DIGITAL TWINS OF LASER PROCESSING FOR MULTI-CAPABILITY MANUFACTURING OF COMPLEX COMPONENTS AND DIGITAL CERTIFICATION

Newsletter #9

01. A Common Audit Procedure for Digital Laser Production

In previous **DILAPRO** updates, we introduced how the project is building the foundations for digital certification in laser-based manufacturing. We explored certification requirements, stage 1 audits, and the growing role of digital data in quality assurance.

With Deliverable 8.2, we are now taking an important next step: turning those early concepts into a practical and commonly agreed audit procedure that can be used across DILAPRO pilot lines.

The main goal of Deliverable 8.2 is to provide a standardized audit template that helps demonstrator sites assess how digital quality-control tools can support or even replace traditional manual inspection methods. In other words, **the deliverable focuses on the "substitution potential" of digital QC**: how far sensor data, machine logs, and monitoring systems can reduce the need for manual checks while still meeting certification and traceability requirements. This common approach is fully linked to relevant ISO/ASTM standards and is designed to support more efficient, data-driven auditing in industrial laser manufacturing.

To make this possible, **DILAPRO** combined two key elements. First, a shared Sensor Data-Collection Workbook was distributed across all five pilot lines. This workbook captures information on installed and planned digital QC tools, calibration evidence, monitored data areas, and Technology Readiness Levels. Second, each pilot's risks were mapped in Qualified AM's risk-assessment platform, where failure modes were linked directly to the same data areas recorded in the workbook. By combining these two datasets, the consortium created a robust audit basis that connects digital quality data with the risks those data streams are intended to mitigate.

This methodology has already delivered valuable results. Across the five pilot lines, 24 digital QC tools were logged, with an average substitution score of **2.1 out of 3**, showing that digital tools already provide partial replacement of manual inspection in many areas.

The average digital-certification readiness level is around **TRL 7**, meaning that many of the systems are already prototype-validated. At the same time, the analysis identified **14 "Must-Improve" gaps**, most of them related not to missing sensors, but to post-process data logging, immutable data storage, and automated backups.

This is an important finding: in many cases, the main barrier to digital certification is not the lack of monitoring hardware, but the need for stronger traceability and data management.

The cross-pilot comparison also revealed clear trends. In-process monitoring is currently the strongest area across the consortium.

Melt-pool sensors, pyrometers, cameras, and machine-condition monitoring already give several pilot lines the ability to move away from fully manual checks toward more automated and continuous quality assurance. CRM currently sets the benchmark, with the highest average score and a highly mature sensor landscape, while Fieldmade shows strong improvement potential once its planned eddy-current sensor is fully commissioned. Across all pilots, however, post-process traceability and infrastructure-related topics such as secure archiving and automated server backup remain common priorities for further development.

What makes Deliverable 8.2 especially important is that it creates a common backbone for future digital certification activities in **DILAPRO**. By using the same audit structure, the same substitution scoring logic, and the same risk-linked data areas across LPBF and DED pilot lines, the project can now benchmark readiness more consistently and identify the highest-impact improvements much faster. This also strengthens the link between technical monitoring, certification requirements, and operational decision-making.

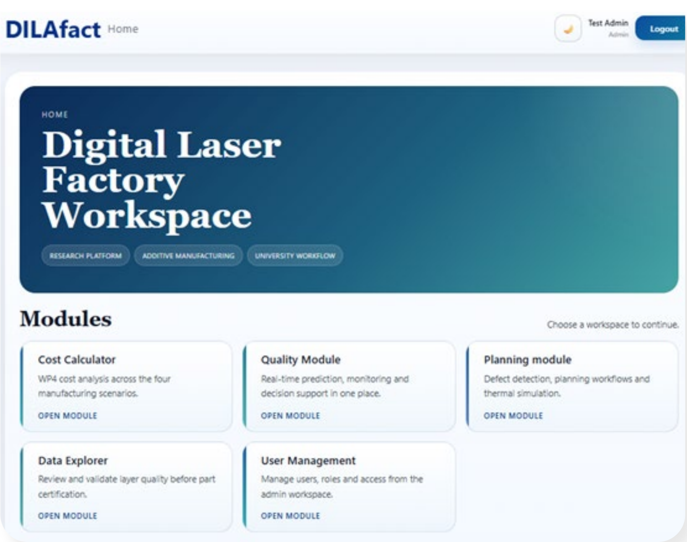
Looking ahead, the insights from D8.2 will directly feed into **Deliverable D8.3**, which will formalize the risk-assessment plan and certification scheme. Building on the audits completed so far, the next step will be to define clearer evidence paths, decision thresholds, and document flows, turning the approach tested in D8.2 into a reusable procedure for future DILACERT deployments. In this way,

DILAPRO is not only improving digital quality assurance within the project, but also helping shape more scalable and trustworthy certification pathways for laser-based manufacturing.

02. DILAfact Platform | Quality Module

The **Quality Module** of the **DILAfact platform (Digital Laser Factory Workspace)** is now operational for **LPBF (Laser Powder Bed Fusion)** technology. This module centralises real-time monitoring, quality prediction and part inspection on a layer-by-layer basis, leveraging data from multiple physical sensors and trained prediction models.

DED and LST technologies are planned for upcoming development iterations.



Configuration & Instrumentation

The module allows the operator to configure the manufacturing context through two main parameters: the **process technology** and the **material** (currently validated with **316L stainless steel**).

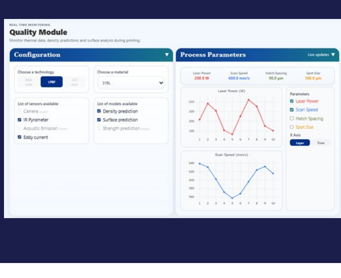
Two sensors are active in the current configuration:

- **IR Pyrometer** — layer-by-layer surface temperature measurement, with a validated operating range of **800°C to 1,300°C**
- **Eddy Current** — microstructure inspection and subsurface anomaly detection via electromagnetic impedance measurement

On the prediction side, two models are currently available:

- **Density prediction** — relative density estimation of the manufactured part
- **Surface prediction** — topography prediction of the top surface layer

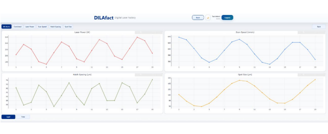
A third model, **Strength prediction**, is under development.



Process Parameter Monitoring

The module continuously tracks the four key LPBF process parameters on a layer-by-layer basis:

Parameter	Current value (example)
Laser Power	200.0 W
Scan Speed	600.0 mm/s
Hatch Spacing	90.0 µm
Spot Size	100.0 µm

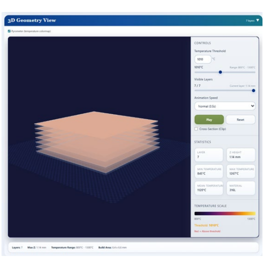


Parameters can be visualised per layer or over time, enabling direct correlation between process variations, sensor signals and quality predictions.

Thermal Inspection — IR Pyrometer

The **Sensors View** displays raw pyrometer data in two complementary forms: a **layer-by-layer time series** and a **temperature distribution histogram**.

The **3D Geometry View** renders the part under construction layer by layer with a superimposed **thermal colormap**, using a configurable temperature threshold. Per-layer statistics include minimum, maximum and mean temperature as well as the associated material. An animation mode allows playback of the build sequence layer by layer.



Eddy Current Inspection

The **Eddy Current Inspection** interface enables detailed analysis of the electromagnetic signal across the entire part. Data is rendered through several complementary views:

- **Signal profile per channel** — real and imaginary components as a function of distance from the build plate centre
- **Impedance plane** — vector representation of the complex signal, enabling identification of drift or anomalies
- **In-phase / Quadrature heatmaps** — layer × position cartography providing a global view of signal evolution throughout the full build.

Density Prediction

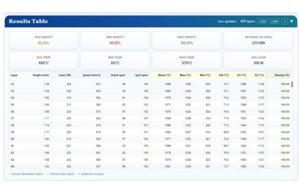
The **Density Prediction** model produces a layer-by-layer estimate of relative density (%) derived from sensor data

Surface Prediction

The **Top Surface Prediction** model generates a 3D reconstruction of the top surface topography for each layer.

Results Table

A comprehensive results table is available in real time, consolidating for each layer the full set of input parameters (process), thermal data (pyrometer) and predictions (density). Export is available in **CSV** and **PDF** formats.



Events

DILAPRO Highlights Innovation and Collaboration at AM Village 2026 in Albacete

In March 2026, the DILAPRO project played a prominent role in the AM Village 2026, held at the Albacete Air Base in Spain.
This intensive, week-long event brought together over 400 professionals from the Armed Forces, industry, and academia to explore the practical implementation of Additive Manufacturing (AM) in defence environments.

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Shaping the Future of Digital Certification in Additive Manufacturing

Between 10th and 13th March, the DILAPRO Project was represented at the prestigious ISO/TC 261 – Additive Manufacturing meetings held in Knoxville, Tennessee.
This participation marked a crucial step in our ongoing efforts to bridge the gap between current industry standards and the future of digital certification.

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Highlights at the IIW Winter Meetings in Genoa

In January, the IIW Winter Meetings took place in Genoa, Italy, at the IIW headquarters. During this significant gathering, the European Federation for Welding, Joining and Cutting (EWF) took the opportunity to disseminate information and exchange insights on several ongoing projects aimed at harmonising and modernising training and qualifications within the manufacturing industry.

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DILAPRO Consortium Enters Final Stretch Following 4th Transnational Meeting in Madrid

On 20th and 21st January, the DILAPRO Project consortium gathered at the IMDEA Materials Institute facilities in Madrid for its 4th in-person transnational meeting. This event marked a pivotal milestone, as it officially signalled the start of the project's final year.

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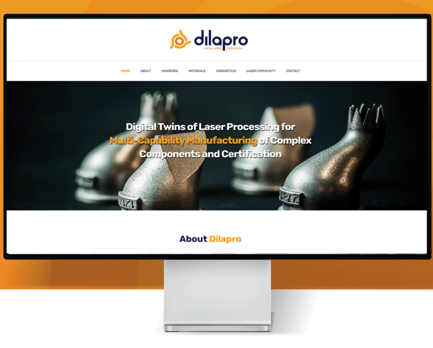

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