Introduction to OPeraTIC

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AIMEN – Project Coordinator

Manufacturing Partnership Day
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OPERATIC
Laser-based technologies for green manufacturing

Funded by the European Union

OPeraTIC is a project funded through the European Union's Horizon Europe programme to **boost the adoption of high-power ultra-short-pulsed lasers**, bringing all the benefits of high-power, ultrafast lasers into large scale industrial applications.

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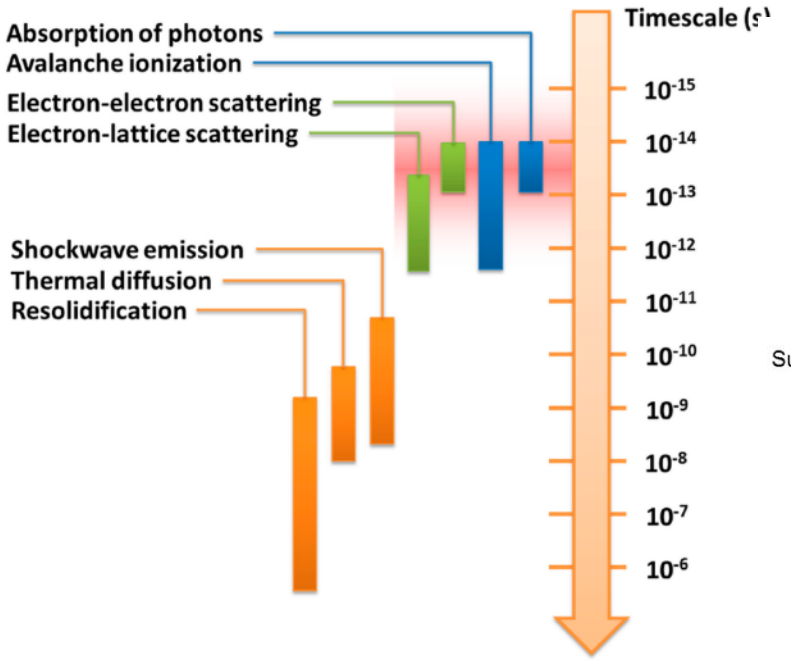
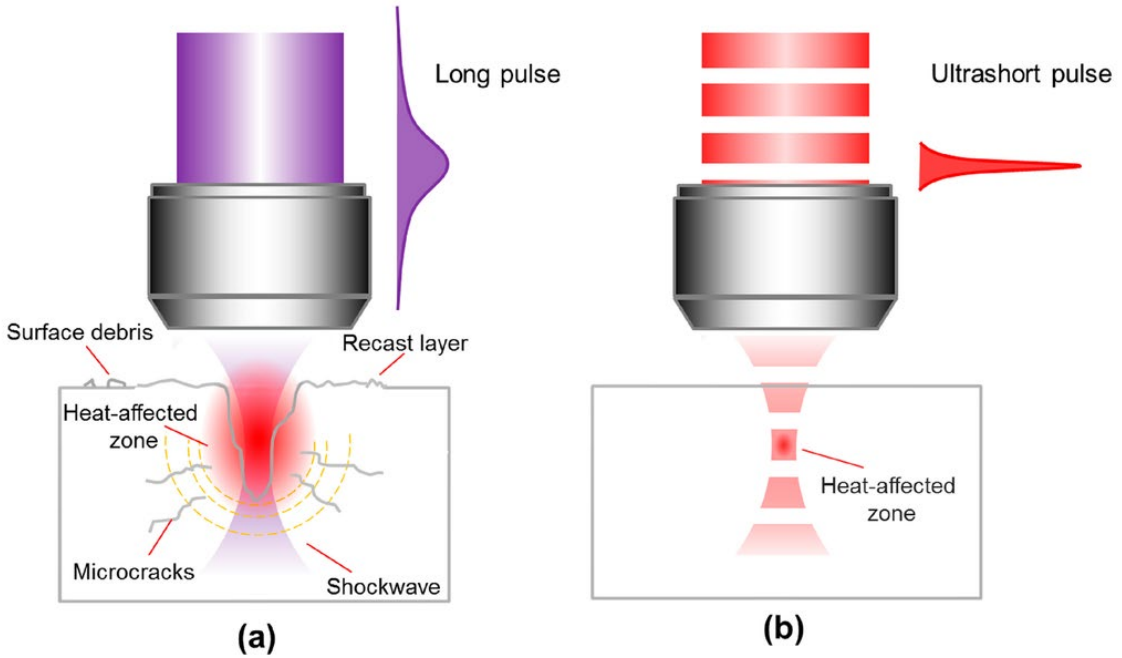
Why Ultrafast Laser

Timescale affects the physics of light-matter interaction.
Reduces the interaction volume, improves efficiency and resolution.





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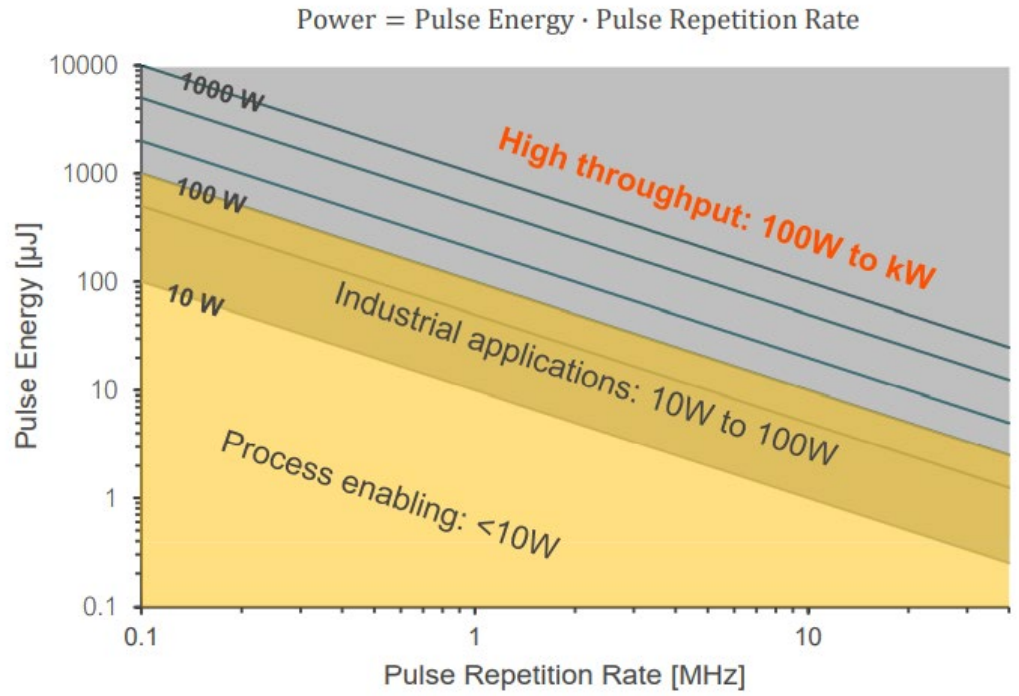
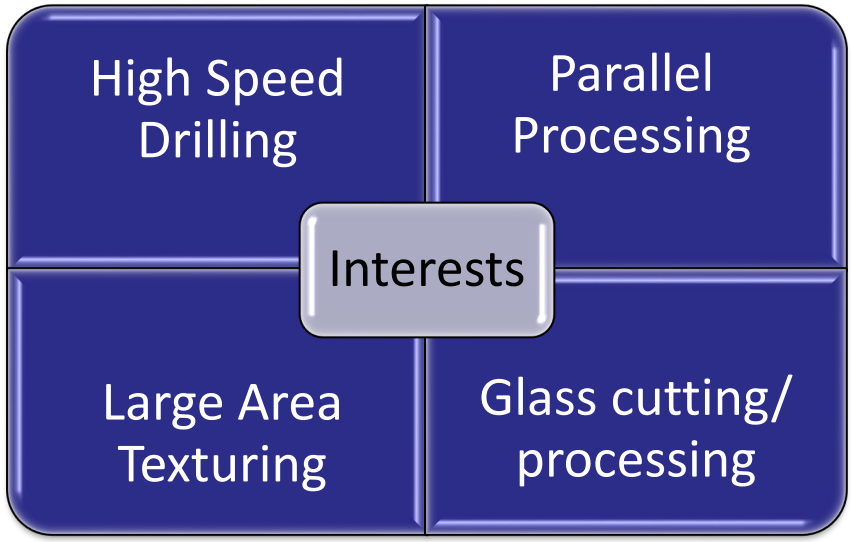
Why High Power

Benefits of ultrafast sources are also their weakness.
High resolution limits productivity, solutions: pulse power or rep.rate





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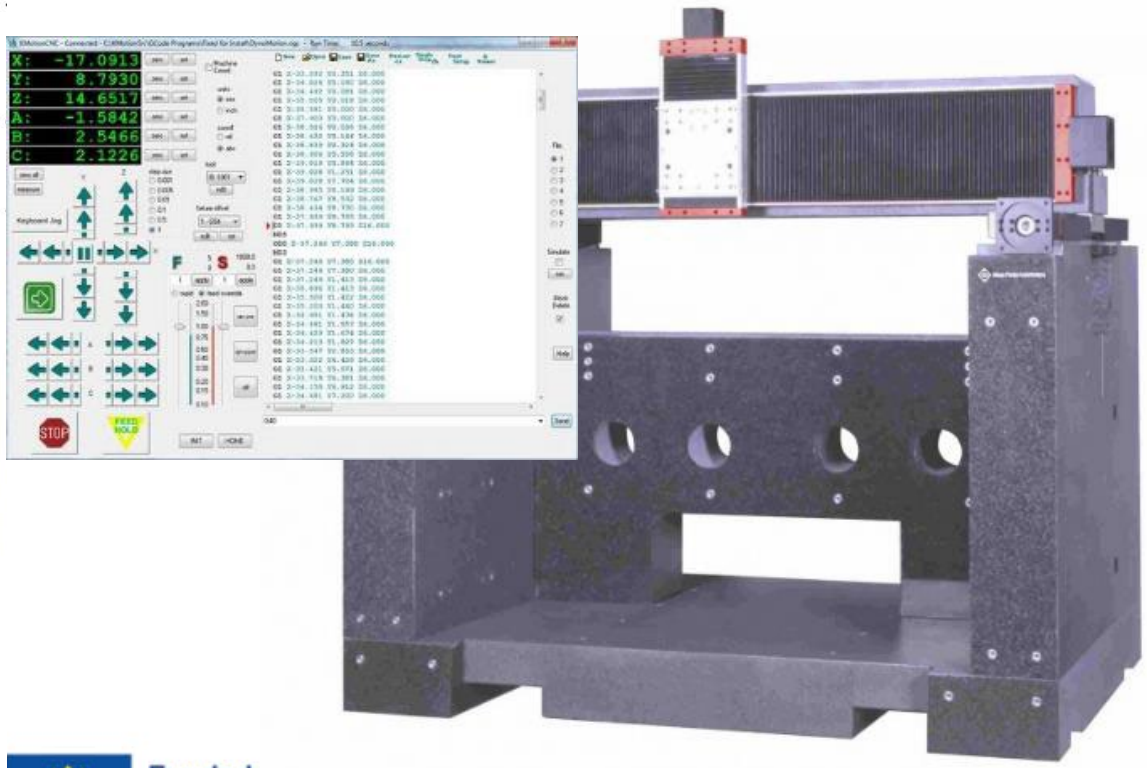
Why OPeraTIC

It’s not all about the laser. Good advances in high power sources.
Only in clean, controlled environment, flat support, 3 ton granites, G-code axis-by-axis control… need for flexible automation. SYSTEM needs R&D.



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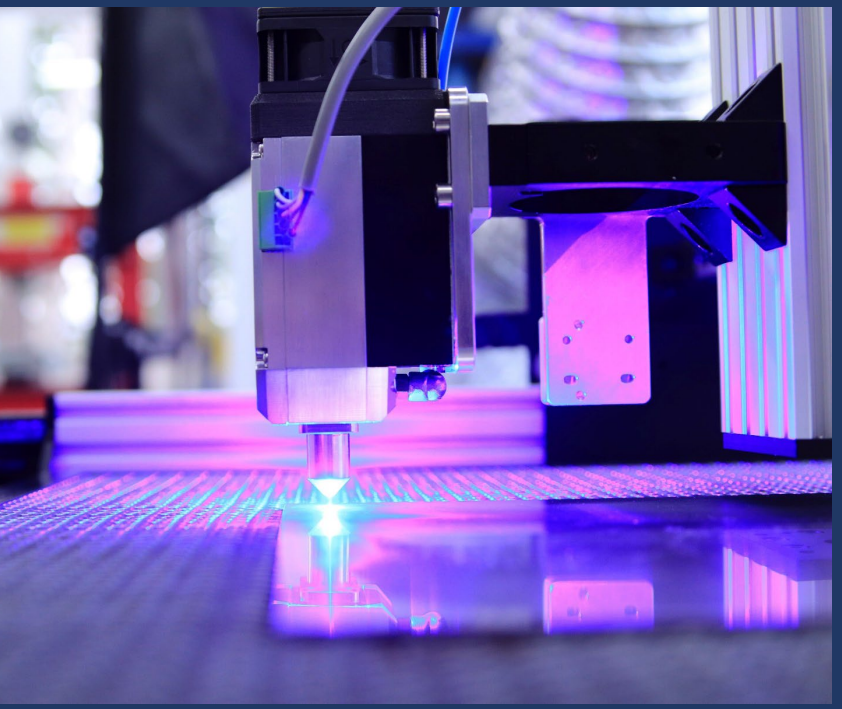

Mission

Four pillars support our development, being the backbone of our research:

- **the machine architecture (optics and mechatronics),**
- **the digital architecture (electronics and data),**
- **the Machine Intelligence (AI),**
- **the adaptive processing of complex 3D parts.**

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Vision

We envisage the development of a platform, which can be useful for a wide range of **industrial applications** up to several square meters of surface to be treated, able to cope with freeform shapes, based on all the technological components developed in the project (optics, mechatronics, control and AI) seamlessly integrated into a **single ultrafast laser-powered machine with unprecedented productivity and capabilities.**

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Solutions

OPeraTIC will develop all the technological components required to allow high-power (>200 W), ultrashort pulse (< 30ps) lasers to become **fully industrial tools for 3D surface treatment**, bringing their advantages in terms of **quality, efficiency, emissions (avoidance of chemicals and waste), flexibility, and functionality**.

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Project Objectives

Modular Laser System	We will develop all the components to take maximum advantage of high-power ultrafast lasers and make them work together, as plug-and-play elements, thanks to a new machine architecture.
Data driven pipeline	We will enable the real time transmission of critical information within the system to allow closed loop control.
Zero Defect Manufacturing	Using AI and real time signals, we will enable the reduction of deviations and target a zero-defect operation, even in complex pieces with dimensional inaccuracies.
Demonstrate the approach	On the basis of four very different and demanding use cases from real industry, the project will demonstrate the effectiveness of the results and the benefits against competing technologies.

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Roadmap towards USPL adoption

Laser-based technologies for green manufacturing

operatic

Outcomes

Greening

Productivity

Large parts & 3D complex geometries and materials

Process replacement

Versatility & reproducibility

Data-based certification

Lifespan extension

Higher adoption

High Impact applications

Leveraging Factors

Low barriers

- Expertise
- Trainning and upscaling
- Standardization

Components remanufacturing

Sub-micron resolution

Human centric

Closed-loop Control

End to end production

Interoperable Modules

Manufacturing Platform

- Beam Management
- System Architecture
- Digitalization and Connectivity
- Machine Intelligence

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Sci-Tech Developments

Beam Management	Delivering the high energy beam through an intricate mechanical configuration
System Architecture	SYSTEM ARCHITECTURE
Digitization/ Connectivity	DIGITIZATION AND CONNECTIVITY
Machine Intelligence	AI for rule extraction and robust adaptability

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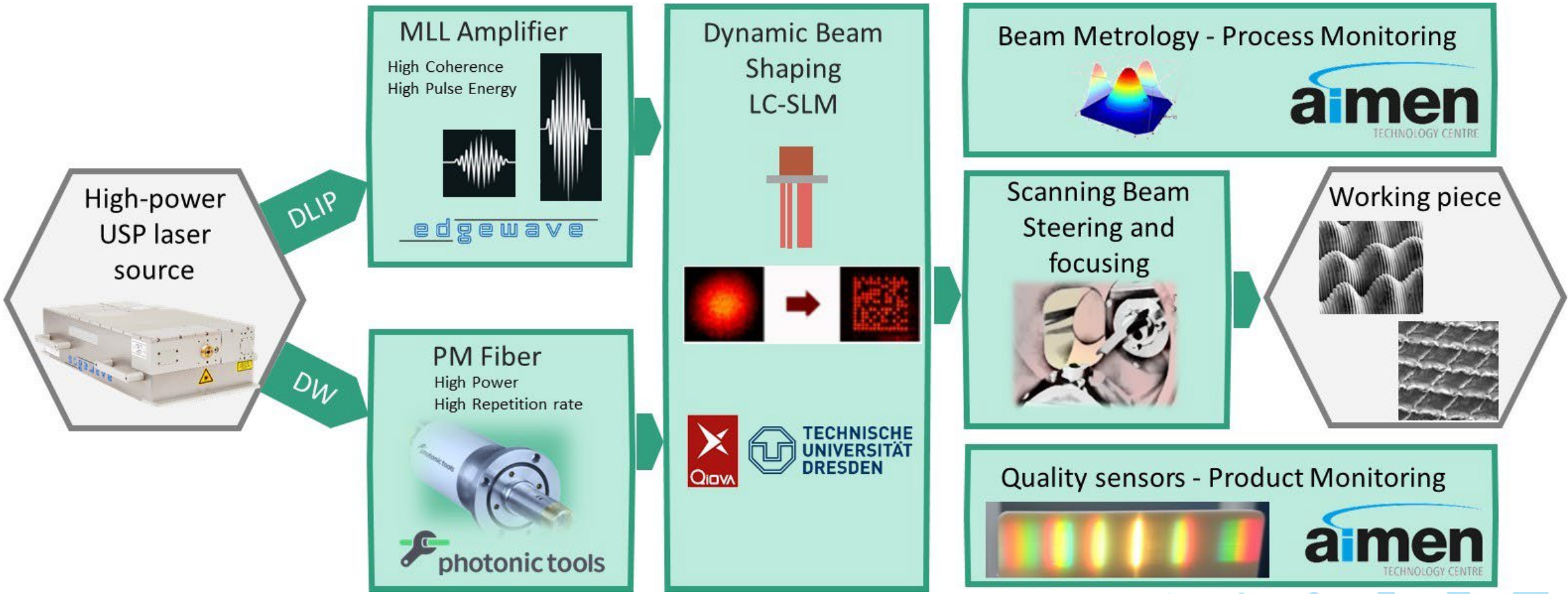
Sci-Tech Developments



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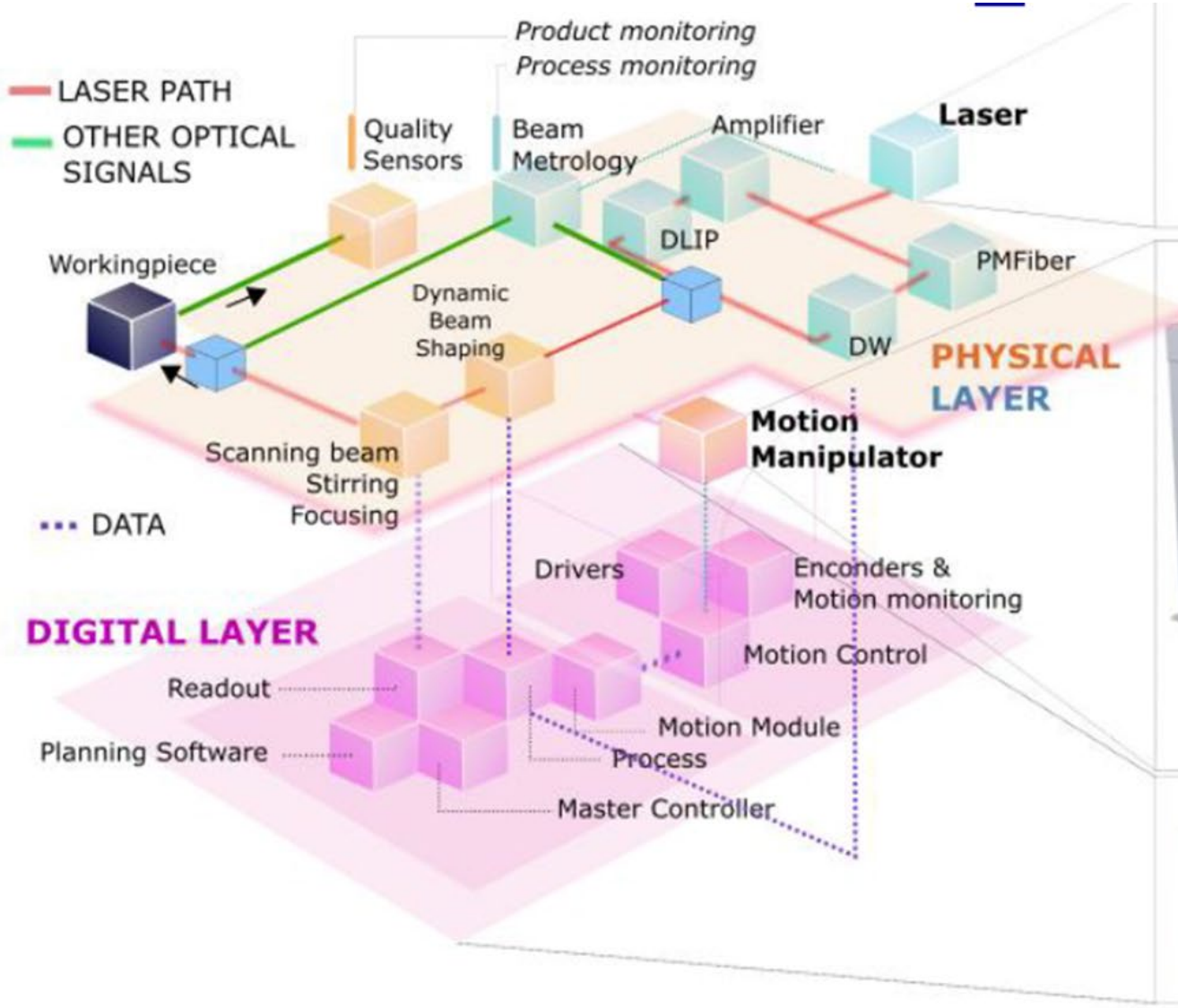
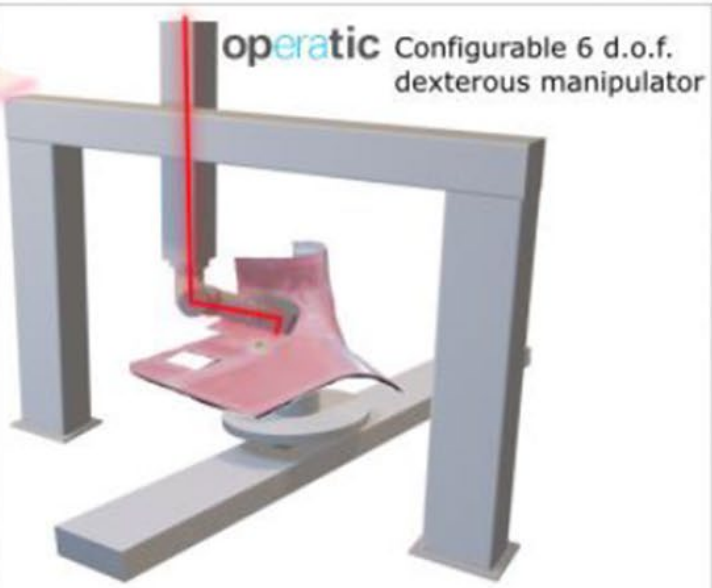
Multilayer architecture





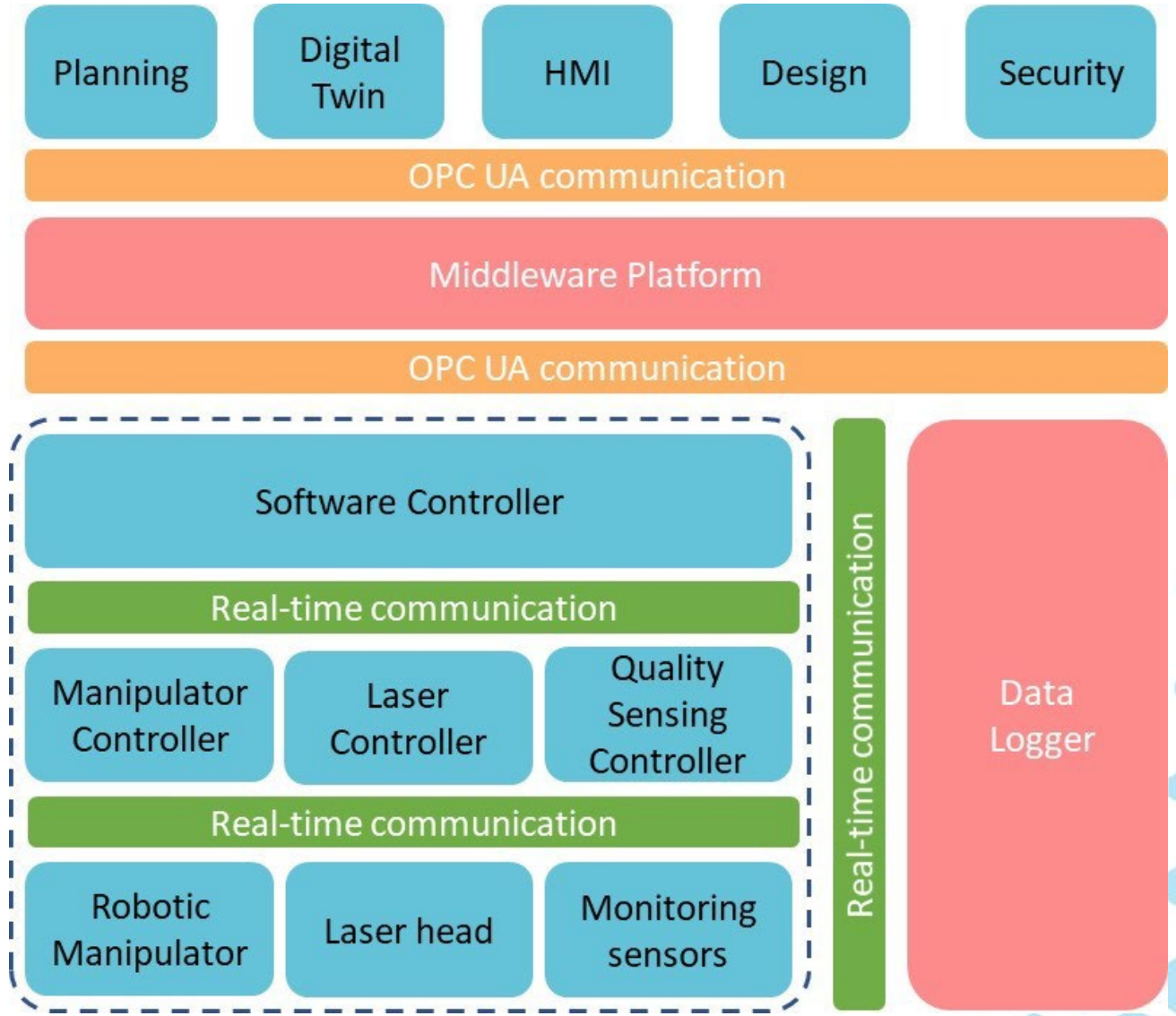
Connectivity and I4.0

RAMI compliant: Not standard in micromachining equipment

Real Time: Hard real time connection among system components and distributed control.

Data acquisition and logging: use of Edge devices and newly crafted data models and pipelines.

Data exploitation: Development of a specific Middleware for data use.



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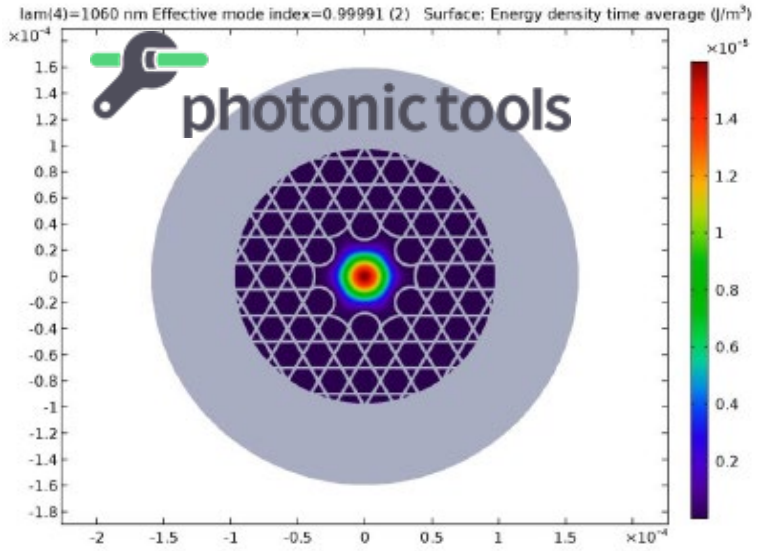
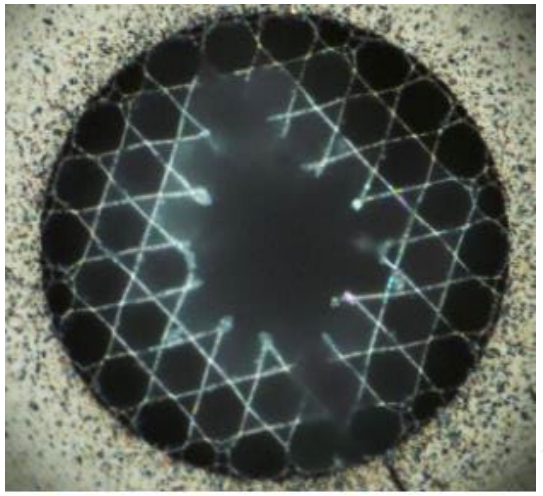
Key Innovations in OPeraTIC

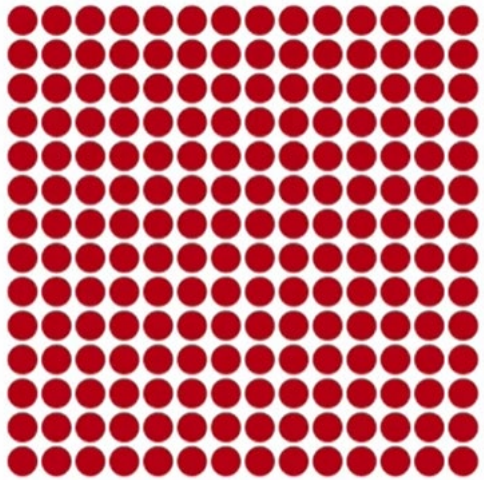
Key Innovations:

- Flexible beam delivery approaches
- Dynamic beamshaping
- In process measurement/correction
- Advanced robotic manipulator
- AI-supported control strategies
- I4.0 ready system.



Microstructured Hollow Core Kagome Fibre





Printing array of beamlets

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Use cases

Product: Dishwasher

Sector: Home Appliances

Targeted function: Hydrophobicity Re-manufacturing

Aim: to reduce water and energy consumption in dishwasher drying cycles.

Objective: Enhance the contact angles of the interior component parts.

OPeraTIC solution: use hierarchical micro-nano topographies to achieve Ultra-Short-Pulsed Lasers (USPL) micro-structuring of the injection moulding tool, transferring the texture to the actual part.

Impact: Reduction of water and energy consumption, improved drying process, extended lifespan of product, avoid plasma coating, achieve better environmental impact, and improve the Restriction of Hazardous Substances (ROHS) compatibility.

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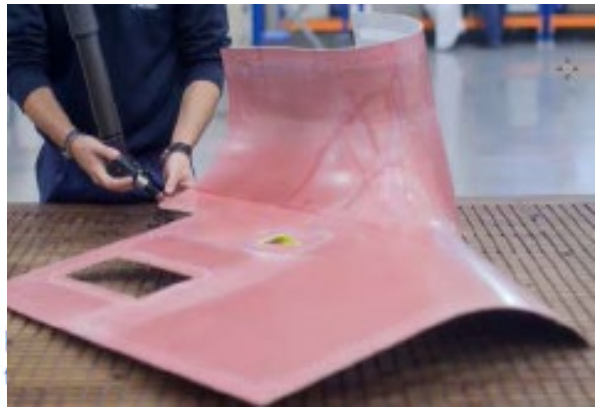
Use cases

Product: Aircraft composite parts

Sector: Aeronautics

Targeted function: Improved adhesion/paintability



Aim: Reduce time consuming and harmful sanding process in current preparation processes.

Objective: Improve the paintability of components while improving the process yield, repeatability, flexibility, and decreasing rejection rates through use of lasers.

OPeraTIC solution: Surface texturing through customised energy distribution of high-energy USPL on the component, ensuring optimal adhesion between composite and paint, as well as avoiding pores.

Impact: Damage avoidance to Kevlar matrix and provision of a functional surface within a competitive process cycle time, high repeatability, reduction in rejection rates and increased yields, improved worker health and safety conditions.

Use cases

Product: Texturized die component

Sector: Automotive

Targeted function: Improved lubrication and re-manufacturability

Aim: Reduce wear, adhesion, and defects in steel blank stamping and deep drawing.

Objective: Improve lubrication and homogeneous gripping, thus also improving formability of intricate shapes, speed of processes and reducing forming steps.

OPeraTIC solution: Utilise USPL machining of microreservoirs in a stamping tool.

Impact: Reduction in energy use, oil, and feedstock, extension of die lifespan, reduction in process downtime, and enabling manufacturing of complex geometrics and difficult materials, and reducing forming steps from 7 to 4.

Use cases

Product: Advanced backlighting

Sector: Lighting/HMI

Targeted function: Functional structuring of backlit panels

Aim: Reduce LED power and energy use in LED Backlit Units (BLU)

Objective: Increase visible light transmissions and lower dielectric permittivity, increasing integration capacities with BLUs and/or capacitive sensing electrodes.

OPeraTIC solution: Use direct laser selective patterning to allow mass customisation in design and function.

Impact: Meet the next wave in automotive design through creating high-quality 3D light emitting surfaces, with dynamically addressable luminance.

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Thank you for your attention!

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