

Photonics for Manufacturing

Connecting with Industry

DEEPSUPPORT



Why is Photonics relevant?

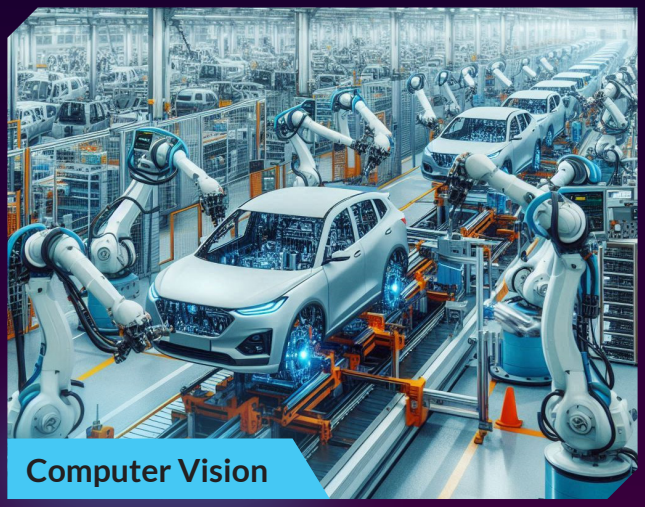
Photonics is one of the Key Enabling Technologies, this means it is a fundamental technology for future technological advancements in a broad range of applications. Its capabilities for manipulating and controlling light open transformative opportunities across industries from Health over Manufacturing to Space.

This offers huge potential for a next innovation cycle due to:

- ***Ubiquity and Versatility:*** Photonics applications span numerous industries, from optical fiber communications, laser manufacturing, medical imaging, and environmental sensing, underscoring its wide-reaching utility.
- ***Enabling High-Speed Data Transmission:*** In telecommunications, Photonics allows rapid, efficient, and high-bandwidth data transfer through fiber-optic cables (up to 95% of the global traffic is done via optical communication).
- ***Driving Innovation in Healthcare and Life Sciences:*** Photonics facilitates advancements in imaging, diagnostics, laser surgery and non-invasive therapeutics.
- ***Increasing Manufacturing Efficiency and Precision:*** Photonic tools like lasers are essential for advanced manufacturing, including micro-fabrication and additive manufacturing. They also improve real-time monitoring, non-destructive testing, and accuracy. Integration with IoT, digital twins, and data analytics enables advanced business models.
- ***Advancing the electronics industry:*** Photonics enables device miniaturization, increases in performance and energy efficiency, and is essential for the emerging field of quantum electronics, particularly in developing quantum computers, sensory and secure communication systems.
- ***Supporting Defense and Security Applications:*** Photonics plays a strategic role in defense, with technologies such as LIDAR (Light Detection and Ranging) for surveillance, laser guidance systems, night vision or meta-materials with special optical properties.

What is Photonics in the field of manufacturing?

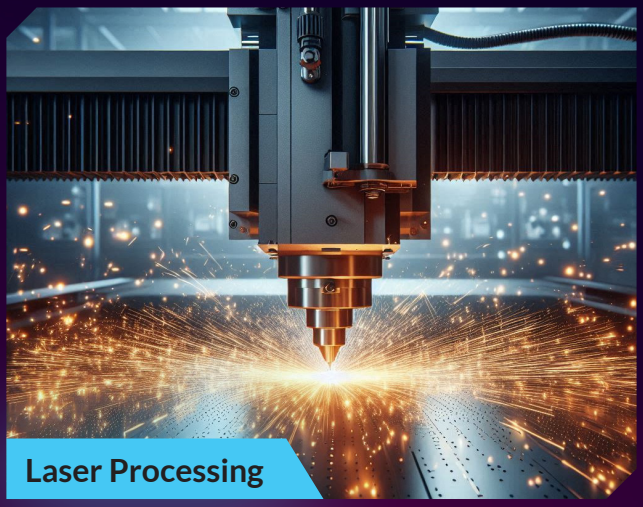
These enabling aspects expand further in specific applications. Photonics is a diverse set of light-based technologies, including:



Computer Vision

Computer Vision, a branch of artificial inteligence (AI), enables computers to extract meaningful information from images and videos, and provide actions based on it. Similar to human vision but using cameras, data, and algorithms, it can analyze thousands of products per minute and detect errors beyond human perception. This technology is used in industries like energy, manufacturing, and automotive.

> *Example: Lens array and multispectral imaging system for autonomous production roboters*



Laser Processing

Lasers are used in manufacturing for cutting, welding, and marking, offering precise, fast, and low-heat processing that boosts production rates and reduces waste. They are essential for processing materials sensitive to heat, and their precision and control over multiple factors result in higher-quality outcomes compared to conventional methods.

> *Example: Welding of explosive components in a battery*



Additive Manufacturing

Additive manufacturing (3D printing) creates objects by adding material layer by layer. This method allows for complex (and sometimes conventionally impossible) geometries and saves costs, time and resources. It often utilizes photonics, such as lasers (Powder bed fusion, Direct Laser deposition, Stereo-Lithography, etc.) and sensors, for enhanced performance and efficiency.

> *Example: Rapid prototyping of lightweight components in a new product*



Material Processing

Photonics material processing develops special properties for specific applications. Techniques like Roll-to-roll nanoimprint lithography are used in mass production to develop innovative properties, often altering surface characteristics to enhance the functionality of components or products.

> *Example: Applications can reach from alloying for wear resistance of strain components to tribological optimized movable parts.*



Sensors and Detectors

Photonics sensors are crucial in areas such as agriculture, medicine, and manufacturing. They precisely measure changes in physical and chemical properties. These sensors provide higher sensitivity and accuracy than traditional ones. Spectrometric technologies, used in environmental and gas monitoring, can operate continuously and autonomously due to their low energy demand, such as for air quality control or gas leak detection

> *Example: Inline-inspection for quality control of processes, Processobserver from nLight plasmo*



Visible Light Communication (VLC)

VLC uses visible light for data transmission and illumination, offering high data rates, secure communication, and immunity to interference. It's ideal for IoT and secure environments and can enable energy transfer, making cables obsolete.

> *Example: Positioning and tracing of persons with normal illumination in an assembly line to optimize processes or detect emergencies*



LIDAR

LIDAR uses laser beams for precise mapping, 3D modeling, and surveillance, with applications in autonomous vehicles, robotics, and drones and create detailed environmental models.

> *Example: Autonomous forklift that automatic supplies assembly lines*



XR Technologies

Virtual-, Extended and Augmented Reality applications enable a new set of opportunities in training of employees (especially in industry / assembly line), remote support or product and component design.

> *Example: Training on the job of employees that change their spot in assembly lines regularly*



Metrology

Optics, microscopy, and photonics technologies like optical coherence tomography are key in high-tech industry quality control, measuring products on a nanometer scale to ensure production tolerance.



Microfabrication

Photonics microfabrication uses light-based techniques to create precise, miniaturized mechanical and electronic systems (MEMs or PICs), playing a key role in developing advanced sensors, actuators, and micro-scale devices.

> *Example: Waveguides in quantum computers*



Energy Efficiency and Lighting

Factories use energy-efficient LED lighting for better illumination, reducing costs and improving conditions with human-centric lighting. Photovoltaic cells are also used to harness solar energy for factory operations.

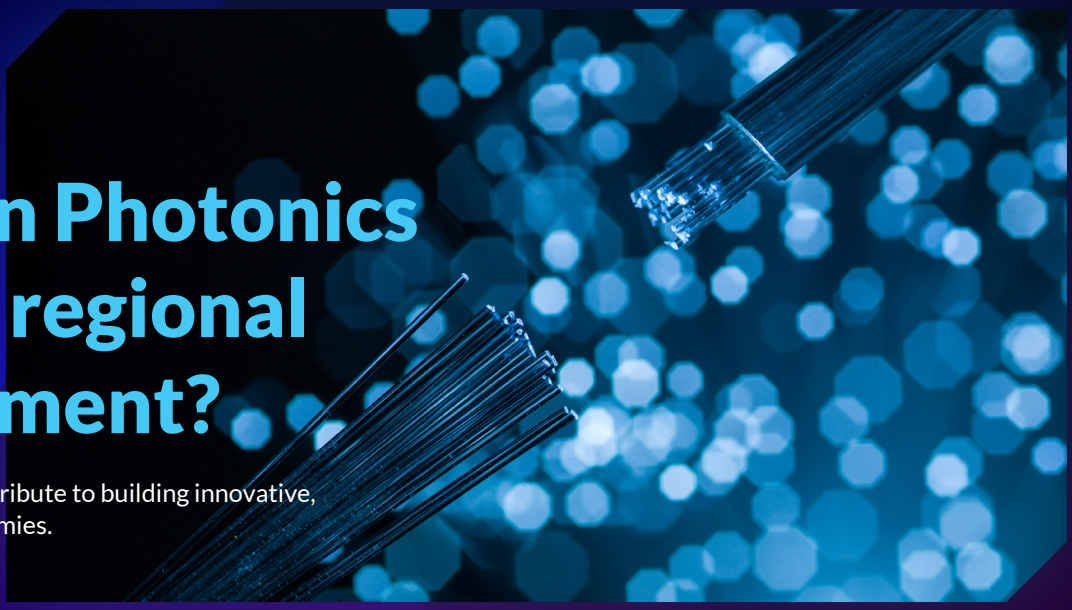
> *Example: PV-Production on factory roof*



Deeptech Technologies

Deep Tech encompasses innovative technologies such as AI, IoT, 5G, blockchain, and quantum technology, driving innovation in autonomous systems, robotics, sensing, and advanced manufacturing and have the potential to create new markets and promote economic growth.

What can Photonics offer for regional advancement?



Photonics technologies contribute to building innovative, future-proof regional economies.

Enhance industrial productivity and efficiency
- Add new functionalities & processes
- Increase energy and resource efficiency
- Enable higher product quality and lower production costs
- Lower time to market

Advance high-tech, sustainable industries
- Green photonics
- Enable digitalization through digital twins and optical communication
- Energy-efficient data and telecommunication infrastructure

Diversify industry, increase resilience and adaptability in global supply chains
- Boost for optical communication, healthcare, security and environmental technologies
- Interdisciplinarity fosters innovation and create opportunities to cooperate between different regions because of strong European Photonics industry

Create high-skill, high-wage jobs
- Job opportunities for highly skilled workers in innovation and R&D
- Photonics experts enhance ecosystem resilience through their interdisciplinary skills across sectors.
- Highly innovative industry that is prone to create start-ups

What is the situation in the Deepsupport region?

Current strategies in the Deepsupport regions do not fully recognize the potential of Photonics technologies in economic, innovation, and research strategies. Photonics and its technologies are not a major area of strategic or policy focus in any of the Deepsupport regions. While regions like Pirkanmaa, North Karelia, North Ostrobothnia, and Styria focus on Photonics and have strong positions as technology providers, other regions address it only indirectly through digitalization or general technology strategies, or not at all. Eastern Slovenia is a special case, where Photonics is covered at the national level but not at the regional level.

The analysis of the Deepsupport region revealed significant differences in technological expertise in Photonics across sub-regions. While the Photonics ecosystems in Styria (AT), North Karelia (FI), North Ostrobothnia (FI), and Pirkanmaa (FI) are relatively strong, regions like Budapest (HU), Northern Hungary (HU), South Tyrol (IT), Friuli-Venezia Giulia (IT), and Podravje (SI) have limited technological resources. Additionally, the regions show varying levels of specialization, with no single region large enough to excel in all Photonics sub-fields, limiting their ability to fully leverage technological advancements.

In contrast, an analysis of the potential and needs for SMEs (Photonics demand-side), particularly in manufacturing, the challenges addressed are similar:

- Lack of knowledge of Photonics and potential application in enterprises
- High investment costs and high risk of application in many cases
- Industry structure dominated by SMEs and hence limited possibilities for inhouse R&D
- Lack of skilled labour in Photonics

What needs to be done?

To accelerate the diffusion of Photonics a tailored approach is needed. The following outlines specific measures to address the main challenges hindering photonics adoption, ensuring that SMEs can leverage photonics effectively, while building regional expertise and infrastructure.

1. ***Building Awareness and Knowledge Transfer Networks:***
Launch targeted campaigns to raise awareness among SMEs and the future workforce about the transformative potential of Photonics. Webinars, regional seminars, and showcase events can highlight successful applications and provide hands-on demonstrations. Engage regional networks (e.g., clusters) to facilitate knowledge exchange, connecting local firms with Photonics experts, suppliers, and research institutions.

2. ***Reducing Financial Barriers through Subsidies and Incentives:***
Provide grants or loans to reduce the financial risk of Photonics investments, focusing on pilot projects, equipment, and prototyping to help SMEs test solutions without incurring prohibitive costs. Public-private partnerships can further lower costs by supporting collaborative projects, infrastructure sharing, and providing access to Photonics expertise from research institutions.

3. ***Developing Accessible, Industry-Relevant Photonics Solutions:***
Fund demonstration projects across industries to provide clear, replicable examples of Photonics applications in real-world contexts, showcasing benefits, risks, and outcomes. Encourage Photonics solution providers to develop modular, ready-to-deploy solutions, offering standardized, "plug-and-play" solutions that reduce complexity for SMEs and don't require extensive R&D or customization.

4. ***Increasing SME Absorptive Capacity for Photonics:***
Collaborate with universities, research and technology organizations (RTOs) and industry Collaborate with universities, RTOs, and industry associations to offer tailored trainings in Photonics for SME employees, including workshops, online courses, and certifications.This will equip SMEs with foundational skills needed to assess and implement Photonics technologies.

   Establish a network of Photonics technology providers who can act as consultants for SMEs. These consultants can support firms in identifying potential applications, planning adoption strategies and accessing relevant resources, effectively bridging the gap between photonics technology and practical application.

5. ***Building a Regional Talent Pipeline in Photonics:***
Increase visibility of Photonics by hosting events and workshops for schoolchildren. Expand Photonics programs in universities, vocational schools, and apprenticeships to build a local talent pool. Offer dedicated degrees, certificates, internships, and R&D placements to ensure access to skilled professionals for SMEs and larger firms.

6. ***Enabling R&D and Innovation for SMEs in Photonics:***
Provide SMEs with R&D grants and subsidies for Photonics projects, covering external research collaborations, materials, and equipment to reduce financial barriers and support innovation.

7. ***Encouraging Industry-Academia Collaboration and Startups:***
Launch co-innovation programs by pairing SMEs with university labs or RTOs for joint R&D projects in Photonics, giving SMEs access to research, expertise, and testing capabilities. Also, establish support structures for Photonics startups.

8. ***Include regional leading companies:***
Leading companies play a key role in the ecosystem through their economic power, supply chains, global visibility, and innovation. They can be involved as Photonics suppliers (many internationals include Photonics products) or users. Their involvement should span across knowledge transfer, innovation, and talent development.

photonics.fi/projects/deepsupport

Why regional cooperation is an answer?

Single regions, given their size, only have limited possibilities to undertake all those necessary measures. Therefore, it makes sense that likeminded regions cooperate. This enables

- Optimising limited resources through synergies
- Addressing skill gaps and labour shortages collectively
- Creating a joint ecosystem of complementary strengths
- Enhancing global competitiveness of each of the regions involved
- Mitigating Political and Financial Constraints

Key Areas for joint supra-regional strategy

Cross-Regional innovation funding and investment schemes:
A joint investment fund across partner regions could support collaborative innovation projects, co-investments in high-potential startups, and public-private partnerships. A supra-regional fund would have a larger capital base, leveraging existing EU funding, such as the "Regional Innovation Valley" under the Interconnected Innovation Ecosystem calls (I3). This would provide expanded funding opportunities and greater access to cooperation partners for partner regions.

Collaborative training and education programmes:
By developing shared photonics training programs across multiple educational institutions, regions can increase access to specialized knowledge. These programs can include online courses and cross-regional internships, offering cost-effective training resources. A specific focus should be on creating joint degree programs in tertiary education.

Shared Photonics infrastructure and prototyping facilities:
Building or upgrading Photonics infrastructure is costly. A supra-regional strategy allows regions to share existing facilities or develop new ones through PPPs, enabling SMEs to prototype and test applications without significant capital investment, while optimizing the use of infrastructure in hosting regions.

Photonics Pilots and Demonstration Projects:
Establish supra-regional demonstration projects to test Photonics applications across industries or make existing projects accessible. These projects showcase Photonics' value, reducing investment risks for SMEs and allowing regional cooperation to explore its potential in diverse sectors.

Shared outreach program:
Existing best practice outreach programs should be adapted, harmonized and rolled out in all regions. The target group should be on the one hand school kids to prepare a talent pipeline for Photonics experts and on the other hand SMEs that do not yet know at all about the opportunities Photonics can offer them.

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