

AluWeld

**Tehokkuutta alumiinirakenteiden hitsaustuotantoon
ja
Laatua elinkaarihallintaan**

**Efficiency in welding production of aluminum structures
and
Quality in life cycle control**



ALUWELD | LUT RESEARCH TEAM

LUT Welded Metal Structures | 16 April 2026



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Laboratory staff
&
M. Sc. thesis workers

ALUWELD | CONSORTIUM

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BUSINESS
FINLAND

Pema
WELDING AUTOMATION



alumeco
Group



ALUCAR
Part of the Extendo Group

PROMECO

RETCO
welding products



 LUT
University

MOBIMAR | MOBILE
MARINE
APPLICATIONS

PURSO

MÄKELÄ ALU

SUISTO
ENGINEERING

ELOMATIC

UUDENKAUPUNGIN
TYÖVENE OY
UUSIKAUPUNKI - FINLAND

ALUWELD | RESEARCH PLAN & WORK PACKAGES

■ LUT Welded Metal Structures | 16 April 2026

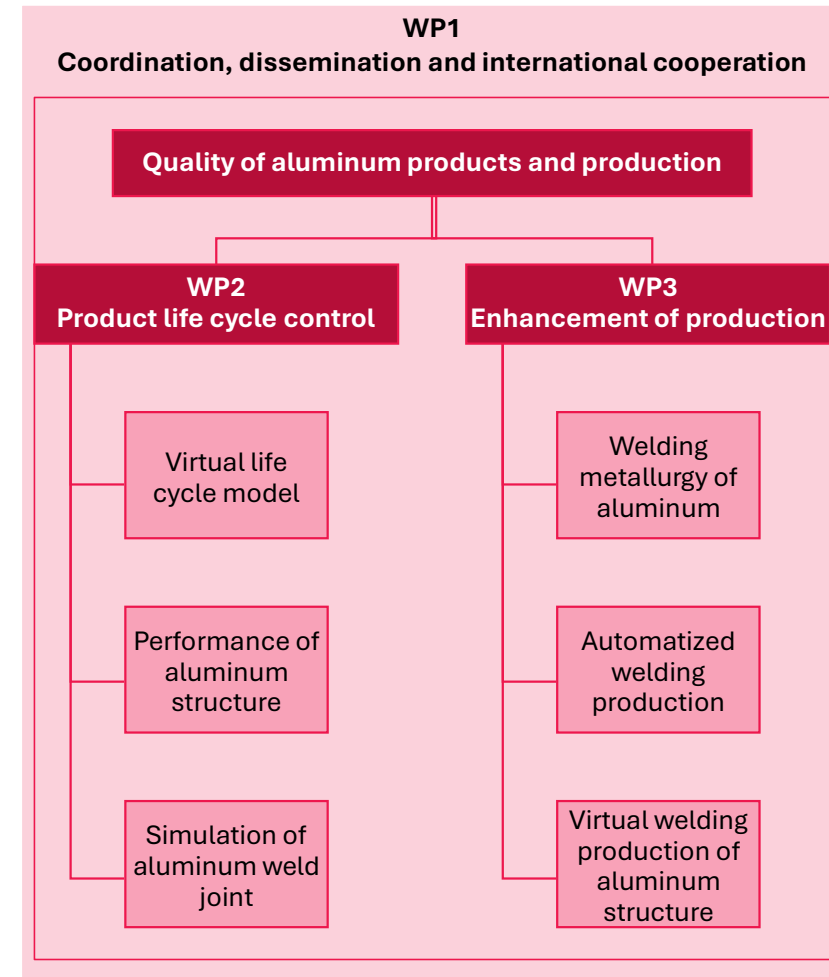
▶ **WP1 Coordination, dissemination and international cooperation | koordinointi, tiedonlevitys ja kv-yhteistyö**

▶ **WP2 Product life cycle control | Tuotteen elinkaarihallinta**

- WP2.1 Virtual life cycle model
- WP2.2 Performance of aluminum structure
- WP2.3 Simulation of aluminum weld joint

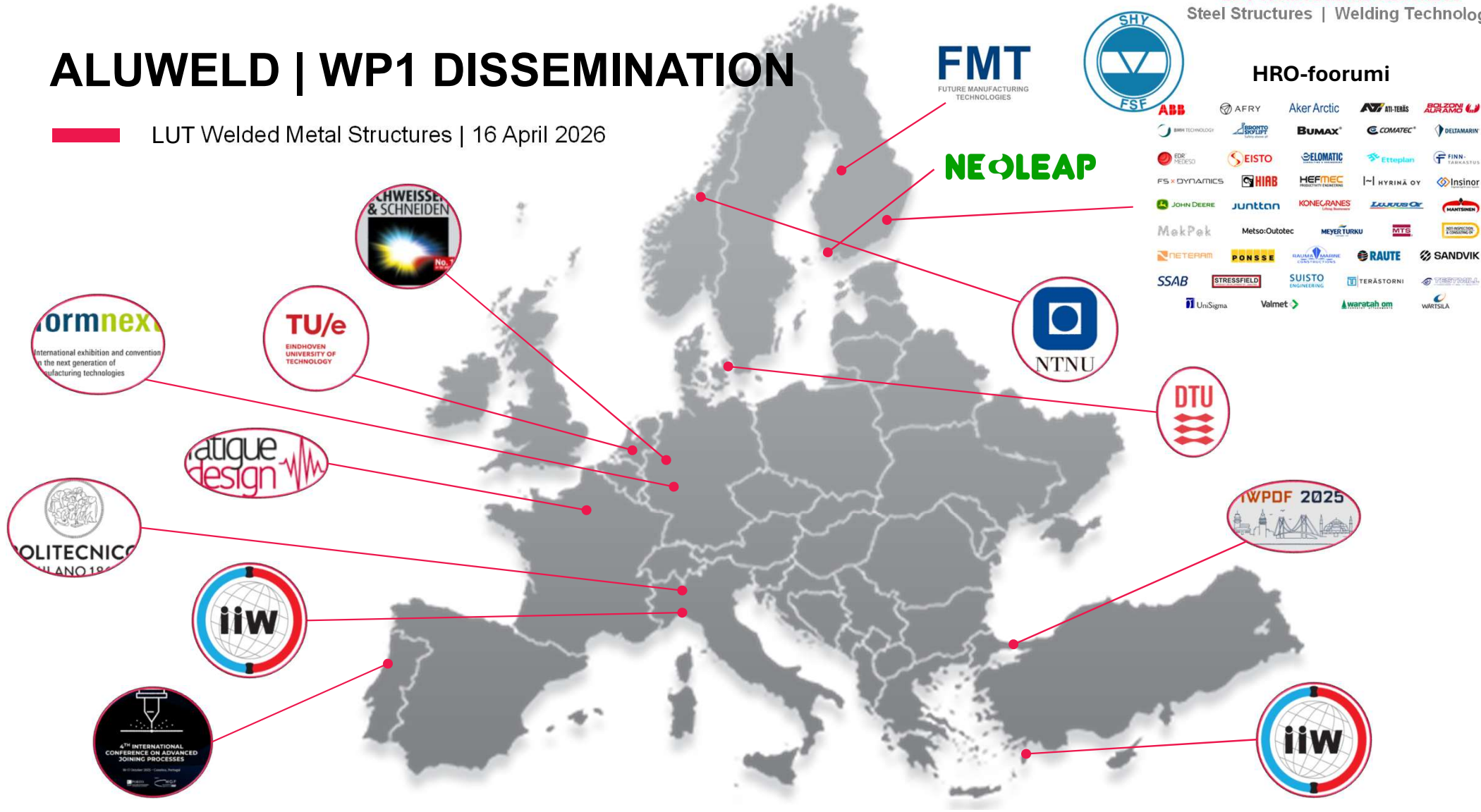
▶ **WP3 Enhancement of production | Tuotannon tehostaminen**

- WP3.1 Welding metallurgy of aluminum
- WP3.2 Automatized welding production
- WP3.3 Virtual welding production of aluminum structure



ALUWELD | WP1 DISSEMINATION

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- ### HRO-foorumi
- ABB
 - AFRY
 - Aker Arctic
 - ATI-TERRIS
 - AURAMBA
 - BMH TECHNOLOGY
 - BOYD SKYLIFT
 - BUMAX
 - COMATEC
 - DELTA MARIN
 - FOR FIDESO
 - EISTO
 - ELOMATIC
 - Ettoplan
 - FINN-TAKKASTUS
 - FS x DYNAMICS
 - HIAB
 - HEFMEC
 - I-HYRINA OY
 - Insinor
 - JOHN DEERE
 - Junttan
 - KONECRANES
 - LEUCOR OY
 - MANTINEN
 - MakPek
 - Metso-Outotec
 - MEYER TURKU
 - MTE
 - NETERAM
 - PONSSE
 - RAUTE
 - SANDVIK
 - SSAB
 - STRESFIELD
 - SUISTO ENGINEERING
 - TERÄSTORNI
 - UNISIGNA
 - Valmet
 - WARATAH OY
 - WARTSILA

ALUWELD | WP1 THESIS WORKS & PUBLICATIONS

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▶ Scientific output:

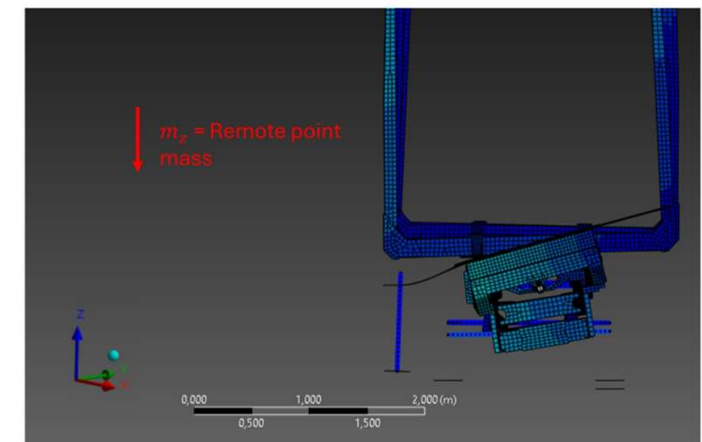
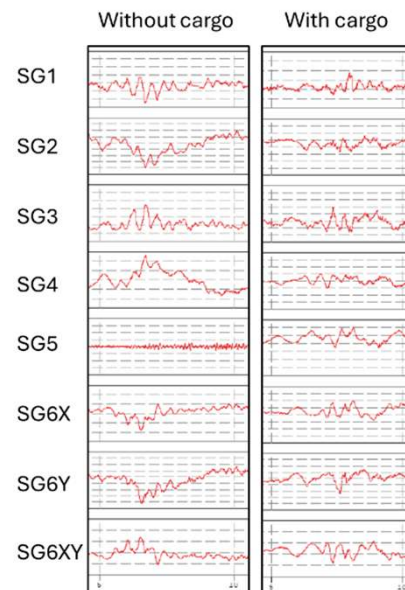
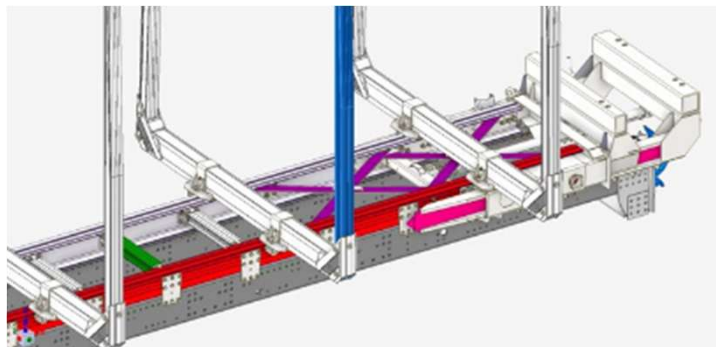
- B. Sc. (tech.) theses: 7
 - M. Sc. (tech.) theses: 8
 - D. Sc. (tech.) Dissertations started: 2
 - 14 peer-reviewed scientific articles
-
- List of theses and publications can be found from Appendix at the end of the presentation

ALUWELD | WP2.1 VIRTUAL LIFE CYCLE MODEL

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► Main actions:

- M. Sc. (tech). Thesis of dynamic loadings of aluminum superstructure

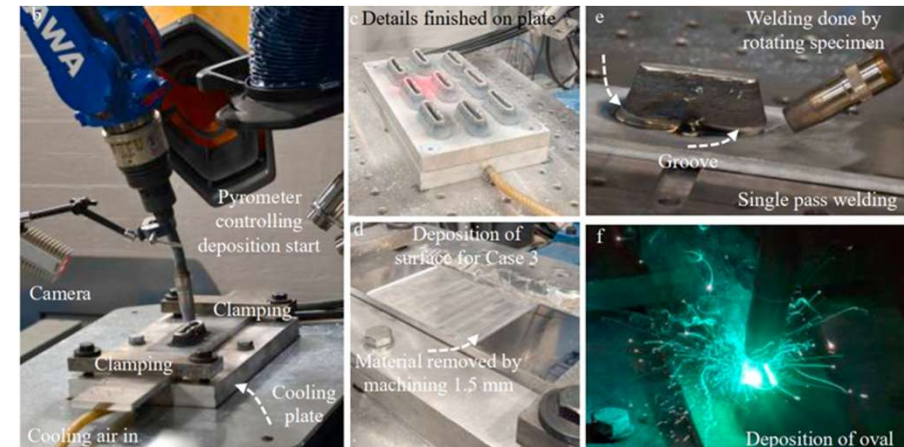
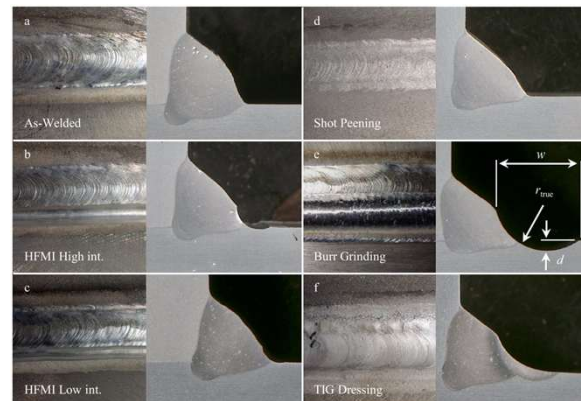
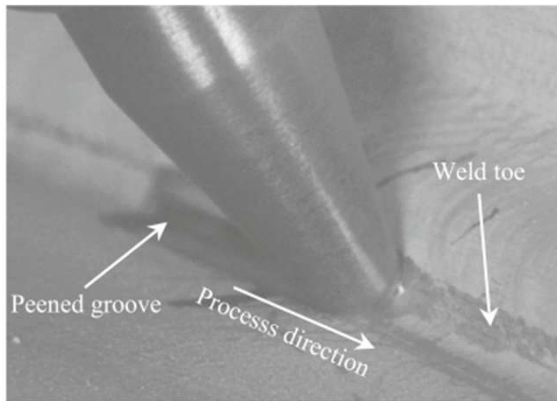
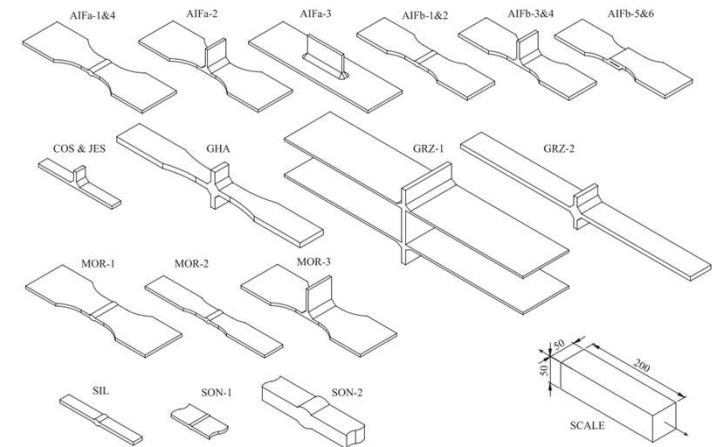


ALUWELD | WP2.2 PERFORMANCE OF ALUMINUM STRUCTURE


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► Main actions:

- Assessment of fatigue behavior in welded and additively manufactured aluminum structures
- Evaluation of both as-welded conditions and post-weld treatments
- Focus on improving accuracy and efficiency of aluminum fatigue design

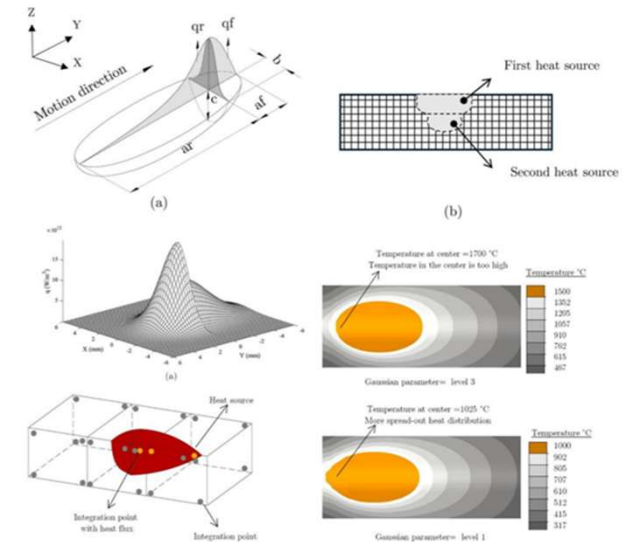
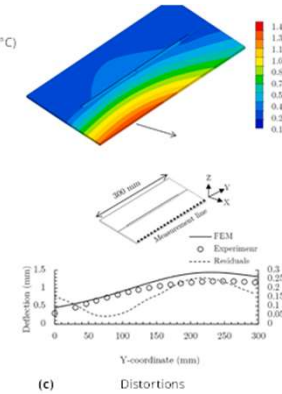
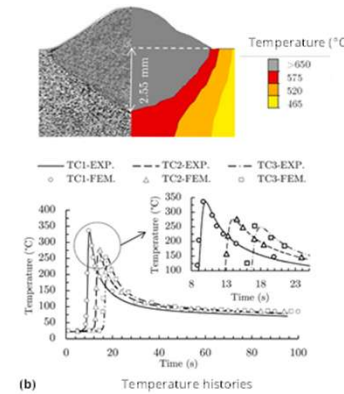
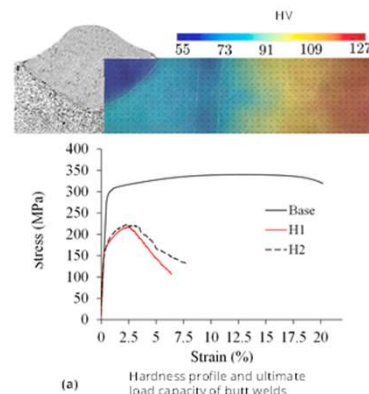
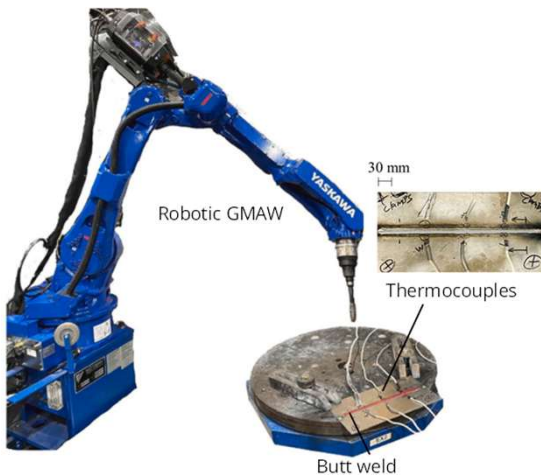


ALUWELD | WP2.3 SIMULATION OF ALUMINUM WELD JOINT

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► Main actions:

- Modeling welding-induced distortion and material behavior in aluminum joints
- Experimental validation of thermo-mechanical FE simulations
- Focus on predicting and controlling welding deformations in aluminum structures

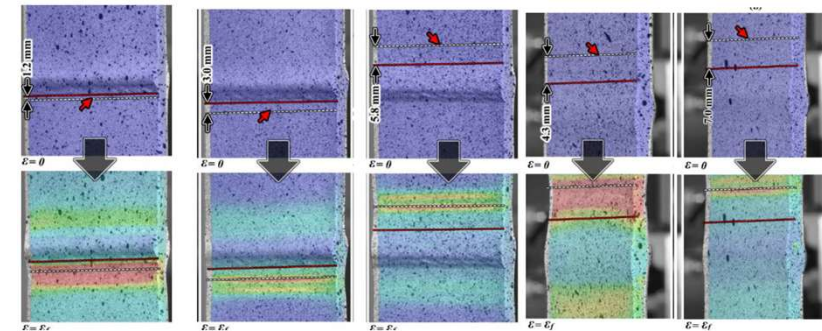
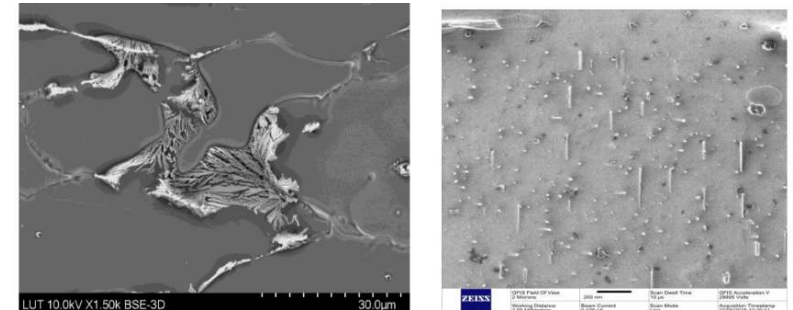
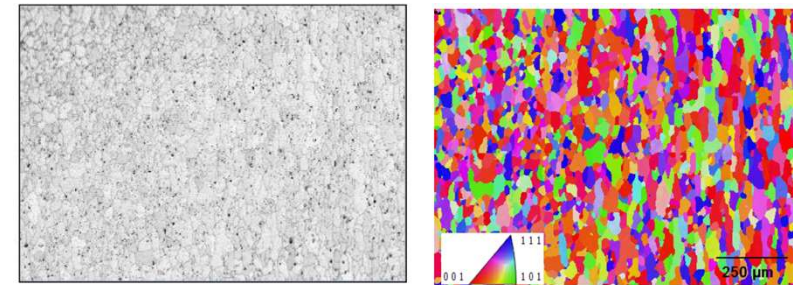
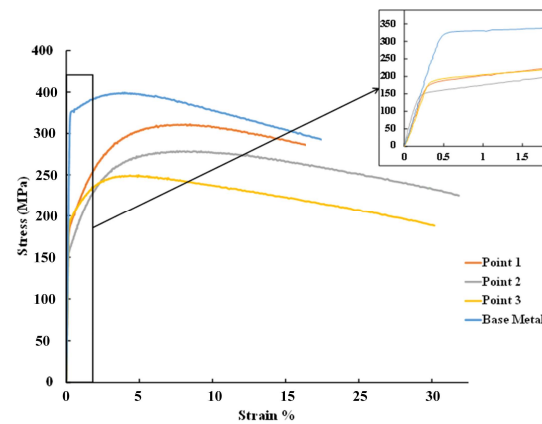
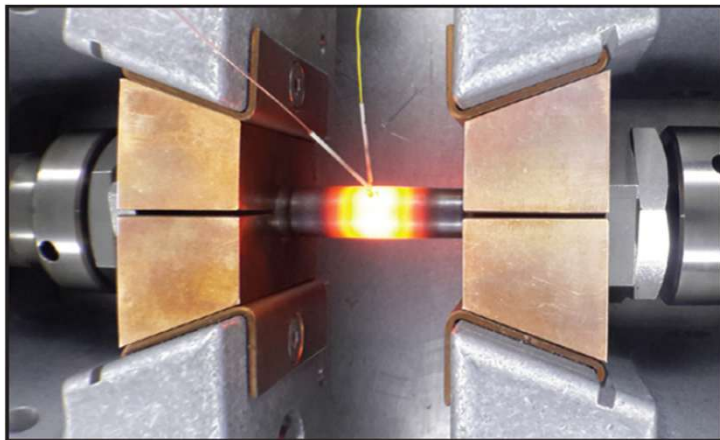


ALUWELD | WP3.1 WELDING METALLURGY OF ALUMINUM

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► Main actions:

- Investigation of microstructural changes in welded aluminum alloys
- Identification of heat-affected zone softening mechanisms
- Support for improved alloy, filler material, and process selection

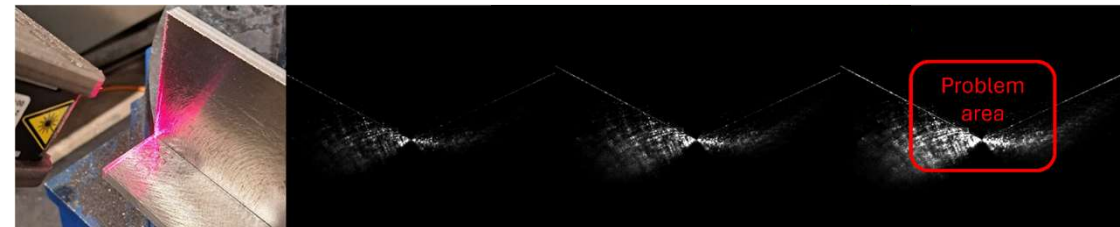
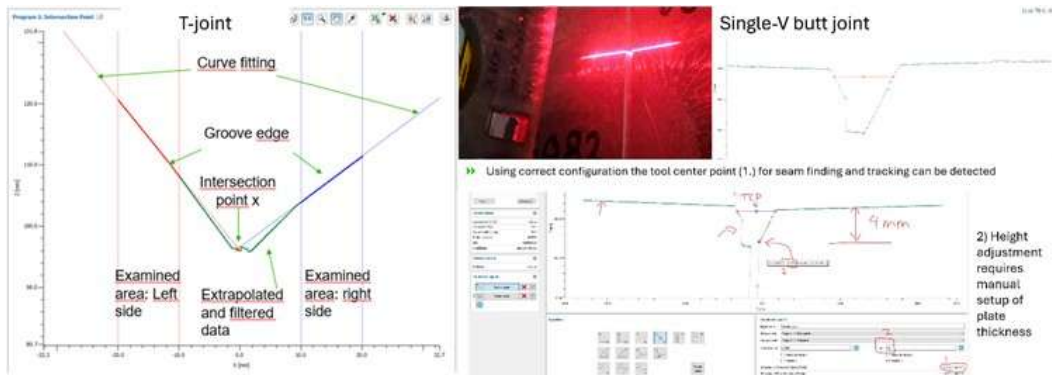
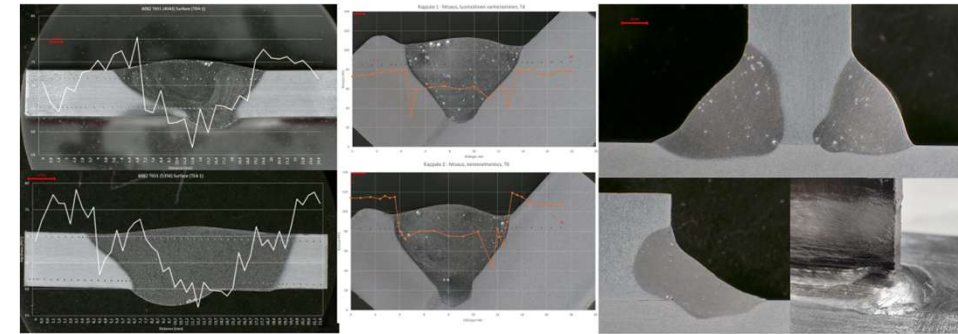
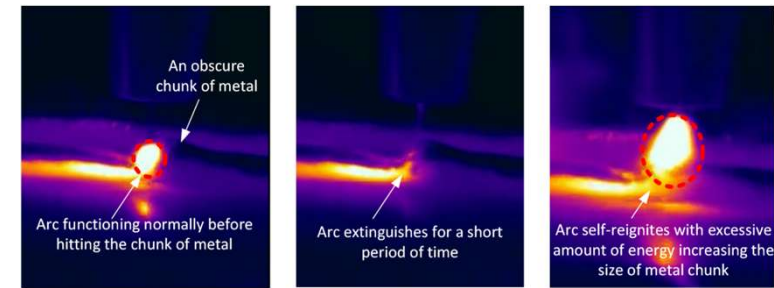


ALUWELD | WP3.2 AUTOMATIZED WELDING PRODUCTION

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► Main actions:

- Robotic welding and arc-DED of aluminum structures
- Evaluation of seam finding, joint tracking, and process monitoring methods
- Improving automation reliability, quality control, and productivity

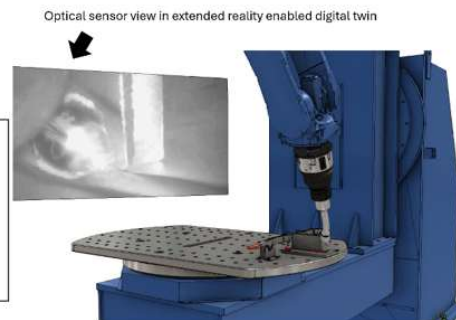
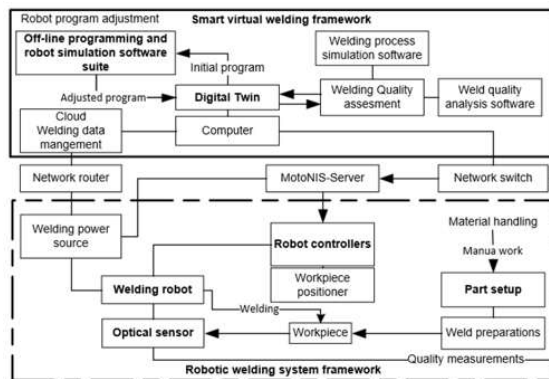
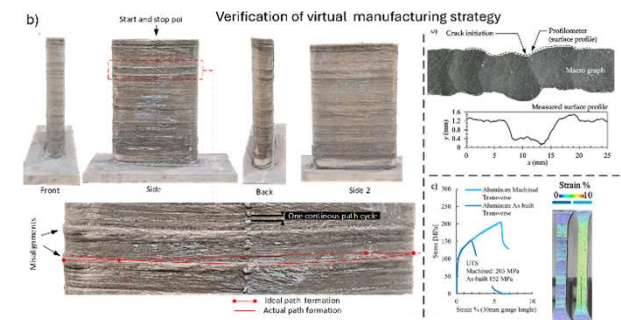
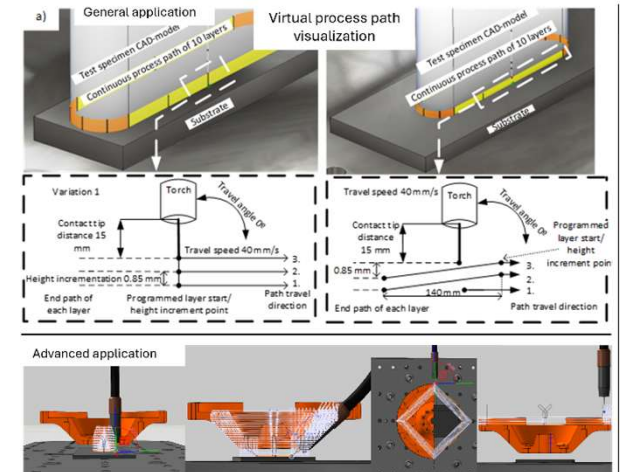


ALUWELD | WP3.3 VIRTUAL WELDING PRODUCTION OF ALUMINUM STRUCTURE

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► Main actions:

- Application of VR/XR and digital twins to aluminum welding and DED
- Visualization, programming, and real-time monitoring of robotic welding
- Enhancing process safety, understanding, and operational flexibility



ALUWELD | FUTURE OF AL-WELDMENTS RESEARCH AT LUT ?

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40 **HITSAUS**
TEKNIikka
5/2025

PILAPIIRROS – EERO NYKÄNEN



AluWeld

2022 - 2025



ALUWELD | APPENDIX

THESIS WORKS & PUBLICATIONS

■ LUT Welded Metal Structures | 16 April 2026

▶ B. Sc. (Tech.) Theses (7)

- A. Kuikka (2024) **Hitsattujen alumiinirakenteiden jälkikäsittely** [LUTPub](#)
- R. Laine (2024) **Toiminnallisten ja tuotannollisten vaatimuksien aiheuttamat rajoitteet alumiinipursoteprofiilin suunnitteluun** [LUTPub](#)
- M. Lintunen (2024) **MIG- ja TIG-prosessien käyttö 5000- ja 6000-sarjan alumiiniseosten hitsauksessa** [LUTPub](#)
- A. Miettinen (2024) **Jigi- ja kiinnitinsuunnittelu robottihitsattavissa tuotteissa** [LUTPub](#)
- M. Nuutinen (2025) **Alumiinin lämpökäsittelyn vaikutus materiaalin hitsattavuuteen** [LUTPub](#)
- L. Suhonen (2024) **Hitsattujen alumiinirakenteiden jäännösjännitysmittaukset** [LUTPub](#)
- A. Vilve (2025) **FSW- ja laserhitsausprosessin soveltaminen metallimateriaalien päittäisliittämiseen** [LUTPub](#)

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THESIS WORKS & PUBLICATIONS

■ LUT Welded Metal Structures | 16 April 2026

▶ M. Sc. (Tech.) Theses (8)

- S. Keshavarz (2025) **Mechanical and microstructural analysis of the Gleeble-simulated HAZ in the 6082-T6 MIG-welded aluminum alloy** [LUTPub](#)
- N. Oinonen (2026) **Effect of joint geometry and dilution on hot cracking in high-power TIG welding of aluminum**
- O. Oittinen (2025) **Dynamic load actions in aluminium superstructure** [LUTPub](#)
- J. Porvari (2025) **Alumiinirakenteiden ja -liitosten robottihitsaus** [LUTPub](#)
- T. Raittila (2025) **Developing software workflows for arc-based directed energy deposition manufacturing**
- T. Suikkari (2024) **Use of aluminium in directed energy deposition (DED) process** [LUTPub](#)
- J. Turunen (2025) **Fatigue strength assessment of butt-welded aluminum joints** [LUTPub](#)
- V.-P. Väisänen (2025) **Comparison of FSW, MIG and TIG welding technologies in aluminium butt joint configuration** [LUTPub](#)

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THESIS WORKS & PUBLICATIONS

■ LUT Welded Metal Structures | 16 April 2026

▶ D. Sc. (Tech.) Theses

- J. Havia “**Fatigue strength of welded aluminum joints**”
(started in AluWeld project)
- A. Khodabakhshi “**Welding metallurgy and weldability of aluminum materials**”
(started in AluWeld project)

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THESIS WORKS & PUBLICATIONS

■ LUT Welded Metal Structures | 16 April 2026

► Scientific publications (14)

- Havia et al. (2025) **Fatigue strength of welded aluminum structures – A re-evaluation of fatigue data of welded aluminum joints with nominal stress approach** [Materials & Design](#)
- Havia et al. (2025) **Fatigue strength assessment of arc-welded aluminum joints by local approaches** [International Journal of Fatigue](#)
- Lipiäinen et al. (2025) **Fatigue strength assessment of additively manufactured component considering local quality** [Welding in the World](#)
- Safyari & Moshtaghi (2025) **Multiscale fatigue assessment of wire arc additively manufactured aluminium alloys with experimental and simulation approach** [Welding in the World](#)
- Rohani Raftar et al. (2025) **Experimental and numerical study of welding-induced deformation and residual stress in 6082 aluminum: Model validation and process design guidance** [Materials & Design](#)
- Rohani Raftar et al. (2025) **Multi-objective optimization of welding-induced residual stress and deflection in 6082-T6 aluminum alloy using validated thermo-mechanical modeling** [Journal of Advanced Joining Processes](#)

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THESIS WORKS & PUBLICATIONS

■ LUT Welded Metal Structures | 16 April 2026

► Scientific publications (14)

- Khodabakhshi et al. (2025) **The effects of different weld zone characteristics on mechanical properties and fracture behavior of MIG welded 5754, 5083, and 6082 aluminum alloys** [Welding in the World](#)
- Havia et al. (2025) **Fatigue behavior of 5000 series aluminum DED component joined to plate in the non-load carrying configuration** [Procedia Structural Integrity](#)
- Havia et al. (2026) **Impact of post-weld treatments on the fatigue strength of 5083 aluminum transversal attachment joints** [Welding in the World](#)
- Havia et al. (2026) **Comparison of the fatigue strength of butt-welded aluminum joints prepared with different welding techniques** [Proc. Inst. Mech. Eng., Part L: J. Mater. Des. Appl.](#)
- Rohani Raftar et al. (2026) **Effect of cooling rate on deflection, microstructure, and mechanical response of butt-welded aluminium 6082-T6 joints** [Proc. Inst. Mech. Eng., Part L: J. Mater. Des. Appl.](#)
- Afkhani et al. (2026) **Experimental-numerical insights into heat-affected zone failure of welded aluminum alloys** [Welding in the World](#)

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THESIS WORKS & PUBLICATIONS

LUT Welded Metal Structures | 16 April 2026

► Scientific publications (14)

- Khodabakhshi et al. (TBA) **Investigation of mechanical properties in the heat-affected zone of MIG-welded 6082 aluminum alloy using simulated thermal histories**
- Lund et al. (TBA) **Sustainability performance of directed energy deposition-arc manufactured large-scale AlMg5Cr products**