Working Group initiatives & objectives for 2025

Productivity, Quality, and Transferability in Additive Manufacturing					
WG Name	Additive Manufacturing	**Chair**	Vladimir Navrotsky (Siemens Energy)	**Co-chair**	Ludo Bautmans (Oerlikon)
Project lead	Katrin Wudy (TU Munich)				
Core team	Ludo Bautmans (Oerlikon), Vladimir Navrotsky (Siemens Energy), Jonas Eriksson (Siemens Energy), Katrin Wudy (TU Munich), Jonas Gruenewald (TU Munich), Philipp Stich (EOS)				
ETN officer in charge	Rene Vijgen, Nicolò Cairo				

Initiative description

Short project description

The Additive Manufacturing (AM) WG aims to launch a new industrial initiative on AM process quality and productivity. High-end critical parts in the turbomachinery industry, such as turbine blades & vanes, are identified as interesting use cases. In the turbomachinery industry, parts are not currently produced using AM due to high costs, primarily driven by limited productivity and demanding materials. The project aims to enhance productivity by generating larger and more stable melt pools with beam shaping, making AM more economically attractive for this industry. Furthermore, we aim to change the process strategy from frozen printing parameter sets towards controlling the resulting melting pool while keeping homogeneous microstructure and uniform material properties across the entire volume of the AM component. We believe that this approach to monitoring and adaptive control of the melt pool by beam shaping will enable a significant leap in process reliability and part quality, addressing current challenges in the turbomachinery sector.

Objective setting

Our goal is to achieve microcrack-free AM of turbine vane (Siemens Energy for a standard Gaussian intensity distribution of the laser beam) for two defined high gamma prime alloys (e.g. IN939, AE13421), leveraging R&D equipment with open hard- & software platforms. In the next step, beam shaping technology will be implemented to create ring-shaped intensity distributions (in Collaboration with TUM) to improve the AM process productivity combined with the manufacturing of defect-free parts.

The ultimate goal is to control the melting pool geometry and solidification behaviour for defect-free manufacturing of these demanding high gamma prime alloys by capturing & analysing data from thermal imaging, absorption measurements, and diode-based optical process emission measurements. This captured data set will be fused and partially utilized in the 2nd phase of the project on industrial equipment. The selected beam shaping equipment (e.g. nLIGHT AFX) shall be chosen from a technical/functionality point of view and cost/price impact on AM systems.

Expected outcome

- Recommendations on laser beam shaping equipment (e.g., nLIGHT AFX) and process setup,
- Recommendations on melt pool monitoring, and
- AM productivity improvement (50% or better), homogeneous microstructure, and improved material properties

Implementation of the activities

Project execution.
A core group will describe the project scope, target, and deliverables in more detail. The scope and cost will be presented to the ETN community and interested parties to form a consortium.
The project duration will be 3 years. The consortium will include universities, industries, and organizations that could execute the scope of work. A dedicated project manager (TBC) will manage the project, reporting to a steering group.

Project finances
The project will be funded by Consortium members and potentially by Governmental funding.
The expected Project Fee for participants will be around:

- EUR 300,000 € for 2 years for TUM (To be finalized based on member contributions and funding approvals).

Meeting schedule and dissemination
The steering group will meet on a basis to ensure close collaboration and dissemination of detailed results within the consortium. High-level results will be reported on the various platforms.

Deliverables & Milestones (max. 1 per each objective)

Deliverable 1	Recommendations on laser beam shaping equipment and process setup (Report)	**Timing**	November 2025

Selection of R&D equipment with open hard- & soft-wares.
- Selection of laser beam shaping equipment (e.g., nLIGHT AFX)
- Selection of high gamma prime AM material
- Use case selection (SE turbine Guide Vane, CAD model)
- Set up DoE and AM of test specimen (simple geometry)
- Develop a catalog of laser beam shapes combined with process parameter
- Demonstrate microcrack-free AM of vanes, homogeneous microstructure, and AM productivity improvements.

Milestone 1	Laser beam shaping equipment and process setup capabilities	**Date**	June 2026

Demonstrate benefits of laser beam shaping (e.g., microcrack-free AM of vanes, homogeneous microstructure, and AM productivity improvements).

Deliverable 2	Recommendations on melt pool monitoring/controlling (Report)	**Timing**	November 2026

Definition of new control parameters in a melt-pool-based process instead of frozen/fixed machine parameters as laser power, e.g.,
- Planning DoE.
- AM of simple test specimens/components with analysis of different sensor data (especially diode-based optical process emission measurements)
- Material investigation, including HIP/HT.
- Demonstrate microcrack-free printing of vanes, homogeneous microstructure, and AM productivity improvements with a characteristic footprint in the monitoring system.

Milestone 2	Melt pool monitoring/controlling capabilities	**Date**	30.08.2027

Define a new way of working instead of the frozen parameter as fixed laser power, e.g., Demonstrate benefits of melt pool monitoring/controlling (e.g., quality assurance enhancement, AM manufacturing cost reduction).

Project timeline
Starting date: 01.06.2025
30.11.2025: **Deliverable 1** - Recommendations on laser beam shaping equipment and process setup (Report).

30.06.2026: **Milestone 1** - Laser beam shaping equipment and process setup capabilities demonstrated (e.g., microcrack-free AM, homogeneous microstructure).
30.11.2026: **Deliverable 2** - Recommendations on melt pool monitoring/controlling (Report).
30.05.2027: **Milestone 2** - Demonstrate melt pool monitoring/controlling capabilities (e.g., enhanced quality assurance, reduced AM manufacturing costs).
Project end: 30.05.2027