Solving the Problems of Remote Laser Aluminum Welding in Automotive Applications

Welcome

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Solving the Problems of Remote Laser Aluminum Welding in Automotive Applications

Panelist

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Key Accounts Manager
Laser Systems

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Outline

1. Requirements and challenges for laser welding of aluminum
2. Options to solve the challenges
3. Laser welding of fillet welds with filler wire
    i. Setup for classic laser welding
    ii. Bridging gaps in fillet welds
    iii. Example
4. Remote laser welding of fillet welds without filler wire
    i. Setup for remote laser welding
    ii. Bridging gaps in fillet welds
    iii. Example
    iv. Hot cracks
5. Conclusion

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Remote Laser Welding - Example

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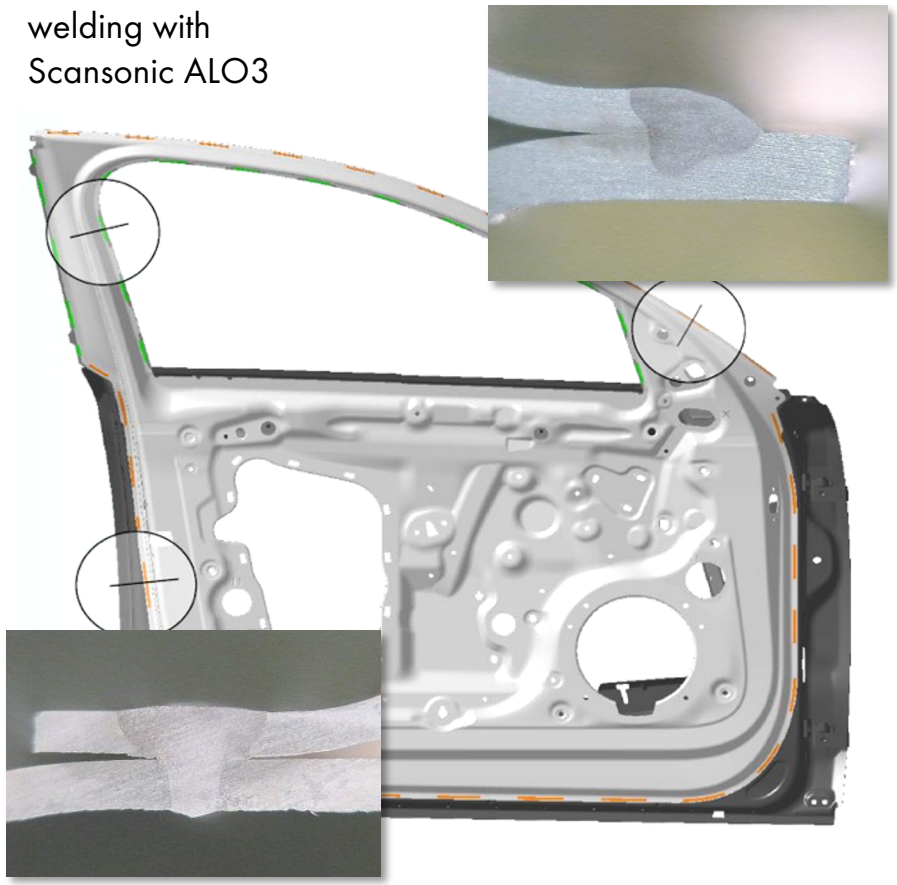
Requirements & Challenges

Door Audi A8 *)

welding with
Scansonic ALO3



Requirements with Car Bodies

- Use of different high strength Aluminum alloys (typ. AW6xxx or AW5xxx) for the realization of light weight constructions
- Reduction of flanges to reduce mass and to increase entry areas at doors or view areas at windows

→ fillet welds or square butt welds at overlap configuration

Challenges

- Welding of Aluminum AW6xxx and AW5xxx sheets
  - with gap bridging
  - without cracks

*) Latzl., M.: Die leichte und funktionale Tür des neuen Audi A8. In: Proceedings of Türen und Klappen, 2010

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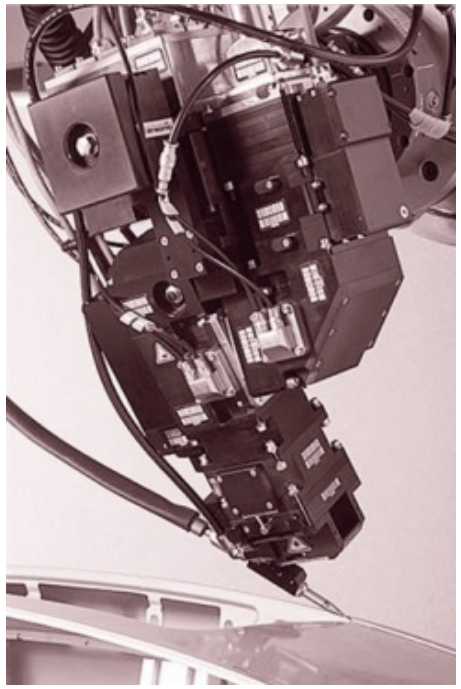
Options to Solve the Challenges

Welding with Additional Material



Welding with Scansonic ALO3

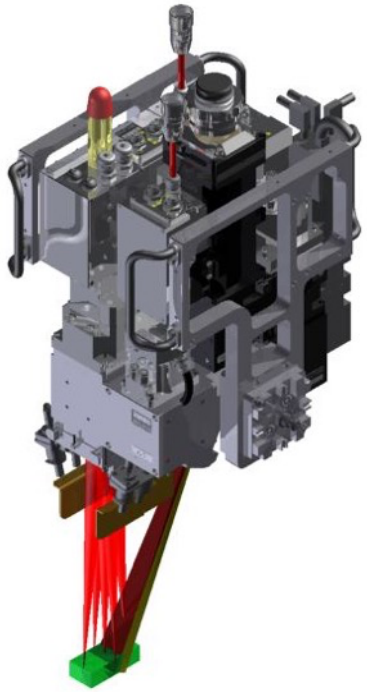
worldwide ~ 1.600 Scansonic ALO1-3 optics
for aluminum welding and steel brazing/welding

+ Metallurgical effects

+ Established process

- Wire costs

Remote-Welding without Additional Material



Welding with Scansonic RLW-A

new optic for high precision Remote-Welding with optical seam tracking

+ No wire costs

+ High efficiency

- How to bridge gaps?

- How to avoid cracks?

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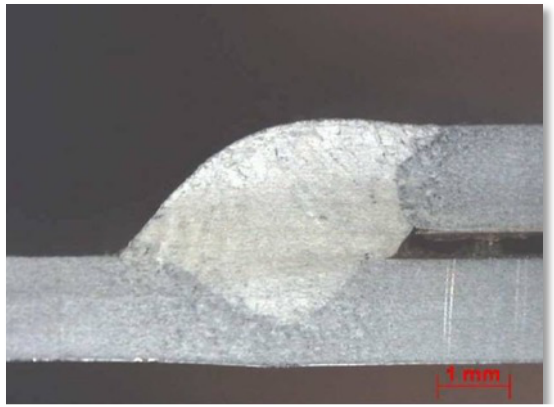
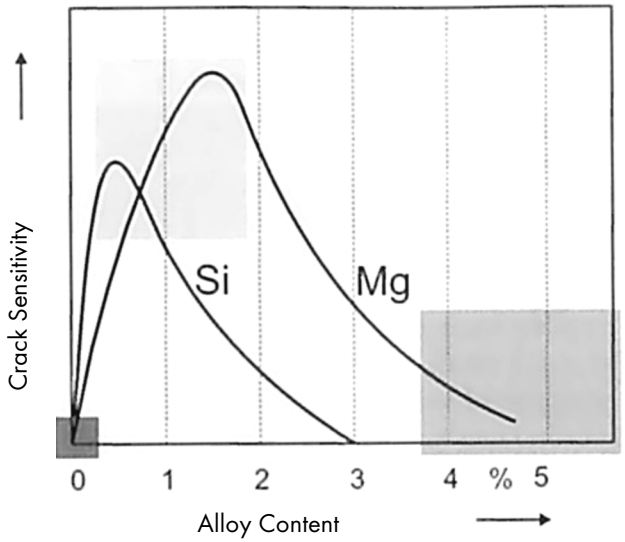
Fillet Welds with Filler Wire

State of the Art - realization of fillet welds with additional material

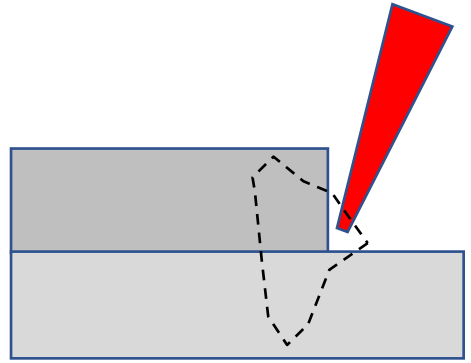
top view





Parameter

- P_L = 2,3 kW; v_R= 4 m/min; v_W= 4,2 m/min
  a_{lat} = 45°; d_S= 0,68 mm
- AW6014 with 0,3...0,6% Si and 0,4...0,8% Mg
- Additional wire AlSi5



Results

- Gap bridging up to ~ 0.5 mm at sheets with
  t ~ 1.0 ... 1.5 mm
- No hot cracking
  - Nearly independent of flange length or welding depth because of metallurgical effects by the use of additional wire

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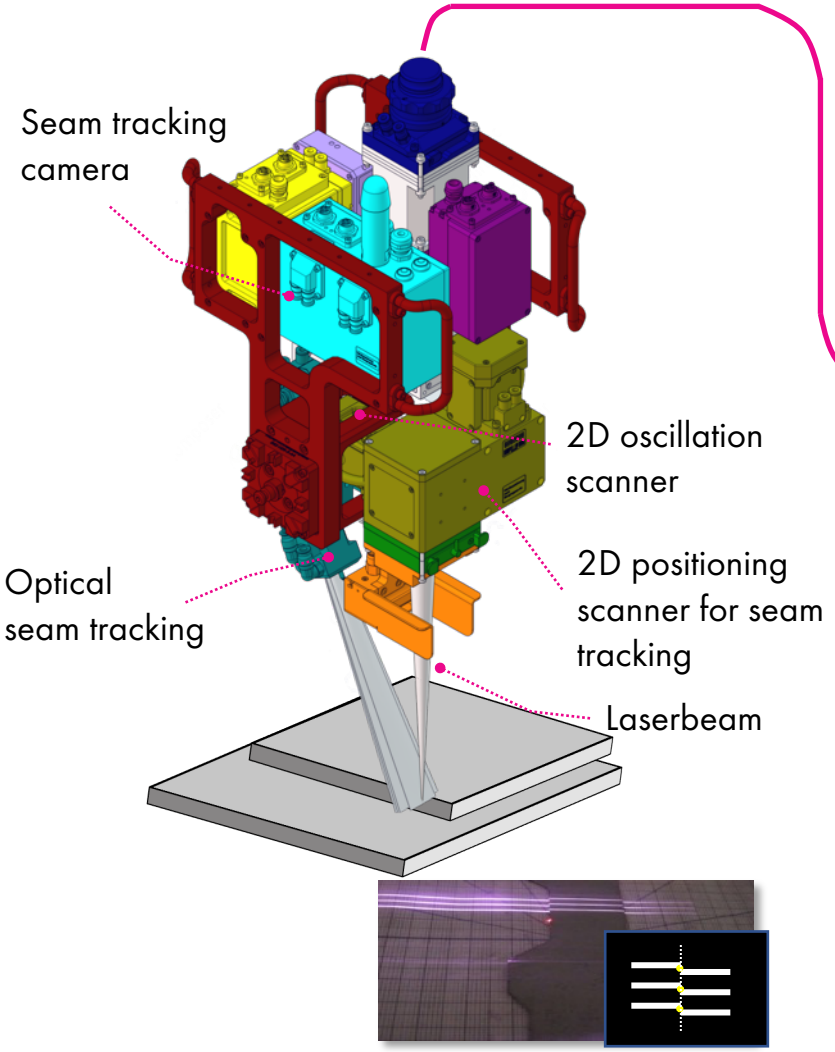
Laser Optic & Laser Source



Laser (type, max. power, bpp)	TruDisk 5001	5 kW	4 mm · mrad
Fibre (type, core diameter, length)	Trumpf	100µm	30 m
Optic (type, opt. ratio, focal length)	RLW-A	1:2.9	500 mm

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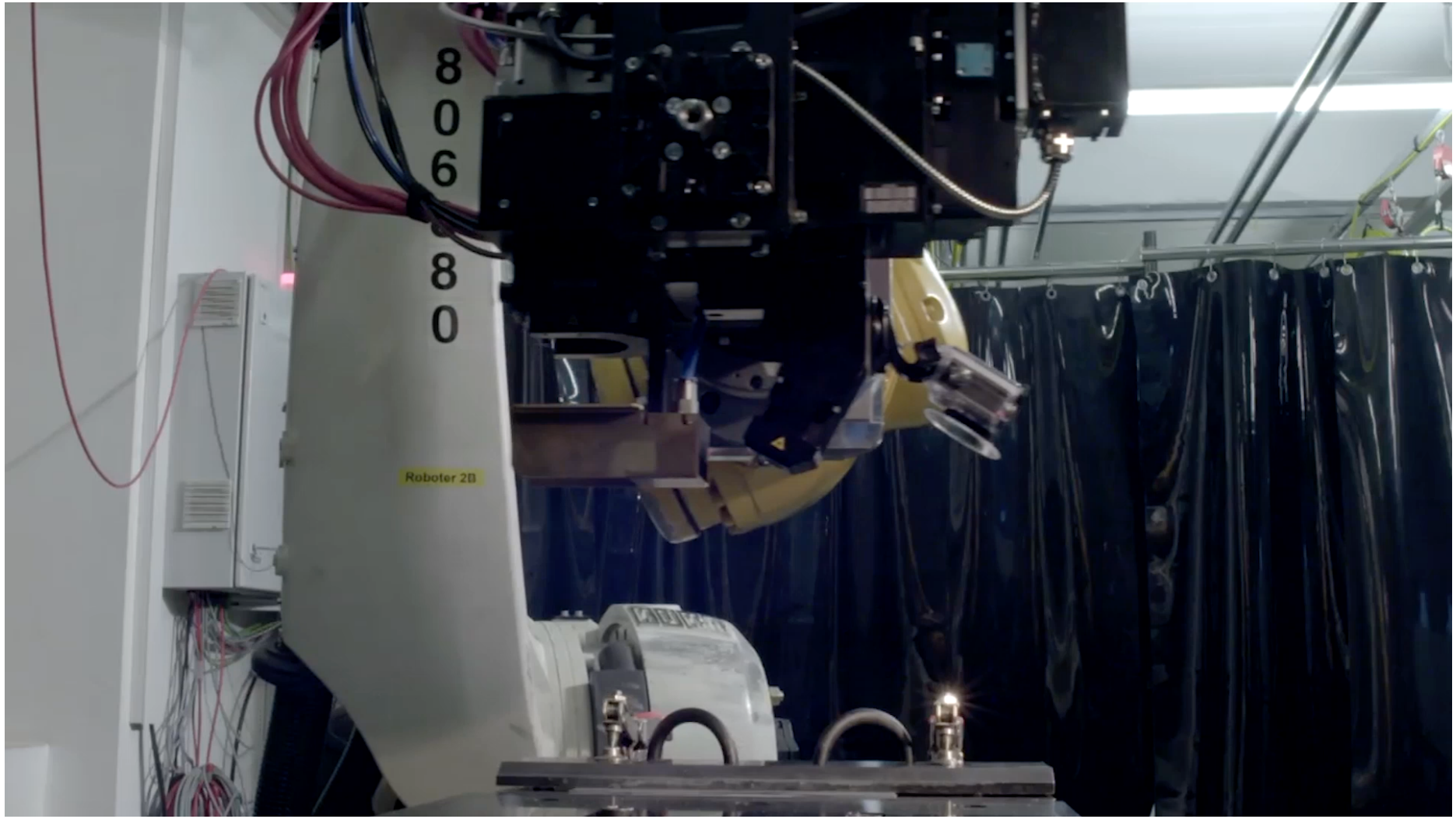
Seam Tracking - Example



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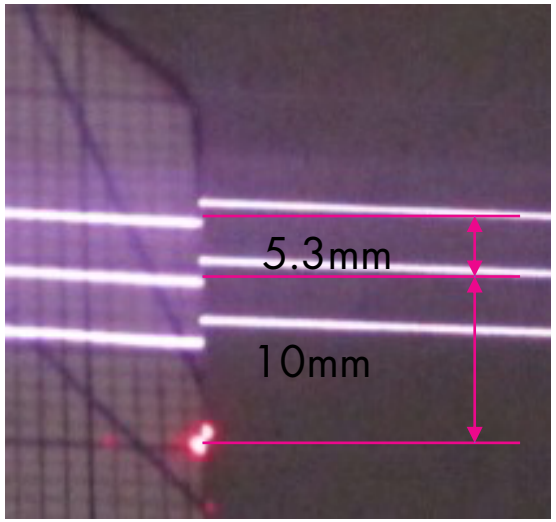
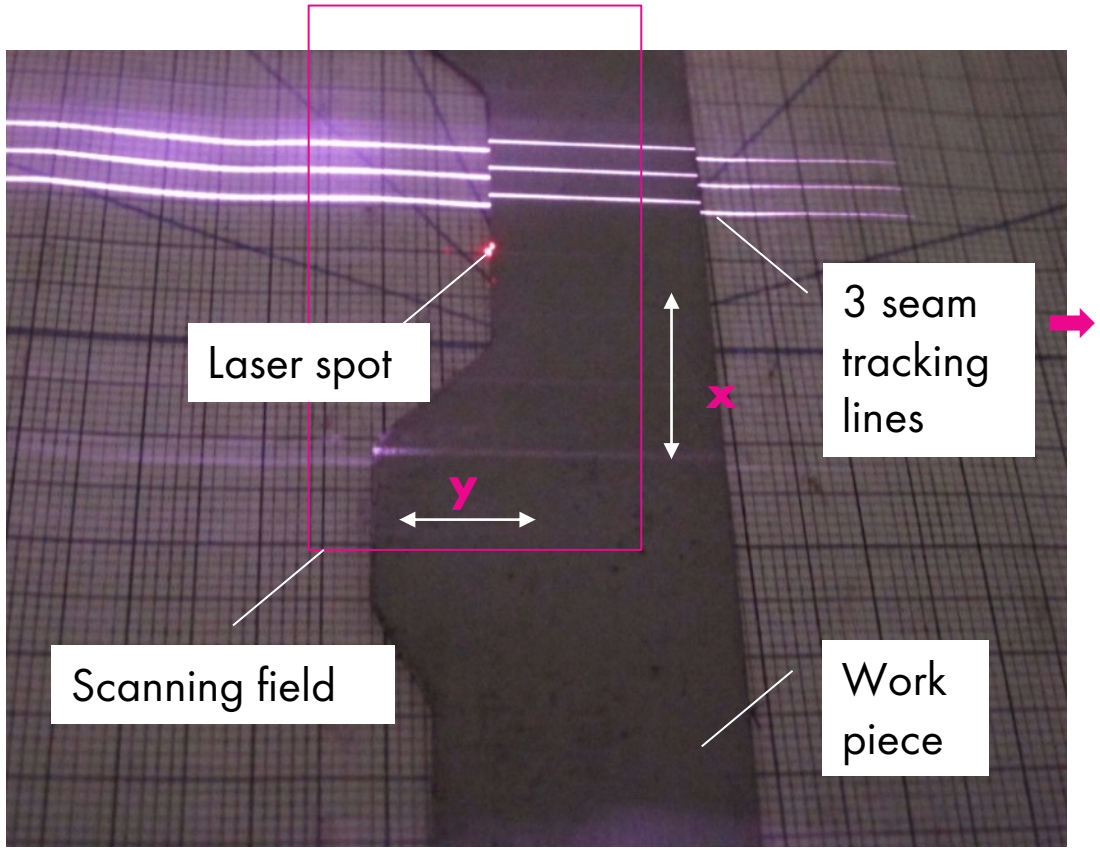
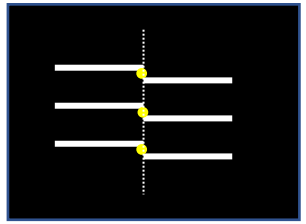
Seam Tracking

10 mm forerun compensation





Measurement of
- cartesian positions: x, y, z
- angular positions: a, b, c (6 D)
- gap, misalignment



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Typical Part Shapes

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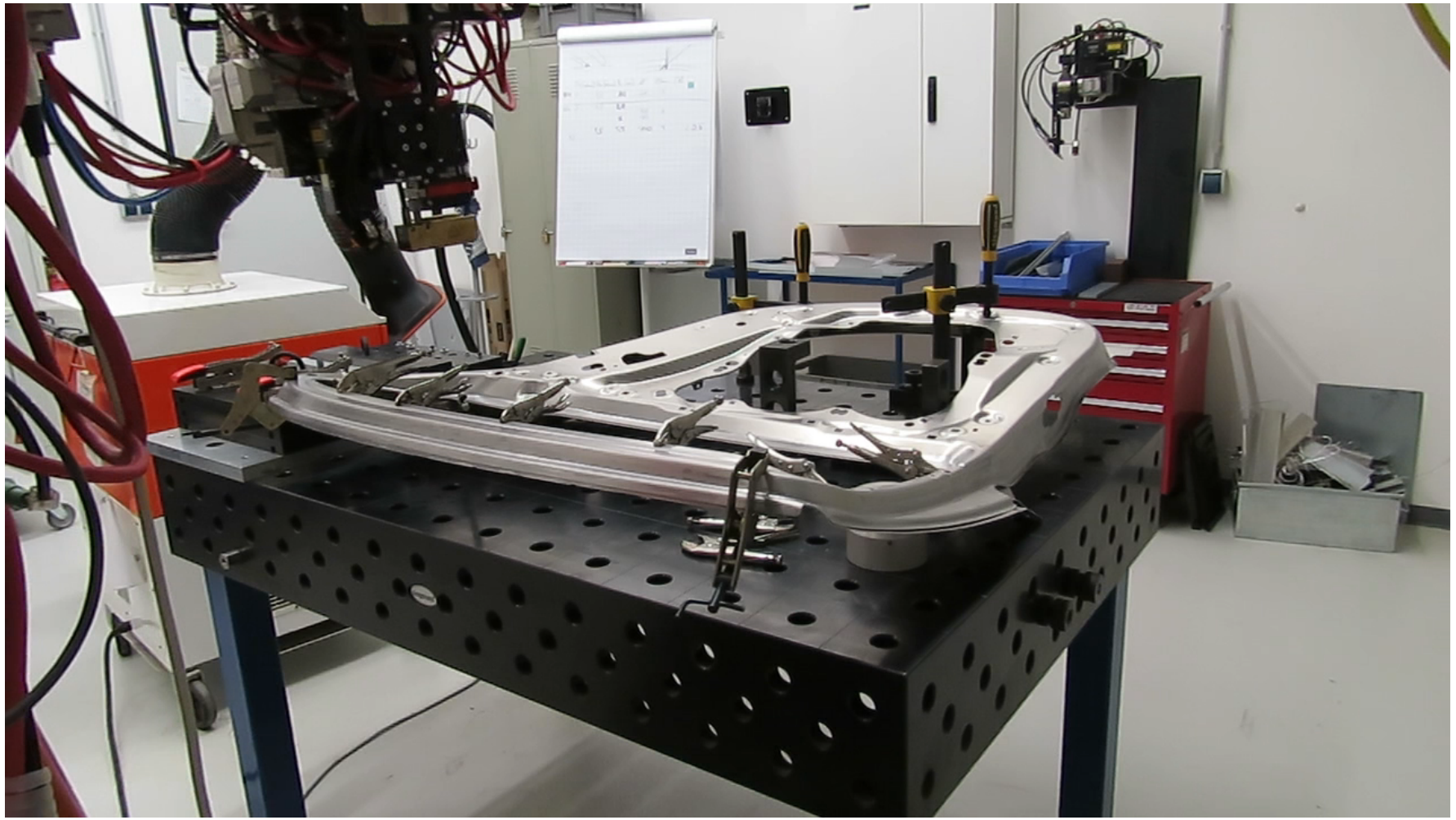
6D Seam Tracking



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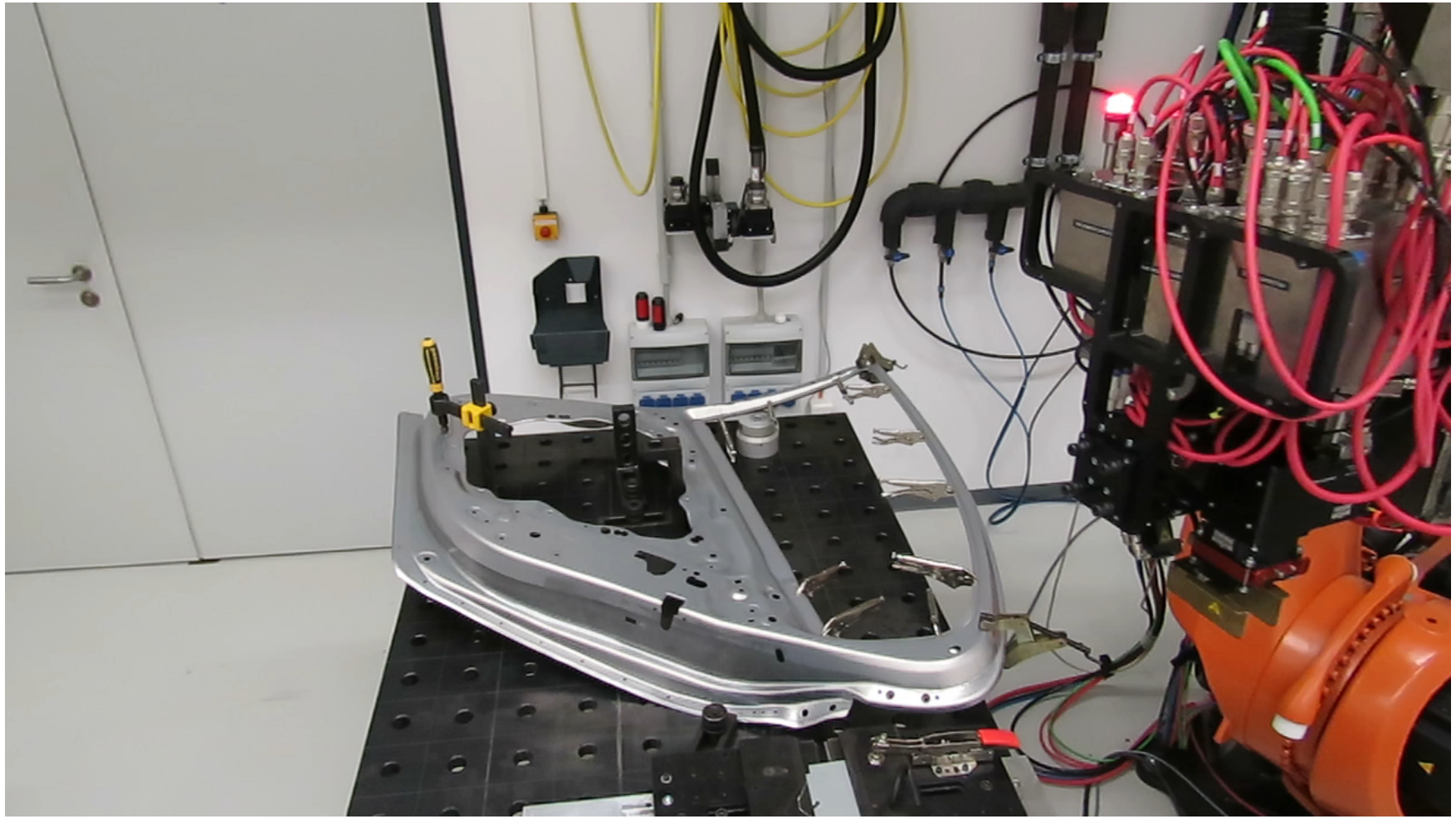
Seam Tracking Around Tightly-Radiused Corners



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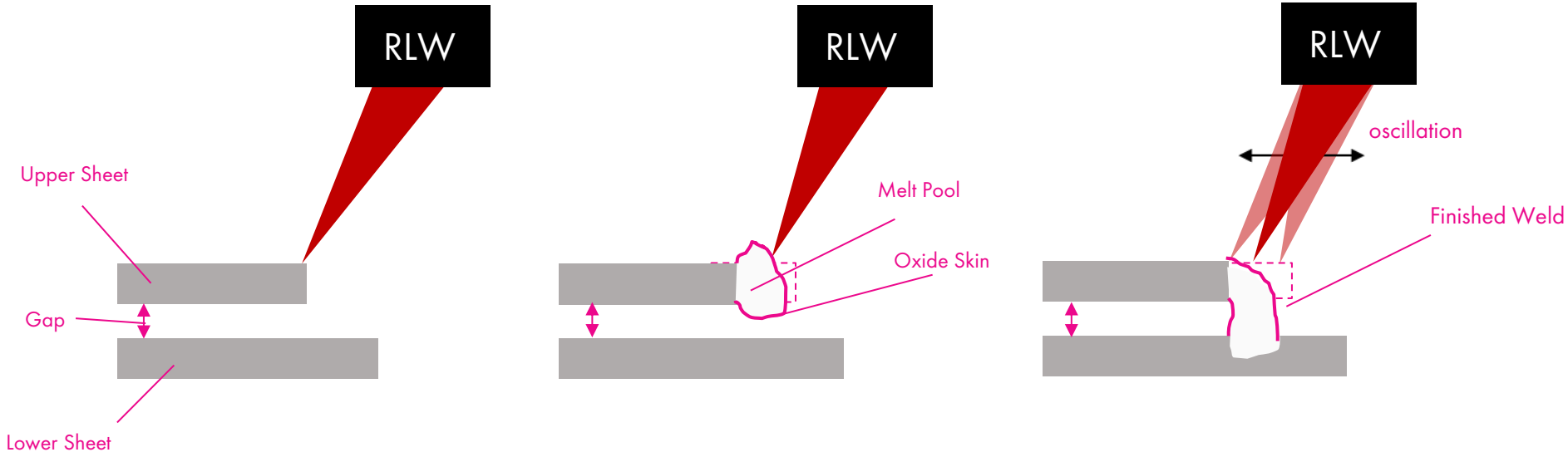
Gap Bridging while Remote Welding without Filler Wire



Initial Situation

- Gap between upper and lower sheet can not be bridged with standard parameter for zero gap situation

→ Adjustments of process parameters are necessary

Problem

- Oxide skin around the melt pool leads to high surface tension
- Connection between upper and lower sheet can not be realized
- Increasing of melt pool by using higher beam diameters is not sufficient due to loss of beam intensity → instable keyhole

Solution

- Increasing the melt pool by using small beam diameter with oscillation → high beam intensity + large melt pool
- High beam velocity leads to higher dynamic in molten pool → better material deposition from upper to lower sheet possible

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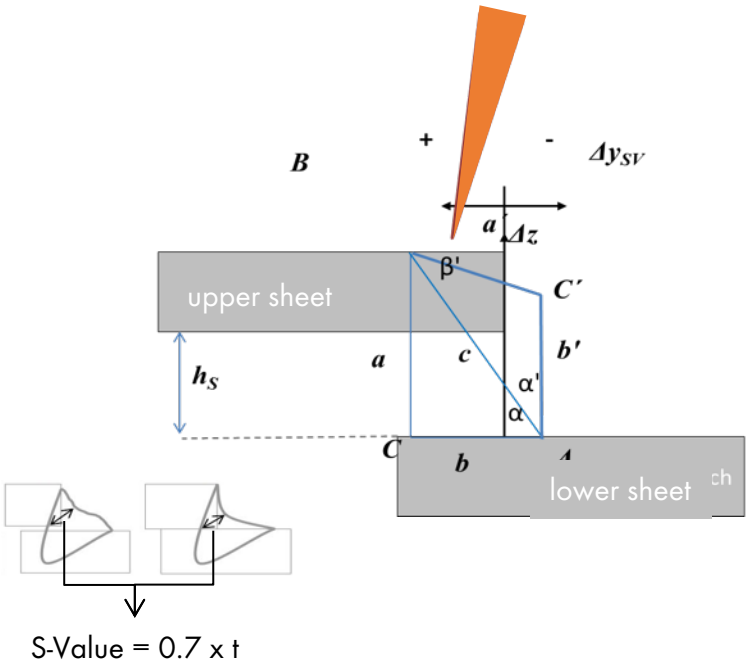

- By seam tracking the correct position of the laser beam is known
- The geometrical model and the necessary S-Value give information about:
  - Y-Offset of the beam
  - Amplitude of beam oscillation
  - Laser power
  - (Frequency of beam oscillation)

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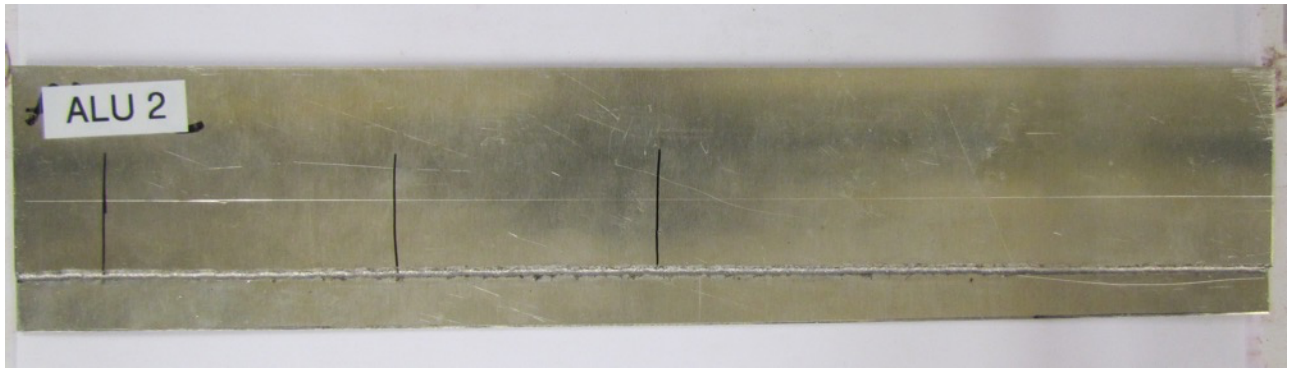
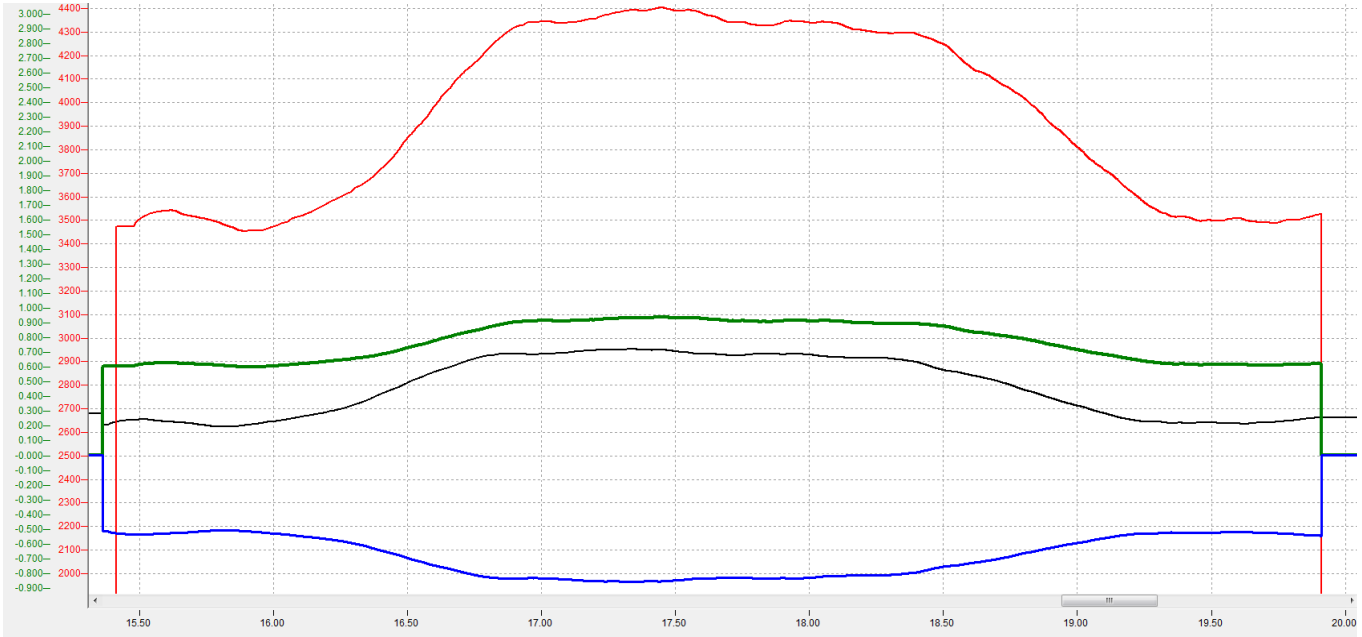
Beam Oscillation in Y Direction





Material: AW 6082; t=1,5

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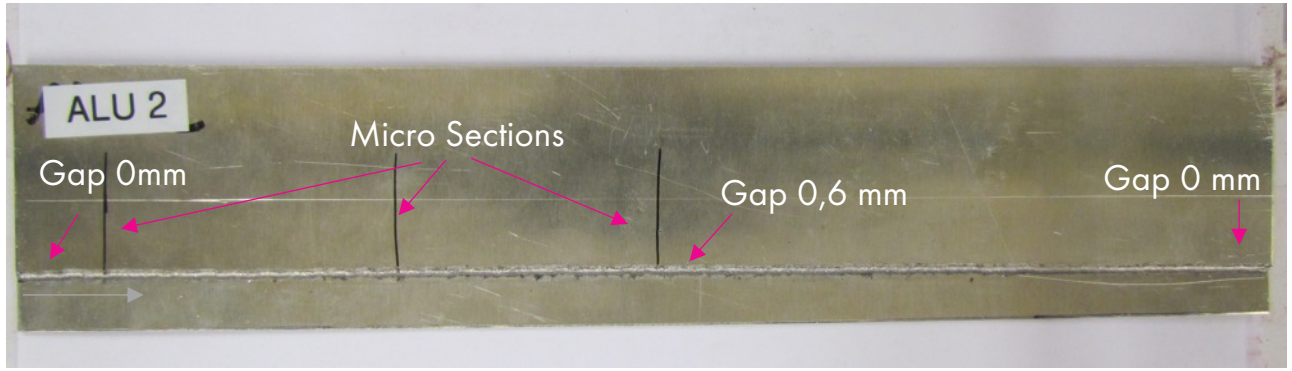
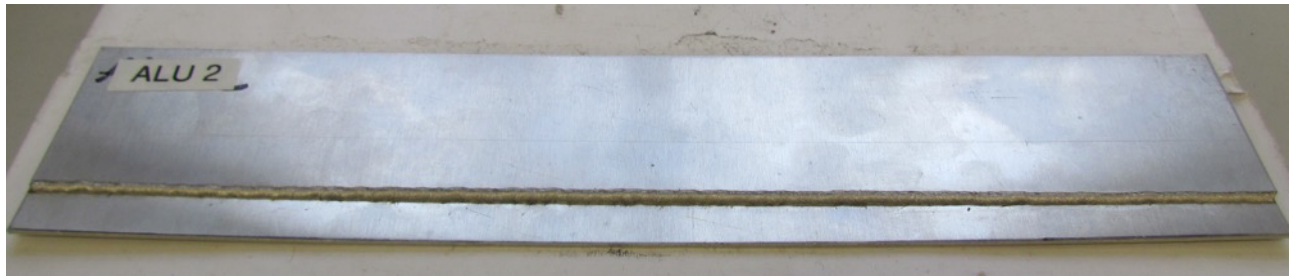
Beam Oscillation in Y Direction



Material: AW 6082
t=1,5



Partial penetration, uniform heating

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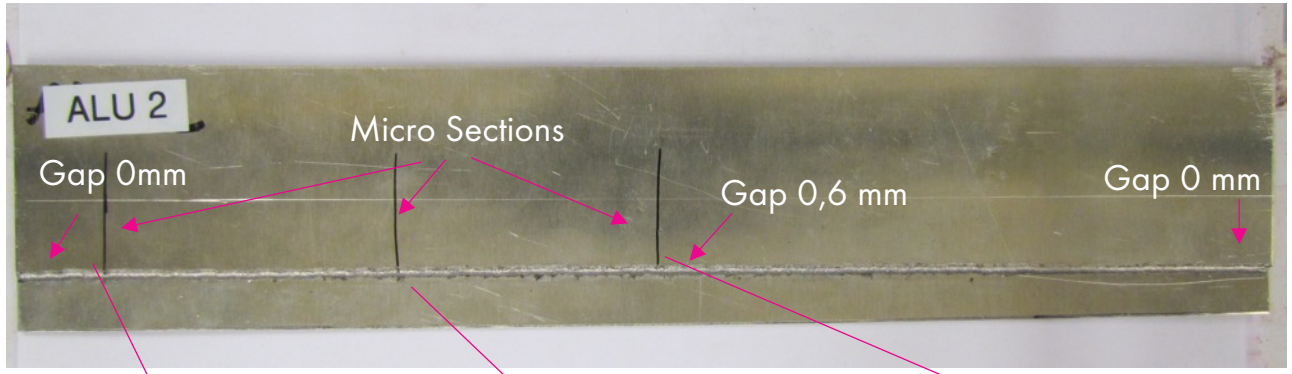
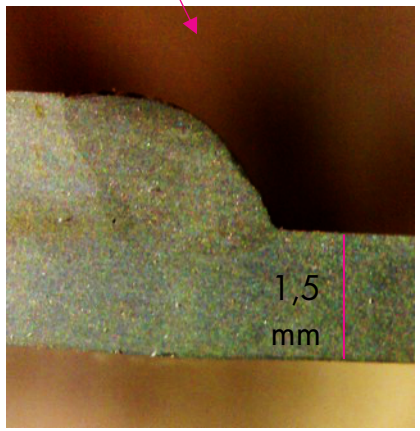
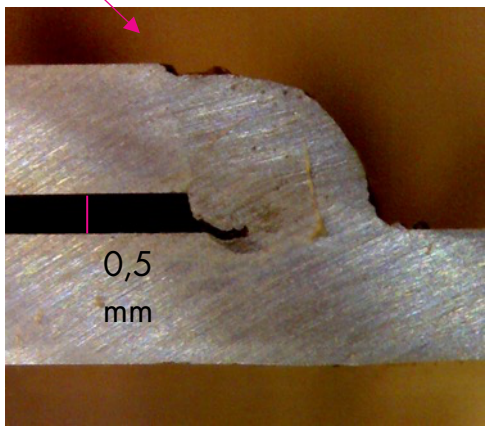
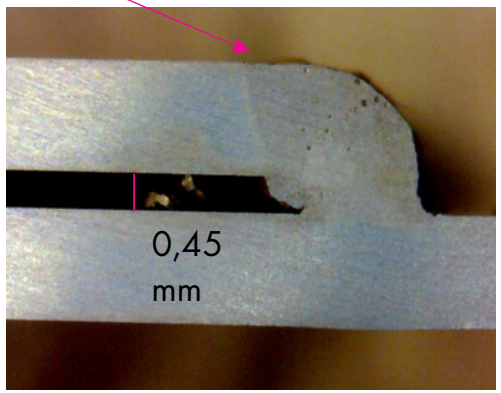
Beam Oscillation in Y Direction









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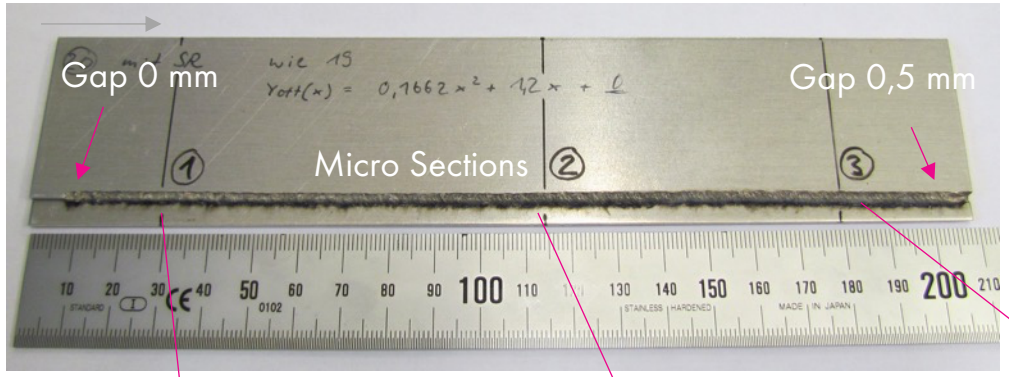
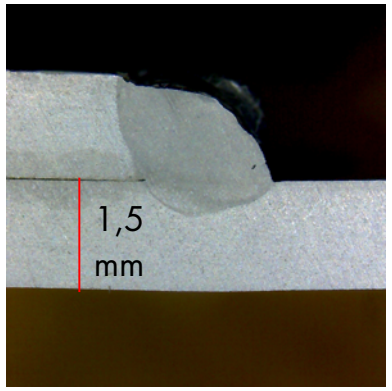
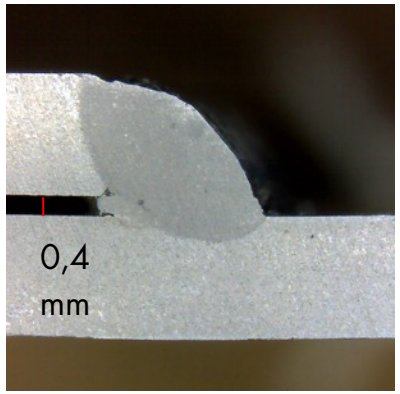
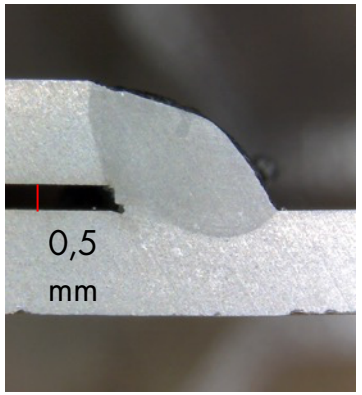
Beam Oscillation in Y Direction



Material: AW 5182
t=1,5







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Bridging Gaps

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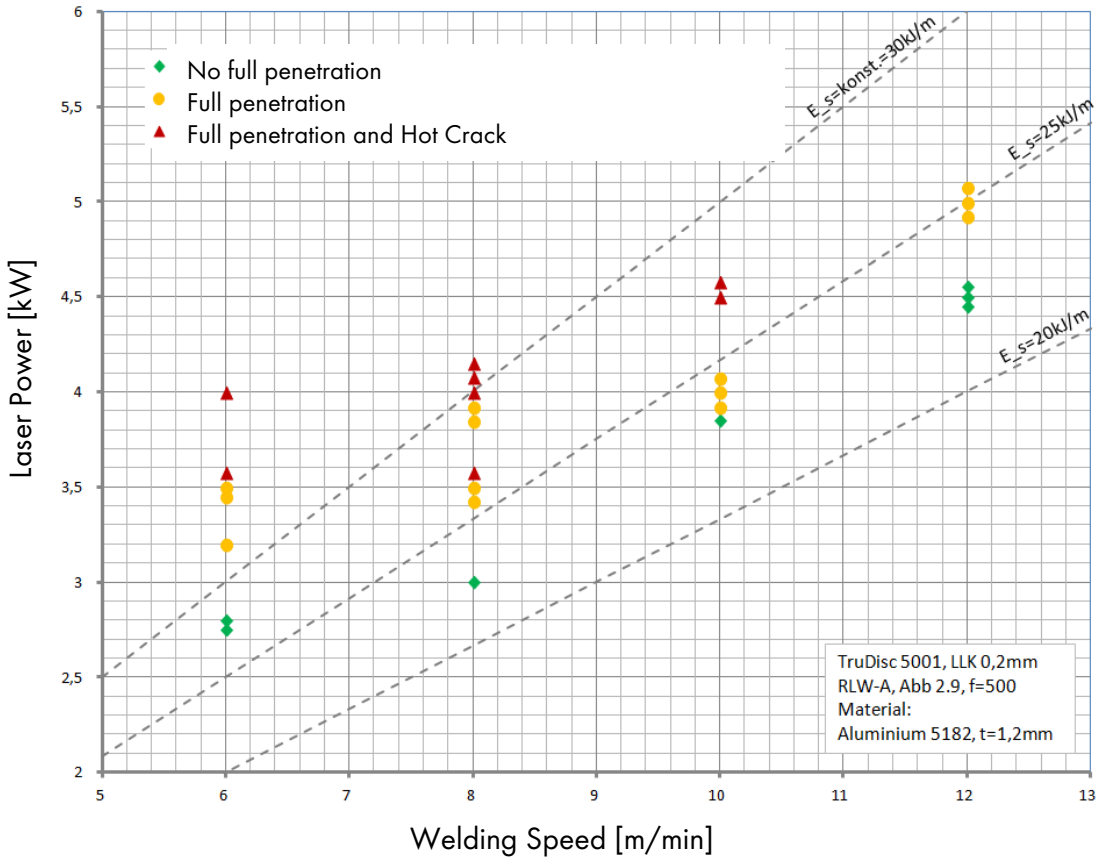
Influence of Laser Power & Welding Speed on Hot Cracks



AW5182; t = 1.5 mm fillet welds

- Hot cracks only at full penetration and with high energy input
- No hot cracks at partial penetration welding

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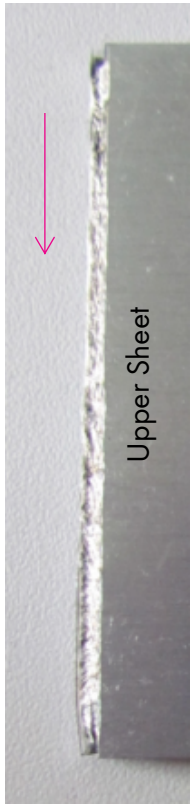
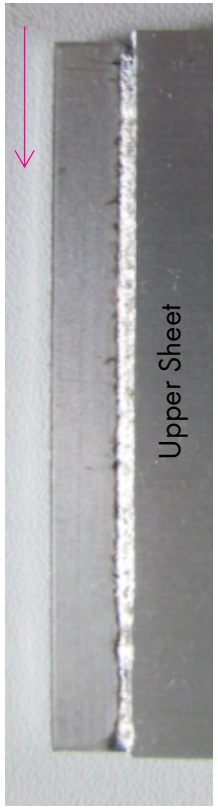
Influence of Flange Width on Hot Cracks



Flange Width = 1 mm

Flange Width = 3 mm



Flange Width = 7 mm

v = 8m/min; P_L = 3,5kW

AW5182; t = 1.5 mm fillet welds

- In the instable region of hot cracking:

  → dependency of flange width

- At flange widths between 2...6 mm high hot cracking risk

→ **Seam tracking necessary!**

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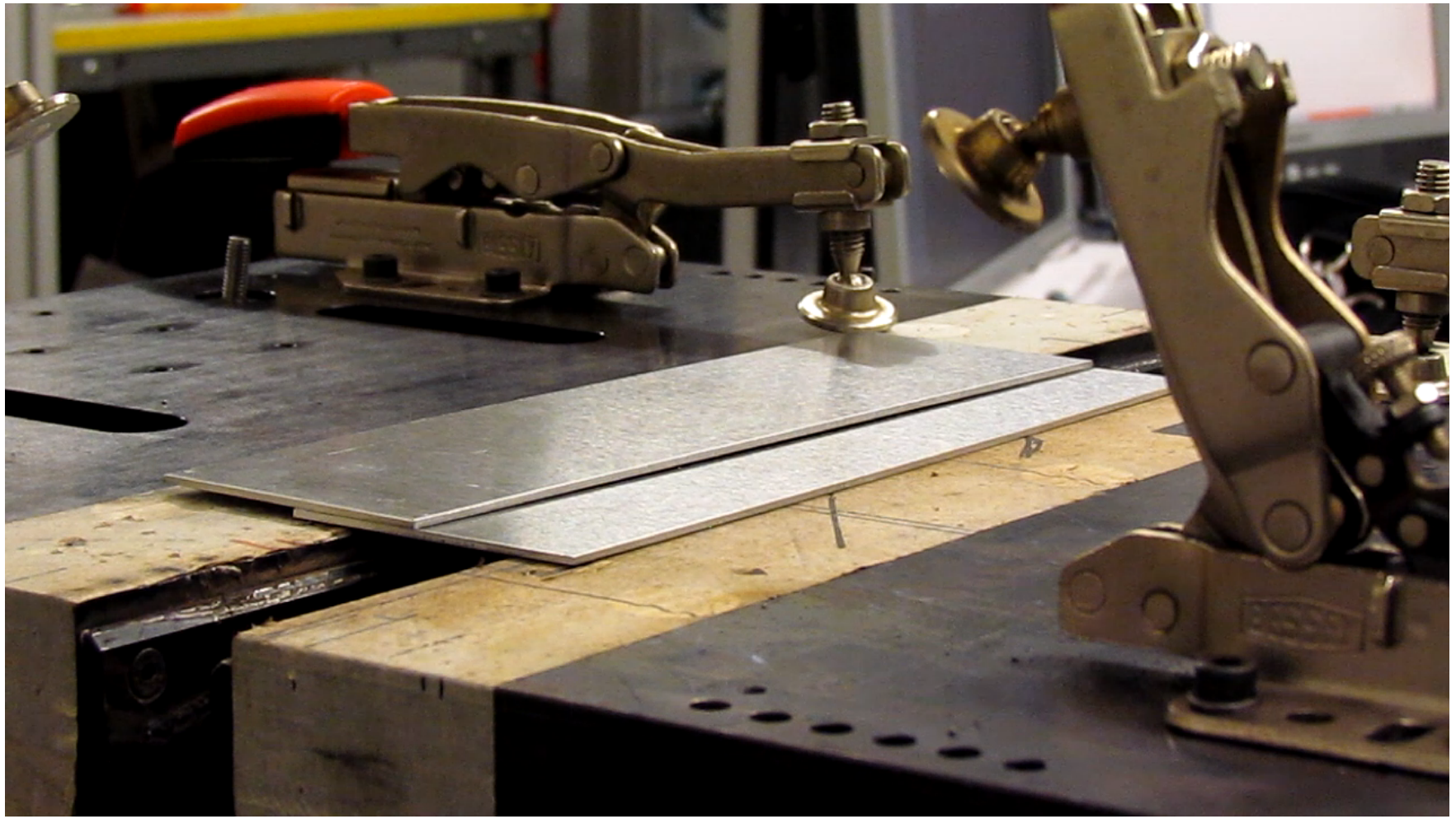
Welding without Clamping



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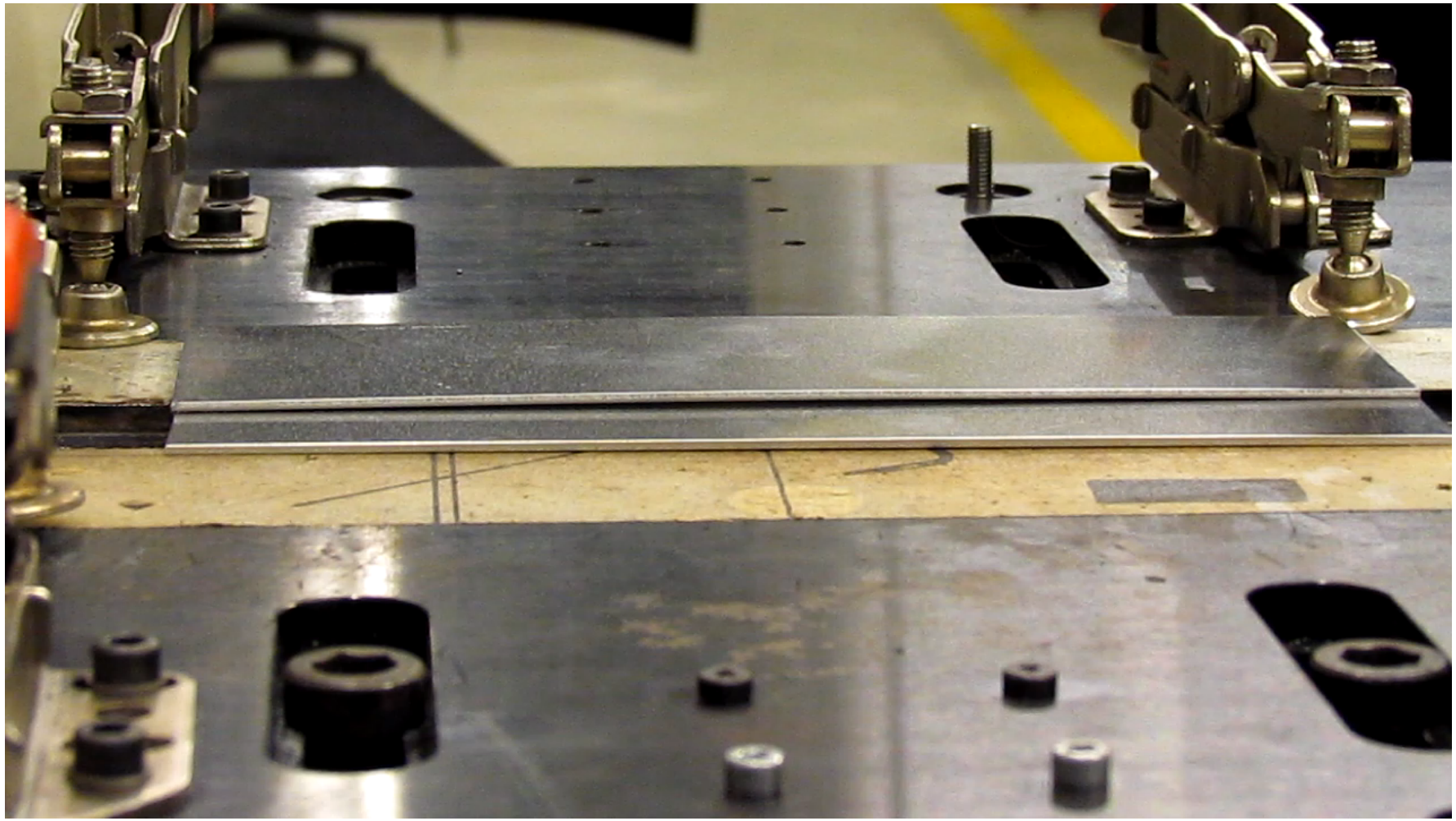

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Conclusion

Welding of thin aluminum sheets of AW5xxx or AW6xxx:

- When traditionally laser welding good gap bridging is given by the use of filler wire
- When remote welding gap bridging is possible by a beam oscillation
  - The measurement of the gap allows to control the process parameter (laser power, beam offset, amplitude and frequency of oscillation)
  - The necessary S-value leads to correct parameter
- At the investigated samples hot cracks are no problem as well as with or without filler wire if there is no full penetration at flange widths between 6 mm < wFl < 2 mm

Weld Inspection

Contact Us!

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