A large industrial ladle is suspended in a steel mill. Molten metal is being poured from the bottom of the ladle, creating a bright yellow glow and steam. The ladle is surrounded by complex industrial machinery, including cranes and structural beams. The scene is dimly lit, with the primary light source being the molten metal.

# PIEPER

LadleCheck - Condition Monitoring of Casting Ladles

al cameras  
commissioning  
Industry 4.0  
Process M  
Systems high temperatu  
full HD Cross-  
development  
ce probes  
W

# FOREWORD

## ABOUT PIEPER

intelligent vide

### Your safety in good hands

50 years of experience, a highly qualified team and a high level of customer satisfaction is what PIEPER GmbH, which has its head office in Schwerte/Germany, stands for. We plan, develop, produce and install complete video, security and image processing systems for industry. Our portfolio also includes support operations and therefore the maintenance, repair and modernization of customized solutions. We are world-renowned for our combustion chamber systems, which monitor processes and furnaces in high-temperature environments at maximum resolution.

Customers value our manufacturer-independent advice, our industry-specific know-how, and our high-quality special solutions for:

- steel industry
- aluminum industry
- glass production
- cement processing
- waste management
- power plants
- petrochemical industry
- passenger and freight transportation

In this regard, our focus lies on combustion chamber video technology for visual process observation in temperature ranges of up to 2,00°C, in video and management systems for mass transportation and airports, as well as in industrial video solutions for production control.

We produce and install systems for digital image processing, communication and data technology, network technology, access control systems, building management solutions, and outdoor area security, plus all the supplementary system components.

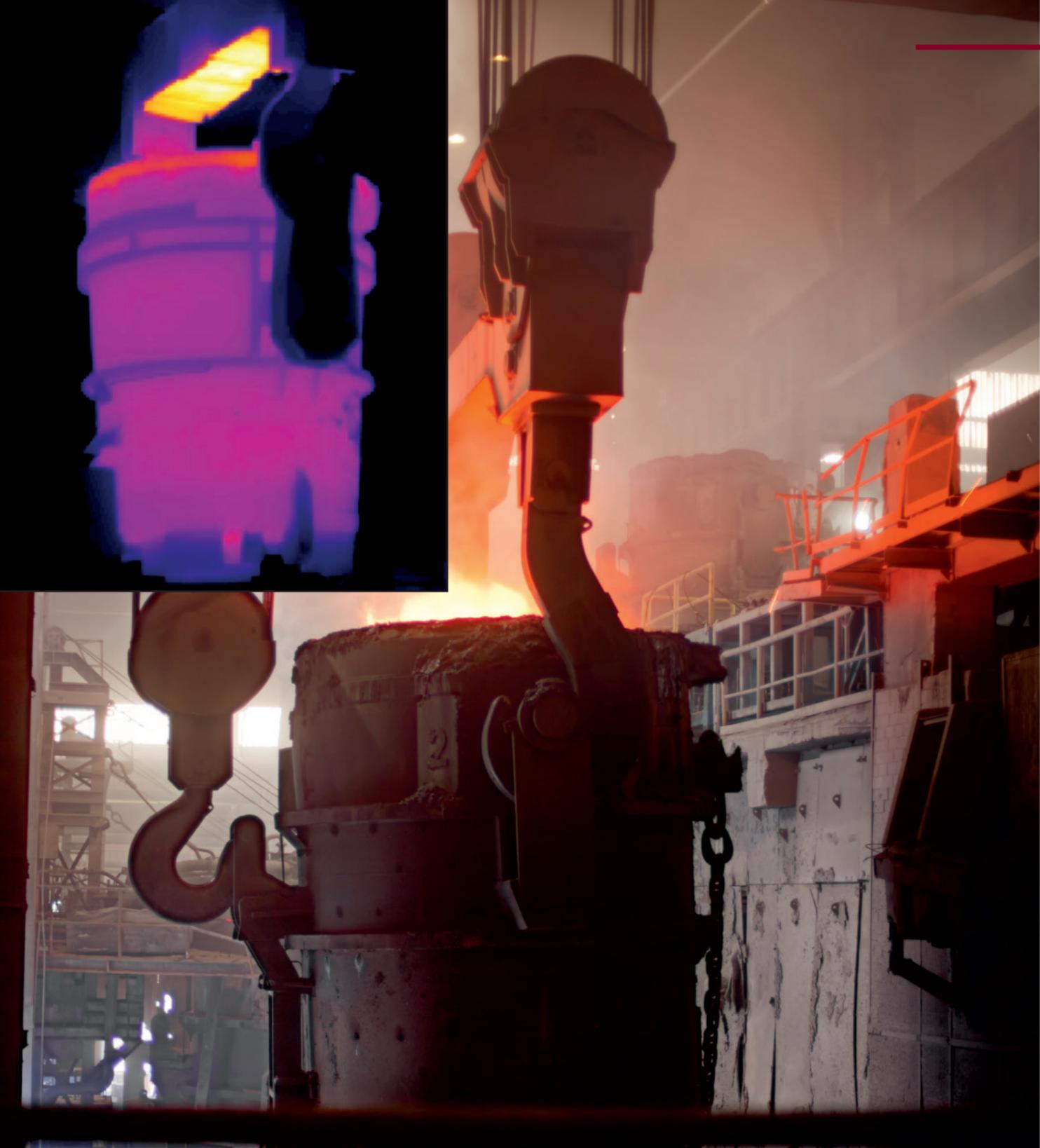
Since our company was established in 1968, we have offered our customers futureproof solutions. The fact that we are certified according to DIN ISO 9001 and SCC proves that we offer to quality. We are there for you all over Germany - in Berlin, Cottbus, Düsseldorf and Munich, as well as at our head office in Schwerte. Internationally, we are represented by partnerships and cooperative relationships all over the world.

### Hard- und Software

PIEPER has devoted its energies to video technology for half a century. We know the video security and process observation market better than almost any other company. We are therefore on hand to assist you as a reliable partner when it comes to individual recommendations, to which special camera, probe or software is best suited for your system, and to adapting both components and software exactly to your requirements.

We have been working closely with many suppliers for a number of years, including well-known manufacturers such as AG Neovo, aimetis, Automation Technology, AXIS Communication, Barco, BASLER, digivod, IndigoVision, Panasonic and Qognify (formerly SeeTec)

However, we do not supply you with single solutions; what you get from us are complete systems. We help you to select technologies and individually tailor each system to your needs - from planning to commissioning. Our very own R&D department at our head office in Schwerte develops special solutions.



# LADLECHECK MONITORING

## About LadleCheck

*LadleCheck Refractory Monitoring System serves as a key solution to increase safety in steel making and to support the ladle maintenance schedules. It minimizes the risk of liquid steel breakouts while maximizing the lifetime of the refractory lining.*

### Increased Safety

Liquid metal breakouts from a defective refractory lining of a ladle are a common danger in steel production. The well known consequences are damages of the surrounding equipment, high repair costs and loss of revenue due to production delays. Besides the economical impact there is always a high risk of personnel injuries or even the loss of lives.

The LadleCheck system is designed to effectively prevent hot breakouts. By continuously monitoring the ladles during production, areas with defects or depletions in the refractory lining are automatically detected long before they become critical.

### Cost Reduction

The system also helps to reduce the production costs by extending the service life of the ladle refractories. Each time the fireproof lining gets into contact with liquid metal its condition deteriorates until finally the ladle must be relined. Generally, the maintenance schedule for the refractory is determined based on the experience. For safety reasons, the time intervals are commonly quite conservative.

LadleCheck allows a reliable assessment of the remaining lifetime of the refractory lining. The number of heats can thus be maximized without any safety issues and the re-lining can be scheduled more precisely. Considering the high costs for the refractory maintenance, the system can significantly contribute to a reduction of the production costs of steel.

### How it works

While the ladles are transported by overhead crane, several thermal imaging cameras automatically measure the temperature distribution on their external surface. The measurements are performed in full movement; there is no need to stop the crane. Due to the completely modular concept of the LadleCheck system, an inspection station can comprise a varying number of cameras. For covering the complete outer surface of the ladle including the bottom, generally 4-5 cameras are required.

Once a measurement is performed, the thermal data are analyzed and the status of the ladle is indicated to the crane operator. All thermal images, the temperature data and process related data are stored in a database enabling dedicated analyses of the refractory lining status.





# LADLECHECK

## FEATURES

### Temperature Trend Analysis

Based on the stored data of previous measurements LadleCheck analyzes the temperature as a function of the ladle service time. A sudden increase in the temperature trends implies a potential breakdown of the refractory and will trigger an alarm. Moreover, the temperature trend information also provides a clear information for the progressive wear of the refractory lining, allowing to schedule maintenance activities more precisely.

### Alarm Colors

Areas on the ladle, where the temperature indicate excessive wear or a defect are highlighted with alarm colors in the on-screen display. This way, the operator gets a clear impression about the location and severeness of a potential problem with the refractory.

### Ladle Status Indication

Depending on the configuration of the LadleCheck system, the ladle status is displayed to the operators in multiple different ways:

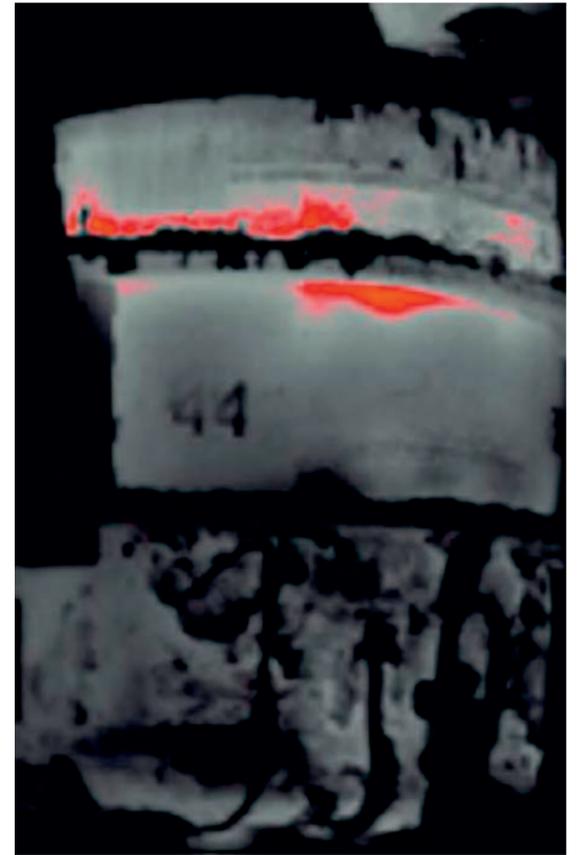
- A signal light shows the condition information to the crane driver immediately after a measurement has been released.
- If the crane cabin is equipped with a computer, the Status page of the web application will give the crane driver all the additional details about the measurement.
- Other personnel, like the operators in the control room or the ladle maintenance personnel may use the pages of the web application, either to display the data of the current measurement or to perform a dedicated analysis.

### Various Interfaces

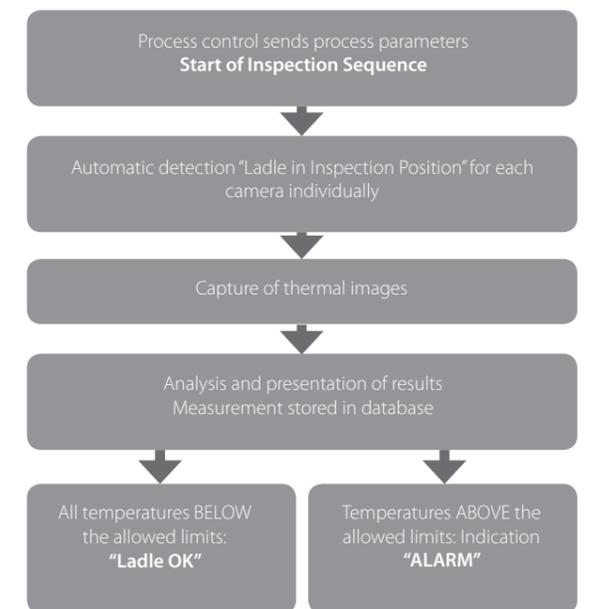
LadleCheck features various interfaces for connecting to your process control, data management and visualization. This comprises ODBC for connecting to a database as well as a data-telegram server for the exchange of process related data via LAN. With its COM/DCOM automation interface the system can be easily connected to a PLC, a process-visualization, or other computers.

### Designed for Steel Plants: Robust and Fail-Safe

The whole system is designed for reliable 24/7 operation in the harsh environment of a steel plant. Integrated self-diagnostic functions impairment will be immediately detected and indicated. All system states are displayed and stored in a log file in the database which grants for a full traceability. With its intelligent reconfiguration-functions the systems is able to eliminate most malfunctions without any user interaction.

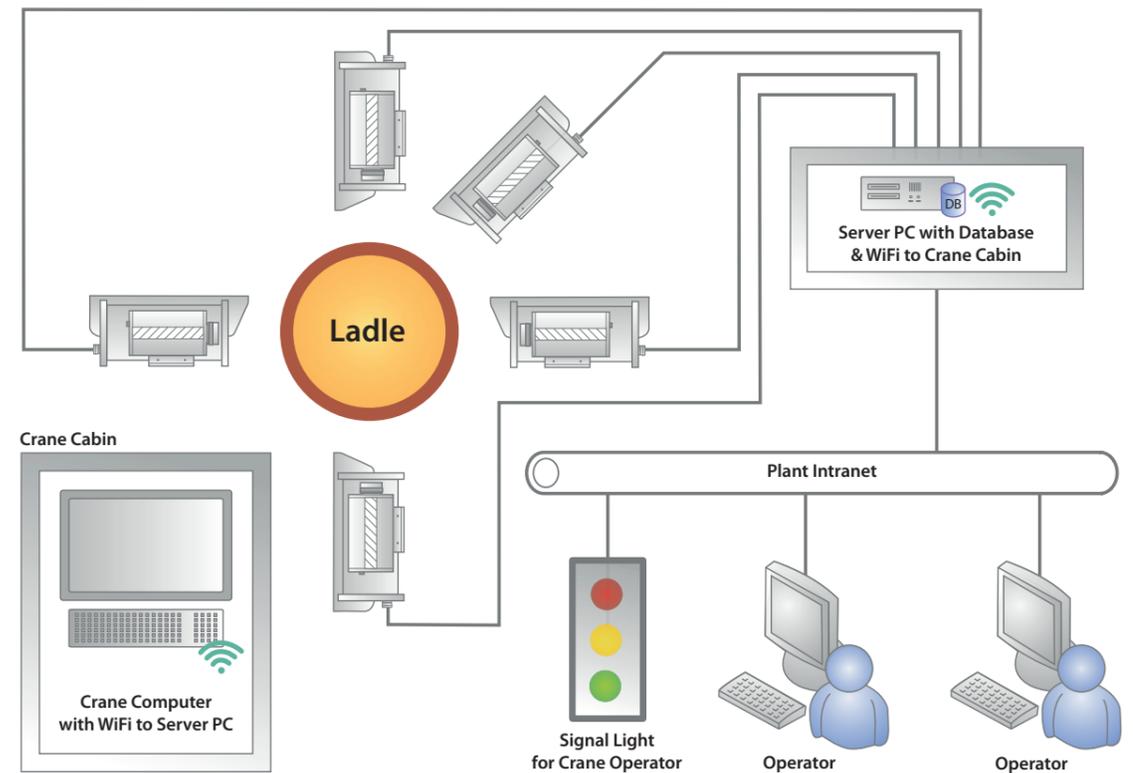


### Inspection Sequence



# LADLECHECK

## SYSTEM SETUP



### Typical Ladle Inspection Station

- 5 thermal cameras in air-cooled enclosures for monitoring the complete outer surface of the ladles
- Server computer with database and web server
- Signal light for indicating the ladle status to the crane operator
- Computer in the crane cabin for the display of details about the current measurement

### Key Advantages

- Improved Safety
- Prevention of liquid steel breakouts
- Early identification of areas with increased wear
- Cost savings: Maximization of the refractory lining service life without safety risks
- Optimized refractory maintenance schedule and strategy
- Comparative evaluation of different refractories

### Key Features

- Fully automated measurement sequence; no operator interaction required
- Modular and scalable: 1 to 5 thermal cameras to cover the whole ladle surface
- 100% traceability: Automatic storage of images, measured temperatures and process related data
- Advanced data management and analysis with database and web server
- Various interfaces for connecting to your process control, data management and visualization



# LADLECHECK SOFTWARE

The application dedicated LadleCheck system comprises the complete functionality for performing the ladle inspections, as well as for storing and analyzing data.

### Fully Automated Inspection Procedure

Inspections are performed fully automatically in the background without any operator actions. The software utilizes highly accurate shape recognition functions and object tracking routines which determine for each camera individually, if the ladle is in the optimum position for performing a measurement. The measurement is the released automatically. With these features the crane driver can focus on his job in the usual way; neither there is a need to drive the ladle to a defined measurement position nor to perform any operating steps for releasing the measurement.

### Configurable Ladle Analysis

The temperature measurement and analysis is fully configurable to allow an optimum adaption to the ladles and production conditions of the steel plant. Temperatures are evaluated in individual areas which can be freely placed within the infrared image of the ladle. With LadleCheck you can use an unlimited number of these so called Regions of Interest, to get arbitrarily fine subdivision for the temperature evaluations on the ladle surface. During and inspection the measured temperature data are compared with preset alarm thresholds. Each exceeding of a threshold will trigger an alarm.

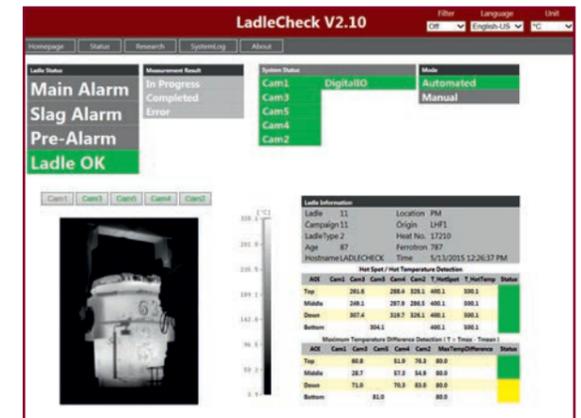
Temperature data outside the Regions of Interest are not considered for the evaluation, which effectively prevents false alerts due to hot objects in the background of the image.

### Advanced Management

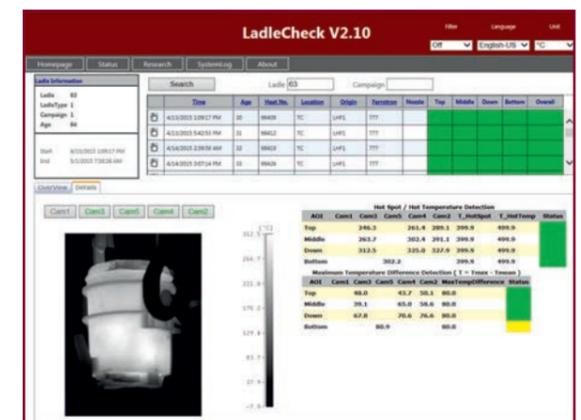
LadleCheck includes a powerful database for automatically storing the temperature data, the thermal images and the process parameters (ladle ID, heat number, campaign, ladle type, measurement location etc.). This allows a long-term analysis for all ladles. The database may also be connected to the intranet of the plant in order to allow data exchange and to pass the data to other data processing systems

### Web application for data display and data mining

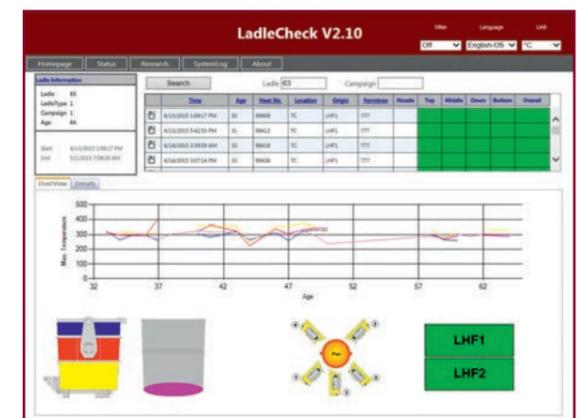
A configurable web-application serves for displaying the inspection results and for performing extensive analyzes. With this concept an unlimited number of users can get simultaneous access by just using a standard web-browser. The web-application includes several pages: A *Status* page gives a complete overview of the currently performed inspection, showing all temperature data, thresholds, thermal images and process-related data. With the *Research* page the user can perform detailed analyzes for all ladles, based on the content in the database. The *SystemLog* page lists all status messages, ensuring a complete traceability of all system functions.



Status page of the web application  
Display of detailed information about the current measurement



Research page of the web application  
Details about previous measurements on the ladle



Research Page of the Web application  
Temperature trend for selectable areas of interest on the ladle



# LADLECHECK

## TECHNICAL DATA

### Thermal Cameras

Maintenance-free thermal cameras with uncooled detector (5 pcs. for capturing the complete outer surface of the ladle). The camera are consistently designed for industrial applications, featuring intelligent processing functions and a standard-GigE-interface for data exchange. They are calibrated with an extended measurement range of up to 600°C for measuring absolute temperatures with high accuracy

Type	IRSX-I industrial IR camera	
Temp. Measuring Range	+40°C bis +600°C	
Temp. Measuring Accuracy	± 2°C oder ± 2% of meas. data	
Thermal Resolution	0,1°C	
Image Pixels	336 x 256	640 x 512
Field of View	25° x 19°	45° x 35°
	Other lenses avbl. on request	
Frame Rate	9Hz or 60Hz	
Detector	Uncooled Microbolometer	
Interface	Gigabit-Ethernet	
Ambient Temperature Range	-40°C bis +60°C	
Weight	310g	
Dimensions	55 x 55 x 87mm	
Protection Class	IP67	

### Camera Housings

Double-chamber protective housings, manufactured from stainless-steel. An air barrier installed at the front side effectively prevents dust formations at the durable Germanium window. All connection cables are guided through one cable gland with a high-temperature-resistant hose at the rear of the housing. Quipped with a wall mount with many adjustable joint, the housings can be easily installed in any required position.

Type	IRCamSafe AIW 168
Housing Material	Stainless Steel
Coolant	Air or Water
Germanium Window	Ø 70 x 3mm, DLC coated
Air Barrier	Adjustable air flow, supply pressure 1-3bar
Cable Protection	Heat resistant hose, configurable length. Resistant to thermal load: up to +1,640°C
Ambient Temp. Range	-40°C to +350°C
Weight	10,5kg
Dimensions	Ø 168 x 505mm
Protection Class	IP67
Mounting Bracket	Heavy duty bracket with joint, made from stainless steel. Load rating 45kg

### Other components

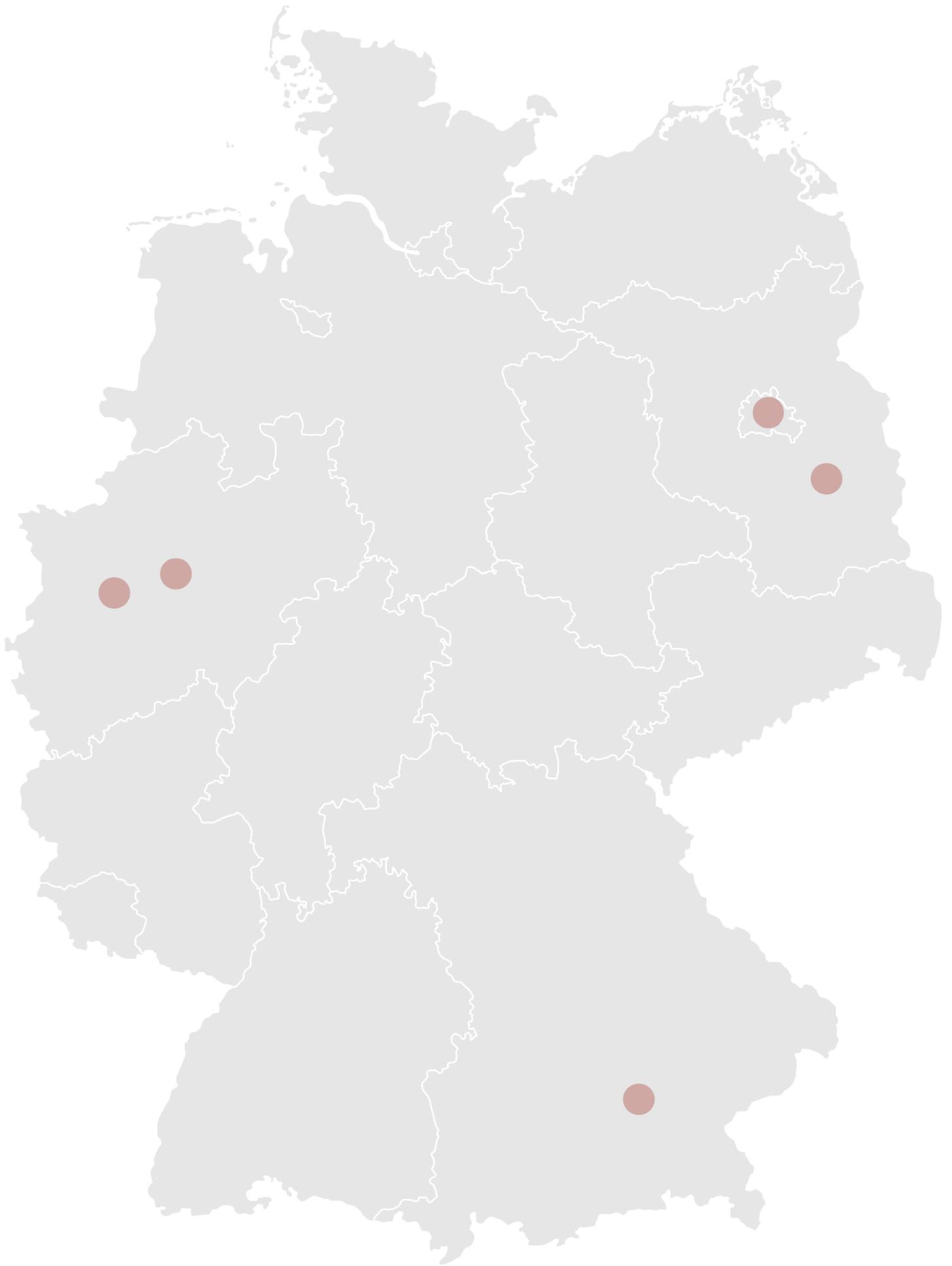
Server Computer	Industry standard server computer, 19" metal case for rack installation. The server computer hosts the LadleCheck measurement software, the database and the web-server
IRCamSafe Controller	Integrated inside the camera housing. The board gives a significantly reduced installation effort, allowing a direct connection to mains power and Ethernet without any additional connection cabinet. It features various sensors to continuously monitor the ambient conditions in the enclosure, thus ensuring a safe operation of the camera. <ul style="list-style-type: none"> <li>• 4 Port Switch with 2 x LWL-LC 100Base-FX or 2 x RJ45 (10/100) Up-Links</li> <li>• 2 internal sensors for temperature; sensors for pressure and humidity</li> <li>• Supports a ring structure of the network for lower cabling complexity</li> <li>• Switchable camera power and heater via Modbus-TCP/IP (controlled by the monitoring software)</li> </ul>

### Interfaces

Web-Server	Ethernet Link
ODBC	OPC
Modbus-TCP	SQL data base
Digital i/O, 24V Input/Output, Potential-Free (Fieldbus Module)	

### Data Link of Cameras and Computer

Gigabit Ethernet
Up to 90m with Industrial Ethernet Cable
Up to 500m with Multi-Mode Glass Fiber Cable
Up to several km with Single Mode Glass Fiber Cable



**PIEPER**

[www.pieper-video.de](http://www.pieper-video.de)  
[info@pieper-video.de](mailto:info@pieper-video.de)

HQ

PIEPER GmbH  
Binnerheide 33  
58239 Schwerte

T: +49 2304 4701 0  
F: +49 2304 4701 77

office Düsseldorf

PIEPER GmbH  
Gumbertstr. 111  
40229 Düsseldorf

T: +49 211 2150 33  
F: +49 211 2150 36

office Berlin

PIEPER GmbH  
Großbeerenstr. 169  
12277 Berlin

T: +49 30 722 52 99  
F: +49 30 722 4487

office Cottbus

PIEPER GmbH  
Calauer Str. 70  
03048 Cottbus

T: +49 355 430 903 40  
F: +49 355 430 903 41

office München

PIEPER GmbH  
Weidenweg 3  
84434 Kirchberg

T: +49 8706 949 77 97  
F: +49 2304 4701 77

Errors excepted. Possible technical alterations without notice.