Preliminary studies of acoustic emission for in-situ detection of instabilities in keyhole laser welding

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Motivation

- Laser-arc hybrid welding (LAHW) has shown a remarkable productivity boost, ranging from 5 to 20 times higher than conventional arc welding, as validated in laboratory testing. The principle of the LAHW is shown in Fig.1.

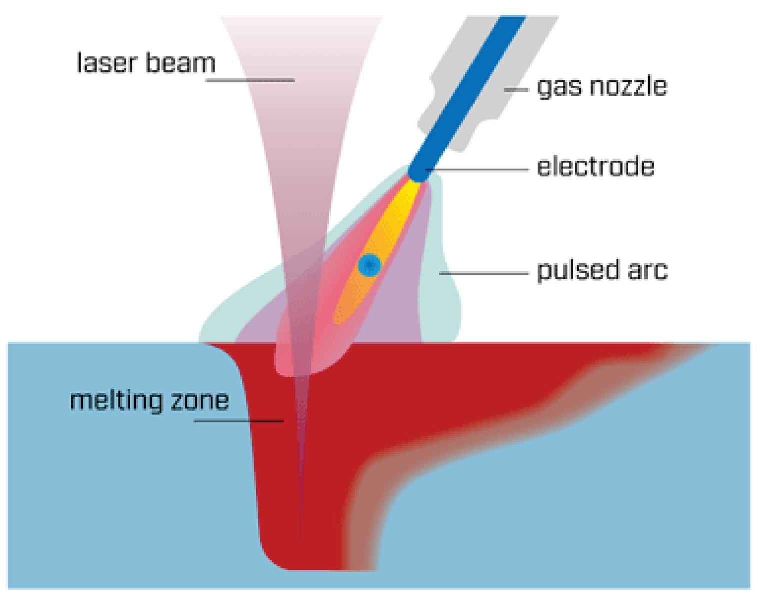


Fig 1. The basic principle the laser-arc hybrid welding.

- However, the keyhole mode in laser welding may be unstable and cause defects in welds. The direct observation of a keyhole using vision-based technique is challenging due to limitation of equipment and high cost.
- Therefore, fast and reliable method for process monitoring and defect detect methods are needed to improve the process robustness and weld quality.

Methodology

- In this study, the acoustic emission (AE) technique was used for in-situ laser beam welding (LBW) process monitoring (listening) and detecting possible defects during welding, as illustrated in Fig.2.
- The objective of this study is to demonstrate the concept and establish a meaningful relationship between AE signals and defects.

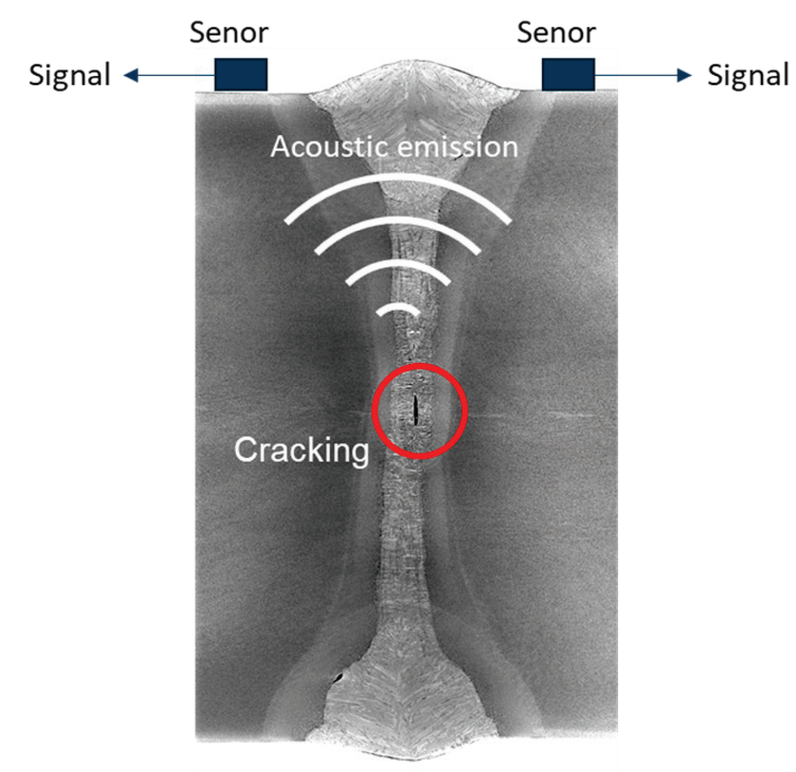


Fig 2. Illustration of the concept.

Test setup

- **Acoustic emission system**
  - Vallen system, AMSY-6
  - Amplifier AEP4, Vallen system 40dB
  - Transducer: Digital wave B-1025, wideband (50 kHz – 2 MHz)
  - Contact: Bee wax
- **Laser beam welding equipment and parameters**
  - Laser type: Yb:fiber laser with 1070 nm wavelength
  - Laser power output: 10 kW
  - Welding speed: 1.0 m/min
  - Material: high-strength carbon steel (Strenx® 700)

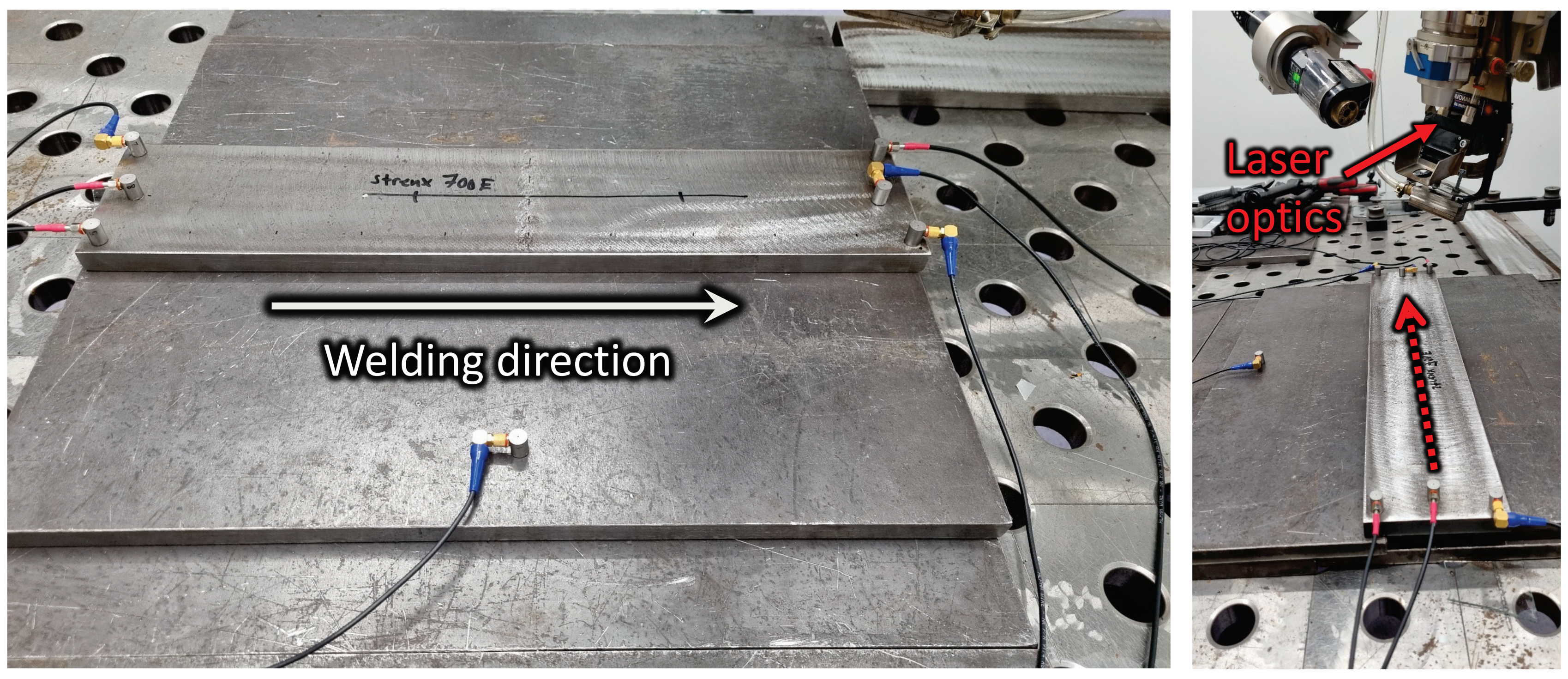
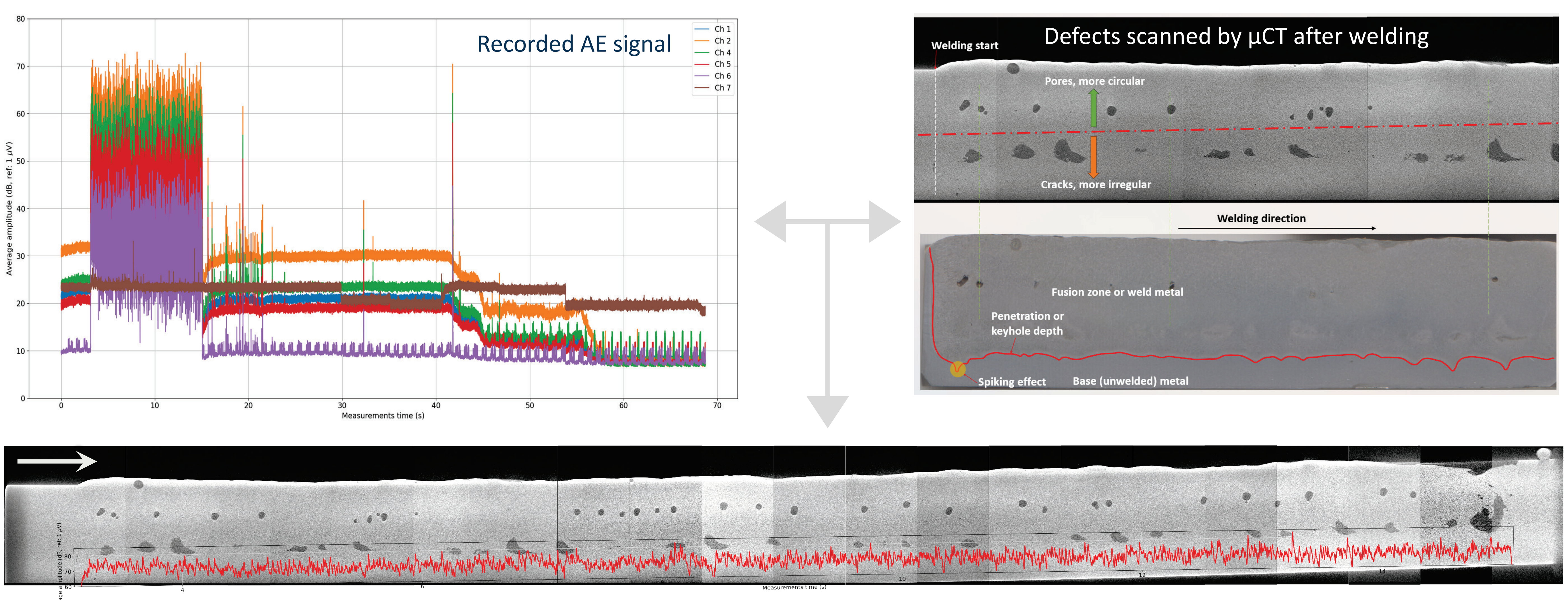


Fig 3. Test setup in SINTEF Welding Lab

Preliminary results



In our quest for answers, we also wonder: Could you enlighten us on what secrets the defect is whispering?

Future work

- The methodology will be further developed in 2024.
- Establish the corelation between AE signals and defects to explore the potential use of machine-learning (ML) with digital twin for defect detection.

Acknowledgement

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