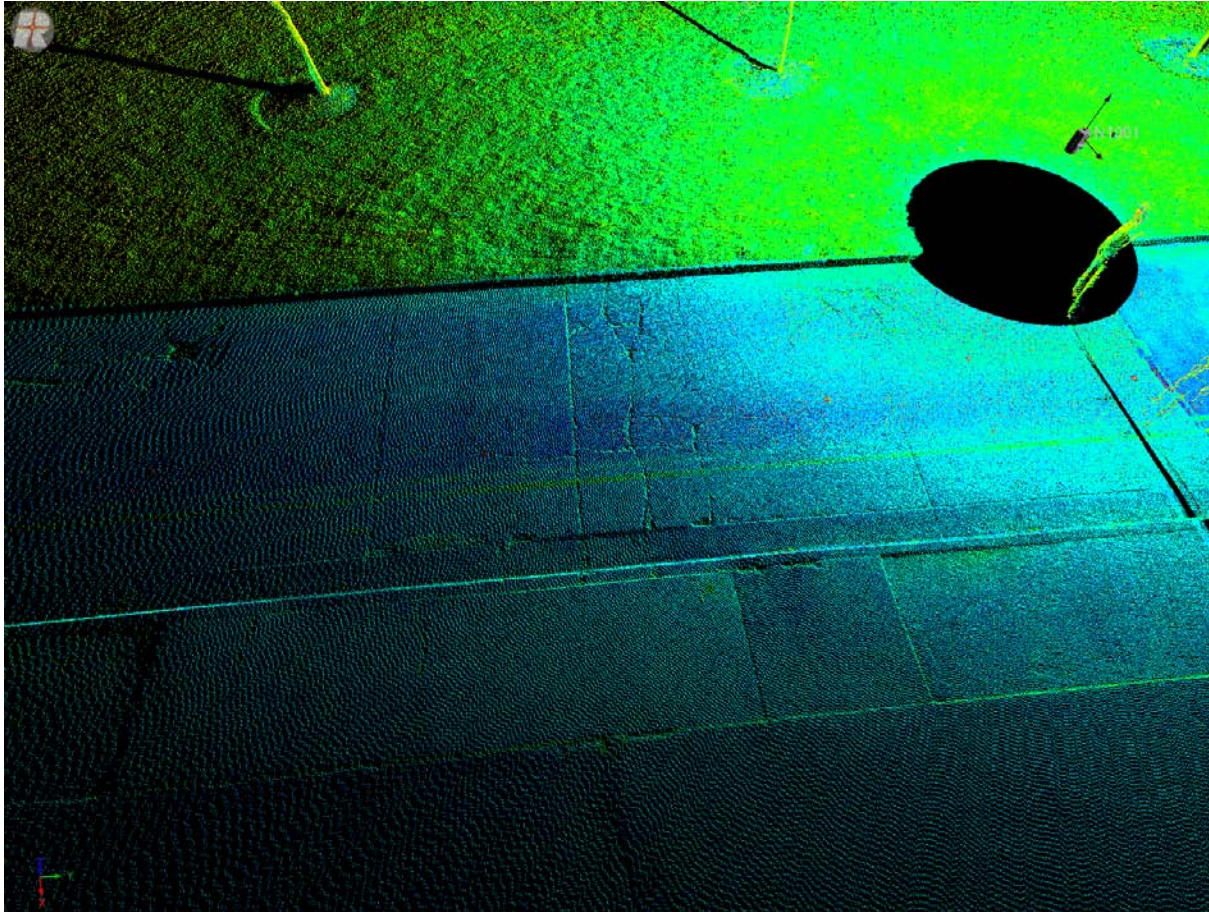
Equipment



Data

- Point Cloud
- X Y Z coordinates
- R G B color mapped
- Intensity value (return signal strength)
- 3D model

Point Cloud Example



Point Cloud Example



Laser Scanning Advantages

- Multiple Profiles
- Redundant Data
 - Dense Point Cloud (1-5 cm Spacing)
- Quick Data Acquisition
- Improved Safety
- Road Open to Traffic
- Identify Localized Depressions
- Continual Evaluation
- As Built Survey Data

Laser Scanning Disadvantages

- Individual measurements accurate to +/- 5mm
- Objects can block line of sight
- Field setup time
- Data processing requires training and time

Mobile Laser Scan System

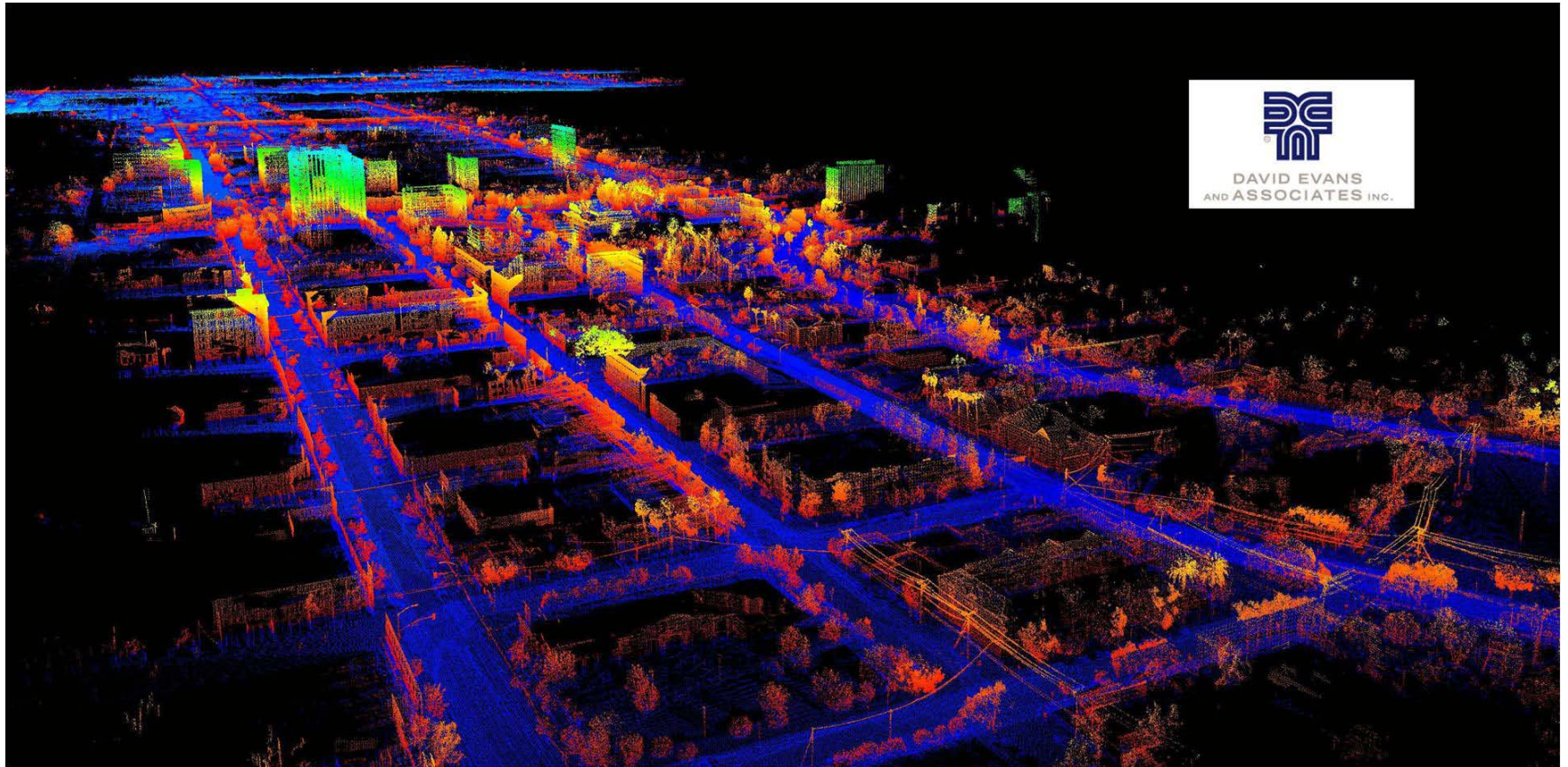
GPS receiver

Laser scanner

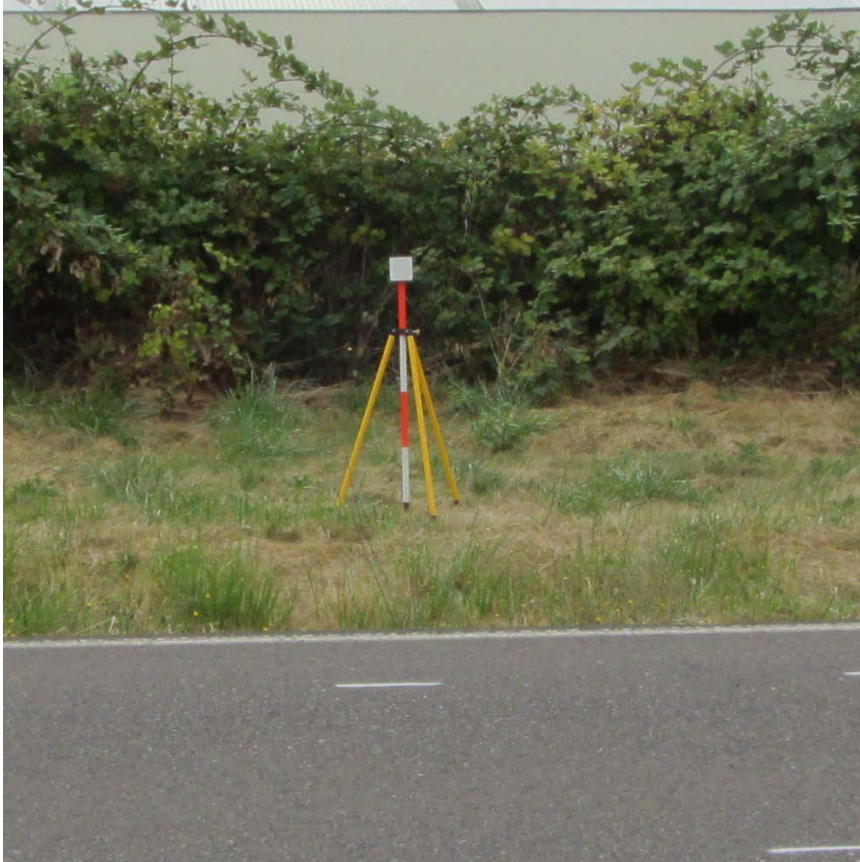
Camera



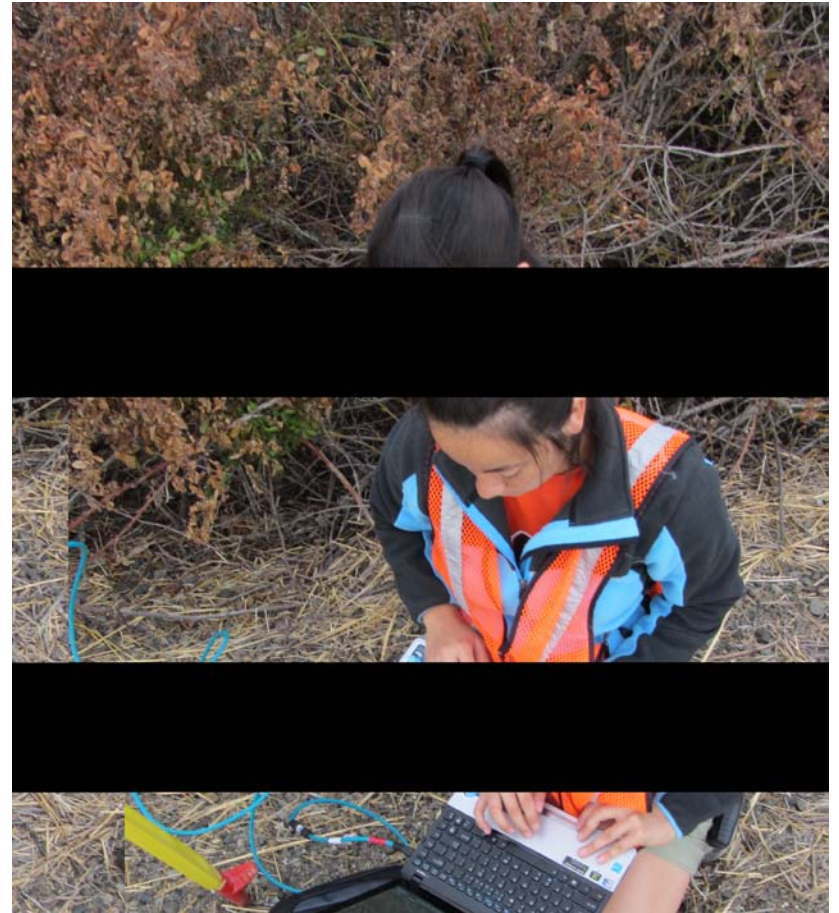
Mobile Laser Scan Example



Test Site – Albany, Oregon



Field Testing

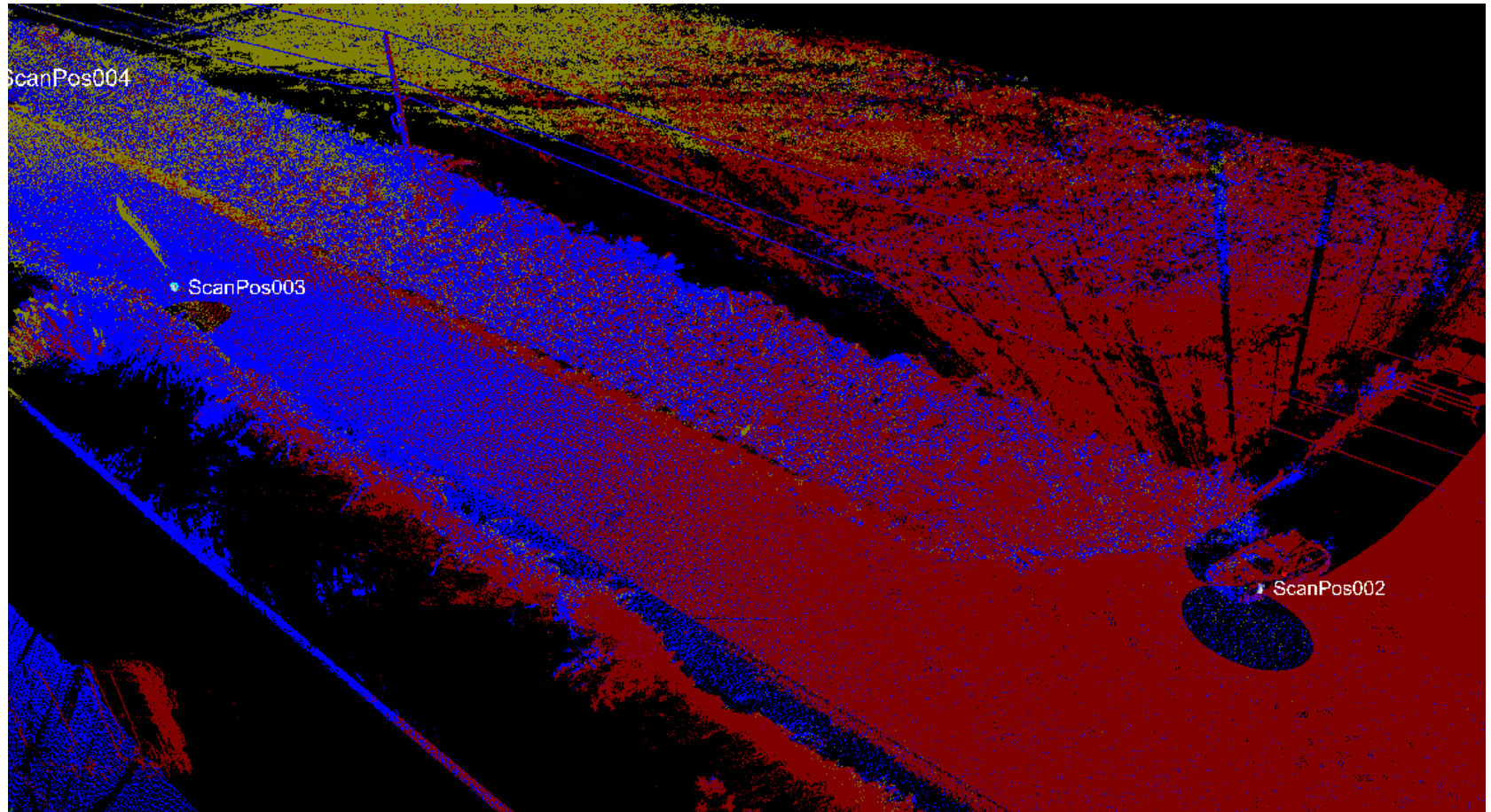


Field Test Setup

- 528 ft Section
- 6 Scan Positions
 - Every 50 m
 - GPS used to determine position
- 5 Targets
 - Every 50 m
 - Total station used to determine position



Point Cloud



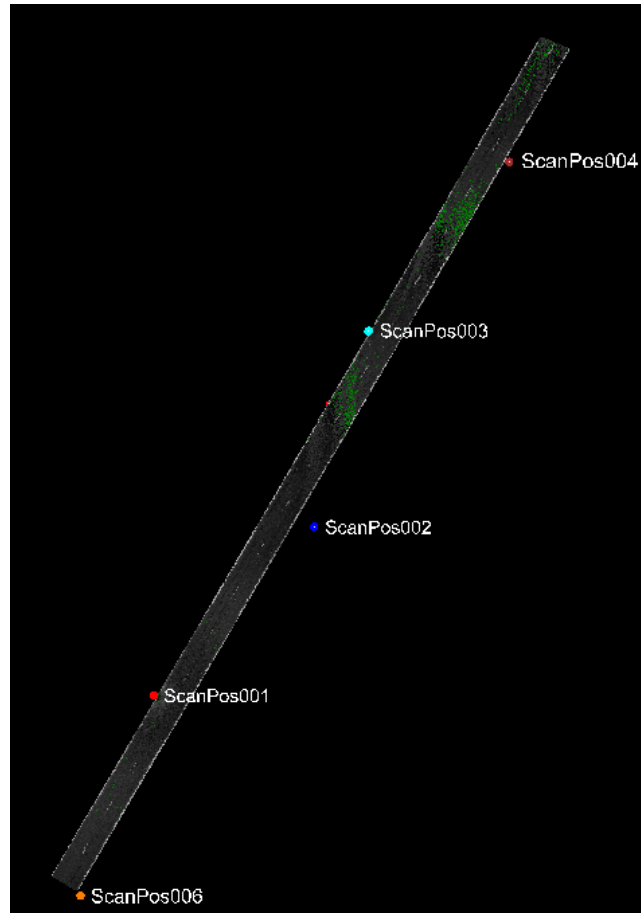
Point Cloud – Colored from Photos



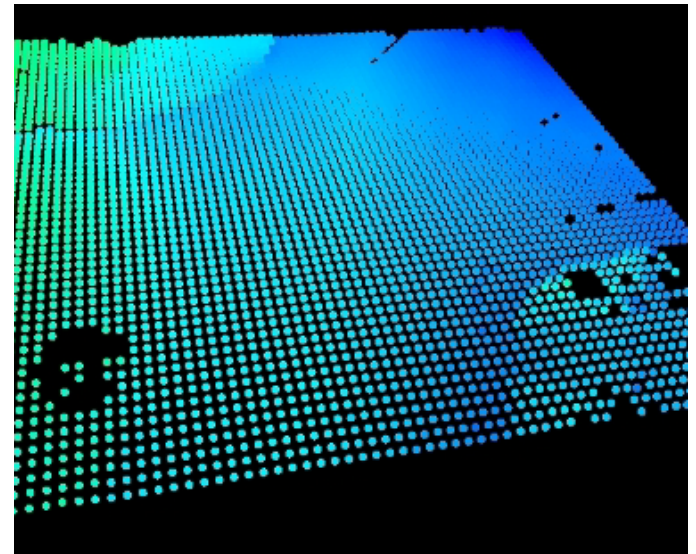
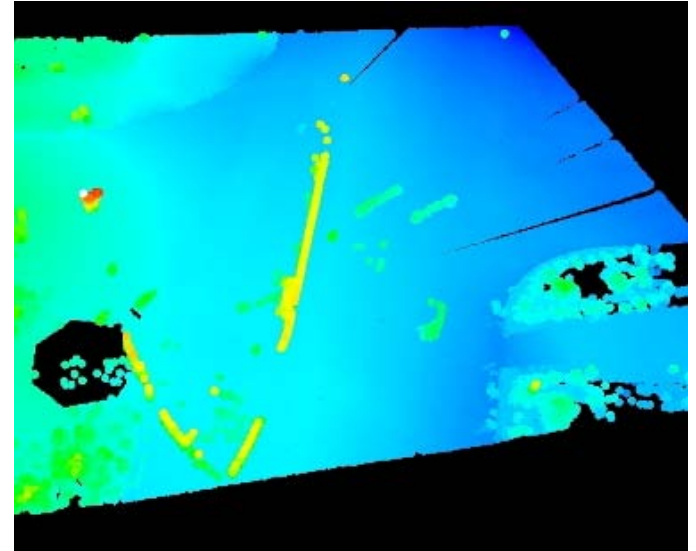
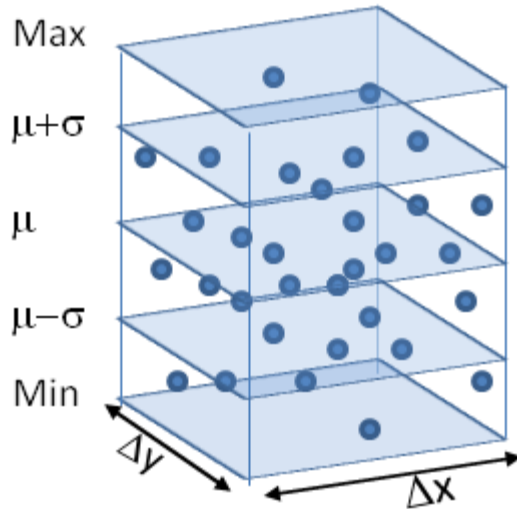
Field Data - Workflow

- Obtain 3D point cloud
 - Prune data to roadway
- Statistically filter data to specified spacing
- Obtain profile using GIS
- Input data in ProVAL

Editing Point Clouds



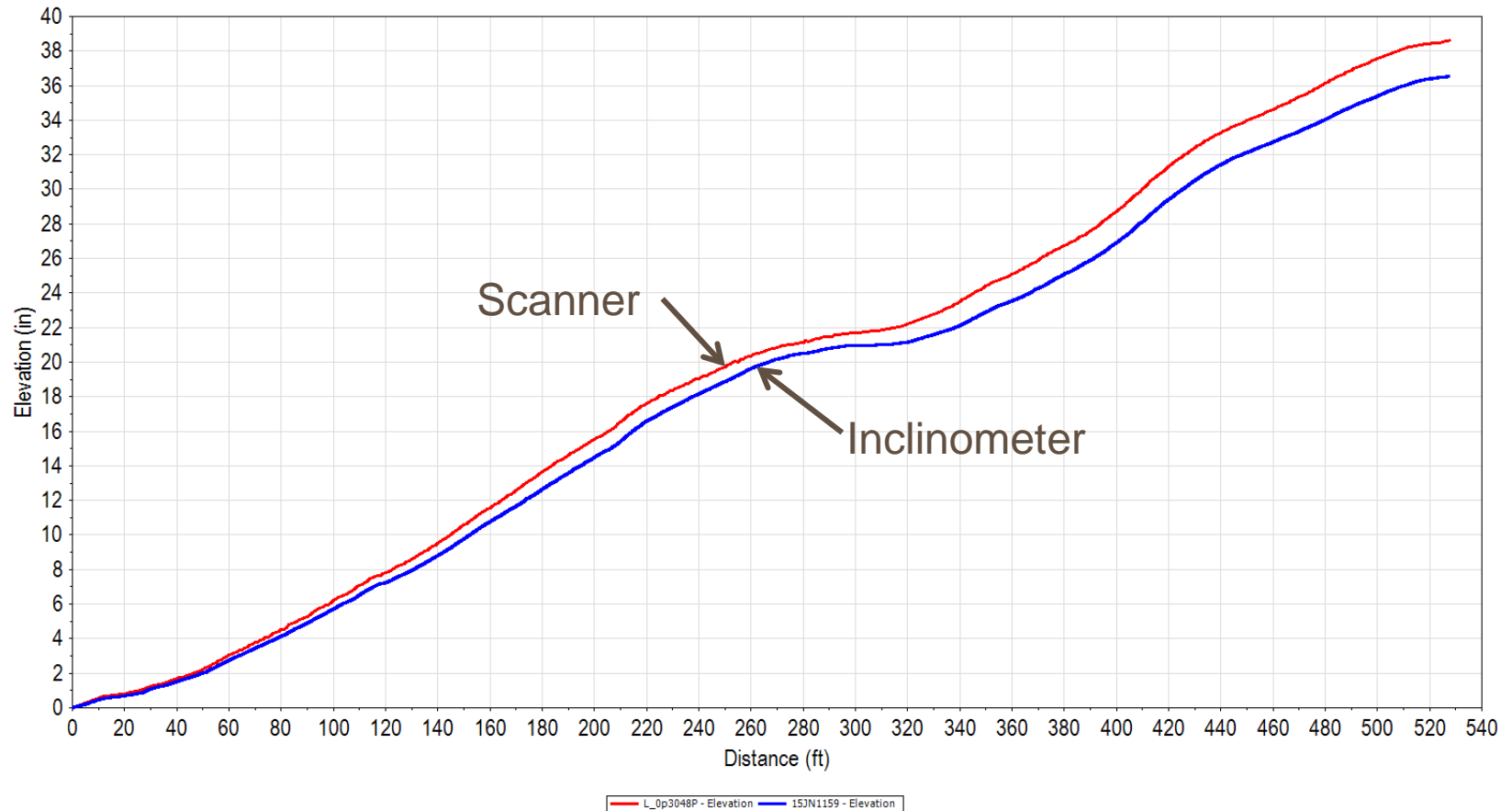
Statistical Filtering Process



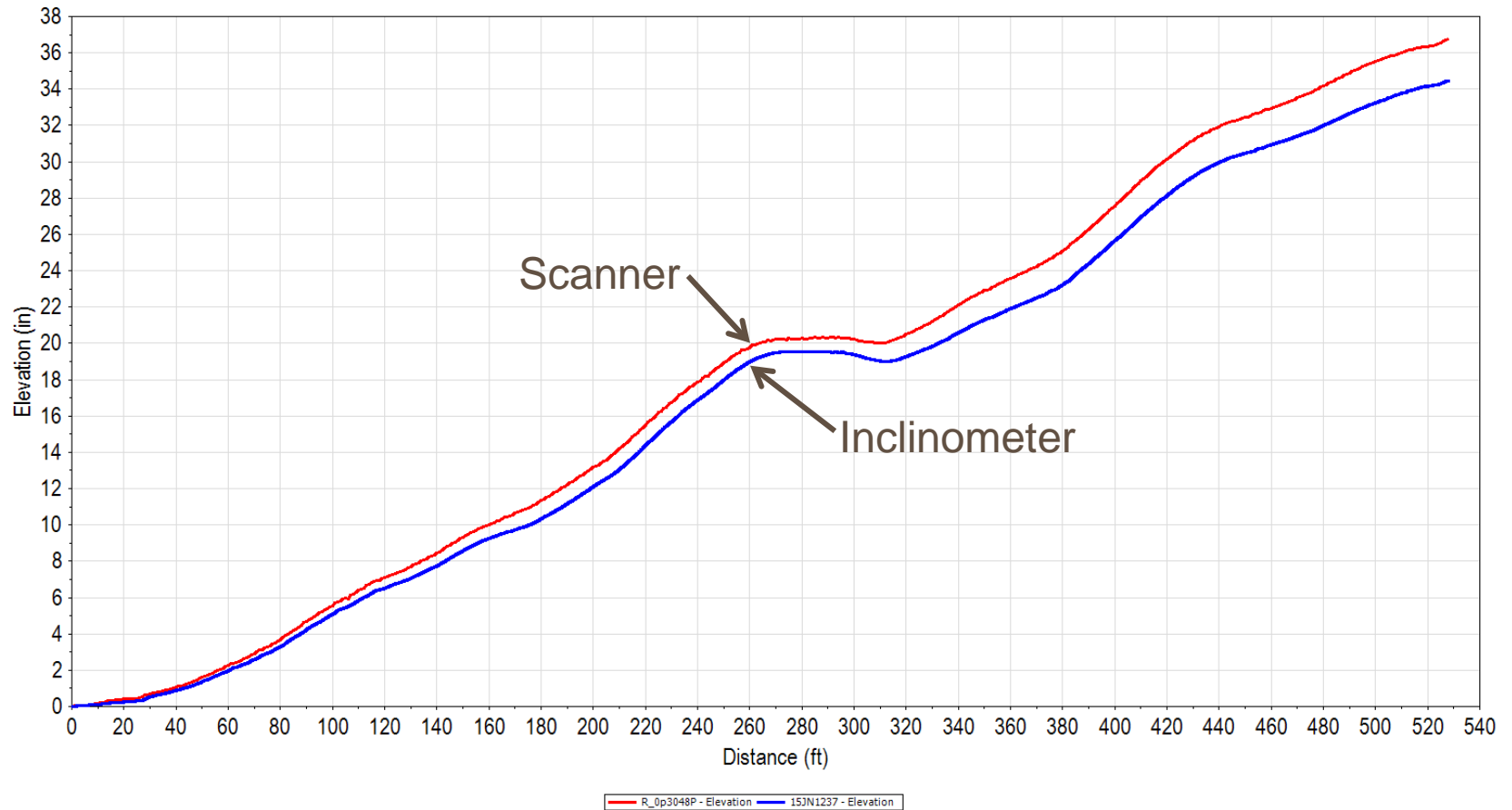
IRI Comparisons

- Inclinometer Profiler
 - Left – 66 in/mi
 - Right – 84 in/mi
- Laser Scanner
 - Left – 73 in/mi
 - Right – 88 in/mi

ProVAL Data – Left Wheel Path



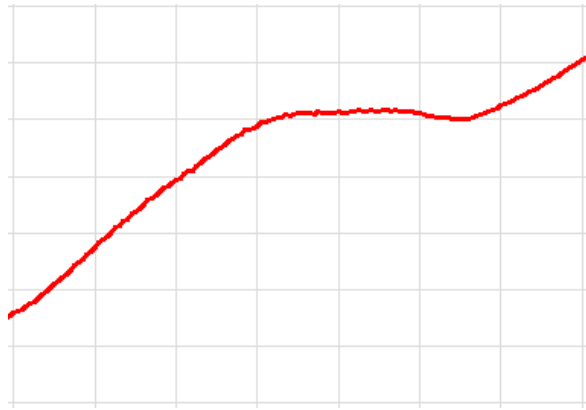
ProVAL Data – Right Wheel Path



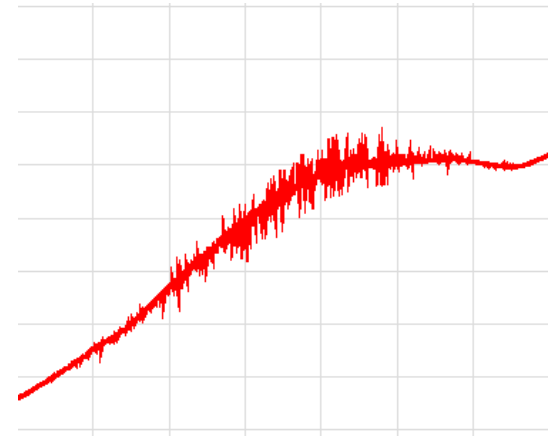
Observations

- Data between inclinometer profiler and laser scanner is offset
 - Offset gets larger
- Laser scan data filtered to 1 ft intervals
 - Visible noise in the data
- Starting points may not be exactly the same

Laser Scan Data Comparison - Worst

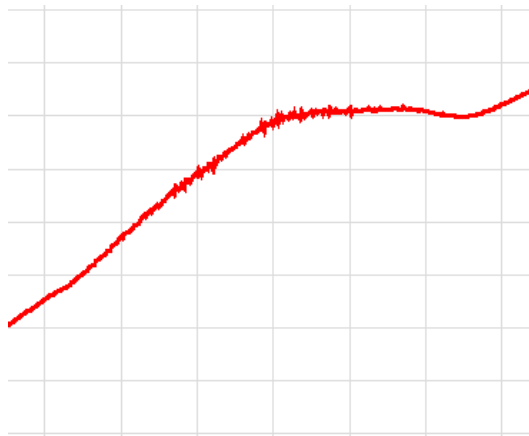


1 ft Spacing



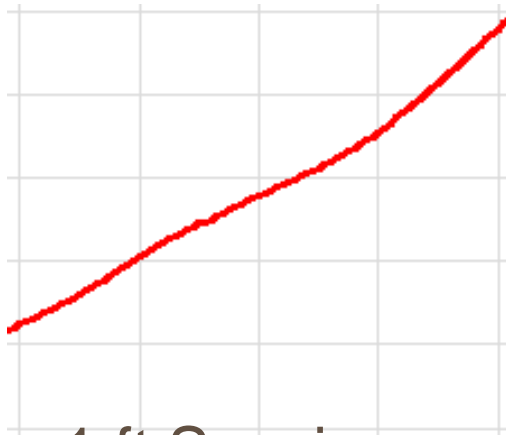
0.25 ft Spacing

Grid Cell
Dimensions
2" V x 20' H

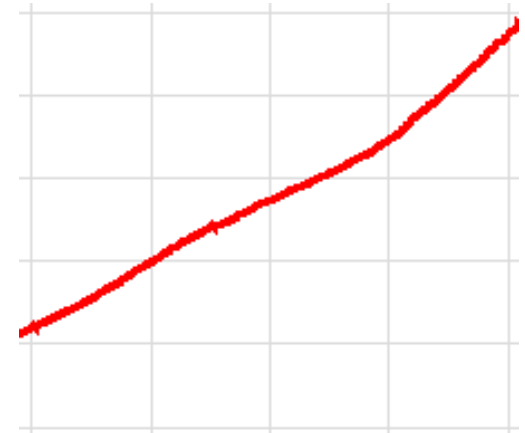


0.5 ft Spacing

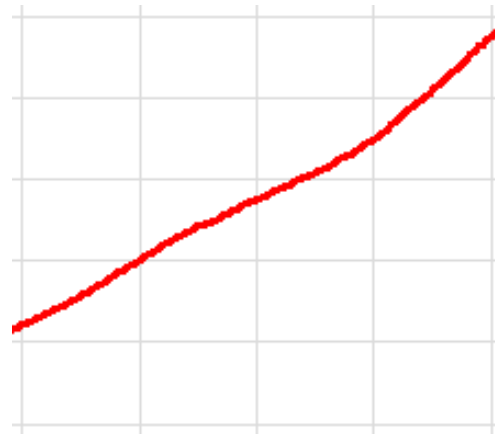
Laser Scan Data Comparison - Best



1 ft Spacing



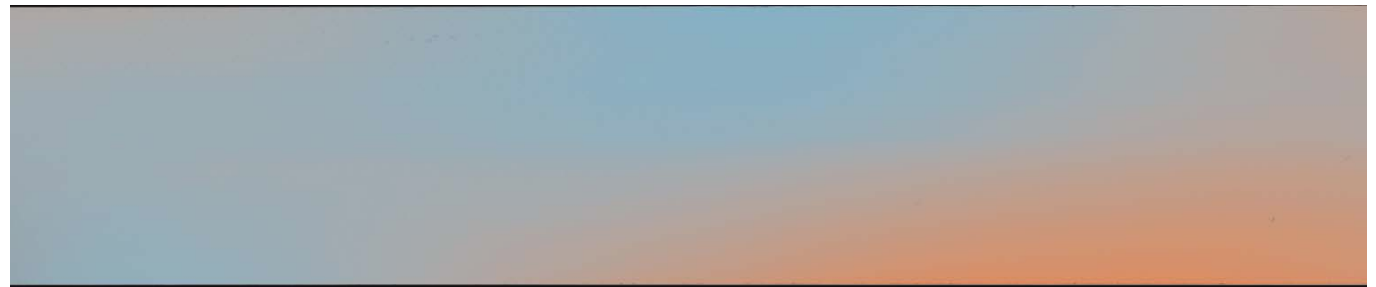
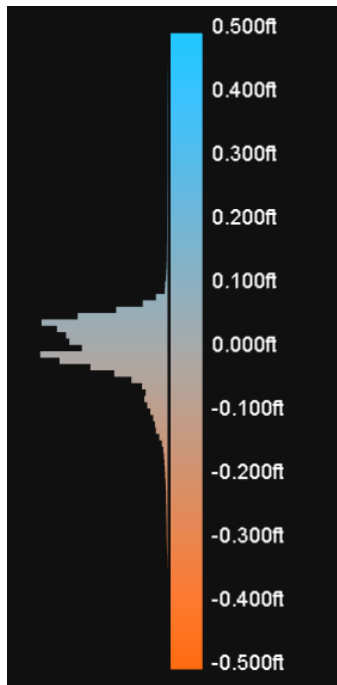
0.25 ft Spacing



0.5 ft Spacing

Grid Cell
Dimensions
2" V x 20' H

Localized Depressions



Middle Section



Right End

Questions to Investigate

- Laser Scanning
 - Can the noise be smoothed out while taking advantage of the dense data?
 - i.e. close point spacing
- Compare the profiles in ProVAL
 - Are IRI values consistent?
 - Do the distance vs. elevation plots agree?
 - What are the reasons for any discrepancies?

Future Work

- Obtain and compare additional profiles from test site
 - Laser Scanning
 - Inertial Profiler
 - Rod & Level
- Create procedures and guidelines for certification

Questions?

