Polish Nordic Road Forum 2018

Traffic Speed Deflectometers (TSD) as the most advanced tool for making structural measurements at project level for the whole network

by

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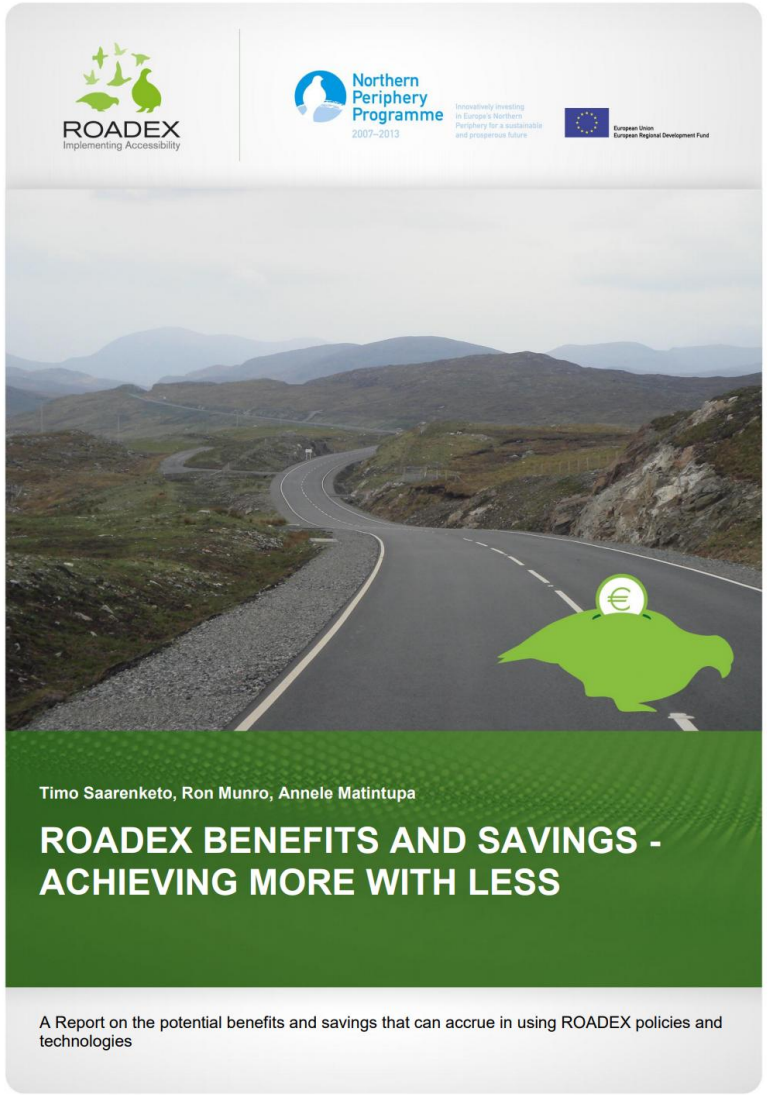
- Profiling of pavements and functional data
- MiniProf – Profiling of train wheels and rails
- TSD – deflection of pavements and structural bearing capacity

Road Maintenance Savings



The ROADEX Network; a collaboration of northern European roads organisations whose aim is to share roads information and research.

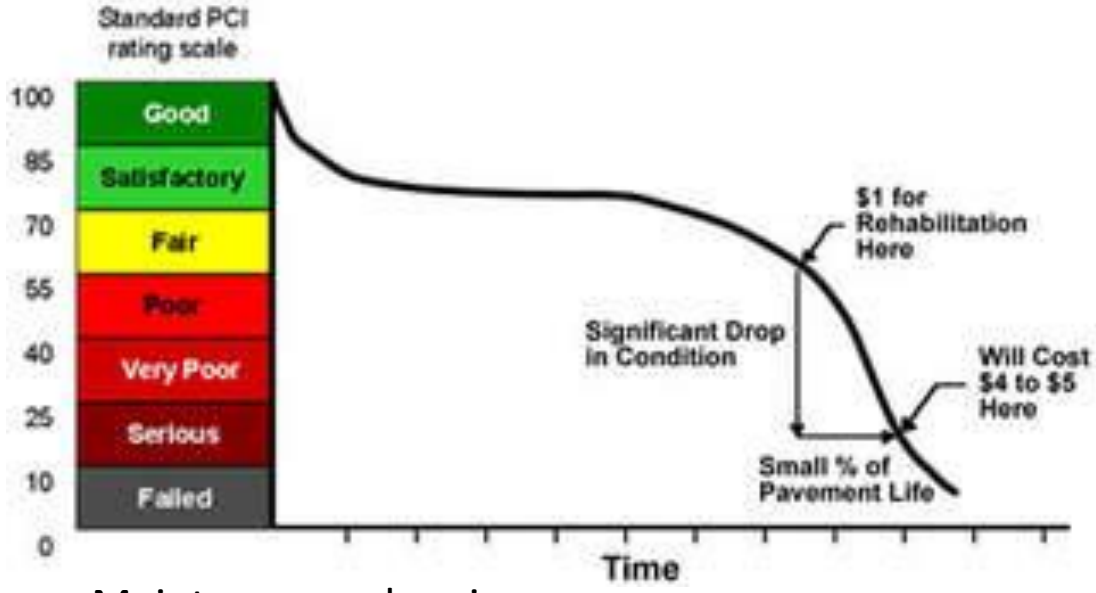
<u>Conclusion</u>: When road strengthening can be optimized using road diagnostics to meet a target level the savings can be 15-50% of the project level cost, and the **saving over the lifetime of the rehabilitation can be up to 50%.**

Focus areas:

1) Focus on repairing the underlying reasons of the road problems, instead of dealing with the symptoms
2) Focus on the weakest road section in strengthening measures
3) Focus on the correct timing
4) Focus on preventive maintenance

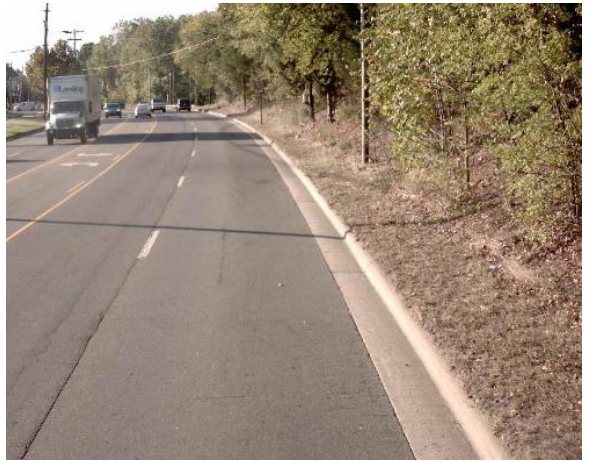
Bearing Capacity Measurements

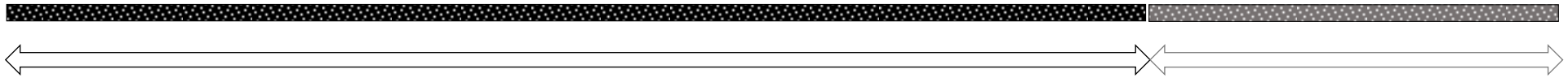
Quality assurance



Maintenance planning

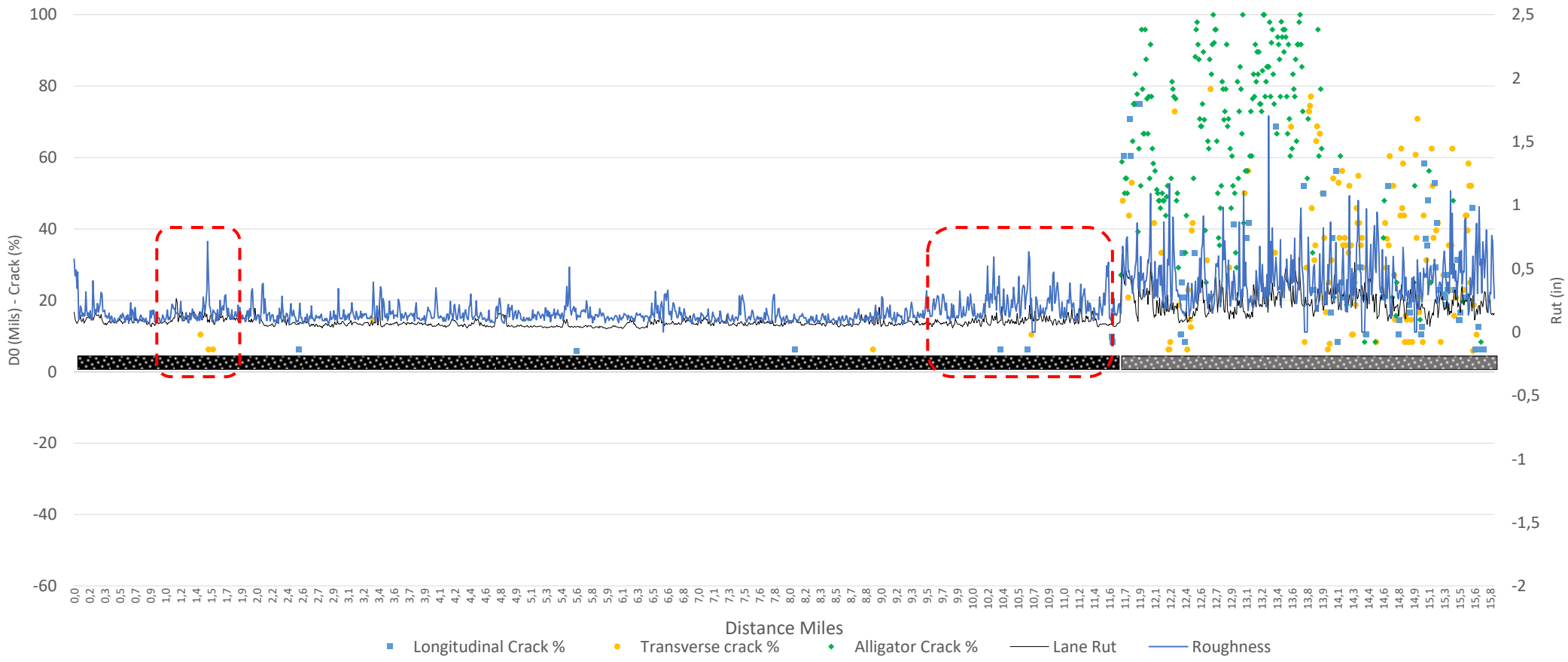
Example - recent reseal



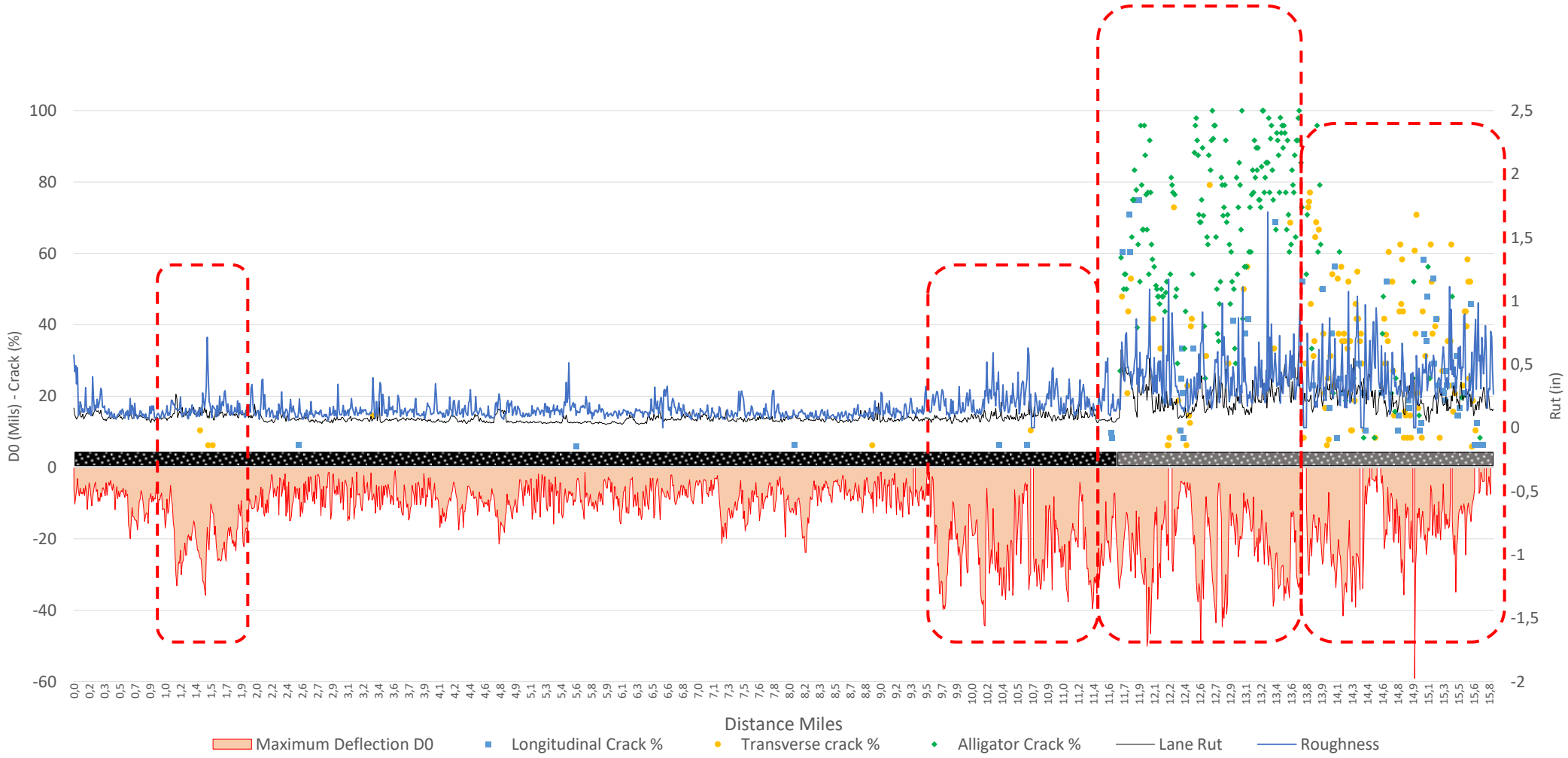


Resealed

Surface characteristics



Strength


D0 (Mils) - Crack (%)
Rut (in)
Distance Miles
Maximum Deflection D0
Longitudinal Crack %
Transverse crack %
Alligator Crack %
Lane Rut
Roughness

The State Road Network

Min. 1/6 of motorways every year

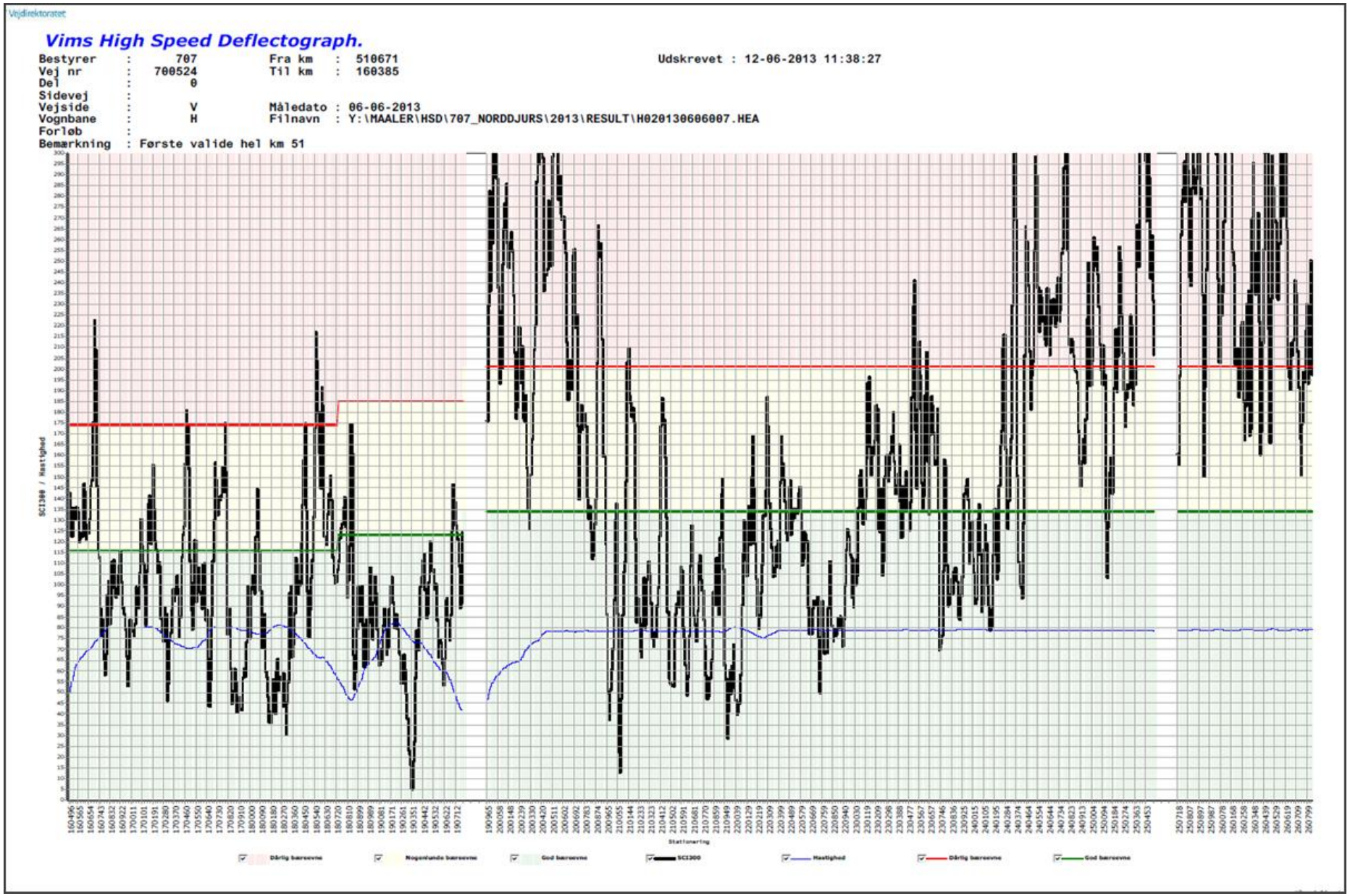
(total of approx. 1.500 km (940 miles))

1/3 of remaining roads every year

(total of approx. 2.100 km (1.300))

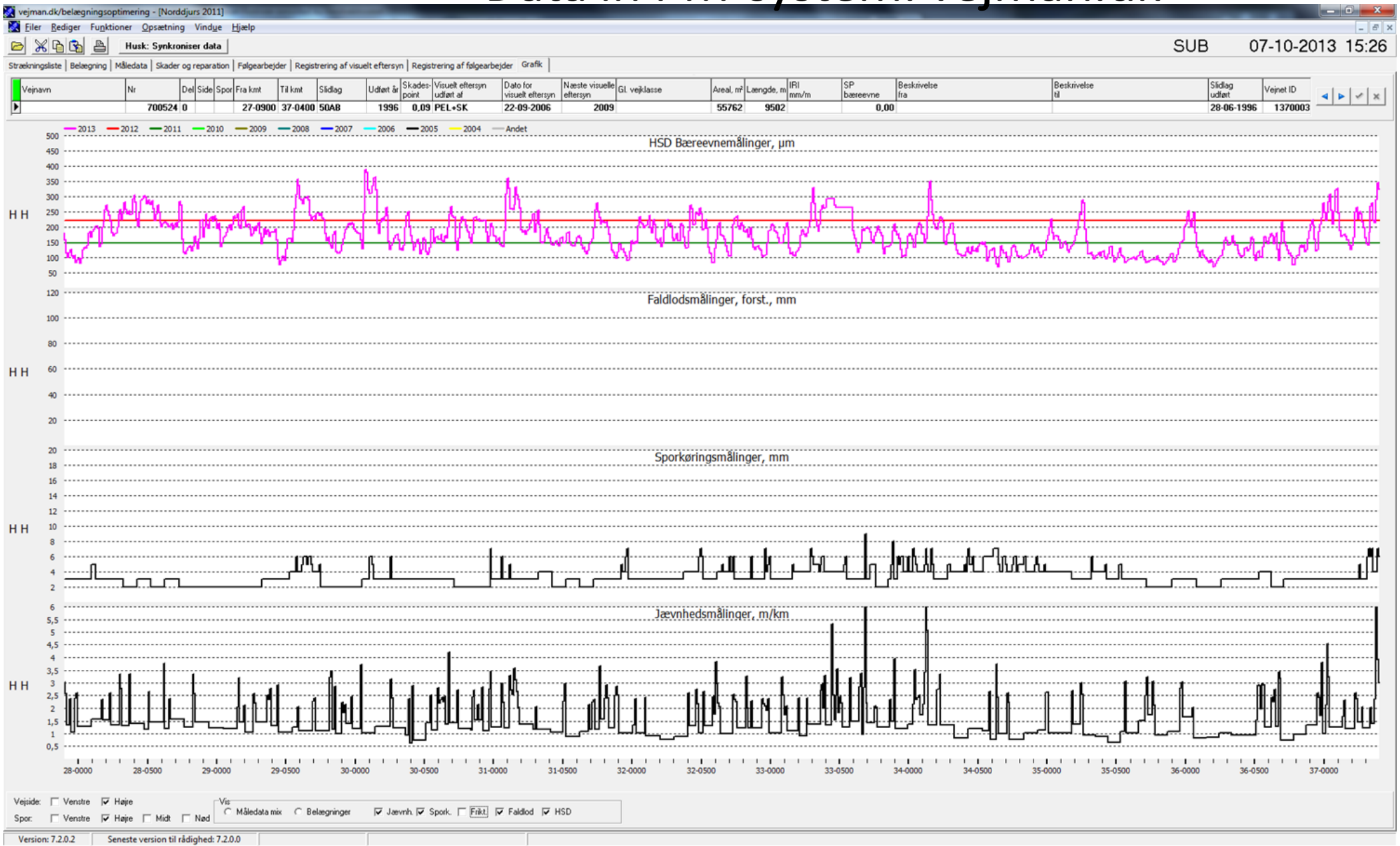
Road Directorate

SCI - 300



Road Directorate

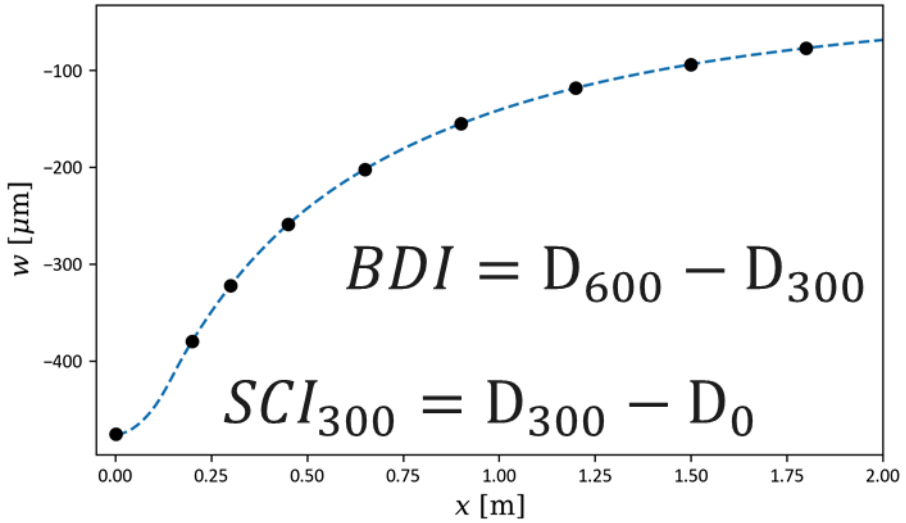
Data in PM-system: vejman.dk



Road Directorate

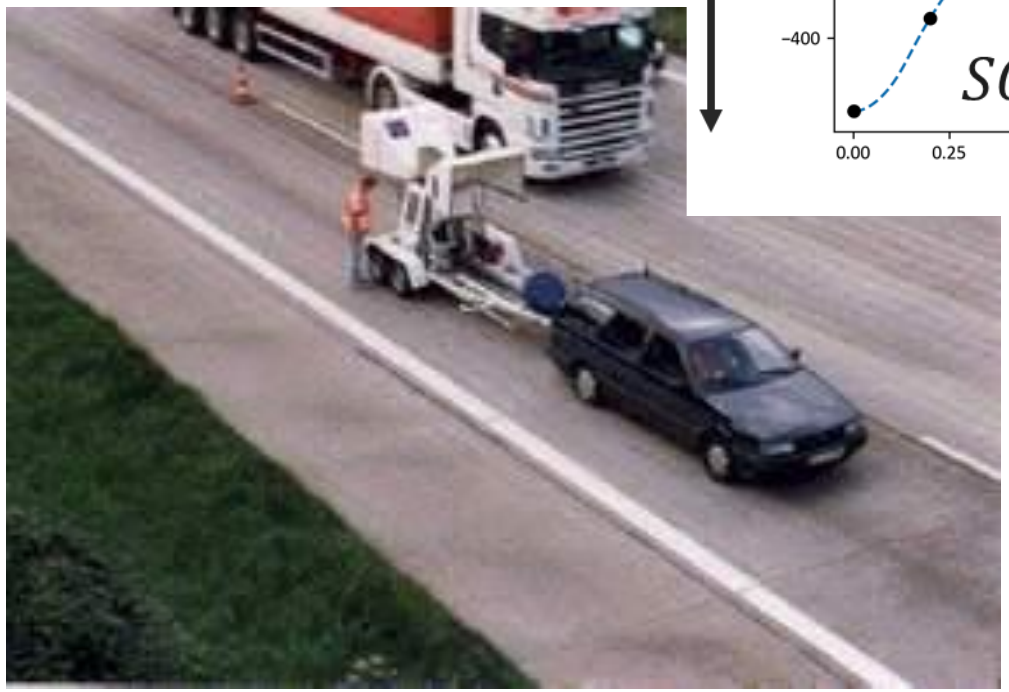
Bearing Capacity Measurements

D_0



$$BDI = \mathrm{D}_{600} - \mathrm{D}_{300}$$

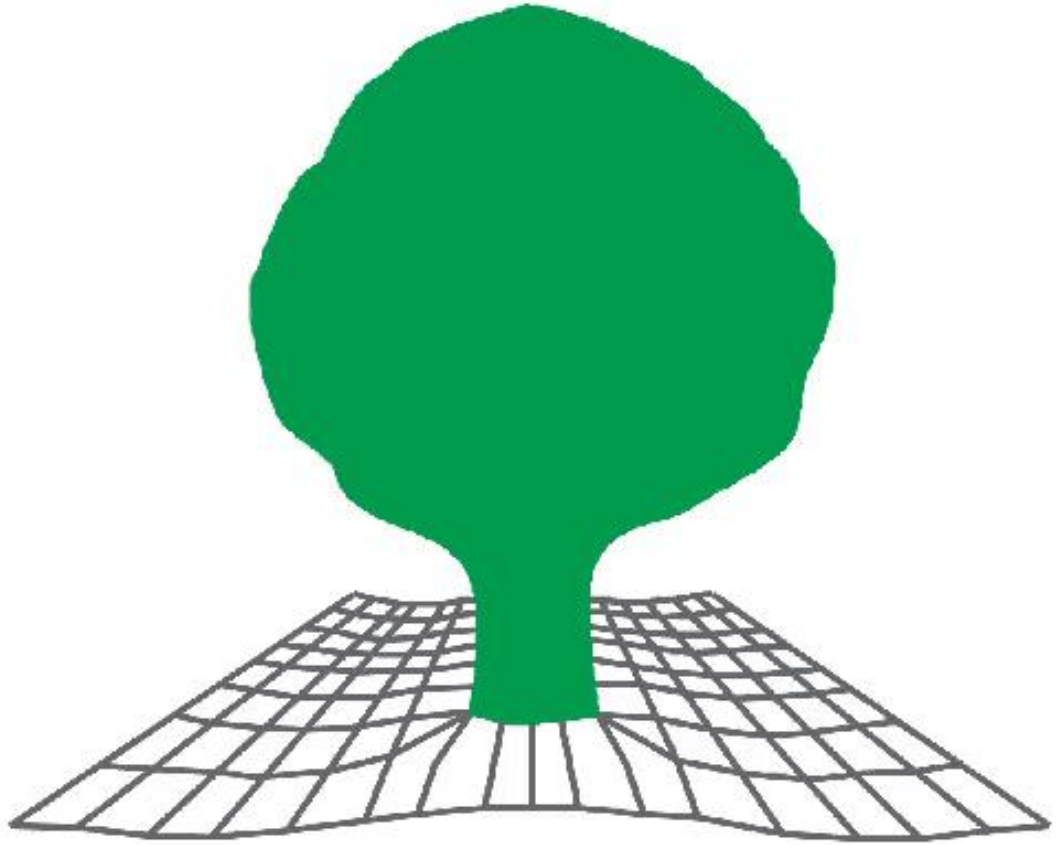
$$SCI_{300} = \mathrm{D}_{300} - \mathrm{D}_0$$



Falling Weight Deflectometer, FWD

Traffic Speed Deflectometer, TSD

- Measures at traffic speed 5 km/h – 80 km/h
- Uses laser Doppler vibrometers to measure pavement response



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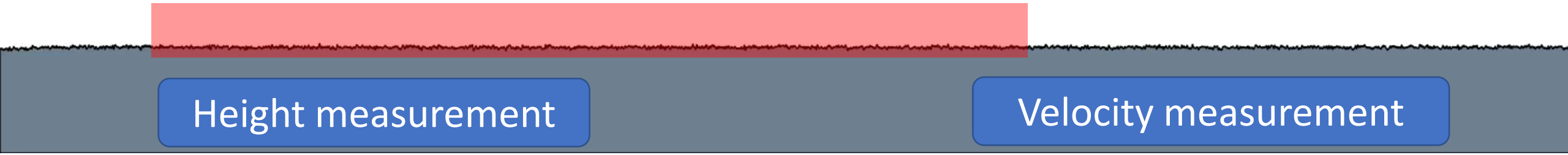
Why measure velocity instead of distance ?

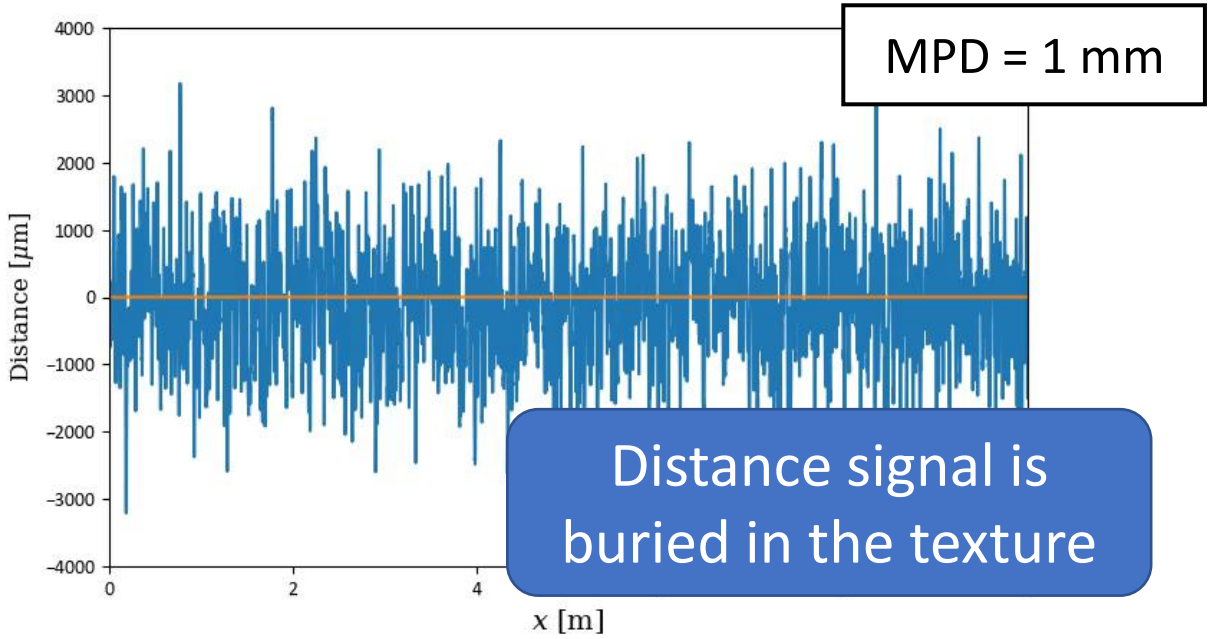
Velocity is insensitive to surface texture!



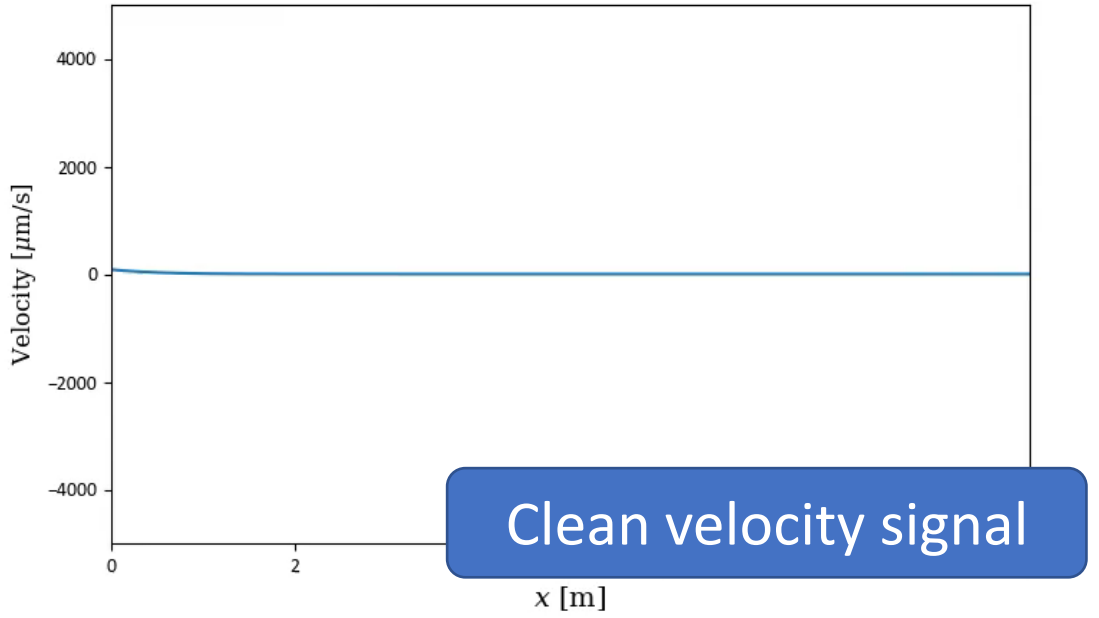
Height measurement

Velocity measurement

MPD = 1 mm

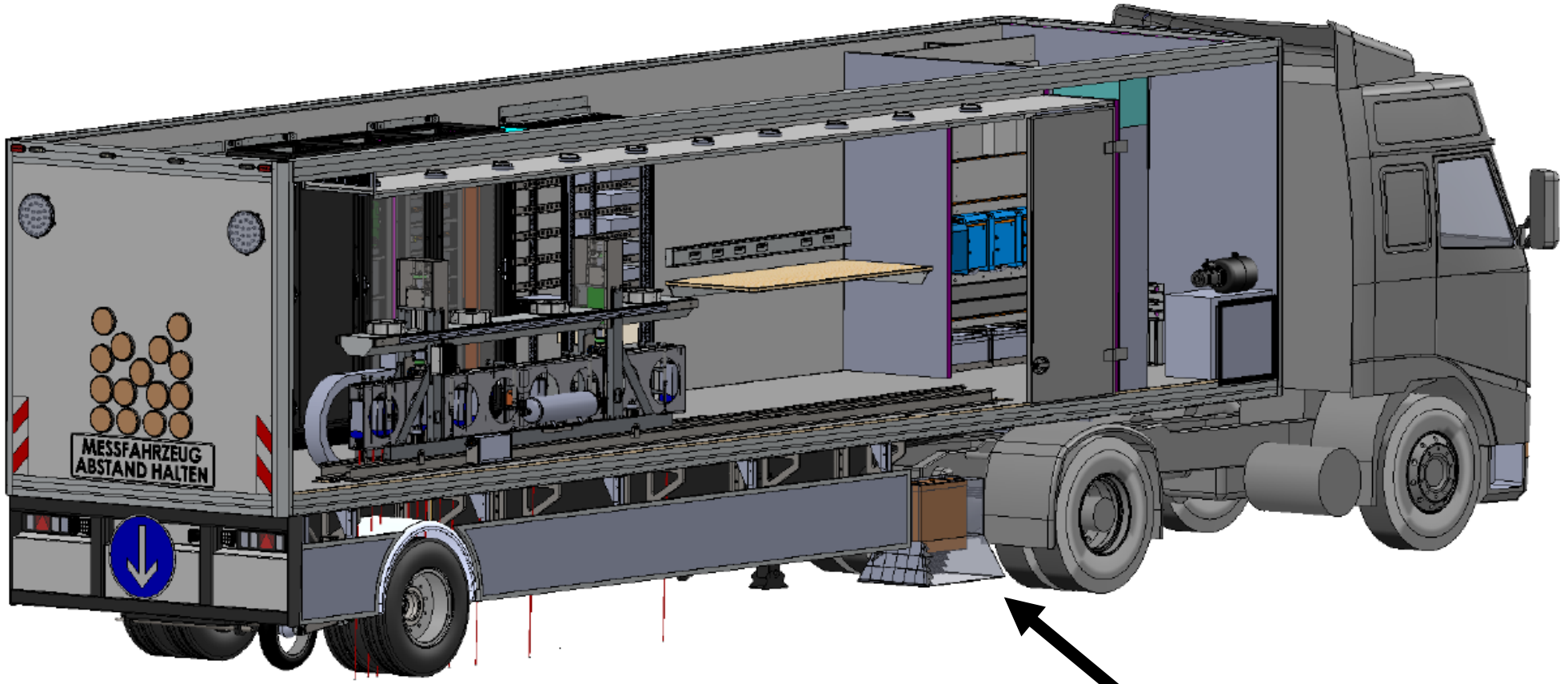


Distance signal is buried in the texture



Clean velocity signal

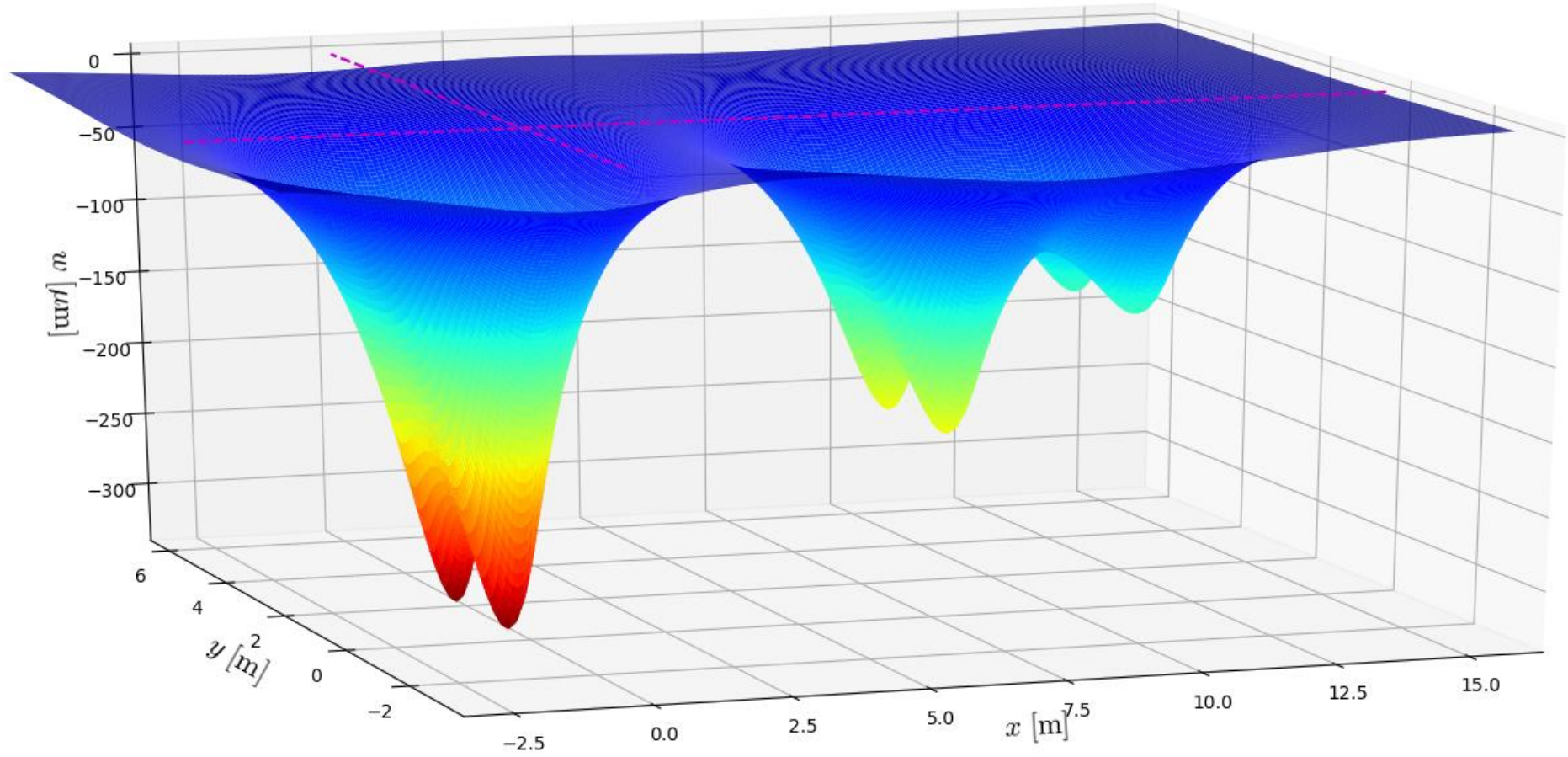
13 operating TSDs

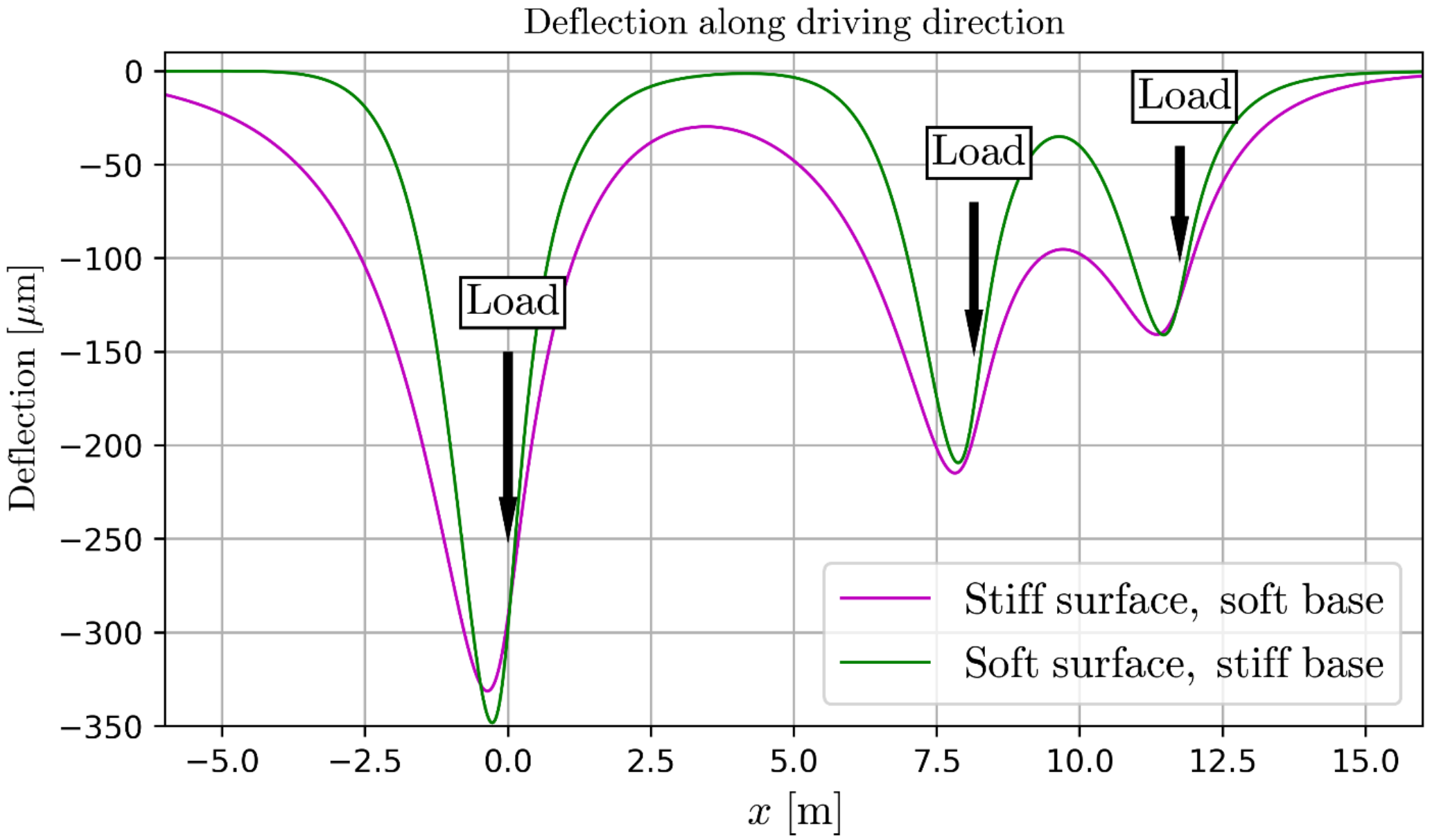


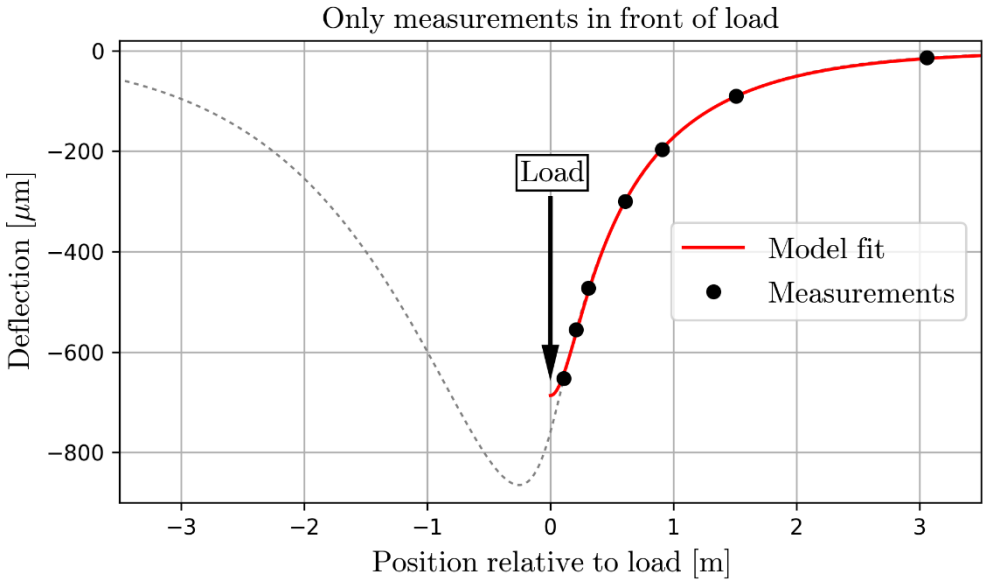
Ground Penetrating Radar (GPR)

Measurements behind load

TSD ”footprint”

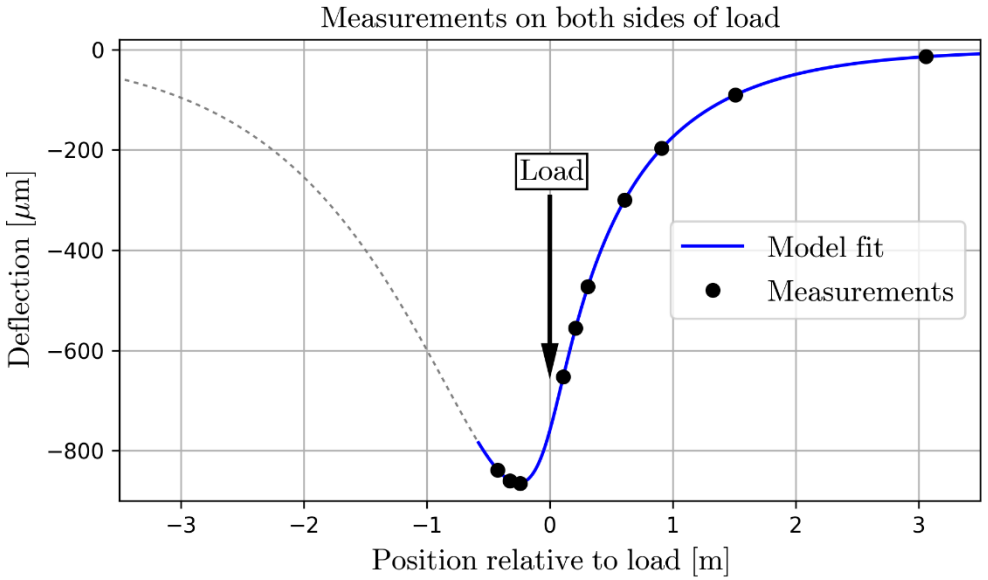


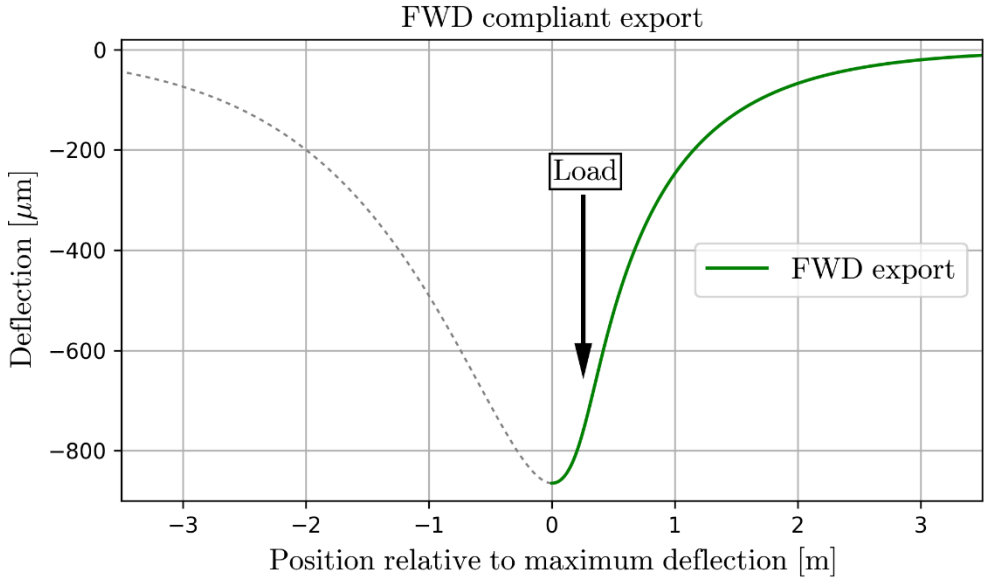

Deflection along driving direction
Deflection [μm]
0
−50
−100
−150
−200
−250
−300
−350
−5.0
−2.5
0.0
2.5
5.0
7.5
10.0
12.5
15.0
x [m]
Load
Load
Load
Stiff surface, soft base
Soft surface, stiff base



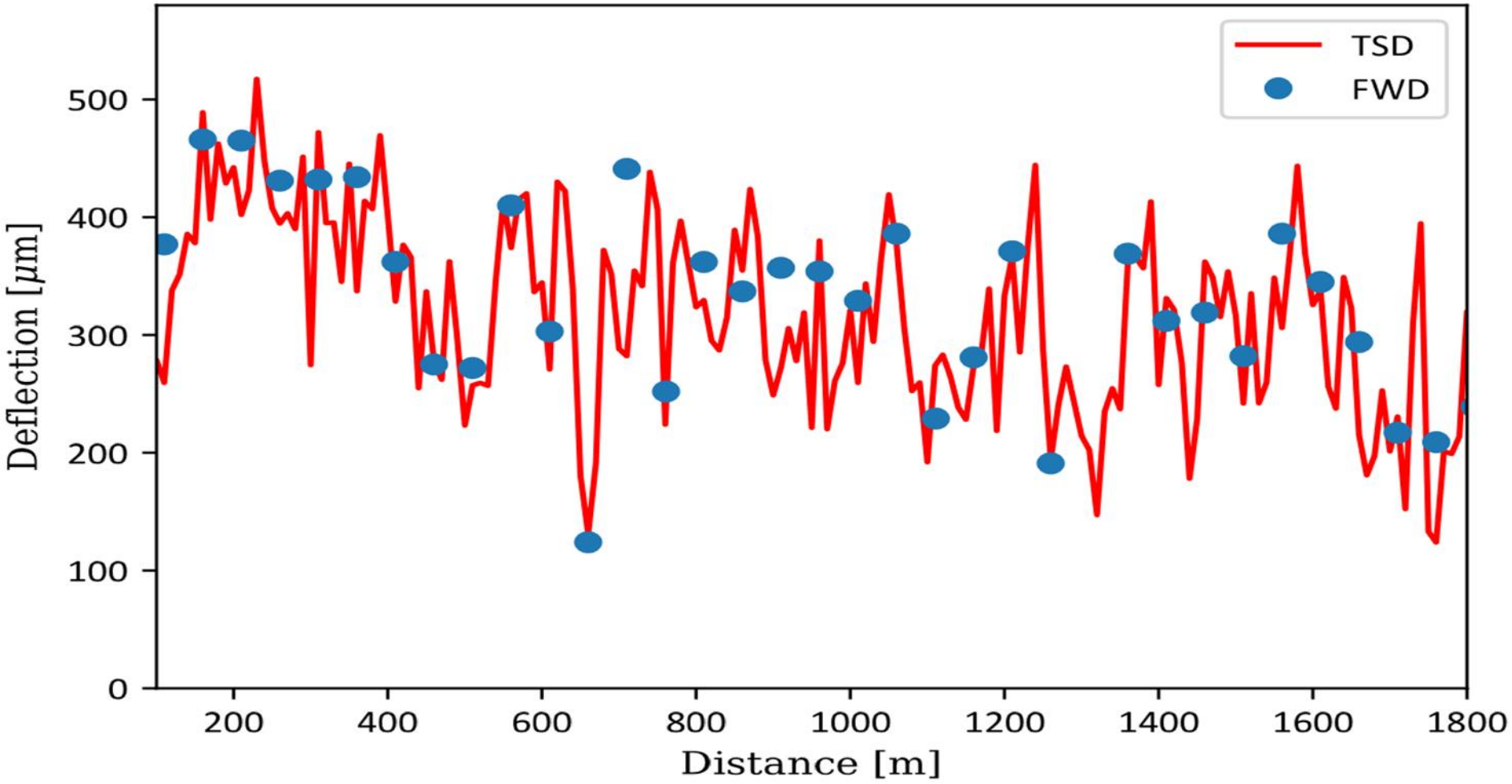
Measuring both leading and trailing deflection facilitates:

- Asymmetrical assesment of deflection bowl
- Compliance with usual back-calculation
- Evaluation of damping properties
- Speed normalization





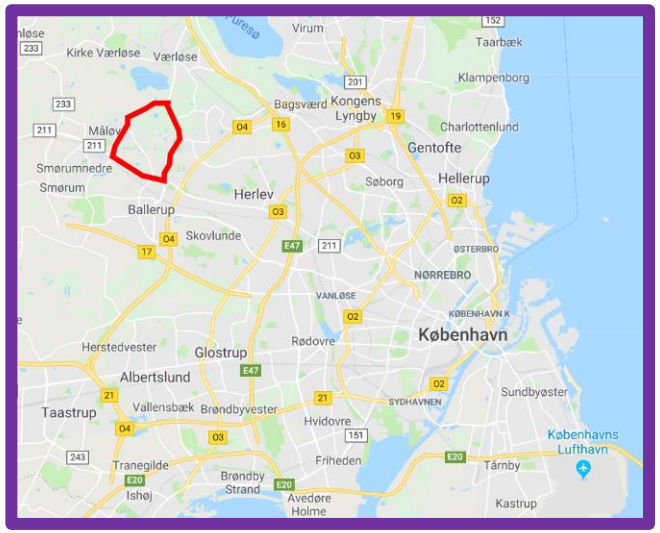
TRAFFIC SPEED DEFLECTOMETER <-> FALLING WEIGHT DEFLECTOMETER

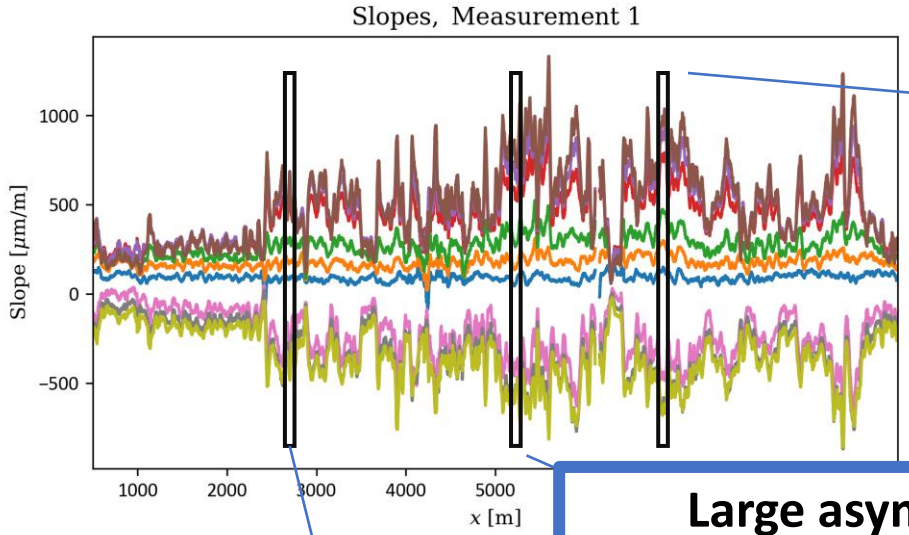


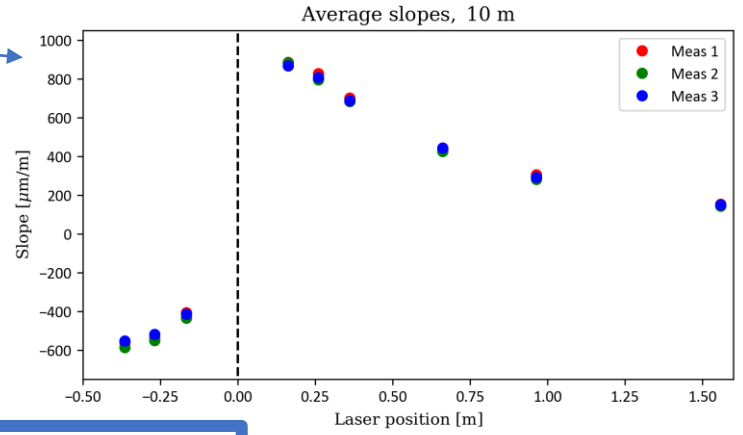
Measured November 14 and 15, 2017. Temp. app. 10^0C. Highway E47 on Lolland, Denmark
Measured with TSD 7, with 10 lasers in right wheel centre line between twin-tires
(three lasers behind rear axle to show deepest deflection point behind the wheel)

Time dependence: measurement examples

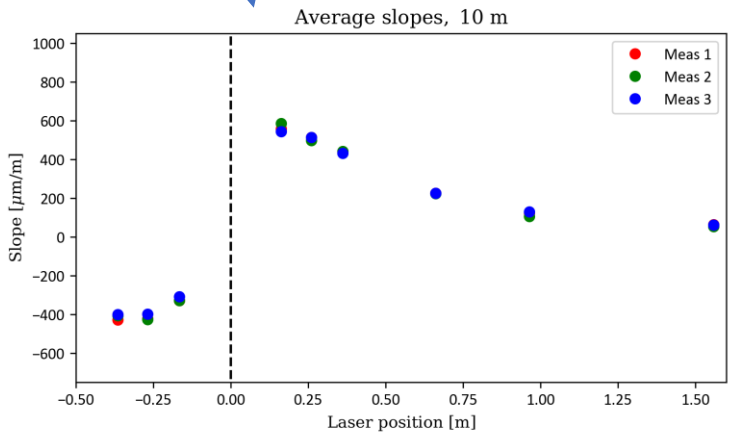
Road near Copenhagen.
Three runs.

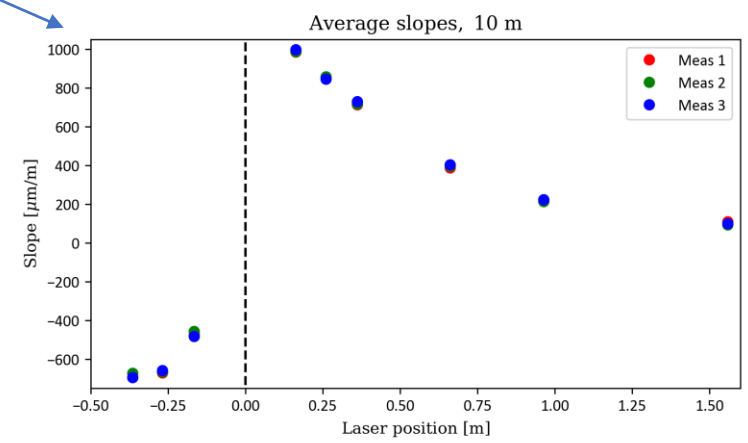






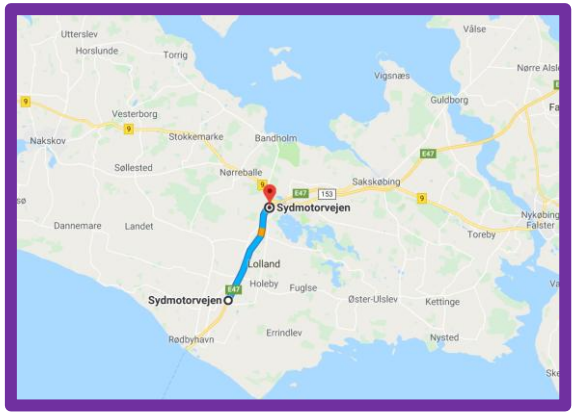
Large asymmetry
Due to visco-elastic effects



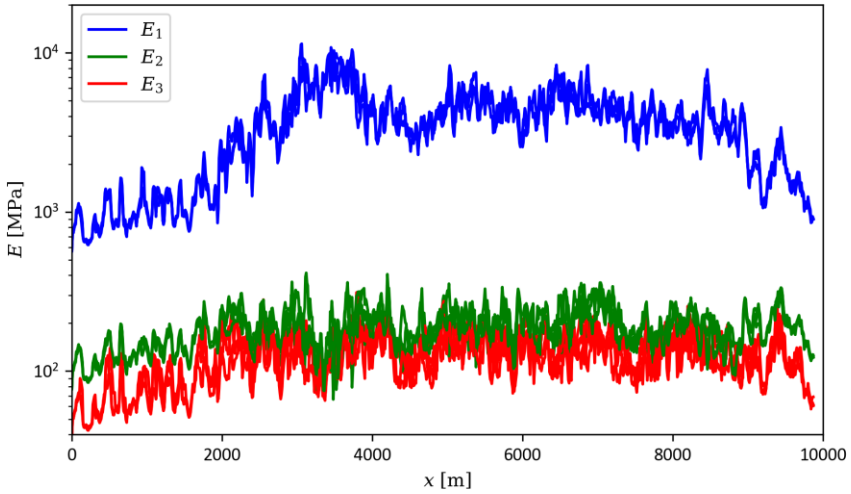


Slope based back-calculation: Example

Highway in the south of Denmark.
Three runs.

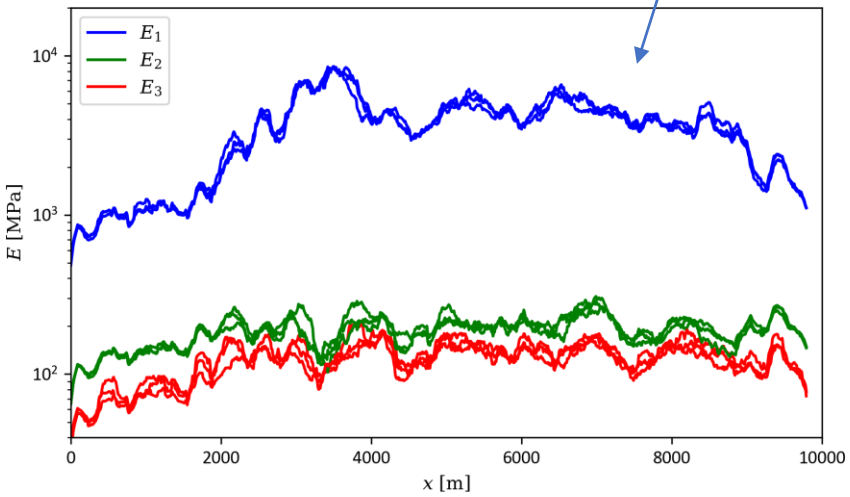


Back-calculation: Good repeatability



200 m moving average

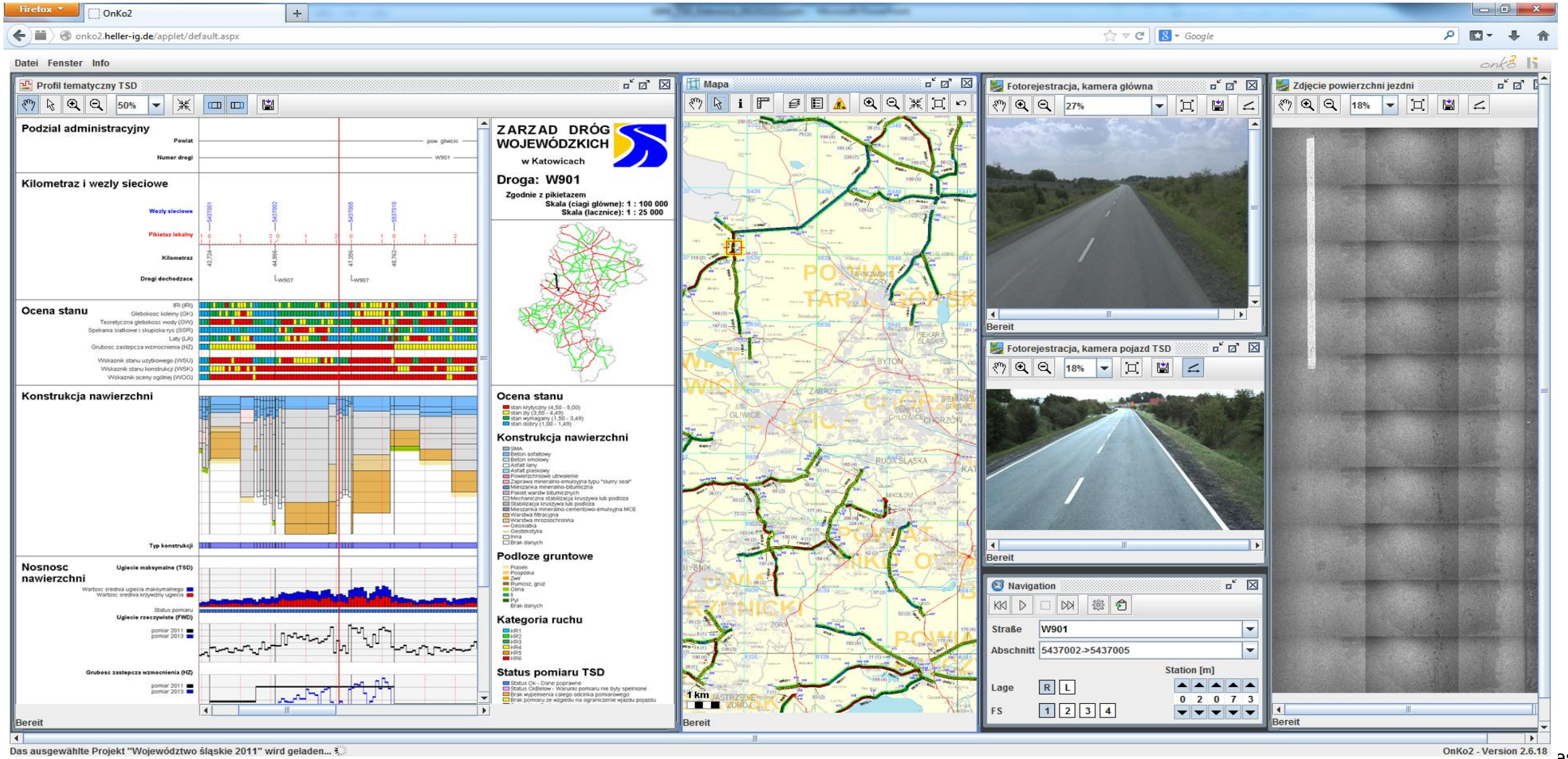
FWD results



Results are:

- Reasonable ✓
- Repeatable ✓
- Agrees with FWD (✓)

INTERACTIVE DATA VISUALIZATION



All numbers are estimated budget values

Thank you for your attention