

Welcome

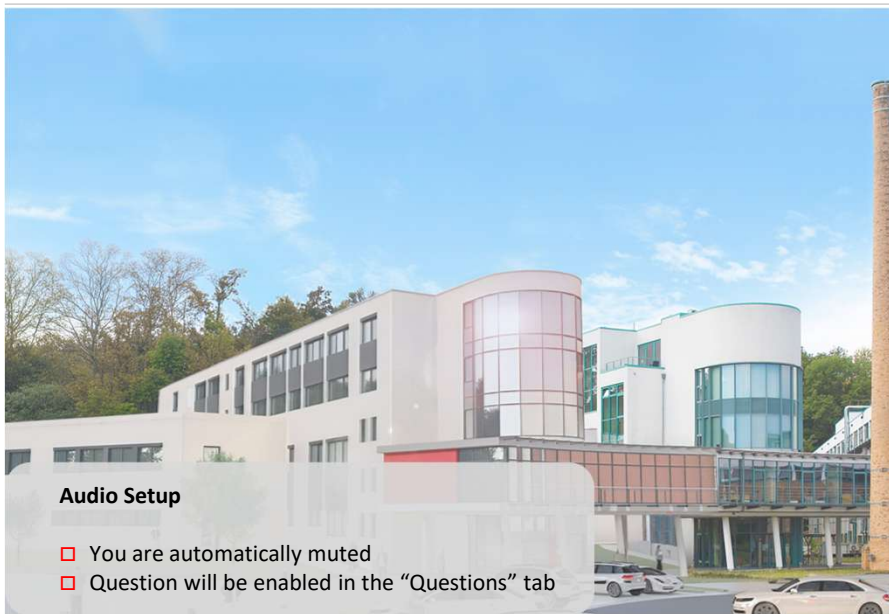
To Our Webinar

Micro-Thermography

Contactless Temperature Measurement in the Micrometer Scale



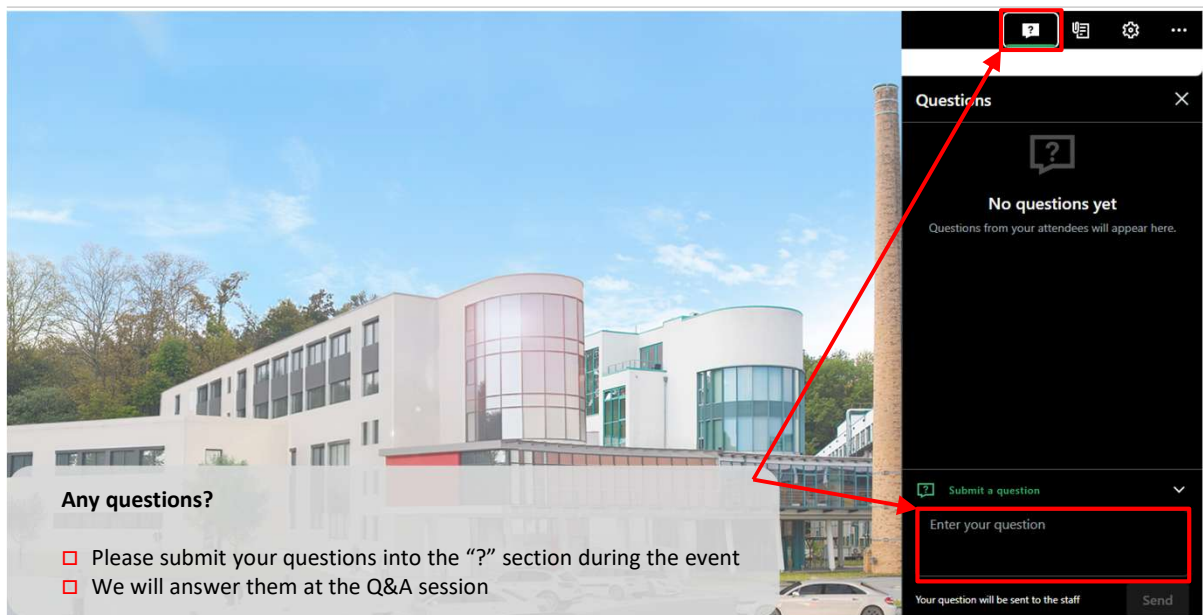
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Audio Setup

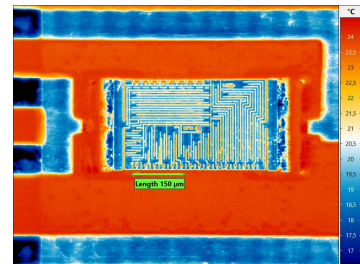
- ☐ You are automatically muted
- ☐ Question will be enabled in the "Questions" tab

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Agenda

- ➔ ☐ Introduction – What is micro-thermography and what is the purpose?
- ☐ Short introduction InfraTec Company
- ☐ Basics of radiation physics and equipment technology
- ☐ Product portfolio in relation to micro-thermography
- ☐ The challenges for micro-thermography and InfraTec solutions
 - ☐ Spatial resolution in relation to available camera technology
 - ☐ Material influences
 - ☐ Use of microscopes – calibration
 - ☐ Measurement set up, vibrations, hardware and software measures
 - ☐ Active thermography
- ☐ Answering your questions



What Is Thermography?

Temperature a Key Parameter of Process and Product Quality

Infrared Thermography



Non-contact



Imaging



Temperature Measuring



No interference with process
and safe working distance



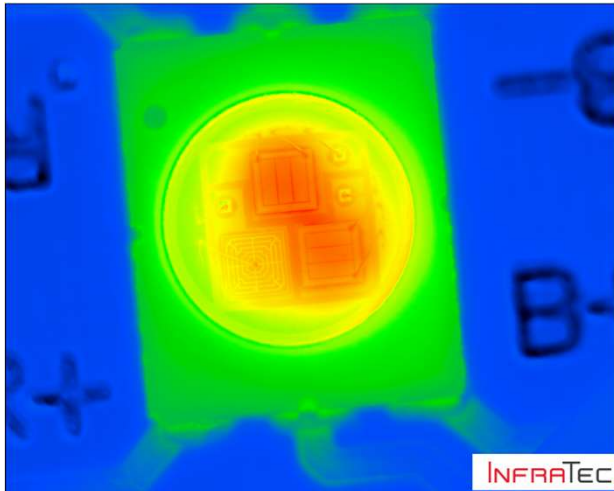
See temperature distribution
not omitting essential parts



Understand and subsequently control heat
to improve processes and products

...And the Micro? ☺

Non-contact Temperature Measurement in the μm Range



ImageIR® 8300 hp

- ❑ (640 × 512) IR pixels
- ❑ M=1.0x, FOV (9.6 × 7.7) mm, IFOV 15 μm
- ❑ Single LED approx. 1 × 1 mm²



RGB LED

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InfraTec - A Long-standing Global Player in Infrared Technology

Overview



FACTS

- ❑ Founded at Dresden in 1991
- ❑ Staff: 250
- ❑ Sensor Division
- ❑ Infrared Measurement Division

MISSION

Infrared technology specialists, offering best service and consultancy to customers and partners

Company Presentation

Sensor Division

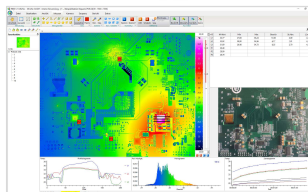
- ❑ Development, engineering and production of pyroelectric analog and digital infrared detectors
- ❑ Production in 1,900 m² clean-room area in Dresden
- ❑ Modular concept with 50 standard detectors offers optimized solutions for nearly each application demands
- ❑ Development and production of customized single and multi channel IR detectors for:
 - ❑ Pyrometry
 - ❑ Gas and flame analysis
 - ❑ Heat and fire detection
 - ❑ Optical measurements



Company Presentation

Infrared Measurement Division: Development, Design and Production of Thermographic Camera Solutions

- ❑ Thermographic systems for:
 - ❑ Research and development
 - ❑ Non-destructive testing
 - ❑ Process and quality control
- ❑ Bespoke solutions for:
 - ❑ Process monitoring
 - ❑ Automatic fire detection
 - ❑ Surveillance
- ❑ Thermography training courses
- ❑ Thermographic services
- ❑ Thermographic software
- ❑ Pre- & after-sales support



Comprehensive Service Concept

In-time After-sales Customer Service for High System Availability



- ❑ > 35 years of thermography experience made available for our customers by:
 - ❑ Well designed products
 - ❑ Comprehensive application support
 - ❑ Feasibility studies
 - ❑ Qualified trainings at our headquarters and at customer sites
- ❑ Rental and lending service
- ❑ Fast service response (24 h hotline)
- ❑ ISO 9001 certified



InfraTec's Sales and Service Network Acts Globally

Experts and Technology where They Are Needed



18th International Sales Meeting 2024

INFRAtec.

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Micro-Thermography

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Worldwide Customers Trust in InfraTec

More than 8,000 thermography solutions for customers all over the world



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Micro-Thermography

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Modes of Heat Transfer

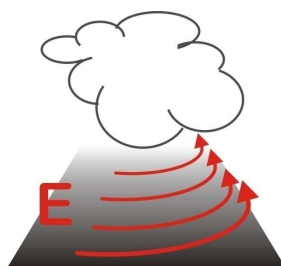
Physical Basics

Heat conduction



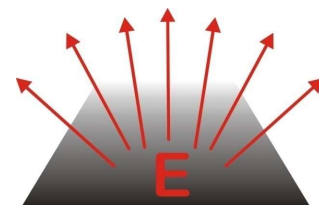
In solids

Convection



Between gases and solids

Thermal radiation



No transmission medium necessary

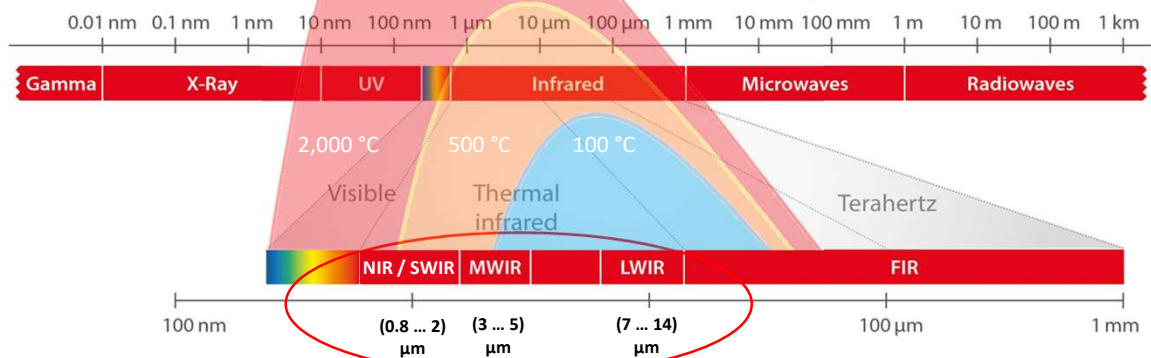
→ Temperature sensor

→ Thermography systems

The Electromagnetic Spectrum and Its Usage for Thermography

Definition

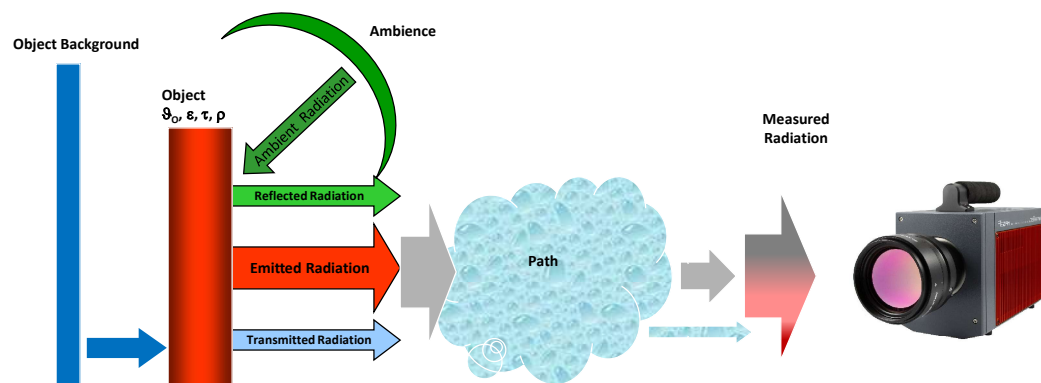
- **Thermography** = Contactless (!) imaging & measuring (!) **InfraRed** radiation with FPA detectors
- Each object / material is emitting **IR radiation** because of its **temperature** > 0 (zero) Kelvin
→ IR-sensitive cameras measure IR-radiation and via Planck's law finally temperature as an **IR/T image**



- MWIR and LWIR bands are most used for T-measurement

Thermographic Measurements

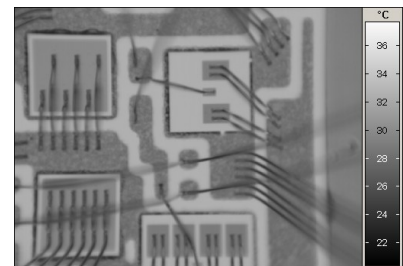
Physical Principle – Radiation Components of the Thermographic Measurement Set-up



Physical characteristics of the measurement object ($\vartheta_o, \epsilon, \tau, \rho$) have a significant influence, e.g. for absolute temperature measurements

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Criteria for the Selection of Suitable Camera Technology

The Heart – The Infrared Detector

□ Photon detectors

- + Very high sensitivity
- + Suitable for spectral thermography
- + **Excellent thermal resolution** and long-term stability
- + Extremely **low integration time in microsecond range, very high frame rates**
- + **Snapshot** readout method
- More costly, complex cooling technology
- Mechanical parts influence lifetime



□ Thermal detectors (microbolometer detectors)

- + Independent wavelength sensitivity
- + **No cooling required**, long lifetime
- + Relatively **inexpensive**
- Time constant in millisecond range
- Long-term stability
- Lower temperature resolution
- Line-by-line readout method



System Cameras

High-Class μ -Bolometer Cameras: VarioCAM® HD(x)



1,024 768 Detector	1,200 °C 2,000	Focus
2,048 1,536 MicroScan	±1 %	Trigger
GigE 240 Hz	≥ 20 mK	IP67

VarioCAM® HD head

- (1,024 × 768) IR pixels native
- (2,048 × 1,536) IR pixels MicroScan
- 30 Hz FF / 60 Hz HF / 120 Hz QF / 240 Hz line
- 15 / 30 / 60 / 120 mm lenses + close-up lenses
- M=1× lens (iFOV 17 μ m)

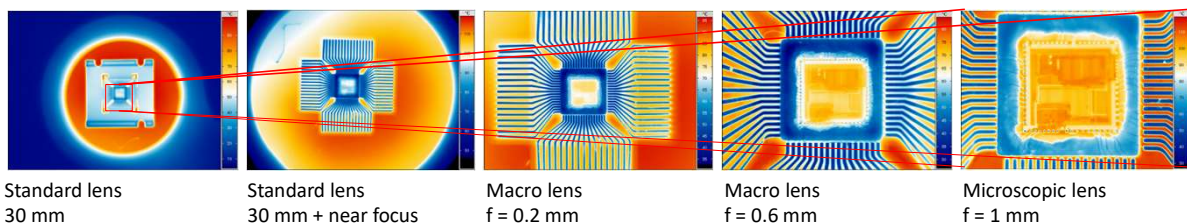
VarioCAM® HDx head

- (640 × 480) IR pixels native (HDx)
- 30 Hz FF
- 10 / 20 / 30 / 40 / 60 mm lenses + close-up lenses

VarioCAM® HD – Range of Lenses

Thermography of Small Objects with Camera Series VarioCAM®

- Example: VarioCAM® field of view representation with VGA detector
- Measured with standard lens in combination with near focus, various macro lenses and microscopic lens



Standard lens

Microscopic lens

ImageIR® High-End Cameras – Flexibility Beyond Resolution

A Modular Concept At a Glance

MADE
IN
GERMANY



2,560
2,048
Detector

105 kHz
640
512
1.105 Hz

MWIR
LWIR

Trigger

Calibration

Software

Meets highest resolution needs:

Thermal – down to 13 mK

Geometrical – up to (2,560 × 2,048) IR pixels

Temporal – up to 105 kHz; 1.1 kHz VGA full-frame

MWIR & LWIR

Exact triggering for data acquisition of very fast processes

Precision calibration up to 3,000°C

Comprehensive range of optics

User-specific software packages



Meet demands in high-speed, lock-in and spectral thermography

High-End Thermography Systems

High-end Cameras of ImageIR® Series – Modular Design for Customer-specific Configuration



Module 0 & 1 (lens/filter module)

- ☐ Lens interface
- ☐ Motorized focus/autofocus*
- ☐ Filter wheel, up to 7 positions*
- ☐ Aperture wheel, up to 5 positions*
- ☐ MicroScan*, fast filter wheel*
- ☐ Shutter*

Module 2 (sensor module)

- ☐ IDCA (detector + cooler)
- ☐ Thermal management
- ☐ Temperature sensors
- ☐ Water cooling*

Module 3 (camera intelligence, interfaces)

- ☐ Camera electronics for control, processing, transmission and storage of data (internal SSD)
- ☐ 10 GigE, GigE, HDMI, USB 3, WiFi, CAMLink*, trigger interface
- ☐ Power on/off, wide-range input (9 ... 36) V DC, UPoE/PoH

* optional

High-End Cameras ImageIR® – Compatible Interfacing

Camera Control & Professional Data Handling

Trigger Interface

- ☐ 3 x OUT / 4 X IN
- ☐ Both digital and analogue IN / OUT
- ☐ (-10 ... 10) V analogue IN / OUT
- ☐ Switchable input impedance
- ☐ IRIG-B
- ☐ Analogue input resolution of 24 bits

Main Functions

- ☐ Power supply
 - ☐ Lemo (connector type 1E 6 pole)
 - ☐ Wide range input (9 ... 36) V
 - ☐ PoE++
- ☐ GigE interface
 - ☐ RJ45; ≥ Cat5e
 - ☐ GigE vision compatible



HighSpeed Interface

- ☐ 10 GigE via SFP

Communication Interface

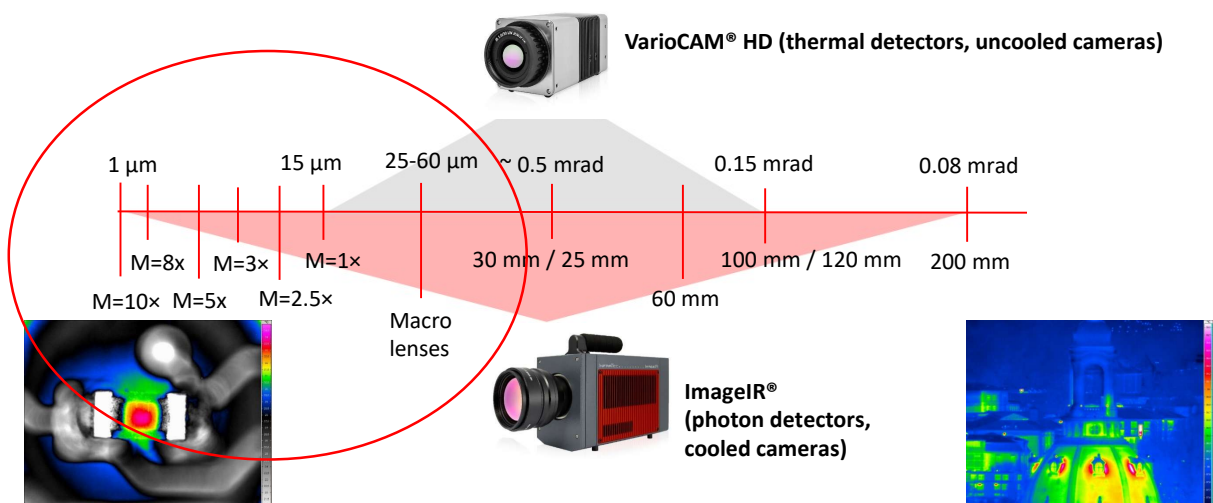
- ☐ Display Port (HDMI adaptor)
- ☐ USB 3.0 (WLAN option, GPS)
- ☐ Web interface

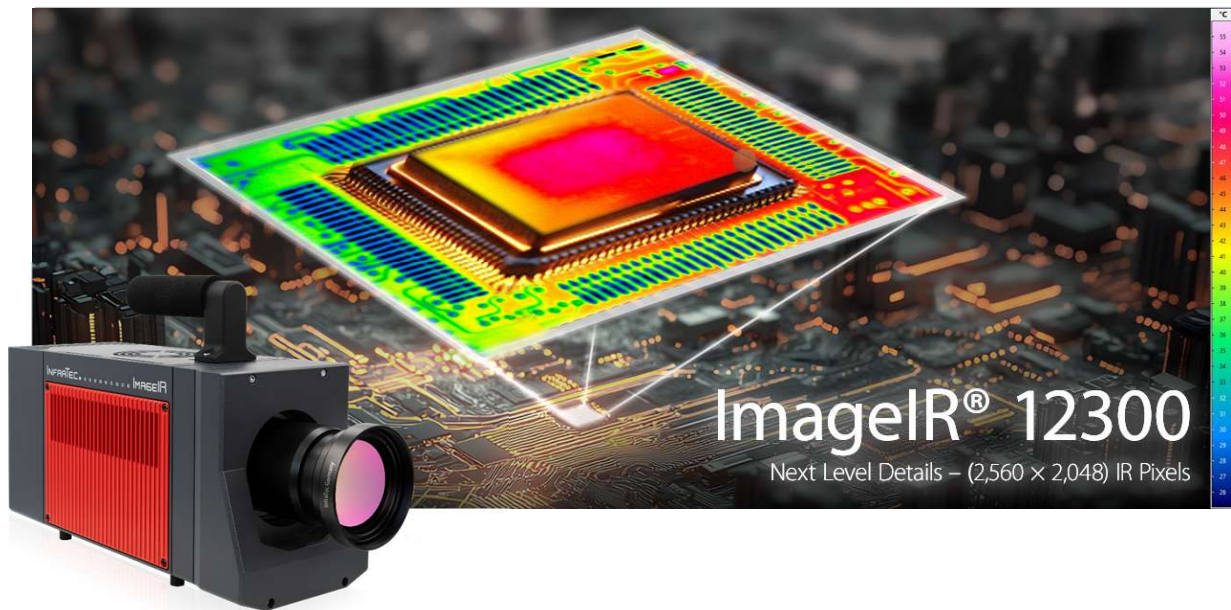
Optional Built-in Storage

- ☐ SSD
 - ☐ Up to 512 GB
 - ☐ Up to 150 Hz SXGA resolution
- ☐ Ultra-High-speed storage inbuilt

Wide Lens Range - A Criteria for the Selection of Suitable Camera Technology

Overview of Available Lenses per Camera Type





ImageIR® 12300 – The Flagship in Spatial Resolution

Next Level Details with (2,560 × 2,048) IR Pixels

5.2
MegaPixel

Detector Format: High resolution thermal images for monitoring large areas by **(2,560 × 2,048) IR pixels**

5 µm
Pitch

Pitch Dimension: Smaller pixel sizes avoids geometrical measurement errors

2,560
2,048
140 Hz

IR-Frame Rate: Analysis of extreme temperature changes and gradients in full frame

High-speed
Mode

High-speed Mode with 1,600 Hz: Increase frame rates and thermal resolution at the same time using binning technology

±1
%

Measurement Accuracy: Highly accurate and repeatable measurements

≤ 20
mK

Thermal Resolution: Precise detection of small temperature differences in high-speed mode



Research and Development

iPhone 6 Touch ID Microscopic Image with ImageIR® 9400 (1,280 × 1,024) IR Pixels

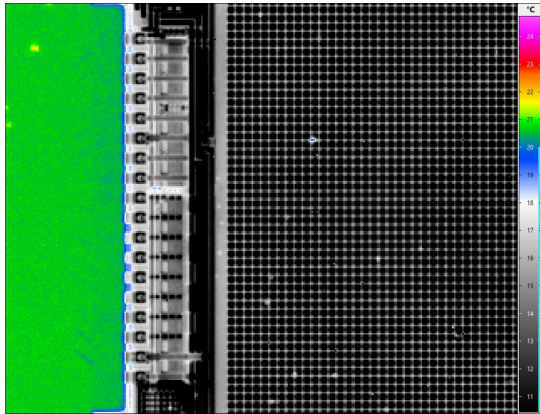


Image with 1.0x microscopic lens (digitally zoomed) → IFOV 10 µm/pixel

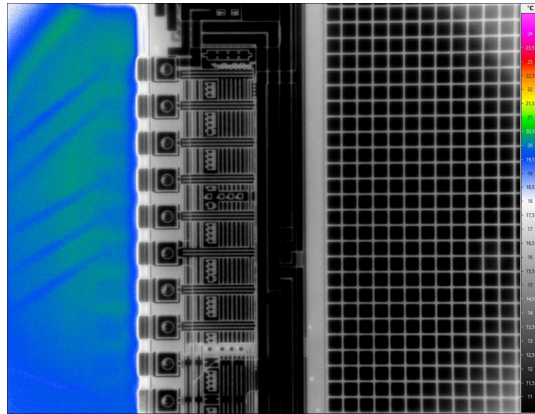
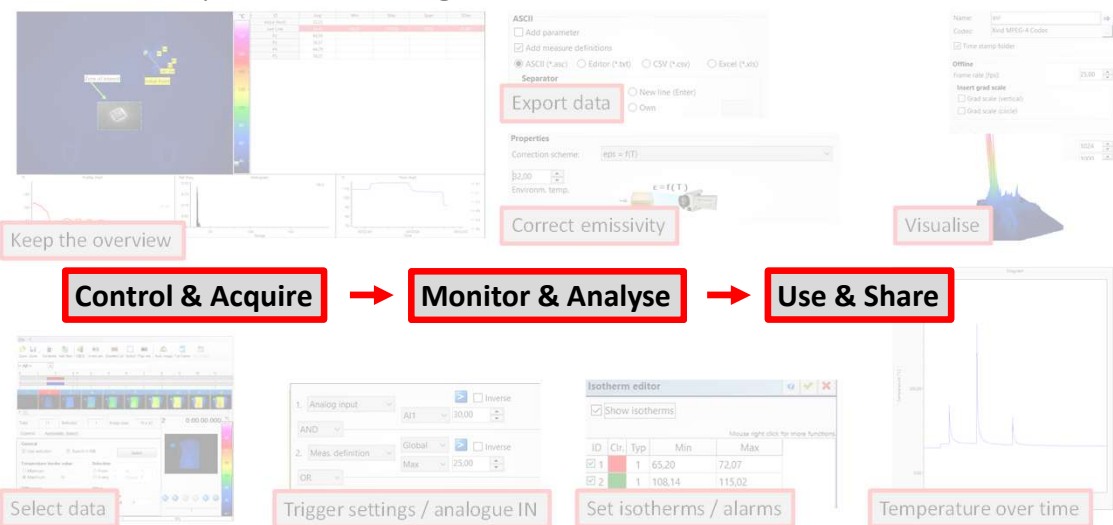


Image with 8.0x microscopic lens → IFOV 1.25 µm/pixel

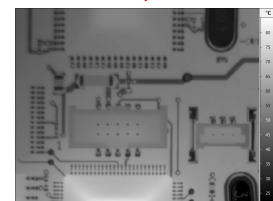
Thermography Software Suite IRBIS® – Complex Measurements at a Fingertip

Focus on Efficiently Make Data Knowledge for Action



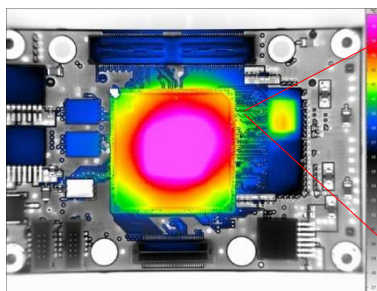
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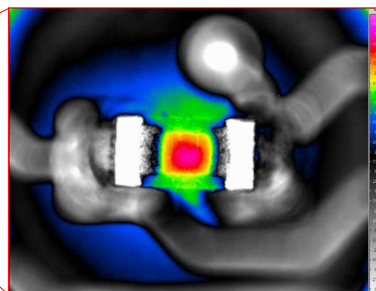


What Does Micro-Thermography Mean for You?

Application-related Contactless Temperature Measurement in the μm Range



Standard range
FOV ~ 10 cm range
IFOV ~ 0.1 mm range
LWIR, MWIR systems
Standard lenses

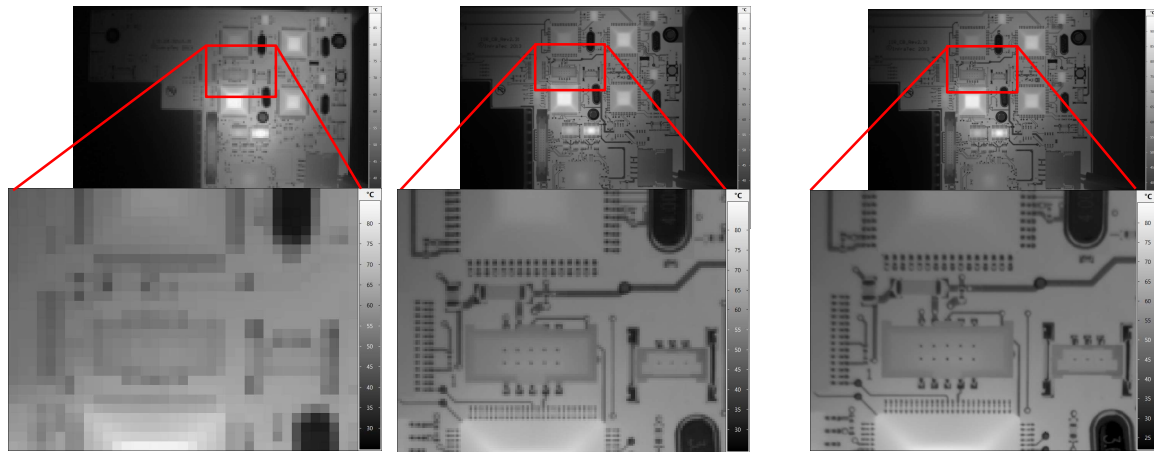


μm range
FOV ~ 1 cm range
IFOV ~ μm range
MWIR systems (LWIR systems)
Standard lenses + macro lenses
Microscopic lenses

"Which camera-lens combination meets my requirements?"

Key for Measurement Precision – Spatial Resolution

Only Details Which Can Be Clearly Resolved Are Measureable



QQVGA detector

VGA detector

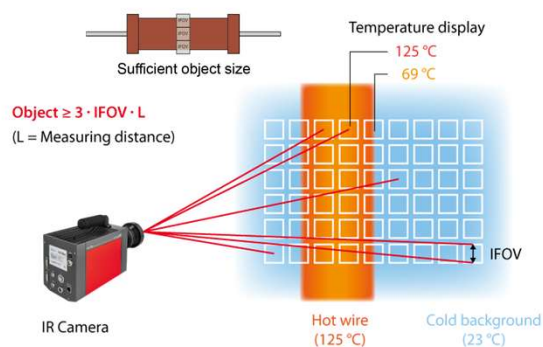
SXGA detector

(Pixel pitch differences can additionally attribute to differences in detail resolution)

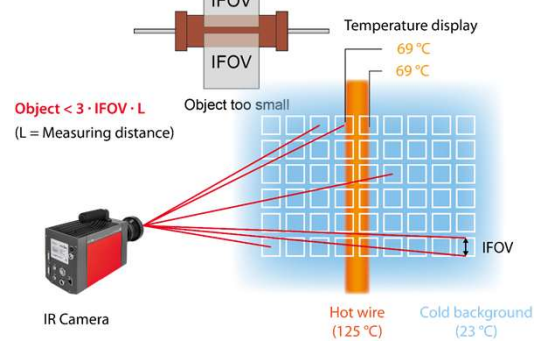
Criteria for the Selection of Suitable Camera Technology

Avoidance of Geometrically Induced Measurement Errors

Sufficient geometric resolution



Insufficient geometric resolution

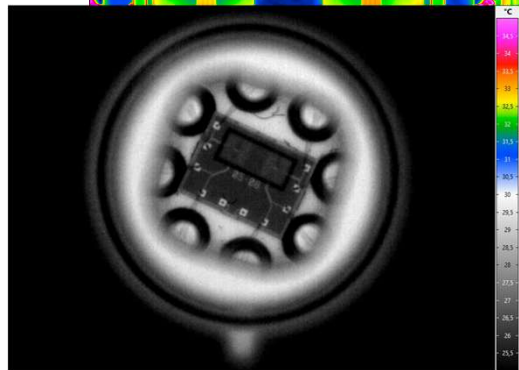
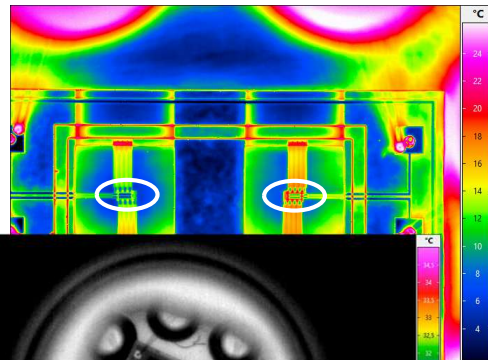


Rule of thumb: Object size / 3 = required pixel size

Example: Suitable Resolution

Micro Heating Element

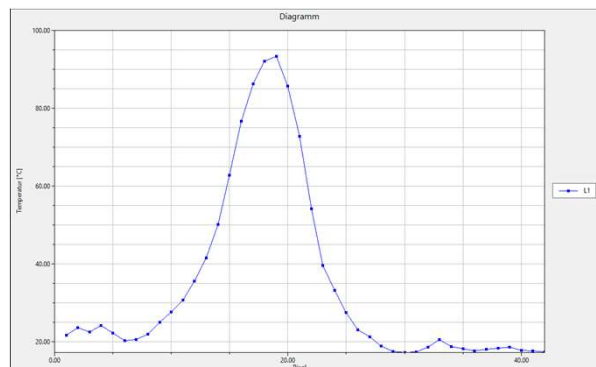
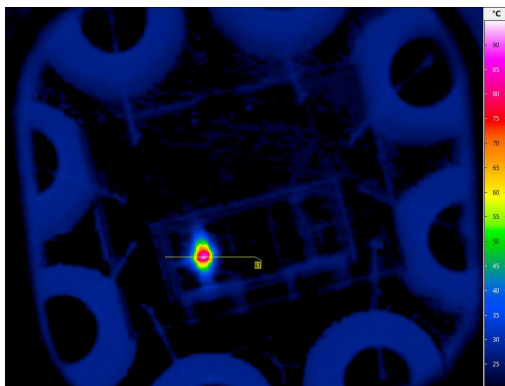
- ❑ MEMS element
- ❑ Two electrical driven heating elements
- ❑ Dimensions ($150\ \mu\text{m} \times 75\ \mu\text{m}$)
- ❑ Distance $\sim 1.2\ \text{mm}$
- ❑ Temperature with constant heating $\sim 95\ ^\circ\text{C}$



Micro Heating Element

Effect of IFOV on Measurements

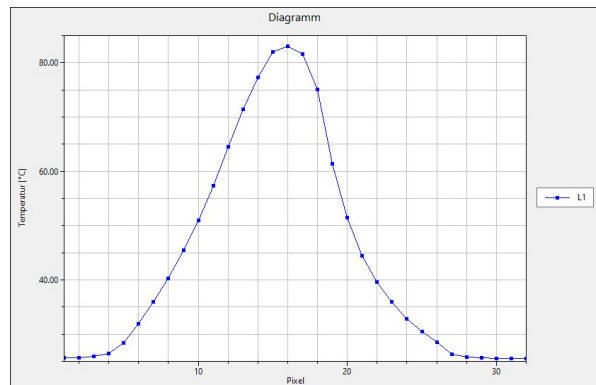
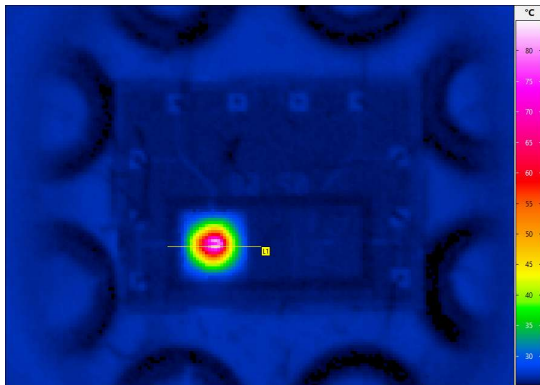
- ❑ Dimensions $150\ \mu\text{m} \times 75\ \mu\text{m}$ → Demand on IFOV $25\ \mu\text{m}$ pixel grid → Target temperature $95\ ^\circ\text{C}$
- ❑ Experiment: $28\ \mu\text{m}$ IFOV / $84\ \mu\text{m}$ MFOV
- ❑ Measurement: $93.0\ ^\circ\text{C}$



Micro Heating Element

Effect of IFOV on Measurements

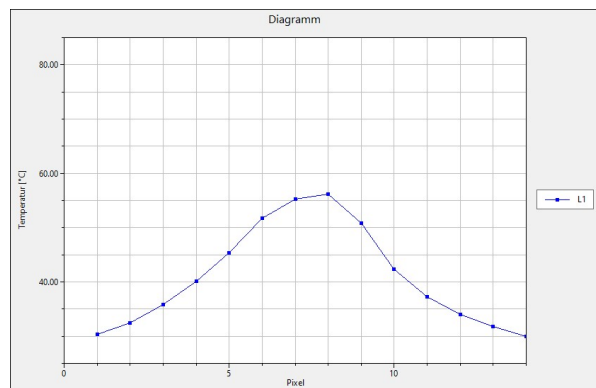
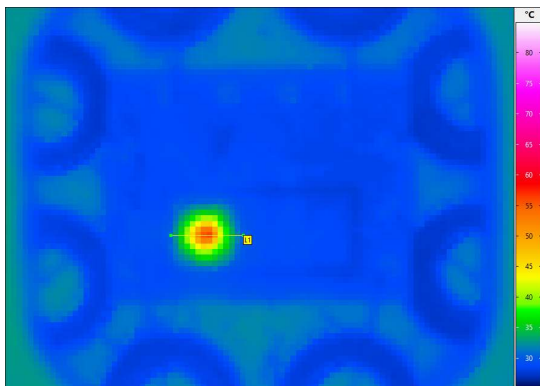
- Dimensions $150\ \mu\text{m} \times 75\ \mu\text{m}$ → Demand on IFOV $25\ \mu\text{m}$ pixel grid → Target temperature $95\ ^\circ\text{C}$
- Experiment: $32\ \mu\text{m}$ IFOV / **$96\ \mu\text{m}$ MFOV**
- Measurement: $83.0\ ^\circ\text{C}$



Micro Heating Element

Effect of IFOV on Measurements

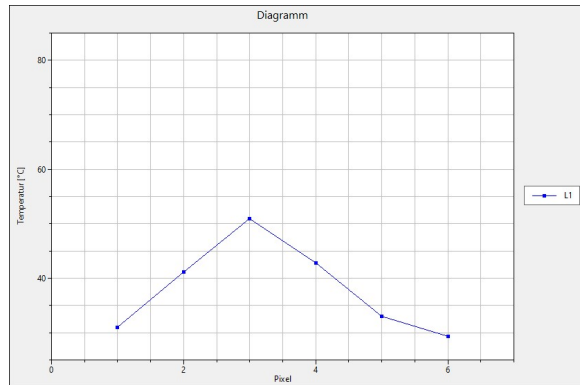
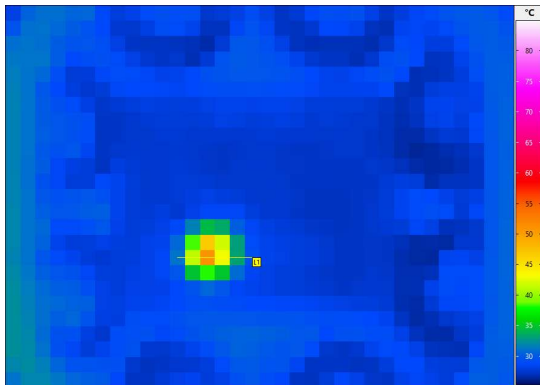
- Dimensions $150\ \mu\text{m} \times 75\ \mu\text{m}$ → Demand on IFOV $25\ \mu\text{m}$ pixel grid → Target temperature $95\ ^\circ\text{C}$
- Experiment: $61\ \mu\text{m}$ IFOV / **$183\ \mu\text{m}$ MFOV**
- Measurement: $56.2\ ^\circ\text{C}$



Micro Heating Element

Effect of IFOV on Measurements

- Dimensions $150\ \mu\text{m} \times 75\ \mu\text{m}$ → Demand on IFOV $25\ \mu\text{m}$ pixel grid → Target temperature $95\ ^\circ\text{C}$
- Experiment: $174\ \mu\text{m}$ IFOV / **522 μm MFOV**
- Measurement: $50.9\ ^\circ\text{C}$



High-End Cameras ImageIR® – Lenses for a Multitude of Applications

Wide Variety of High-quality Infrared Lenses

Standard lenses	12 mm	25 mm	50 mm	100 mm	200 mm			
Close-up lenses	300 mm for telephoto lens 50 mm		500 mm for telephoto lens 100 mm					
Microscopes	M=1.0× WD 40 mm	M=1.0× WD 200 mm	M=1.0× WD 300 mm	M=2.5×	M=3.0×	M=5.0×	M=8.0×	M=10.0×

ImageIR® – Lens Selection

Interplay Between Lens and Detector



	(640 × 512) IR pixels @ 15 µm pitch		(1,280 × 1,024) IR pixels @ 10 µm pitch	
	FOV	IFOV	FOV	IFOV
	ImageIR® 8300		ImageIR® 9400	
Close-up 300 mm	(58 × 46) mm	90 µm	(77 × 61) mm	60 µm
Close-up 500 mm	(48 × 38) mm	75 µm	(64 × 51) mm	50 µm
M = 1.0×, WD40, WD 200, WD 300	(9.6 × 7.7) mm	15 µm	(13 × 10) mm	10 µm
M = 3.0×, WD22	(3.2 × 2.6) mm	5 µm	(2.2 × 1.7) mm (HF)	3.3 µm
M = 5.0×, WD 14	(1.9 × 1.4) mm	3 µm	(2.6 × 2.0) mm	2 µm
M = 8.0×, WD14	(0.6 × 0.48) mm (HF)	2 µm	(1.6 × 1.28) mm	1.3 µm
M = 10×, WD 14	(0.48 × 0.38) mm (HF)	1.5 µm	(1.3 × 1.0) mm	1.0 µm

Field of view calculator: <https://www.infratec.eu/thermography/infrared-camera/field-of-view-calculator/>

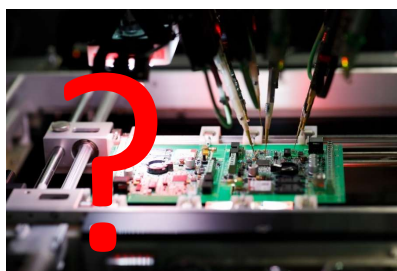
Special Lenses for ImageIR® M=1.0× WD 200 and M=1.0× WD 300

M=1.0× Microscope with Large Working Distance



Microscope =
small working distance

- ☐ M=1.0× WD 40
- ☐ M=3.0× WD 22
- ☐ M=8.0× WD 14
- ☐ M=5.0× WD 14
- ☐ M=10.0× WD 14



Contacting by measurement and test
electrodes requires space above the
measured object



ImageIR® with
M=1.0× WD 200
M=1.0× WD 300



Working distance
200 mm / 300 mm

Advantage of Macro Lenses Compared to Extension Rings

Flexible Lens Combinations

Macro lenses (close-up)

- ❑ Macro lenses with 0.5x magnification
- ❑ Optimisation of FOV and IFOV
- ❑ Attachment to telephoto lenses 50 mm and 100 mm
- ❑ Consistently **high image quality and measurement accuracy**



Extension rings (ER)

- ❑ Installation **between** lens and camera
- ❑ Graduations in 2 mm or 6 mm, combinable
- ❑ Application specific optimisation of FOV and IFOV
- ❑ Reduction of minimum focus distance and limitation of focusing range
- ❑ **Lens-dependent vignetting due to ER**
- ❑ **Negative influence on image quality and measurement accuracy**

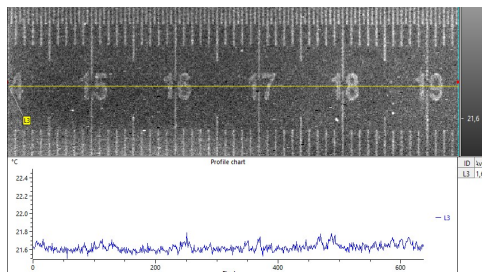


Advantage of Close-up Lens Compared to Extension Rings

Flexible Lens Combinations

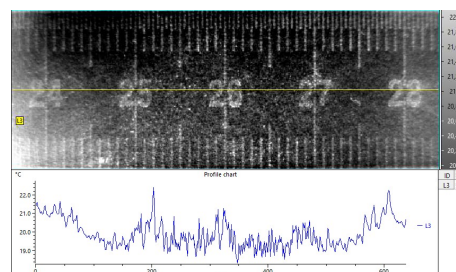
Close-up lens

- ❑ Excellent image quality over the whole FOV



Extension rings

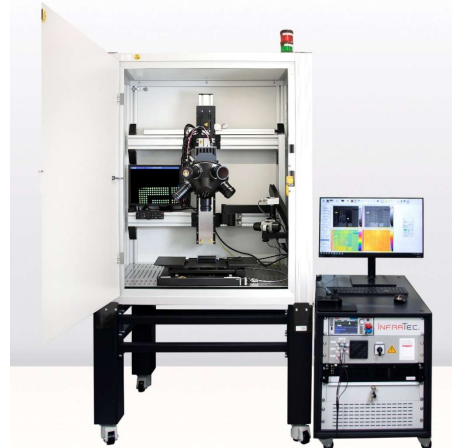
- ❑ Vignetting based on the lens and number of rings
- ❑ Negative effect on the image quality



Multi-Microscopic Measurements

Flexible Lens Change by Turret Solution within InfraTec's E-LIT Test Bench

- ❑ 5 position turret
- ❑ Remotely controlled from E-LIT GUI
- ❑ Flexible for most microscopic lenses by InfraTec



ImageIR® 6300 Z – Resolve Small Details

FOV Flexibility by Zoom Lens Capability



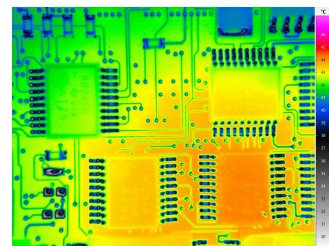
Modern XBN detector, 10 µm pitch



7.5x zoom lens; focal length ranges
(15 ... 115) mm or (25 ... 170) mm



Short working distance starting @ 5 cm for pixel resolutions down to 50 µm

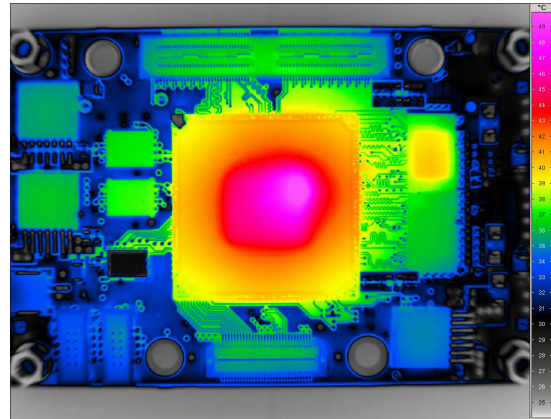


Example – Board (PCB)

From the Overview to the Detail



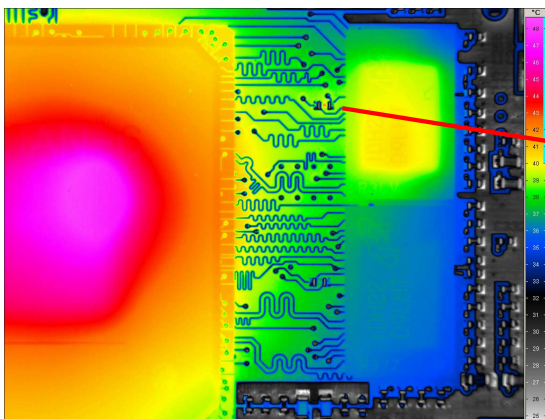
VIS PCB (9 × 6) cm



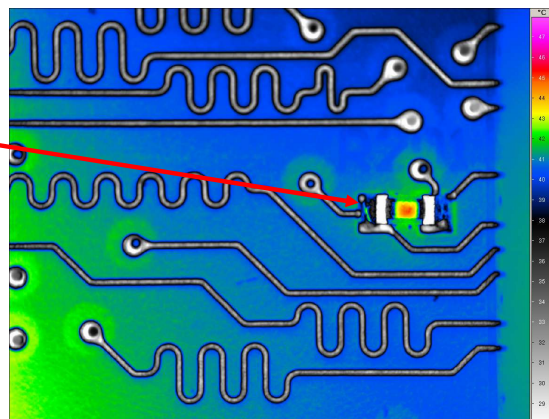
(640 × 512) IR pixels, 25 mm lens, IFOV 180 μm

Example – Board (PCB)

From the Overview to the Detail



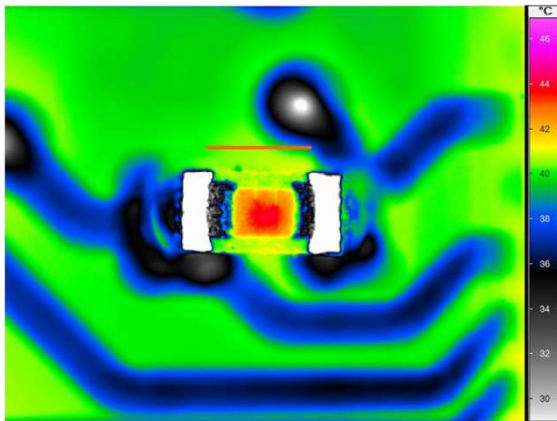
(640 × 512) IR pixels, 100 mm lens with macro attachment IFOV 75 μm



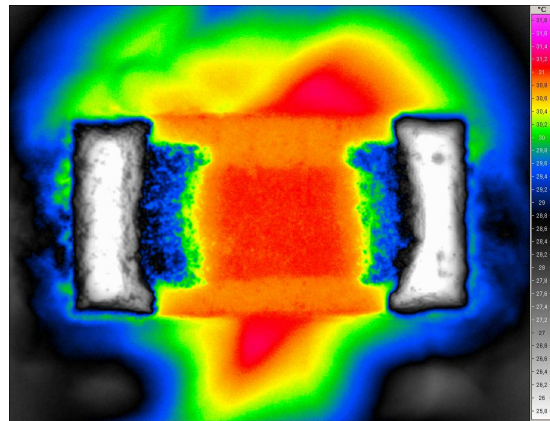
(640 × 512) IR pixels, microscope M=1.0×, IFOV = 15 μm

Example – Board (PCB)

From the Overview to the Detail



(640 × 512) IR pixels, microscope M=3.0×, IFOV = 5 μm
Reference line 1.2 mm

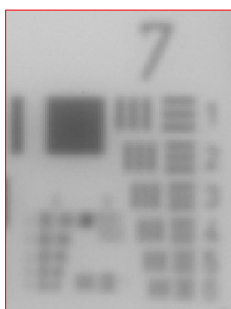


(640 × 512) IR pixels, microscope M=8.0×, IFOV = 2 μm

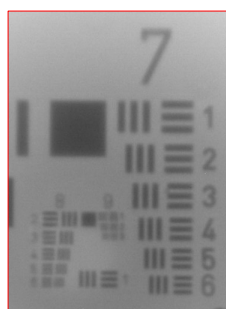
Solid Immersion Lens (SIL) for ImageIR®

InfraTec Development for Microscopic Lenses

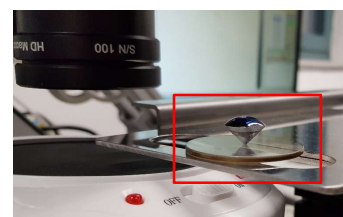
- ❑ Enhancement of the resolution by immersion medium, being mounted at the microscopic lens
- ❑ Microscopic thermal images taken with a SIL (right picture) show a significantly improved resolution of extremely small structures:



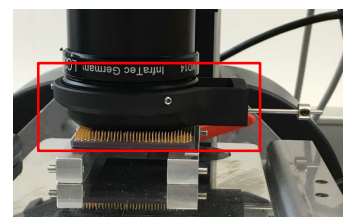
Without SIL



With SIL



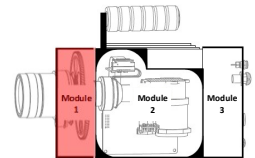
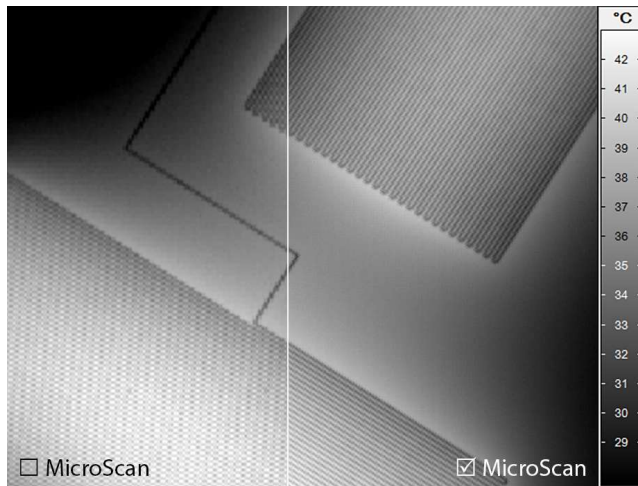
Lens without mount



Lens with mount

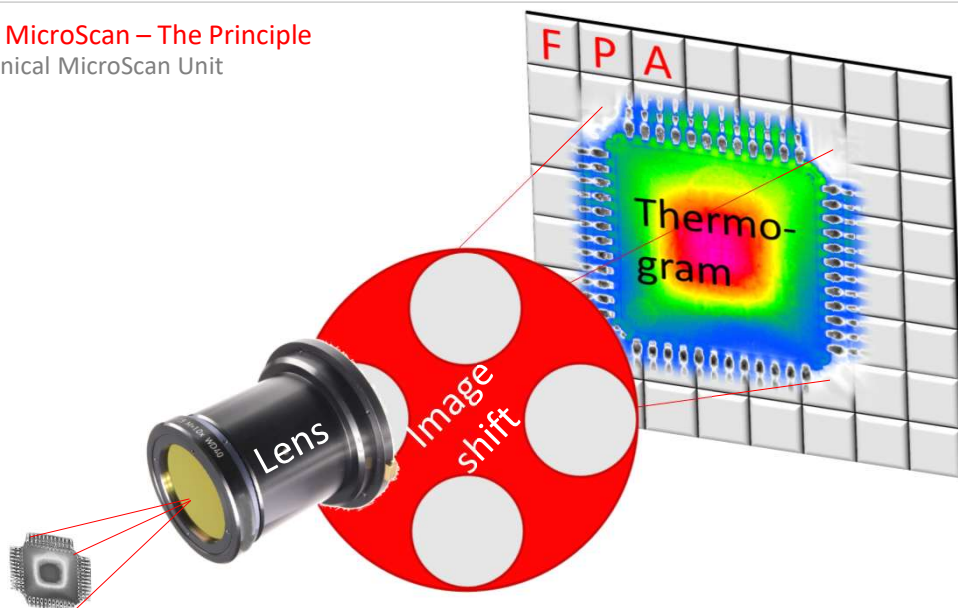
ImageIR® – MicroScan – The Result

ImageIR® 8300 with (640 × 512) IR Pixels



ImageIR® – MicroScan – The Principle

Opto-mechanical MicroScan Unit



ImageIR® – MicroScan – The Scope

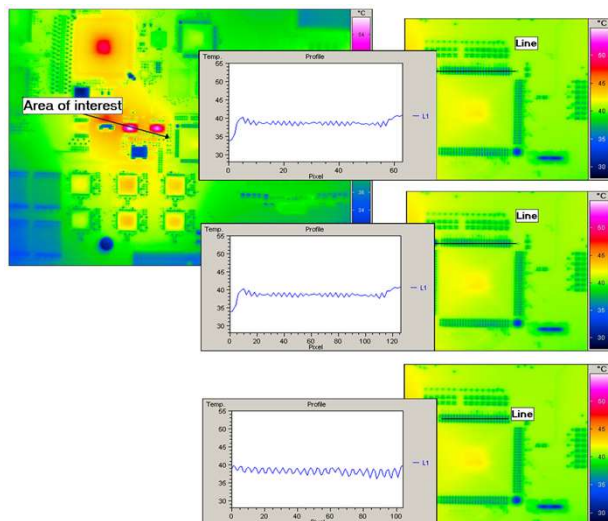
Opto-mechanical MicroScan Unit

- ❑ InfraTec's MicroScan technology offers the following advantages:
 - ❑ 4 times the amount of pixels
 - ❑ Half the pixel raster on the object
 - ❑ Improved image quality (imaging of finer structures, avoidance of artefacts)
 - ❑ Maintenance-free operation and designed for permanent industrial use
 - ❑ High-resolution, high-speed thermography images with a frame rate of up to 350 Hz
- ❑ With MicroScan technology, additional real measurement values are recorded (as compared to interpolation)
 - ❑ **MicroScan formats:**
 - ❑ (1,280 × 1,024) IR pixels = 1.3 MegaPixels
 - ❑ (2,560 × 2,048) IR pixels = 5.2 MegaPixels



MicroScan – Not Just ImageIR®

Comparison Images VarioCAM® with (640 x 480) pixels



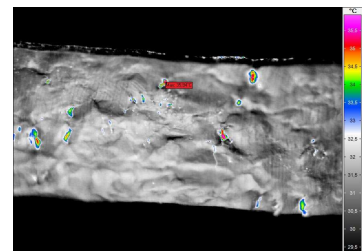
native

Interpolation → no resolution improvement

MicroScanning → resolution improvement

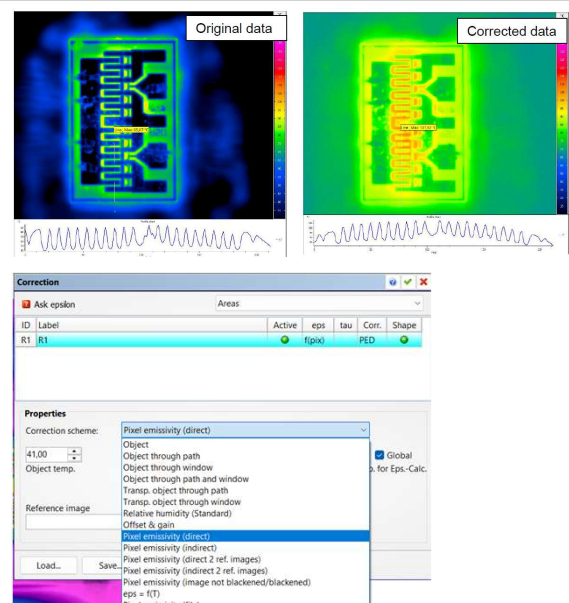
Agenda

- Introduction – What is micro-thermography and what is the purpose?
- Short introduction InfraTec Company
- Basics of radiation physics and equipment technology
- Product portfolio in relation to micro-thermography
- The challenges for micro-thermography and InfraTec solutions
 - Spatial resolution in relation to available camera technology
 - Material influences
 - Use of microscopes – calibration
 - Measurement set-ups, vibrations, hardware and software measures
 - Active thermography
- Answering your questions from the chat



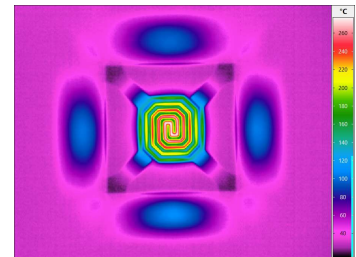
IRBIS® Software – Real-Time Emissivity Correction Solution Approaches for Material Mix

- Emissivities especially in microelectronics unfavourable for absolute temperature measurements
- Blackening only possible for some micro-thermography applications
- Use of correction models implemented in IRBIS® 3
 - Definition of arbitrary correction areas
 - Pixel-wise automatic emissivity correction
 - Consideration of different influencing factors
 - Storage of defined scenarios



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Criteria for the Selection of Suitable Camera Technology

Calibration – Precise and Customised

- Precision calibration incl. **calibration certificate** in measuring ranges (20 ... 500) °C for microscopes (-40 ... 3,000) °C for standard lenses
- **3-parameter calibration** with one main and two secondary curves to compensate for ambient temperature fluctuations enables repeatable measurements and optimum run-in behaviour
- Partially automated calibration of **customer-specific** special measurement ranges



Microscope Calibration and Lens Design

Details on Infrared Lenses, Differentiation Characteristics and Design Targets

□ Design targets and differentiation characteristics

Cold stop design:

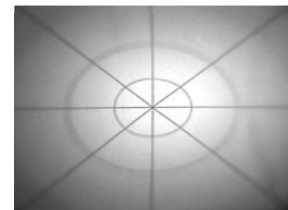
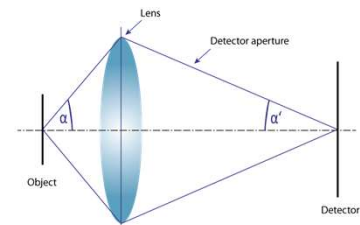
- Full utilisation of the (detector) aperture size
- Good optical resolution and MTF
- Good radiometry

Warm stop design:

- Cost-effective design approach
- With vignetting (homogeneous / at the edges)
- Difficult radiometry (temperature drift due to self-radiation)
- Optimisation possible with retroreflective warm stop or intermediate images

Definition of permissible vignetting

- Vignetting high – cost-effective
- Vignetting low or non-existent – cost-intensive



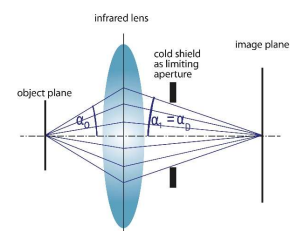
Microscope Calibration and Lens Design

Selection Criteria for an Infrared System

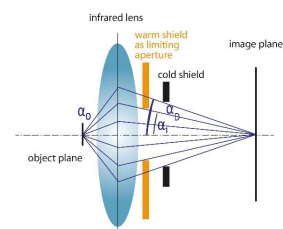
Lens design

- IR lenses are usually designed as so-called cold stop lenses
- The defining aperture is the detector's cold stop
- Apertures in the lens / optical path function as sources of interference, which increases the lower measuring range limit (warm stop lens)
- For higher magnifications, however, an aperture is required, e.g. for $M=8.0\times$
- T_{\min} des $M=8.0\times$
 - Warm stop: 60 °C
 - Cold stop: 20 °C

microscope with $|M| > 1$
 $NA_0 > NA_d = NA$
 cold shield limited design



microscope with $|M| > 1$
 $NA_0 > NA_d = NA$
 warm shield limited design



Criteria for the Selection of Suitable Camera Technology

Details on Infrared Lenses, Differentiation Characteristics and Design Targets

❑ Important characteristics of a microscope lens

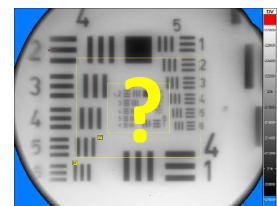
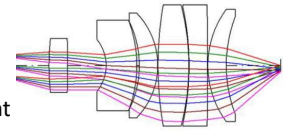
- ❑ Price, measurement distance, compatibility with different detector types, size, weight
- ❑ Spectral range, enlargement factor, brightness / F-number, MTF / imaging quality
- ❑ Radiometry, type of focusing, focus stability / athermalisation

❑ Cost-benefit analysis

- ❑ Lens development cost-intensive
- ❑ Complex lenses with high production costs

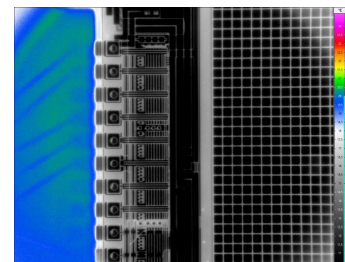
Only high-quality lenses offer:

- ❑ First-class imaging quality
- ❑ Measurements with minimal interference from lenses



Agenda

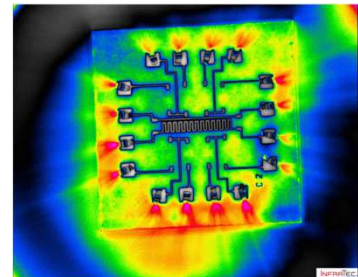
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 - ❑ Use of microscopes – calibration
 - ❑ Measurement set-ups, vibrations, hardware and software measures
 - ❑ Active thermography
- ❑ Answering your questions from the chat



Challenge – Minimize Interference

Counteract / Compensate Vibrations

- ❑ Even minor vibrations can have a very disruptive effect in micro-thermography applications
- ❑ The higher the enlargement of a microscope, the greater the influence of external vibrations on the measurement and test results
- ❑ Vibrations can be transmitted via the IR camera or the measurement and test set-up
- ❑ Cooled IR cameras contain so-called Stirling coolers; the cooled system causes slight vibrations that must be compensated
- ❑ Transmission of mechanical vibrations at the measurement set-up
- ❑ **InfraTec's solution approaches**
 - ❑ Mechanical:
 - ❑ Design measures to reduce / avoid vibrations
 - ❑ Decoupling the vibrations of camera and measurement object
 - ❑ Software:
 - ❑ Compensation using filter algorithms in IRBIS® 3



Micro-heating element,
ImageIR®, M=8.0x

Hardware Based Vibration Reduction

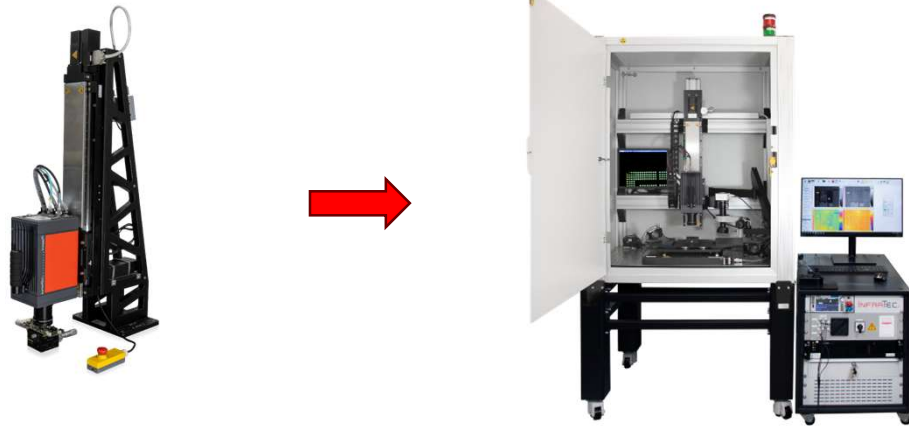
Motorized Microscopic Stand by InfraTec

- ❑ Full range of macroscopic and microscope lenses usable
- ❑ Motorized - for precise adjustment of the measurement distance
- ❑ Remote control directly from InfraTec IRBIS® software suite
- ❑ For fixed mounting on optical tables or breadboards



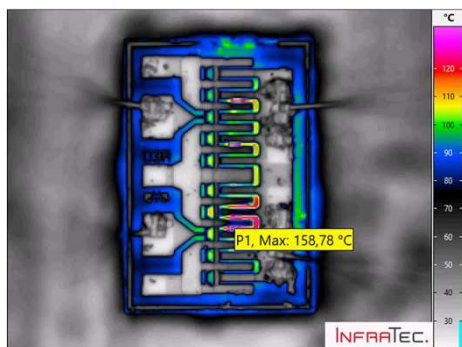
Motorized Microscopic Stand → Electronics Test Bench

More Options for Failure Analysis

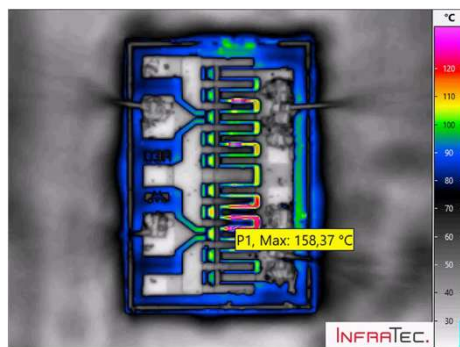


Vibrations in the Measurement Set-up

Compensation by Software IRBIS®



Without software stabilisation

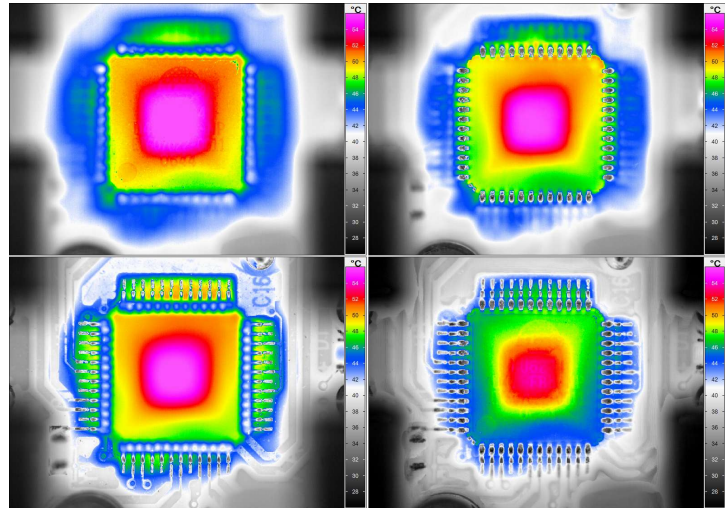


With software stabilisation

Additional Benefit Using Motorized Focus - Multifocus Function

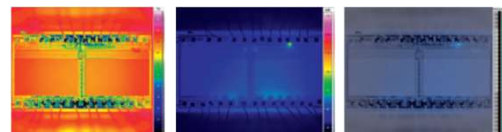
Increase the Depth of Field

- ❑ Constantly sharp image of all object structures in the thermogram, regardless of the object distance as well as the depth of field of the lens used



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- ❑ **The challenges for micro-thermography and InfraTec solutions**
 - ❑ Spatial resolution in relation to available camera technology
 - ❑ Material influences
 - ❑ Use of microscopes – calibration
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- ➔ ❑ Active thermography
- ❑ Answering your questions from the chat

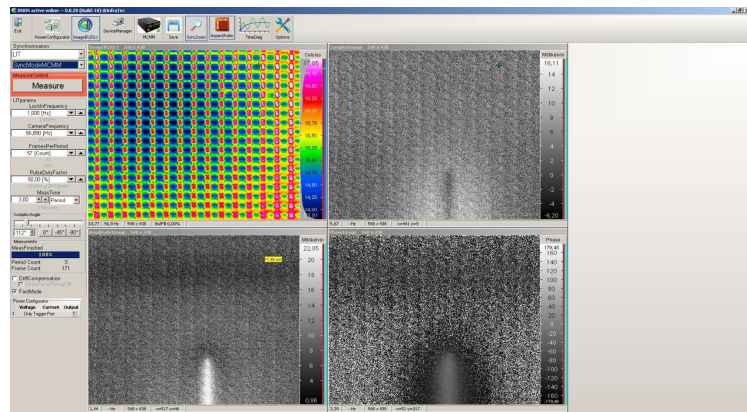


Thermography Software Family IRBIS® 3

Special Software for Active Thermography IRBIS® 3 active online



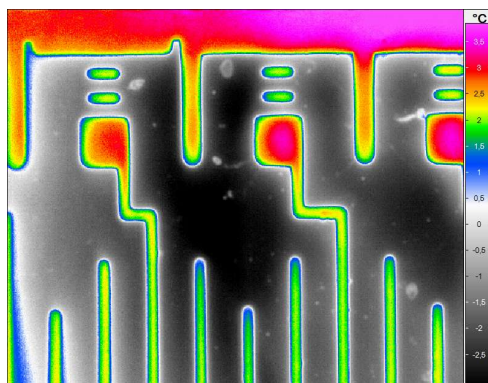
- Contactless defect inspection, e.g. on semiconductor materials (integrated circuits) through active electrical excitation
- Reliably differentiate defective from intact structures and detect temperature differences in the millikelvin and microkelvin range



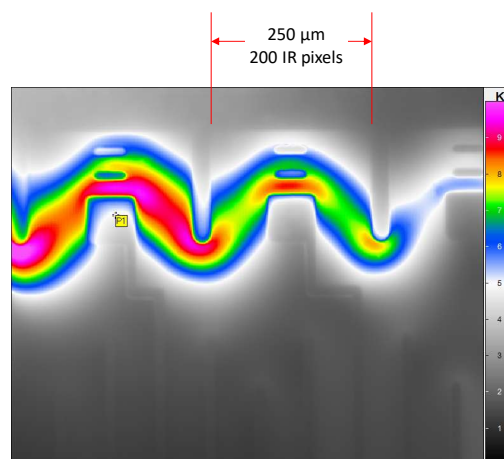
Application Example

Electronics, Microscopy and Lock-in Thermography

- SMD resistor (metal film on ceramic)



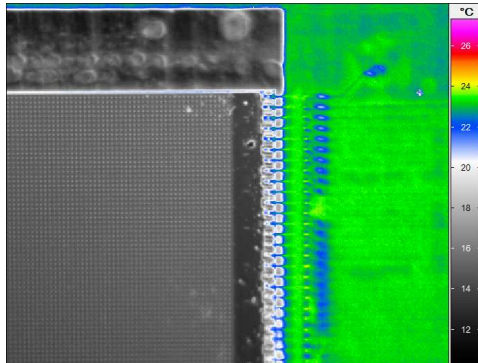
Passive thermography



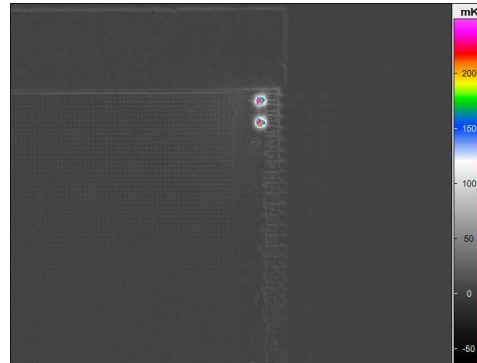
Lock-in thermography amplitude image

Application Example

Failure Analysis / Microchip – Example



Standard thermography image → No defect visible



Amplitude result from lock-in thermography → 2 defect locations

- ☐ ImageIR® 8300 hp with M=1.0× lens due to the small defect areas
- ☐ Normal or differential thermography does not provide any insights
- ☐ Lock-in thermography (electrical excitation) with 25 Hz excitation frequency makes the defects “visible”

Integrated Electronics Test Bench (E-LIT)

Comprehensive Solution Including Lock-in Thermography

- ☐ Combinable components:
 - ☐ Chamber for shielding samples from outside effects during the measurement (e.g. radiation, light)
 - ☐ Lock-in control and analysis software
 - ☐ Sample heating / cooling with thermochuck
 - ☐ Power supply
 - ☐ Probe station to position and contact DUT
 - ☐ X-Y-table for positioning (with image stitching)
 - ☐ Light sources (e.g. spectral measurements)
 - ☐ Turret



Summary

Micro-Thermography – Contactless Temperature Measurement in the μm -Range

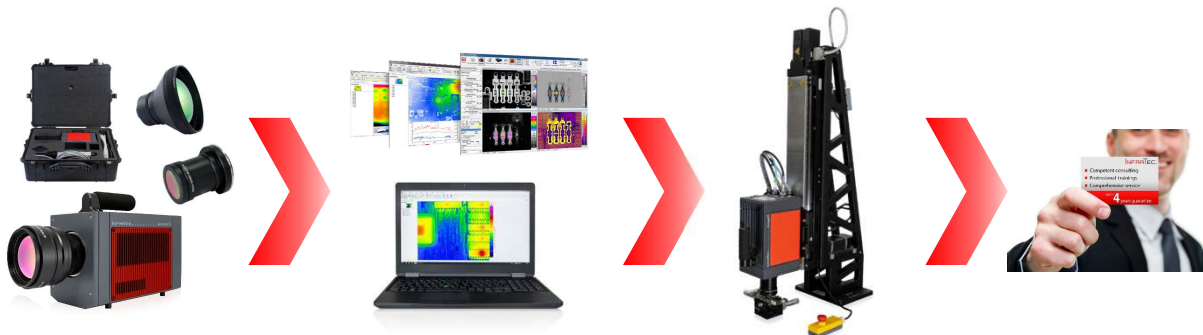
□ InfraTec's Benefits for Micro-Thermography

1. Cooled and uncooled camera solutions with high pixel count and small pitch
2. Flexible range of lenses up to M=10.0× microscope
3. Microscopes with large working distances - 200 mm or 300 mm
4. Minimal lower temperature limits due to optimized lens design
5. Vibration: mechanical decoupling and software compensation
6. Multifocus imaging to widen depth of field
7. Extensive emissivity algorithms to compensate for emissivity-related error effects
8. Lock-in thermographic solutions available
9. Motorized focusing for repeatable, fast and precise adjustment of optimal focus areas
10. Working with professional partners supporting your application



Comprehensive Product Range of InfraTec

Plug & Play – Ready-to-use & Application Specific



- Plug & play systems
- Multiple lenses and calibrations

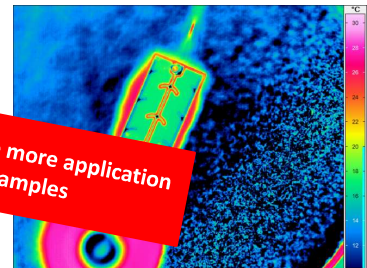
- Application-specific software
- Ready-to-use PC hardware

- Special accessories

- Training and service

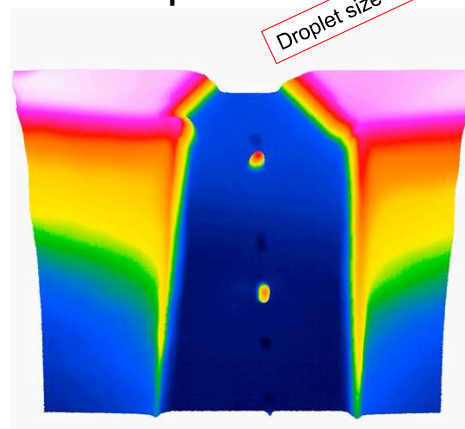
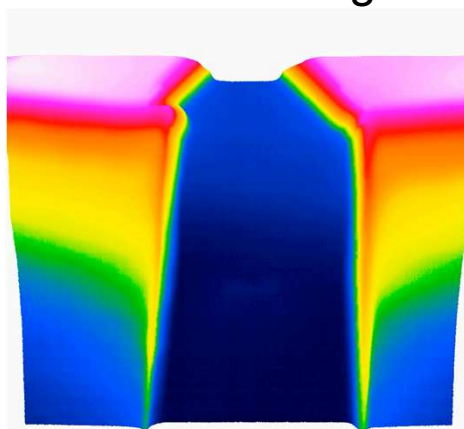
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... and some more application examples

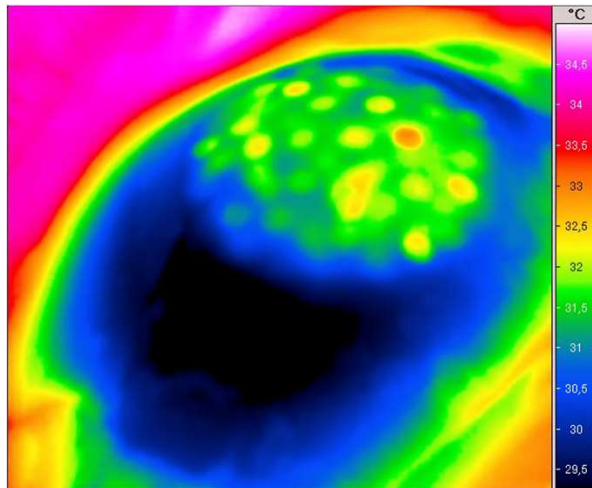
Bestimmung der Tropfentemperatur



Droplet size 300 – 1,000 µm

Application Example

Treatment of the Eye with Laser



- ☐ Laser eye treatment
- ☐ Optimisation of the laser pulses
- ☐ High time and spatial resolution necessary
- ☐ ImageIR®, normal lens + macro attachment lens

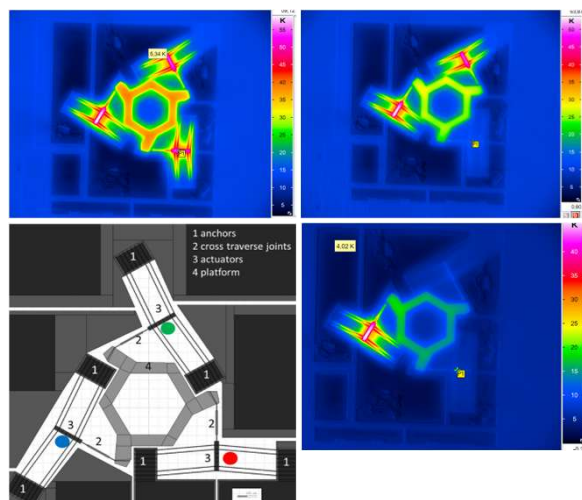
Application Example – MEMS

Micro Actuators with Thermal Drives

- ☐ Micro-actuators for rotary and linear motion in the μm range
- ☐ Use in electron microscopes
- ☐ Thermal actuators move platform (4)
- ☐ R&D using ImageIR®

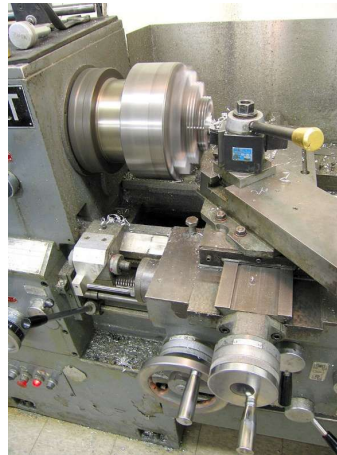
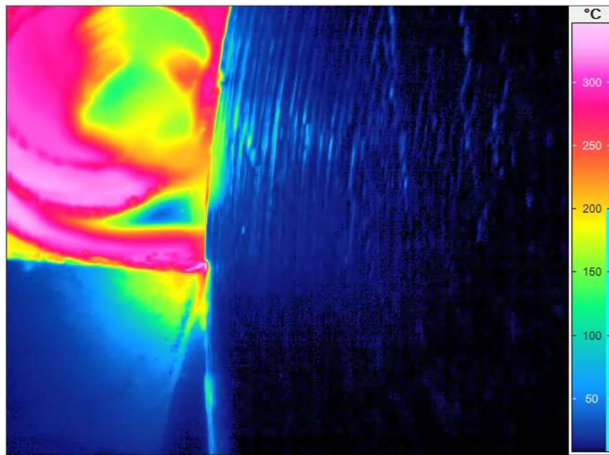


Chemnitz University of Technology
 Professorship of Microsystems and Biomedical Engineering
www.tu-chemnitz.de/etit/microsys/index.php



Application Example – R&D Machine Tools

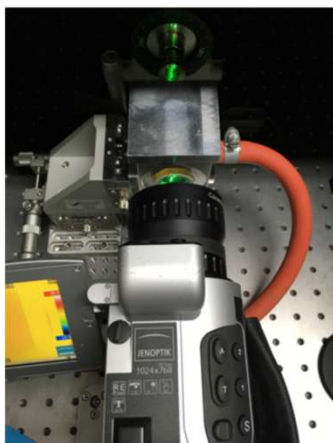
Lathe Optimization



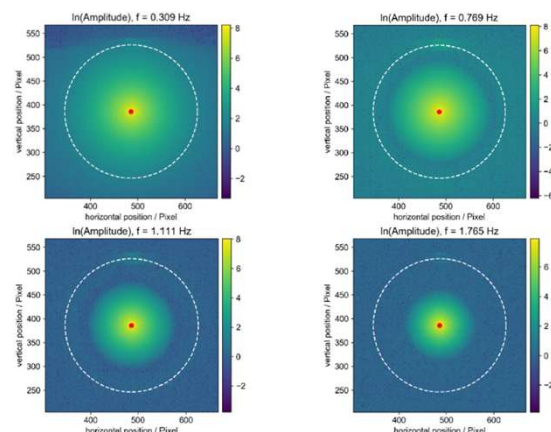
ImageIR® 8300 with M=1.0×: Excellent spatial resolution and high frame rates

Application Example: Polymere

Material Testing with Laser Excitation



VarioCAM® HD with standard lens and macro attachment, measuring chamber with laser excitation



UNIVERSITÄT
BAYREUTH

University of Bayreuth
Chair of Physical Chemistry 1
<http://www.retsch.uni-bayreuth.de/en/>

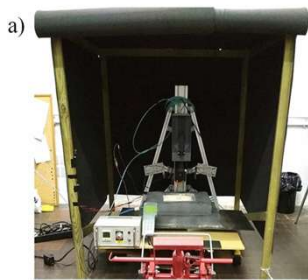
Application Example: Physical Chemistry

Behaviour of Liquids with Nanoparticles

Professional article at [Nature.com](https://www.nature.com)

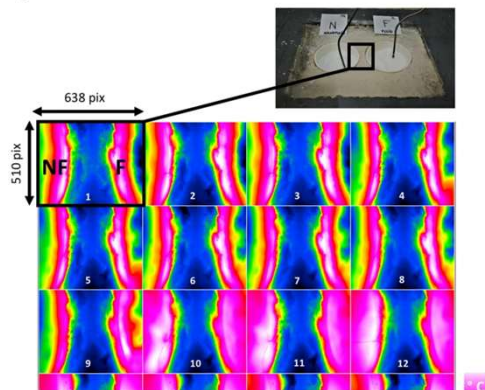
„Understanding the abnormal thermal behavior of nanofluids through infrared thermography and thermo-physical characterization“

Adela Svobodova-Sedlackova et. al, University of Barcelona



ImageIR® and motorised focus bench

Figure 1



Personally Get in Touch With InfraTec

Meet Us at the Following Events



SENSOR+TEST / June 09 – 11, 2026
Nuremberg, Germany



FeuerTrutz / June 24 – 25, 2026
Nuremberg, Germany



QIRT / June 30 – July 03, 2026
Naples, Italy



THERMINIC / September 16 – 18, 2026
Berlin, Germany



ISTFA / October 04 – 08, 2026
Pasadena, USA

Online Events:

Thermography for Industrial Automation: Quality Assurance at the Highest Level August 26, 2026

Spectral Thermography – Basics and Application September 2, 2026

Thermography Compact – Enter the World of Infrared Technology September 9, 2026

Infrared Lock-in Thermography for Inspection of Electronics and Integrated Circuits November 4, 2026

For more on-site and on-line events please check out our websites:

www.infraTec.eu
www.infraTec-infrared.com



Thank you for your attention!

Questions will be answered now or afterwards in writing.
Presentation slides are given to all participants who fill in a feedback sheet when leaving the webinar.

Get in touch with us – not just for Micro-Thermography!

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