

# Vibro- Thermogrady

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## Method for:

- **Detecting Cracks in complex constructions.**
- **Visualising thermal responses from elastic effects.**
- **Localisation of bonding defects.**

# Vibro- Thermograpy

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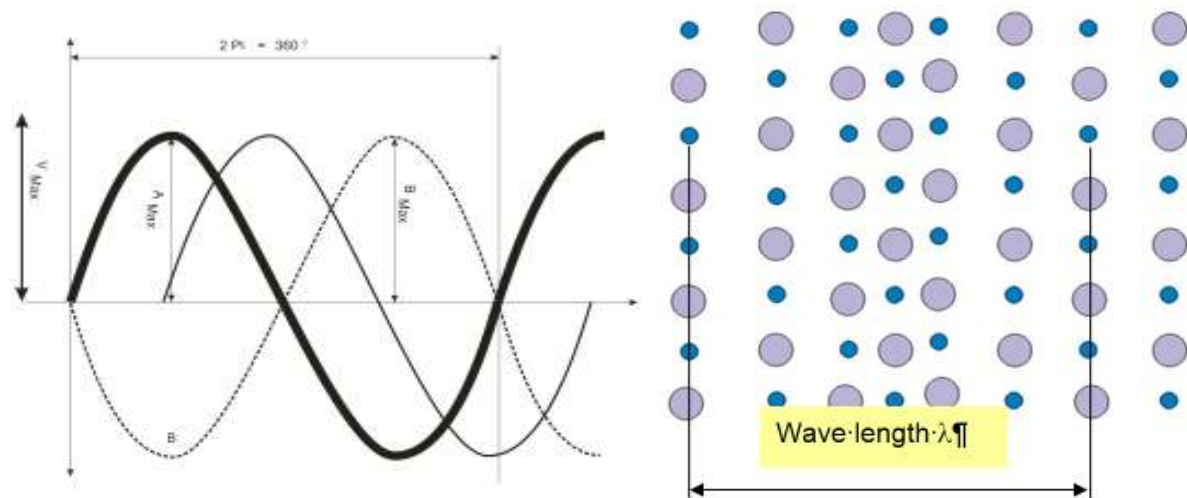
- Acoustic Thermography
- Thermoelastic effects
- Ultrasound thermography
- Elastic wave activated thermography
- Thermoelastic

## What is behind the idea?

# Vibro- Thermography

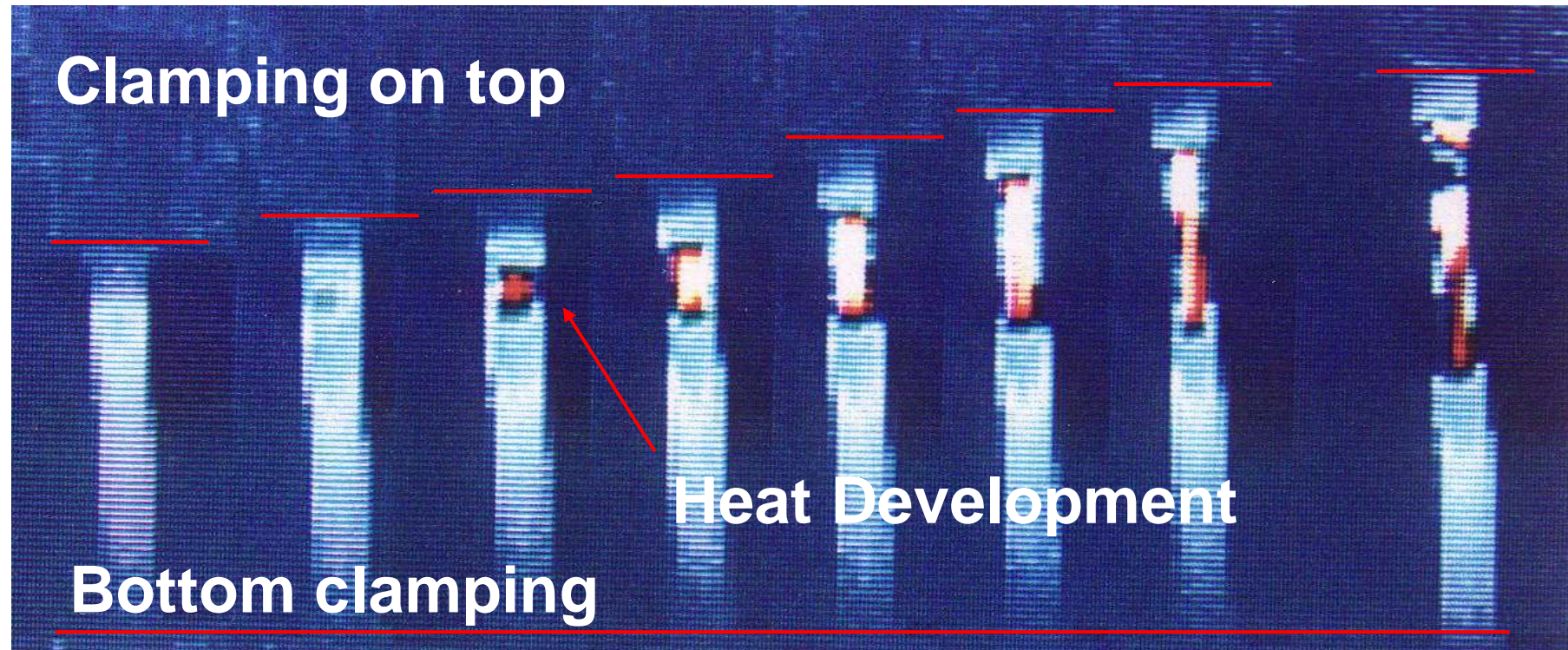
The idea is to provoke thermal responses by activating the object with mechanical waves.

## Vibration



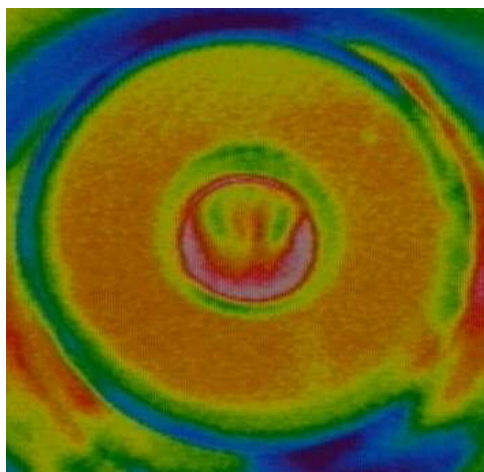
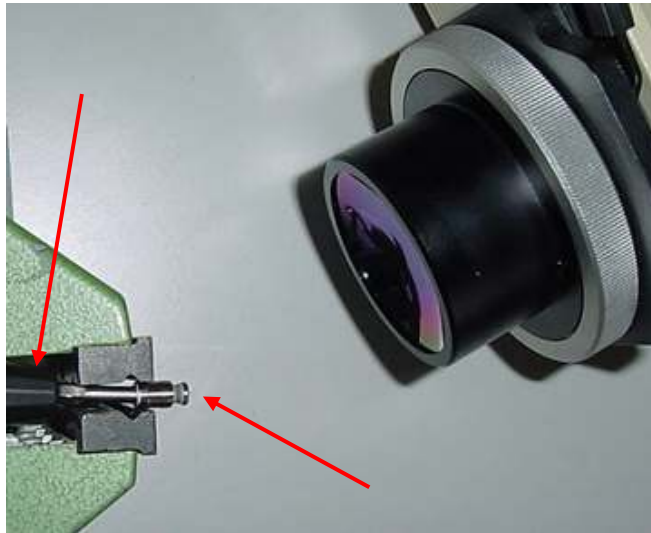
## Thermography

# Vibro- Thermograpy

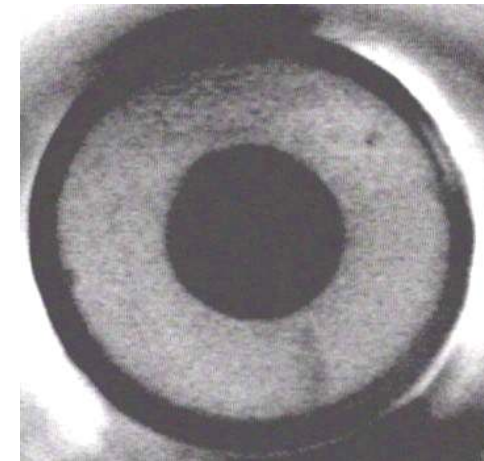


**8 pictures of the development of the temperature in the material during a tensile test as a function of the force ( $\sigma_{x,y,z}$ ). (Picture taken in 1980)**

# Vibro- Thermography



**Development of the temperature between two materials, based on vibration of the adhesive layer.**

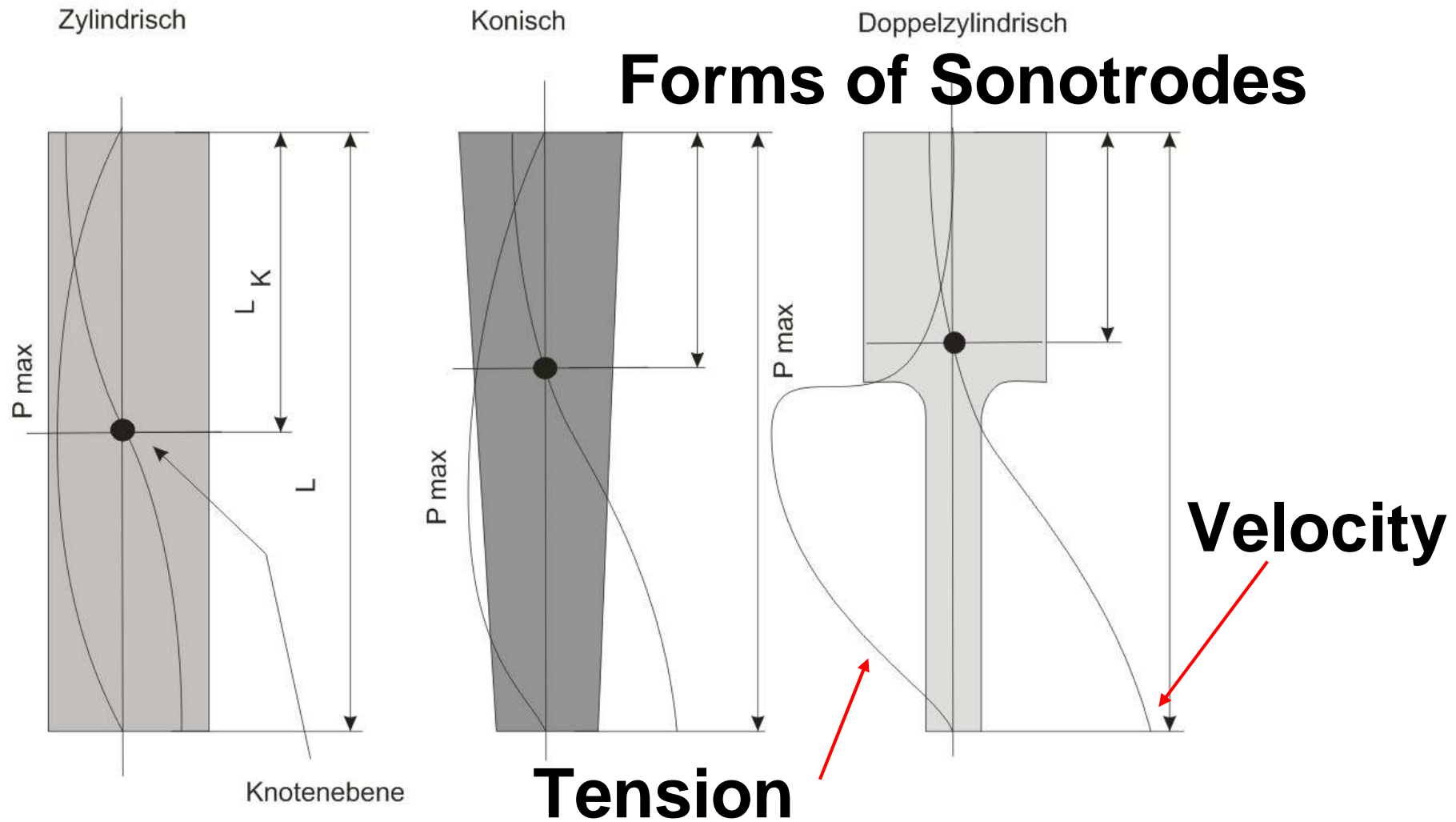


# Vibro- Thermograpy



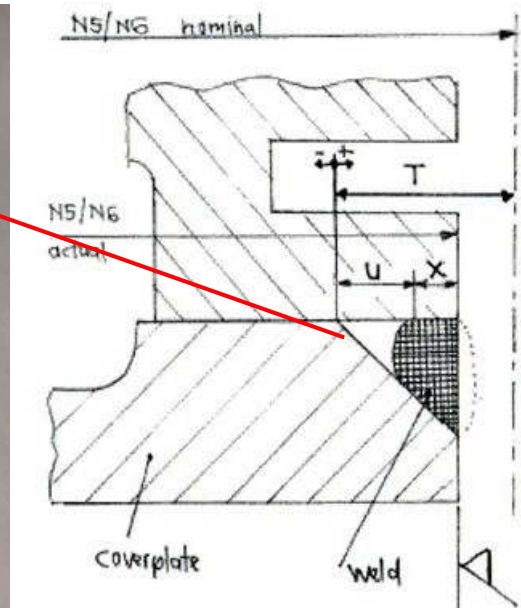
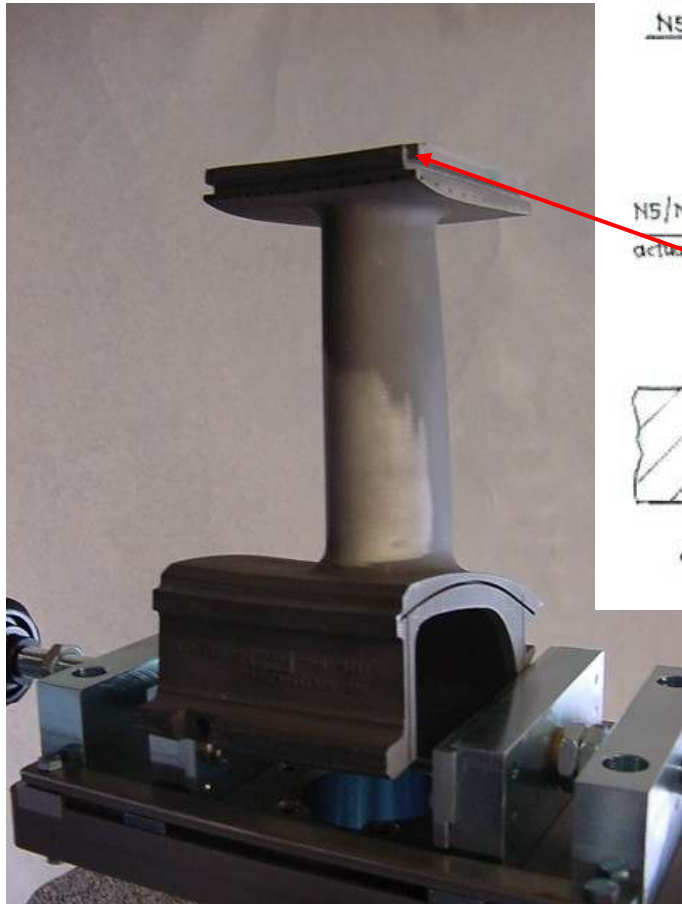
**Standard Booster**  
**Frequency 20 kHz fix**  
**Stroke 10  $\mu\text{m}$  up to 40  $\mu\text{m}$**



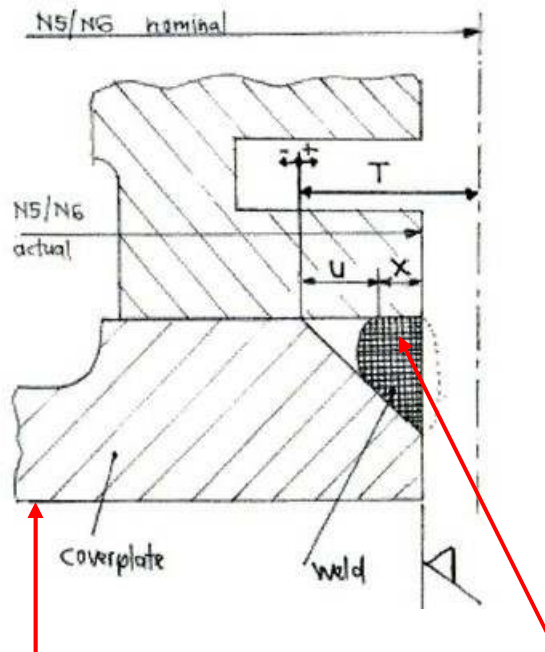


# Vibro- Thermograpy

Is it possible to locate bad welding seams with the vibrothermography?

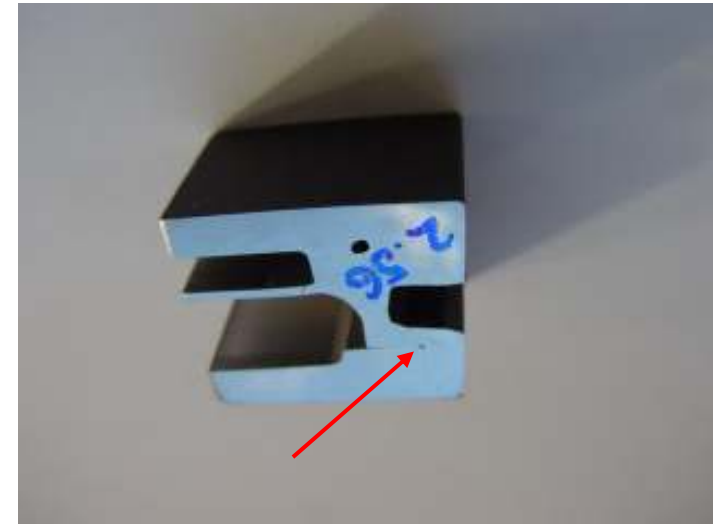


# Vibro- Thermogrady

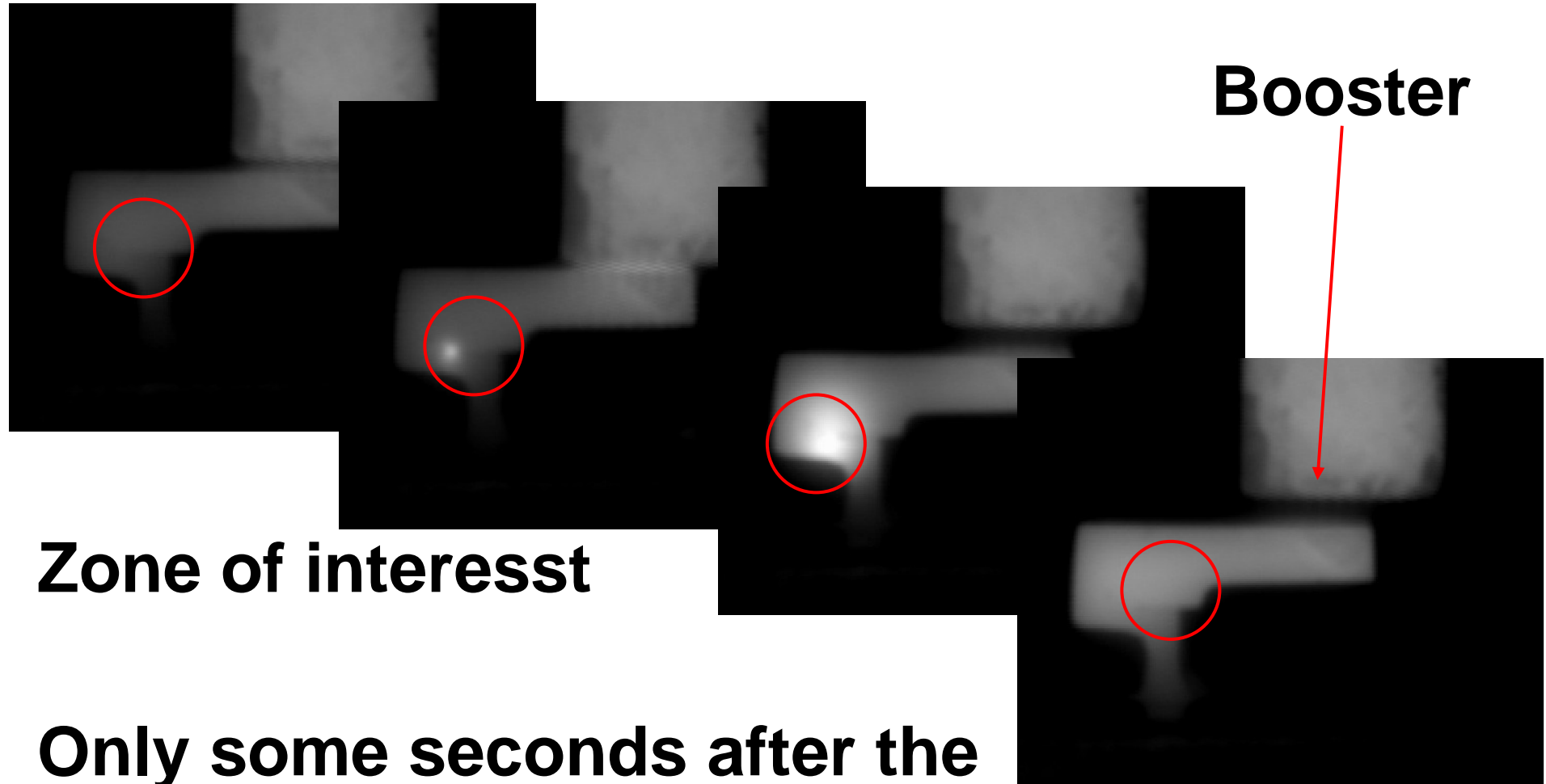


In the cross-section are differences in the welding clearly seen.

**Activated zone**



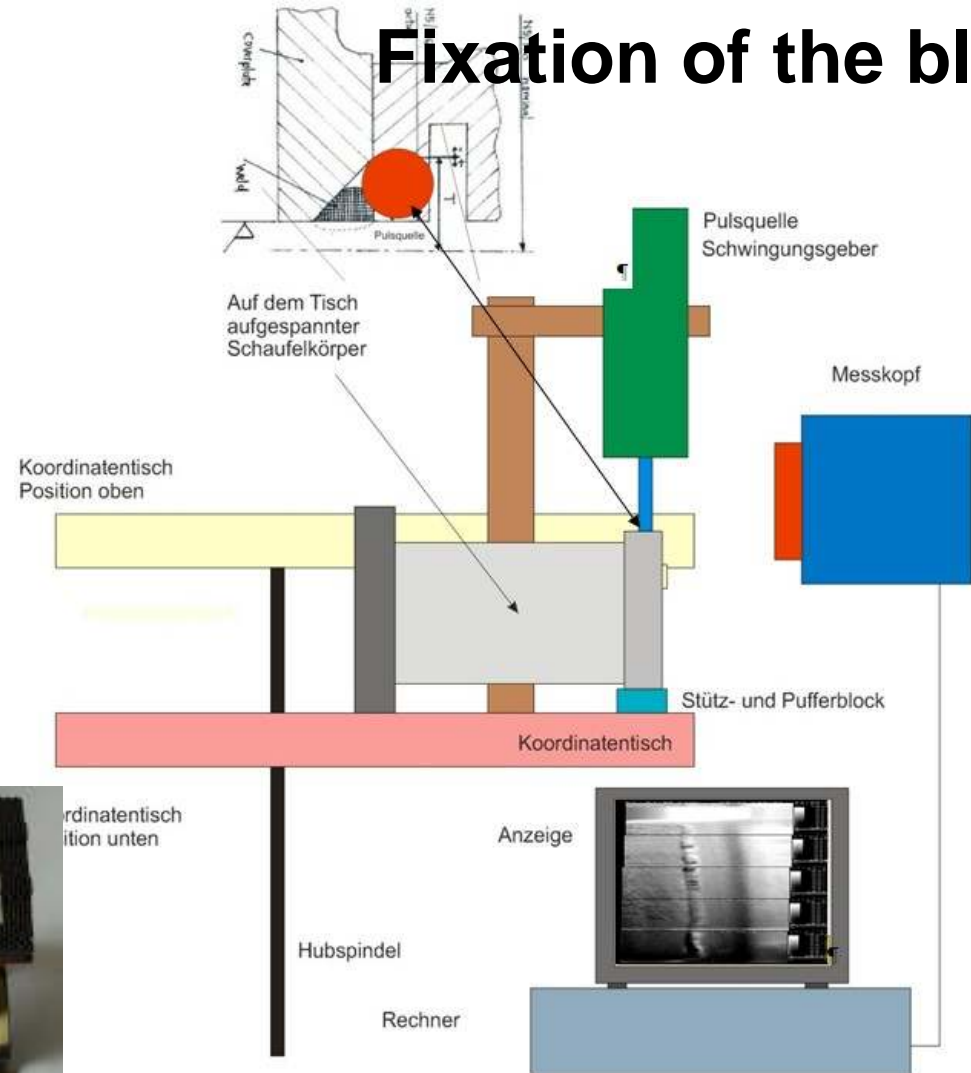
# Vibro- Thermograpy



**Zone of interesst**

**Only some seconds after the sonotrode activate the heat appears.**

# Vibro- Thermograpy



# Vibro- Thermograpy

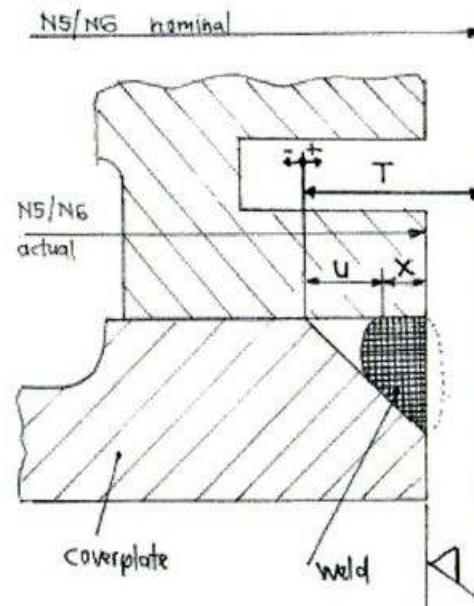


**Results from inspections of welded turbine blads**

**The location of the thermal response is defined.**



To detect the required differences in the weld seam a geometrical spatial resolution of the IR- System of  $40 \mu\text{m}$  per pixel is required.



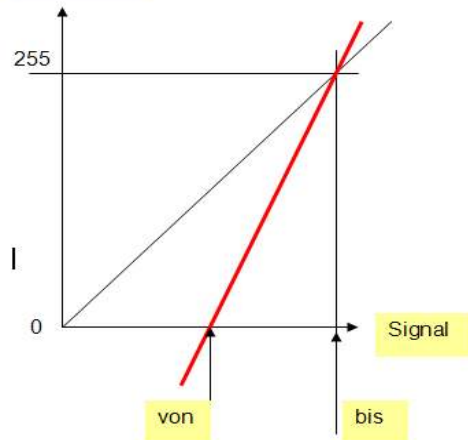
## More Results

Datensatz Nr. 304692\_16 Seite A Schaufel Nr.

Das komprimierte Bild.

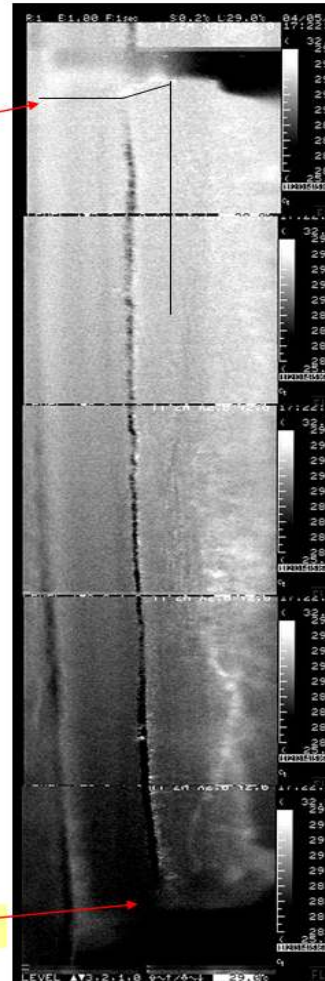
Zur Bildkompression:

Grauwert



Anfang

Ende



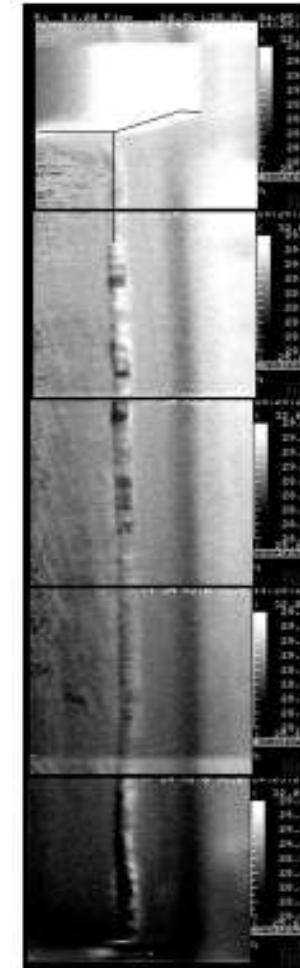
Datensatz Nr. 304692\_15 Seite A Schaufel Nr.



Anfang

Höhe der verschweissten Zone

Ende



# Vibro- Thermograpy

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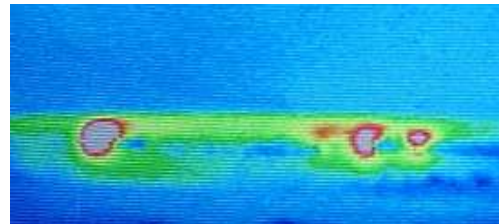


## Difficulties

# Vibro- Thermography

## Crack – not crossing

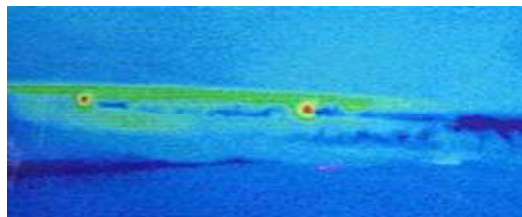
### In the Substrate



### In the Coating



## Crack crossing



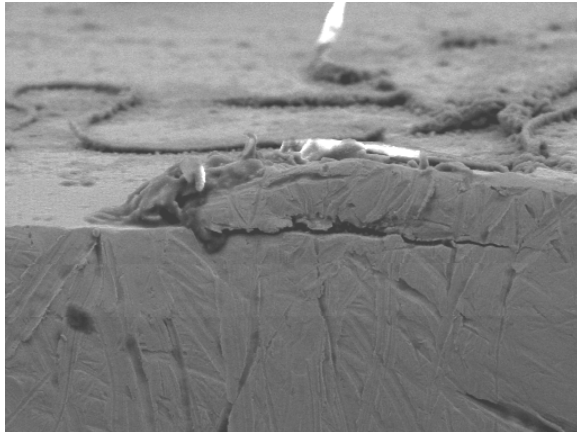
# Vibro- Thermogrady

**Often, the crack grows with the vibration or the part goes defect.**



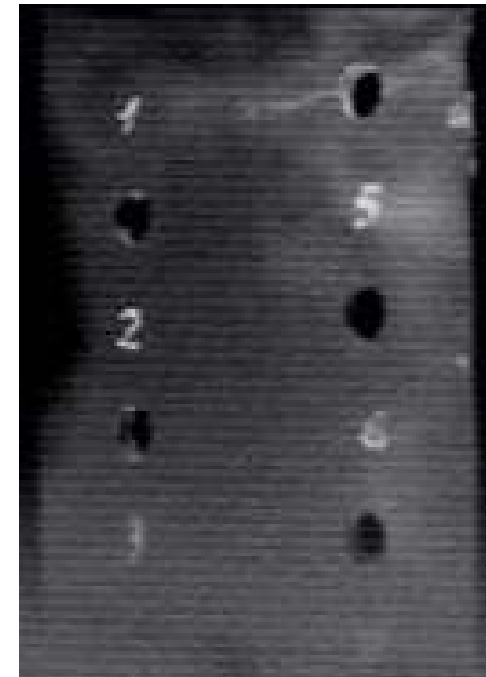
# Vibro- Thermograpy

## Crack – or no crack

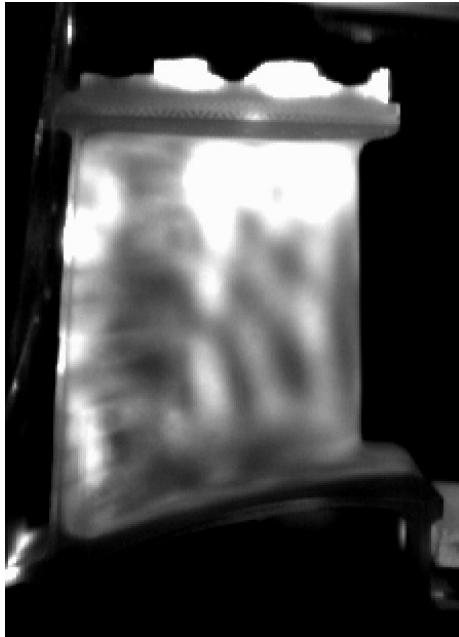


**Pressed metal chip**

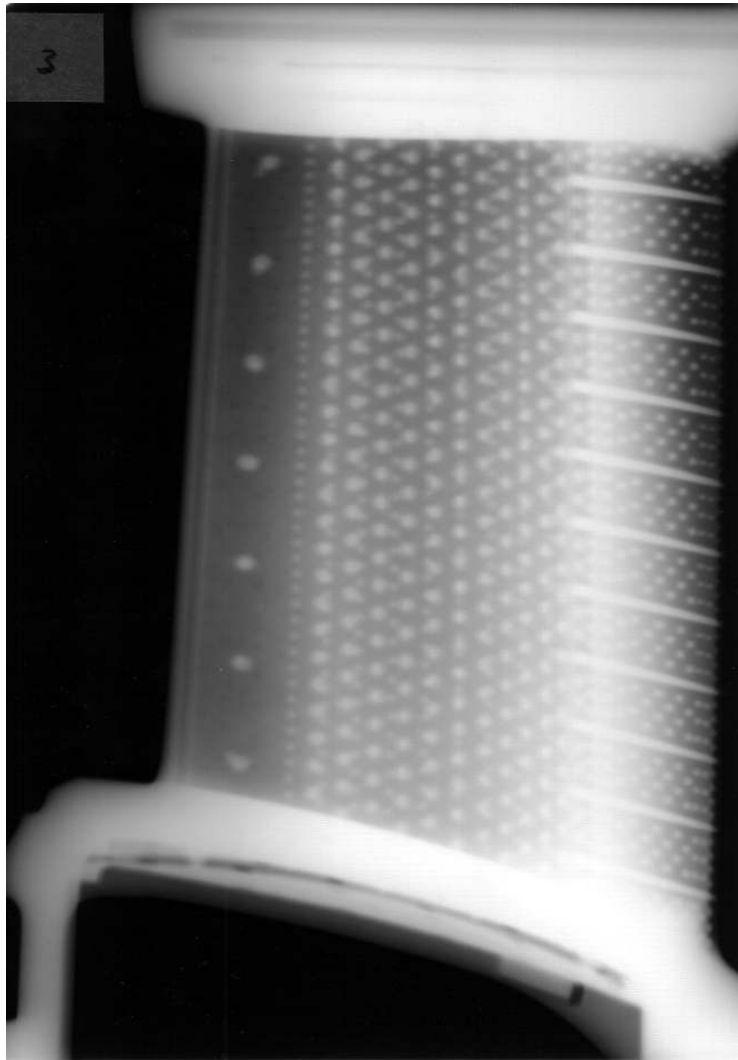
## Differences in the emissitivity



# Vibro- Thermograpy



**Thermal  
differences, which are not influenced by cracks**



**Why  
„Vibrothermography“  
if other solutions are  
available.**

**X-ray picture of the  
turbine blad.**

# Vibro- Thermograpy

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**I thank you for your kind attention**