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SURFACE VISION



Surface Inspection and Monitoring Systems for the Copper Industry

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The Ametek Surface Vision logo. It features the word 'AMETEK' in a large, bold, black, sans-serif font with a registered trademark symbol (®) to its upper right. A red diagonal line is positioned to the left of the 'A'. Below 'AMETEK', the words 'SURFACE VISION' are written in a smaller, bold, black, sans-serif font.

AMETEK[®]
SURFACE VISION

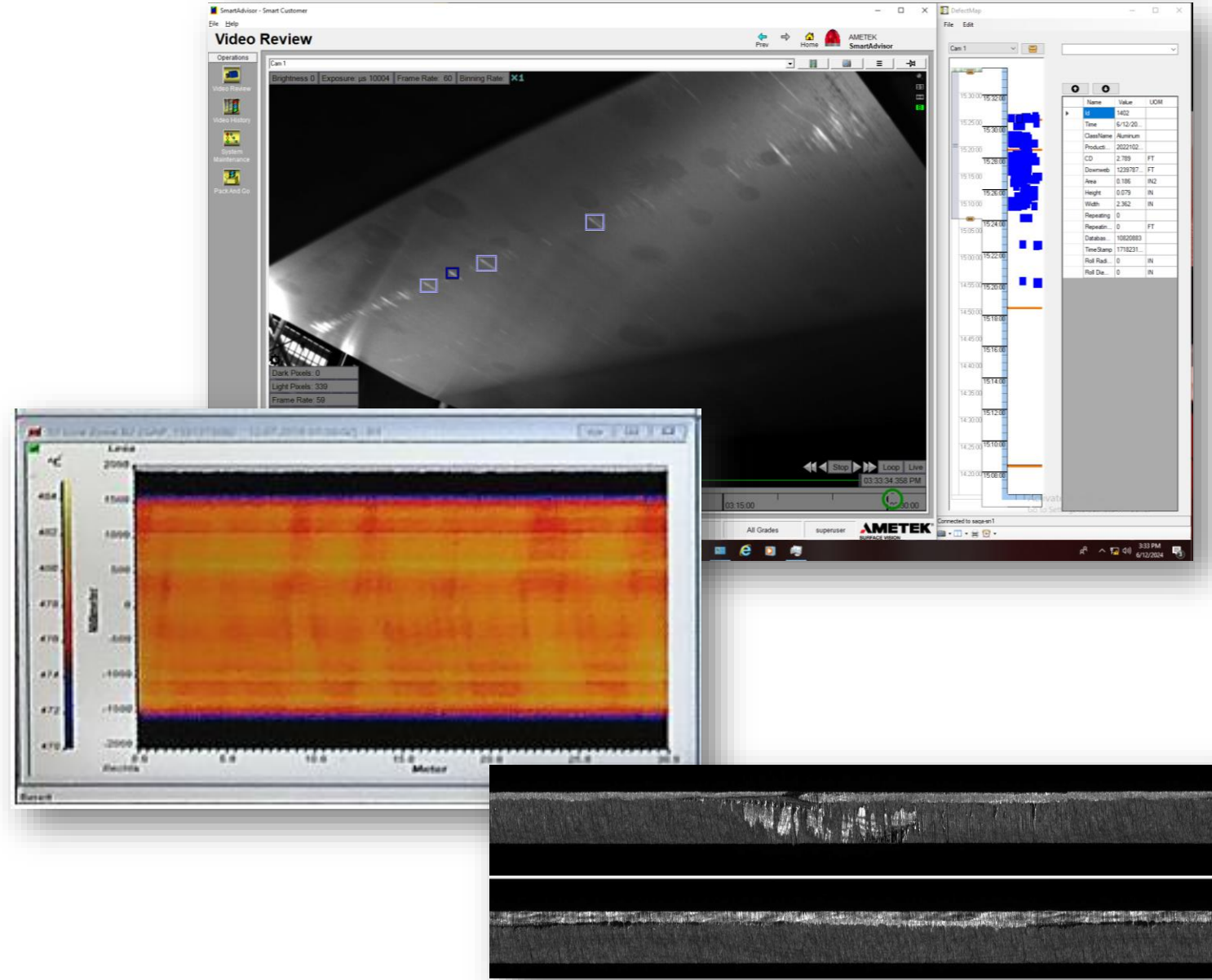
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IWCC Legal Disclaimer

- The purpose of this presentation is to guide programs benefiting the copper industry and to provide attendees with information to make independent business decisions.

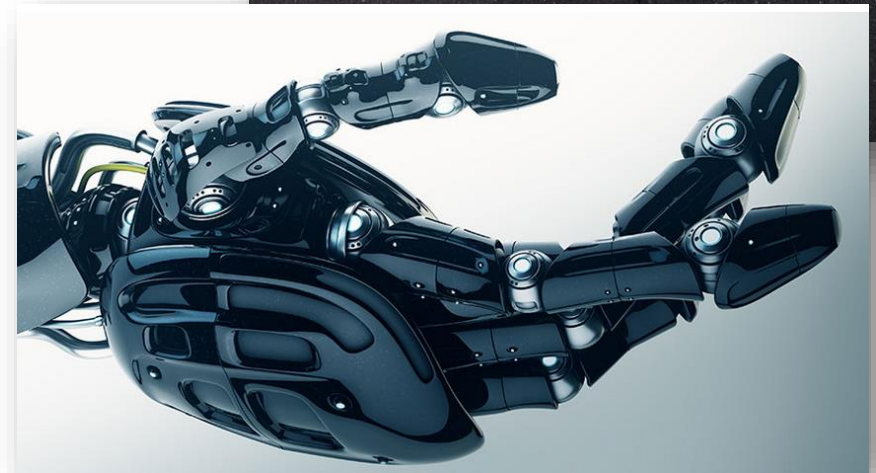
Agenda

- AMETEK Overview
- Process Monitoring
 - Streaming Video
 - Process Video
 - Temperature (IR) Sensors
- Edge Quality Monitoring
- Surface Inspection





- Global manufacturer of high-tech industrial products
- Quoted on the NYSE (AME) since 1930, headquartered in Berwyn, PA
- Annual sales of \$6.6 billion in 2023.
- Serve a diverse set of niche markets and applications
- Distributed operating structure with ~18,500 colleagues
- 150 operating locations in 30 countries



Solving complex challenges to make the world a better place. It's what we do.

Applications

Covering all steps of flat sheet production:

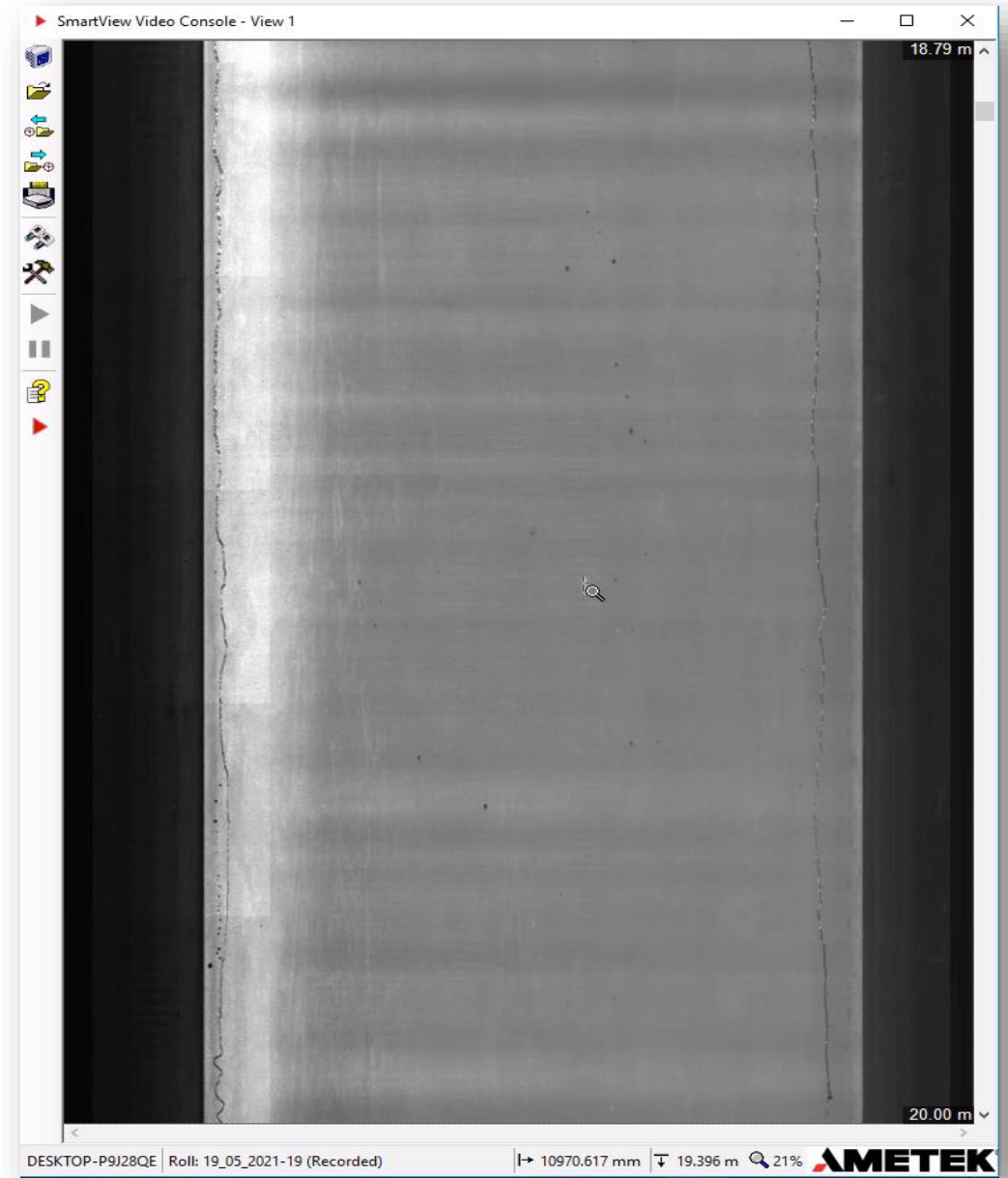
- Milling
- Pickling line
- Cold rolling mill
- Annealing line
- Stretch bend leveler line
- Coating line
- Foil treatment line
- Inspection line
- Slitter
- Automotive Lithium-Ion batteries
(anodes material based on copper foil)



Over 3,000 SmartView installations with more than 1,000 in Metals

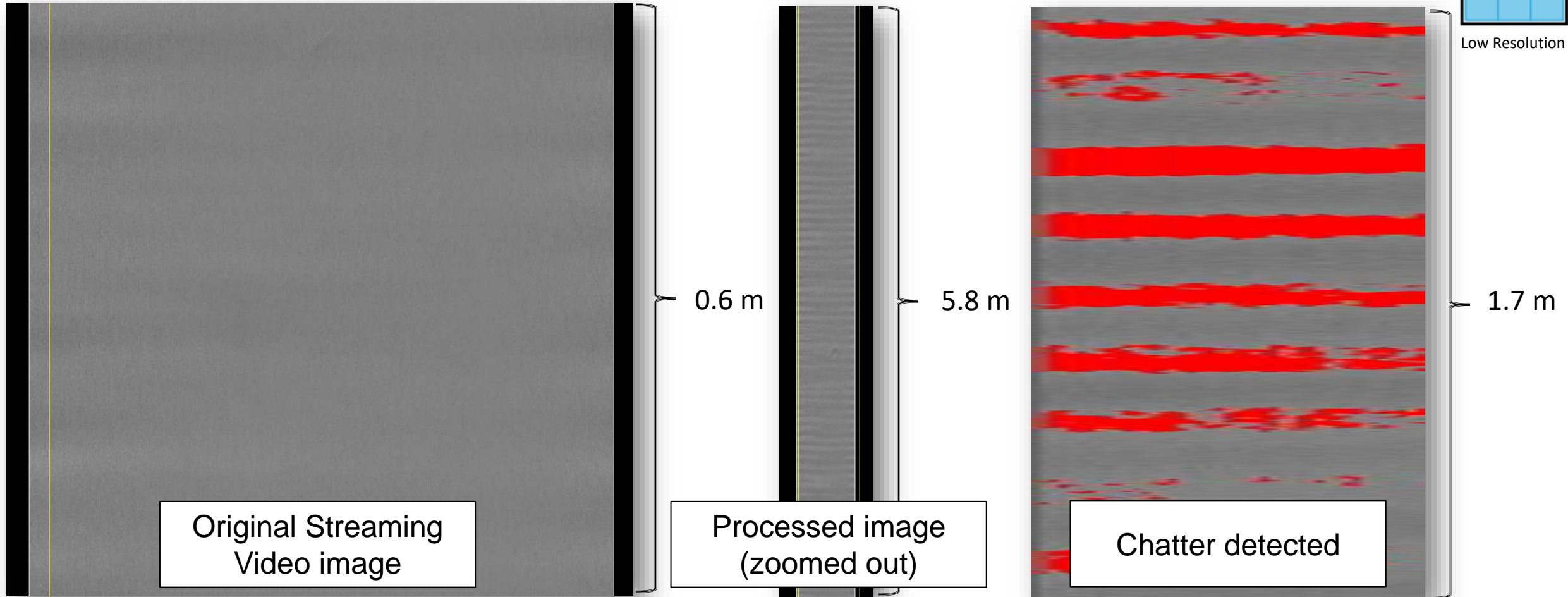
Streaming Video

- ✓ Same resolution as SmartView inspection
- ✓ Lossless image compression
- ✓ Days of production videos. Each camera can have up to 40TB at the camera level!
- ✓ Ability to lock coils
- ✓ **Virtual coil rerun**
- ✓ **Golden coil for detection and classification improvements**
- ✓ 60 fps update rate, smooth scrolling, “catch-up” mode after live mode pause, and more!
- ✓ Many live mode settings: pause at start of inspection, start scrolling automatically, etc.



VirtualView Inspection + Low Resolution Filter

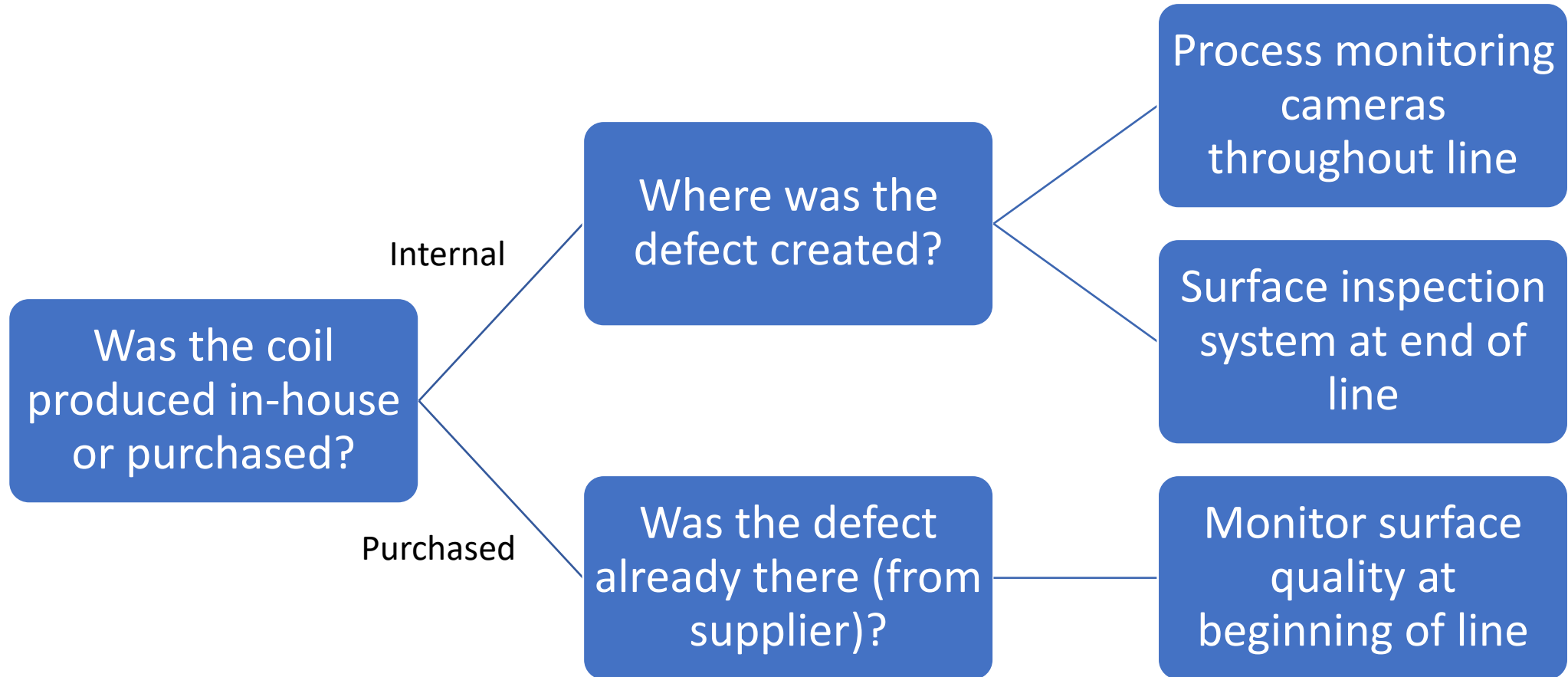
➤ Rolling mill chatter creates large, low contrast defects



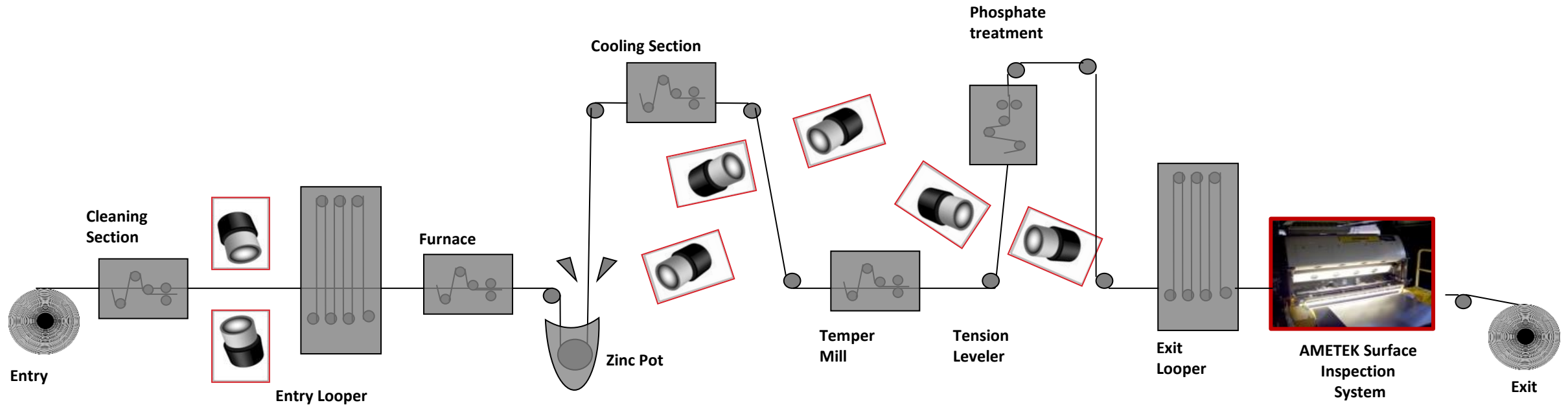
SmartAdvisor 6.0

Latest Generation – based on 30+ years of experience
Monitoring Solutions

The system detects a defect, now what?



Integrating Surface Inspection + Process Monitoring



- > Monitor **different locations** or **areas** of your process
- > Synchronize SmartView and SmartAdvisor cameras for **root cause analysis**

**SMART
ADVISOR**[®]

Integrating Surface Inspection + Process Monitoring

The screenshot displays a software interface for surface inspection and process monitoring. It features several camera views of industrial equipment, each with a corresponding data table and a scale profile graph. The views are labeled as follows:

- #1 Bridle Roll Bottom(2)**: Shows a scale profile with a red arrow pointing to a scale feature. A callout box states: "Scale originating from line incoming coil".
- Zinc Pot Bottom(4)**: Shows a scale profile with a red arrow pointing to a scale feature. A callout box states: "Scale upstream of the phosphate treatment".
- Bottom Phosphate(8)**: Shows a scale profile with a red arrow pointing to a scale feature.
- Cooling Tower Bottom(5)**: Shows a scale profile with a red arrow pointing to a scale feature. A callout box states: "Scale exiting the cooling tower".

On the left side, a data table for a detected scale is shown:

Defect No.	17
Class	Large
Distance from Drive	43.163 mm
Distance from Oper	1.115.139 mm
Distance from Near	43.163 mm
Height	343.781 mm
Width	24.857 mm
Aspect Ratio	13.831
Defect Area	344.267 sq mm
Box Area	8.545.241 sq mm

Other callouts include "Scale detected by the SmartView" pointing to the top-left area and "Scale upstream of the phosphate treatment" pointing to the Zinc Pot Bottom view.

Process Monitoring – Heat Treat Furnace Exit (Stitch)

The screenshot displays the SmartAdvisor software interface, divided into two main windows: Video Review and DefectMap.

Video Review Window:

- Title: SmartAdvisor - Smart Customer
- Menu: File Help
- Section: Video Review
- Operations: Video Review, Video History, System Maintenance, PackAnd Go
- Cam 1: Brightness 0, Exposure: μ s 10004, Frame Rate: 60, Binning Rate: $\times 1$
- Parameters: Dark Pixels: 3560, Light Pixels: 21542, Frame Rate: 59, Dark Pixel Threshold 150, Light Pixel Threshold 70, SDV Threshold 20
- Timestamp: 06/12/2024 09:16:13.931 PM
- Buffer: 186:41:47, 12:57:09.734 PM
- Controls: Stop, Loop, Live
- Time: 07:38:56.837 AM

DefectMap Window:

- Title: DefectMap
- Menu: File Edit
- Cam 1
- Timeline: Shows a sequence of defects from 07:25:00 to 07:38:00.
- Table:

Name	Value	UOM
Id	34375	
Time	6/12/20...	
ClassName	Dark	
Product...	2022102...	
CD	4.938	FT
Downweb	2968471...	FT
Area	0.293	IN2
Height	0.118	IN
Width	2.48	IN
Repeating	1	
Repeatin...	2.779	FT
Databas...	10853347	
TimeStamp	1718252...	
Roll Radi...	0	IN
Roll Dia...	0	IN

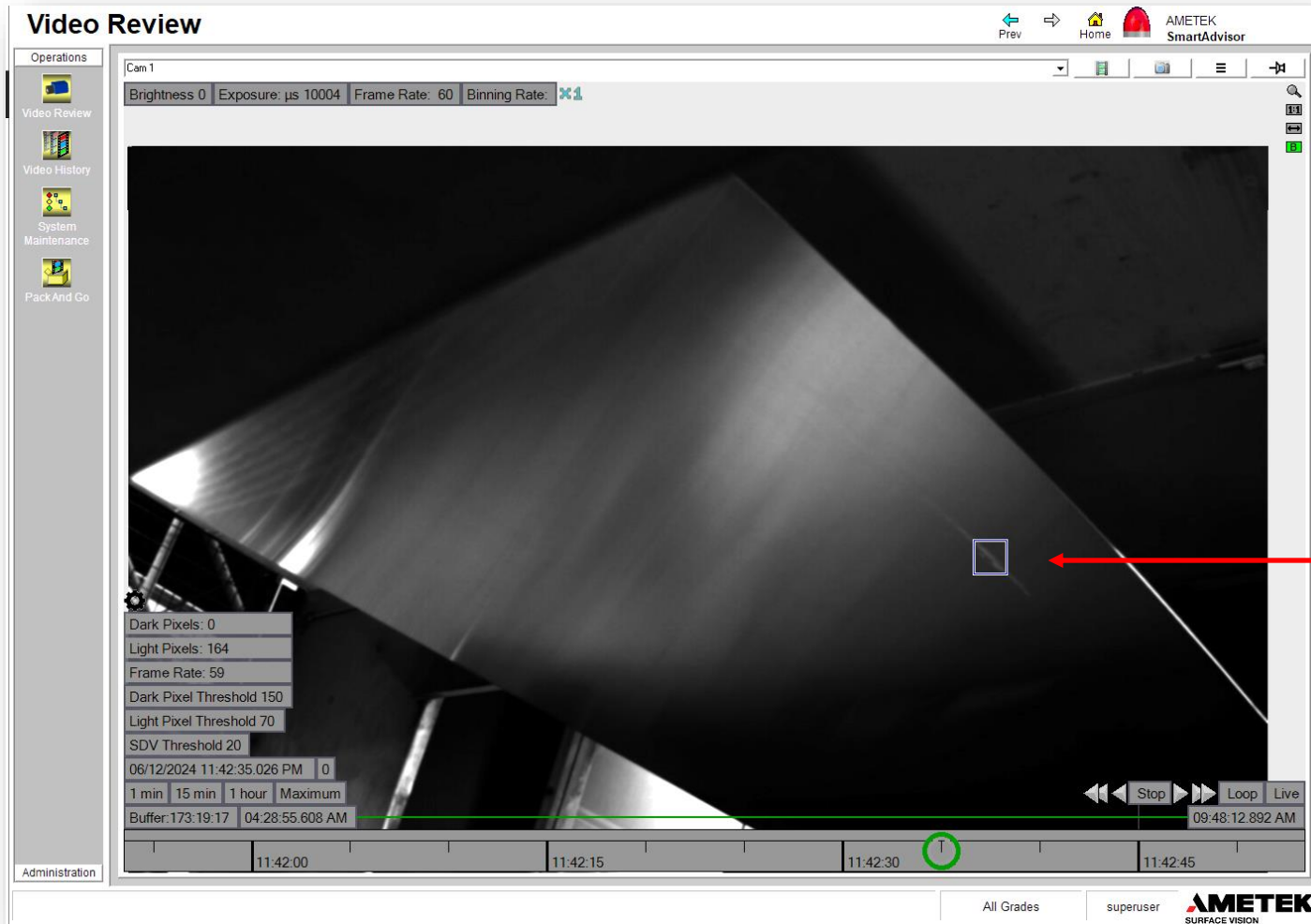
Process Monitoring – Heat Treat Furnace Exit (Scratch)

The screenshot displays the SmartAdvisor software interface. The main window is titled "Video Review" and shows a live video feed of a heat treat furnace exit. Three red arrows point to diagonal scratches on the metal surface, which are also highlighted with blue boxes. The video player includes a "Toggle blob defect display" button and playback controls. The DefectMap window on the right shows a timeline of detected defects with a corresponding data table.

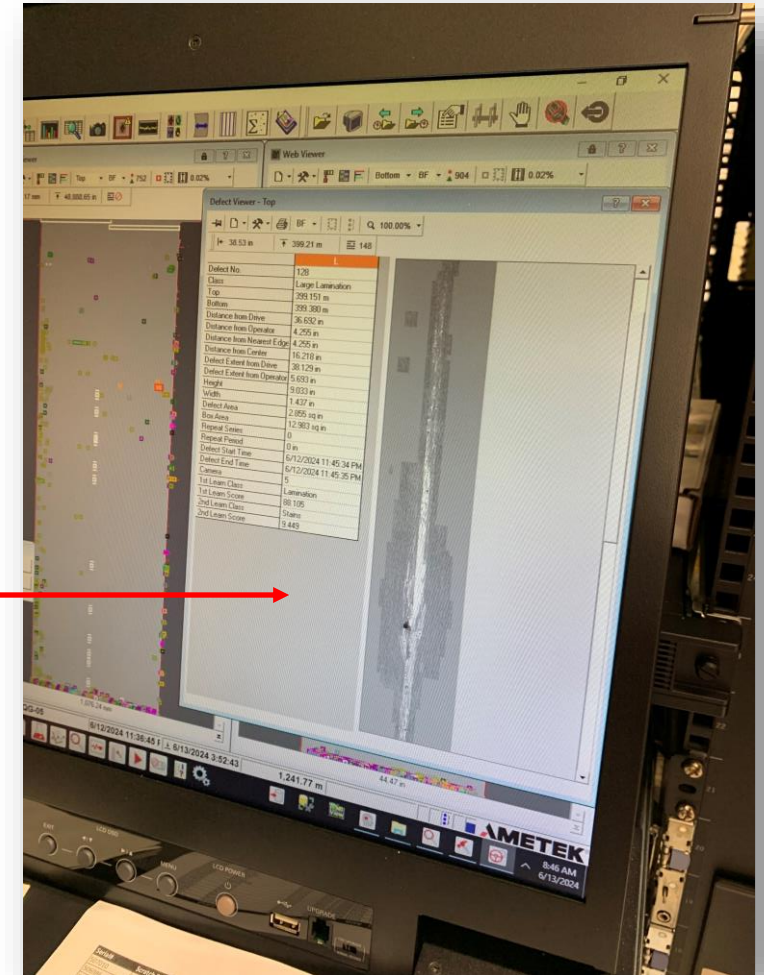
Name	Value	UOM
Id	16712	
Time	6/12/20...	
ClassName	Aluminum	
Production Unit		
CD	4.108	FT
Downweb	2219779...	FT
Area	3.426	IN2
Height	0.669	IN
Width	5.118	IN
Repeating	0	
Repeatin...	0	FT
Databas...	10836053	
TimeStam	1718243...	
Roll Radi...	0	IN
Roll Dia...	0	IN

Scratches detected

Process Monitoring – Synchronized w/ Surface Inspection



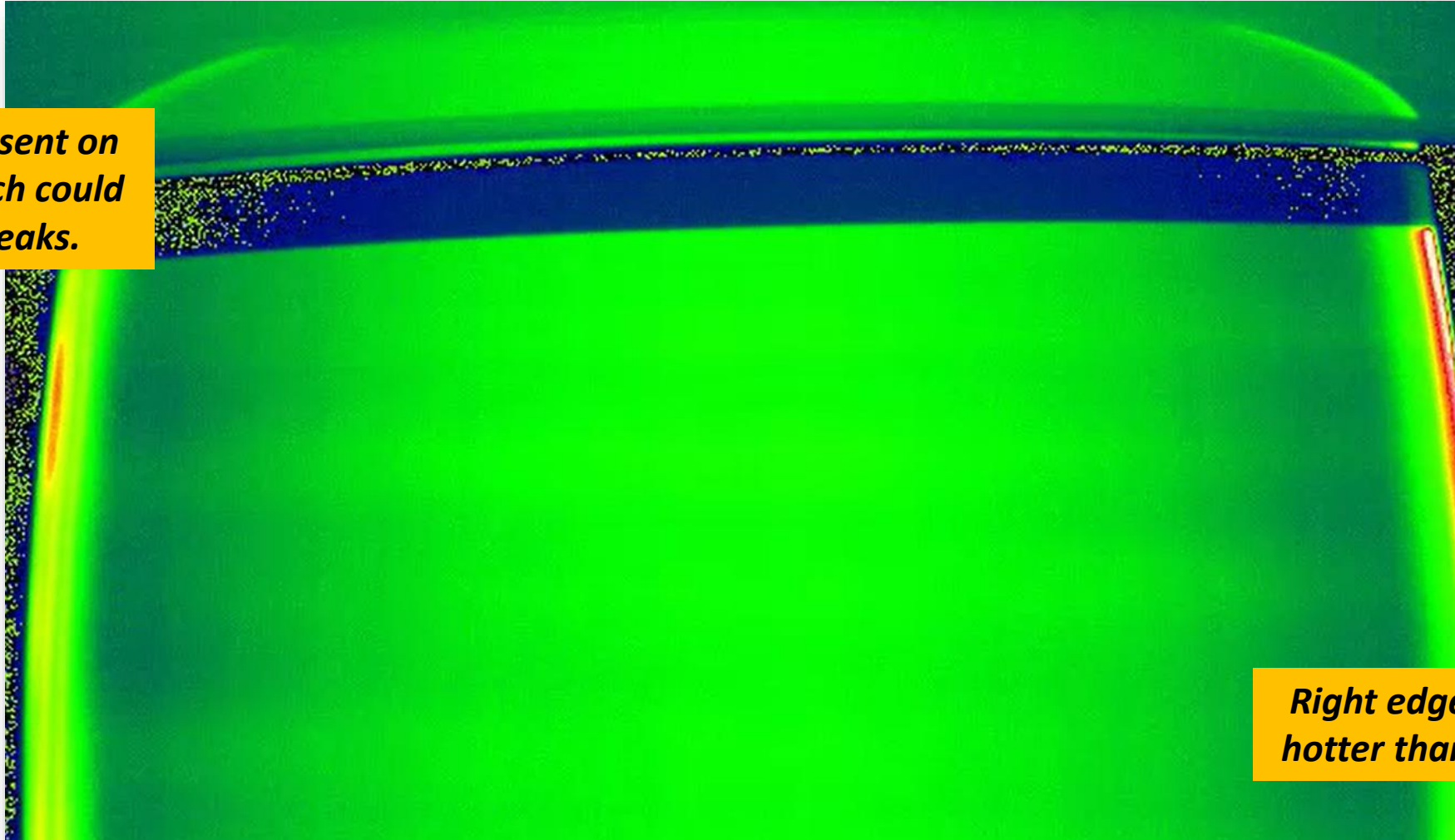
**Process Monitoring – SmartAdvisor System
– At Exit of Heat Treat Furnace**



**Surface Inspection – SmartView System
– At End of Heat Treat Line**

Process Monitoring – Temperature (IR Camera)

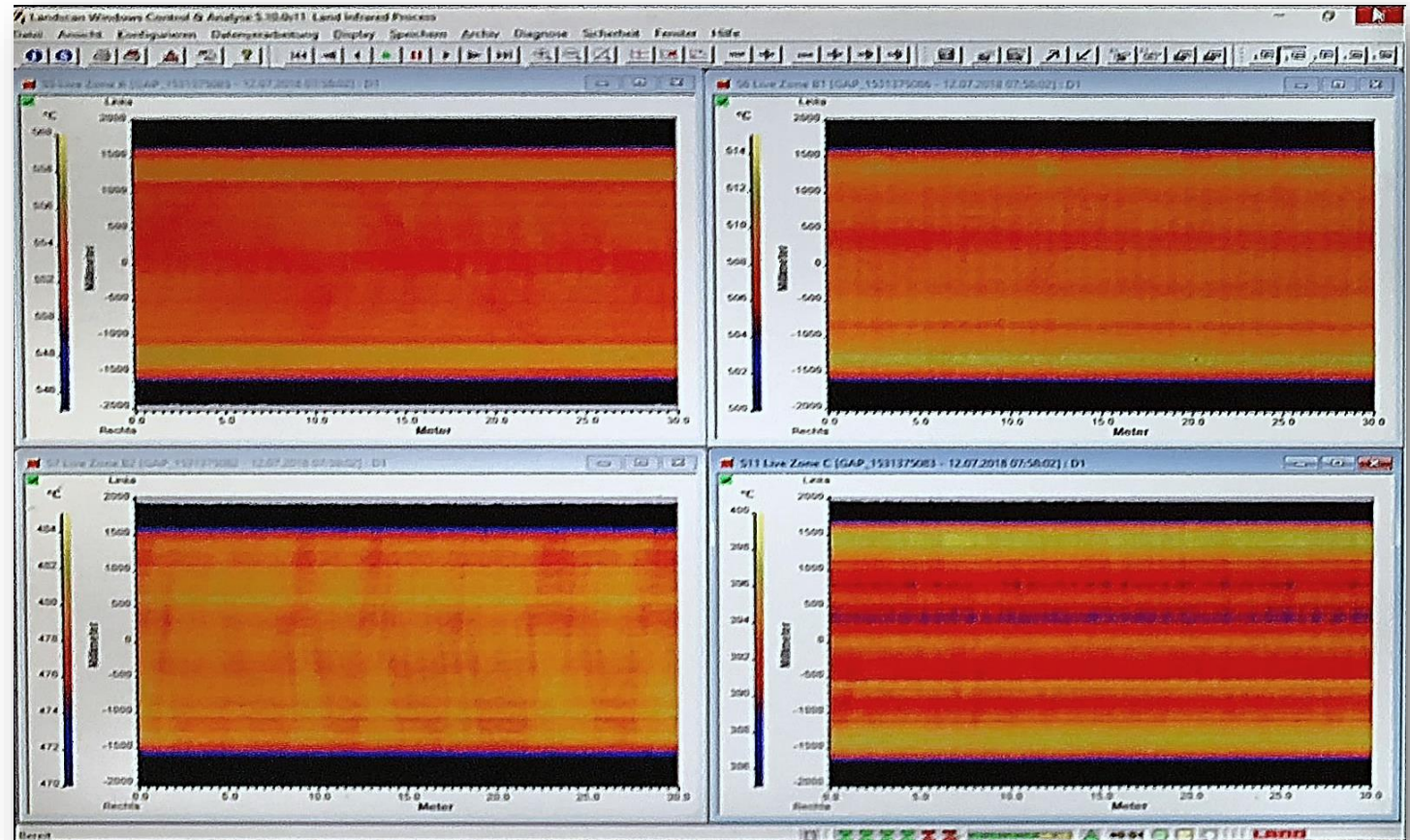
Hot spots are present on the left edge which could lead to strip breaks.



Right edge of the strip is hotter than the left edge.

Process Monitoring – Temperature (Casting)

Application



Copper Slabs/Bars Casting

Temperature measurement in bar and slab processing and production

Profile temperature measurement in copper casting and hot rolling processes using **line scanners** to provide a full thermal map of the product and control the process.

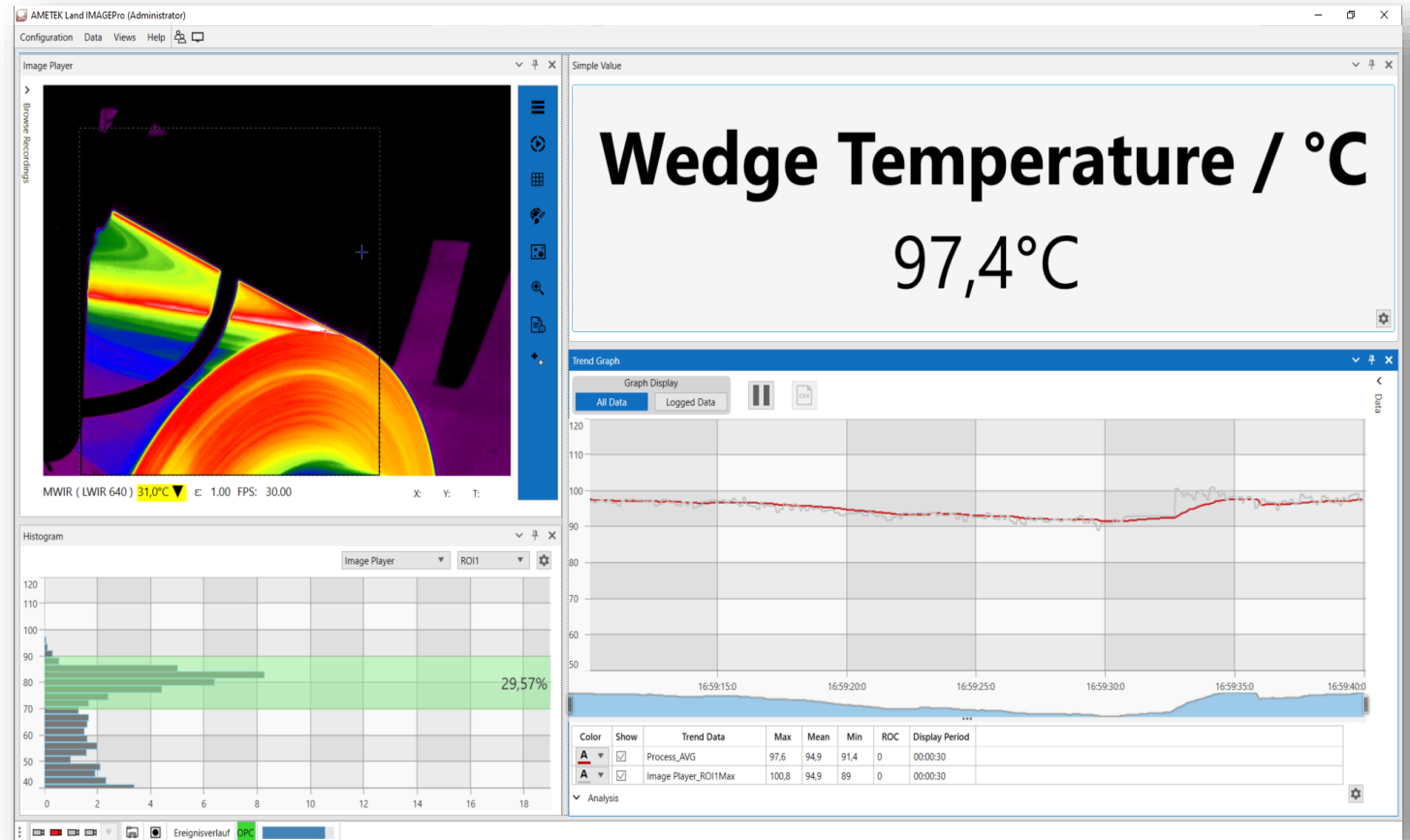
Process Monitoring – Temperature (Cold Rolling)

Application



Copper Cold Rolling and Coiling

Temperature measurement in cold rolling processes and for copper strip and foils



Using the wedge effect, thermal imagers (scanners or pyrometers) are used to measure the strip temperature continuously to monitor and control the process.

SmartEdge

Latest Generation – based on 30+ years of experience
Monitoring Solutions

SmartEdge – Knife Edge Monitoring

Avoid Scrap

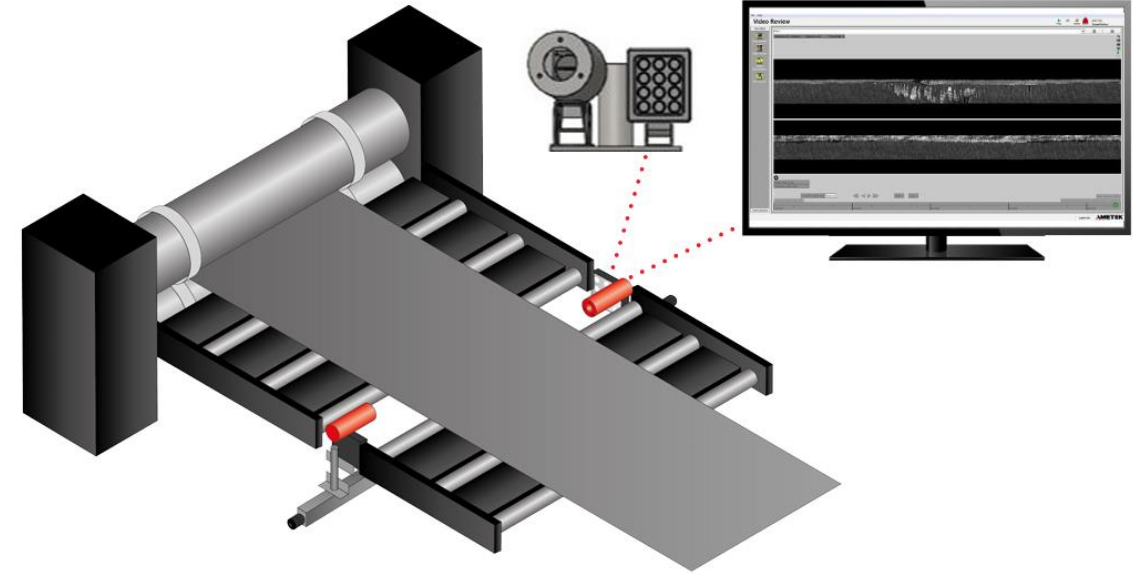
- Detect the onset of edge burr now, before bad product is produced
- SmartEdge Monitoring show knife wear is approaching time for maintenance

Reduce Knife Wear

- SmartEdge Monitoring provides real-time feedback for knife adjustment while running, so knives stay in proper alignment for the longest possible life

Meet Customer Quality and Tonnage

- SmartEdge Monitoring helps keep your line running smoothly with less downtime for improved yield
- Edge quality is always in view



**SMART
EDGE**®

SmartEdge – Knife Edge Monitoring

Auto-Calibration

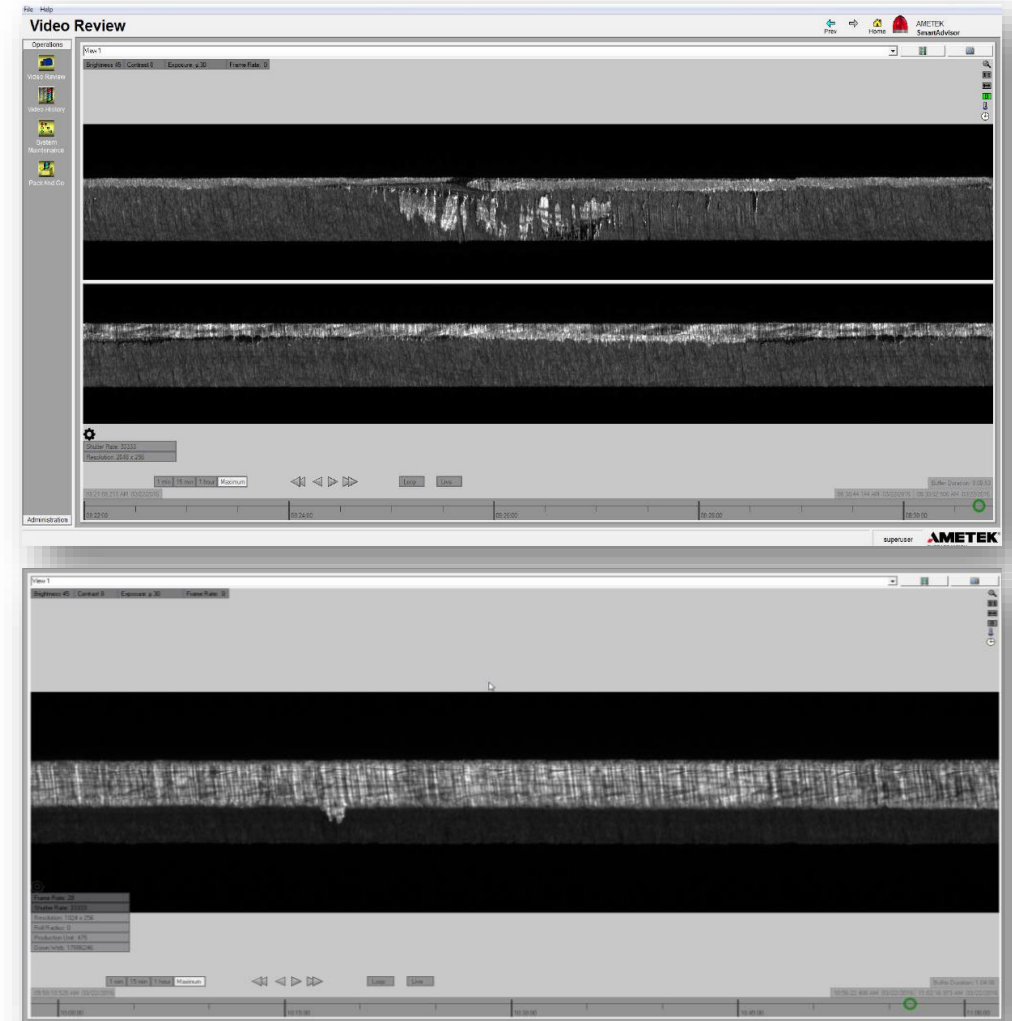
- Thickness changes are detected and presented onscreen at the best magnification of the edge.

100% Video capture and storage

- SmartEdge captures the entire length of the trimmed edge
- Events can be found and analyzed for root cause.

Stabilized Video

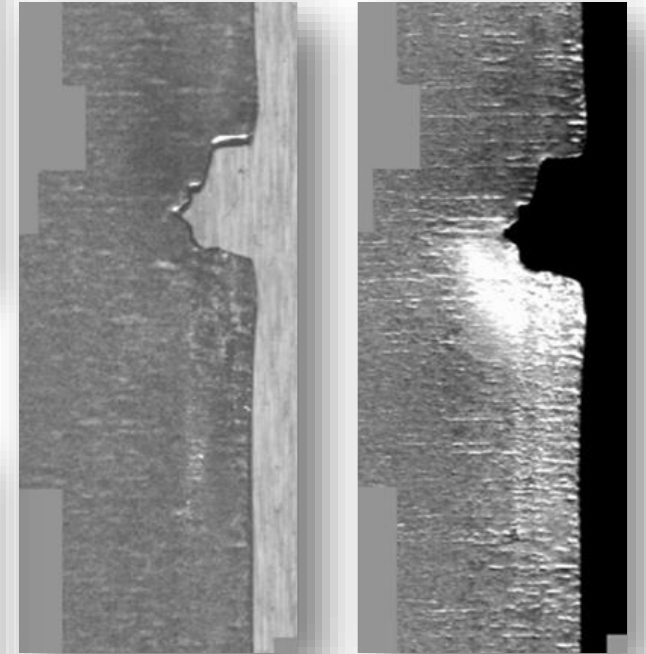
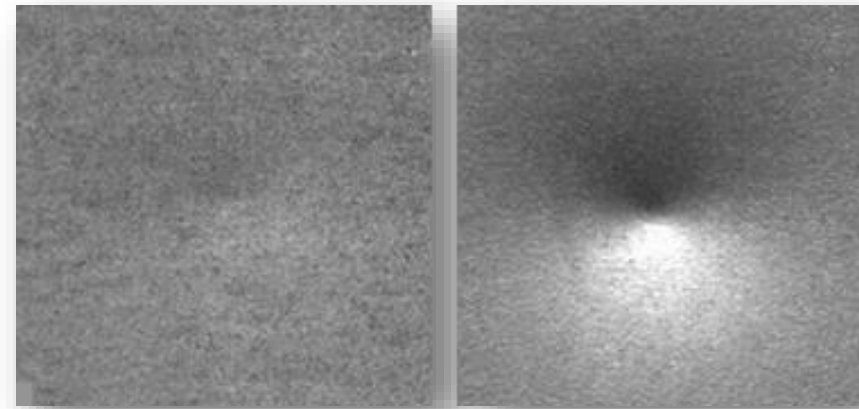
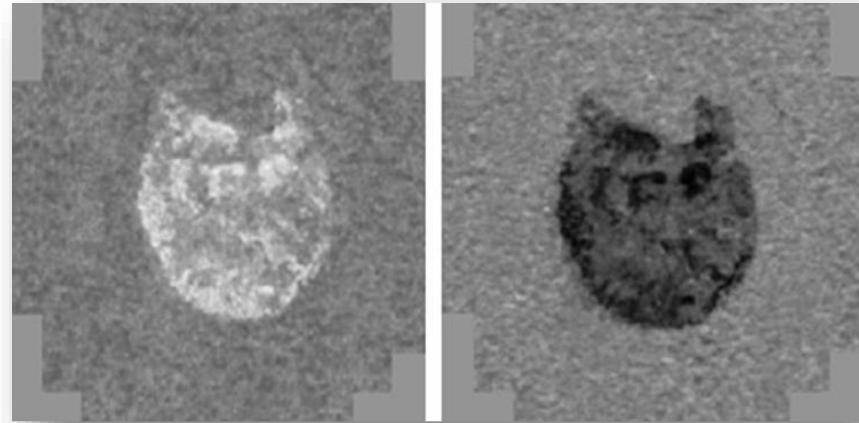
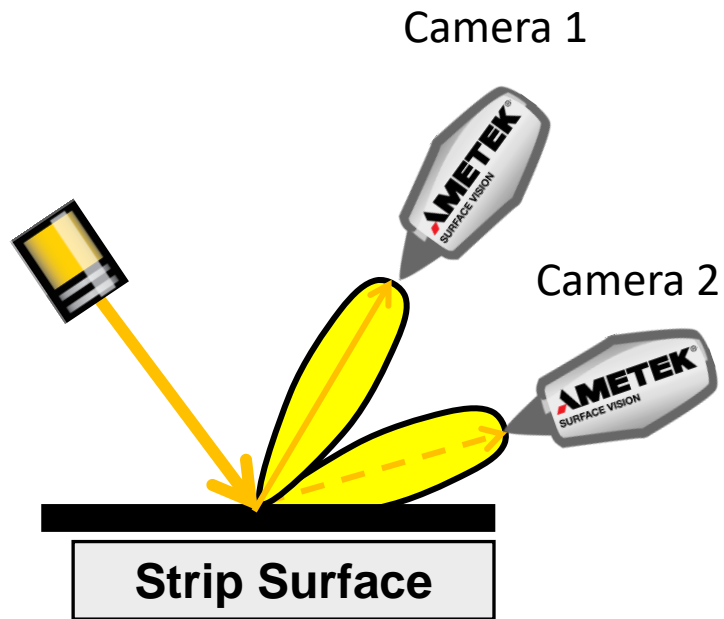
- Large-sensor linescan cameras make SmartEdge immune to material bounce even at high magnification.
- Stabilized video on-screen helps the operator see subtle defects and even shows knife eccentricities in the cut.



SmartView 9.0

Latest Generation – based on 30+ years of experience
Surface Inspection

Surface Inspection Principles



Evolution of Surface Inspection

> Camera sensors

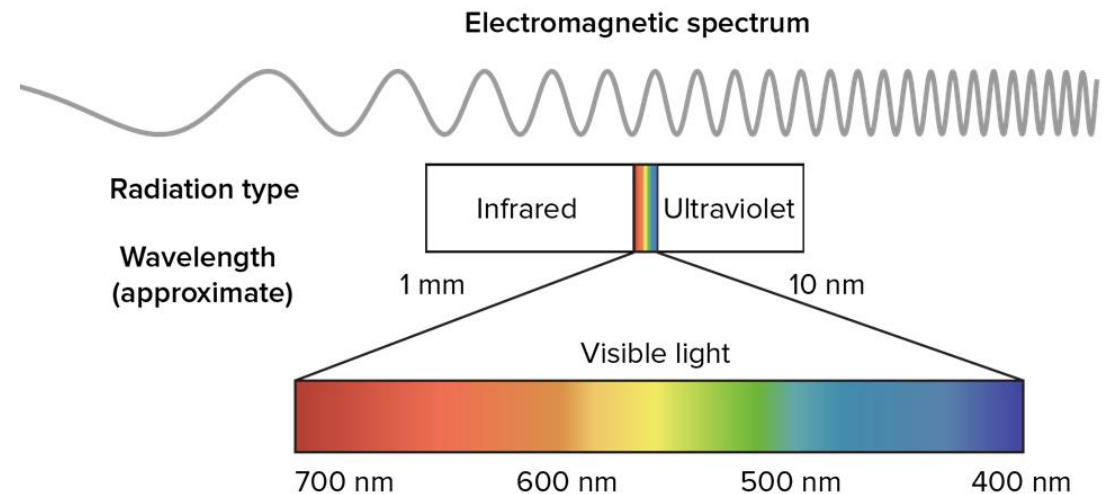
- CCD → CMOS
- High Sensitivity
- High Speed
- High Resolution

> Illumination

- High power LED
- Collimated or diffused
- Full light spectrum (from IR to UV)

> Software

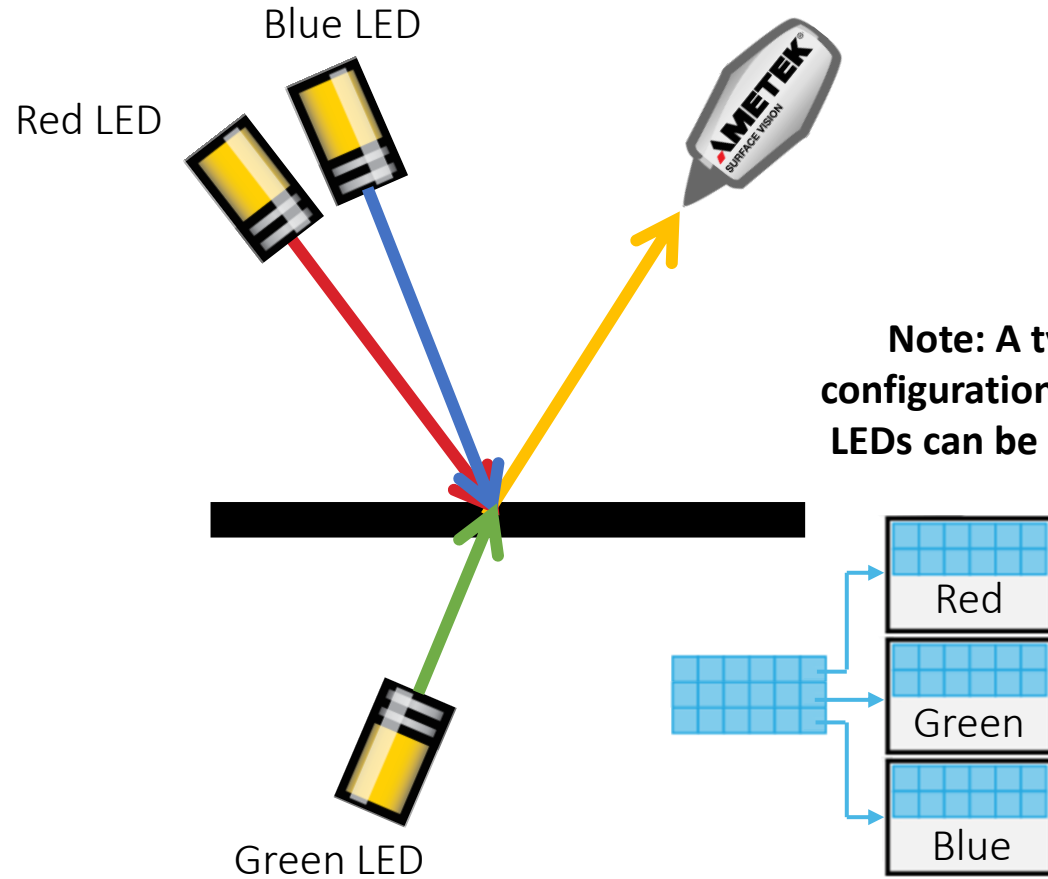
- New, powerful computers are suited for the computing demands of machine-learning/AI software
- A single computer can process multiple camera signals



Evolution of Surface Inspection – Multi-Channel Options

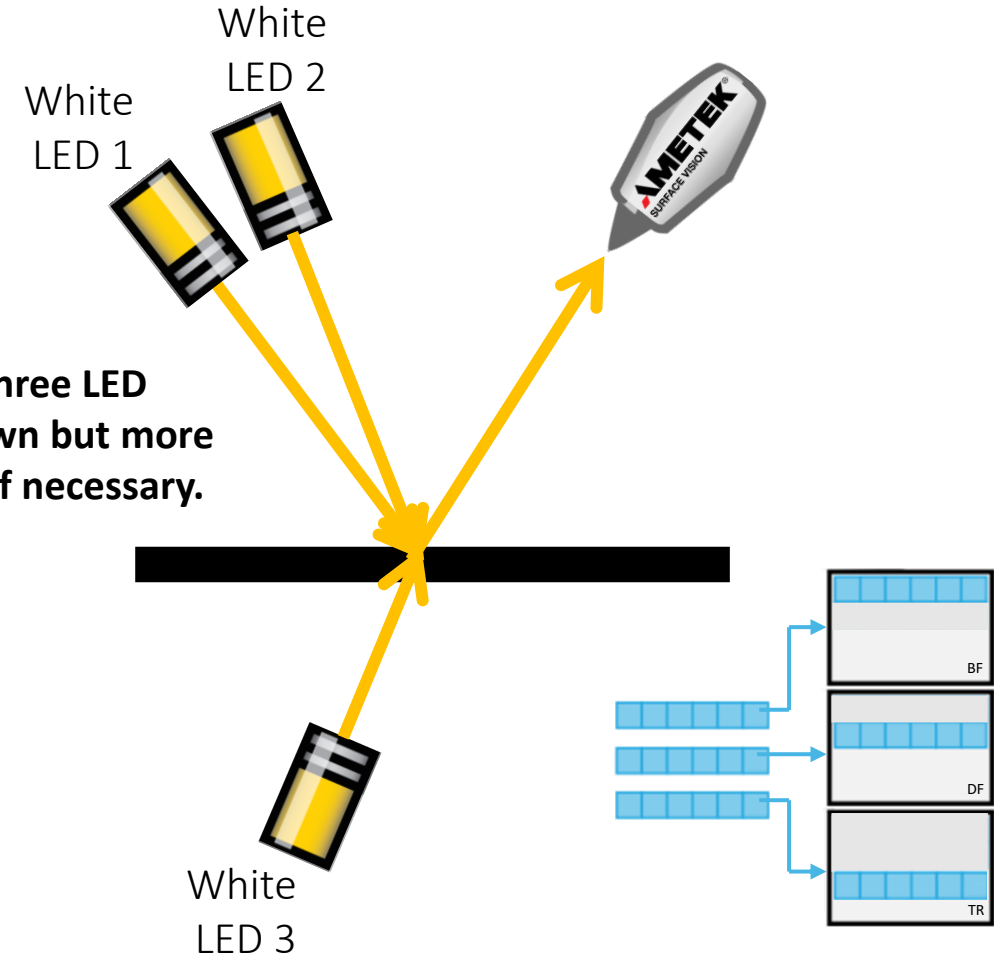


Continuous Color Inspection



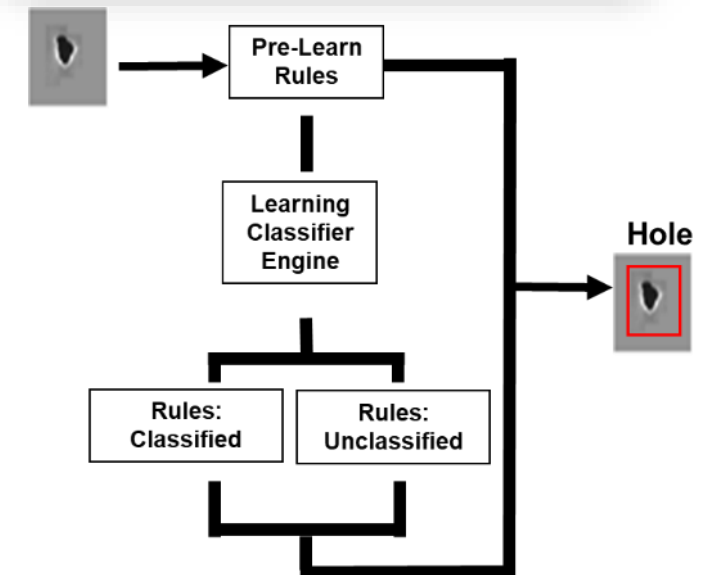
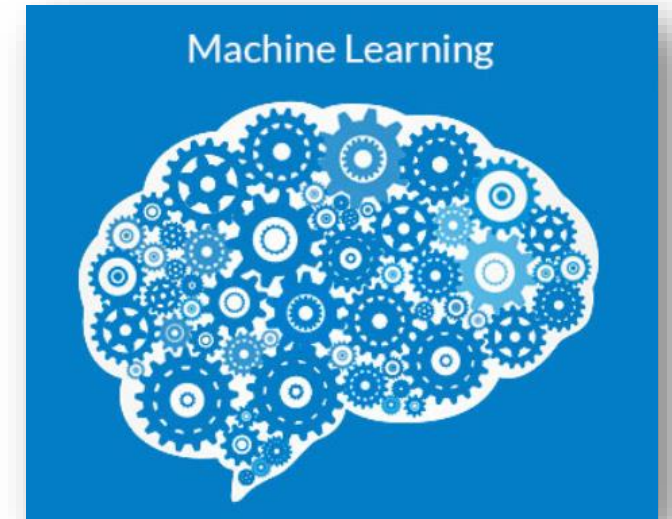
Note: A typical three LED configuration is shown but more LEDs can be added if necessary.

Time Multiplexing



SmartLearn – Machine Learning (AI)

- SmartLearn uses machine learning (AI) to enable it to learn without being directly programmed.
- SmartLearn uses a machine learning algorithm to learn how to recognize different defects.
- “Training” is simply done by collecting image samples and allowing it to adjust itself and improve.
- By utilizing Color Multiplexing and VirtualView, SmartLearn has multiple images of the same defect which improves classification accuracy.
- SmartLearn allows simple classification rules (ex. Repeaters) prior to machine learning algorithm and after making easy to adjust.
- The interface is designed for the end user with a simple and powerful interface.



Benefits of Color Multiplexing/VirtualView + SmartLearn

- Color Multiplexing provides **continuous** inspection for multiple camera/light angles to provide multiple images of the same defect.
- VirtualView provides **continuous** inspection and allows multiple classifiers and recipes to be used for a single physical camera.
- Powerful defect classification software (SmartLearn) increases classification accuracy when compared to rules-based classification.
- With optimized defect classification, identifying where defects are occurring is simplified and corrective actions can be taken quickly.
- By reducing the number of defects, production yield is maximized.

Thank You

Questions?