

**XenomatiX**  
True solid state lidar



# Digitizing Bike lanes for Bike PMS

ERPUG 2023 – Athens, October 25-27

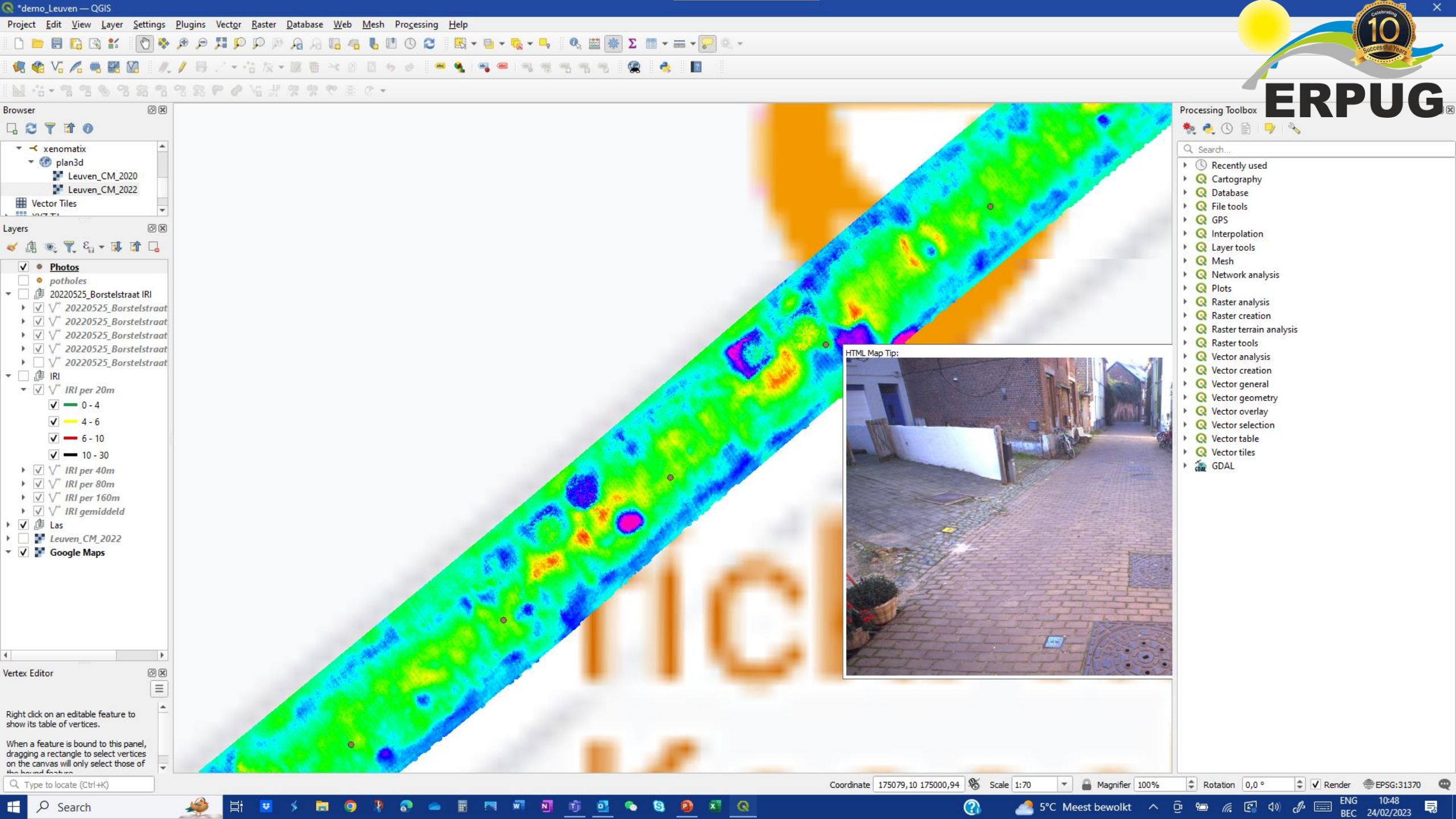


# Agenda

- × **Refresh 6D Road Lidar System with the XenoTrack**
- × Further performance and certification proof
- × New XenoTrack application - Bike Lane Inspection
- × New XenoTrack applications – Traffic Signs , Mobile Mapping, ...
- × Overview of applications







Browser

- xenomatix
  - plan3d
    - Leuven\_CM\_2020
    - Leuven\_CM\_2022
  - Vector Tiles

Layers

- Photos
  - potholes
  - 20220525\_Borstelstraat IRI
    - 20220525\_Borstelstraat
    - 20220525\_Borstelstraat
    - 20220525\_Borstelstraat
    - 20220525\_Borstelstraat
    - 20220525\_Borstelstraat
  - IRI
    - IRI per 20m
      - 0 - 4
      - 4 - 6
      - 6 - 10
      - 10 - 30
    - IRI per 40m
    - IRI per 80m
    - IRI per 160m
    - IRI gemiddeld
  - Las
  - Leuven\_CM\_2022
  - Google Maps

Vertex Editor

Right click on an editable feature to show its table of vertices.  
When a feature is bound to this panel, dragging a rectangle to select vertices on the canvas will only select those of the bound feature.

Processing Toolbox

- Search...
- Recently used
  - Cartography
  - Database
  - File tools
  - GPS
  - Interpolation
  - Layer tools
  - Mesh
  - Network analysis
  - Plots
  - Raster analysis
  - Raster creation
  - Raster terrain analysis
  - Raster tools
  - Vector analysis
  - Vector creation
  - Vector general
  - Vector geometry
  - Vector overlay
  - Vector selection
  - Vector table
  - Vector tiles
  - GDAL





**Contents**

Map X Catalog

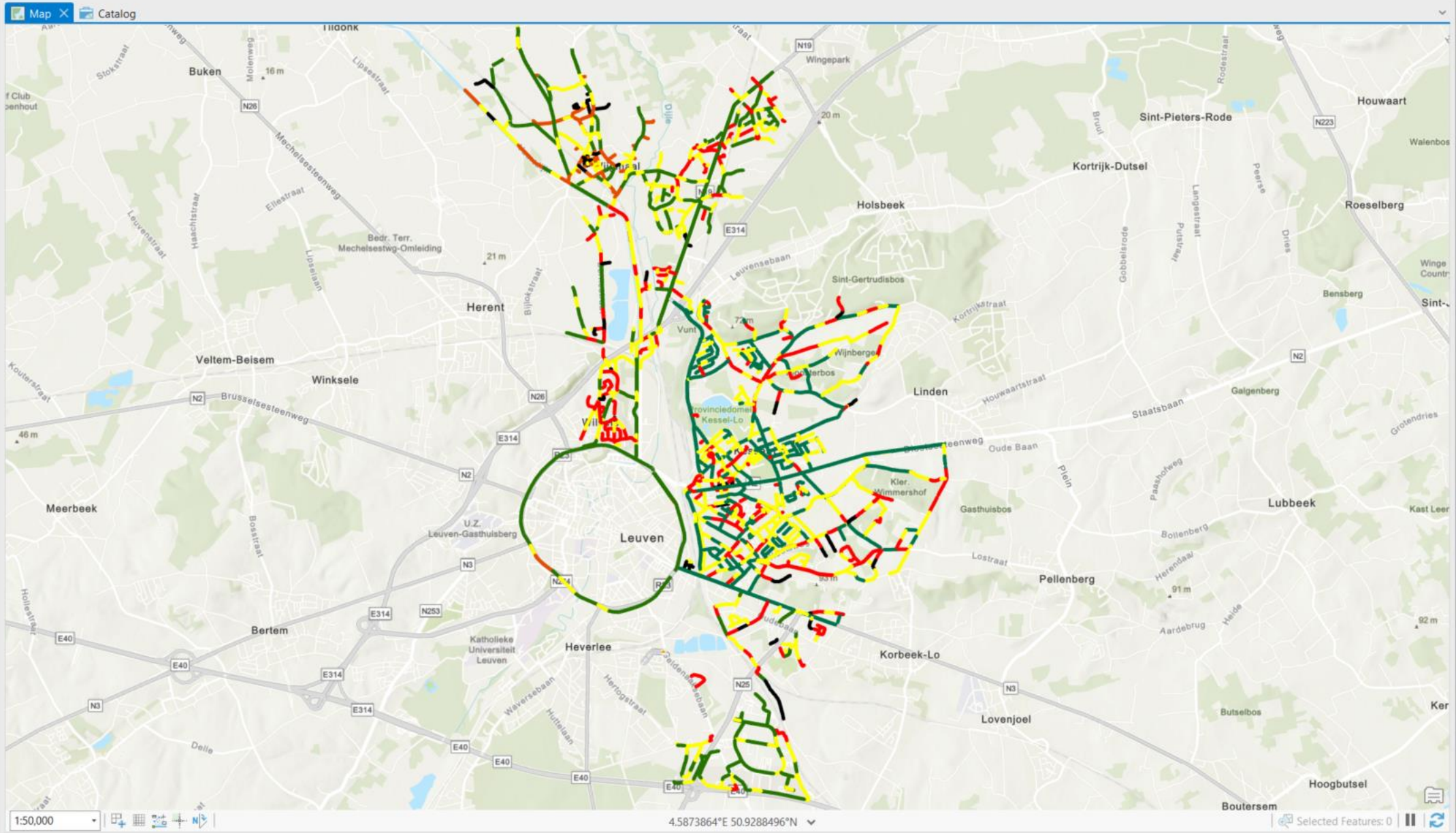
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Data percentage: 0

plan3d



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# Performance Tests

1. APL correlation test with BRRC
2. Repeatability of XenoTrack Evenness results for BRRC
3. **IRI accuracy & repeatability test for NCAT**  
**Distance accuracy test for NCAT**
4. Rutting correlation test with MFV
5. Height accuracy test
6. Profile comparison test with Total Station
7. Handling of tunnels
8. Accuracy of georeferencing
9. **Bike Lane measures – BLP vs XenoTrack**

# 3. NCAT Certification tests

XenoTrack went through the NCAT certification process to evaluate accuracy and repeatability of IRI measurement

- ✗ *The profiler passes the repeatability test scoring >93%*
- ✗ *The profiler passes the accuracy test scoring >96%*
- ✗ *The profiler passes the distance accuracy test scoring >99,85%*
- ✗ *The profiler allows a process flow within 24h*

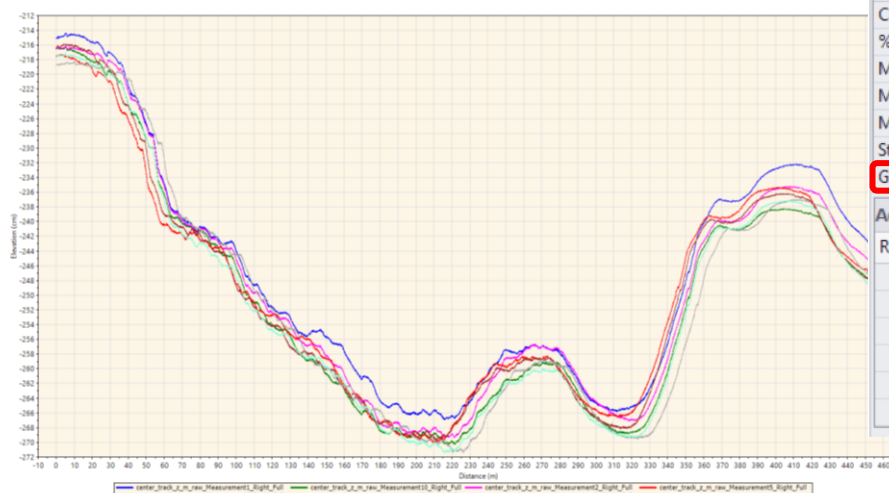
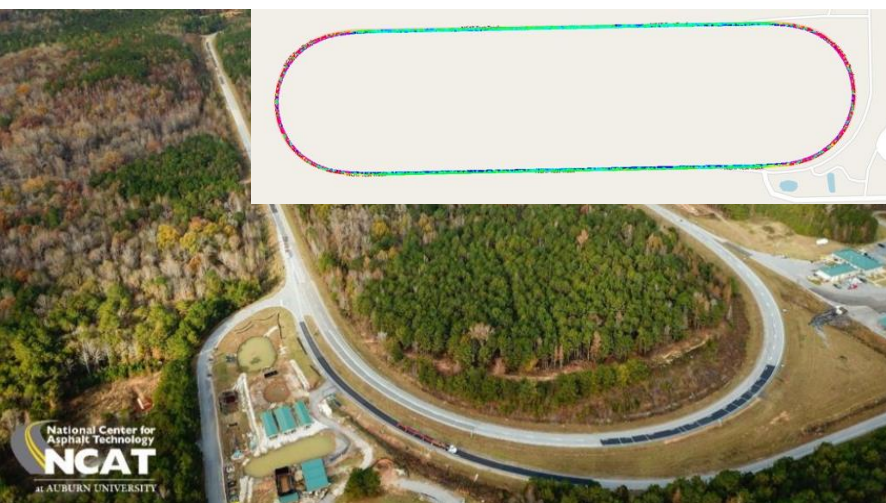


### Profiler Certification: Summary Results

Statistics		Repeatability - Right	Accuracy - Right
Statistic			
Comparison Count		15	6
% Passing		53.33	83.33
Mean		90.13	91.82
Minimum		87.92	87.40
Maximum		93.08	93.59
Standard Deviation		1.5	2.3
Grade		Passed	Passed

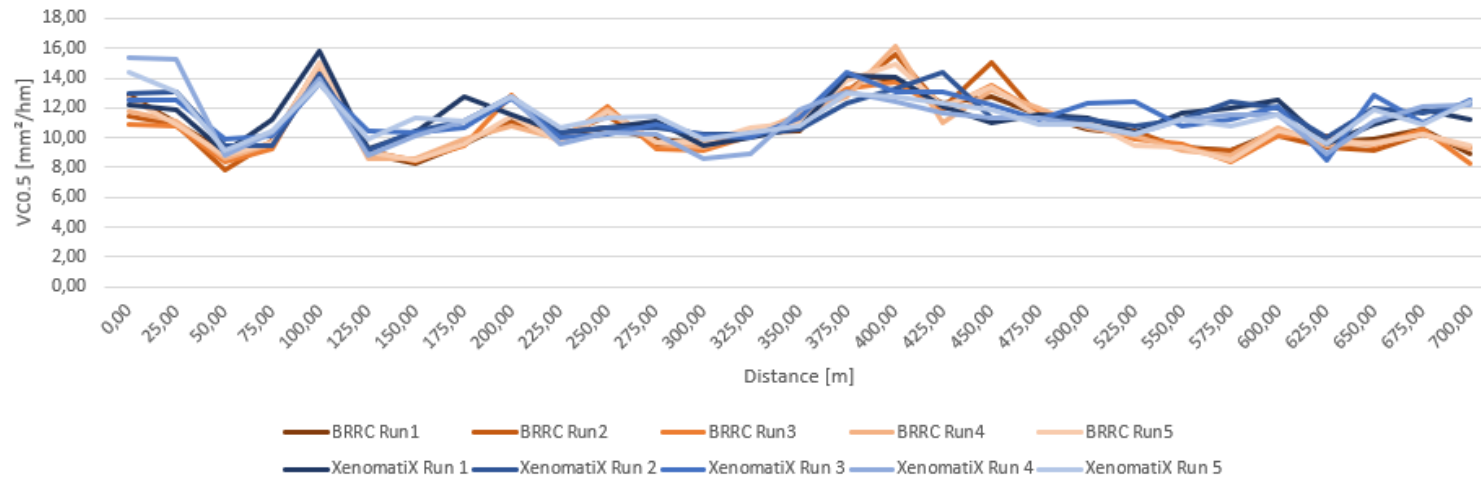
Accuracy	Repeatability - Right Correlations (%)					Repeatability - Right Offsets (m)							
Run	Right	Run	2	3	4	5	6	Run	2	3	4	5	6
1	91.24	1	88.54	89.19	91.52	91.35	89.87	1	0.9	0.7	0.7	0.7	1.3
2	87.40	2		88.75	88.21	87.92	90.45	2		-0.1	-0.1	-0.1	0.5
3	93.11	3			90.00	89.05	93.08	3			0.0	0.0	0.6
4	93.00	4				92.04	91.02	4				0.0	0.6
5	92.60	5					90.89	5					0.6
6	93.59	6						6					



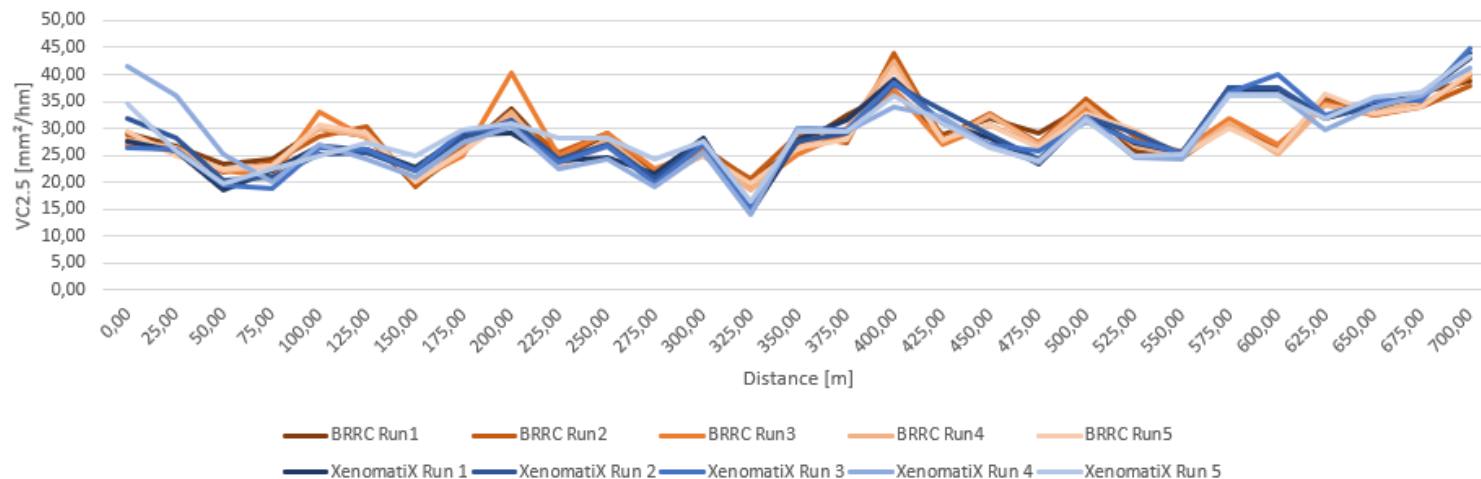


# 9. BLP vs XenoTrack – ECo,5 / EC2,5 comparison

Comparison of VC0.5 between the XenoTrack and the "fietspad profilometer"



Comparison of VC2.5 between the XenoTrack and the "fietspad profilometer"



Bike Lane Profilometer (BLP):



REPEATABILITY and ACCURACY

- ✘ 5 orange graphs for 5 BLP measures
- ✘ 5 blue graphs for 5 XenoTrack measures

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# Bike lane inspection – Political Context

- x Shift to sustainable transportation is priority for government and road authorities:
  - tax incentives for sustainable mobility, incl. biking
  - efforts for comfort & safety
  - extra incentive for healthcare budget
- x Results
  - more bikes on the 'road'
  - new types of bikes (also for cargo)
  - need for wider and more comfortable bike lanes

Need for :

- more, safer and better quality bike lanes and
- **dedicated bike lane inspection solutions**



# NEW "XenoBike-1"

1. XenoTrack (4D)  
for lane-wide digitization

2. XenoCam (2D)  
for 12Mpixel images

3. GPS (RTK)  
for precise geo-referencing

7. Warning labels  
for safety & visibility



4. Tablet  
for driver UI

5. Cargo box  
for safe storage of  
computing equipment

6. Wheelencoder  
for precise distance and  
speed measurement

# XenomatiX

Riding the Path to Safety

# “XenoBike-1” specifications

- x Zero-emission vehicle
- x Allowed on **all bike lanes** without special permission or certification
- x No driver license required (**anyone** can drive)
- x Narrow vehicle (86cm) for **easy access**
- x 3-wheeler: **measurement stability**
- x Suspension for **stable** measurements
- x Swappable batteries for long **autonomy**



Vehicle specifications	
Maximum speed	25 km/h
Range / battery	~60 km
Weight	70 kg
Width	86 cm
Charging time	3.5 hours
Carrying Capacity	200 kg
Vehicle dim. (LxWxH)	205/86/195 cm

# “XenoBike-1” advantages

- × Good **productivity** (up to 120km per day)
- × ‘Free’ **fitness during worktime** 😊 ..... ??
- × Very **precise localisation** of defects in earth coordinates
- × Works on **any pavement type** (so also gravelroads, dirt roads, brick roads, ...)
- × Works **day & night**
- × **Adjustable** measurement width , up to 4m wide
- × Results are **speed-independent, including start & stop (!)**
- × Results can be uploaded in any Pavement Management Systems (**PMS**) or any GIS
- × Pavement “coefficients” adaptable to **any Standard**



# "XenoBike-2"



# XenoBike output – measures

- x **3D height maps:** 3D surface model and Color-coded pavement model revealing detailed geometry – *evaluation*
- x **Intensity maps:** orthoprojected, gray-scale road image, revealing pavement markings and variations in material - *evaluation*
- x **2D color images:** High resolution color pictures for visual checking - *evaluation*
- x **IRI or ECo.5 and EC2.5:** Quantification of unevenness - *comfort and safety measure*
- x **Bike lane width:** the usable width of the lane is critical for safety – *safety measure*
- x **Bike lane banking:** the lateral slope is critical for safety – *safety measure*
- x **Bike lane slope:** the longitudinal slope is important for attractiveness - *comfort*
- x **Crack detection:** location, quantity and severity of cracks – *repair planning*
- x **Pothole detection:** localization and sizing of potholes – *repair planning*
- x **Obstacle detection:** bumps, element elevation, ... - *repair planning*







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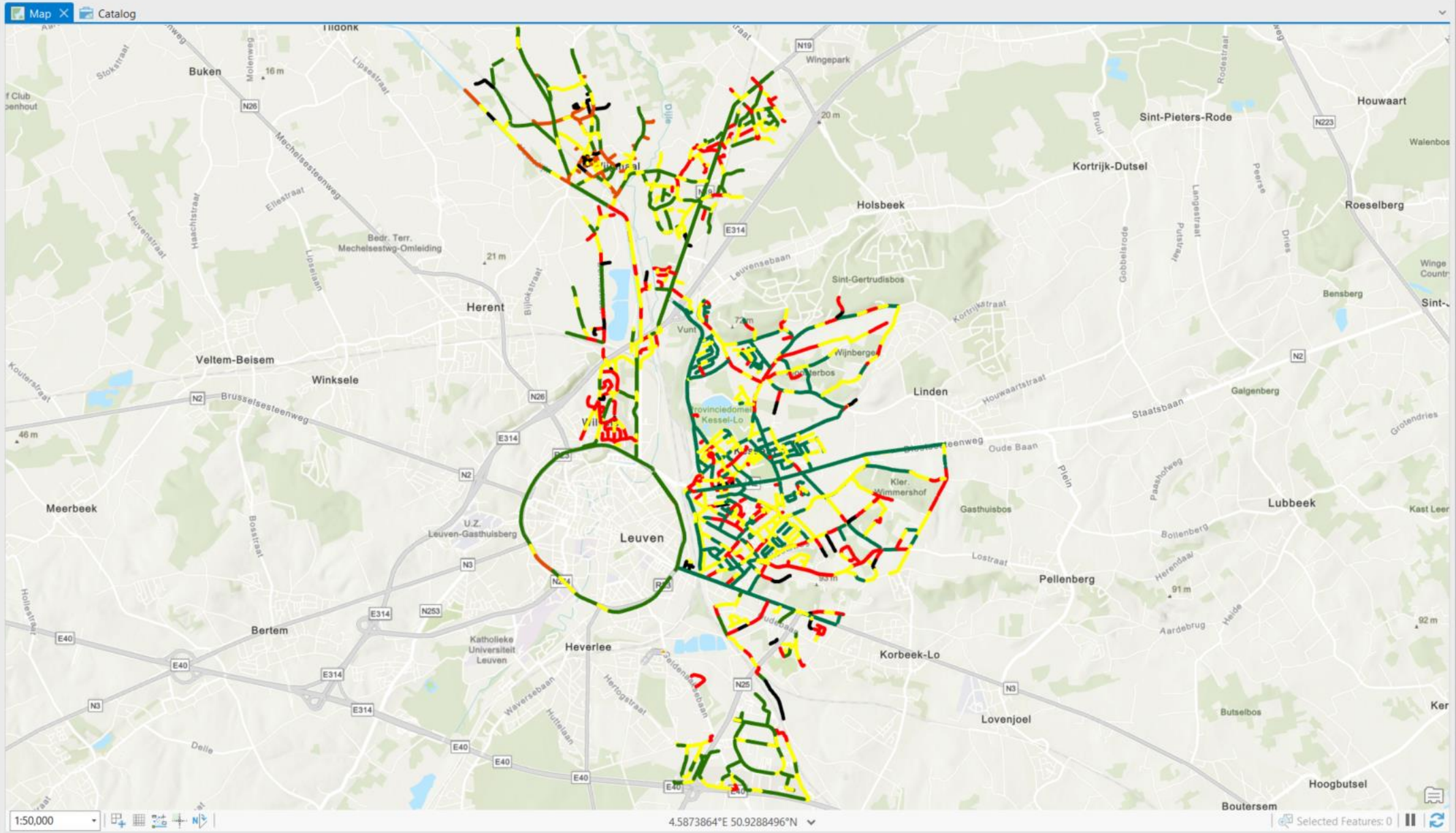
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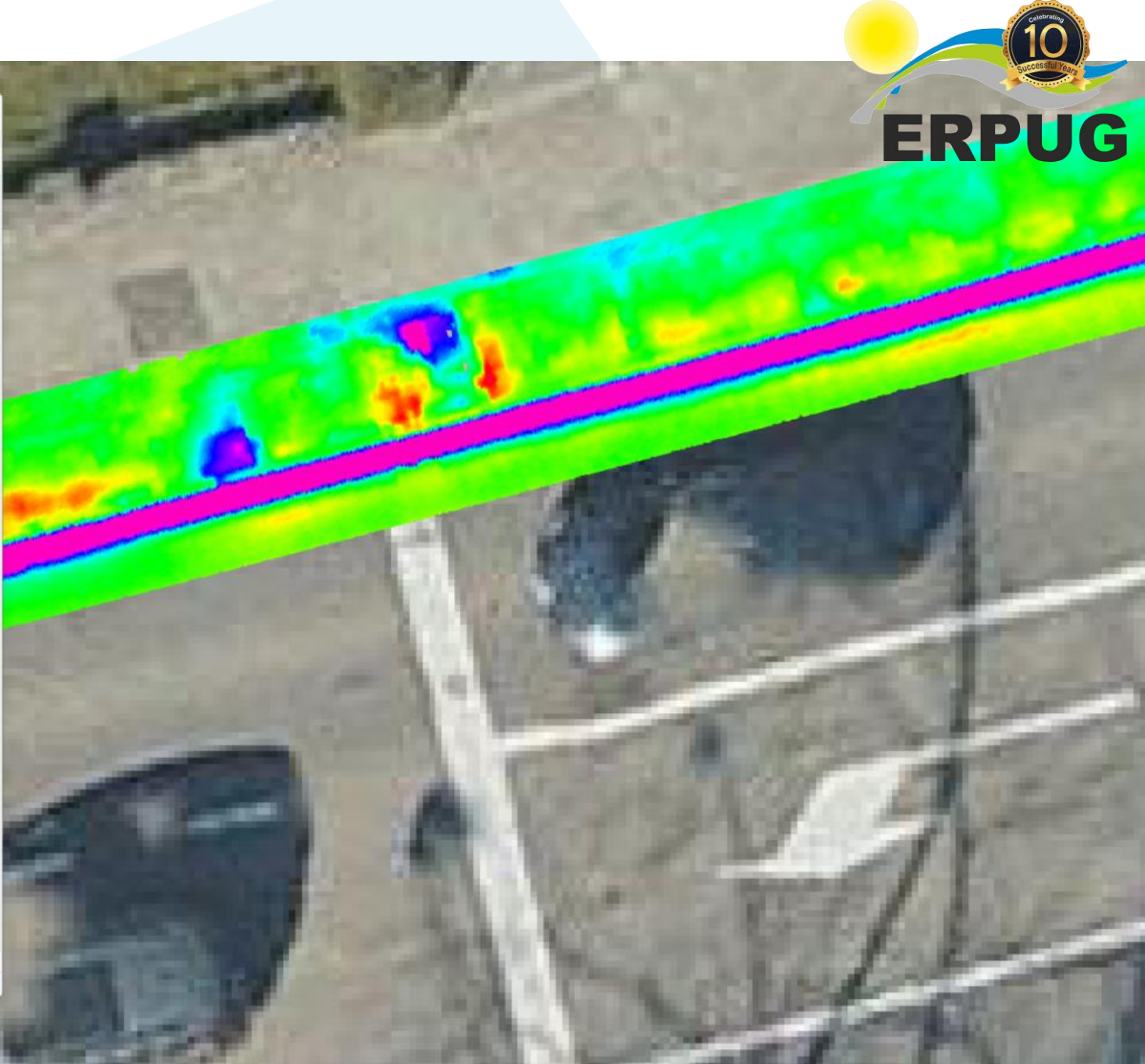
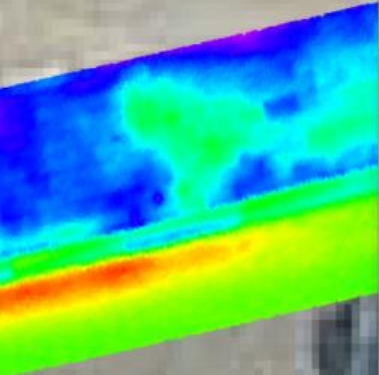
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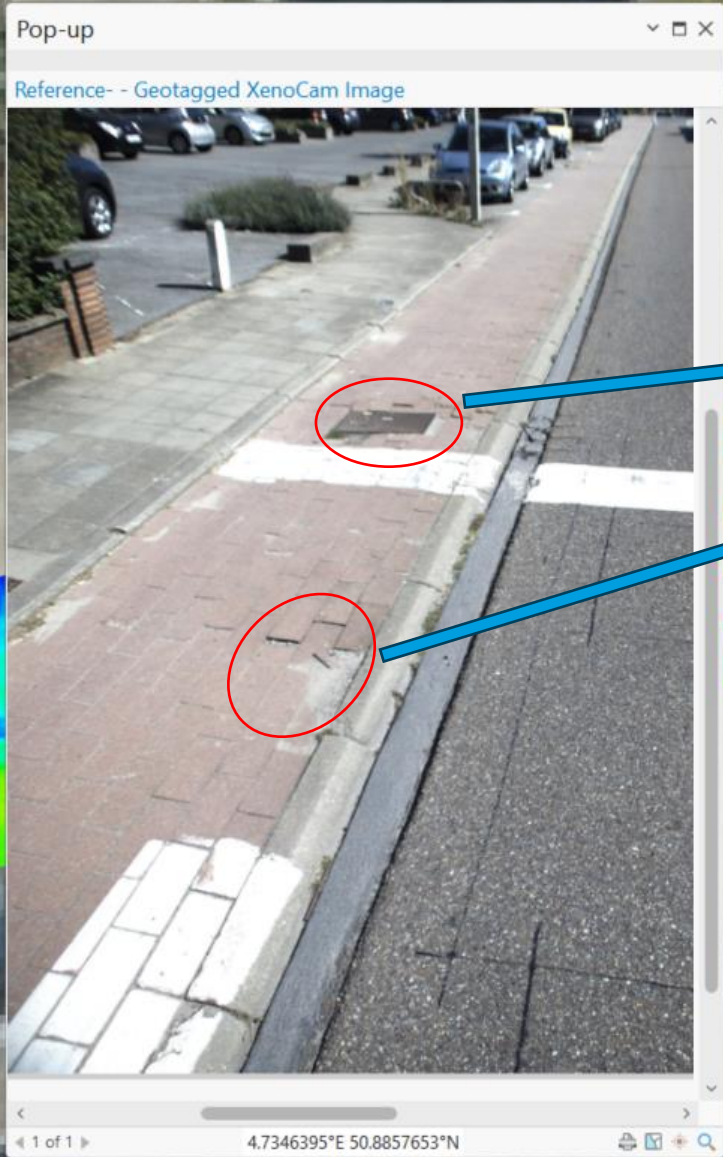
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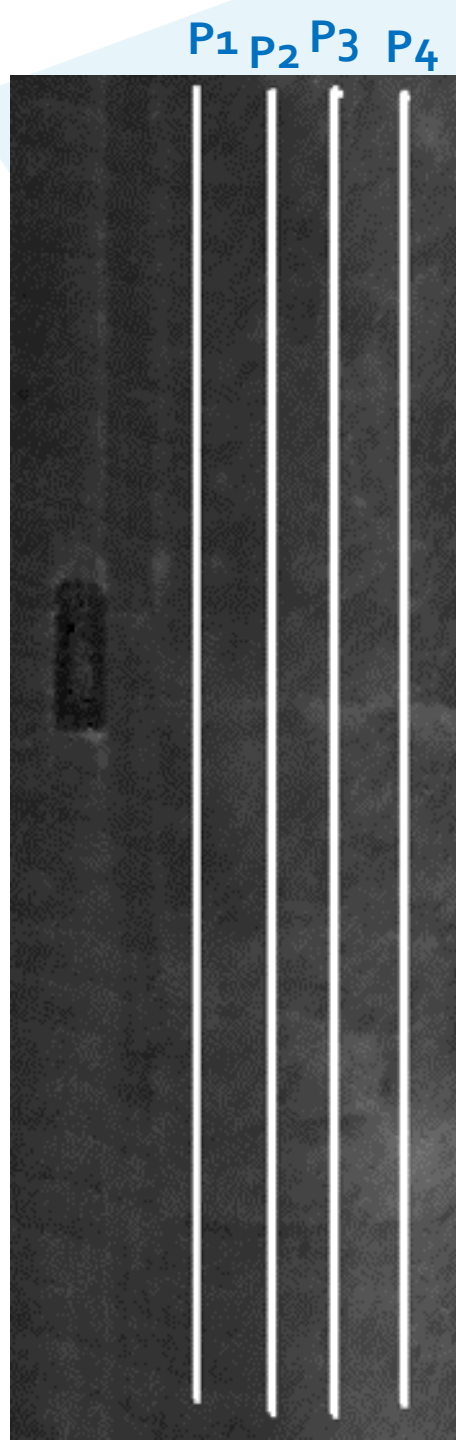






# Bike Lane Profiles

- x 4 profiles P<sub>1</sub>, P<sub>2</sub>, P<sub>3</sub> and P<sub>4</sub> taken with 20-30cm between each other
- x White lines represent where the profiles were taken.



# Bike Lane Profiles



- ✘ Profiles follow the same global trend but differ when zoomed in
- ✘ We can expect differences in the VC values

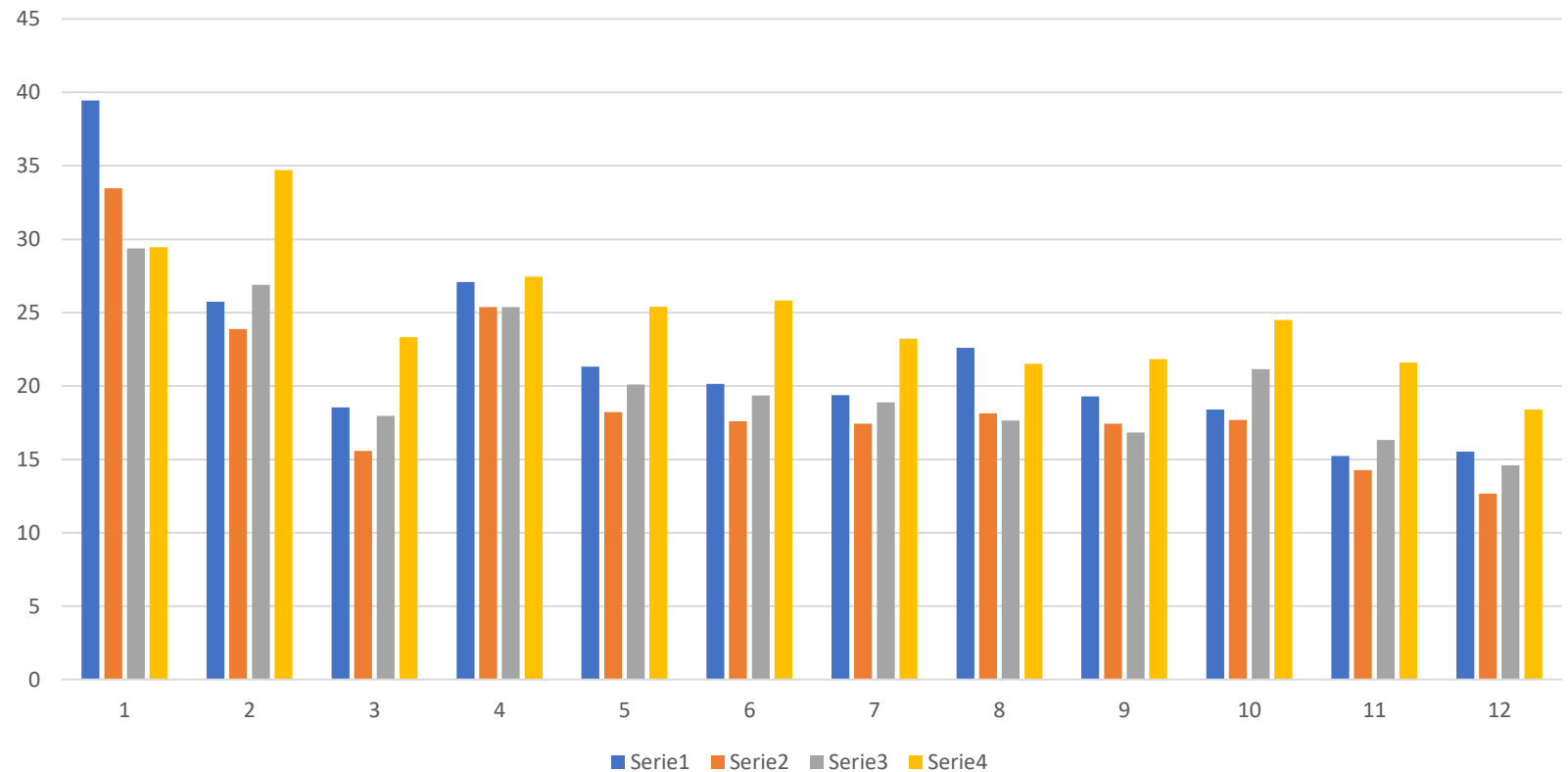


# 'Good' bike lane - EC2.5 per 25m

- x Difference can be observed between the tracks up to >30%.



VC2.5 for different tracks

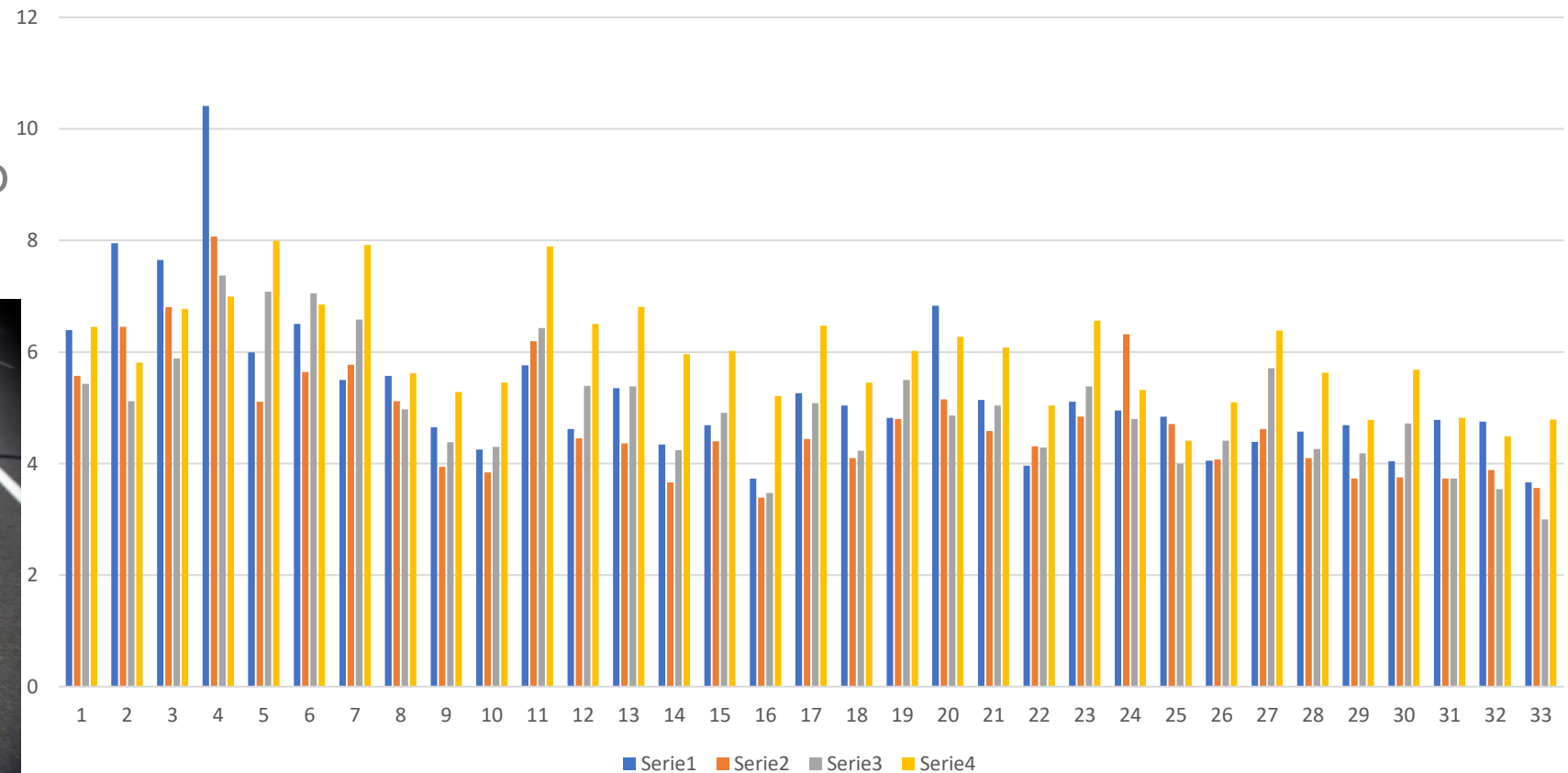


# 'Good' bike lane - ECo.5 per 10m

- x Bike lane in good condition so the difference is not so big in absolute values but in % up to 50%.



VC0.5 for different tracks

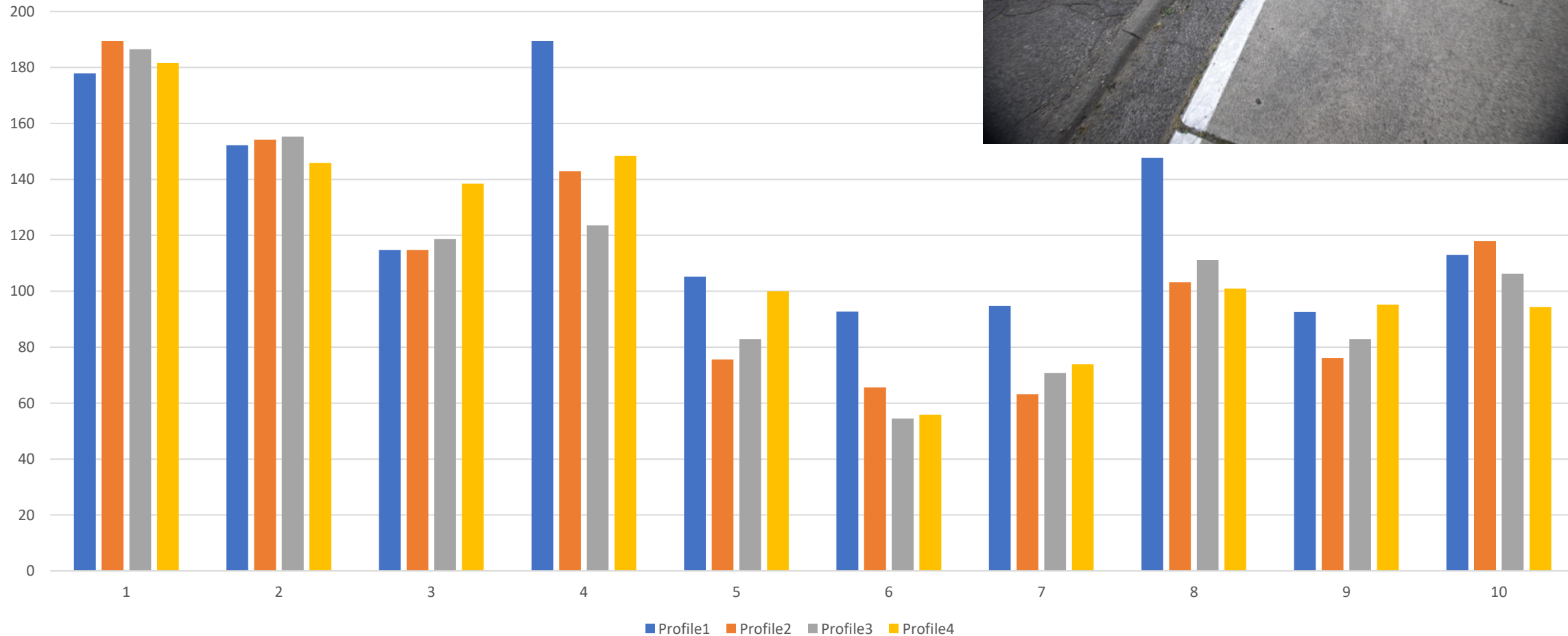




# 'Bad' bike lane - EC2.5 per 25m

x Values differ up to 50%:

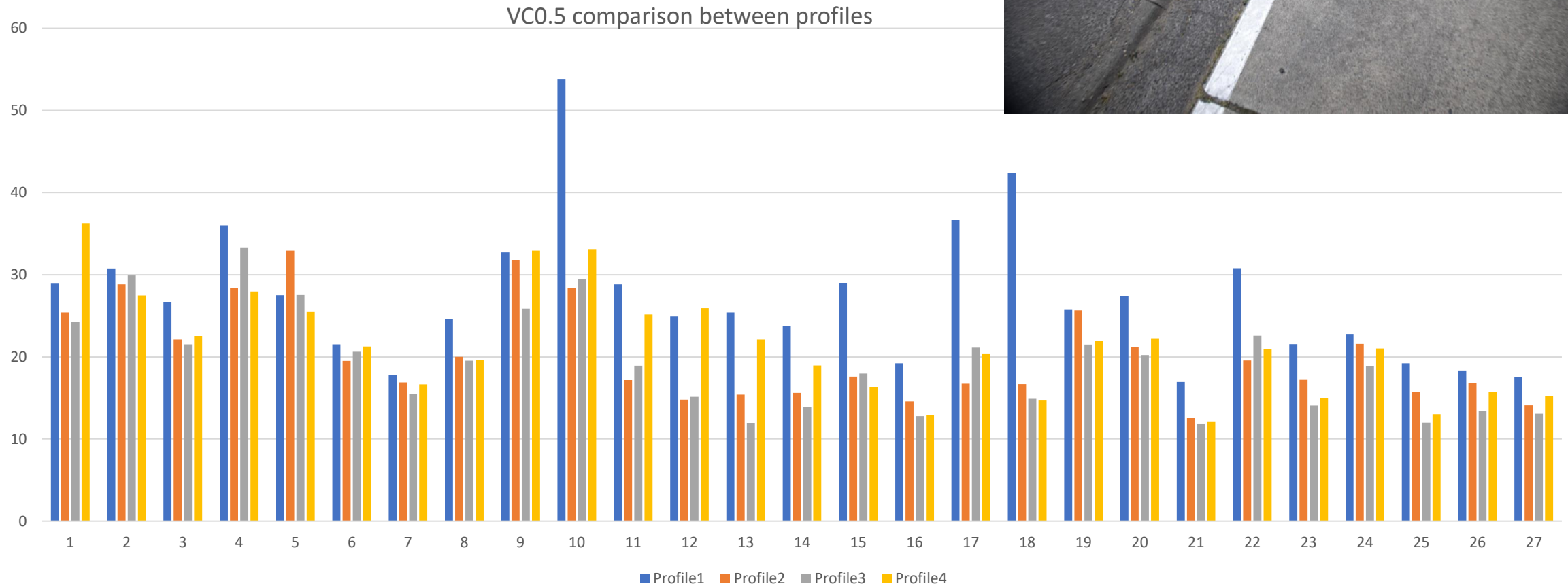
VC2.5 comparison between profiles



# 'Bad' bike lane - ECo.5 per 10m

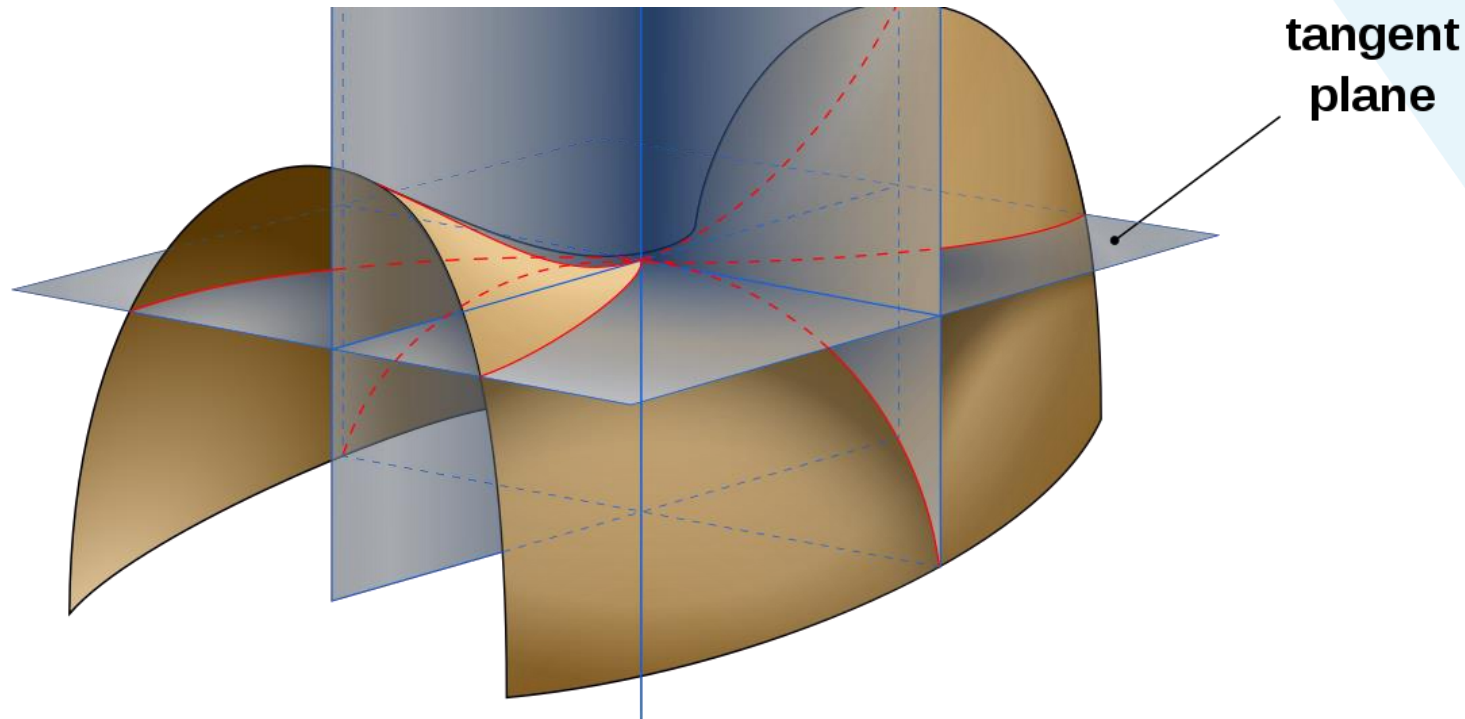


x Big differences up to 100%, mainly on the sides



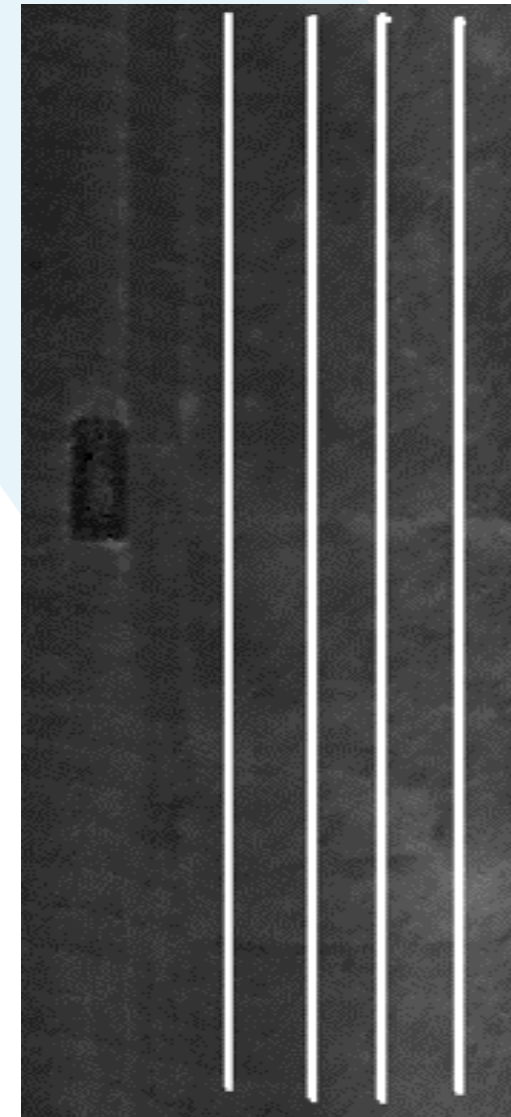
# Bike Lane – Safety & Comfort – LINE vs PLANE ?

- × 3-5 profiles spread over bike lane width or
- × 3D Plane Evenness Coefficient



By Eric Gaba (Sting) - Based upon a drawing in a book, CC BY-SA 3.0,

P<sub>1</sub> P<sub>2</sub> P<sub>3</sub> P<sub>4</sub>





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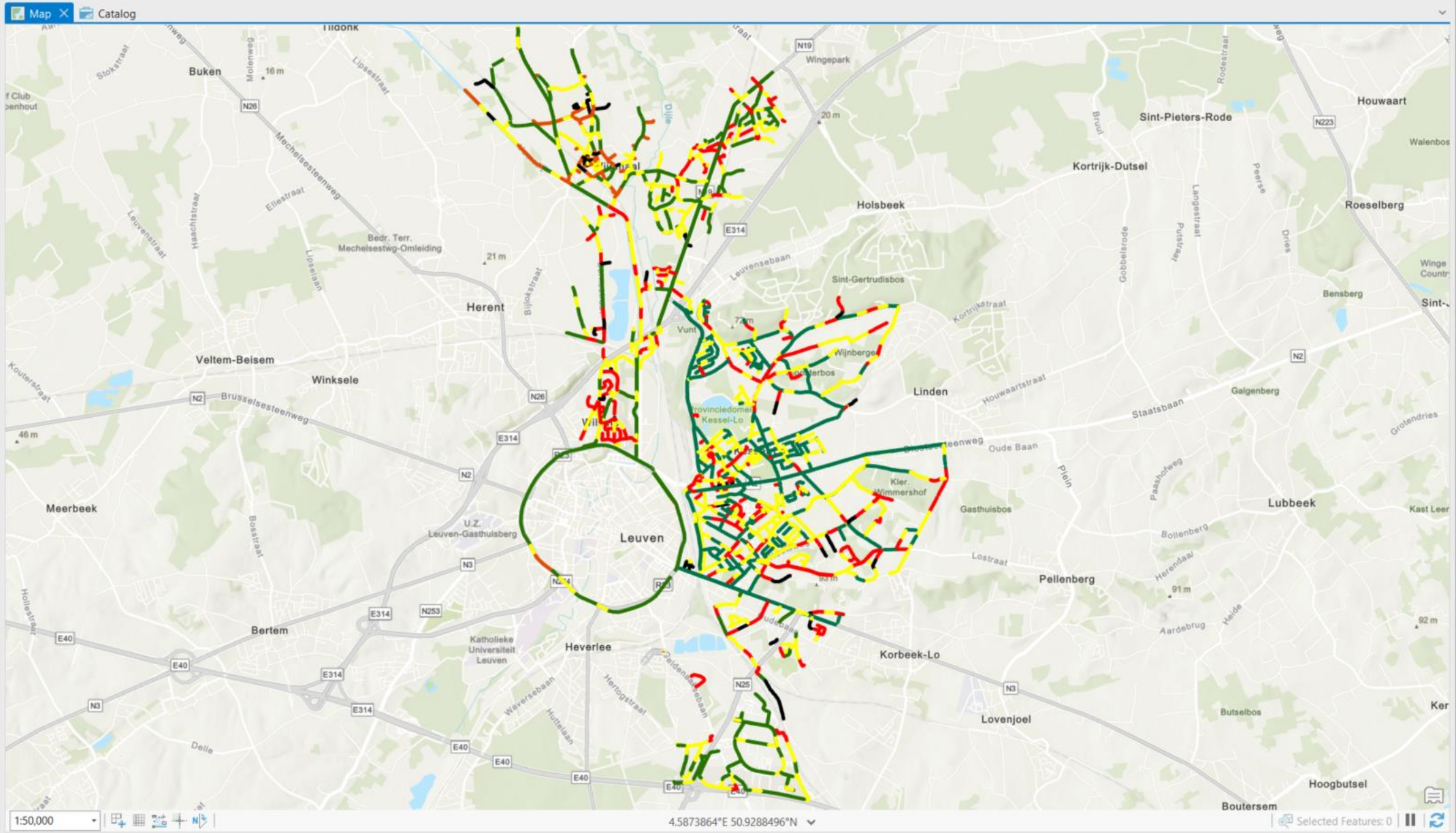
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plan3d



# Credentials XenomatiX bike lane solution

- × XenoBike already digitized thousand kilometers for the Flemish government
- × Comparison tests confirmed correctness of XenoBike results
- × Based on proven product (XenoTrack) globally used for road inspection
- × Highly automated solution, resulting in superior productivity and traceable results
- × Any NEW bike lane index can be extracted



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# New applications with XenoTrack – Traffic signs

1.



Install data capturing device, start driving, upload data.

2.



Recorded data will be annotated and made available in web app.

3.



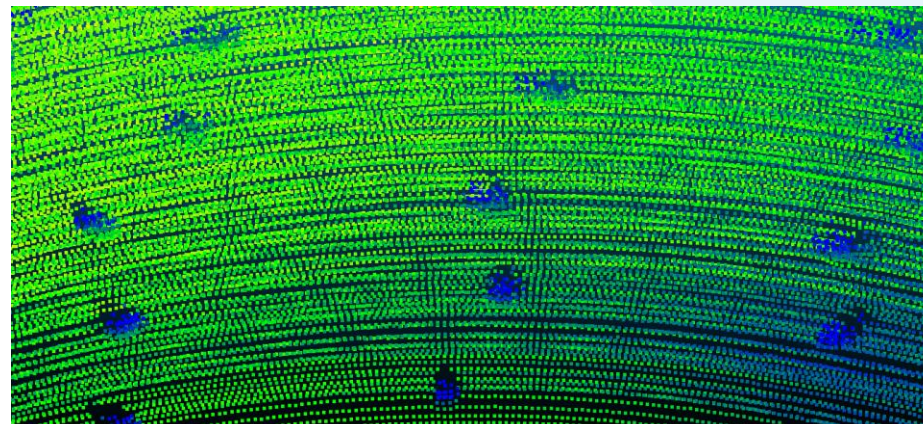
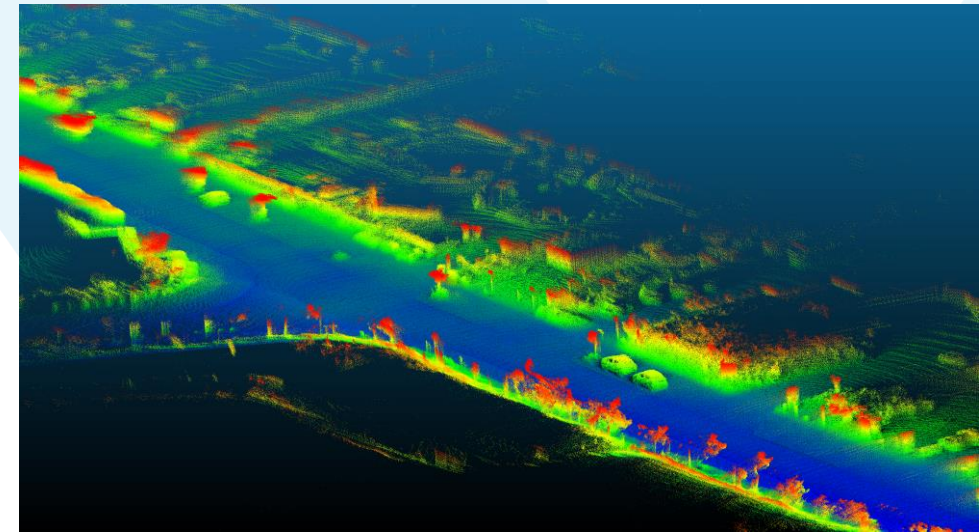
Analyse and compare data, receive notice of missing or defective signs.

# New applications - Mobile Mapping with 360° Lidar



Based on expertise built up, we enter the Mobile Mapping market, offering:

- ✘ quick setup: no separate alignment step needed
- ✘ compatible with XenomatiX' software suite DRP for pavement analysis (LAS, CSV, IRI, ...)
- ✘ Resulting 'BIM' scene models can be uploaded in softwares such as CloudCompare & GIS products
- ✘ Pointclouds in earth coordinates with dm accuracy





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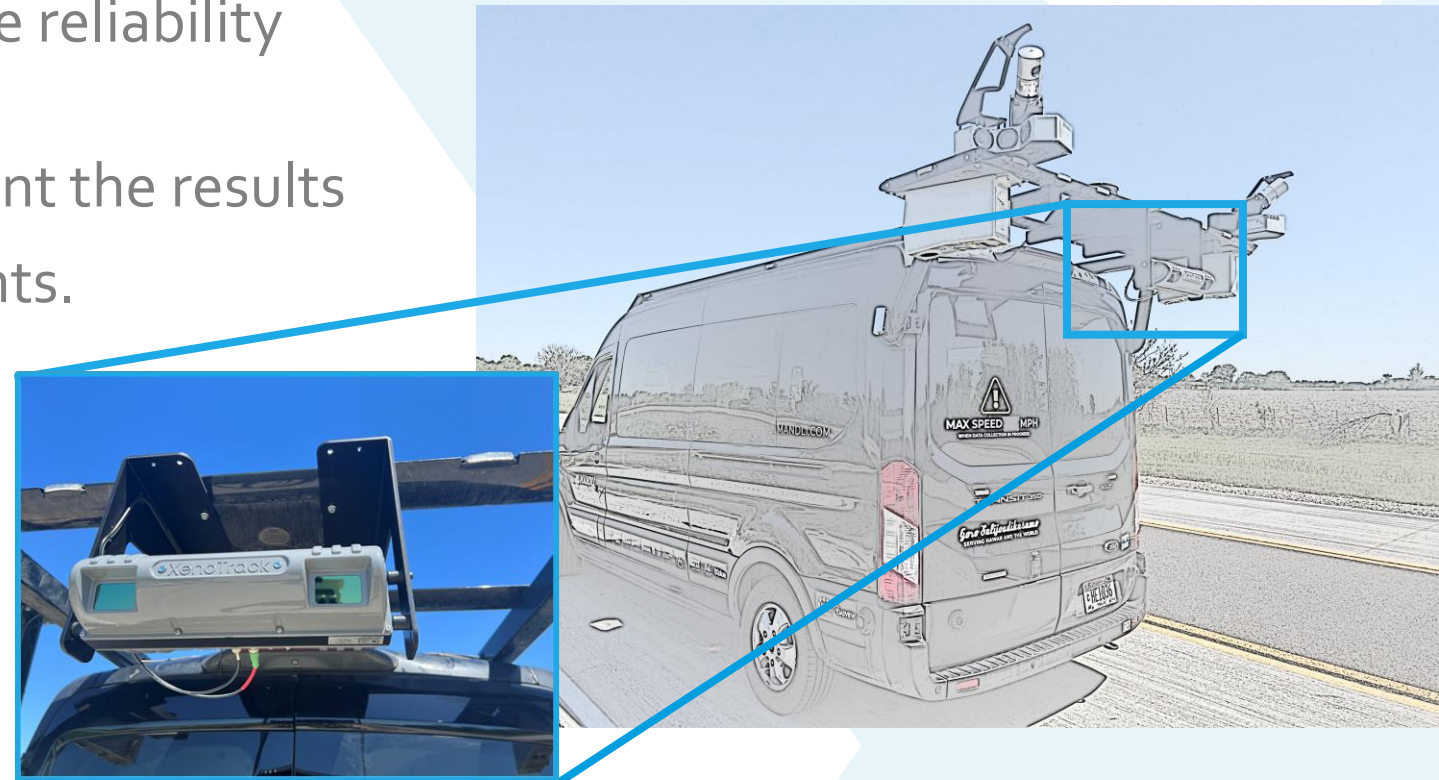
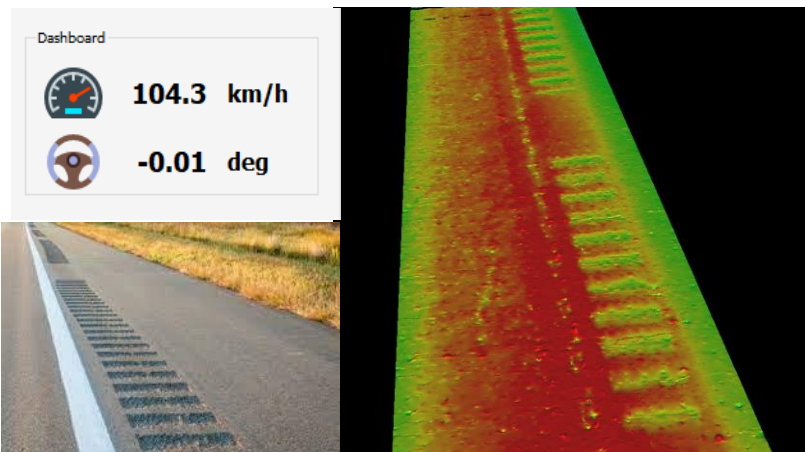


# a. Bike Lane inspection with the new XenoBike



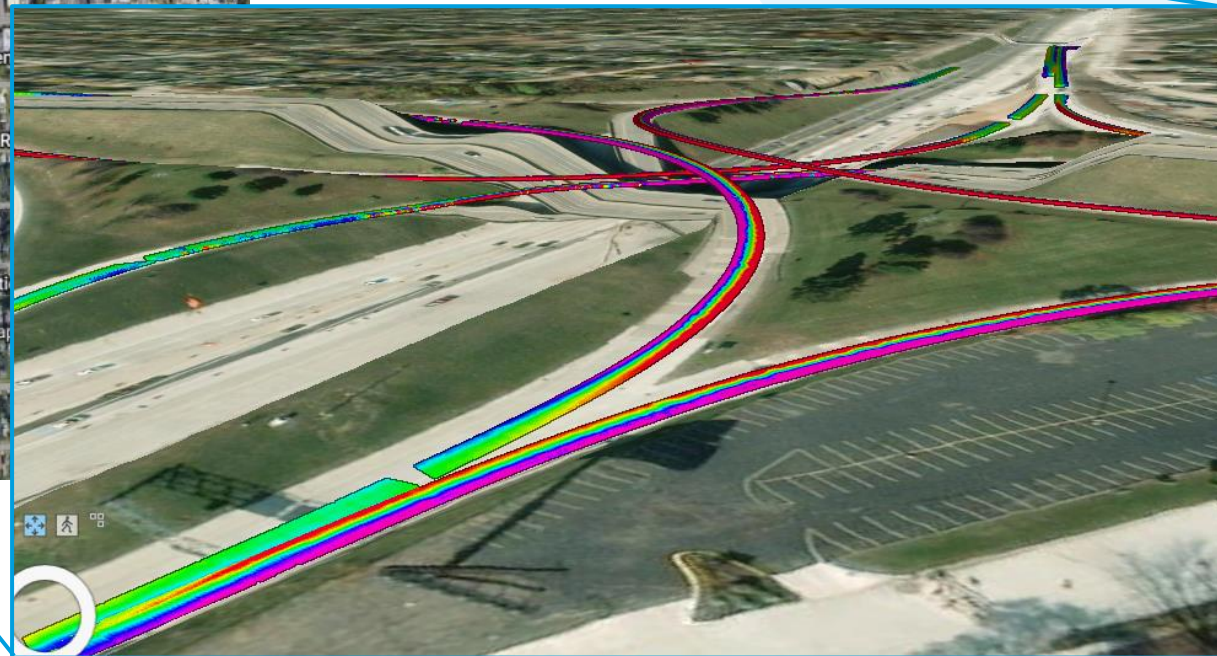
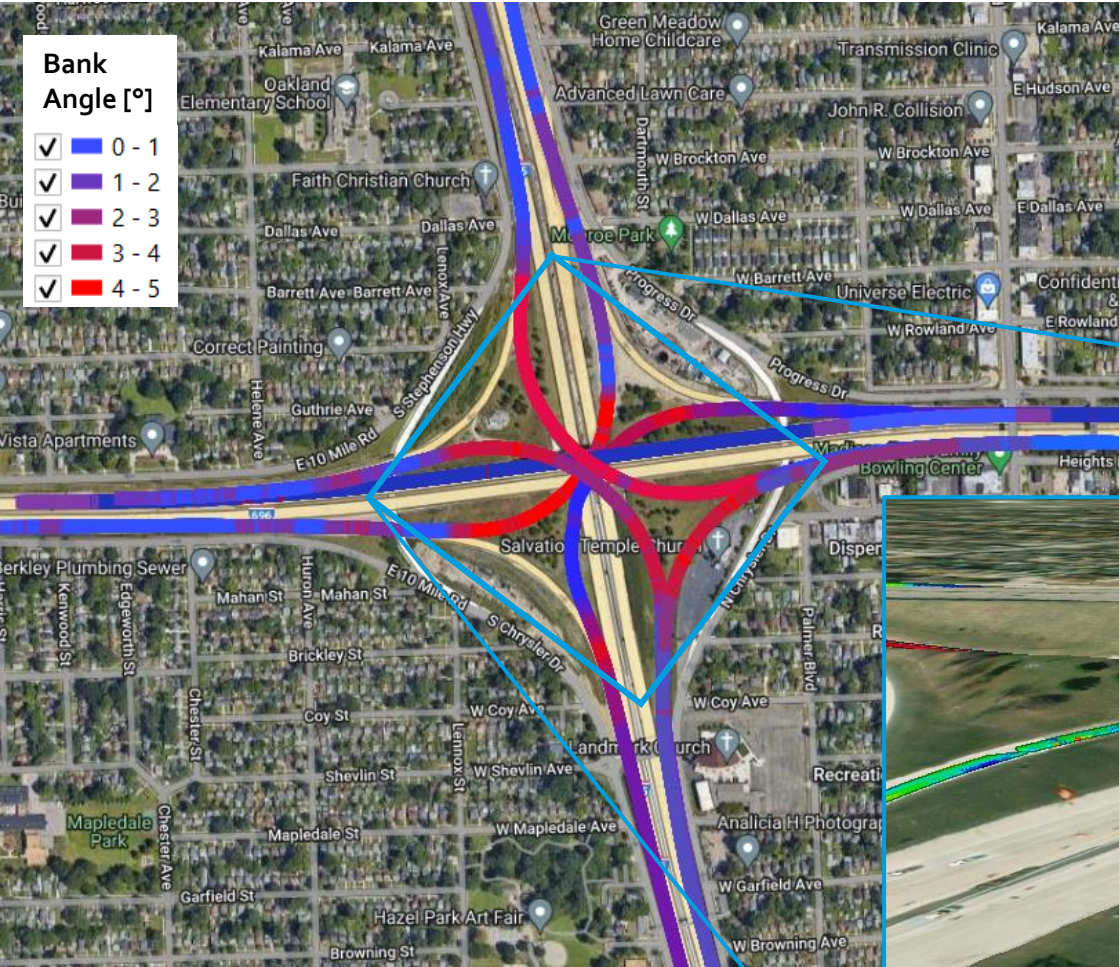
## b. Road Pavement Inspection

- ✘ Multifunctional vehicle operation can be simplified and optimized reducing the number of sensors
- ✘ True-solid state technology increase reliability ensuring smoothing operations
- ✘ With IRI and Rutting ASTM compliant the results are compliant with DoT requirements.

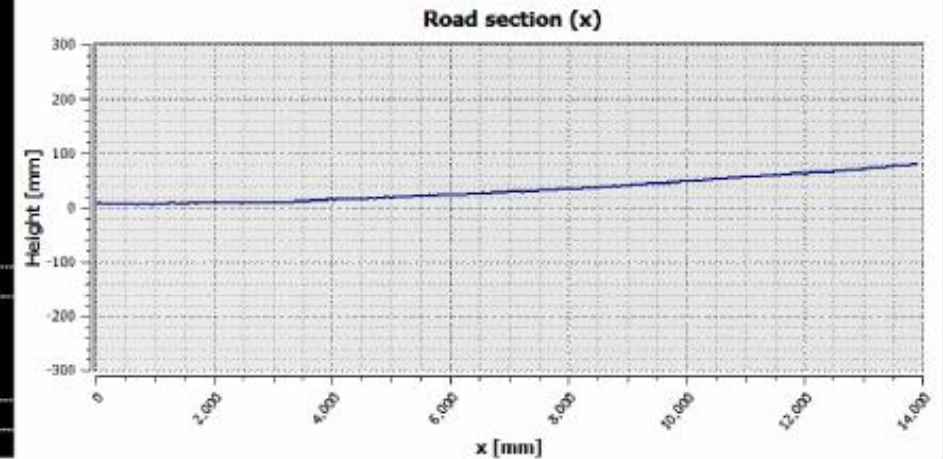
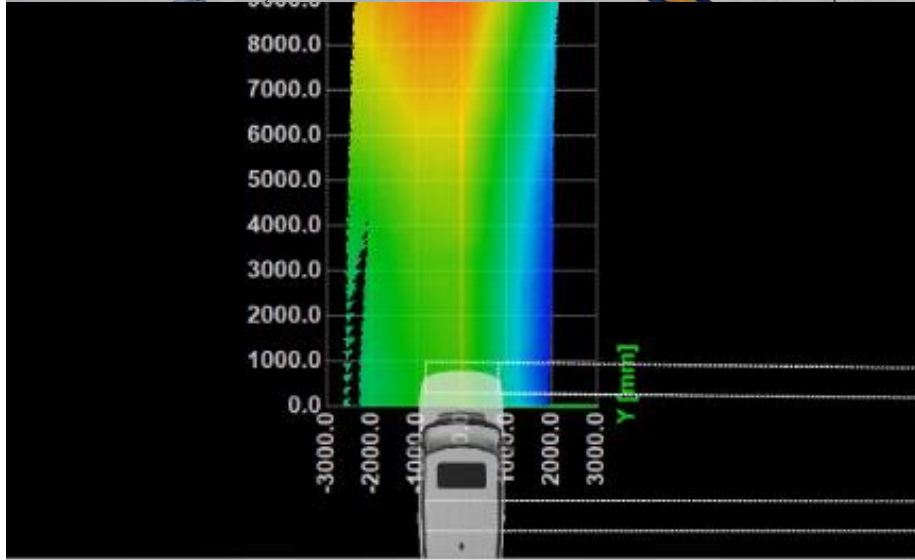
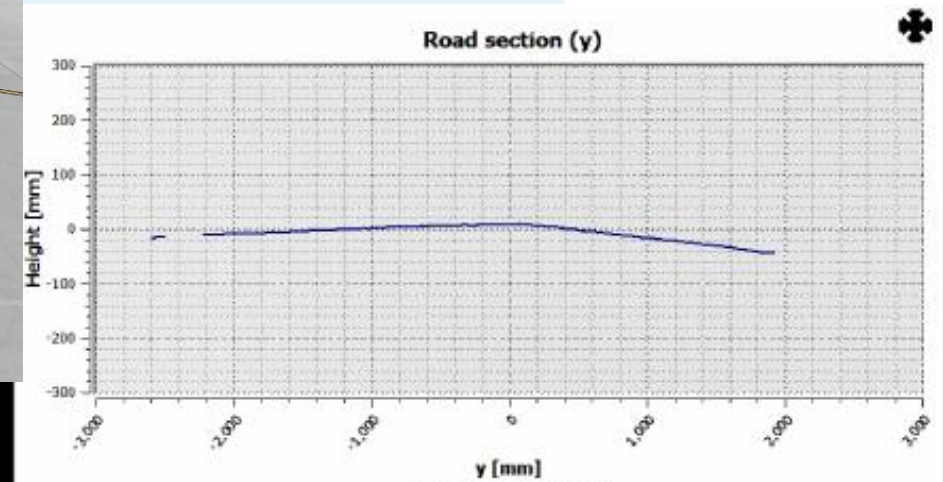


# c. Highway Bank Angle Validation

- x Low Bank Angle in the main lanes for water evacuation
- x No Bank Angle in the steep exit and entrance ramps
- x High Bank Angle in the turning bridge
- x Bank Angle validation on the road height map with red to blue coloration of the pavement height indicating higher or lower elevation from a horizontal plane



# d. Airfield taxi- and runway inspections



# e. Test-tracks & race-tracks

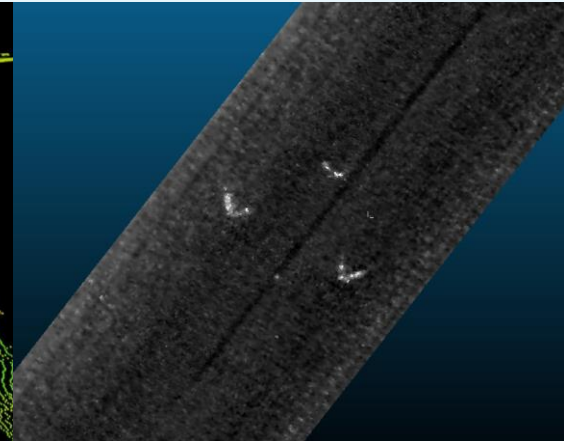
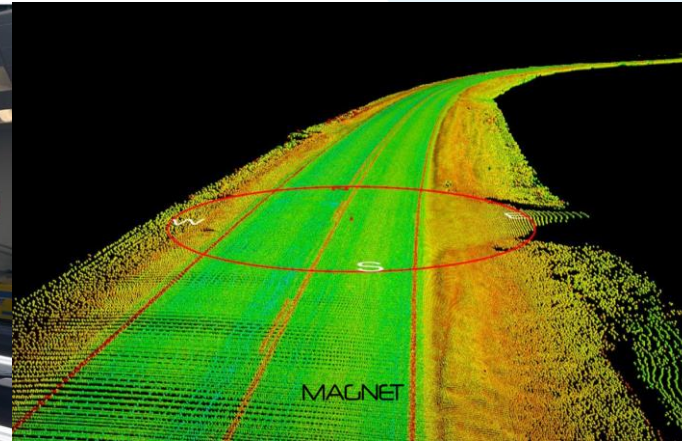
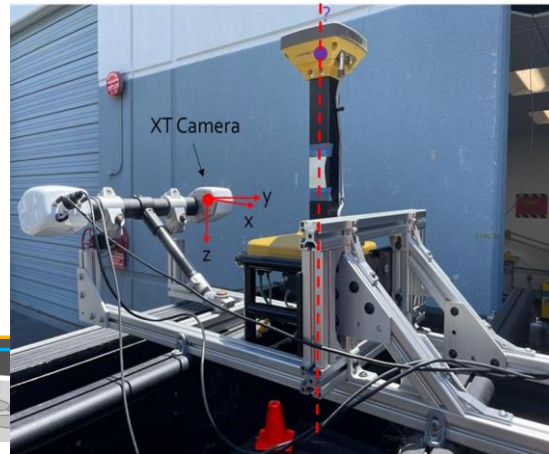
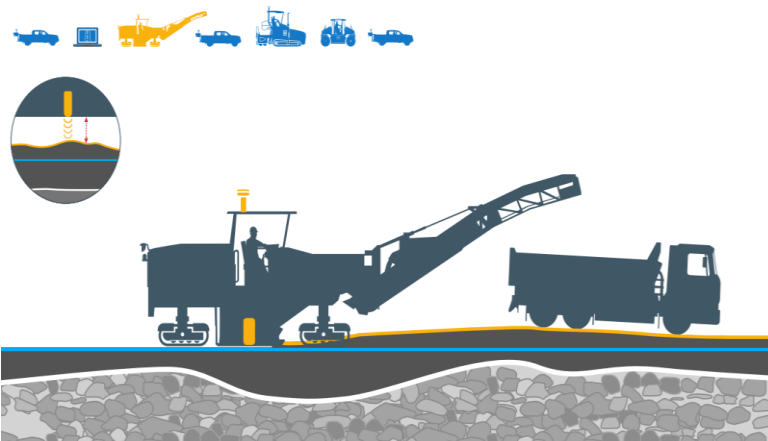
- ✗ Monitoring evolution over time to assure vehicle test consistency
- ✗ Digitization as input for automotive engineering & pre-test simulations
- ✗ As ground-truth values



XenoTrack supports the CRG format which is the automotive standard for road models

# g. 3D Variable Milling and Pavement Design

- ✘ The milling machine (vertical) path is defined to eliminate the waviness and obtain a flat surface for the new layers.
- ✘ The digital twin used as a reference to define the local depth of the milling blade.
- ✘ The XenoTrack can also be installed on the equipment for real time quality control based on evenness



# Renowned customers paved the way



- 2013 XenomatiX invents solid state multi-beam LiDAR for road scanning aiming at comfort improvement on active suspension systems, mainly for automotive customers
- 2015 First Road LiDAR sold
- 2018 Start of road assessment by and for road surveyors, network management companies and road construction companies
- 2022 4<sup>th</sup> generation Road LiDAR raises the bar of Lidar-based road digitization





# To Remember ...

- x High performant 6D Road Lidar System with highly accurate 6D georeferencing
- x NCAT Certification support service offered to customers
- x Multiple high demanding POC successfully benchmarked
- x New Bike lane inspection application and outlook for new Bike Lane index
- x Multitude of Applications and more to come ...
- x Renowned customers paving the way ...

Want to get more ?  
Ask for free sample data sets so you can have a closer look to  
raw XenoTrack data and run your own analysis.



X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
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**XenomatiX**