

Photonics in the Netherlands

Photonics and optical technologies have been rightfully recognized as a Key Enabling Technology (KET). This acknowledgment enhances the role of photonics in driving innovation across various market segments. Historically the Netherlands is leading in many research and application areas for new innovations in Photonics and Optical technologies, which has led to a significant increase in international engagement, resulting in enhanced trade, research, innovation, and collaboration with partners worldwide. In this article, this strong position and the value of the photonics sector in the Netherlands is illustrated.

History of Dutch Photonics

The Netherlands has a long tradition in photonics, already starting in the 17th century with Christiaan Huygens (inventor of the telescope) and Antoni van Leeuwenhoek (inventor of the microscope), which means 350 years of optical instruments. Nowadays we find some large world players in the Netherlands like ASML, Philips, and Signify.

ASML, one of the most high-tech companies in the world, designs lithography machines that utilize advanced optical technology, to create increasingly smaller and more complex circuit patterns. But it's not just ASML that is using photonics, also their suppliers do.

Another great example is Philips. Founded in the late 19th century they already started with 'photonics' by the manufacturing of carbon-filament lamps. In the 80s of the last century, they introduced groundbreaking products like the Compact Disc and the CD player, which... use light. Nowadays, they put their focus more and more on health. Optical technology allows Signify to reduce energy consumption by 80% with their LED solutions for their governmental, industrial, and consumer markets. Efficient lighting solutions are also crucial in green house applications. Today communication is an essential part of our society and new optical technologies provide steadily increasing capacity for stable and safe data transfer.

Let's have a closer look at the societal challenges we are facing worldwide. We see climate change, poverty, health crises, sustainable development, security, and feeding 8 billion people. We can't solve all these challenges with high tech and photonics, but we can play an important role in it. But how?

Photonics, or light, has some very nice properties: it's fast, precise, small, and clean. These properties play a fundamental role in driving innovation and enabling advancements across various industries and sectors. It's therefore set as a Key Enabling Technology, also recognized by the EU.

This key enabling technology can be used in many other technologies: Automotive, Semicon, Space, Smart Industry, Aviation, Health, Safety, Nanotechnology, Virtual Reality, Augmented Reality, and 5G.

In the Netherlands, we do what we are good at. Therefore we focus on some markets to use photonics in: Agri-food, Health, Manufacturing, ICT, Semicon, Energy & Environment. And, remarkable for such a small country, you find an industrial ecosystem. There's a strong collaboration in Photonics and we all do our part in solving the societal challenges, on less than 45.000 krñ.

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Photonics, Optics and Integrated Photonics

Photonics and Optical technologies have been rightfully recognized as a Key Enabling Technology (KET). This recognition extends to multiple application areas, including Quantum Technologies and Artificial Intelligence. This acknowledgment enhances the role of Photonics in driving innovation across various market segments.

The Dutch Photonics Ecosystem has seen a significant increase in international engagement, resulting in enhanced trade, research, innovation, and collaboration with partners worldwide, particularly in the EU, Asia, and the Americas. This global outreach strengthens the Netherlands' position in the photonics sector. The Netherlands boasts a thriving ecosystem of not only a few multinationals but also over 300 SMEs and start-ups that rely on Photonics and Optical technologies in their core operations.

Furthermore, the financial sector has shown a growing interest in Photonics, resulting in significant investment rounds. A major milestone was achieved with the award of the National Growth Fund grant, of 472 M€ for boosting Integrated Photonics for the years 2023-2029. With a combined effort from industrial partners, the substantial investment will amount to approximately 1 B€ to support research, innovation, human capital development, and industrialization within the Dutch Integrated Photonics ecosystem. This not only amplified initial capital but also increased confidence in the production capabilities of front- and back-end foundries, a key element of the Growth Fund program.

Optics, Photonics, and Integrated Photonics play a vital role in addressing Societal Challenges.

Important is that translating research into successful businesses is essential for tackling societal challenges through valorization efforts by recognizing the immense potential of the Photonics ecosystem and creating a significant opportunity to facilitate the growth of groundbreaking companies. This can be further enhanced by ensuring that the entire value chain, spanning from fundamental research and development to large-scale production, is firmly rooted within the Netherlands. Such a comprehensive approach will drive innovation, economic growth, and progress in addressing societal challenges.

Societal challenges and economic relevance

Photonics finds itself at the forefront of a diverse array of applications. Its significance in bolstering and facilitating an array of services and products is on a continuous ascent. As humanity strives to meet the ever-expanding demands in communication, enhancing quality of life, and safeguarding health, the overarching goal is to achieve these milestones with the least possible ecological footprint stemming from these technological advancements.

Photonics plays a crucial role in addressing a wide range of societal challenges by leveraging the properties of light for various applications. There are several ways in which Photonics contributes to tackling these challenges. Photonics is a versatile technology that directly addresses numerous societal challenges by advancing fields such as healthcare, energy, communication, and environmental monitoring. Its applications contribute to improving the quality of life, reducing environmental impact, and driving technological innovation across various sectors. We mention some of our foundational principles:

- **Significance in Addressing Societal Challenges:** Photonics presently plays a significant role in resolving critical contemporary societal issues.

THE NETHERLANDS

- **Amplifying Research and Innovation Yield:** Our focus encompasses valorizing a substantial portion of scientific knowledge and infrastructure, aiming to maximize the returns from research efforts and joint innovation.
- **Nurturing Human Capital:** Cultivating a highly educated populace is pivotal in realizing our aspirations, whether directed towards pioneering research or the social and economic application of knowledge.
- **Collaborative Endeavor Involving Science, Government, and Enterprises:** The responsibility for driving this process lies jointly with the scientific community, government bodies, and corporate entities.
- **Enhancing Excellence:** The Netherlands holds an international lead in various Photonics research domains. Preserving and, when feasible, augmenting this position is imperative. It's essential to also navigate the space between fundamental science and practical applications, preventing a potential hindrance to innovation.

Position of the Dutch ecosystem

Photonics is a fast-growing technology and therefore an important driver of employment and economic growth in the Netherlands. In recent years the impact of Photonics as a Key Enabling Technology has been growing steadily. More than 300 companies with their headquarters in the Netherlands contribute 30 B€ of revenue to the economy with an annual expected job growth of 5-20 percent. The high growth expectations are reflected in the initiatives taken at the regional level. Several provinces collaborate to build on their strength in the field of Integrated Photonics aiming for thousands of new jobs in the future. The leverage Photonics offers to the manufacturing industry and end markets is considerable.

The expertise required for Photonics in the Netherlands is concentrated in multiple locations, working on a variety of topics. For successful positioning within European and worldwide markets, we present the Netherlands as a single, coherent, and well-synchronized Photonics region. However, while the Dutch Photonics ecosystem has these strengths, global competition

remains intense. Other countries and regions also have vibrant Photonics ecosystems and are investing in research, development, and commercialization. Staying competitive requires continuous innovation, investment, and adaptation to emerging trends through collaborations, network meetings, and events, specifically for collaborations. We point out some Dutch regions:

- **Amsterdam region (northwestern part of the Netherlands):** strong in medical Photonics including development of affordable minimally invasive screening methods, computational imaging, and metrology, as well as building a strong activity in EUV light sources, development of next-generation photovoltaics, quantum nanophotonics and photonic technology for quantum information.
- **Nijmegen area:** working on further integration of microelectronics with photonic technology as well as the knowledge for the large-scale packaging and testing of such chips
- **The Twente region (east part of the Netherlands):** strong knowledge base concerning the development and production of nanophotonics, in particular silicon nitride Integrated Photonics, integrated lasers, microwave Photonics, 3D nanophotonics, photovoltaics, and scattering optics. Further activities focus on optical quantum information technologies within the Quant center, optical sensing and medical diagnostics; opto-mechatronic systems; generic packaging technology, integration with microfluidics, and the assembly of Photonics and electronic circuits.
- **The North Brabant region (southern part of the Netherlands):** a strong position in integrated photonic chips based on Indium Phosphide, Equipment manufacturing for photovoltaic, microelectronics, and healthcare applications, Photonic technologies for consumer electronics and lighting. And of course, ASML that develops lithographic scanners (with extreme ultraviolet (EUV) and deep ultraviolet (DUV) light), metrology, and computational lithography tools with partners from industry and academia throughout the Netherlands.
- **The South Holland region (southwest part of the Netherlands):** a unique optics cluster. It includes the complete chain of academic knowledge & research, application development, and original equipment manufacturers (OEMs) combined with a wide range of component suppliers to industries like aerospace, agriculture & food, ICT, maritime, health & life science equipment, automotive, manufacturing industry, energy, infrastructure, building & construction, semicon.

PhotonicsNL members October 2023.
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Photonics for precision farming. ©Avantes BV.

- Northern region of the Netherlands: strong activities in material development for light detection and photovoltaics.
- Knowledge institutes: Dutch academic research is at the forefront of many of photonics disciplines. The (technical) universities and universities of applied sciences play a prominent role in achieving a new level in the generation, control, and application of light in many high-tech markets, together with Dutch industries.

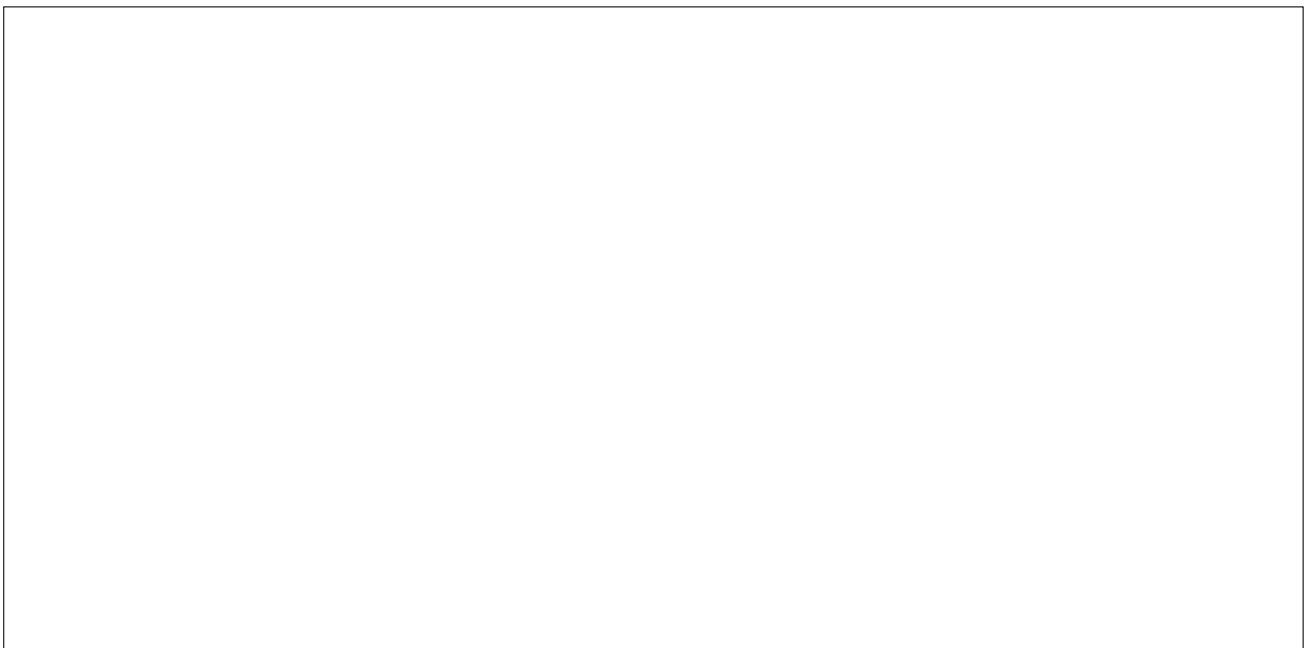
Dutch collaboration in Europe

As shown above, the Netherlands has a very strong Photonics, Optics, and Integrated Photonics ecosystem. However, due to the changing geopolitical situation, collaboration with European countries is necessary to create an independent Europe. To establish European technology and data sovereignty and supply chains we have to keep developing cutting edge Photonics technology platforms and manufacturing key Photonics components and systems to enable also the digital and green transformation of the European economy and society. As a Key Enabling Technology, Photonics is synergistic with other technologies and application areas. Thus, close cooperation with other partnerships and Horizon Europe clusters is necessary. The Netherlands is always open to collaboration and has proven to be a reliable and strong partner.

PhotonicsNL – The Dutch Association for Photonics

With its roots in the 50s of the previous century, PhotonicsNL has a long history in Photonics. It started with the foundation of the Dutch Society for Photonics (NVvF), succeeded by different associations and a non-profit organization. On 19 September 2023, PhotonicsNL was established, which means they celebrate our 10th anniversary this year!

OCT catheters used for bladder cancer diagnosis.
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Label-free biosensor PIC of Delta Diagnostics for biomolecular interaction analysis and protein quantitation. ©DeltaDiagnostics.

PhotonicsNL wants to stimulate Photonics, Optics, and Integrated Photonics innovations and economics actively. They want to enable collaborations and cross-fertilization in the Photonics value chain, propagate the importance of Photonics for our economy, at all levels of education, and towards the government, and promote the national Photonics community in the Netherlands and abroad. They do this by organizing networking, knowledge, and matchmaking events, participating in national and international shows and (trade) missions, creating links between their members and outside the PhotonicsNL community, and collaborating in European Projects and with other national clusters in the EU as well as worldwide. PhotonicsNL has over 60 members from the complete value chain, from research to knowledge institutes to industry and large companies.

Since the establishment of PhotonicsNL, Photonics in all its elements has been growing enormously. For PhotonicsNL, it has been important to connect with different technologies and markets to create awareness about the importance of Photonics, that it is a significant technology with remarkable properties and can be used in many other technologies and markets. In this way, they have been able to strengthen and extend the Photonics network and community and connect with different application areas and (end) users.

More Photonics entities

PhotonicsNL is the umbrella of Photonics in the Netherlands. Under this umbrella, we also find two other entities: PhotonDelta and Optics Netherlands.

PhotonDelta is a growth accelerator for the Photonic chip industry. Photonic Integrated Circuits (PICs) are chips that use photons instead of electrons to sense, process, and transmit data at unparalleled speed and sensitivity. The use of PICs allows for the creation of devices that are smaller, faster, and more energy-efficient and can contribute to solving various societal and technological challenges, such as reducing the energy consumption of data centers, safe autonomous driving, cost-effective monitoring of diseases, and more efficient food production.

Over the years, PhotonDelta established an ecosystem of organizations that research, design, develop, and manufacture

photonic chip technology. PhotonDelta actively supports the ecosystem by stimulating collaboration between partners, providing funding, and connecting them with viable markets. PhotonDelta is located in the Netherlands but collaborates worldwide.

Optics Netherlands comprises all optical research and education in the Netherlands at all universities and continues to support the close cooperation between the Dutch industry and academic institutes.

The institute has three focus areas: Education, Research, and Innovation.

Education of new talent is a first focus. Since Photonics and Optics are all around us, new talents need to be educated at all levels, from Secondary vocational education, Higher professional education, and University education. There is a bright future for a workforce that maintains optical technologies, adapts new optical technologies into the current infrastructure of our ever-increasing high-tech lifestyle and research new optical principles and applications.

Research focuses on new emerging technologies and creative ideas of using Photonics and Optical principles to solve existing societal challenges. By combining the knowledge of researchers at all academic institutions and having brainstorming sessions they will develop new ideas for proposals.

Innovation to turn academic research results into products is the third focus area of Optics Netherlands. They need a thriving industry that drives the innovation of new Photonics and Optical technologies. They create economic impact in The Netherlands by applying energy-saving, safe, and high-quality innovations. Startups need not only financial support but also a well-organized community that is easy to navigate for defining new application markets. ●

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A close-up of a 12/12 quantum processor. © QuiX Quantum.

