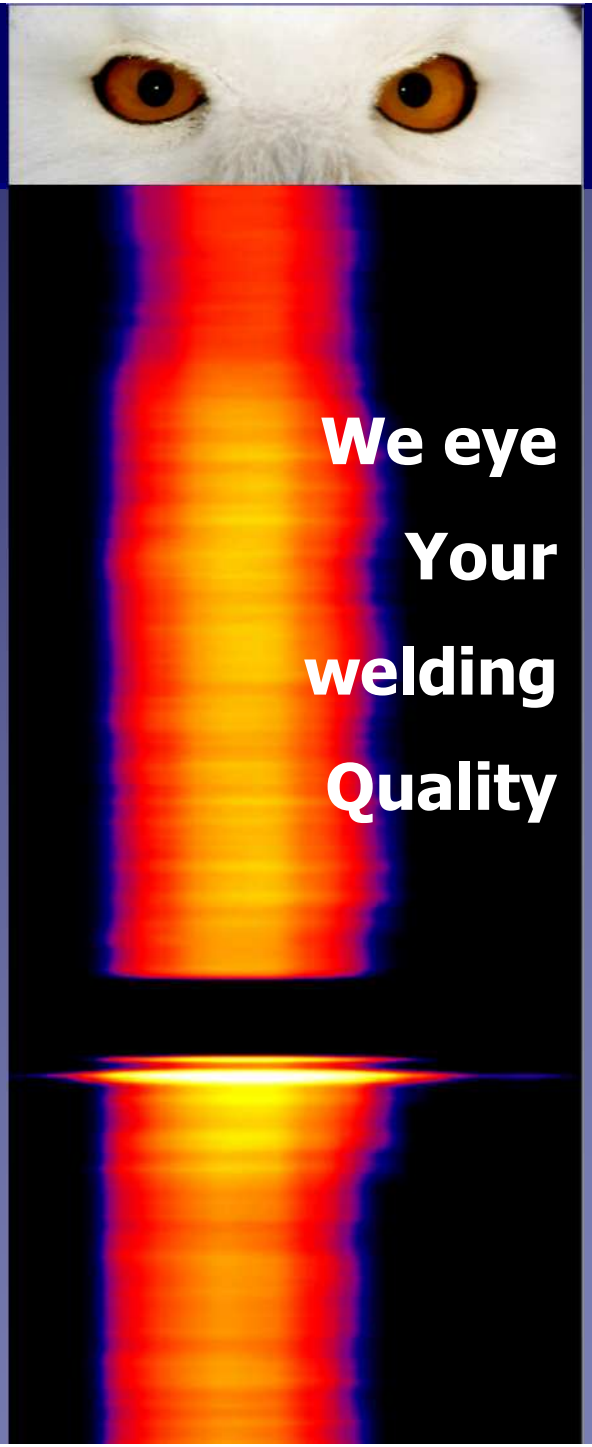
Thermo Profile Scanner

for tube welding



HKS-Prozesstechnik GmbH

The view *through the arc* into the heat signature

Local heat input is melting and is changing the structure of materials during brazing and welding processes.

The correct heat input and also the undisturbed heat distribution is an important attribute for the evaluation of welding seams.

The human eye can not see heat radiation. The glare of the visible part of an arc is so intense, it will cover up any heat information.

Here fore technology is required that can capture the heat information in spite of:
- Massive glare of the arc
- Fumes and spatter contaminated environment

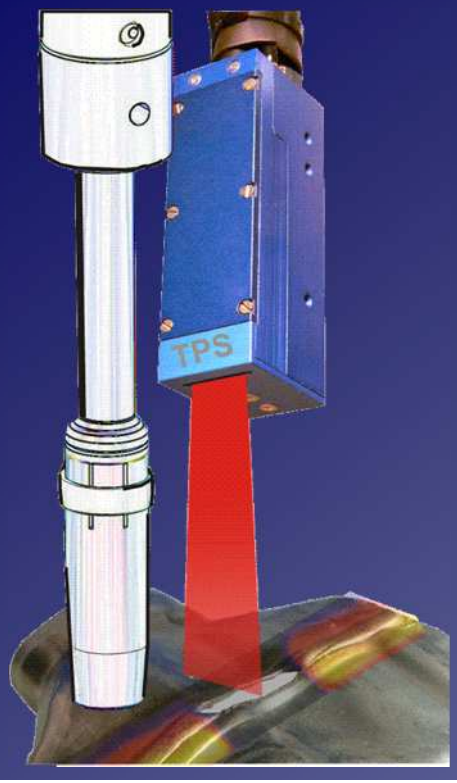
permanently.

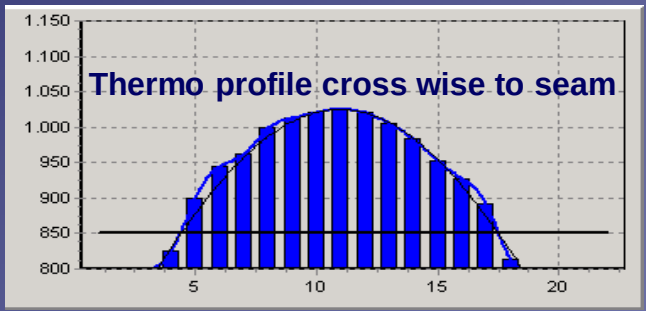
HKS is introducing a device , that fulfills these requirements

ThermoProfilScanner (TPS)

HKS-Prozesstechnik GmbH

Principle of operation ThermoProfilScanner





The Thermoprofilscanner is constantly capturing a thermo profile **across the welding seam.**

Hereby it is able to fade out the visible light from the arc. A heat image of the welding seam is created by the continues movement of the welding torch.

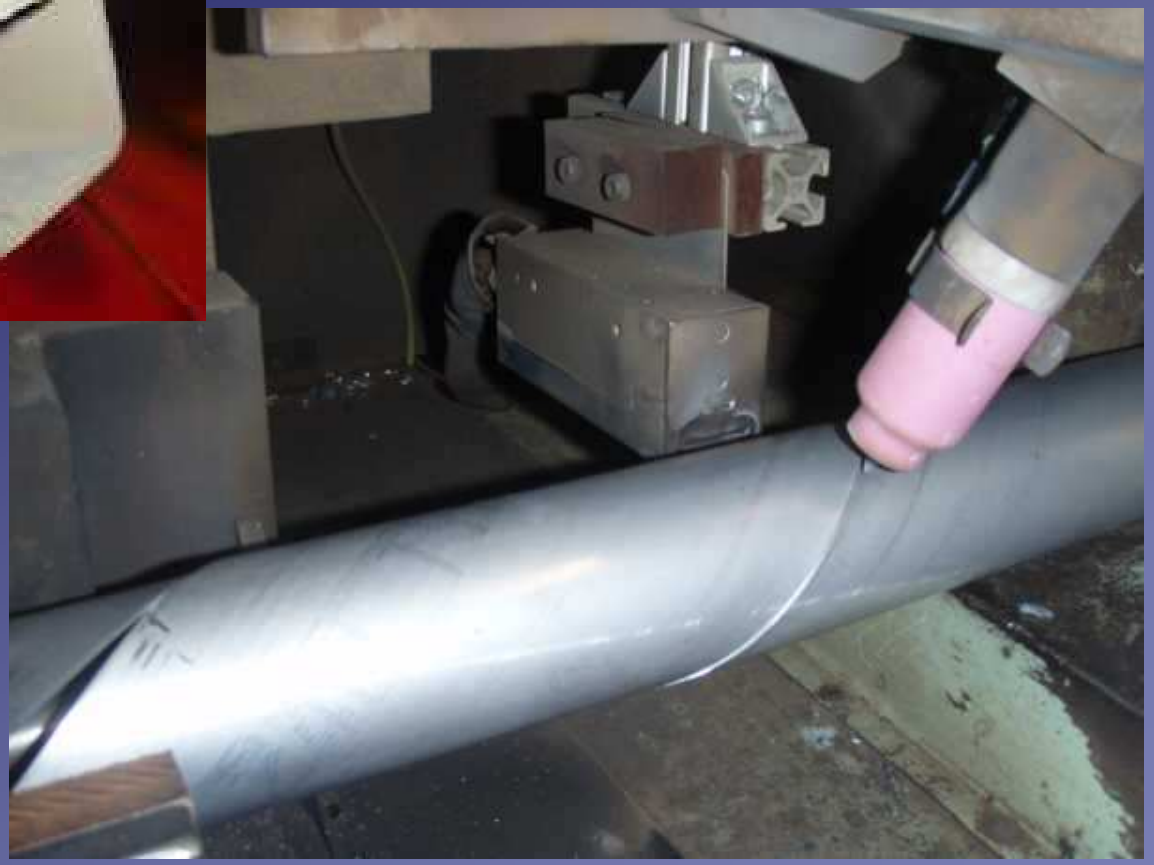
Technical data:

- Work distance 15 to 120 mm (special edition 200mm)
- Scan frequency >= 400 Profiles/s and shutter speeds of a single line of 50 µs allowing a resolution of up to 15 m/min (Laser / arc welding) or high frequency of 180 m/min.
- better than 1 mm by speeds up to 20 m/min.
- Advanced design features allows **continuous use in strongly contaminated environment (welding smoke, welding splash, water vapour etc.):**

  - ✓ Glass free design
  - ✓ Gas curtain
  - ✓ Anti spatter concept
  - ✓ Integrated water cooling

Extremly robust action directly on the welding torch

The sensor can withstand most extreme working conditions and works reliable in great heat, dirt and spatters



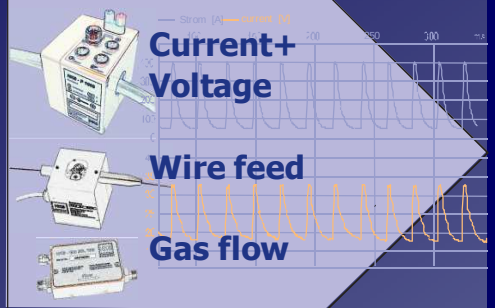
The heat signature is captured after solidification of the welding seam, before the seam is cooled of.

Depending on the application this can be 5 mm to 40mm behind the torch.

The ThermoProfilScanner as component for monitoring system WeldQAS

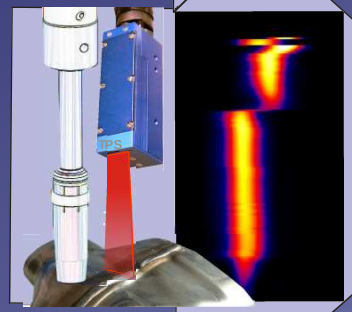
Measurement weld-parameter

SENSORS



Measurement Heat field

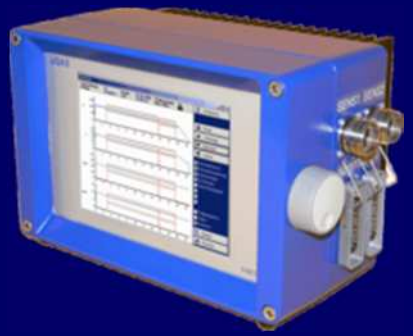
TPS



ThermoProfilScanner

WeldQAS

Weld monitoring system



Production documentation
Extensive representation and analysis functions

Welding process supervision
Thresholds for warnings and faults

Recognize faults reject
automatic recognition of faulty part and rejection in serial production

Fault output for part marking, ejection and alarm

HKS PROZESSTECHNIK

HKS-Prozesstechnik GmbH

Design and method of operation

1. The Thermoprofilscanner is capturing the temperature over the welding joint and is sending the data to the WeldQAS-device.
2. The WeldQAS-device is calculating for each line the attributes of the profile (width and position of the heat field, symmetry and max. temperature.)
3. The heat images are displayed simultaneous visually by the WeldQAS, stored and compared with programmed set values.
4. By recognizing violations of limit values the unit detecting welding irregularities and there position within the pipe.
5. The error signal is generated immediately or can be buffered to mark the defective with a marking spray unit.
6. The WeldQAS-device is storing all data pertaining to the pipes, which will be numbered, and can be synchronized with a saw signal.
7. The data are stored in a data base and are displayed in a pipe monitor program.

TPS advantages compared to other test methods

Optical offline-method (after welding)

(Automatic visualization via
laser triangulation)

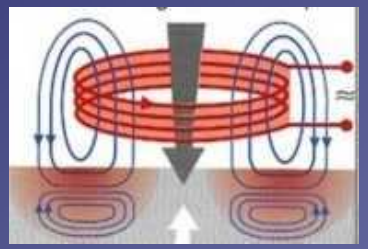
Principle: Laser is projecting a cut line onto seam, a camera system with image processing unit is evaluating patterns.

In comparison: Use of TPS

- **better fault detection** of
  - Pores
  - Penetration faults
  - Fusion faults below surface
- **substantially lower investment costs**
- **no tact time increase**

Eddy current method

Principle: Is inducting eddy currents into base material and is processing disturbances in current flow.



In comparison: Use of TPS

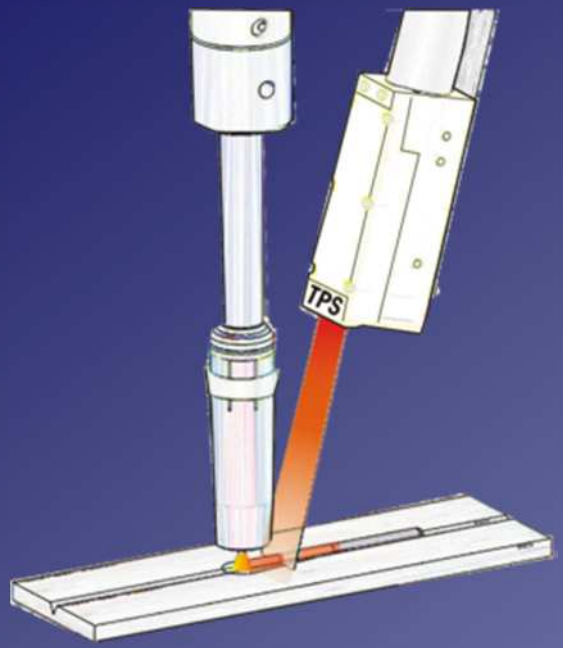
- **better fault detection** with
  - Seam offset
  - insufficient penetration
    (for example due to current deviation up to 50 %)
  - small holes
  - unsymmetrical edge penetration
- **lower Investment costs**

New possibilities of seam control

TPS =

Visual seam inspection
Recognition of seam position

+



Evaluation of metallurgic-thermal processes in the seam
to recognize penetration faults and insufficient fusion along edges

The temperature profiles are processed in **real time,** width, position and symmetry e.t.c are analyzed.

Welding inconsistencies compared to the OK-seam are recognized as deviations within the thermo profiles and will be flagged.

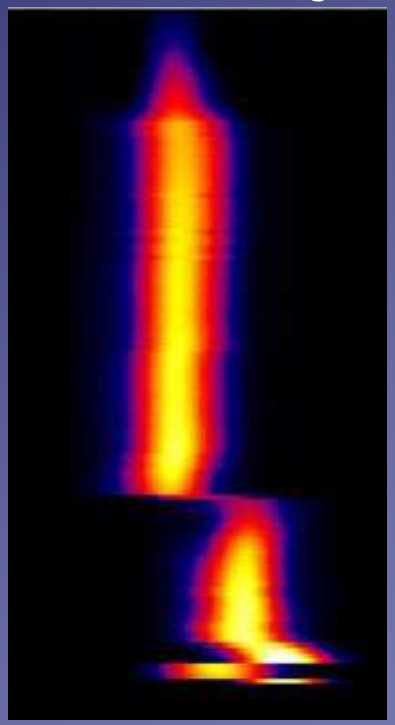
Attributes of the thermo profiles (width, position..) are thought the same way as other parameters, and can be monitored via thresholds or envelopes.

The view *into* the welding seam in creation

The thermo profile is captured after solidification of the welding seam,
before it is cooled down.
Depending on the application this happens 5 to 50 mm behind the torch.

brazing seam
with offset

affiliated heat image



New possibilities of seam control

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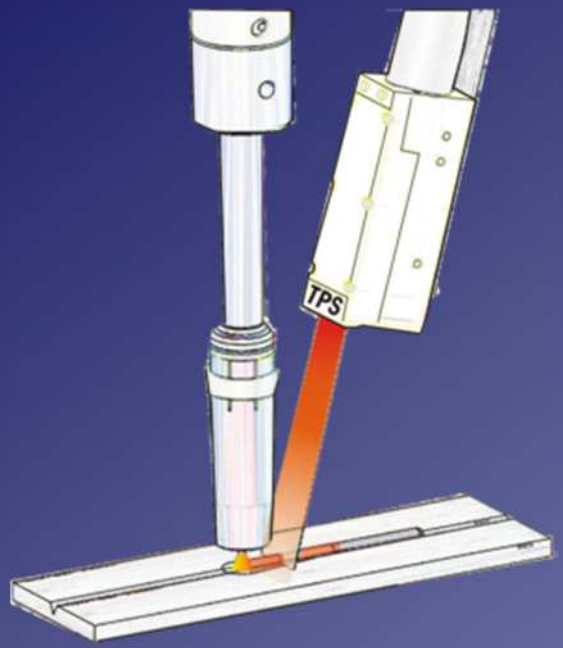

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Example 1 Spiral tube production TIG

Task

Recognition of visible and invisible welding inconsistencies
as holes, pores larger than 1 mm, edge fusion faults and penetration fluctuations.

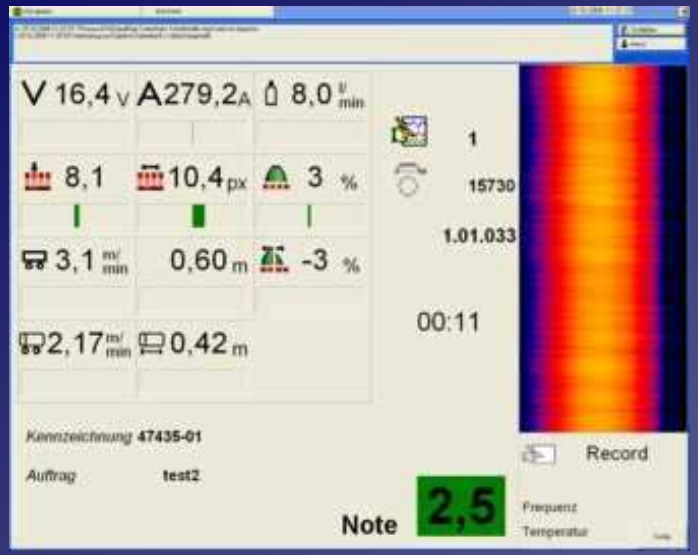
Recognition of "weld ability" problems with supplied materials.

The existing eddy current detection system does not fulfill requirements.

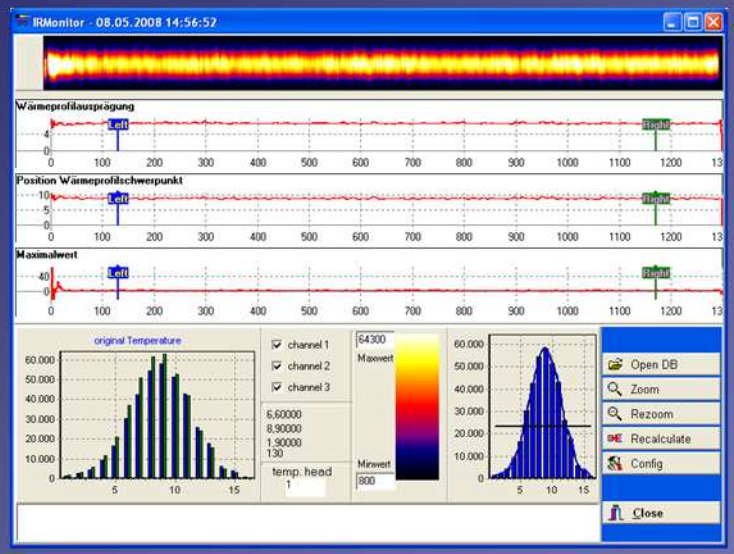
ThermoProfilScanner

offset to the torch: **40 mm**
scan frequency: **100 Hz**
resolution: **0,9 mm**
working distance: **20-60 mm**
purging gas: **3 l/min**
welding speed up to **3,5 m/min**
water cooling via power source

Example 1 Spiral tube production



Work monitor with actual seam evaluation and heat signature



Heat signature of a 6 m tube

Captured are:

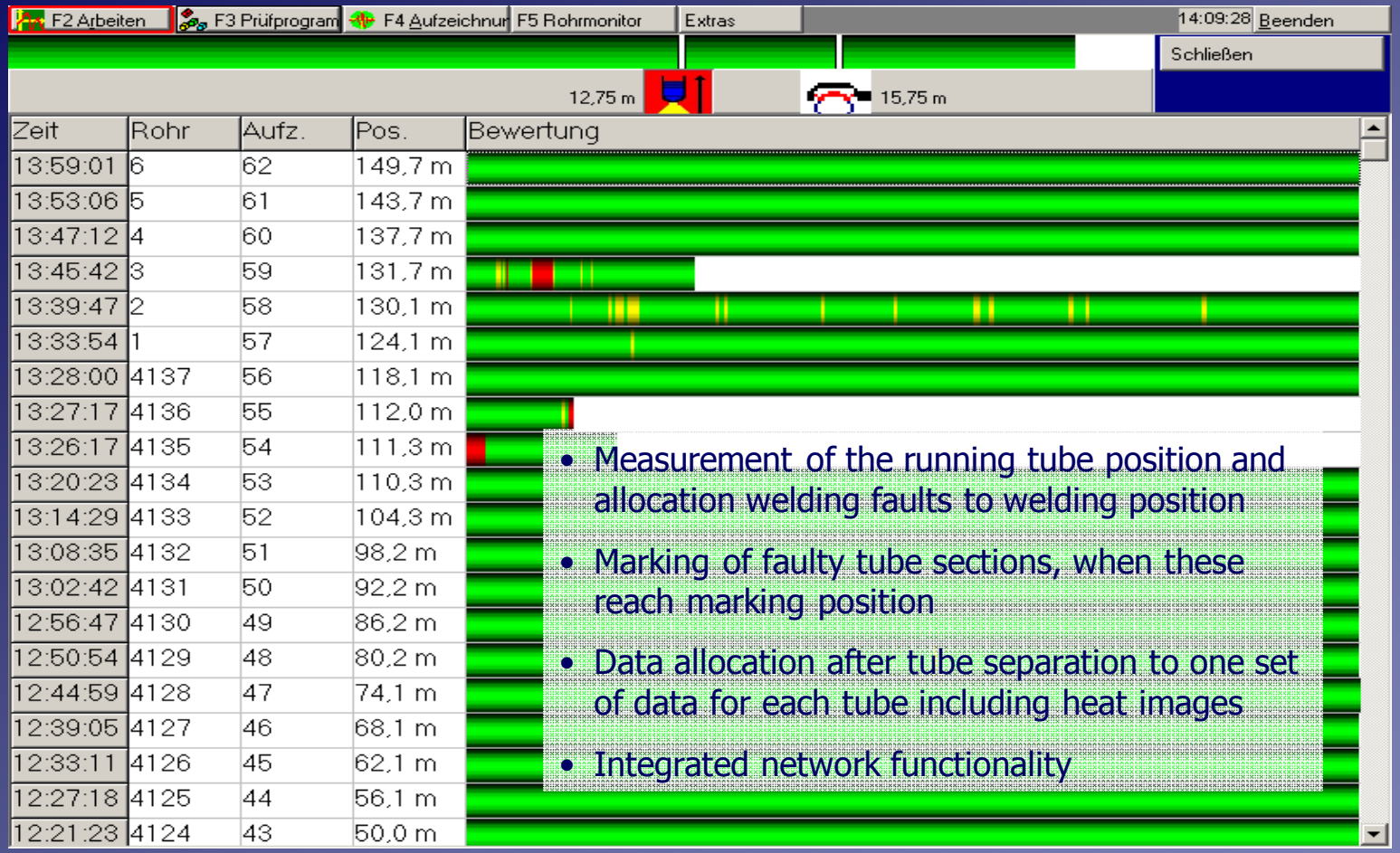
- Welding current,
- Voltage,
- Shield gas amount,
- Band position and -speed

From the heat signature the following is calculated:

- Welding seam position
- Width of temperature zone
- Symmetry of heat field
- Cool down characteristic

Example 1 Spiral tube production

Special features for seam pipe welding

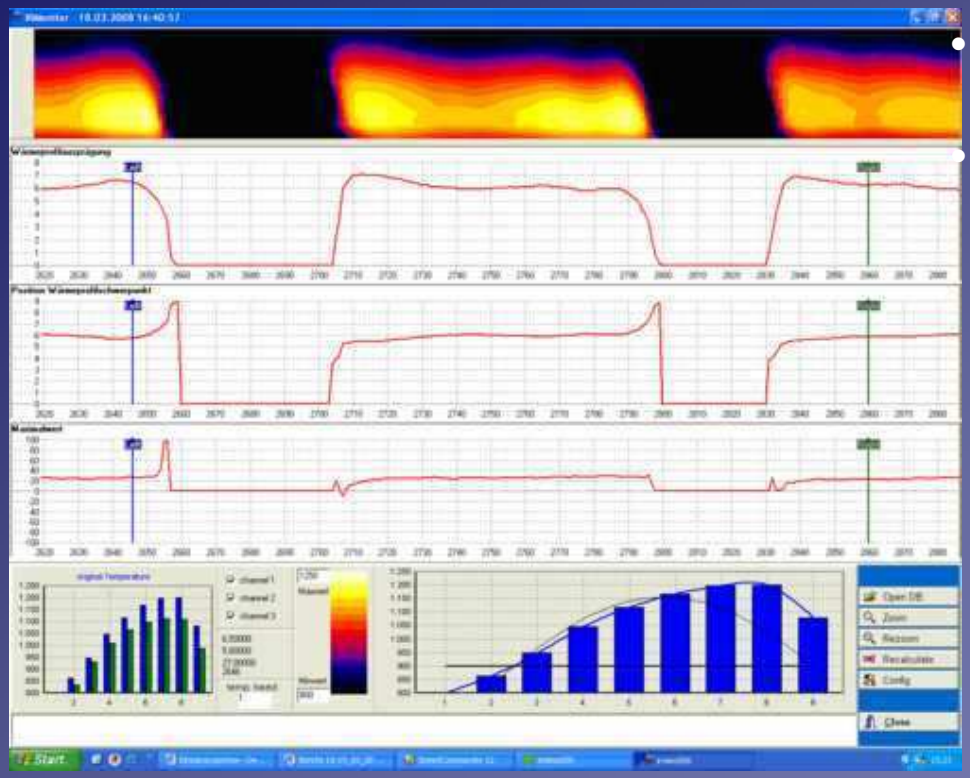


Graphic display of the last 25 tubes in **tube monitor** application

Example 1 Spiral tube production

Fault image: Burn trough

CrNi – Band 73*1,0 tube 32mm



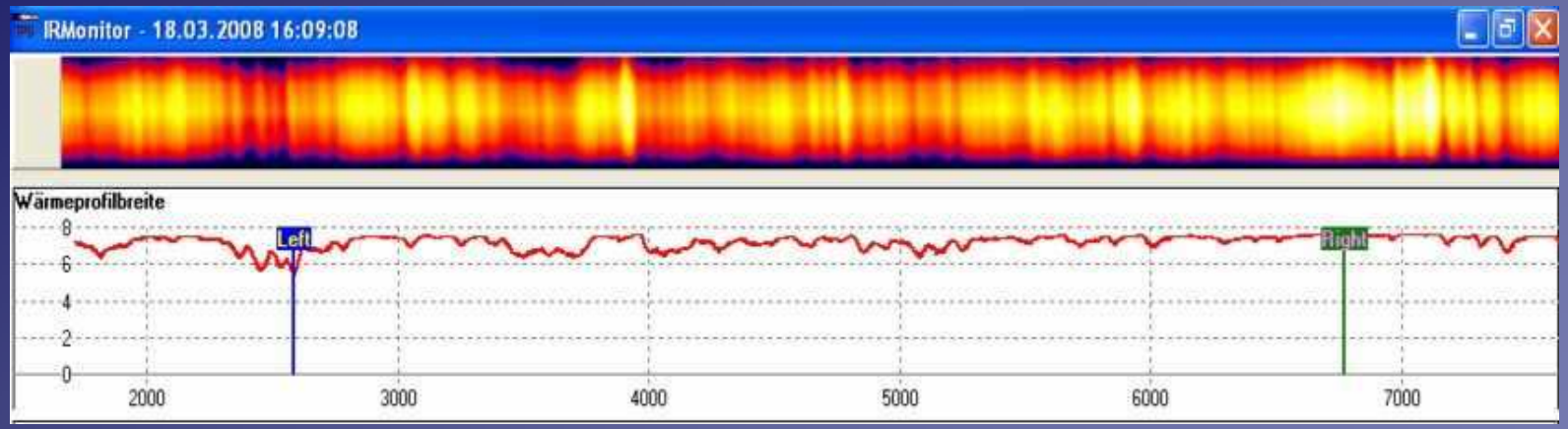
Burn through is causing heat jam.

One scan is equivalent to scan width of 0,62 mm.

Example 1 Spiral tube production

Fault image:
Uneven heat distribution

Steel band 86*1,5 – tube 38 mm

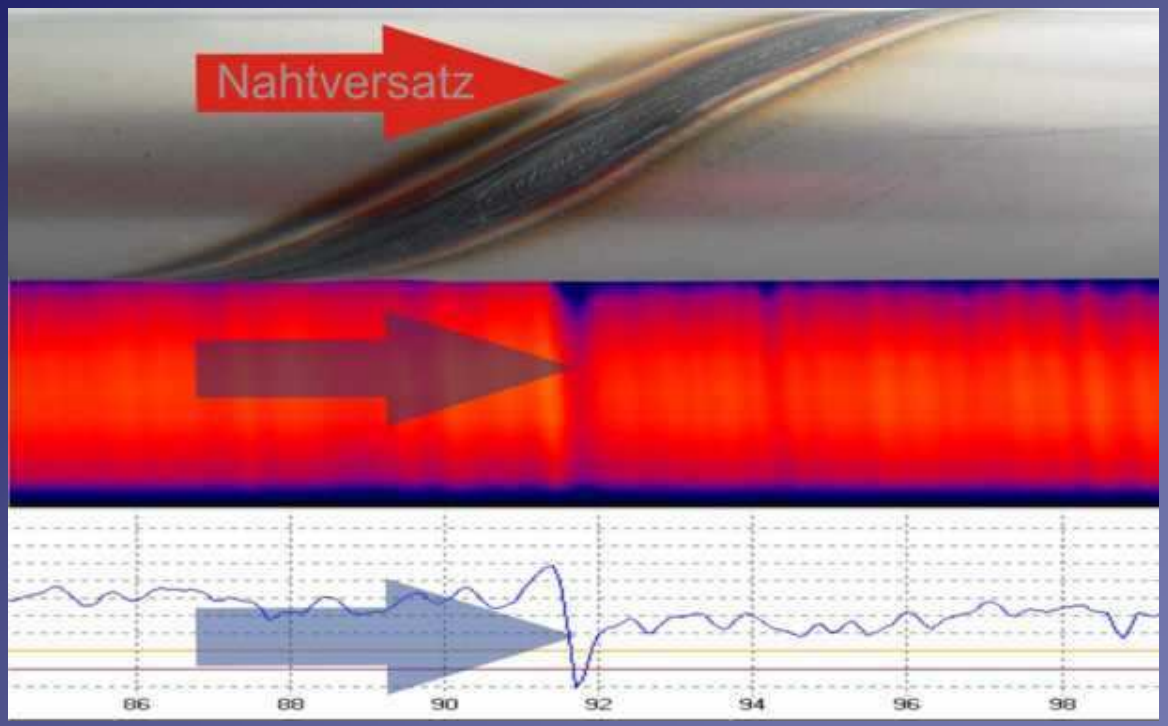


Uneven heat input and penetration fluctuations due to defective band material
(Seam appearance – fish scaling)

Example 1 Spiral tube production

Fault image:
Seam offset / seam position

CrNi - Band 73*1,0 tube 32mm



Such seam offsets causing welding seam to fail when the tube is pressurized.

Example 2 Longitudinal pipe manufacturing TIG/Plasma

Task

Detection of visible and invisible welding irregularities as pores, insufficient side-fusion, defect root penetration and the detection of torch misalignments.

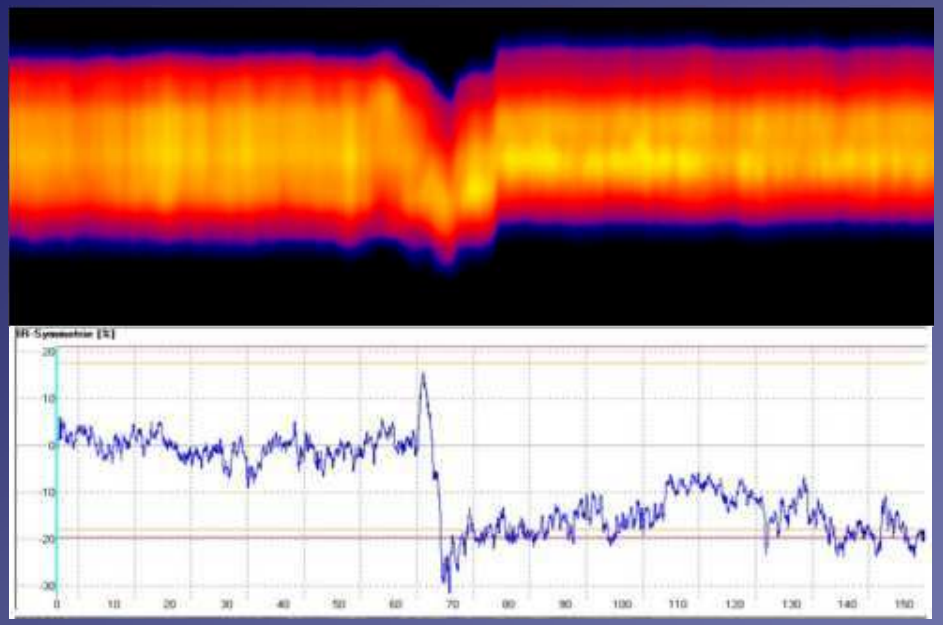
ThermoProfilScanner

offset to the torch: 2**0 mm**
scan frequency: **100 Hz**
resolution: **0,9 mm**
working distance: **80 mm**
purging gas: **3 l/min**
welding speed up to **1,5 m/min**
water cooling

Example 2 - Longitudinal pipe manufacturing Plasma welding/TIG

Fault image: Torch is not in center line of the welding joint. (Seam symmetry)

CrNi - pipe 20*3 mm



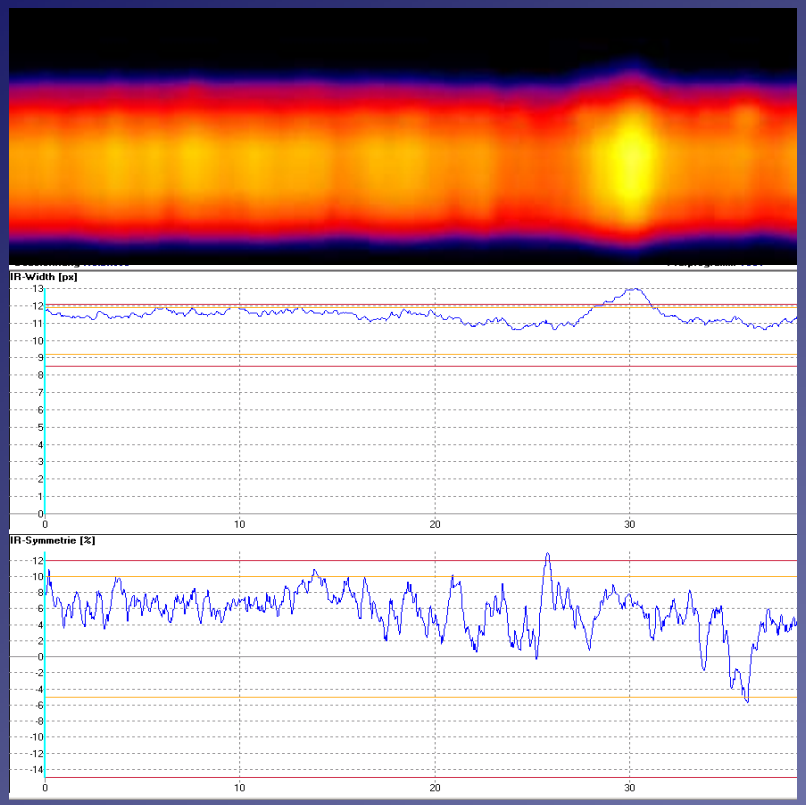
An off- center torch position is causing an asymmetric penetration. One fusion edge is melted more than another.

Optical hardly visible, but clearly visible in the heat signature.

Example 2 - Longitudinal pipe manufacturing Plasma welding/TIG

Fault image: pores

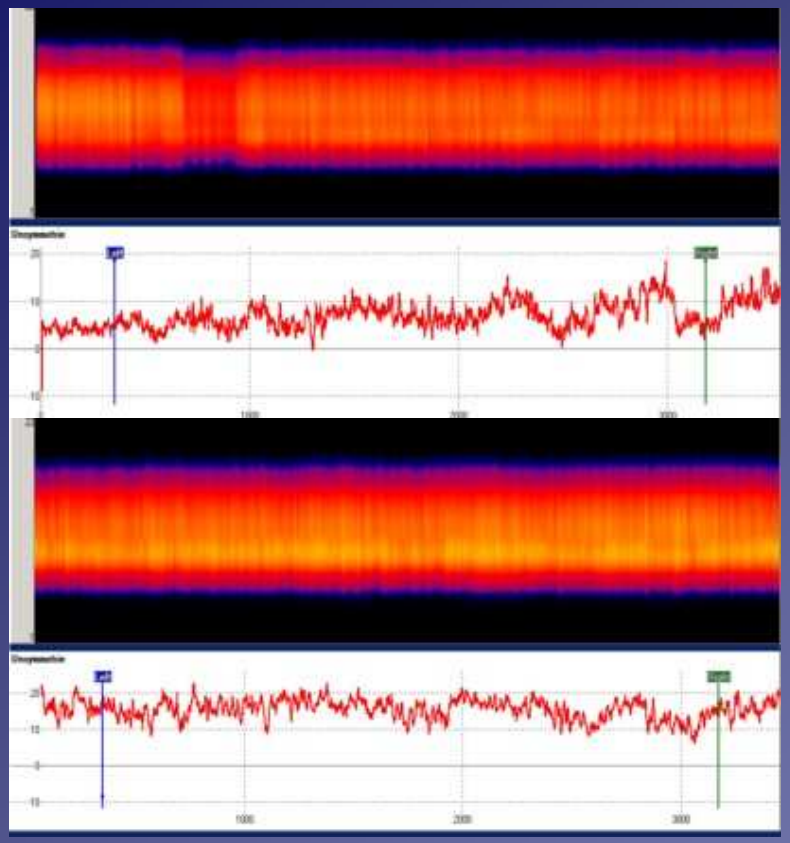
CrNi - tube 20*3 mm



Hot cracks and pores are represented as „Hotspots" in the heat image. Faults like these are causing a disturbance in the heat conduction and are therefore detectable.
These pipes are defective.

Example 2 - Longitudinal pipe manufacturing Plasma welding/TIG

Fault image: asymmetric penetration due to a misaligned coil feed.



Optical not visible, here the thermo profile is becoming more and more asymmetric, because of wear and tear or insufficient lubrication on a roller set.

CrNi - tube 20*3 mm

Example 3 High Frequency-Induction Welding (HFI)

Application Data TPS

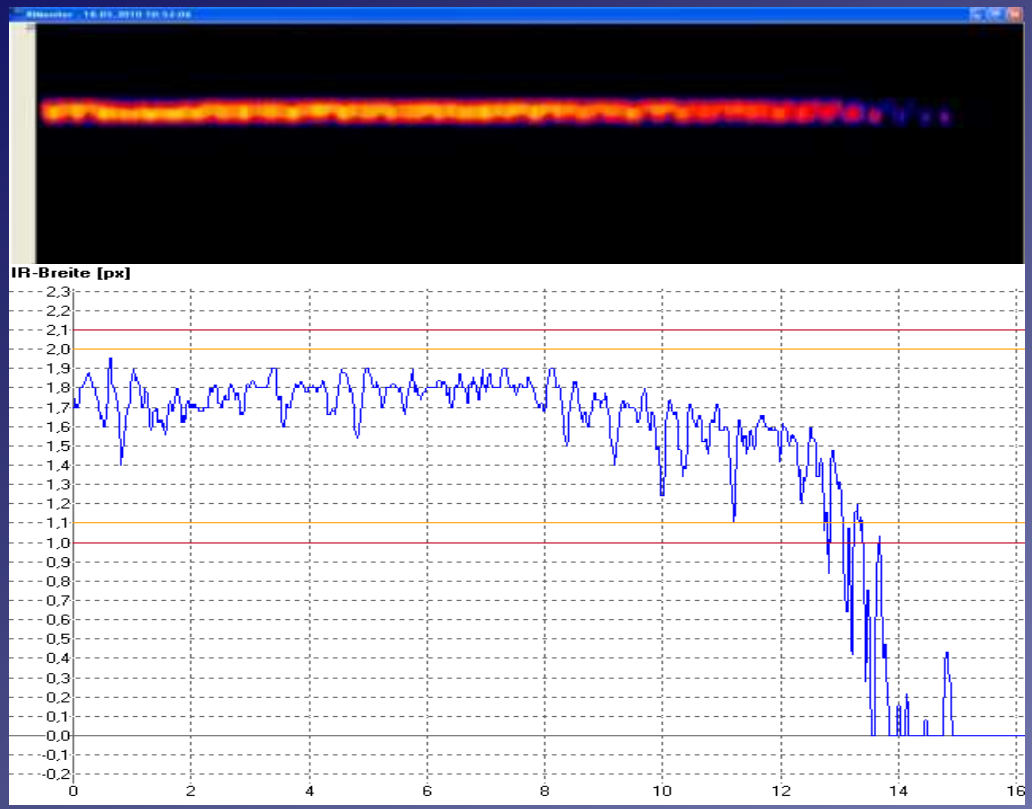
After running to torch : **100 mm**
Working distance: **60 mm**
Gas purge Shield gas: **3 l/min**
Welding speed **80 m/min**
Water cooling
Pipe dimensions: **13 x 2,5 mm**
HFI-Generator 250 kW – conductive HF-welding
Pipes are spooled to coil

Task

- Realizing a set up help for optimal welding parameters based on heat signature
- Recogognition of visible and invisible welding faults, cold joints, and excessive root penetration.
- Color marking faults
- Re-place Eddy Current Detection Systems since these can not detect these faults

Example 3 High Frequency-Induction Welding (HFI)

Detecting cold fusion points



Heat signature when fault through cold fusion joint

When the melting temperature is not reached, the temperature is falling in the joining zones.

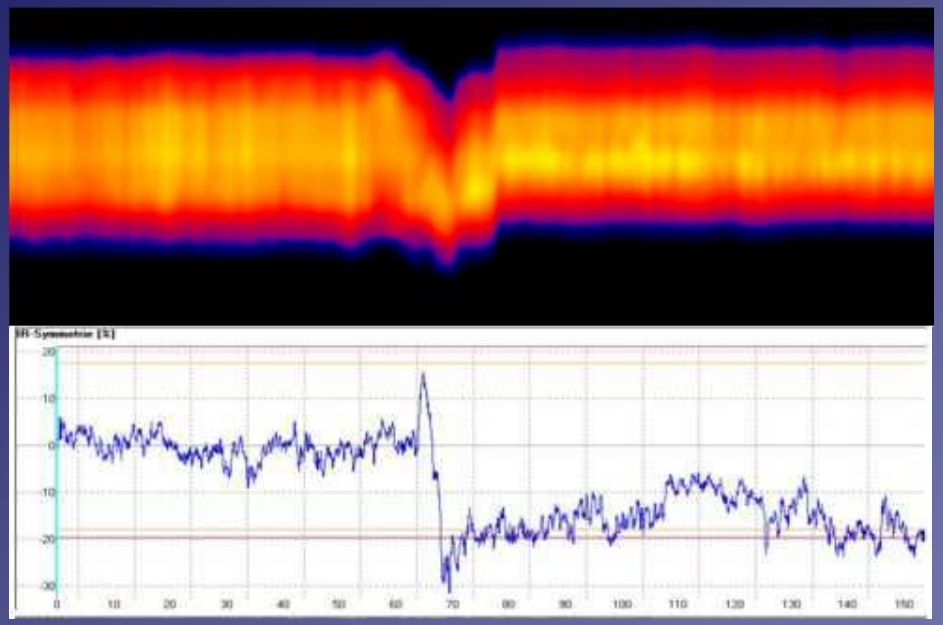
The sensor is calculating the heat field width via a set temperature threshold. Cold welding joints can be clearly seen in the diminishing heat field width.

Width of heat filed and learned thresholds values.

Example 2 - Longitudinal pipe manufacturing Plasma welding/TIG

Fault image: Torch is not in center line of the welding joint. (Seam symmetry)

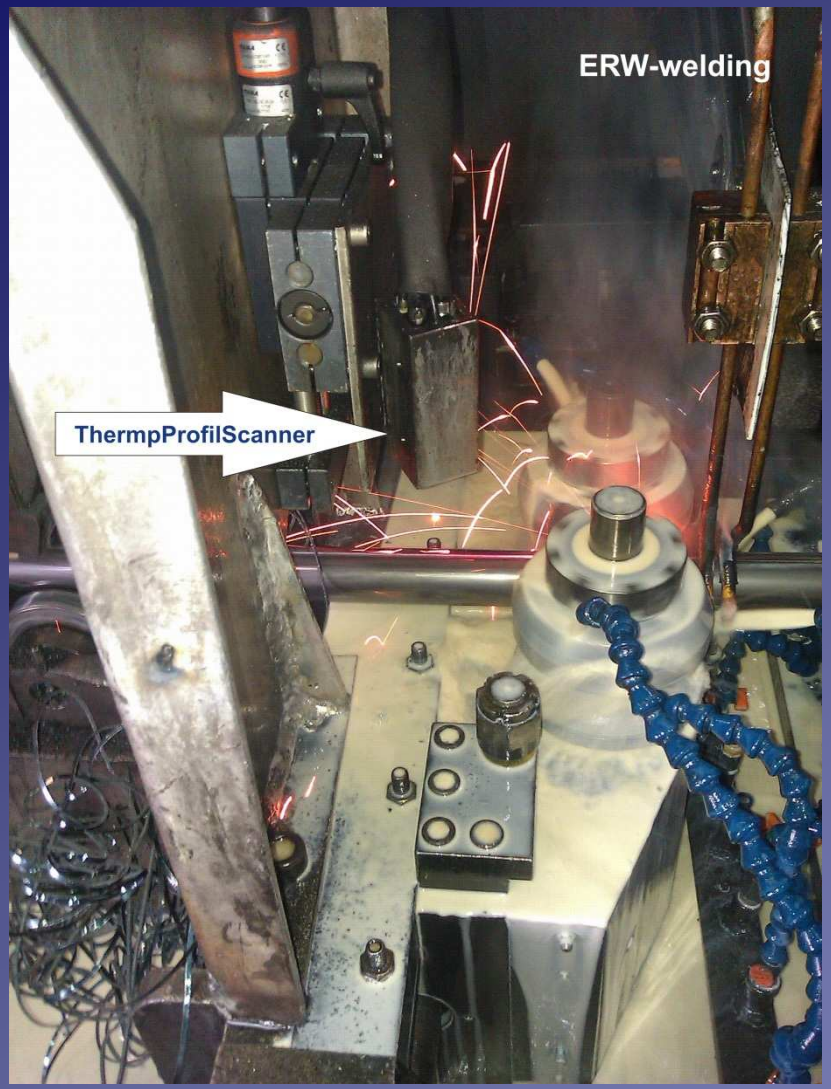
CrNi - pipe 20*3 mm



An off- center torch position is causing an asymmetric penetration. One fusion edge is melted more than another.

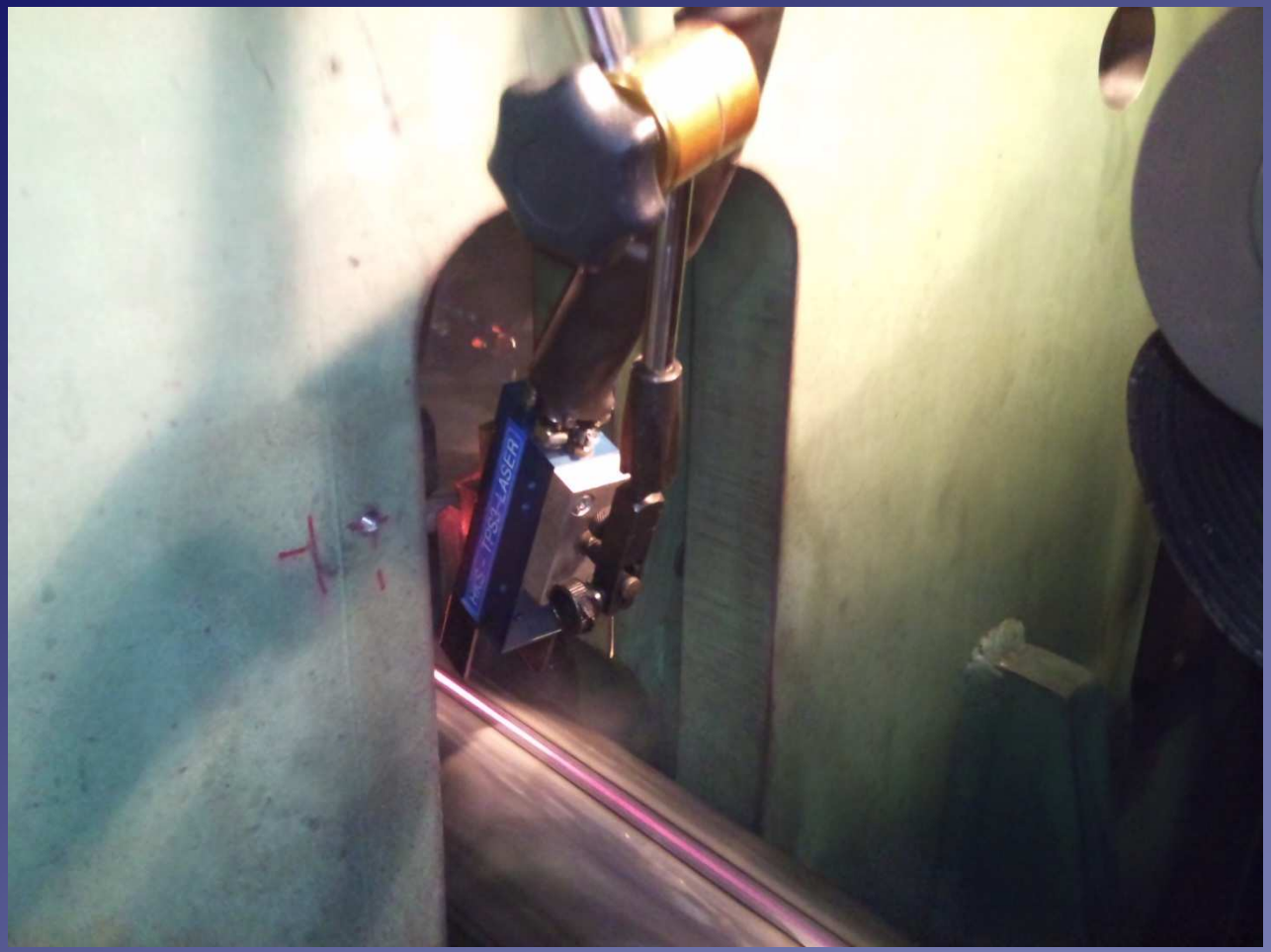
Optical hardly visible, but clearly visible in the heat signature.

Examples for mounting of the TPS

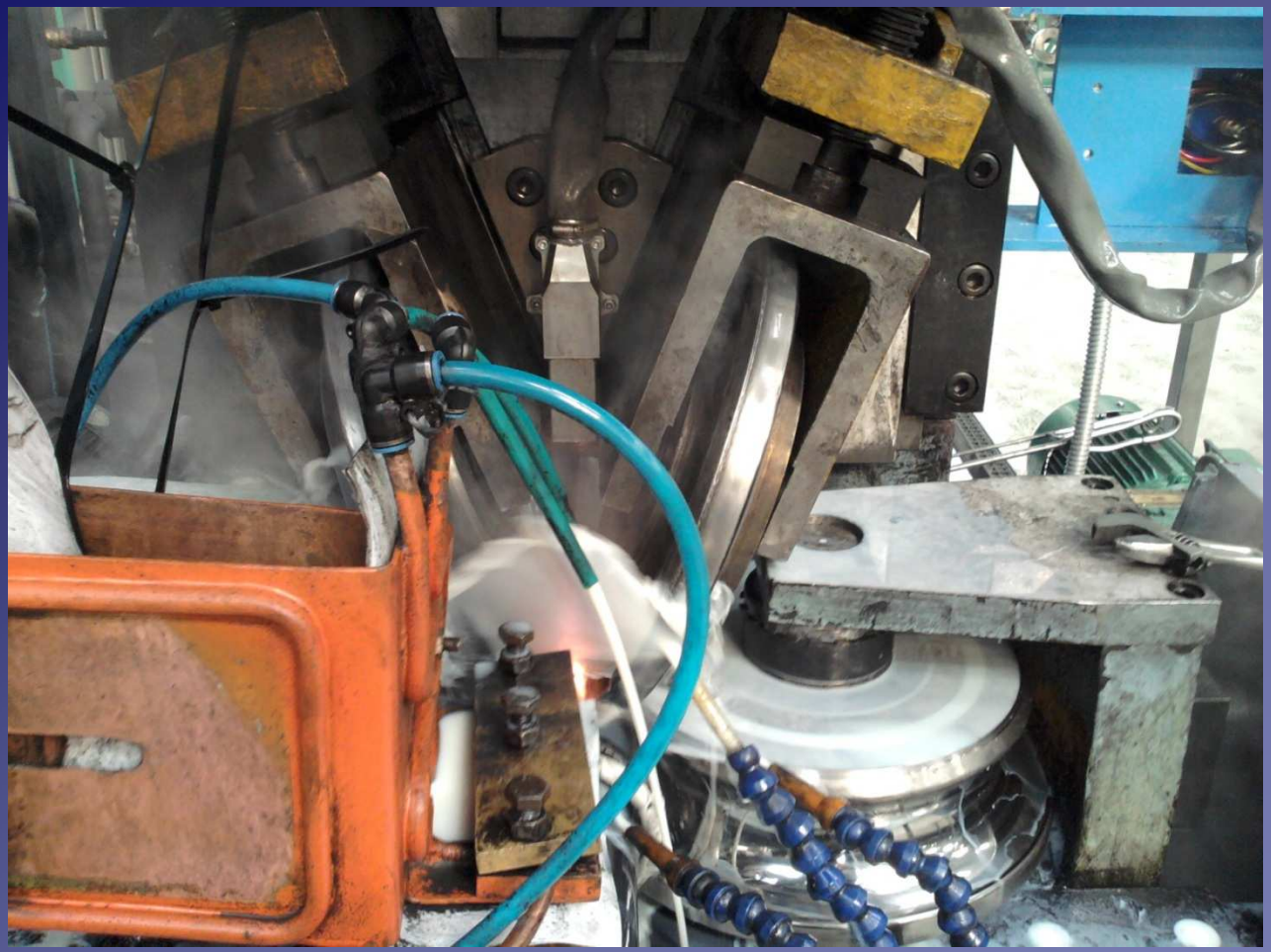


HFI – process 105 x 3 mm / 30 m/min

TIG – process



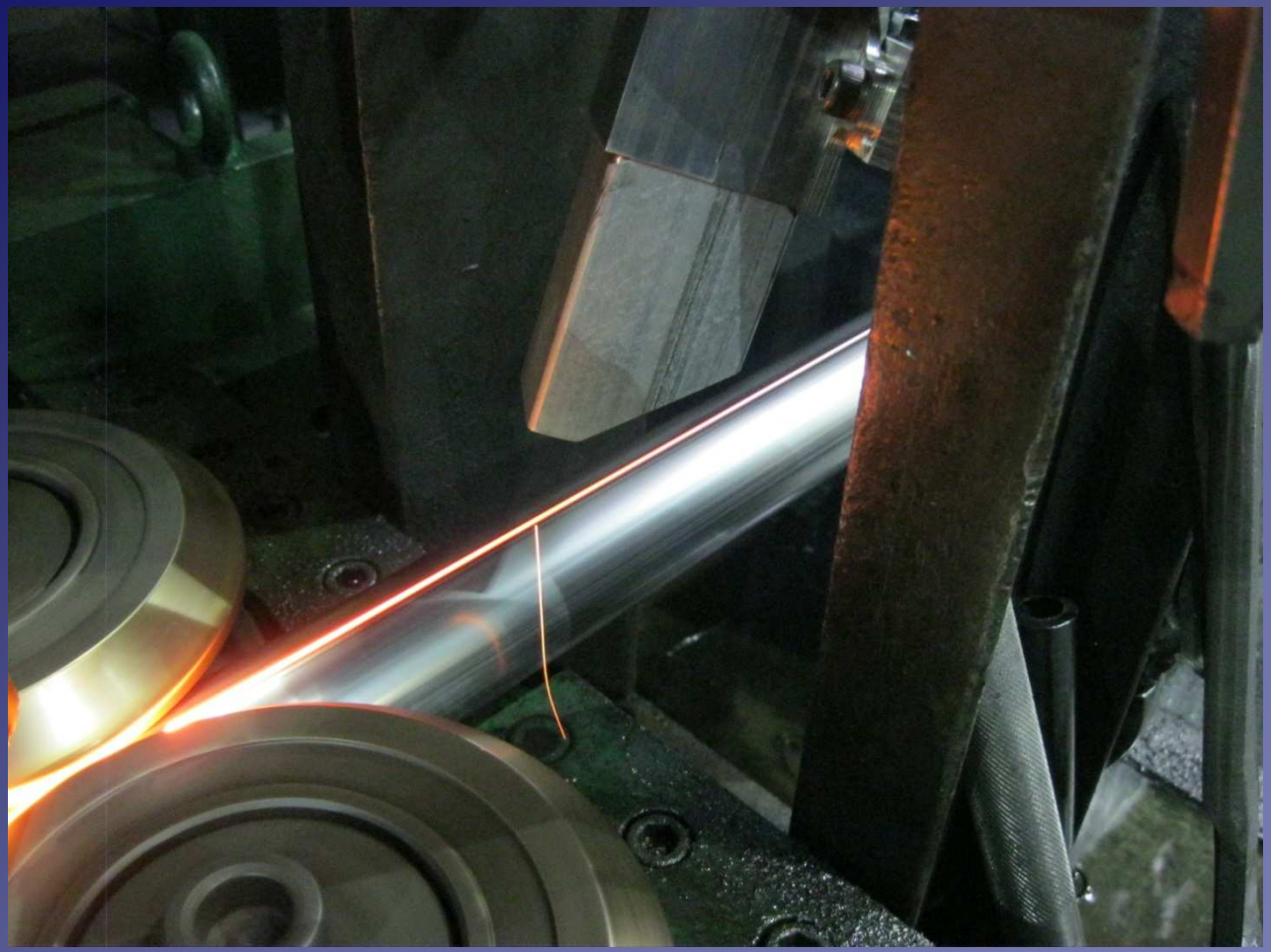
HFI – process 80 x 3 mm 40 m/min



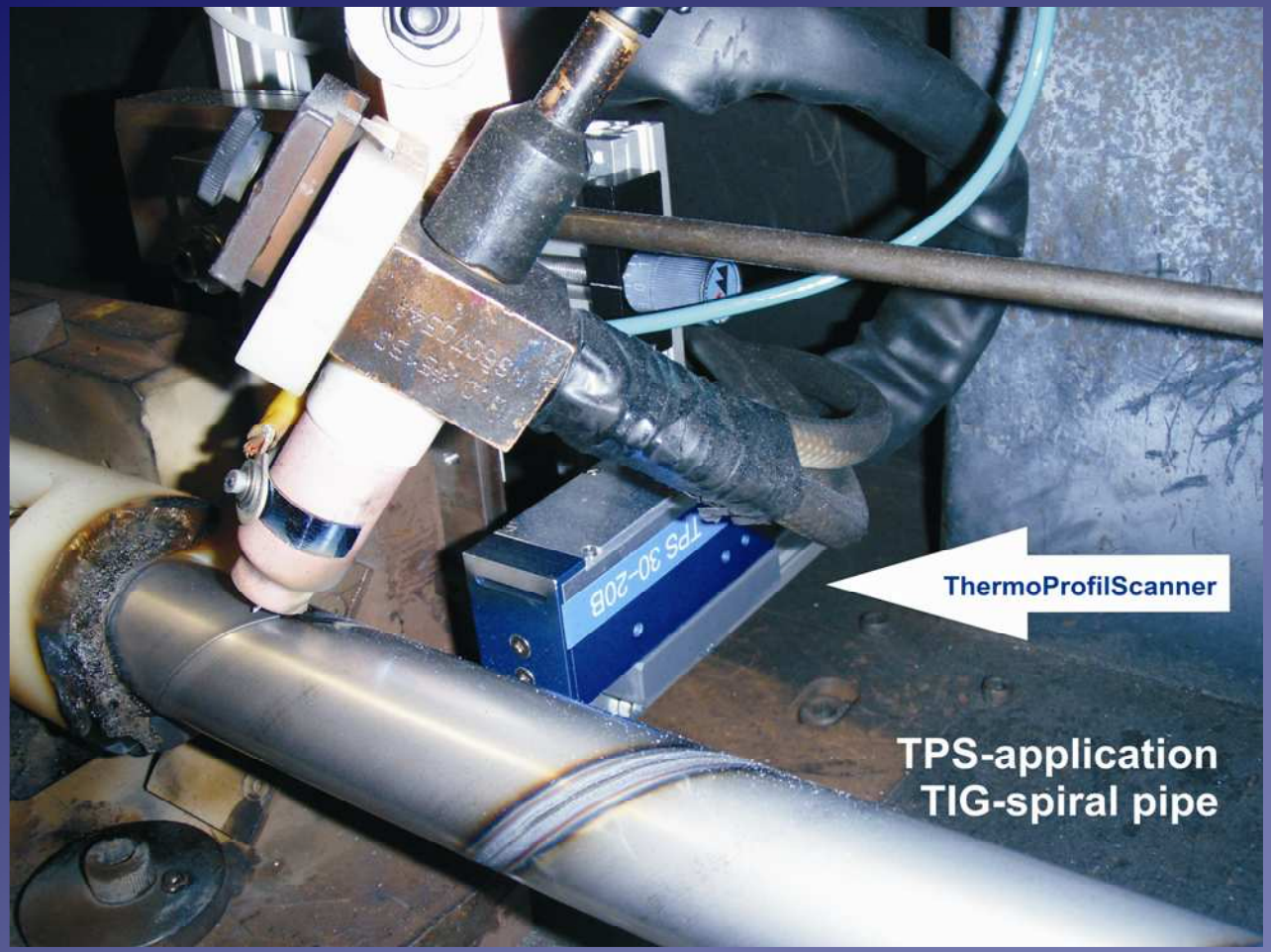
HFI – process 90 x 2 mm / 79 m/min

Plasma – welding 35 x 3 mm / 3 m/min

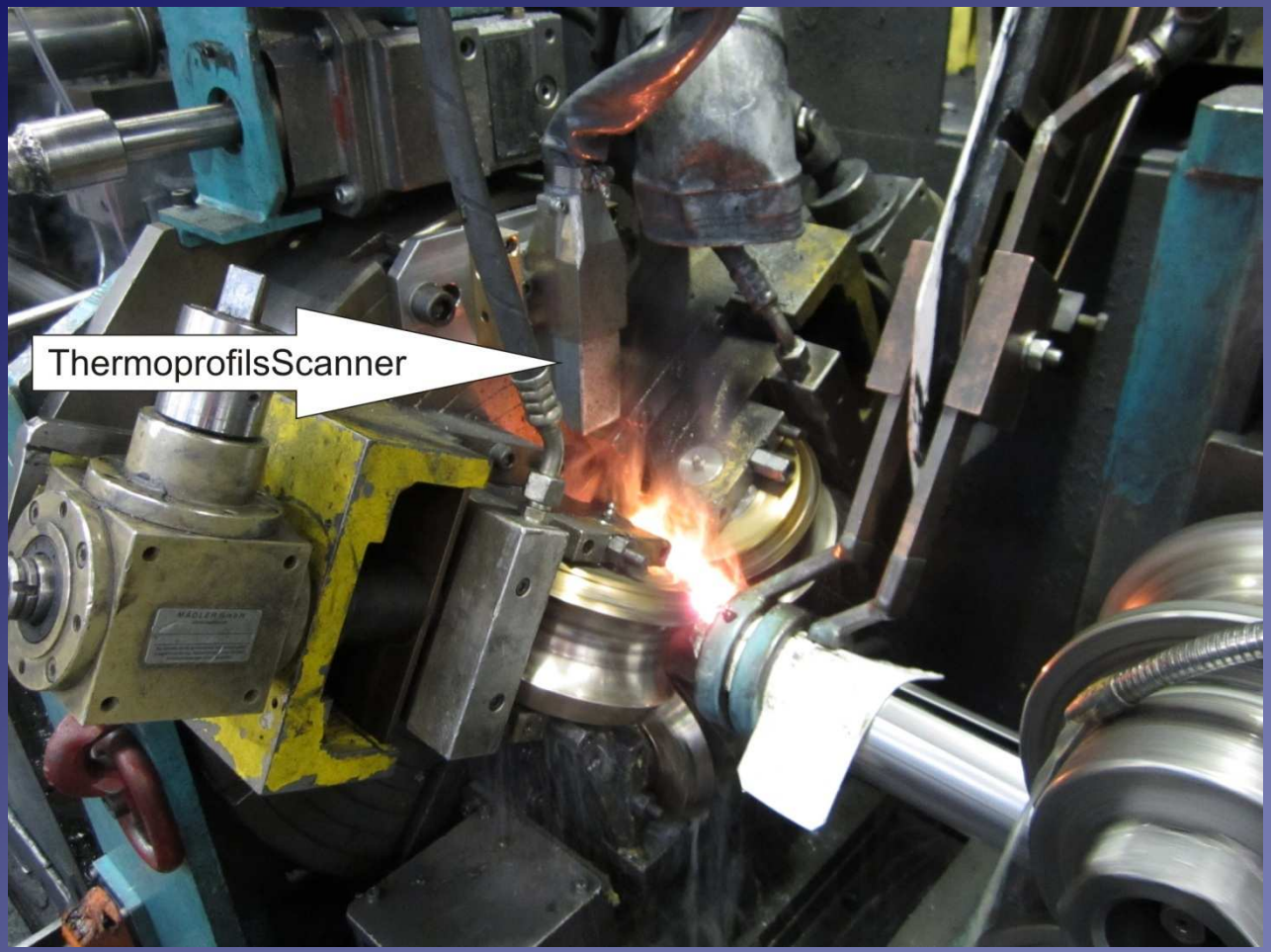
HFI – process 120 x 4.5 mm / 45 m/min



TIG – welding / spiral tubes variable diameters



HFI - welding



Thank you for your interest.

For further assistance please do not hesitate to contact us:

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