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6–11 May 2018
ISTANBUL

High Resolution Multi-Lane Road Surface Mapping Using 3D Laser Profilers

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Pavemetrics Systems Inc.
www.pavemetrics.com

EMBRACING OUR SMART WORLD WHERE THE CONTINENTS CONNECT:
ENHANCING THE GEOSPATIAL MATURITY OF SOCIETIES

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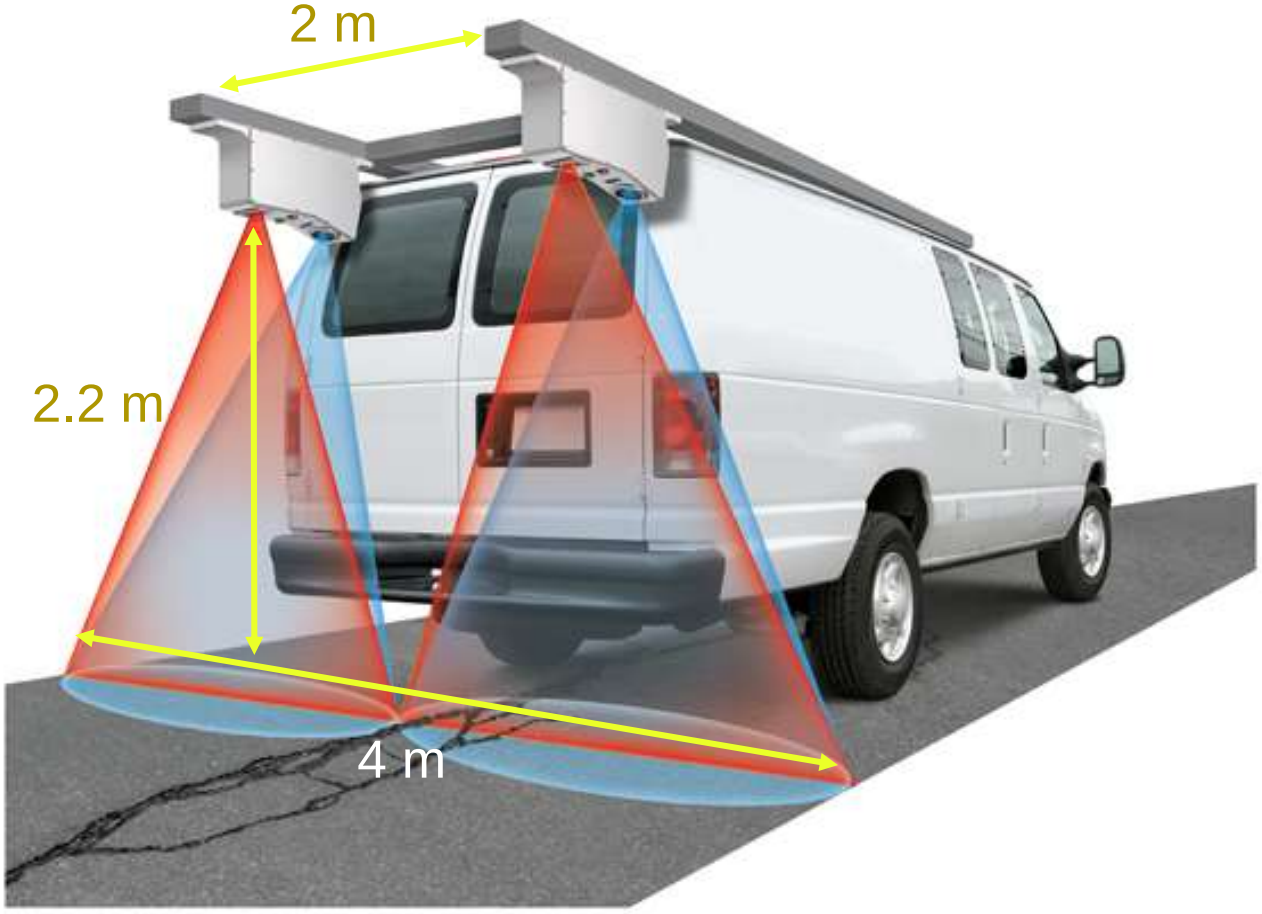
LCMS - System configuration



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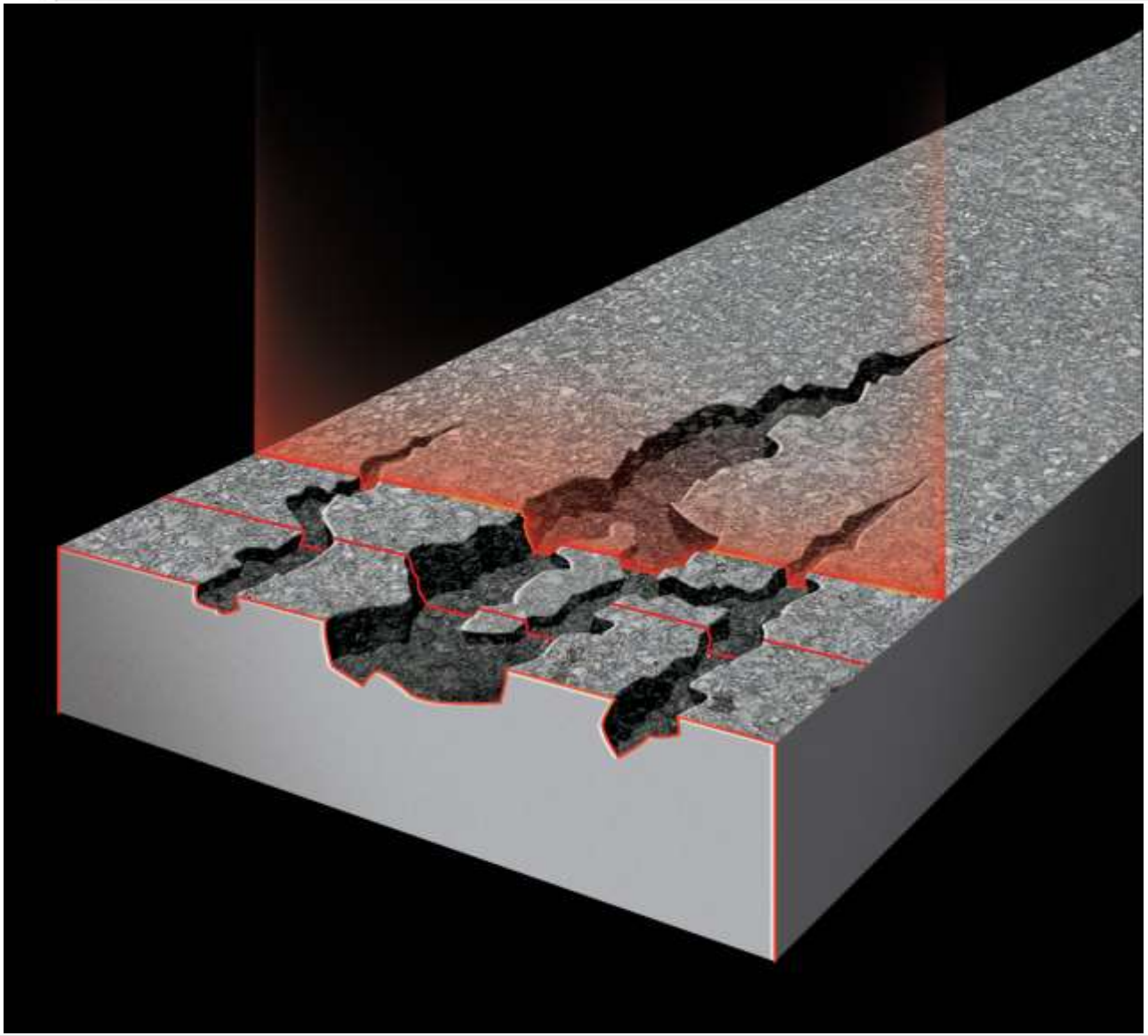
Laser profiling (principle)



“3D Time of Flight” vs. “3D Laser Triangulation”

LiDAR

LCMS

Specifications	Lidar	LCMS
Acquisition Rate	200 profiles/s	5,600-28,000 profiles/s
Range Accuracy/Resolution	5 to 20 mm	*0.25mm / 0.1mm*
Lateral Resolution	10 mm ++	1mm (FOV = 4m)
Number of points/s	1 MHz	45 MHz (3D and 2D)
Range	3 to 1000 m	3 m

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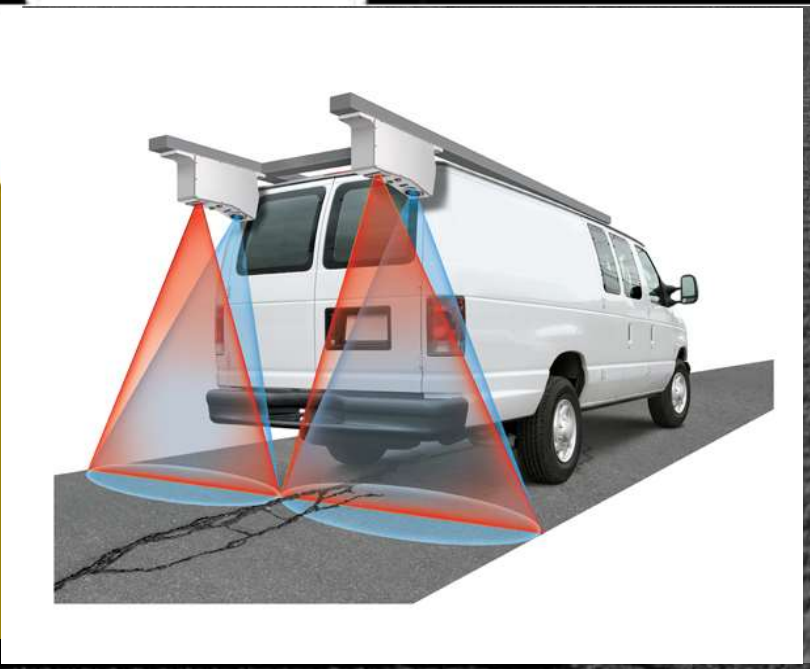
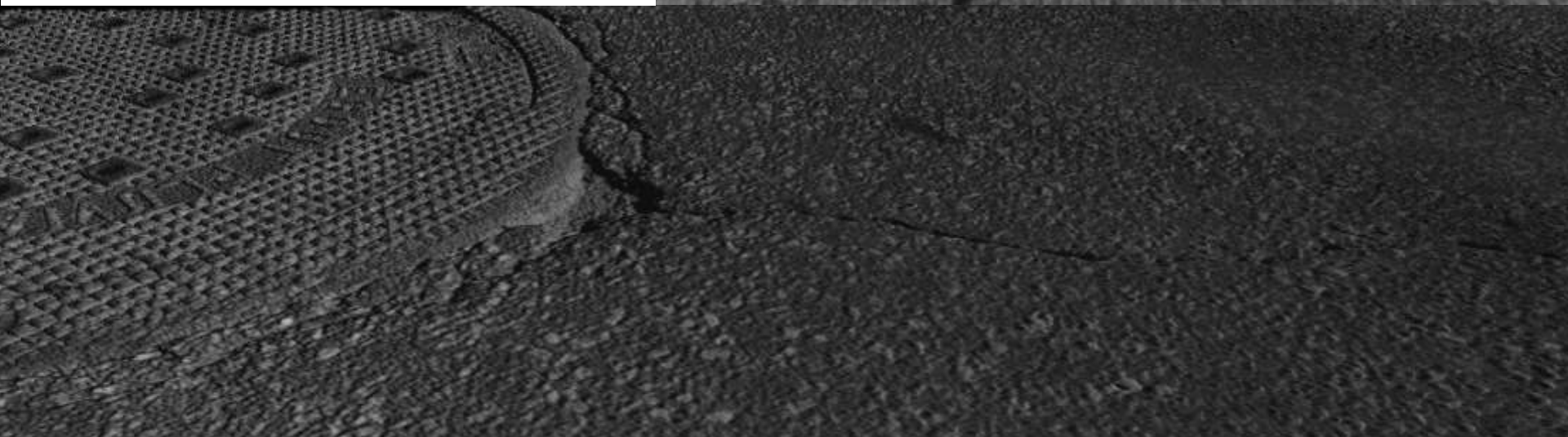
APPLICATION: Roads





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Landscape vs. Macro

LiDAR

LCMS

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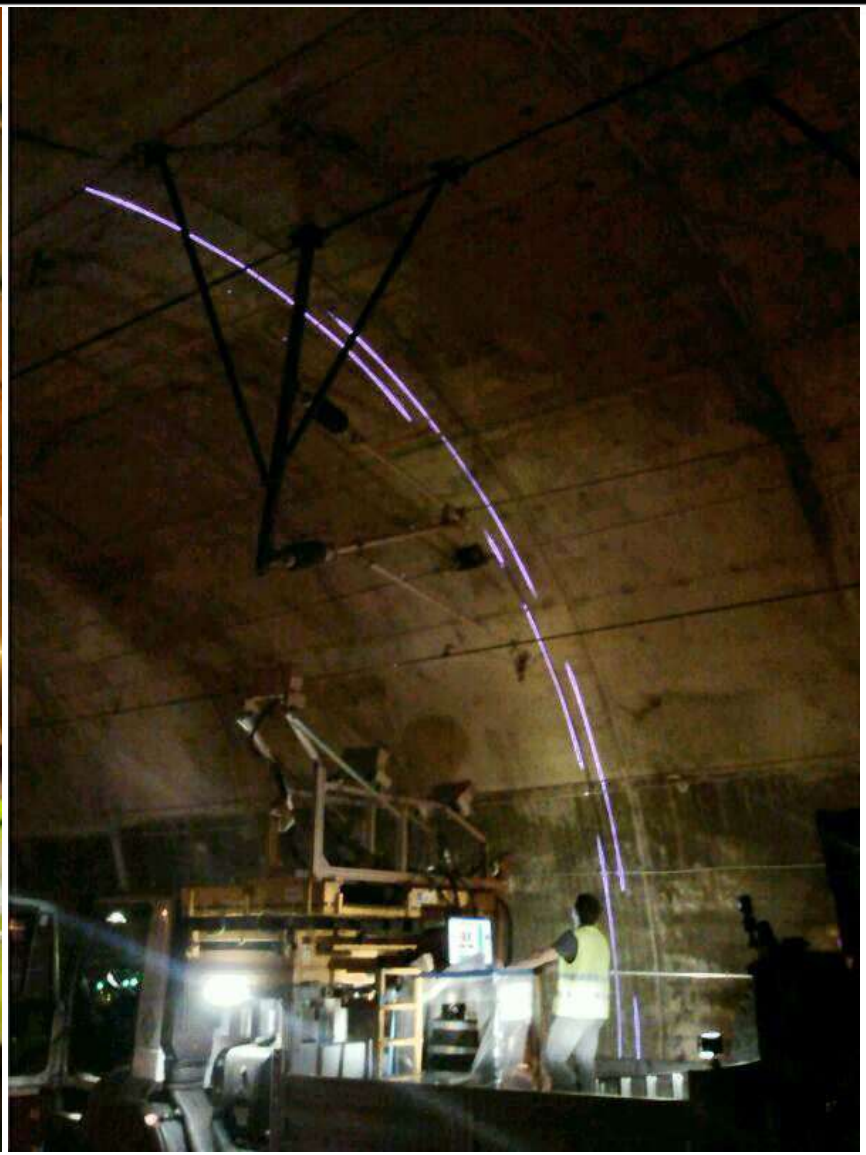
LTSS – Tunnel scanning



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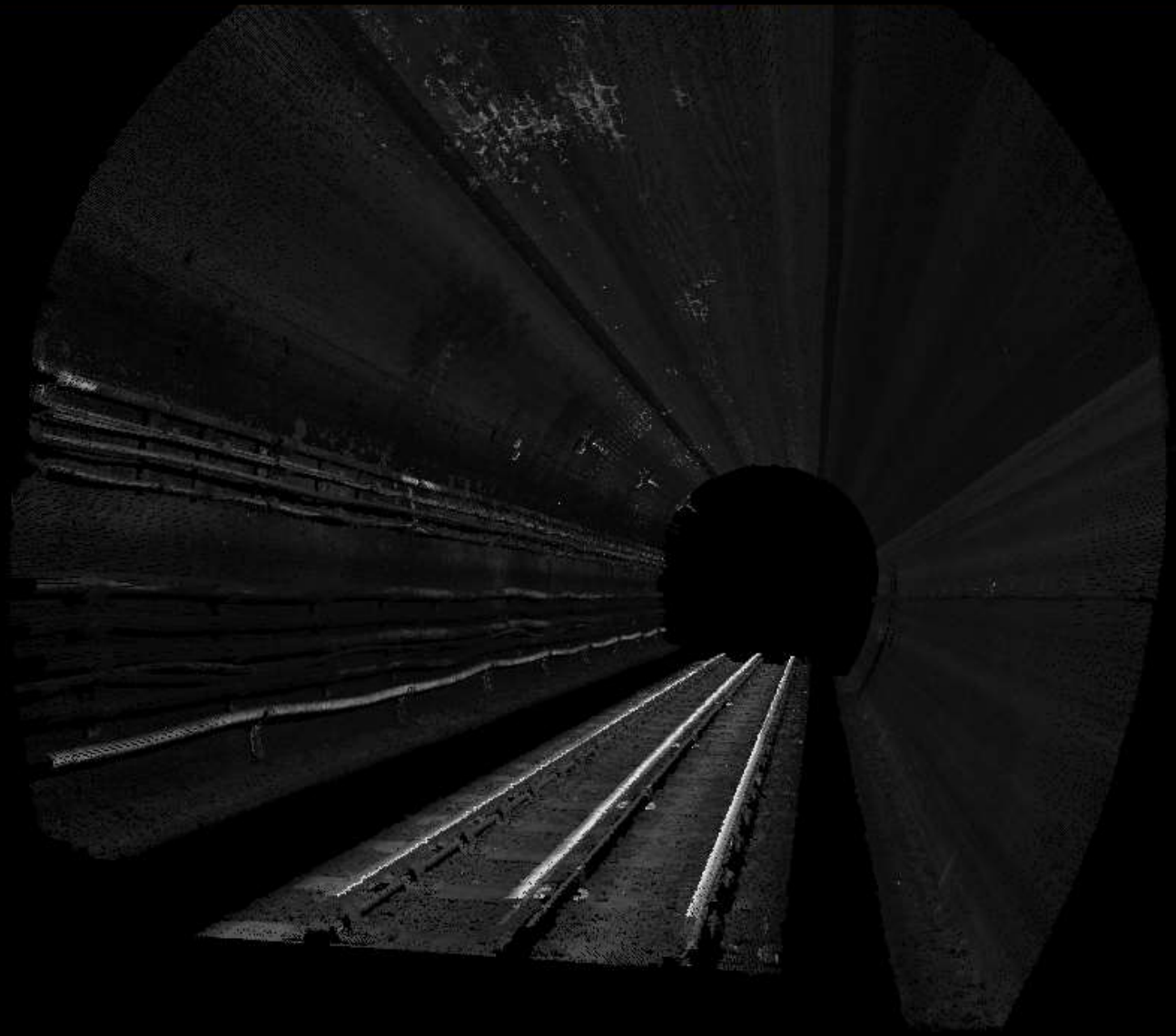
LCMS/LTSS Capabilities



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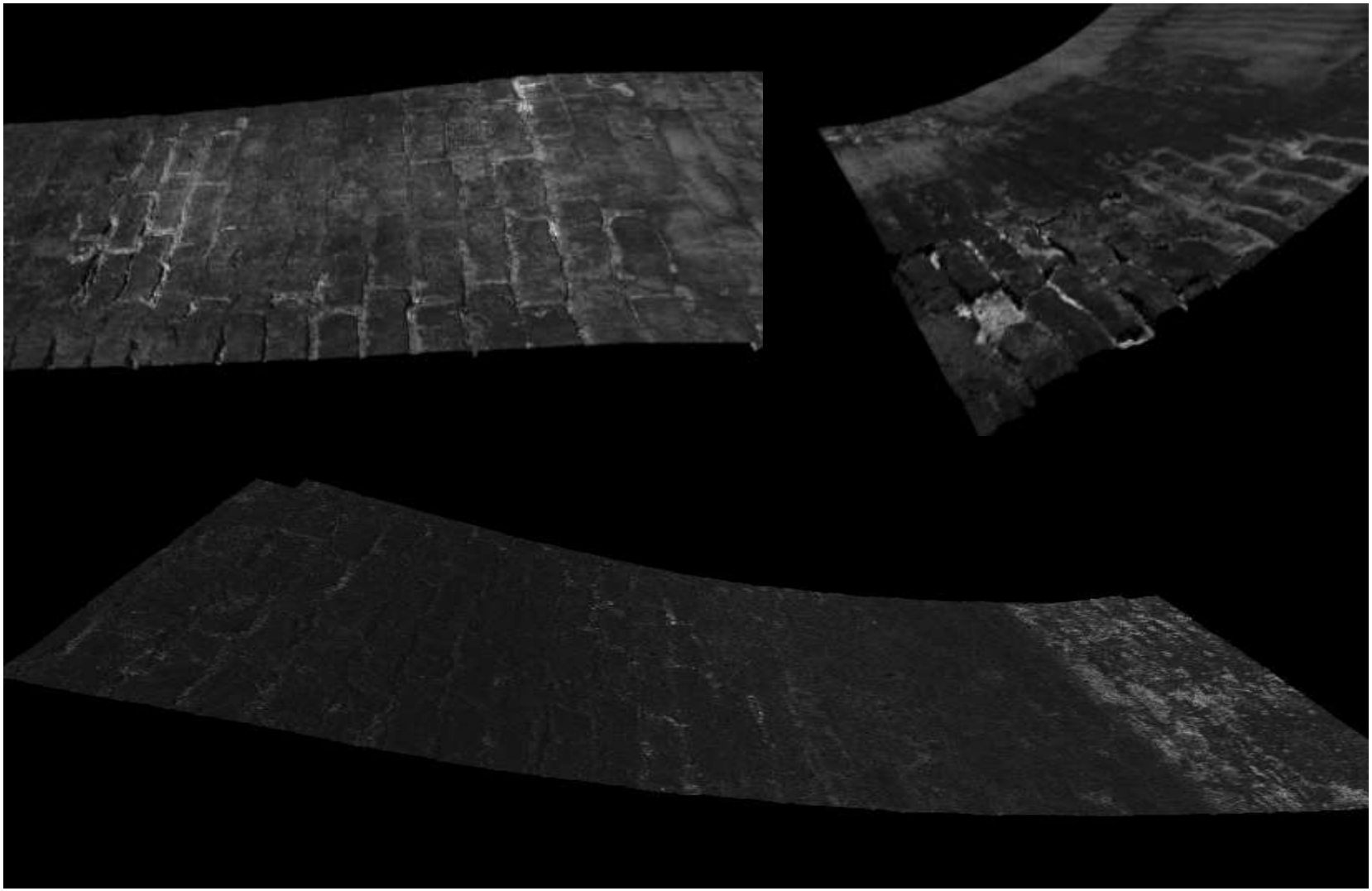
LCMS/LTSS Capabilities



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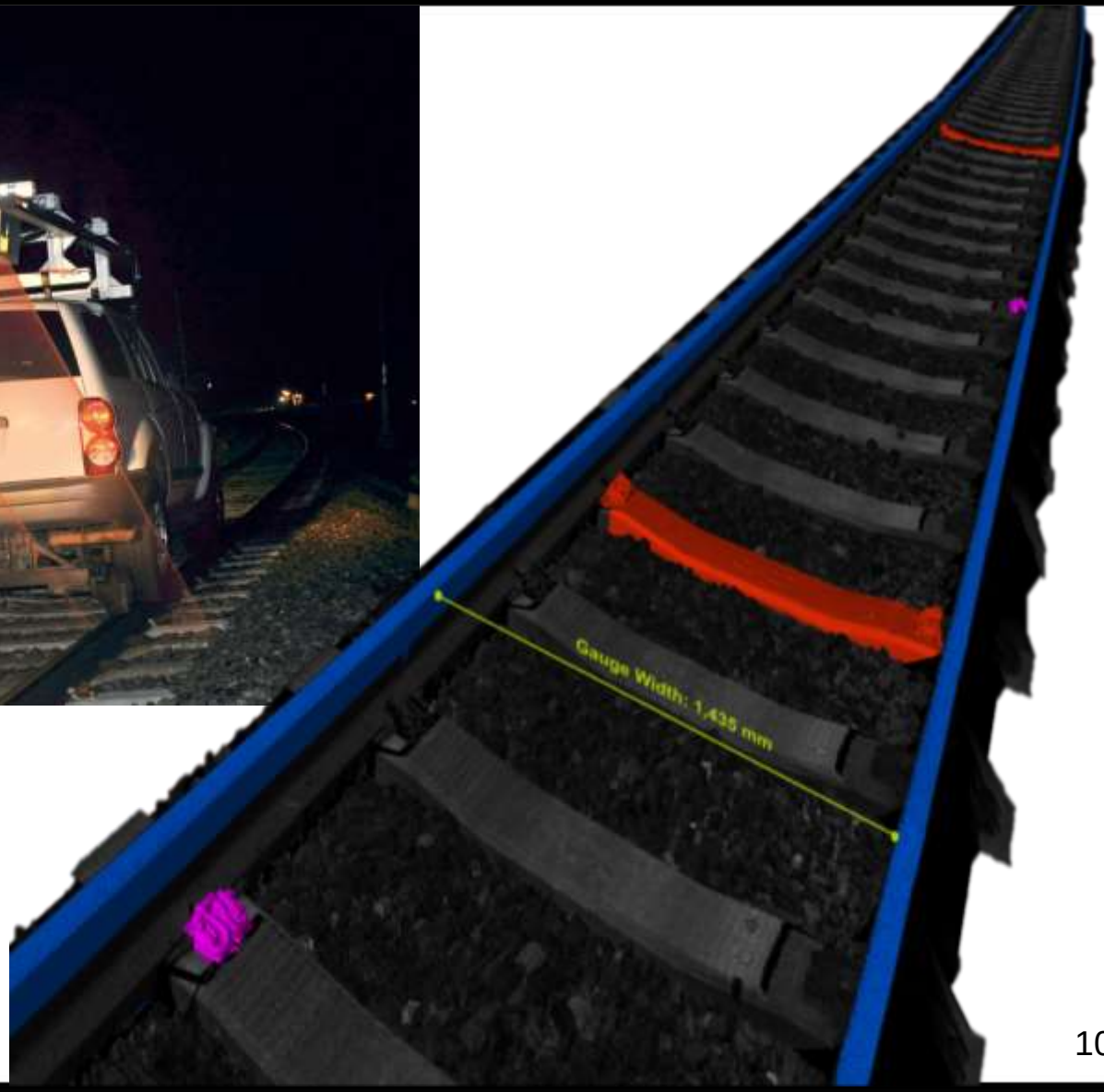
APPLICATION: Rails



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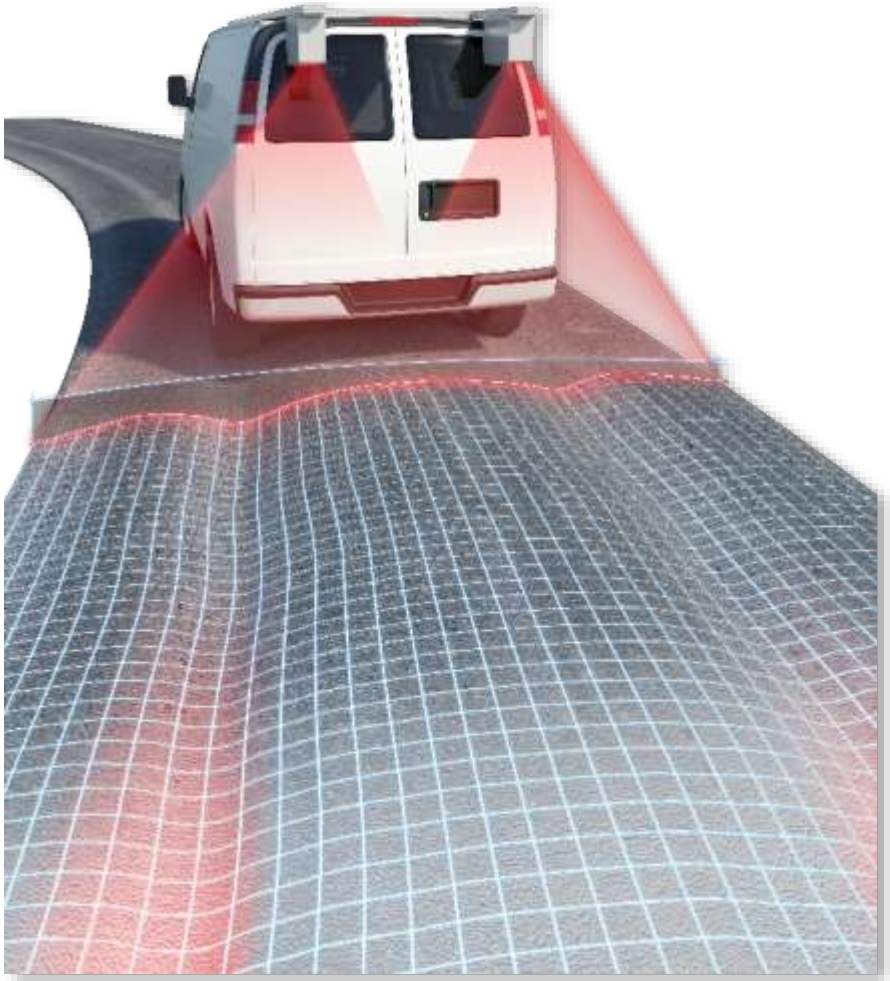
LDTM – Surveyor grade Terrain Mapping



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The importance of road smoothness

- Very wavy roads:
  - 30-40% increase of wear of road
  - Vertical acceleration increases dynamic load impact of traffic
  - Self destruction of bumpy road surfaces
- Driving comfort
- Fixed depth milling operations do NOT improve the longitudinal road profile

Road Rehabilitation

Ref.: Bentley Microstation InRoads ™

Ref.: http://construction.trimble.com/

Manual Road Surveying → Engineering CAD Tool → GPS/Laser Controlled Milling → GPS/Laser Controlled Paver

Road Rehabilitation

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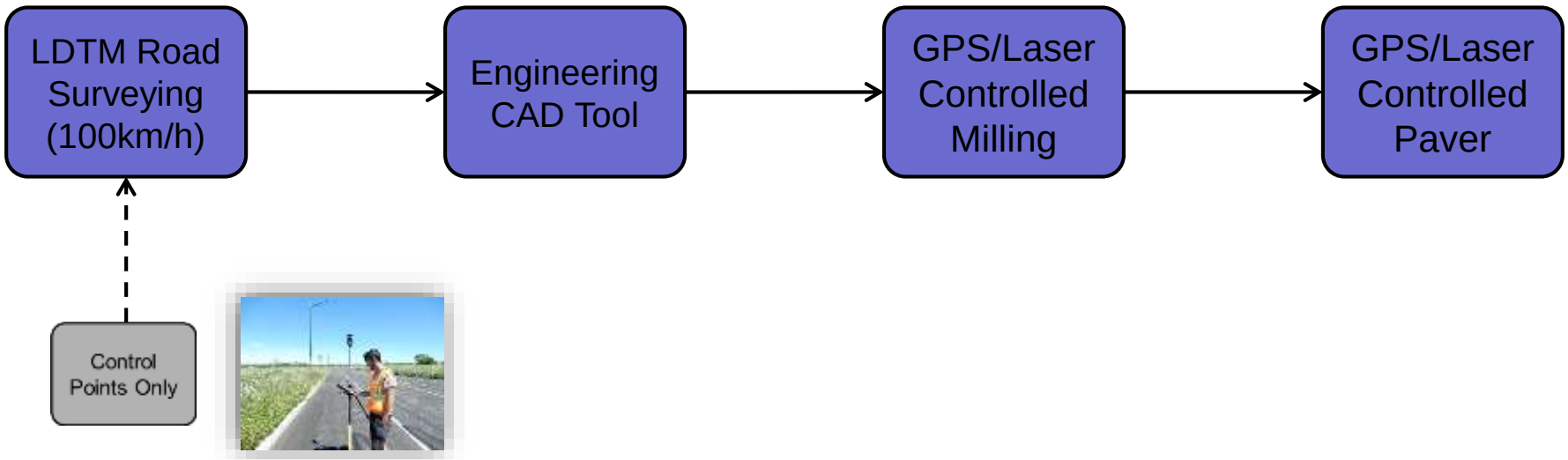


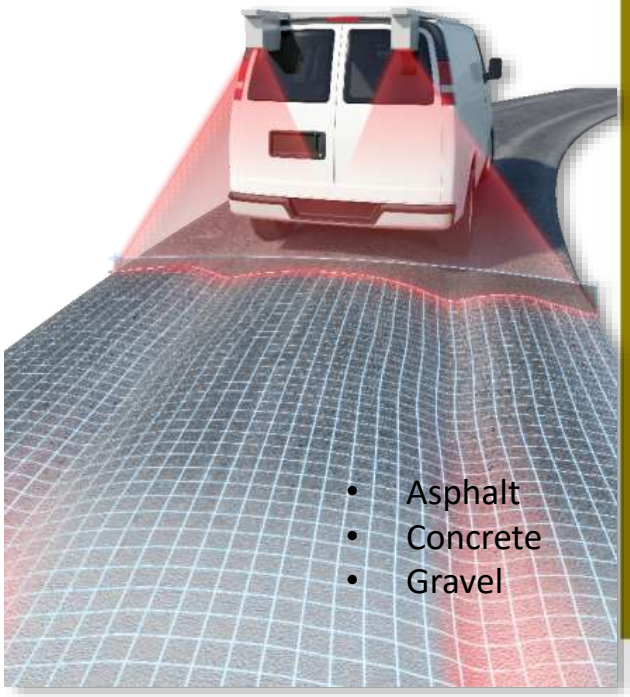
Pavemetrics LDTM solution

1. LCMS system

- 2 Laser profilers (4 meters field of view)
- 2 Inertial Measurement Units (IMU)
- Distance Measuring Instrument
- (DMI)

2. Applanix POS-LV 420

- Optical encoder (DMI)
- Inertial Measurement Unit (IMU)
- GNSS



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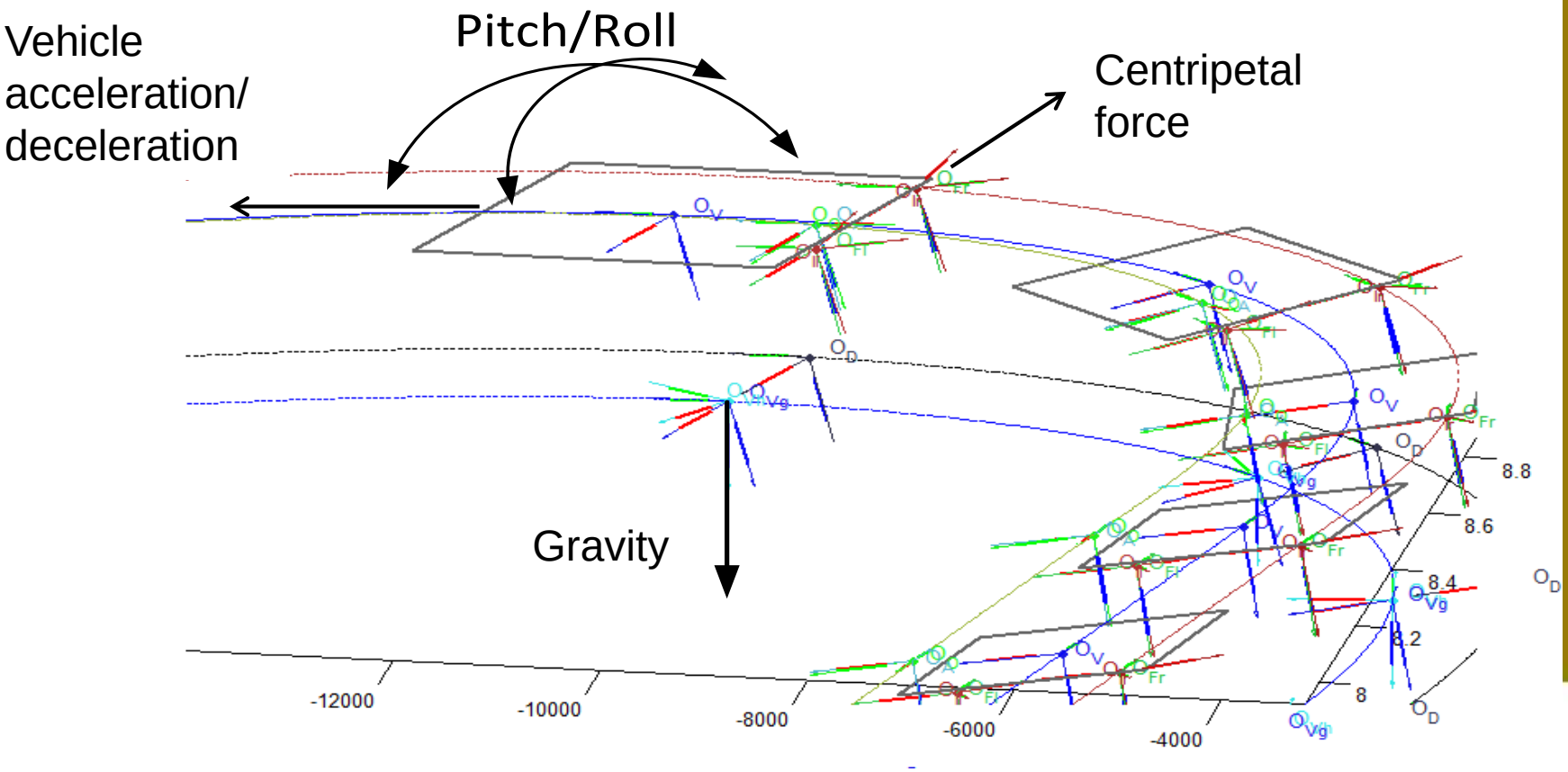
Complex Vehicle Dynamics



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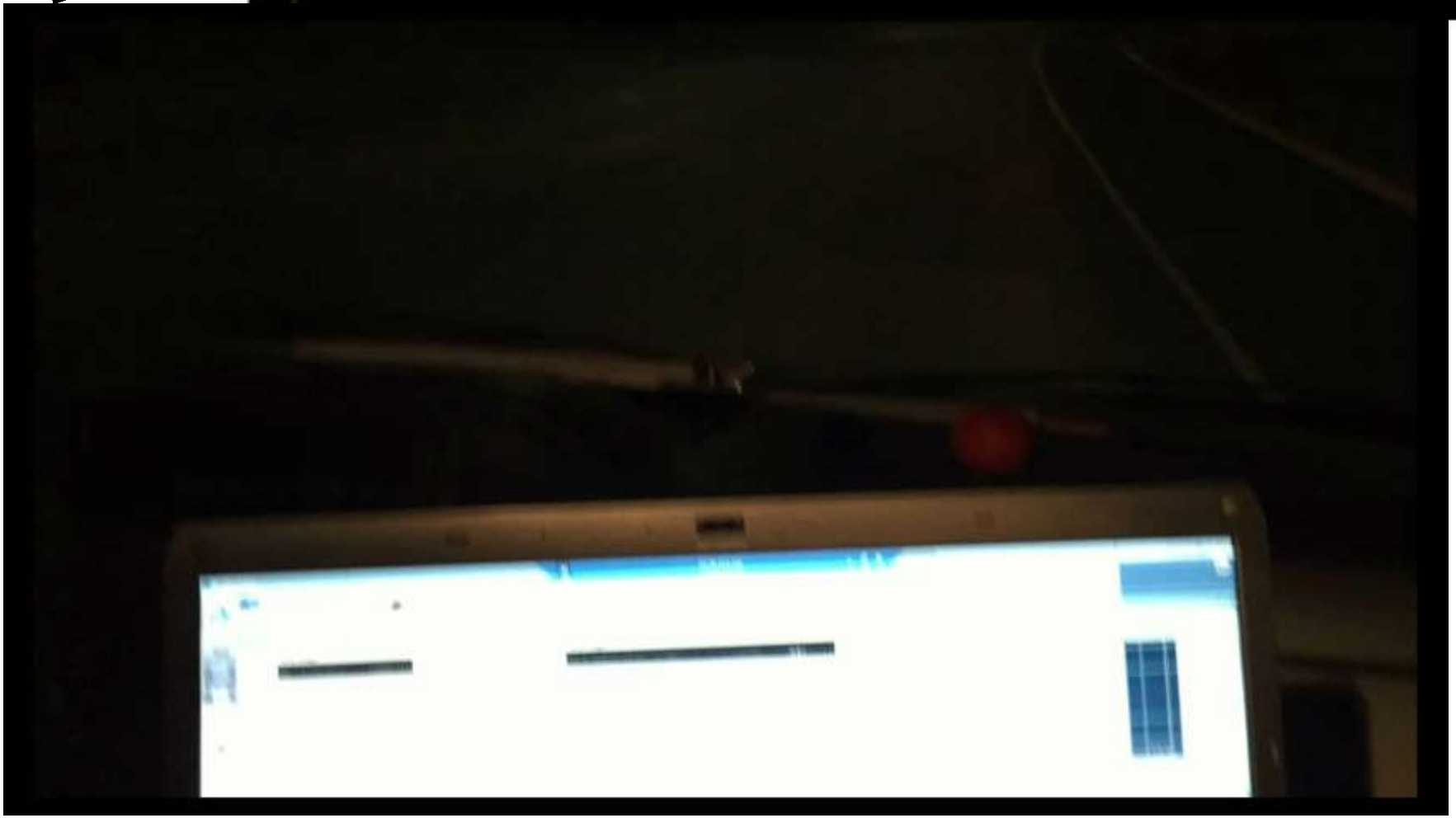
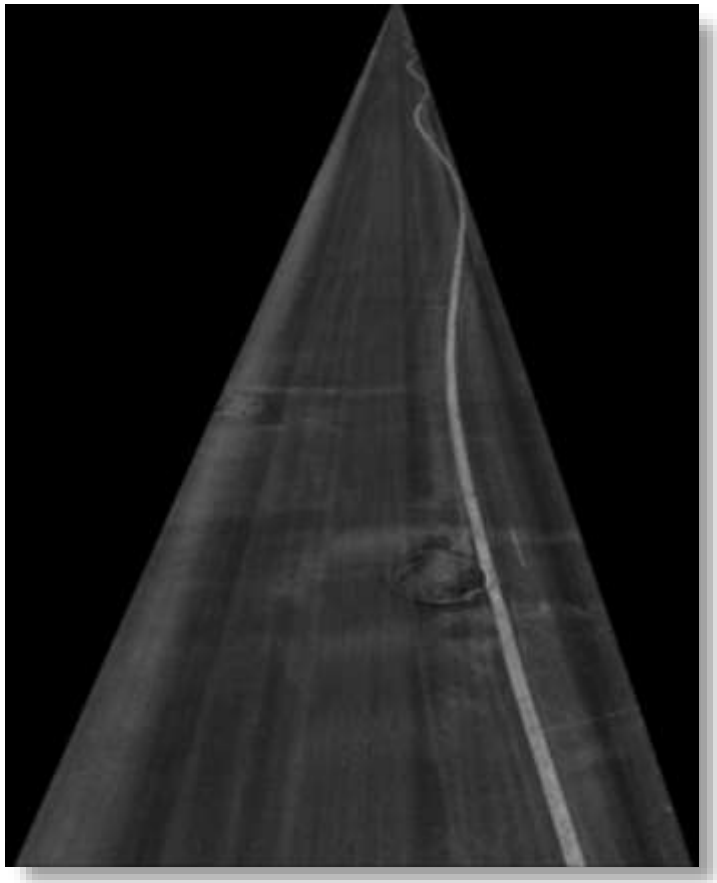
Wandering Driver example



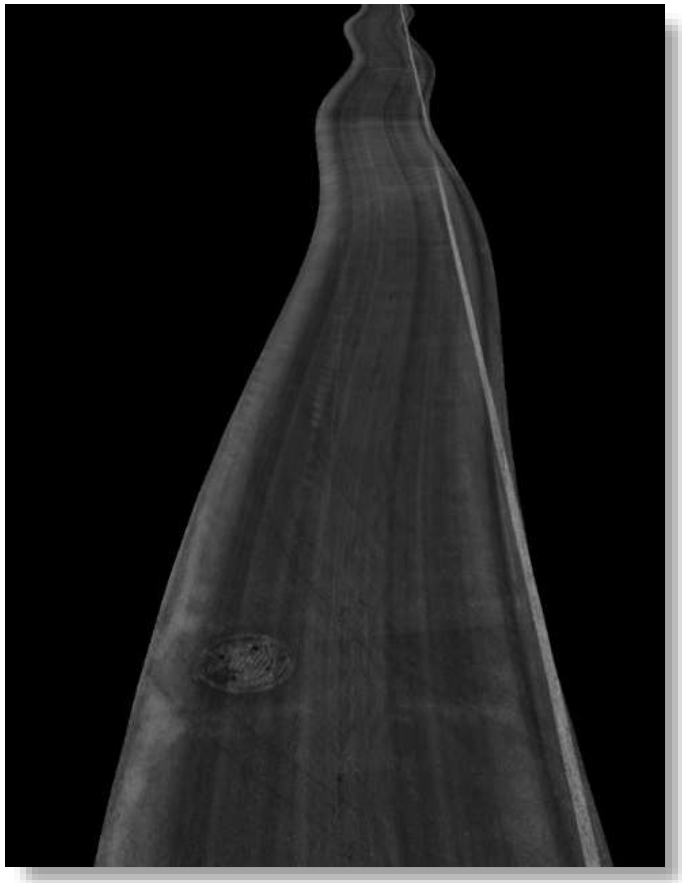
Wandering Driver example

Compensating for highly dynamic vehicle movement

Before



After



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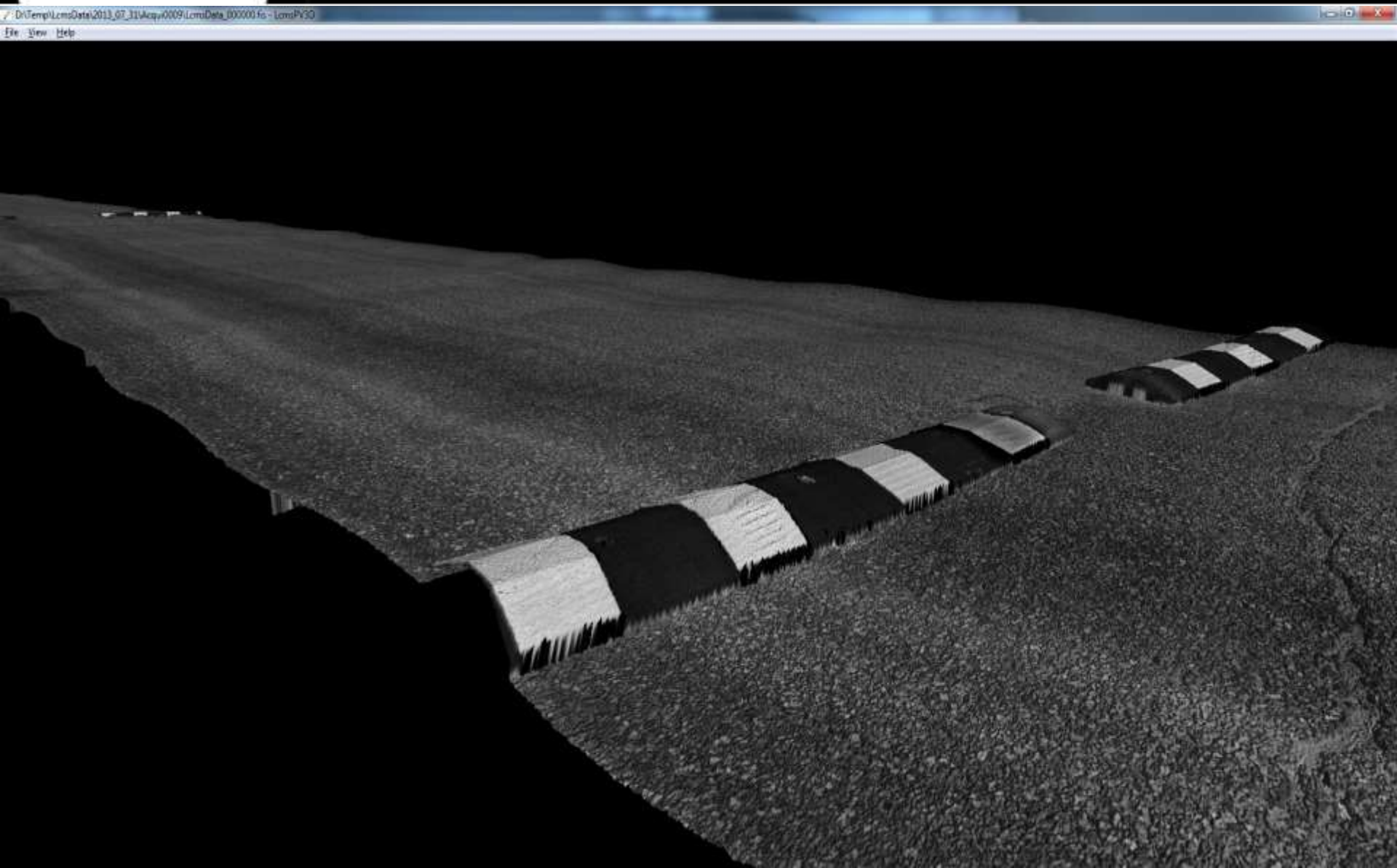
3D Road Profile Before Dynamic Corrections



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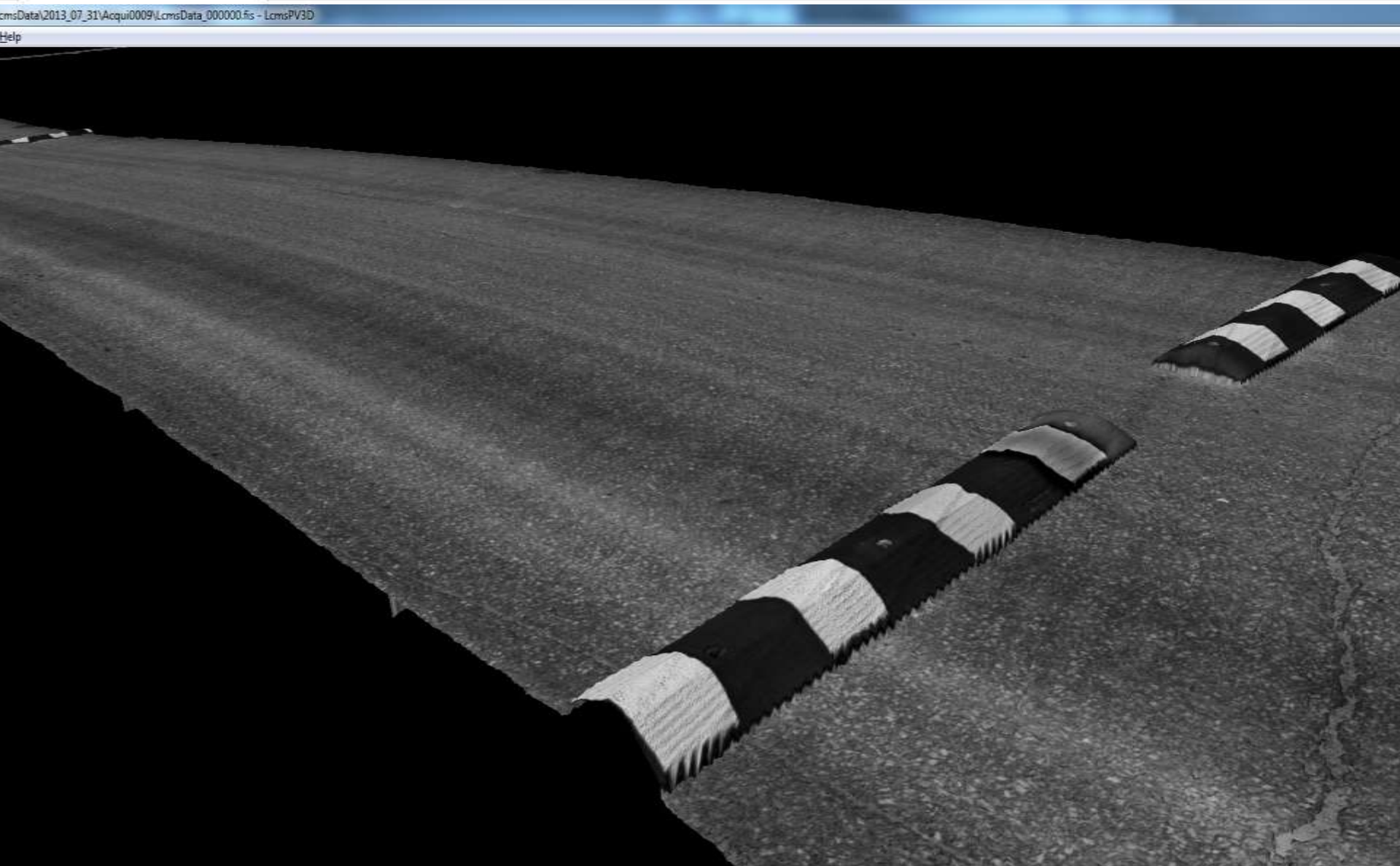
3D Road Profile After Dynamic Corrections



LDTM - Steps

- **Equipment Calibration**
- **Survey**
- **Processing**
  - Navigation solution
  - Controls Points
  - Stitch lanes
- **Data Exportation**

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LDTM Calibration

1 - Scan of the calibration validation object

2 – Stop and GO

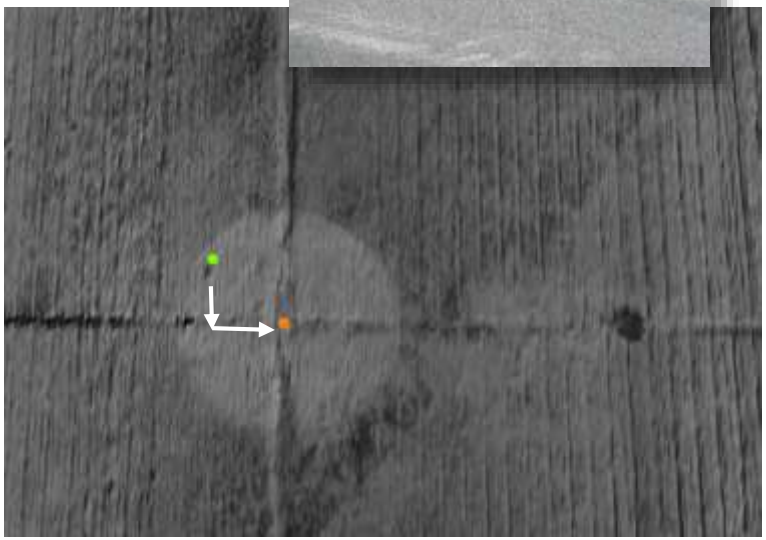
3 – Measurement of the position of the sensors

Done only once during sensors installation

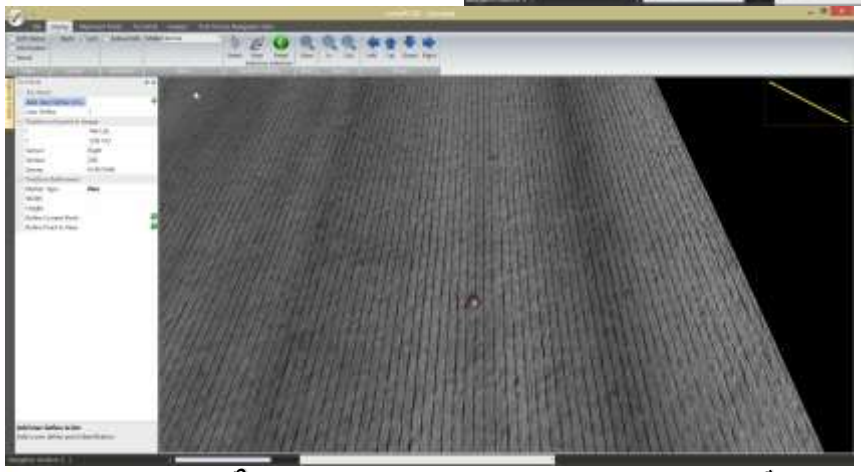
Ground Control Points Survey

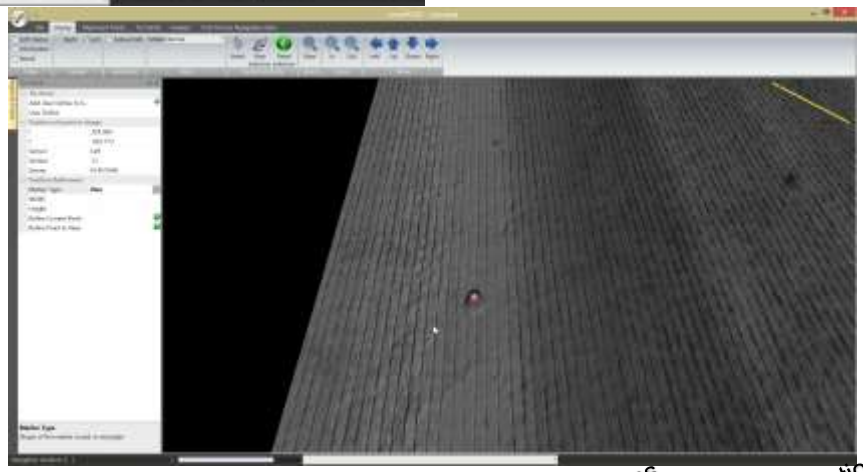
Ground Control Points

- Surveyed using a robotic total station
- One point every 300 to 1000 meters on road surface or shoulder
- Converted in UTM
- Imported in LCMS-PV3D software



Tie Points Creation





LDTM Calibration | LDTM Survey | Data Processing | Control Points | Tie Points | Applying Solutions | Data Exportation (LAS)

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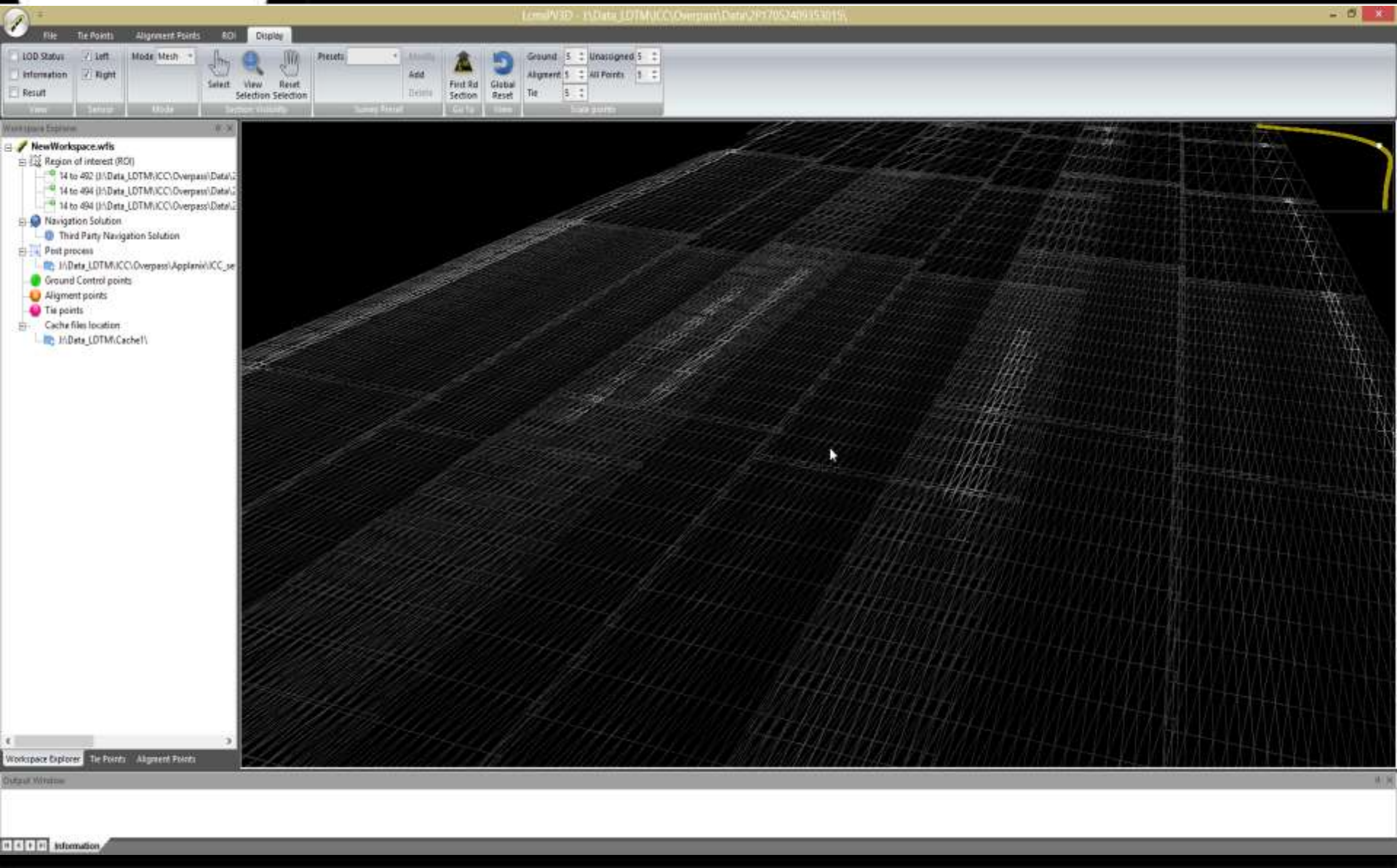
Shift between runs before processing results



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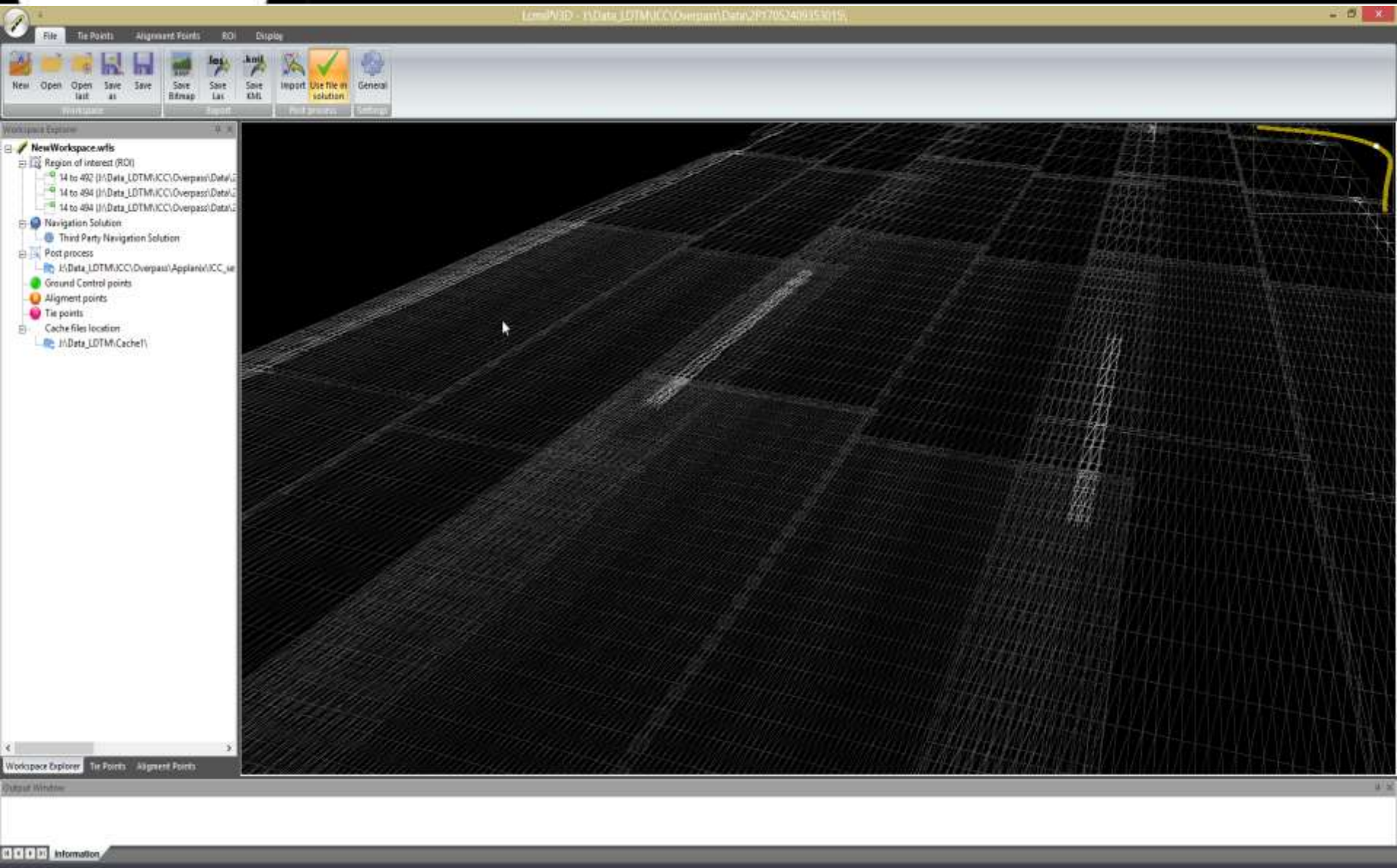
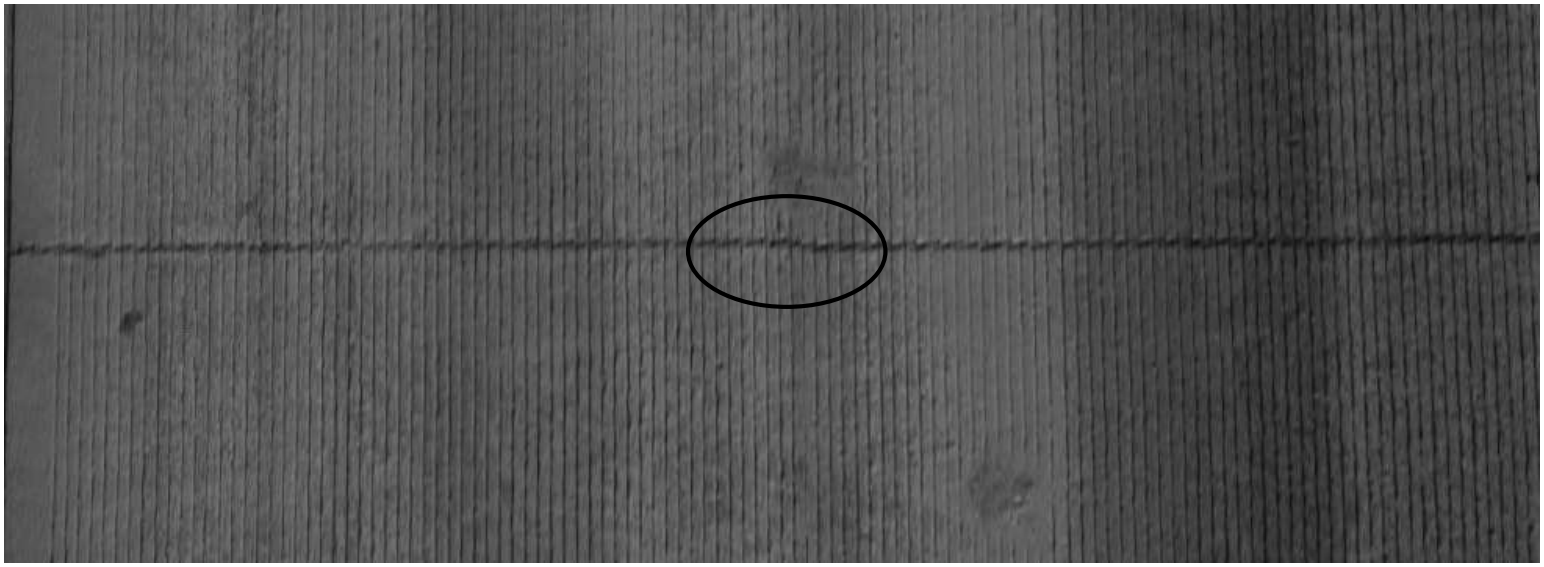
No more shift between runs after processing is applied



Stitching

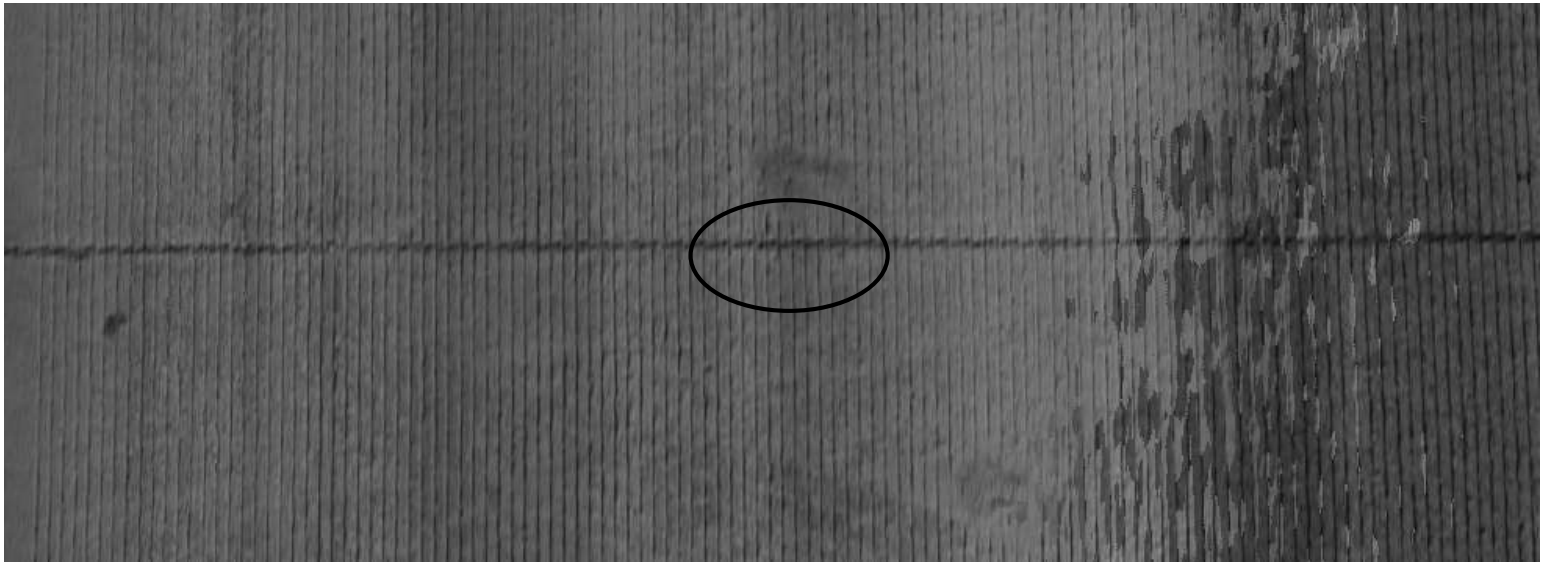
Stitching Runs (before processing)



LDTM Calibration → LDTM Survey → Data Processing → Control Points → Tie Points → Applying solutions → Data Exportation (LAS)

Stitching

Stitching Runs (after processing)



LDTM Calibration → LDTM Survey → Data Processing → Control Points → Tie Points → Applying solutions → Data Exportation (LAS)

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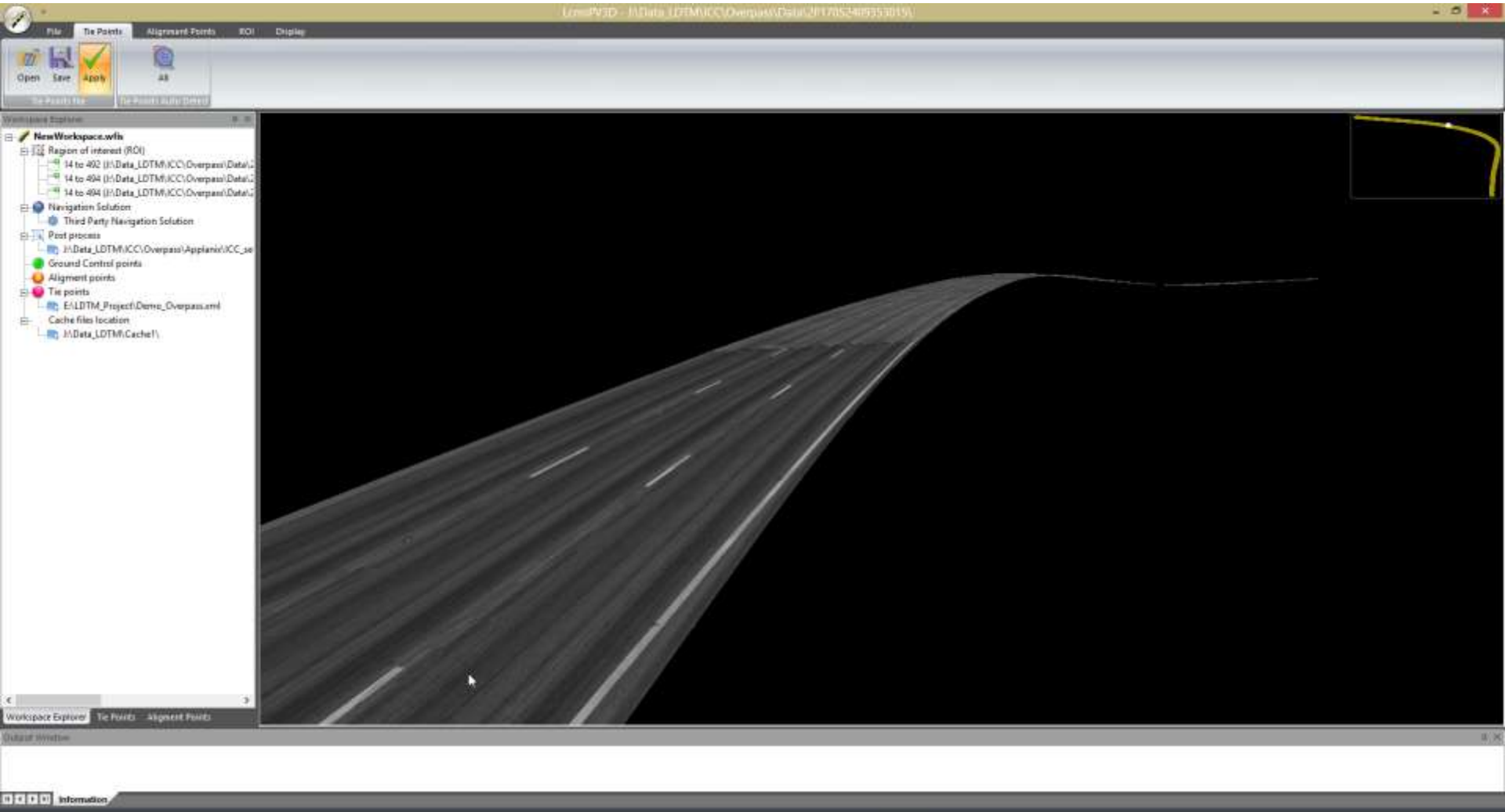
Final surface



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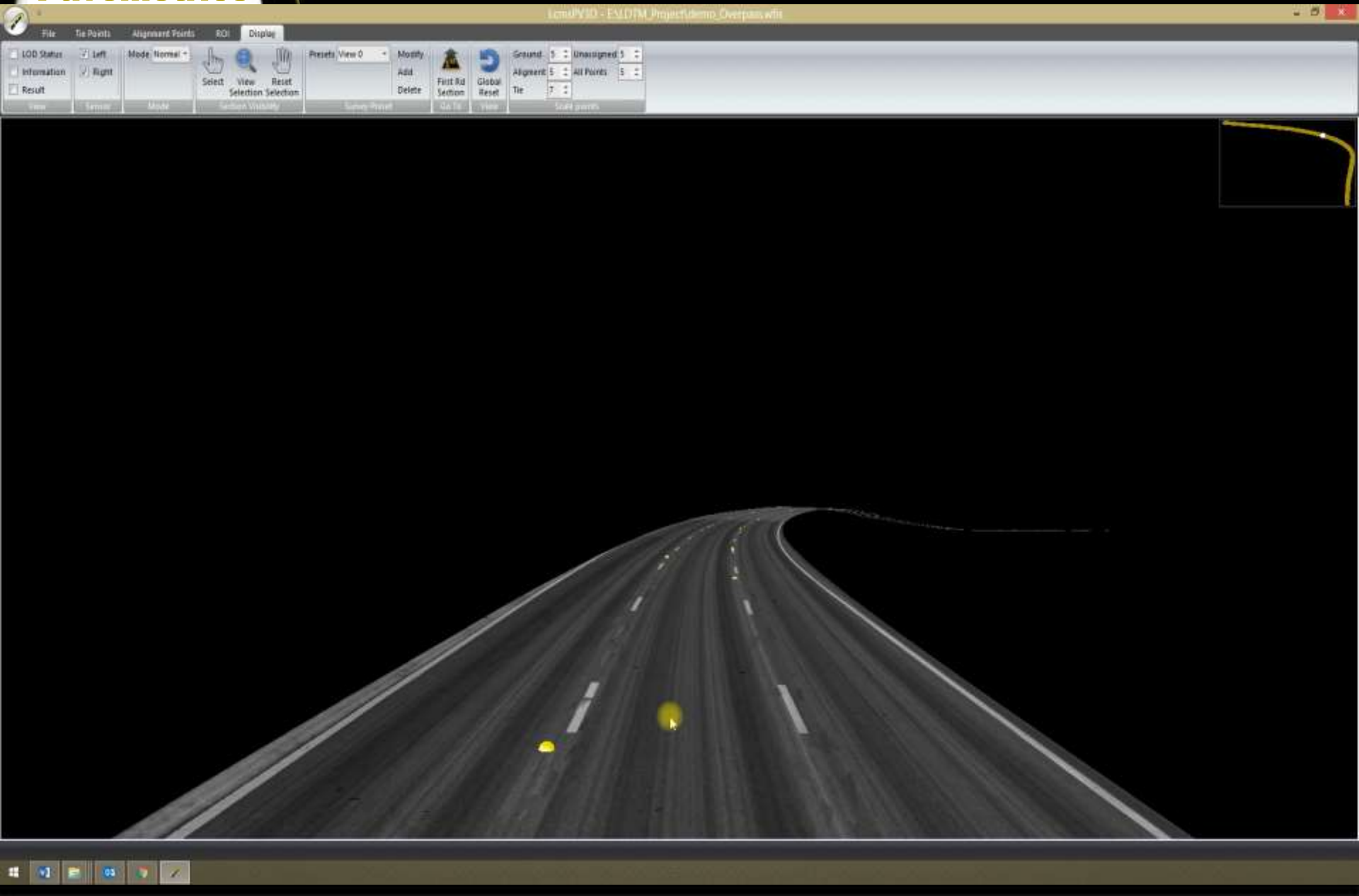
Final surface



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LAS file viewer (100 x 100)

LDTM validation - Test Track

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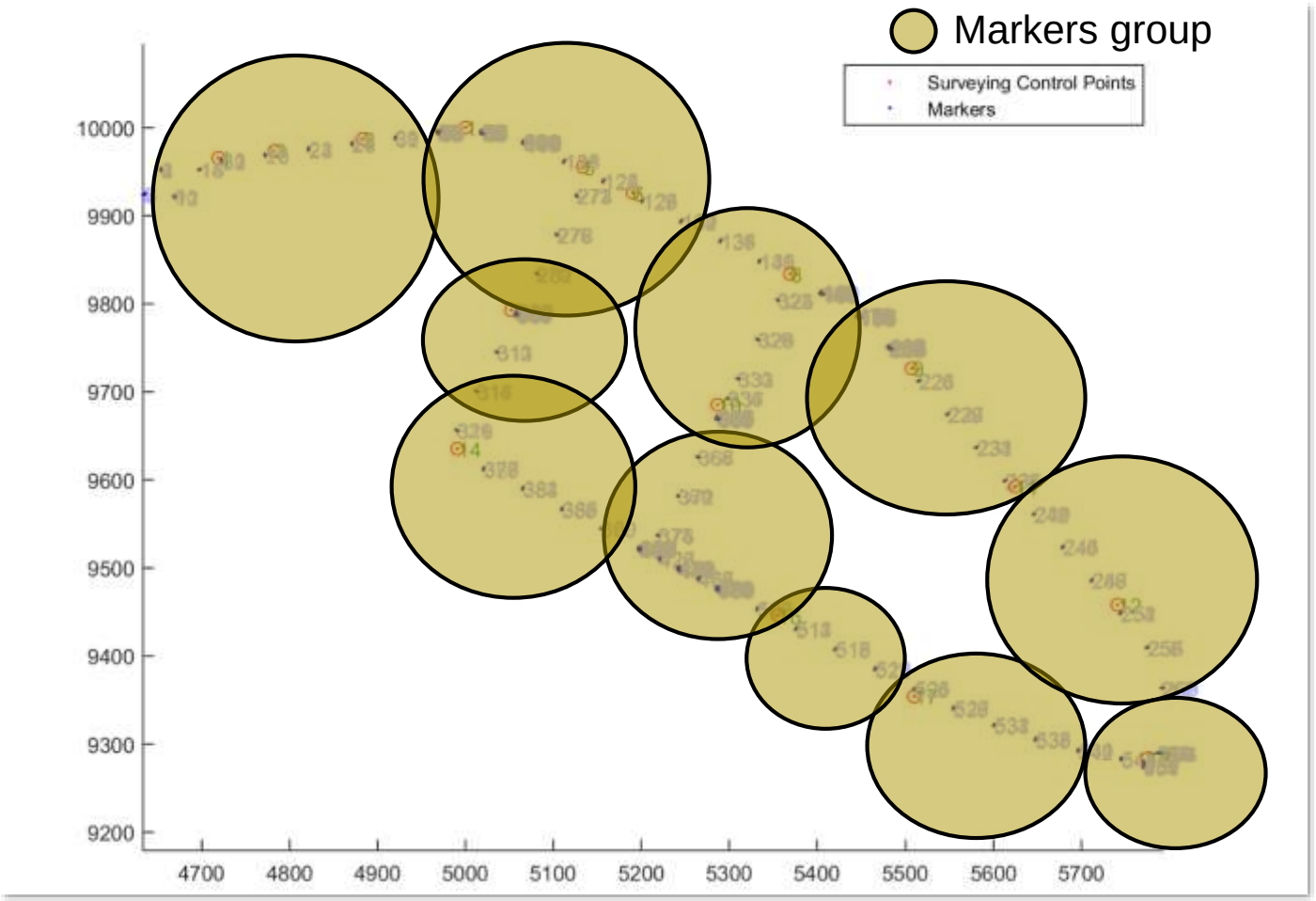
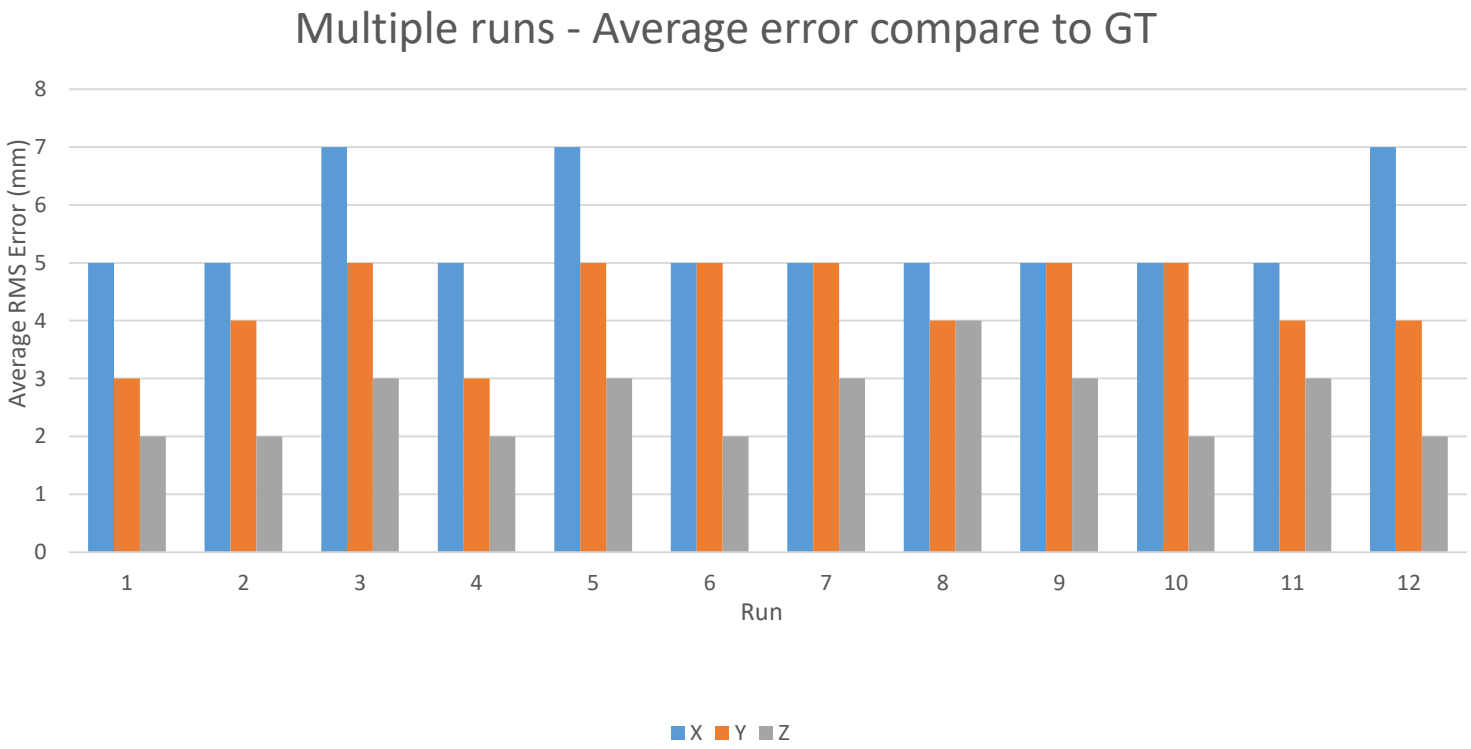
LDTM Test Track

Test S



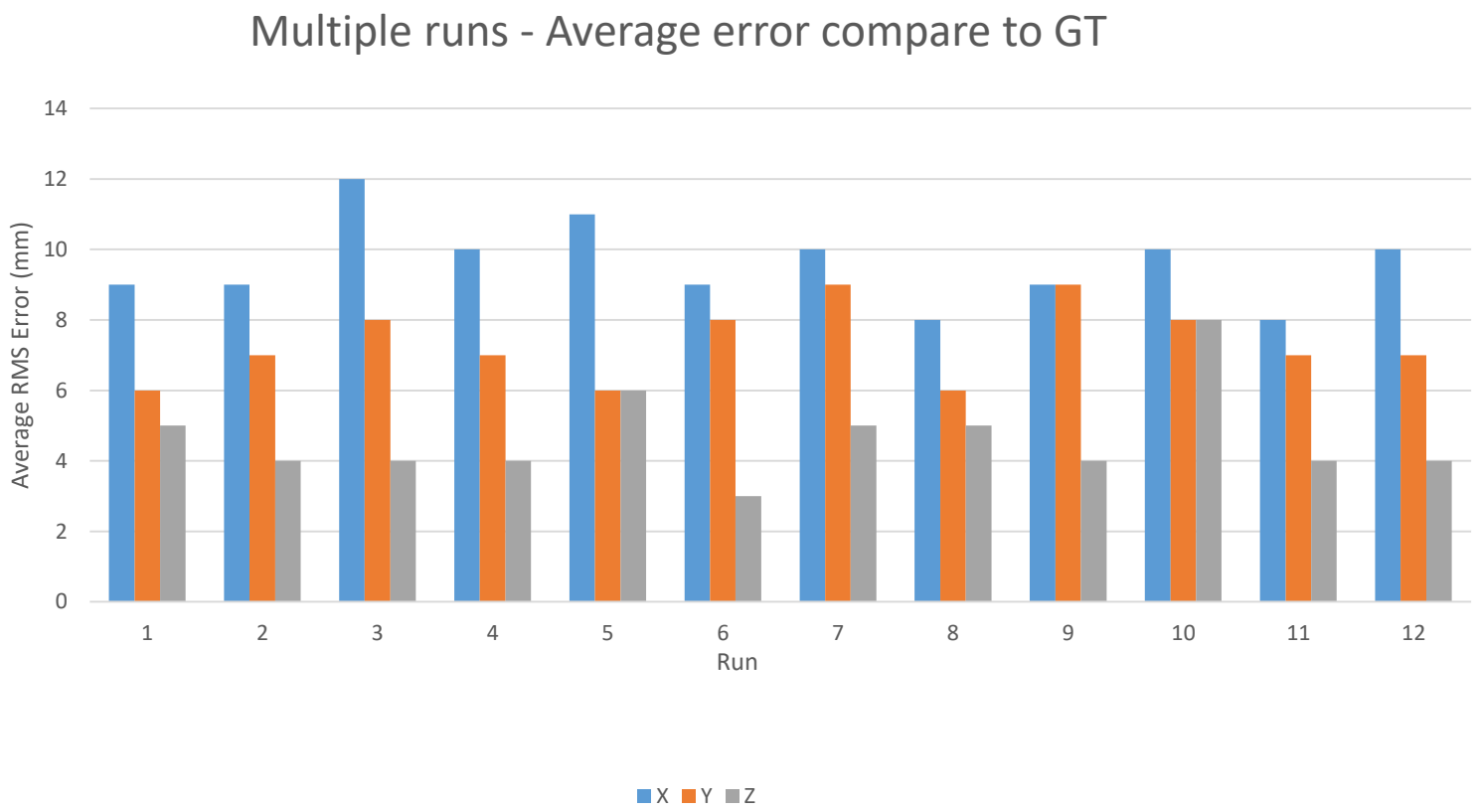
LDTM vs Ground Truth – 300m



Accuracy compare to GT (Avg. in mm):	X: 5.0	Y: 4.0	Z: 2.5
Repeatability compare to first scan (mm)*:	X: 3.0	Y: 5.0	Z: 2.0

*Mean of RMS Error over 12 scans

LDTM vs Ground Truth – 825m



Accuracy compare to GT(Avg. in mm):	X: 9.0	Y: 7.0	Z: 5.0
Repeatability compare to first scan (mm)* :	X: 6.0	Y: 6.0	Z: 4.0

*Mean of RMS Error over 12 scans

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Other Example: Airfield survey

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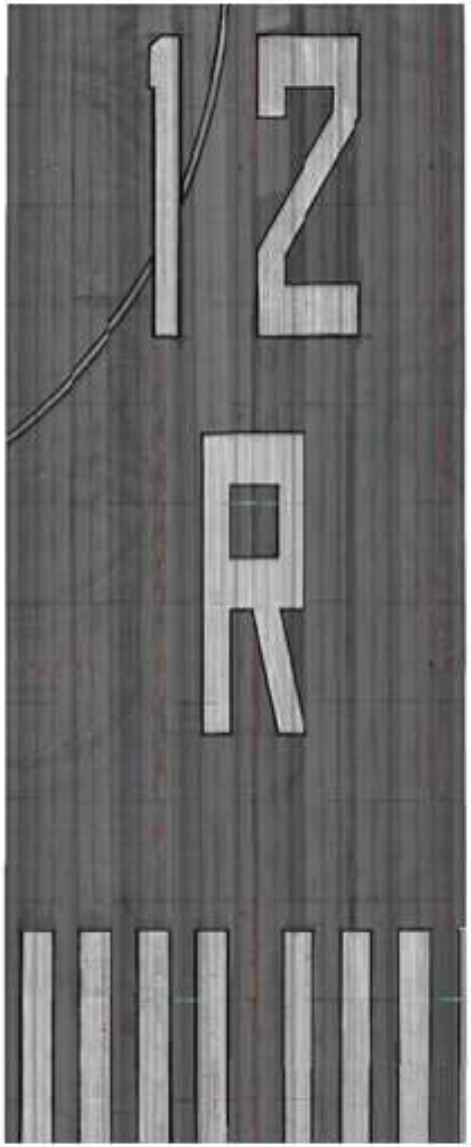
Other Example: Airfield survey



Other Example: Airfield survey

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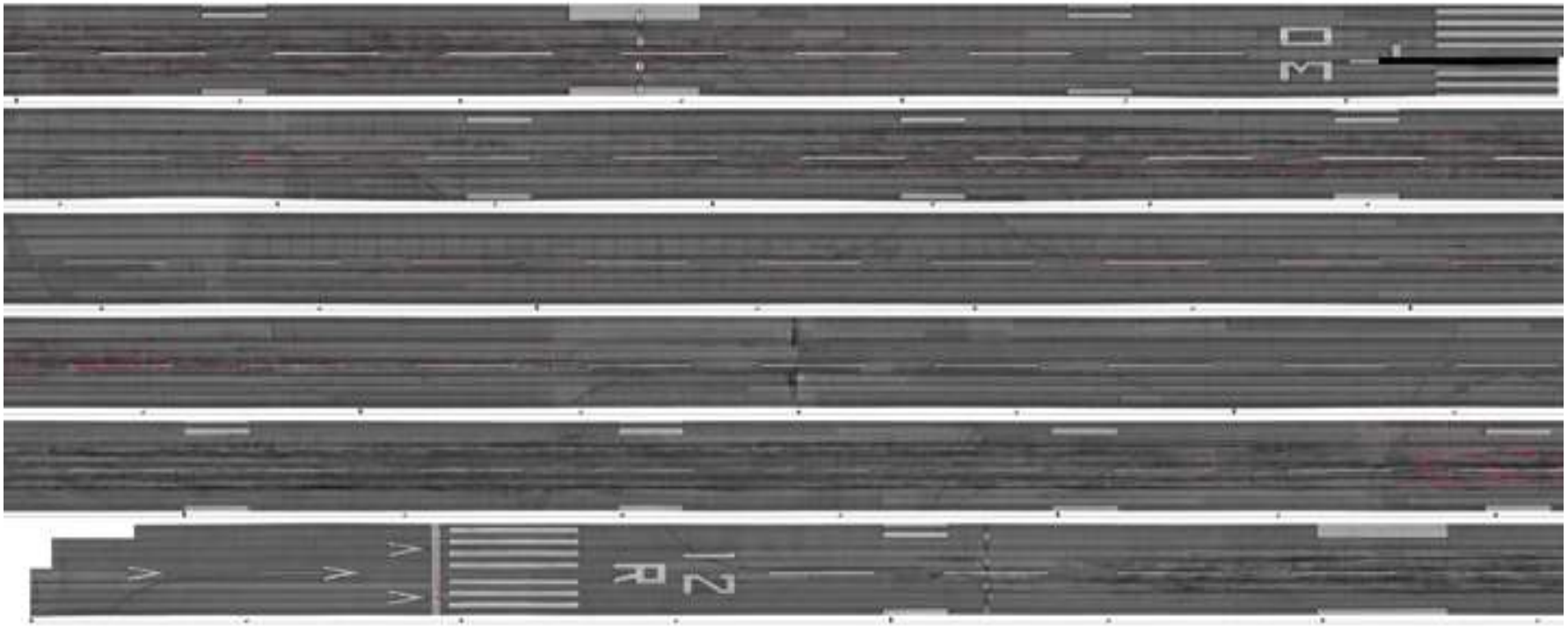
Results:



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Questions ?