

FLASH

Flexible Laser-Based Manufacturing

FLASH: PIONEERING FLEXIBLE LASER-BASED MANUFACTURING ACROSS EUROPE

Hybrid Robotics and Artificial Intelligence Integration

The FLASH project consortium announced today significant progress in the development of its advanced manufacturing technologies, marking a crucial evolution on two vital fronts: the implementation of an intelligent cloud data management system and the mechanical integration of a high-precision hybrid robotic cell.



Advanced Cloud Data Management & AI Analytics

The project's data team has successfully deployed an Operational Cloud Data Management System MVP, significantly enhancing its machine learning (ML) capabilities.

Key technical advancements in this area include:

- **Physics-Informed Feature Engineering:** To capture complex, non-linear cause-and-effect relationships, the team engineered new input features derived directly from process physics, including Power x Speed, Power per Hatch, and Energy Density.
- **Exceptional Model Performance:** Utilising Gradient Boosted Trees, the engineered feature model achieved a global R^2 value of approximately 0.94. Compared to baseline models, it reduced Mean Absolute Error (MAE) by 45.7% for surface roughness and 30.5% for average pocket depth. Furthermore, Root Mean Squared Error (RMSE) saw massive reductions, dropping by 53.4% for pocket depth.
- **Forward Modelling and Optimisation:** The system employs forward modelling combined with an optimisation algorithm. This allows users to minimise the difference between predicted and desired quality outcomes while retaining the flexibility to adjust objective weights and enforce parameter limits. The team is also evaluating Single Multi-Output models to better learn shared dependencies among quality targets.
- **Actionable Dashboards and Copilot Integration:** Beyond raw data, integration APIs are exposing insights, key performance indicators (KPIs), and alerts to user interfaces. A "Copilot" Proof of Concept (POC) is also under development to assist operators with process quality and real-time fault diagnosis.

Next-Generation Hybrid Robotic & CNC Integration

On the hardware front, the physical machine demonstrator is being modified to merge robotic flexibility with CNC precision.

Critical engineering milestones achieved include:

- **8-Axis Kinematic Architecture:** The system integrates a 6-axis articulated robot arm (featuring a 30 kg payload and 1665 mm reach) with a Lehmann 2-axis CNC rotary/tilt table. This combination provides full 8-axis motion without requiring extra CNC axes.
- **Expansive and Precise Working Envelope:** The integrated platform targets a working envelope. It is designed to maintain a stringent positional accuracy of under 10 μm and repeatability of under 5 μm .
- **Rapid Modular Tooling:** To support multi-process manufacturing, the reconfigured cabinet structure accommodates three beam delivery heads and includes two designated storage zones. The mechanical interfaces are being engineered to support quick-change docking for payloads up to 14 kg at a 100 mm center of gravity, achieving automated changeovers in just 10 to 15 seconds.
- **Industrial-Grade Control and Safety:** The upcoming integration phase will focus on deploying a detailed electrical panel accommodating PLC modules, alongside dedicated fluidic groups (water, air, and gas manifolds) and industrial process PCs for local control and head alignment.

Looking Ahead

While the current AI models perform exceptionally well on controlled experimental data, the consortium recognises that building machine-type specific models requires diverse datasets encompassing varied materials, laser sources, and optics.

Moving forward, the focus will shift toward structured experimentation with planned process variations to fuel these algorithms, culminating in the industrial validation of the fully integrated FLASH machine system.



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