See degrees differently.

Revolutionizing Glass Furnace Operations through AI-Based Batch Coverage Detection and NIR-B 2K Thermal Imaging

Philippe Kerbois – Global Industry Manager

GPC 2025 – Toledo – October 2025

Abstract

Effective control of batch coverage on the melt line is critical for maximizing glass furnace efficiency and ensuring consistent product quality in glass manufacturing. In this presentation, we introduce a next-generation approach that leverages a new AI-driven batch coverage detection module within LAND's Image Pro Software, seamlessly integrated with the high-resolution thermal imaging capabilities of the LAND NIR-b-2K (Near-Infrared Borescope).

By capturing real-time, near-infrared thermal data inside the furnace, the NIR-b-2K with Image Pro provides a detailed view of both surface temperatures and batch distribution. The Image Pro Software then applies advanced AI algorithms to pinpoint the exact location and extent the batch coverage on any zones of the melting area. This allows operators to make immediate and informed adjustments to heat inputs, batch feed rates, and furnace parameters. Furthermore, the system's continuous monitoring and machine learning capabilities automatically detect emerging anomalies—such as cold spots, hot spots, or refractory wear—before they escalate into costly downtime events.

Case studies demonstrate how this integrated solution leads to consistent product quality, improved furnace throughput, and significant energy savings. By focusing on precise control of batch coverage, glass plants can reduce foaming formation, enhance melting efficiency, and optimize overall furnace performance. Attendees will gain practical insights into the implementation of AI-driven batch coverage detection, best practices for NIR-b-2K borescope integration, and strategies to realize both immediate and long-term operational benefits in modern glass furnace environments - regardless of the furnace technology employed.

Short Introduction

- Global Industry Manager – Glass and Steel

- Philippe has extensive sales and project management experience from working in the steel, glass and automotive industries including Rockwell Automation and ABB where he was specifically involved in major robot-based factory automation projects.
- Having worked at LAND since 2012, Philippe initially managed the sales of infrared temperature measurement solutions into line builders and glass and steel furnace OEMs within France, however now he works very closely with the global glass market and is actively promoting the award-winning Near Infrared Borescope (NIR-b) Glass thermal imaging solution for glass furnaces.

- philippe.kerbois@ametek.com
- +33 (0) 6.75.38.39.87

LAND portfolio – complete temperature offering

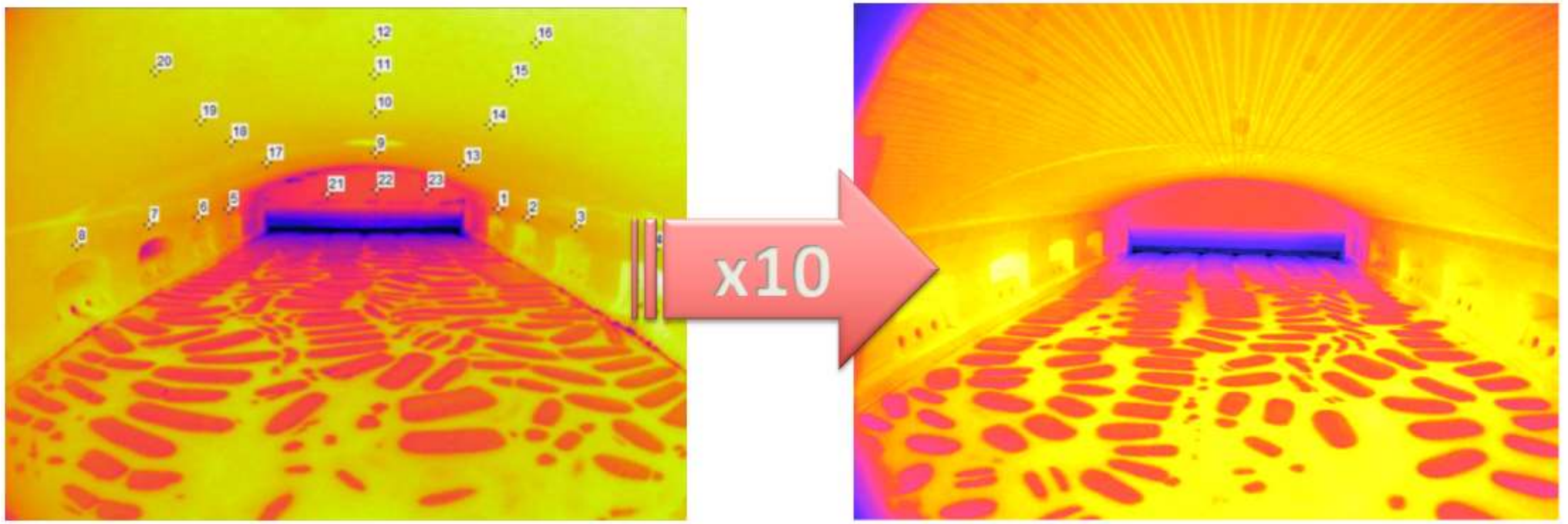
- Leverage demand for the NIR borescope to promote a wider portfolio packages including :
- The Fiber Optics “Legend FG” for forehearth and furnaces
- FLTs and LSP-HDs for thin bath and Lehrs
- LWIR-640 cameras for glass leak detection and refractory monitoring (Regens)
- As installation becomes more critical – possible to integrate and provide AMEcare
  - Advanced Services into the offering
- Thermal Surveys with NIR-b-2K demonstrating benefits of NIR-b
- More than 200 NIR-bs implemented Worldwide in major producers in the Glass industry

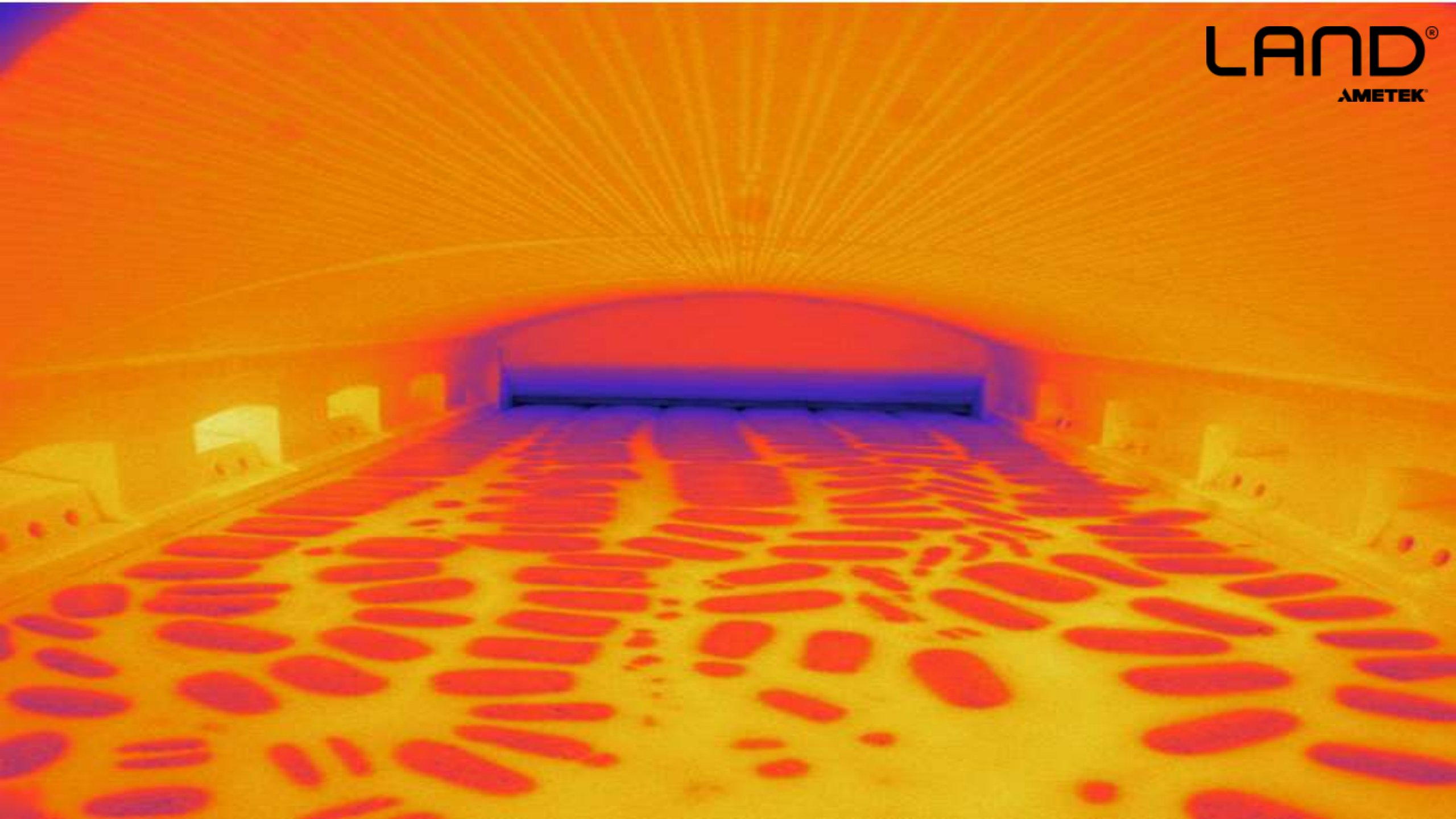
AMECARE
PERFORMANCE SERVICES

Introducing NIR-b-2K HD

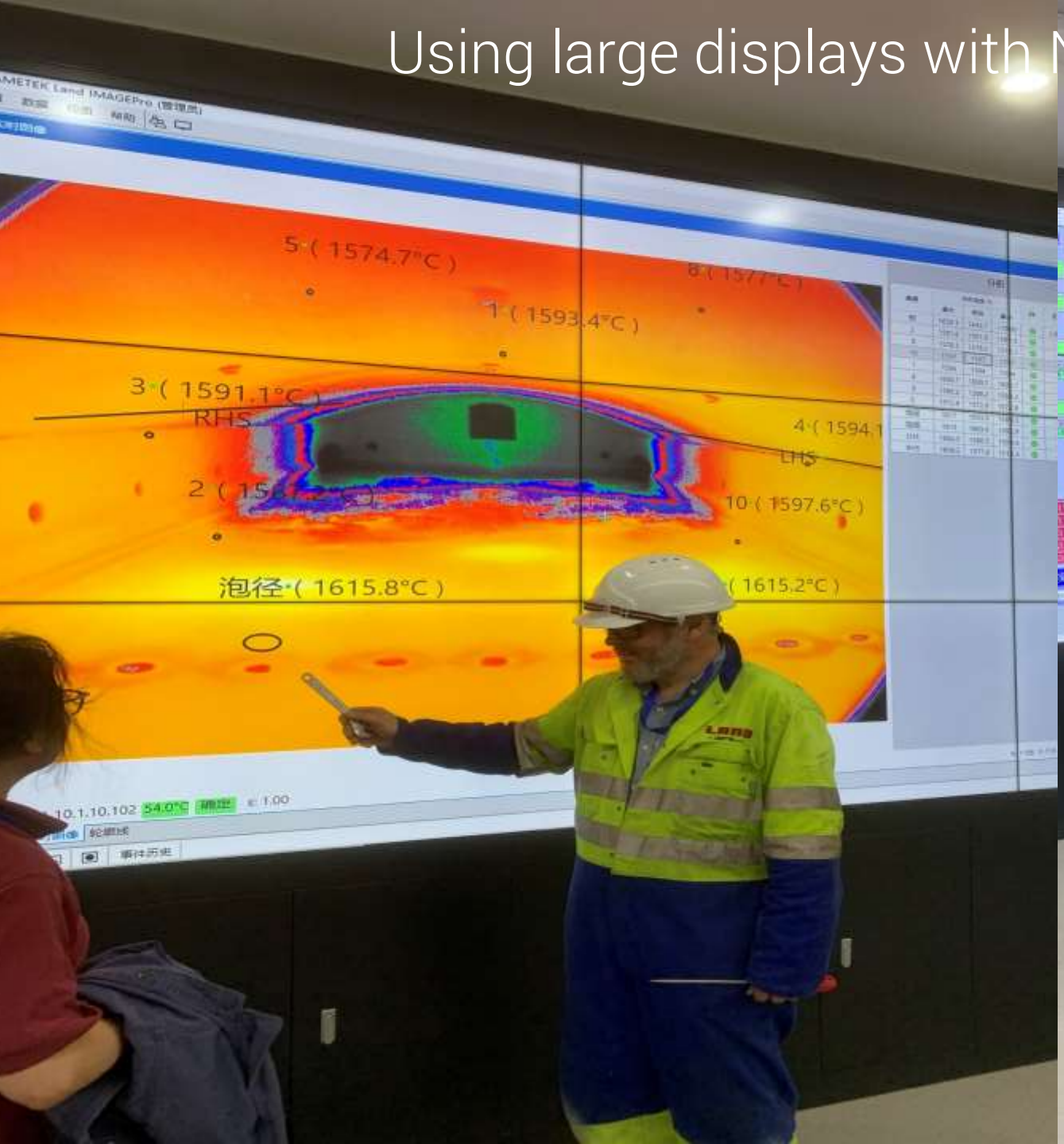
NIR-B (GLASS)
656x494 Pix = **324.064 PIXEL**

NIR-B-2K-95 (GLASS)
2000x1500 Pix = **3 MIO PIXEL**



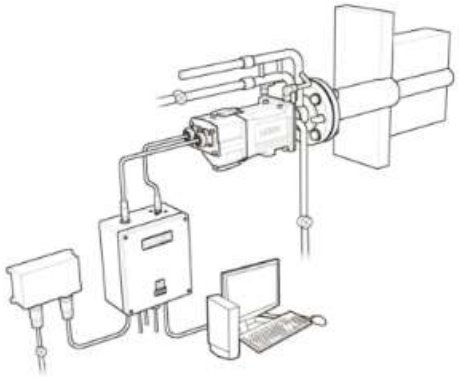

LAND®
AMETEK

Using large displays with NIR-b-2K



NIR-b-2K GLASS - 3 x possibilities

- NIR-b-GLASS-90-18-3-25 (50) –NR
- Stand alone version



- **NIR-b-2K-1000/1800C-95/3-25-LPARW-GLASS** Complete with Pneumatic auto retraction system – fixed Centerline location

* Recommended where airline pressure is below 6 bar.

NIR-b-GLASS-90-18-3-25-PAR
Complete with Pneumatic auto retraction system – fixed Centerline location

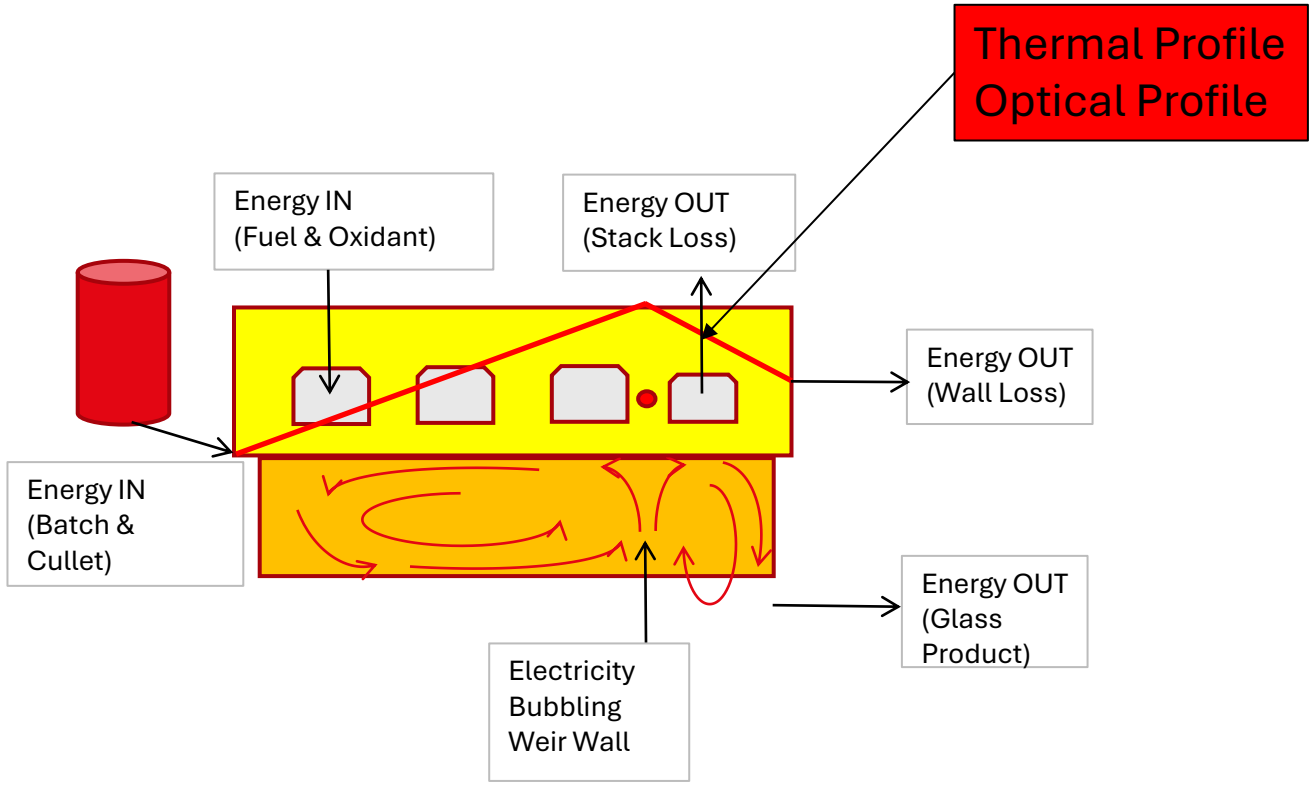
* Recommended for higher Ambient Temperatures

New LPAR EXTRACT

The benefits in furnace operations
“Not just a pretty image”

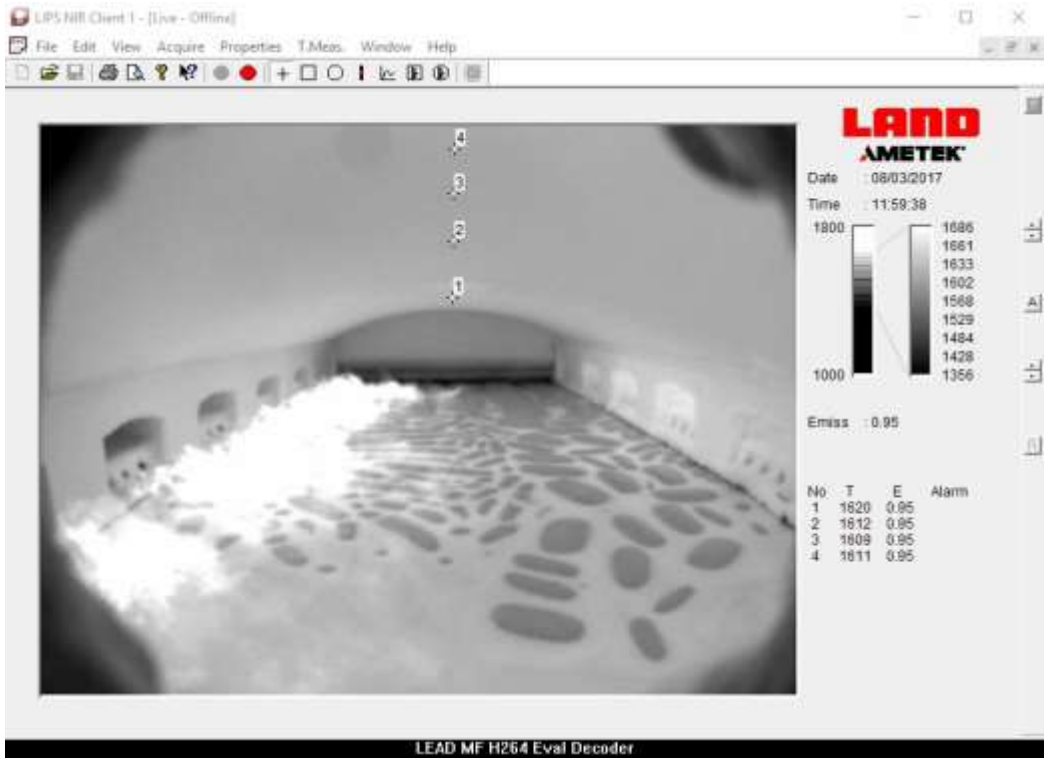
Primary goals of melting => Energy & Emission

- Maintain Temperature Profile for Good Glass
- Use materials that are easier to melt
- Optimise wall losses (insulate) or increase pull to reduce%
- Reduce Stack losses through heat recovery
- Optimise Combustion and Heat Transfer
  - Note: Glass furnaces do not use PID control- typically manual



Remember the four pillars of benefits with thermal imaging NIR-b! This is not only a pretty image!

Thermocouple Verification



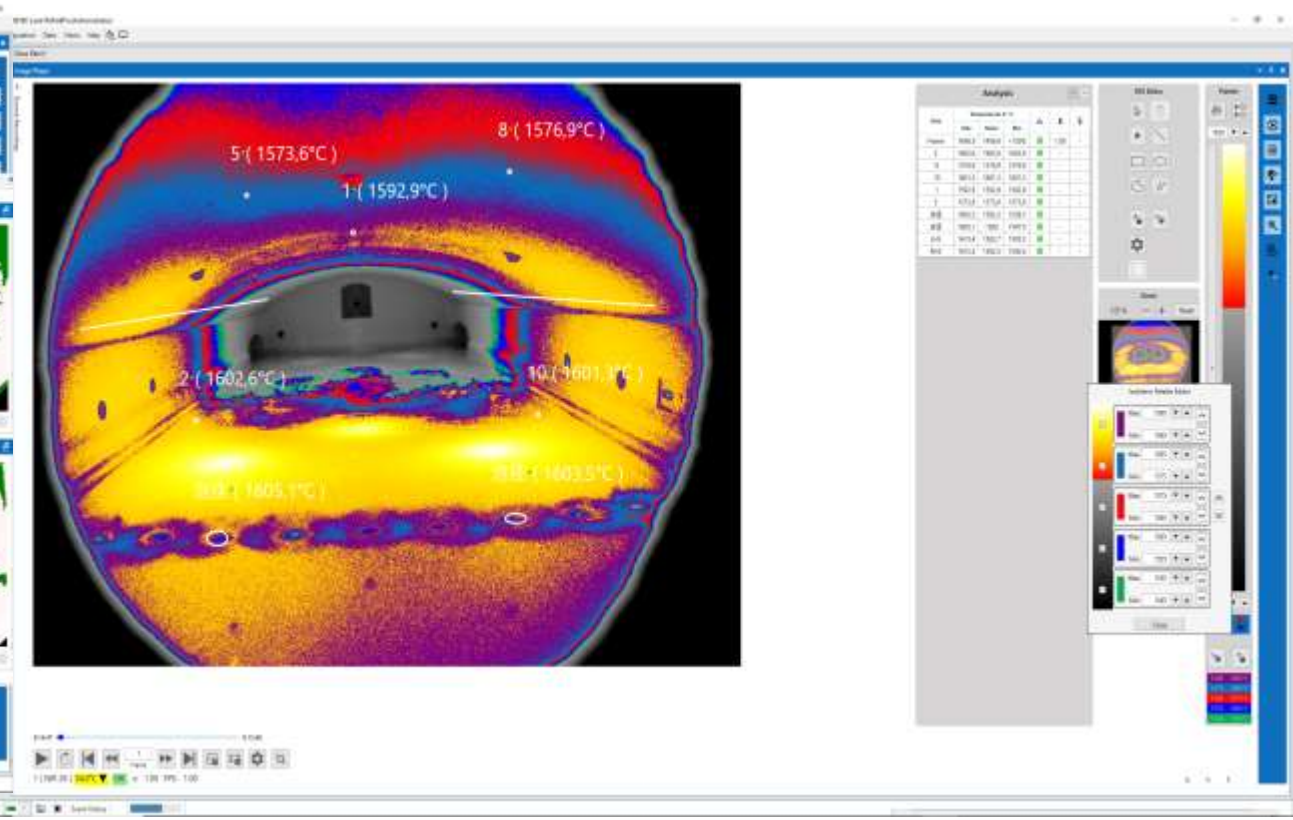
Optical-Thermal profiles with hot spots

See degrees differently.

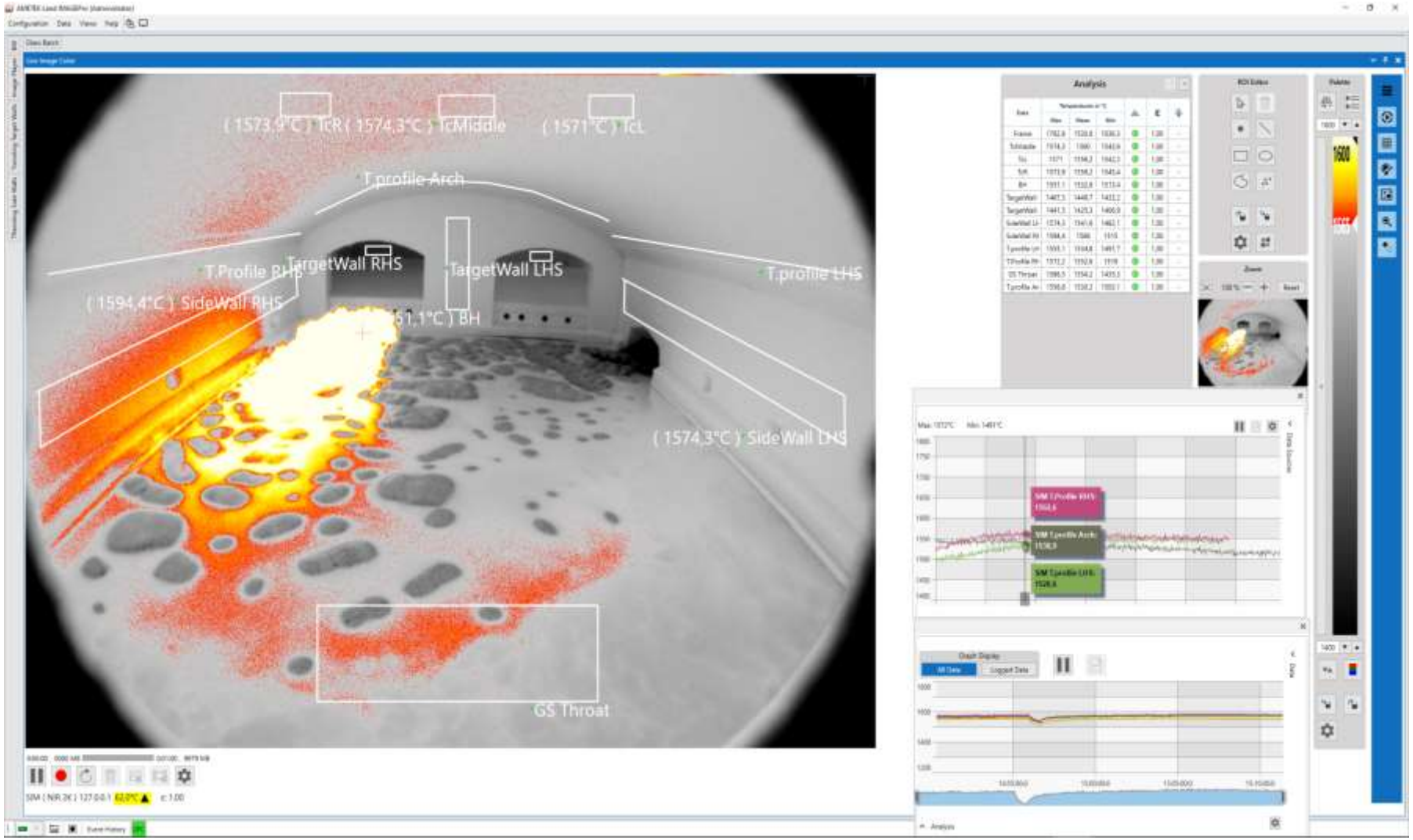
Remember the four pillars of benefits with thermal imaging NIR-b! This is not only a pretty image!

BW Palette for Air ingress and Batch pattern

Rainbow Isotherms with 5 bands for hot and cold spot locations



Flame shape and intensity – mono / rainbow / integrator



- Highlights flame shape and areas of high intensity for combustion and emissions optimisation
- Continuous real time Temperature data.
- Areas used to monitor Highest or Average or Lowest Temperature.
- Crown, Regenerator and Side Wall temperature monitoring.

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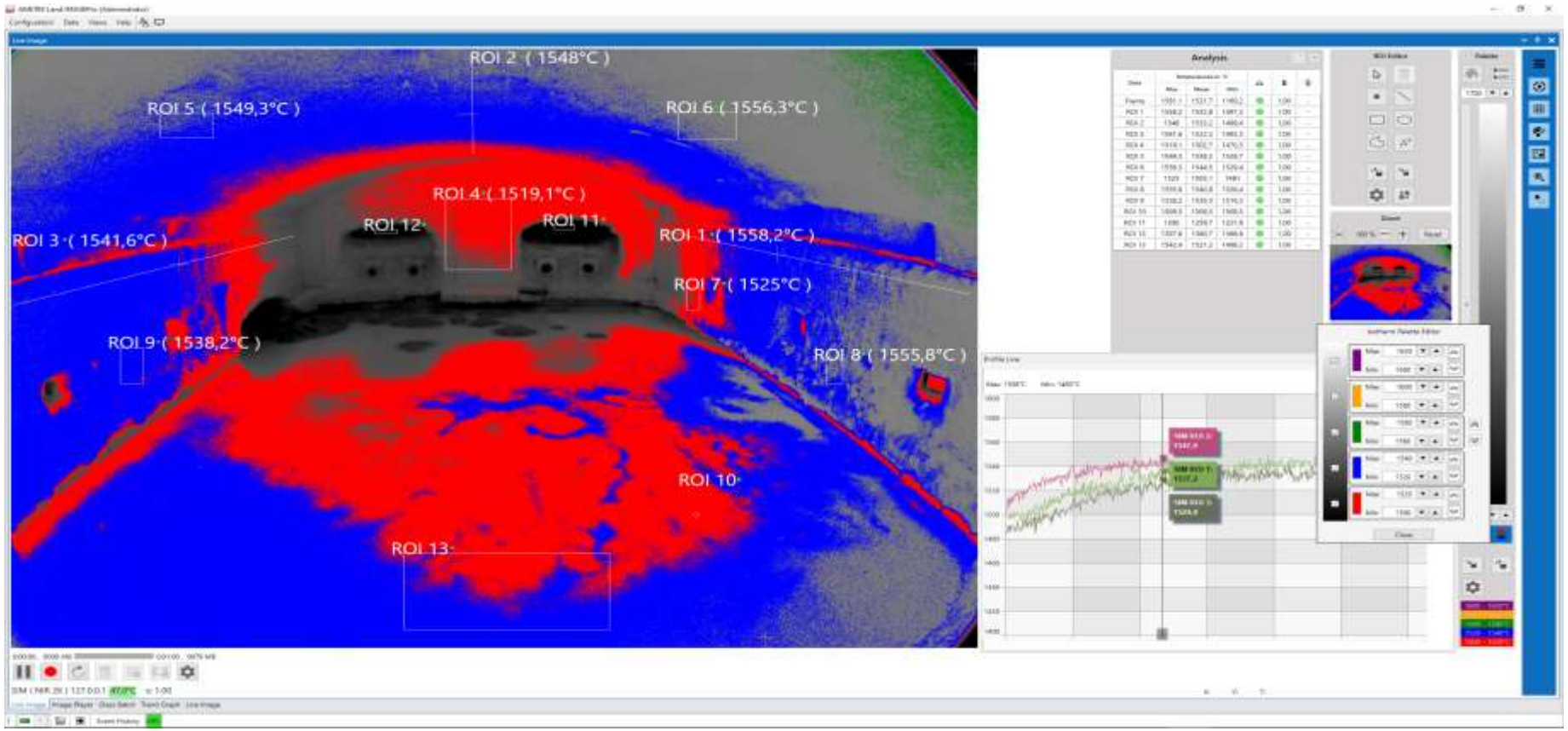
Isotherms



- Isotherms can highlight foaming on the glass surface – red areas

Flexible HMI interface with ImagePro V2

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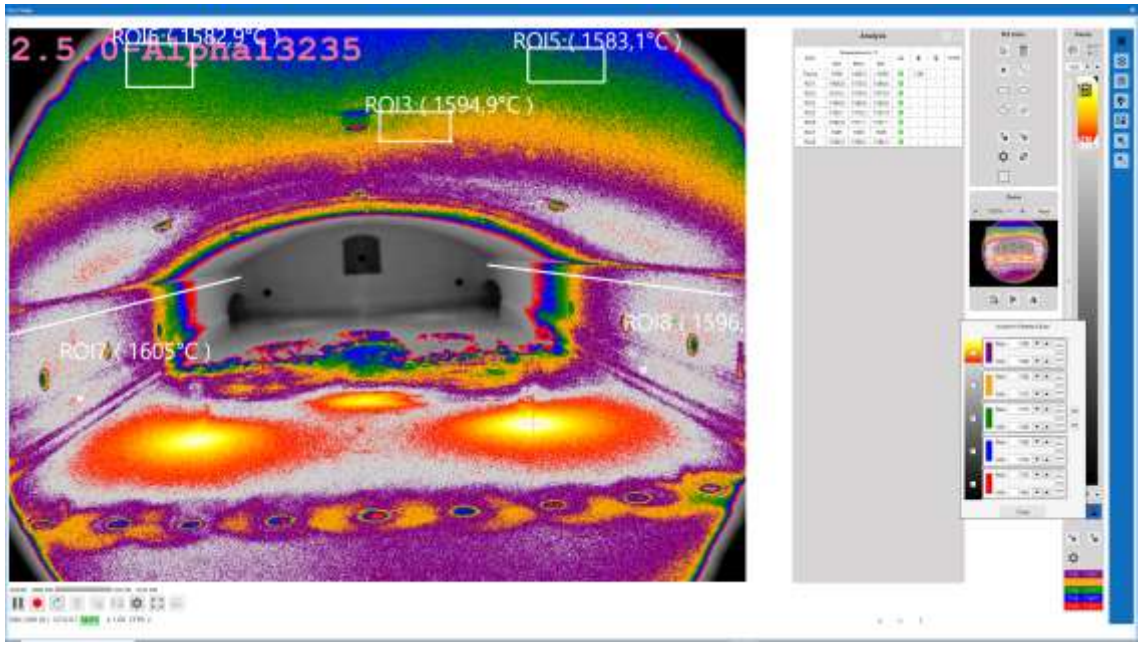
NIR-b-2K and oxygas furnaces

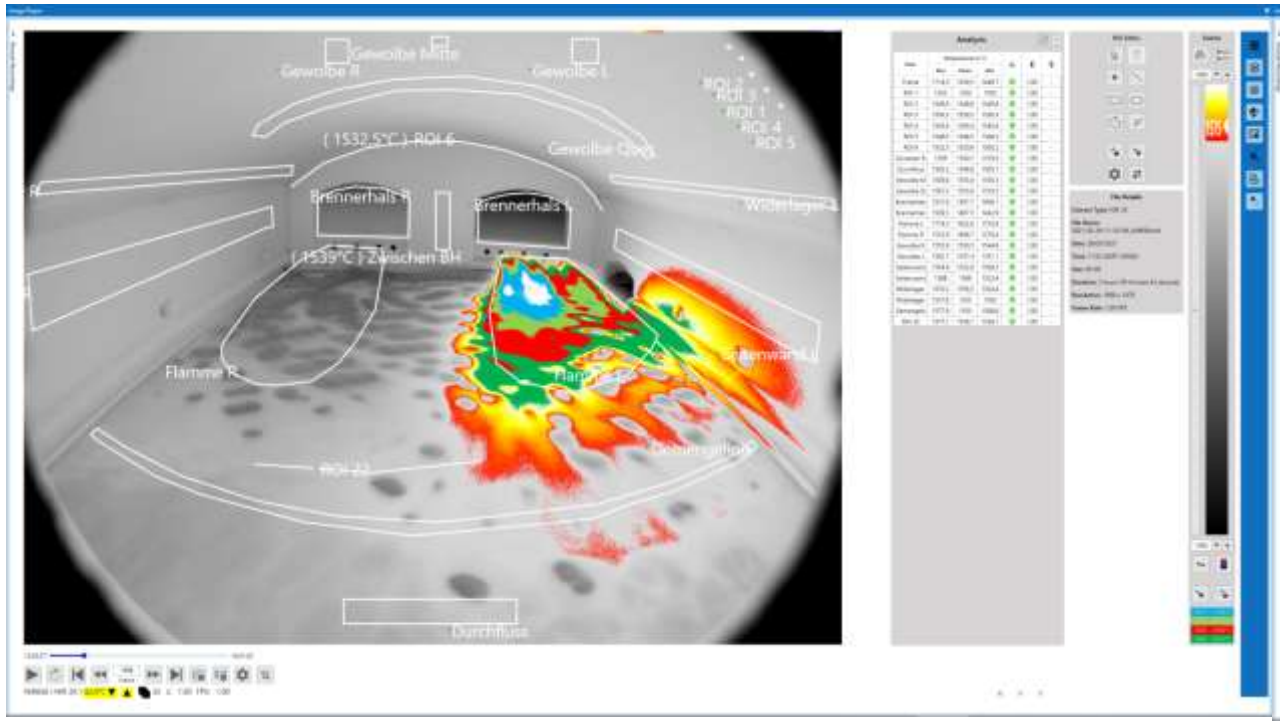
Benefits of NIR-b-2K on oxygas or Hybrid furnaces

- Batch line location in conjunction of thermal profiling and isotherms
- Burners block cleaning and overheating
- Isotherms with hot spots and cold spots
- Burner Block inspection where possible
- Flame impacts on refractories and glass surface
- Identify areas of concern and recommendations for further investigation

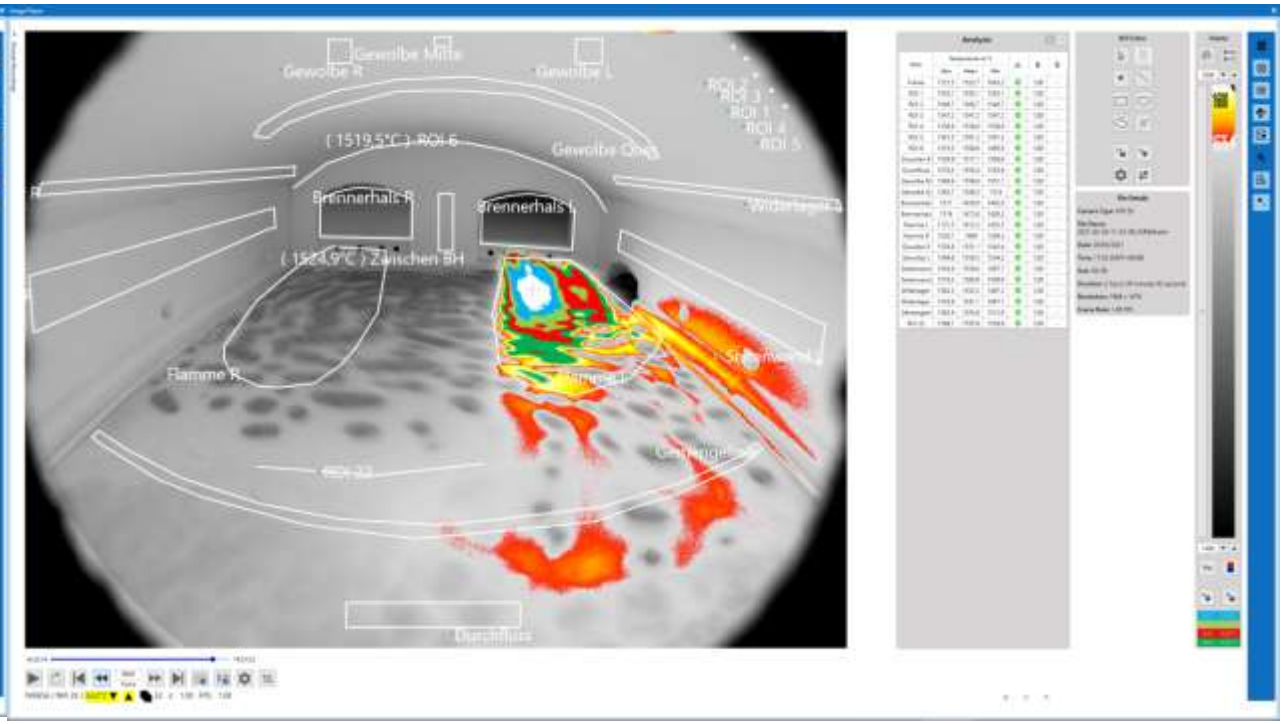


Flames optimisation with NIR-b-2K

Flames Optimisation with fixed NIR-b

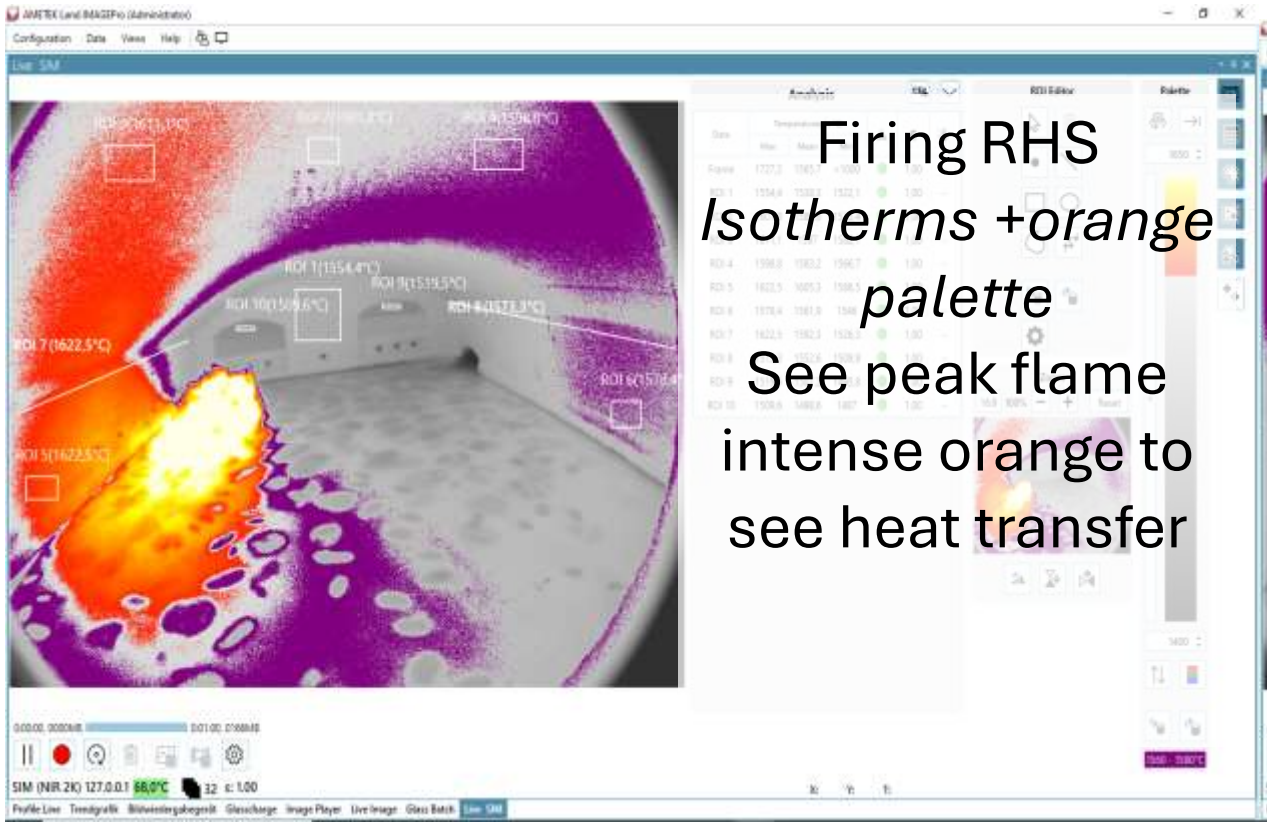


LHS to RHS Frame before reversal frame 2112
Flames Before 2^{sd} reversal

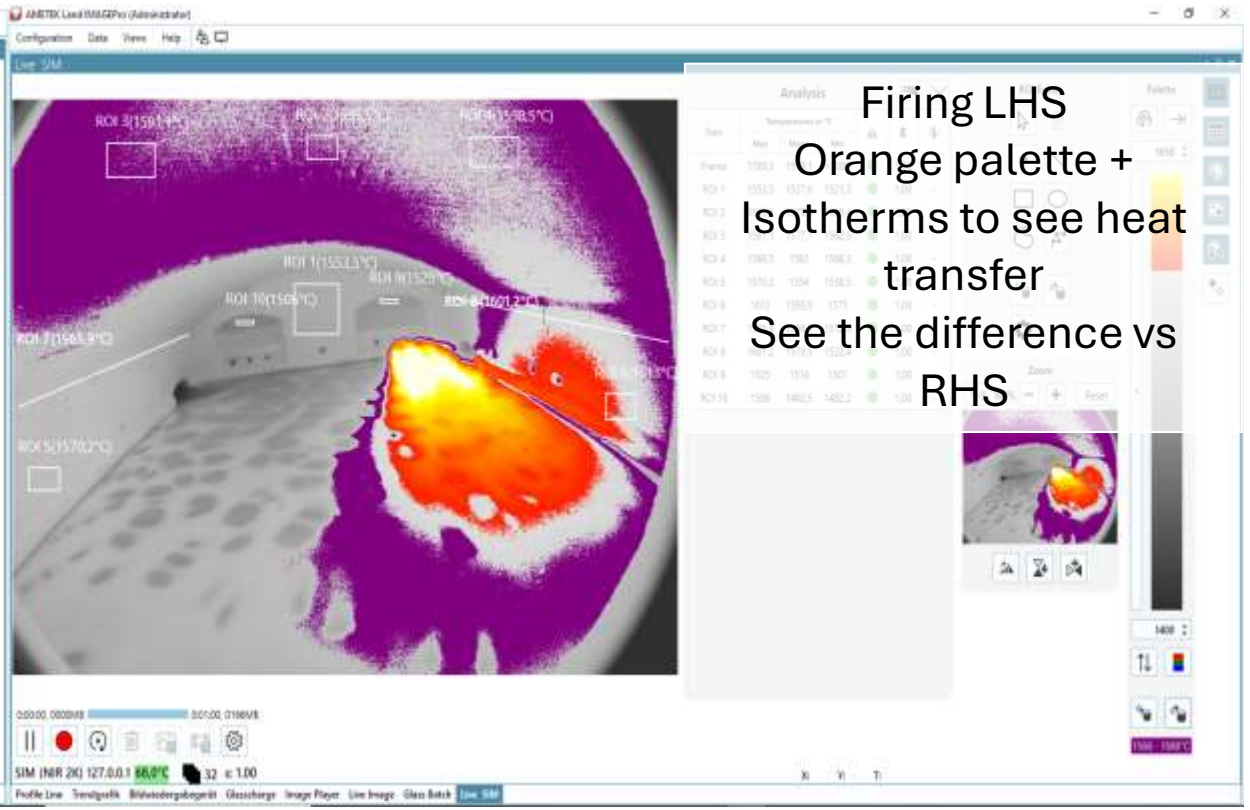


RHS to LHS Frame before reversal frame 9795
Flames Before 8th reversal
Left angle burner definitively changed
Peak flames centred

Flame Shape and heat transfer



Firing RHS
Isotherms +orange palette
See peak flame intense orange to see heat transfer



Firing LHS
Orange palette + Isotherms to see heat transfer
See the difference vs RHS

See the flames impact difference vs RHS

NIR-b-2K – Survey Mode

Heat-Up and Cool-Down processes
Flames optimisation

Benefits of NIR-b-2K – Survey Mode with Amecare

Full survey kit in Storm case

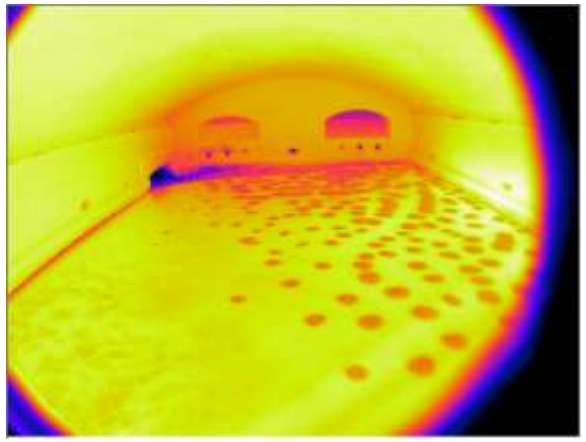
NIR-b-2k camera, 2ft probe, range 1000-1800C.

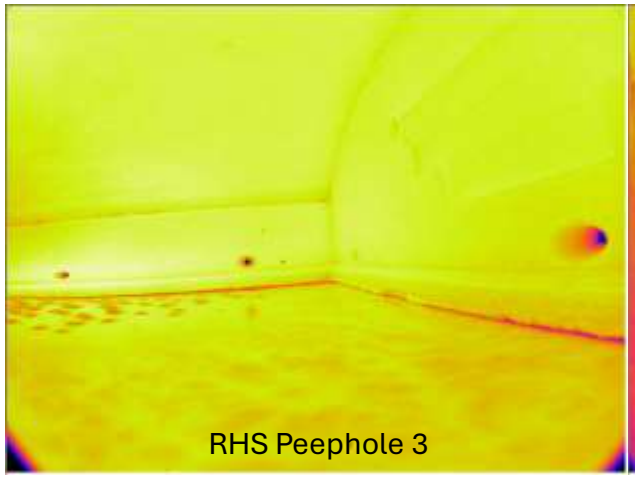
2ft Water Cooled Jacket

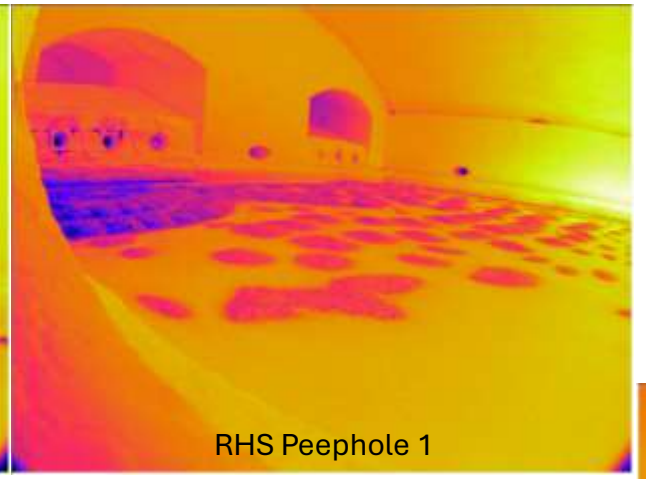
25m Power and Ethernet cables.

Thermal Images – Survey Mode

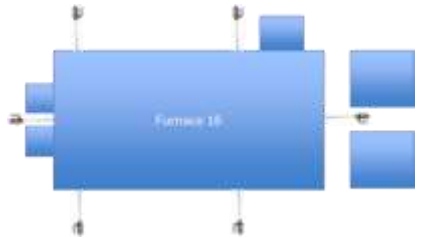
Centre above throat
Existing CCTV location

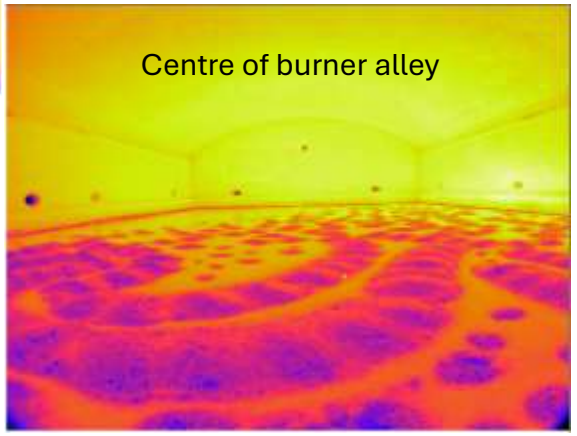


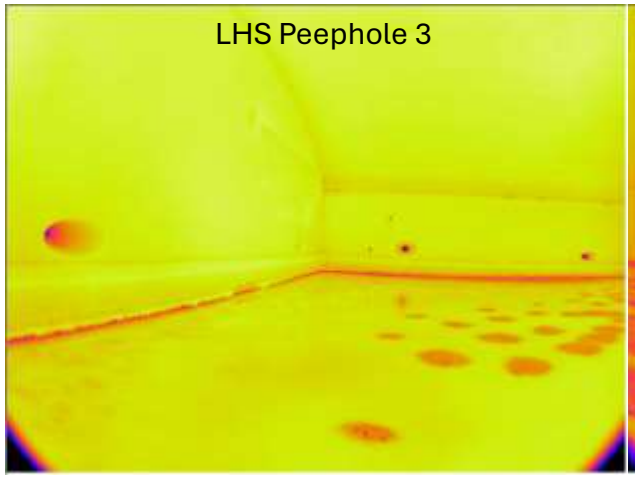


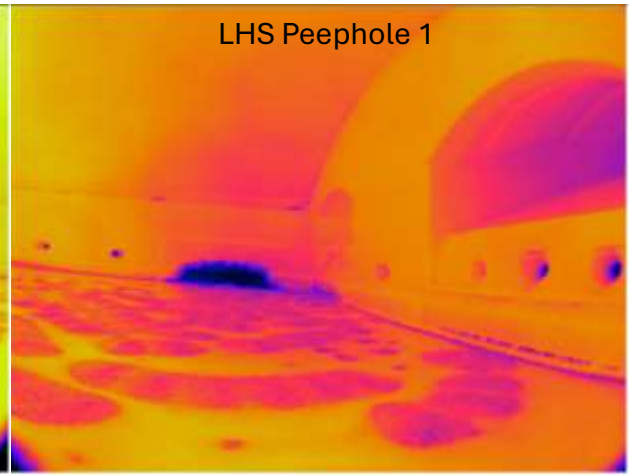


Right Hand Side







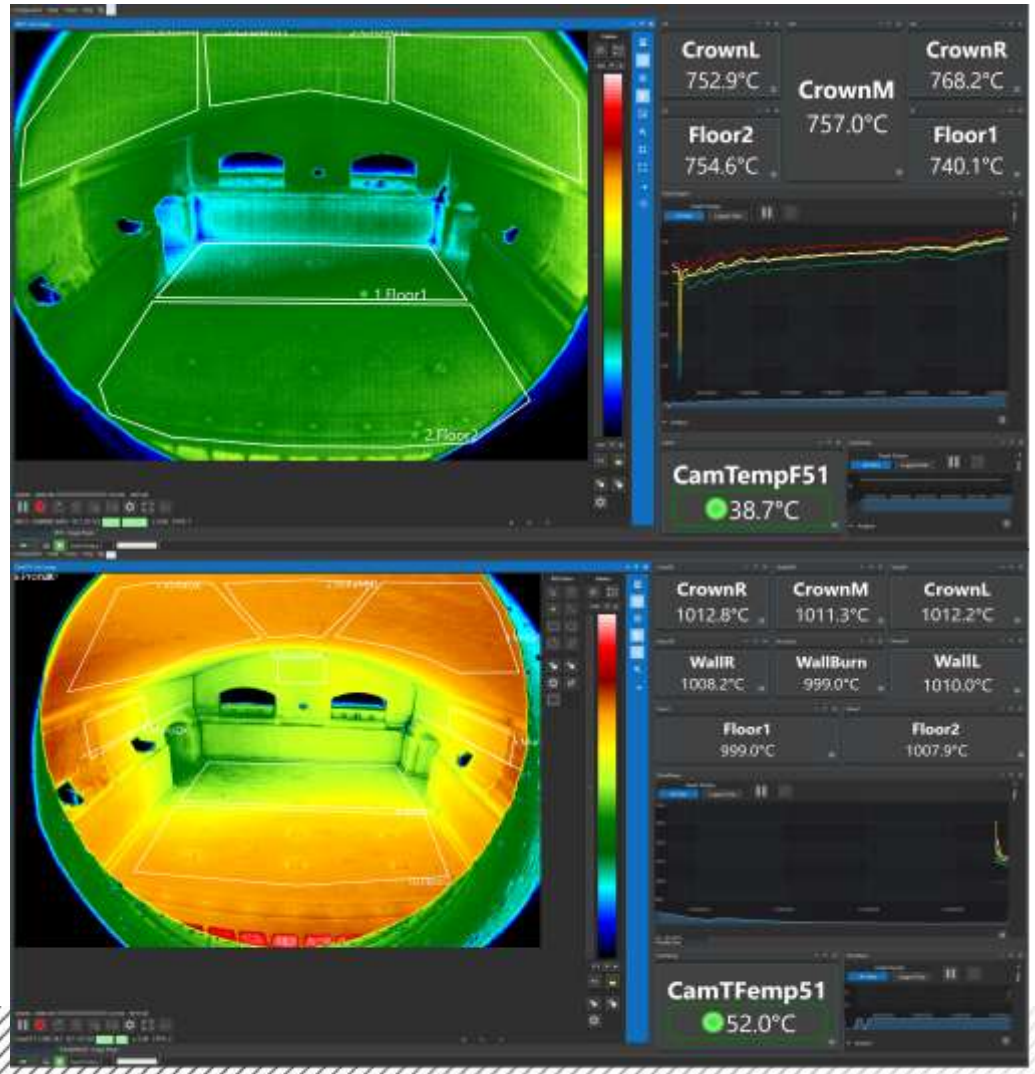


Left Hand Side

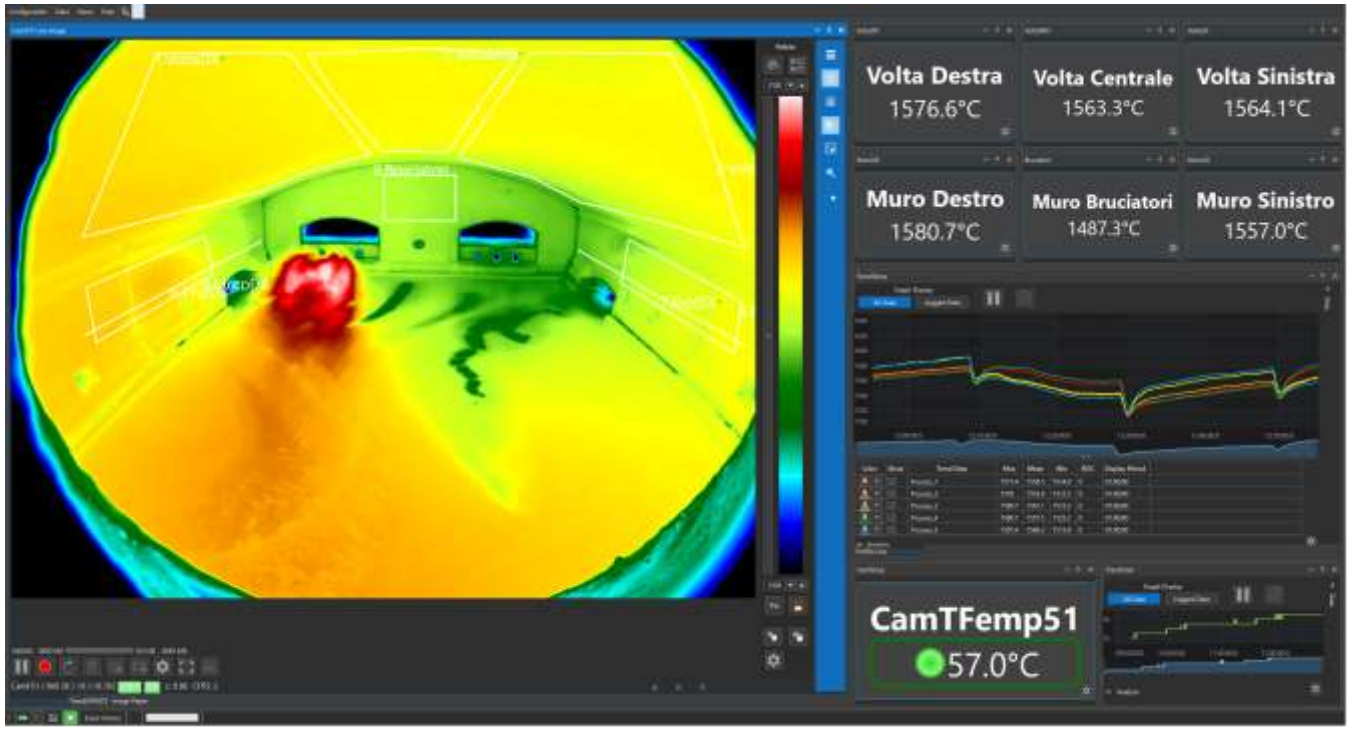

See flames impact on crown (bad angle)
with second burner –
not enough air for proper combustion
Optimisation possible

Heat-up with bundle based on LWIR-640, MWIR-b and NIR-b cameras

Heat-up phase from 100°C to 1000°C



Charging phase with NIR-B 2K



See degrees differently.

Batch coverage and crown temperature with ImagePro V2
GLASS with AI batch coverage based on neural networks

Introduction

- Tracking batch in a glass furnace is challenging due to environmental obstacles especially for regenerative cross fired and large float furnaces.
- Machine learning can improve accuracy over traditional threshold-based methods whatever the furnace technologies.
- This study explores and proposes the use of neural networks for batch tracking and batch line determination.

Batch Coverage and Crown Temperatures

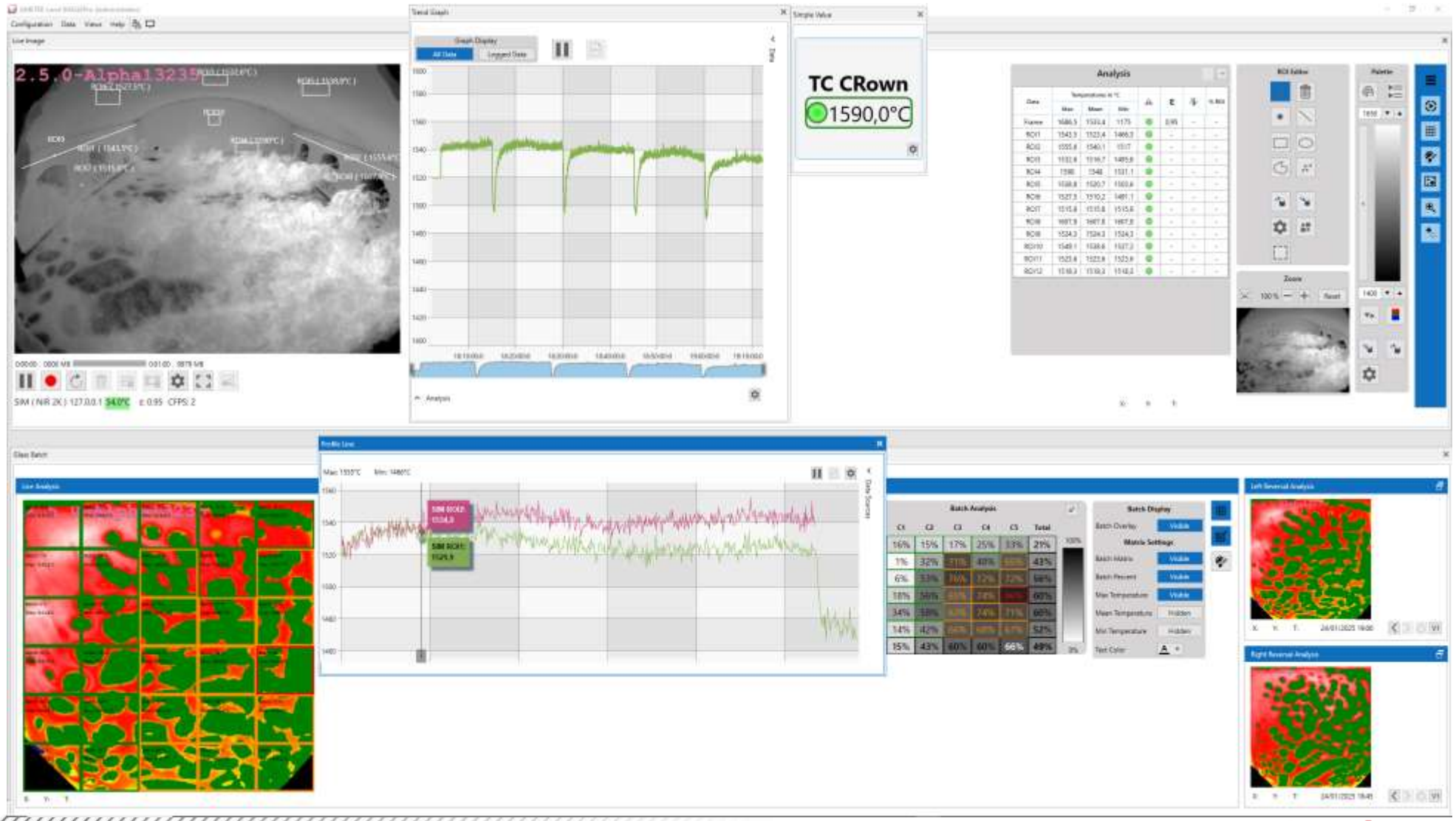
- Variation in Batch coverage has a direct impact on furnace temperatures . The temperature clearly drops when the batch moves to the front of the furnace.
- Better efficient control of the batch coverage by adjustment of the batch charging direction can be adjusted to prevent glass defects.

Top Down 2D view of Batch coverage - The Grid with Neural Network

- A simple method uses a single temperature threshold to distinguish melt from batch creating a Grid on melter surface
  - The key point is to determine the batch coverage and batch line location and
  - Make sure the zone near by the throat is glass only
- Limitations with the threshold method :
  - Incorrect measurements due to varying energy levels across the furnace.
  - Reflections, flames, and hotspots cause inaccuracies especially for cross fired and large float furnaces.

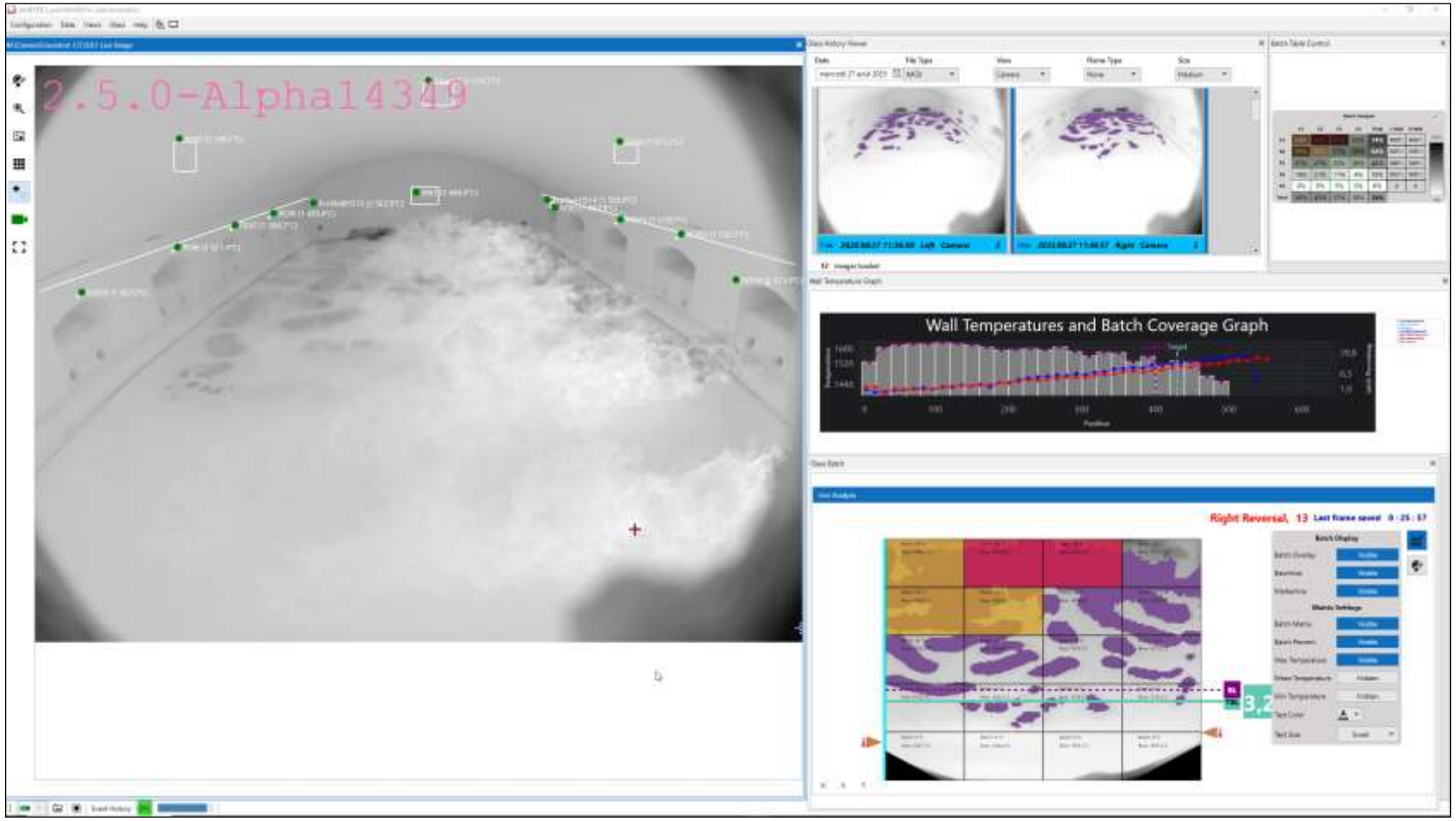
- Introduction to neural network in next ImagePro software
  - Advancements in deep learning allow for improved batch tracking
  - This is based a modified U-Net architecture - Based Model for Batch Tracking developed by LAND based on Semantic Segmentation networks
  - Provide pixel-level classification
  - Multiple category segmentation with single pass (convolutional Encoder-decoder structure) making them more effective.

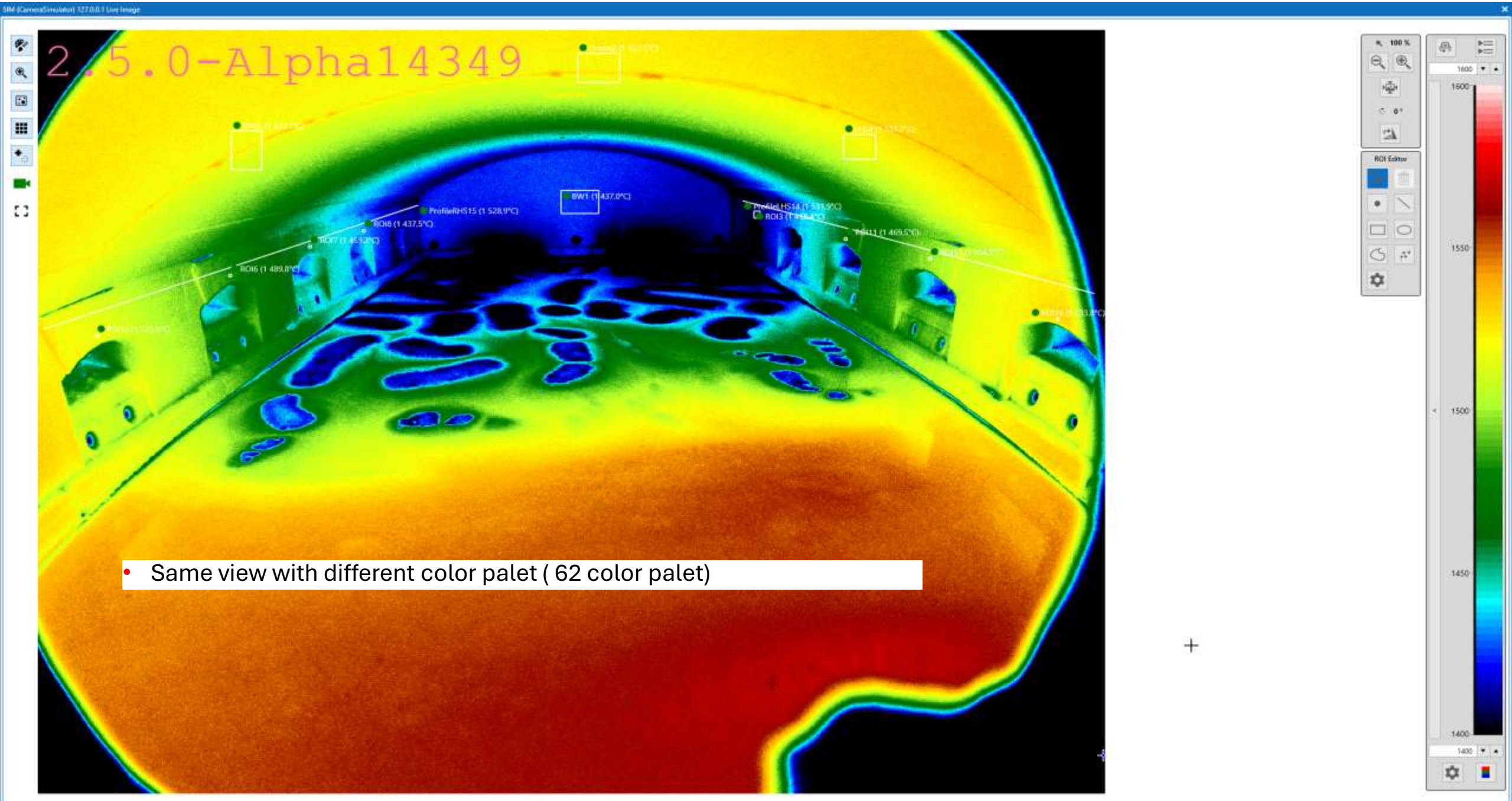
First trials - Regenerative Cross fired result with AI model – Grid repeatable after each reversals



New Interface with IPV2 glass module

- Improved main Camera Field of Views with multiple color palets including orange palet for flames heat transfer
- Improved ROIs interface with scalable values and figures
- New possible interface with AI batch grid
- Glass History Viewer
- Wall Temperature vs Batch coverage graph
- Batch table control

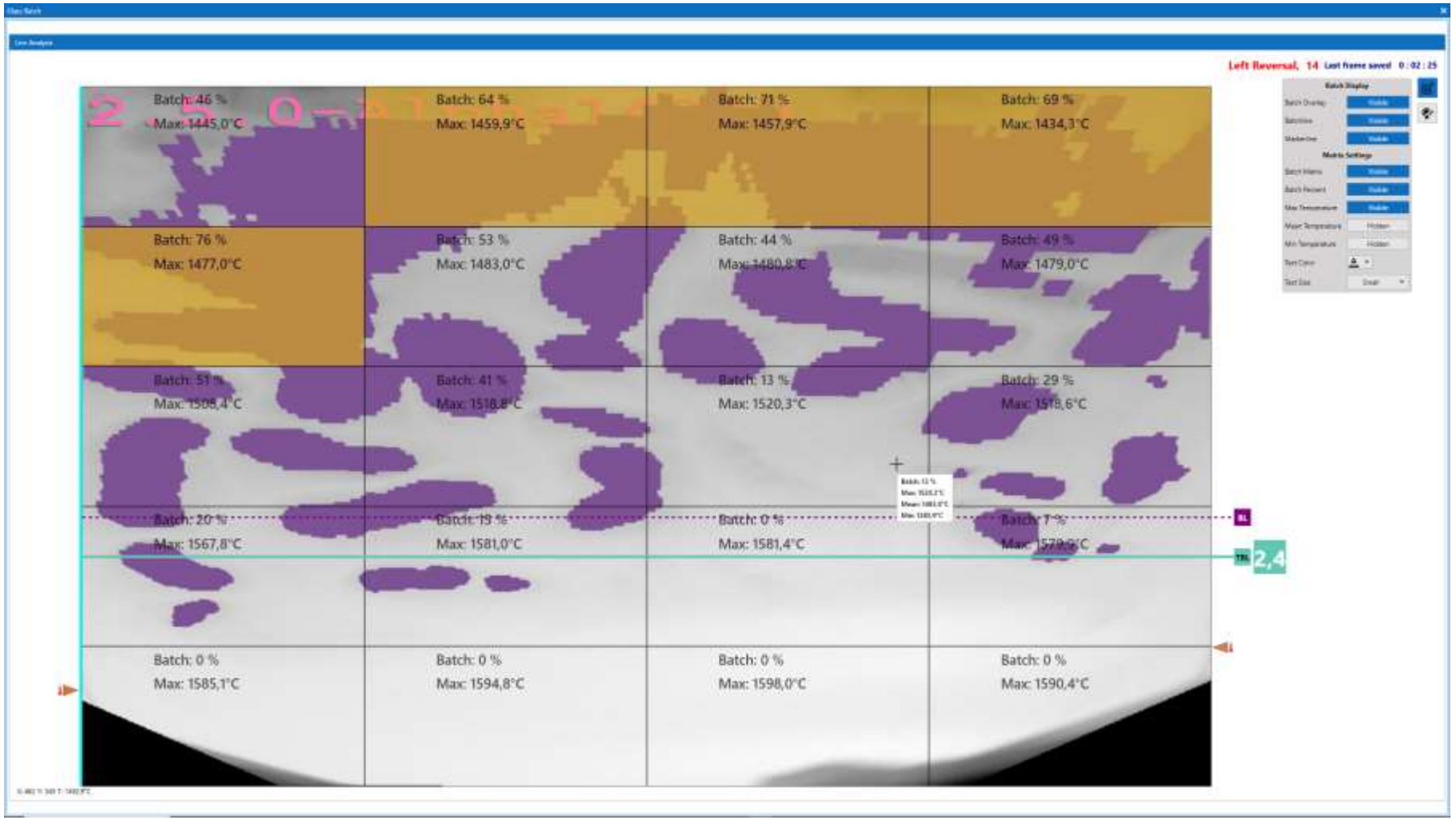




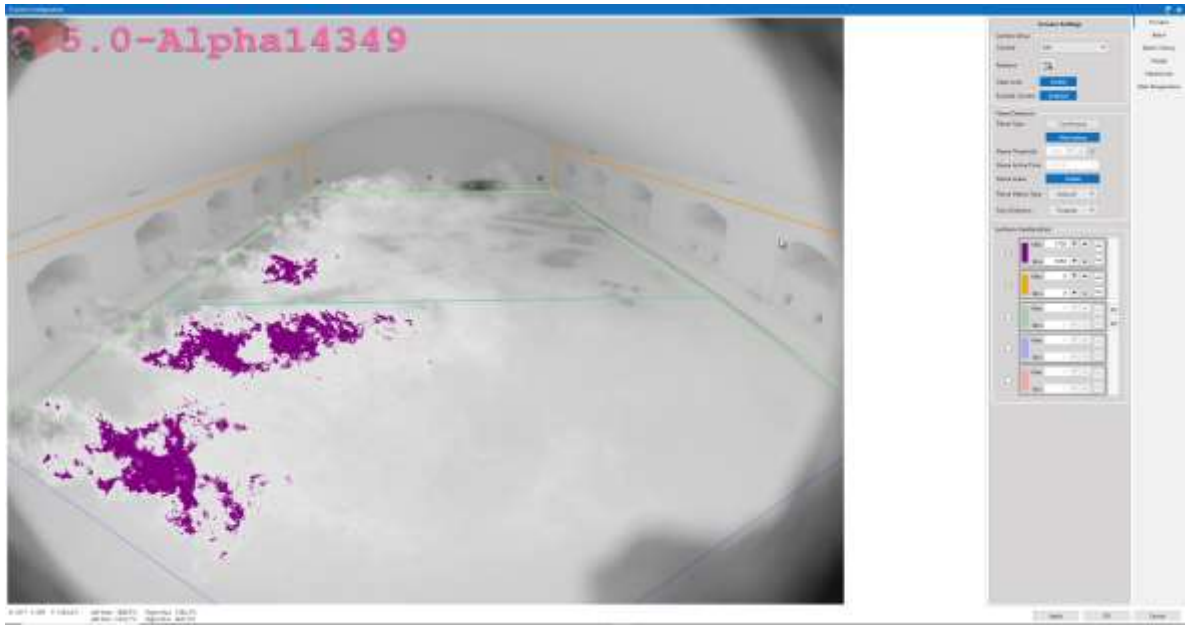
- Same view with different color palet (62 color palet)

Glass Batch Grid with AI Neural Network model

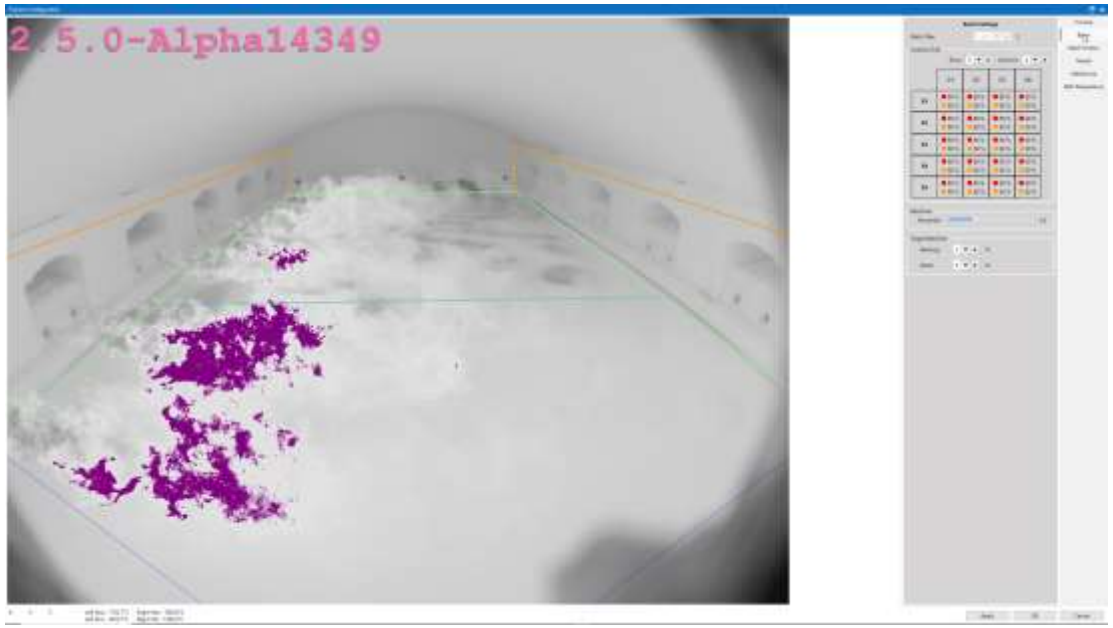
- Calculated batch line BL in purple
- Theorical batch line in green
- Percentage of deviation over time
- Hot Spot locations on side walls in orange



Basic Setting interface for Furnace Configuration

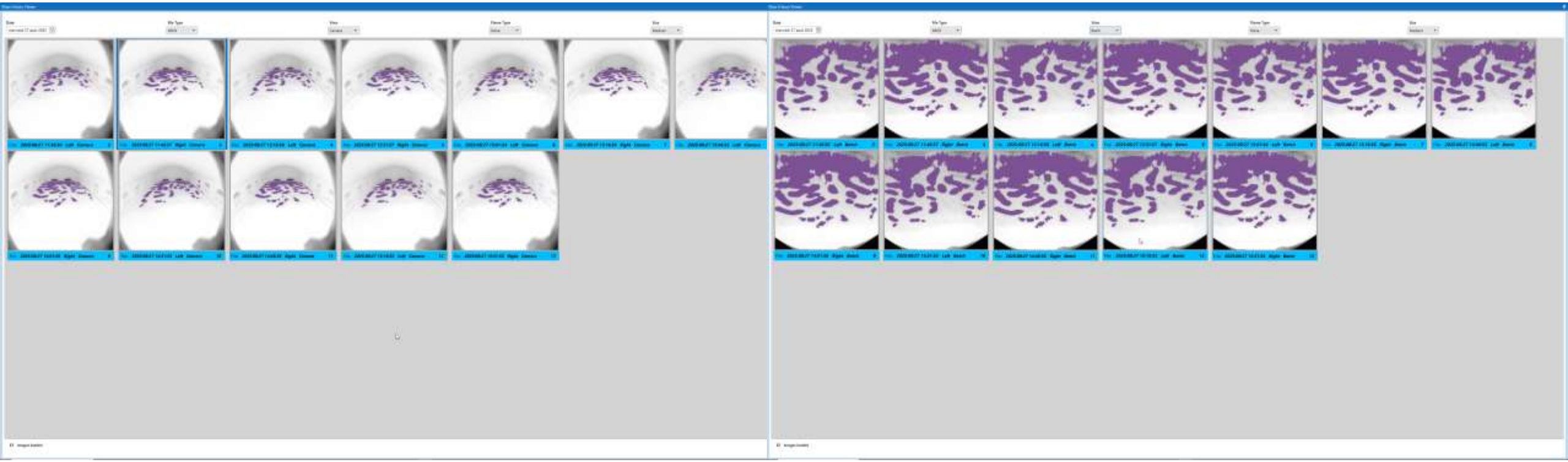


- Interface for basic setting
- Green is melting zone
- Marker line for batch line in blue
- Wall temperature profiles in orange



- Batch mode with Grid selection with alarms
- Batch line target alarms

Glass History Viewer – Batch or Camera view mode



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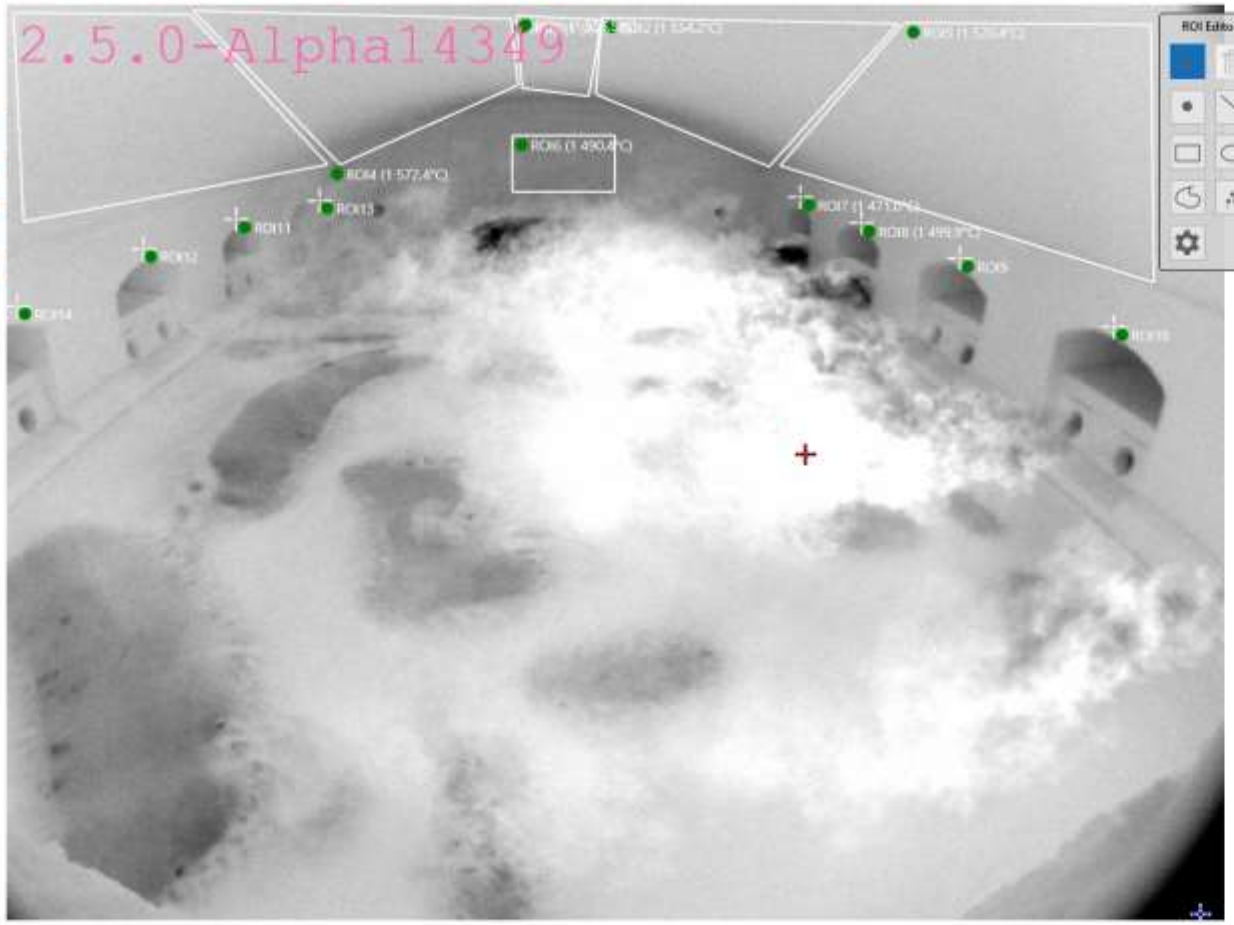
AMETEK Land IMAGEPro (Administrator)

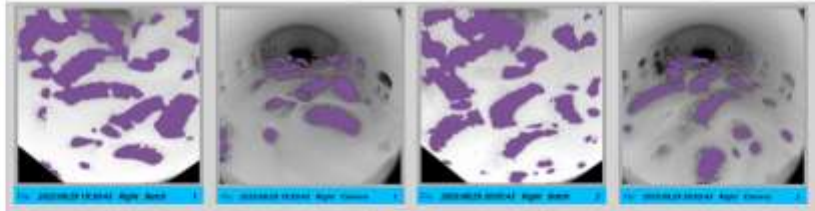
Configuration Data Views Glass Help

SIM (CameraSimulator) 127.0.0.1 Live Image

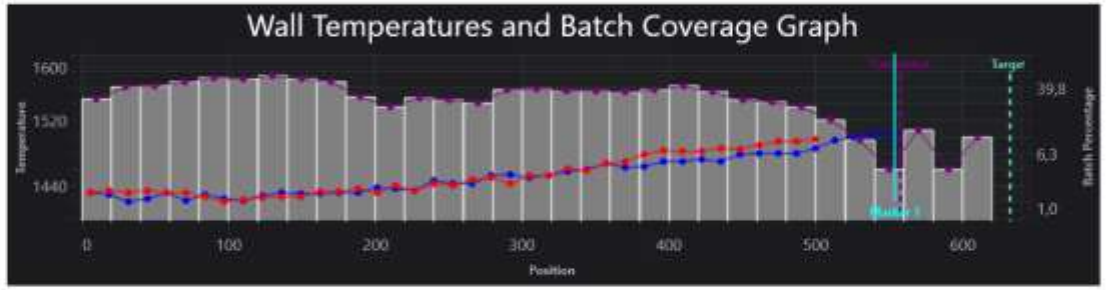


Glass History Viewer

Date: vendredi 29 août 2025 | File Type: IMGK | View: Both | Flame Type: None

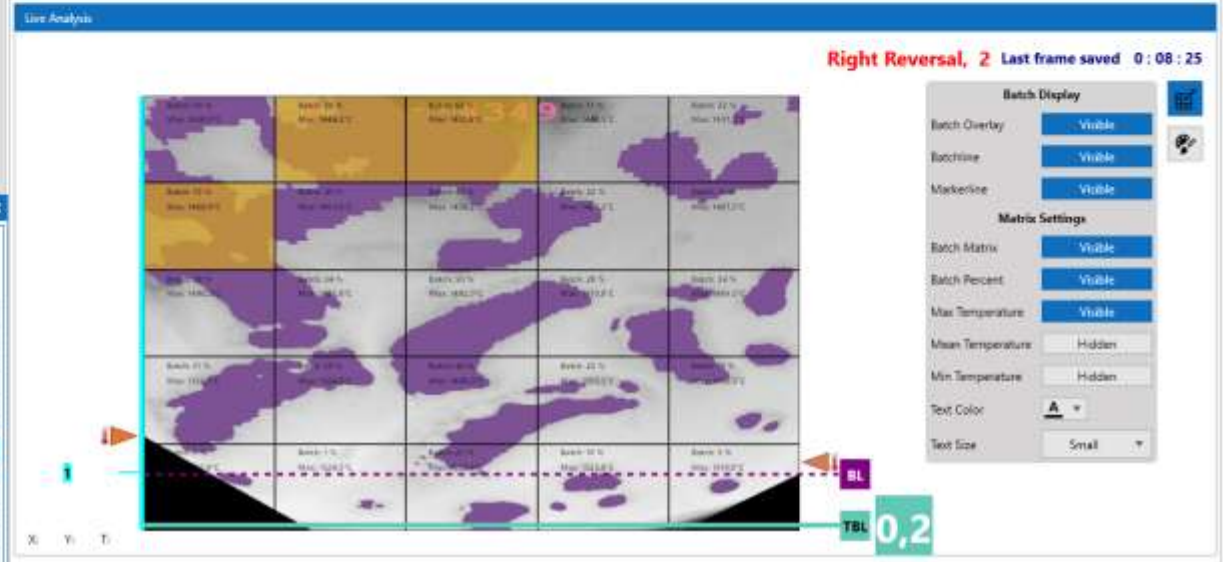


Wall Temperature Graph



Glass Batch

Live Analysis

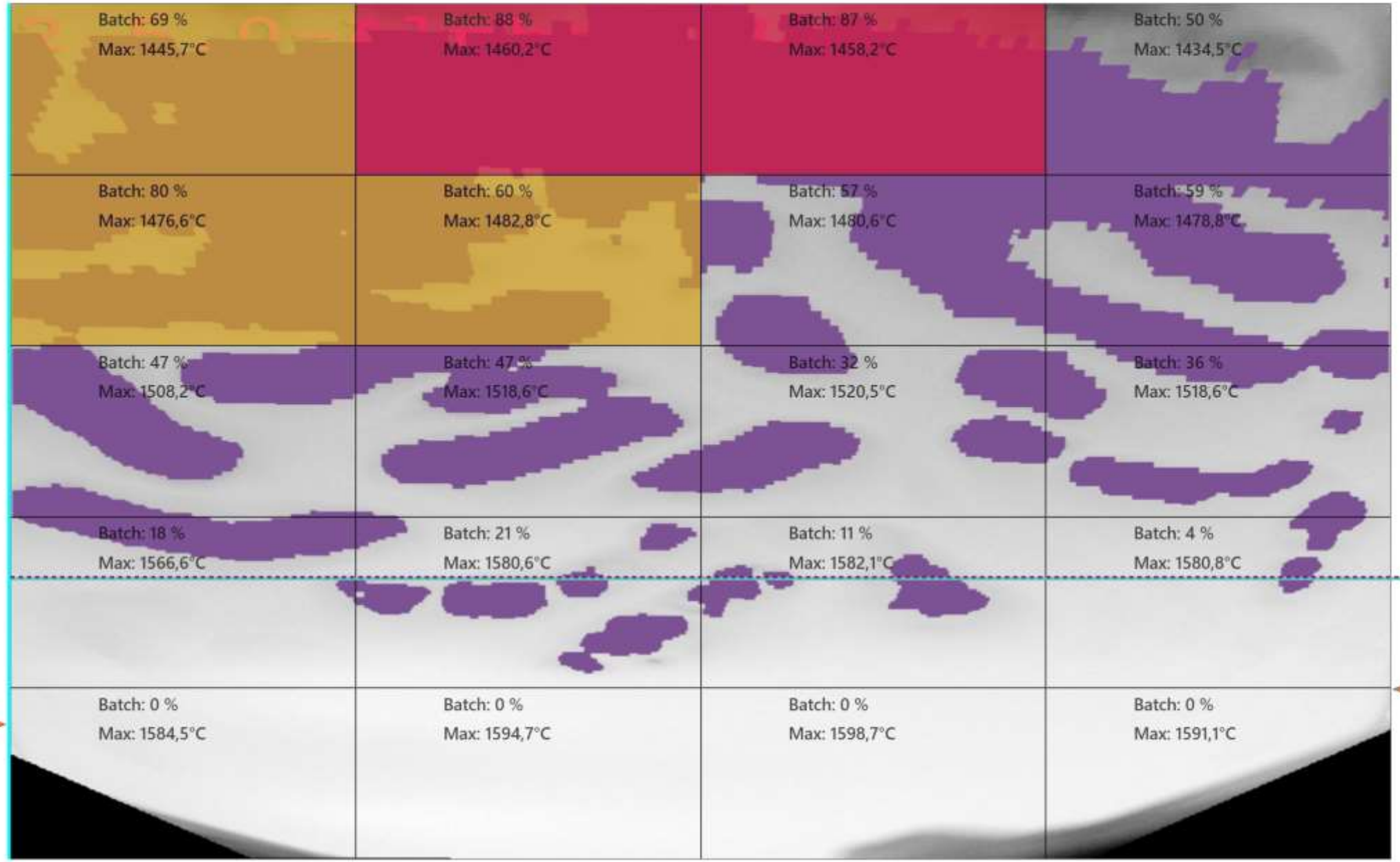


SIM ROI Analysis View

Analysis

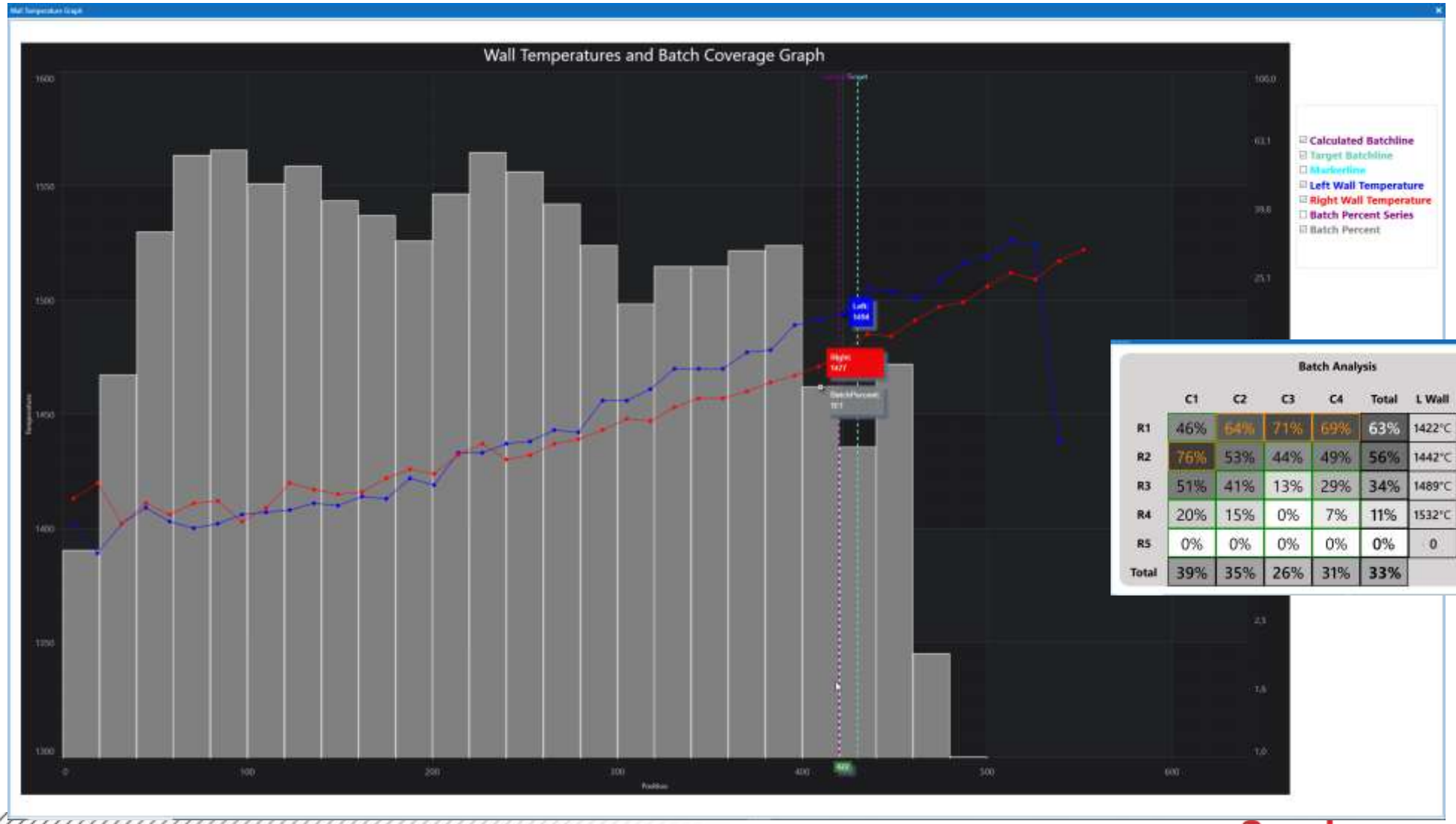
Name	Max	Mean	Min	Alarms	Emissivity	Background
Frame	1665	1538,4	1242,7		0,95	-
ROI1	1555,5	1532,8	1465,7		-	-
ROI2	1554,2	1527,3	1444,9		-	-
ROI3	1562,6	1529,3	1453,6		-	-
ROI4	1572,4	1543,9	1483,6		-	-
ROI5	1570,4	1540	1465,8		-	-
ROI6	1490,4	1474,7	1458		-	-
ROI7	1471	1471	1471		-	-
ROI8	1499,9	1499,9	1499,9		-	-
ROI9	1526,2	1526,2	1526,2		-	-
ROI10	1529,4	1529,4	1529,4		-	-

Right Reversal, 32 Last frame saved 0 : 22 : 11



Batch Display
Batch Overlay Visible
Batchline Visible
Marberline Visible
Matrix Settings
Batch Matrix Visible
Batch Percent Visible
Max Temperature Visible
Mean Temperature Hidden
Min Temperature Hidden
Text Color A
Text Size Small

Wall Temperatures and Batch coverage Graph



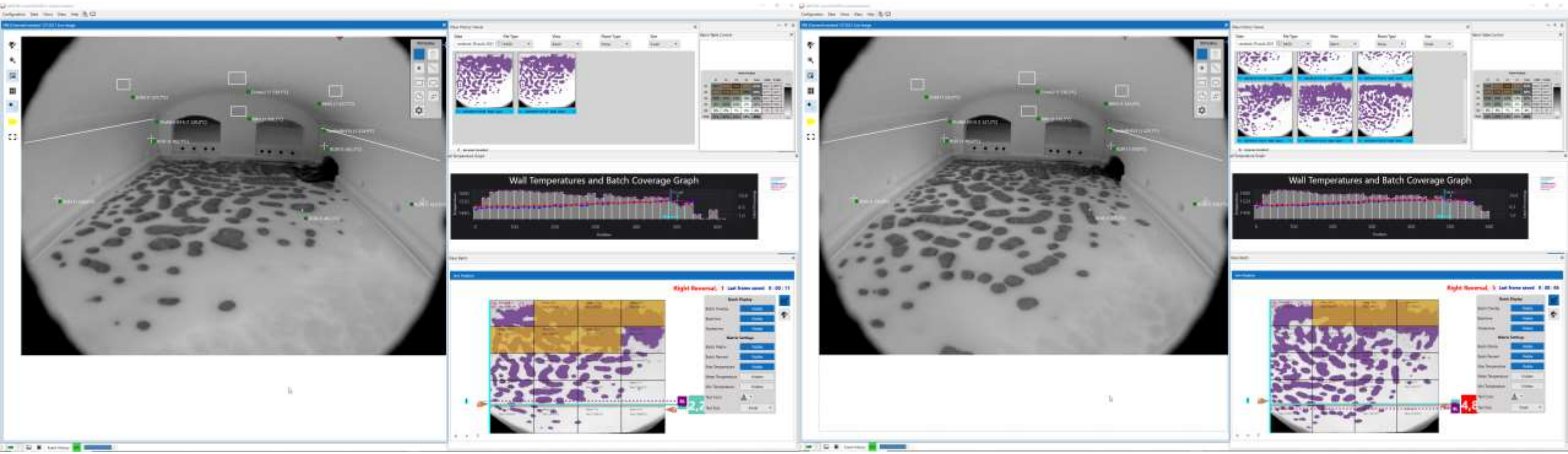
See degrees differently.

End Fired Furnaces
Batch coverage and crown/side walls temperature based on Neural Networks with ImagePro V2 GLASS

Benefits of Batch coverage function – Deviation of Batch Line

Right Reversal #1

Right Reversal #5



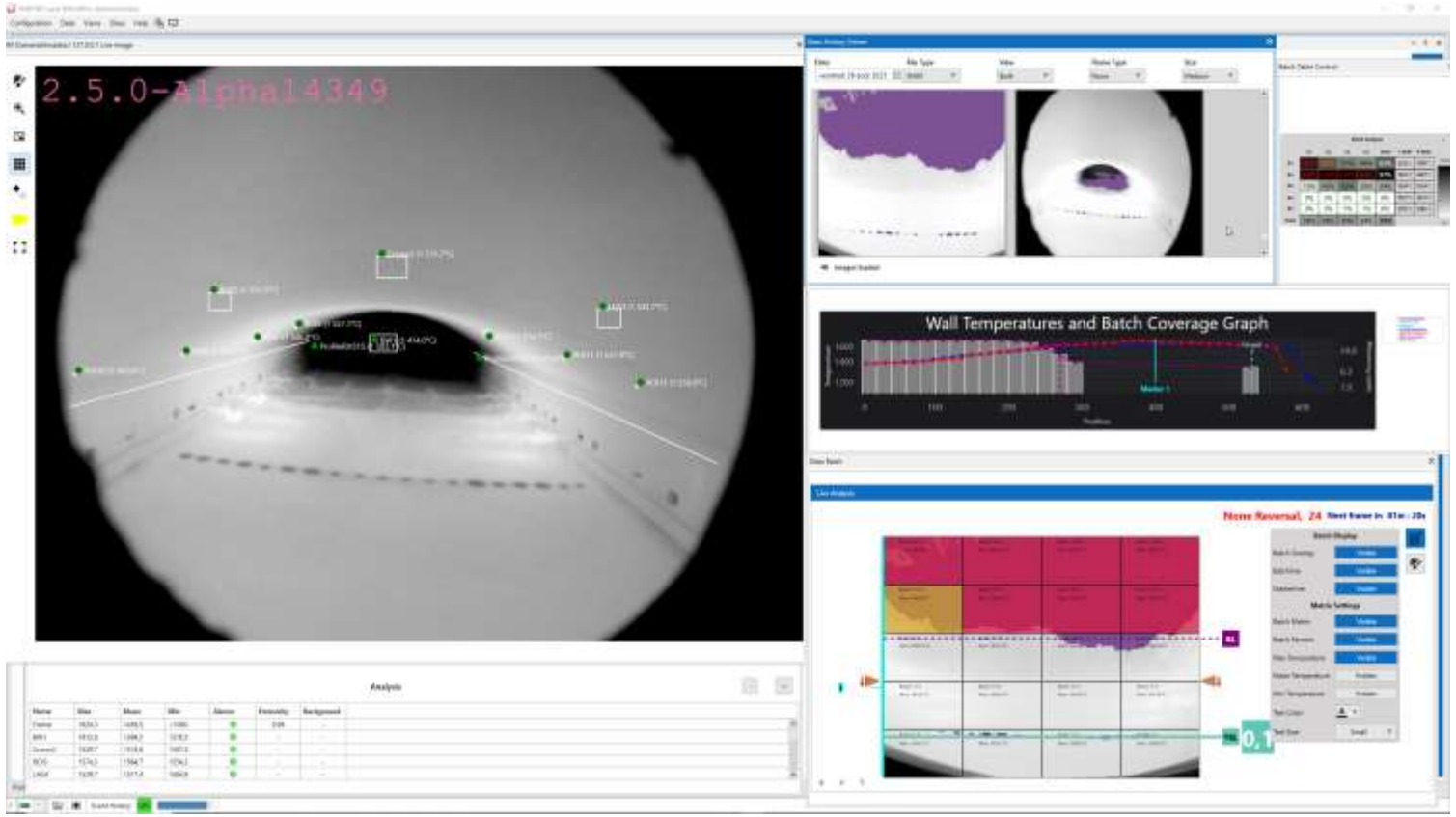
Calculated batch line (BL) behind Theoritical BL after 5 reversals

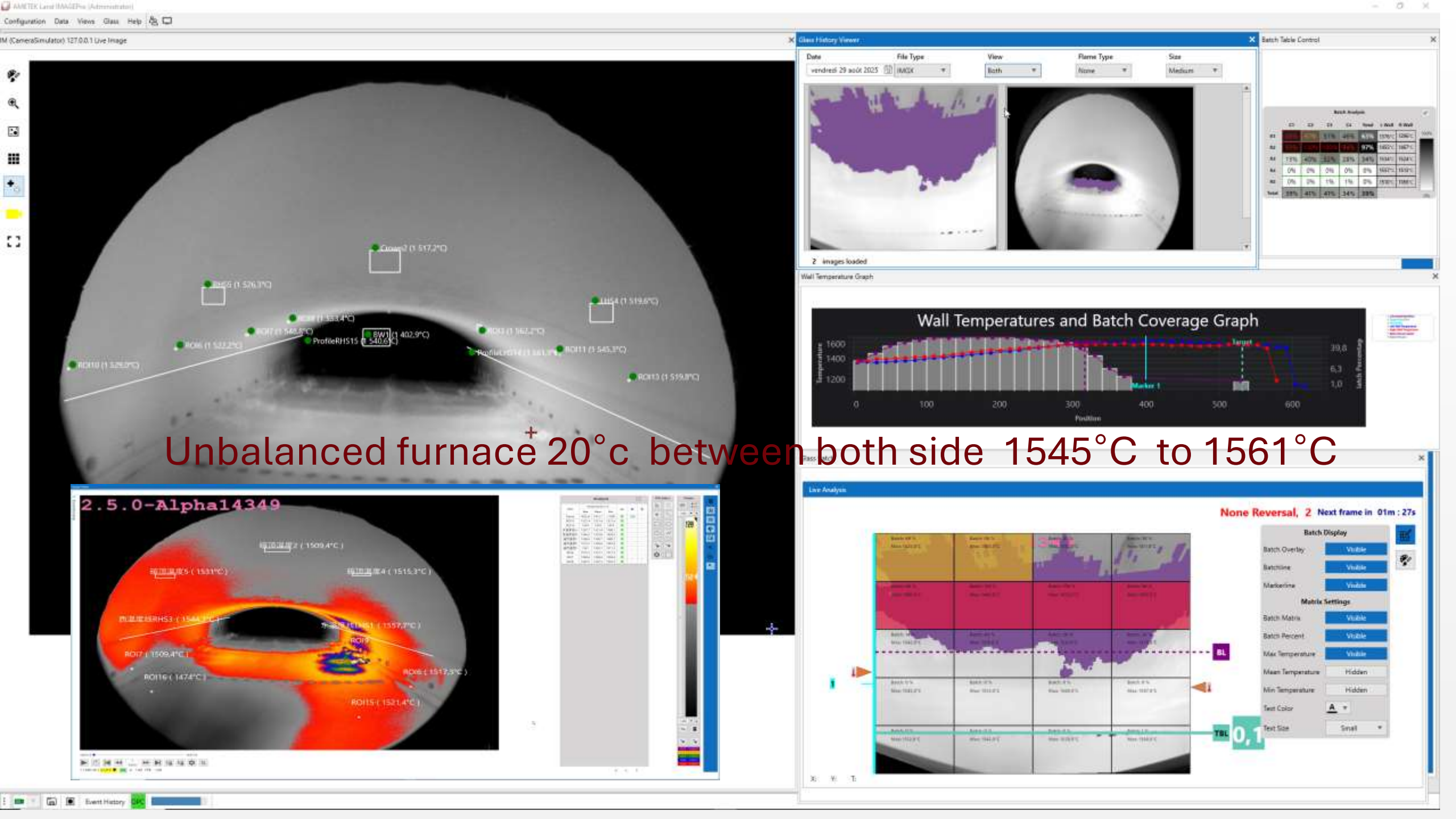
OxyGas furnaces
Batch coverage and crown/side walls temperature with ImagePro V2
GLASS with AI batch coverage based on neural networks

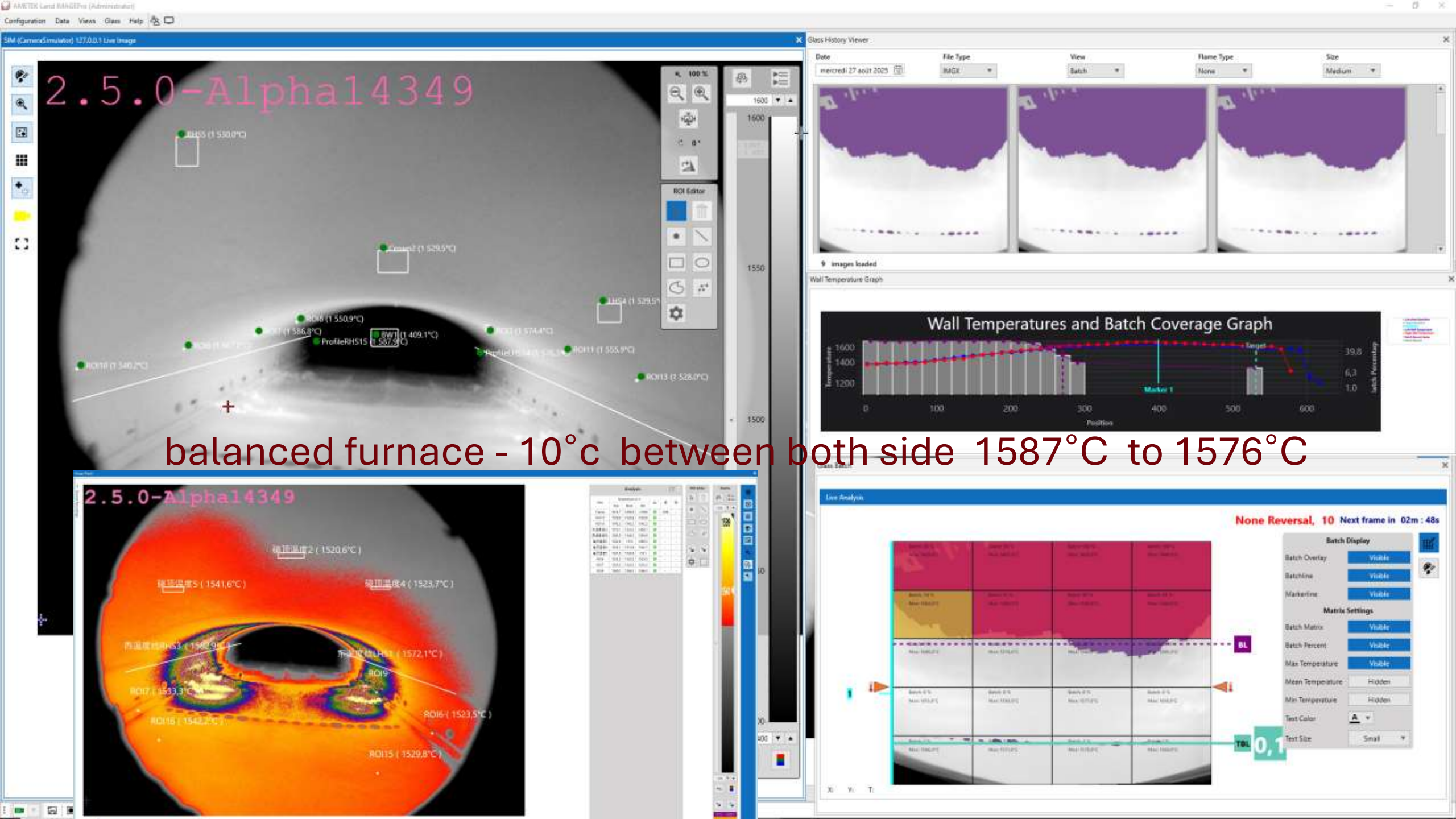
OxyGas furnace – Fiber Glass – optimisation

- During our first site visit, the furnace had already been heated up and commissioned without thermal cameras. At that stage, all settings had been carried out using traditional approaches with thermocouples (TCs) and Cyclops for optical profile determination. The furnace appeared balanced under these methods.

- However, once the NIRB 2K camera was introduced in a later phase, it revealed a significant imbalance: the left-hand side (LHS) of the furnace was hotter than the right-hand side (RHS) by approximately 20 °C. The analysis further showed that the RHS burners were not optimized.
- This issue had not been detected earlier, simply because the TCs and Cyclops measurements could not capture such deviations or subtle temperature differences.

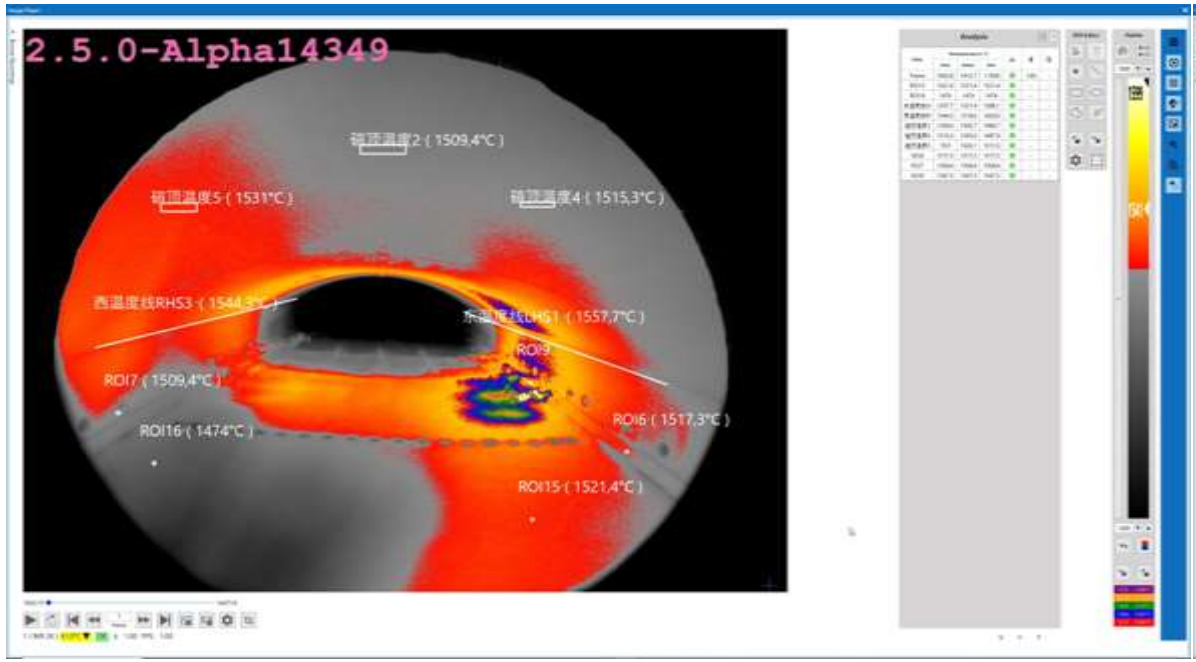



Wall Temperatures and Batch Coverage Graph
Unbalanced furnace 20°c between both side 1545°C to 1561°C
2.5.0-Alpha14349
None Reversal, 2 Next frame in 01m : 27s

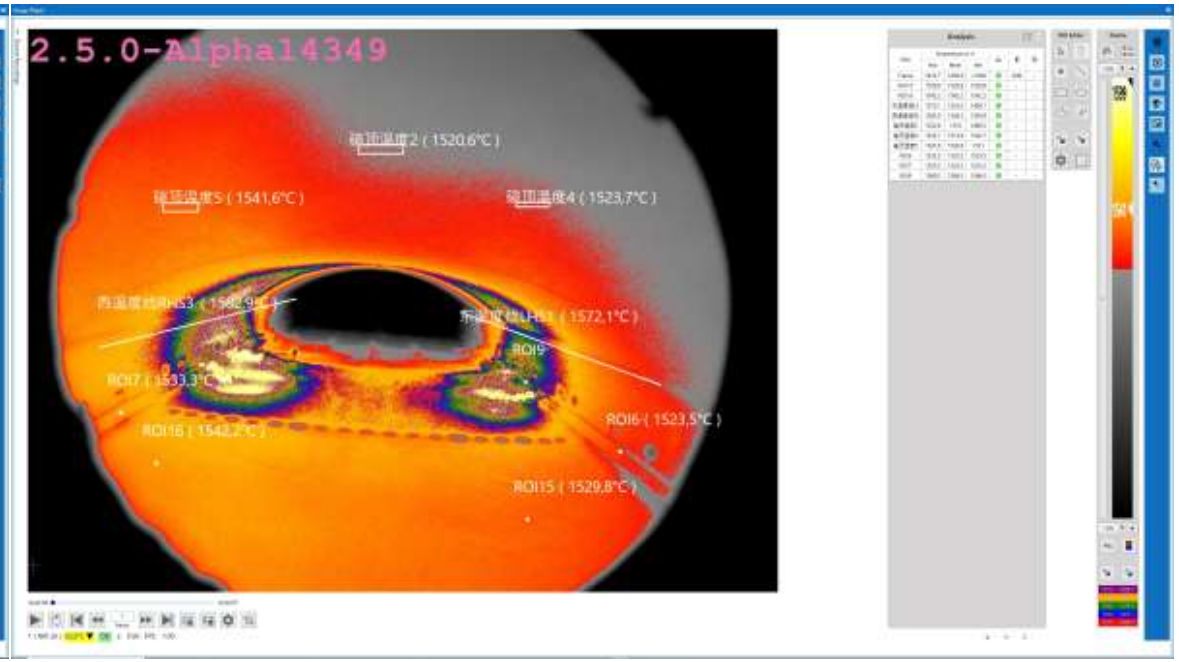

2.5.0-Alpha14349
Glass History Viewer
Wall Temperature Graph
Wall Temperatures and Batch Coverage Graph
balanced furnace - 10°c between both side 1587°C to 1576°C
2.5.0-Alpha14349
None Reversal, 10 Next frame in 02m : 48s

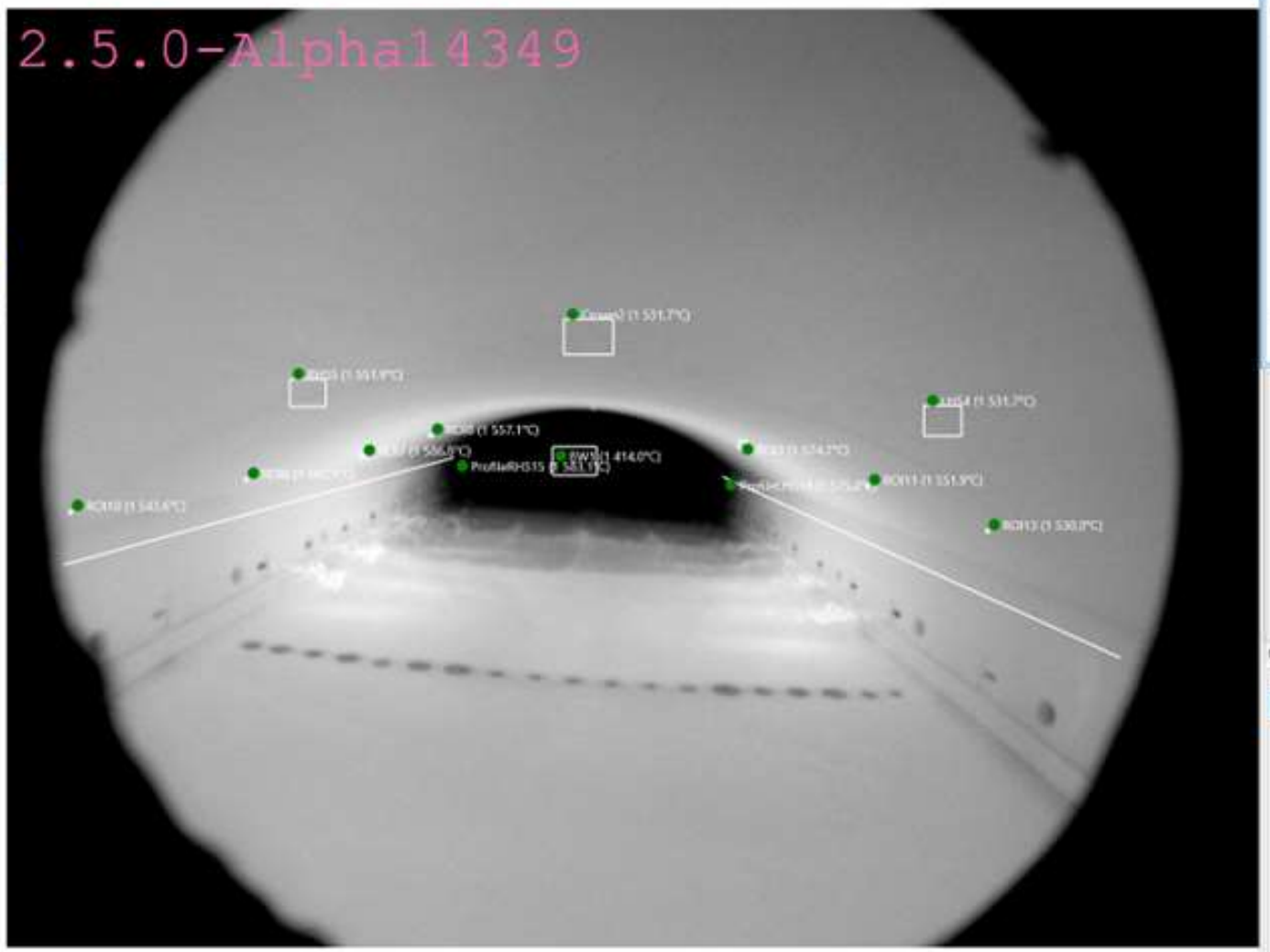
Comparison

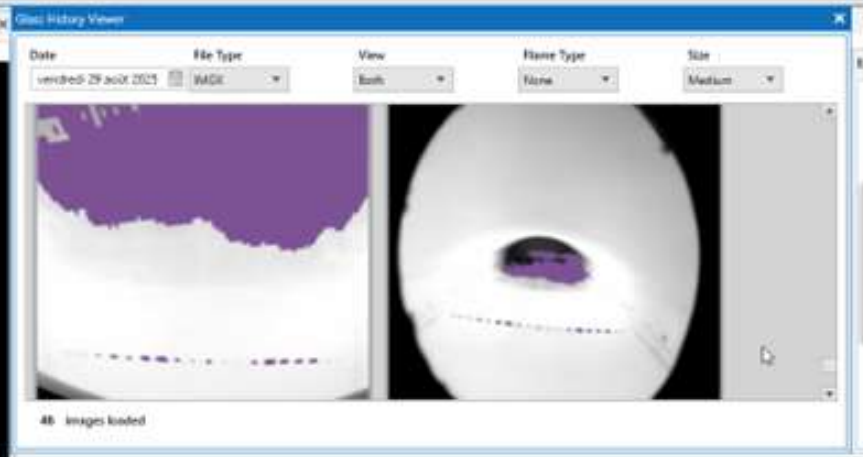
Before

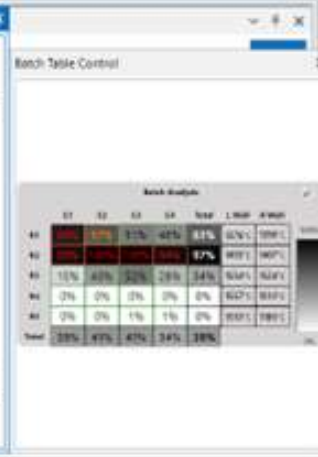


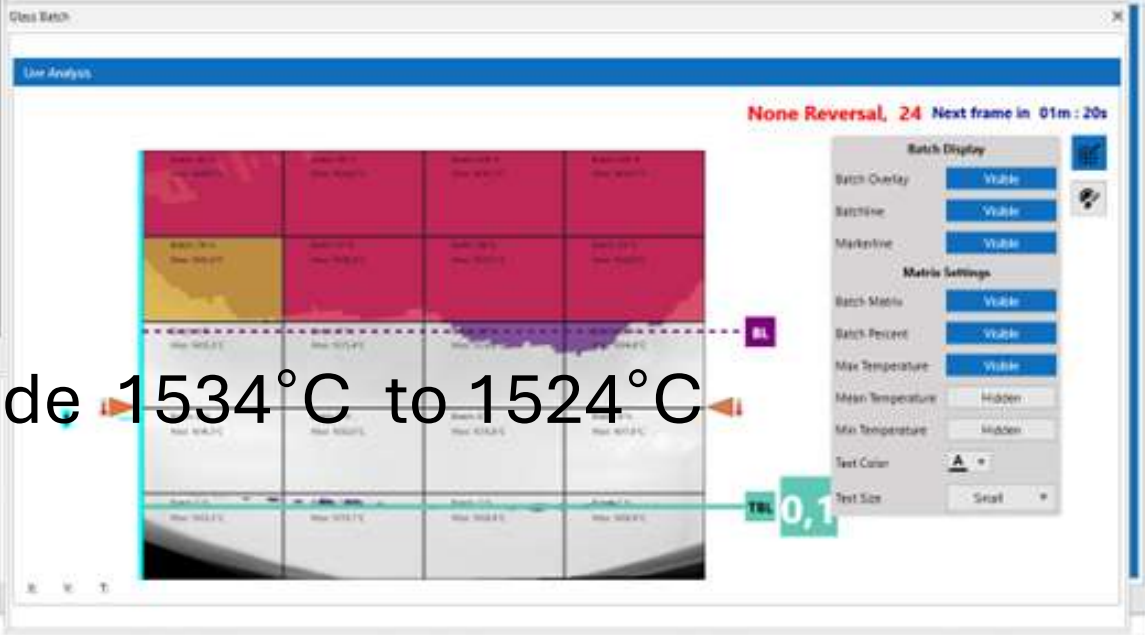
After



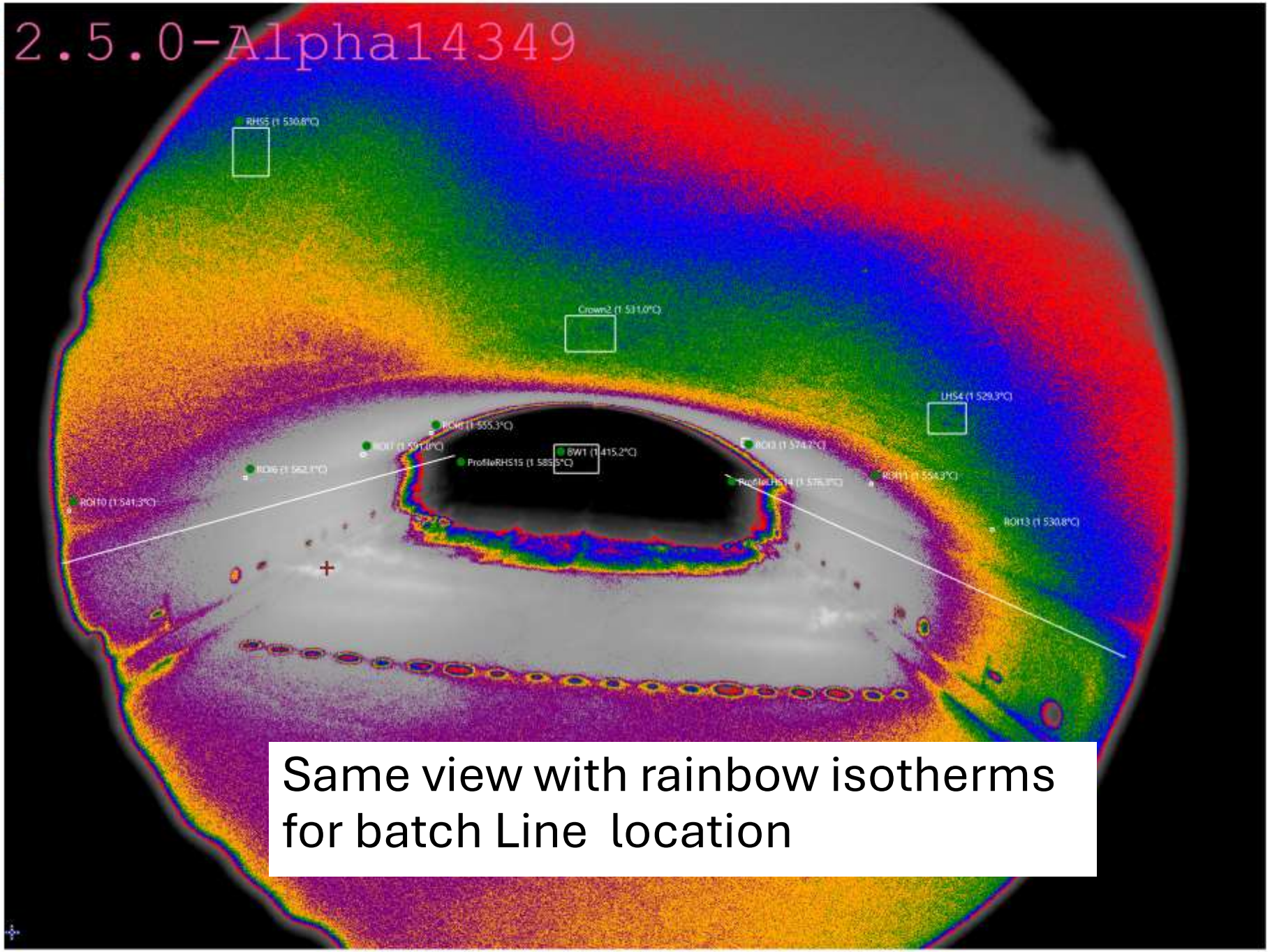








Balanced furnace 10°c between both side 1534°C to 1524°C


2.5.0-Alpha14349
RHS5 (1 530.8°C)
Crown2 (1 531.0°C)
LHS4 (1 529.3°C)
RCW1 (1 555.3°C)
BW1 (1 415.2°C)
ProfileRHS15 (1 585.5°C)
ROI10 (1 541.3°C)
ROI13 (1 530.8°C)
Same view with rainbow isotherms for batch Line location

Conclusion and extended benefits

Why to use NIR-B-2K on glass furnaces? Extended benefits

- The Grid with Neural networks improve batch tracking over traditional threshold-based methods. Available in Q4 2025.
- Better accuracy for batch detection based on Neural existing model.
- Use of SCADA possible to share values of the Grid to get batch line location
- Possible Thermal Surveys with transportable NIR-B combining bundles Gas Analyser and Cyclops C100L
- Combustion optimisation for energy reduction
- Digitalisation with thermal distribution, bird eyes pictures and Glass History Viewer – Modbus or OPC UA server
- Predictive software or SCADA – EU References
- Traceability and Data for quality management
- Extended life of assets and improved daily furnace operations

- The simple way to support the operation team to optimise and balance any Furnace

Thermal Imaging Systems For Continuous Monitoring In Different Furnace And Boiler Applications – Examples

NIR-B-656

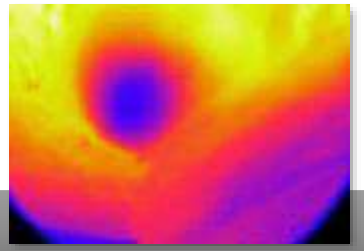
Standard resolution (656 x 494 pixels) gives over 300 thousand temperature points.

Image Pixels:	656 x 494
Measurement Ranges:	600 to 1000 °C / 1112 to 1832 °F 800 to 1400 °C / 1472 to 2552 °F 1000 to 1800 °C / 1832 to 3272 °F
Field of View (Horizontal x Vertical):	90° x 67.5°, 44° x 33°
Glass Melt Tank Model - **NIR-B-656-GLASS** (please refer to NIR-B-GLASS Brochure)	1000 to 1800 °C / 1832 to 3272 °F 90° x 67.5°

TYPICAL APPLICATIONS

Reheat Furnace	Glass Melt Tanks
Reformer Tube Furnaces	Cement Kilns
Coal Fired Power Boilers	Biomass Boilers

Example:
Cement Furnaces (rotary kilns) or boilers



Medium & Small Furnaces

NIR-B-2K

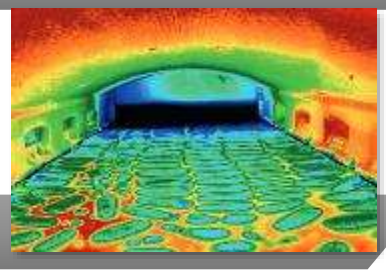
High resolution (1968 x 1472 pixels) gives nearly 3 million temperature points.

Image Pixels:	1968 x 1472
Measurement Ranges:	600 to 1000 °C / 1112 to 1832 °F 800 to 1400 °C / 1472 to 2552 °F 1000 to 1800 °C / 1832 to 3272 °F
Field of View (Horizontal x Vertical):	95° x 71°
Glass Melt Tank Model - **NIR-B-2K-GLASS** (please refer to NIR-B-GLASS Brochure)	1000 to 1800 °C / 1832 to 3272 °F 95° x 71°

TYPICAL APPLICATIONS

Reheat Furnace	Glass Melt Tanks
Reformer Tube Furnaces	Cement Kilns
Coal Fired Power Boilers	Continuous Casting

Example:
Glass Melt Tanks



Large Furnaces

NIR-B-640

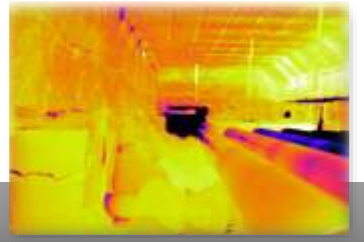
Wide dynamic range imaging technology for furnace applications where a wider temperature measurement range is required from a single imager.

Image Pixels:	640 x 480
Measurement Range:	600 to 2000 °C / 1112 to 3632 °F
Field of View (Horizontal x Vertical):	90° x 67.5°

TYPICAL APPLICATIONS

Cement Kiln	Cement Cyclone Furnace
Reheat Furnace	Continuous Casting (zone 1)
Heat Treatment Furnace	Annealing Furnace

Example:
Reheat Furnaces



Heat & Reheat Furnaces

NIR-B-3XR

Hazardous area compliant to ATEX, IECEx and CSA. Wide dynamic range imaging technology for furnace applications where a wider temperature measurement range is required from a single imager.

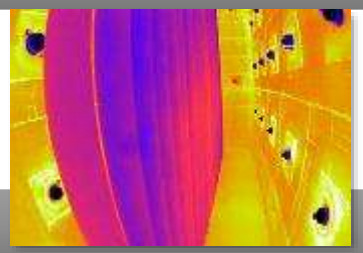
Image Pixels:	640 x 480
Measurement Range:	600 to 1800 °C / 1112 to 3272 °F
Field of View (Horizontal x Vertical):	90° x 67.5°

Hazardous Area Certification: EX NIR-B WG1: Ex nA IIC T4 Gc Tamb=–20 °C to +55 °C (ATEX certificate: CML 15ATEX4086X / IECEx certificate: IECEx CML 15.0042X) EX NIR-B WG2: Class I, Division 2, Groups A, B, C, D; T4 Tamb=–20 °C to +60 °C (CSA certificate for US and Canada: 70080206)

TYPICAL APPLICATIONS

Hydrogen Reformer	Ammonia Production
Ethylene Cracking Furnaces	Methanol Production
Syngas Production	

Example:
Tube Furnaces (Reformers & Crackers)



Tube Furnaces (HPI)

See degrees differently.

Philippe Kerbois
Global Industry Manager - Glass
philippe.kerbois@ametek.com

+33 (0) 6.75.38.39.87

See degrees differently.