This is a peer-reviewed, author's accepted manuscript of the following conference abstract: Zimermann, R., Mohseni, E., Vasilev, M., Loukas, C., Wathavana Vithanage, R. K., MacLeod, C. N., Pierce, G., Lines, D., Pimentel Espirindio E Silva, M., Fitzpatrick, S., Rizwan, M. K., Williams, S., & Ding, J. (Accepted/In press). *In-process non-destructive evaluation of wire + arc additive manufacture components using ultrasound high-temperature dry-coupled roller-probe*. Abstract from European Conference on Non-Destructive Testing 2023, Lisbon, Portugal.

Additive Manufacturing plays a significant role in Industry 4.0, where the demand for smart factories capable of fabricating high-quality customized products cost-efficiently exists. Wire + Arc Additive Manufacturing (WAAM) is one such technique that enables automated, time and material-efficient production of high-value geometrically complex metal parts. To strengthen the benefits of WAAM, the demand for robotically deployed in-process Non-Destructive Evaluation (NDE) has risen, aiming to replace manually deployed inspection techniques deployed after the full part completion.

This novel research presents a synchronized multi-robot WAAM deposition & ultrasound NDE cell aiming to achieve defect detection in-process, enable possible in-process repair, and prevent costly scrappage or rework.

The full external control NDE approach is achieved by the real-time force/torque sensor-enabled adaptive kinematics control package. A novel high-temperature dry-coupled ultrasound roller-probe device is employed to assess the structural integrity of freshly deposited layers of WAAM components. The WAAM roller-probe is tailored to facilitate the in-process inspection by dry-coupling coupling with the hot (< 350 °C) non-flat surface of WAAM using a flexible outer silicone tyre and solid core delay-line at speed and at high coupling force [1].

The demonstration of the in-process inspection approach is performed on hot as-built Ti-6Al-4V WAAM samples. The defect detection capabilities are assessed on artificially produced defects embedded inside these WAAM builds. In this work the defect detection is accomplished using 1) layer-specific beamforming focusing imaging and 2) volumetric inspection using post-processing algorithms applied to collected Full Raw Data e.g. Full Matrix Capture.

The analysis and results comparison show promising results with a sufficient Signal-to-Noise ratio (< 10 dB). Hence, the research directly supports the industrial benefits of the WAAM process intending to achieve the automated production of first-time-right parts.