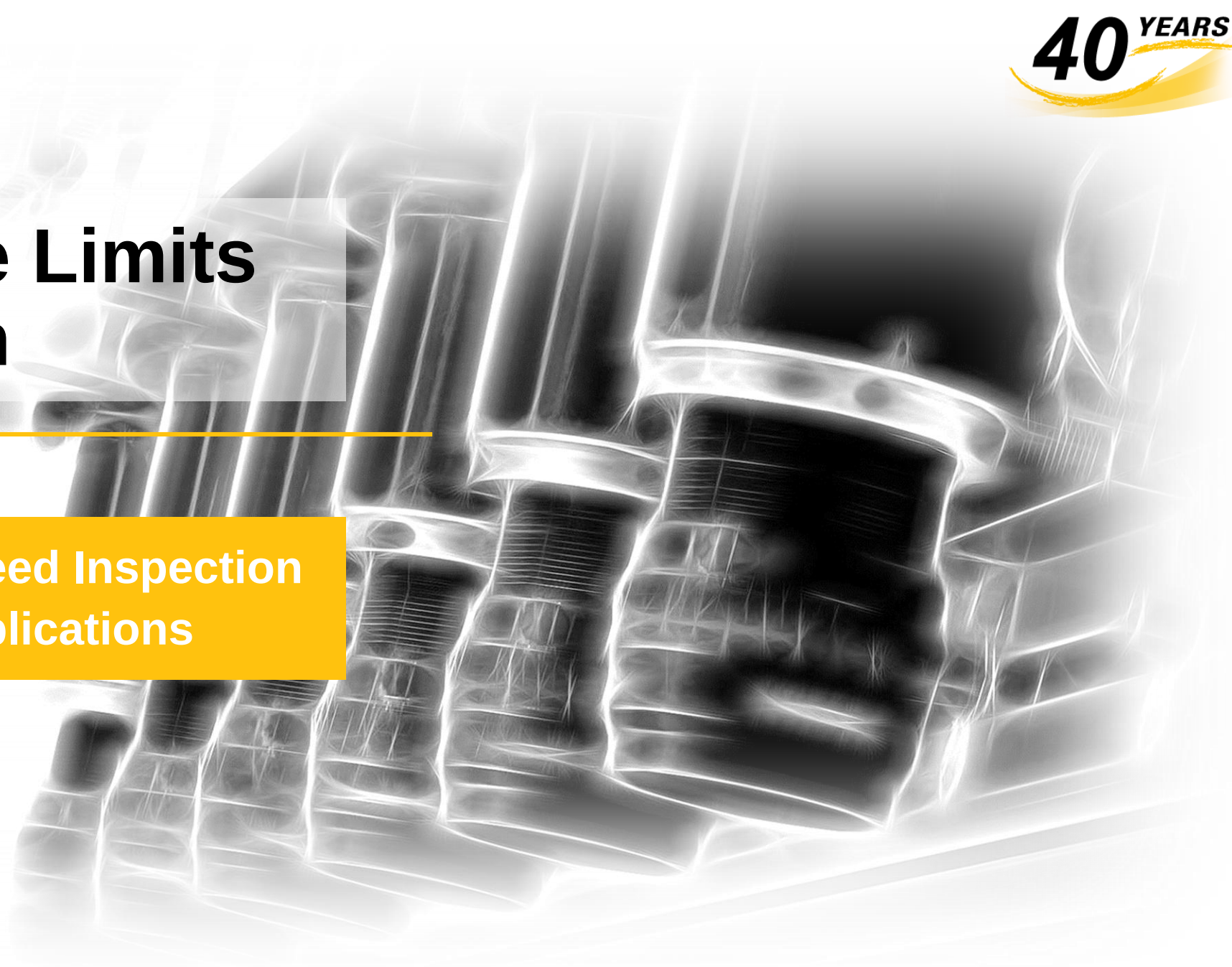


Pushing the Limits of Precision

Advanced High-Speed Inspection
for Dry Coating Applications



**Introducing
Dr. Schenk**

**Innovations for dry
coating inspection**

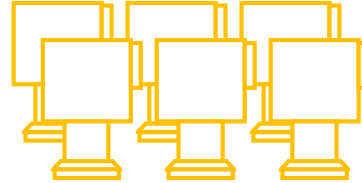
Summary





What we do

- Surface inspection solutions
- Development, manufacture and sales



Systems

- > 16,000 worldwide
- For all applications



Our expertise

- > 40 years of experience
- Perfectly matched, closed systems



HQ

- Near Munich, in Bavaria, Germany
- 18,000 m² production & testing facilities



Foundation

- 1985
- Privately owned



Employees

- > 300
- 60% in R&D, project management

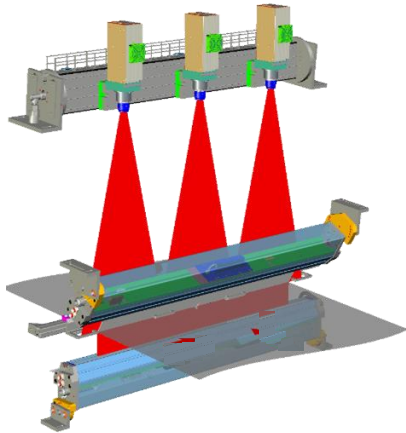
A pioneer of inspection technology.

One Platform for all your inspections

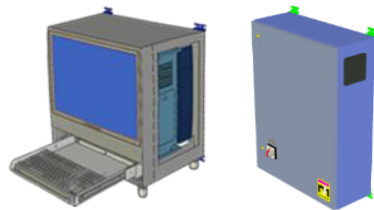
Modular Standard System - flexibly adaptable to your requirements

One standard platform for...

Cameras & Illuminations

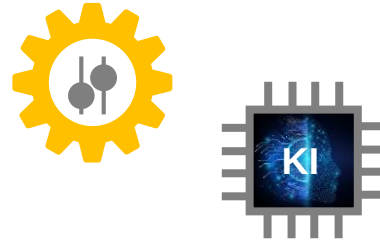


Hardware



- Operator Terminal Box
- All-in-One Box
- Accessories
 - Calibration / Verification
 - Encoder, Frames, ...
 - Interfaces,...

Software



- Data Management (ERP, MES, SCADA)
- Analysis, statistics, reports, remote access
- AI, 2D code traceability,
- And much more...

... for all application



Battery



Hydrogen



Wind



Display /
Glass



Metal



Nonwoven



Plastic



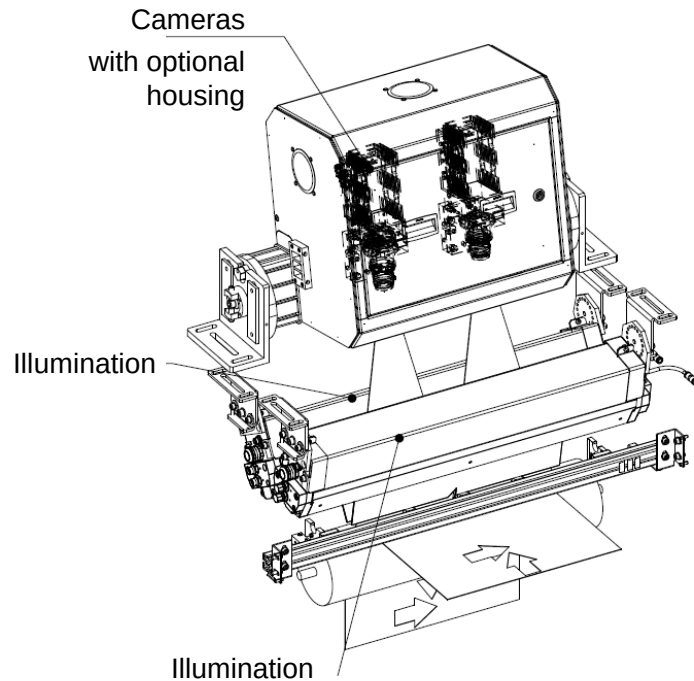
Paper



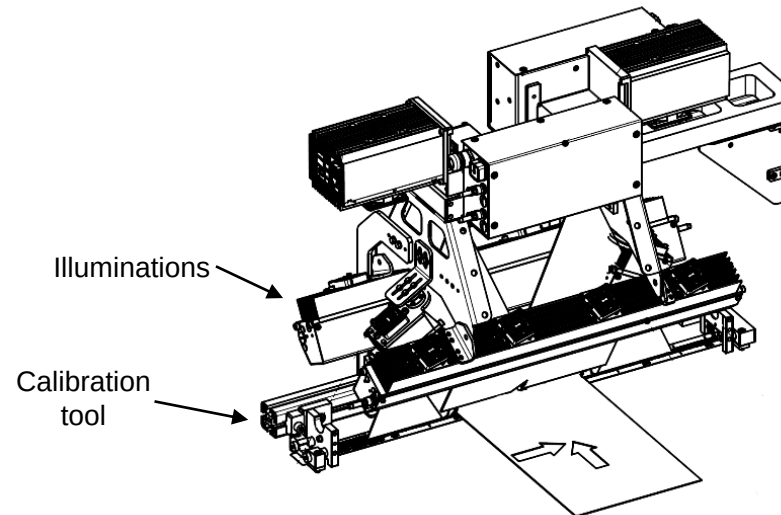
Textile

Examples: Dry Coating Inspection

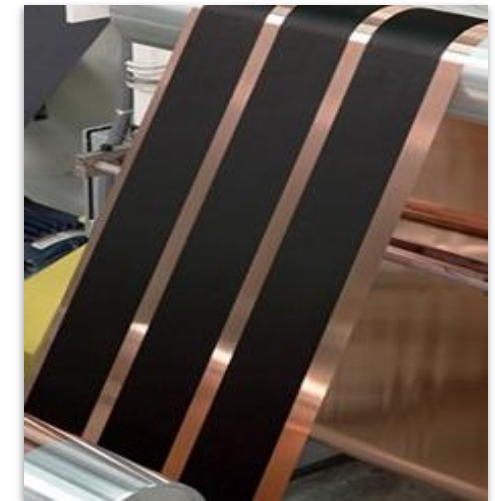
Coating inspection



Customized measurement inspection



Use in production



- Assembled & adjusted
- Compact & flexible design
- Integrated calibration device

benefits

A) One System for complete production workflow



B) One System for three inspection tasks

1

Defects

- Particles, Pinholes,...
- Delamination, peels, ...
- Cracks, scratch,...
- Wrinkle, folds, oxidation, ...

2

Measurement

- Coating width, distance,...
- Coating alignment
- Dimensions / Position

3

Material properties

- Roughness / Homogeneity
- Coating thickness
- Porosity / Streakiness

One System for three inspection tasks

1 Defects

Detection of all kinds of defects

- Contaminations, particles (metal, graphite, other)
- Pinholes, thin spots, bubbles, drops, ...
- Scratches, stripes, strokes, wrinkle, folds, cracks...
- Delamination, density marks,....

High sensitivity

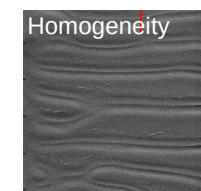
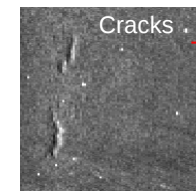
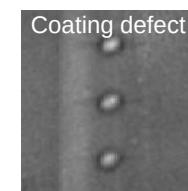
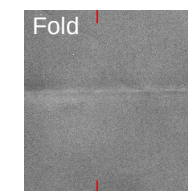
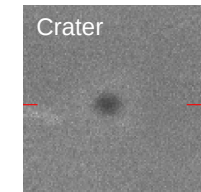
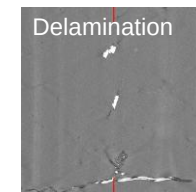
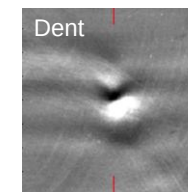
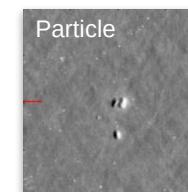
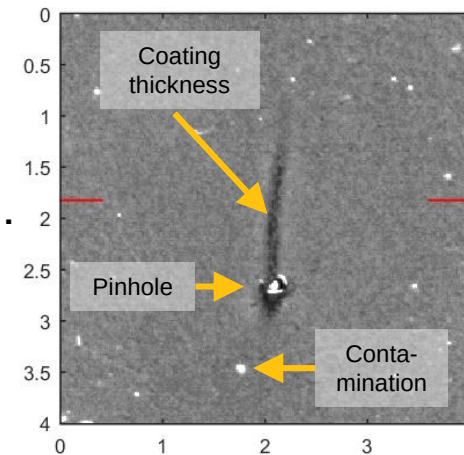
- $< 10\mu\text{m}$
- By multi channel illumination (MIDA)
- 12bit camera, 16bit image processing,...

Precise classification

- Up to 400 features for each defect
- AI or classic classification

2 Measurement

3 Material properties



One System for three inspection tasks

1 Defects

2 Measurement

3 Material properties

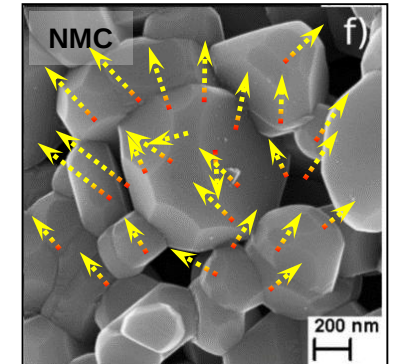
Example: Particle detection

■ Challenge:

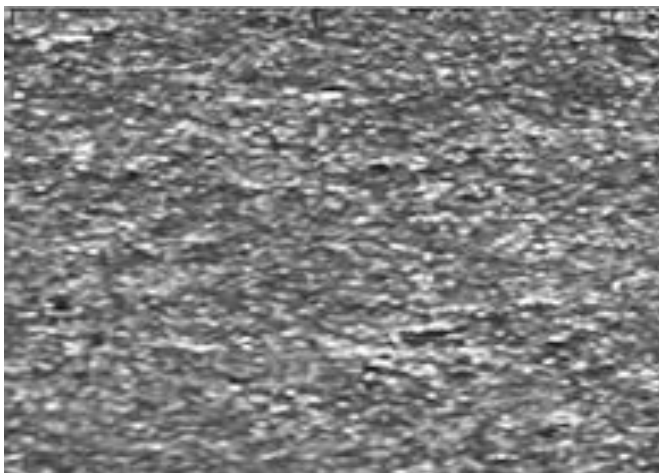
- Typical microcrystal background structure (5 – 30 μm) causes noise
- Small particles cannot be detected with conventional inspection

■ Dr. Schenk Solution:

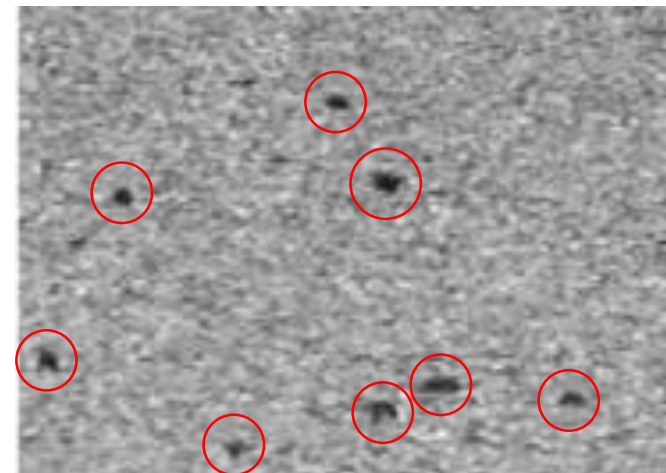
- Unique, proprietary Dr. Schenk illumination technology (ADDI)
- Detection of particles down to 10-20 μm possible even on noisy, structured surfaces



Micro crystals cause a lot of noise



Very noisy image: particles invisible



With ADDI technology: particle clearly visible

One System for three inspection tasks

1

Defects

2

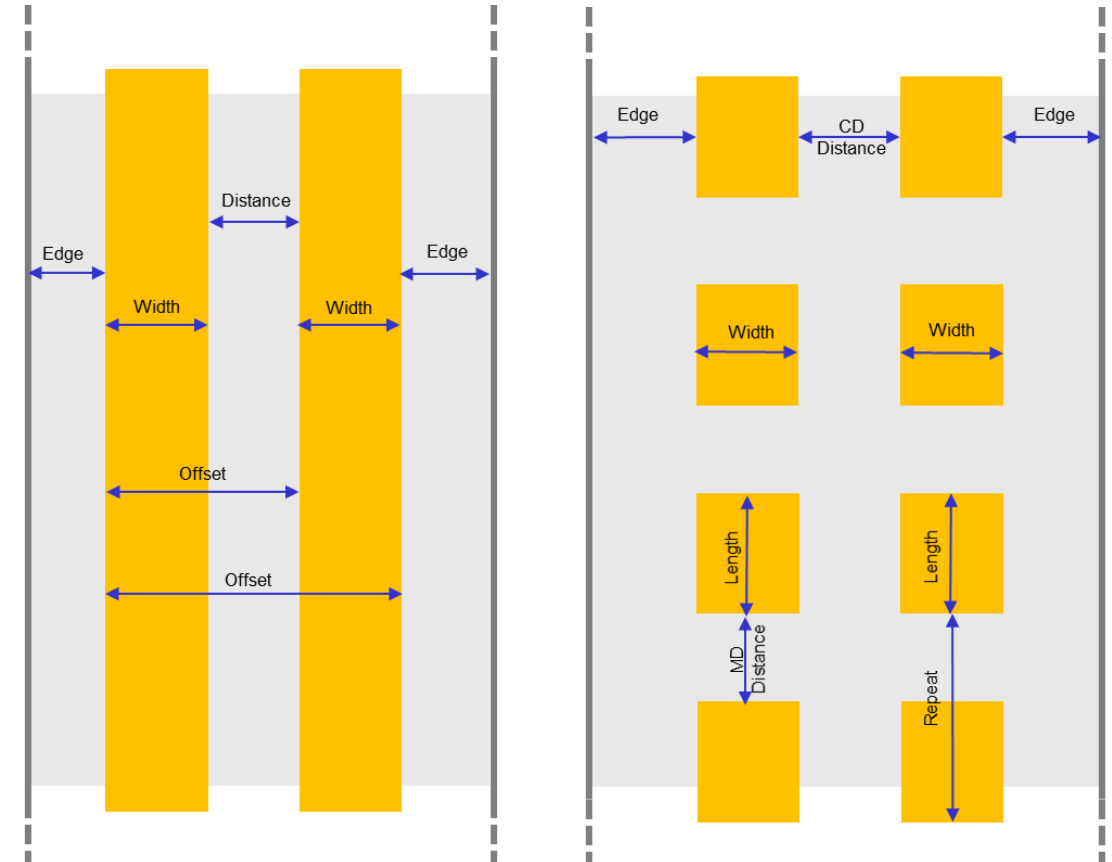
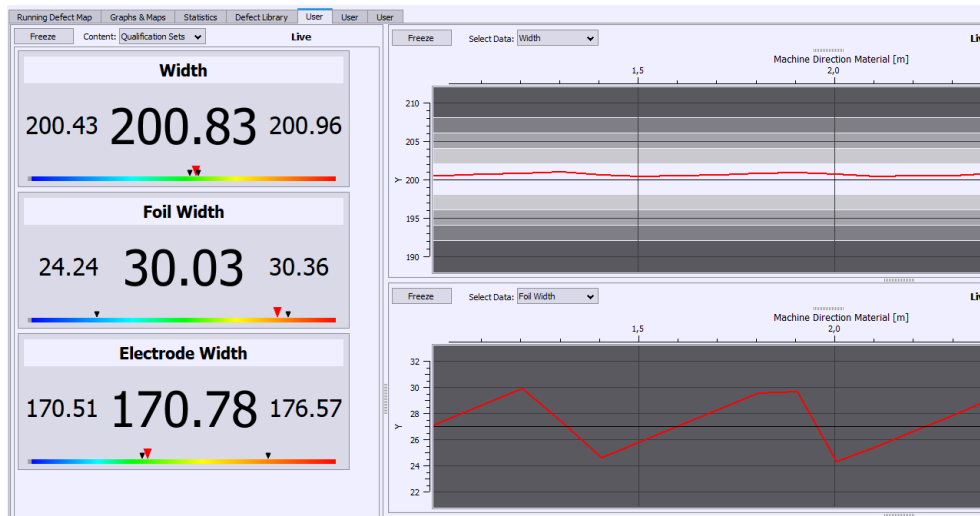
Measurement

3

Material
properties

a) Any type of measurement:

- Coating position / length / width / gap
- Top / bottom coating alignment
- Binder / insulation width & position
- Edge burr / waviness / crack analysis



One System for three inspection tasks

1

Defects

2

Measurement

3

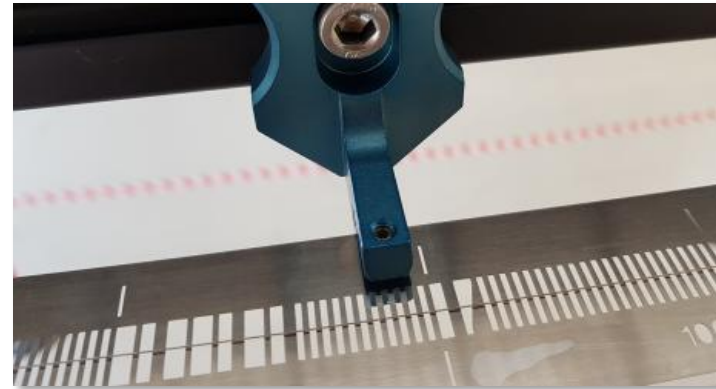
Material
properties

a) Any type of measurement:

- Coating position / length / width / gap
- Top / bottom coating alignment
- Binder / insulation width & position
- Edge burr / waviness / crack analysis

b) Calibration & Verification

- Resolution <5µm
- Closed loop calibration for verification & measurement capability (MSA)



Measurement	Reference Value	Measured Value	Valid Range
Effective Inspection Range	1285.989 mm	1285.978 mm	>= 1200.0 mm

Camera 1, R			
Measurement	Reference Value	Measured Value	Valid Range
Position left	24.215 mm	24.215 mm	Ref +/- 5.0 mm: 19.215 .. 29.215
Position right	192.105 mm	192.108 mm	Ref +/- 5.0 mm: 187.105 .. 197.105
Used Width	167.890 mm	167.893 mm	Ref +/- 1 %: 166.211 .. 169.569 mm
Min. Used Width	167.890 mm	167.893 mm	>= 165.0 mm
Overlap to Next Camera	26.210 mm	26.223 mm	>= 0.0 mm
Pixel Resolution	28 µm	28 µm	1 .. 1000 µm
Relative Focus Measurement	100 %	80 %	> 80 %
Cross Direction Bias Left	0	-0.2	-0.9 .. +0.9
Cross Direction Bias Center	0	-0.3	-0.9 .. +0.9
Cross Direction Bias Right	0	-0.6	-0.9 .. +0.9
Signal Average	128 gv	111.0 gv	Ref +/- 15.0 %: 108.8 .. 147.2 gv
Signal Maximum	255 gv	128.5 gv	<= 255 gv
Signal Minimum	0 gv	100.4 gv	>= 0 gv

Introducing
Dr. Schenk

Innovations for dry
coating inspection

Summary

- **High Speed Measurement**
- **Material Properties**
- **Multi Channel illumination**
- **Artificial Intelligence**
- **Others**

High Precision Measurement

Edge Analytics

Edge Defect Detection

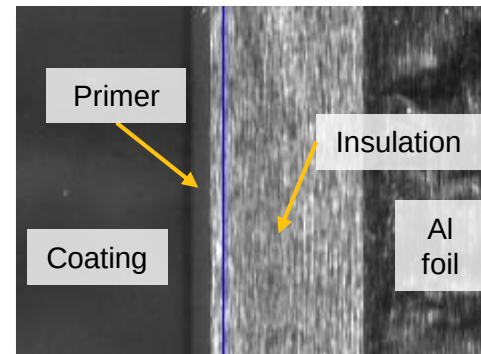
- **High speed for High precision 6µm**
 - 140 kHz for more data
 - About 200.000 measurements for 1m
- **High dynamic (12 bit)**
 - ~ 20x more then standard cameras
- **Measurement Capability**
 - E.g. $C_{gk} > 2,0$ reached

Material speed: 50 m/min

Measurement speed: 140 kHz

6 µm MD

Measurement interval



49,984		
49,979		
50,054		
49,962		
50,012	0,009	1,783
Mittelwert		2,072

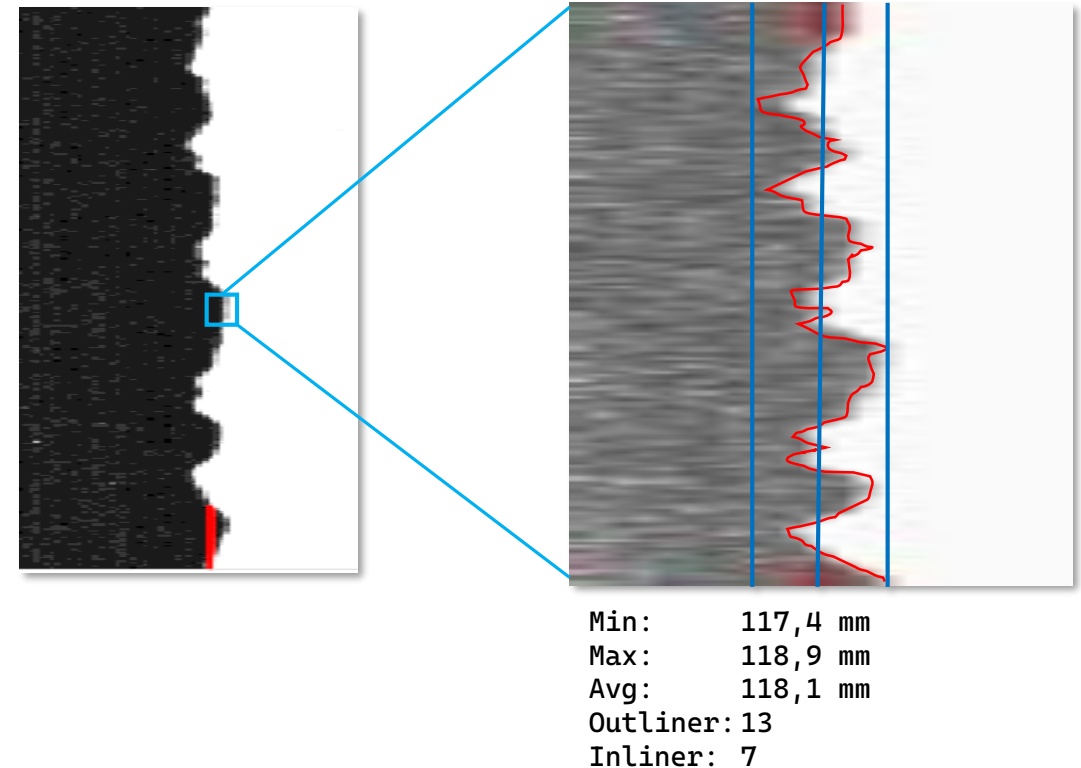
High Precision Measurement

Edge Analytics

Edge Defect Detection

- **Statistic analysis of your edge**
 - Edge smoothness / waviness, etc.
 - Min / Max / Average value
 - Number of Out-/Inliner
- **Highly precise results**
- **Meaningful and robust results**
- **Detect deviation before they become critical**

benefits

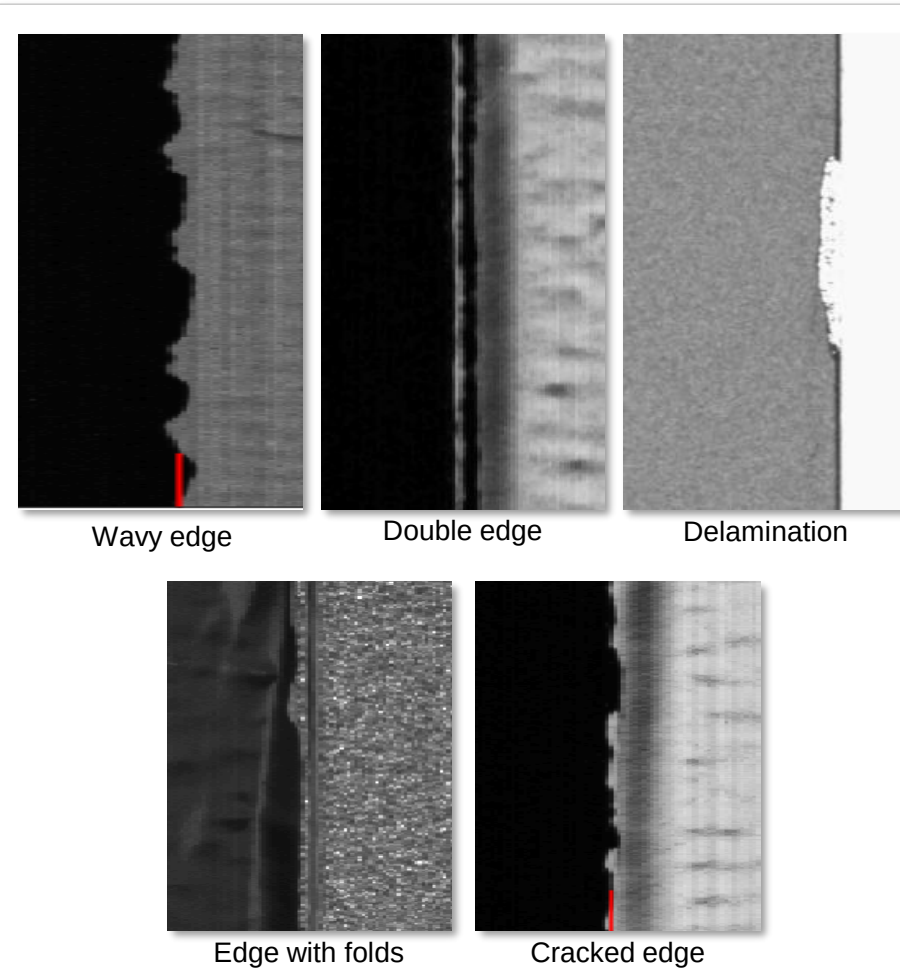


High Precision Measurement

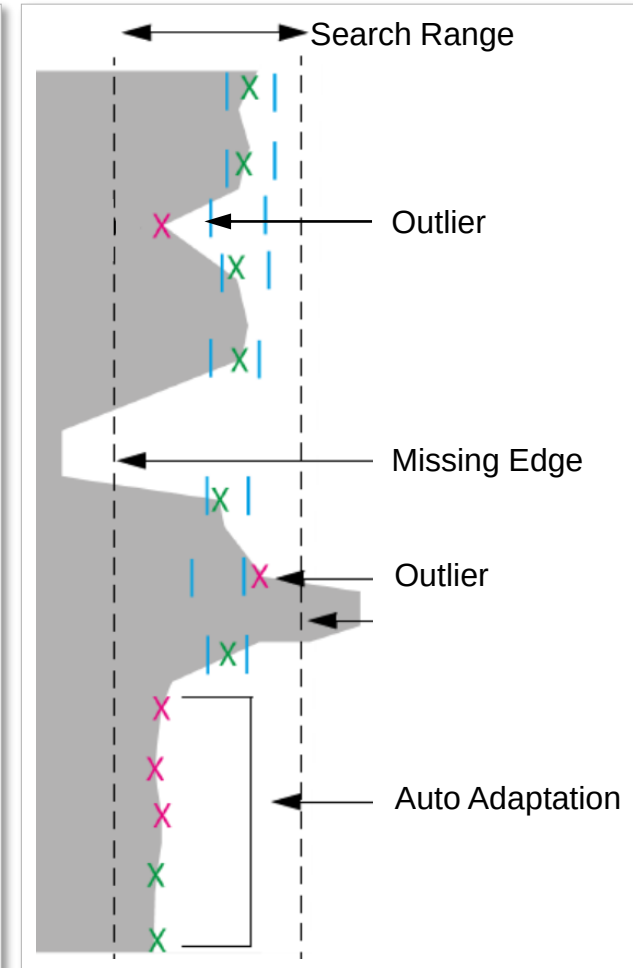
- **Detection of edge defects**
 - Wavy / Double / Missing edge
 - Cracks / Delamination
 - Folds / Burr
 - Outliers / Inliners
- **Very sensitive:** down to 1-2 pixel
- **Flexible setup:**
 - Automatic search range
 - Automatic Adaptation
- **Very robust**
- **More reliable defect detection**
- **Detection of smallest defects**

benefits

Edge Analytics



Edge Defect Detection



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Summary

- **High Speed Measurement**
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1

Defects

2

Measurement

3

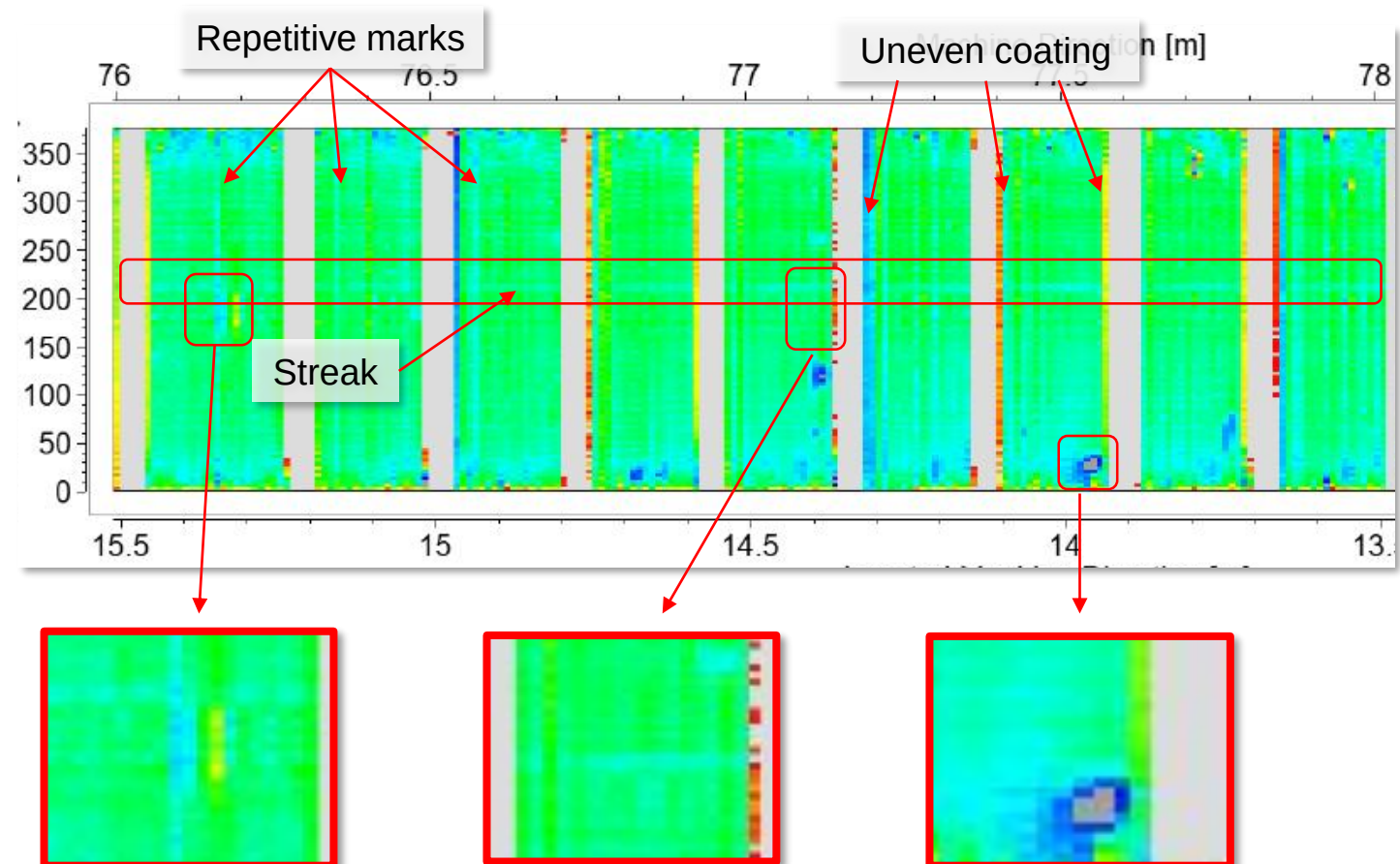
Material
properties

Typical Properties

- Coating thickness variations
- Coating roughness, porosity
- Homogeneity, waviness
- etc,.....

- Sensitive to any deviation
- 100% inspection of full width
- Running with production speed

benefits

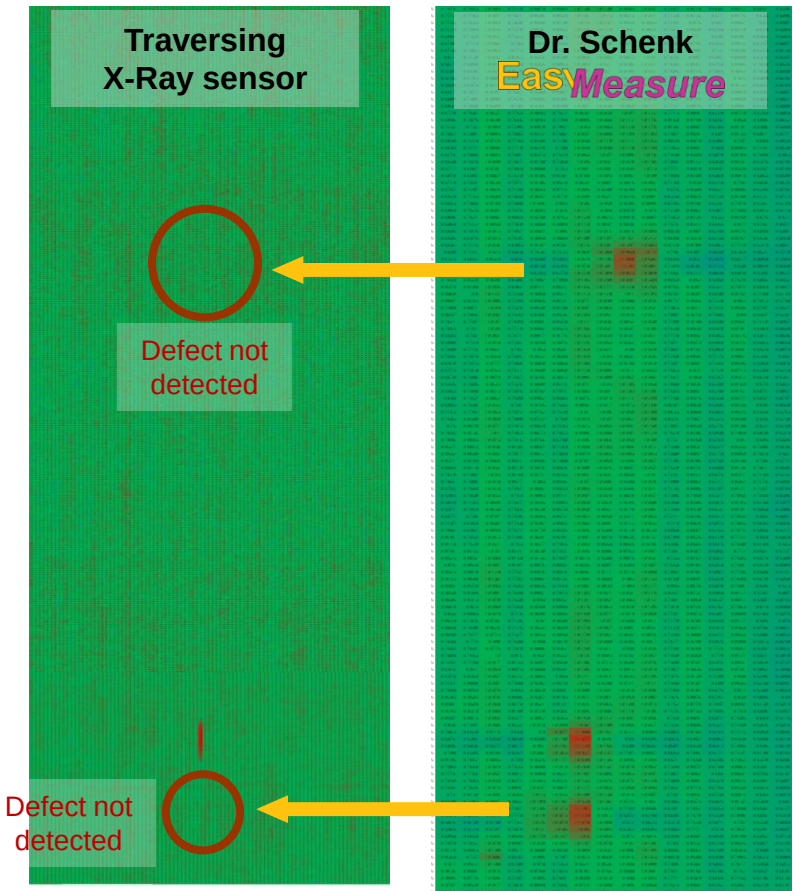


1 Defects

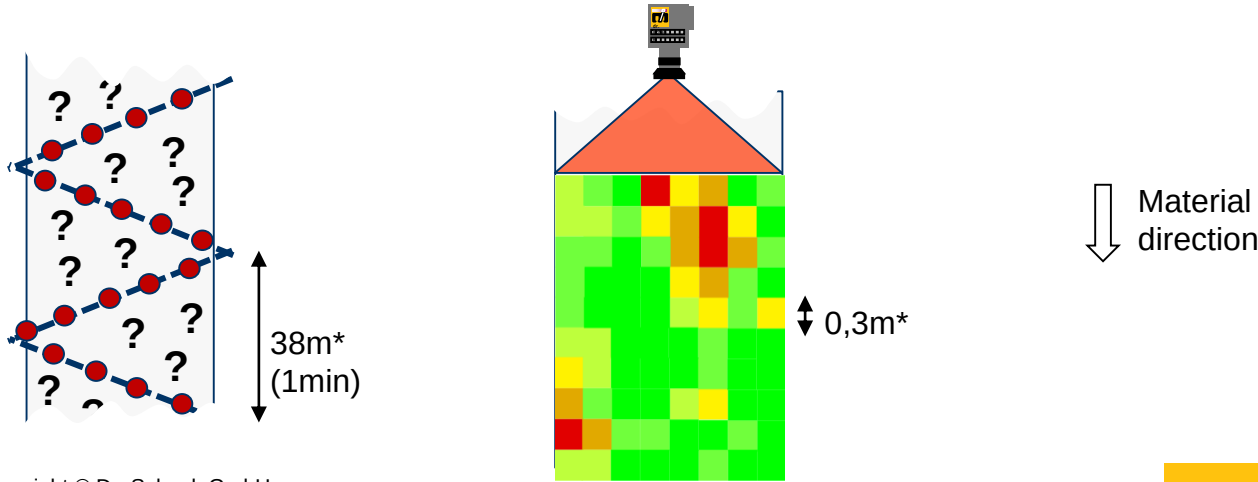
2 Measurement

3 Material properties

Comparison Dr. Schenk Material Properties with Traversing Sensor



Traversing sensor	Dr. Schenk Material Properties
<2% of surface inspected	100% inspection
Only traversing spot measurement	Full surface
Thickness & base weight	Any surface change, homogeneity, roughness, thickness, ..
High sensitivity	High sensitivity
High local resolution	Low local resolution
Absolute results	Relative results (deviation)



1

Defects

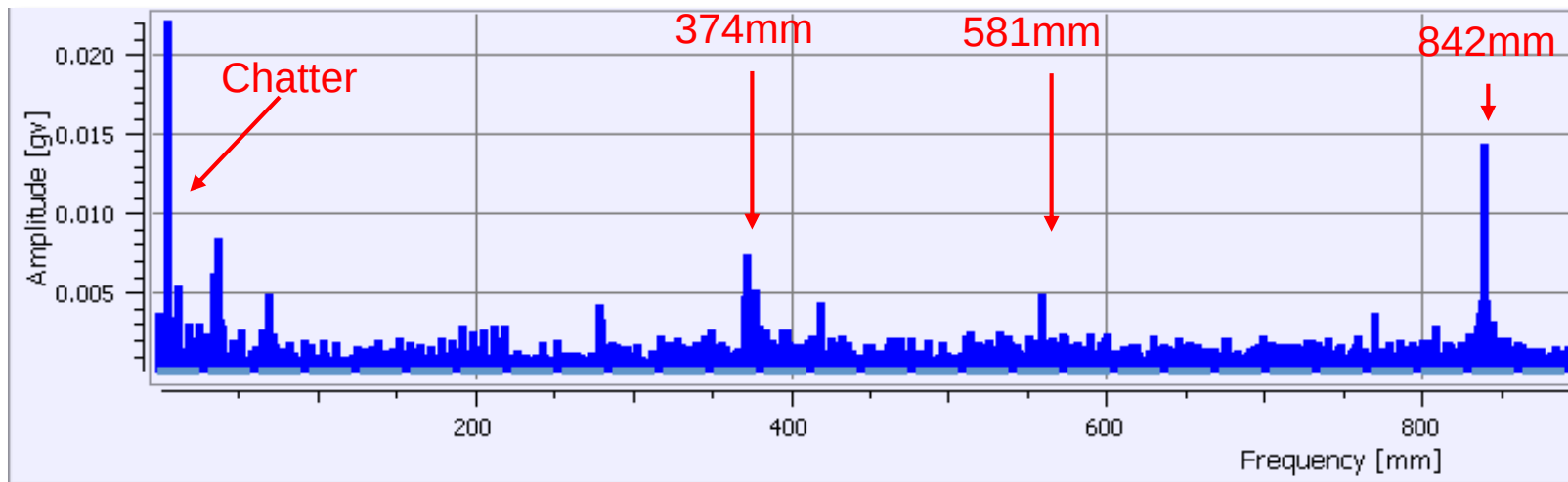
2

Measurement

3

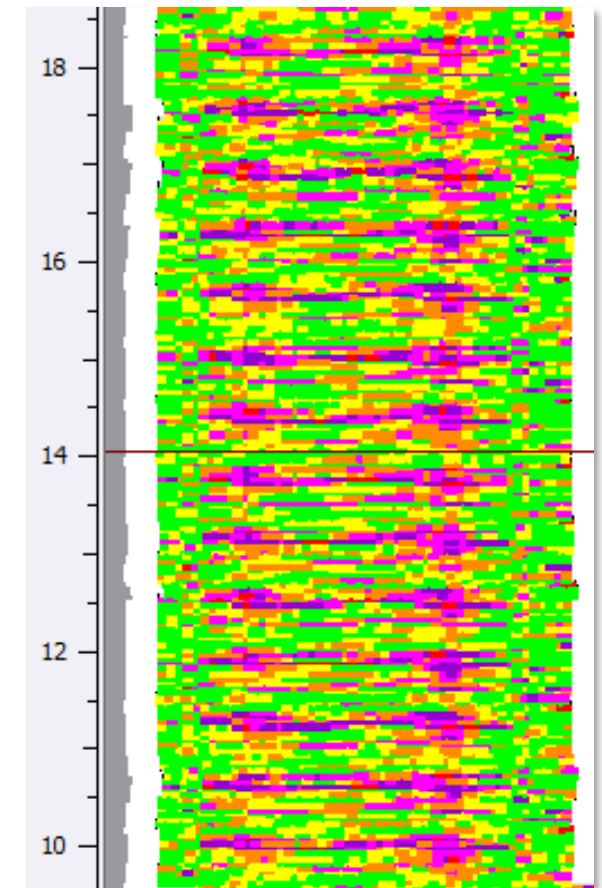
Material
properties

Example: FFT



- Can detect chatter and other vibrations in the system or coming from material
- Highly sensitive: Detects of extremely small changes (down to 0.005 gv)
- Early detection of problems with individual rollers

benefits



Introducing
Dr. Schenk

Innovations for dry
coating inspection

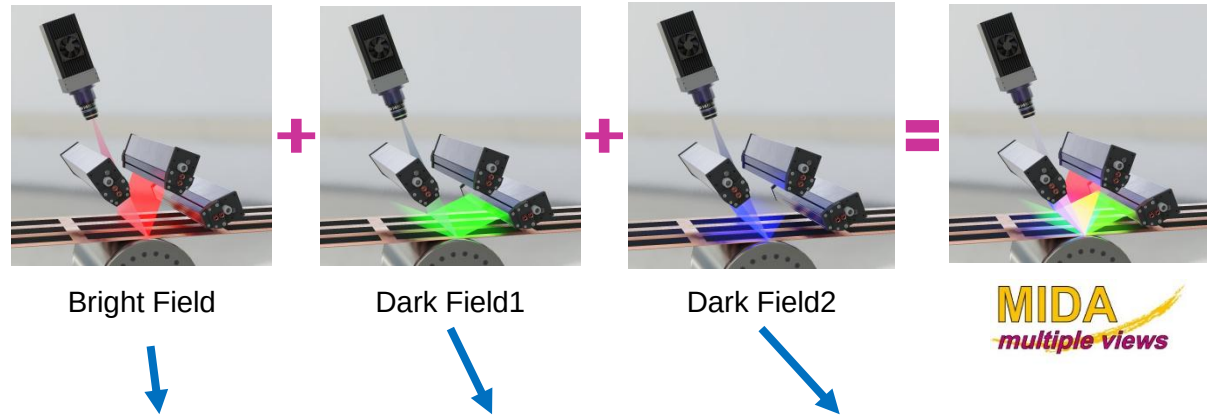
Summary

- **High Speed Measurement**
- **Material Properties**
- **Multi Channel illumination**
- **Artificial Intelligence**
- **Others**

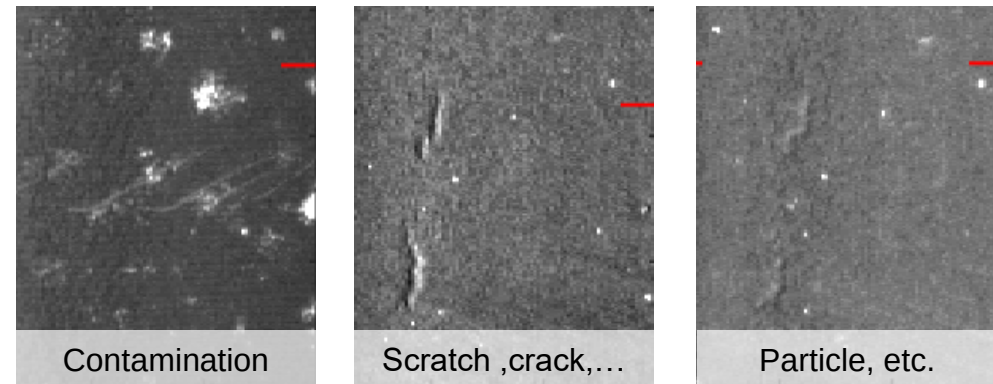
Multi Channel illumination

MIDA – Multiple Image Defect Analysis

- Combine multiple channels in one inspection station
- Illumination switches up to 280,000 times per second
- Up to 4x more information for better inspection**
 - Multi-Angle: e.g. Bright/Dark Field
 - Multi-Spectral: e.g. combine visible and IR
 - Multi-Intensity: different brightness for coating / Al-foil
 - Shape from Shading: calculate 3D and texture image



Distinguish reliable between different kind of defects, e.g....



Different defects in the same image area: only visible with Multi Channel illumination

- Up to 4x more image information**
- Safe detection - reliable classification**
- Multi-functional**
- Small footprint**

benefits

Introducing
Dr. Schenk

Innovations for dry
coating inspection

Summary

- **High Speed Measurement**
- **Material Properties**
- **Multi Channel illumination**
- **Artificial Intelligence**
- **Others**

Innovations for dry coating inspection: AI

Modular AI

High Speed
Detection (AIMI-D)

High Speed
Classification (AIMI-C)

Different AI's optimized
for specific demands...

AIMI SCD

MIDA X

AIMI C

C5

AIMI D

Threshold

... to combine AI's for your
individual application

Threshold

+

C5

Threshold

MIDA X

+

C5

AIMI SCD

AIMI D

+

AIMI C

- Very flexible – growth with you demands
- Future proof – add the latest developments

benefits

Innovations for dry coating inspection: AI

Modular AI

High Speed Detection (AIMI-D)

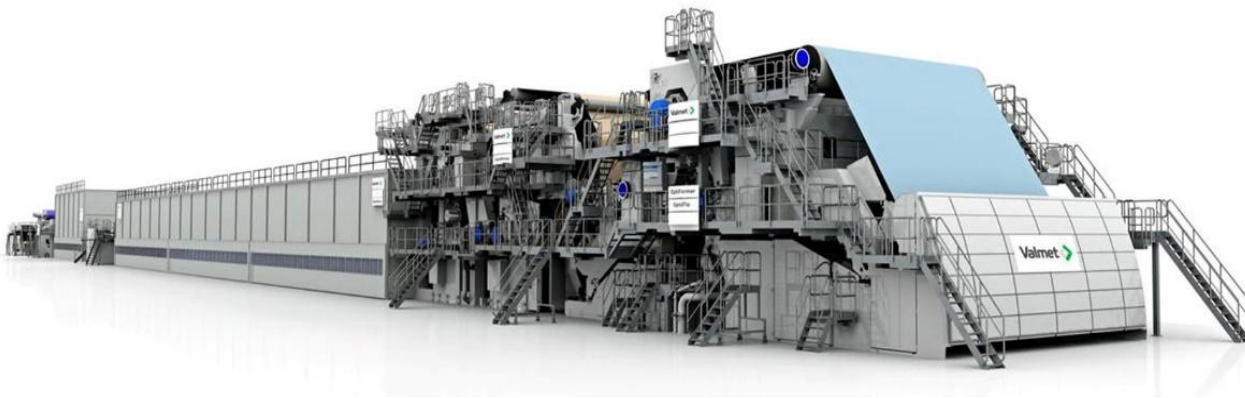
High Speed Classification (AIMI-C)

Example: Paper production

- Width: 12 m
- Resolution: 150 μm
- Speed: 120 km/h
- Cameras: 3

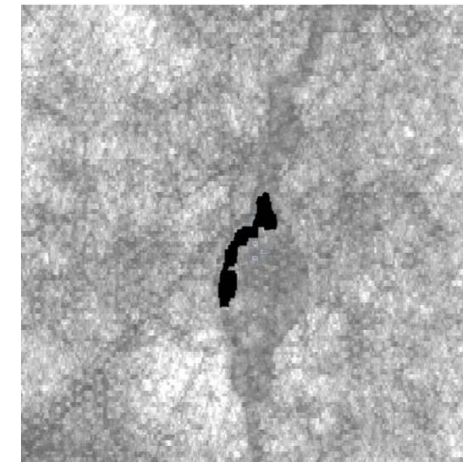
Data to process: 360 Gbit/s

- 1.2 million more than TV HD video rate (0,3 Mbit/s)

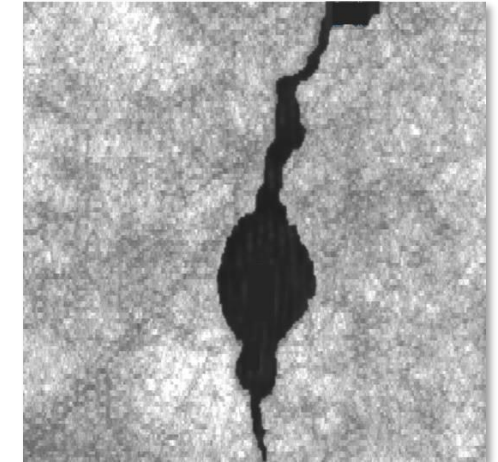


Dr. Schenk solution

- In-Camera AI processing
- Only one PC for data management



Without AI



With AI

Innovations for dry coating inspection: AI

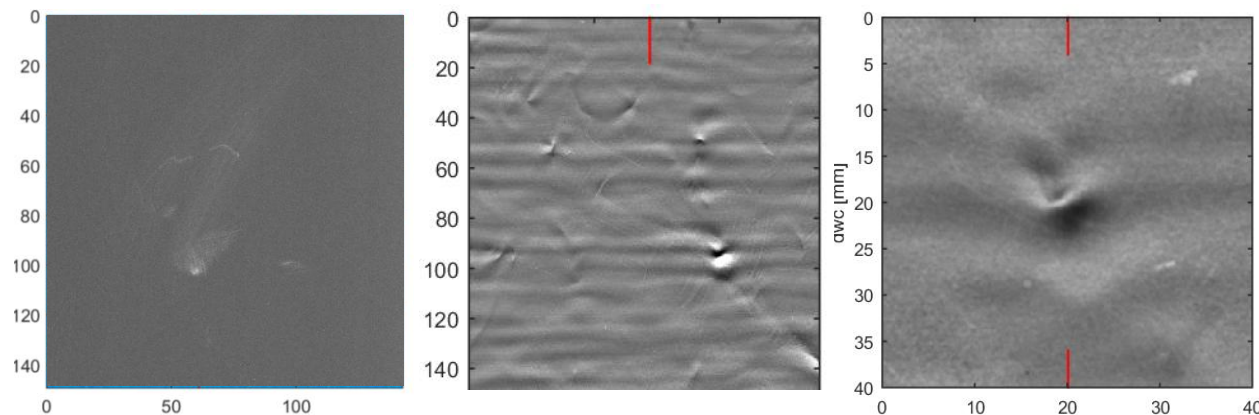
Modular AI

Features:

- Proven 100% defect **detection**
- Extremely fast (up to 2.5 Mio defects/s)
- Only some pictures needed for training

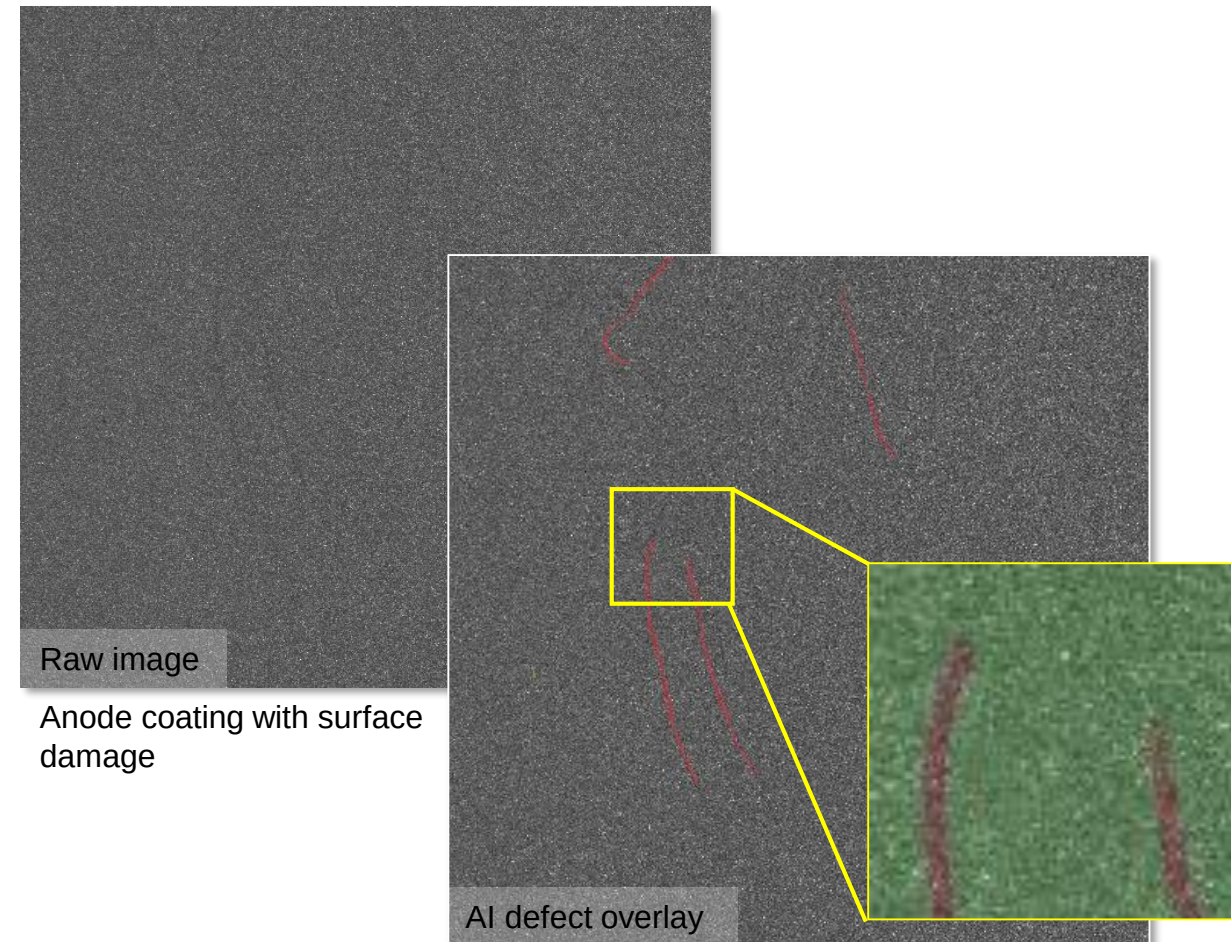
Typical defects:

- Folds, Bump, Dents, ...
- Contamination, Smear, ...



High Speed Detection (AIMI-D)

High Speed Classification (AIMI-C)



Modular AI

Features:

- Most reliable **classification**
- Enormous computing power for complex AI models
- Combine
 - Multi-Channel illumination
 - With high end AI models

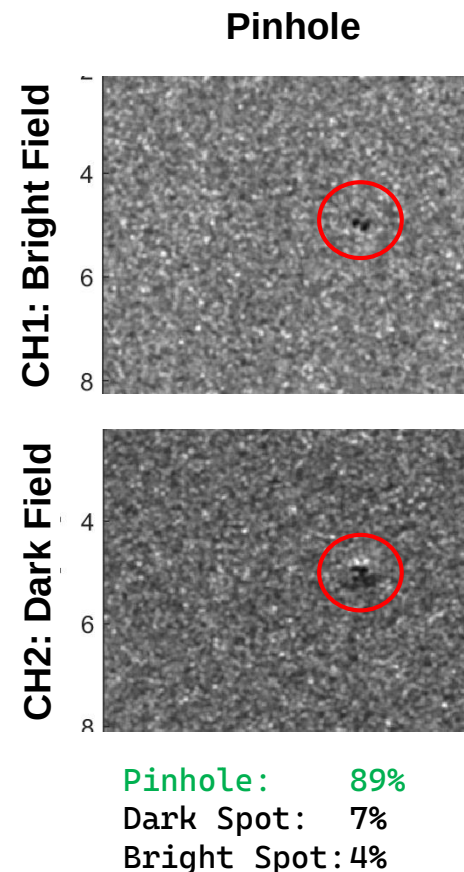
Distinguish between:

- Pinhole, particle, different kind of contamination, foil exposure, ...

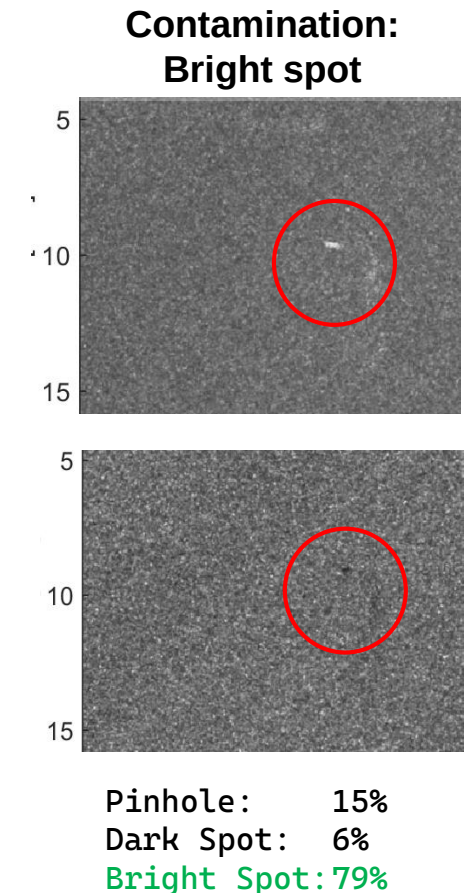
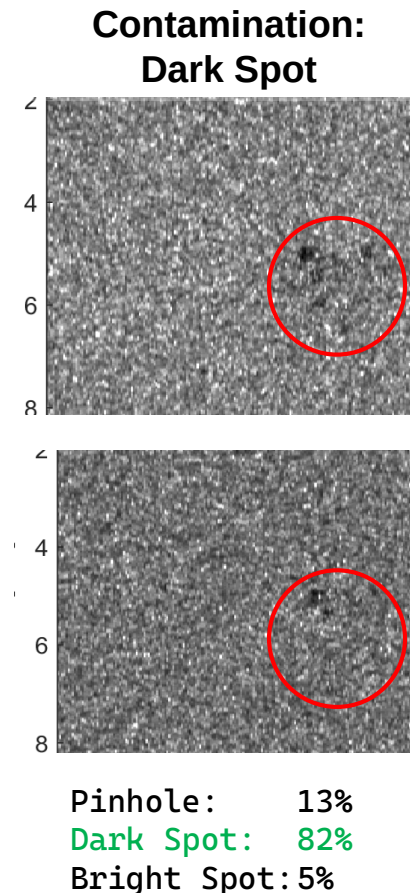
Advantage

- Classification rate >99,9%
- Less training data

High Speed Detection (AIMI-D)



High Speed Classification (AIMI-C)



Introducing
Dr. Schenk

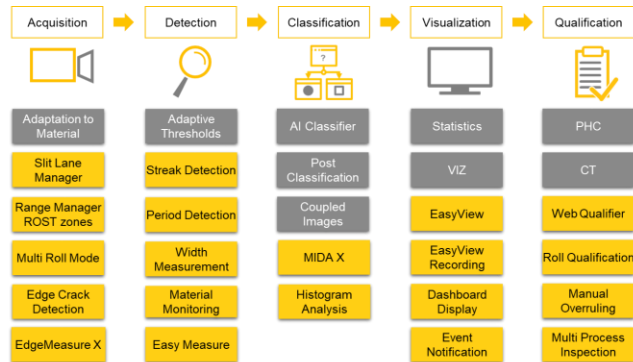
Innovations for dry
coating inspection

Summary

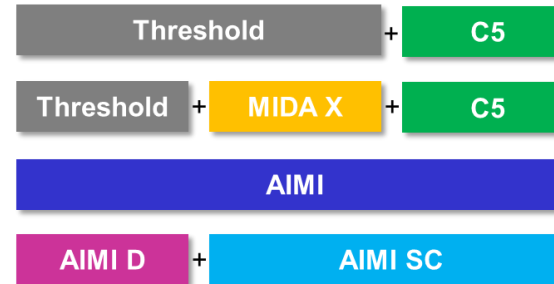
- **High Speed Measurement**
- **Material Properties**
- **Multi Channel illumination**
- **Artificial Intelligence**
- **Others**

Innovations for dry coating inspection

Software for every imaginable application



Powerful, modular AI



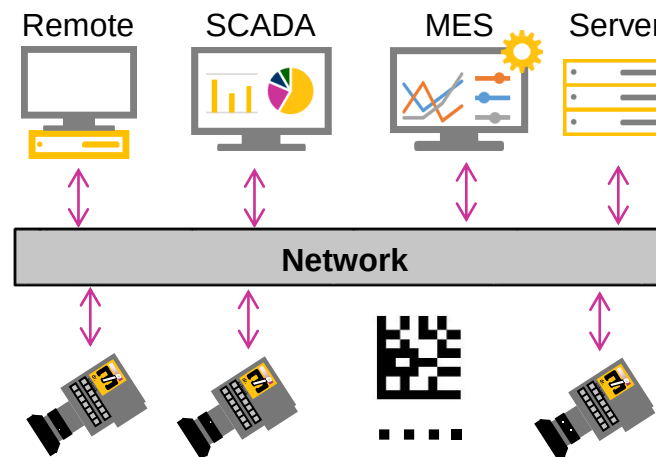
Highest reliability and security



Open Data Access



Connectivity & Tracing



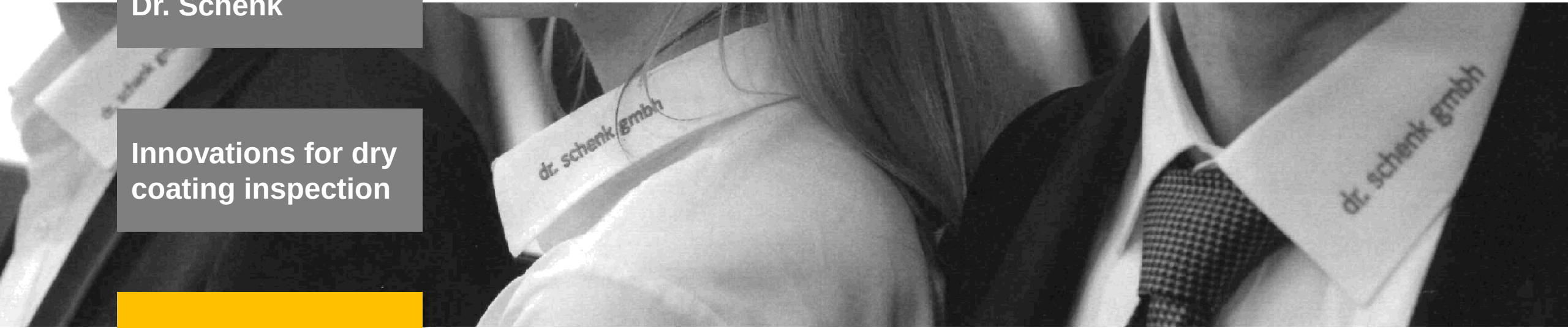
Extensive analysis options



Introducing
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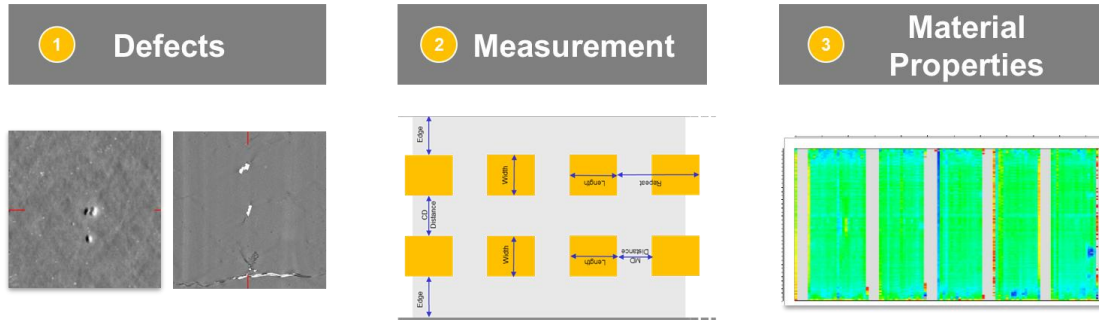
Innovations for dry
coating inspection

Summary

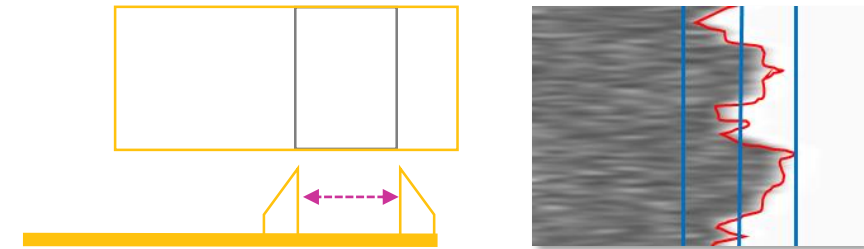


Remind me...

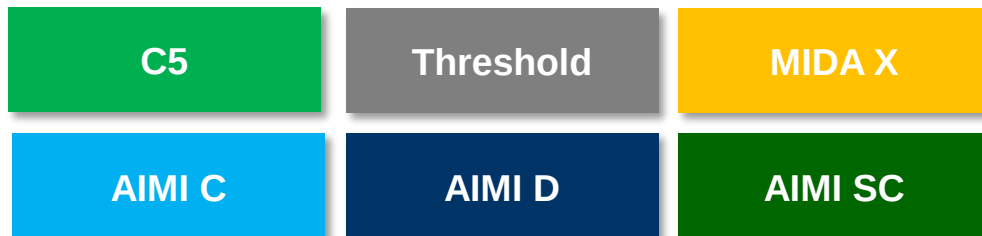
One System for three inspection tasks



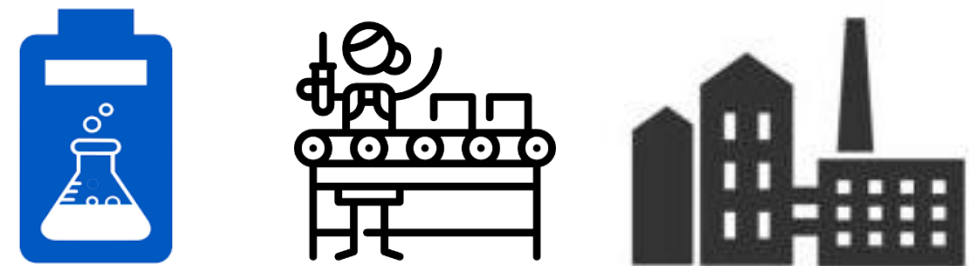
High Precision & High Speed Measurement



Modular, High Speed AI for individually optimized inspection



One System for Lab, Pilot- and Mass production





www.drshenk.com



www.drshenk.com/events/event-list.html



www.drshenk.com/contact.html



www.linkedin.com/company/dr-schenk-gmbh-industriemesstechnik



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