

IMS MESSSYSTEME GmbH
World Market Leader in Measuring Systems

IDS - Inclusion Detection System

Complete inspection for non-magnetic inclusions and impurities



Agenda

- 1 Introduction
- 2 Inclusion Detection System
- 3 Summary

Facts and Figures

IMS Messsysteme GmbH

- Founded 14 January 1980
- Headquarters in Heiligenhaus, North Rhine-Westphalia
- About 460 employees worldwide
- About 380 employees in Heiligenhaus
- 9 international subsidiaries



4500+
Measuring Systems
in use

750+
Customers

60+
Countries



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- 2 Inclusion Detection System
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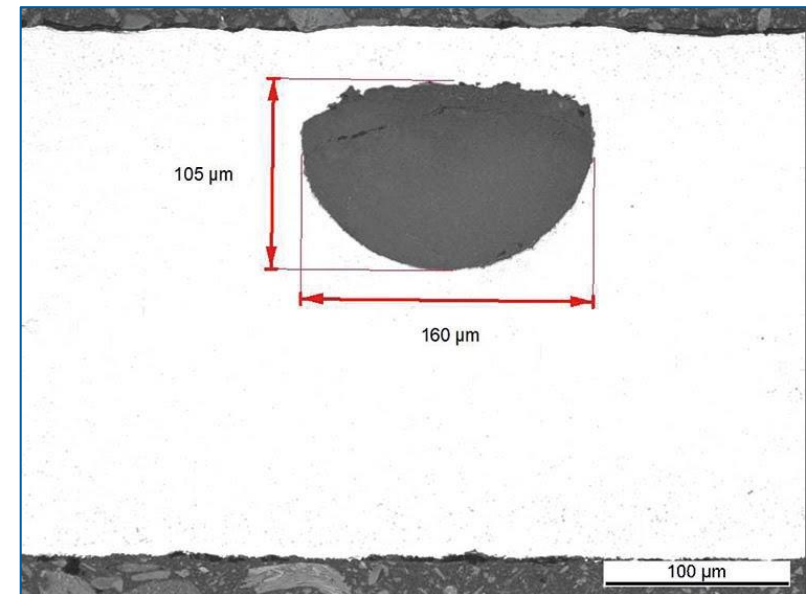
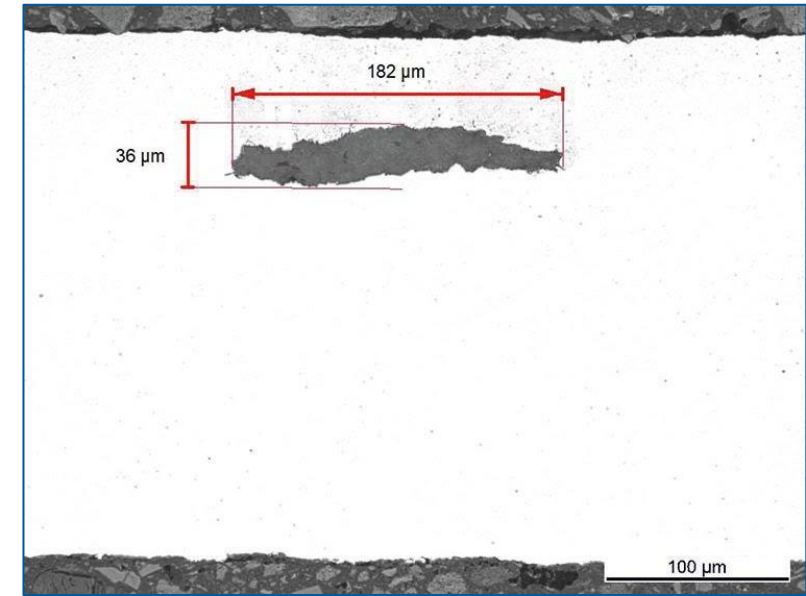
Non-Metallic Impurities (NMI)

Challenge

- Tin plate can contain non-metallic impurities like inclusions and segregations
- NMIs can cause problems during the further processing, especially during deformation
- May lead to ruptures in applications involving high deformation ratios, e.g., beverage cans
- Inclusions are sub-surface and cannot be detected by optical inspection



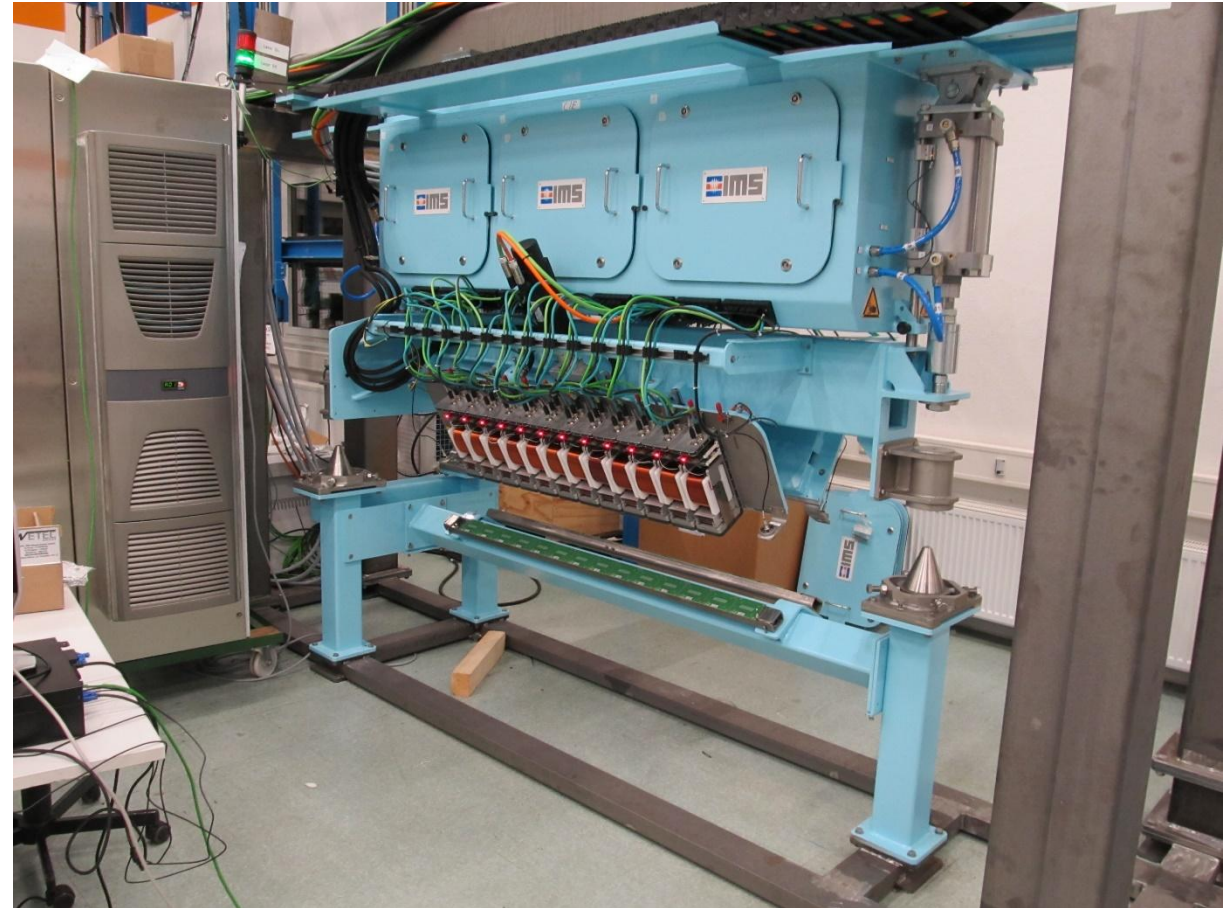
- Mostly oxides of metals like calcium or aluminum
- Deformation by rolling into elongated shapes
- Typical default defect: Inclusion with 1 mm length, 100 μm width and 10 μm length



IDS – Inclusion Detection System

Development

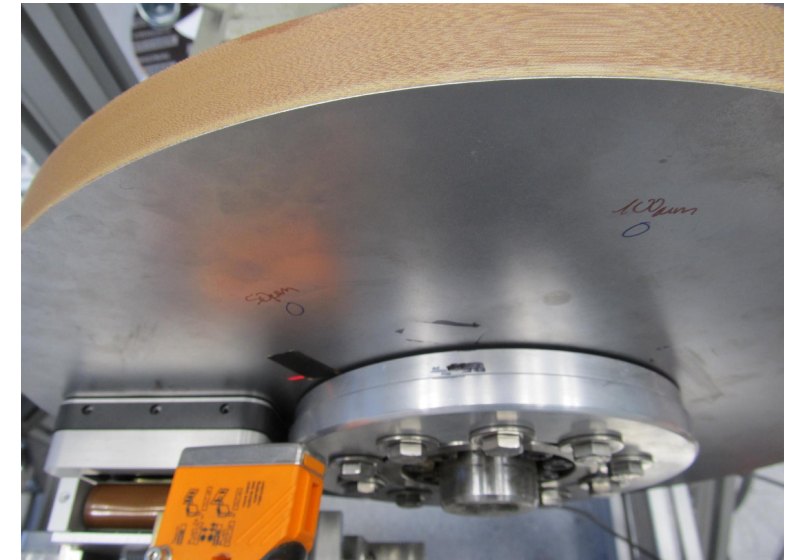
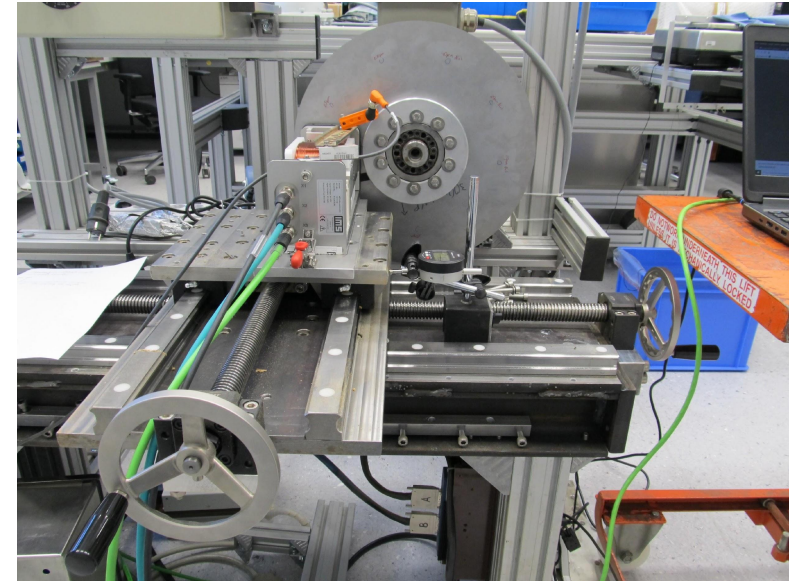
- IMS developed an online inspection system for NMIs based on magnetic flux leakage
- Sensors are incorporated into a compact device acting as a MFL line camera
- Can be combined in different configurations, enabling a gap-free coverage of inspected strip



Development

Laboratory Setup

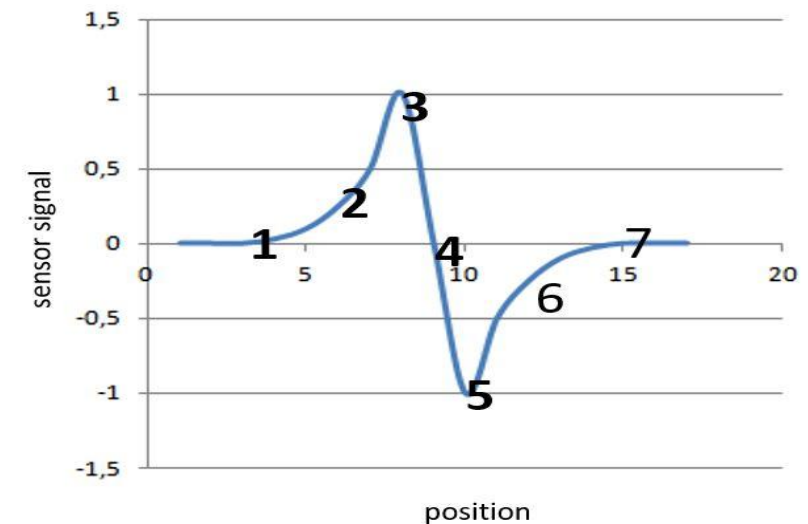
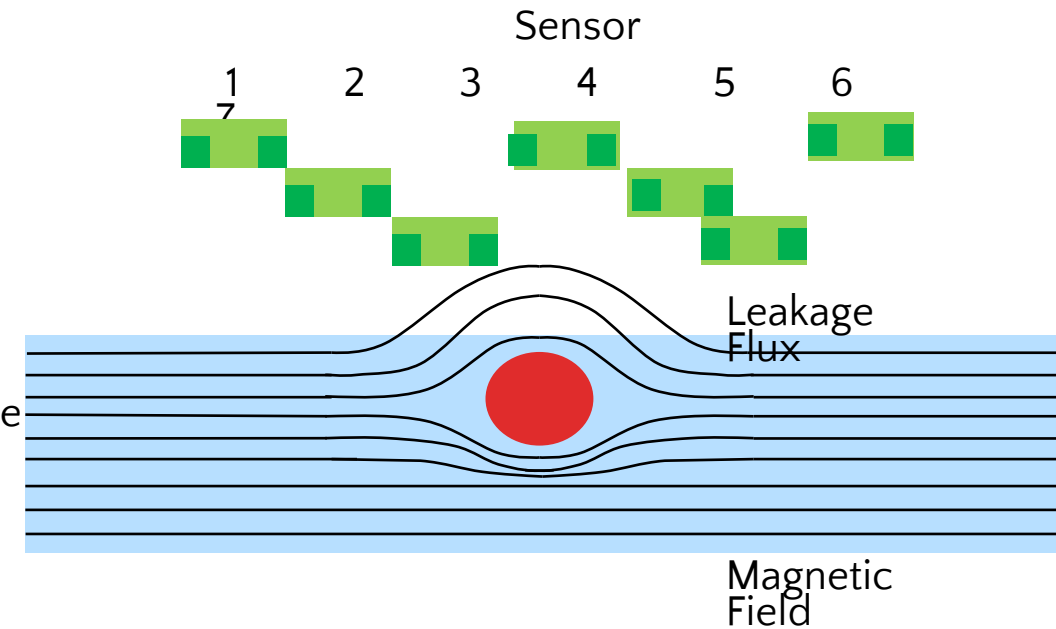
- Material speed simulation is implemented by fixing round plate samples to precisely faced discs
- The discs are rotated by a VFD-controlled motor
- A cross table is placed in front of the discs surface for precise sensor placement
- Customer samples with natural or artificial defects can be examined



Principle of Measurement

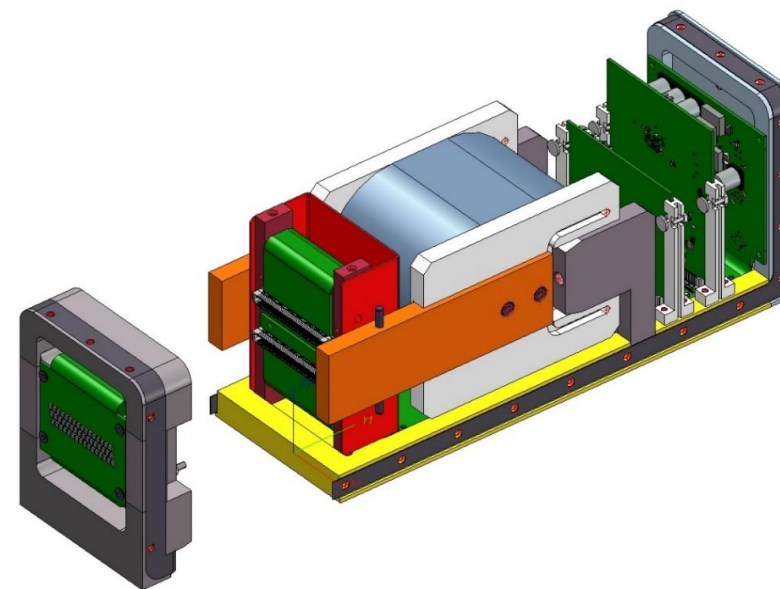
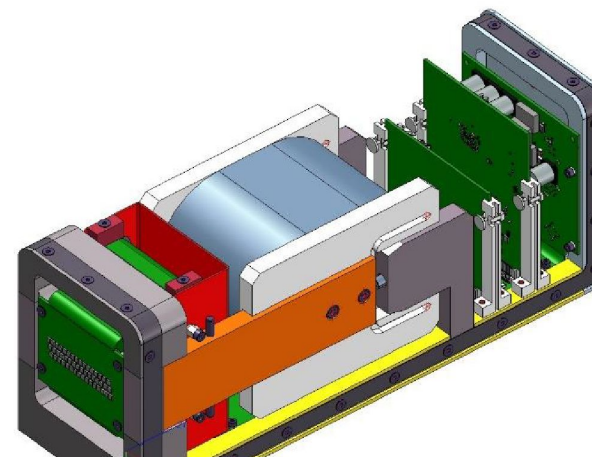
Magnetic flux leakage

- Variation in the magnetic cross-section of a magnetically saturated material causes a flux variation on its surface
- Most defects are non-magnetic, making this approach suitable
- MFL is widely used in form of magnetic powder testing
- IMS Messsysteme developed a measuring system based on GMR-Sensors, enabling complete online MFL inspection
- Compared to similar systems, the liftoff to the inspected material is increased making the system less vulnerable, while sensitivity is improved



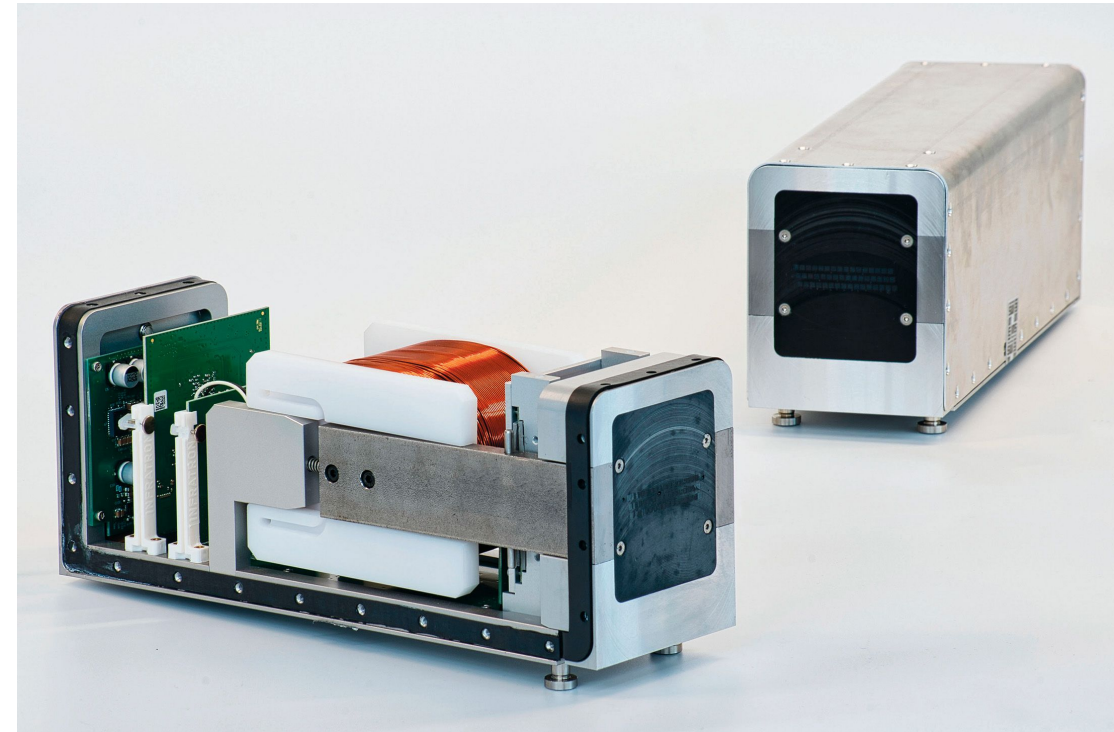
Sensor Modules

- 48 GMR-Sensors in one sensor module
- Spatial resolution is 1 mm
- Total width of a module is 95 mm
- 2 lines of modules are sufficient for full coverage
- Variable sampling rate of up to 200 kSa/s, sufficient for 1000 m/min strip speed
- Protected sensor block, easily exchangeable in case of damage



Sensor Modules

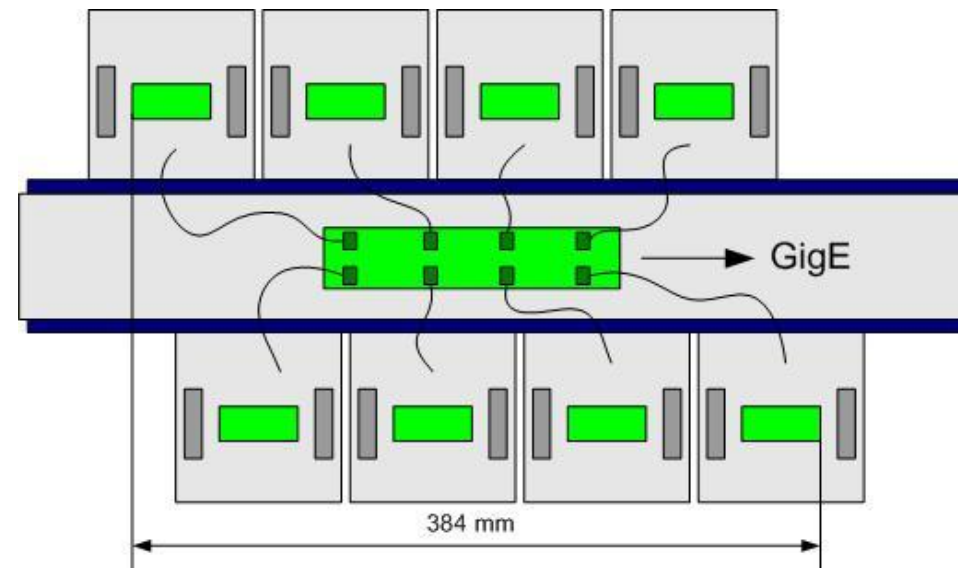
- Protected sensor block, easily exchangeable
- No mechanical adjustment needed after change
- Magnet can be turned off for cleaning and safe maintenance
- Dust- and spray-water-proof



Module Configuration

Aggregator Hub

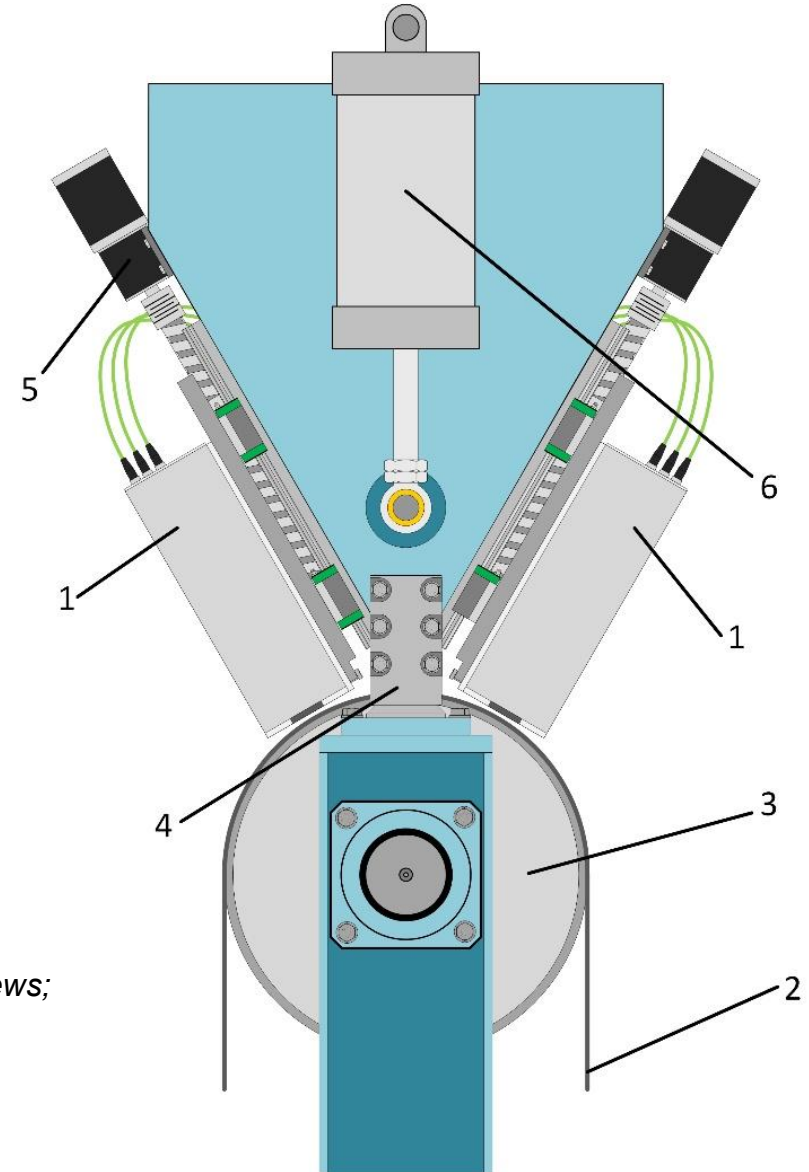
- Sensor modules arranged in two rows
- Max. 8 modules are combined to one group
- Each group covers a width of 384 mm
- Each group represents a MFL Line Scan Camera with GigE connection
- Min. 20 mm/max. 65 mm. at both strip edges are not covered by sensors



Contact-Less Inclusion Detection

- Installation on roll – close to the surface but without contact
- Precise liftoff adjustment by ball screws and servo drives
- Adapts to variable material thickness
- Liftoff is controlled by capacitive sensors
- Fast pneumatic retraction to prevent collisions

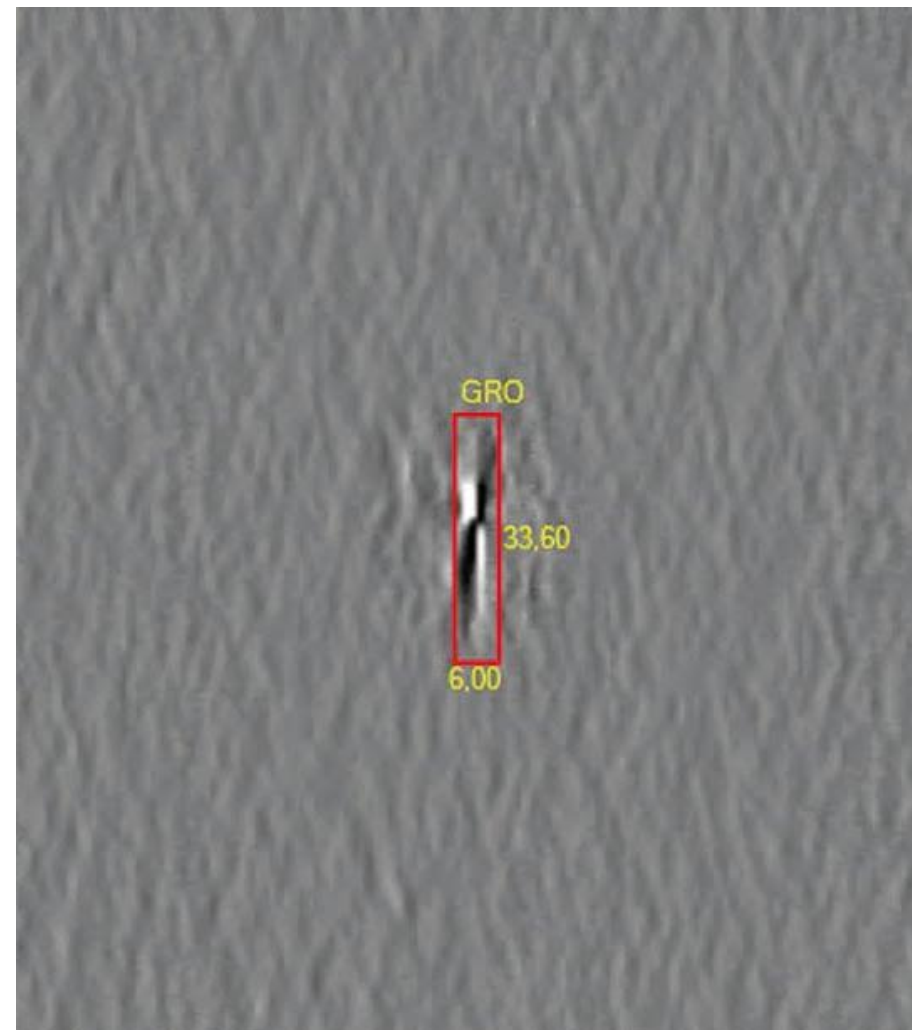
*1: sensor modules; 2: measured strip;
3: support roll; 4: pilot pin;
5: fine adjustment with servo drives and ball screws;
6: fast retraction by pneumatic cylinders*



IDS – Inclusion Detection System

MFL – Line Scan Camera

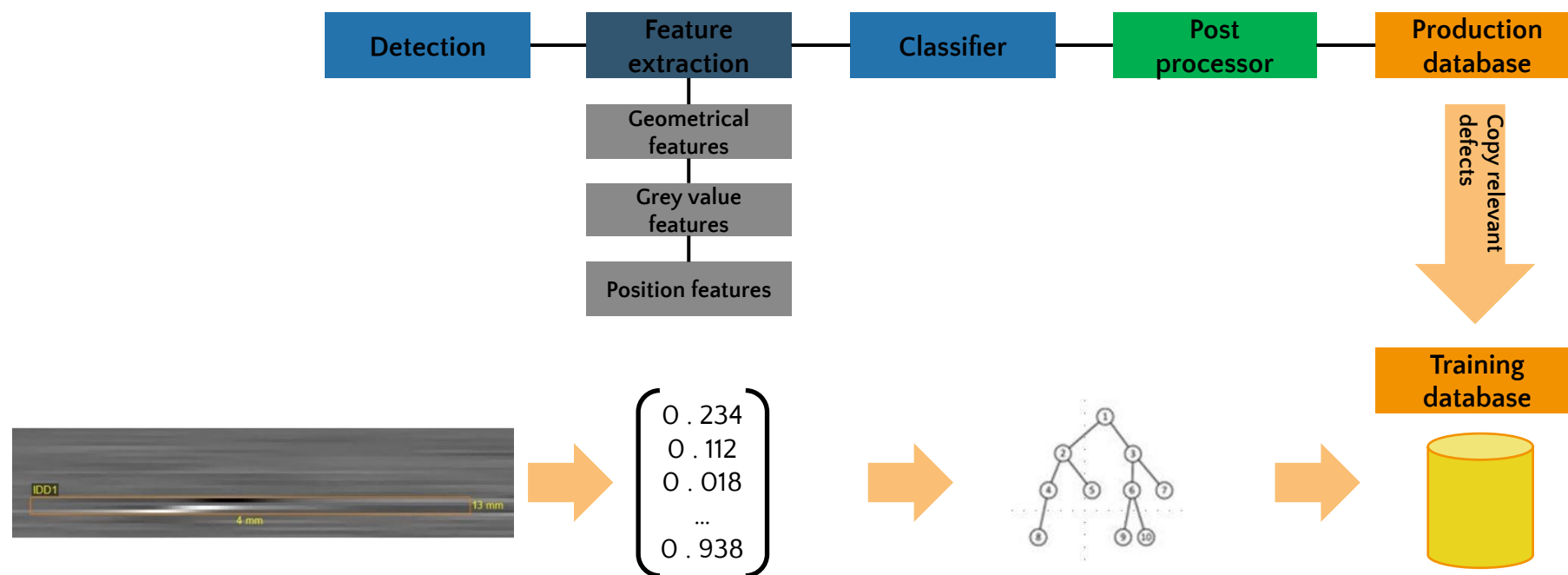
- Sensor output is recorded along the length of the strip
- Result can be interpreted as line scan image
- Exemplary image of a detected defect



Combining Experience: IDS + IMS Inspection Technology

MFL – Line Scan Camera

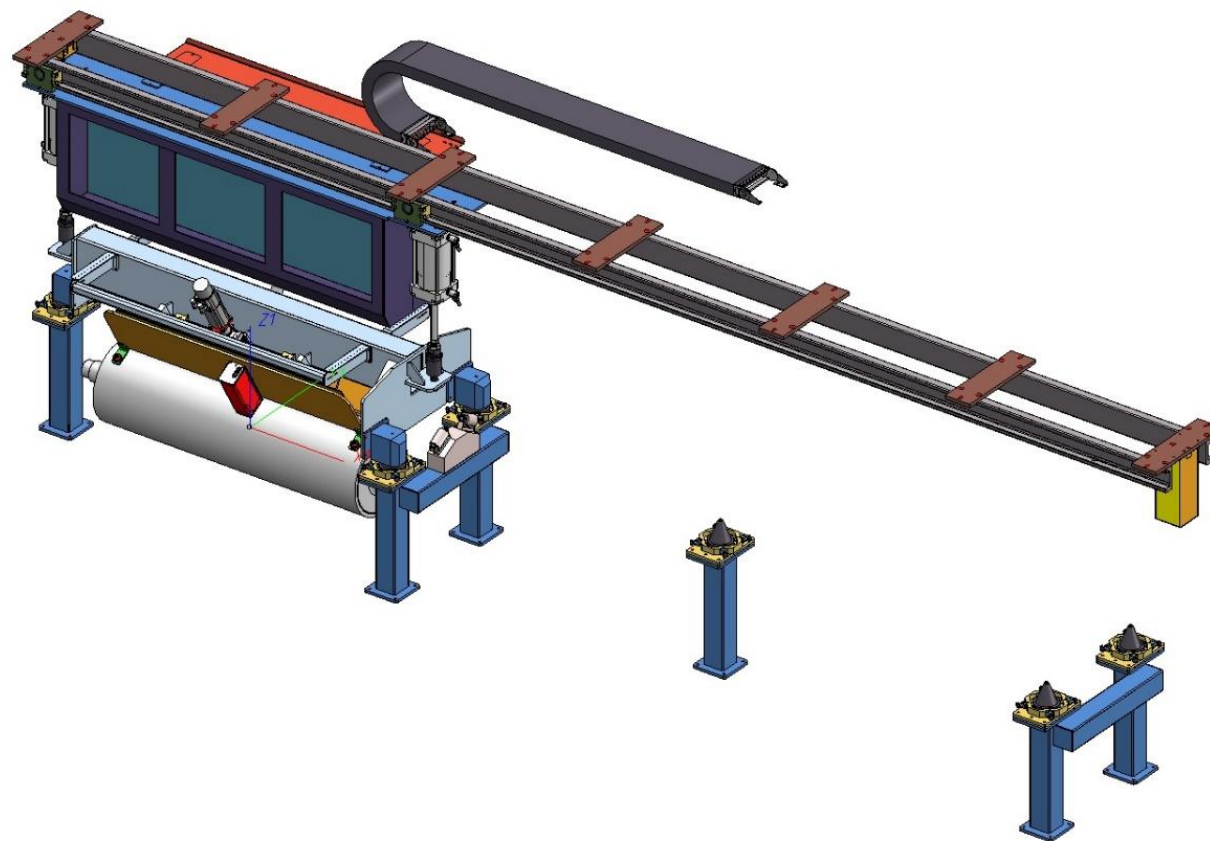
- Images are evaluated by the IMS surface inspection software
- IDS uses all the features of IMS inspection technology - developed for surface inspection systems



IDS – Inclusion Detection System

Easy Maintenance

- System can be completely driven out of line for maintenance
- Features automatic cleaning
- In park position, all sensors are automatically equalized
- Easy module mounting and dismounting

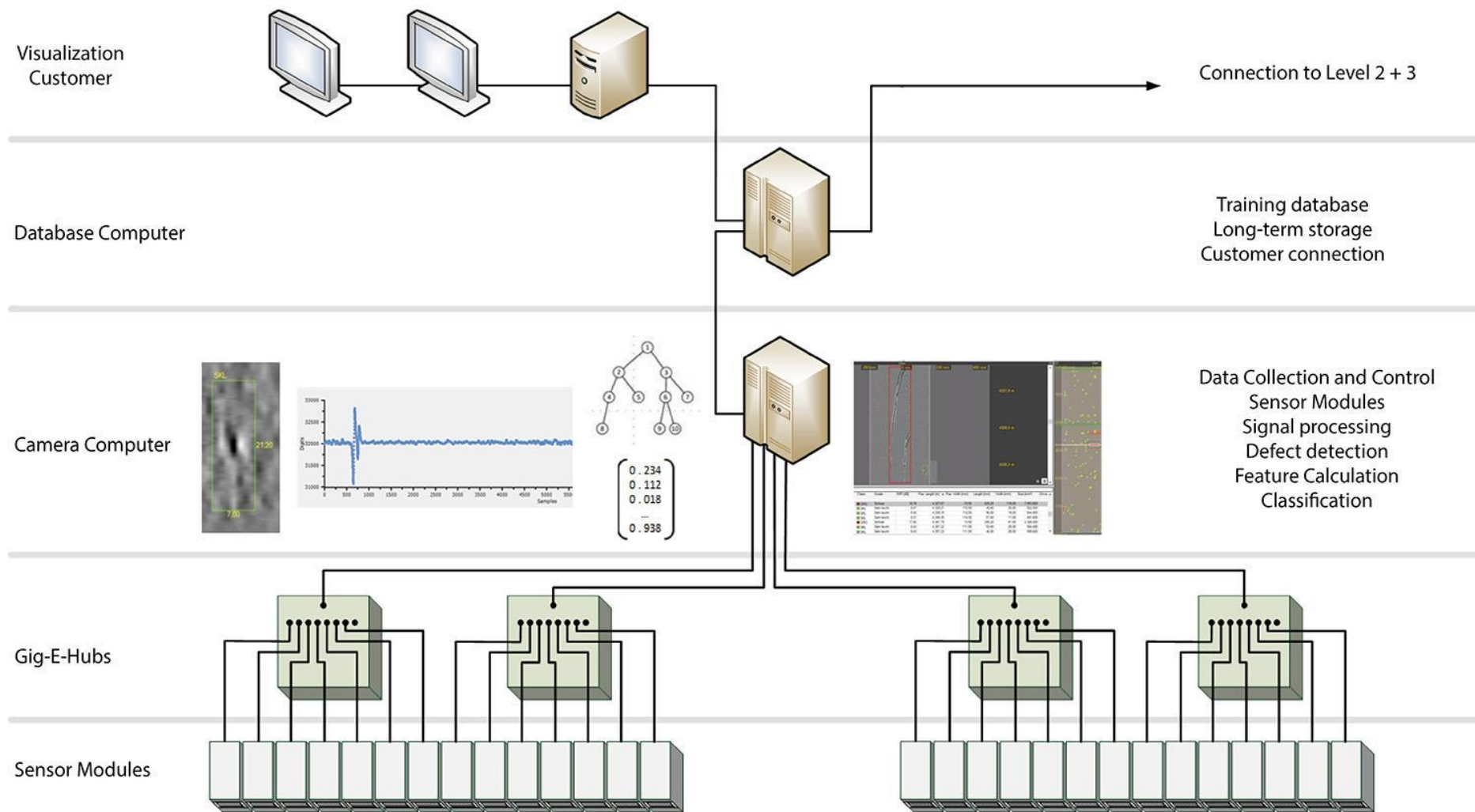


Measuring System

Requirements

Material	Cold Rolled Ferromagnetic Steel
Thickness	0,12 – 0,35 mm (Tin Plate) 0,3 – 1 mm (Colled Rolled Steel)
Speed	10 m/s
Defect Size (LxWxH)	1 mm x 100 µm x 10 µm
Liftoff	app. 0,5 mm
NIMI Material	Air SiO ₂ AL ₂ O ₃ AL ₂ O ₃ CaO
Roughness	Ra < 1,5 µm

Fully Integrated Online System



Sample: Large Scale Defect

IMS VisionLab (x64) - inspector.main.vlp

Application Settings Benutzer Diagnostics Nachbearbeitung Ansicht Fehler Werkzeuge Berichte Schnellstart Strg+F

Side: Top

Top

DS -240 mm -180 mm -120 mm -60 mm 0 mm 60 mm 120 mm 180 mm 240 mm 300 mm DS

3701,28 m SKL SKL 95,20 78,00 41,00 236,80 244,00

3701,34 m

3701,40 m

3701,46 m

0 m-400 mm 0 mm 400 mm

1550 m

3100 m

4650 m

6200 m

7750 m

9300 m

Top

DS

Top

DS

Status	Coil ID	Started	Count	Noml Width	Width [mm]	Nor
17 Inspected		2020-12-02 15:23:48	1319	968,00	991,08	9,1
18 Inspected		2020-12-02 15:49:32	4666	926,00	925,72	6,7
19 Inspected		2020-12-02 16:08:30	4506	948,00	947,11	9,4
20 Inspected		2020-12-02 16:31:50	4233	948,00	947,38	8,9
21 Inspected		2020-12-02 16:52:02	2775	948,00	947,09	6,3
22 Inspected		2020-12-02 17:07:34	3567	948,00	947,37	9,4
23 Inspected		2020-12-02 17:28:51	2175	948,00	947,30	8,7
24 Inspected		2020-12-02 17:48:36	312	961,00	959,18	7,7
25 Inspected		2020-12-02 18:05:37	846	961,00	960,00	8,3
26 Inspected		2020-12-02 18:22:52	1313	961,00	960,00	8,3
27 Inspected		2020-12-02 18:40:22	1845	961,00	960,00	8,0
28 Inspected		2020-12-02 18:58:32	7989	961,00	960,00	7,5
29 Inspected		2020-12-02 19:14:44	2142	961,00	960,00	8,8
30 Inspected		2020-12-02 19:34:28	1213	961,00	960,00	5,2
31 Inspected		2020-12-02 19:46:07	12249	962,00	960,59	7,1

Schweregrad Klassen Default

Class

Top

Defect	Name	Class	Grade	SNR [dB]	Pos. Length [m]	Pos. Width [mm]	Length [mm]	Width [mm]	Size [mm ²]	Drive
705	7485	SKL	Sehr leicht	8,25	9.119,48	114,50	40,00	19,00	422,800	
704	7493	SKL	Sehr leicht	8,27	9.126,75	114,50	57,60	22,00	551,600	
705	7497	SKL	Sehr leicht	8,21	9.130,39	111,50	55,20	20,00	546,400	
706	7498	SKL	Sehr leicht	8,91	9.132,08	-28,50	59,60	18,00	281,200	
707	7501	SKL	Sehr leicht	10,27	9.134,99	33,50	22,00	4,00	87,200	
708	7514	SKL	Sehr leicht	8,17	9.152,20	111,50	60,00	24,00	505,600	
709	7524	SKL	Sehr leicht	8,02	9.163,54	-244,50	26,80	8,00	140,400	

Bilder Fehler

Loaded image in 16,180 ms. Processed image in 16,525 ms.

Sample: Small defect, increasing defect density

IMS VisionLab (x64) - inspector.main.vlp

Application Settings Benutzer Diagnostics Nachbearbeitung Ansicht Fehler Werkzeuge Berichte Schnellstart Strg+F

Side: Top

Top Head

-276 mm -264 mm -252 mm -240 mm -228 mm -216 mm -204 mm -192 mm -180 mm

2728,68 m

SKL

21,20

7,00

2728,69 m

2728,70 m

X: -284,25 mm Y: 2728,67 m Px: 0,476 mm Z: 1000%

ImService

Top Head

0 m 400 mm 0 mm 400 mm

1250 m

2500 m

3750 m

5000 m

6250 m

Tail

Schweregrad Klassen Default

Class Top

37

1C

12

12

40

50

50

50

99

10

10

10

10

10

50

1N

1208

409

2134

2129

2157

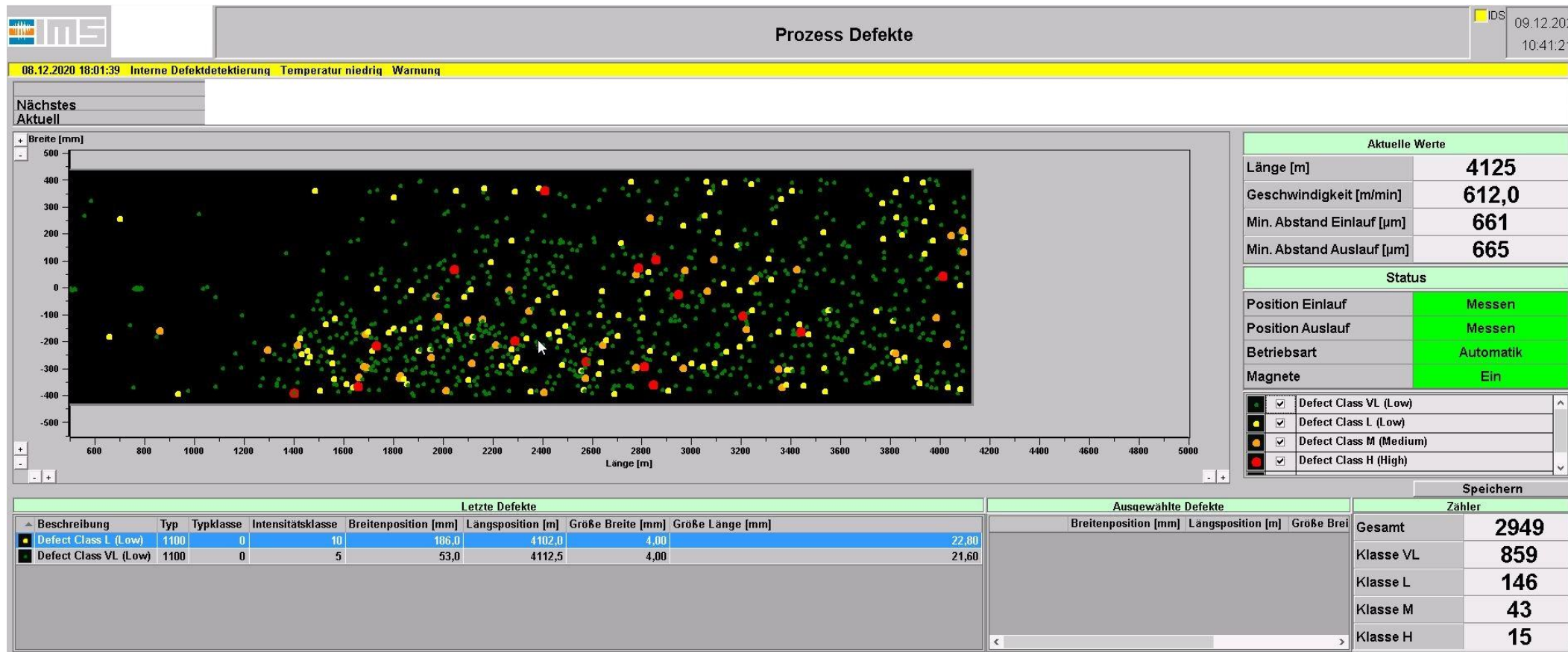
2109

Bilder Fehler

Defect	Name	Class	Grade	SNR [dB]	Pos. Length [m]	Pos. Width [mm]	Length [mm]	Width [mm]	Size [mm ²]	Drive
1666	3110	SKL	Sehr leicht	8,34	2.728,68	-210,00	21,20	7,00	125,200	
1667	3112	GRO	Schwer	14,96	2.729,83	365,00	45,60	15,00	372,000	
1668	3114	MTL	Mittel	14,21	2.731,61	365,00	67,60	20,00	311,600	
1669	3116	GRO	Schwer	14,34	2.733,43	362,00	49,20	18,00	355,600	
1670	3118	SKL	Sehr leicht	9,05	2.734,25	-89,00	46,00	16,00	286,400	
1671	3119	MTL	Mittel	14,09	2.735,22	361,00	65,60	18,00	430,400	
1672	3120	GRO	Schwer	15,81	2.735,82	30,00	36,40	15,00	195,200	

Loaded image in 12,166 ms. Processed image in 16,361 ms.

Online Result



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IDS Installations

- First system was be installed in 2019
- Contains 28 sensor modules
- Follow up system with 34 sensor modules was installed in 2021
- Next installation will be test in CGL in 2023



Conclusions

- The new inspection system enables reliable material grading
- Customers can be supplied with tested material of guaranteed purity
- Defects can be tracked back to individual slabs.
- Enables new possibilities for the optimization of the manufacturing process



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