Online Roughness Measurement

Online Topography Measurement based on the Light Sectioning Principle

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- Optical online roughness measurement
- Implementation
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- Combined roughness and oilfilm measurement
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Motivation

Welf Schiefer: „Mitfahrgelegenheit“

- Significance of roughness and waviness for sheet surfaces
- Traditional roughness measurement

Significance of roughness for sheet material

High surface quality strips required due to:

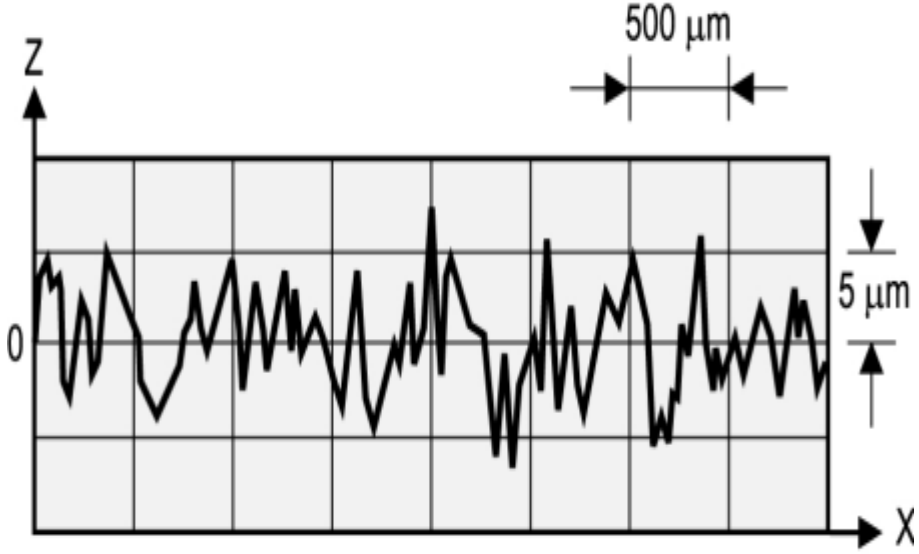
- Complex metal forming
- Increase of productivity
- Paints will be applied without filler in the future
- Higher demands on surface finish

(homogenious appearance for material mix of modern cars)

Rising importance of topography measurement

Traditional measurement of roughness

Mechanical stylus measurement:
- Impossible on moving product
- spot test at the end of a coil or
- on sample in laboratory



$$Ra = \frac{1}{l}\int_0^l \left|z(x)\right| \cdot dx$$

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Optical roughness measurement – online

- Different approaches to measure the roughness online
- Light sectioning principle
- Laboratory 3D scan examples with light sectioning (Waver and EBT)

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Different approaches to measure the roughness online

Relativ measuring principles:

- Scattering of light as measure of an optical roughness which can be correlated with the mechanical roughness
- Speckle analysis

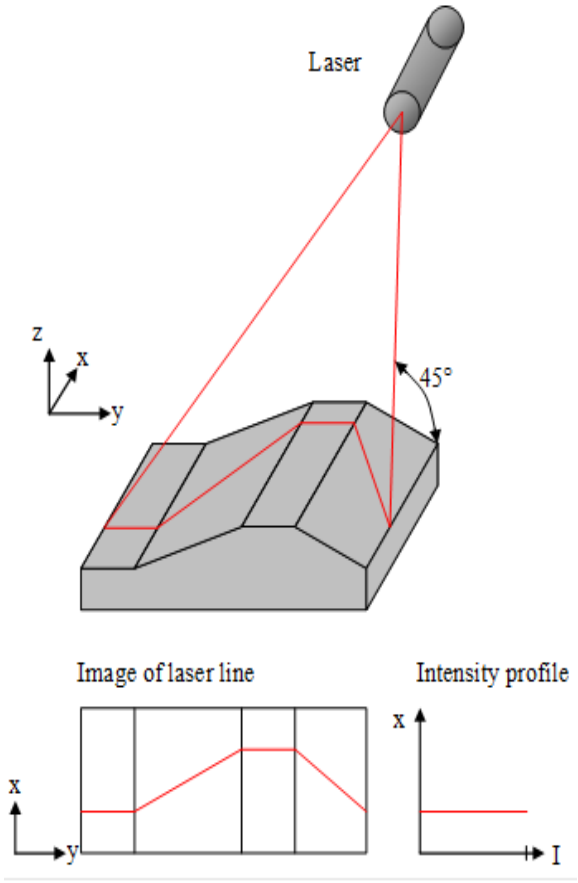
Absolut measuring principles

- Triangulation
- Deflectometry
- Light sectioning principle (2D Triangulation)

Necessary properties of an online system

- Absolute measurement as close as possible to stylus system by optical means
- Usable for all sheet surfaces and coatings
- Unaffected by production environment, e.g. speed, vibrations etc.
- Verifiable by user - not a black box
- High dynamics for process control
- High accuracy and good comparability to stylus results

Light Sectioning Principle



1. Laser line projected onto surface (here 45°)
2. Imaging of distorted line with camera
3. Evaluation of line distortion gives a high resolution surface profile
4. Calculation of roughness parameters

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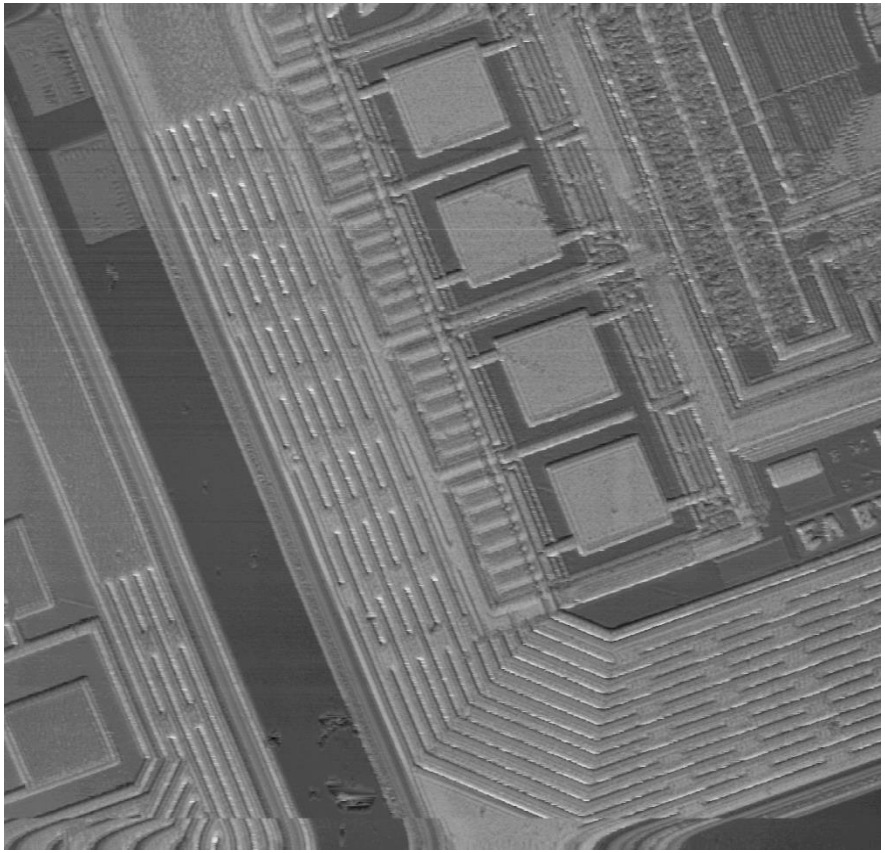
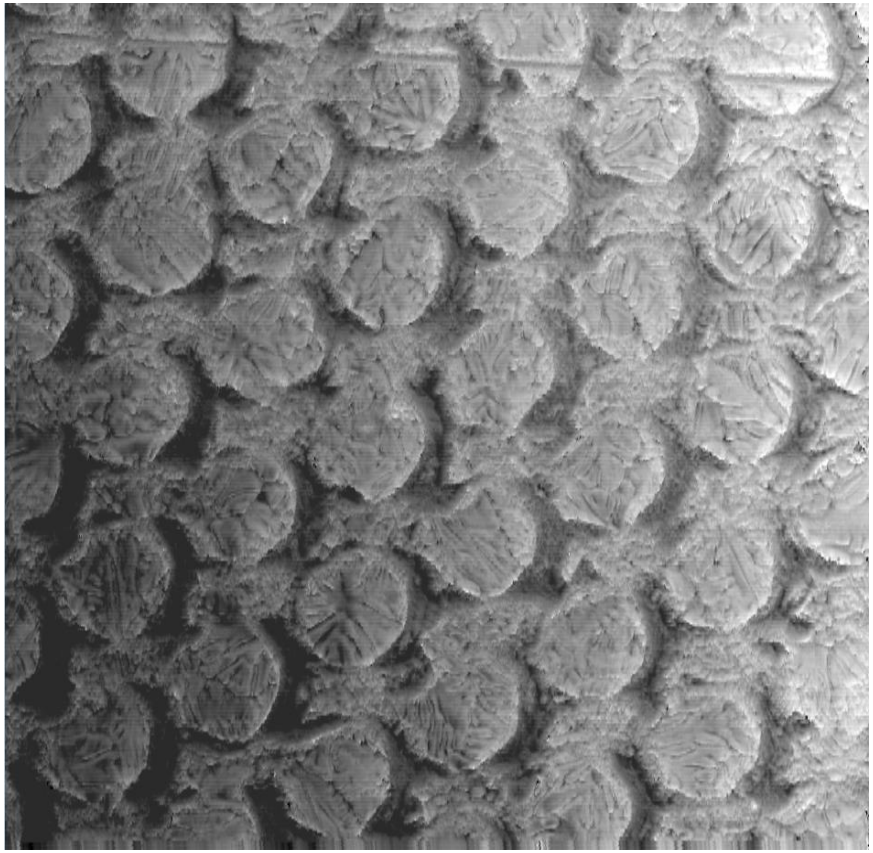
Laboratory 3D scan with the light sectioning principle





3D depth maps (grayscale coded, ca. 1x1mm^2):

a) Waver

b) EBT textured hot dip galvanized steel sheet

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Implementation

- Integration of the system into a rolling mill
- Example for an installation
- Online surface images
- Correlation with stylus measurement

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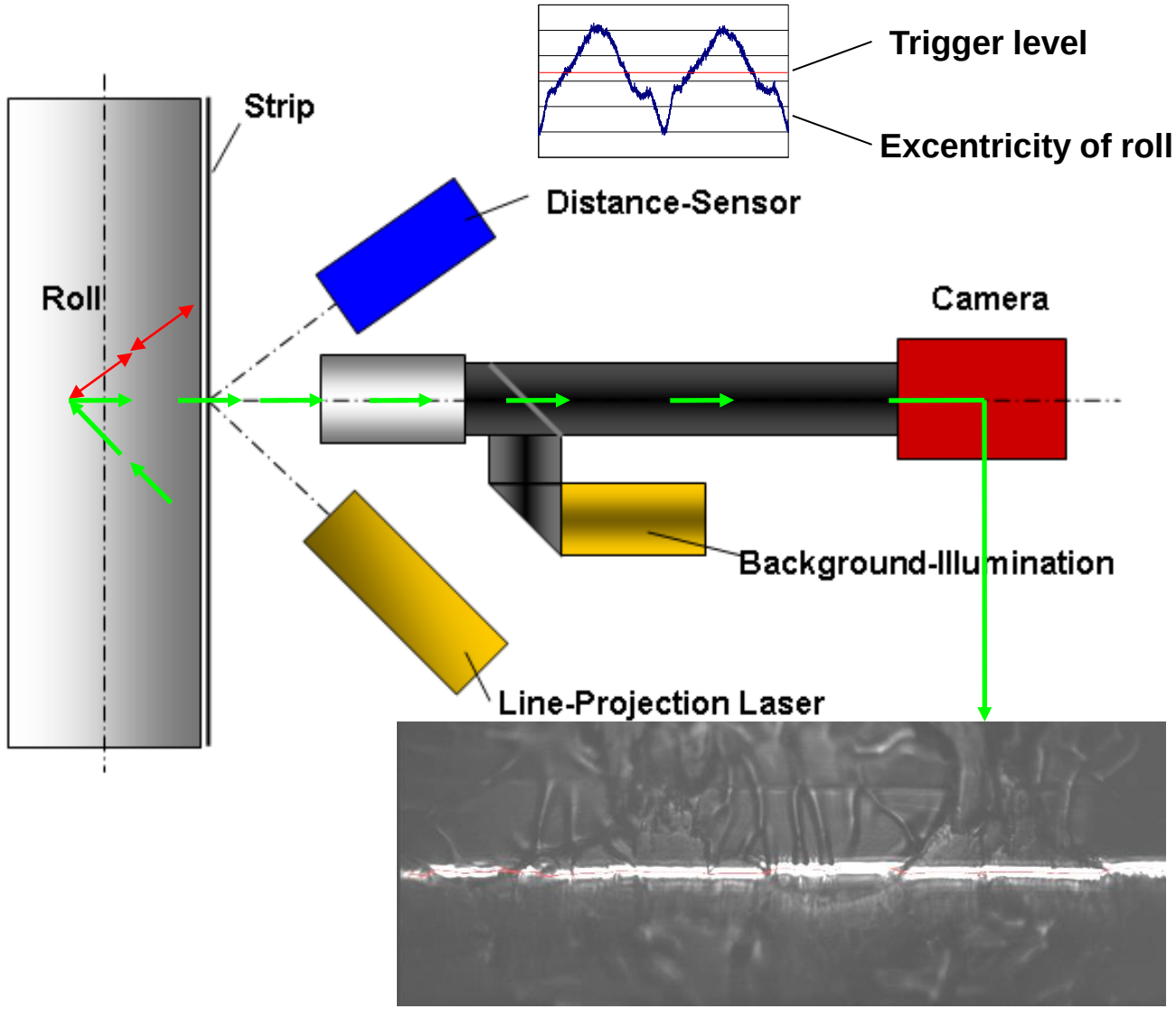
Integration of the system into a rolling mill



Specifications:

Magnification 6x

FOV1200x400µm

WD 28mm

20 (90) images/s

Wavelength 905nm

Pulse length 8ns

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Example for an installation

Installation in Feuerverzinkung (v_{max} = 180m/min)
mit definierten Schutzbereichen

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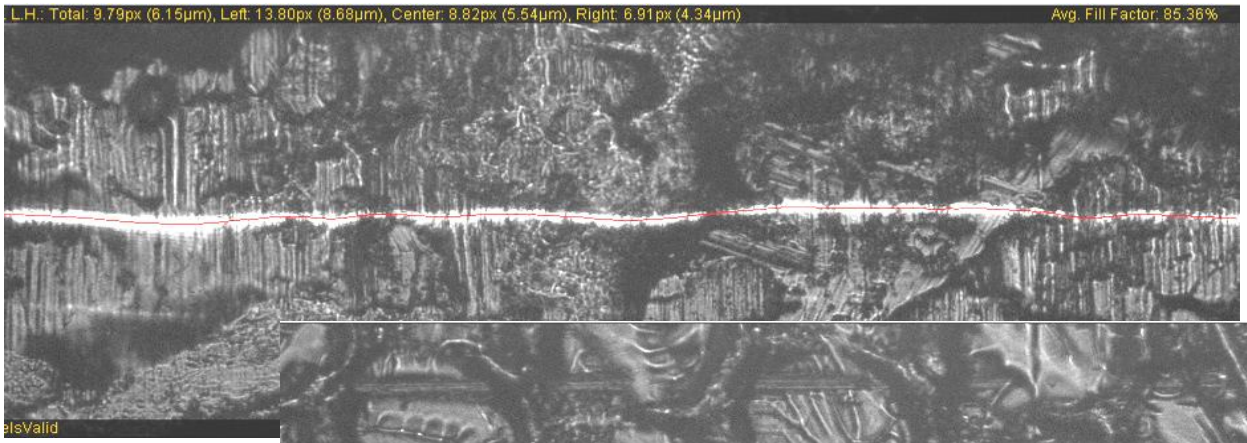
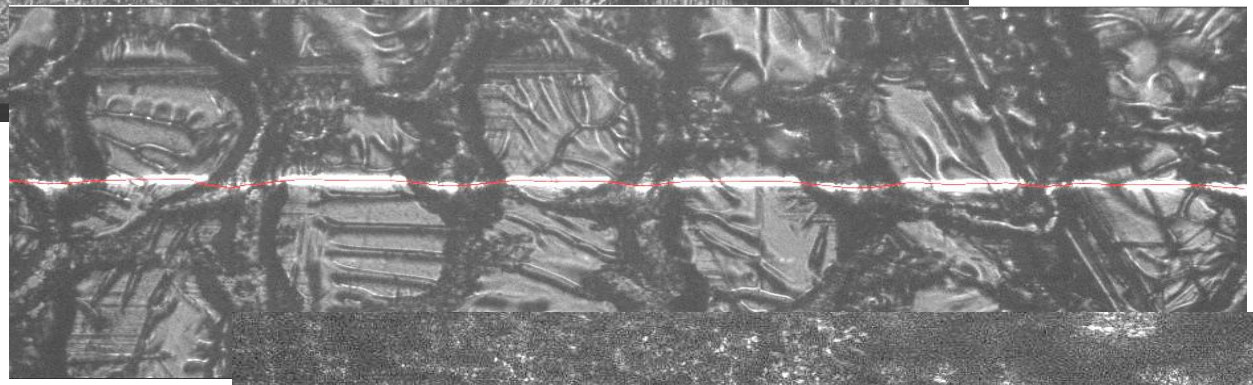
Online surface images

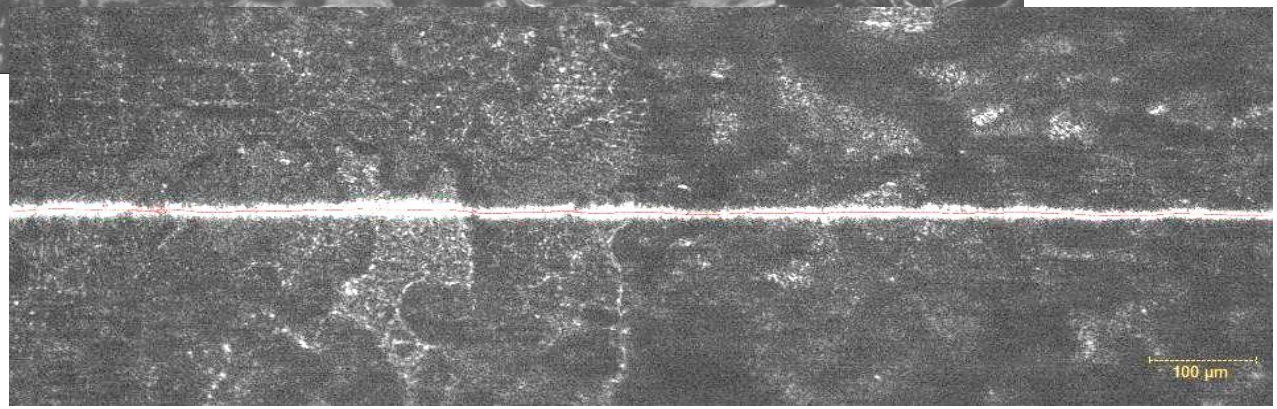


a) Ra = 3.5µm



b) Ra = 1.6µm

c) Ra = 1.2µm



Sheet surfaces:
a) Annealed steel
b) Hot dip galvanized (EBT texture)
c) Electrogalvanized (EDT texture)

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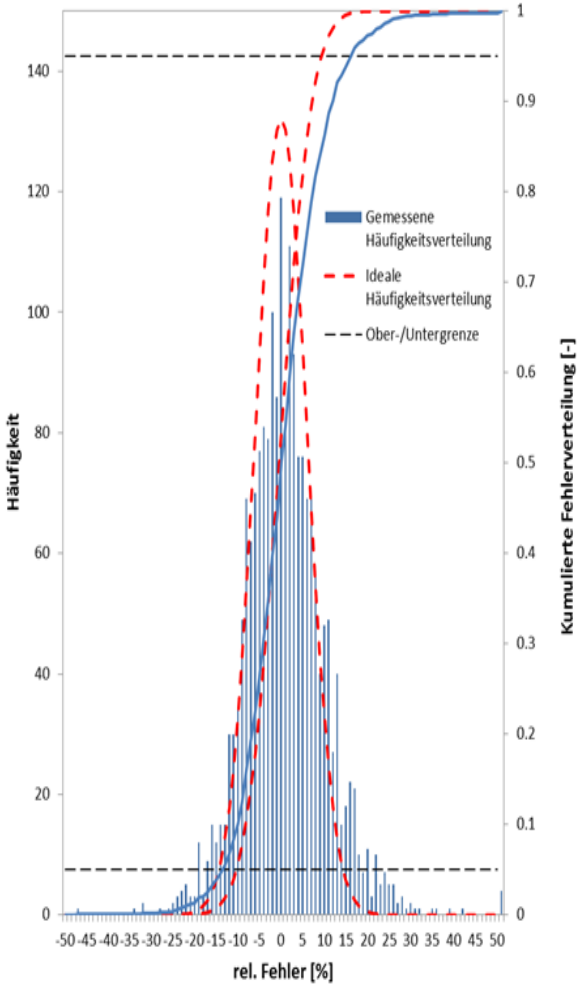
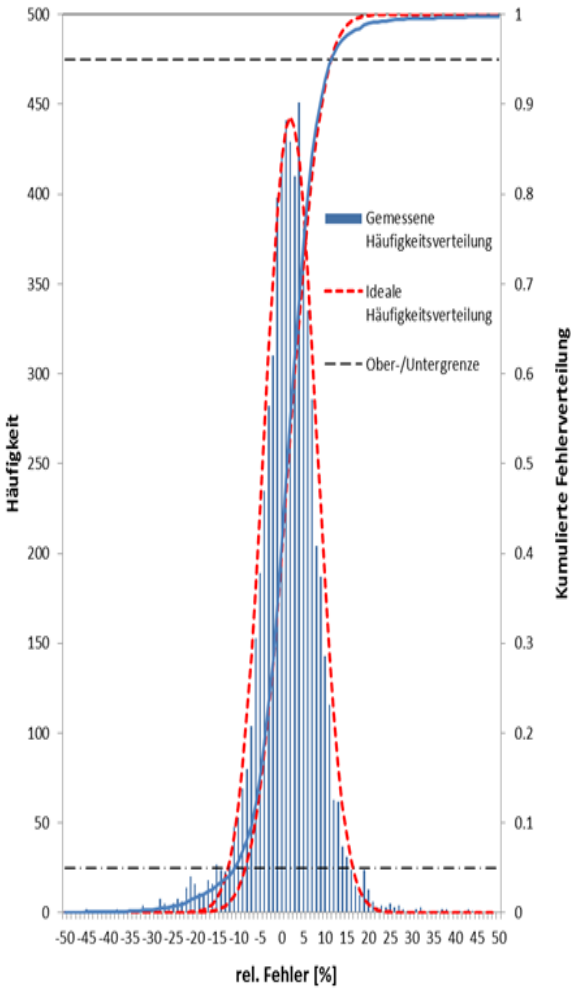
Correlation with stylus measurement



a) Stylus operator vs. Stylus laboratory



b) Stylus vs. optical online

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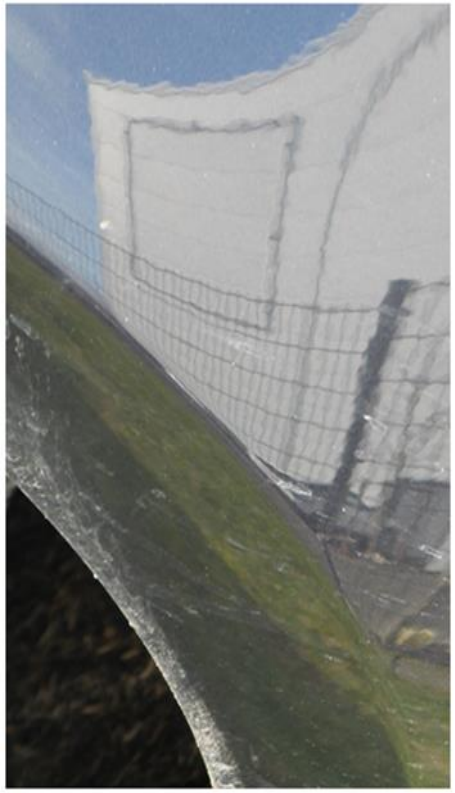
Waviness measurement – online



- Waviness measurement – Wavisurf
- Laboratory results
- Online results
- Prozess optimization

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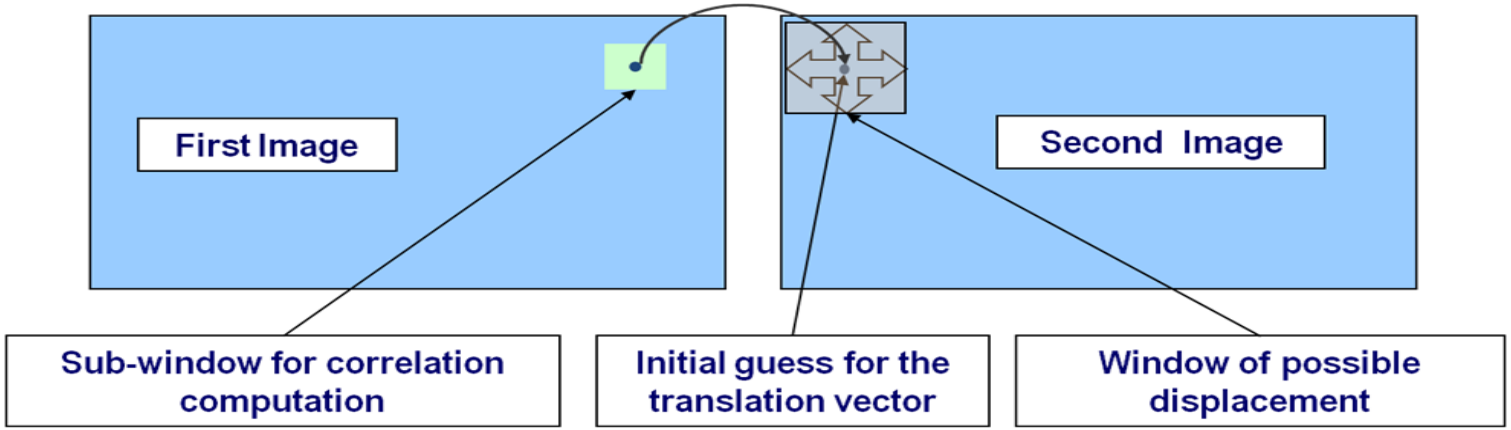
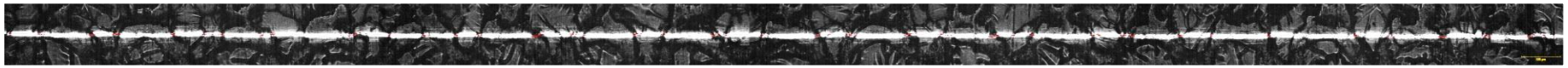
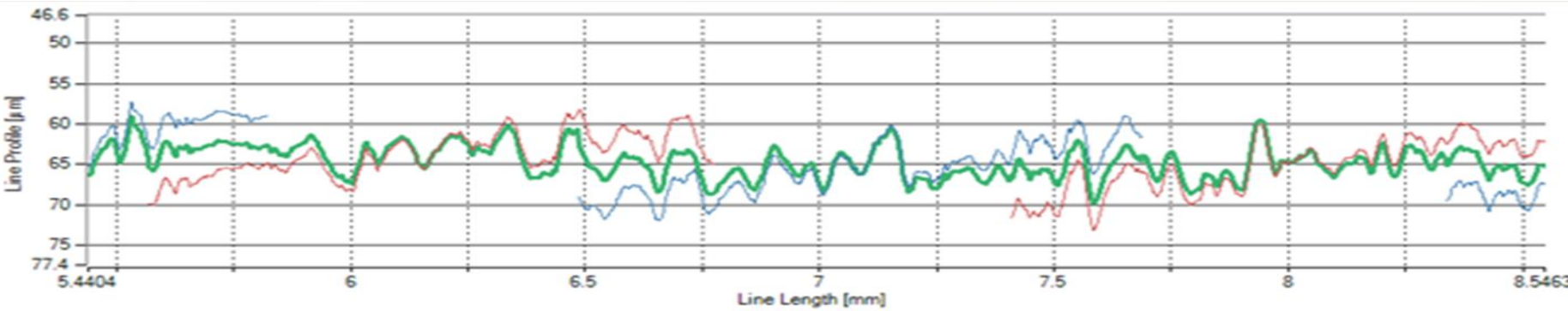
Waviness Measurement – Wavisurf







System requirements:

- High speed camera (ca. 4kHz)
- Dynamische synchronization with strip speed
- Precise allignment of the optics

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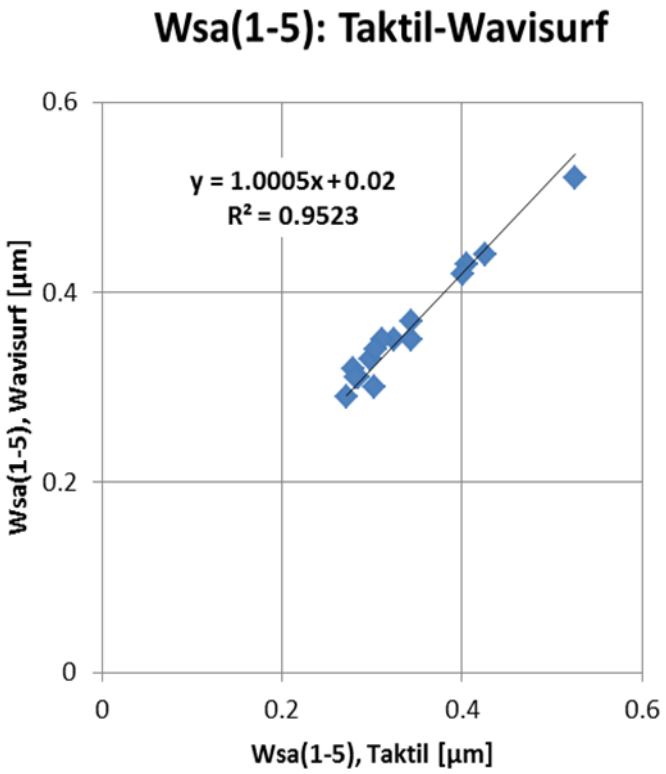
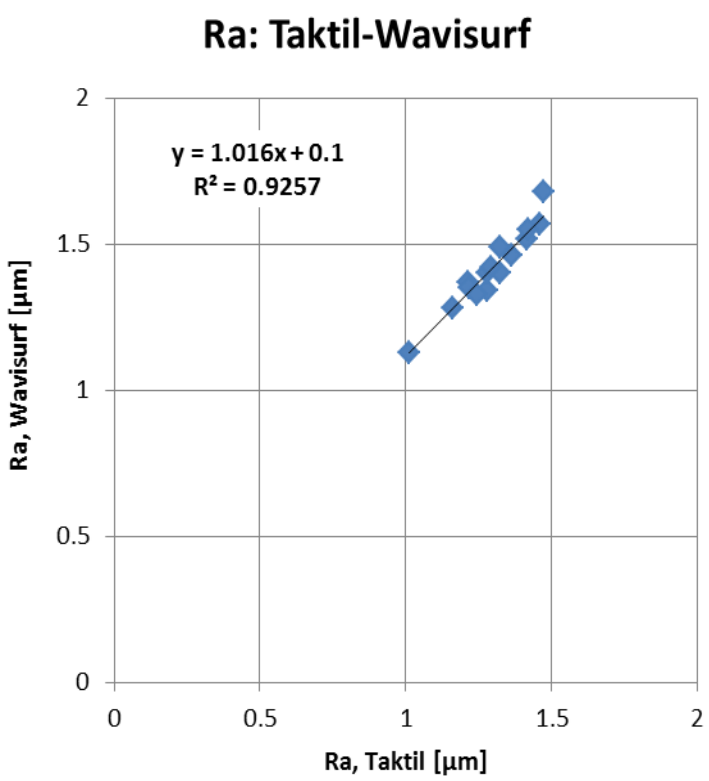
Laboratory results





Comparison of mechanical stylus with optical waviness measurement (sample speed 60m/min)

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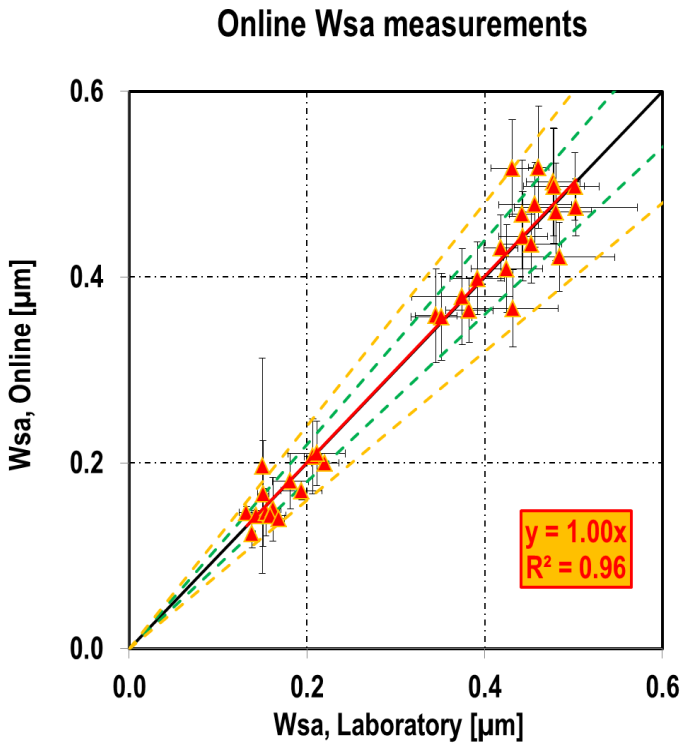
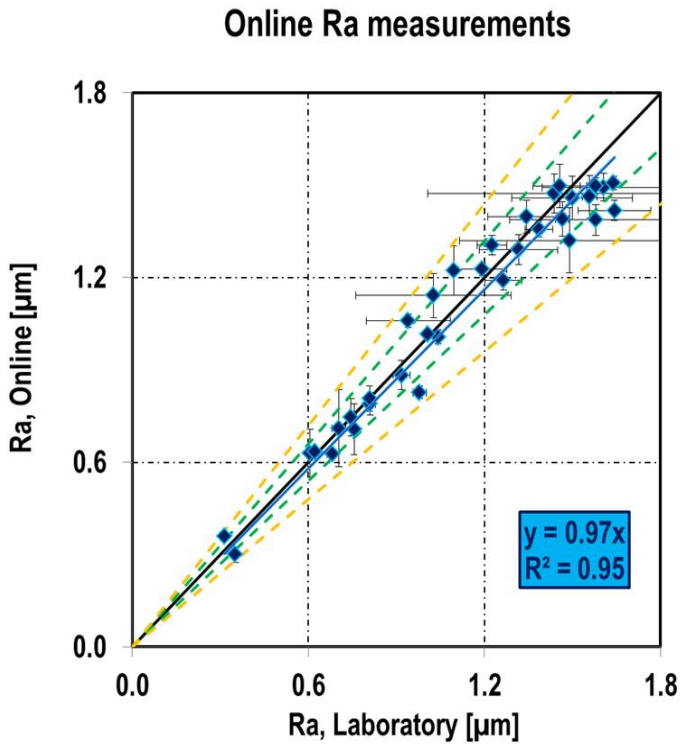
Online results





Comparison of mechanical stylus with optical waviness measurement (v_{max} = 240m/min)

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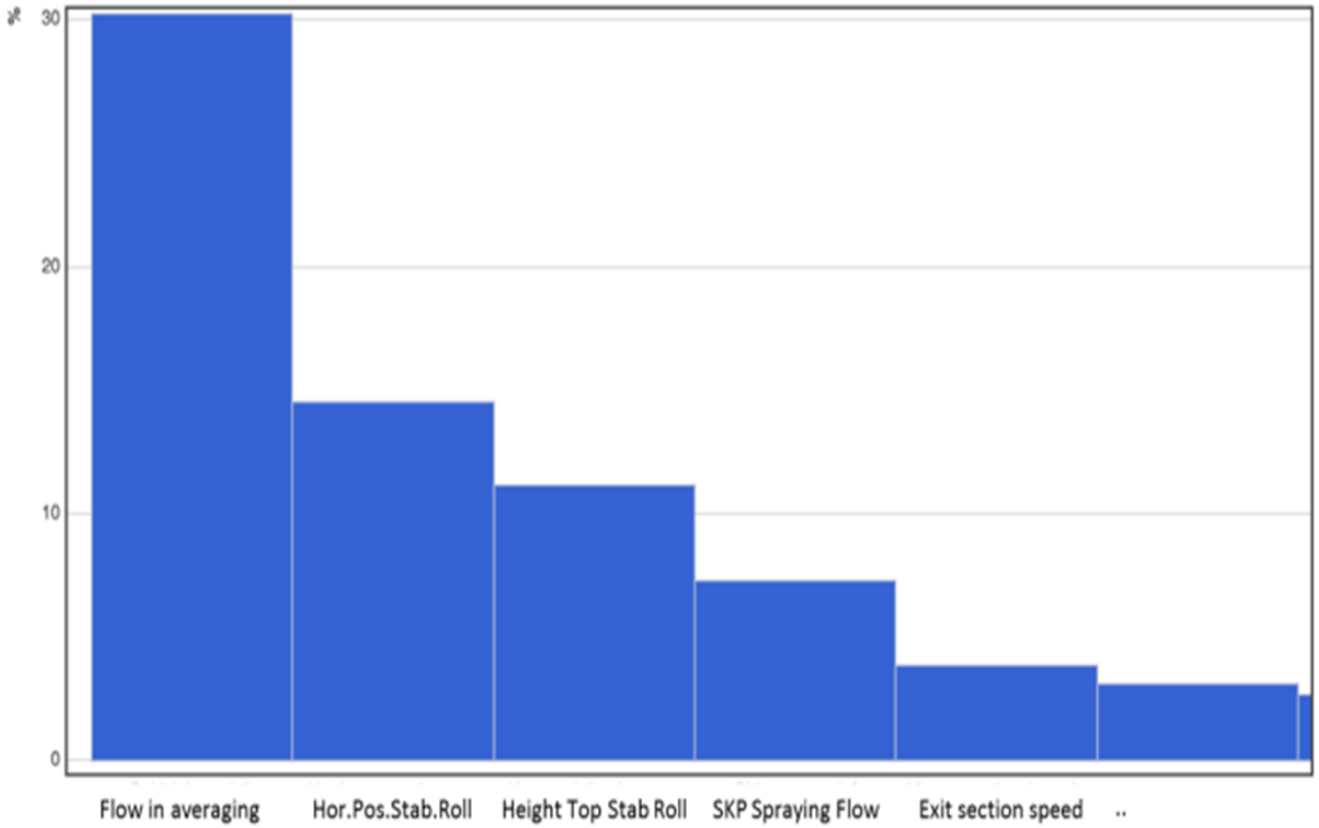
Prozess optimization



Evaluation and quantification of process parameters onto the waviness (hot dip galvanizing line)

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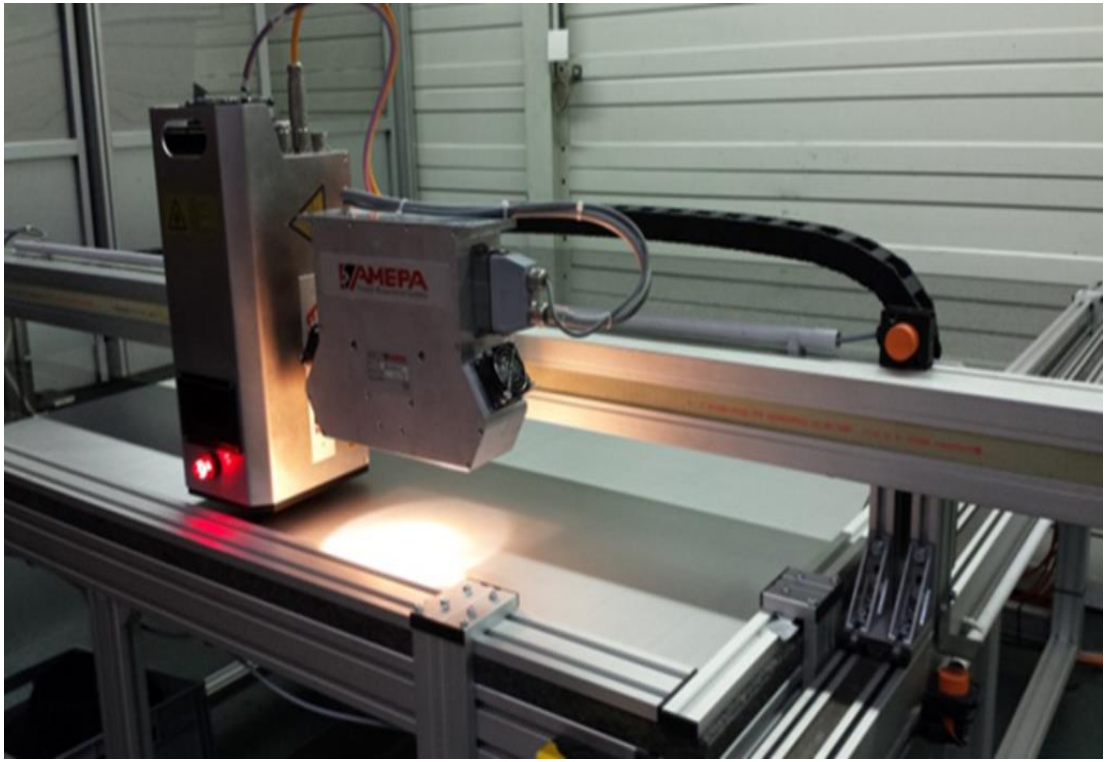
Combination of roughness and oilfilm measurement



Offline analysis of blanks

- Oil film distribution
- Roughness distribution

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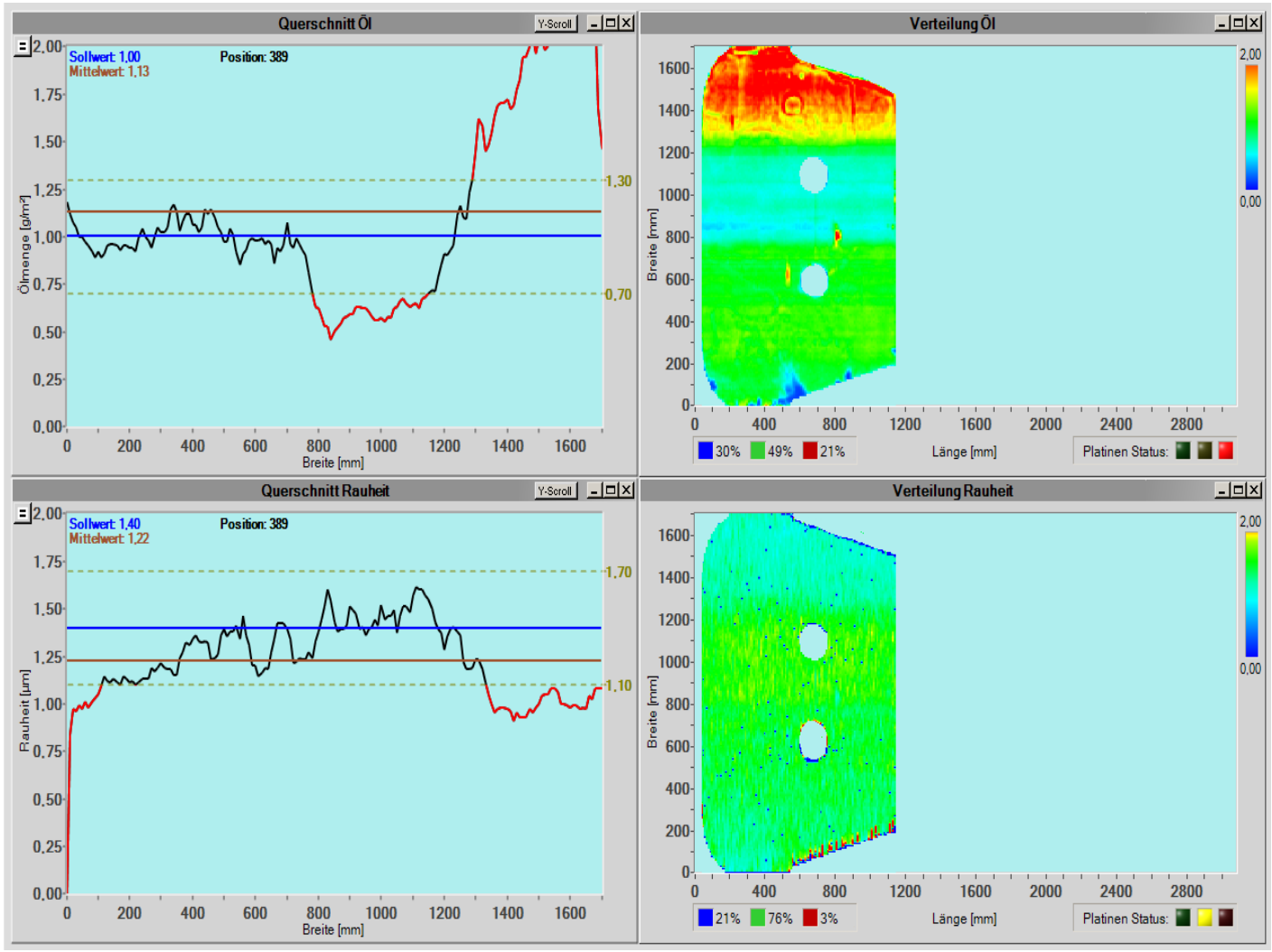
Prediction of deepdrawing behaviour



Used by:

- Audi
- Daimler

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Resumé

- SRM is the standard system for online-roughness measurement in Europe
- Benefit:
  - Modelling of processes
  - Process control
  - Process optimization
  - Product improvement
  - Auditing

- Waviness measurement WMS:
  Extension of the roughness measuring system for the evaluation of waviness parameters (Wsa, Wa0.8 etc)

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Thank you very much for your attention.

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