

The Ultra-Light Inertial Profiler: a New Approach in the Study of Macrotecture

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Outline

- What is the ULIP?
- Type of Data and Processing
- Comparison with CTM method
- Additional Applications

Ultra Light Inertial Profiler (ULIP)

Laser scanning pavement surface

Frequency 10,000 Hz (every 0.5 mm)

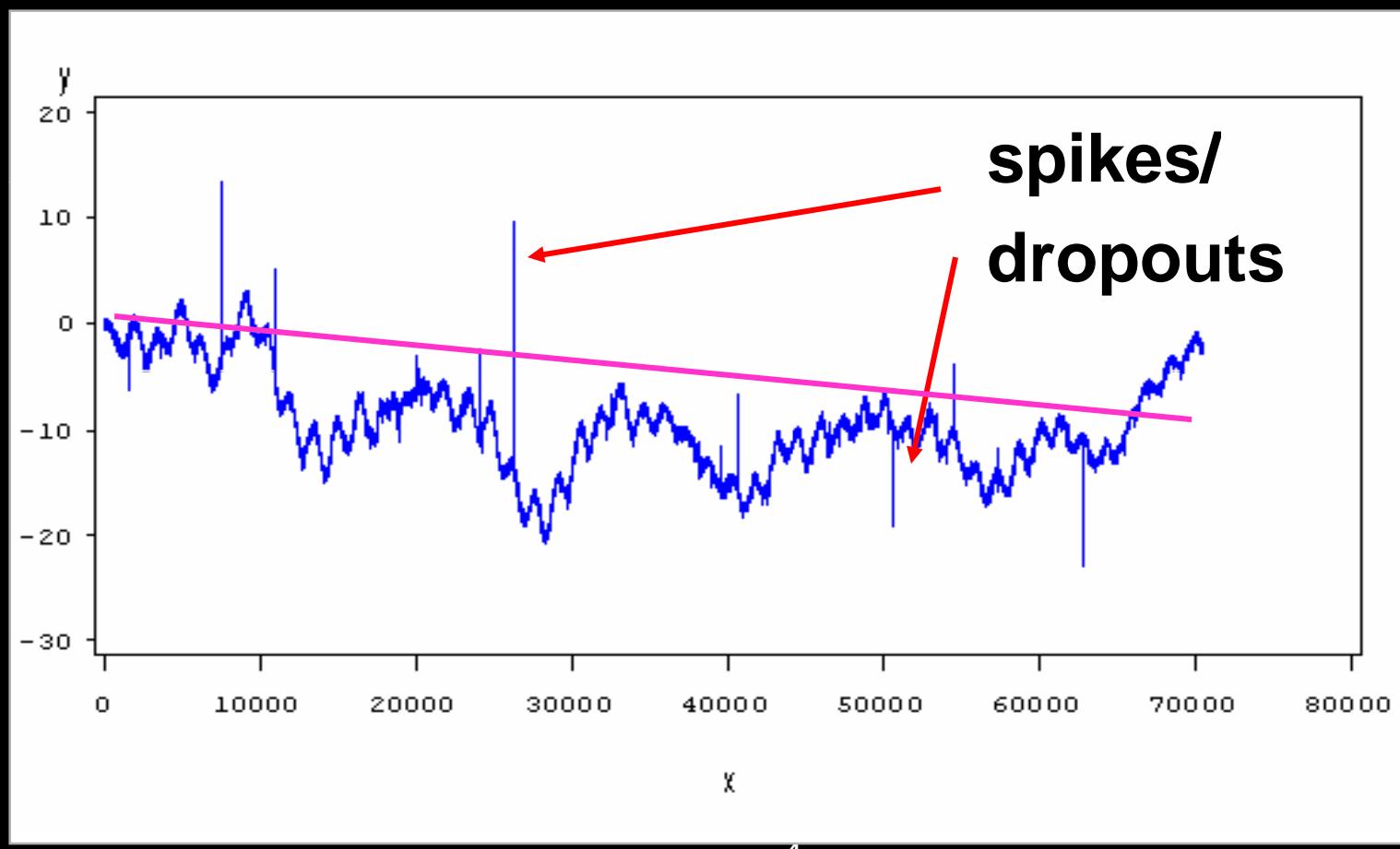
FHWA Software: MPD every 0.5 m of profile



ULIP Surface Profile

Application: Texture identification → Mean Profile Depth

Processing: Data filtering to remove 'spikes' and pavement slope

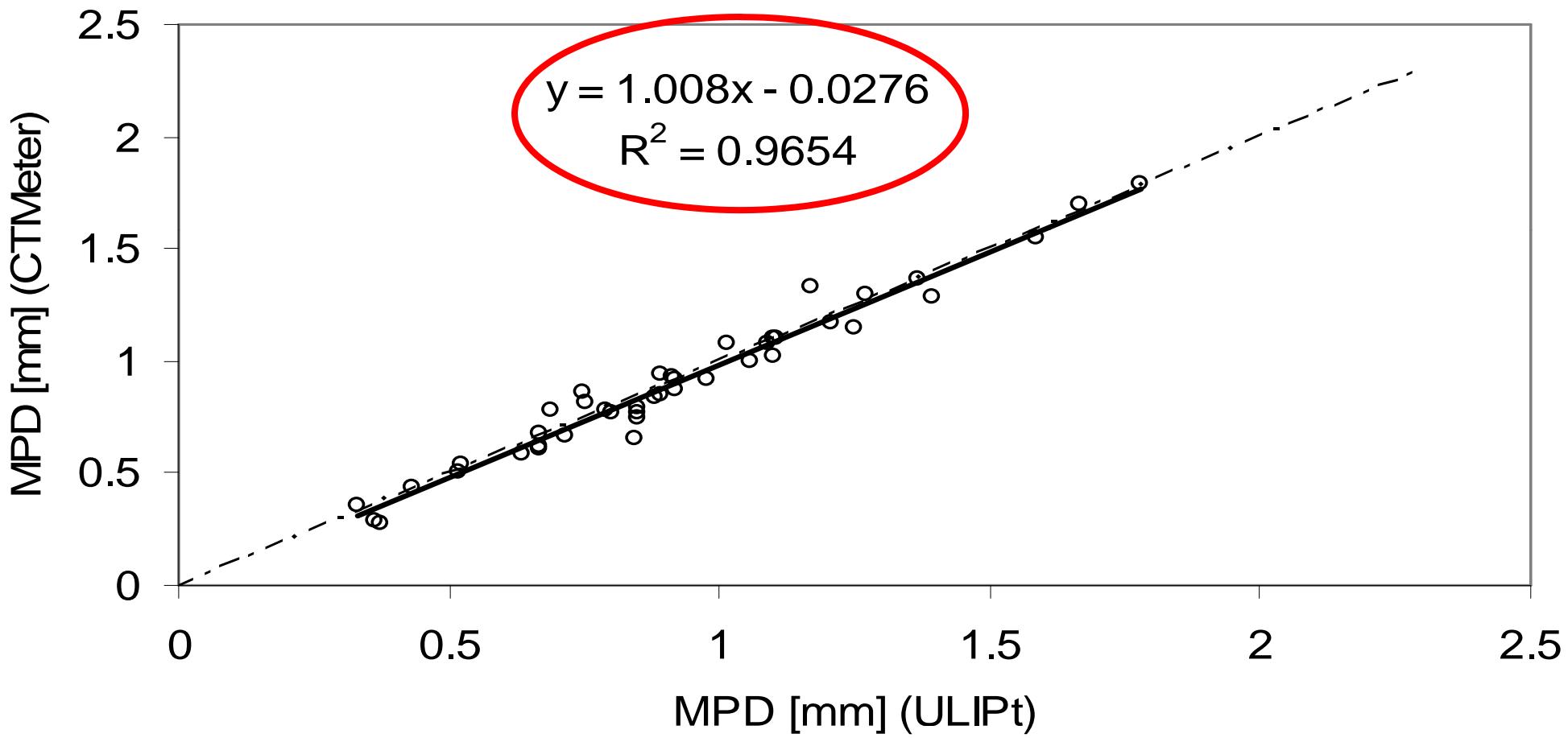


Circular Texture Meter (CTM)

Mean Profile Depth (MPD)



MPD Comparison: ULIP vs. CTM

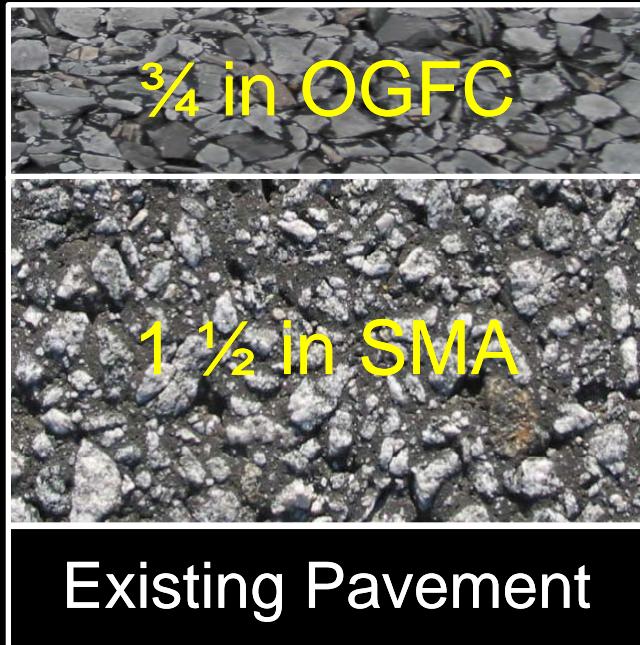


Applications

- Micro-milling macrotecture quality
- Noise prediction
- Segregation prediction



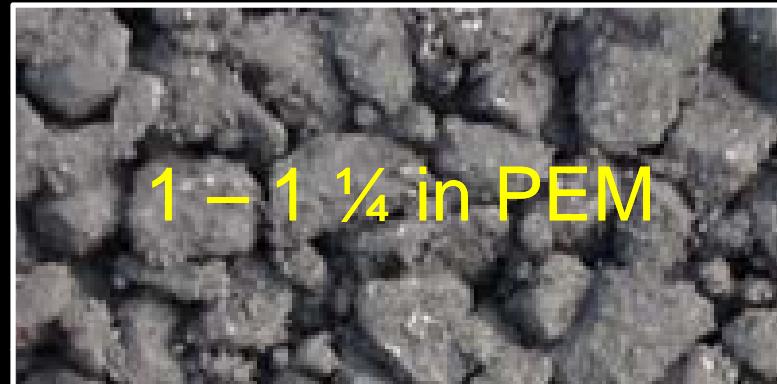
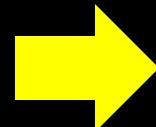
GDOT Old Rehabilitation Strategy



GDOT New Rehabilitation Strategy



Existing Pavement



1 - 1 1/4 in
Existing SMA



Existing Pavement

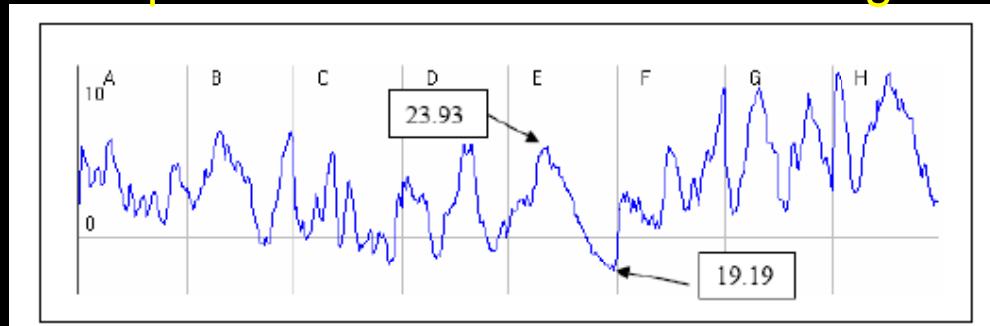
ULIP as QA/QC Tool for Texture

GDOT Micromilling Project

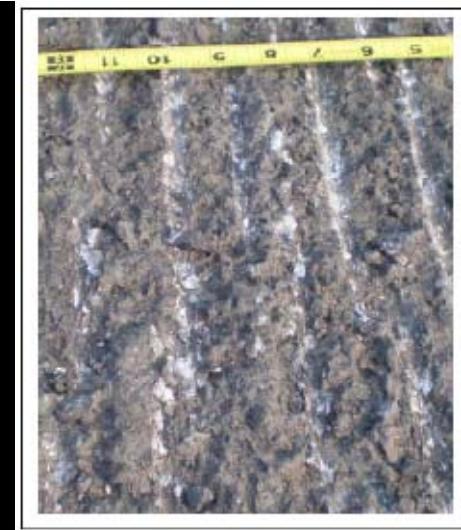
- Ridge-to-valley texture depth (RVD) measurements
- 1.6 mm of RVD required by specs
- Correlation with CTM



Example: Profile – Direction of Milling



(Courtesy of GDOT)



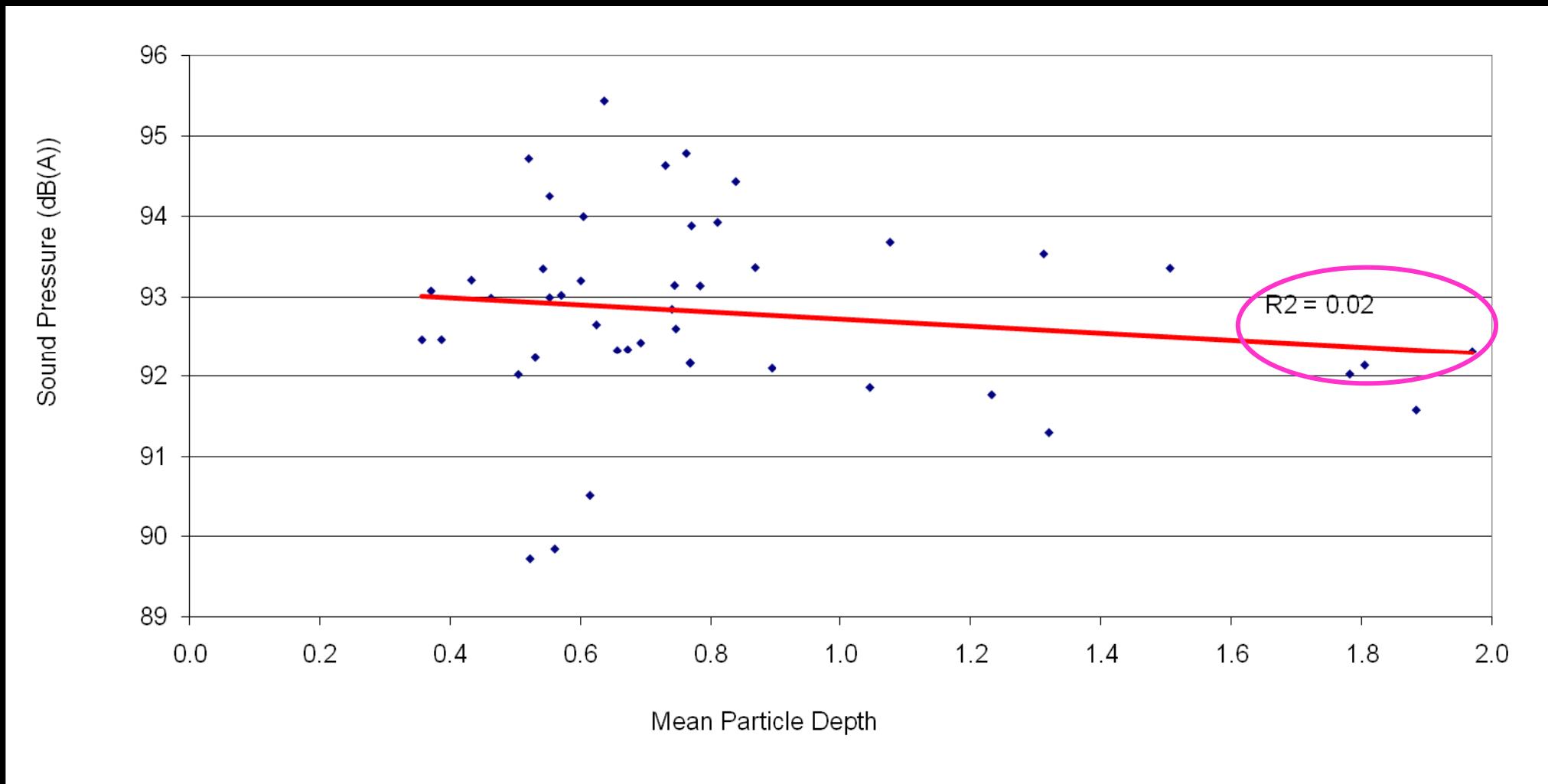
Noise Measurements at the Test Track

- *Texture -- Noise*
 - Dense Graded
 - Stone Matrix Asphalt (SMA)
 - Open Graded Friction Courses (OGFC/PFC)
 - Coarse Porous European Mixture (PEM)



Noise and MPD

- Macrotexture characterization – MPD

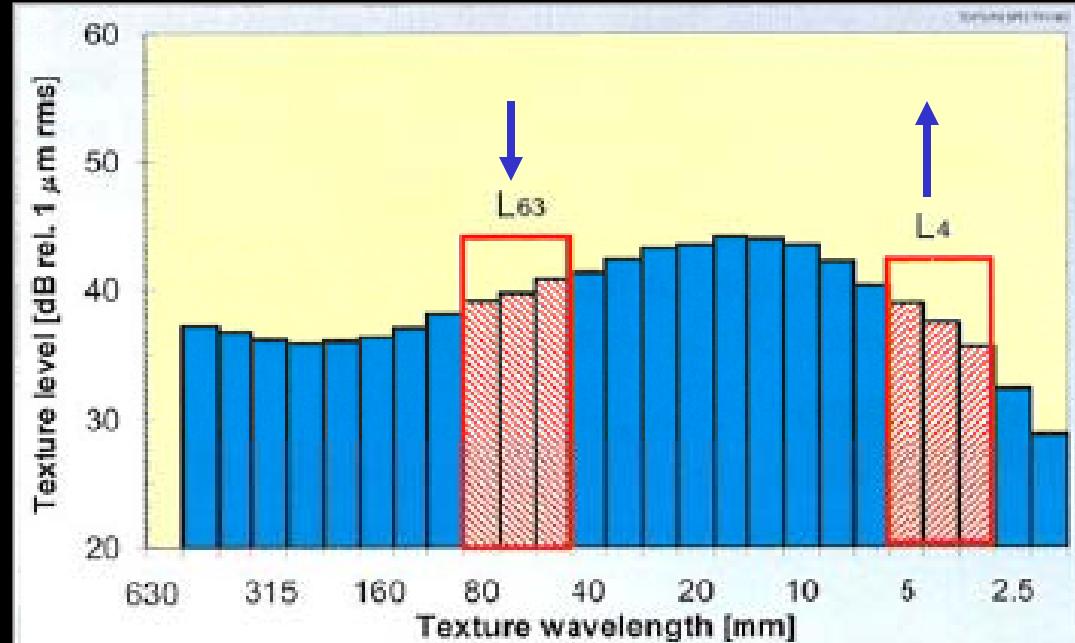
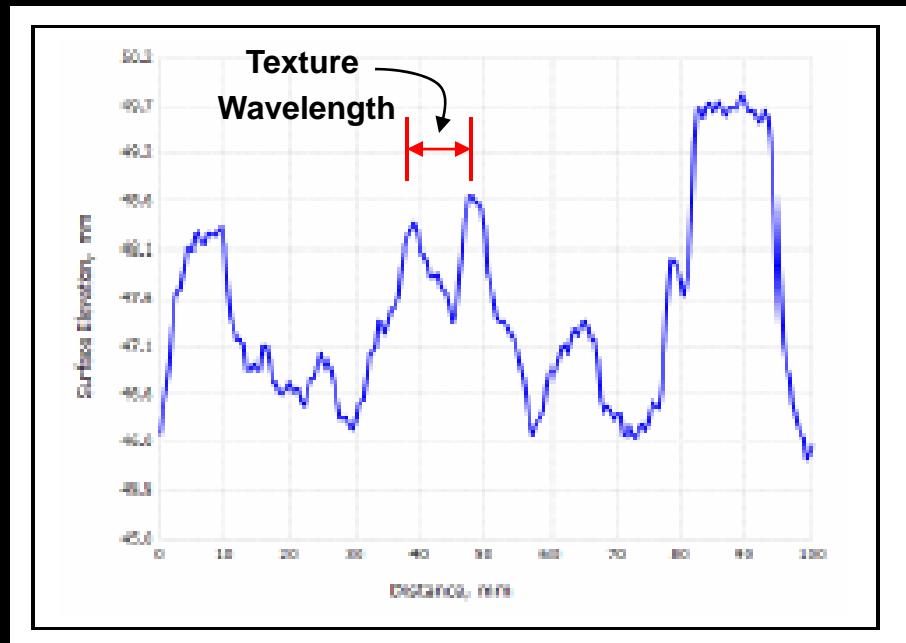


Noise and Texture Spectrum

Microtexture: wavelength $\lambda < 0.5$ mm

Macrotecture: $0.5 \text{ mm} < \lambda < 50 \text{ mm}$

Profile → Fourier Analysis → Wavelength



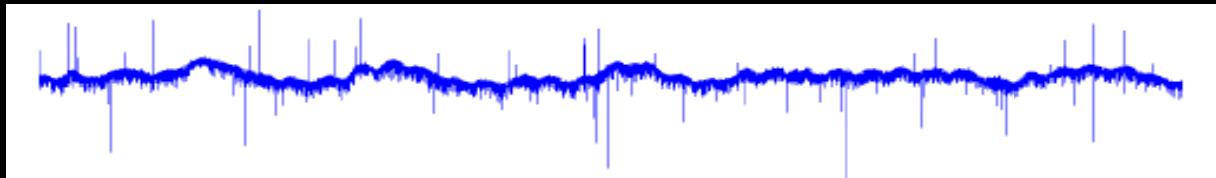
(Sandberg and Ejsmont, 2002)

ISO 13473-4:2008

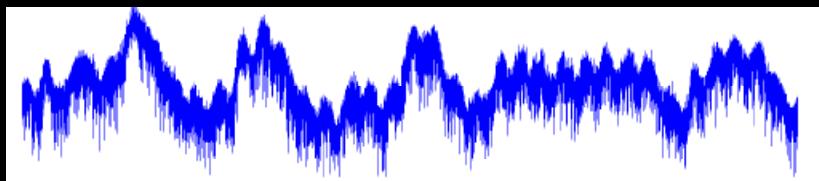
**Characterization of pavement texture by use
of surface profiles -- Part 4: Spectral
analysis of surface profiles**

ULIP Signal Analysis: Example

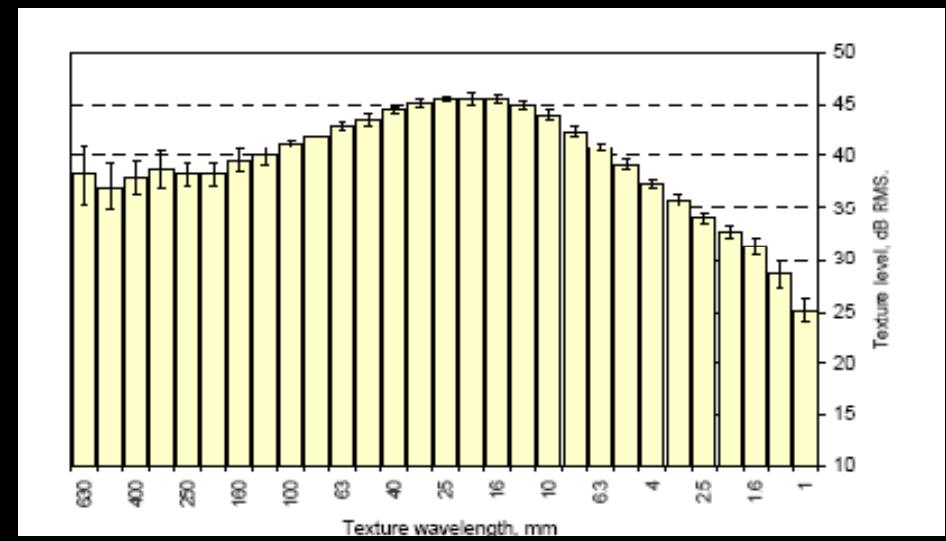
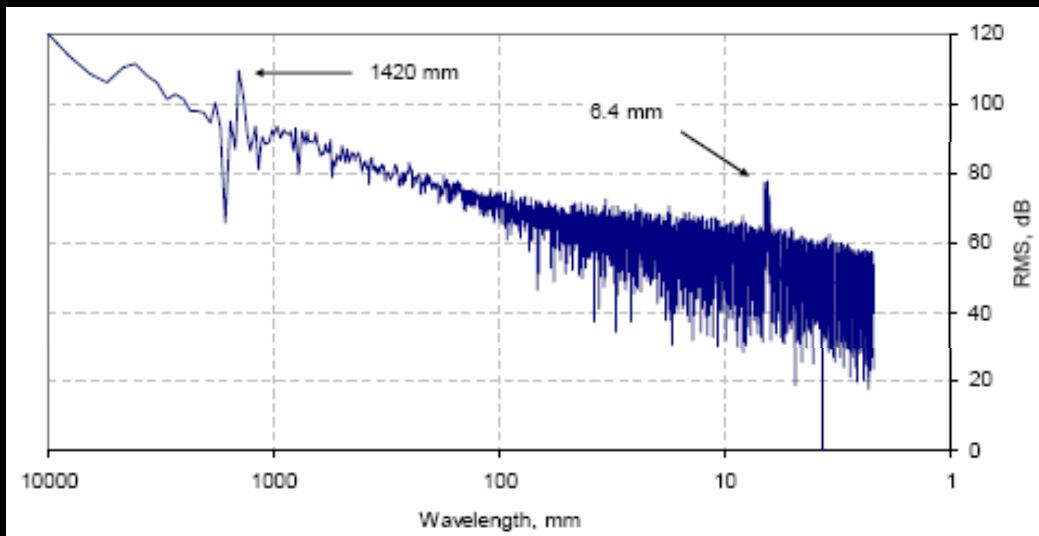
Test Track Section W4 - OGFC



ULIP-Acquired Profile



Filtered data – baseline length



Fourier Analysis – wavelength spectrum

15

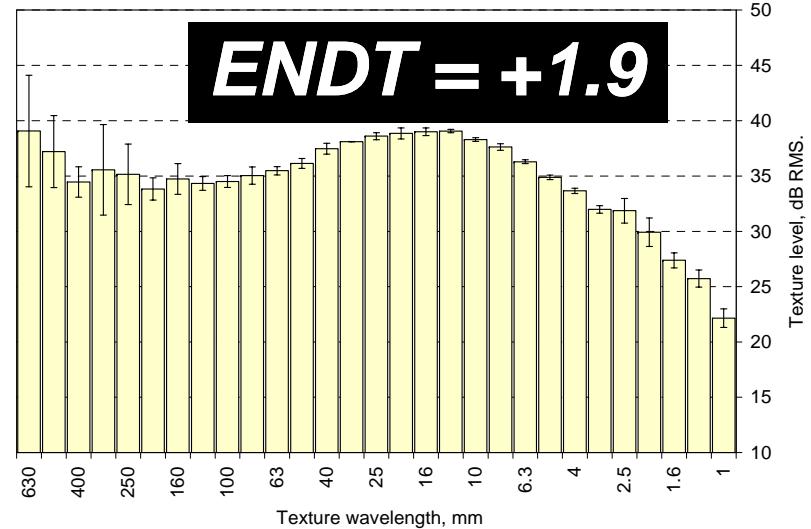
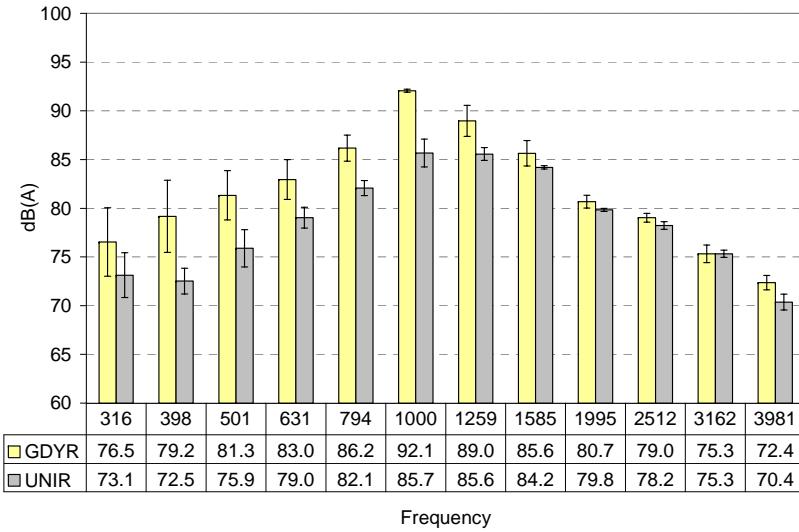
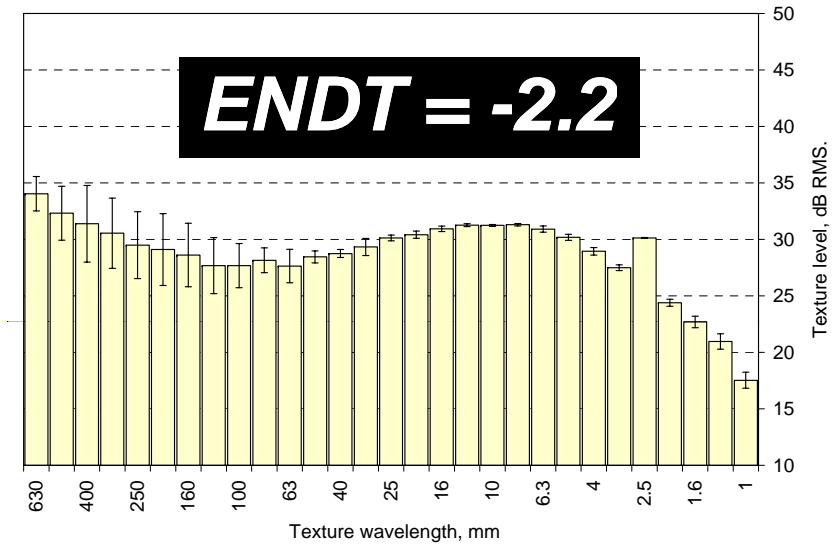
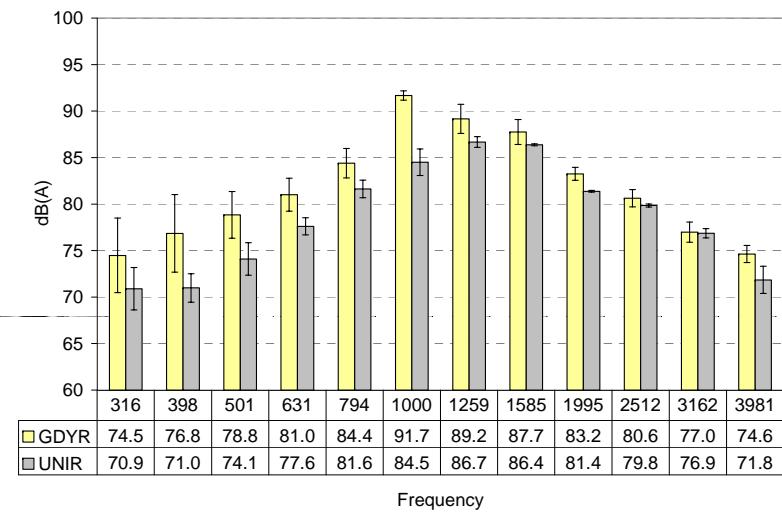


at Auburn University

ISO 10844: Acoustics - Specification of test tracks for the purpose of measuring noise emitted by road vehicles and their tires

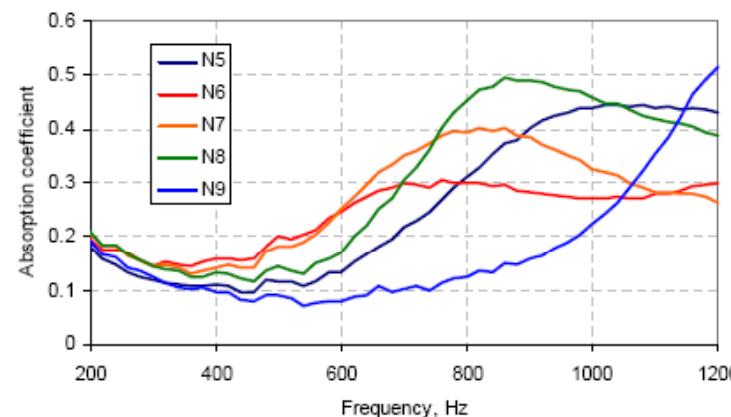
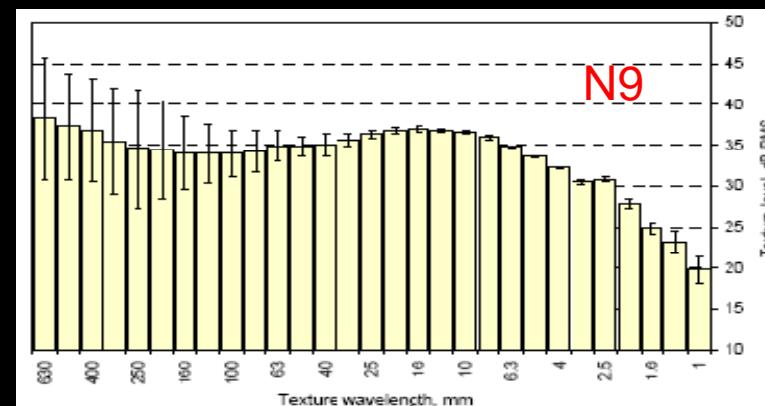
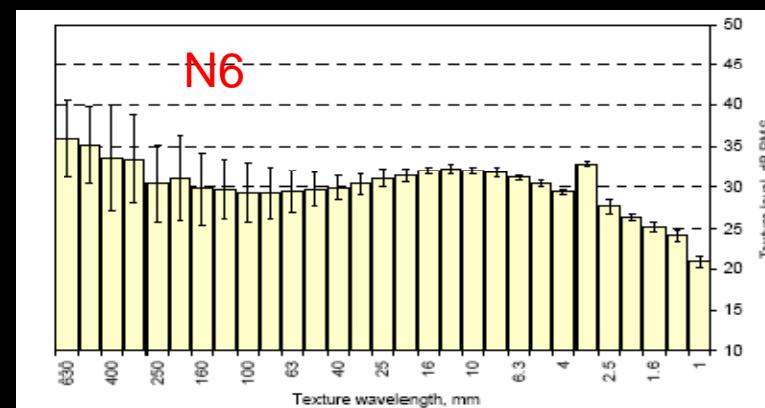
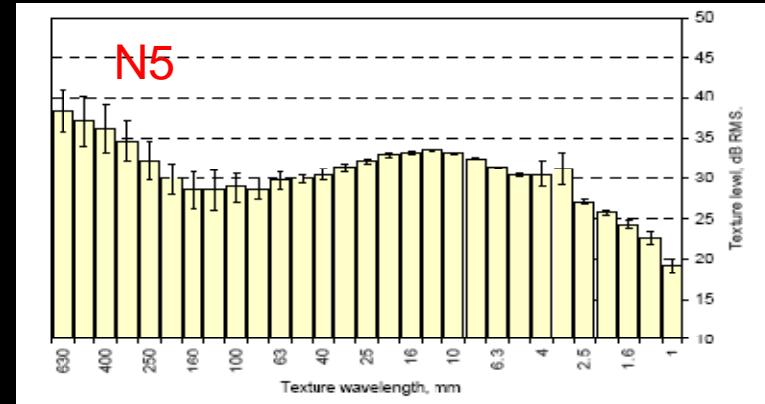
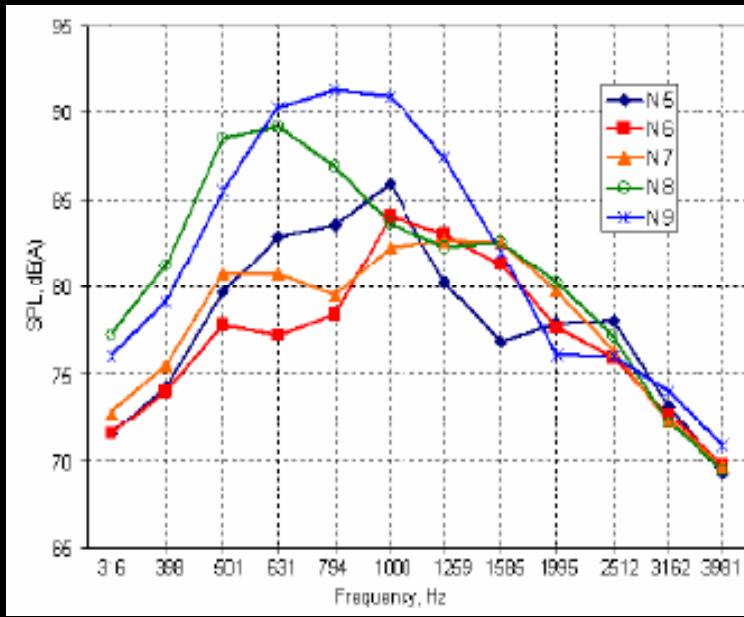
Annex E: Calculation of the Expected pass- by Noise level Difference from Texture level variation of the road surface (ENDT)

Noise & Texture Spectra (DGA)



Noise and Texture Spectra: OGFC Sections

Section	N5	N6	N9
Layer 1 (1.25 in.)	OGFC	OGFC	PEM
Layer 2 (1.25 in.)	DGA	OGFC	DGA

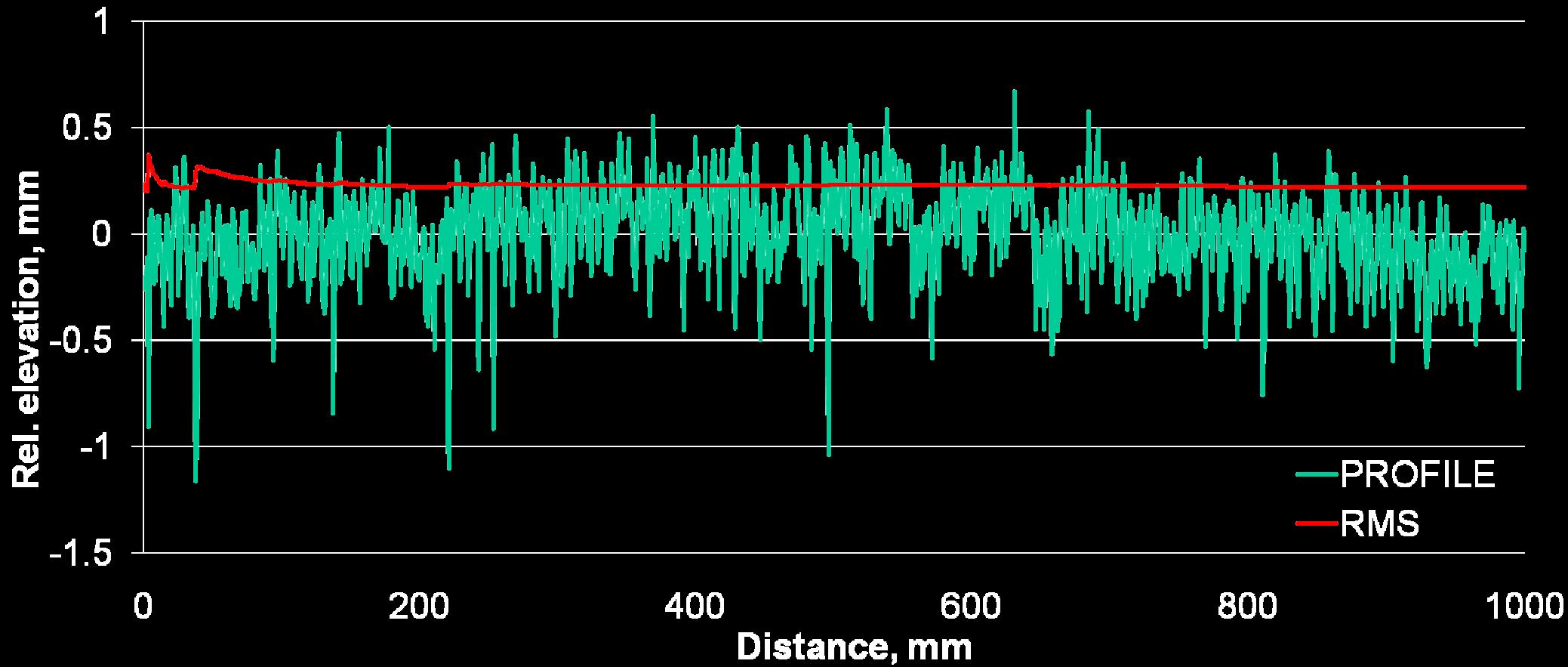


Positive & Negative texture

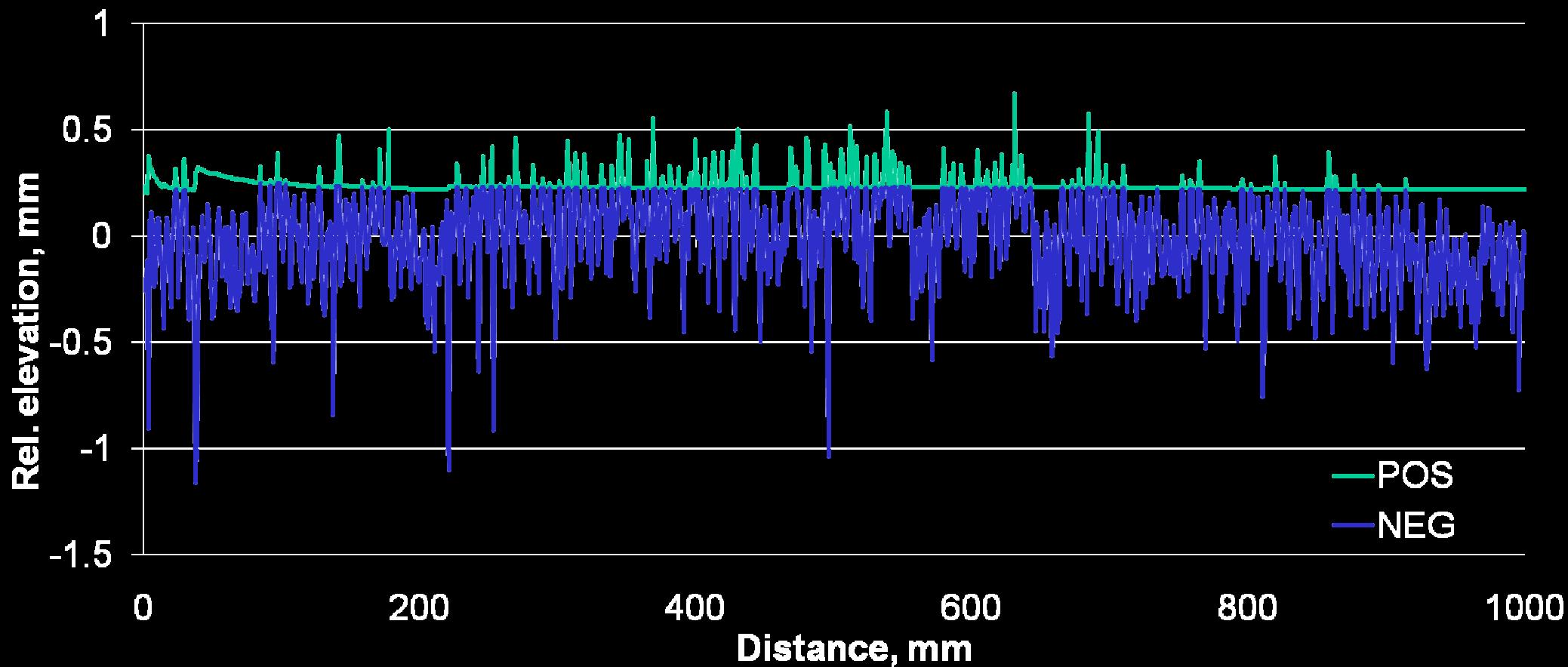
- NCAT research indicates a complex relationship between macrotexture and noise
- Models do not directly account for the influence of positive & negative texture
- Proposal – look at what the tire “sees”:
 - Positive texture
 - Negative texture



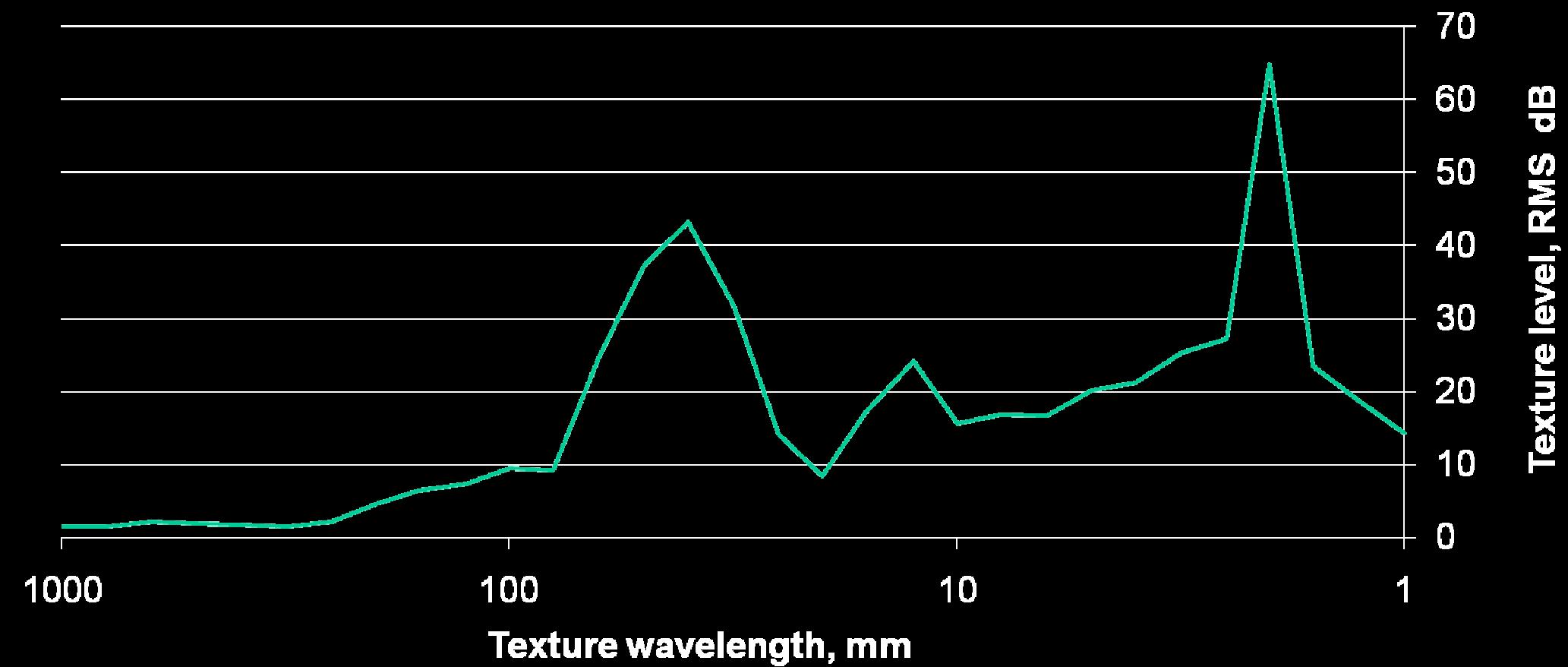
Definition of pos/neg texture?



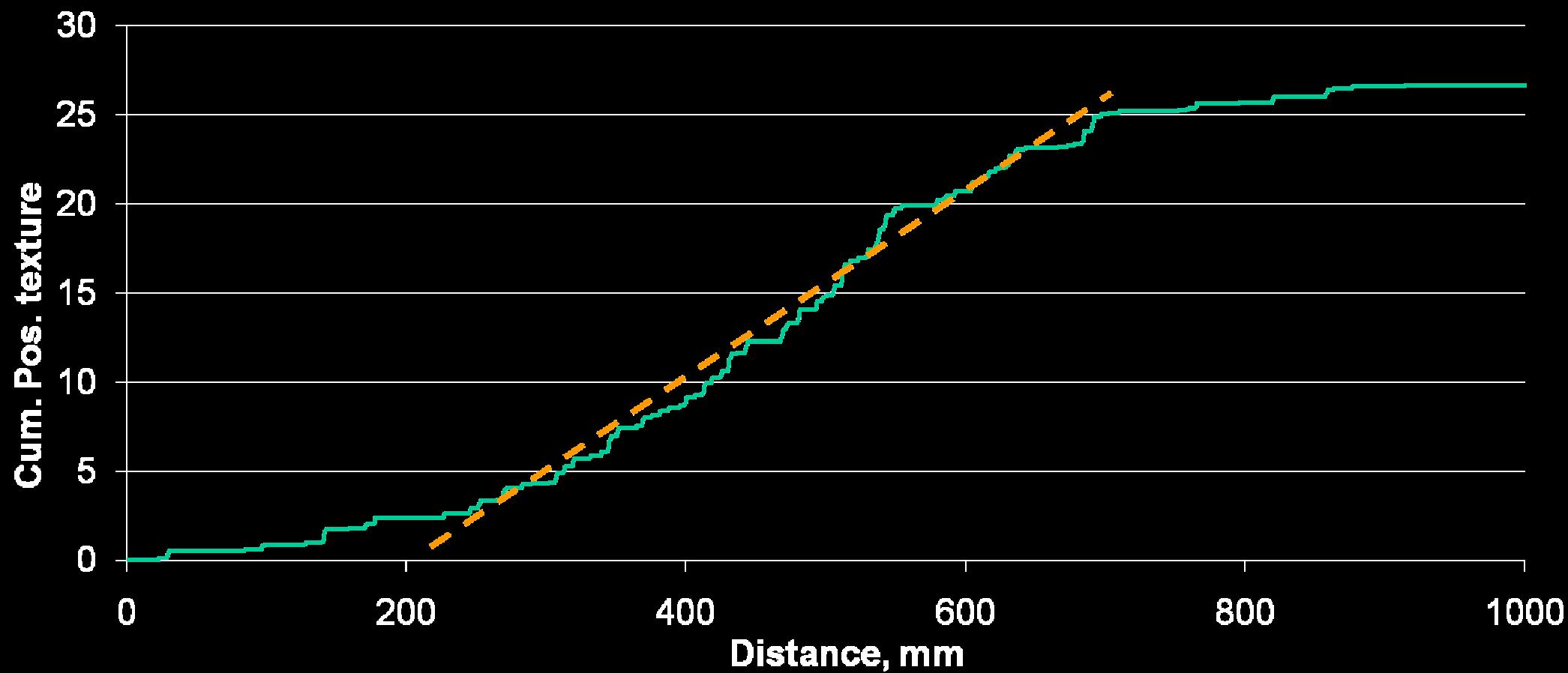
Differentiate pos/neg texture



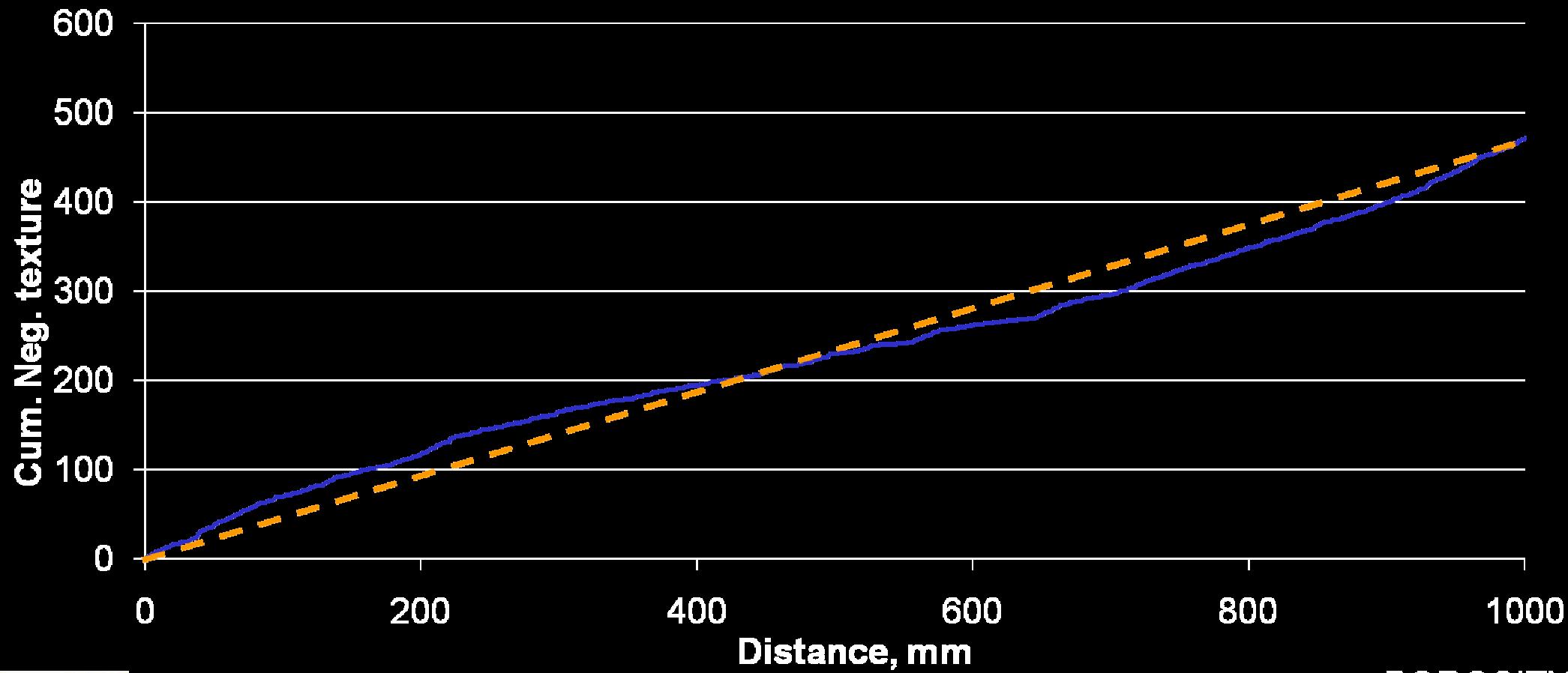
Texture wavelength spectrum of positive texture



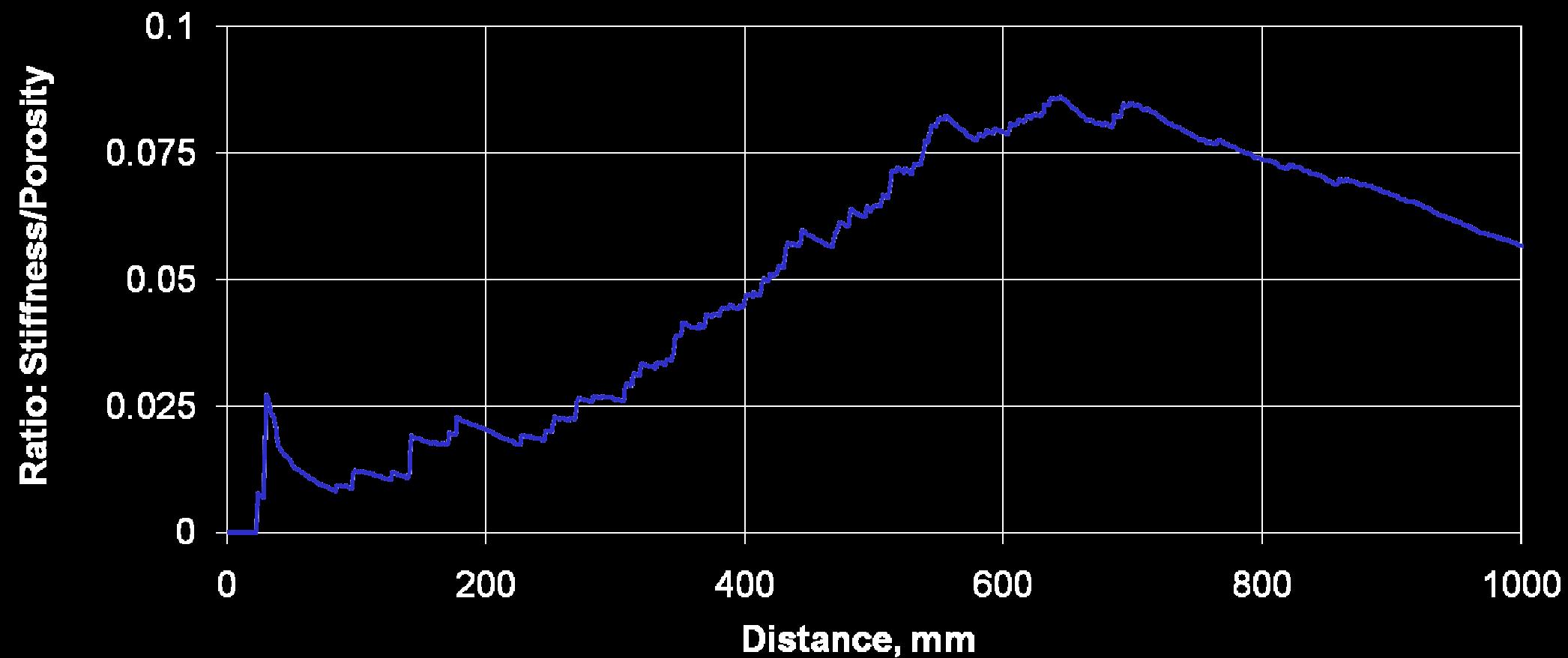
Stiffness = slope of Cumulative Positive texture

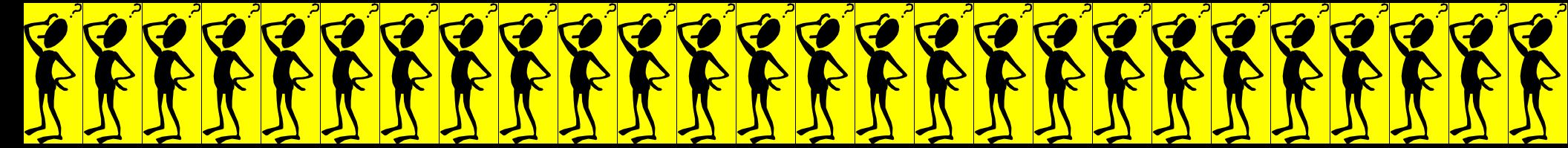


Porosity = slope of Cumulative Negative texture



Segregation profile





Questions?