GRAYESS Inc.

IRT KilnMonitor

User manual

Revision: 7.8.23

www.grayess.com

Contents

1 Installation and general settings 5
1.1 Description 5
1.2 PC requirements 5
1.3 License agreement 6
1.4 Software installation 6
1.5 Managing licenses 10
1.6 Start-up screen 13
1.7 Language and other program settings 15
2 Configuration 17
2.1 Migrating from IRT KilnMonitor version 2.x to version 3.x 17
2.2 Kiln monitoring principles 18
2.3 System configuration 19
2.4 Kilns monitored on one computer 20
2.5 Managing configurations 20
2.6 Importing CS200/CS210 configuration 21
2.7 Kiln dimensions and monitoring hardware 22
2.8 Scanner configuration 28
2.9 MP-scanner communication and parameters 35
2.10 Camera2D communication and parameters 36
2.11 ThermoView TV30/TV40 37
2.12 Pyrometer configuration 41
2.13 Pyrometer communication and parameters 43
2.14 WAGO 750-362 field bus coupler 45
2.15 Kiln shell image composition algorithm 49
2.16 The kiln trigger 50
2.17 Tire slip monitoring 53
2.18 Burning zone monitoring 55
2.19 Bearings / Other monitoring 56
2.20 Kiln refractory and special zones 58
2.21 Alarms 63
2.22 History storage 73
2.23 Monitoring database 75
2.24 System backup and recovery 77
2.25 OPC UA configuration 79
2.26 OPC Classic configuration 80
2.27 Passwords 82
3 Operation 84

3.1 Client-server structure 84
3.2 Connecting a client to a server 84
3.3 Starting and stopping kiln monitoring 86
3.4 Monitoring window 87
3.5 System state window 90
3.6 Alarms indication 93
3.7 Kiln views 94
3.8 Temperature map 2D view 95
3.9 3D kiln views 99
3.10 Temperature scale and palette 102
3.11 Reference views 104
3.12 Horizontal profile 104
3.13 Temperature trend 105
3.14 Image trend 107
3.15 History reference 108
3.16 Refractory diagram 110
3.17 Thickness / Coating diagram 111
3.18 Tire slip indication 112
3.19 Rotation / Tire slip history 113
3.20 Burning zone 114
3.21 Bearings / Other 117
3.22 Resetting maintenance alarm 119
3.23 Monitoring window layouts 120
3.24 Multiple monitoring windows 120
3.25 Alarms suppression 121
3.26 Brick and coating thickness calculation method 122
3.27 Thickness measurement calibration 123
3.28 Temperature inside the kiln 125
3.29 Resetting brick thickness map 126
3.30 Kiln history 127
3.31 Monitoring report 130
3.32 Refractory report 133
3.33 Export 134
3.34 Printing 136
3.35 Access to measured data for third-party applications 136
3.36 Logs 148

4 Procedures 149
4.1 Configuration for a new campaign 149

5 3rd party libraries 150

6 Document revisions.....152

1 Installation and general settings

1.1 Description

IRT KilnMonitor is a comprehensive temperature measurement system for the monitoring, control, and analysis of rotating kiln shells used in cement and lime production, mineral processing, hazardous waste incineration and other processes. This system is a unique combination of hardware centered on the industry-leading IR cameras and linescanners and a powerful, industrial software package. The system allows accurate monitoring of the kiln shell and early detection of hot spots indicating damaged or missing refractory bricks, preventing costly kiln damage and extending production runs.



The key component of the IRT KilnMonitor system is one or more infrared linescanners. The linescanner collects infrared energy, emitted from the kiln surface allowing the system to measure the temperature along the length of the kiln.

The IRT KilnMonitor system provides many features, which include full-color thermograms of the kiln surface, user defined alarms, automatic fan control and extensive historical data analysis capability. The IRT KilnMonitor system also adds OPC server functionality and full integration of all available accessories. Most notably, additional point sensors can be installed and configured to monitor portions of the kiln “shadowed” from the main sensor by physical obstructions and the results displayed as one homogenous thermogram. Similarly, a separate sensor is available to monitor the burning zone of the kiln and again the data will be seamlessly incorporated into one common display in the control room.

Using a optical fiber cable from the scanner in the field to the PC Ethernet interface in the control room is a reliable way for connecting. Using fiber optics, you can prevent electrical interference from corrupting the IRT KilnMonitor system. The optical fiber cable supports high speeds and long distance transmissions (up to 2 km / 1.2 mi). One fiber optic communication line only from the field to the control room minimizes the installation efforts on-site.

1.2 PC requirements

Software

IRT KilnMonitor has been designed to work with Microsoft Windows 7/8/10/11 32 and 64 bit operation systems (ARM architecture is not supported).

Hardware

PC hardware requirements depend on the number of monitored kilns and the number of used scanners. For servers it is also important to consider how many clients should be served simultaneously. For most cases this configuration will be sufficient:

- Processor: x64 architecture, two-core with 3 GHz per core or four-core with 2 GHz per core
- RAM: 4 GB
- Hard disk: at least 500 GB free space (for history database), 7200 RPM HDD or better an SSD
- Display: 1920x1080 or higher resolution with about 96 DPI (high density monitors are not supported).
- Gigabit Ethernet LAN adapter

TCP/UDP ports

If an external firewall is used, this is the list of used ports that must be allowed through the firewall:

- IRT KilnMonitor Server: TCP 8428;
- IRT KilnMonitor Database Server: TCP 8429;
- WAGO fieldbus coupler (Modbus): TCP 502;
- Linescanners: TCP 2727;
- Pyrometers: TCP 6363;
- Serial RS485 / RJ45 Ethernet Converter: TCP 5048, 5058;
- OPCUA: TCP 4840;
- OPC Classic: TCP 135;
- GigEVision (IR cameras): UDP 3956 and a random UDP port for data streaming.

In case of conflicts, most of the port numbers can be changed in Linescano.ini or in the corresponding device configuration.

1.3 License agreement

IMPORTANT NOTICE

Read this License Agreement carefully before using this Software. BY USING THIS SOFTWARE IN ANY WAY YOU ACKNOWLEDGE THAT YOU HAVE READ, UNDERSTAND AND AGREE TO THE TERMS OF THIS AGREEMENT. IF YOU DO NOT AGREE TO THESE TERMS, DO NOT USE THIS SOFTWARE IN ANY WAY, AND PROMPTLY RETURN IT OR DELETE ANY COPIES OF THIS SOFTWARE IN YOUR POSSESSION.

By installing software in his or her PC, the end-user agrees to be bound to the terms of this agreement. The use of this software is licensed. GRAYESS Inc. grants a unique, nontransferable, personal license to use this software on single computer systems for an unlimited time. This documentation is under copyright, all rights reserved. This document may not, in whole or in part, be copied or changed without prior consent in writing from GRAYESS Inc.. Unauthorized use of this software can result in civil and criminal prosecution.

1.4 Software installation

Important

Administrator privileges are required to install IRT KilnMonitor and associated drivers. If you install IRT KilnMonitor on a computer managed by an IT department, please contact your System Administrator for assistance.

After installation and configuration, IRT KilnMonitor can be used as a normal user, a*dministrator privileges* are not required.

Installation procedure

You will receive IRT KilnMonitor installation file on a flash drive or as an Internet download in form of EXE installation file. To install the software on a computer, run the installation file (double click on it in Windows Explorer) an follow the instructions on the screen.

After installation completed, IRT KilnMonitor will be started for the first time and you will need to enter the *Installation Key* from the license that you receive together with the installation file. Please see Managing licenses for details.

Firewalls

During installation IRT KilnMonitor automatically adds itself to the Windows Firewall exceptions list. Steps below are required only if you have problems connecting to the hardware (scanners) or there are problems accessing data by IRT KilnMonitor clients.

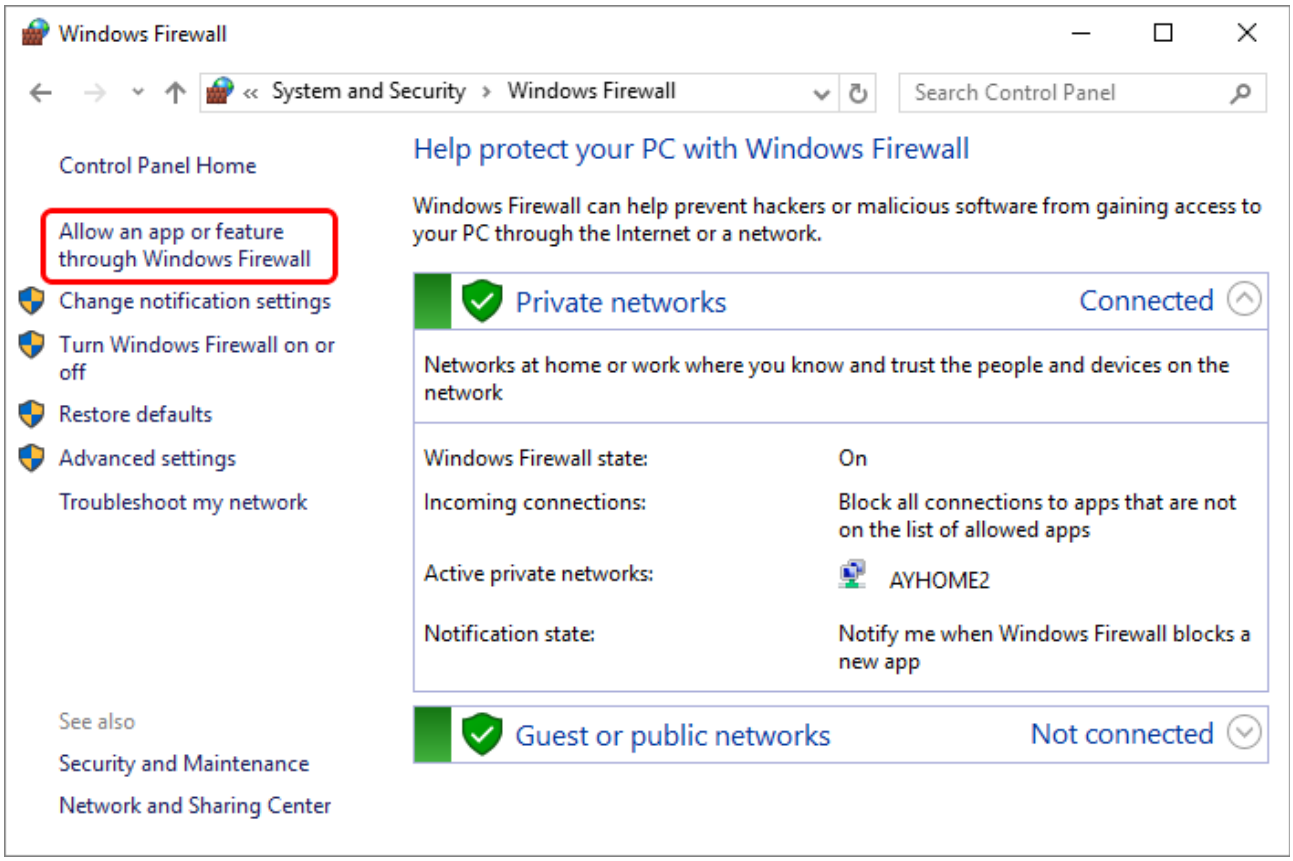
Manual firewall configuration

Firewalls will generally block network connectivity. To restore the connectivity you need to change configuration of the firewall. We will discuss Window Firewall as it is delivered with every Windows installation. If you use another firewall, please consult its documentation.

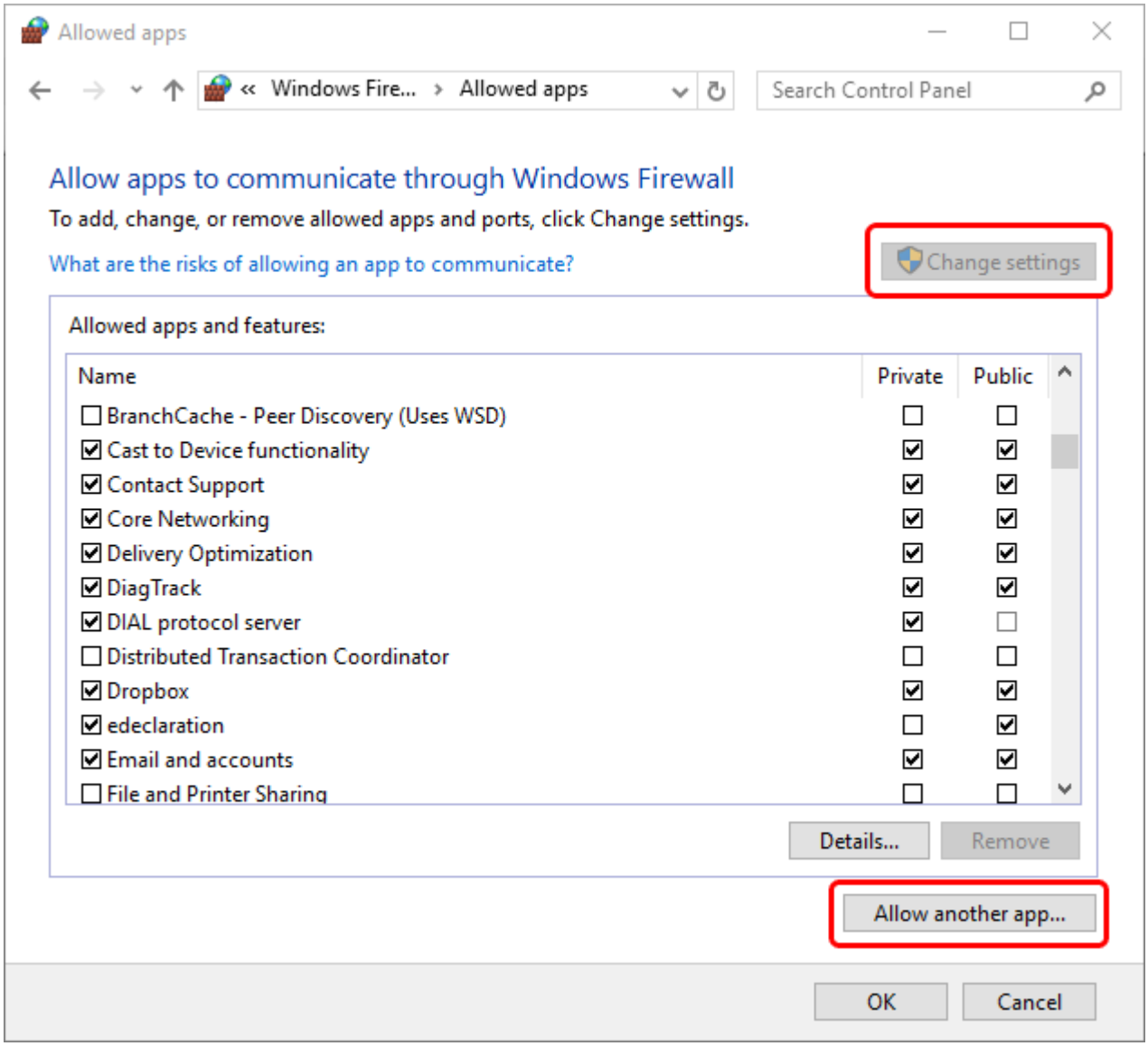
IRT KilnMonitor is automatically added to the exceptions list in Windows Firewall during the first start at the end of installation procedure. If automatic configuration did not work out, please configure Windows Firewall manually as described below.

To allow IRT KilnMonitor to receive data on the network you need to add IRT KilnMonitor to the exceptions list (list of programs allowed to send data to the network) in Windows Firewall:

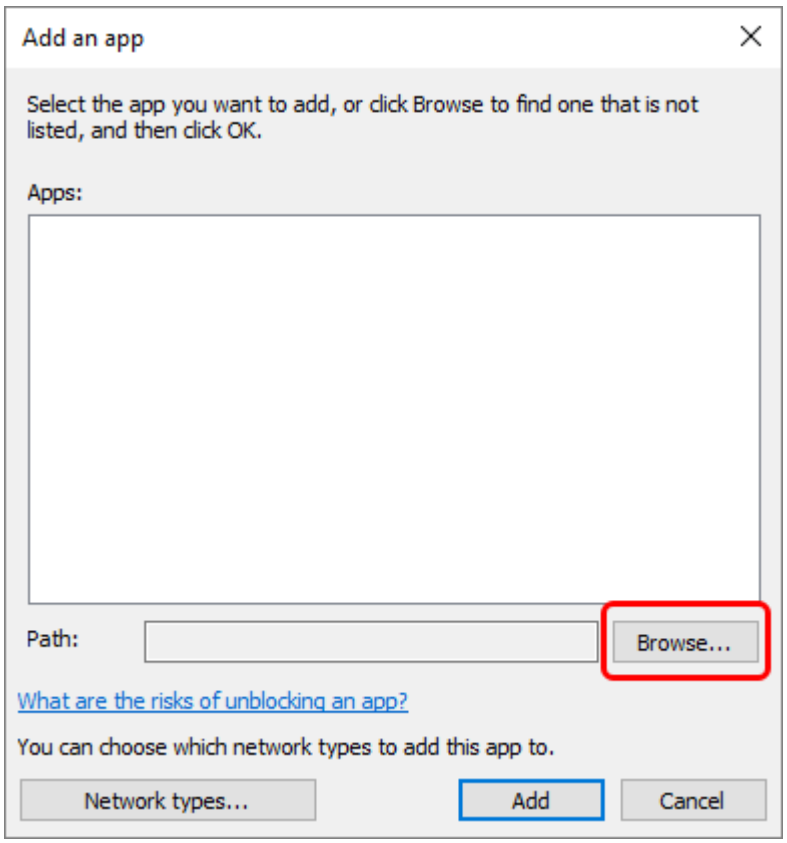
1. Open the Control Panel (icons view), and click/tap on the Windows Firewall icon.
2. Click/tap on the 'Allow a program through Windows Firewall link' in the left pane.



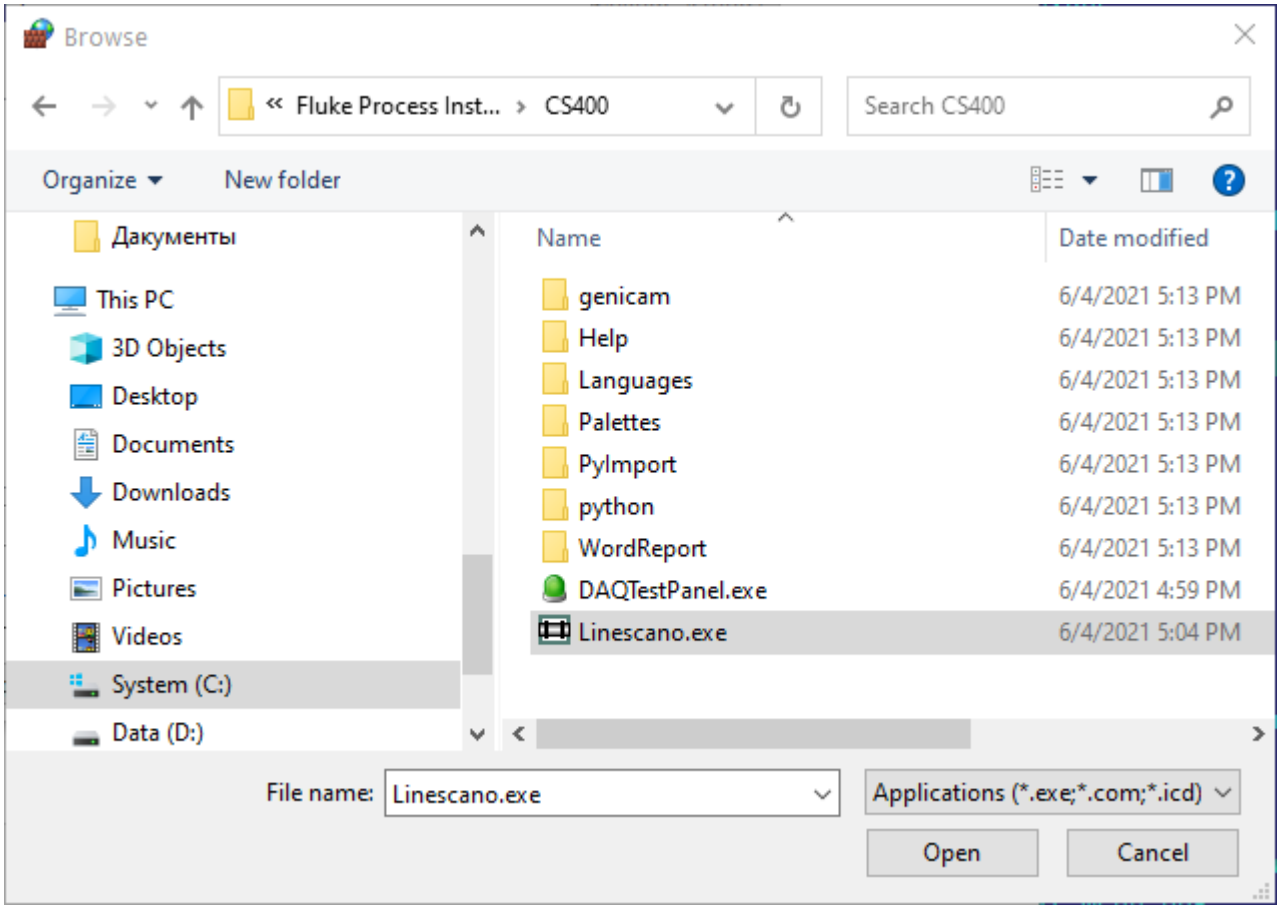
3. Choosing the option to allow a program through the firewall will present you with a list of current exceptions. If the 'Allow another app…' button is disabled then you will need to click the 'Change settings' button. If your computer is controlled by an IT department you may not have permission to change these settings and you will have to get your IT administrator involved.



4. Then you will see the 'Add an app' dialog



5. Click the 'Browse...' button. Go to the place on your hard drive where IRT KilnMonitor is installed. Select Linescano.exe.



6. Enable all the check boxes for Private/Public/Domain.

Removing IRT KilnMonitor

You can remove IRT KilnMonitor from your computer by using the Microsoft Windows uninstall program procedure (Start > Control Panel > Programs > Programs and Features).

1.5 Managing licenses

GRAYESS IRT KilnMonitor incorporates cloud based licensing system to prevent unauthorized use of the software. With your copy of software you will get so called *Installation Key*, a text string in form:

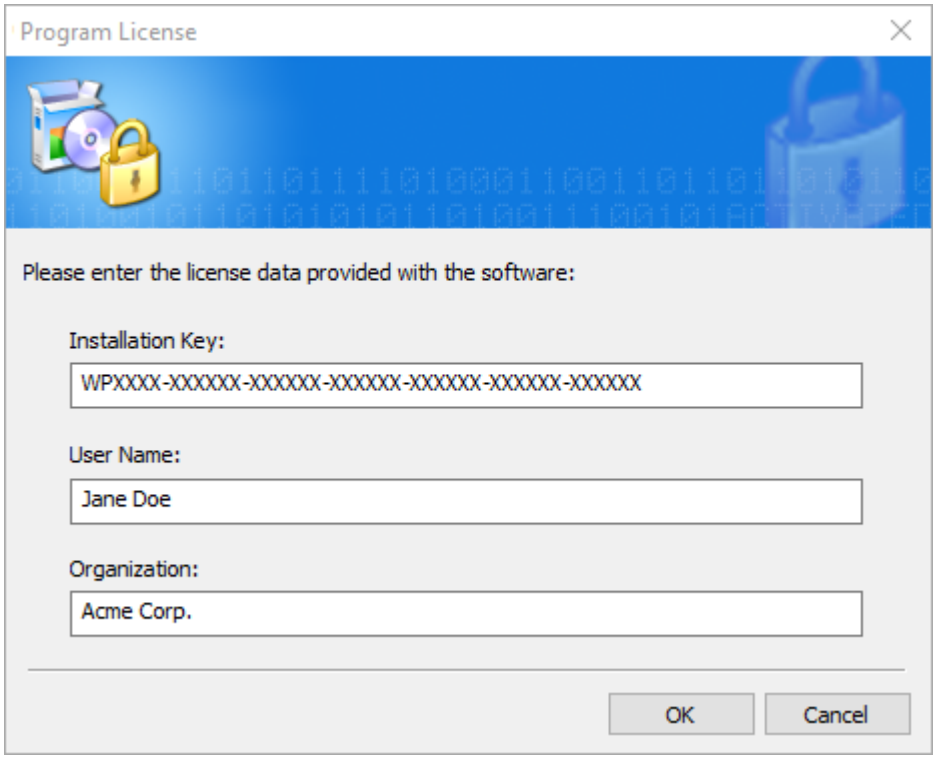
WPXXXX-XXXXXX-XXXXXX-XXXXXX-XXXXXX-XXXXXX-XXXXXX.

This key represents your license and links your copy of software with our licensing database. With one *Installation Key* you can install software on one PC or several PCs. This depends on the license that you have purchased.

There are also trial installation keys available that allow to use IRT KilnMonitor with all its functions for a limited period of time.

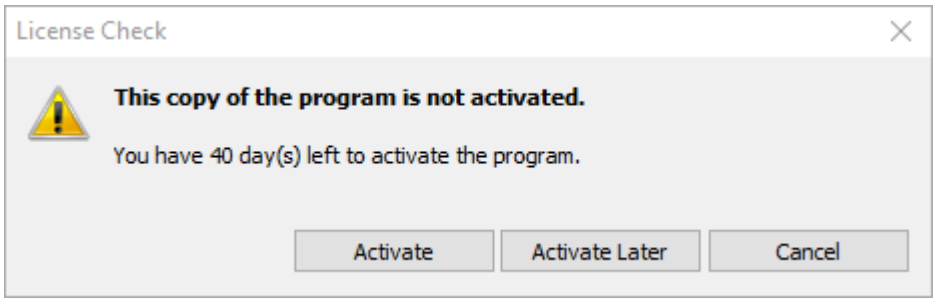
First run

After installation IRT KilnMonitor will be launched for the first time and you will need to enter the *Installation Key*, your name and name of the organization purchased license belongs to.

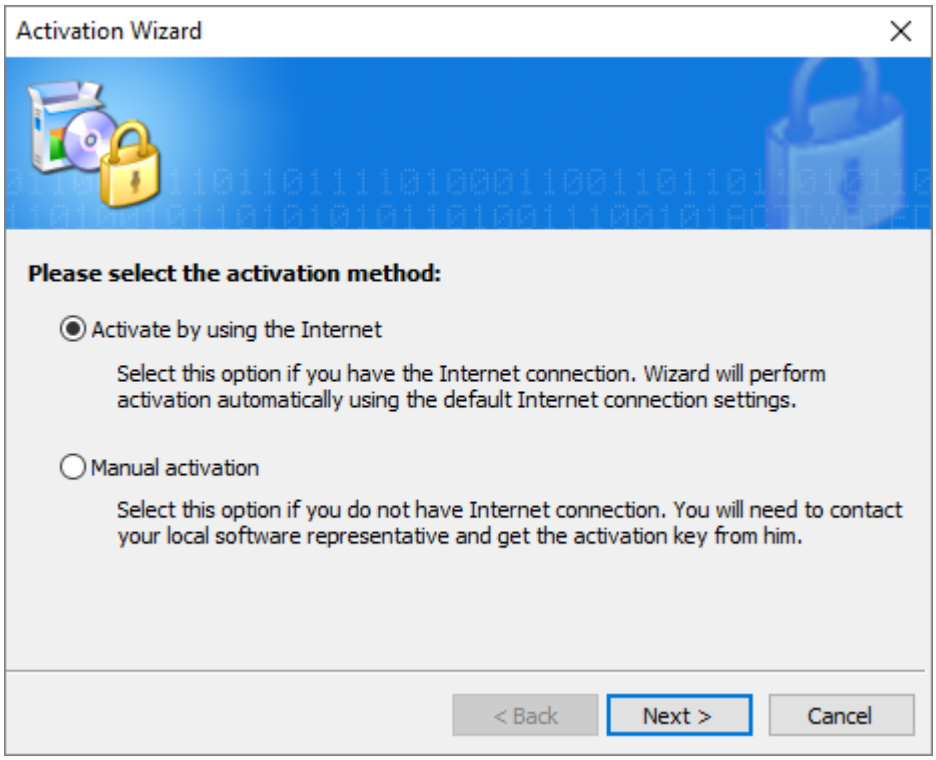


Activation

Before you can use the software you need to connect to our licensing server and activate the program.



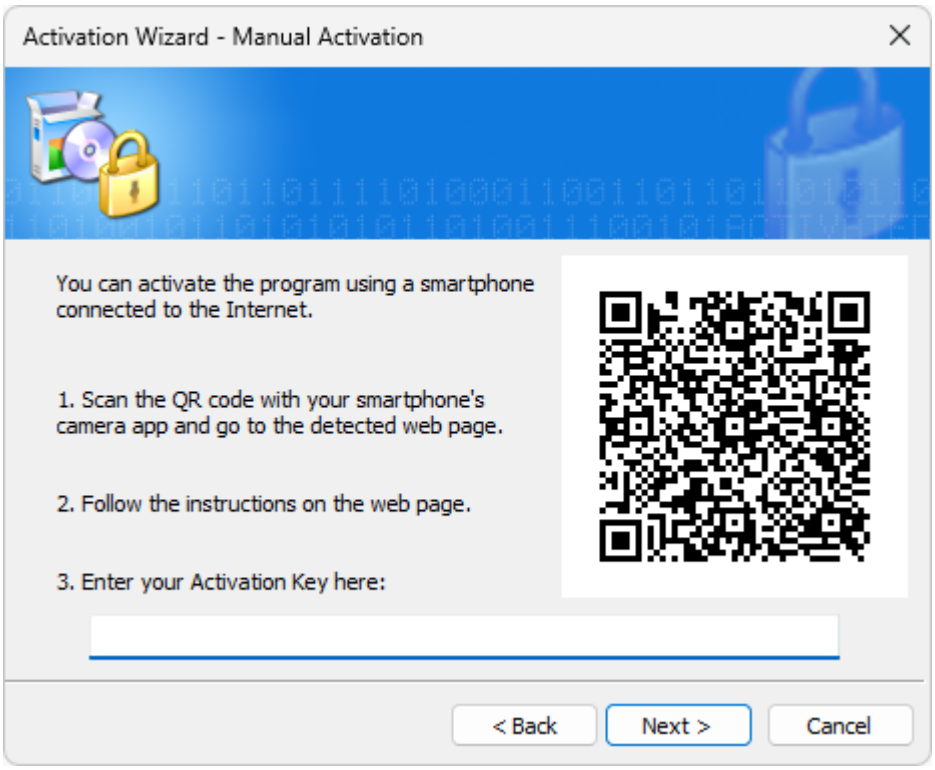
If you have Internet connection, select "Activate by using the Internet".



IRT KilnMonitor will connect to the activation server and activate your copy of the program.

Manual activation

If your PC is not connected to the Internet, select the "Manual activation" option. To activate the program, you will need a smartphone with an Internet connection and a camera application that can recognize QR codes. Most standard camera applications can do this, but if you have an older smartphone model, you may need to use a special application for scanning QR codes.



Use the camera on your smartphone to scan the QR code. The QR code contains a link, which will take you to the program's activation page. On this page, an **Activation Key** will be generated for you. Enter this key in the corresponding field in the Activation Wizard on the page with the QR code.

> **Note**
>
> It's important to remember that if you generate an Activation Key but don't use it, the program license will still be activated and your computer will be counted as activated.

Activation with help from your software provider

If, for some reason, both activation options did not work for you, you can contact your software provider to get assistance. Please leave the Activation Key field blank and press 'Next' button. This will bring you to a page with an **Installation Id** code. This code is needed for our support team to find your license on the server, solve the problem and generate an Activation Key for you.

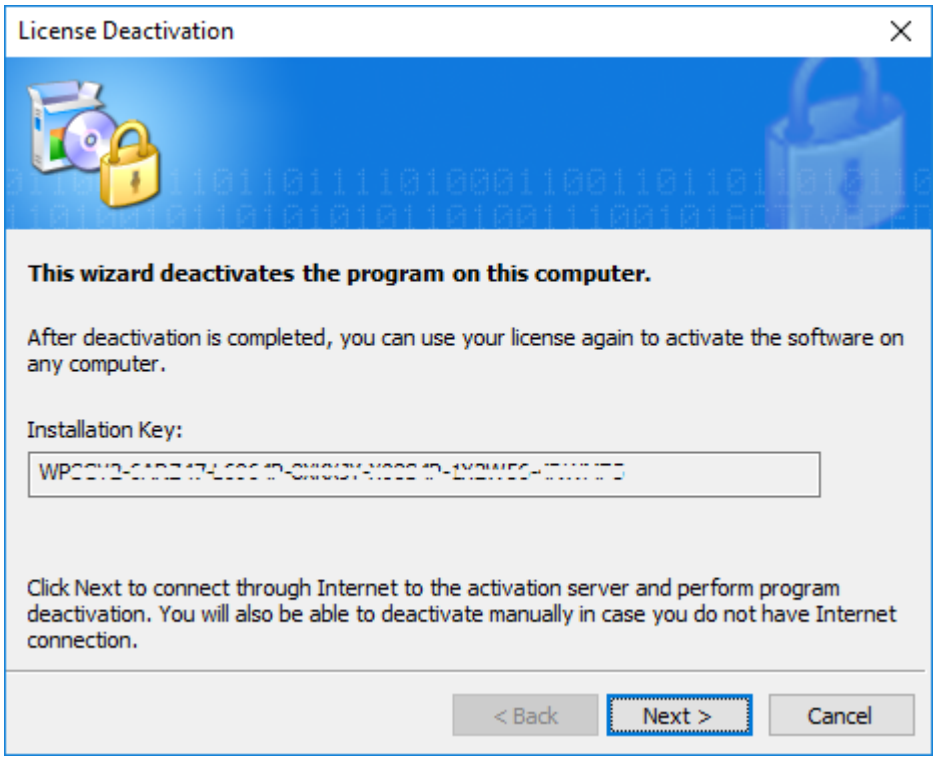
Please pass the *Installation Id* to your software provider. *Installation Id* is a unique signature of your PC that will be linked to your license. It is used to generate *Activation Key* that activates your copy of the software.

At this point you can close Activation Wizard. When you will get *Activation Key*, please run Activation Wizard again (you will need to close and open IRT KilnMonitor) and type or copy *Activation Key* to the corresponding edit box (the key can be entered also on the page with QR code). Click 'Next' to finalize the activation.

Transferring license to another PC

If you stop using IRT KilnMonitor on a PC you can transfer your license from this PC to another computer. For this you need to deactivate the license on the old PC. After that your license (*Installation Key*) can be used to install IRT KilnMonitor on any other PC.

Select 'Help | Deactivate License' in the main menu.



Click 'Next' to deactivate the software automatically through the Internet. In case your computer is not connected to the Internet, you will be given the possibility to deactivate manually with help of a QR code and a smartphone. Procedure is very similar to the manual activation described above.

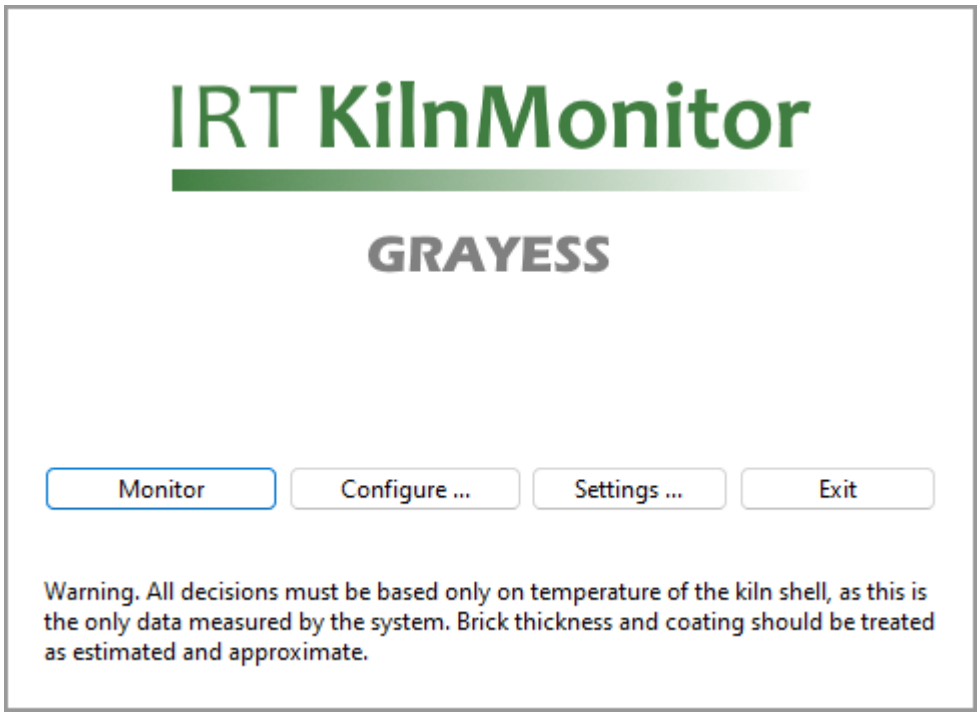
Important

When you reach the page with the QR code, the program will be deactivated but will still be counted as active on the license server. To complete the deactivation process, you must either use the QR code or seek assistance from your software provider.

If for any reason the deactivation process was not completed, you will need to reactivate the software on this computer and then deactivate it again in order to remove the computer from the activation list and free up the license.

1.6 Start-up screen

When you start IRT KilnMonitor the start-up screen is shown with the selection of options to continue:



- Press **Monitor** to start monitoring all kilns and to see and analyze the current results of kiln monitoring. You should do it after kilns configuration and program settings are adjusted. Program will switch to the Monitoring window.
- Press **Configure** to create or change kilns configuration. See System configuration for details.
- On IRT KilnMonitor Clients press **Connect** button (shown instead of Configure) to select IRT KilnMonitor server which will provide monitoring data.
- Press **Settings** to adjust program settings - language, passwords, date format, temperature and linear units, etc. See Language and other program settings for details.
- Press **Exit** to stop all kilns monitoring and close the application.

The start-up screen also shows the current state of kiln monitoring – the table under the main menu, each line corresponds to the monitored kiln.

First Kiln	Stopped	ALARM	
Second Kiln	Stopped	Error	
Third Kiln	Stopped	Outdated	

Double click on a kiln line to open its System State window.

When the start-up screen is displayed, the following menu commands are available:

System menu

- **Change Passwords** opens Passwords dialog to set or change access passwords.
- **Program Settings** opens program settings. See Language and other program settings for details.
- **Configurations** opens dialog to create new or change active system configuration.
- **Restore Configuration**, **Restore History** restores system configuration and kiln history from a backup.
- **Rebuild Monitoring Database** recreates the monitoring database using data in the kiln history (not used during normal operation).
- **Configure Kilns** sets up or changes kilns configuration (same as the **Configure** button).
- **Export Configuration** saves active system configuration in a file and then import this file on a different PC

- **Exit** quits the application.

Monitoring menu

- **Open Monitoring Window** opens window that displays current results of kiln monitoring (same as the **Monitor** button, but without starting monitoring).
- **Start (Stop) Monitoring All Kilns** starts or stops monitoring of kilns configured on this computer.
- **Remotely Monitored Kilns** displays the dialog to connect to the kiln monitoring server over the network (this menu item is available only in Clients).

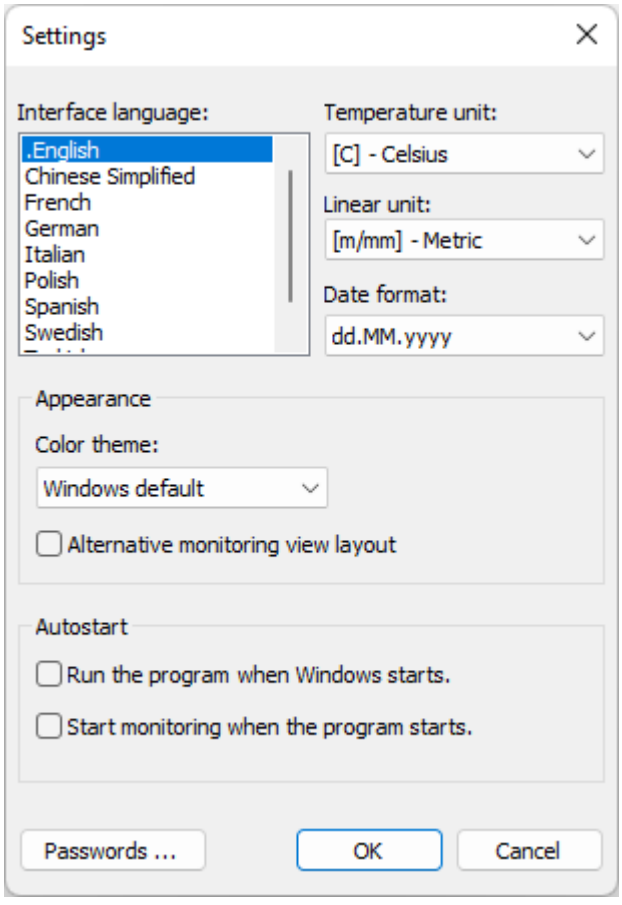
View menu

- **View / Log Files** opens the folder with log files containing detailed information about events and alarms for each kiln (in text files).
- **View / Program Settings** displays program settings (same as the **Settings** button).
-

> **Hint**
>
> Every time you close all monitoring windows and the configuration window you return to the start-up screen. This does not stop kilns monitoring. Monitoring continues in the background with data gathered, processed, checked for alarms and stored.

1.7 Language and other program settings

To display the Settings dialog, on the start-up screen press **Settings** button or choose **System / Program Settings** in the main menu.



Here you can modify the following settings:

Color theme: *Windows default* or *Dark*. Dark theme is supported in Windows 10 and later. Only monitoring windows will use dark mode, configuration windows are always displayed with Windows default theme.

Alternative monitoring view layout: it is about the relative position of the horizontal profile and the kiln image. Alternative is when the kiln image is at the top and the horizontal profile in at the bottom.

Temperature unit: *Celsius*, *Kelvin* or *Fahrenheit*.

Linear unit: *Metric (m/mm)*, *Imperial (ft/inch)* or *Centimeters (cm/cm)* measure of lengths. Large lengths, like the kiln length or a scanner distance are displayed using the first unit in the brackets; small lengths, like tire slip or brick thickness are displayed using the second unit.

Date format: *dd.MM.yyyy*; *MM/dd/yyyy*; *yyyy-MM-dd*.

Passwords allows to limit access to different functions of the program with passwords.

Run IRT KilnMonitor when Windows starts: if selected, this option instructs Windows to automatically start the application when Windows starts (upon user logon).

Start monitoring when program starts: automatically switch to the monitoring window and start monitoring of all kilns when program is restarted. If this option is not enabled, kiln monitoring will not start when program starts and the operator will need to start kiln monitoring manually.

> **Note**
> Changes in the settings will be applied only after the program restart.

2 Configuration

2.1 Migrating from IRT KilnMonitor version 2.x to version 3.x

While IRT KilnMonitor version 3.x is generally backward compatible with version 2.x, users should be aware of some notable changes:

1. **Program Location**:

   Version 2.x: The recommended installation directory was C:\KilnMonitor.

   Version 3.x: The software now installs to Program Files (x86), consistent with many other applications.

2. **Kilns Configuration Location**:

   Version 2.x: Supported a single configuration set located in the **LSC-Settings** subfolder of the IRT KilnMonitor installation directory.

   Version 3.x: Supports multiple configurations, with one being active at any given time. These configurations are stored in C:\ProgramData\GRAYESS\GRAYESS IRT KilnMonitor\Configurations.

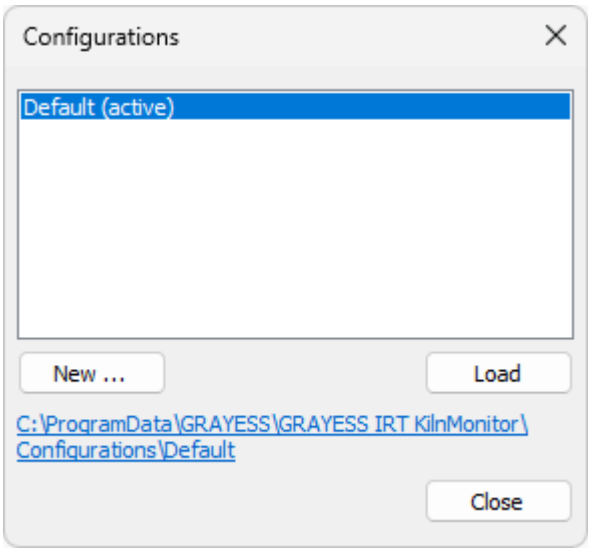
3. **History Folder Location**:

   Version 2.x: Allowed users to define an individual history folder for each kiln.

   Version 3.x: Consolidates the history of all kilns into a single folder. However, the overall structure of the history folder remains unchanged.

IRT KilnMonitor Server: installing version 3.x on computer where version 2.x was installed

1. **Backup LSC-Settings Folder**: Before initiating the 3.x installation, create a backup of the LSC-Settings folder. It is usually located at C:\KilnMonitor\LSC-Settings.
2. **Backup Kiln History Folder**: Save a copy of the kiln history folder, preferably to an external drive for safety.
3. **Installation**: Launch the IRT KilnMonitor 3.x installer. It will automatically detect, uninstall the older 2.x version, and proceed with the 3.x installation.
4. **Close the Application**: After the installation completes, close the IRT KilnMonitor application.
5. **Transfer Configuration**: Copy the contents of the **LSC-Settings** folder to C:\ProgramData\GRAYESS\GRAYESS IRT KilnMonitor\Configurations\Default.
6. **Verify Configuration**: Open IRT KilnMonitor. In the Start-up screen, navigate to menu **System | Configure Kilns** to confirm the new configuration. If the configuration appears empty, ensure you followed step 5 correctly. Remember, restarting IRT KilnMonitor may be necessary. Also, ensure that "Default" (the folder you transferred configurations to) is set as the active configuration under menu **System | Configurations**.



7. **History Folder Configuration**: In the configuration view (menu **System | Configure Kilns**), click on **Common Settings**. This opens the **Common Kiln Settings** dialog where you can specify the history folder's location. If in version 2.x all kilns used the same old history folder, you can repoint to it. Otherwise, consolidate all kiln data into a singular directory. Ensure the history folder's structure resembles:

```
KilnHistory
   |-- Kiln1
   |   |-- Config
   |   |-- State
   |-- Kiln2
   ...
```

2.2 Kiln monitoring principles

As the kiln rotates the thermal scanner records temperatures at each point of the kiln body. After each complete revolution, the data is analyzed and a temperature map of the entire kiln surface (thermal image) is generated. Knowing the temperature inside and on the surface of the kiln and using the thermal conductivity formula it is possible to estimate the thickness of the bricks as well as the thickness of the stuck clinker material ("*coating*").

Often one scanner is not enough to cover the whole surface of the kiln. In this case additional scanners are used. Also, depending on the kiln design and the room where the kiln is located (supporting rings, pillars etc.), parts of the kiln can be inaccessible to the scanners. Such areas are called "*shadow zones*". Pyrometers are used to monitor the temperatures of these areas. Data from all scanners and pyrometers are gathered together to form one composite map of the kiln surface condition.

To find out when the kiln made a complete revolution and the temperature map can be build IRT KilnMonitor needs a signal from the outside. A sensor that sends a signal after each complete revolution must be connected to the system. The signal is called "*kiln-trigger*". A complete revolution of the kiln is called a "*lap*".

Laps

After each full revolution (lap) IRT KilnMonitor system executes the following operations:

1. Kiln shell temperature map is constructed from temperature data received from scanners and pyrometers.
2. Envelope profile is constructed from the kiln shell temperature map.
3. Alarm zones are checked for alarm conditions, hardware outputs assigned to alarm zones are updated.

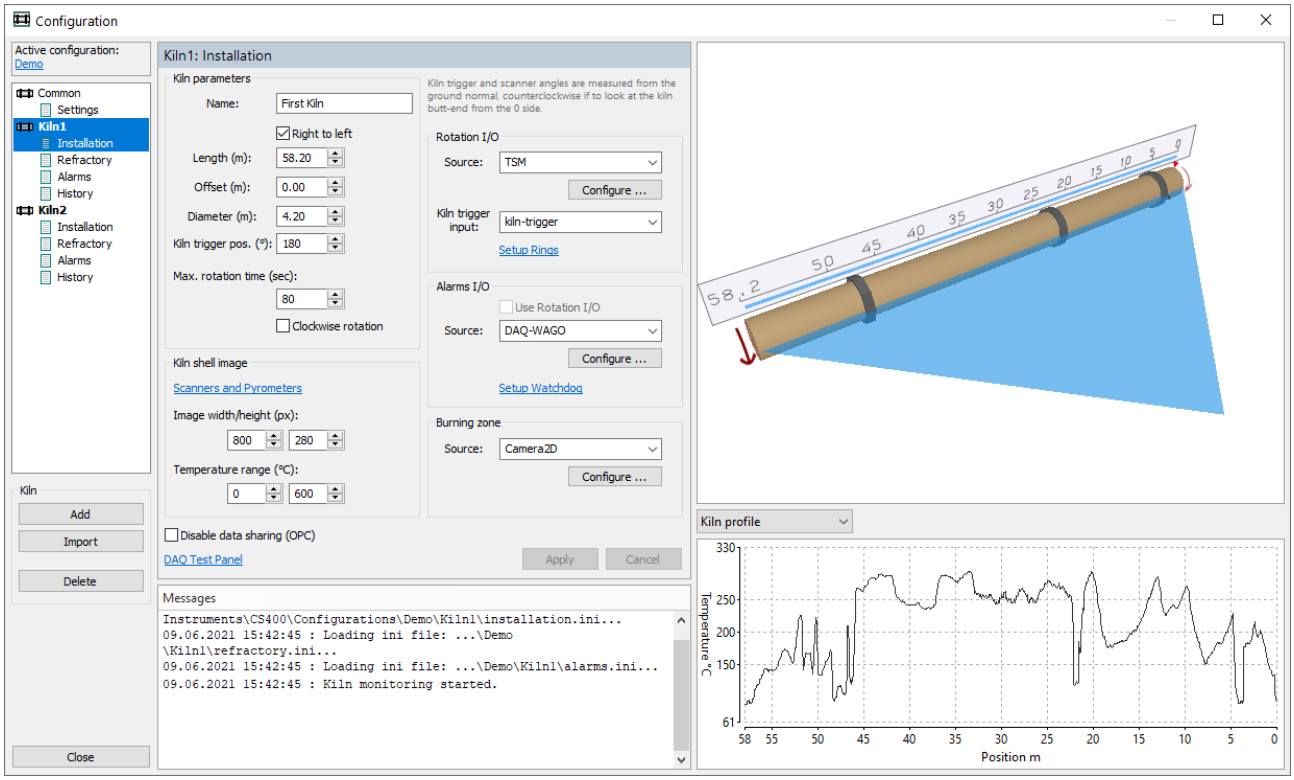
4. Envelope profile is checked for alarms, corresponding hardware outputs are updated.
5. Kiln shell image with information about alarms and measurements is saved to the history storage.
6. New kiln state data is sent to clients connected remotely.

2.3 System configuration

Kilns can be configured only on the server PC. Configuration is not possible in IRT KilnMonitor clients where kiln data is received from the server remotely through the network.

To open the configuration dialog, press **Configure** button on the start-up screen or select **Configuration / Configure Kilns** in the main menu.

System configuration includes configuration of one or more kilns. Every kiln configuration has Installation, Refractory, Alarms and History parts. There is also configuration area that contains settings common for all kilns (**Common Settings**).



The system configuration can be password protected. In this case, a dialog box appears on the screen asking you to enter the password. Enter the password you were given, or leave the password field blank. In the second case, you will be not allowed to change the configuration settings, you can only view them.

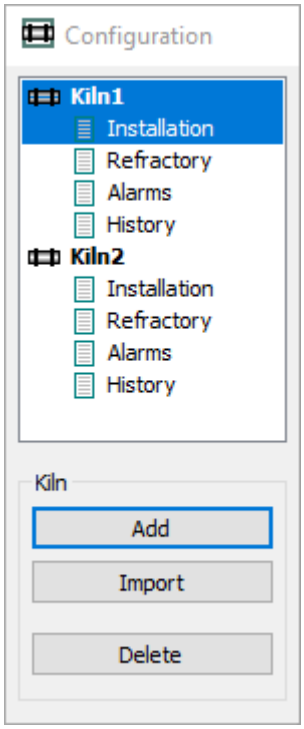
> **Note**
>
> When Configuration window is opened, data received from scanners and other kiln monitoring devices is not processed (alarm conditions are not checked, tire slip values are not calculated, history storage is disabled, monitoring windows are not updated).

In the configuration window for every monitored kiln you should define four sets of settings:

1. **Installation**: parameters and dimensions of the kiln, number and positions of scanners and pyrometers, resulting image size, tire slip monitoring and alarm output devices, burning zone monitoring hardware. See Setting up the kiln and monitoring hardware for details.

2. **Refractory**: brick zones, special zones, drillings and shell repairs. See Setting up kiln refractory for details.
3. **Alarms**: reference envelope profile and alarm zones, tire slip and other alarms. See Setting up alarms for details.
4. **History**: parameters of historical storage of the kiln state. See Setting up history storage for details.

2.4 Kilns monitored on one computer



In the left part of the Configuration window you see the list of kilns and their settings (installation, refractory, alarms and history).

To add a new kiln to the monitoring system, press **Add** button.

To add a kiln configured in CS200, press **Import** button. See Importing CS200 configurations below.

To delete a kiln from configuration, press **Delete** button.

> **Warning**
>
> When you delete a kiln, its settings are permanently deleted from the disk and you will not be able to undo this action.

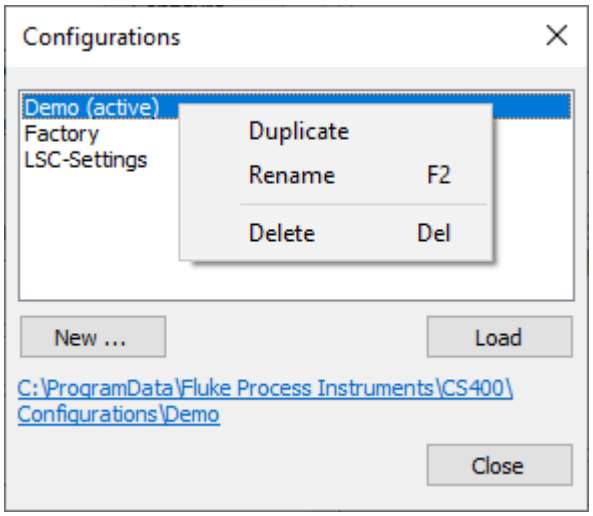
2.5 Managing configurations

Configuration data is saved in INI files on the local disk. Every kiln has its personal configuration folder, named Kiln1, Kiln2 and so on.

Active configuration

IRT KilnMonitor supports several system configurations. This is useful mainly for demonstration and testing. IRT KilnMonitor running on the plant normally needs only one configuration.

In the start-up screen, use main menu **System \ Configurations** to open the **configuration selection dialog:**

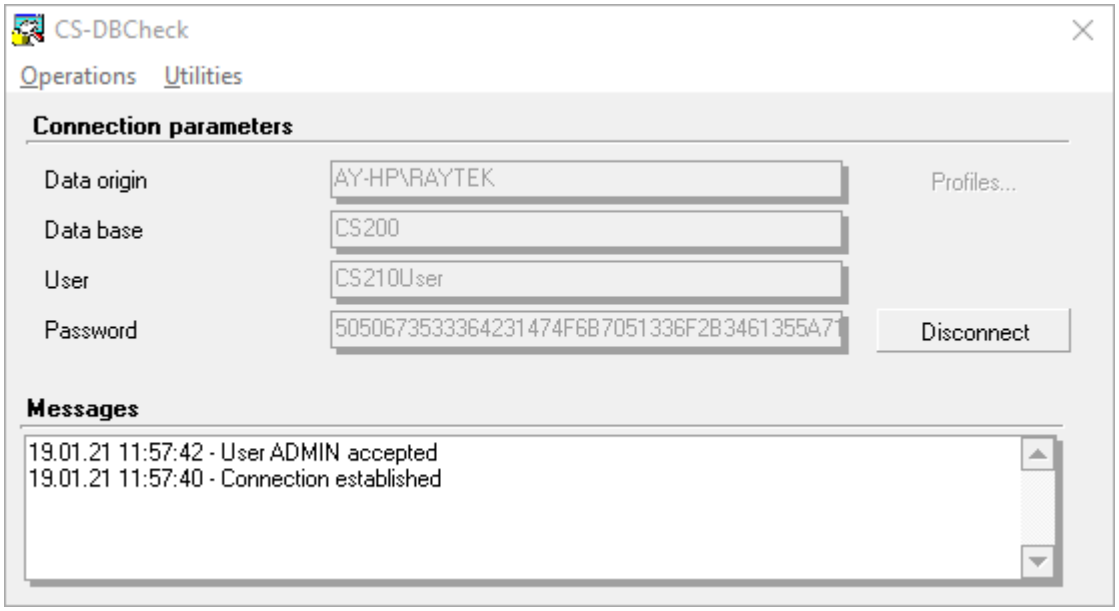


Copying configuration to another computer

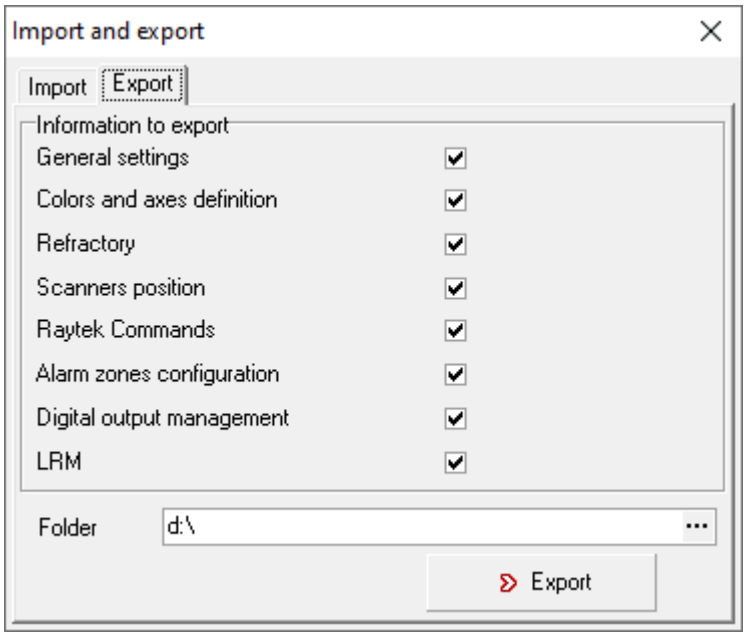
1. Close all monitoring windows to get to the start-up screen. In the main menu select **System \ Export Configuration** and select a file where configuration should be saved.
2. On another computer, open the configuration window and use **Import** button load data from the configuration file you created on step 1. Kilns from the configuration file will be added to the already existing kilns.

2.6 Importing CS200/CS210 configuration

First you need to export CS200/CS210 configuration from the old CS system. Use **CS-DBCheck** tool for this:



After connecting to the CS database, select menu item **Operations | Import and export**:

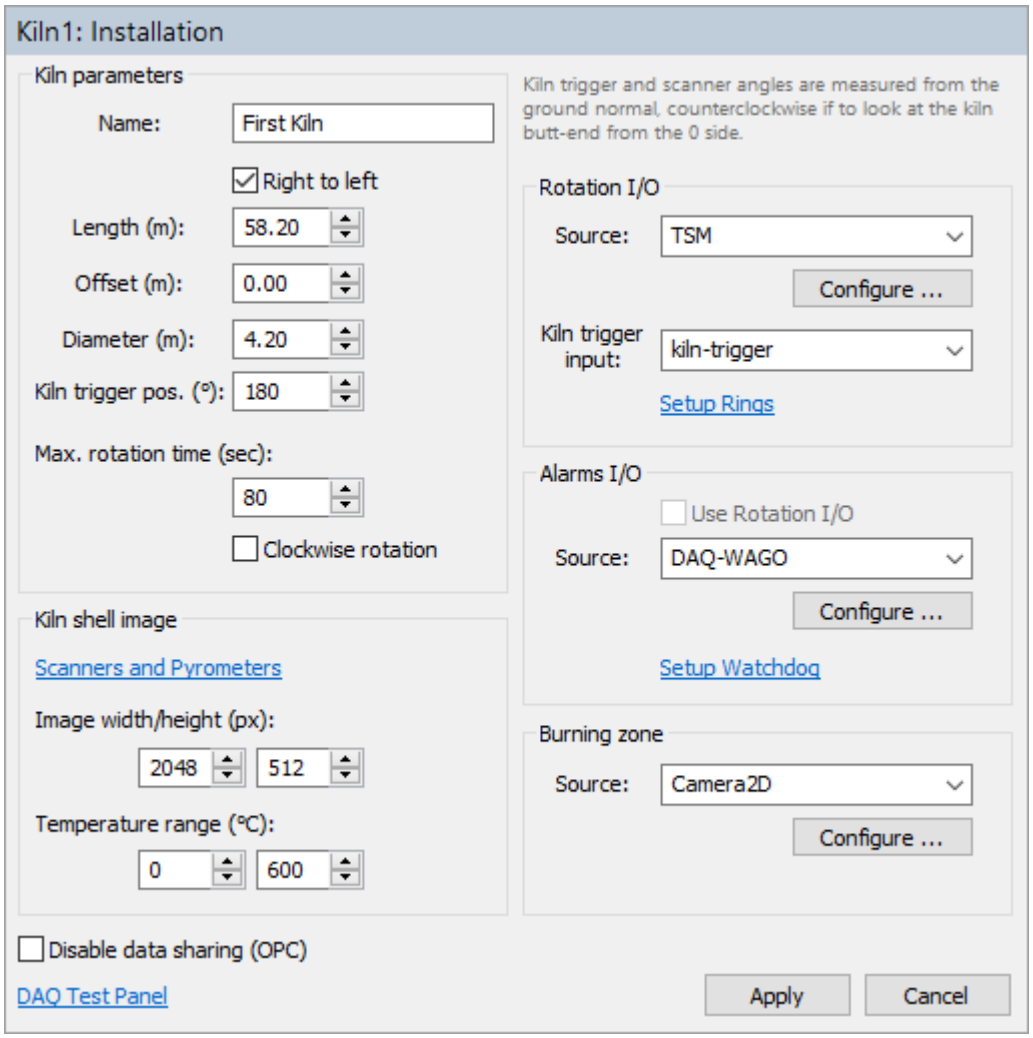


In **Export** tab mark all check boxes and press **Export** button. Configuration will be saved to the specified folder in a text file named like 20210119120442_ExportCS200.txt. CS200/CS210 configuration contains settings for one kiln.

You can import CS200/CS210 file in IRT KilnMonitor by pressing Import button in the left part of the configuration window.

2.7 Kiln dimensions and monitoring hardware

Installation page is protected by Level 2 password.



Kiln Parameters

Name: the name of the kiln to be displayed in the monitoring screens. You can use any name you like.

Length: the length of the kiln (or part of the kiln exposed to the IR scanners).

Right to left: if the check box is not marked – kiln axis direction goes from left to right, if marked – kiln axis goes from right to left.

Offset: the kiln position offset. Allows kiln position to begin with value other than 0. Changing this value will change refractory positions accordingly.

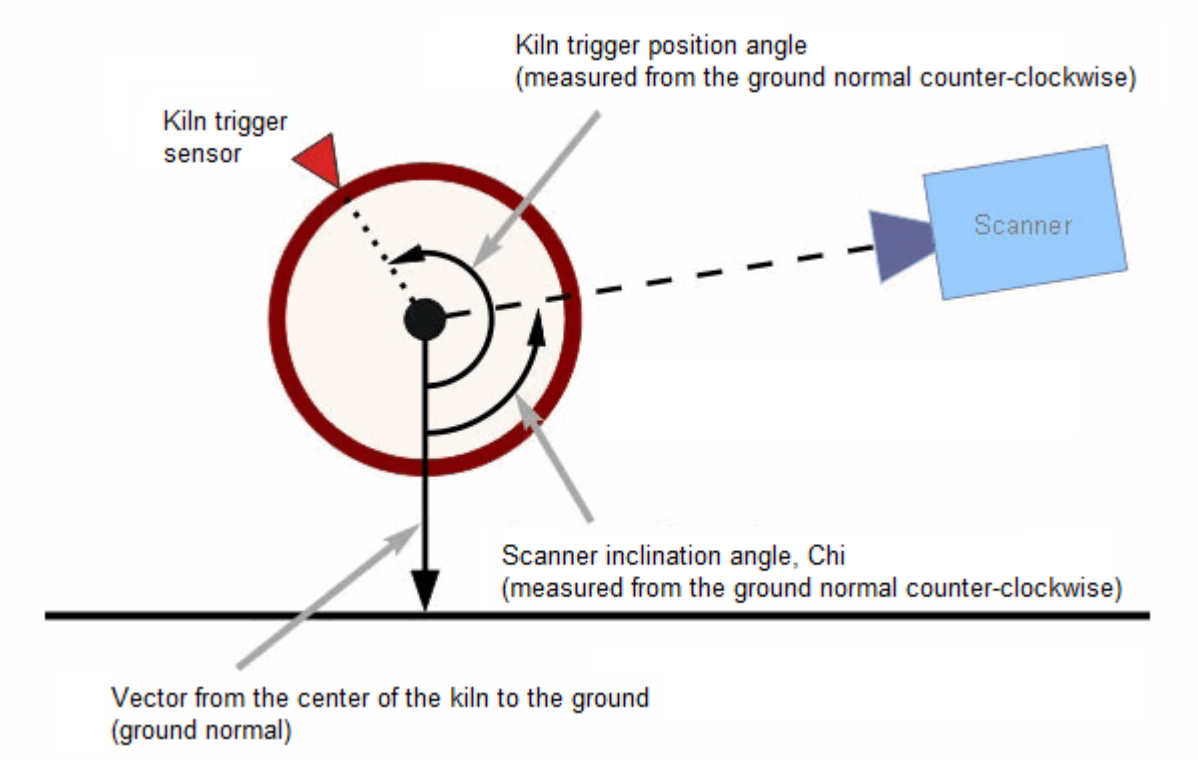
Diameter: the diameter of the kiln.

Kiln trigger position: the angle (in degrees) to the kiln trigger sensor. The angle is measured from the ground normal vector, in the counter-clockwise direction if to look at the kiln butt-end from the kiln axis origin side. See the picture below.

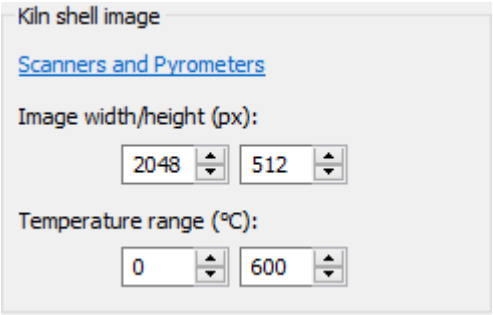
Maximum rotation time: the maximum time of one full kiln rotation in seconds. If kiln trigger signal is not coming during this period of time, Kiln-Trigger alarm is generated.

Clockwise rotation: check box marked means that the kiln rotates clockwise, otherwise – counter-clockwise (if to look at the kiln butt-end from the kiln origin side).

Disable data sharing (OPC): if marked, disables remote access to this kiln. It will be not possible to view this kiln using IRT KilnMonitor clients. Also measured data will not be published through OPC.



Kiln infrared image



Temperature data from all scanners and pyrometers is rendered into one kiln shell image. This section defines the parameters of this image.

Image width/height: you can select any width and height values, IRT KilnMonitor will automatically interpolate lacking data or remove redundant data. Please follow these recommendations to get a higher quality kiln image and a better looking monitoring screen:

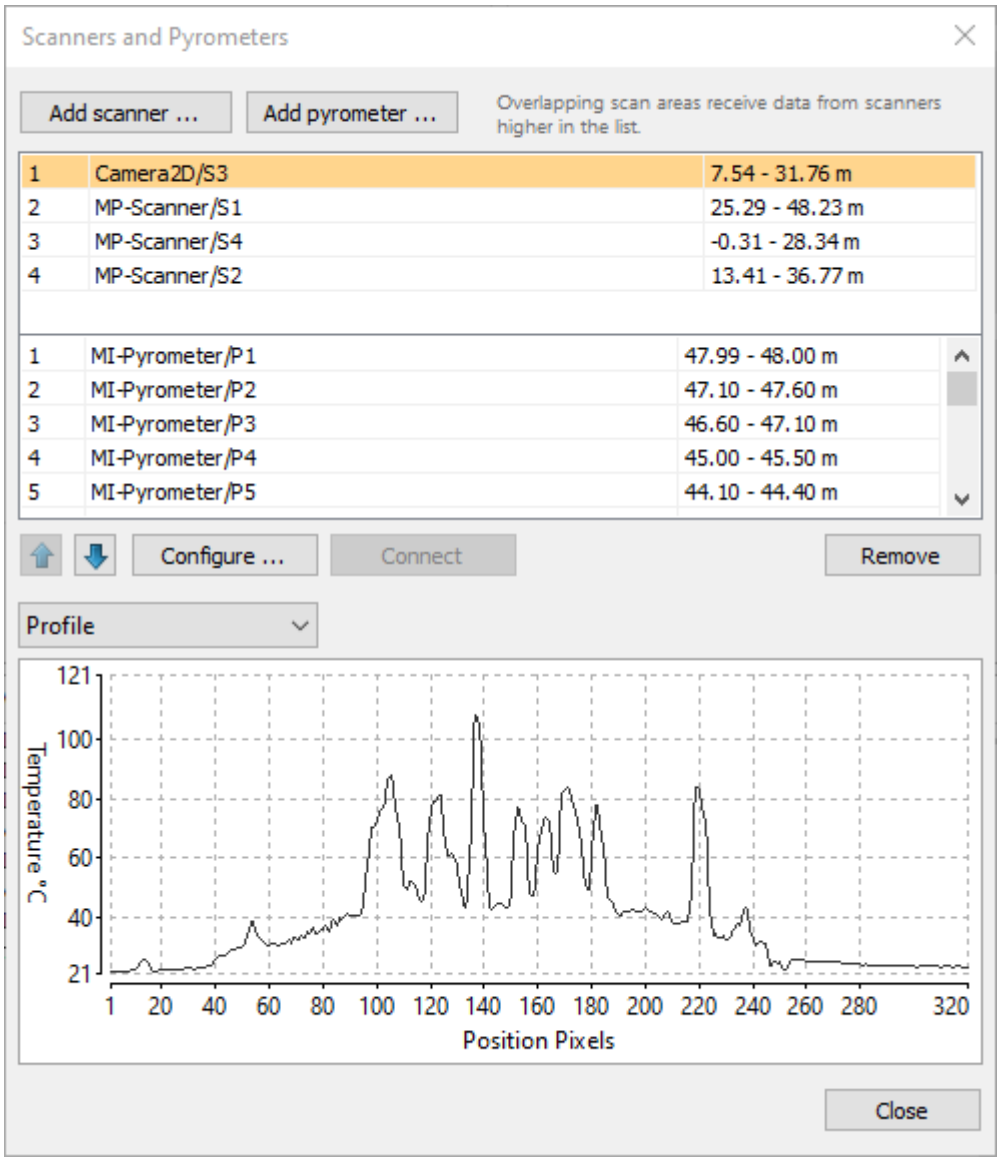
1. The image width should be close to the number of pixel the scanner line has. If more than one scanner is used in monitoring - the sum for all scanners should be taken.
2. The image height should be selected taking into consideration the size of the smallest spot the monitoring system needs to detect. *Height in pixels* = *kiln circumference* / *spot size*. For example, if kiln is 3 meters in diameter and we want to have 5 cm resolution, image height = Pi * 3 / 0.05 = 188 pixels. So image height should be 188 pixels or more.
3. If to take into account the way kiln shell image is displayed on screen in IRT KilnMonitor and consider additional windows and analysis, it is better if the image height will be in the range of 1/3 to 1/4 of the image width.

See Kiln shell image composition algorithm for kiln shell image rendering details.

Temperature range: possible minimum and maximum kiln shell temperature. The monitoring system will not be able to display temperatures outside this range.

Scanners and pyrometers

Click **Scanner and Pyrometers** link to display the list of scanners and pyrometers:



To add a scanner to the system press Add scanner button.

To add a pyrometer press Add pyrometer button.

To change selected scanner or pyrometer configuration double click on the scanner or pyrometer name in the list or press Configure button.

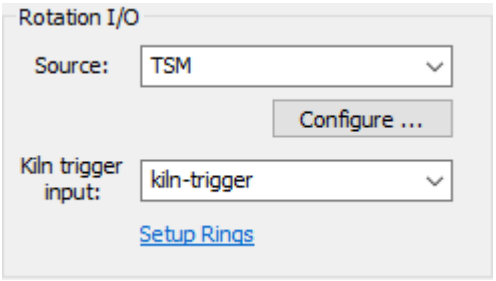
To test a scanner or a pyrometer communication and see its data select the scanner or pyrometer in the list and press Connect button. Device data will be displayed in the window below the list.

See Setting up a scanner and Setting up a pyrometer for each device configuration details.

Scanner and pyrometers list order

The order of scanners and pyrometers in the list is important because it affects the order temperature data is rendered to the resulting kiln shell image in the areas where scanners' and pyrometers' FOVs overlap. See Kiln shell image composition algorithm for more details.

Rotation I/O



This section defines hardware used to register kiln revolutions and to measure tire slip values for kiln external rings.

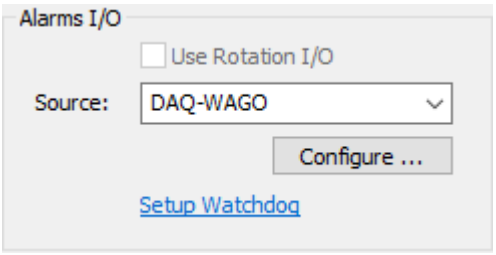
Source: the device type used for signals input (can be TSM, MP-Scanner, DAQ-WAGO and signal simulation timers). Press **Configure** button to configure connection and other parameters of the selected device.

Kiln trigger input: the name of the input used to receive signals from the kiln trigger sensor (different device types use different input names).

Setup Rings: click the link to define kiln external rings and select inputs used by their revolution sensors.

See Kiln trigger and Tire slip monitoring for details.

Alarms I/O

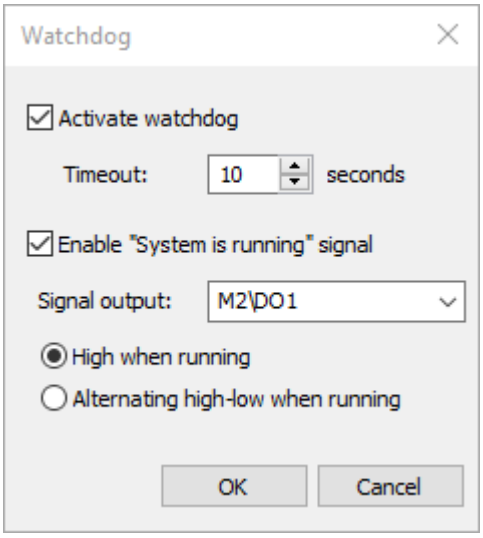


This section defines hardware used to trigger external alarms.

Source: device type used for signals output. Press **Configure** button to configure connection and other parameters of the selected device.

Use Rotation I/O: mark this check box to use the same device for both signal inputs and outputs. Enabled only if selected Rotation I/O device in addition to inputs has also outputs.

Setup Watchdog: click the link to define parameters of the watchdog. This link is available only if selected I/O device supports watchdog functionality.



"System is running" signal

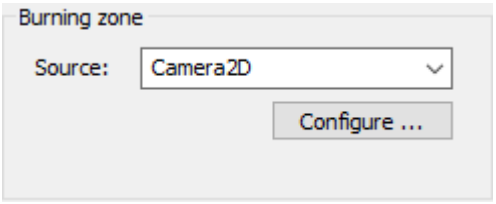
"System is running" signal is not available if the selected alarm I/O device does not support watchdog.

This signal can be used to ensure that kiln monitoring system is running and there are no problems with the monitoring hardware and software:

1. PC is running, IRT KilnMonitor is running, kiln monitoring is started.
2. Devices used for monitoring kiln temperatures are functioning properly: the scanners and pyrometers send data, the kiln trigger signal comes in expected intervals.

> **Note**
>
> "System is running" state is not affected by problems with the ring revolution sensors even if the problems are hardware related.
>
> "System is running" state is not affected by the alarm states (zone alarms, maintenance alarms and others).

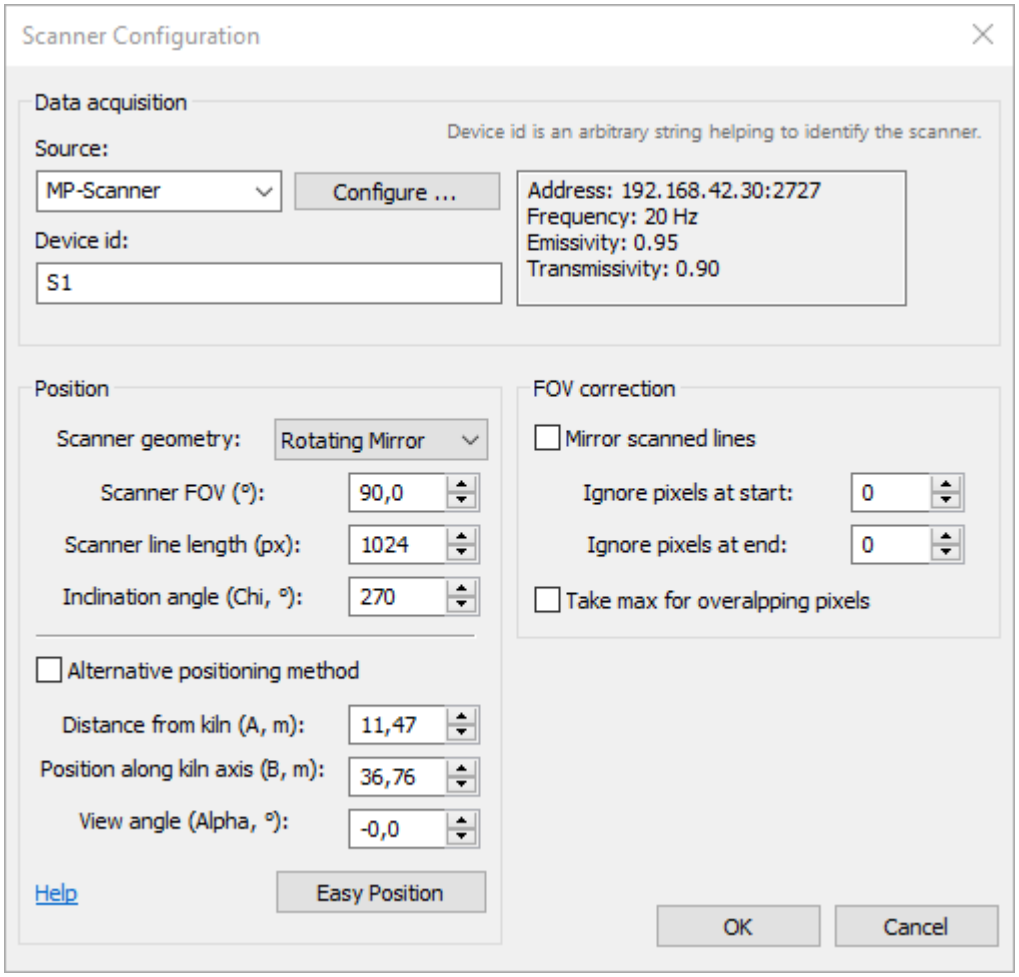
Burning zone



This section defines the device used to monitor the burning zone temperature. This can be an infrared camera (TV40) or an pyrometer (Endurance).

See Burning zone monitoring for details.

2.8 Scanner configuration



Source: device type used as a scanner (available devices are MP-Scanner, Camera2D). Press **Configure** button to setup up scanner communication and adjust its parameters.

Device id: used to identify the scanner in messages reporting scanner problems and other cases. Can be any text string you like.

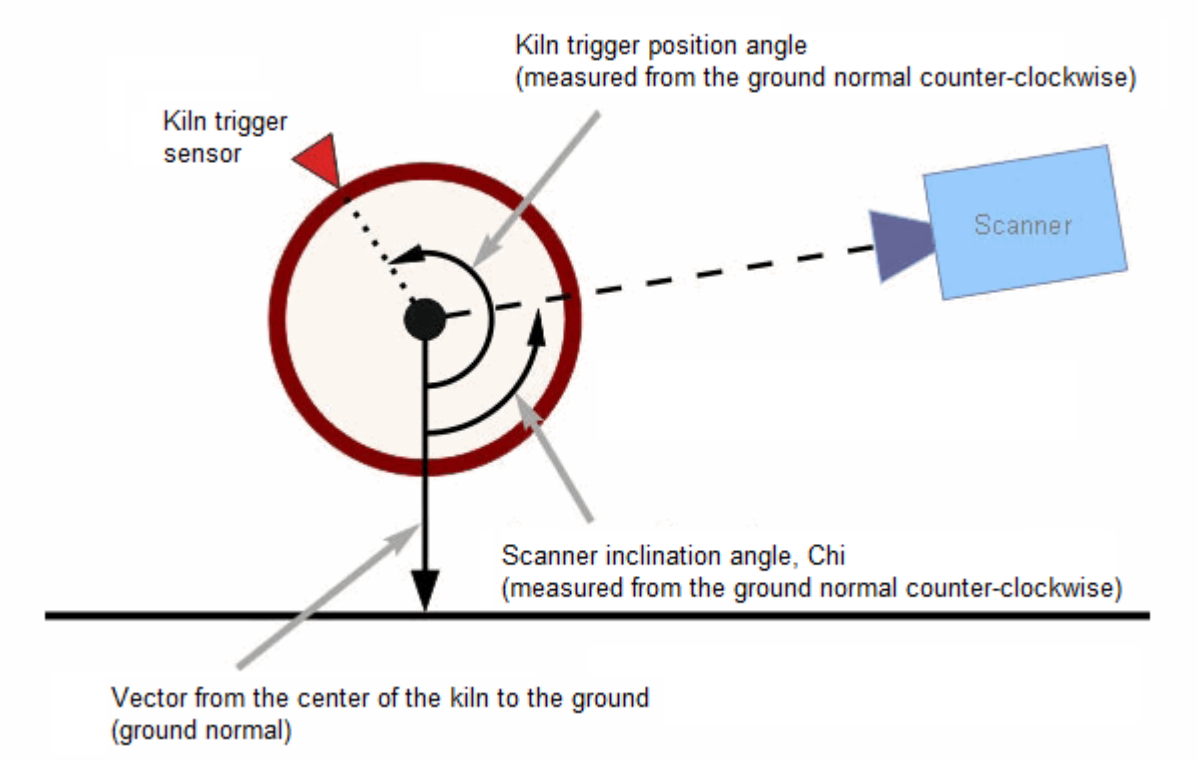
Scanner geometry: possible values are "Rotating Mirror" and "Detector Array". This selection will define the perspective correction formula. It is used when the scanner view angle is not zero.

Scanner FOV: scanner's field of view in degrees.

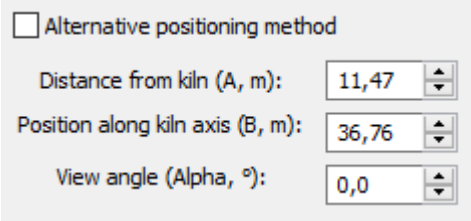
Scanner line length: number of pixels in the scanned line.

Scanner geometry, FOV and line length are filled automatically after communication with the scanner is established. You can set these values manually in case the scanner is not yet connected to the system.

Inclination angle, Chi: angle (in degrees) from the ground normal to the scanner field of view in counter-clockwise direction if to look at the kiln butt end from the kiln axis origin side.



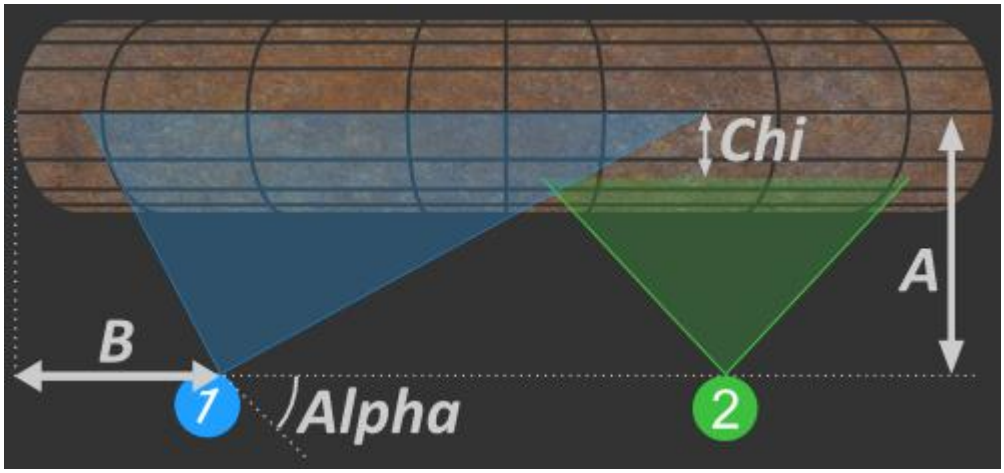
Scanner position



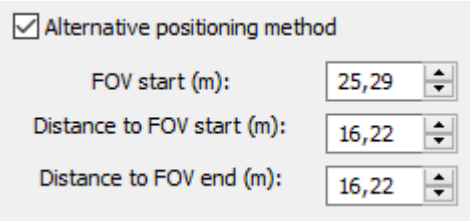
Distance from kiln, A: direct distance from the scanner to the kiln.

Position along kiln axis, B: distance from the kiln origin to the scanner along kiln axis.

View angle, Alpha: scanner view angle, see the picture.



Alternative scanner positioning method

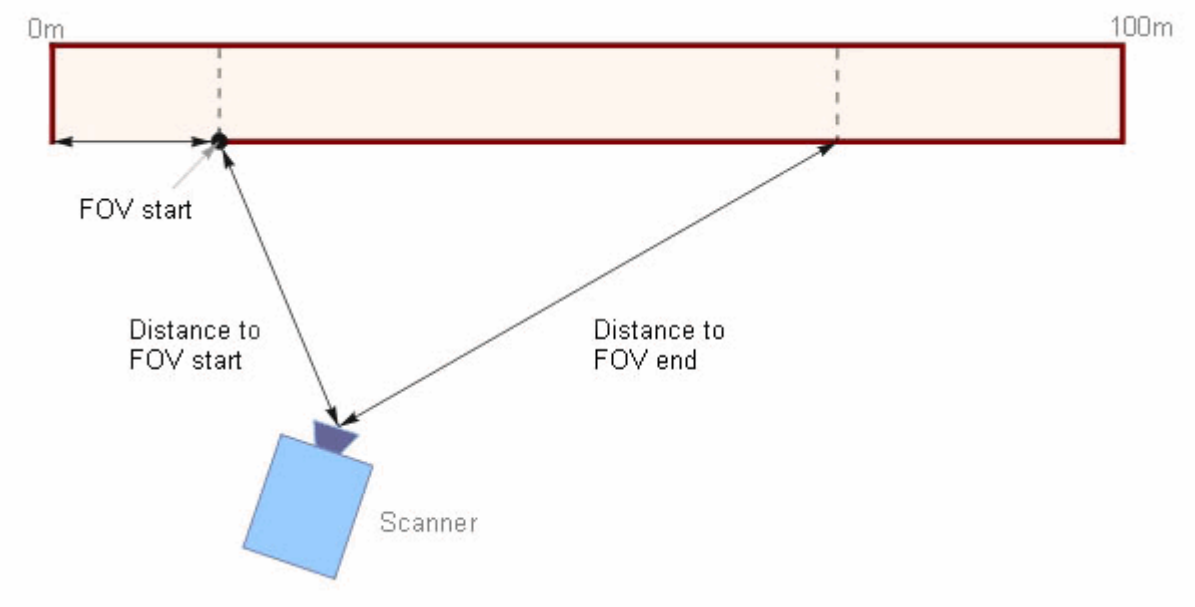


If you mark **Alternative positioning method** check box, you can use different measures to define the scanner position. In some cases this method is more convenient because you do not need to set scanner view angle which is often difficult to measure.FOV

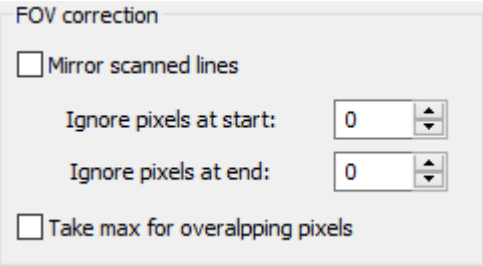
FOV start: coordinate of the starting point of the kiln area observed by the scanner along kiln axis.

Distance to FOV start: distance from the scanner to to the scanner FOV start point.

Distance to FOV end: distance from the scanner to the scanner FOV end point.



FOV correction

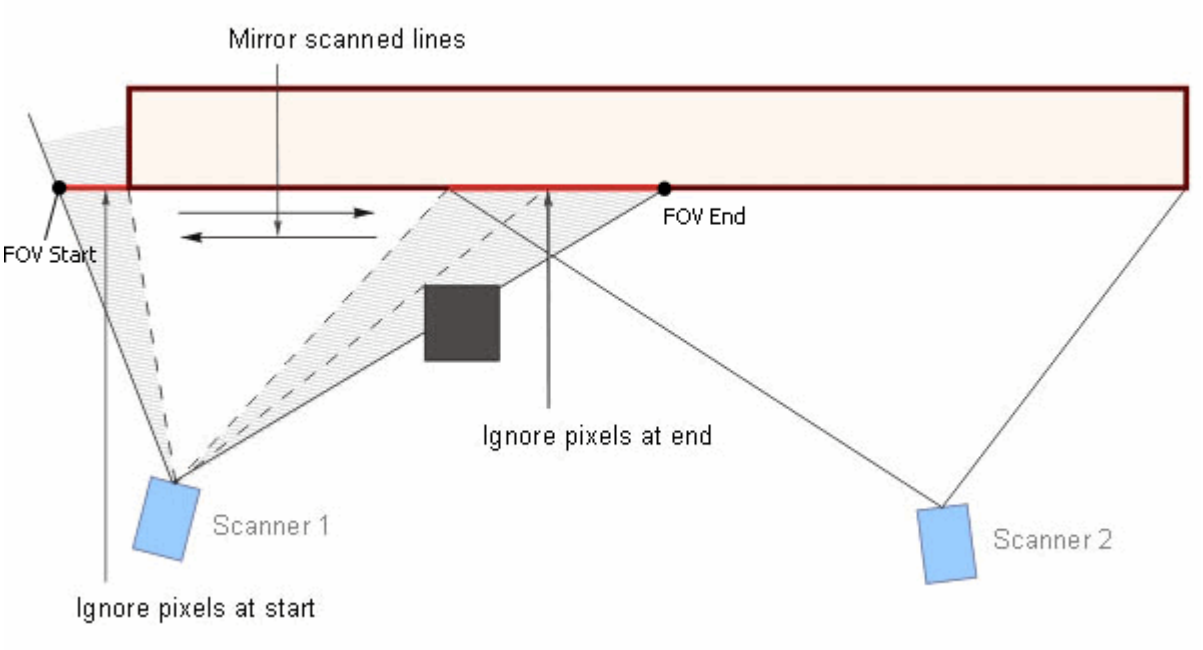


Mirror scanned lines: if marked – before processing, every line coming from the scanner is inverted (mirrored). You may want the scanned lines mirrored if, for example, you have scanners installed on different sides of the kiln. In this case, to have the proper image of the whole kiln on the screen, you need to mirror lines from one of the scanners. Another is of this option is if the scanner is mounted upside down.

Ignore pixels at start: number of pixels to ignore at the beginning of the scanned line.

Ignore pixels at end: number of pixels to ignore at the end of the scanned line.

It may be necessary to ignore some pixels at the start or at the end if, for example, the scanner is installed so that its field of view includes some area that does not belong to the kiln, or if on the path from the scanner to the kiln there is a foreign object that gets into scanner's field of view.



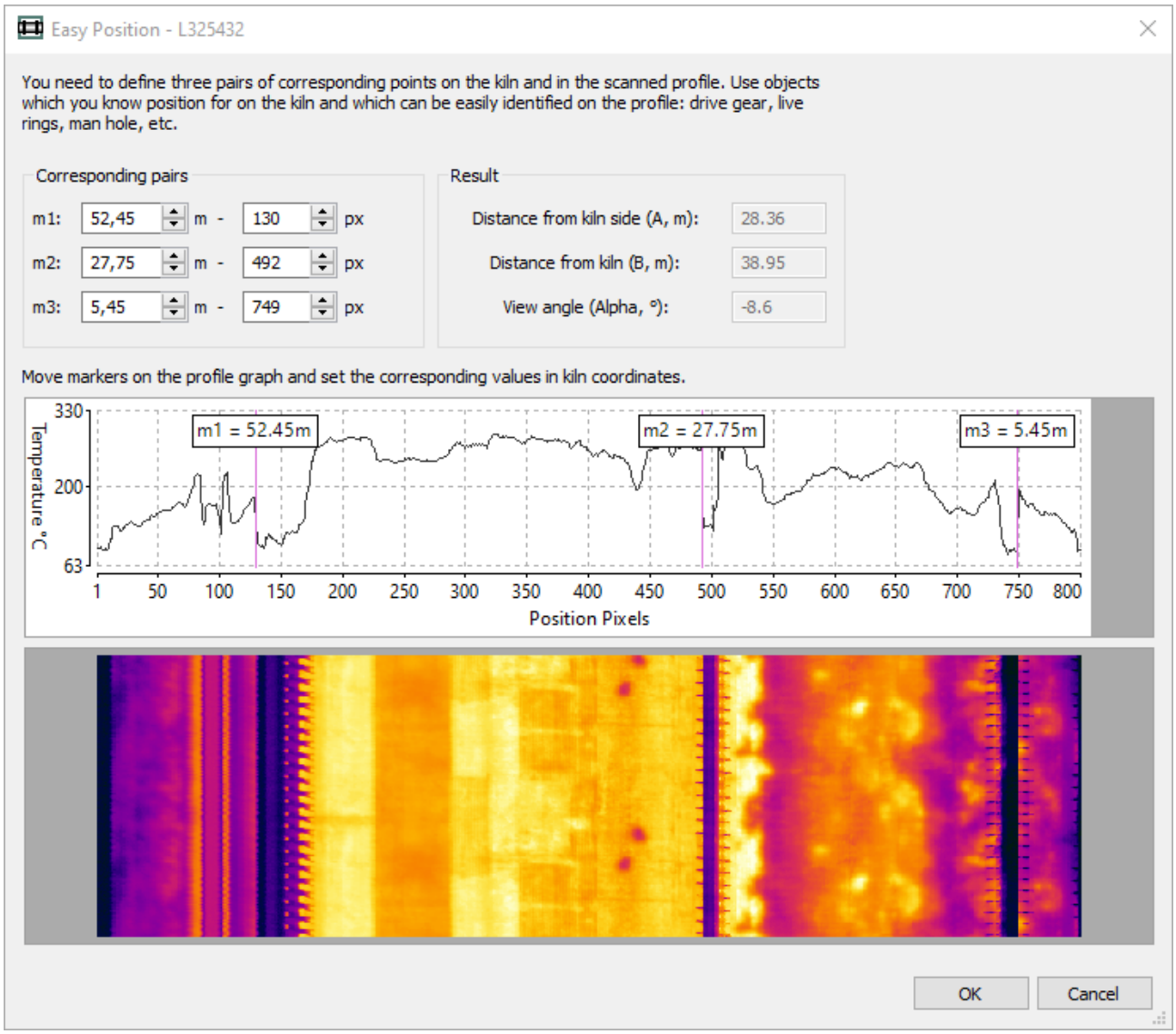
Take max for overlapping pixels: another method to solve problems when two scanners FOVs overlap. If this option is selected, when scanned pixels are rendered to the resulting image, the new pixel replaces the underlying pixel only if its value is higher. See Kiln shell image composition algorithm for more details.

Easy Position

Easy Position function allows to set scanner position without measuring distances and angles. It uses scanned data and recalculates the scanner position by coordinates of know kiln objects visible on the scanned data.

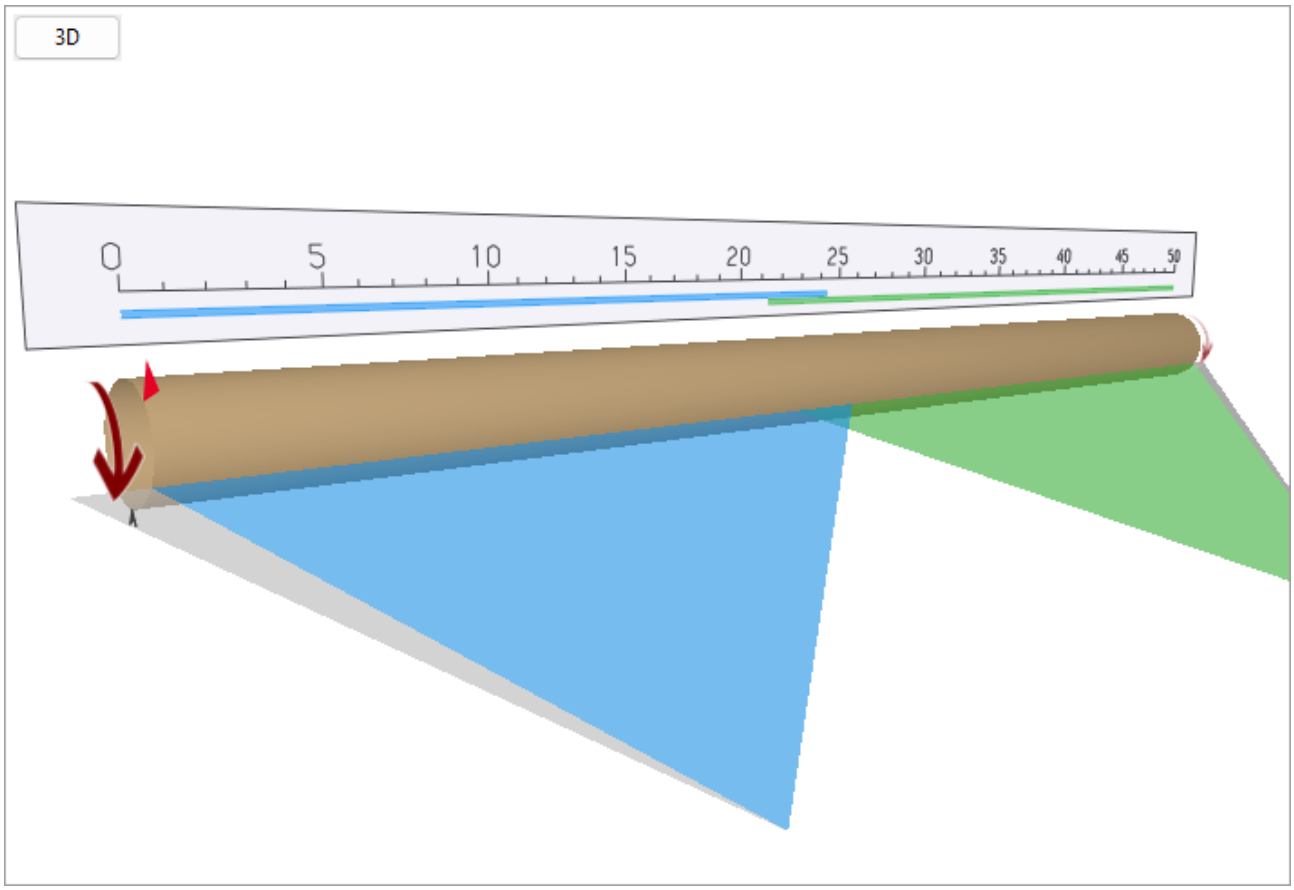
You need to define three pairs of corresponding points on the kiln and in the scanned profile. Use objects which you know position for on the kiln and which can be easily identified on the profile: drive gear, live rings, man hole, etc.

Move markers on the profile graph and set the corresponding values in kiln coordinates.



2D/3D scanners position view

When you change a scanner position or other parameters you immediately see the changes in the kiln view at the right.

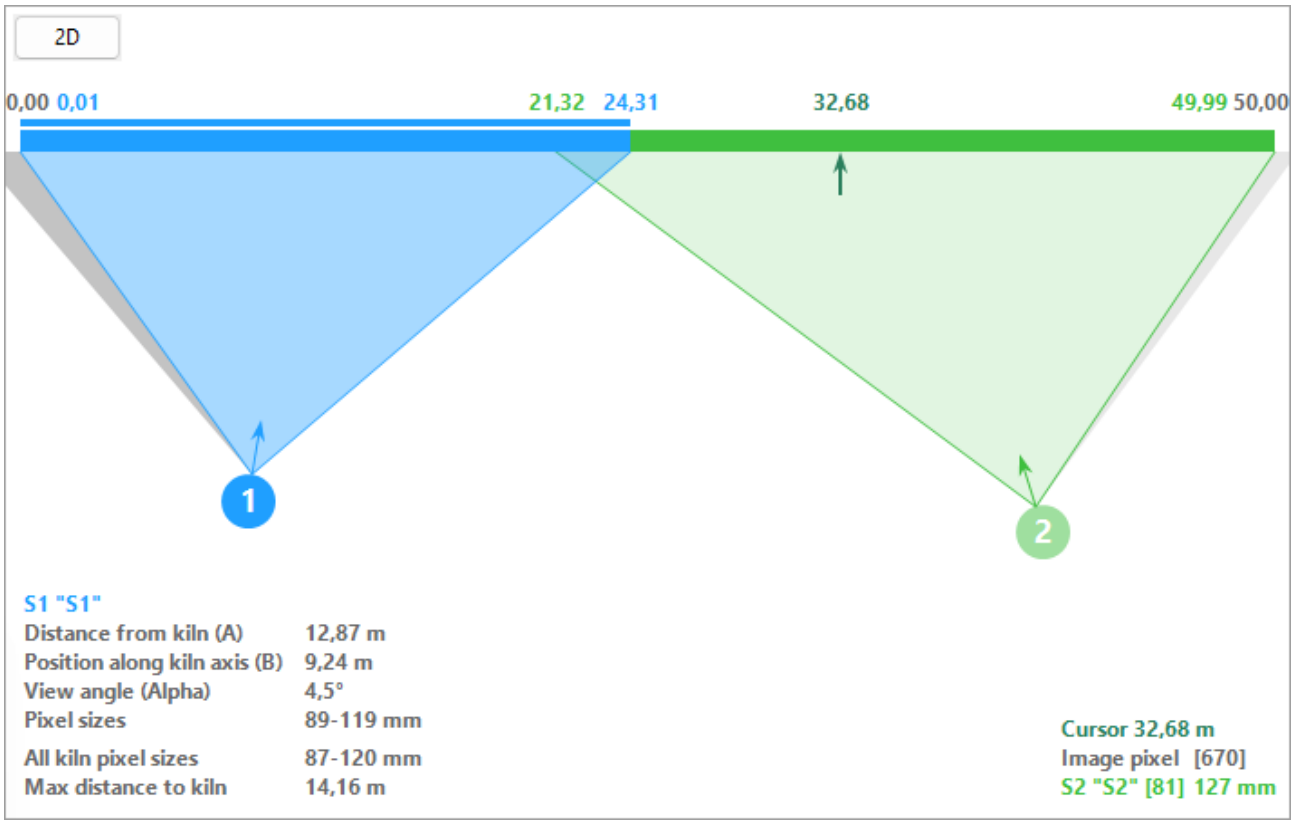


Big burgundy arrow - rotation direction.

Red arrow - position of the kiln trigger sensor on the kiln circumference (position along kiln is not important).

Small gray arrow - zero position on the kiln circumference.

Colorful triangles show scanners' FOVs. Part of a scanner FOV which is not used is shown in gray.



This view shows detailed information about the scanners - their positions and resolution.

Resolution

Resolution is the number of pixels on a scanned line that covers a certain area of the kiln.

The pixel size is the reciprocal of the resolution and indicates the area of the kiln shell that corresponds to one pixel on the scanned line.

Pixel size is important because if the size of a hotspot we want to measure temperature of is smaller than the pixel size, we won't get correct temperature value - it will be averaged with the temperature of a spot lying next to our hotspot. In fact, the pixel size should be half the size of the hotspot whose temperature we are measuring. For kiln monitoring the smallest hotspot size we are interested in is usually the refractory brick size.

This view shows pixel sizes only along the X coordinate.

Areas on the kiln shell that are further away from a scanner have worse resolution on the scanned kiln infrared image than areas that are closer to the scanner. IRT KilnMonitor automatically corrects these resolution differences when the kiln shell image is displayed on the screen using approximation for areas with lower resolution.

What we see in the 2D kiln view

Here we see information about the selected scanner - its position and the best and the worst resolution.

Here we see the best and the worst resolution along the entire length of the kiln, as well as the straight distance to the furthest scanner.

Here we see information about the kiln position indicated by the cursor. The cursor is an arrow next to the kiln strip, it can be moved with the mouse.

[670] - pixel number on the kiln image.

[81] 127 mm - pixel number on the scanner line and the size of this pixel in kiln coordinates.

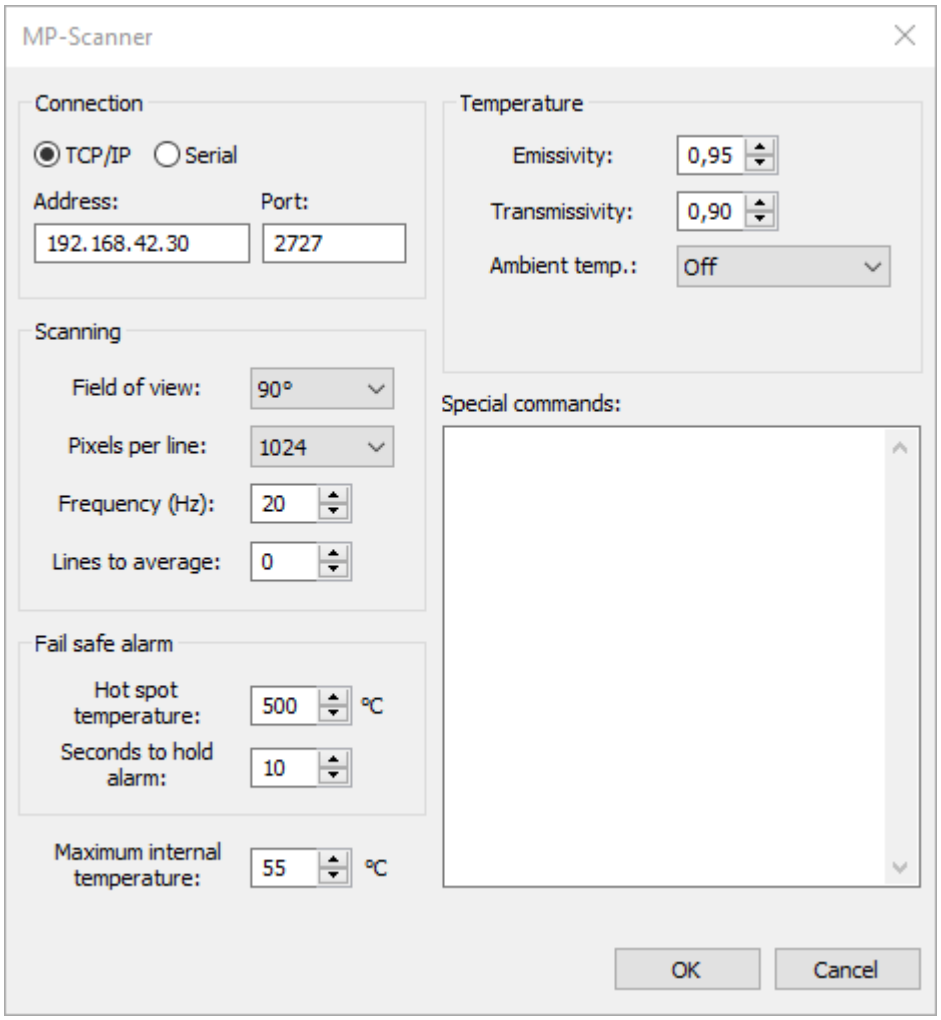
Positioning scanners using the mouse

Scanner edit mode must be active to move the scanners with the mouse. Scanners are in edit mode when the scanners list edit dialog or the single scanner edit dialog box is open.

- Double-click the scanner circle to activate it and open its editing dialog box. If you double-click outside any scanner, the scanner list edit dialog will show up and you will be able to reposition any scanner, not just the active one.
- To change the position of a scanner, press the left mouse button on the scanner circle and, while holding the button, move the mouse.
- Use the mouse wheel to change scanner view angle.
- Hold the Shift key on the keyboard while moving the mouse to change the position of the scanner without changing the scanned part of the kiln (Fixed FOV Move Mode).

2.9 MP-scanner communication and parameters

MP150 linescanners are supported with Ethernet or RS485 interfaces.



Connection

If your MP scanner has Ethernet interface, select **TCP/IP** and set its IP address (default: 192.168.42.30 for the first scanner; 192.168.42.31 for a second scanner, and so on) and port (default: 2727). For further information to configure the Ethernet communication for scanner and PC network adapter, see MP150 manual. Please note that each scanner in a multiple scanner system requires a unique IP address.

If your scanner is connected to a COM port, use **Serial** option and specify which COM port to use, then select baud rate RS485 interface of the scanner should be configured to.

Baud rate

If selected baud rate does not correspond to the baud rate the scanner is currently expecting communication at, IRT KilnMonitor will try to connect to the scanner at different baud rates, and then, upon a success, will switch scanner's current baud rate to the requested baud rate.

Scanning parameters

Field of view: 90° or 45°

Pixels per line: normally you should select the maximum value supported by the scanner.

Frequency: 20 Hz is normally more than enough for any kiln monitoring application.

Lines to average: helps to improve temperature accuracy and reduce noise. Please take into account that by enabling averaging you reduce actual scan frequency: *Scan frequency = Selected frequency / Lines to average*.

Temperature parameters

These parameters affect temperature measurement.

Emissivity: the kiln shell usually have surface with high emittance, so emissivity value should be around 0.95.

Transmissivity: this parameter is used to compensate thermal radiation losses because of atmospheric absorption. Depends on the distance from the kiln to the scanner. Usually in the range 0.8 to 1.0. This parameter can also be used if there is an extra window on the path between the scanner and the kiln.

Ambient temperature: compensation for reflected radiation, normally not used because effect is not large comparing to the kiln temperatures.

Special commands

List of additional MP scanner commands that will be executed immediately after connection to the scanner is established. Please refer to the scanner manual for a list of possible commands.

Each command should be on its own line. To have more than one command on a line, commands must be separated with a semi-colon.

Internal temperature

Maximum internal temperature: if the specified temperature value is exceeded, a system state alarm is generated.

Fail safe alarm

To increase reliability of the system it is helpful to have hot spot alarming even when the PC or the software stops functioning. MP scanners provides an internal relay that will be triggered if a hot spot exceeding the predefined limit is detected within the scanner field of view. The relay contacts are available on the terminal line in the system connection box.

Hot spot temperature: if the scanner registers temperature higher than this limit the alarm is triggered.

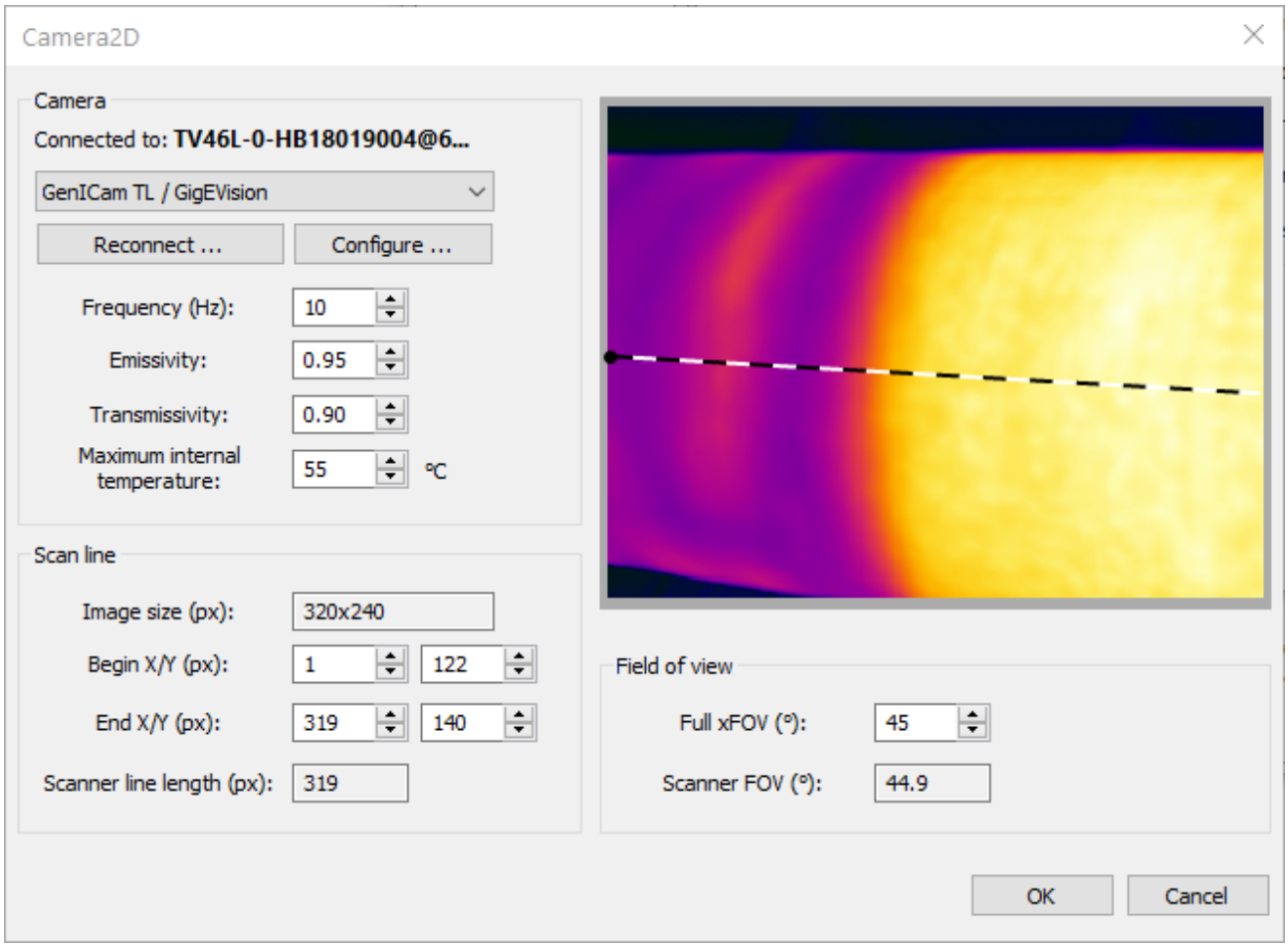
Seconds to hold alarm: the alarm signal will be held at least this number of seconds even after the hot spot moves away from the scanner view.

2.10 Camera2D communication and parameters

IRT KilnMonitor can use thermal cameras for different purposes:

- The thermal camera can be used both as a primary scanner and instead of a pyrometer to monitor shadow zones. A line on the image is selected which will be the source of data for scanning the kiln surface.
- The thermal camera can be used to monitor the temperature of the burning zone.

Configuration settings are the same in both cases, in the first case you must also select the scanning line:



Frequency: scanning frequency in Hz (or frames per second).

Emissivity: the kiln shell usually have surface with high emittance, so emissivity value should be around 0.95.

Transmissivity: this parameter is used to compensate thermal radiation losses because of atmospheric absorption.

Maximum internal temperature: if the specified temperature value is exceeded, a system state alarm is generated.

Scan line: the source for scan data. You can change the line by clicking on the image. First click will set the begin position, second - the end. The line begin is marked with the black dot.

Field of view: enter the horizontal field of view of the camera which will allow to calculate scan line field of view.

2.11 ThermoView TV30/TV40

TV40/TV30 series cameras have GigEVision interface and can be connected to a PC using Ethernet cable. When connected to a local area network camera acts as any other Ethernet (IPv4) device and needs an IP address:

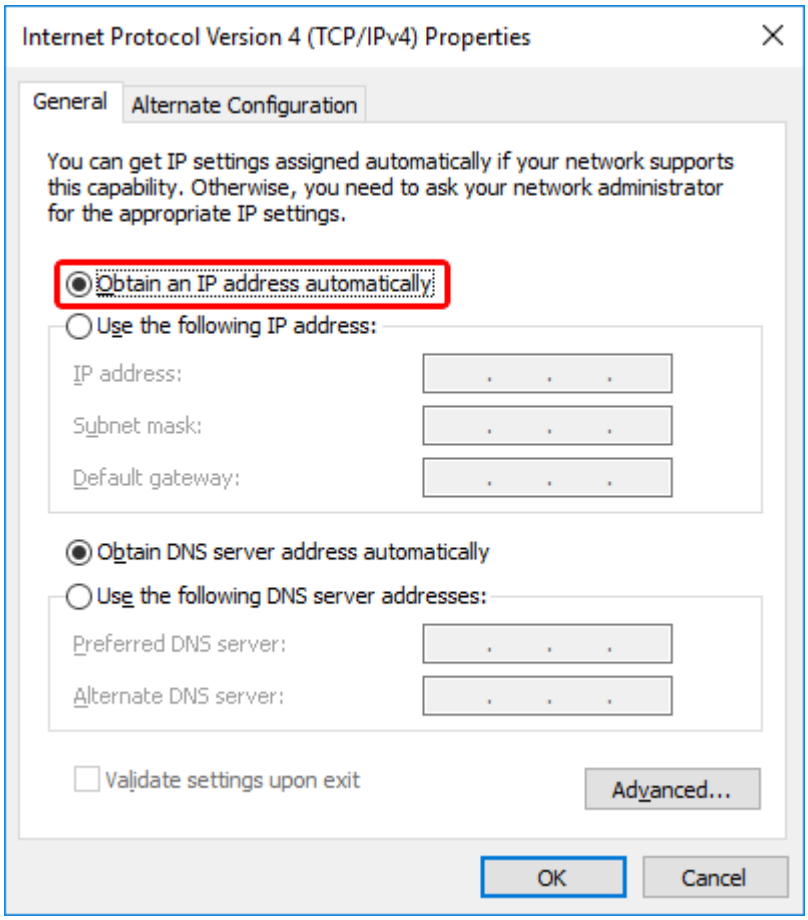
- If a DHCP server is available, camera gets IP address from the DHCP server.

- If there are no DHCP server or camera is connected directly to the Ethernet port of a PC - IP address is selected automatically from the private IP range: 169.254.0.1 through 169.254.255.254.
- It is also possible to set a fixed IP address in an Internet browser using the camera web interface (you need to know current IP address of the camera and type it in the address line).

Configuring network adapter for direct camera to PC connection

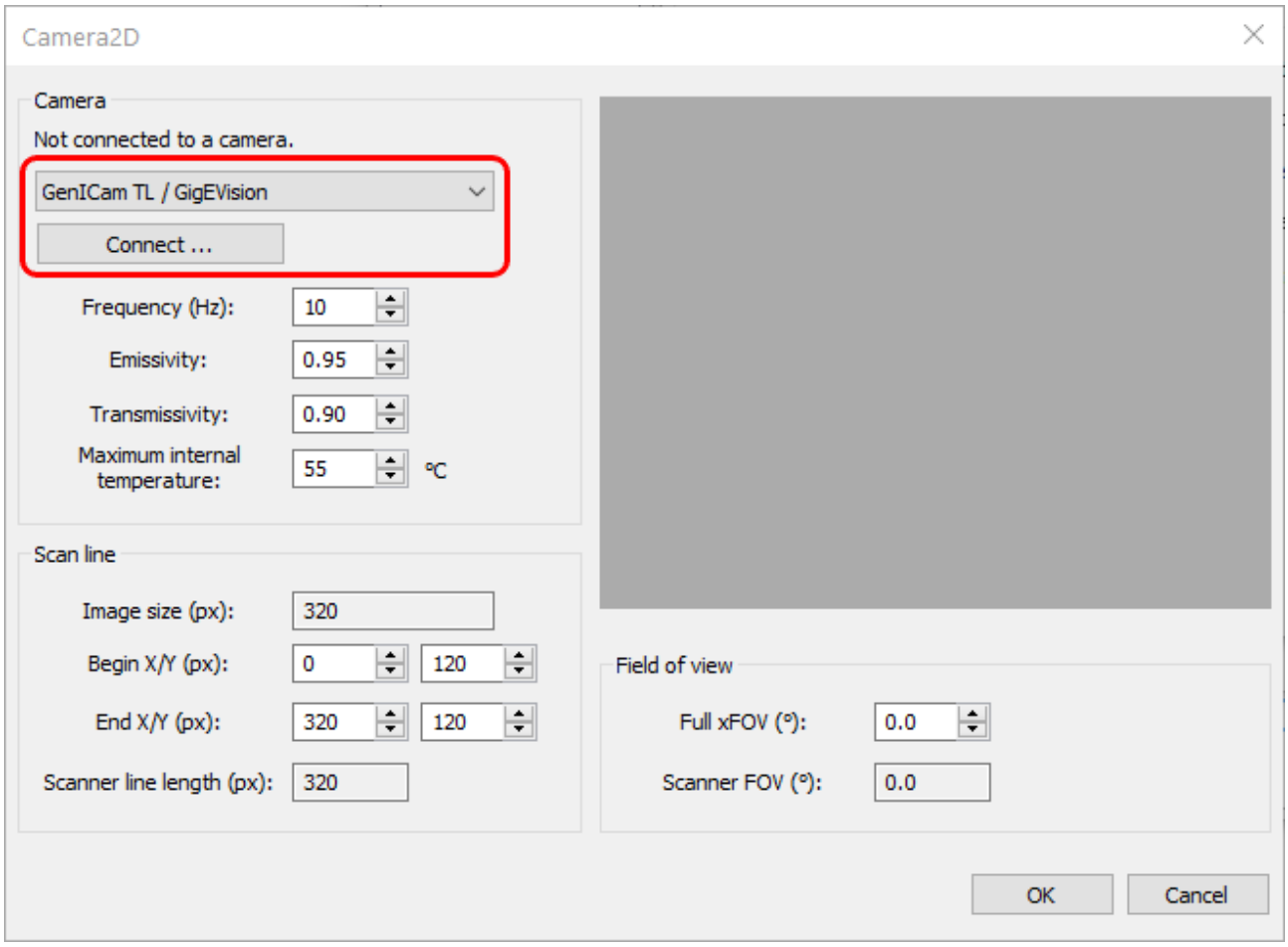
You can connect Ethernet cable from the camera directly to the PC, without any router in between. In this case camera IP address is selected from the automatic private IP range.

In order to communicate with the camera, your PC network adapter must be configured to use the same IP range (subnet). The easiest way to do it is to select "Obtain an IP address automatically" option in the TCP/IPv4 settings of the PC network adapter connected to the camera. In this case computer's IP address will be also automatically selected in the same 169.254.X.X range.

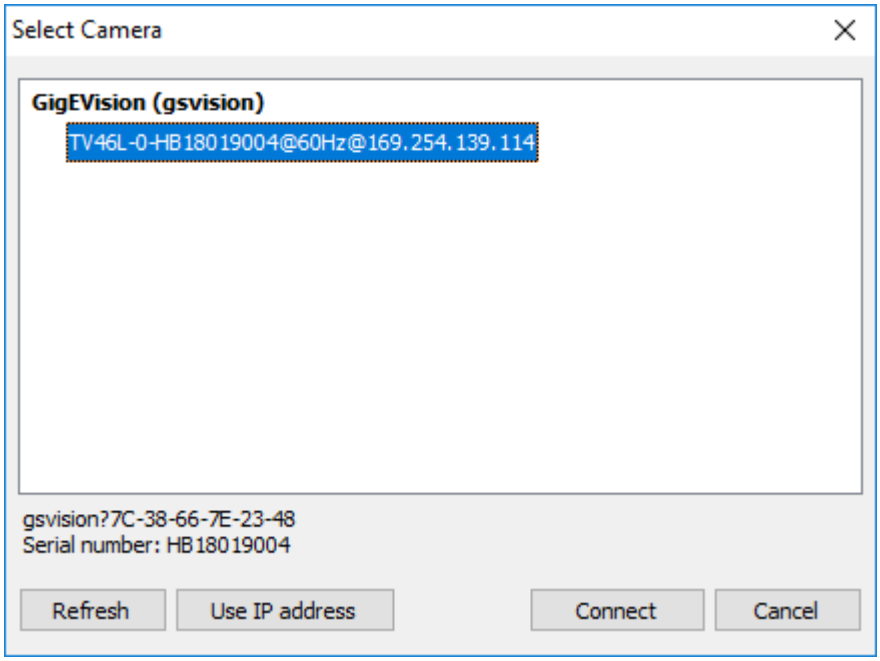


Connecting to the camera

1. In the Camera2D configuration dialog, select "GenICam TL / GigEVision" driver and click the **Connect** button:



2. Select the camera you want to connect to and press **'Connect'** button. If you do not see the camera in the list, you can try to update camera list by pressing **'Refresh'** button.



You may see "***other subnet***" text after the camera name. It means that IP address of the camera does not match IP address of the PC: the PC and the camera are in different subnets. If the subnets are not linked by a router connection to the camera will not be possible.

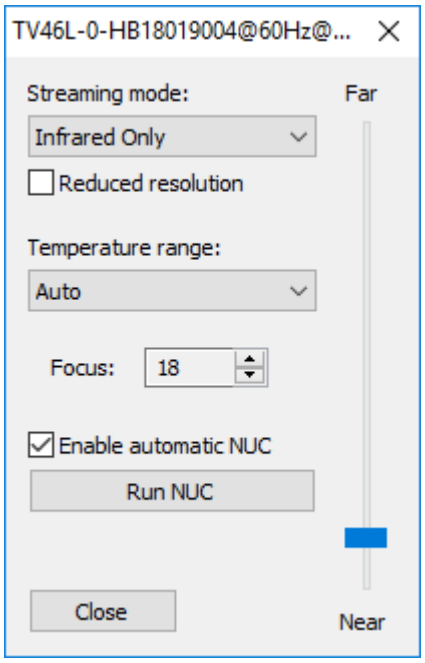
Text "***in use***" after the camera name means that another PC or another program on your PC already established connection with the camera. This will not allow you to connect.

Connecting to camera in another subnet

If the camera and the PC are in different subnets, IRT KilnMonitor cannot detect camera automatically. Reason for this - camera discovery messages are broadcasted and in most cases broadcast messages are not forwarded by routers to other subnets. To overcome this limitation you have to know the IP address of the camera and set it by clicking **'Use IP address'** button.

Changing camera settings: focusing, temperature range, shutter

After you connected to the camera you can change camera settings, like focusing, temperature range and non-uniformity correction parameters. Press Configure button in the **Camera2D** dialog.



Streaming mode

TV40: Can be 'Infrared Only' or 'Fusion'. Infrared Only must be selected as Fusion is not used in IRT KilnMonitor.

Reduced resolution

TV40: This option allows to reduce infrared image resolution by half. Can be useful when you experience problems with losses during data transmission or low PC side performance.

Temperature range

Your camera is calibrated to measure temperatures in different ranges. If the viewed object has a high temperature and a low temperature range is selected in the camera, measured temperature values will be inaccurate or completely wrong.

'Auto' range: camera will automatically select the appropriate range. Using Auto range is not recommended in Automation mode as range switch may happen during an important measurement. Range switch procedure takes several seconds, during this period measured values may be absolutely wrong.

Focus

Allows to drive motorized focus position. Displayed focus position number has no physical meaning. Use **'Near-Far'** slider to change focus position. Focus edit box spin buttons are handy for fine focus changes.

Enable automatic NUC

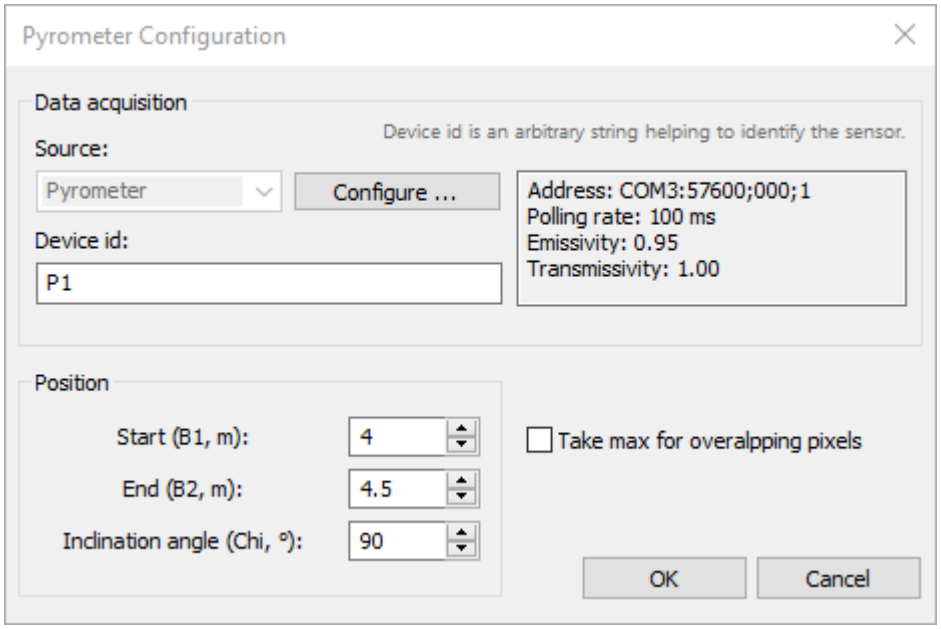
TV40: When enabled, the camera performs non-uniformity correction (NUC) automatically at times it determines based on sensor temperature. For kiln monitoring, **automatic NUC must remain enabled at all times**.

TV30: Automatic NUC is always enabled.

Run NUC

TV40: Click this button to start a non-uniformity correction (NUC) cycle immediately. This triggers a single NUC operation and does not change the camera's long-term operating mode or settings..

2.12 Pyrometer configuration



Source: device type used as a pyrometer, only "Pyrometer" source is supported. Press **Configure** button to setup up pyrometer communication and adjust its parameters.

Device id: used to identify the pyrometer in messages reporting problems and other cases. Can be any text string you like.

Pyrometer position

A pyrometer measures temperature in a single spot. Its position defines area of the kiln that should be overwritten with the pyrometer measurements.

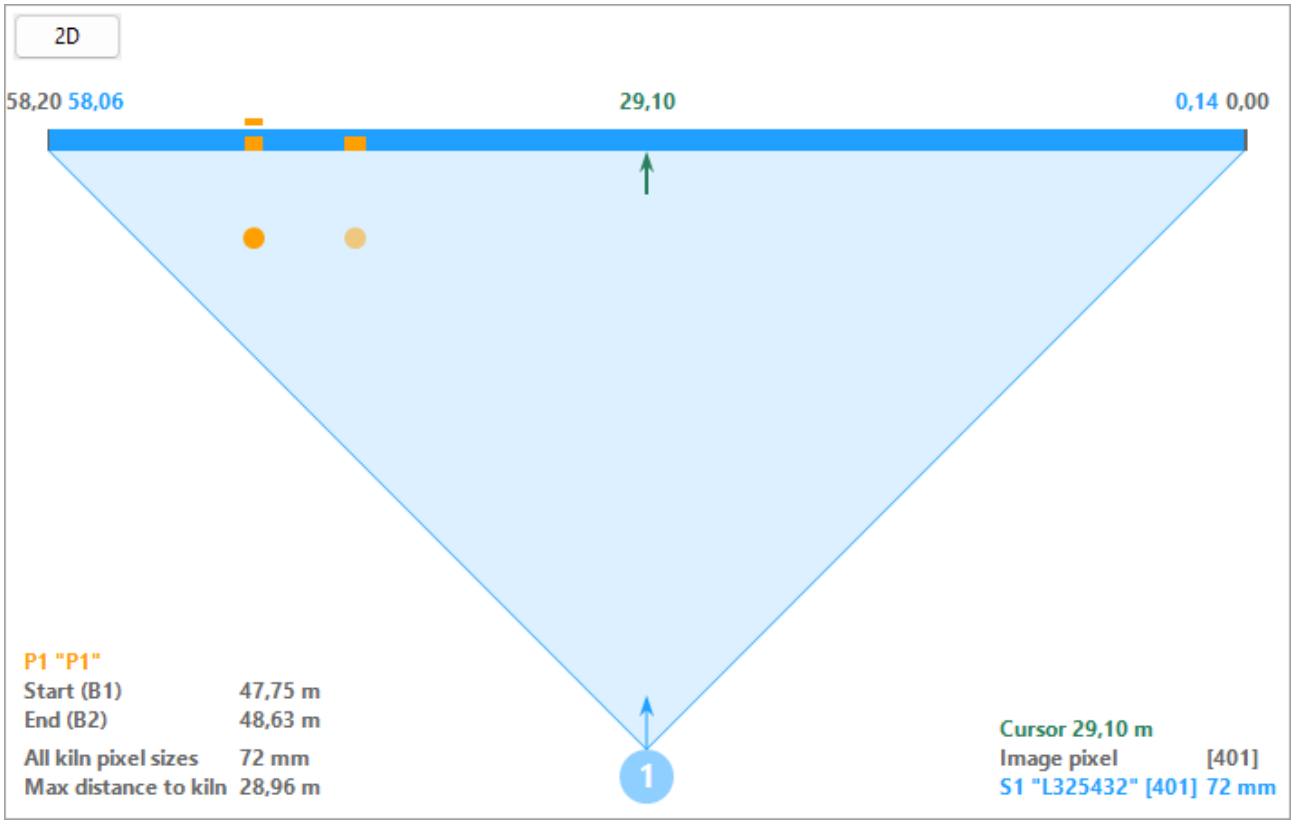
Start, B1: position along the kiln axis that defines pyrometer area begin.

End, B2: position along the kiln axis that defines pyrometer area end.

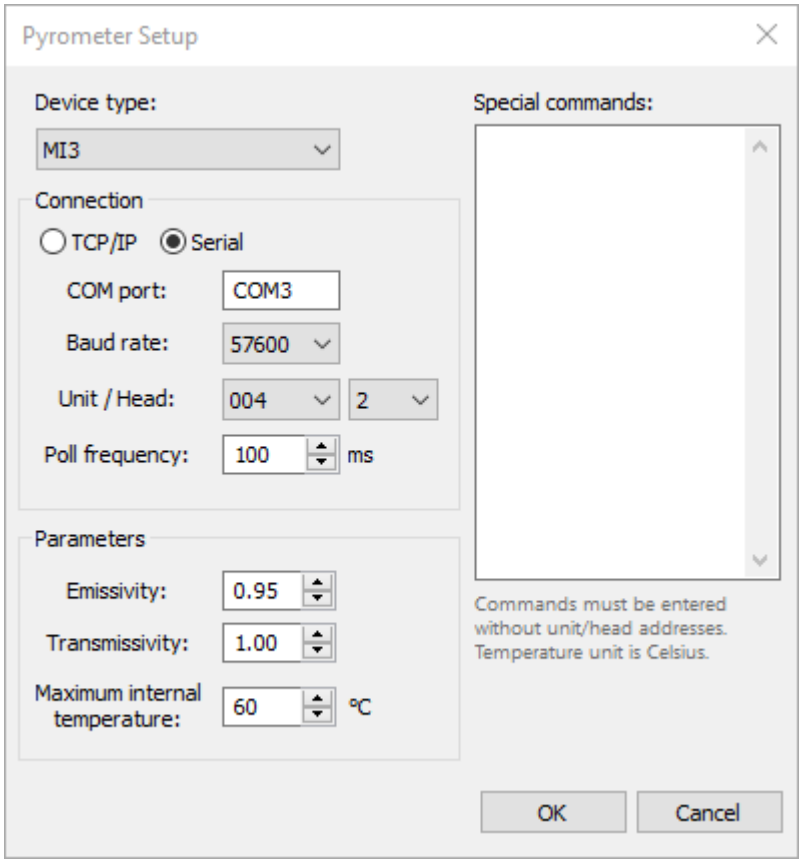
Inclination angle, Chi: angle (in degrees) from the ground normal to the scanner field of view in counter-clockwise direction if to look at the kiln butt end from the kiln axis origin side.

Take max for overlapping pixels: If this option is selected, the pyrometer measurement replaces the scanner measurements only if its value is higher. See Kiln shell image composition algorithm for more details.

On the 2D configuration view pyrometers are shown as orange dots and can be moved there using the mouse.



2.13 Pyrometer communication and parameters



Device type

Supported devices include Endurance, MI3 and Thermalert 4.

IRT KilnMonitor does not support configuration of all parameters a pyrometer may support, it only polls already configured devices. Some extra parameters can be set using Special commands, but communication related parameters like baud rate, multidrop address or IP address must be configured in the special software delivered with pyrometers.

Connection

Depending on your device type connection can be **TCP/IP** or **Serial**. Serial is used when RS485 device is connected to a COM port. TCP/IP is used if the pyrometer has Ethernet interface or if you connect RS485 pyrometer with RS485 to Ethernet converter without virtual COM ports (see RS485 to Ethernet converter below).

Baud rate: you should select the baud rate that matches the baud rate the pyrometer is currently configured for. If baud rates do not match, communication is not possible, baud rate auto negotiation is not supported.

Unit: RS485 multidrop unit address.

Head: head address for devices that support several sensing heads (MI3).

Poll frequency: IRT KilnMonitor will try to poll the pyrometer for measured temperatures at this rate. The selected rate might not be achieved when response time of the device is slower or when there are several devices connected to the same RS485 multidrop network. Also sometimes it makes no sense to poll too frequently as pyrometer may not update its reading fast enough. Please consult the pyrometer manual for response times and update frequencies.

Parameters

Emissivity: the kiln shell usually have surface with high emittance, so emissivity value should be around 0.95.

Transmissivity: this parameter is used to compensate thermal radiation losses because of atmospheric absorption. Pyrometers are usually installed close to the kiln, so transmissivity is normally close to 1.0.

Maximum internal temperature: if the specified temperature value is exceeded, a system state alarm is generated.

Special commands

List of additional pyrometers commands that will be executed immediately after connection to the pyrometer is established. Please refer to the pyrometer manual for a list of possible commands.

Each command should be on its own line. To have more than one command on a line, commands must be separated with a semi-colon.

Commands should be entered without unit/head addresses! Temperature unit in commands is Celsius.

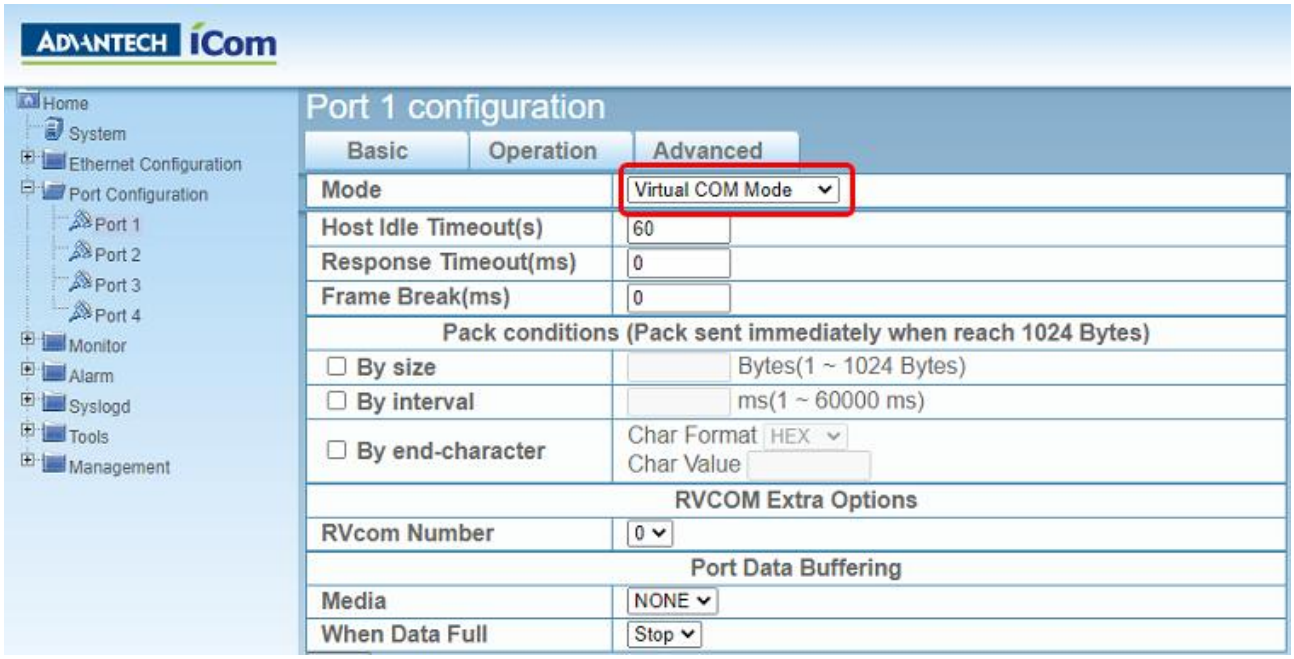
RS485 to Ethernet converter

The usual way of connecting an RS485 device to a PC is to use special RS485 boards or RS485 to RS232 converters and talk to the device through a corresponding COM port. There is also another possibility - to use an RS485 to Ethernet converter. Such converters work in a way that they convert RS485 data into TCP/IP packets and back. On the PC side they create virtual COM ports and send data through them as if the remote device is directly connected to the PC COM port. This fully simulates serial communication and PC software does not even know that Ethernet is used in the middle.

Converter to Ethernet can also work without creating virtual COM ports on the PC side. Then they just convert RS485 data to TCP/IP packets and PC software should establish connection using TCP sockets. IRT KilnMonitor supports this method as well - use the Ethernet connection option.

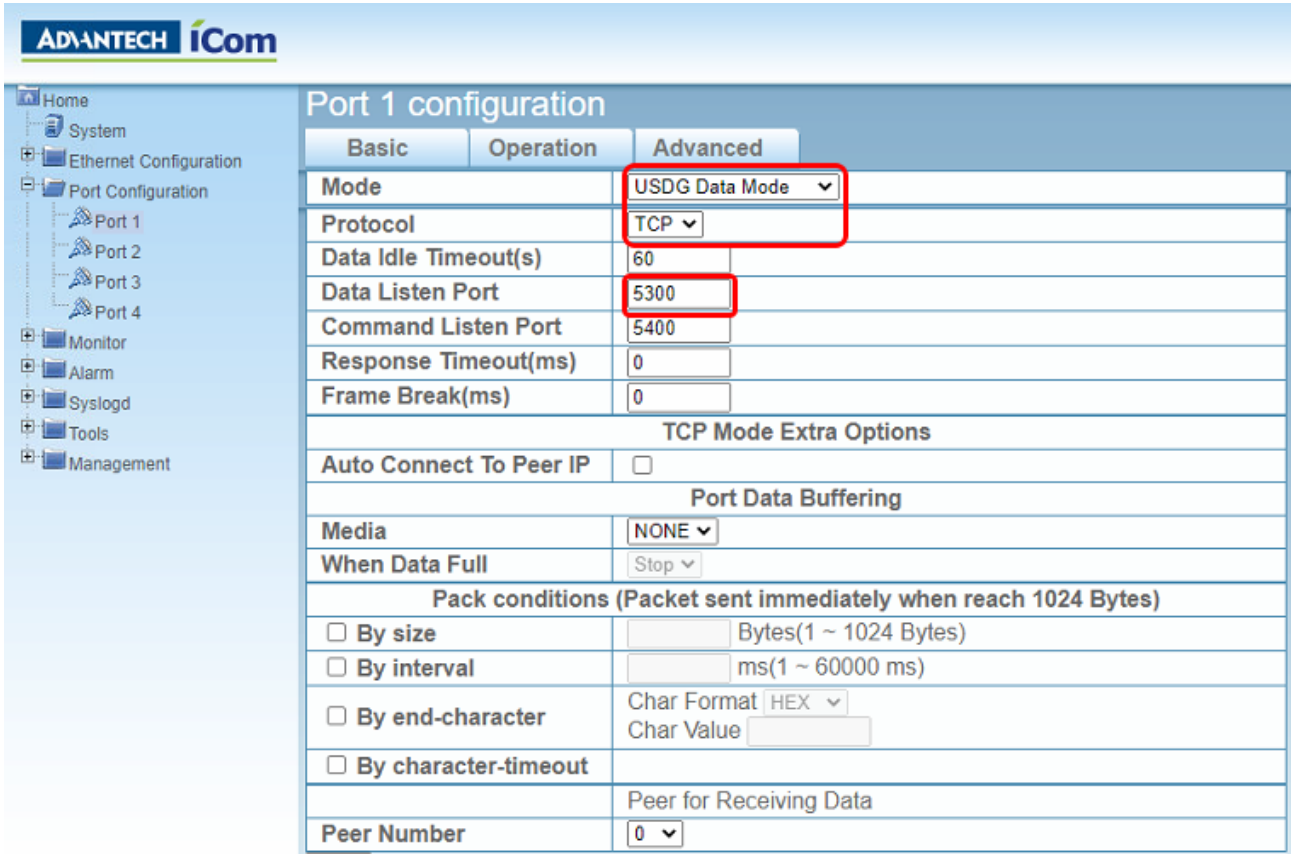
Advantech EKI-1524

Here is a only a brief description for the two modes for Advantech EKI-1524 converter. For details please check the CS400 hardware manual.



In the port configuration if you select **Virtual COM Mode**, you will need to install Advantech software on the PC and use virtual COM ports there.

You can also use **USDG Data Mode** with TCP protocol. Then Advantech software and virtual COM ports are not needed on the PC side. In IRT KilnMonitor you select Ethernet connection option. IP address is the address of the EKI-1524 device and Port is the port number selected in the EKI-1524 Port configuration:



2.14 WAGO 750-362 field bus coupler

WAGO 750-362 (750-352) fieldbus coupler is used to output alarm and analog signals to the plant automation system.

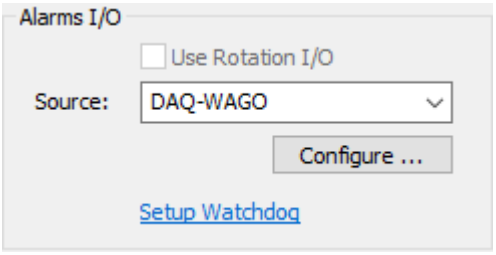
These WAGO 750 extension modules are tested and supported:

- Digital output module 750-1504;
- Relay output modules 750-513, 750-517;
- Analog output modules 750-562, 750-563;
- Digital input module 750-1406.

Proper work of other modules is not guaranteed.

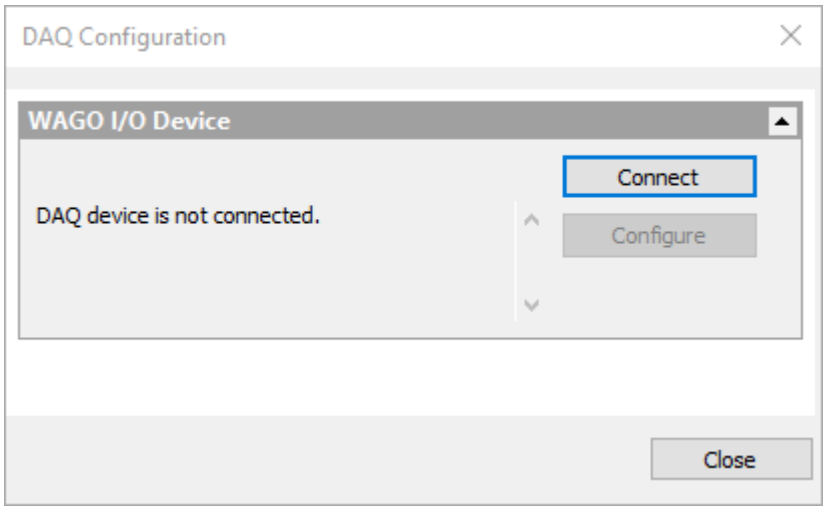
> If an unsupported module is used, IRT KilnMonitor may not be able to address the inputs and outputs correctly even in the supported modules. Because of this the program will not allow connection to the device.

To set a WAGO coupler to be used as the output device, select **DAQ-WAGO** as the source for Alarms I/O on the Installation configuration page:

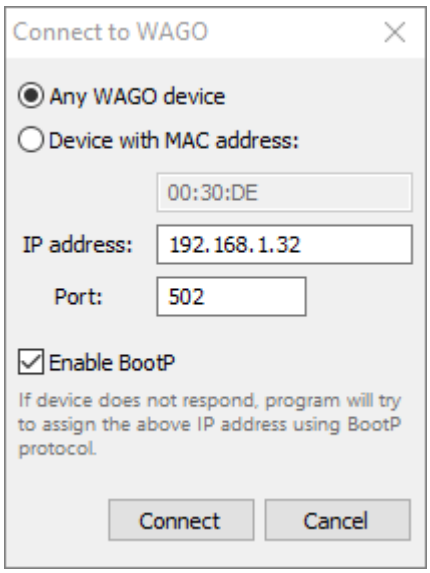


Press Configure to establish communication with the WAGO module (it must be already connected to the computer) and to change communication parameters.

First you will see DAQ Configuration dialog:



Press Connect to connect to the device.



MAC address

If you have several fieldbus couplers in your network, you need to select to which of the available couplers to connect. The identification is done using the MAC address. There is a sticker with unique MAC address on every WAGO fieldbus coupler.

If you have just one fieldbus coupler, select Any WAGO device option.

IP address

WAGO fieldbus coupler supports several methods of IP address assignment. You can read about them in the WAGO fieldbus coupler documentation. In this manual you will find description of methods that we recommend to use. Please see it below.

Port

If not changed in fieldbus coupler configuration, port used to exchange data with the fieldbus coupler is 502 (default for Modbus protocol).

Enable BootP

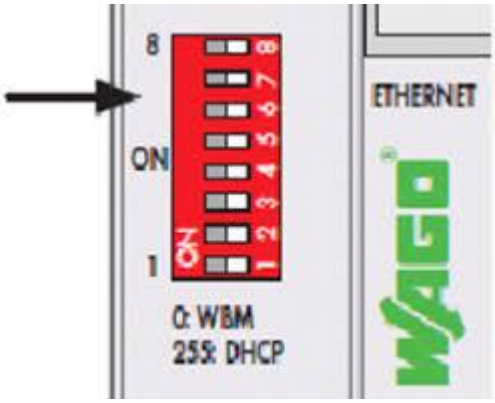
Mark the check box to enable BootP protocol on the PC side.

Using BootP protocol to connect to a WAGO device

May not work if device's factory default configuration is changed.

We recommend to use BootP protocol for IP address assignment. This is also the default method - WAGO fieldbus coupler has BootP enabled in the factory default configuration.

Before you try to connect to your WAGO device, please make sure that all switches on the red DIP switch on the fieldbus coupler case are set to 0. On the picture below, all switches (white) are moved to the right, OFF side.



You need to select proper IP address that will be assigned to the WAGO fieldbus coupler:

IP address of the WAGO device must belong to the same subnet with PC's network adapter to which the coupler is connected to. For example, if PC's network adapter has IP address 192.168.1.X, for the fieldbus coupler you should select IP address which also starts with 192.168.1. Make sure that no other PC or network device uses the same IP address.

To know which IP address your PC adapter has you need to find the adapter in Windows settings and check its properties.

Please also consider the following:

- If WAGO device already has an IP address assigned, it cannot be changed with BootP.
- BootP server is running only during the connection process. It is stopped as soon as appropriate WAGO device is found and connected.
- IP address negotiation with BootP protocol may take some time, but not longer than two minutes.
- If IP address assignment takes too long, you may try to restart (power-on reset) the WAGO device, then it will send a BootP request immediately after booting.
- If BootP is used as the IP address assignment method, you should leave 'Enable BootP' option on as the BootP-assigned IP address is not remembered when WAGO device is rebooted.

Using DIP switch to set IP address

Again we assume here that factory default configuration of WAGO fieldbus coupler is not changed.

Default WAGO IP address starts with 192.168.1 and you can use the red DIP switch located on WAGO device case to set the IP address last number. There are 8 switches which allows to select a number from 0 to 255 in the binary form:

- **0**: WAGO WBM (web based) configuration is used, which has BootP method enabled (factory default). This is the BootP option described above.
- **1-254**: WAGO device will have fixed IP address 192.168.1.1-192.168.1.254, BootP protocol will not be used.
- **255**: WAGO device will use IP address assigned by a DHCP server (DHCP server should be available on LAN where WAGO device is connected to). This option is not recommended as DHCP assigned IP addresses are often dynamic and there is no easy way to know which address was used.

You should set 'IP address' field in 'Connect to WAGO' dialog to the same value as was configured by the DIP switch.

Other IP address selection methods

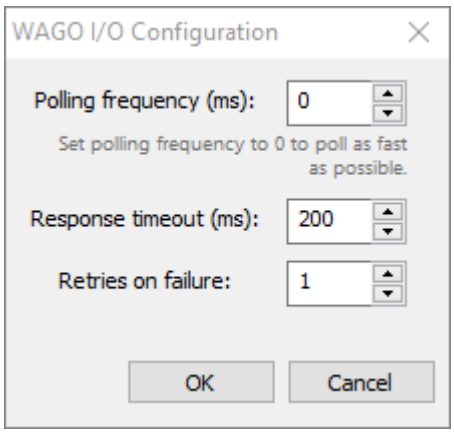
BootP and the DIP switch is not the only methods of IP address configuration. Fieldbus coupler settings can be also changed in Web-based Management System (WBM). If they are changed, methods described above may not work. Please read WAGO documentation for details.

Configuring data exchange delays for WAGO fieldbus coupler

Modbus TCP protocol is used to read input signals and to set output signal values. The protocol works in a way that PC program sends a request to the WAGO device and WAGO device reports current state of the inputs. You can configure how often to check the state of the inputs. The faster your controlled process is the higher should be the polling rate, but there are limitations.

In perfect conditions (short Ethernet cable, no interferences) it takes about 2 ms for WAGO device to respond. This allows to read input states about 500 times per second. Windows is not a realtime OS, at some moments response time may fall to about 20-40 ms.

To open WAGO configuration dialog press **Configure** button in the **DAQ Configuration** dialog.



Polling frequency

Specify the delay in the polling requests in milliseconds. 10 ms delay corresponds to 100 requests per second. If you set the delay to 0, polling will be done at the maximum frequency. This frequency is limited by WAGO filedbus coupler response time and the network capabilities. Practically the maximum frequency that can be achieved is 400-500 Hz (2-3 ms delay between requests).

Response timeout / Retries on failure

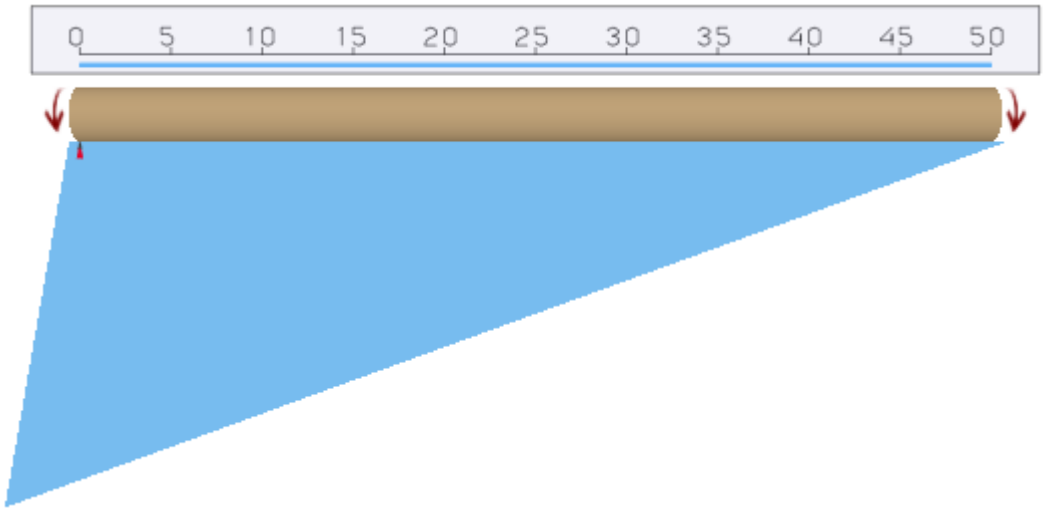
This is the time in milliseconds PC waits for a response from the WAGO fieldbus coupler. If response is not coming in this time, fieldbus coupler failure is suspected. Program will try to repeat the request. Number of such requests is defined by 'Retries on failure' field. If after the retries response is still not received, a connection loss state is reported.

> These timeouts are used only during device polling.
>
> And to establish connection with the WAGO device, timeout values from an INI file are used. Please check *ConnectResponseTimeoutSec*, *ConnectRetryCount*, *BootPTimeoutSec* parameters in **gsmodbus.ini** file located in the program installation folder.

2.15 Kiln shell image composition algorithm

Resolution compensation

For scanners with rotating mirror technology object area covered by each scan line pixel differs along the line. This is also true for devices with detector array technology (like 2D IR cameras), when the device is looking at the kiln not straightly. This pixel resolution difference are automatically compensated by IRT KilnMonitor.

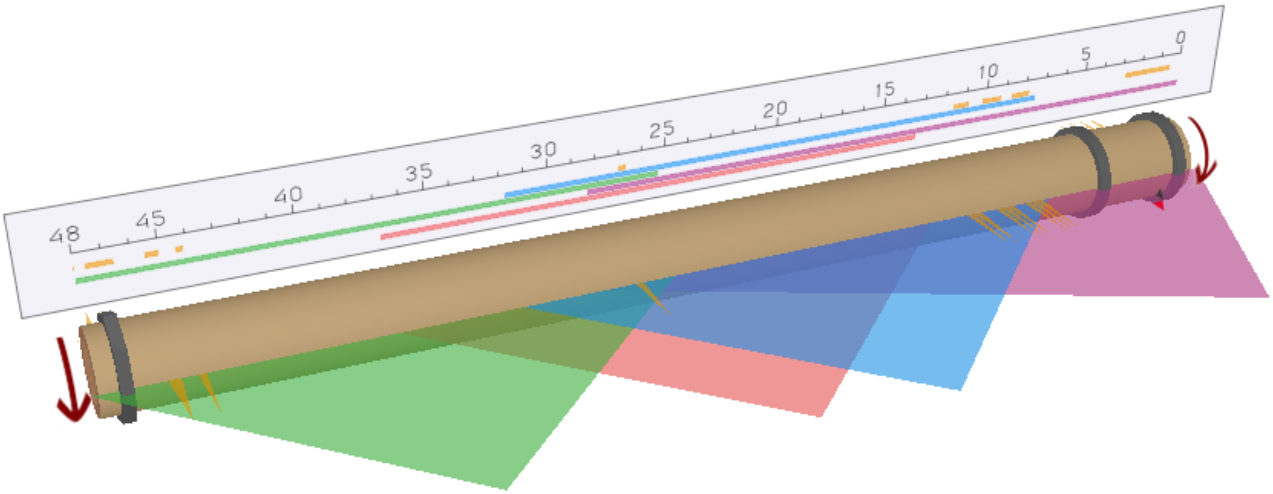


Scanned data gathering and position around the kiln circumference

1. For each scanner and pyrometer temperature data scanned during the period between two kiln trigger signals are buffered in the memory. Each line is stored together with its timestamp.
2. Memory buffer size for one revolution is limited to 4096 lines (constant, cannot be changed) per each scanner and pyrometer. In extreme cases (slow kiln rotation, fast scanning rate), when the buffer is full and a new line is received, every second line is removed from the buffer to free space.
3. When the kiln trigger signal is received the buffered lines are used to render next kiln shell image.
4. Line timestamps are used to map scanned lines to kiln shell image lines.
5. If several scanned lines correspond to one image line they are merged using the maximum operation.
6. If there are no scanned lines found, the image line is interpolated using scanned lines with the closest timestamps.
7. If kiln rotation speed is changing IRT KilnMonitor estimates acceleration and corrects lines distribution accordingly. This is done automatically, no configuration is needed.

Scanner and pyrometer data render order

The fields of view of the scanners may overlap. The positions of the pyrometers may also overlap, both with each other and with the scanners.



You need to decide what source to use for overlapping areas.

The rules are:

- Pyrometers always have higher priority than scanners: pyrometers measurements overwrite scanners measurements.
- If two devices fields of view overlap, the device higher in the list overwrites measurements of the device lower in the list.
- If a scanner or a pyrometer has "Take max for overlapping pixels" option enabled its measurements overwrite other measurements only if they have bigger temperature value.

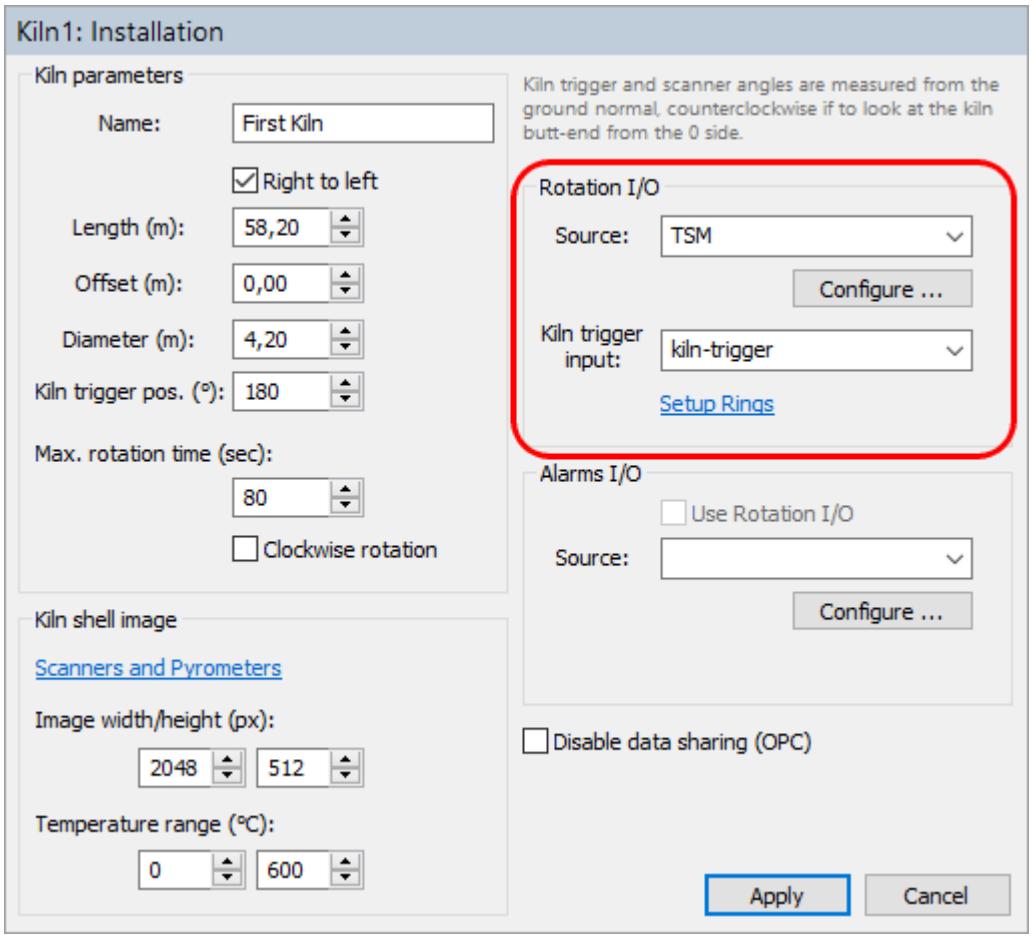
2.16 The kiln trigger

IRT KilnMonitor monitoring system updates its measurements and alarms once per full kiln revolution. To know that kiln has made a full revolution a sensor is needed. Usually this is a proximity sensor installed on the kiln.

Device that sends signals after each kiln revolution is called **kiln trigger**.

Configuration

You should define an I/O device that is used to receive signals from kiln rotation sensors and select an input that corresponds to the kiln trigger signal. This is done in Configuration on the Installation page:

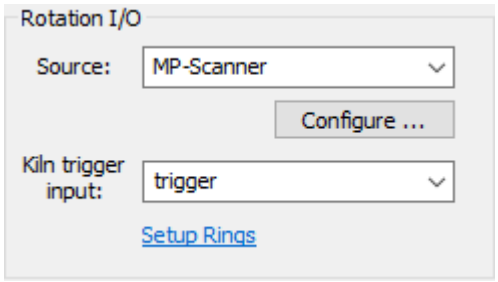


TSM device

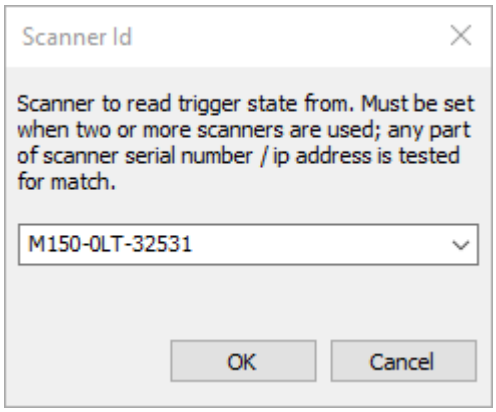
If your monitoring system uses TSM device, select TSM as Rotation I/O source. As Kiln trigger input select **kiln-trigger**.

MP scanner as kiln trigger source

You can use the MP scanner trigger input to connect kiln trigger sensor to the system. To do so as Rotation I/O source use MP-Scanner. As Kiln trigger input select **trigger**.



If you have more than one MP scanner in the system, you also need to define which scanner to use. Press Configure button and enter the corresponding scanner ID (a unique part of the scanner ID):



No signal from kiln trigger, Kiln-Trigger alarm

Having stable and reliable kiln trigger signal is very important. There are several abnormal situations related to kiln rotation that the system must handle properly.

If kiln is not rotating or rotating too slowly or if kiln trigger sensor does not function monitoring system will not receive kiln trigger signal in time. **Kiln-Trigger** alarm is generated If there is no signal from the kiln trigger within the period defined by **Max. rotation time** parameter.

In case there is no kiln trigger signal, kiln shell image is updated after max. rotation time passes. Such kiln shell images contain more than one revolution if kiln rotation is too slow, or less than one full revolution in case kiln trigger sensor is broken. These images are still valid for zone alarms and envelope alarms conditions, alarm states are updated.

Kiln shell images without correct kiln trigger signal cannot be used to update brick thickness map and are not saved to the history.

Kiln rotation speed is not constant

It is sometimes required during production process to change kiln rotation speed. When speed is changing consequent kiln shell images are slightly distorted in the vertical direction. This has no influence on alarm conditions detection, but does not allow to compare kiln shell images one with another. It is better not to use such images in the brick thickness calculation, so they are not used there and also not saved to the history.

There is no alarm for not constant rotation speed. If rotation is not stable or not measured a warning text is shown on the monitoring window status bar:



To detect that kiln speed rotation is changing IRT KilnMonitor compares several consecutive revolution times and calculates their variation (maximum - minimum). If measured variation is too big, corresponding kiln shell images are marked as not stable and are not used in brick thickness calculation and are not saved to the history.

Parameters used for rotation stability measurement are taken from Linescano.ini file:

```
[ROTATION]
stability_samples_count: number of revolutions used to calculate rotation variation;
acceptable_revolution_time_variation: maximum variation value (in seconds) that is considered as stable.
```

False kiln trigger signals

Contact bounce is easily filtered out by defining a minimum value for time between two consecutive signals.

There is also a filtering mechanism available to detect false signals that come from a not properly working system (with, for example, randomly induced interference). This filtering works like this.

- Average revolution time is constantly maintained by averaging signal periods from last N revolutions.
- When a new signal comes and its period differs from the average by more than X percent, this signal is ignored.

It is possible to adjust signal filtering (and to turn it off) by editing parameters in Linescano.ini file:

[ROTATION]
false_signal_filter_minimum_time: minimum time between two signals in seconds. If next signal comes earlier, it is ignored;
false_signal_filter_size: number of consequtive signal periods used to calculate average rotation time, 0 to turn filtering off;
false_signal_filter_accept_difference: 0..1 (1 corresponds to 100%) - difference to the average rotation period that is still acceptable.

2.17 Tire slip monitoring

Kiln design normally includes external rings (tires) that support the kiln hull. Rings are not fixed to the kiln and have a slightly bigger than the kiln diameter. Rings are not rotated – kiln rotates the rings. Because of temperature change inside the kiln, kiln diameter varies. If kiln diameter becomes bigger than the ring diameter, the ring will damage the kiln. Rings diameter should be all the time bigger than the kiln diameter.

Tire slip is the difference between kiln circumference and ring circumference (measured in millimeters or inches).

$$tire\ slip = \pi D \frac{T_{ring} - T_{kiln}}{T_{kiln}}$$

T_{kiln} – kiln revolution time

T_{ring} – ring revolution time

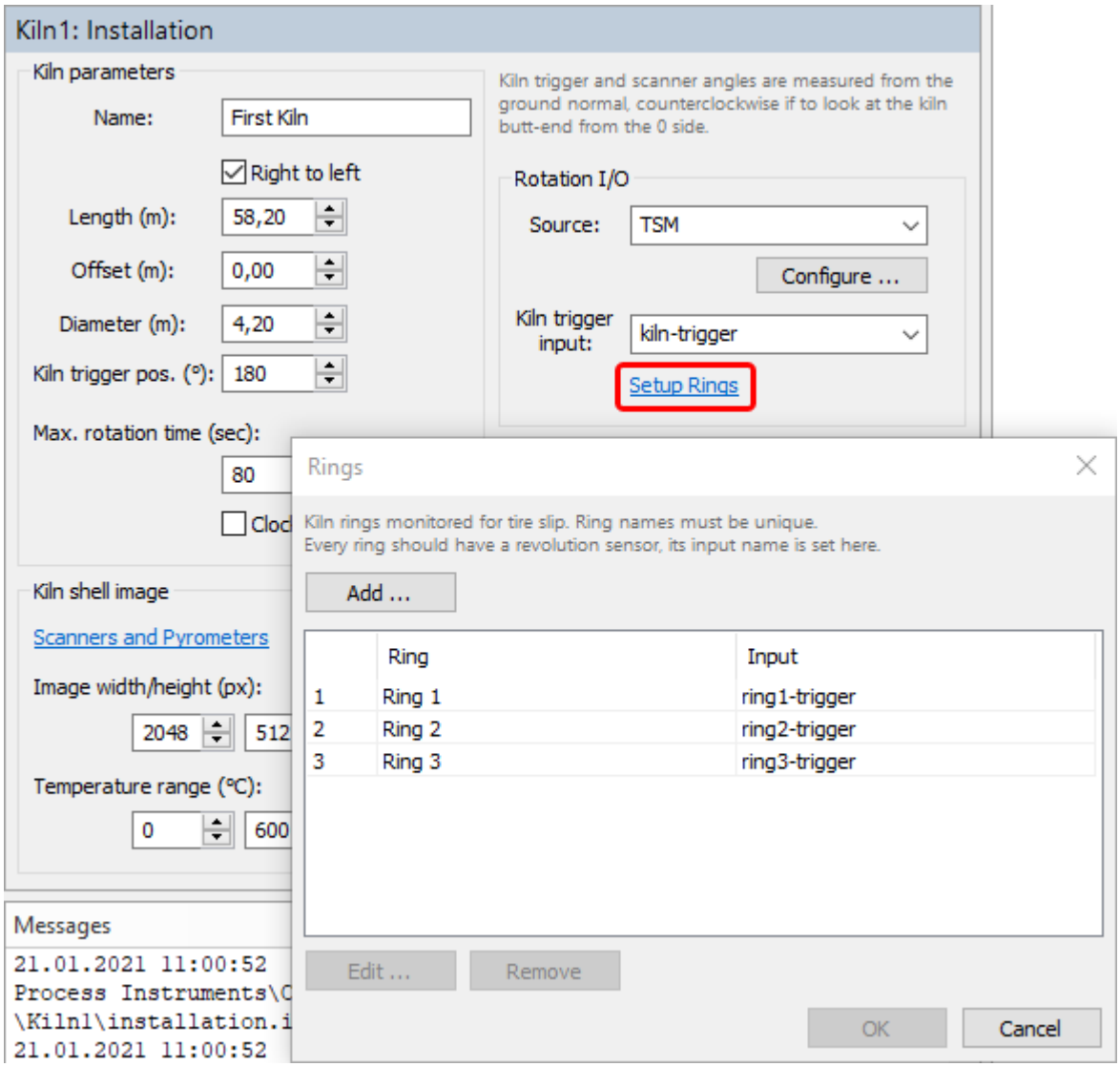
D – kiln diameter

IRT KilnMonitor includes monitoring system (**TSM**), that measures tire slip for each ring and generates alarms when measured values exceed defined limits.

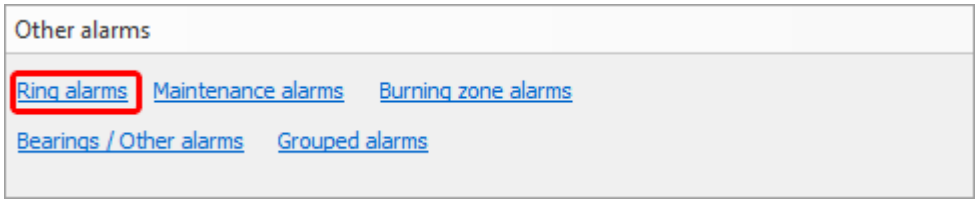
Tire slip monitoring system needs sensors that generate signals every time a ring makes full rotation. When the kiln or a ring makes a full rotation, the system gets a signal from the kiln trigger sensor or a ring sensor, so that kiln and ring rotation time is known and can be compared. IRT KilnMonitor calculates tire slips of all rings and generate alarms if calculated values are out of the predefined range. Alarm is also generated if we have not got the signal during the period of maximum kiln rotation time.

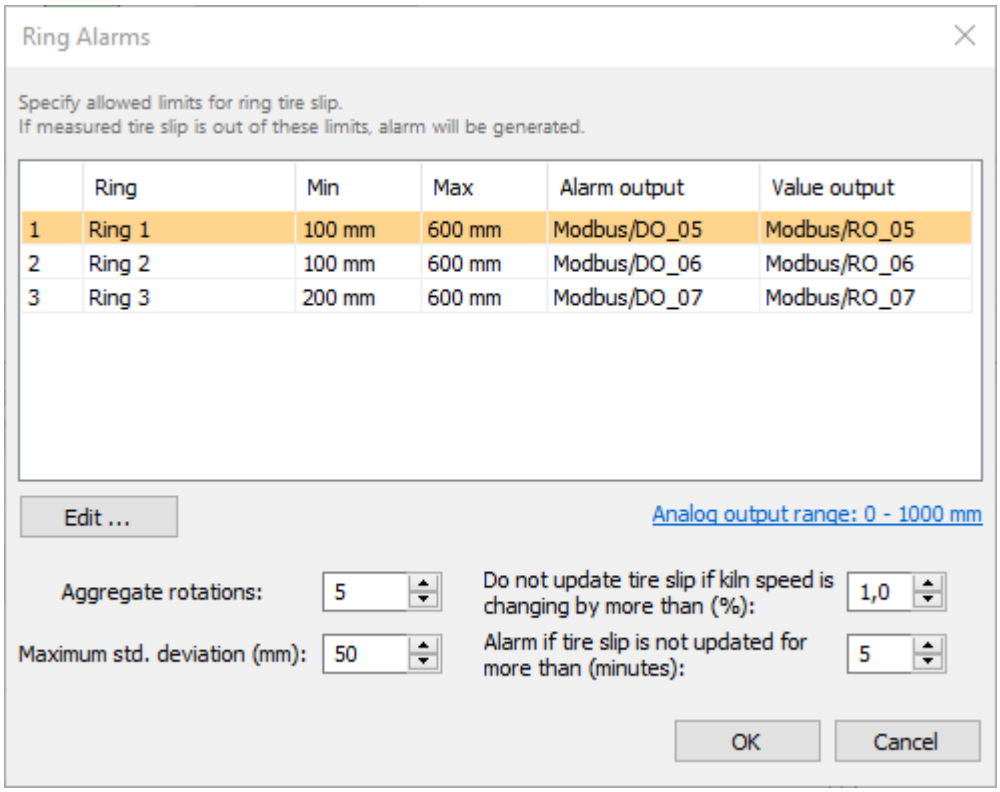
Configuration

You need to define the rings and select I/O device inputs used for each ring. This is done on the Installation page:



To define allowed tire slip limits for each ring, go to the **Alarms** page, **Other alarms** window:





Tire slip value measured by one revolution may not be accurate enough. To improve the accuracy IRT KilnMonitor averages values from several kiln revolutions.

Aggregate rotations: number of revolutions that are used to measure tire slip value more accurately.

Maximum std. deviation: allowed standard deviation for values measured at each revolution. Number of revolutions for standard deviation calculation is defined by Aggregate rotations parameter. If standard deviation exceeds the allowed value, ring alarm is generated.

Varying kiln rotation speed

If kiln rotation speed is not constant, measured tire slip values will be inaccurate and cannot be used to trigger alarms.

Do not update tire slip if kiln speed is changing: percent value of acceptable kiln rotation speed change. Current revolution time is compared to the average revolution time measured from N last revolutions, where N is the Aggregate rotations parameter. If rotation speed change is too big, tire slip value is not updated.

Alarm if tire slip is not updated: because of changing kiln rotation speed current tire slip value can stay without updates for long time. This parameter allows to generate ring alarm if its tire slip value was not updated for too long.

False ring sensor signals

False ring sensor signals are filtered using the same method as the kiln trigger signal is filtered. The same setting in Linescano.ini are applied to both kiln trigger and ring sensor signals. Please see False kiln trigger signals description for details.

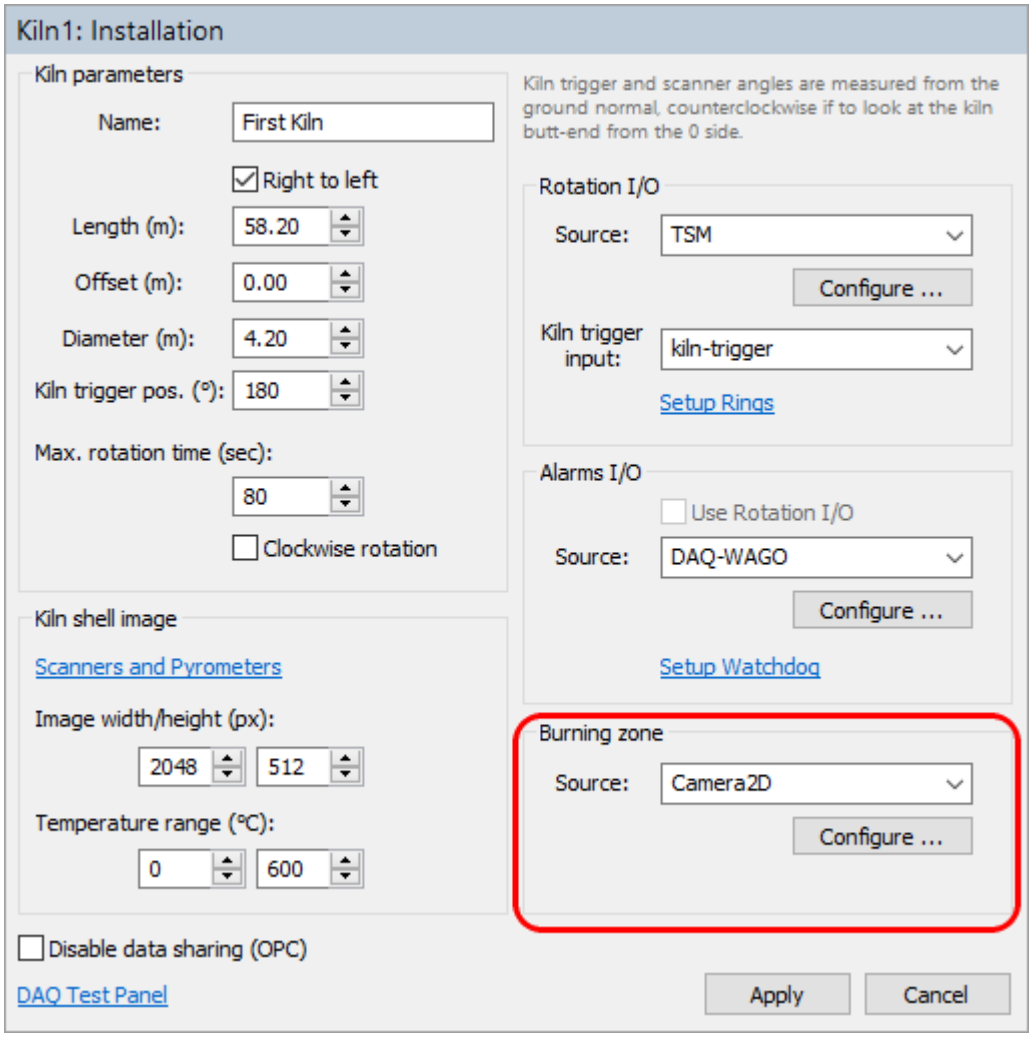
2.18 Burning zone monitoring

To setup burning zone monitoring you need to define the device that is looking into the burning zone and measures its temperature. This device can be a pyrometer (with or without video camera) or an IR camera.

In case of IR camera the maximum temperature found on the image is used as the temperature value of the burning zone.

Burning zone monitoring device internal temperature (Instrument temperature) is checked in the same way as the internal temperature of the other devices.

Configuration is done on the Installation page:



You need to select the source: Camera2D or Pyrometer and then define the communication parameters.

See Camera2D and Pyrometer topics.

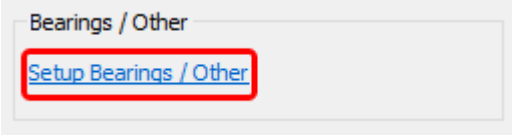
To setup burning zone alarms, use Burning zone alarms button on Alarms configuration page.

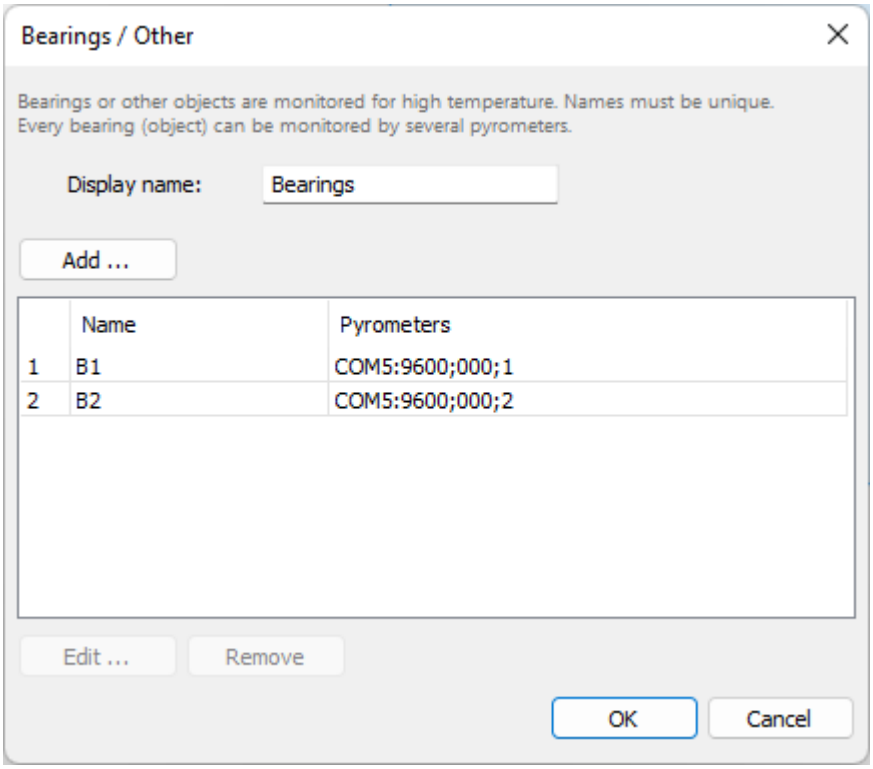
2.19 Bearings / Other monitoring

With IRT KilnMonitor you can also monitor temperature of additional kiln parts. Normally this function is used to monitor bearings, hence the name of the function. But it is possible to monitor temperature of any other object, not only bearings.

Configuration

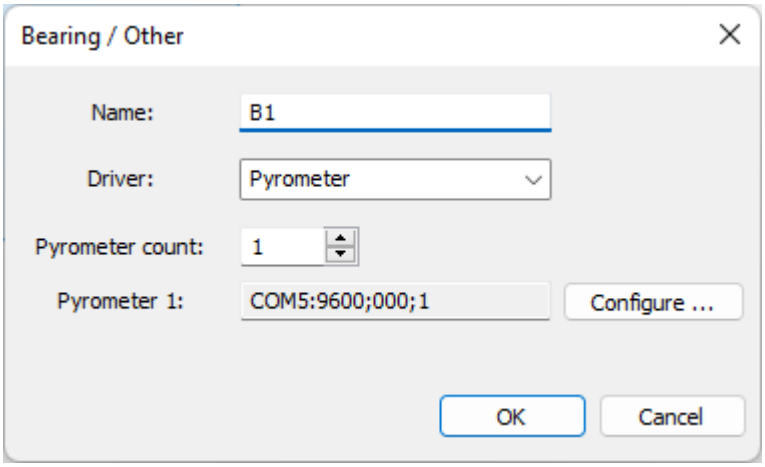
You need to enter the names of controlled objects and configure pyrometers that will be used as temperature meters for each object. This is done on the **Installation** page:





Display name - name that will appear as a caption everywhere the list of objects is displayed (the monitoring window, reports, etc.).

By pressing Add, you add the next object. Each object needs a name and at least one pyrometer associated with it.



Each object can be monitored by up to 3 pyrometers. The resulting object temperature is the maximum temperature of all 3 measurements.

Alarms

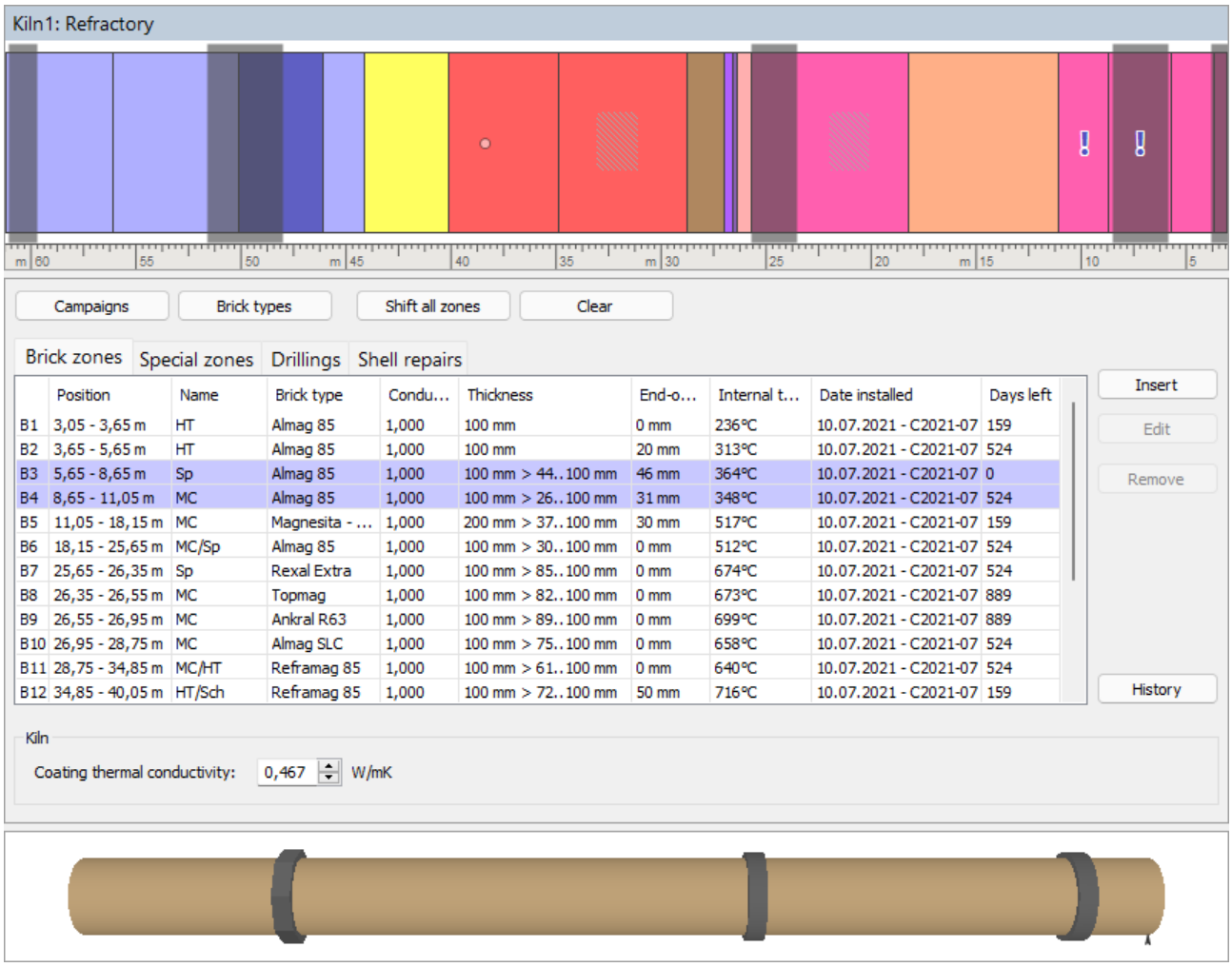
To define allowed temperature limits for each object, go to the **Alarms** page, **Other alarms** window:

2.20 Kiln refractory and special zones

Protected by Level 2 password.

Information about bricks is used to calculate brick and coating thickness during kiln monitoring. It also allows IRT KilnMonitor to create a graphical diagram of the kiln refractory zones. It is important to keep the refractory information up-to-date.

Select **Refractory** item in the tree structure at the left part of the **Configuration** window. Before you can define refractory zones, kiln dimensions on the **Installation** page must be defined. See topic Kiln dimensions and monitoring hardware.



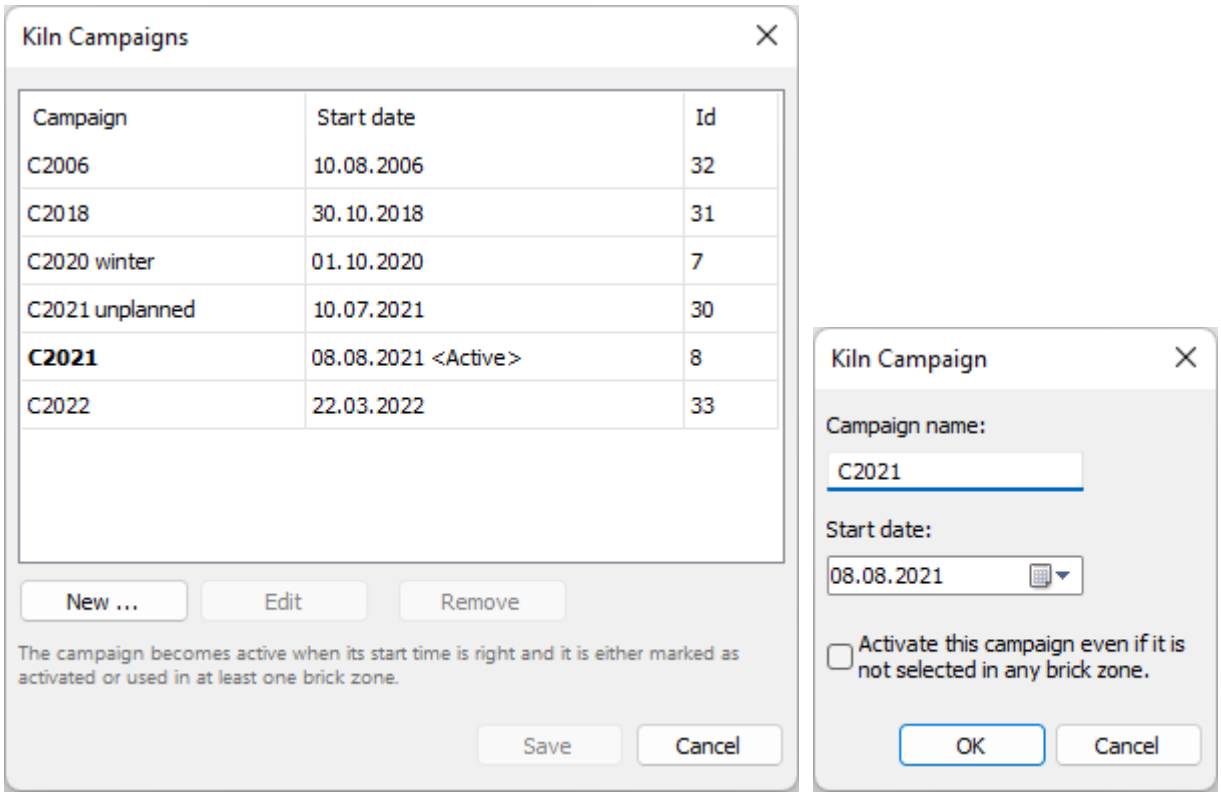
Kiln campaigns

Campaign is the time of kiln operation between maintenance stops. Campaigns are mainly needed to improve the structure of refractory history reports.

Refractory brick zones are replaced during kiln maintenance stops, before a new campaign starts. This way every brick zone is linked to a campaign.

> IRT KilnMonitor allows to change refractory zones without creating a new campaign. This possibility should only be used to correct wrong entries if mistakes have been made.

Press **Campaigns** button to show the list of campaigns.



For a campaign you need to specify a name of the campaign and a start date. The campaign start date will also be used as the installation date for brick zones installed at the beginning of this campaign.

It is safe to change the campaign start date. This will automatically modify installation date of the brick zones linked to this campaign and recalculate brick life time.

A campaign becomes active when its start time is right and it is either marked as activated or used in at least one brick zone.

Brick types

Press **Brick types** button to show the list of all available brick types. This list is for convenience only, so you don't have to enter the same data multiple times.

It is possible to import bricks from a CSV file. The format of the file is fixed:

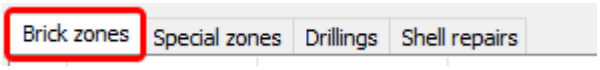
UTF-8; separated by comma

Columns:

1. Manufacturer (text)
2. Name (text)
3. Material (text)
4. Thermal conductivity (W/mK)
5. Thickness (mm)
6. Zone color (number R+(G*256)+(B*65536))
7. Description (text)
8. Brick life (days, optional)
9. Minimum thickness (mm, optional)

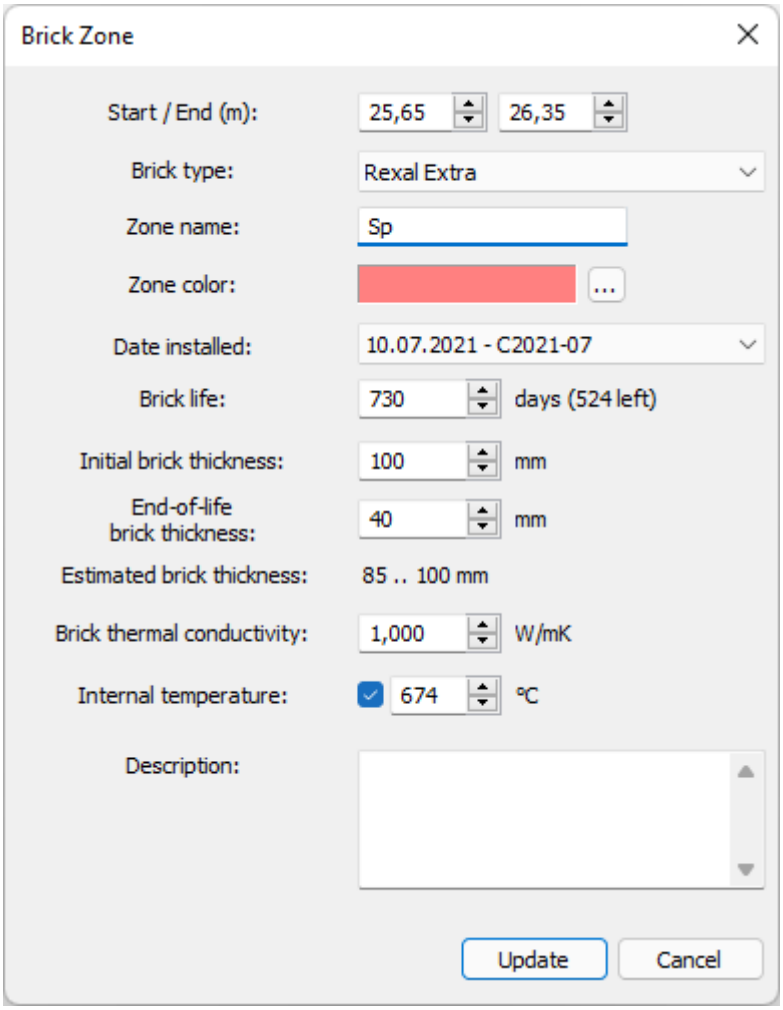
Brick zones

To show the list of all brick zones, select **Brick zones** tab:



Use the **Insert** button to add new zone definitions to the kiln refractory. For every zone you can specify different parameters depicted below. To modify already existing zone, double-click on it or select it and press **Edit**. To remove a zone, mark it in the refractory window or in the list of zones and press the **Remove** button.

In case a new or a modified zone overlaps some existing zones, the existing zones will be automatically sized or deleted.



Every brick zone has the following parameters:

- **Start/End** position along the kiln axis;
- **Brick type**: type of the brick used in the zone;
- **Zone name**;
- **Zone color**: color to display the zone in the kiln design view;
- **Date installed**: link to the campaign when this brick zone was installed;
- **Brick life**: typical working time of bricks in this zone;
- **Initial brick thickness**: working thickness of a new brick;
- **End-of-life brick thickness**: `thickness limit, if brick becomes thinner than this limit it must be replaced (Refractory alarm);`

- **Estimated brick thickness**: actual brick thickness estimated from the temperatures measured on the kiln shell;
- **Brick thermal conductivity**: usually ranges from 0,1 to about 10 W/mK;
- **Internal temperature**: temperature inside the kiln at this zone. If internal temperature is not known, remove the mark in the check box.
- **Description**: any text description you may need.

> **Note**
>
> Brick conductivity, internal temperature and initial brick thickness are important for proper estimation of brick and coating thickness.
>
> In case the internal temperature is not specified (no check in the check box), brick thickness estimation algorithm will try to estimate the internal temperature by using the average kiln shell temperature in this zone (inaccurate).

Brick life and Refractory alarm

Date installed and **Brick life** parameters are used to control typical brick duration. When bricks in one of the refractory zones reach the end of their typical life cycle, the **Refractory** alarm is generated and corresponding brick zones are marked with an exclamation mark.



Refractory pre-alarm is displayed 30 days before the end of the brick's typical life.

I/O	Ok
Scanners	Ok
Refractory	26 days
Kiln-Trigger	Ok

30-day period can be changed in Linescano.ini configuration file:

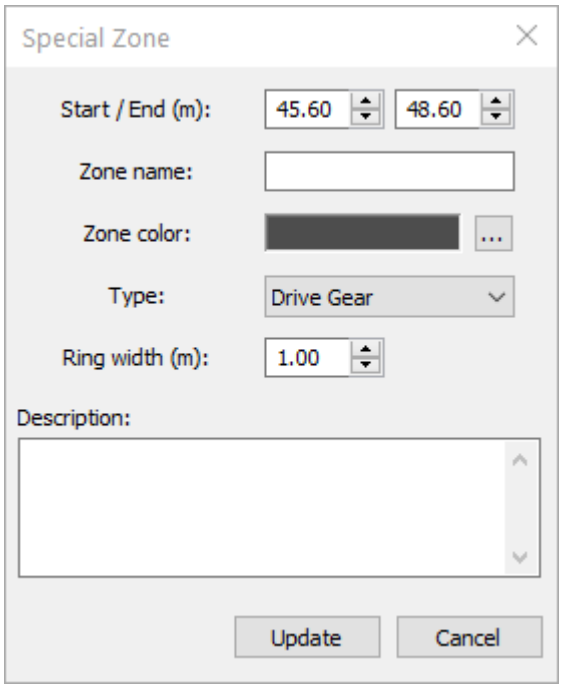
```
; if remaining brick life is less than this value, pre-alarm will be generated. Set to 0 to
disable pre-alarm.
brick_life_prealarm_days = 30
```

Refractory alarm is also activated when estimated brick thickness is smaller than the **End-of-life brick thickness**.

Special zones

Special zones are needed to mark the areas of the kiln where brick thickness calculation is not possible because these areas are blocked from scanners and pyrometers view.





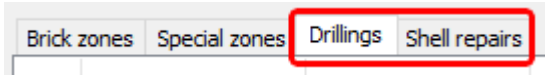
For special zones, beside location, name and color, you can define zone type ("Gear Rim", "Live Ring" or "Other") and ring width.

Zone type and ring width is used to display corresponding “ring” on the 3D kiln model. There are no 3D display for special zones with type "other".

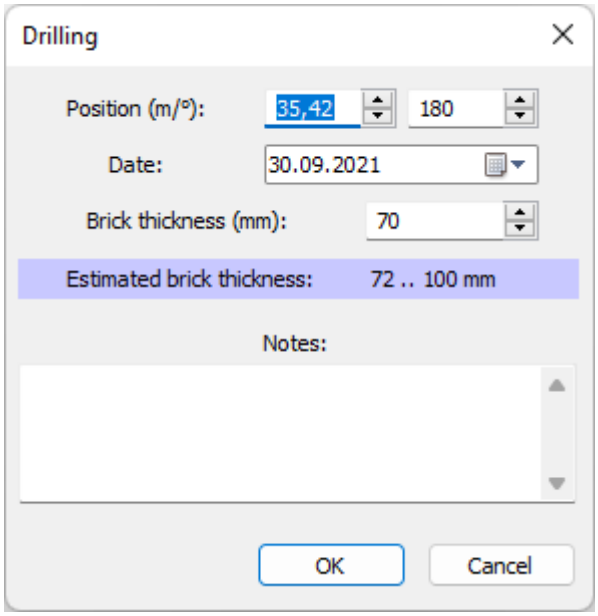
Note

Special zones are excluded from brick and coating thickness calculation (using the Start/End position) as they do not allow scanners to measure temperature on kiln surface in these zones.

Drillings



This list is used to register kiln drillings. Data from this list does not affect system functioning.

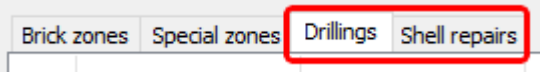


Brick thickness: the actual brick thickness that was measured when drilling (entered by the operator).

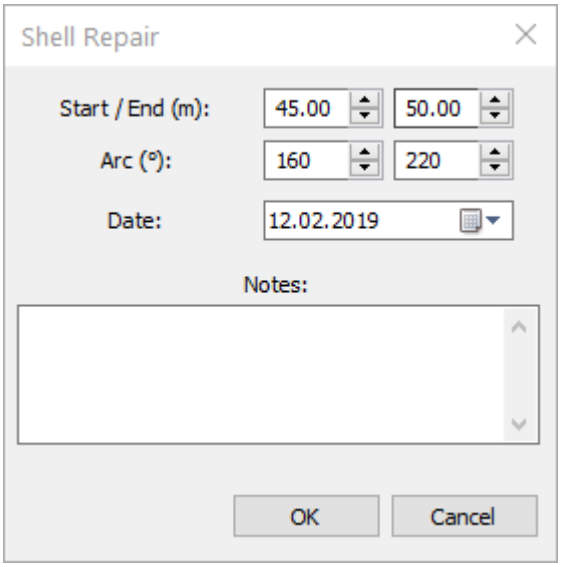
Estimated brick thickness: brick thickness of the brick zone at the drilling position estimated by IRT KilnMonitor.

The two values - actual and estimated - should usually be similar. If they are very different, this means that parameters for the brick thickness estimation algorithm (such as the bricks thermal conductivity or the temperature inside the kiln) are set up incorrectly.

Shell repairs



This list is used to record places of the kiln where shell repairs were made. Data from this list does not affect system functioning.



Whole kiln related controls

Use **Shift all zones** button to shift all brick and shadow zones along the kiln right or left by a specified value. Shift value is added to start and end position of each zone. To make a left shift, enter a negative value.

Pressing **Clear** button deletes all refractory zones - brick zones, special zones, drillings and shell repairs.

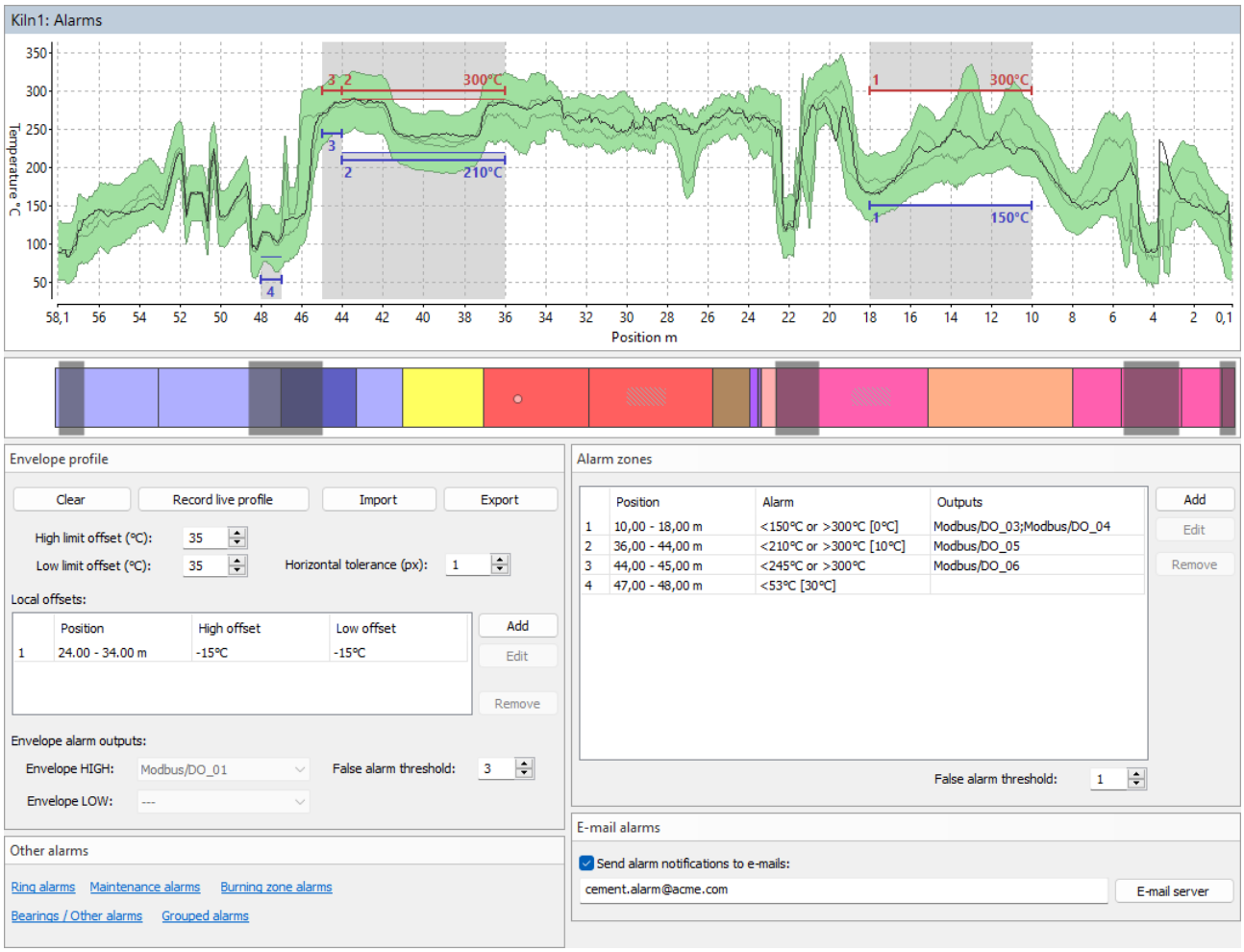
At the bottom of the window, you can set **Coating thermal conductivity** used for calculation of coating thickness. (Clinker conductivity is about 0.467 W/mK for 0-700°C, and it increases above 700°C). The same value is used at any part of the kiln.

2.21 Alarms

Protected by Level 1 password.

Alarm conditions can be defined for different kiln parts. When an alarm condition is met alarm is displayed on the monitoring screen and also can be reported to an external expert system with the help of external outputs (Alarms I/O).

To configure alarm conditions select **Alarms** item in the tree structure at the left part of the **Configuration** window. Before you can define alarms, **Installation** part of the configuration must be ready and working, you should have access to the scanned data and to the alarms I/O device. See topic Kiln dimensions and monitoring hardware for details.



Envelope profile alarms

Kiln envelope profile can be used to define permissible temperature range for every position along the kiln. The main idea behind it is to record kiln shell temperatures when the kiln is in a good condition, and then check that the temperature at each position does not differ too much from the original good value. When the difference is too big, **Envelope alarm** is generated.

There are several ways to define the envelope profile:

1. Record current kiln temperatures: press **Record live profile** button, the live profile will start forming the envelope profile. Press the same button again (then it is called **Stop live profile**) to stop forming the envelope profile.
2. Import from a previously stored infrared image of the kiln shell: press **Import** button and select a path to a previously stored infrared image of the same kiln.
3. Import from a text file: press **Import** button. In the File Open dialog, in the **Files of type** combo-box, select *Envelope files (*.txt)* and locate a text file with envelope values.

To define how much temperatures of the kiln are allowed to differ from the recorded envelope use **High limit offset** and **Low limit offset** fields. Two gray lines on the envelope graph shows the initial envelope - the envelope without offsets.

To prevent false alarms caused by possible horizontal displacement of the kiln, use the **Horizontal tolerance** parameter, which is defined in pixels.

You can also add offsets to the envelope locally. Use **Local offsets** list for that.

Envelope alarm outputs: when measured kiln temperature at some point goes outside the limits defined by the envelope profile, an alarm is generated. **Envelope HIGH** is generated when the upper limit

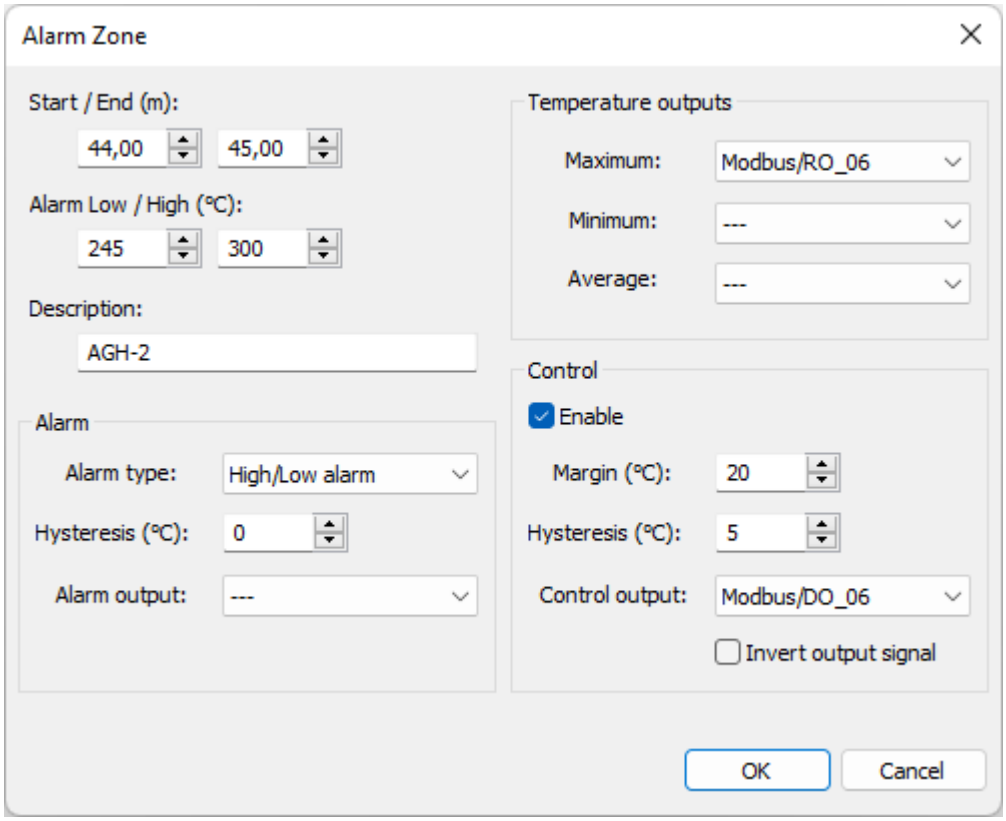
is passed, **Envelope LOW** - the lower limit. You can select external outputs that will be triggered when the alarm is active.

False alarm threshold: indicates for how many kiln revolutions the alarm condition should be met to trigger an alarm.

Alarm zones

You can define a temperature limit that should not be exceeded at some particular part of the kiln. You can define both upper and lower limits.

When the limit is exceeded, an alarm signal is triggered. This signal can be forwarded to an external output. The alarm message will also appear on the computer screen.



To add an alarm zone press the **Add** button in the **Alarm zones** frame. An alarm zone is defined by the following parameters:

- **Start / End**: start and end positions along the kiln axis.
- **Alarm Low / High**: lower and upper limits to trigger an alarm.
- **Alarm type**: can be "High/Low alarm", "High alarm", "Low alarm" or "Off".
- **Hysteresis**: hysteresis to prevent alarm from turning off too quickly. For example, in the event of a high alarm, the alarm is activated if the measured temperature rises above the high limit. The alarm is deactivated only after the temperature has dropped below the limit minus the hysteresis value.
- **Alarm output**: name of the external output for the alarm signal. It can also be the beeper or no output.
- **Temperature outputs**: alarm zone maximum, minimum and average values can drive analog outputs.

Alarm zones are marked on the diagram with red and blue horizontal lines and zone numbers.

Alarm zone Control

Alarm zone control defines an additional condition which is triggered earlier than the alarm condition. The control condition is set by the **Margin** property. The margin value is subtracted from the alarm level, it defines the level when the control condition is turned on:

For “High alarm” zones the control condition is on when the temperature of the zone is higher than the alarm level minus the margin.

For “Low alarm” zones the control condition is on when the temperature is lower than the alarm level plus the margin.

For “High/Low alarm” zones the control condition is on when the temperature is higher than the alarm level minus the margin or lower than the alarm level plus the margin.

The control condition also has its own **Hysteresis** setting, it prevents the control output from turning off prematurely.

Control output – hardware output used to turn on/off external hardware.

Invert output – sets the output to zero when the control condition is met and to one when it is not.

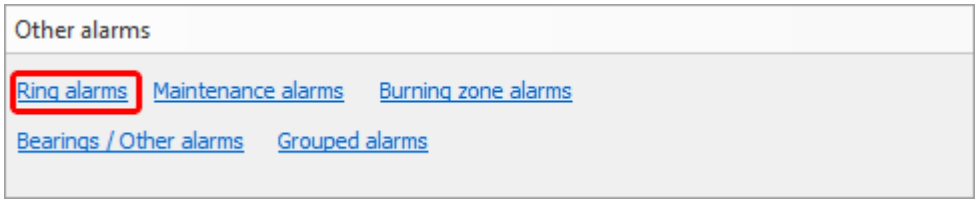
The actual control state is displayed in the alarm list of the monitoring window and also on the horizontal profile.

> **Note**
>
> If you specify a new zone which overlaps previously defined zones, the existing zones will be sized or deleted to free space for the new zone.
>
> To define an alarm zone that corresponds to a brick zone, double-click on the brick zone in the refractory view below the kiln profile.

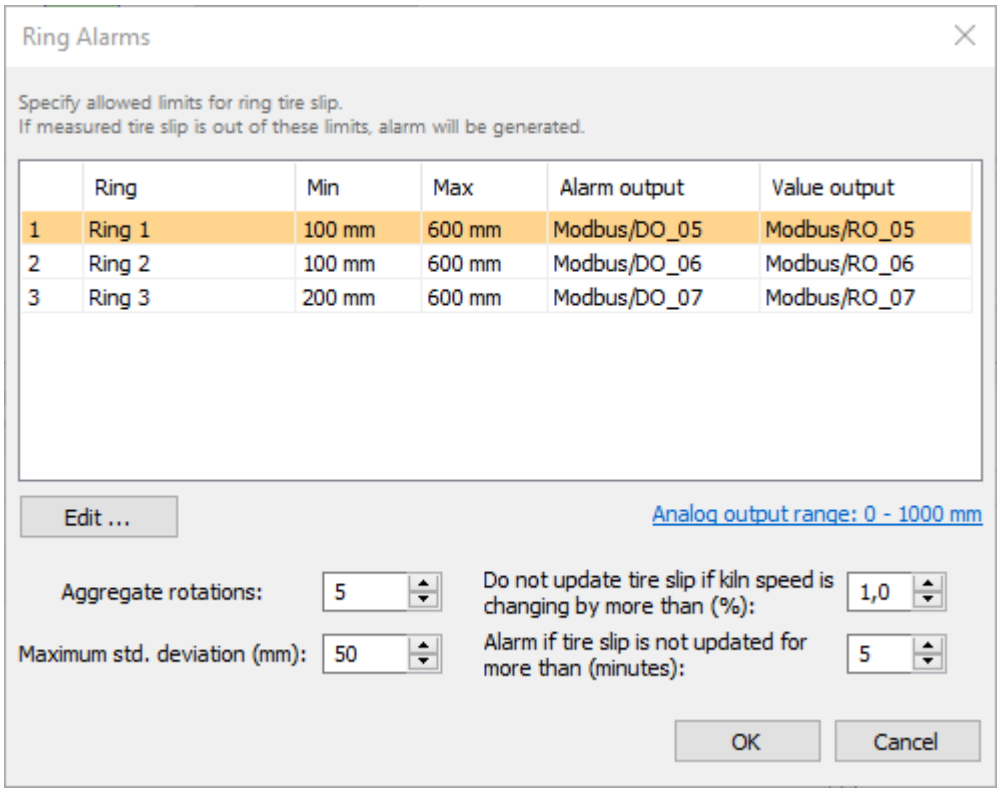
Analog output range: for 4..20 mA analog outputs defines which temperature value corresponds to 4 mA and temperature value that corresponds to 20 mA. Similar for VDC analog modules. For digital interfaces like Modbus these values can be configured but are not used.

Ring alarms

Ring alarm is an alarm that informs that something is wrong with a kiln external ring. Ring alarm is generated w**hen measured tire slip value for a ring goes out of the defined limits or a problem with the revolution sensor is detected and there are no changes registered in the kiln rotation speed that could influence tire slip measurement.**

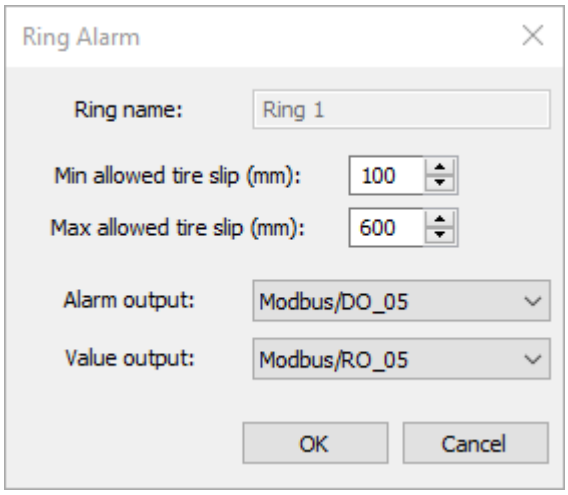


Rings and corresponding revolution sensors are defined on the Installation page. Here you define permissible tire slip limits, tire slip calculation parameters and hardware outputs.



To learn what Aggregate rotations, Maximum std. deviation and other parameters mean please see Tire slip monitoring topic.

Double click on a ring to change alarm settings for this ring:



Minimum allowed tire slip: if measured tire slip value is smaller than this value alarm is generated.

Maximum allowed tire slip: if measured tire slip value is larger than this value alarm is generated.

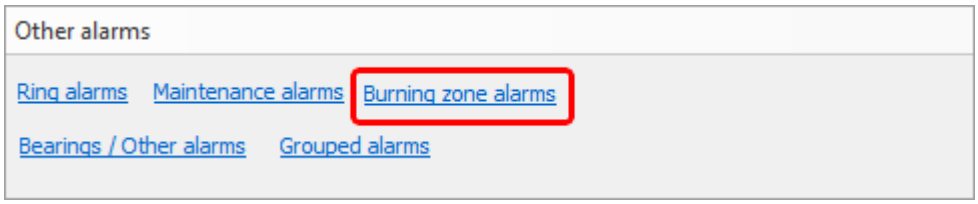
Alarm output: discrete output that is set to 1 when alarm related to this ring is detected.

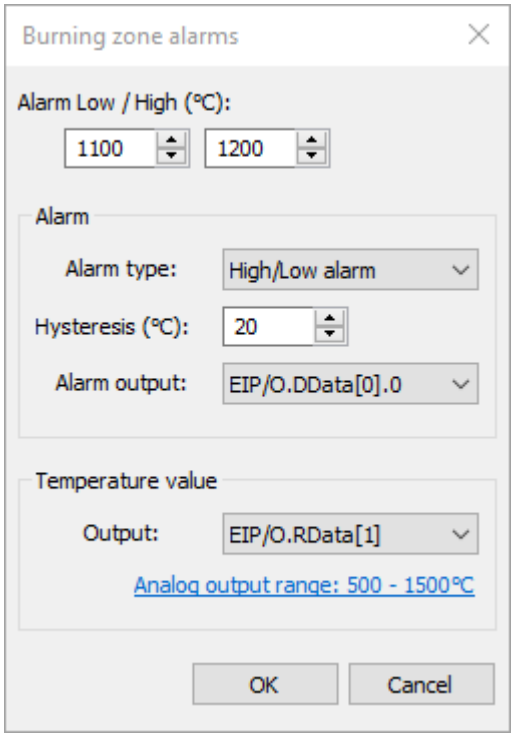
Value output: analog output which value is changed according to the measured tire slip value.

Analog output range: defines what temperature value corresponds to the lowest output signal value and what temperature to the highest.

Burning zone alarms

You can control the temperature of the burning zone and be sure that it stays withing the required range.

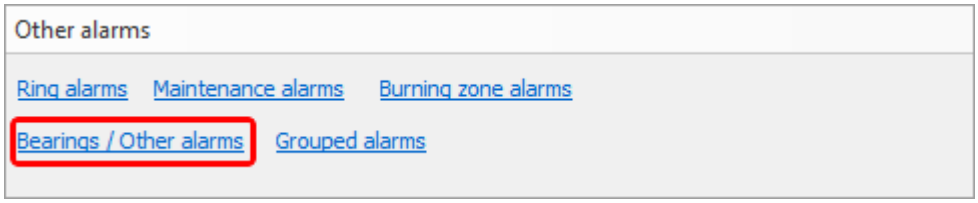


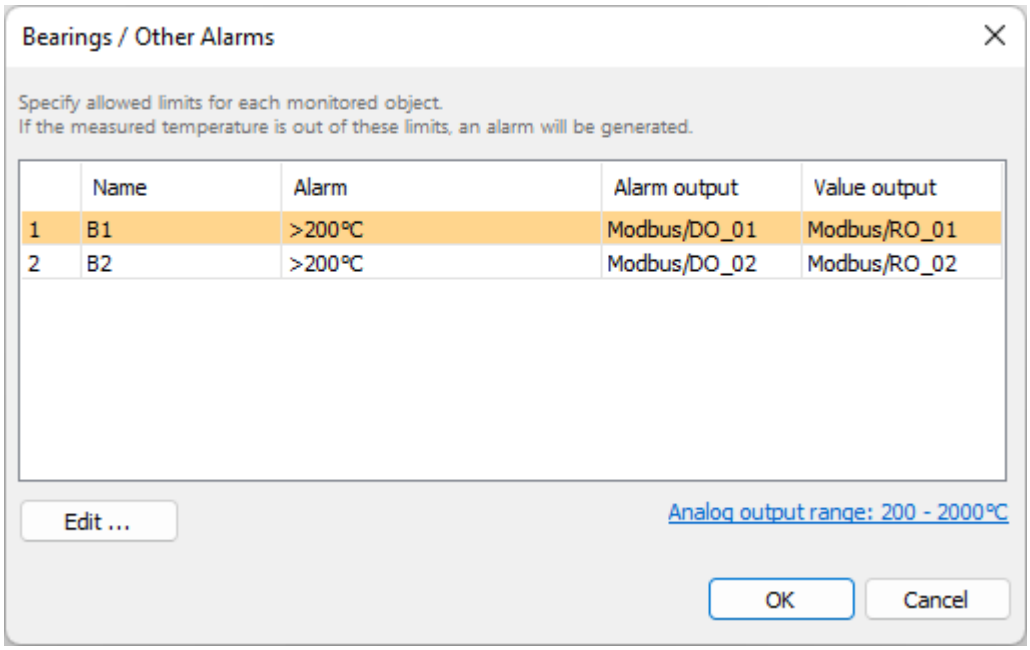


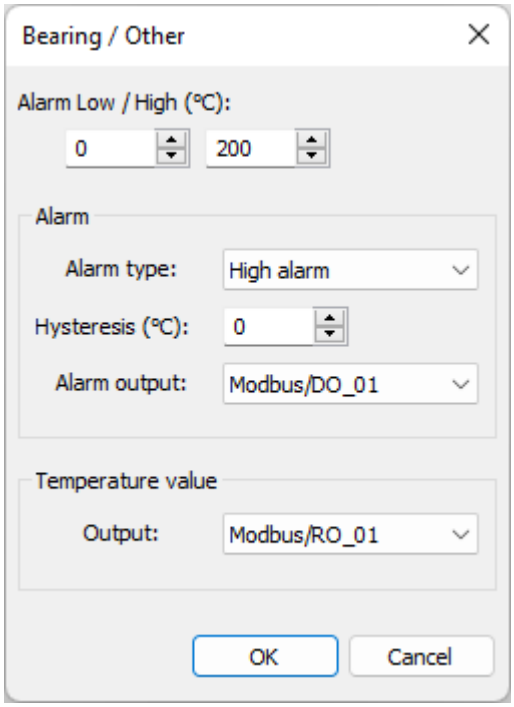
- **Alarm Low / High**: lower and upper limits to trigger an alarm.
- **Alarm type**: can be "High/Low alarm", "High alarm", "Low alarm" or "Off".
- **Hysteresis**: hysteresis to prevent alarm from turning off too quickly. For example, in the event of a high alarm, the alarm is activated if the measured temperature rises above the high limit. The alarm is deactivated only after the temperature has dropped below the limit minus the hysteresis value.
- **Alarm output**: name of the external output for the alarm signal. It can also be the beeper or no output.
- **Temperature value output**: analog output to be set by the measured burning zone temperature.
- **Analog output range**: the range used to convert the temperature value to the output level (current or voltage).

Bearings / Other alarms

To setup temperature limits for bearings (other monitored objects) use Bearings / Other alarms dialog. Each monitored object has its own alarm settings.



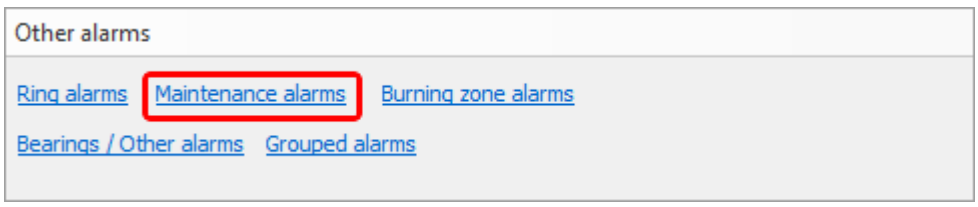




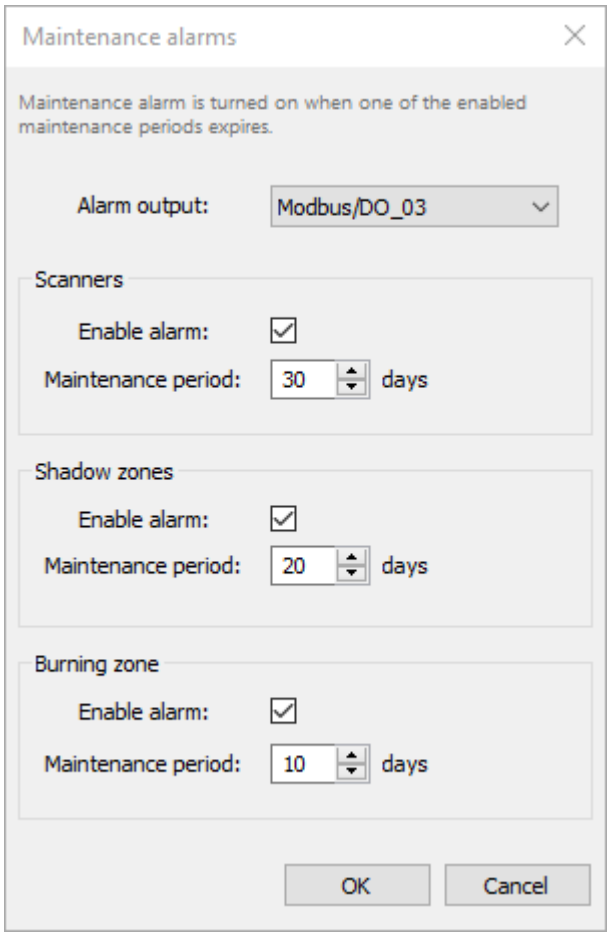
Alarm parameters are the same as for the Burning zone alarms.

Maintenance alarms

Purpose of a maintenance alarm is to remind that it is time to inspect the hardware - check that everything is fine, clean the lenses and so on.

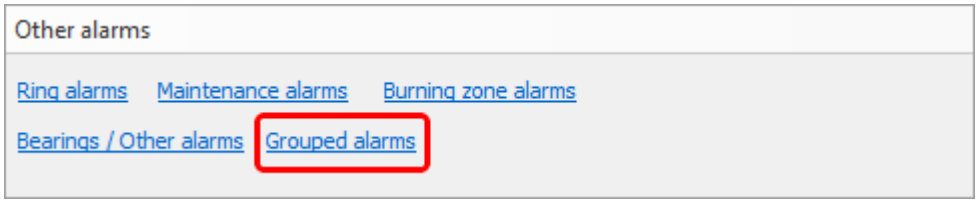


There are three groups: scanners, shadows zones (pyrometers) and burning zone. Each group has its own period.

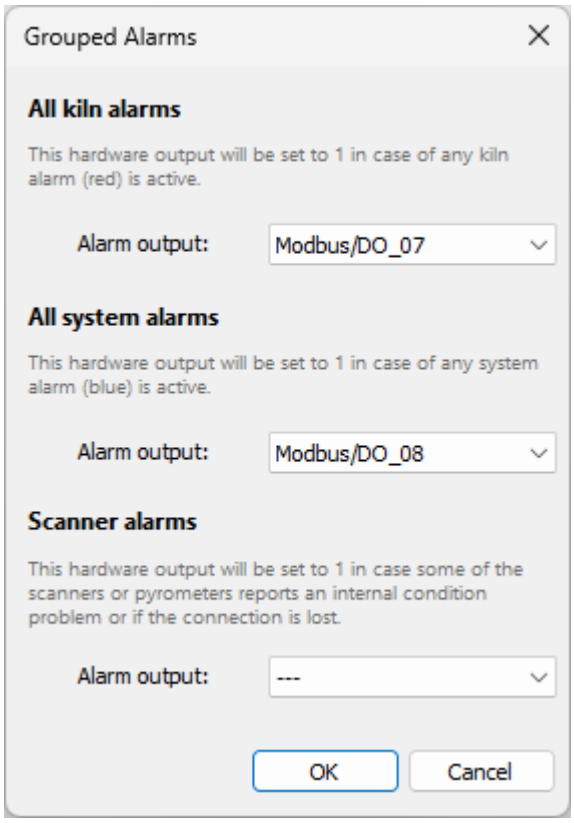


Grouped alarms

Alarms that are aggregation of other alarms.



There are three such aggregations/groups: All kiln alarms, All system alarms, and Scanner alarms.



All kiln alarms

This group includes all kiln state alarms (alarms shown in red in the monitoring window): envelope alarms, alarm zones, ring alarms, bearing alarms, burning zone alarms. Selected hardware output will be set to 1 in case any kiln state alarm is active.

All system alarms

This group includes all system alarms (alarms shown in blue in the monitoring window): kiln trigger alarm, scanners alarm, maintenance alarm, refractory alarm. Selected hardware output will be set to 1 in case any system alarm is active.

Scanner alarms

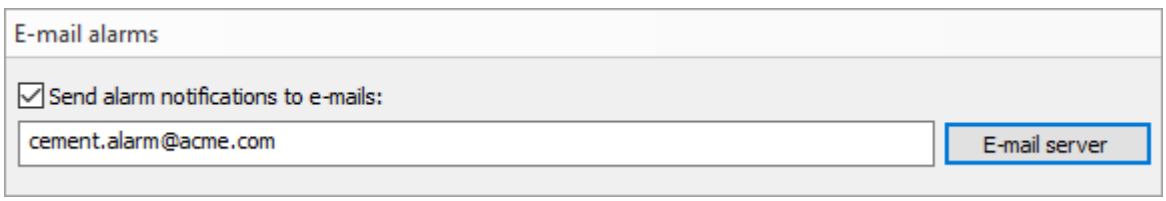
Scanner alarm is triggered when there is a problem with a scanner or with a pyrometer.

Causes for the alarm are:

- Connection lost, data from a scanner or pyrometer stops coming.
- Scanner or pyrometer internal temperature is higher than the defined limit.
- Scanner or pyrometer reported an error state.

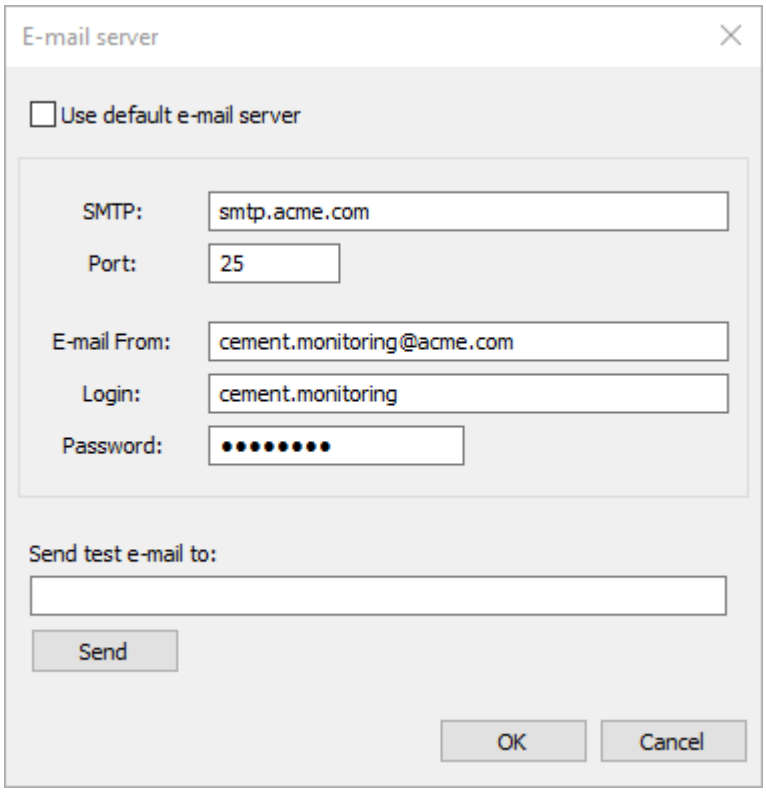
E-mail alarms

It is possible to configure IRT KilnMonitor to send notification e-mails in case of alarms. The e-mail is sent when active alarm list is changing.



E-mail server

In order to send e-mails, IRT KilnMonitor needs access to an e-mail server that will handle e-mail delivery. To configure server settings press **E-mail server** button.



SMTP: address of the e-mail server.

Port: port to use to send e-mail messages to the server.

E-mail From: source e-mail address (alarm notifications will be coming from this address).

Login: login required to sign in to the e-mail server.

Password: password required to sign in to the e-mail server.

Testing that e-mail server is configured properly

To test that e-mail server configuration is correct, try to send a test e-mail to any address of yours. Type the address in the **Send test e-mail to** field and press **Send** button.

Alarm outputs

Sound alarm outputs

These sound outputs are always available:

- **Beeper**: sound signal from the beeper;
- **Sound/Alarm**: alarm siren (with 3 seconds turn-off period);
- **Sound/AlarmQF**: alarm siren (with short turn-off period).

Outputs sharing

I/O hardware outputs and sound alarm outputs can be shared by several signal sources (alarms):

- Signal sources that can share same outputs: alarm zones, envelope profile alarms, ring alarms, maintenance alarms, scanner alarms, burning zone alarms, grouped alarms.
- Signal sources that use outputs exclusively: alarm zone controls, ‘system is running’ signal, all value outputs (temperature, tire slip).

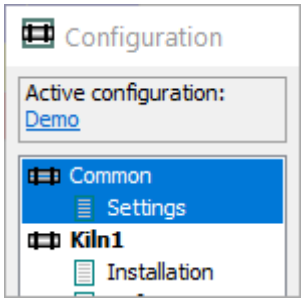
- Outputs can be shared only within one kiln. Two kilns cannot use the same output (but sound alarm outputs still can be used).

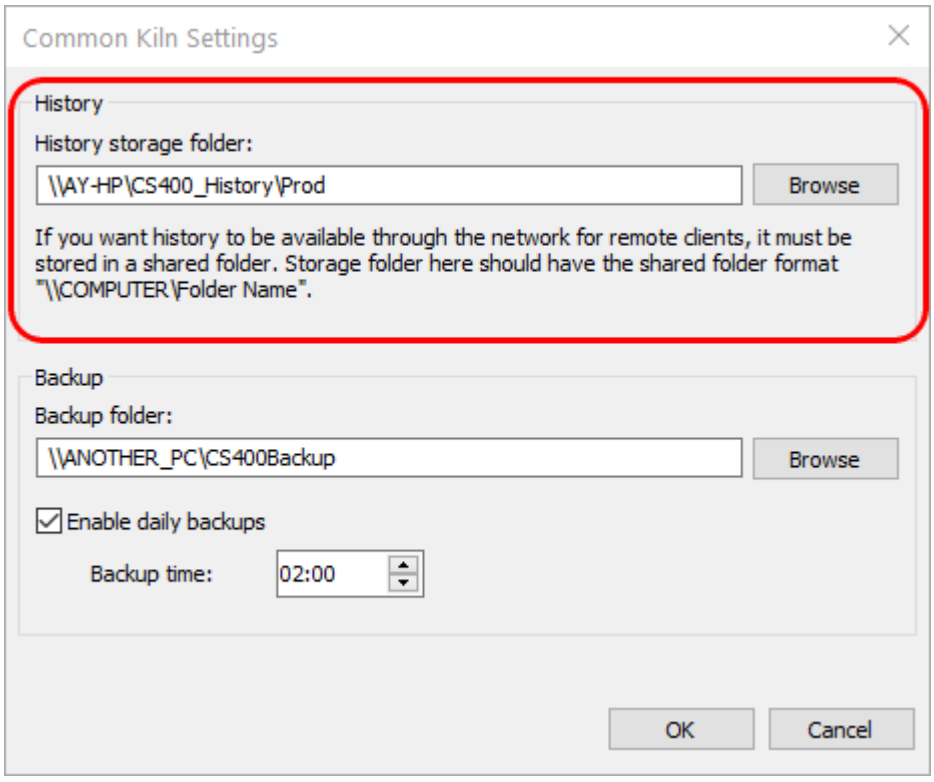
2.22 History storage

Protected by Level 1 password.

History storage folder

Use **Common Kiln Settings** dialog to see where history data is stored. To open the dialog click on **Common Settings** in the kiln tree at the left part of the **Configuration** window.





It is not recommended to change the storage folder. If you do need to change it, please make sure that your new folder is accessible from the network and has the shared folder format.

Default history storage folder is shared automatically during system installation.

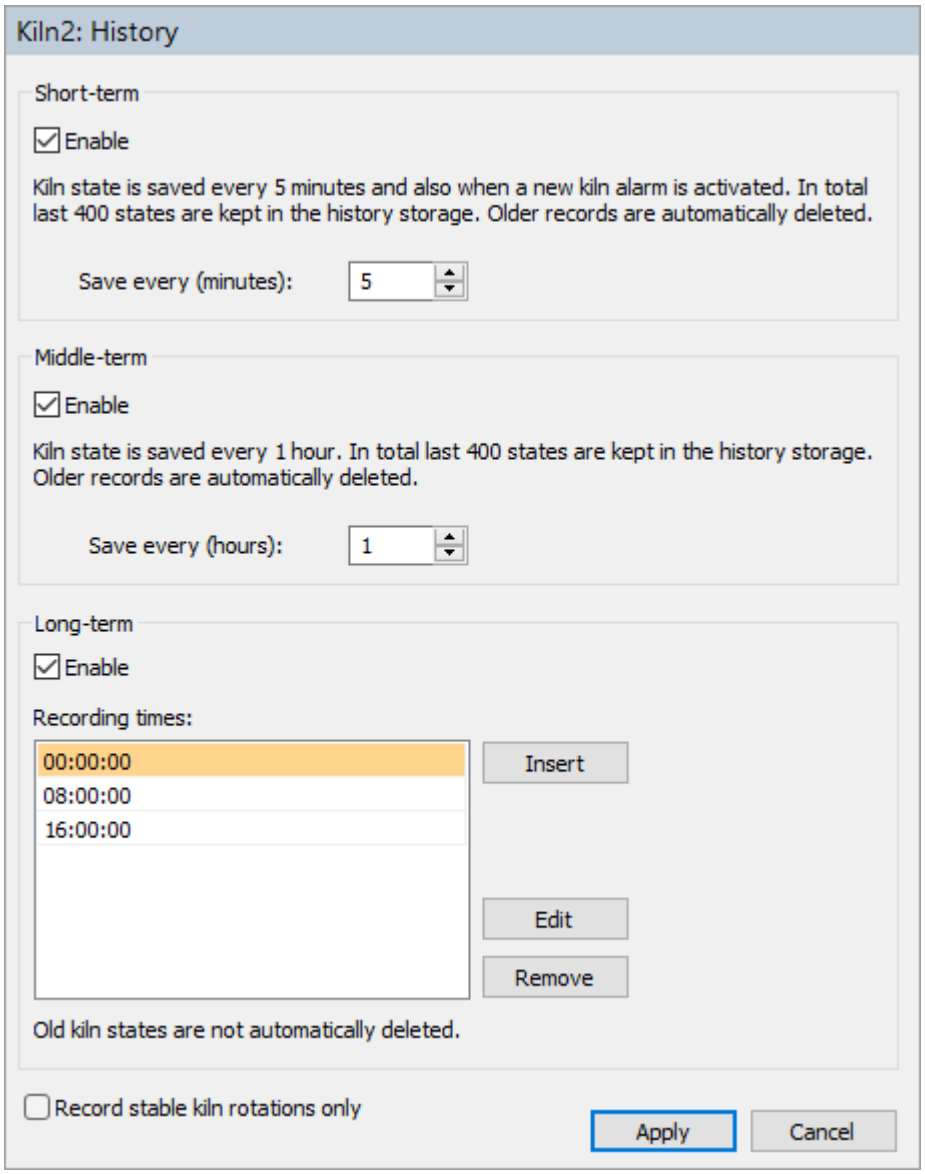
Click **Browse** to select the folder where the history database will be stored.

In order to give access to the history data to IRT KilnMonitor clients the history storage folder must be accessible by other computers in the network using the same path. To make it possible, the folder path must have the shared folder format ("\\COMPUTER\Folder"), otherwise clients in the network will not be able to load history data.

History will be saved in a sub-folder named "KilnN". If you have two and more kilns monitored on one server, they all will use the same storage folder. For example, if you define storage folder for to be "\\AY-HP\KilnHistory", kiln data will be saved to "\\AY-HP\KilnHistory\Kiln1". Second kiln's data will be saved in \\AY-HP\KilnHistory\Kiln2" and so on.

History storage periods

Select **History** item in the tree structure at the left part of the **Configuration** window.



Here you can specify how often kiln state data will be stored.

There are three types of history storage: short-term, middle-term and long-term.

Short-term

Short-term history is designed to save kiln state every 5 minutes (e.g. 14:00, 14:05, 14:10, and so on). Only 400 latest states are stored, older records are automatically deleted. You can change the 5 minutes period.

Additionally, kiln state will be saved to the short-term history when a new kiln alarm is activated (only envelope alarms and alarm zones are checked).

Enable short-term history by placing a marking **Enable** check box.

Middle-term

Middle-term history keeps kiln states recorded every hour (e.g. 00:00, 01:00, 02:00, ...). In this case also no more than 400 latest states are stored. Older records are automatically deleted. You can increase the one hour period.

Long-term

Long-term history is different:

- The data is never deleted, the entire history is always available.
- Record times are selectable. You decide by yourself when, at what time every day kiln state data will be recorded.

Press the **Insert** button to add a new recording time. You can also edit or remove already existing time by clicking on it and pressing the appropriate button.

It is also possible to make an unscheduled recording of the actual kiln state (main menu **Extras / Save Kiln State to History** in the Monitoring window).

Record only stable kiln rotations

The "Record stable kiln rotations only" option allows to record only the reliable thermal imaging data for your kiln. When this setting is enabled, the system will only record kiln data when the kiln's rotation speed is stable and within the normal operational range. This is crucial for maintaining the integrity of the historical data, as unstable or slow rotation speeds can result in distorted thermal images.

By filtering out periods of unstable or slow rotation, you ensure that your dataset consists only of the reliable information. However, please note that enabling this option may limit the data available for troubleshooting issues specifically associated with unstable or slow rotation speeds. If you are conducting diagnostic tests or need to capture data during the kiln light-up phase, you may want to disable this setting.

2.23 Monitoring database

Main purpose of the monitoring database is to provide data for reports. It can also be used by 3rd party applications to get detailed monitoring data with historical values.

Monitoring database stores **information about the kiln**:

- kiln campaigns;
- refractory brick zones and brick zone replacement history;
- kiln shell drilling and repairs.

Monitoring database stores **measurements from every kiln rotation**:

- revolution time;
- active alarms;
- min/max/average temperature for every alarm zone;
- min/max/average temperature and thickness for every brick zone;
- analysis objects' measurements;
- tire slip values;
- burning zone temperatures.

Database internal structure is described here.

When monitoring database is updated

To reduce the amount of stored data (and also to speed up report generation) measurements from several kiln revolutions are combined together:

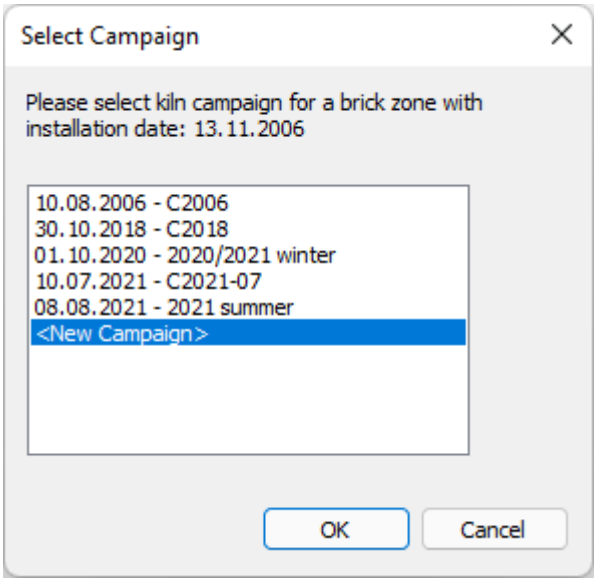
1. IRT KilnMonitor accumulates measurements from several successive kiln revolutions for 5 minutes. After that IRT KilnMonitor combines accumulated measurements into one record and writes it into the database.
2. If a measured value does not change much, it is saved to the database less frequently (every 15 minutes).
3. Active alarms are accumulated and saved to the database every 5 minutes.

Application INI file Linescano.ini contains the update periods and parameters that define what is a significant measurement change and what is not (REVSDB section).

Creating monitoring database

Monitoring database is created automatically when monitoring is started for the first time. If IRT KilnMonitor is upgraded from an older version that did not have any monitoring database, monitoring database will be filled with data taken from the kiln history,

During data import IRT KilnMonitor may ask you to link a historical brick zone installation date with a kiln campaign. This is necessary to do because older versions of IRT KilnMonitor did not support kiln campaigns.



Rebuilding monitoring database

It is possible to rebuild monitoring database, overwriting the existing one. This possibility should be used in the following situations:

1. There is a problem: you get errors/warnings related to the monitoring database during kiln monitoring.
2. If you just upgraded from an older version of IRT KilnMonitor which did not have monitoring database and want to relink campaigns and brick zones installation dates.

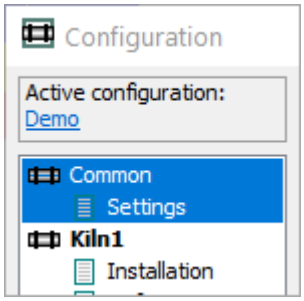
In other situations rebuilding the database is not recommended because detailed monitoring data is lost: a monitoring database contains information about every kiln rotation and alarm, while a kiln history saves data according to a storage plan.

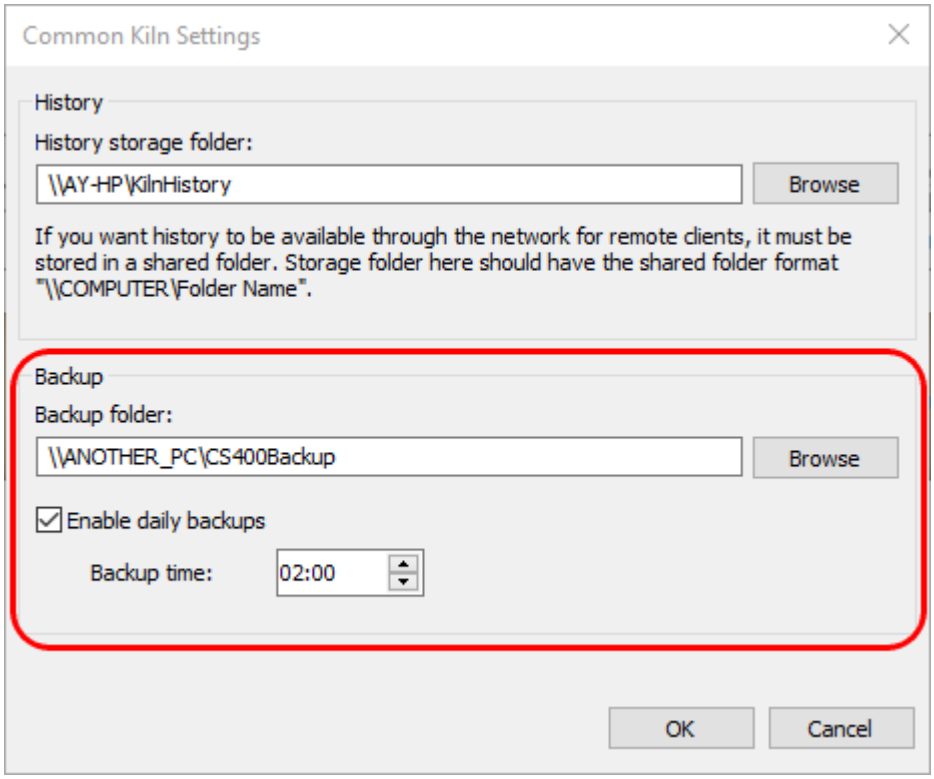
To rebuild the database use main menu **System | Rebuild Monitoring Database** on the Start-up screen.

2.24 System backup and recovery

Enabling backups

To enable backups, you must specify the location where the backup data will be stored. This is done in the **Common Kiln Settings** dialog. To open the dialog click on **Common Settings** in the kiln tree at the left part of the **Configuration** window.





The backup folder must be located on another physical drive on the same computer, or, better, on another computer in the network. This will allow to restore system configuration and historical data in case of a PC hardware breakdown.

It is recommended to enable daily backups, otherwise operator will need to start backups manually. Backup process does not influence kiln monitoring, it is run in a separate process.

Data to be backed up

Backed up data includes:

1. Complete system configuration (includes configuration of the monitoring hardware, the refractory, the alarms and the history storage settings);
2. Kiln history;
3. Rotation / Tire slip history;
4. Burning zone history.

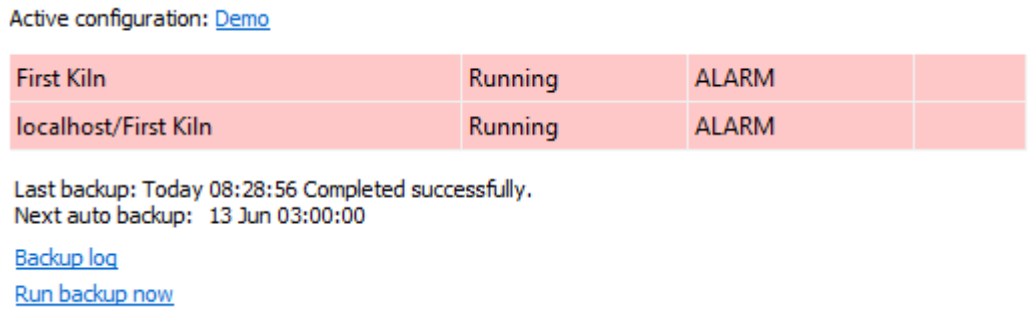
Configurations are backed up incrementally. This means you can revert not only to the last backed up configuration, but also to an older configuration.

All other data (kiln history, etc.) is just mirrored, an exact copy of the data is maintained in the backup folder.

Checking backup status and starting backup manually

Backup status is displayed on the start-up screen. To show the start-up screen, close all monitoring windows (this will not stop monitoring).

Information about backups is displayed under the list of kilns. There you can see if the daily backups are enabled, time and result of the last backup and also next planned backup time.



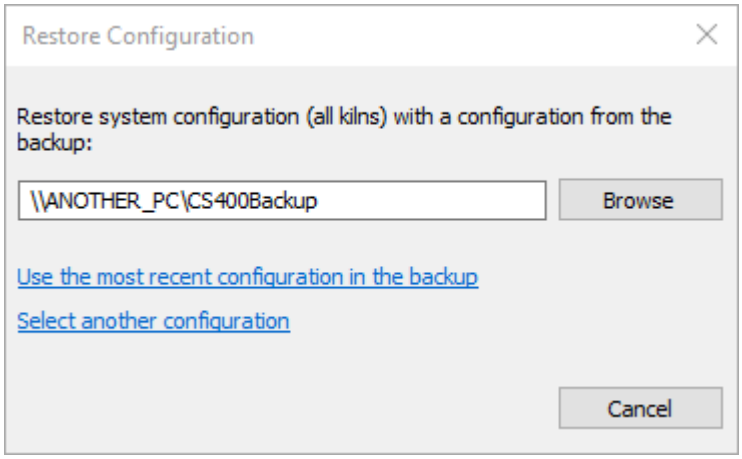
If the last backup did not complete successfully, the reason can be found in the backup log. Click Backup log link to see the log file.

Click Run backup now to start the backup manually. This link should be used to do backups if automatic backups are not enabled.

Restoring system configuration

To recover system configuration:

1. Close all monitoring windows to show the start-up screen.
2. In the main menu select **System / Restore Configuration**.

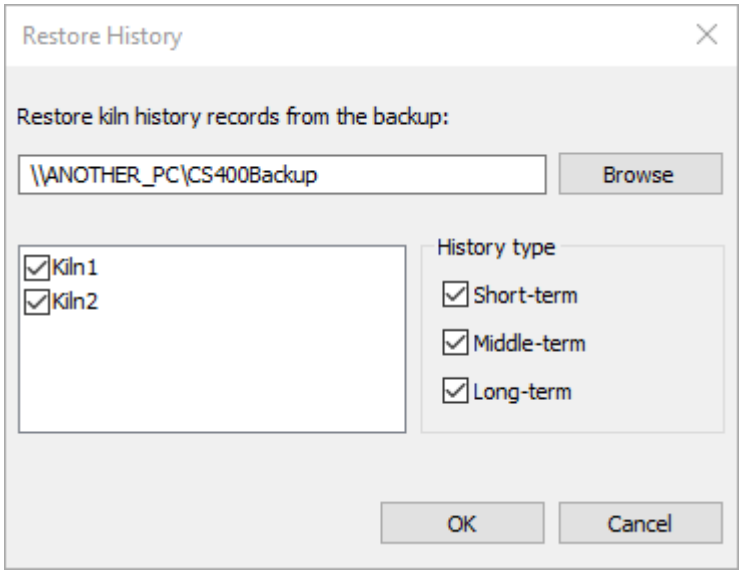


3. If you want to use another backup folder, not the currently configured one, press **Browse** and select the other backup folder.
4. Clicking **Use the most recent configuration in the backup** will use the last available configuration.
5. If you want to revert to an older configuration, click **Select another configuration** and choose the needed folder by date.

Restoring historical data

To recover history data:

1. Close all monitoring windows to show the start-up screen.
2. In the main menu select **System / Restore History**.



3. If you want to use another backup folder, not the currently configured one, press **Browse** and select the other backup folder.
4. Select kilns you want to restore history data for and also history types that you want to restore.
5. Press **OK** to begin copying data from the backup.

> **Attention**
>
> During recovering from a backup, the current configuration (if the configuration is being recovered) and the existing history data (if the history is being recovered) will be permanently deleted, overwritten with the data from the backup.

2.25 OPC UA configuration

OPC UA does not require any specific configuration.

If you have other OPC UA servers running on the same computer, you may need to change the discovery server port, so there is no conflict with other servers. This is done in Linescano.ini configuration file, in [OPCUA] section.

Current discovery URL can be found in the System state window, on the **System** tab.

2.26 OPC Classic configuration

> **Important**
> OPC will not work if IRT KilnMonitor server is started in a Remote Desktop session. Please do not use Remote Desktop to configure and run IRT KilnMonitor server, use other alternatives like VNC.

OPC Core Installation

IRT KilnMonitor uses OPC version 2.0. OPC Core components are installed together with the main application, so there is no need to install them separately.

Configuration summary

To setup OPC on the computer you should do the following:

1. Server and client: Run IRT KilnMonitor as administrator to allow it to register itself in Windows Firewall.
2. Server and client: Add *Remote Access* Permission for *ANONYMOUS LOGON* user in “DCOM Default Access Permissions Limits” dialog.
3. Server and client: Add *Remote Launch* and *Remote Activation* Permissions for the *Everyone* user in “DCOM Default Launch and Activation Permission Limits” dialog.
4. Server only: Add *Remote Launch* and *Remote Activation* Permissions for the *Everyone* user for **Linescano** application.

Below these steps are described in details. Pay attention to the screen shots.

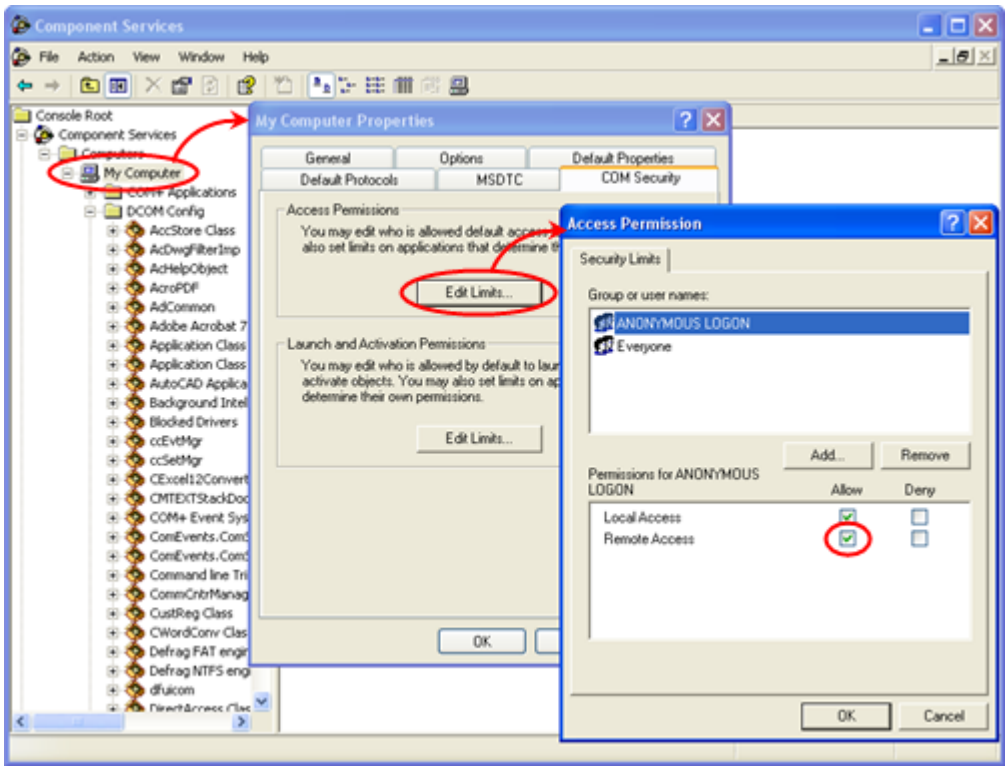
Windows firewall configuration (server and client)

IRT KilnMonitor automatically configures Windows firewall when its is started with Administrative privileges. This happens automatically after the installation. The user might not allow the program to run with administrative privileges after the installation. In this case program will not have the opportunity to register itself in Windows firewall. To fix this problem, just run IRT KilnMonitor once "As Administrator".

DCOM configuration, global limits settings (server and client)

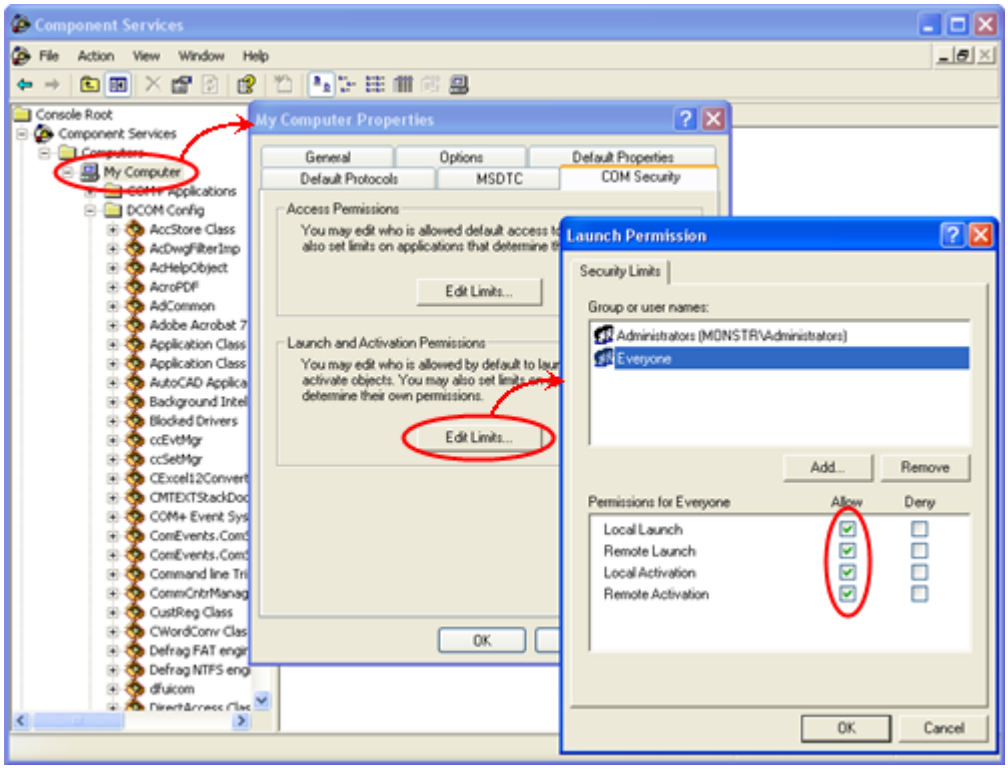
Click Windows **Start** button, then select **Run**. Start “**dcomcnfg.exe**” and perform the following actions.

1. On the client and server computers make sure that *ANONYMOUS LOGON* user has *Remote Access* Permission in “DCOM Default Access Permissions Limits”.



Note: this is needed only to access *OpcEnum* objects, as *OpcEnum* does not use COM-security (it uses Authentification Level: *None*).

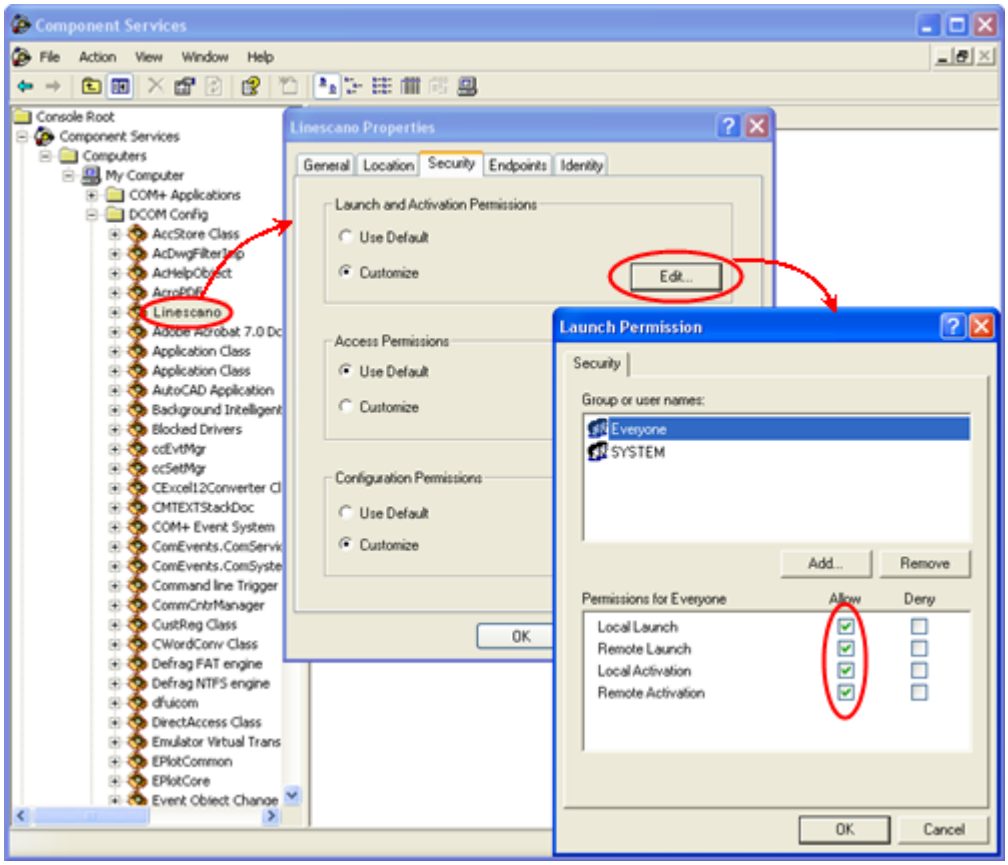
2. On the client and server computers make sure that *Everyone* user has *Remote Launch* and *Remote Activation* Permissions in “DCOM Default Launch and Activation Permission Limits”.



DCOM configuration, Linescano OPC server settings (only server)

Click Windows **Start** button, then select **Run**. Start “**dcomcnfg.exe**” and perform the following actions.

On the server computer, find **IRT KilnMonitor** application and add *Remote Launch* and *Remote Activation* Permissions for the *Everyone* user.



Note: you can manually specify computer users instead of specifying *Everyone*. All computer users IRT KilnMonitor must be specified, otherwise they will not have remote access to the OPC data.

2.27 Passwords

Access to different functions of the system can be protected by passwords. There are two access levels: **Level 1** and **Level 2**.

Without getting the appropriate password, only the read-only access is granted.

Level 1

Is required to start and to stop kiln monitoring, also it is needed to change the alarm setup and other kiln parameters which are necessary to change during the kiln run:

- Alarms including rings alarms;
- Alarm suppression;
- History storage setup;
- Inner temperature of the kiln;
- Brick thickness map.

Level 2

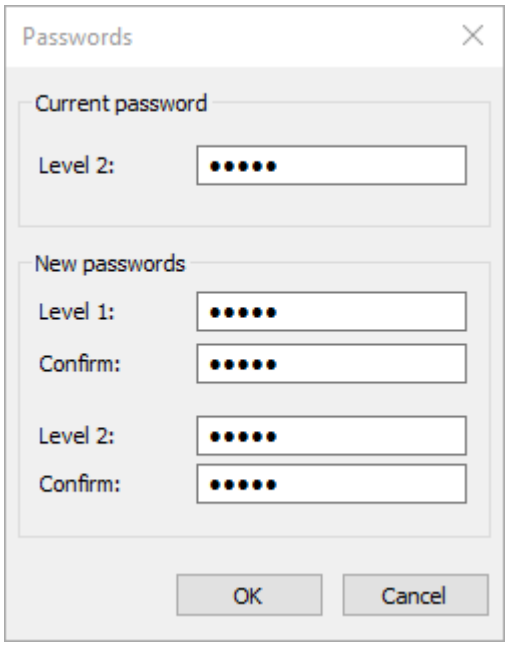
In addition to the areas accessible by Level 1 password, Level 2 password allows to modify the configuration:

- Installation;
- Refractory.

Changing passwords

To change passwords IRT KilnMonitor must be run with Windows administrator rights. Also you need to enter the current Level 2 password.

Close all monitoring windows to get to the Start-up screen and select **System / Change Passwords** in the main menu.



To remove password protection, use empty passwords.

Forgotten passwords

If you have forgotten your Level 2 password, you can use the Master password to set new passwords. Please contact your distributor to know the master password.

Configuring password protected features

It is possible to configure which functions are password protected by modifying corresponding parameters in **Linescano.ini**.

```
[PASSWORD PROTECTION]
; password will not be asked if a protected feature is accessed within this time (seconds) after
the password was entered.
password_work_time_s = 300
; configurable protected features and their password levels
temperature_scale = 1
monitoring_start = 0
monitoring_stop = 1
acknowledge_alarms = 1
```

For example, if you want IRT KilnMonitor to ask Level 1 password every time kiln monitoring is started, you should set **monitoring_start** parameter value to 1.

3 Operation

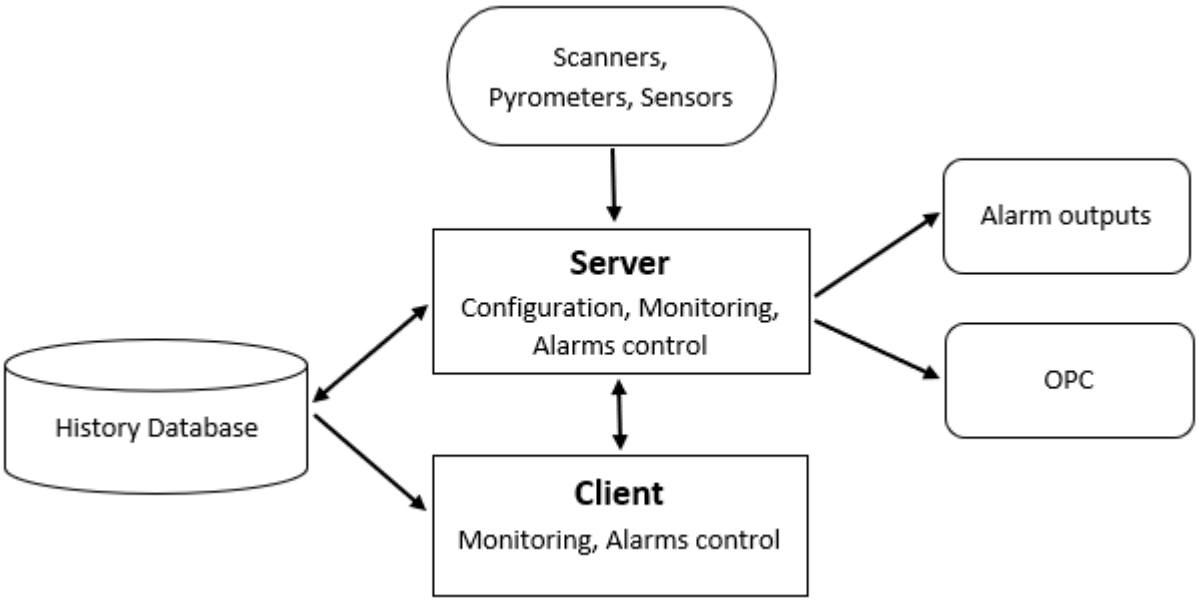
3.1 Client-server structure

The system is designed in a client-server structure. There is IRT KilnMonitor server that runs on a computer where monitoring instruments are connected to and IRT KilnMonitor client that connects to the server through a local area network and gets information about current state of the kiln.

Therefore, IRT KilnMonitor server runs the main system tasks, such as communicating with the temperature measuring devices (scanner, pyrometers), interpreting the incoming information, and interfacing with the digital output modules. Its other important task is serving the IRT KilnMonitor clients and OPC clients.

IRT KilnMonitor clients are designed solely for monitoring, their main duties are displaying the actual physical state of the kiln, as well as recovering historical data from the system. Furthermore, they permit the user to control the events (alarms and errors) that can show up in the system.

All monitoring functions are also present in IRT KilnMonitor servers.



IRT KilnMonitor server and IRT KilnMonitor client applications look pretty much the same:

- They use the same installation program. IRT KilnMonitor knows if it is a client or a server only by the license code used during installation.
- Program icon and program name in the system is the same - IRT KilnMonitor.
- Both the client and the server have monitoring functionality. The difference is that a server displays kilns which data it gathers directly, while a client needs help of a server to get kiln information.
- If you have IRT KilnMonitor server installed on a computer, you cannot install IRT KilnMonitor client.

3.2 Connecting a client to a server

Kiln data monitored by a IRT KilnMonitor server is made available for other computers in the network.

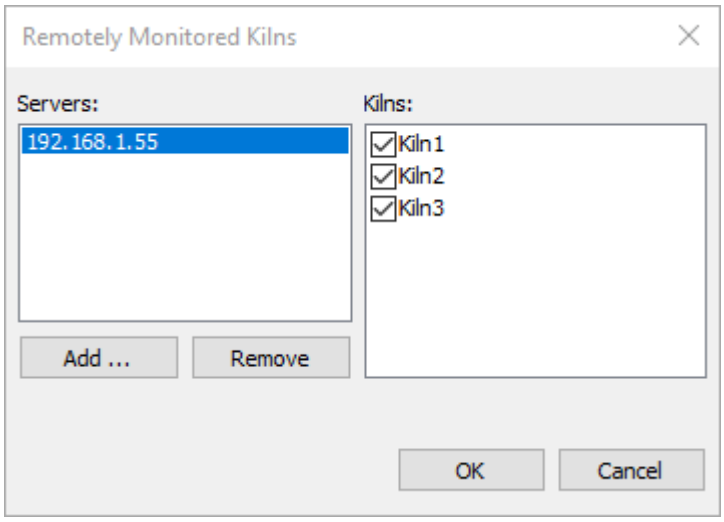
Kiln monitoring server is a computer in the network which is directly linked to kiln monitoring instruments and gathers data from them.

Kiln monitoring client is a computer which connects to a kiln monitoring server and gets data from this computer and not directly from kiln monitoring instruments.

The server and clients use the TCP protocol to communicate. Required ports are **8428** (server) and **8429** (monitoring database). Port values can be changed in Linescano.ini.

After installing IRT KilnMonitor client, to establish connection with a kiln monitoring server:

1. In the main menu choose Monitoring / Remotely Monitored Kilns. Monitoring window also has a button for this: .
2. In the Remotely Monitored Kilns dialog, select or add a server network name or its IP address.
3. If connection is established with the remote server and it has IRT KilnMonitor configured and running you will see list of kilns available for remote monitoring. Choose kilns you want to monitor by placing marks in the corresponding check boxes.



After connecting to a kiln it is added to the list of monitored kilns and you can see its state and do analysis in the monitoring window. You can see status of the connection in the status bar:



Possible server statuses are:

- *Running*: kiln monitoring is running, connection to the server is present.
- *Stopped*: kiln monitoring is not started on the server, connection to the server is present.
- *Not connected*: no connection to the server - connection is not present and it was not possible to establish it.
- *Connection lost*: no connection to the server - connection was established but then it was lost, automatic reconnection is running, but without success.

> **Note**
>
> If connection to the server is lost, IRT KilnMonitor client will try to automatically restore it. You are informed about lost connection by blinking kiln update time.

Changes you do on the IRT KilnMonitor client will not in any aspect affect the server.

Limited functionality

Functionality of the client is limited if to compare with functionality of the server:

1. You cannot start and stop monitoring.
2. You cannot save additional kiln states to the history storage.
3. You cannot change kiln configuration.

History access

Remote kilns history is available if history storage is properly configured for remote access on the server.

To view it, select necessary remote kiln in the History Tabs dialog (main menu **Monitoring / Kiln History**).

Troubleshooting

If you have problems connecting to a server you get errors in Remotely Monitored Kilns dialog. Most common reasons are:

1. IRT KilnMonitor server is not running.
2. If you can connect to the server but see empty list of kilns, check that data sharing is not disabled in the kiln configuration (Installation page, **Disable data sharing** check box).
3. You have a firewall in your local network that blocks TCP ports used by IRT KilnMonitor.

3.3 Starting and stopping kiln monitoring

After configuration is complete, you can start kiln monitoring. Monitoring can be started only on the IRT KilnMonitor server.

Monitoring stops when the IRT KilnMonitor server application is closed.

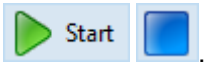
Start-up screen

On the Start-up screen, you can start or stop monitoring for all kilns by selecting **Monitoring / Start Monitoring All Kilns** or **Monitoring / Stop Monitoring All Kilns** from the main menu.

When you click the **Monitor** button, IRT KilnMonitor opens the monitoring window but does not start monitoring.

Monitoring window

When the monitoring window is open, you can start or stop monitoring for the selected kiln by selecting **Monitoring / Start Kiln Monitoring** or **Monitoring / Stop Kiln Monitoring** from the main menu.

You can also use the corresponding buttons on the toolbar: 

.

Kiln maintenance mode

You can monitor a kiln in **maintenance mode**. In this mode, all alarm checks are suspended.

Use maintenance mode when the kiln is not running under normal operating conditions, for example:

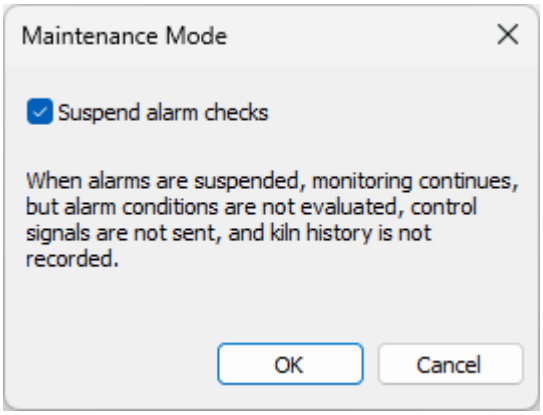
- The kiln is running without load.
- The kiln is starting up or stopping and has not yet reached normal speed.
- The kiln is heating up.
- The kiln is cooling down.
- Other conditions are present in which normal alarm evaluation is not required.

When monitoring is running in maintenance mode:

- Alarms are not evaluated, and alarm I/O is reset.
- Control signals are reset.

- Refractory thickness is not calculated or updated.
- History is not recorded.
- Temperature trends are not updated.

To turn on maintenance mode, select **Monitoring / Maintenance Mode** from the main menu, and then configure the mode in the **Maintenance Mode** dialog.



When monitoring is running in maintenance mode, a blinking label is displayed on the toolbar:



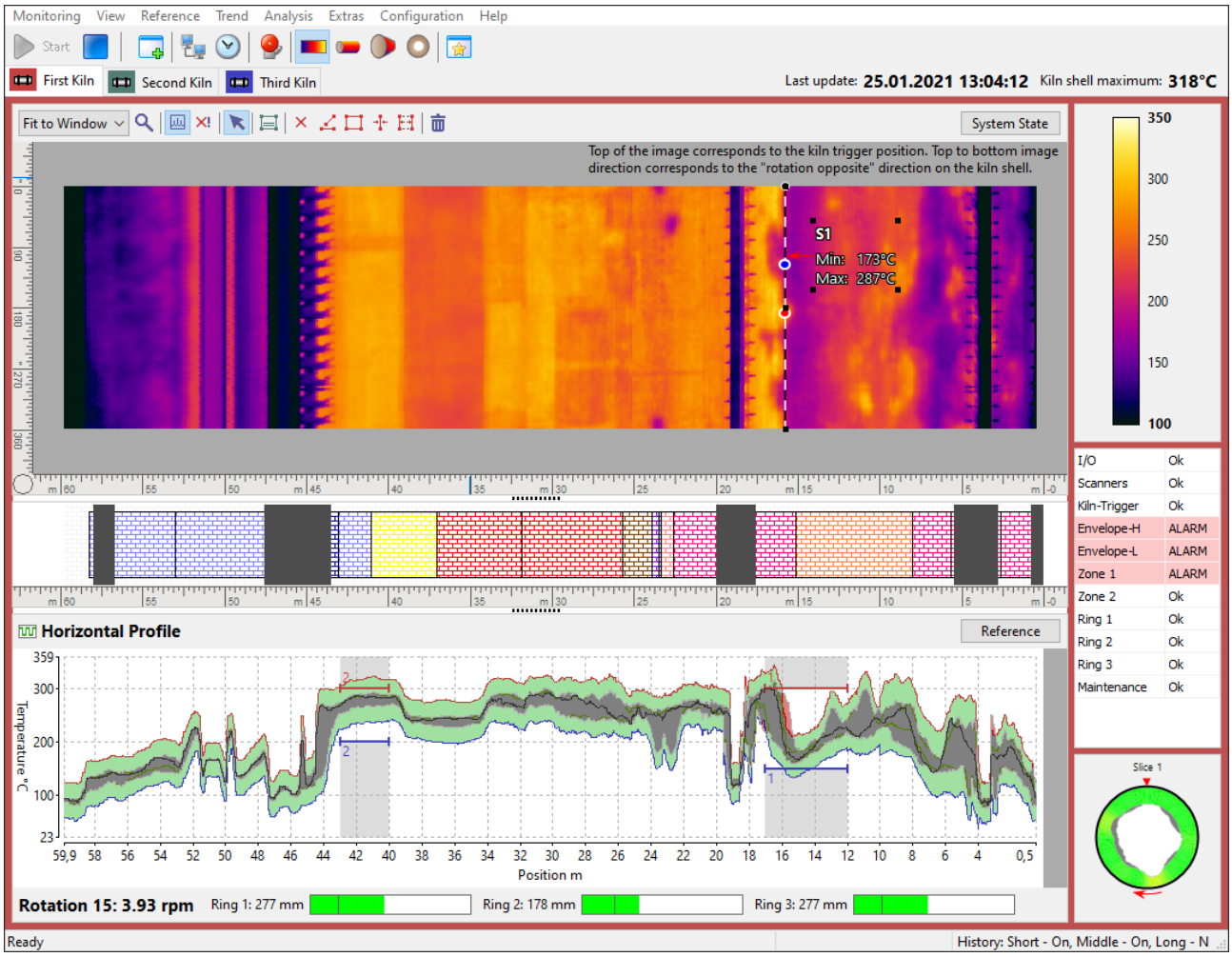
To switch to normal monitoring mode, click the label and clear the **Suspend alarm checks** option in the Maintenance Mode dialog.

Automatically start monitoring when application starts

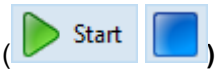
You can configure IRT KilnMonitor to start monitoring all kilns automatically when the application starts. Configure this option in the **Settings** dialog.

3.4 Monitoring window

To open the Monitoring window from the start-up screen, press **Monitor** button or select **Monitoring / Open Monitoring Window** in the main menu (using the menu will open the monitoring window without starting kiln monitoring).



Start / Stop Kiln Monitoring

Use **Start** and **Stop** buttons in the toolbar () to start or stop monitoring of the selected kiln. To select a kiln, click on the corresponding tab at the top of the monitoring window.

Views

Monitoring window is divided into three parts: the main view (top), the reference view (bottom) and the side view.

Main view can display:

- Temperature map (infrared image of the kiln shell);
- 3D virtual kiln;
- 3D kiln section;
- 3D end-view.

Reference view can contain:

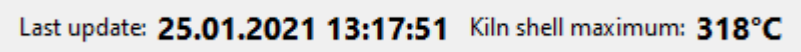
- Horizontal profile;
- Temperature trend;
- Image trend;
- History reference.

Side view displays:

- Temperature scale;

- Alarms status window;
- Burning zone view;
- Rotation / Tire slip trend;
- Thickness / Coating diagram.

Kiln state update time and the maximum kiln shell temperature is displayed in the top-right corner of the monitoring window.



At the bottom of the window, kiln rotation counter, rotation speed (rpm – rotations per minute) and tire slip information is displayed.



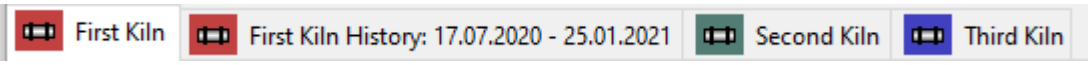
The main menu and the toolbar of the monitoring window is dynamic, their contents depend on the active view mode and on the type of data source (server or client).

Data sources

Monitoring window can receive the data it displays from different sources. If the screen is running on IRT KilnMonitor server it is getting data directly from the kiln monitoring instruments. On a IRT KilnMonitor client, the data is received from the server through the network. History database can also serve as a data source.

Tabs at the top of the measurement window correspond to the data sources - each data source has its own tab. There are three types of data sources:

1. **Local**: data source for a kiln monitored directly by this computer.
2. **Remote**: data source for a kiln monitored remotely by another computer in the network.
3. **History**: data source that gets data from the history database of a kiln.



- Red light on the tab informs about an alarm.
- Green means everything is OK.
- Blue light indicates a hardware breakdown. The breakdown details can be found in the System State window.

All tabs contain the name of the kiln they refer to. Besides, remotely monitored kiln tabs contain server computer name. Data from the history storage is accompanied with the time information.

Status Bar

The status bar contains specific information depending on the selected tab (e.g. next history recording time, remote server status, date and time of the current history frame, etc.).

- For local data sources the left cell of the status bar indicates whether short-term and middle-term history is on or off, and the next long-term recording time if it is enabled (see Configuring history storage).
- For history data sources the status bar shows the date and the time of the current history frame.
- For remote data sources the status bar indicates the monitoring server status (running, stopped, connection lost, server is shut down) and the last data update time.

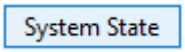
3.5 System state window

System state window displays detailed information about the kiln monitoring system and its hardware. It has several tabs. Active tab is marked by the blue color. If a tab has information about an error, this tab is marked with the red color.

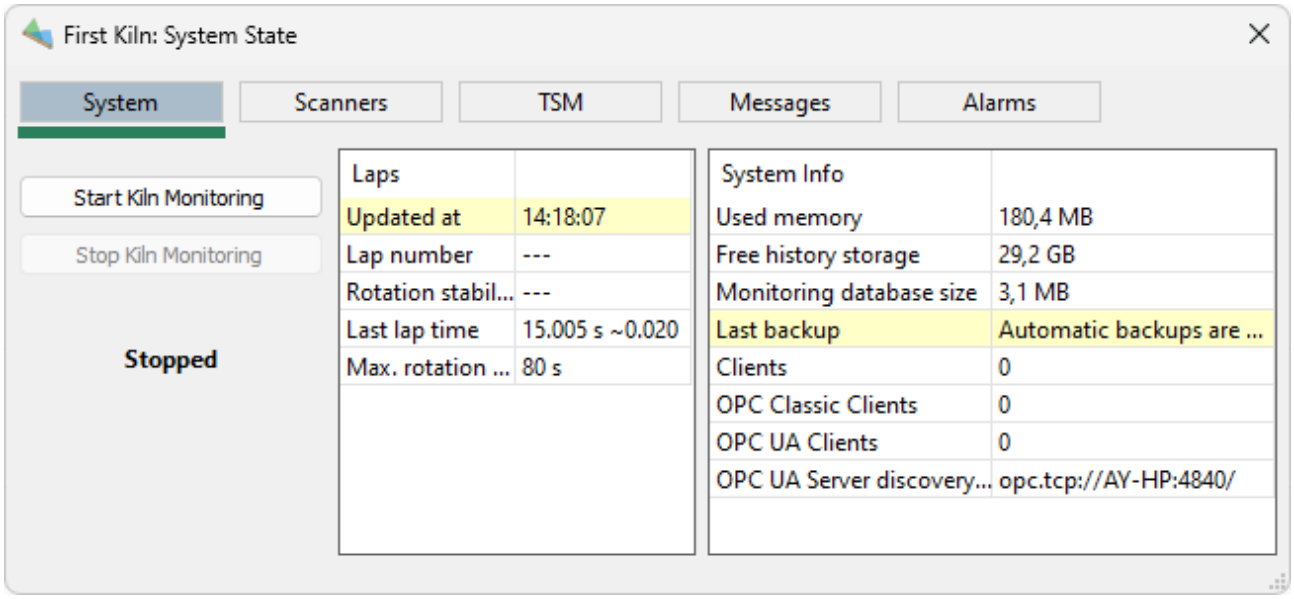
***Scanners* and *Pyrometers* tabs are available only for the actual kiln state on IRT KilnMonitor server. For kiln states loaded from the history and for kiln states received remotely by IRT KilnMonitor clients these tabs are not available.**

System state window will automatically pop out in case of a problem.

You can also open this window using main menu **View / System State** or corresponding button on the measurement screen.



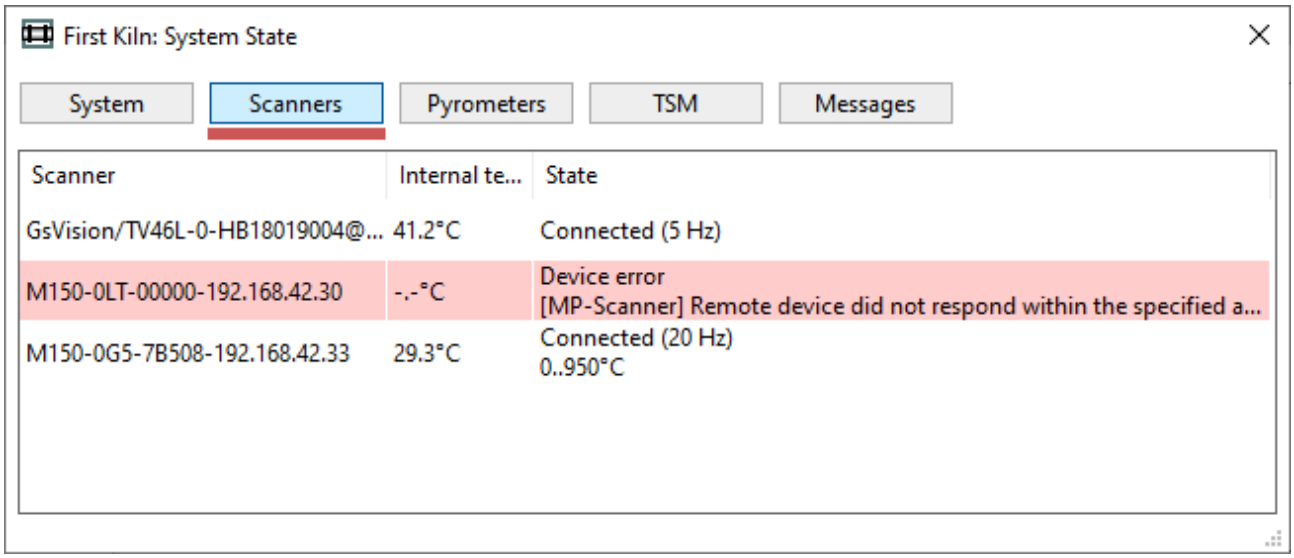
System tab



On this tab you will find the commands needed to start and stop kiln monitoring. It also shows:

- **Updated at**: the time the kiln state was updated at.
- **Lap number**: the number of laps (kiln revolutions) registered since kiln monitoring started. The number with tilde is the lap time variation measured on several recent rotations (see The kiln trigger).
- **Rotation stability**: if kiln rotation speed is stable or not.
- **Last lap time**: the time duration of the last lap.
- **Max. rotation time**: maximum expected time for one kiln revolution (from the kiln configuration).
- **Used memory**: RAM memory occupied by the program (it should stay relatively stable from the program start and day after day).
- **Free history storage**: the disk space available for history storage. If there is no disk space left, IRT KilnMonitor will not be able to save new kiln states to the history storage.
- **Monitoring database size**: the size that the monitoring database occupies on the hard drive.
- **Last backup**: date and time of the last successful backup.
- **Clients**: the number of IRT KilnMonitor clients currently connected to this server.
- **OPC Classic Clients**: the number of OPC DA clients currently connected.
- **OPC UA Clients**: the number of OPC UA clients currently connected.
- **OPC UA Server discovery URL**: the URL that should be used by an OPC UA client to connect to IRT KilnMonitor OPC UA server.

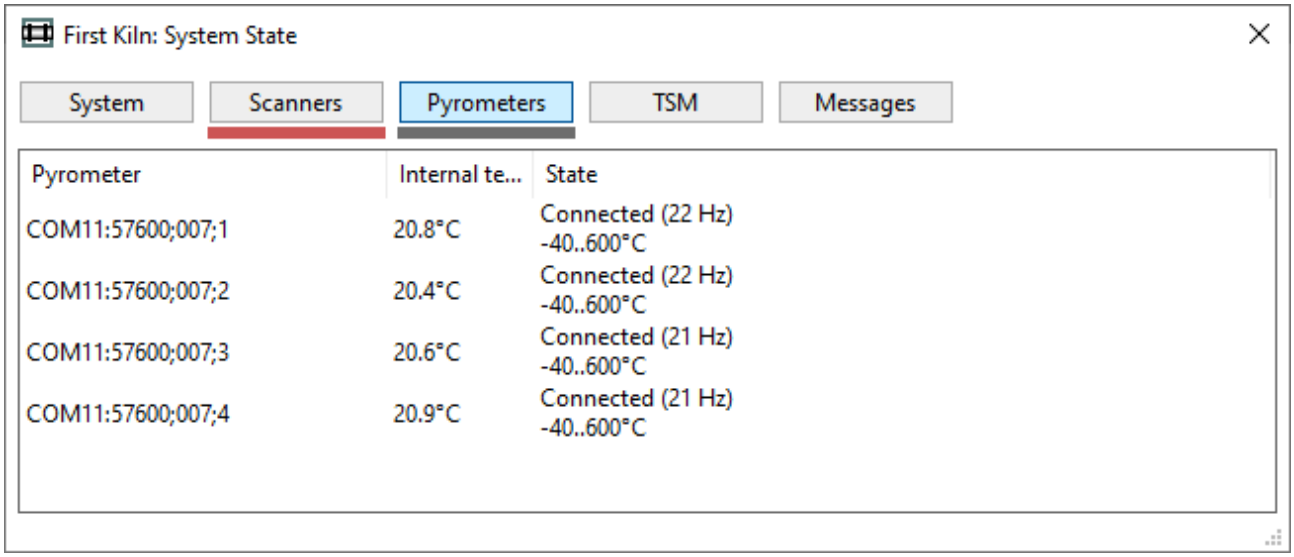
Scanners tab



This tab shows information on the scanners configured to work with the system. This information includes device ids assigned to scanners in the configuration, internal temperature of each scanner, line scanning frequency and, in case of a problem, the problem text.

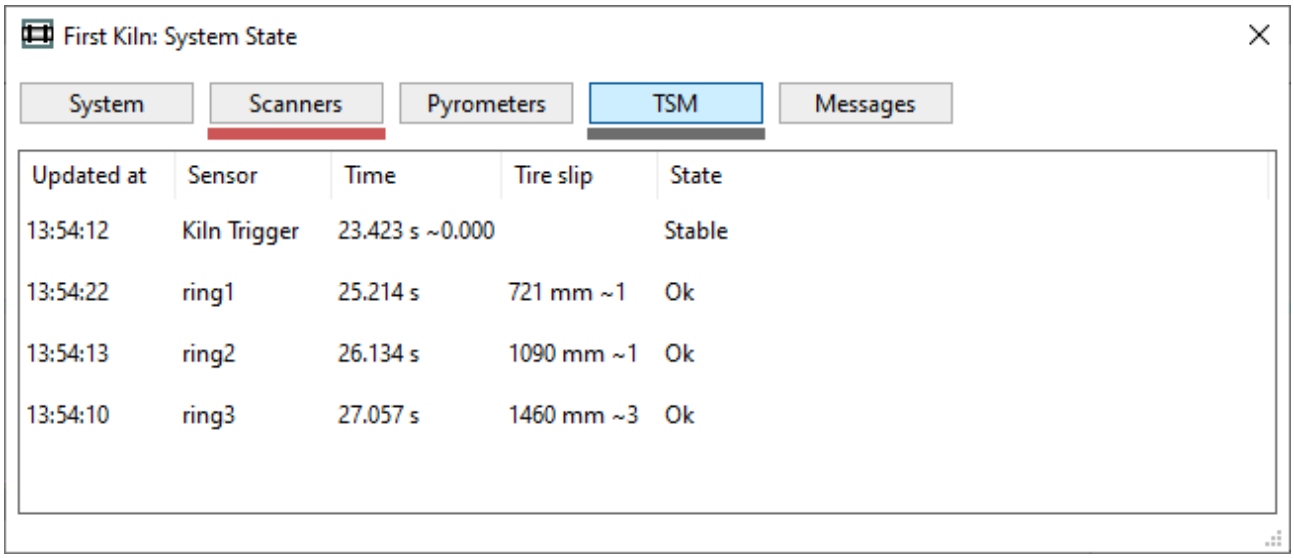
The information shown is updated every second. If communication is interrupted the information will be updated as soon as detection takes place.

Pyrometers tab



Similar as for the scanners, this tab shows information on the pyrometers configured in the system.

Tire slip monitoring tab



This tab shows information related to the TSM system (Tire Slip Monitoring).

Updated at: time when corresponding parameter was last updated. Tire slip values may not be updated after every kiln revolutions, for example, in case kiln speed is not constant. See Tire slip monitoring for details.

Sensor: name of the sensor (kiln trigger or ring name).

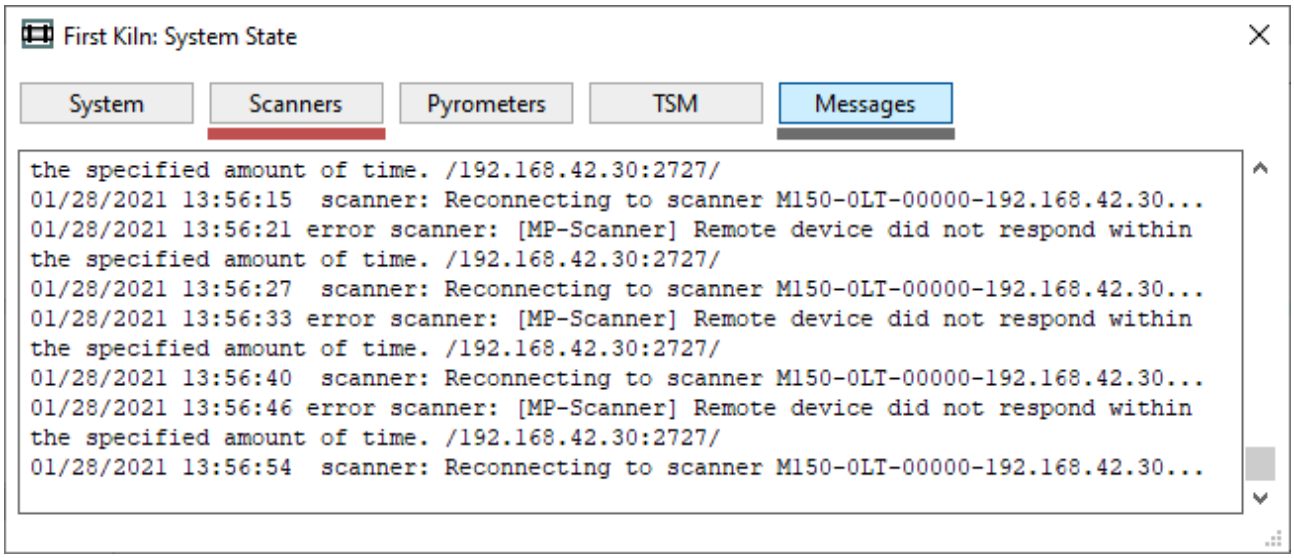
Time: last measured lap time (with time variation for the kiln trigger).

Tire slip: calculated tire slip and its variation (the number with tilde). Tire slip value is averaged from several revolutions, see Tire slip monitoring for details.

State: for kiln trigger possible states are: *Measuring rotation stability*, *Stable*, *Rotation is not stable*. For rings: *Gathering data*, *Ok*, *No signal from ring sensor*, *Update timeout*, *Non uniform*.

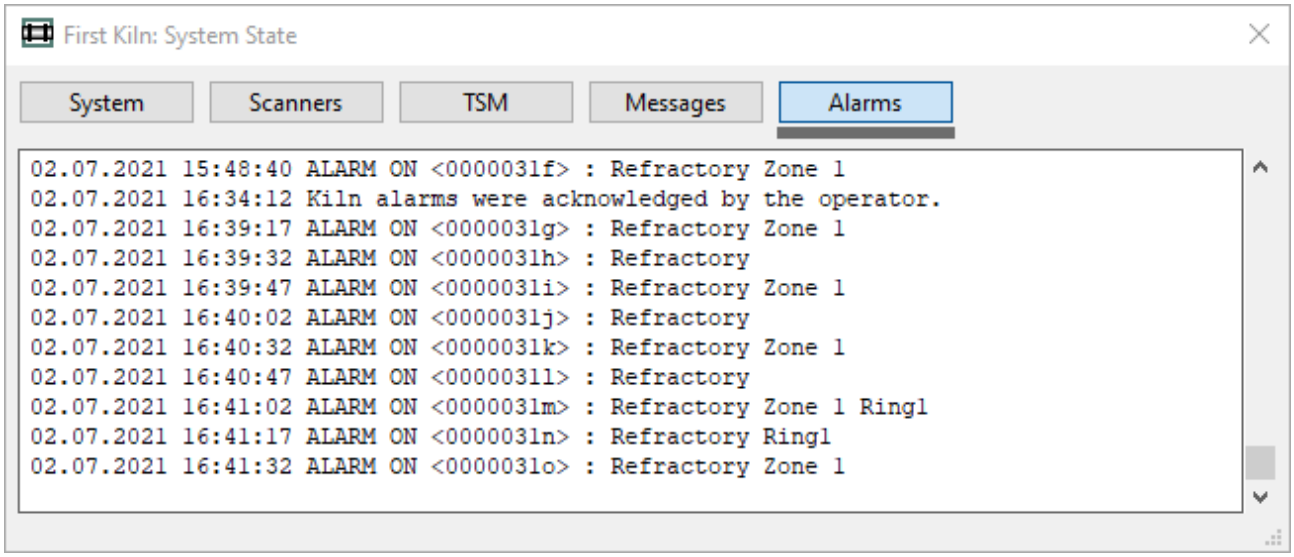
The numbers with tilde is the variation measured on several recent rotations (lap time variation for the kiln trigger and tire slip variation for rings).

Messages tab



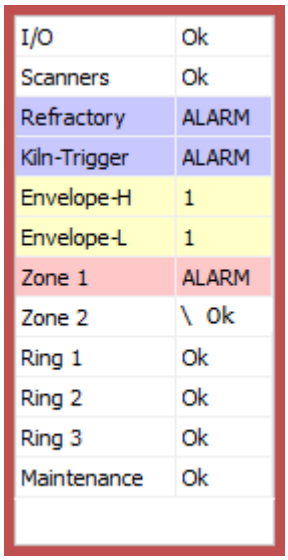
This tab displays all messages from the system. These message can be just informative, like that monitoring was started and also messages reporting about problems. All these messages make up the events log.

Alarms tab



Show the history of alarms (alarms log).

3.6 Alarms indication



Alarms window shows all monitored alarm conditions.

- If an alarm condition is met alarm signal is triggered and the alarm condition item is marked red or blue in the list.
- The background becomes **red** for kiln state alarms and **purple blue** for hardware problem alarms.
- If the alarm condition was not met at the last revolution, alarm signal is reset and the corresponding line shows **Ok**.
- If the alarm condition was met at the last revolution but there is still the **False alarm threshold** to pass, the corresponding line becomes yellow and shows how many revolutions meeting the alarm condition are still needed to trigger the alarm signal.
- **Rotating bar** near the alarm state indicates that the control condition is active.

To manually reset all kiln state alarms, choose **Monitoring / Reset Alarms** in the main menu.

Alarm types

I/O alarm (purple blue) informs that there is a problem with I/O (for example connection to alarms I/O device is lost).

Scanners alarm (purple blue) indicates that there is a problem with a scanner or a pyrometer (connection lost, the internal temperature is too high).

Kiln-Trigger alarm (purple blue) is generated if there is no signal from the kiln trigger sensor during the maximum kiln rotation time.

Envelope alarms (red) are generated when high or low temperature limits are surpassed. See Envelope profile alarms configuration.

Zone alarms (red) are triggered if kiln temperature passes limits defined for a zone. See Zone alarms configuration.

Burning Zone alarm (red) is triggered when measured burning zone temperature goes out of the limits defined in Burning zone alarms configuration.

Bearings / Other alarms (red) are triggered when if measured temperature is out of the limits configured in Bearings / Other alarms configuration.

Ring alarms (red) are generated when measured ring tire slip value is out of the defined range, when there is no signal from the ring sensor and when measured values are nor reliable (large deviation). See Ring alarms configuration.

Maintenance alarm (purple blue) tells that it is time to check the hardware. See Maintenance alarms configuration and Resetting maintenance alarms.

Refractory alarm (purple blue) tells that bricks in one of the refractory zones have reached the end of their typical life cycle.

> **Hint**
>
> To get more information about an alarm, double click on the alarm line.

To change or define alarm conditions select **Configuration / Alarms** in the main menu or press corresponding button in the toolbar. See Alarms topic.

Kiln alarms acknowledgment

If there is an active kiln alarm, the monitoring window will show a flashing KILN ALARM message.

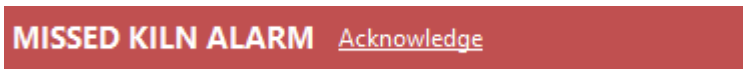


Click on the **Acknowledge** link to stop the message flashing and make it not so alerting:



Kiln alarm message will switch back to the flashing state if a new alarm is triggered (for example, Zone 1 alarm was acknowledged and Zone 2 alarm becomes active). An alarm turning off and then on again will also re-activate the flashing state.

If you do not acknowledge an active kiln alarm and the alarm disappears by itself (because its alarm condition is not met any more), IRT KilnMonitor will display the missed alarm message, which you also need to acknowledge to make it disappear.



> Only the kiln state alarms (red) are displayed in such a manner with a possibility to acknowledge them. System alarms (purple-blue) do not require acknowledgment. When a system alarm occurs, the System State window pops up automatically and it will continue to pop up as long as the corresponding problem is not solved.

3.7 Kiln views

The upper half of the measurement window is called **Main view**. It represents the actual thermal state of the kiln shell.

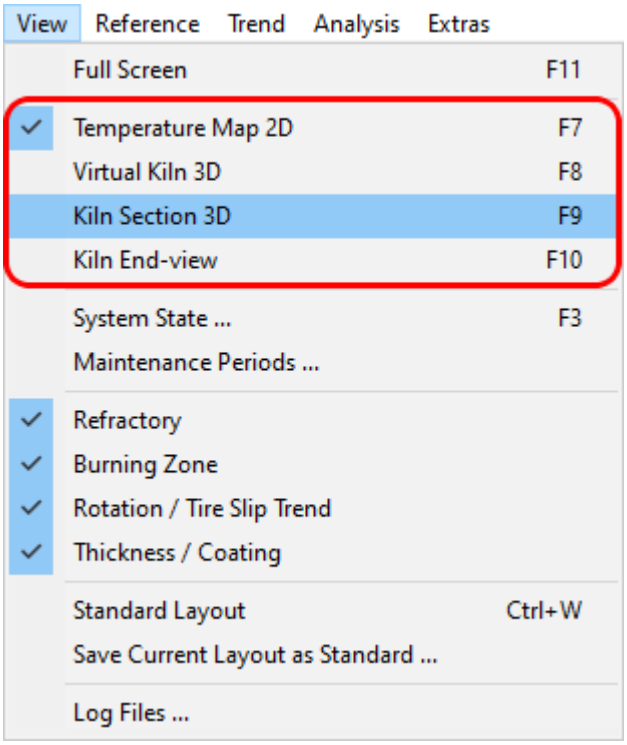
There are four basic views of the kiln shell:

1. Two-dimensional infrared view (Temperature map 2D);

2. Three-dimensional view of the whole kiln in motion (Virtual kiln 3D);
3. Three-dimensional view of the kiln interior (Kiln section 3D);
4. Three-dimensional view from the kiln end (Kiln end-view).



To switch between these view modes, use appropriate toolbar buttons or commands in the **View** main menu:



3.8 Temperature map 2D view

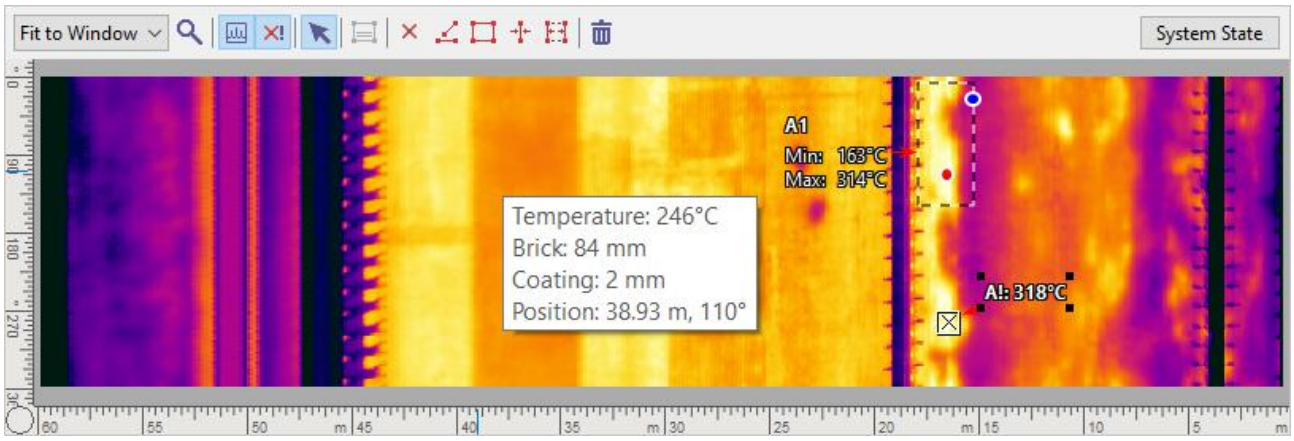


The Temperature Map 2D view represents a plane two-dimensional infrared image of the kiln.

The axes show the real kiln shell coordinates. The X-axis is the kiln axis; Y-axis is the angle measured in the direction opposite to the kiln rotation. 0 of the Y-axis corresponds to the kiln trigger position.

The 2D infrared image is updated after each kiln revolution.

When the mouse pointer is moved over the infrared image, an info window is displayed showing the temperature and coordinates of the spot under the pointer; brick and coating thickness values are also displayed if they are available.

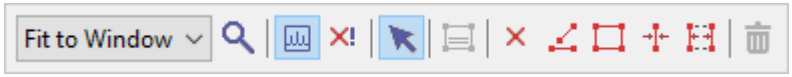


The temperature Map 2D can be displayed at the top or bottom part of the screen (when combined with one of the 3D views).

Analysis objects

The Temperature Map 2D view allows creating measurement objects on the infrared image. Here you can perform thermal analysis of the infrared image of the kiln shell: measure spot temperatures, create temperature marks, get statistical information on lines and areas, etc.

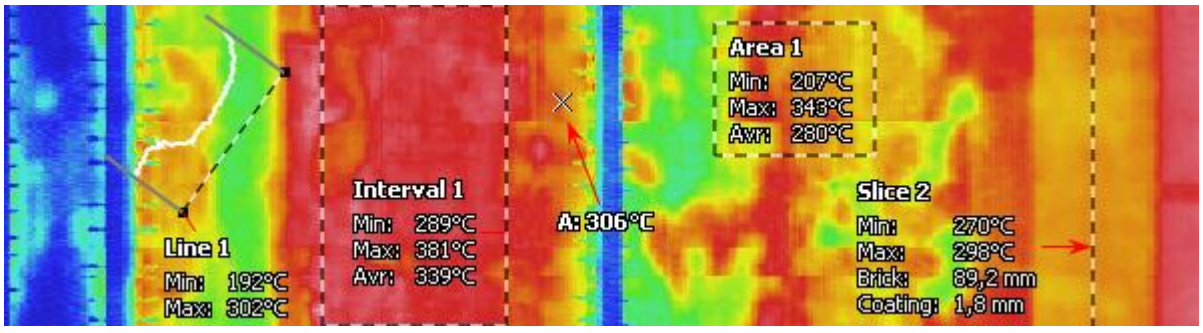
The Temperature Map 2D view has its local toolbar with all the measurement tools that can help you to analyze the infrared image:



	Zoom tool	Allows to scale the image. Pick up the zoom tool and click on any area of the image to increase it. Use the right mouse button to restore the normal image size (corresponds to Fit to Window command in the Zoom combo box). You can also use the mouse wheel to control the zoom. When the zoom factor is adjusted so that not the whole image is visible, a rectangle appears in the kiln design view showing the location of the visible area on the shell.
	Selection tool	Selects, moves and resizes analysis objects. It is also used as the flying spot temperature meter to check the temperature under the mouse pointer. With the help of the selection tool you can move and reshape objects and their labels. Hint: to switch to the Selection tool after using another tool, just right-click on the image. Double-click on any place on the image to open the brick or shadow zone information window.
	Suppress alarm tool	Allows to mark rectangular areas on the kiln shell image that will be excluded from alarm tests. See Alarms suppression topic.
	Spot tool	Creates an analysis spot object on the image. The default label of the spot object shows only the temperature at this spot. However it can also display the brick and coating thickness values at this spot. To choose which parameters to show on the label, right-click on the spot object and select Label in the context menu.

	Hot spot tool	Shows or hides the hottest spot on the kiln shell image.
	Line tool	Creates an analysis line object. You can draw a straight line in any direction (horizontal, vertical, diagonal). The line label displays maximum and minimum temperature along the line. Brick and coating thickness is not available for lines. In line's context menu you can choose to show On-Image Profile that will display the distribution of temperatures along the line.
	Area tool	Creates a analysis rectangle object on the image. The default parameters of a rectangle object are the minimum and maximum kiln shell temperature in this area. Using the Label dialog the minimum brick thickness and the maximum coating thickness can be displayed as well. The area object has an additional command in its context menu - Zoom Area. This command shows image part taken by the area in a separate window with increased zoom factor.
	Slice tool	Makes a vertical slice of the kiln shell at the selected position. The slice object represents one vertical line of the image. Parameters of the slice object are the same as of area objects. In addition you can display the position of the slice in the label. As lines, slices can have on-image profile. Additional command in the context menu: Make 3D Section Here. This command opens the 3D Kiln Section view combined with the Temperature Map view, and the section position is set to the slice position.
	Interval tool	Creates an analysis interval object. The interval objects is a special case of the rectangle object, so it has the same parameter and functionality. The difference is that interval objects always cover the entire height of the image.
	Delete button	Deletes the selected object. To select an analysis object, use the selection tool. To delete all analysis objects at once, choose Analysis / Delete All Objects.

The picture below presents all the above-mentioned analysis objects.



When the Temperature Map view is activated, it is possible to perform trend monitoring of any object. See the topic Temperature Trend for details.

Objects' labels

Labels can show object properties. To see what properties are available on each type of measurement object, right-click on the object and select Label in the context menu. In the Label dialog you can adjust different settings for labels and add any custom text to them.

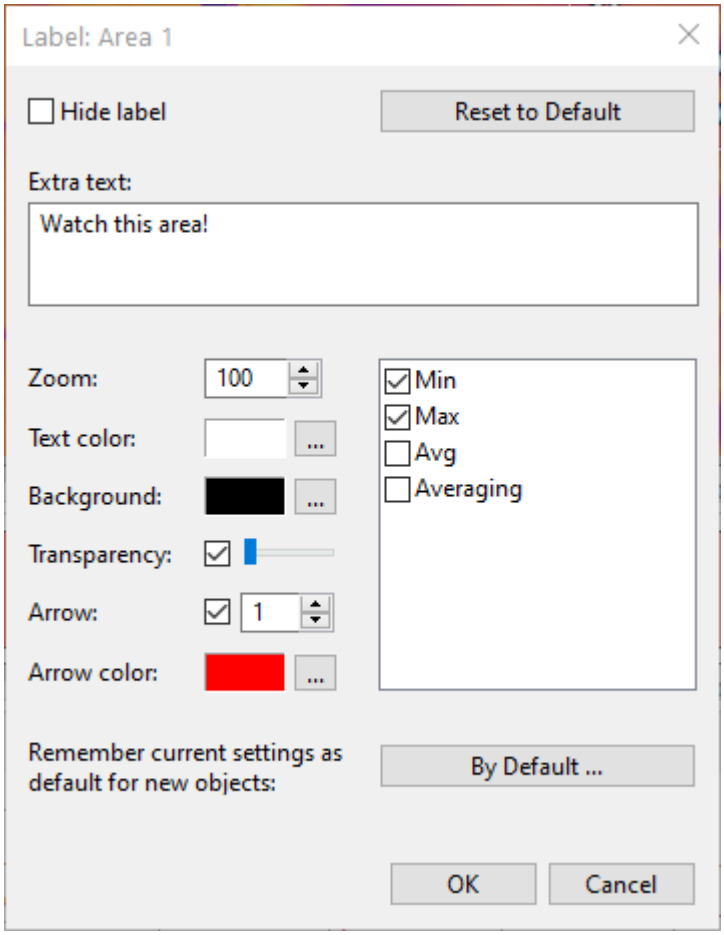
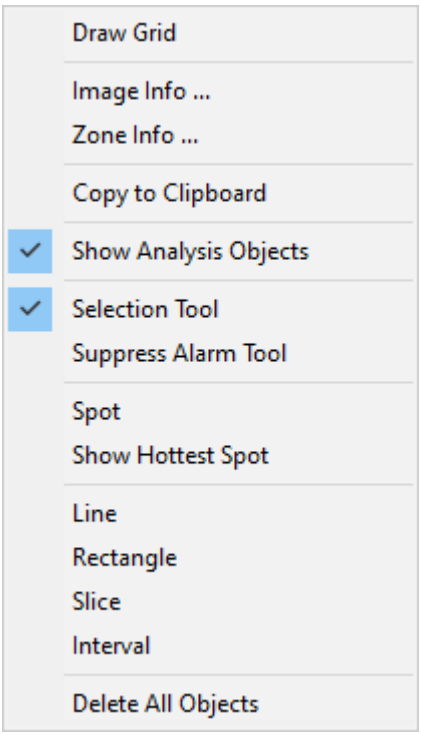


Image context menu

The infrared image of the kiln shell has its own context menu that contains all set of analysis tools described above as well as some additional commands.

- **Image Info** opens a dialog with image information such as image size, date and time image was created, calibration range. These properties are read only.
- **Zone Info shows brick and shadow zone information for the zone at the mouse pointer position (place where you clicked with the right mouse button to display the context menu).**
- **Draw Grid shows or hides the coordinates grid on the infrared image.**



3.9 3D kiln views

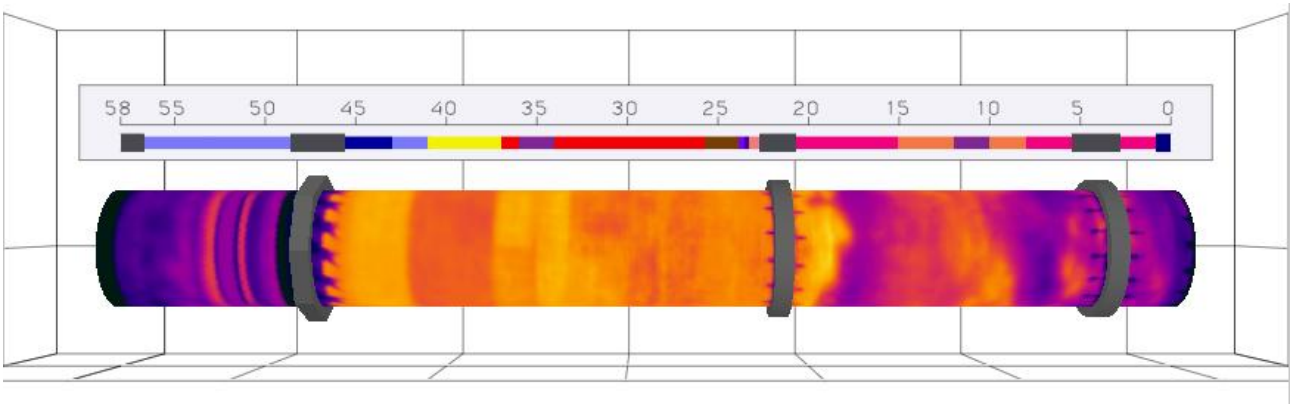
Virtual kiln 3D



This view displays the virtual kiln model in three dimensions. To switch to the Virtual Kiln 3D view, press the corresponding button in the toolbar.

The 3D virtual kiln model consist of the following parts:

- The kiln shell with infrared image on it;
- live rings and the gear rim;
- kiln trigger position marker (red triangle);
- ruler with refractory zones.



The kiln model on the screen rotates at the same speed as the real kiln. You can stop the rotation on the screen by clicking button in the local toolbar or choosing **Show Kiln Rotation** command in the 3D menu.

Virtual kiln 3D view can be combined with other views on the screen:

- combines 3D view with the Temperature map view;
- combines 3D view with the Reference view;
- 3D view is displayed full-screen.

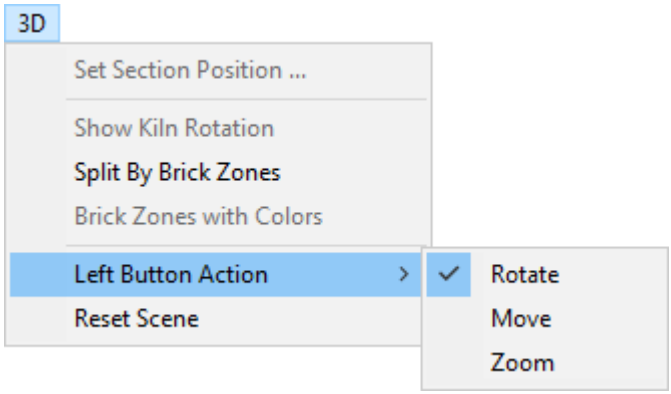
These options are available in the local toolbar and in the **View / Windows** menu.

Adjusting the 3D scene view

The following actions can be used to arrange the scene:

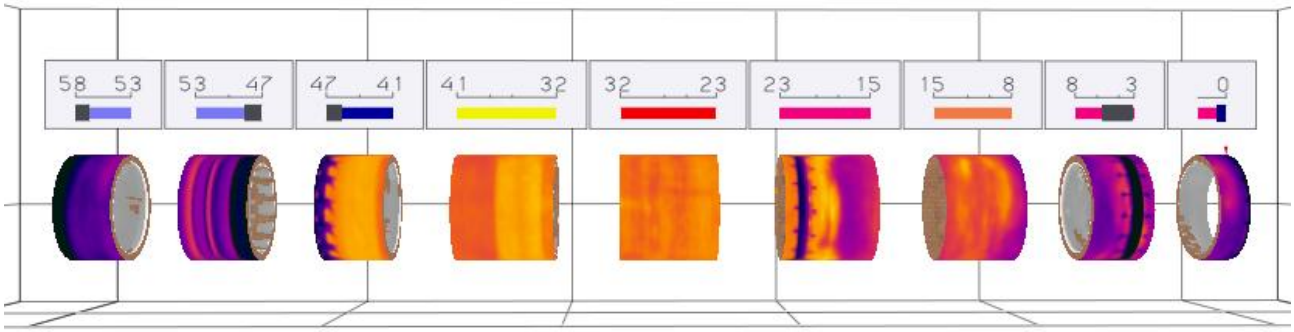
1. Mouse move when the left button is pressed (by default) rotates the scene. The kiln will turn in the indicated direction so that you could see it from other angles.
2. Mouse wheel (scrolling) changes the zoom moving the kiln model nearer or farther.
3. Mouse move when the middle button (wheel) is pressed moves scene right/left, up/down over the screen.
4. Double-click with the left mouse button resets the scene – returns the scene to the default position after you have rotated, moved or zoomed the model.

However the left button action can be changed: to rotate, to move or to zoom the scene. This is useful when your mouse does not have the wheel. To change the left button action, use the **3D** main menu or the context menu.



Split by brick zones

Virtual Kiln 3D view has an additional display mode: **Split by Brick Zones**. In this case the kiln (static or in motion) is cut into pieces according to the brick refractory zones (shadow zones are hidden). To return to the whole view, push the same button again.

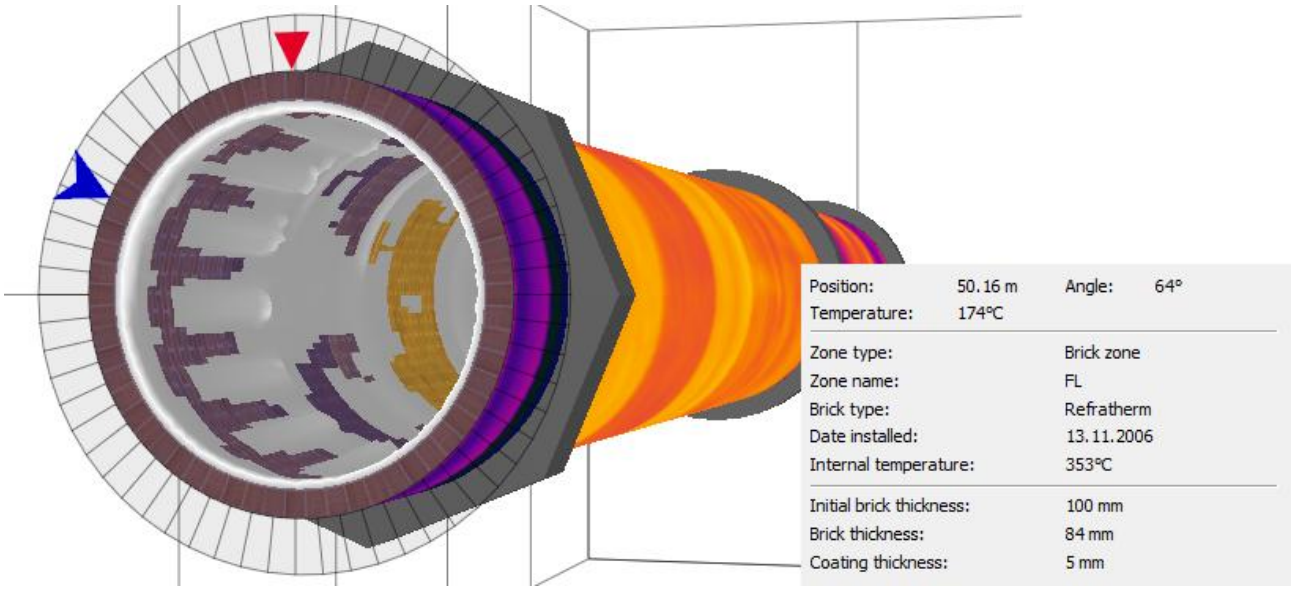


Split by Brick Zones view makes differences between the brick zones more obvious.

Kiln section 3D view



Kiln Section 3D View virtually cuts the kiln at some position. So it shows more the kiln interior (bricks and coating), while the Virtual Kiln 3D view is more suitable for observing kiln's surface.



The small red triangle shows the kiln trigger position (as set in the Configuration). Blue arrow is the angle position marker. Dragging it you can see brick and coating parameters at any point along the kiln circumference.

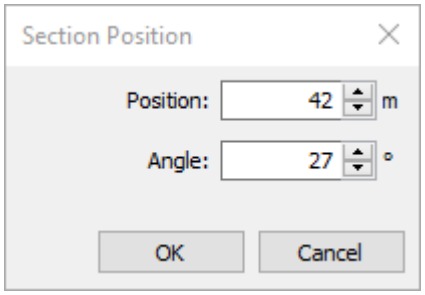
Changing section position

To change section position, click on the kiln with the left mouse button and holding it drag the mouse left or right. Mouse wheel can be also used for this purpose.

You can change the section position by dragging the cursor at the kiln design view or at the 2D infrared image view (if it is displayed).



You can also set the exact section position and value of the angle marker manually. Click **Set Section Position** in the context menu (or press the appropriate button in the local toolbar) and key in needed position and angle value.



Colored bricks

Section 3D has one more display mode: Colored Bricks. In this mode color of bricks is defined by mixing the original texture color with the color of corresponding brick zone taken from the refractory structure.



Click the corresponding button in the local toolbar (or choose menu **3D / Brick Zones with Colors**) to see refractory zones in different colors.

Scene arrangement

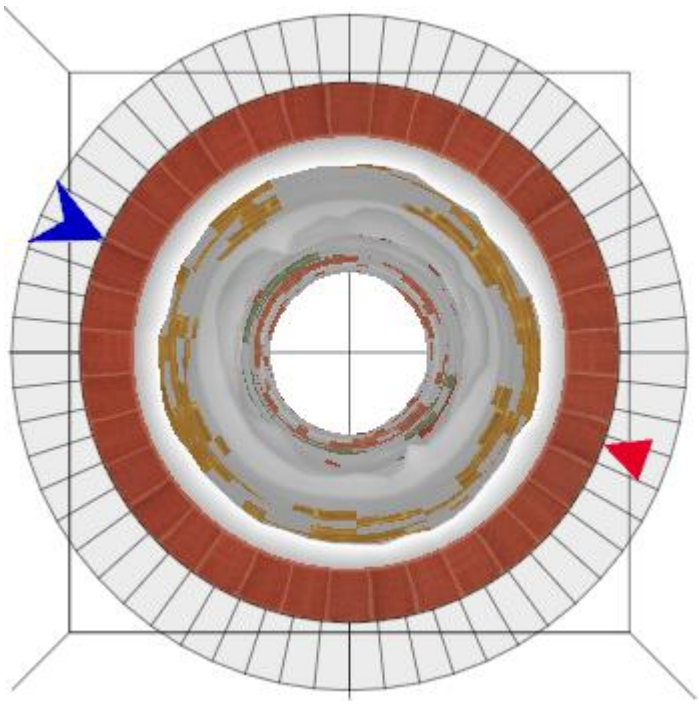
1. **The local toolbar contains a slider that rotates scene from 60° to 120°.**
2. **Section position can be changed by mouse wheel or mouse moving while left button pressed.**

3. **Angle position marker (blue arrow) can be dragged when the mouse pointer is over it (the mouse pointer changes its shape).**
4. **Double-click on the section position marker to open the Section Position dialog.**
5. **Double-click on any area outside the blue arrow to reset the scene to the normal position and orientation.**

Kiln end-view 3D



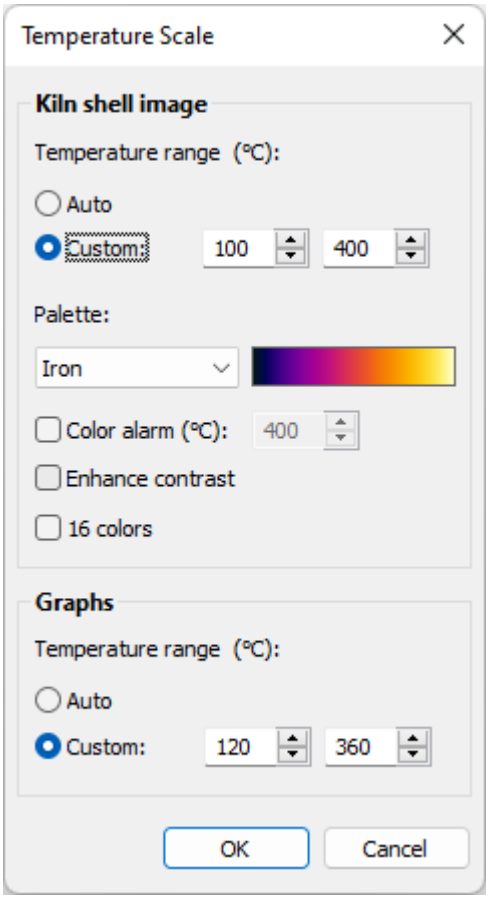
Kiln end-view is a special case of the Kiln Section 3D view when scene angle is fixed at 90°. The rest of the functionality is the same.



3.10 Temperature scale and palette

In infrared images color of every pixel depends on its temperature. IRT KilnMonitor has means to adjust this dependency to make visual appearance of the kiln shell image better and to intensify important details. To set relation between colors and temperature you need to define *temperature range* and select *color palette*.

To configure temperature scale use main menu **Configuration / Temperature Scale**:



Kiln shell image temperature range

Temperature range defines visible temperatures of the image. Pixels with temperatures below the lower range limit are shown with the darkest palette color (color at the bottom of palette); pixels with temperatures above the upper range limit are shown with the brightest palette color (color at the top); pixels with temperatures in between have corresponding intermediate palette colors.

There are two possibilities that you can use to set temperature range:

1. **Auto:** IRT KilnMonitor calculates the best range automatically taking into account the current image histogram.
2. **Custom:** you can set your own range limits. This is useful when you are not interested in all temperatures present on the image but need a sub-range.

Palette

Palette is the set of colors that allows to see temperature differences. IRT KilnMonitor has a wide selection of color palettes that can be used to display infrared images. Sometimes one palette suits better to reveal the problem than the other.

Color alarm: pixels with temperatures above the selected value will be displayed with a contrast color. This contrast color depends on the used palette and cannot be user selected.

Enhance contrast: automatically distributes colors on the palette to improve image contrast.

16 colors: leaves only 16 colors on the palette.

Graphs temperature range

Defines vertical (Y) axis limits for the horizontal profile and for the temperature trend graphs. You can set the values or select the **Auto** option. With auto, IRT KilnMonitor will be adjusting the axis limits depending on the graph data values.

3.11 Reference views

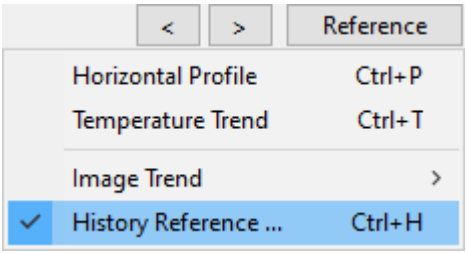
The Monitoring window is divided into two parts.

The upper part of the window is the Kiln view. It represents the actual image of the kiln shell in a 2D or 3D view.

The lower part is the **Reference view**. Reference view can display the following information:

- horizontal profile with the actual kiln shell envelope profile and alarm zones;
- temperature trends for analysis objects;
- image trend by images from the history;
- single history image as a temperature map or as an envelope profile;
- worst case image (since the indicated moment in the history) as a temperature map or as an envelope profile.

Reference view options are accessible through the **Reference** main menu or the **Reference** button menu that is in the right-hand corner of the reference window.



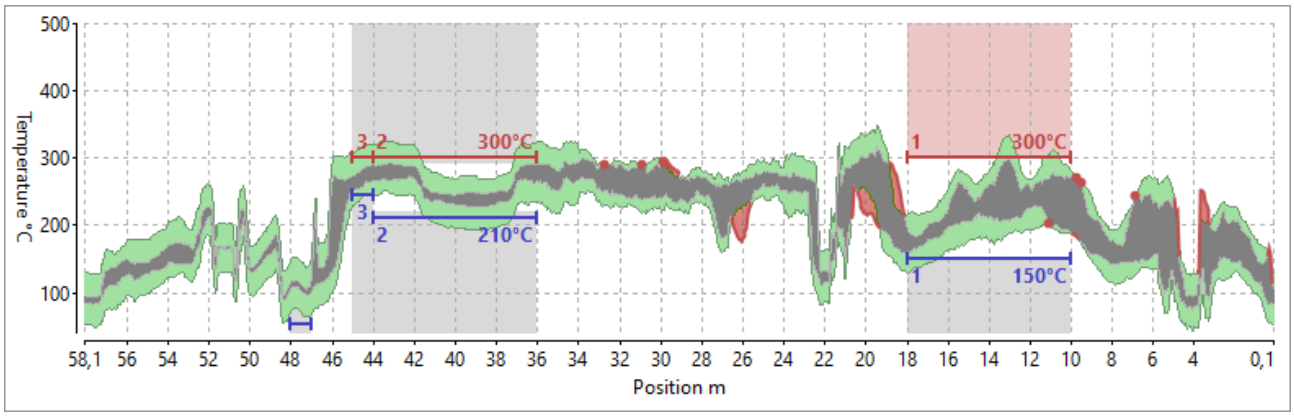
To learn more about the Reference view functionality, see these topics:

- Horizontal profile
- Temperature trend
- Image trend
- History reference

3.12 Horizontal profile

Horizontal profile can be viewed in the lower part of the Monitoring window, it is one of the several possible choices for the Reference view.

The X-axis shows position along the kiln, the Y-axis shows the temperature. You can change the Y-axis limits in the Temperature scale and palette dialog.



Horizontal profile consists of the following graphs:

- **Green** is the reference envelope profile (it is taken from the alarms configuration – see Envelope profile alarms for details).
- **Gray** and **red** is the envelope profile of the actual kiln shell image. When the envelope profile goes out of the reference envelope profile, it is drawn in the red color.
- **Black** moving line is the live profile coming from the scanners.
- Thin **red** and **blue** selvedge lines mark the high and low limits of the reference envelope profile.
- **Red** and **blue** horizontal lines (with numbers) are the alarm zones markers.
- The blinking arrow next to an alarm zone line indicates that the alarm control state is active.



To get quick access to the profile and alarms configuration, use main menu **Configuration / Alarms** or press the corresponding button in the toolbar.

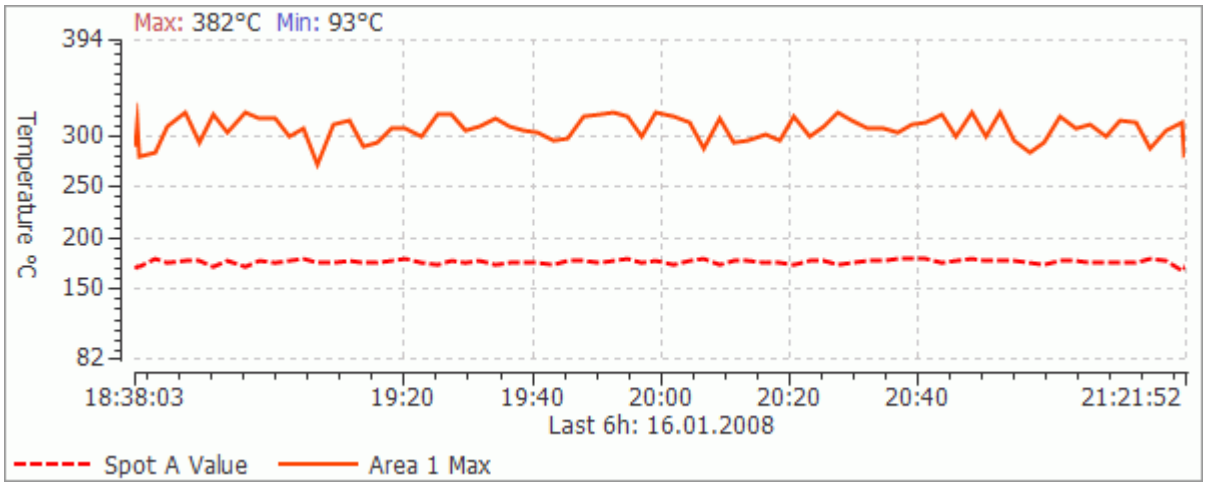
3.13 Temperature trend

IRT KilnMonitor can continuously monitor selected areas of the kiln shell and display trend graphs for them.

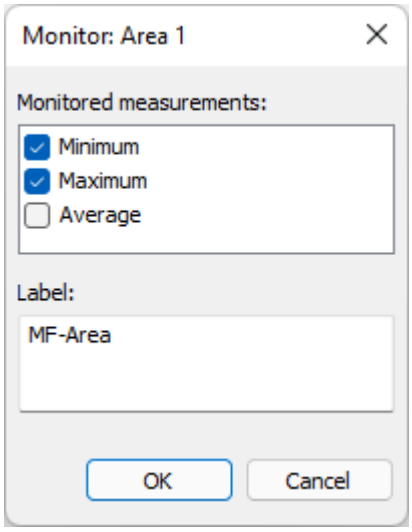
To start trend monitoring, follow the steps:

1. Switch to the Temperature map 2D view.
2. Place analysis objects on the areas which you want to monitor in the trend. All analysis objects can be monitored: spots, lines, areas, slices and intervals. See Analysis objects to learn more about analysis objects).
3. In the main menu select **Trend / Monitor All Objects**.

All analysis objects will be added to the trend and IRT KilnMonitor will start gathering data for these objects. After each kiln rotation new data will be added to the trend. At the same time, IRT KilnMonitor will start to load images from the kiln history and will update trend with historical values.



By default, only the maximum temperature of every object is monitored. But it is also possible to monitor the minimum and the average temperatures. To set this, click with the right mouse button on an analysis object and select **Monitor** command. In the object monitoring dialog, set the properties you want to monitor in addition. Here it is also possible to set **monitoring label**. This label is used in the monitored measurements part of the monitoring report.



Monitor command in the context menu can also be used when you do not want to monitor all the objects and want to select yourself which objects to monitor.

Notes

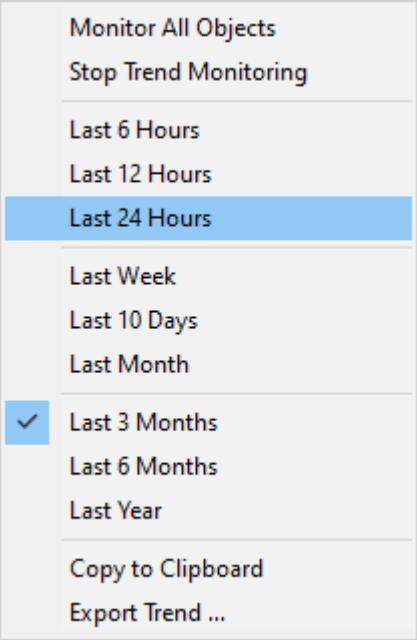
When an analysis object is monitored in the trend, it is not possible to move it or to change its size and parameters.

When an object is monitored, it is also added to the monitoring database and can be displayed in reports.

You can change the Y-axis limits in the Temperature scale and palette dialog.

Trend period

You can select displayed trend period. You may choose periods from *Last 6 hours* to *Last Year*. Select the corresponding command in the main menu **Trend** or in the trend window context menu.



Exporting trend data

Trend data can be exported to a **CSV/TXT/PNG/JPEG** file. To do this, right click on the trend diagram window and select **Export** in the context menu.

Trend in the kiln history view

You can display temperature trend in the history view. Trend period will be the same as the selected history period. It is also convenient to use the cursor on the trend to navigate through kiln history.

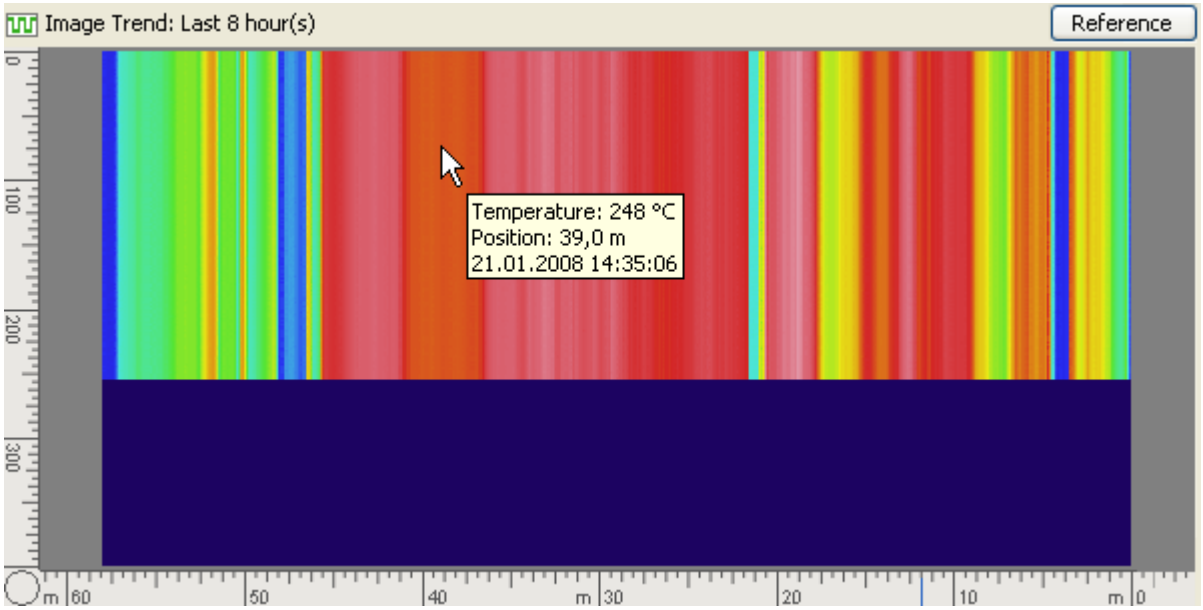
1. Open the History tab and load the history data for some period of time (see Kiln history).
2. Place analysis objects.
3. In the main menu select **Trend / Monitor All Objects**.

IRT KilnMonitor will automatically load all images from the selected history period and will update trend with data from them.

3.14 Image trend

Image trend is a thermal image composed from many kiln shell images taken from the history. Every horizontal line represents one image, it consists of maximum column temperatures along the X-axis. The X-axis corresponds to the kiln X-axis.

To show the Image trend, choose **Reference / Image Trend** and select a history type: *short-*, *middle-* or *long-term*. The operation of processing history data and building the image trend may take some time.



The number of lines in the trend image is equal to the height of the kiln shell image, but it cannot bigger than the number of kiln states that can be possibly saved in the history database (usually 400, can be changed in Linescano.ini).

The most recent data is placed at the top. When new data is added to the history, Image trend is automatically updated – new data occupies the first (upper) line, and the rest descends one line down.

The Trend image caption shows what period of time is displayed (e.g. Last 17 hours, Last 6 months, etc.).

When you move the mouse cursor over the trend image, line and spot information is displayed in the small window.

The context menu allows to zoom in and out the image. You can also do it using the mouse wheel.

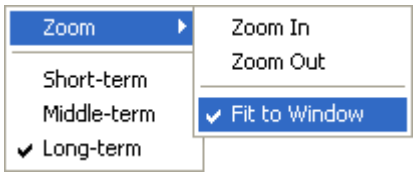


Image trend is also available in History Tabs.

3.15 History reference

History reference is designed to compare the actual kiln state with an earlier kiln condition.

History reference can be:

- a single kiln shell image taken from the history;
- a worst case image since the indicated time in the history and to the current time.

History reference image is displayed using the same temperature scale and palette as the actual image, so the images can be easily compared.

History reference image can be also presented as an envelope profile and compared with the envelope profile of the actual image.

> **Note**
> History reference can use only the long-term history, it is only available if the long-term history is enabled (see History storage).

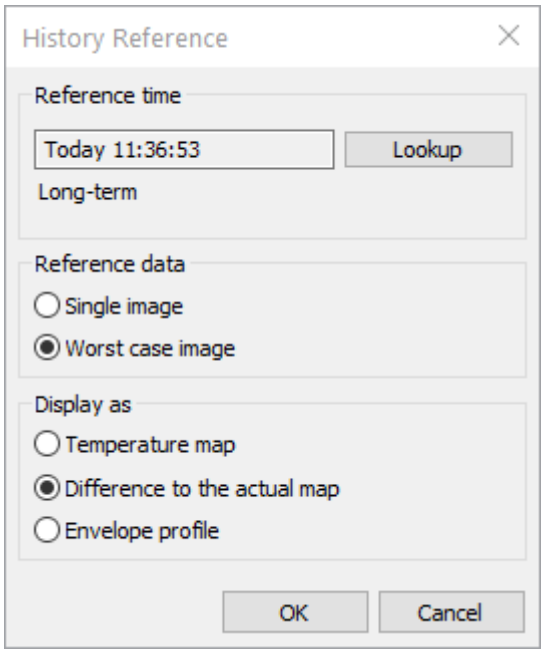
Worst case image

Worst case image is an infrared image which is composed from many infrared images taken from the kiln history. Every point shows the **maximum temperature** measured at this point since the indicated time.

> **Note**
> The worst case image is automatically updated when the new kiln state is saved to the long-term history storage, which is done by the defined schedule. So the worst case image is not always "worse" than the actual image. During periods between saving to the history, the actual image can be "worse".

History reference dialog

To load a History reference image, choose **History Reference** command in the **Reference** menu.



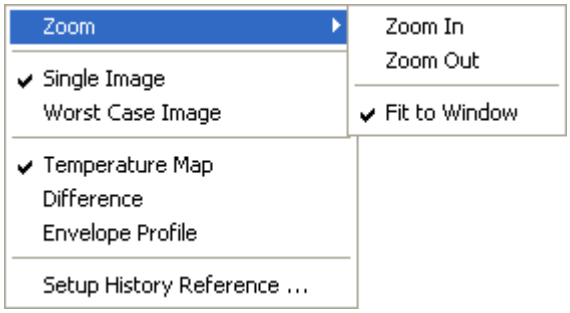
- In the dialog, press the **Lookup** button to display the list of all compatible records in the long-term history. Choose the needed date and time, and press **OK**.
- Choose **Reference data** – *Single image* or *Worst case image*. To build the worst case image all images saved in the history since the indicated time and until the current time will be checked.
- Then choose the way to display historical data – as *Temperature map*, *Envelope profile* or *Difference to the actual map*.
- When **OK** is pressed, corresponding data is shown in the Reference view.

History reference window

History Reference is the window with caption "History Reference - Single Image" or "History Reference - Worst Case".

If the **Envelope profile** option is selected, the reference window displays profile of the chosen history image in blue color and the actual image profile in gray and red colors (the actual profile is red when it goes out of the history profile bounds).

History reference window has the context menu with quick selection of what and how to display.



Zoom is available for the Temperature map only.

Hint

History reference also works in History tabs.

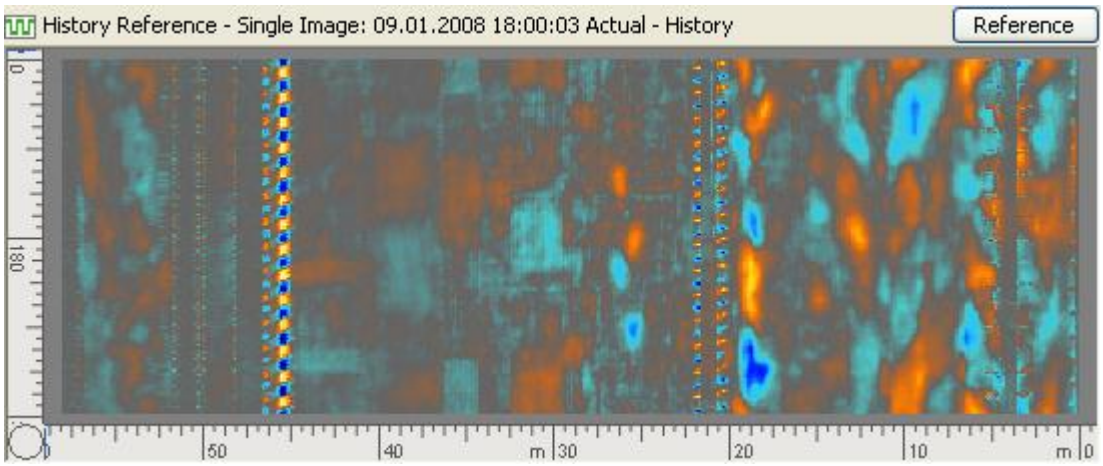
Difference display

History Reference image (single and the worst case) can be displayed as a **difference map**. In this mode the reference image is subtracted from the actual image.

The result is displayed using the special palette:

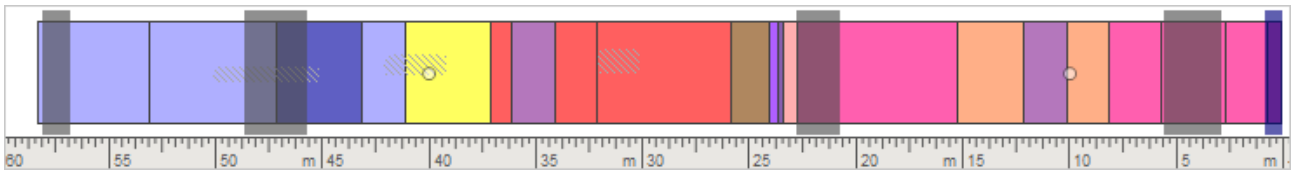
- places where the actual data has higher temperature than the history data are orange;
- places where the actual data is lower than the history data are blue;
- gray color means that the difference is not big.

To display difference map, choose **Difference to the actual map** in the History Reference dialog (Reference / History Reference command) or corresponding item in the Reference view context menu.



3.16 Refractory diagram

The kiln refractory structure is shown in the middle of the measurement screen or at the bottom. The refractory structure is taken from the configuration.



Refractory diagram displays:

1. Brick zones.
2. Special zones.
3. Drillings (drawn using circles).
4. Shell repairs (hatched areas).

Double click on a refractory object to display its properties dialog (position, date of installation, initial brick thickness, etc.).

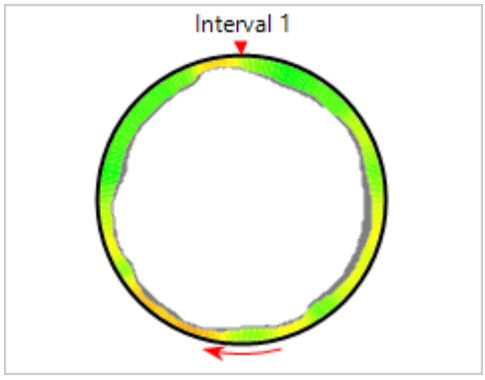
When bricks in one of the refractory zones reach the end of their typical life cycle (defined by 'date installed' and 'brick life' parameters), the **Refractory** alarm is generated and corresponding brick zones are marked with an exclamation mark. Refractory alarm is also activated if estimated brick thickness in one of the brick zones is smaller than the end-of-life thickness defined for this zone.



When Kiln Section 3D or End-view is active, the section position is marked with a vertical marker. Dragging this marker moves the section position.

3.17 Thickness / Coating diagram

Thickness / Coating diagram is placed at the right bottom corner of the screen. It displays the worst case diagram with minimum brick thickness and maximum coating thickness along the selected kiln area. It also shows the kiln trigger position and the rotation direction.



Depending on the active kiln view the data in the diagram refers to:

- the whole kiln,
- selected area or
- slice / section position.

When the Temperature map 2D view is selected, thickness diagram displays brick and coating data for the whole kiln. But if there are interval or slice analysis objects on the image and one of them is selected at the moment, thickness diagram displays data for the selected interval or slice.

Overall kiln data is also presented for the Virtual kiln 3D view. When the Kiln section 3D or the Kiln end-view are active, the diagram refers to the section position.

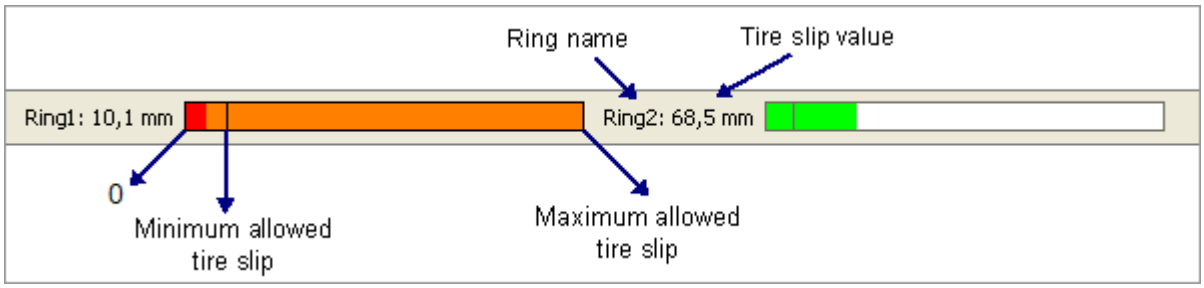
3.18 Tire slip indication

External rings are not fixed to the kiln and have a slightly bigger radius than the kiln. Besides, they are not rotated – kiln rotates the rings. Because of the change of temperature inside the kiln, the kiln diameter may become bigger and smaller (at some places). If kiln becomes bigger than the ring, the ring can damage the kiln. So, the ring should be all the time bigger than the kiln, and therefore its rotation time should always be bigger than the kiln rotation time, that is we should always have some *tire slip*.

When the kiln or a ring makes full rotation, system gets a signal from the kiln trigger sensor or a ring sensor, so that the kiln and the ring rotation time is known and can be compared. We calculate tire slips of all rings and generate alarms if the calculated value is out of the predefined range. Alarm is also generated if we have no signal during the period of maximum kiln rotation time.

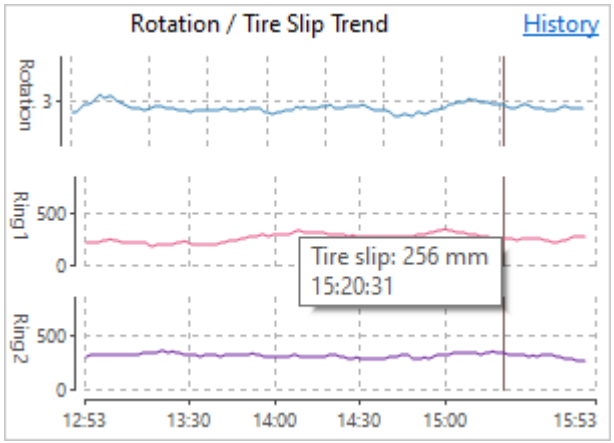
For more information see Tire slip monitoring topic.

Tire slip indicators are placed at the bottom of the measurement window. Each controlled ring has its own indicator. A tire slip indicator is a horizontal graphical stripe that changes its color depending on the ring condition. If tire slip falls into allowed range the bar is drawn in green, and the background is white. If tire slip value is outside the range, the bar becomes red, and the background orange.



Short tire slip trend

IRT KilnMonitor can display not only the current but also the recent rotation and tire slip values, several hours. To show them make sure that **View | Rotation / Tire Slip Trend** menu item is checked. Rotation and tire slip trends are displayed in the side view in the right part of the monitoring window:



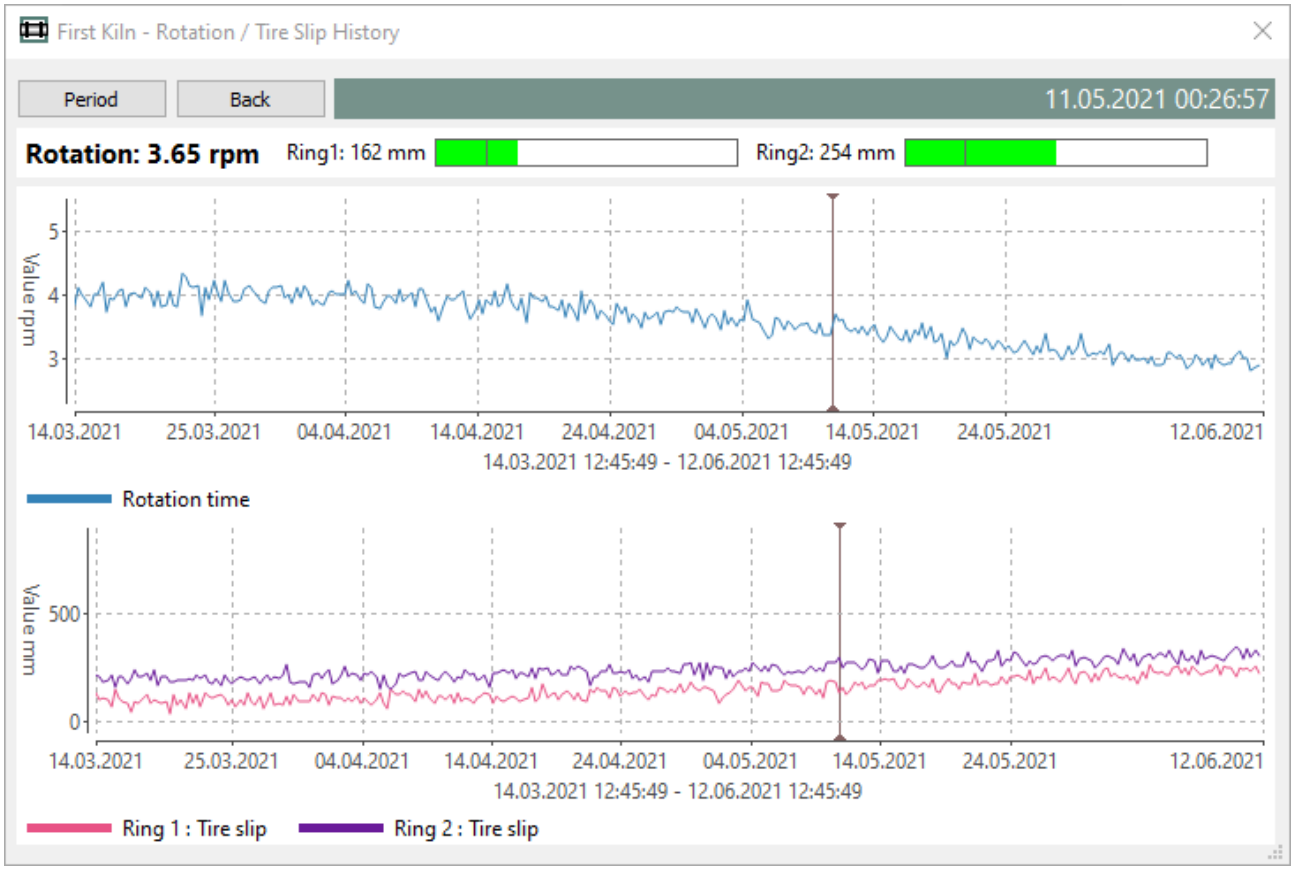
If you click on the History link you will see tire slip trend in a separate window. Also you will be able to select large trend periods and load historical data. See Rotation / Tire slip history topic.

Trend period is 3 hours by default, can be configured in Linescano.ini:

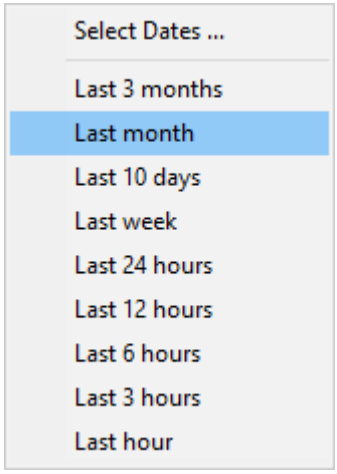
```
[ROTATION]
recent_trend_time_span = last_3_hour
```

3.19 Rotation / Tire slip history

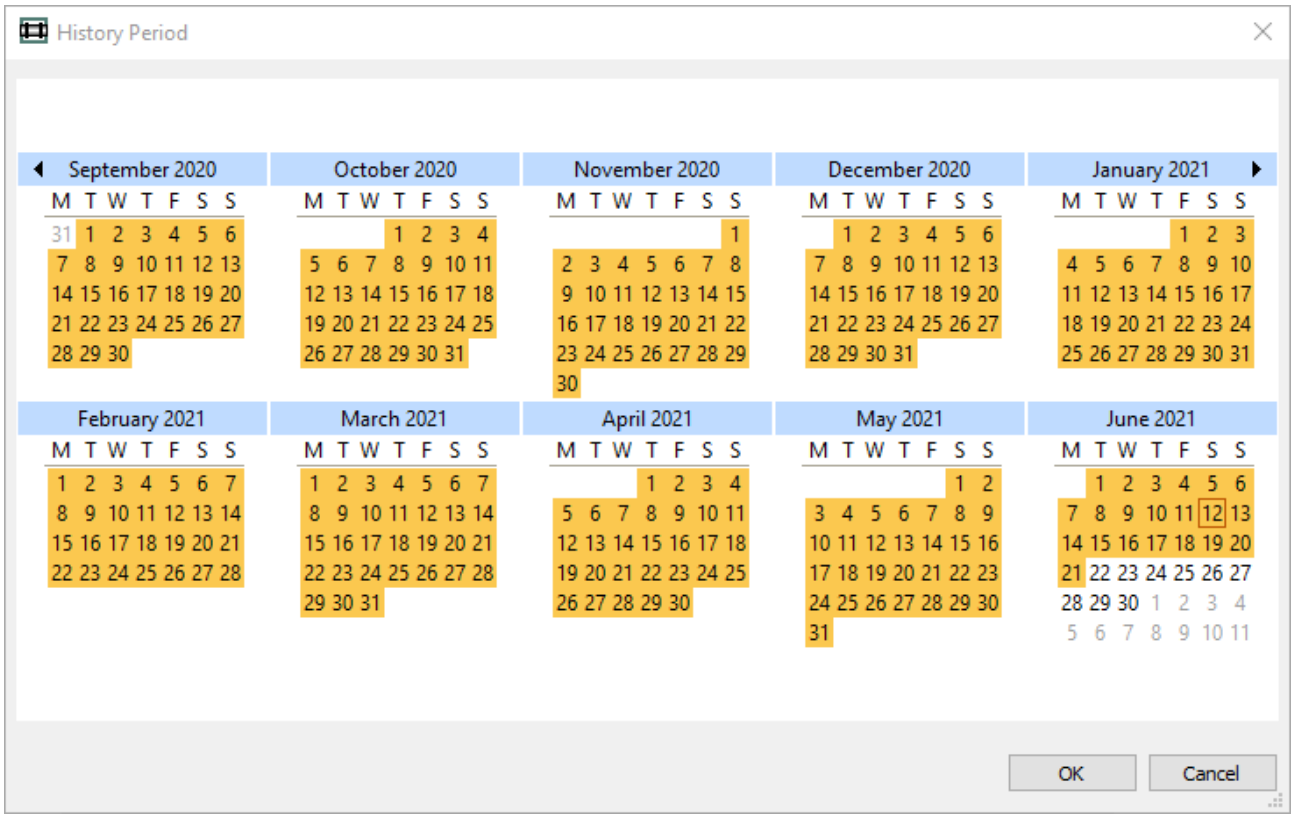
To show Rotation / Tire slip history window use main menu **Monitoring | Rotation / Tire Slip History**.



To select displayed history period press Period button:



You can select one of the predefined "Last something" periods or set the dates you need by using Select Dates menu.



To select dates, click on the begin date and holding the mouse button move the mouse to the end date. Make dialog window bigger to be able to select larger periods.

If you select a large period (more than a year) IRT KilnMonitor might not be able to load all the data. In this case the resulting period will be cut.

History cursor

Click on the diagram to show the cursor.

- Tire slip and rotation data that corresponds to the cursor position is displayed above the diagrams.
- You can move cursor using the mouse. Also with the mouse you can drag the trend to move the displayed period.
- Use the mouse wheel to change the time scale and see smaller or bigger periods.

3.20 Burning zone

To display the small burning zone view make sure that **View | Burning Zone** menu item is checked. Burning zone monitoring device must be configured, otherwise the menu item will not be available.

Information about burning zone is displayed in the side view in the right part of the monitoring window:



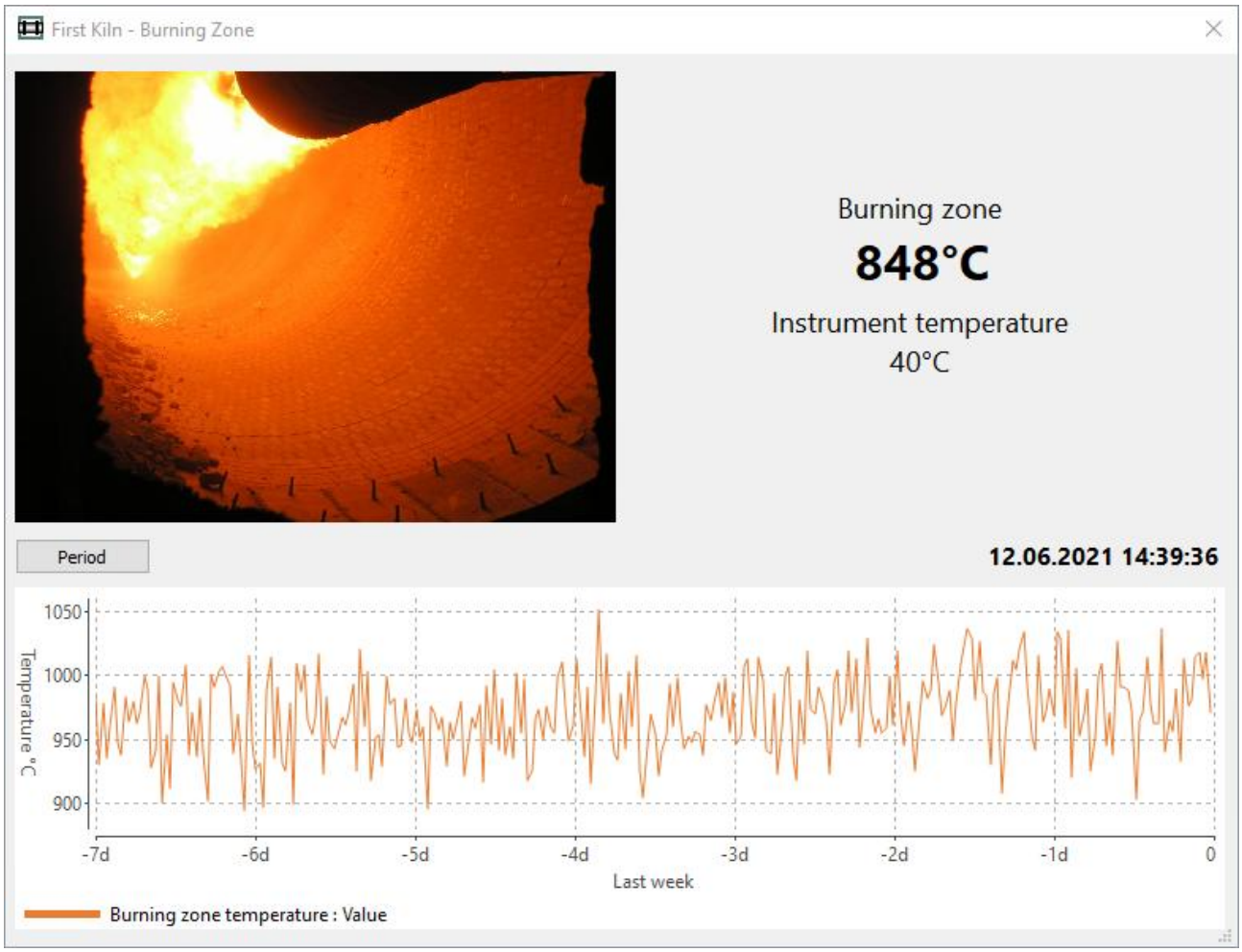
Information includes:

- Measured temperature of the burning zone. If an IR camera is used, the maximum temperature on the image is used as the temperature of the burning zone.
- Instrument internal temperature. If the instrument internal temperature exceeds the limit defined in the configuration, Scanner alarm is generated.
- If the burning zone monitoring device provides video, video is also displayed in the burning zone view, but only if window is big enough and there is enough space for an image.

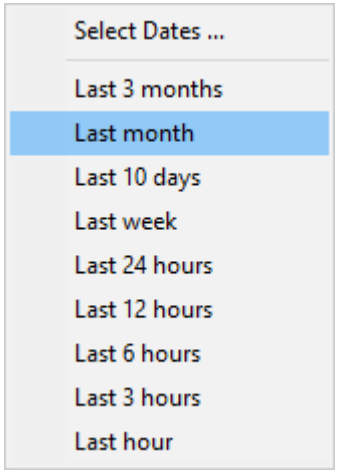
> **Note**
>
> Burning zone video is only available on IRT KilnMonitor server. Clients cannot display video.

Burning zone window

To see burning zone data in a bigger window and to display the burning zone temperature trend, click on the **More** link. Same window is shown if to select **Monitoring / Burning Zone Window** in the main menu.



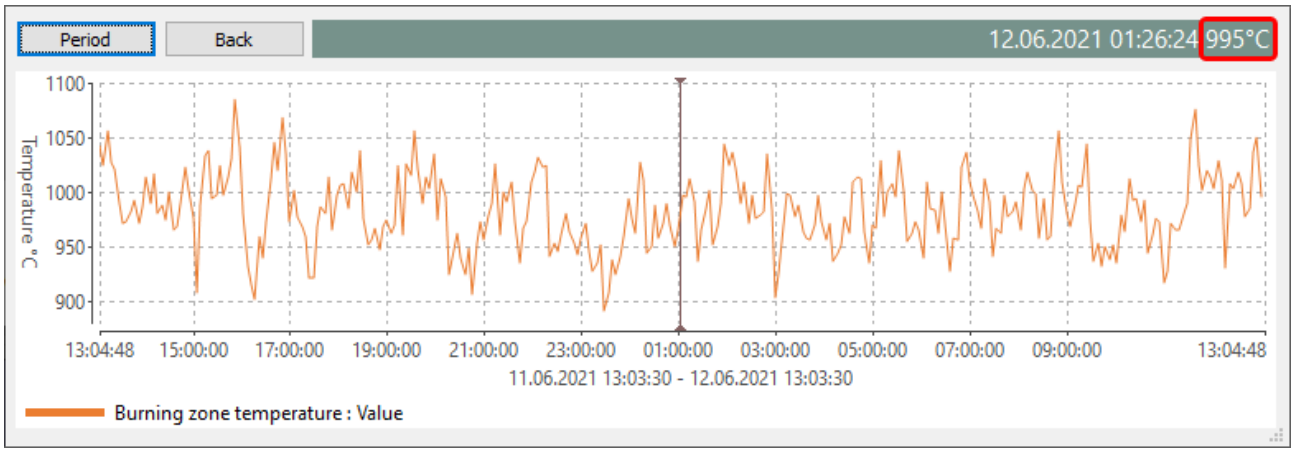
To select displayed history period press Period button:



Select Dates work same as in [the tire slip history](#).

Burning zone history

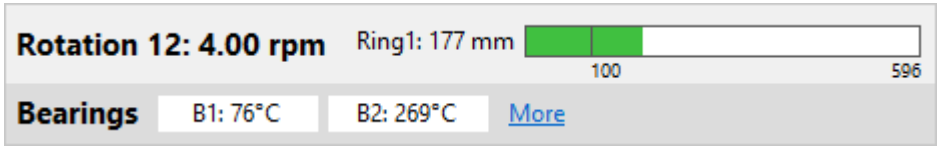
Click on the diagram to show the cursor. Diagram caption will change its color to gray, this means that it shows history data, not the actual data.



- Cursor position time and the corresponding burning zone temperature is show in the diagram caption with the gray background.
- You can move cursor using the mouse. Also with the mouse you can drag the trend to move the displayed period.
- Use the mouse wheel to change the time scale and see smaller or bigger periods.

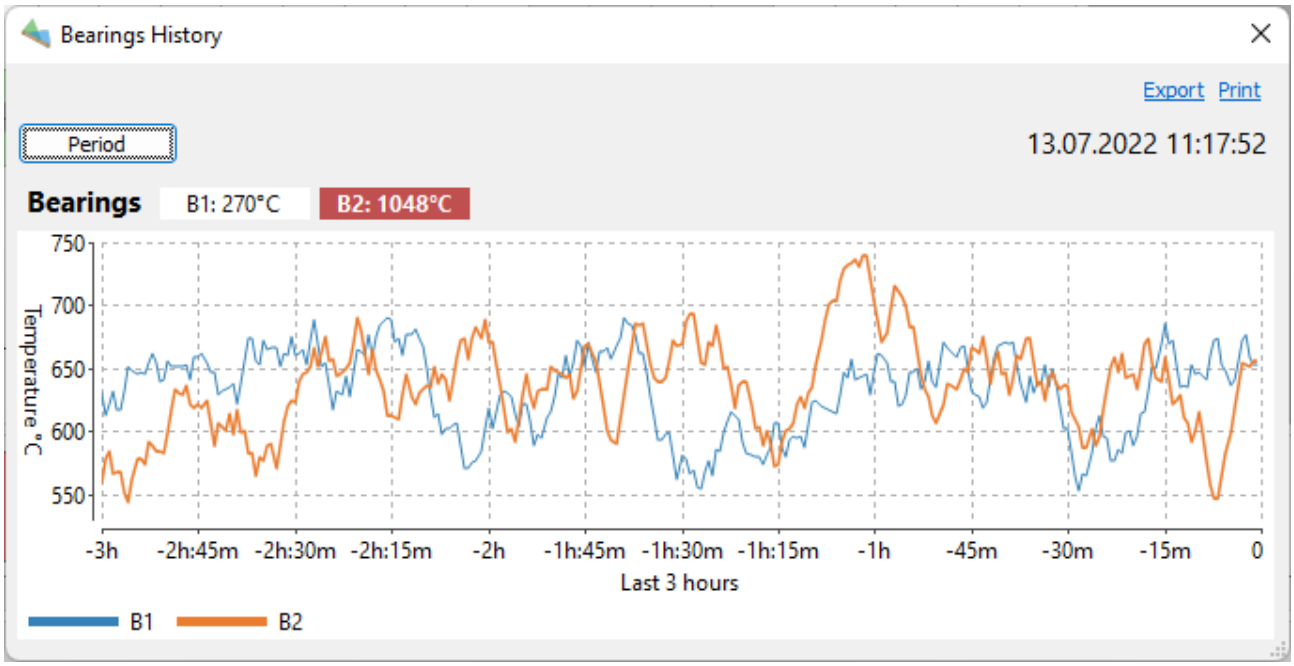
3.21 Bearings / Other

Current measurements of bearings (or other monitored objects) are displayed at the bottom of the monitoring window below the rotation information.

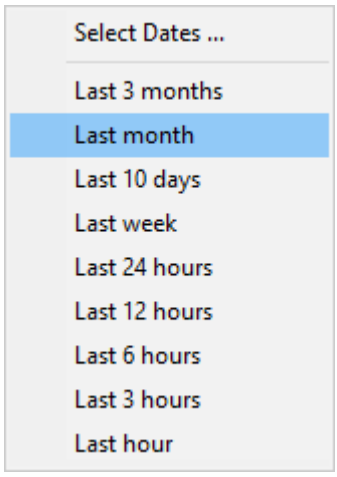


History trend

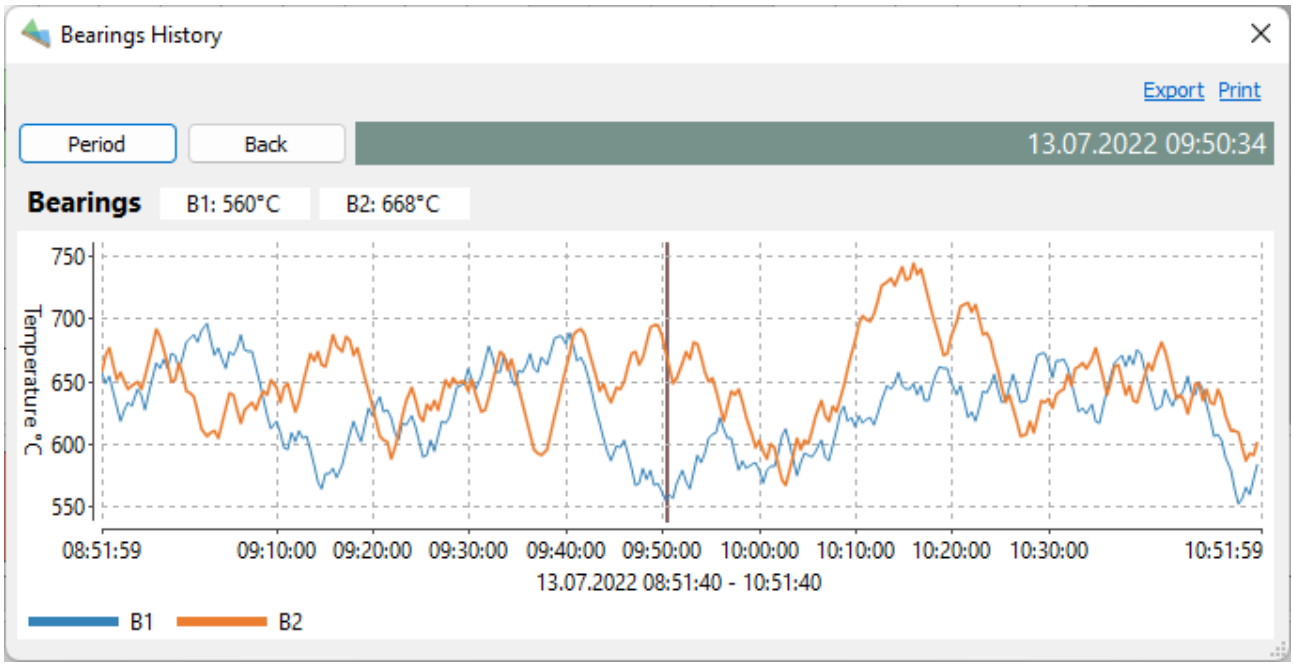
To see the data in a bigger window and to display the temperature trend, click on the **More** link. Same window is shown if to select **Monitoring / Bearings History** in the main menu (the name will be different if another name is set in the configuration).



To select displayed history period press Period button:



Click on the diagram to show the cursor. Diagram caption will change its color to gray-green, this means that it shows history data, not the actual data.

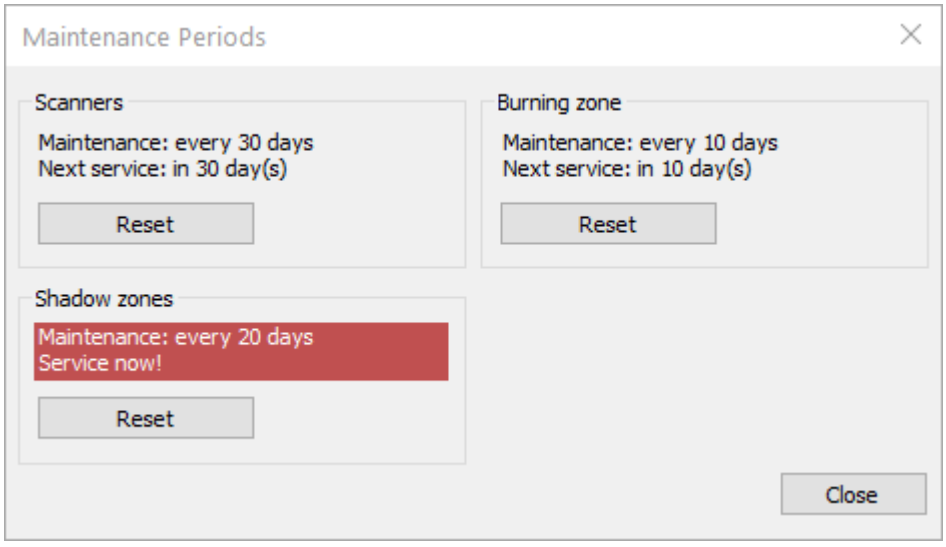


- Cursor position time is show in the diagram caption with the gray background.
- You can move cursor using the mouse. Also with the mouse you can drag the trend to move the displayed period.
- Use the mouse wheel to change the time scale and see smaller or bigger periods.

3.22 Resetting maintenance alarm

Purpose of a maintenance alarm is to remind that it is time to inspect the monitoring instruments - check that everything is fine, clean the lenses and things like that. See Maintenance alarms configuration.

If you see that maintenance alarm is active in the alarms window, double click on the alarm line to open **Maintenance Periods** dialog. There is also **View / Maintenance Periods** item in the main menu



Click on the corresponding **Reset** button if the the necessary maintenance was done and the maintenance period can start from the beginning.

3.23 Monitoring window layouts

Standard Layout

IRT KilnMonitor gives possibility to save the current windows layout as the standard in order to return back to it quickly at any time. The Standard Layout is also used when the application is restarted.



At any time you can switch back to the standard layout with just one click – on the corresponding button in the toolbar.

Saving current layout as the Standard Layout

To save current windows layout as the standard layout:

- adjust the measurement screen as you need it and
- in the main menu click **View / Save Current Layout as Standard**. This command is protected by Level 1 password (see Passwords).

The following parameters are remembered:

- Monitoring windows: number and positions.
- Kiln view mode: Temperature map 2D or one of the 3D modes.
- Kiln view, reference view and side view sizes.
- If it is a 3D mode: kiln view parameters - scene orientation, section position and so on.
- Reference view settings: what is displayed and the way it is displayed. But not the history reference time. The reference time is remembered individually for every opened tab.
- Thickness/ Coating, Refractory, Burning zone view, Rotation / Tire slip trend: visibility and sizes.

The standard layout is the same for all data sources, that is for remotely monitored kilns and for history tabs.

> **Note**
>
> Temperature scale parameters (range and palette) are not saved in the layout. To define default temperature scale parameters, use the Temperature scale configuration dialog.

3.24 Multiple monitoring windows

If you have several monitors attached to your computer it is convenient to have several monitoring windows. Especially it is convenient when you use IRT KilnMonitor to monitor more than one kiln. Several monitoring windows can also be used on a single monitor.



To add a measurement window, use main menu **Monitoring / New Window** or corresponding button in the toolbar.

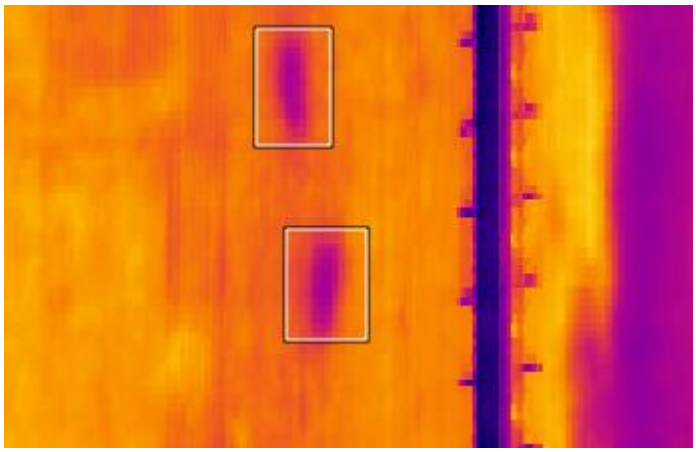
Each measurement screen can show its own data and can be arranged independently. For example you can:

- Display different kilns in different monitoring windows.
- Display monitored kiln data in one window and kiln history in another.
- Display 2D temperature map in one window and 3D virtual kiln in the other.
- Other similar uses.

You can remember number of opened monitoring windows by saving current layout as standard. After that, when application is restarted, all saved monitoring windows are reopened automatically.

3.25 Alarms suppression

If there are spots (hot or cold) on the kiln shell that should not participate in the alarm detection algorithm, they can be marked with **Suppress Alarm Tool** ( ):



Using this instrument, you can mark rectangular areas of the kiln shell that will not be scanned when envelope profile or zone alarms are checked.

In order to properly maintain alarm suppression history, it is not allowed to move a suppression area later than 1 hour after it was created. You can delete the old area and create a new one.

Alarm suppression summary log

IRT KilnMonitor maintains a text log file with summary of all alarm suppression areas.

Every record in this file has the following data:

1. Date and time when alarm suppression object was created (UTC).
2. Left and right coordinates of the area (in meters) – L, R.
3. Top and bottom coordinates of the area (in degrees) – T, B.

Example: 2019-03-18 11:34:12 L: 25.0051 R: 11.7415 T: 48.8571 B: 164.571

Rules used to create the log file:

- When you create a new area, it is automatically added to the log file.
- If to move an area, its position is updated in the log file.
- When you delete an area, it is not deleted from the log file and can be used for reference when the kiln is stopped for repair.
- When all areas are deleted (for example by using menu Analysis | Delete All Objects), a new log file is started.

Folder with the log files can be open using main menu **View / Log Files**. The file is named **alarm_suppression.log**.

3.26 Brick and coating thickness calculation method

We present a basic concept of how brick and coating thickness estimation works. The actual algorithm is more complex and requires a calibration process to estimate unmeasured kiln parameters, such as heat loss due to convection.

Calculations are based on two equations, one for heat radiation, the other for heat conduction:

Heat radiation:

$$P = \varepsilon\sigma A(T_{hot}^4 - T_{cold}^4)$$

P is radiated power;

A is radiating area;

ε is emissivity;

σ is Stefan's constant = $5.6703*10^{-8}$ watt/(m^2K^4);

T_{hot} is temperature of the radiator;

T_{cold} is temperature of the surroundings.

Heat conduction:

$$\frac{Q}{t} = \frac{kA(T_{hot} - T_{cold})}{d}$$

Q is heat transferred in time t;

k is thermal conductivity;

A is area;

T is temperature;

d is thickness.

Formula to calculate temperature inside the kiln (used during calibration), assuming there is no coating and brick thickness is known:

$$T_{in} = \frac{\varepsilon\sigma(T_{out}^4 - T_A^4)d_B}{k_B} + T_{out} \quad (1)$$

T_{in} is temperature inside the kiln at light-up;

T_{out} is kiln shell temperature;

T_A is ambient temperature;

d_B is initial brick thickness;

k_B is thermal conductivity of brick.

Brick and coating thickness formulas

Assumptions:

- The calibration procedure has been performed, so the internal temperature is known.
- The kiln's internal temperature remains relatively consistent throughout the entire production run, or the operator consistently updates temperature values in the system.
- The internal temperature is relatively stable within each refractory zone.
- The growth in kiln shell temperature is a result of brick wear, while a reduction in temperature is attributable to the build-up of coating.

Formula for brick thickness calculation (with no coating):

$$d_B^{'} = \frac{k_B(T_{in} - T_{out})}{\varepsilon\sigma(T_{out}^4 - T_A^4)} \quad (2)$$

Coating thickness calculation, when brick thickness is known:

$$d_C = (\frac{T_{in} - T_{out}}{\varepsilon\sigma(T_{out}^4 - T_A^4)} - \frac{d_B^{'}}{k_B})k_C \quad (3)$$

Algorithm for brick and coating thickness calculation

Formula (2) is employed to determine the actual brick thickness at each point on the scanned kiln shell. If the newly calculated brick thickness is smaller than the previously determined value, the system concludes that there is no coating and the brick is wearing out. Conversely, if the calculated brick thickness surpasses the thickness known from prior revolutions, the system infers that coating is accumulating. Once the brick thickness is established, formula (3) is be used to compute the coating thickness.

To mitigate random errors, the brick thickness map is not updated immediately. Instead, a weighted average between recently calculated values and previously stored values is utilized:

$d = (1 - k)d + kd_{last}$

d is the updated value in the brick thickness map;

d_{last} is the newly calculated brick thickness value;

k is the averaging weight, value is taken from Linescano.ini:

```
[THICKNESS]
accumulation_coefficient = 0.1
```

> **Important**
>
> For the brick estimation method to work properly it is important to run calibration at the beginning of each production campaign.

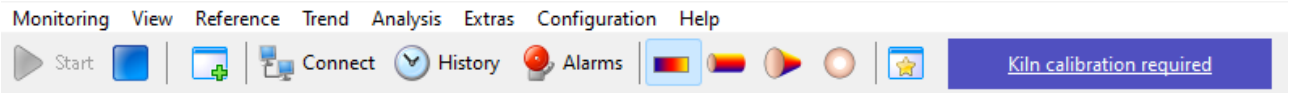
3.27 Thickness measurement calibration

Protected by Level 1 password.

The system cannot directly measure the thickness of the bricks. Instead, it estimates the thickness by observing the temperature on the kiln shell. Therefore, our algorithm needs calibration at the start of each production campaign when the kiln is just reworked and the actual brick thickness within each refractory zone is known, either through measurement or estimation during a physical kiln inspection. The system will utilize the brick thickness data input during calibration, in conjunction with the kiln's state, as a reference point to predict changes in brick and coating in subsequent operation.

Before proceeding with the calibration, ensure that the internal kiln temperatures are correctly set. If temperatures remain constant throughout the whole production campaign, this step is not necessary. However, if temperature changes are expected, you should keep these values updated - both before and after the calibration, updating them as soon as any changes occur.

IRT KilnMonitor will notify the operator that calibration is required by showing a message in the toolbar.



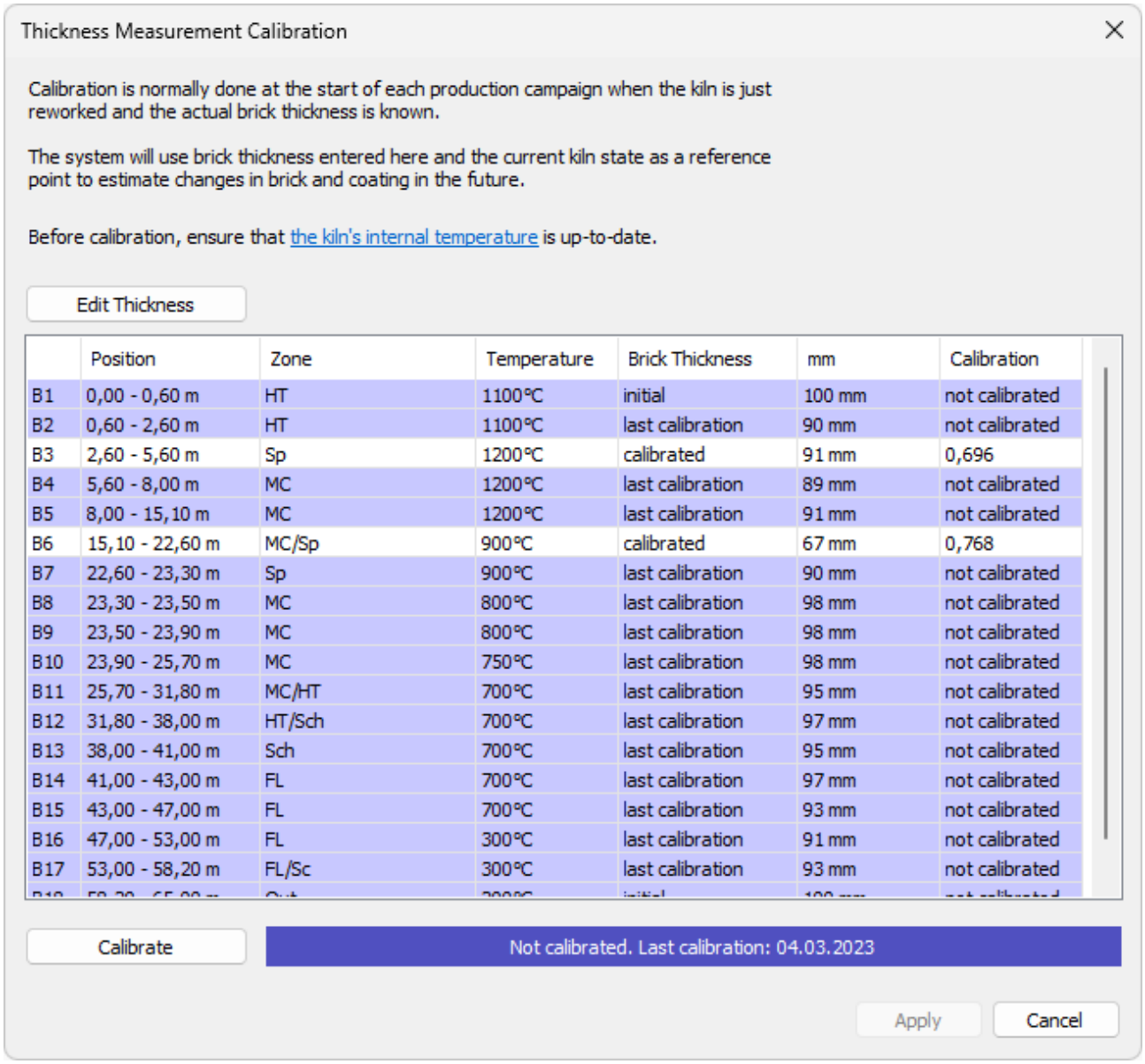
For precise calibration, it's essential to conduct the procedure under appropriate conditions:

1. The kiln has been recently serviced, and you have knowledge of the actual brick thickness in each brick zone.
2. There is no coating present within the kiln.
3. The kiln has been fully heated and is operating under standard production load.
4. The weather conditions are normal: no occurrences of heavy rain, snow, or strong winds.

IRT KilnMonitor isn't capable of verifying these conditions, thus the responsibility falls on the operator.

Calibration procedure

To begin thickness measurement calibration, click on the "Kiln calibration required" message. Alternatively, you can perform the calibration at any time, even in the absence of this message, by selecting **Thickness Measurement Calibration** from the **Configuration** menu.



Start by clicking the **Edit Thickness** button to enable the editing mode. Then, proceed through all brick zones, inputting the actual brick thickness for each zone. If a zone isn't new and the thickness varies within it, input the average thickness. If you're unsure of the actual thickness in a zone, you can choose one of the recent thickness values provided by the system, selecting the one you believe most accurately reflects reality.

The recent thickness values options include:

- Initial: The new brick thickness from the refractory configuration.
- Last calibration: The thickness set during the previous calibration of this zone.
- Estimated: The thickness predicted by the system at this kiln position during the previous campaign.
- Drilling: The result from drilling in this area.

IRT KilnMonitor does not reset the calibration for brick zones where parameters have remained unchanged, assuming no alterations occurred during refractory rework. These zones are displayed in the list as "calibrated". If you need to recalibrate them, simply input the actual thickness (or select "changed" from the thickness dropdown menu). If you leave the thickness unchanged and the zone is marked as calibrated, IRT KilnMonitor will not recalibrate it.

To compute calibration parameters, click the **Calibrate** button. All zones marked as not calibrated will be recalibrated using the brick thickness indicated in the list. Note that at this stage, the new calibration has not yet been saved in the system. To save and implement the new calibration, click the **Apply** button.

3.28 Temperature inside the kiln

Protected by Level 1 password.

The internal kiln temperature is an important parameter used in the brick thickness estimation formula. While this temperature is estimated during the thickness measurement calibration and doesn't need manual setting, there are scenarios where it's beneficial to input it into the system:

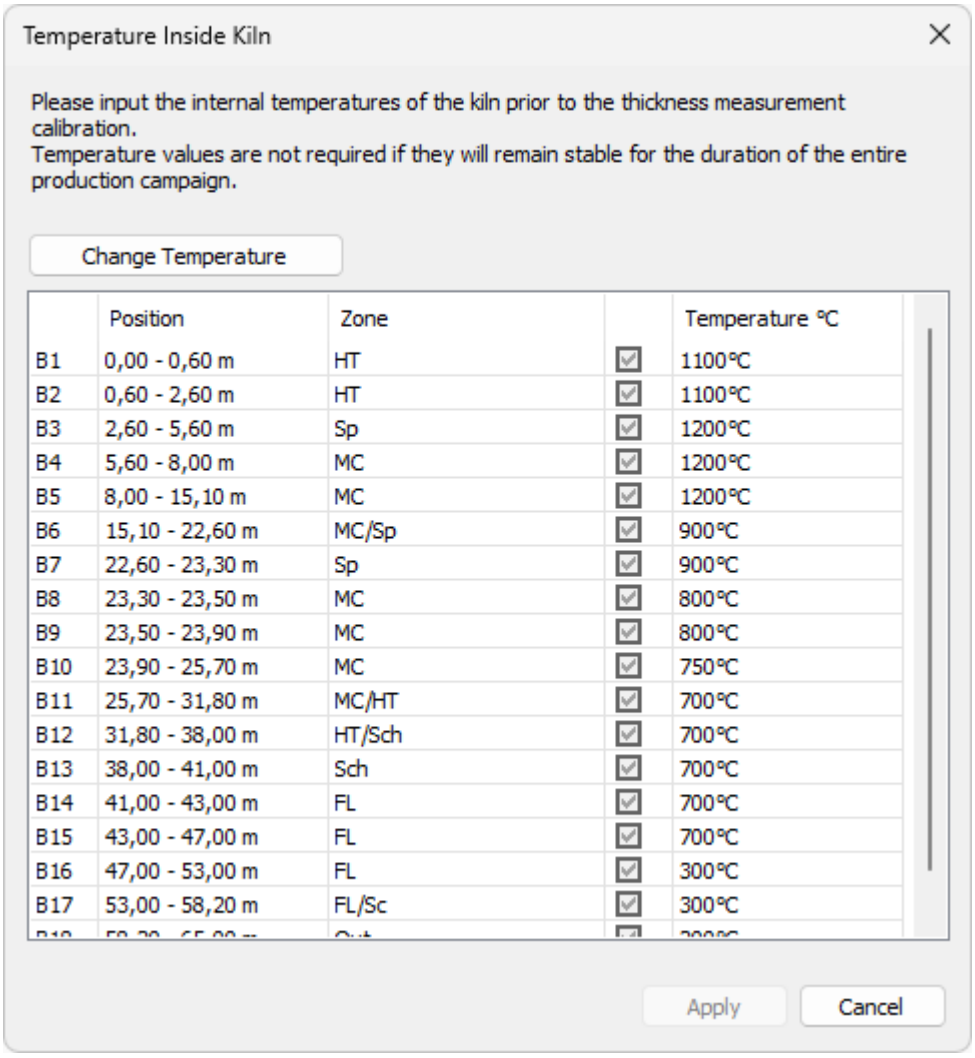
- For informational purposes: The temperature can be displayed alongside other parameters in the information about a brick zone.
- If the internal temperature isn't constant and varies during the production campaign. Setting the temperature prior to the thickness measurement calibration and updating it when changes occur will enable the system to incorporate corresponding adjustments into the thickness estimation algorithm.

Each brick refractory zone has its own internal temperature setting. Set internal temperatures before thickness measurement calibration.

Internal kiln temperatures can be changed in the Temperature Inside Kiln dialog and also in the brick zone configuration, theses are the same settings.

Temperature Inside Kiln dialog

Choose **Configuration / Temperature Inside Kiln** in the main menu. The dialog displays the internal temperature value for each brick zone.



To begin changing the temperatures, click the **Change Temperature** button.

- To input a temperature, tick the checkbox adjacent to it and enter the value.
- If the temperature value is unknown and needs to be estimated, untick the checkbox.

Remember, any changes are only saved in the system once you've clicked the **Apply** button.

3.29 Resetting brick thickness map

To estimate brick thickness IRT KilnMonitor also uses brick thickness values calculated at previous rotations. These values are automatically loaded from the history storage. Sometimes the historical values are wrong (for example because of a system breakdown). In such cases it is possible to tell the system to start brick thickness estimation procedure from the actual moment and not to use the older history data.

Use main menu **Configuration / Reset Thickness Map**.

This function should be used only if you suspect something went wrong with brick thickness calculation. IRT KilnMonitor automatically handles all "normal" situations when thickness map has to be restarted, e.g. after changes in kiln configuration or in the refractory.

3.30 Kiln history

History is available for kilns monitored locally on this PC and for kilns monitored remotely through the network (history storage on the server must be enabled and configured for remote access).

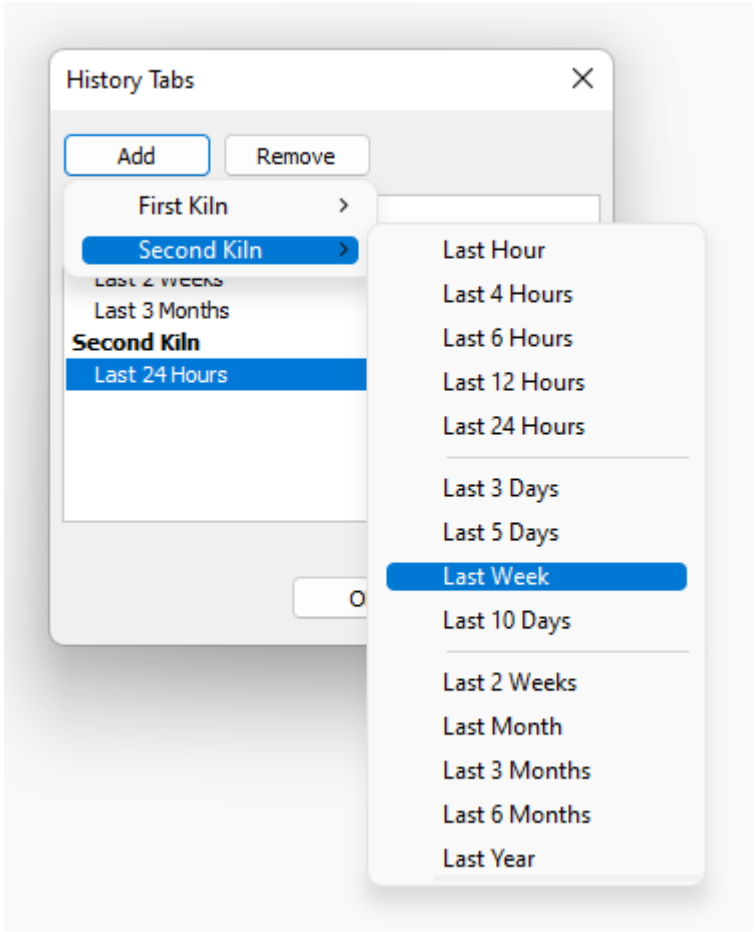
History storage settings can be viewed and changed in the configuration - see History storage.

History tab

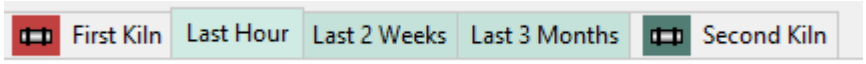
Kiln history is displayed in a similar way as the actual kiln data is displayed - in the monitoring window.



To open history, in a monitoring window select **Monitoring / Kilns History** in the main menu or press the corresponding button in the toolbar. Then, in the **History Tabs** dialog, press **Add** button and in the menu select a kiln (local or remote) and a history period. You can add several history periods for each kiln. New tabs will be added to the monitoring window.



History tabs are shown near the main kiln tab.



Using the same History Tabs dialog you can remove history tabs. Another way to close a history tab is to click with the right mouse button on the tab and select **Close** in the menu.

Selecting history period

To choose what period of recorded history to load click **History / History Period** in the main menu and then click the period that you want to load:

- *Last Hour* (short-term history);

- *Last 4, 6, 12 or 24 Hours* (short-term history);
- *Last 3, 5, 7 or 10 Days* (middle-term history);
- *Last 2 Weeks, 1, 3 or 6 Months* (long-term history);
- *Last Year* (long-term history).

Last "something" starts from the last saved record in the history, not from the current time. If kiln monitoring is running the current time corresponds to the last saved record time.

Some of the mentioned commands may be disabled if the corresponding history type is not available.

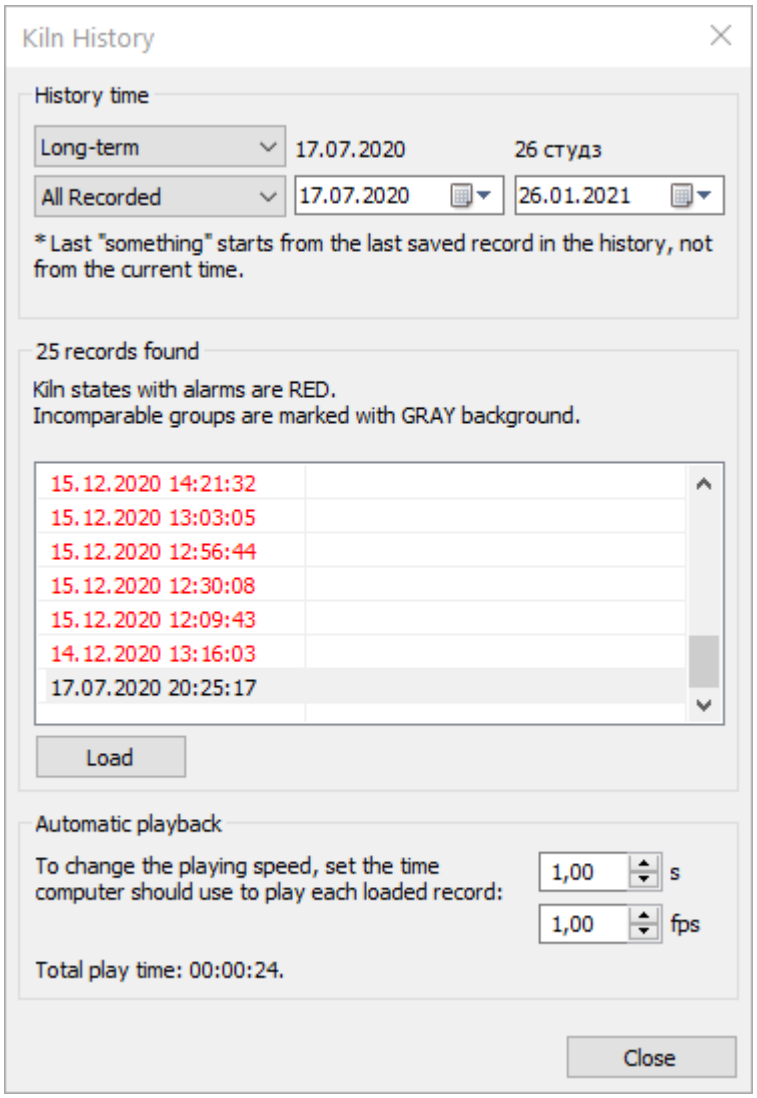
Kiln history dialog

History period

In addition to the quick period selection in the menu you have more control for the period selection in the **Kiln History** dialog. In this dialog you can also adjust the speed for a VCR kind of history playback.



To show the Kiln History dialog, choose **History / Setup History** in the menu or press the appropriate button in the toolbar.



In the first combo box, choose the history type you are interested in (*short-*, *middle-* or *long-term*).

In the second combo box, choose the period of interest or indicate a custom period in two time pickers on the right (available only for the long-term history).

In the "found records" field the program displays how many records were found by your request and gives the list of the found records. The first column in the list shows state date and time, the second column - state labels.

Load button loads the selected kiln state to the monitoring window. You can also double click on a state in the list to load it.

Kiln states with alarms are marked with the red color. Incompatible kiln state groups are marked with gray background color. Kiln states from different groups (incompatible states) cannot be compared because different configuration settings were used to record the data.

Playback speed

The playback speed can be adjusted in two ways:

- Time in seconds to display one record.
- How many frames to display per one second (fps).

When you change one parameter, the other is recalculated automatically. The program then displays the time needed to play all loaded records.

Playing history states

When you open a history tab, the history toolbar is displayed.



It is possible to play all loaded records (kiln states) forward or backward. The playback time depends on the number of records and time set to play each record in the Kiln History dialog.

To pause the playback, use the Pause button in the middle. This button is enabled only during playback.

The slider displays the current position among all records. To the right of the slider the currently displayed kiln state date and time is shown.

Using the **Delete** button you can erase a record from the history. In this case it will be physically deleted from the history database. This action is protected by Level 1 password (see Passwords) and cannot be executed for kilns accessed remotely through the network.

Automatic history playback is only available in 2D views. During automatic history playback it is not possible to activate any of the 3D views. However, even in 3D, you can switch between frames manually.

The **History** menu duplicates the toolbar and contains several additional commands:

- First State – moves to the first loaded record (to the beginning);
- Last State – moves to the last loaded record (to the end).

Other features that are available when history data source is active are similar to those in the normal monitoring mode. You can perform thermal analysis of the 2D image, make kiln sections, measure brick and coating thickness, build trends and so on. Your actions in a History tab will not influence other tabs. For example, if you add or delete analysis objects in a history tab, analysis objects in other kiln tabs will stay unchanged

Kiln state labels

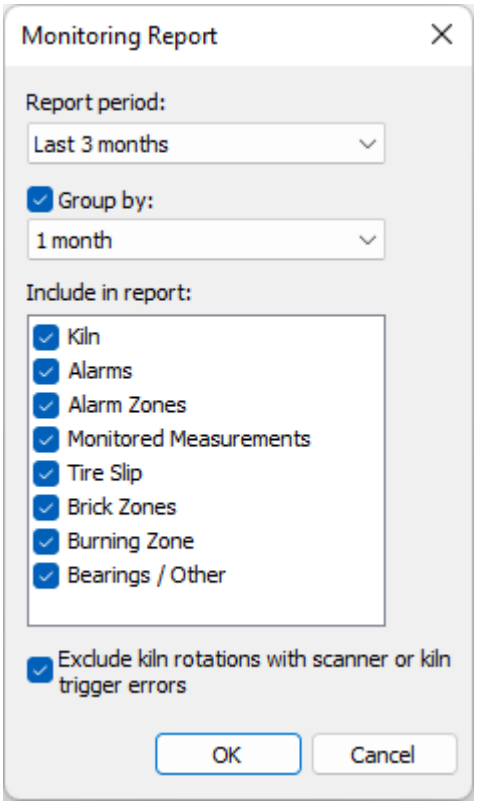
There is a possibility to save the actual kiln state to the history storage out of the defined schedule. This is usually done to remember a kiln state which shows something unusual. When such a kiln state is saved, operator can specify a text label describing the case. These labels are shown in Kiln History dialog in the frames list, the second column.

Use main menu **Extras / Label Kiln State** to label kiln states, and **Extras / Save Kiln State to History** to save current kiln state to the history outside the history recording schedule. These commands are available for online tabs.

3.31 Monitoring report

The monitoring report summarizes the monitoring data – all measurements are combined by zones and time periods. Data for the report is taken from the monitoring database.

To generate a monitoring report use main menu **Extras | Monitoring Report** in the Monitoring screen.



Report period: from "All recorded" to "Last 24h"; you can also select a custom report period;

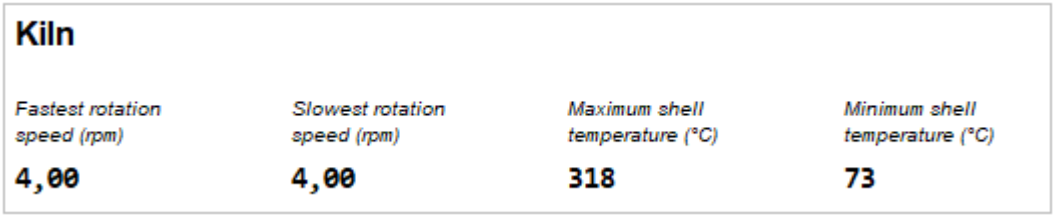
Group by: if selected, the report period is divided into groups and the report is generated for each group separately;

Include in report: report parts that must be included in the report;

Exclude kiln rotations with scanner or kiln trigger errors: does not use database records that could be inaccurate because of some hardware issues.

Kiln

Shows kiln rotation time difference and the maximum and the minimum kiln shell temperature registered during the selected report period.



Alarms

Shows all configured alarms and time each particular alarm was active during the selected report period.

Alarms

Kiln Trigger	-
I/O	-
Scanners	-
Envelope-H	53 hours 8 minutes
Envelope-L	53 hours 8 minutes
Zone 1	58 hours
Zone 2	-
Burning Zone	3 hours 9 minutes
Maintenance	58 hours
Refractory	58 hours
Ring1	-
Ring2	4 hours 59 minutes
Ring3	-

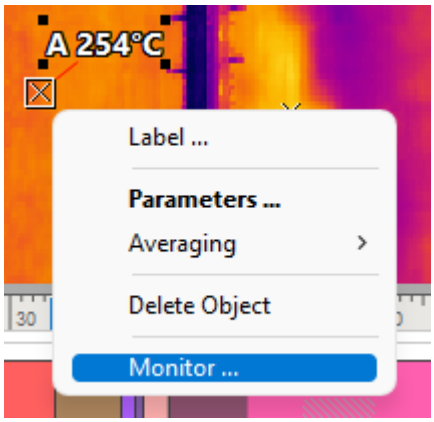
Alarm zones

Shows the maximum, the minimum and the average kiln shell temperature registered for each alarm zone and alarm limits active during the selected report period.

	Position (m)	*Maximum temp. (°C)*	*Minimum temp. (°C)*	*Average temp. (°C)*	*Alarm limits (°C)*	*Zone decription*
1	13,05-21,05	301	159	219	300>T>150	ZZZ-1
2	39,05-47,05	294	227	259	300>T>220	ZZZ-2
	3,05-61,03	273	73	190	E>40..321	Envelope-L
	3,05-61,03	318	93	232	E<59..353	Envelope-H

Monitored measurements

This part includes data from analysis objects (spots, lines, areas, …). Analysis objects are not monitored automatically. To monitor an analysis object – right click on an object and select **Monitor**. The object will be monitored in the Temperature Trend and saved to the monitoring database and so will appear in reports. Kiln shell maximum and minimum is always monitored and always appear in the report.



Measurement	Maximum temp. (°C)	Minimum temp. (°C)	Average temp. (°C)	Label
Kiln Shell	318	73	211	---
Slice 1	226	129	183	---
Line 1	314	119	233	---
Spot A	261	254	260	---
Spot B!	318	317	318	---
Spot C	243	242	243	Hello world
Spot D	289	285	285	---

Tire slip

Shows tire slip values measured for each ring during the selected report period.

	Ring	Minimum tire slip (mm)	Maximum tire slip (mm)	Allowed range (mm)
1	Ring1	133	179	100 - 600
2	Ring2	0	91	100 - 500
3	Ring3	172	183	0 - 0

Brick zones

Shows kilns shell temperatures measured in every brick zone during the selected report period. Also shows:

Brick days left: remaining brick days at the end of the report period;

Thinnest brick: the smallest brick thickness within the brick zone at the end of the report period;

Thickest coating: the biggest coating thickness withing the brick zone at the end of the report period.

	Position (m)	Zone name	Brick type	Brick days left	Maximum temp. (°C)	Minimum temp. (°C)	Average temp. (°C)	Thinnest brick (mm)	Thickest coating (mm)
1	3,05-3,65	HT	Almag 85	164	440	352	392		
2	3,65-5,65	HT	Almag 85	529	496	386	432	30	53
3	5,65-8,65	Sp	Almag 85	0	524	346	420	44	69
4	8,65-11,05	MC	Almag 85	529	522	402	448	26	66
5	11,05-18,15	MC	Magnesita - Magkor S2	164	574	416	496	37	87
6	18,15-25,65	MC/Sp	Almag 85	529	591	383	486	30	64
7	25,65-26,35	Sp	Rexal Extra	529	548	455	534	84	10

Burning zone

Shows the maximum and the minimum burning zone temperature and the internal instrument temperature range measured during the selected report period.

Maximum temp. (°C)	Minimum temp. (°C)	Average temp. (°C)	Alarm limits (°C)	Instrument temperature (°C)
1024	76	388	900..1000>T	40..44

Bearings

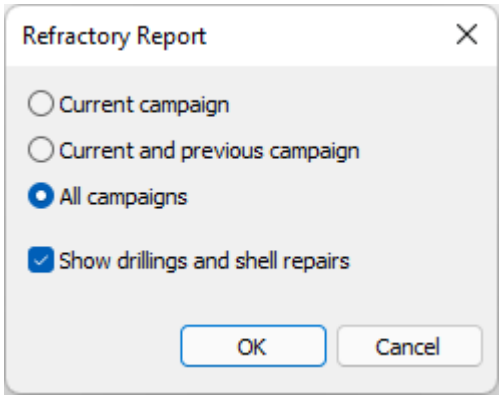
Shows the maximum, minimum and average temperature for each bearing (or other monitored object) measured during the selected report period.

		Maximum temp. (°C)	Minimum temp. (°C)	Average temp. (°C)	Alarm limits (°C)
1	B1	1016	76	432	999>T
2	B2	1358	269	968	1000>T

3.32 Refractory report

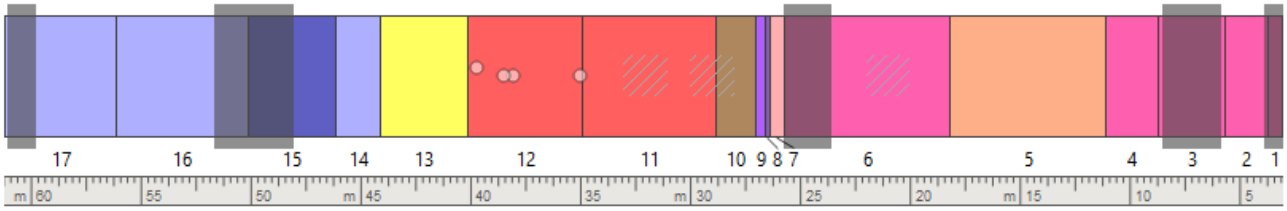
The refractory report is designed to show kiln refractory performance: how long bricks lasted in previous campaigns and the actual state of brick zones in the active campaign.

To create a refractory report select main menu **Extras | Refractory Report** in the Monitoring screen.



You can select to show all campaigns in the report or only the current campaign or the current and the previous. Also you can select to include information about kiln shell drillings and repairs.

Start date: 08.08.2021
End date: 02.02.2022
Campaign duration (months): 5,9
Running time (months): 2,2



	Position (m)	Zone name	Brick type	Installation date	Lifetime (months)	Running time (months)	Thinnest brick (mm)	Wear
1	3,05 - 3,65	HT	Almag 85	10.07.2021	6,9	1,0		0%
2	3,65 - 5,65	HT	Almag 85	10.07.2021	6,9	1,0	30	88%
3	5,65 - 8,65	Sp	Almag 85	10.07.2021	6,9	1,0	44	100%
4	8,65 - 11,05	MC	Almag 85	10.07.2021	6,9	1,0	26	100%
5	11,05 - 18,15	MC	Magnesita - Magkor S2	10.07.2021	6,9	1,0	37	96%
6	18,15 - 25,65	MC/Sp	Almag 85	10.07.2021	6,9	1,0	30	70%
			Shell repairs: 18.12.2021 20 mm patch					
7	25,65 - 26,35	Sp	Rexal Extra	10.07.2021	6,9	0,4	84	16%
8	26,35 - 26,55	MC	Topmag	10.07.2021	6,9	1,0	82	18%
9	26,55 - 26,95	MC	Ankral R63	10.07.2021	6,9	1,0	89	11%
10	26,95 - 28,75	MC	Almag SLC	10.07.2021	6,9	1,0	74	26%
11	28,75 - 34,85	MC/HT	Reframag 85	10.07.2021	6,9	1,0	61	39%
			Shell repairs: 13.10.2021					
12	34,85 - 40,05	HT/Sch	Reframag 85	10.07.2021	6,9	1,0	71	58%
	Drillings: 30.09.2021 88 mm 30.09.2021 88 mm 30.09.2021 89 mm 18.12.2021 60 mm							

Start date: campaign start date;

End date: if the campaign is active - the date of the report, for historical campaigns end date is the start date of the next campaign;

Campaign duration: calendar duration of the campaign;

Running time: counts days when the kiln was running and monitoring in IRT KilnMonitor also was running;

Lifetime: calendar time from the installation date to the date when the brick zone was replaced (or to the current date if the zone is still installed);

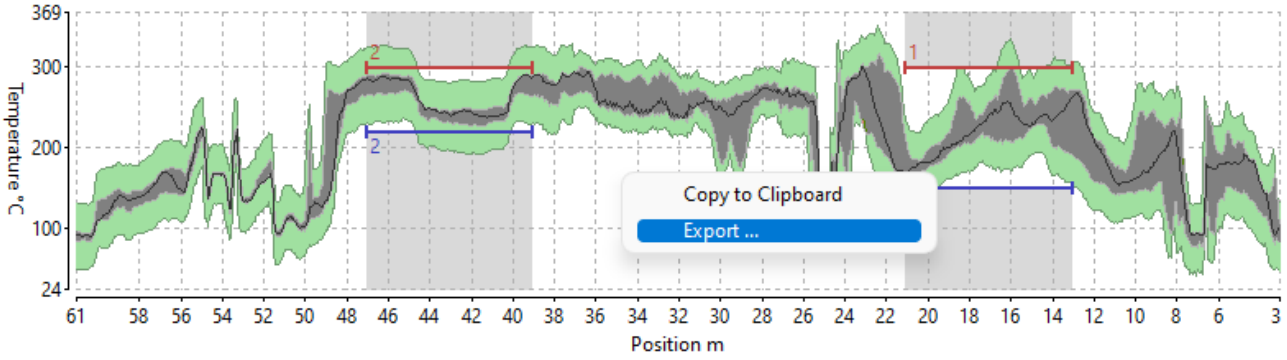
Thinnest brick: estimated thinnest brick from the brick zone monitoring history;

Wear: maximum of *time wear* and *thickness wear* in percent, 0% means no wear, 100% means bricks must be replaced.

time wear = running time / brick life
thickness wear = 1 - (estimated thickness – end of life thickness) / (new brick thickness - end of life thickness)

3.33 Export

Data from every monitoring window or trend graph can be copied to the clipboard or saved in a file on disk in **CSV/TXT/PNG/JPEG** formats. Right click on a window and use **Copy to Clipboard** or **Export** menu.



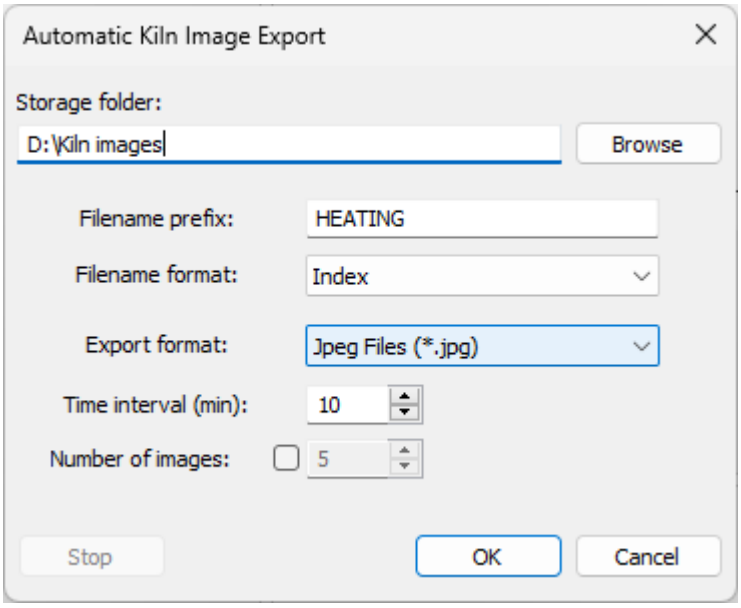
CSV and **TXT** formats are similar but have the following differences:

- CSV is supposed to be directly opened in Microsoft Excel. Excel uses different column separators depending on Windows locale settings (it can be comma or semi-colon);
- CSV format stores data using date format and units specified in IRT KilnMonitor settings;
- TXT uses locale and settings independent format: column separator is always 'tab', time is UTC and in yyyy-MM-dd format, temperature is in Celsius.

Automatic kiln image export

It is possible to define a simple schedule to save several kiln shell images. In Monitoring screen, use main menu **Extra | Automatic Kiln Image Export**.

When export is started, the current kiln image is saved. After that every kiln rotation is saved if it meets the time interval condition.



Filename prefix: file names will have this prefix;

Filename format: Index (prefix + number) or Timestamp (prefix + time stamp in format "yyyy-MM-dd-hh-mm-ss");

Export format: Excel (CSV), Text, PNG, JPEG, Binary or Infrared Image;

Time interval: minimum interval between saved images, set to zero to save every kiln rotation;

Number of images: you can limit the number of saved images; if the check box is not marked, images will be saved infinitely.

Binary image format

Little endian

4 bytes, integer: image width

4 bytes, integer: image height

Width x Height x 4 bytes, float: image pixel temperature values

Infrared Image format

Usually has IRSU extension. These images can be open in specialized infrared software like ThermoView for additional thermal analysis.

3.34 Printing

Monitoring window (current kiln state)

To print the contents of the Monitoring window, select **Extras / Print Current Kiln State** in the main menu. Same result can be achieved by using the **Print** link at the top of the kiln image view (or the 3D kiln view):

Normally everything you see in the monitoring window will be present on the print out: the kiln image, the horizontal profile, the temperature trend, the rotation/tire slip/bearings view, the alarms list and the thickness/coating diagram. There is a hack that can be used to hide some unneeded parts - Linescano.ini:

```
[REPORTS]
print_kiln_state_show_right_part = 1; shows or hides the alarms list and the thickness/coating
diagram
print_kiln_state_show_bottom_part = 1; shows or hides the rotation/tire slip/bearings view
```

Tire slip window, burning zone window, bearings window

Each of those windows has a **Print** link at the top part.

3.35 Access to measured data for third-party applications

OPC UA

OPC UA implementation in IRT KilnMonitor does not require any configuration. Also it does not use any authentication and allows anonymous access.

NodeIds

Each property node in OPC UA has a stable node ID. The numbering scheme has changed starting with build 7.8.23. If you are upgrading from an earlier version of IRT KilnMonitor and need to preserve the original numbering scheme, you can revert to it by setting the **node_id_version** parameter in the Linescano.ini file to 1.

IRT KilnMonitor OPC UA address space contains the following objects.

Kiln1, Kiln2, ...: KilnType

Component	DataType and Unit	Description
KilnName	String	Kiln name specified in the configuration
Monitoring	Boolean	Kiln monitoring is running
Synchronized	Boolean	Signal from the kiln trigger is present and stable
SystemOk	Boolean	No hardware problems (same as system is running signal)
Alarm	Boolean	Kiln alarm state (true if there is at least one active alarm present)
TemperatureMin	Double, °C	Measured minimum temperature value on the kiln shell
TemperatureMax	Double, °C	Measured maximum temperature value on the kiln shell
ObservedStart	Double, m	X coordinate of the starting point of the kiln area observed by the scanners
ObservedEnd	Double, m	X coordinate of the end point of the kiln area observed by the scanners
Rotation	KilnRotationType	Kiln rotation information
TSM	KilnTSMType	Tire slip monitoring information
AlarmZones	KilnAlarmZonesType	Contains information about each alarm zone
Profile	KilnProfileType	Envelope profile of the kiln shell image
Refractory	KilnRefractoryType	Information about refractory
BurningZone	BurningZoneType	Burning zone data
Bearings	KilnBearingsType	Bearings data
Devices	DevicesType	Information about the state of the scanners and pyrometers used to monitor the kiln.

Rotation: KilnRotationType

Part of a KilnType object.

Component	DataType and Unit	Description
LapCounter	UInt32	Kiln revolution counter since monitoring start

Component	DataType and Unit	Description
LapTime	Double, second	Last kiln revolution duration
LapTimeVariation	Double, second	Kiln revolution time difference during 5 last laps
RotationSpeed	Double, revolutions per minute	Kiln rotation speed

TSM: KilnTSMType

Part of a KilnType object.

Component	DataType and Unit	Description
Ring1	TireSlipType	Tire slip data of Ring1
Ring2	TireSlipType	Tire slip data of Ring2
...		
RingN	TireSlipType	Tire slip data of RingN

Ring1, Ring2, ...: TireSlipType

Part of a KilnTSMType object.

Component	DataType and Unit	Description
TireSlip	Double, millimeter	Estimated tire slip. EURange property contains permissible limits defined in the kiln configuration.
TireSlipStdDev	Double, millimeter	Tire slip value standard deviation calculated from several kiln revolutions. EURange property contains permissible limits defined in the kiln configuration.
Alarm	Boolean	Alarm set when the estimated tire slip value is out of permissible range or if measured tire slip values are not uniform.

AlarmZones: KilnAlarmZonesType

Part of a KilnType object.

Component	DataType and Unit	Description
Zone1	AlarmZoneType	Alarm zone data for Zone1
Zone2	AlarmZoneType	Alarm zone data for Zone2
...		

Component	DataType and Unit	Description
ZoneN	AlarmZoneType	Alarm zone data for ZoneN

Zone1, Zone2, ...: AlarmZoneType

Part of a KilnAlarmZonesType object.

Component	DataType and Unit	Description
PosStart	Double, meter	Positing of the zone in kiln coordinates
PosEnd	Double, meter	Positing of the zone in kiln coordinates
LimitHigh	Double, °C	The upper temperature limit defined in the kiln configuration used to trigger the zone alarm
LimitLow	Double, °C	The lower temperature limit defined in the kiln configuration used to trigger the zone alarm
Hysteresis	Double, °C	Hysteresis to prevent alarm from turning off too quickly (defined in the kiln configuration)
TemperatureMin	Double, °C	The minimum temperature value in the zone
TemperatureMax	Double, °C	The maximum temperature value in the zone
TemperatureAverage	Double, °C	The average temperature value in the zone
Alarm	Boolean	Zone alarm state
Control	Boolean	Zone control condition state
ControlMargin	Double, °C	The margin that defines control condition temperature level
ControlHysteresis	Double, °C	Hysteresis to prevent control output from turning off too quickly (defined in the kiln configuration)

Profile: KilnProfileType

Part of a KilnType object.

Component	DataType and Unit	Description
TemperatureMax	Double Array, °C	Array size is equal to the kiln shell IR image width. Each element contains the maximum temperature value of the corresponding IR image column (maximum temperature along kiln circumference).
TemperatureMin	Double Array, °C	Each array element contains the minimum temperature value.

Component	DataType and Unit	Description
TemperatureAverage	Double Array, °C	Each array element contains the average temperature value.
PixToPosA	Double	Coefficient A to convert array index to kiln position:KilnPosX = A + B * index
PixToPosB	Double	See above
HighAlarm	Boolean	State of the envelope high alarm (kiln temperature at some point is higher than the defined envelope profile limit)
LowAlarm	Boolean	State of the envelope low alarm (kiln temperature at some point is lower than the defined envelope profile limit)

Refractory: KilnRefractoryType

Part of a KilnType object.

Component	DataType and Unit	Description
BrickZone01	BrickZoneType	Brick zone 1 data
BrickZone02	BrickZoneType	Brick zone 2 data
...		
BrickZoneN	BrickZoneType	Brick zone N data
BrickThicknessMin	Double, mm	An estimation of the minimum brick thickness (of all bricks in the kiln)
CoatingThicknessMax	Double, mm	An estimation of the maximum coating thickness

BrickZone01, BrickZone02, ...: BrickZoneType

Part of a KilnRefractoryType object.

Component	DataType and Unit	Description
PosStart	Double, meter	Positing of the zone in kiln coordinates
PosEnd	Double, meter	Positing of the zone in kiln coordinates
ZoneName	String	Name of the brick zone
BrickType	String	Type of the brick
InstallationDate	DateTime	Date when brick zone was installed

Component	DataType and Unit	Description
BrickLifeDays	Int32	Set brick life in days
BrickLifeDaysLeft	Int32	Remaining brick life in days
EstimatedBrickThicknessMin	Double, mm	Estimated brick thickness - minimum of all pixels in the zone
EstimatedBrickThicknessMax	Double, mm	Estimated brick thickness - maximum of all pixels in the zone
TemperatureMin	Double, °C	The minimum temperature value in the zone
TemperatureMax	Double, °C	The maximum temperature value in the zone
TemperatureAverage	Double, °C	The average temperature value in the zone

BurningZone: BurningZoneType

Part of a KilnType object.

Component	DataType and Unit	Description
Temperature	Double, °C	Measured temperature of the burning zone flame.
InstrumentTemperature	Double, °C	Measuring device internal temperature.
Alarm	Boolean	Set to true if the measured burning zone temperature is higher than the limit defined in the kiln configuration.
InstrumentAlarm	Boolean	Set to true if the measuring device internal temperature is higher than the limit defined in the kiln configuration.

Bearings: KilnBearingsType

Part of a KilnType object.

Component	DataType and Unit	Description
Bearing1	BearingType	Bearing1 data
Bearing2	BearingType	Bearing2 data
...		
BearingN	BearingType	BearingN data

Bearing1, Bearing2, ...: BearingType

Part of a KilnBearingsType object.

Component	DataType and Unit	Description
Temperature	Double, °C	Measured temperature of the bearing
Alarm	Boolean	Set to true if the measured bearing temperature is outside the limit defined in the kiln configuration.

Devices: DevicesType

Part of a KilnType object.

Component	DataType and Unit	Description
Scanners	ScannerListType	Scanners folder
Pyrometers	ScannerListType	Pyrometers folder

Scanners, Pyrometers: ScannerType

Component	DataType and Unit	Description
ID	String	Device ID
Connected	Boolean	False if monitoring is not running or there is a problem connecting to the device.
InternalTemperature	Double, °C	The internal temperature reported by the device (if available)
FrequencyHz	Double	Actual scanning frequency in Hz

OPC Classic

If properly configured IRT KilnMonitor gives access to the measured kiln data and monitoring status through OPC DA 2.0 interface. Here is the list of OPC tags available for each monitored kiln:

OPC Tag	Value type and unit	Description	OPCUA analog
running	VT_BOOL	Kiln monitoring is running	Kiln.Monitoring
synchronized	VT_BOOL	Signal from the kiln trigger is present and stable	Kiln.Synchronized
system_ok	VT_BOOL	No hardware problems (same as system is running signal)	Kiln.SystemOk

config_kiln_name	VT_BSTR	Kiln name specified in the configuration	Kiln.KilnName
config_observed_start	VT_R8, meters	X coordinate of the starting point of the kiln area observed by the scanners	Kiln.ObservedStart
config_observed_end	VT_R8, meters	X coordinate of the end point of the kiln area observed by scanners	Kiln.ObservedEnd
kiln_shell_min	VT_R8, °C	Measured minimum temperature value on the kiln shell	Kiln.TemperatureMin
kiln_shell_max	VT_R8, °C	Measured maximum temperature value on the kiln shell	Kiln.TemperatureMax
brick_thickness_min	VT_R8, mm	An estimation of the minimum brick thickness (of all bricks in the kiln)	Kiln.Refractory.BrickThicknessMin
coating_thickness_max	VT_R8, mm	An estimation of the maximum coating thickness	Kiln.Refractory.CoatingThicknessMax
zone_1_min .. zone_32_min	VT_R8, °C	Measured minimum temperature in alarm zone 1 .. 32	Kiln.AlarmZones.Zone.TemperatureMin
zone_1_max .. zone_32_max	VT_R8, °C	Measured maximum temperature in alarm zone 1 .. 32	Kiln.AlarmZones.Zone.TemperatureMax
zone_1_avr .. zone_32_avr	VT_R8, °C	Measured average temperature in alarm zone 1 .. 32	Kiln.AlarmZones.Zone.TemperatureAverage
rotation_time	VT_R8, seconds	Duration of the last full kiln revolution	Kiln.Rotation.LapTime
tire_slip_1 .. tire_slip_8	VT_R8, mm	Estimated tire slip in millimeters (tire 1 .. 8)	Kiln.TSM.Ring.TireSlip
tire_delay_1 .. tire_delay_8	VT_R8, seconds	Revolution duration difference compared with the kiln revolution duration (tire 1 .. 8)	Kiln.TSM.Ring.Delay
tire_time_1 .. tire_time_8	VT_R8, seconds	Ring revolution time (tire 1 .. 8)	Kiln.TSM.Ring.LapTime

OPC Tag	**Value type and unit**	**Description**
history_connection_string	VT_BSTR	Path to the history folder
last_short_term_record_time	VT_DATE	Time stamp (UTC) of the last short-term history record

last_middle_term_record_time	VT_DATE	Time stamp (UTC) of the last middle-term history record
last_long_term_record_time	VT_DATE	Time stamp (UTC) of the last long-term history record

Kiln state data saved on disk

After each kiln revolution IRT KilnMonitor saves current kiln state to files on disk. This function does not require configuration.

Kiln state data is saved in the kiln history folder.

```
<Kiln history folder>\State\last
    - state.json
    - image.csv
```

Path to the kiln history folder can be set in the kiln configuration.

state.json contains the followings data:

- *update_time_UTC*: time when data was updated (UTC);
- *image_width, image_height*: kiln image dimensions in pixels;
- *xA, xB, yC*: parameters to convert image pixel coordinates to kiln coordinates;
- *rotation*: measured kiln rotation data (*lap_counter*, *measured/nosignal/stable* states, *lap_time_s*, *lap_time_variation_s*);
- *rings*: measured tire slip for each ring (*measured/nosignal/uniform* states, *tire_slip_mm*, *tire_slip_stddev_mm*);
- *burning_zone*: measured buring zone temperature;
- *alarms*: list of alarms with their state (true or false).

image.csv contains kiln shell image temperatures:

- comma is used as columns separator;
- next line (0x0D, 0x0A) is used as lines separator;
- number of columns correspond to *image_width* from state.json;
- number of lines correspond to *image_height* from state.json;
- temperature values are always in °C.

To convert image pixel position to kiln position, use the following formulas:

- Image coordinate system: left to right, top to bottom;
- Kiln coordinate system: defined in the kiln configuration (can be left to right or right to left, formulas work in both cases);
- "position along x kiln axis in meters" = *xA* + *xB* * x pixel pos";
- "position opposite to kiln rotation in degrees" = *yC* * "y pixel pos".

Monitoring database

Monitoring database is an **SQLITE** database containing all measurements made by IRT KilnMonitor, including historical measurements. It also stores kiln refractory information with a history of changes.

The database file for each kiln is stored in the kiln history folder:

```
<Kiln history folder>
    - revs.db
```

Database structure

Access to this database is possible using free libraries (https://www.sqlite.org) and open source tools (https://sqlitestudio.pl).

TABLE campaigns

: kiln campaigns
CampaignId INTEGER: campaign id (as defined by IRT KilnMonitor)
DisplayName TEXT: campaign display name
StartDate DATE: campaign start date

TABLE brickzones

: information about brick zones
BrickZoneId INTEGER: an id used to reference brick zones from other tables
ZoneName TEXT: zone name as defined in refractory configuration
InstallationDate DATE: date of brick zone installation (start of use); only used if campaign is not defined
InstallationCampaignId INTEGER: reference to **campaigns** table; first kiln campaign with this brick zone installed
BeginPos_cm, EndPos_cm INTEGER: position of the brick zone along the kiln axis (cm)
BrickType TEXT: brick type used in this brick zone
BrickLifeDays INTEGER: planned brick zone work time in calendar days
InitialBrickThickness INTEGER: working thickness of new bricks
EndOfLifeBrickThickness INTEGER: thickness limit, if brick becomes thinner than this limit it must be replaced
BrickConductivity REAL: brick conductivity used to estimate brick thickness by the shell temperature (W/mK)
InternalTemperature REAL: kiln internal temperature (°C)
Color TEXT: zone color on the refractory diagram
Description TEXT: zone description

TABLE shadowzones

: shadow zone is a part of the kiln monitored area which is not visible for scanners and pyrometers ("special zones" in IRT KilnMonitor configuration)
ShadowZoneId INTEGER: an id used to reference shadow zones from other tables
BeginPos_cm, EndPos_cm INTEGER: shadow zone position along the kiln axis (cm)
Color TEXT: color of the shadow zone on the refractory diagram

TABLE refractories

: refractory is a set of brick zones; when a new brick zone is installed, new refractory version is created
RefractoryId INTEGER: an id used to reference refractories from other tables
KilnBeginPos_cm, KilnEndPos_cm INTEGER: monitored kiln area as defined in the IRT KilnMonitor kiln configuration
RightToLeft BOOLEAN: kiln axis direction
CoatingConductivity REAL: coating conductivity used to estimate brick/coating thickness by the shell temperature (W/mK)

TABLE refractorybrickzones

: defines what brick zones every refractory version contains
RefractoryId INTEGER: reference to **refractories** table
BrickZoneId INTEGER: reference to **brickzones** table

TABLE refractoryshadowzones

: defines refractory shadow zones
RefractoryId INTEGER: reference to **refractories** table

ShadowZoneId INTEGER: reference to **shadowzones** table

TABLE manipulations

: manipulations with kiln - drillings and shell repairs
ManipulationId INTEGER: defined by IRT KilnMonitor
ManipulationType INTEGER: "1" for drilling, "2" for shell repair
Date DATE: date when manipulation was made
BeginPos_cm, EndPos_cm INTEGER: position along the kiln axis (cm)
BeginArc_deg, EndArc_deg INTEGER: position along kiln circumference (degrees)
Notes TEXT: text defined by operator
Measurement REAL: measured brick thickness for drillings (mm)

TABLE revolutions

: information about kiln revolutions; several revolutions can be combined into one record
RevId INTEGER: an id to reference revolutions from other tables
UpdateTimeUTC DATETIME: Unix time of the record
CampaignId INTEGER: reference to **campaigns** table
RefractoryId INTEGER: reference to **refractories** table
RevolutionTimeMin REAL: minimum revolution time since the previous record (seconds)
RevolutionTimeMax REAL: maximum revolution time since the previous record (seconds)
Stable BOOLEAN: stable means there is a reliable signal from kiln trigger and kiln rotation speed variation is within configured limits
SystemAlarmBits INTEGER: bit0 - Kiln Trigger, bit1 - Scanners, bit2 - I/O, bit3 - Maintenance, bit4 - Refractory
KilnAlarmBits INTEGER: bit0 - Envelope Low, bit1 - Envelope High
ZoneAlarmBits INTEGER: bit0 - Alarm Zone 1, bit1 - Alarm Zone 2, ...
RingAlarmBits INTEGER: bit0 - Ring 1, bit1 - Ring 2, ...

TABLE alarms

: information about available alarm types
AlarmId INTEGER: an id used to reference alarms from other tables
AlarmTextId TEXT: text id as it is used in IRT KilnMonitor
DisplayNameTrs TEXT: display name with translation id
SortPriority INTEGER: used to order alarms list

TABLE alarmsregistered

: information about alarm occurrences
AlarmId INTEGER: reference to **alarms** table
CampaignId INTEGER: reference to **campaigns** table
RecordTimeUTC DATETIME: Unix time stamp when alarm record was made
AlarmOnDuration INTEGER: duration in seconds this alarm was active since the previous record

TABLE alarmzones

: information about alarm zones (positions, limits, but not measured values)
AlarmZoneId INTEGER: an id used to reference alarm zones from other tables
ZoneIndex INTEGER: index as defined in IRT KilnMonitor alarms configuration
BeginPos_cm, EndPos_cm INTEGER: position along the kiln axis (cm)
AlarmType TEXT: "none" - alarm is off, "upper" - high alarm, "lower" - low alarm, "range" - high/low alarm, "envhigh" - envelope high alarm, "envlow" - envelope low alarm, "envrange" - envelope high/low alarm
HighLimit REAL: alarm high limit (°C)
LowLimit REAL: alarm low limit (°C)
Hysteresis REAL: alarm hysteresis (°C)
Description TEXT: description from alarm zone configuration

TABLE alarmzonesmeasured

: kiln shell temperature values measured within alarm zones and zones' alarm states
AlarmZoneId INTEGER: reference to **alarmzones** table
RevId INTEGER: reference to **revolutions** table
TemperatureMin REAL: minimum temperature measured within the alarm zone since the previous record (°C)
TemperatureMax REAL: maximum temperature measured within the alarm zone since the previous record (°C)
TemperatureMean REAL: average temperature measured within the alarm zone since the previous record (°C)
AlarmHigh BOOLEAN: high alarm was detected

AlarmLow BOOLEAN: low alarm was detected

TABLE analysistools

: information about analysis tools/objects (monitoring must be enabled for an object)
ToolId INTEGER: an id used to reference tools from other tables
ToolTextId TEXT: text id as it is used in IRT KilnMonitor
Label TEXT: a label specified by the operator when object monitoring is started
DisplayNameTrs TEXT: display name with translation id
BeginPos_cm, EndPos_cm INTEGER: position on the kiln shell along the kiln axis (cm)
BeginArc_deg, EndArc_deg INTEGER: position on the kiln shell circumference (°)

TABLE analysistoolsmeasured

: values measured by analysis tools/objects when monitoring is enabled for them
UpdateTimeUTC DATETIME: Unix time when record was made
ToolId INTEGER: reference to **analysistools** table
RevId INTEGER: reference to **revolutions** table
Type INTEGER: "1" for kiln shell temperature (°C), other values not used
Min REAL: minimum value measured within the tool area since the previous record (value unit depends on Type)
Max REAL: maximum value measured within the tool area since the previous record
Mean REAL: average value measured within the tool area since the previous record

TABLE brickzonesmeasured

: kiln shell temperature measured within every brick zone; estimated brick and coating thickness
BrickZoneId INTEGER: reference to **brickzones** table
RevId INTEGER: reference to **revolutions** table
TemperatureMin REAL: minimum kiln shell temperature measured within the brick zone since the previous record (°C)
TemperatureMax REAL: maximum kiln shell temperature measured within the brick zone since the previous record (°C)
TemperatureMean REAL: average kiln shell temperature measured within the brick zone since the previous record (°C)
BrickThicknessMin INTEGER: estimated minimum brick thickness within the brick zone (mm)
BrickThicknessMax INTEGER: estimated maximum brick thickness within the brick zone (mm)
CoatingThicknessMin INTEGER: estimated minimum coating thickness within the brick zone (mm)
CoatingThicknessMax INTEGER: estimated maximum coating thickness within the brick zone (mm)

TABLE rings

: information about kiln rings
RingId INTEGER: an id used to reference rings from other tables
RingIndex INTEGER: ring index defined in IRT KilnMonitor configuration
RingName TEXT: ring name defined in IRT KilnMonitor configuration
AllowedMin REAL: allowed tire slip minimum value (mm)
AllowedMax REAL: allowed tire slip maximum value (mm)

TABLE ringsmeasured

: measured tire slip values
RingId INTEGER: reference to **rings** table
RevId INTEGER: reference to **revolutions** table
RevolutionTime REAL: duration of ring revolution (seconds)
DelayToKilnTrigger REAL: ring revolution minus kiln revolution time (seconds)
TireSlip REAL: estimated tire slip value (mm)
TireSlipStdDev REAL: tire slip values standard deviation from several rotations (mm)
StateBits INTEGER: bit0 - tire slip value is measured, bit1 - tire slip value is uniform, bit2 - low alarm, bit3 - high alarm, bit4 - no signal/update timeout/non uniform alarm

TABLE burningzonemeasured

: burning zone measurements
RevId INTEGER: reference to **revolutions** table
AlarmZoneId INTEGER: reference to **alarmzones** table
TemperatureMin REAL: minimum burning zone temperature measured since the previous record (°C)
TemperatureMax REAL: maximum burning zone temperature measured since the previous record (°C)
TemperatureMean REAL: average burning zone temperature measured since the previous record (°C)
AlarmHigh BOOLEAN: high alarm was detected
AlarmLow BOOLEAN: low alarm was detected
InstrTemperatureMin REAL: minimum internal instrument temperature since the previous record (°C)

InstrTemperatureMax REAL: maximum internal instrument temperature since the previous record (°C)
InstrAlarm BOOLEAN: instrument internal temperature alarm was detected

TABLE bearings

: bearings names
BearingId INTEGER: an id used to reference bearings from other tables
BearingIndex INTEGER: bearing index defined in IRT KilnMonitor configuration
BearingName TEXT: bearing name defined in IRT KilnMonitor configuration

TABLE bearingsmeasured

: bearings measurements
RevId INTEGER: reference to **revolutions** table
BearingId INTEGER: reference to **bearings** table
AlarmZoneId INTEGER: reference to **alarmzones** table
TemperatureMin REAL: minimum bearing temperature measured since the previous record (°C)
TemperatureMax REAL: maximum bearing temperature measured since the previous record (°C)
TemperatureMean REAL: average bearing temperature measured since the previous record (°C)
AlarmHigh BOOLEAN: high alarm was detected
AlarmLow BOOLEAN: low alarm was detected

3.36 Logs

Every event and every alarm in IRT KilnMonitor is registered in logs files. There are the following logs:

1. Events log: events like monitoring started, monitoring stopped, kiln configuration changed, scanner communication problem, other hardware problem.
2. Alarms log: an alarm condition changed, alarm condition is reset by operator.
3. OPC server log: OPC events like a client connected or disconnected, OPC errors.

Each kiln has its own logs. Log data is separated by months.

To see the logs, use main menu item **View / Log Files**. This will open the folder with log files in Windows Explorer.

4 Procedures

4.1 Configuration for a new campaign

Kiln operation is divided into campaigns. Between campaigns, the kiln is shut down for maintenance, refractory inspection and replacement of worn-out bricks. It's essential to halt kiln monitoring when the kiln isn't operational.

Any modifications to the kiln must be mirrored in the IRT KilnMonitor configuration. This topic outlines the necessary steps.

Creating a new campaign

The first step involves creating a new campaign. The campaign's start date should coincide with the planned kiln restart date. This date, primarily used in reports, doesn't need to be highly accurate.

Changing the refractory

Add the newly installed brick zones. For "Date installed", choose the new campaign's start date. There's no need to delete brick zones that have been replaced. When a new brick zone is added, any zones it overlaps are automatically resized or deleted.

Do not modify brick zones that remained unchanged during the maintenance shutdown. The "Initial brick thickness" should always reflect the thickness of the new brick. The actual brick thickness (measured during physical kiln inspection) should be set during thickness measurement calibration. If inspections reveal that the bricks are in good condition and can last longer, it's fine to increase the "Brick life".

Monitoring start

Start monitoring once the kiln has restarted, heated up, and resumed normal production.

Thickness measurement calibration

After the campaign start and several days of monitoring, IRT KilnMonitor will automatically prompt a calibration requirement. This prompt will only appear if the kiln revolution speed is stable. Ensure other calibration conditions are met before running the calibration.

After the calibration, the configuration for the new campaign is complete. If you notice errors in brick zone parameters, correct them as soon as possible. This will require a recalibration of the modified zones.

5 3rd party libraries

To implement some features IRT KilnMonitor uses these open source libraries and programs:

Qt



https://www.qt.io/

© The Qt Company

Source code of the library can be downloaded from here Qt official web site. Used Qt version is 5.15.2.

Python



https://www.python.org/

zlib



https://zlib.net/

Copyright (C) 1995-2017 Jean-loup Gailly and Mark Adler

libzip

https://libzip.org/

Copyright (C) 1999-2017 Dieter Baron and Thomas Klausner <libzip@nih.at>

libcurl



https://curl.haxx.se/libcurl/

Copyright (c) 1996 - 2019, Daniel Stenberg, <daniel@haxx.se>

open62541

https://open62541.org/

QR Code generator library

Copyright © 2022 Project Nayuki. (MIT License)

https://www.nayuki.io/page/qr-code-generator-library

Axialis

http://www.axialis.com

Some of the used icons are courtesy of Axialis Software.

If source code of a library was modified it can be downloaded from here:
http://www.grayess.com/open_source/

6 Document revisions

1.0.8-7.5.233

1. Operation | Export | Automatic kiln image export: Filename format added.
2. Configuration | Alarms: subsection "Scanner alarms" is replaced by "Grouped alarms"; "Envelope profile alarms" subsection: Horizontal tolerance added; new subsection "Alarm outputs".
3. Installation and general settings | PC requirements: new subsection "TCP/UDP ports".

1.0.9-7.5.240 (11.01.2023)

1. Operation | System state window | System tab: screen shot updated, description added for Monitoring database size, Last backup, Clients, OPC Classic Clients, OPC UA Clients, OPC UA Server discovery URL.
2. Configuration | OPC UA configuration: added instructions for changing server port.

1.0.10-7.5.242 (25.01.2023)

1. Installation and general settings | Managing licenses: QR code activation method added.
2. 3rd party libraries: Nayuki QR code library added.

1.0.11-7.5.243 (09.02.2023)

1. Operation | Access to measured data for third-party applications: new OPCUA properties Kiln.ObservedStart, Kiln.ObservedEnd, Kiln.Refractory; OPC Classic - new column OPCUA analog.

1.0.12-7.5.244 (20.03.2023)

1. Operation | Refractory report: wear calculation description and formula was wrong.

1.0.13-7.6.0 (10.05.2023)

1. Operation | Brick and coating thickness calculation method: text changed.
2. Operation | Thickness measurement calibration: new topic.
3. Operation | Temperature inside kiln: topic entirely rewritten.
4. Procedures | Configuration for a new campaign: new topic.

1.0.14-7.6.11 (02.10.2023)

1. Configuration | History storage: "Record only stable kiln rotations" paragraph added.

1.0.15-7.8.23 (02.09.2025)

1. New contact information.
2. Operation | Access to measured data for third-party applications: new OPCUA properties (Refractory.BrickZones, Devices, Devices.Scanners, Devices.Pyrometers).
3. TV30 support.