

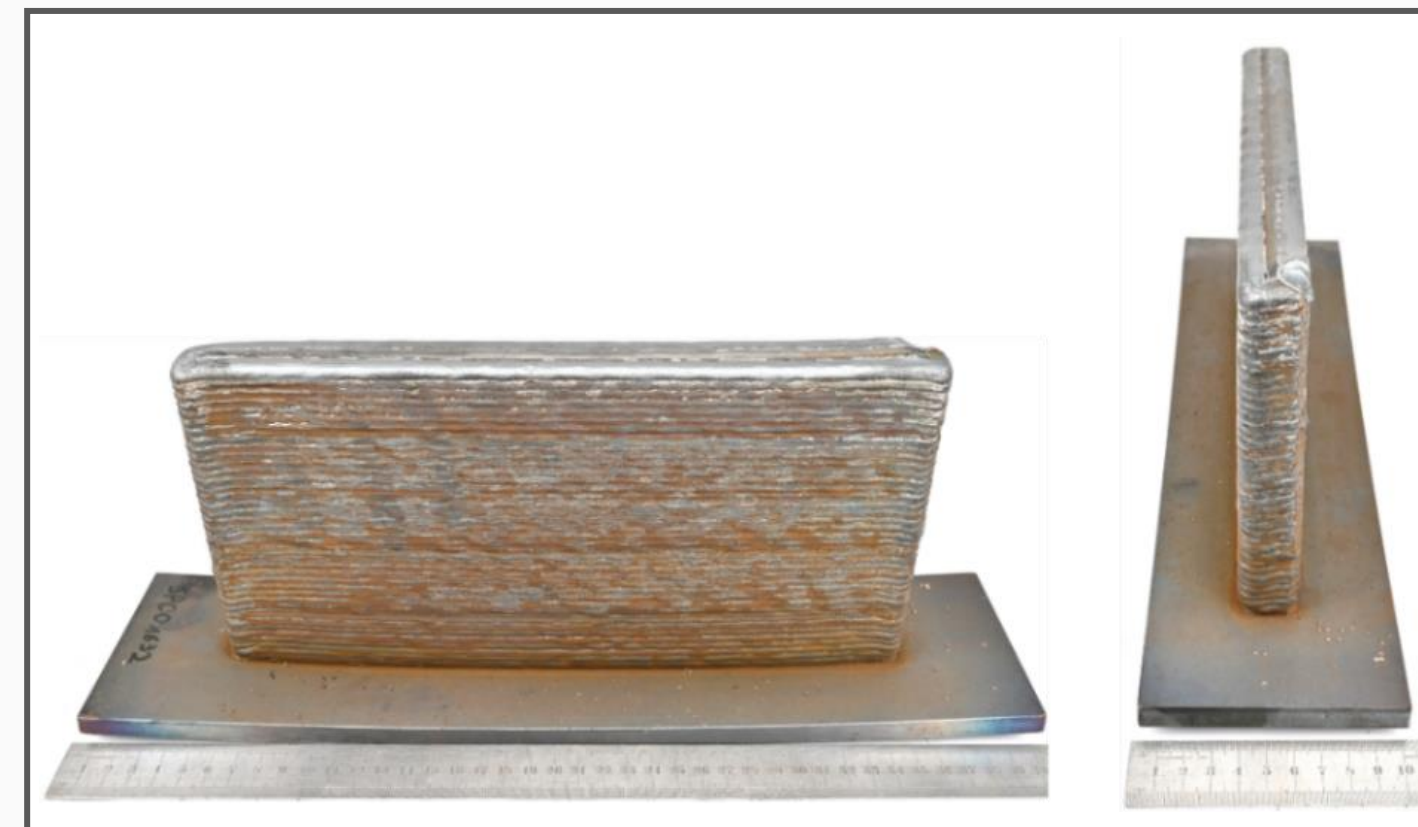
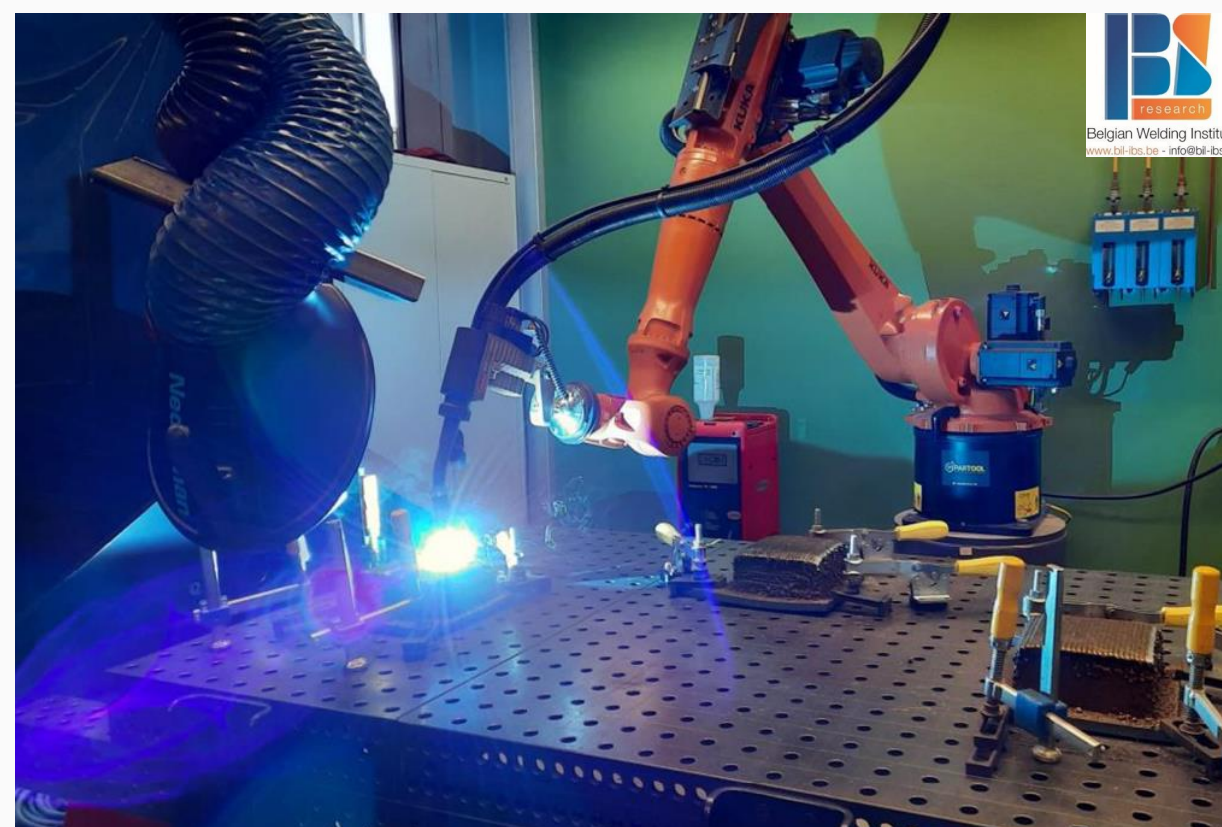
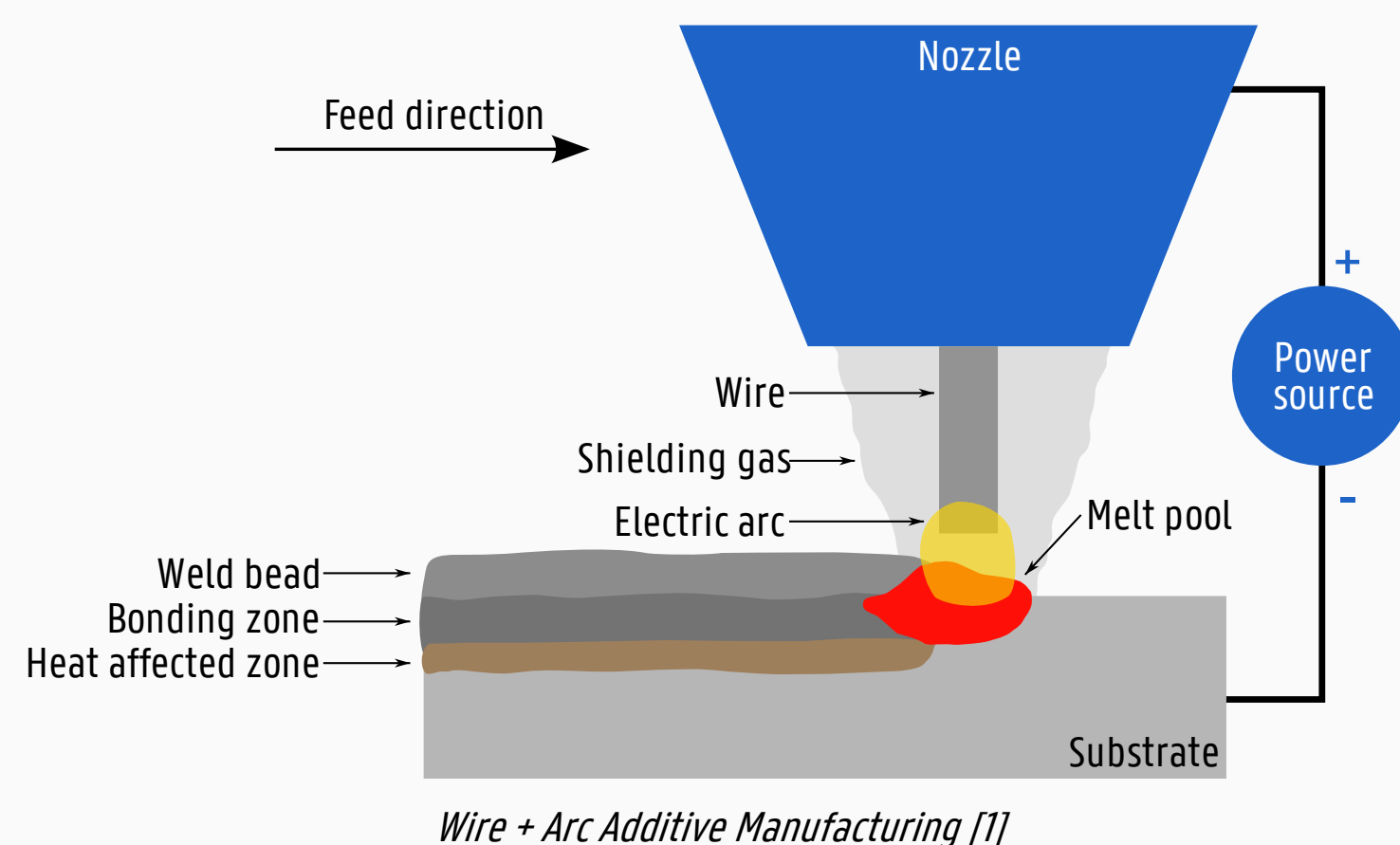
SOETE LABORATORY – EMSME (EA08)

Jun Cheng, Rafael Nunes, Robin Motte, Wim De Waele

PHD PROJECTS ON WIRE + ARC ADDITIVE MANUFACTURING AT SOETE LABORATORY

Wire + Arc Additive Manufacturing (WAAM)

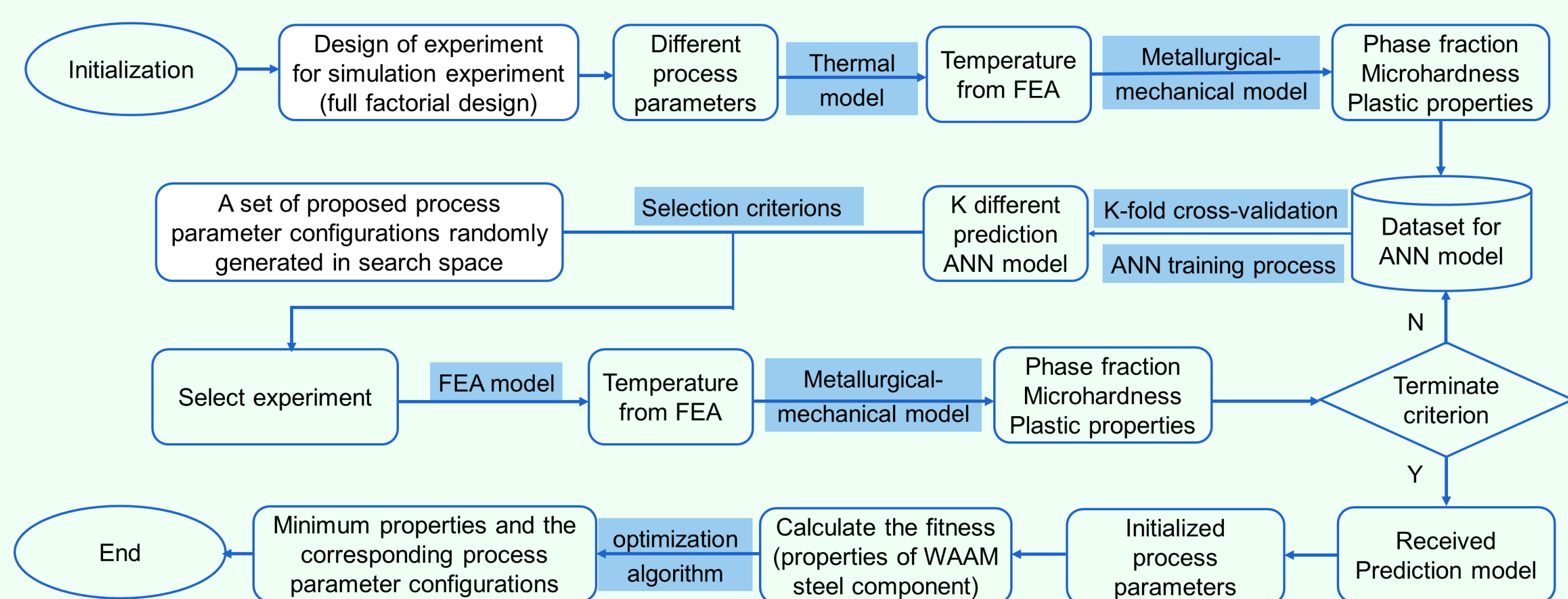
- Based on electric arc welding processes
 - Melting of metal feedstock wire using an electric arc
- High deposition rates
- High material usage efficiency
- High cyclical heat input
 - Microstructural gradients
 - + heterogeneous and anisotropic material properties
 - + residual stresses



Modelling and prediction tools for WAAM based on machine learning

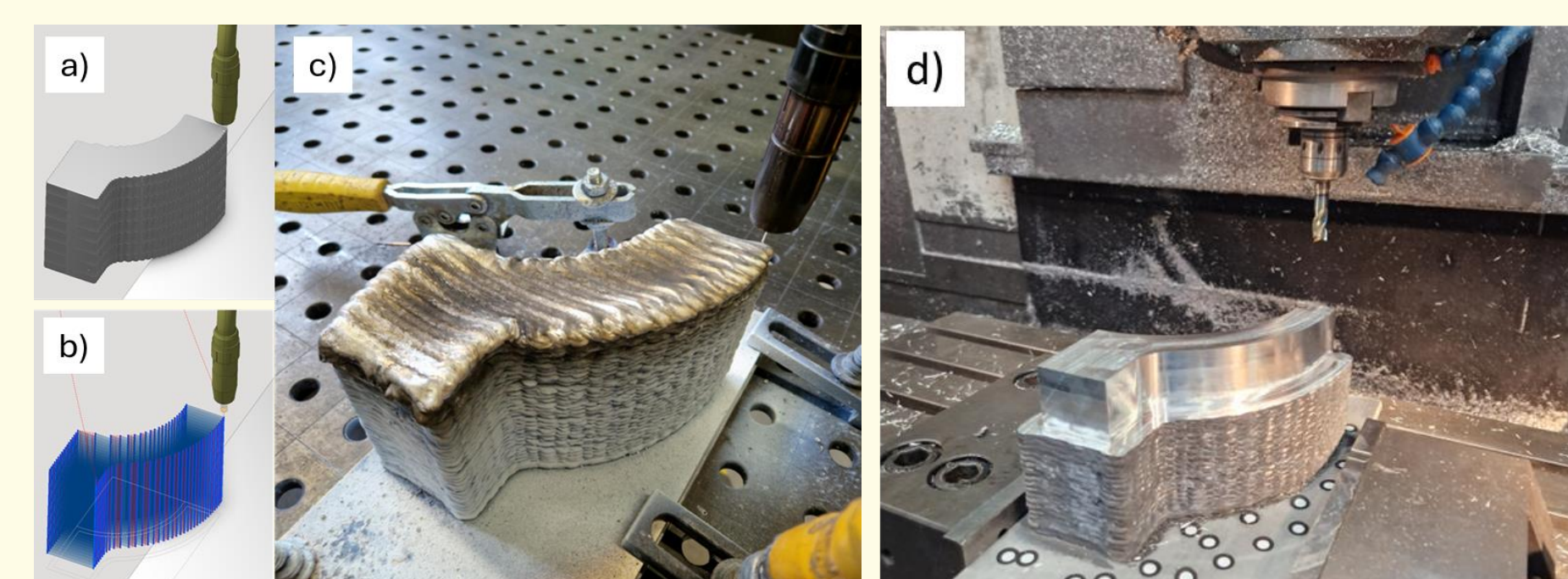
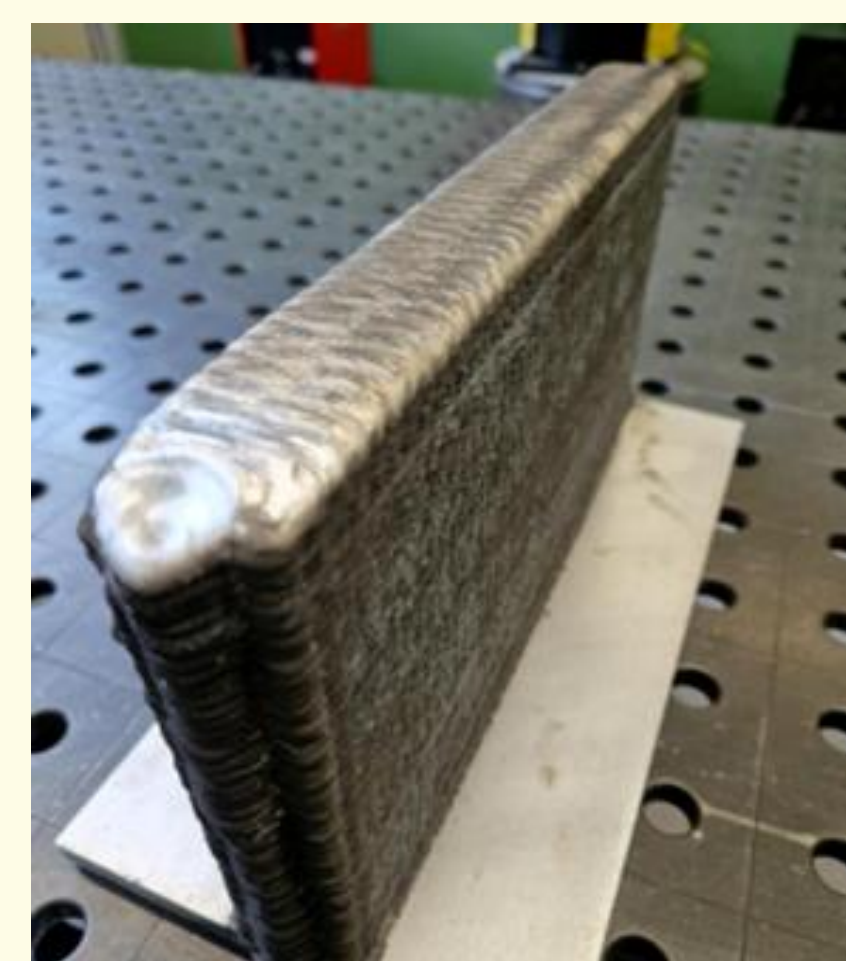
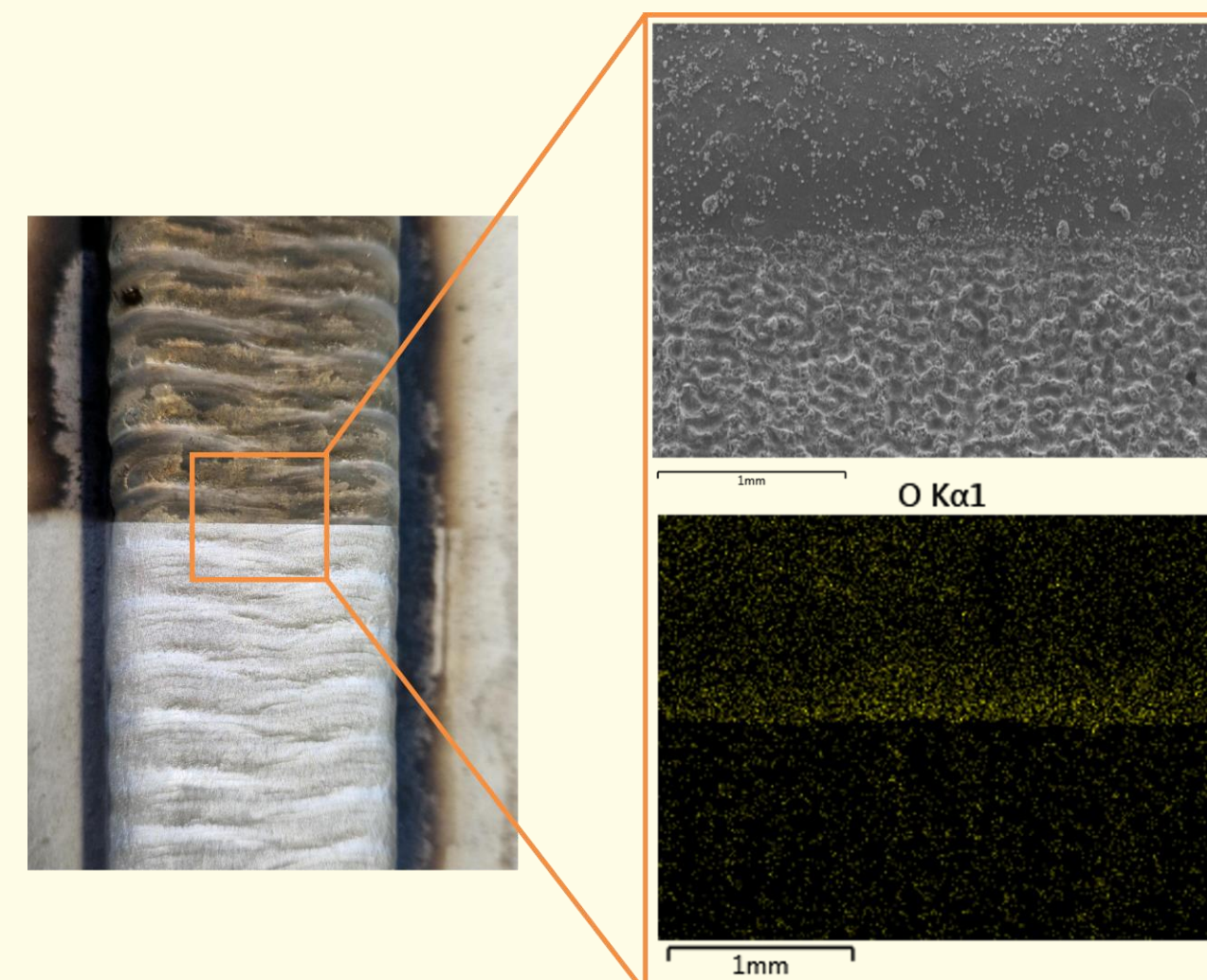
– Jun Cheng

- Dataset generation: a FE based thermal-metallurgical model for mild steel
 - Thermal analysis using different heat source models
 - Phase transformation theory for phase fractions
 - Empirical equations to calculate microhardness, etc.
- Adaptive design of experiment (DOE) approach to develop and ANN model for prediction of microhardness etcetera.
 - Full factorial design of experiments (DOE) to build the initial dataset for ANN model via K-fold cross-validation
 - Selection criterion to decide new virtual experiment based on 1) distance between new experiment parameters and finished experiment parameters; 2) variance of prediction set generated based on K different ANN prediction models.
 - Termination criterion for DOE: maximum number of experiments
- Intelligent optimization algorithm for microhardness, etc.



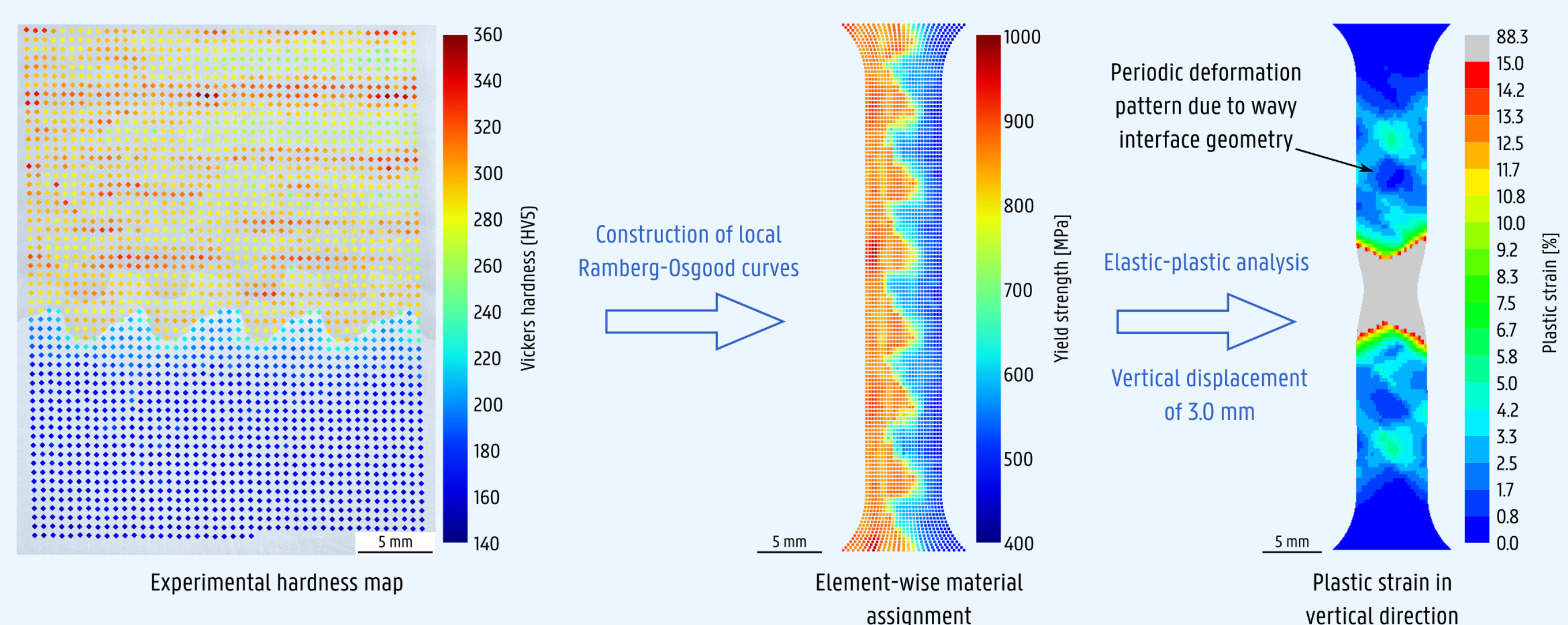
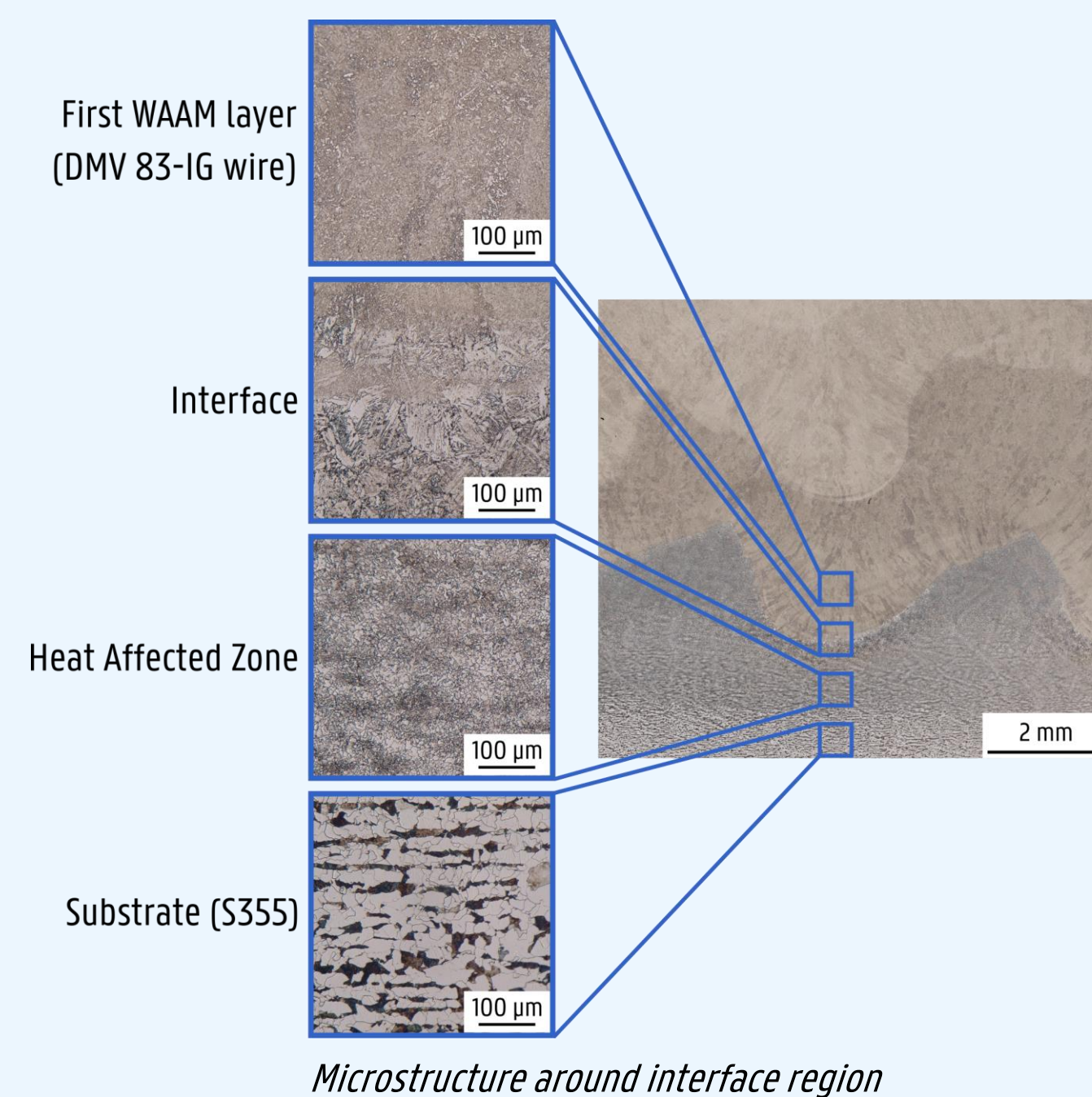
WAAM of high-strength aluminium alloys– Rafael Nunes

- Optimization of manufacturing process of ER 7075 high-strength aluminium alloys:
 - Exploratory experiments with ER 5183 and ER 2219 alloys
 - Welding parameters optimization
 - Deposition path strategy optimization
 - Influence of the filler metal quality
 - Influence of the shielding gas mixture
 - Laser cleaning during WAAM process
 - Post Welding Heat Treatment optimization
 - Fatigue testing of selected samples
 - Manufacturing of industrial-designed demonstrators



Structural integrity of steel WAAM components – Robin Motte

- WAAM to remanufacture worn or damaged components
- Interface between original component and WAAM deposit
 - Wavy geometry due to adjacent weld beads
 - Heterogeneous microstructure
 - Finite element model with element-wise material assignment based on local Vickers hardness (HV)
- Ongoing work: fatigue lifetime calculation
 - Local fatigue strength based on HV
 - Fatigue crack growth simulation: X-FEM



References

- [1] Adapted from: Nele Dewagtere. (2021). *Characterization of residual stresses in Wire + Arc Additive Manufactured steel components using Digital Image Correlation*.
- [2] Image courtesy: Belgian Welding Institute

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