Photonics cPPP
Progress Monitoring Report 2018

PHOTONICS PUBLIC PRIVATE PARTNERSHIP

Photonics21 – Photonics cPPP Progress Monitoring Report 2018

Contents

Executive Summary

Photonics is a key enabling technology (KET) for Europe and as such crucial for the future competitiveness of European strategic industries. By developing and providing latest photonics technologies towards the European end user industries, photonics massively supports making European products more competitive. This was the basic reason for the European Commission to establish the Photonics contractual Public Private Partnership (cPPP) and the European Technology Platform Photonics21.[1]

The Photonics cPPP represents a long-term commitment between the European Commission and the Photonics industry to jointly invest in Europe for fostering photonics manufacturing, job and wealth creation in Europe, accelerating Europe's innovation process and time to market in Photonics as well as mobilizing, pooling and leveraging public and private resources to provide solutions for major societal challenges facing Europe.

To this end, the Photonics industry and academia jointly prepared the Photonics cPPP roadmap "*Towards 2020 – Photonics driving economic growth in Europe*" (2013) in an open and transparent process. Since then the Photonics cPPP roadmap is updated bi-yearly by the community and provided to the European Commission to be included into the Horizon 2020 Photonics KET calls.

Under the Photonics cPPP in Horizon 2020, the public support for photonics by the European Commission has been increased to €700m. Moreover, the photonics industry made a strong commitment to leveraging public funds with private sector investment by a factor of 4. As a matter of fact, the European SME based Photonics industry is investing about 10 billion Euro per year in Research and Innovation in Europe and belongs to the most innovative industries in Europe.

Operational since 2014, the Photonics cPPP has started 86 Horizon 2020 Photonics KET (PPP) research and innovation projects, up to now with a public investment of about €330m to address and societal challenges and at the same time make European end user industries more competitive at global scale. (*More details to be found in §1*)

The Photonics cPPP is looking back on a very successful 2017 – as underlined by the following milestones (*More details to be found in §2*):

- 17 new Horizon 2020 projects started with a total budget of €96,387,748.75 – demonstrating a strong industrial commitment and driven by end-user needs.
- A community based Strategic Vision Document was prepared: *"Europe's age of light! How photonics will power growth and innovation"* outlining 8 bold missions on how photonics will drive Europe's long term future competitiveness was prepared.
- A "European Photonics Venture Forum" (EPVF) was successfully conducted in Dublin, bringing together >30 high tech investors and >30 photonics start-ups to respond to the so far unmet capital demand of innovative young photonics companies.
- Teaming up with member states and regions: The Photonics cPPP triggered joint funding activities between the PPP, member states and regions (e.g. in the ERANET Cofund) and linked the Photonics PPP strategy with regional Smart Specialization Strategies (S^3). More than 15 regions are involved in the photonics S^3 initiative, North Brabant being in the lead.
- Nearly 15 Mio. people reached through Photonics cPPP project impact and success stories: More than 209 articles on cPPP projects have been published in newspapers, magazines, and websites, covering more than 15 countries.

17
new Horizon 2020 projects started with a total budget of €96,387,748.75.

>209
articles on cPPP projects have been published in newspapers, magazines, and websites, covering more than 15 countries.

[1] Photonics21 is an industry driven stakeholder organization representing more than 1700 photonics affiliations.

- The Photonics cPPP was evaluated best in class by a European Commission independent expert panel as part of the "Mid-term review of the contractual Public Private Partnerships (cPPPs) under Horizon 2020".[2]

More generally, and looking back at 4 years of activities, it can be stated that most objectives of the Photonics cPPP –have been achieved (*More details to be found in §3.1*):

- European Photonics Industry has grown by 62% (CAGR +5%) in the last 10 years, leading to an overall European Photonics Production of €66.7bn in 2015. Since 2011, the European Photonics Industry has shown a solid long-term growth.
- In the same time (2005–2015), the number of people employed in the European Photonics Industry has shown an impressive overall growth of + 23% (CAGR +2.1%) – leading to 290,000 people employed in this sector in 2015. This trend is expected to continue, and current estimations assume that 42,000 new jobs could be created by 2020 compared to 2011.
- More than 30 new curricula have been developed so far by the Photonics PPP projects and many different PPP projects aim at promoting skills creation for young people, for entrepreneurs and employees.
- Photonics related projects in Horizon 2020 cover all targeted application areas, e. g. personalized healthcare, industry 4.0, smart cities, digital society, etc.
- European photonics companies are highly committed to research and innovation. The private sector's involvement in Horizon 2020 in the photonics segment is better-than-average with e.g. photonic SMEs succeeding better than average in submitting SME Instrument (SME-INT) projects.
- The Photonics cPPP has contributed to leverage Research & Development in Photonics. In total, innovation spending in the European Photonics Industry in 2015 accounted for nearly €10bn and R&D intensity in the Photonics industry amounts to nearly 10% – much higher than in most other industry sectors.
- Most PPP projects have already at this early stage and still far from commercialisation and market entry reported of a leverage factor of 1–3, some even 4–5, so that it can be safely assumed that the committed leverage factor of 4 will be easily met by the photonics industry.

Progress made in relation to the specific Key Performance Indicators (KPIs) has been measured using an online survey among all PPP projects coordinators. The good response rate of about 60%, as well as the specific answers given – concerning patent / standardisation activities, SME turnover increase, spin-off and new jobs creation, etc. – underline the success of the Photonics cPPP. (*More details can be found in §3.2*).

Over the last years, the Photonics cPPP has become a successful and increasingly effective partnership. The European Photonics SME based community has never before worked together to develop and implement the European R&D strategy in Photonics. Key to involvement of SMEs is the fully open, democratic and transparent decision-making process of Photonics21. (*More details on lessons learned can be found in §4*).

€10bn
innovation spending in the European Photonics Industry in 2015.

290,000
people employed in the European Photonics Industry with estimations of 42,000 new jobs that could be created by 2020 compared to 2011.

[2] Mid-term review of the contractual Public Private Partnerships (cPPPs) under Horizon 2020; Report of the independent expert group, September 2017. https://publications.europa.eu/en/publication-detail/-/publication/6de81abe-a71c-11e7-837e-01aa75ed71a1/language-en (last accessed on 2018/09/06).

1. Introduction: The Photonics cPPP

On the 17th of December 2013 Vice-President Neelie Kroes signed the agreement setting up the contractual Photonics Public-Private Partnership (Photonics cPPP). In recognition that – as one of six Key Enabling Technologies (KET's) in Europe – Photonics plays a major role for driving growth and employment in Europe and contributes to solve the major societal challenges such as aging society, energy efficiency, inclusion and smart living, the Photonics cPPP aims at promoting European photonics. The Photonics PPP represents a long-term commitment between the European Commission and the Photonics Stakeholders to invest in Europe with the aim of securing Europe's industrial leadership and economic growth in photonics, a highly skilled workforce, and the capability to generate new jobs attractive to young people. Never before had the European Industry and European Policy worked so closely together in such an important technology domain.

The Photonics cPPP has grown from the Photonics21 European Technology Platform which was launched in 2005 with the aim to be the first European platform to bring together stakeholders from industry, academia, and policy in photonics. Since its establishment, the platform has steadily grown and includes today about 1700 organisations – two fifths of them being companies – with more than 3300 members. Over the period 2007–2013, Photonics21 coordinated two strategy processes involving the whole European Photonics community and focused on promoting Photonics research in Europe. This lead to two strategic reports: the strategic research agenda "*Lighting the way ahead*"[3] (2010) and the Multiannual Strategic Roadmap "*Towards 2020 – Photonics driving economic growth in Europe*"[4] (2013). Both reports have played an important role in securing substantial support for Photonics R&D under the 7th Framework Programme for Research of the European Commission (EC) (2007–2013) and Horizon 2020 (2014–2020). Under the Photonics cPPP in Horizon 2020 the budget for photonics has been increased to €700m. Moreover, the photonics industry made a strong commitment to leveraging public funds with private investment by a factor of 4. Based on the strategic work of the European Technology Platform, the European Commission has started 86 Horizon 2020 Photonics KET (PPP) projects up to now with a public investment of about €330m[5] (cf. §3.3).

Today's challenge: Europe "on the threshold of a new era, [...] moving from the age of electronics to the age of photonics"[6]

The global market for photonics applications amounts for €447bn and has nearly doubled in the last 10 years. It has become a highly competitive market growing by 6.2% per year and global economic players put enormous efforts to reap the benefits of photonics technologies. Today, Europe has established a strong position with an overall total global market share of 15.5%, leaving Europe second only to China.[7] Europe has a highly dynamic photonics industry which is already "the world's innovation and market leader in many of the products and services that will power the digital economy of the 21st century".[8] Europe's photonics industry employs ~300,000 people directly, and more than 5,000 photonics companies, mainly SMEs, drive the sector. Even more important: photonics has a substantial leverage effect on other key industries in Europe providing solutions to make them more competitive. In 2009, this was estimated that 20–30% of the overall economy and 10% of the workforce depended on photonics.[9] The recent publication of the European Investment Bank "Financing the digital transformation" underlines the strategic means and high economic leverage factor of photonics technologies estimated at 10% of the European economy "with leverage ratios that may go up to 50 between the photonics market size and the total market size impacted".[10]

[3] European Technology Platform Photonics21 c/o VDI Technologiezentrum, coordinating editors VDI Technologiezentrum: Flaig, Katharina; Wilkens, Markus (2010): Lighting the Way ahead, Strategic Research Agenda in Photonics, Düsseldorf.

[4] European Technology Platform Photonics21 c/o VDI Technologiezentrum (2013): Towards 2020 – Photonics Driving Economic Growth in Europe (Multiannual Strategic Roadmap 2014–2020), Brussels.

[5] Source: EC, DG CONNECT.

[6] A. Kamper, President Photonics21 in the Foreword to the Vision Paper "*Europe's age of light! How photonics will power growth and innovation*" (2017) published by European Technology Platform Photonics21 c/o VDI Technologiezentrum GmbH, Photonics21 Secretariat.

[7] European Technology Platform Photonics21 c/o VDI Technologiezentrum GmbH, Photonics21 Secretariat (2017): Market Research Study, Photonics 2017, Brüssel / Düsseldorf / Tägerwilen, May 2017.

[8] European Technology Platform Photonics21 c/o VDI Technologiezentrum GmbH, Photonics21 Secretariat (2017): "*Europe's age of light! How photonics will power growth and innovation*", Photonics21 Vision Paper, Brussels / Düsseldorf / Berlin / Frankfurt am Main, 2017, P. 11.

[9] European Commission's study SMART 2009/0066 – The leverage effect of photonics technology: the European perspective.

[10] European Investment Bank: Innovation Finance Advisory Studies "Financing the digital transformation – Unlocking the value of photonics and microelectronics", prepared for DG Research and Innovation and DG Connect, European Commission, 2018, P. 11.

In the future, photonics will continue to have a growing impact on most areas of our lives and will be "literally everywhere, from smartphone displays to fibre-optic broadband to energy-saving LED lights to the laser surgery that saves our life. As light particles (known as photons) replace electrons in many of our most important technologies, innovations already in the pipeline will improve healthcare, grow food, save energy, cut pollution, expand connectivity, transform manufacturing and usher in a new era of mobility. All across the economy, photonics technology will protect jobs and drive growth".[11] As underlined by Aldo Kamper, Photonics21 President from 2016 to 2018, in the Vision Paper published in November 2017 (cf. §4), Photonics will be at the very heart of Europe's digital transformation and will provide "tools and solutions to literally every industry in every region in Europe that takes up the challenge to become more competitive".[12]

In a highly competitive environment where Europe's competitors never sleep, the years ahead will show whether Europe will lead or lag behind in the coming revolution. For the European Photonics Industry to explore the future applications of light and to reap the expected benefits of creating jobs and wealth, joint European initiatives between industry, the scientific community and policymakers are required. By establishing the Photonics cPPP, the European Commission, the photonics industry – represented by Photonics21 – and the research community, have joined forces to keep up to speed with the latest developments and to stay ahead in the global competition. The challenge for the Photonics cPPP is – now more than ever – to secure leadership in those areas where Europe is strong or where there is potential for creating new markets. The cPPP aims to accelerate Europe's innovation process and the time to market for solutions – encompassing the entire innovation and value chain from advanced materials to manufacturing and from advanced research to technology take-up, pilot production lines and demonstration actions.

The Public and Private Side of the cPPP regularly meet in the Partnership Board to discuss joint strategic topics for the future development of the PPP – such as Research and Innovation priorities, budgeting, financing, digitization of industry, regulatory issues, structure of the PPP and the European Technology Platform Photonics21 as well as to agree on the priorities of future calls for proposals and monitor the performance, outputs and impact of the cPPP. Following the recommendations of the Multiannual Strategic Roadmap 2014–2020 by Photonics21, a set of Key Performance Indicators (KPIs) has been defined to monitor and assess the implementation and the socio-economic impact of the Photonics cPPP, to control the bold commitment of the European Photonics Industry, but also to assess the functioning of the cPPP itself. These Key Performance Indicators (KPIs) have been monitored over the last years and provide the data for this progress monitoring report as well as for the recently published PPP Impact Report 2017.[13]

"The challenge for the Photonics cPPP is – now more than ever – to secure leadership in those areas where Europe is strong or where there is potential for creating new markets."

[11] European Technology Platform Photonics21 c/o VDI Technologiezentrum GmbH, Photonics21 Secretariat (2017): "*Europe's age of light! How photonics will power growth and innovation*", Photonics21 Vision Paper, Brussels / Düsseldorf / Berlin / Frankfurt am Main, 2017, P. 11.

[12] A. Kamper, President Photonics21 in the Foreword to the Vision Paper "*Europe's age of light! How photonics will power growth and innovation*" (2017) published by European Technology Platform Photonics21 c/o VDI Technologiezentrum GmbH, Photonics21 Secretariat.

[13] European Technology Platform Photonics21 c/o VDI Technologiezentrum GmbH, Photonics21 Secretariat (2017): Jobs and Growth in Europe – Realizing the potential of Photonics, PPP Impact Report 2017, Düsseldorf.

2. Main activities and achievements during 2017

2.1 Implementation of the calls for proposals evaluated in 2017

Photonics PPP projects demonstrate a strong industrial commitment and are driven by end-user needs.[14]
In the work programme 2017, the **ICT-30-2017** call addressed photonics related proposals and covered Research and Innovation Actions (RIA), Innovation Actions (IA) and Coordination and Support Actions (CSA).

The **RIA proposals ICT-30-2017.a** "should demonstrate strong industrial commitment, be driven by user needs and concrete exploitation strategies and they should cover the value/supply chain as appropriate".[15] The focus had to lie on (i) Application driven core photonic technology developments for a new generation of photonic devices (including components, modules and sub-systems) for agile Petabit/s Optical Core and Metro Networks; (ii) Photonic integrated circuit (PIC) technology, as well as (iii) Disruptive approaches to optical manufacturing by 2 and 3 D opto-structuring.

Among the **52 RIA proposals submitted, 10 (19% of all submitted RIA-proposals) were retained** and allocated a total budget of: **€48,466,816.25**.

The **IA proposals ICT-30-2017.b** intended to cover the following themes: *(i)* Innovation Incubator for SMEs; and *(ii)* Application driven core photonic devices integrated in systems – for: *1*) Biophotonics: imaging systems for in-depth disease diagnosis and *2*) Sensing for process and product monitoring and analysis. Among the **27 IA proposals submitted, 6 (22% of all submitted RIA-proposals) were retained** and allocated a total budget of: **€44,923,532.50**.

The CSA sub-topic **ICT-30-2017.c** intended to support the industrial strategy for photonics in Europe. The only **one CSA proposal submitted was retained (100%)** and allocated a total budget of: **€2,997,400.00**.

An overview on the budget allocated as well as the participants in the Horizon 2020 ICT-30-2017 call is given in §3.2 when discussing the operational aspects of the PPP.

The Photonics PPP projects resulting from the 2017 call have started in the last months of 2017 or at the beginning of 2018. An overview on the entire portfolio of the funded (past and current) Photonics PPP projects can be found on the website of the Photonics21 Platform (www.photonics21.org/ppp-projects).

2.2 Mobilisation of stakeholders, outreach, success stories

The PPP unites more than 3300 experts from industry and academia to develop and implement a joint European industrial strategy in Photonics.
The Photonics Public Private Partnership Annual Meeting, organized by VDI TZ in its function as Photonics21 Secretariat, is the central community building and networking event for photonics in Europe. In 2017, this two-day event entitled "*#next.photonics_forum*" gathered the attendance of several hundred key stakeholders and focused on a pan European Photonics strategy development and implementation issues as well as on overarching issues affecting the photonics industry at large, like the digitization of industry. The event served to review the milestones for the ongoing Photonics PPP projects and marked the starting point for the development of a strategic Vision for the coming Framework Programme FP9 (cf. §2.3 below) which lays the ground for starting to develop the next Multiannual Strategic Roadmap for the period 2021-2027. More than 3000 Photonics21 members representing 1700 companies and research organisations are involved in the strategy process.

[14] All figures in the following paragraph: EC, DG CONNECT.

[15] EC, Horizon 2020 – Work Programme 2016–2017, European Commission Decision C(2017)2468 of 24 April 2017.

Photonics PPP Strategy development – Preparing a European Photonics Vision towards 2030

Against the background of the preparation of the 9th Framework programme for European Research & Innovation by the European decision-making bodies, the Photonics PPP has engaged in a discussion on the strategic and operational needs to get prepared for the upcoming socio-economic needs to meet the challenges and support a sustainable growth of the European society, economy and the creation of jobs and wealth.

The development of a Vision towards 2030 for European Photonics started in early 2017 and was achieved in a three-stage process coordinated by VDI TZ and involving the Executive Board of Photonics21, the Photonics21 Work Groups, as well as the Photonics21 BoS and external experts, reflecting thereby the governance structure of Photonics21. As the outcome of an extensive consultation process, the Photonics

Photonics21 Advocacy Paper
(Source: Photonics 21 / All photos from top left courtesy of: Chombosan, Romolo Tavani, Chombosan, Fotofabrika and Deagreez all from fotolia.com)

Vision Paper *"Europe's age of light! How photonics will power growth and innovation"*[16] was published in fall 2017. By coordinating the process, VDI TZ gave high importance to taking various perspectives into consideration regarding potential future application markets of photonics. The Vision Paper outlines 8 missions of the European photonics community to drive the future of Europe and serves as input to the preparation of the new EU framework programme. According to the Vision Paper, European leadership in photonics will deliver the following benefits in 2030:

- Instant diagnosis of major diseases;
- Quality food from farm to fork;
- Accident and congestion-free road transport;
- A truly circular economy;
- A million new jobs;
- 10% higher productivity;
- Zero downtime in a terabit economy;
- Photonics as a flagship science for innovation.

Improving access to venture capital for Photonics start-ups and SMEs in Europe

Responding to the needs of the European Photonics Industry, namely to have limited access to venture capital, the Photonics PPP supported the **European Photonics Venture Forum (EPVF)** – 2017 edition held in Dublin – seeking private equity for seed phase and entrepreneurs. Its purpose is to promote technology entrepreneurship and investment in the European photonics sector and to facilitate the investment in up to 30+ selected photonics start-ups and SMEs from Europe by regional and pan-European investors. It furthermore promotes investment and partnering activities in state-of-the-art photonics technologies and brings together 40 specialized investors or corporate partners to enhance investment interest and readiness amongst the SMEs and start-ups.

Photonics21 'Europe's age of light!' report cover
(Source: Photonics 21)

[16] European Technology Platform Photonics21 c/o VDI Technologiezentrum GmbH, Photonics21 Secretariat (2017): "*Europe's age of light! How photonics will power growth and innovation*", Photonics21 Vision Paper, Brussels / Düsseldorf / Berlin / Frankfurt am Main, 2017.

Joint funding between the PPP and member states and regions initiated: ERANET Cofund

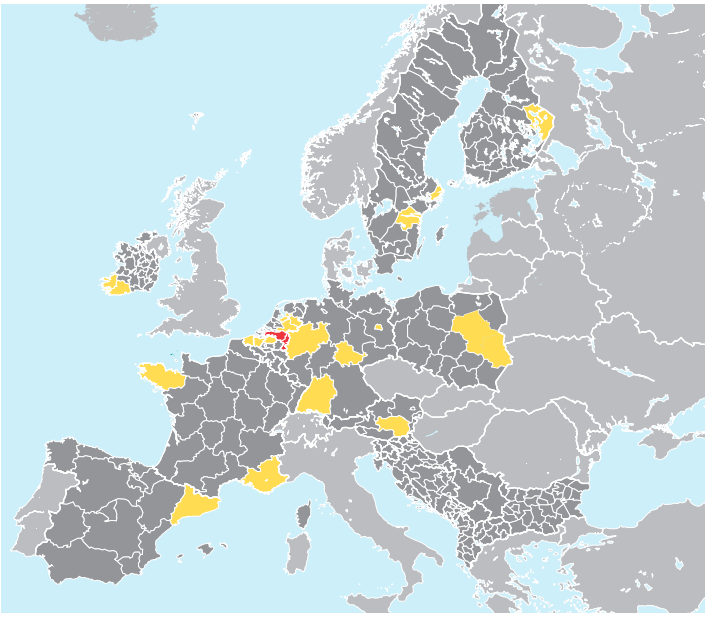
The Photonics PPP has established a network of 13 National Photonics Technology Platforms to establish contacts with policy decision makers to outline the national and regional potential for photonics and to make them engage in the ERANET cofund scheme. In 2017, 13 National networks were very active in involving member states in the Photonics PPP through their own National circle. One ERANET+ project: "Photonics sensing"[17] has been initiated with projects planned to be started in 2018.

Linking the Photonics PPP strategy with regional Smart Specialization Strategies (S^3)

In September 2017 a thematic area "Photonics" has been established under the Smart Specialisation Platform[18] of DG Regio by European Photonics Digital Innovation Hubs and clusters. Following the identification of regions with an investment priority in Photonics in the Smart Specialisation Programme, the objective of this year was to set the good conditions to build a European interregional Photonics Alliance in the framework of the smart specialization strategy of the European Commission. The regions of North-Brabant (South Netherlands) and Flanders (Belgium) were engaged to lead the newly created photonics initiative in the framework of the Smart Specialisation platform for industrial modernization and have gradually increased their implication during 2017. At the moment 16 regions are involved in this action initiated by the Photonics PPP.

Photonics PPP project impact and success stories reached out to nearly 15 million people

The communication campaign focused on promoting a selection of high-impact projects funded through the Photonics Public Private Partnership and resulted in 2017 in over 209 articles in newspapers, magazines, and websites in more than 15 countries, representing an advertising value in excess of around €500K. Highlights have included coverage in De Morgen, Fox News, Yahoo News, Digital Trends, News Medical, The Engineer, etc. With an estimated readership of over 14.9 million people so far, the PR campaign has helped applied photonics research groups and industry across Europe to promote the value and potential uses of photonics as well as raising awareness with the public. Furthermore, in 2017, seven so-called "success stories" of specific Photonics PPP projects have been identified according to their impact and newsworthiness and the project coordinators have been contacted, interviewed and a press release been prepared and distributed.



Leading regions:
South-Netherlands (NL)

Participating regions:
Baden Wurttenberg (DE)
Berlin (DE)
Bretagne (FR)
Catalonia (ES)
Cork South West region (IE)
East Netherlands (NL)
Flanders (BE)
Lubelskie (PL)
Mazowieckie (PL)
North Karelia (FI)
North Rhine-Westphaliaa (DE)
Östergötlands (SE)
Provence-Alpes-Côte d'Azur (FR)
Stockholm (SE)
Styria (SE)
Thuringia (DE)

Regions involved in the Photonics area under the Smart Specialisation Platform
(Source: EC-JRC, http://s3platform.jrc.ec.europa.eu/photonics)

[17] www.era-learn.eu/network-information/networks/photonicsensing, last accessed on 2018/09/06.

[18] http://s3platform.jrc.ec.europa.eu/photonics, last accessed on 2018/09/06.

Promoting Photonics to young minds via social media
In 2017, Photonics21 constantly communicated latest photonics news, impact stories and event via Twitter and LinkedIn and issued about 1000 tweets in 2017. Photonics21 tweets successfully address younger minds, 65% of Photonics21 Twitter followers are between 18–34 years old. Furthermore, in order to further increase the level of engagement of photonics experts and inform about Photonics PPP activities and projects, the Photonics21/PPP LinkedIn account created in 2016 got further updated during 2017. The number of follower has constantly been increased on both channels. By the end of 2017 Photonics21 had 2492 followers on its Twitter account and the LinkedIn account had 161 Follower.

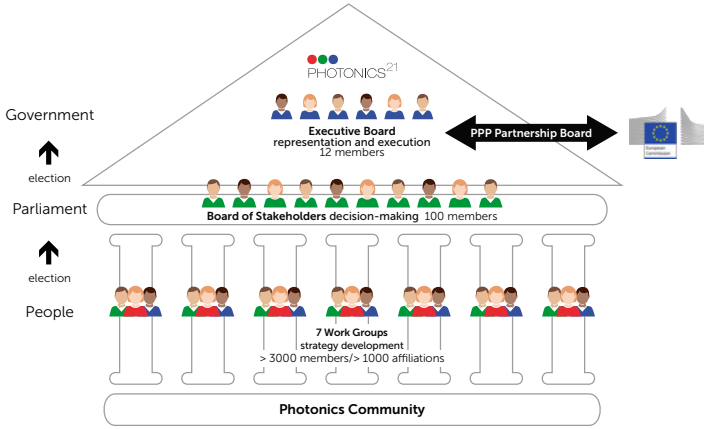
Relaunched Photonics21 website gives information about Photonics PPP projects and activities and serves as the central communication platform for the Horizon 2020 Photonics PPP
In the course of 2017, the Photonics21 website, (www.photonics21.org), was constantly updated and provided latest information on photonics news, events as well as photonics reports and presentations for download. The new website, relaunched at the end of 2017, underlines and supports a platform-oriented approach and provides a wealth of information in a very user-friendly manner. In addition to the website, regular newsletters have been circulated to the Photonics21 community to inform about the strategy consultation process, and Photonics PPP projects (www.photonics21.org/ppp-projects) and activities in members states and regions.

2.3 Governance

Establishing a SME based Photonics community with more than 3000 members to develop and implement a joint European Photonics strategy – open, lean and transparent governance
The Photonics PPP is a contractual relationship between the European Commission as the public partner and the Photonics21 Association as the private partner. The ***Photonics21 Association***, created in November 2003, acts as a "mouthpiece" of the European Technology Platform Photonics21 (and its more than 3000 members; 1700 companies and research organisations) towards the European Commission in the Photonics Public Private Partnership. The EC and the Photonics21 Association meet at least twice a year in the ***Partnership Board (PB)*** and discuss a joint strategy and develop the work programmes for Horizon 2020 based on input from Photonics21. The members of the Partnership Board are on the one side, the representatives of the European Commission, and on the other side, the ***Executive Board members of Photonics21*** as representatives of the Association. The Photonics Partnership Board is responsible for the implementation of the PPP strategy.[19]

What's unique is the fact that strategy development under the frame of Photonics21 relies on a fully democratic structure and transparent decision-making process following a people – parliament – government principle: Photonics21 Membership is free to all involved in European photonics and each Photonics21 member is assigned to at least one Photonics21 Work Group (***people***). ***Photonics21 members*** elect the decision-making body of Photonics21, the ***Board of Stakeholders (BoS)*** (***parliament***), consisting – according to the Photonics21 Terms of Reference – of at least 50% industry representatives to guarantee industry leadership in the process. The **Executive Board (EB)** coordinates the input of the Photonics21 work groups and executes the decisions of the Board of Stakeholders (***government***). All positions in the Executive Board, as well as most other positions in the Board of Stakeholders and the Work Groups, are occupied by C-level executives – underlining the Photonics21's prestige in Europe.

[19] cPPP PMR 2016.

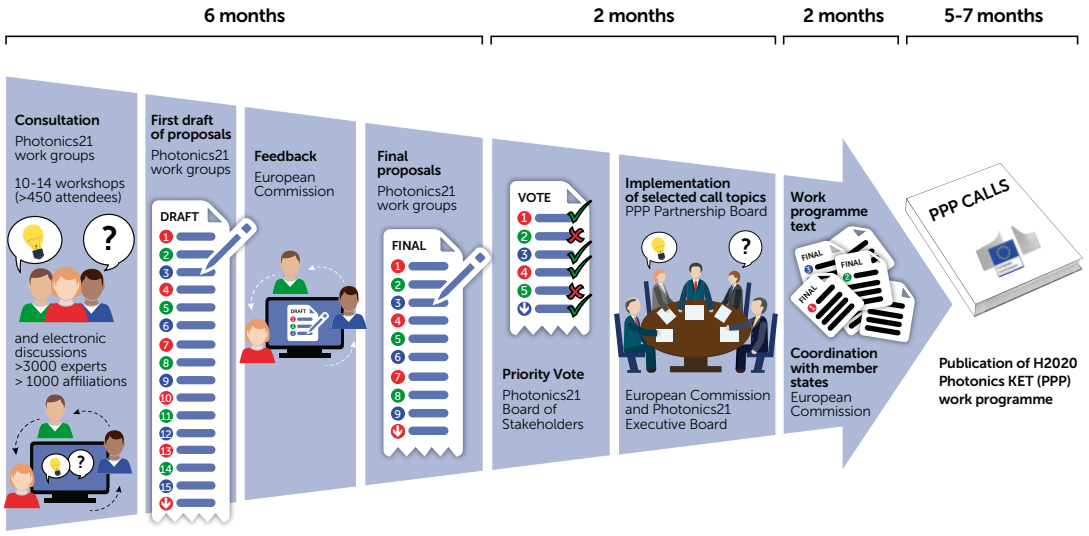


Governance structure of Photonics21 and decision-making process of the Photonics PPP.
The Photonics21 community drives the Photonics PPP. (Source: VDI TZ GmbH)

In 2017 two Photonics PPP Partnership Board (PB) meetings were held, both in Brussels. The first one took place on 28th March 2017 and the second one was held on 29th November 2017.

The first PB meeting focused on the presentation of the PPP Impact Report 2017[20], the discussion of strategic PPP Actions (financing photonics beyond Horizon 2020; Digital Innovation Hubs as well as the coordination of PPP Pilot Lines Activities). Research and Innovation Priorities of the Horizon 2020 Work Programme 2018–2020 were approved. Furthermore, the approach for the next strategy process and the development of a Vision for Photonics in 2030 was discussed.

The second PB meeting focused on the potential role of the photonics PPP in the next framework programme as well as on the planning for the Photonics21 Strategic Research and Innovation Agenda. In particular, a state-of-the-art of the discussions of the European High Level Group on Key Enabling Technologies was discussed. Furthermore, the results of the study conducted by VDI TZ in Fall 2017 on the role and contribution of Photonics in past and current Horizon 2020 projects (beyond Photonics PPP)[21] were presented and discussed (cf. § 3.1).



Open and transparent decision making process in the Photonics PPP.
Source: VDI TZ GmbH)

[20] European Technology Platform Photonics21 c/o VDI Technologiezentrum GmbH, Photonics21 Secretariat (2017): Jobs and Growth in Europe – Realizing the potential of Photonics, PPP Impact Report 2017, Düsseldorf.

[21] European Technology Platform Photonics21 c/o VDI Technologiezentrum GmbH, Photonics21 Secretariat (2018): Photonics – a critical Key Enabling Technology for Europe – Role and Impact of Photonics in H2020, Düsseldorf, September 2018.

3. Monitoring of the overall progress since the launch of the cPPP

3.1 Achievement of the goals of the cPPP

The general objectives of the Photonics cPPP are ***(1)*** to **foster photonics manufacturing, job and wealth creation** in Europe through a long-term investment commitment by both industry and the European Commission; ***(2)*** to **accelerate Europe's innovation process** and time to market by addressing the full innovation and value chain in a number of market sectors where European Photonics Industry is particularly strong; as well as ***(3)*** to mobilise, pool and leverage public and private resources to **provide successful solutions for some of the major societal challenges facing Europe**, in particular in healthcare & well-being, and energy efficiency.

On the basis of a multi-annual roadmap, the cPPP Parties intend to develop, implement and support a multi-annual research and innovation agenda with concrete specific objectives for ***a) Improved Competitiveness*** (e.g. increase the photonics production volume or consolidate and increase the European share of the world market), ***b) Strengthened Innovation*** (e.g. accelerating the time-to-market in the photonics sector and overcoming the "valley of death"), as well as for ***c) Socio-Economic Benefits*** (e.g. increase the number of high-skilled jobs in the photonics sector or increasing education and training opportunities).

Looking back at 4 years of activities in the scope of the PPP, it can be stated that most objectives have been achieved and two studies published in 2017, namely the "*Market Research Study Photonics 2017*"[22] as well as the "*PPP Impact Report 2017*"[23] underline that the efforts made to increase the production capacity and to strengthen the competitive capabilities of Europe's photonics industry have paid off (***Objective a***):

European Photonics Industry has experienced a 62% growth in the last 10 years

The European Photonics Production accounted for €66.7bn in 2015 – compared to €41.1bn in 2005. This represents an overall growth of about 62% over this period and an average CAGR of 5%. However, the growth rate had not been constant over that time, decreasing from 5.7% from 2005–2011 to 3.9% from 2011 to 2015. The slowdown of the growth rate of the Photonics industry in the period 2011–2015 is primarily due to currency effects and the devaluation of the Euro vs the US dollar, as well as to increasing competition from China in the global Photonics production and an overall less favourable economic conjuncture in Europe in the period 2011–2015.[24]

European Photonics Production Growth rate more than 3.5 higher than EU GDP Growth rate

The European Photonics Production grew much stronger than industrial production in Europe in general, which nearly stagnated in the EU28 in the period 2011–2015 with a CAGR of only 0.1%. The growth rate of the European Photonics Industry has been also higher than the growth rates of EU GDP (3.7 times multiple growth rate) or global GDP (1.5 times multiple growth rate) in that period. Looking into the long-term performance from 2005–2015 the EU Photonics industry was able to demonstrate about twice of the average long-term global GDP growth of 2.8%.

The regional specialization in the various photonics segments remained intact and became even more pronounced in the last years. The segments Production Technology, Measurement & Machine Vision, Medical Technology & Life Science as well as Lighting make up for the largest portion of the European photonic market.[25]

[22] European Technology Platform Photonics21 c/o VDI Technologiezentrum GmbH, Photonics21 Secretariat (2017): Market Research Study, Photonics 2017, Brüssel / Düsseldorf / Tägerwilen, May 2017.

[23] Ibid.

[24] Ibid.

[25] Ibid.

Ensuring high long-term growth in European core photonics segments

Since 2011 the European Photonics Industry has shown a solid long-term growth – most of the European photonics segments displaying a growth rate far above the average World GDP growth rate or the average EU GDP & Industrial Production Index growth rate. The European Photonics Industry grew especially strong in its already large segments like Machine vision / measurement & image processing (CAGR +5.6%), medical technology (CAGR +5.3%) and production technology (CAGR +4.7%). Today, the European Photonics Industry holds high global market share in Photonics for the Production Technology (50%), Optical Measurement & Image Processing (35%), Optical Components and Systems (32%), Photonics based Medical Technology and Life Sciences (28%), as well as in Defence and Security Photonics (26%) and Lighting (25%).

Compared to 2011 – and despite of increasing global competition as well as the devaluation of the Euro over the last years – the European Photonics core segments remained strong and could defend a leading world position up to 50% – far beyond the average EU industry share of 15.5%.[26]

Furthermore, in the frame of the Photonics cPPP, a wide range of actions have been taken to strengthen the innovation capacity of the European Photonics Industry (***Objective b***):

Photonics PPP – Boosting industry's digital innovation capacities

The Photonics PPP is supporting a number of flagship initiatives which are designed to giving any industry, wherever in Europe, easy access to the latest state-of-the-art photonics expertise, development and pilot manufacturing capabilities. These activities include a number of SME innovation accelerators (ActPhast 4.0, LaShare, Apollo) and four Manufacturing Pilot Lines (Pix4Life, MirPhab, Pi-Scale and PIXAPP) and all of these target in particular the use of photonics to increase Europe's competitiveness in other industrial sectors, such as health care, safety and security, lighting.[27]

Bridging the gap between lab and fab.
(Source: VDI TZ GmbH)

The European Commission's Innovation Radar lists while searching "Photonics"[28] 43 innovations labeled as "great" and developed from 57 Innovator Organizations, which they classify along the categories "Excellence Science", "Deep Tech", "Enabling Technologies and Components", "Industrial Technologies" and "Secure Networks".

"The European Photonics core segments remained strong and could defend a leading world position up to 50% – far beyond the average EU industry share of 15.5%".[26]

[26] European Technology Platform Photonics21 c/o VDI Technologiezentrum GmbH, Photonics21 Secretariat (2017): Market Research Study, Photonics 2017, Brüssel / Düsseldorf / Tägerwilen, May 2017.

[27] Photonics cPPP Progress Monitoring Report 2016.

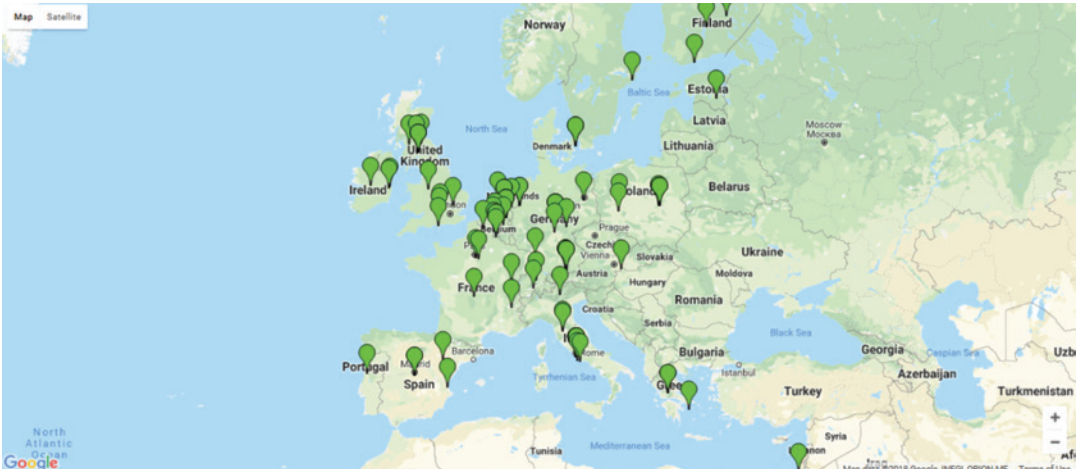
[28] See: European Commission – Horizon 2020 – Innovation Radar under www.innoradar.eu/.

Accelerating the time from Lab to Fab: PPP Prototyping and pilot production services for European SMEs

Statistics collected by the Photonics PPP project ACTPHAST 4.0 and its predecessor ACTPHAST to measure its impact on European innovation are quite impressive: ACTPHAST 4.0 is currently supporting companies (over 90% are SMEs of different sizes) with photonics innovation across 18 different European member states and succeeds in reaching companies that had not been supported under the frame of /previous EU innovation funding mechanisms. 53% of companies have no previous experience in EU-funded innovation projects.

ACTPHAST reaches companies beyond the Photonics sector: nearly half of the companies supported are "non-photonic companies" of various sectors (e.g. healthcare, transport, consumer goods, industrial manufacturing, etc.). With the support of ACTPHAST, more than 30% of the companies supported are able to conduct an innovation process in photonics for the first time. The following figure makes the potential socio-economic impact of support mechanisms as provided by ACTPHAST tangible: over the next five years, over 700 new EU jobs are expected to be created by companies that are benefitting from support by ACTPHAST as a direct consequence of their ACTPHAST innovation projects.[29]

In addition, the PPP supports a significant effort to strengthen Europe's position in laser-based manufacturing, an area where Europe currently leads the global market. There is also support for other activities addressing access to financing and other business services for SMEs as well as entrepreneurial outreach.[30]



ACTPHAST 4.0 is currently supporting SMEs with photonics innovation across 18 different European member states.
(Source: ACTPHAST, www.actphast.eu/supported-companies, last accessed on 2018/09/06)

End user industry involvement in PPP projects ensures quick market uptake of innovation[31]

One of the strengths of the European Photonics Industry lies in having global market leaders in several core industrial segments as well as in already established links with application industries – this was one of the findings of the SWOT-analysis of the European Photonics Industry, as conducted by the EC a few years ago.

The Photonics PPP aimed to build on this strength and promote the involvement of end-user industries in the PPP projects. A number of PPP projects either directly involve end-user industry such as Health Tech companies (see e.g. the projects DiCoMo[32], CardiS[33], INNODERM[34]) or are directly driven by end-users requirements in the various potential sectors of application.

[29] www.actphast.eu/support-statistics, last accessed on 2018/09/06.

[30] Photonics cPPP Progress Monitoring Report 2016.

[31] European Technology Platform Photonics21 c/o VDI Technologiezentrum GmbH, Photonics21 Secretariat (2017): Jobs and Growth in Europe – Realizing the potential of Photonics, PPP Impact Report 2017, Düsseldorf.

[32] http://dicomo-project.eu/, last accessed on 2018/09/06.

[33] www.cardis-h2020.eu/, last accessed on 2018/09/06.

[34] innoderm2020.eu/, last accessed on 2018/09/06.

For example, in the manufacturing sector, the project ultraSURFACE[35] aims at developing sophisticated optical components for more efficient laser structuring, laser polishing or laser thin-film processing applications. The project HIPERDIAS[36] is driven by end-user requirements and aims at demonstrating highthroughput laser-based manufacturing – for a wide range of applications but focussing on 3D structuring of silicon at high speed, precision processing of diamond material and fine cutting of metal for the watch and the medical industry. Another example of the involvement of end-user industry is the project SEERS[37] aiming at developing a modular, compact and cost-effective snapshot spectral imaging system to be demonstrated in coastal and road tunnel surveillance and involving AIRBUS Defence & Space.

These projects are only a small number of examples for end-user involvement in the PPP Projects. They all promise a quicker implementation of new photonics innovations into marketable products and promise to overcome one of the former weaknesses of the European Photonics Industry, (as identified by the EC a few years ago), the time-to-market of innovations being considered too long.[38]

Leaving the technology silos – engaging with end user industry in regions to foster photonics take up

By the end of 2017 in total 21 end user industry workshops have been conducted These workshops established links and synergies between photonics SMEs as technology providers and end user industries in the regions, to set up new collaborations and to foster photonics innovation closer to the market. Each regional end-user workshop was devoted to the specific industrial strength of the region.

Looking at ***Objective c***, several figures underline the success of the Photonics cPPP:

Overview of PPP end user workshops with industry

Extract – PPP end user workshops with industry	Location
Photonics for Industry 4.0	Milano
Photonics for smart road transportation	Athens
Photonics 4 Digitalisation of Industrial Manufacturing	Athens
Photonics 4 Agriculture	Warzaw
Photonics 4 Automotive	Barcelona
Photonics 4 Blue Growth	Santiago de Compostela
Photonics 4 Aeronautics	Madrid
Photonics 4 Healthcare	Birmingham
Photonics 4 Sorting	Graz
Photonics 4 Additive Manufactured Products	Graz
Photonics 4 Luxury Coatings	Geneve

Source: Photonics21

Creation of 19,000 new jobs in the period 2011–2015 and 42,000 potential new jobs in 2020 compared to 2011[39] [40]

By the end of 2015, the EU Photonics industry employed 290,000 people – compared to 271,000 employees in the sector in 2011. This represents a CAGR of +1.7%. The growth rate has been slower in the last years than in the years 2005–2011 due to the economic crisis in Europe– however, on a ten-year comparison, the number of employees in the European Photonics Industry has increased from 235,000 in 2005 to 290,000 in 2015. This means that, with regard to the number of people employed in this sector, the European Photonics Industry has shown an impressive overall growth of + 23% since 2005 and a solid long-term CAGR of 2.1%.

[35] www.ultrasurface.eu/, last accessed on 2018/09/06.

[36] www.hiperdias.eu/, last accessed on 2018/09/06.

[37] www.seersproject.eu/, last accessed on 2018/09/06.

[38] For more information, see the analysis conducted by the EC in the frame of the Key Enabling Technologies (KET) initiative of Strengths, Weaknesses, Opportunities and Threats of the European Photonics: https://ec.europa.eu/growth/industry/key-enabling-technologies/challenges_en, last accessed on 2017/03/16.

[39] European Technology Platform Photonics21 c/o VDI Technologiezentrum GmbH, Photonics21 Secretariat (2017): Jobs and Growth in Europe – Realizing the potential of Photonics, PPP Impact Report 2017, Düsseldorf.

[40] Remarks concerning the evaluation of the KPIs New Skills and/or job profiles and impact on cPPP on SMEs as made in the final PMR review reports could only be partly taken into consideration for this year's report, since the online survey among the cPPP Project coordinators had been completed before. All remarks will be addressed in-depth in the preparation of the cPPP PMR 2019.

Estimating that the employment growth rate of 2011–2015 in the photonics segments will continue, it can be expected that by the end of Horizon 2020 the European Photonics Industry will employ 313,000 people. This represents an increase of 42,000 positions versus the 2011 employment level and an estimated long-term growth rate of 1.6% for the period 2011–2020.

Developing skills for tomorrow's European Photonics industry[41] [42]

As mentioned above, the European Photonics Industry grows rapidly and much faster than GDP. To support this growth in the long term this requires making sure that a growing highly-skilled photonics workforce is available in Europe – at all levels of technology development, from basic R&D to pilot projects prior to market introduction, and all levels of production chain and hierarchy, from management to manufacturing floor. The issue of skills creation and lifelong learning is particularly important against the background of demographic trends in Europe and of the related shortage of competent workforce, as well as of sharp global competition in this promising field. For companies of the photonics industry to be able to maintain their market share on the long run or to tap into new markets, it appears therefore crucial to invest in and promote skills creation and lifelong-learning in Photonics. In total more than 30 new curricula have been developed so far by the Photonics PPP projects.

PPP activities targeting minds at all ages[43]

It is a remarkable achievement that many different PPP projects, relying on highly innovative concepts, have been initiated under the frame of the Photonics PPP with the aim at promoting skills creation for young people (at school or / and university) and for entrepreneurs and employees, as well as raising awareness for the potentials of the photonics technologies among the general public. The concepts developed in the PPP projects related to research, education and training are very diverse and targeted at different categories of people, namely: – Activities targeted at children and teachers (e.g. toolkits for schools, such as the Photonics Explorer[44] developed in the project Light2015, so-called children's universities[45] as developed e.g. by Photonics4All and photonics games for pupils in schools as developed by Photonics4All[46]); – Activities targeted at universities like the Light2015 Awards[47] aiming at honouring young photonics experts; – Activities targeted at companies and employees covering information events "highlighting photonics as driver of entrepreneurship and industry"[48] (cf. LIGHTtalks[49] of the project Light2015); – Activities and concepts targeted at a more general public, such as the app developed by Photonics4All[50] to encourage all interested people to learn more about light and the potential applications of Photonics, the science slams organized by Photonics4All[51] and the iSPEX-EU[52] campaign, being the 1st photonics experiment involving the general public and using smartphones to measure air pollution.

[41] Ibid.

[42] Remarks concerning the evaluation of the KPIs New Skills and/or job profiles and impact on cPPP on SMEs as made in the final PMR review reports could only be partly taken into consideration for this year's report, since the online survey among the cPPP Project coordinators had been completed before. All remarks will be addressed in-depth in the preparation of the cPPP PMR 2019.

[43] European Technology Platform Photonics21 c/o VDI Technologiezentrum GmbH, Photonics21 Secretariat (2017): Jobs and Growth in Europe – Realizing the potential of Photonics, PPP Impact Report 2017, Düsseldorf.

[44] www.europe.light2015.org/Home/Activities/The-Photonics-Explorer.html, last accessed on 2018/09/06.

[45] http://photonics4all.eu/young-people/children-university, last accessed on 2018/09/06.

[46] http://photonics4all.eu/young-people/photonics-game, last accessed on 2018/09/06.

[47] www.europe.light2015.org/Home/Activities/LIGHT2015-Awards.html, last accessed on 2018/09/06.

[48] www.europe.light2015.org/Home/Activities/LIGHTtalks.html, last accessed on 2018/09/06.

[49] www.europe.light2015.org/Home/Activities/LIGHTtalks.html, last accessed on 2018/09/06.

[50] http://photonics4all.eu/young-people/photonics-app/, last accessed on 2018/09/06.

[51] http://photonics4all.eu/general-public/science-slam/, last accessed on 2018/09/06.

[52] www.europe.light2015.org/Home/Activities/iSPEX-EU/Overview.html, last accessed on 2018/09/06.

Highlighting the key role of Photonics in coping with major current and future socio-economic challenges

A study on the role and contribution of Photonics in past and current Horizon 2020 projects[53] has been initiated by VDI TZ in its function as Photonics21 Secretariat at the beginning of September 2017. The study aimed at examining whether, in Horizon 2020 (and not only in Horizon 2020 Photonics PPP Projects), Photonics plays indeed the role of an enabling technology for new and innovative products, services and developments in areas far beyond obvious lighting application fields. The study was performed from September to December 2017 and highlighted that Photonics related projects can be found in almost all Horizon 2020 programmes. From the 13643 projects examined in the Cordis database as of May 2017 they identified 1145 projects related to photonics[54]. Moreover, it was demonstrated that Photonics related projects cover all application markets of high relevance for tomorrow's society and economy from personalized healthcare, industry 4.0, smart cities to securing the digital society, connected mobility – to name but a few. Furthermore, the study highlights that European photonics companies are highly committed to research and innovation and the private sector's involvement in Horizon 2020 in the photonics segment is better-than-average. Photonic Small and medium size enterprises (SMEs) have succeeded better than average in submitting SME Instrument (SME-INT) projects.

In addition to the 3 objectives a, b and c, the Photonics cPPP aimed at **leveraging Research & Development in Photonics:** The Photonics PPP represents a long-term commitment between the European Commission and the Photonics Stakeholders to invest in Europe with the aim of securing Europe's industrial leadership and economic growth in photonics, a highly skilled workforce, and the capability to generate new jobs that attract young people. Never before have the European Industry and European Policy worked so closely together in such an important technology domain. Acknowledging the importance of this Public-Private Partnership for fostering Photonics in Europe, the European Photonics Industry committed itself to increase significantly the level of private funding allocated to R&D in Photonics and, in particular, to match every Euro spent by the European Commission in the PPP with four Euro spent by Industry. The European Photonics Industry also engaged to support SMEs and young workers through the creation of new jobs and skills.[55] One of the aims of the Photonics PPP was to increase R&D spending in Photonics. In fact, the measures taken have been efficient and lead to increased investments in Photonics R&D in Europe:

Nearly 10 billion Euro industry investments on Photonics Innovation in Europe in 2015[56]

In total the European Photonics Industry showed Innovation Spending (R&D spending and Capex) in Europe in 2015 in the size of €9.6bn – about €6.4bn for R&D spending and €3.1bn for Investment (Capex).[57]

"The European Photonics Industry is devoting much more funding to R&D than many other industry sectors do."

[53] European Technology Platform Photonics21 c/o VDI Technologiezentrum GmbH, Photonics21 Secretariat (2018): Photonics – a critical Key Enabling Technology for Europe – Role and impact of Photonics in H2020, Düsseldorf / Paris. For more details on the results of the study, see Annex Part 6.

[54] Ibid.: Intro: "891 "photonic based projects" were identified. Furthermore, 122 "photonic enabler development projects", i.e. projects developing technologies that will be critical for the implementation of a Photonic technology, as well as 132 projects for which "Photonics [is] a critical enabler" The share of "Photonics related projects" in Horizon 2020 is therefore about 8,4%."

[55] European Technology Platform Photonics21 c/o VDI Technologiezentrum GmbH, Photonics21 Secretariat (2017): Jobs and Growth in Europe – Realizing the potential of Photonics, PPP Impact Report 2017, Düsseldorf.

[56] Ibid.

[57] European Technology Platform Photonics21 c/o VDI Technologiezentrum GmbH, Photonics21 Secretariat (2017): Market Research Study, Photonics 2017, Brüssel / Düsseldorf / Tägerwilen, May 2017.

R&D intensity in the Photonics industry amounts to nearly 10%[58]
On average, in 2015 European Photonics companies spent 9.7% of their revenues for R&D. In addition, they invested in average 4.7% of their revenues (Capex / sales) bringing the total R&D and investment quota to 13.8%.[59]

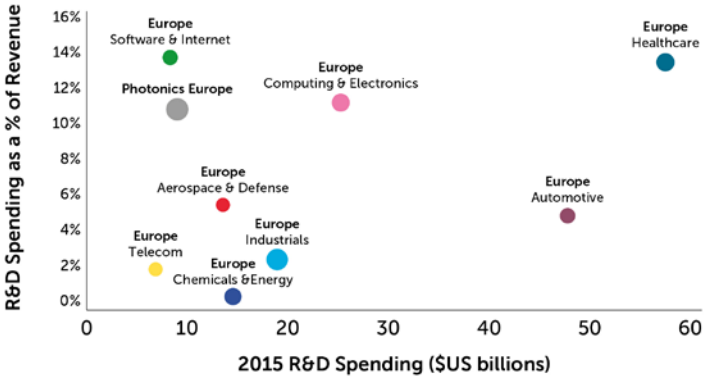
Of course, the R&D intensity does vary, depending on the Photonics segment as well as on single companies. For instance, R&D intensity at ASML, the largest Photonics producing company in Europe, is very high, amounting to 17.7%. The R&D intensity is comparably high in the communication segment (e.g. 17.7% for Adva Optical and 16.6% for Alcatel Lucent). The situation is similar when considering the Capex / sales ratio, which is particularly high for companies "operating in product segments requiring costly manufacturing equipment and facilities".[60]

In fact, the R&D intensity of companies of the Photonics segment may vary from 3% to 18% and the Capex / sales ratio ranges from 2% to 11%.

R&D intensity in the Photonics industry much higher than in most other industry sectors[61]
The European Photonics Industry is devoting much more funding to R&D than many other industry sectors do: the figure of 9.7% of its revenues spent by the European Photonics Industry for R&D has to be compared to the average industrial R&D intensity in Europe of about 3.2%.[62] When differentiating by industry sectors, it appears – according to a PwC Study – that the R&D intensity in the European Photonics Industry is much higher than in most other industry sectors – even beyond the Aerospace & Defence sector, the automotive sector, the Industrials sector, and the Chemicals & Energy sector.[63]

Eurpoean Photonics Industry

Photonics Industry well positioned in terms of R&D spending an percentage of revenue about Industrials, Chemicals & Telecom



R&D Spending in the Photonics Industry compared to other sectors
(Source: Key Data Photonics Research Study 2017, www.photonics21.org/ppp-services/photonics-downloads.php)

Also the OECD "BERD" analytics confirm the above average rate of most of the main photonics industries as being shown in the below interactive graphics for selected photonics areas compared with the entire industry.[64]

[64] See OECD "BERD" Analytics, drawn on 16.07.2018 at: www.oecd.org/innovation/inno/anberdanalyticalbusinessenterpriseresearchanddevelopmentdatabase.htm

[58] European Technology Platform Photonics21 c/o VDI Technologiezentrum GmbH, Photonics21 Secretariat (2017): Jobs and Growth in Europe – Realizing the potential of Photonics, PPP Impact Report 2017, Düsseldorf.

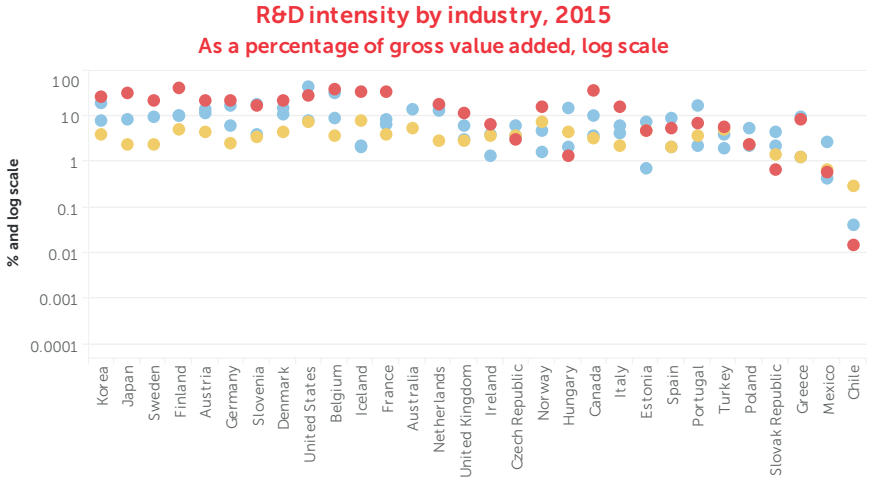
[59] European Technology Platform Photonics21 c/o VDI Technologiezentrum GmbH, Photonics21 Secretariat (2017): Market Research Study, Photonics 2017, Brüssel / Düsseldorf / Tägerwilen, May 2017.

[60] Ibid.

[61] European Technology Platform Photonics21 c/o VDI Technologiezentrum GmbH, Photonics21 Secretariat (2017): Jobs and Growth in Europe – Realizing the potential of Photonics, PPP Impact Report 2017, Düsseldorf.

[62] Cf. The 2016 EU Industrial R&D Investment Scoreboard.

[63] Cf. PwC, The 2016 Global Innovation 1000 Study: Comparison of R&D Spending by Regions and Industries, PriceWaterhouse & Coopers. www.strategyand.pwc.com/innovation1000#VisualTabs3, last accessed on 2017/02/22.

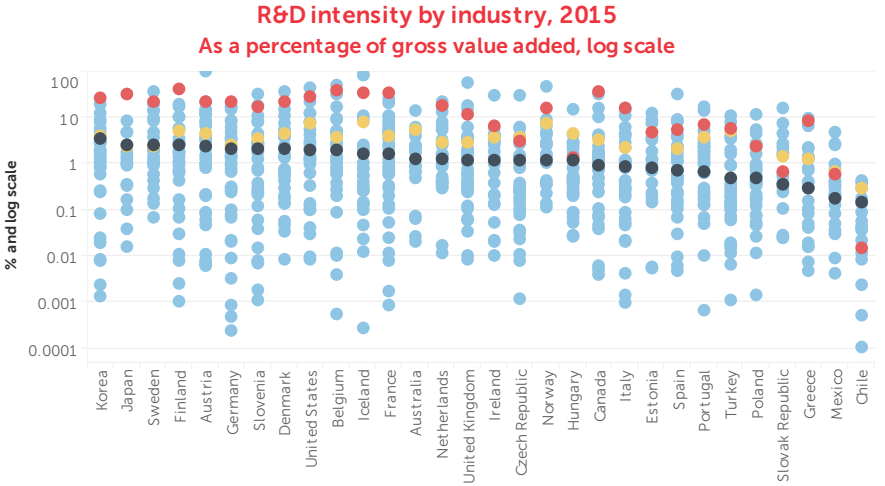


Source: OECD (2017), *OECD Science, Technology and Industry Scoreboard 2017: The digital transformation*, OECD Publishing, Paris. Data and notes: http://dx.doi.org/10.1787/888933619163

Countries All **Industries** Multiple values

Industries
- 26 - Computer, electr..
- 58T63 - Information a..
- 21 - Pharmaceuticals, ..
- 28 - Machinery and eq..

International comparison of R&D intensity by industry – Focus on Computer, electronic and optical products (Cat. 26), Information and Communication (Cat. 58T63), Pharmaceuticals, medicinal chemical and botanic products (Cat. 21) and Machinery and Equipment (Cat. 28).
(Source: OECD 2017, OECD's Analytical Business Enterprise Research and Development (ANBERD) database:www.oecd.org/innovation/inno/anberdanalyticalbusinessenterpriseresearchanddevelopmentdatabase.htm)



Source: OECD (2017), *OECD Science, Technology and Industry Scoreboard 2017: The digital transformation*, OECD Publishing, Paris. Data and notes: http://dx.doi.org/10.1787/888933619163

Countries All **Industries** All

Industries
- TOTAL - TOTAL BUSIN..
- 26 - Computer, electr..
- 58T63 - Information a..
- 01T03 - AGRICULTUR..
- 05T09 - MINING AND ..
- 10T12 - FOOD PRODU..
- 13T15 - TEXTILES, WE..
- 16 - Wood and of prod..
- 17 - Paper and paper ..
- 18 - Printing and repr..
- 19 - Coke and refined ..
- 20 - Chemicals and ch..
- 21 - Pharmaceuticals, ..
- 22 - Rubber and plasti..
- 23 - Other non-metalli..
- 24 - Basic metals
- 25 - Fabricated metal ..
- 27 - Electrical equipm..
- 28 - Machinery and eq..
- 29 - Motor vehicles, tr..
- 30 - Other transport e..
- 31T33 - FURNITURE, ..
- 35T39 - ELECTRICITY, ..
- 41T43 - CONSTRUCTI..

International comparison of R&D intensity by industry – All industries considered.
(Source: OECD 2017, OECD's Analytical Business Enterprise Research and Development (ANBERD) database: www.oecd.org/innovation/inno/anberdanalyticalbusinessenterpriseresearchanddevelopmentdatabase.htm, last accessed on 2018/09/06)

Photonics PPP well on track in leveraging public investment by a factor of 4

A major aim of the Photonics PPP is to trigger common investments of industry and the public side in a jointly agreed Strategic Research and Innovation Agenda. In this respect the private side committed to leverage the investment of the European Commission by a factor of 4 by 2022 (Horizon 2020 +2 years).

Already at this stage where most of the Photonics PPP projects are still in its early stage and first commercialisation and manufacturing of the R&I project results has not even been started, most PPP projects report already of a leverage factor of 1–3, some even 4–5 (cf. §3.2). Since the commercialisation and manufacturing requests significant investment – often 10x or more than in the R&D phase – it can be safely assumed that the committed leverage factor of 4 will be easily met by the photonics industry.

As mentioned earlier – looking in the overall European Photonics Industry the Capex and R&D spending amounts to more than 10 billion Euros (Capex: €9.6bn Euros + R&D spending of €3.1bn Euros) and indicates a far higher innovation spending than the EU funding for Photonics under Horizon 2020 which is in the range of €0.7–1.0bn Euros.

3.2 Progress achieved on KPIs

In order to calculate the common Key Performance Indicators (KPIs) as defined in the PPP contract and presented in Annex 1, an online survey was carried out in April 2018. An online questionnaire was addressed to 84 current PPP Projects: 18 Innovation action projects, 57 Research and Innovation action projects, 7 CSAs, 1 FP7 project (ACTPHAST) with relevant activities in Horizon 2020, 1 ERANET-Cofund. 22 of the projects started in 2017 or after.

Overall, 51 projects reacted to the questionnaire, leading to a good response rate of 60.7%.

Of the 50 answers collected (one project coordinator felt not able to answer the questionnaire, as his project has just been started), 15 projects started 2017/2018 and even 10 of them in late 2017 or after. It should be noticed that, for these last 15 projects, one cannot yet expect many results in terms of innovations, patents or exploitation of the project results. The answers with a higher significance are those of projects starting before 2017. Excluding CSAs, 32 projects started before 2017, i.e. 66.7% of the projects which filled in the questionnaire, leading to a quite good significance of the average answers.

Mostly RIA and IA projects participated in the survey (respectively 35 and 7 answers). 4 CSA answered. 2 answers came from the pilot lines and also 2 answers come from collaborative projects (PPP Prototyping services). We present an overview of the results of the survey in the table below; more details can be found in the Annex Part 1 and in the Annex Part 3.

Overview of the Monitoring of the Common KPIs as a Result of an Online Survey[65]

Number of **new systems or technologies**	1–3 projects (excluding ACTPHAST and PILOT LINES).
Number of **patent applications**:	5 projects (11.1%) applied for 1 patent, 2 projects (4.4%) for 2 patents and respectively 1 project (2.2% of all respondents) applied for 4 and 5 patents.
Number of projects active in	
Standardisation activities:	21 of the projects (46.7% of all valid answers) declare that there are standardization activities or contribution to new standards at project level.
Leverage factor project participants:[66]	31 projects (i.e. 68.9%) declare a 1–3 leverage factor, 3 projects a 4–5 leverage factor (6.7%), and 11 projects declare 0 leverage (24.4%).
SME turnover increase:	10 projects (22.2%) declare 6–10% turnover increase and even 13 projects (28.9%) declare a higher turnover increase. However, 13 projects (28.9%) declare no turnover increase.
Spin-offs / Start-ups arisen from the project:	1 project reported more than 1 spin-off or start-up, 1 reported from one spin-off, more than half of the projects – 24 of 45 expect spin-offs or start-ups later, 3 do not know, and 16 said "no".
New high-skilled jobs created:	Most projects (21, 46.7%) declare 1–5 new jobs, 6 projects declare 6–10 new jobs, 5 projects declare 11–20 new jobs and respectively 1 project declares 21–50 new jobs and more than 50 jobs.
Outreach:	Most projects (54.5%) have 1–5 outreach activities as well as 1–5 joint public publications issues in the scope of the project (29) or even more up to 6–10 (4).
Total number of new **curricula:**	More than 30.
Results for higher technology readiness level:	Most projects (19, i.e. 42.2%) declare that 1–3 **project results** will be taken up for higher technology readiness levels using additional investments. 13 projects (28.9%) declare 4–5 project results, 7 projects (15.6%) declare 6–10 results and even 2 projects (4.4%) declare more than 10 results.

Source: VDI TZ GmbH.

[65] For full survey report – go to Annex Part 5.

[66] For more leverage factors – the macroeconomic one on Capex and R&D Spending and the estimated leverage factor as impact on the other industries – see chapter "introduction".

Operational aspects of the PPP

Efficiency, openness and transparency of the PPP Consultation Process

The Photonics PPP is based on an open and transparent community involvement through Photonics21 addressing more than 3000 photonics end user industry experts.
The fully democratic and transparent decision-making process implemented to identify Photonics R&I priorities (Horizon 2020 Photonics PPP calls) guarantees that implementation does not only take place at European Commission programme level, but also on the ground at company and research organisation level by the people involved in the process.

Efficiency of the implementation of the call for proposals ICT-30-2017: The following table displays the evaluation results of the proposals submitted to the cPPP call closed in 2017.

Evaluation results on the cPPP calls closed in 2017

	Submitted proposal			Evaluation results		
Call Reference	Submitted proposals	Eligible proposals	% of retained	Above threshold	Selected for funding	Success rate%
ICT-30-2017	80	80	100%	50	17	21%

Source: European Commission, DG CONNECT.

Photonics PPP valued best in class by independent expert group of the European Commission as part of the Horizon 2020 mid-term evaluation.[67]

Overview of evaluation results of the Horizon 2020 PPP

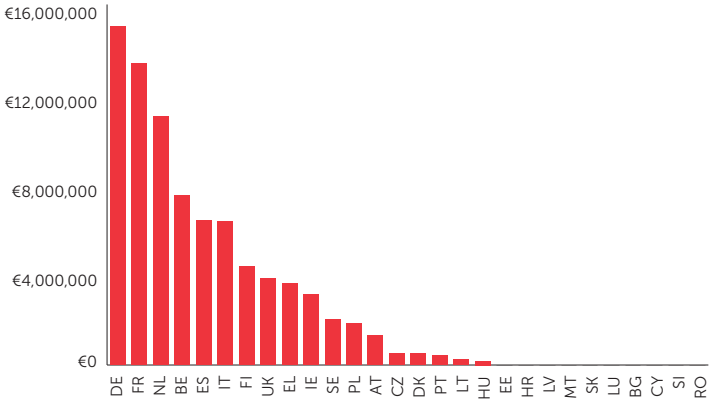
Evaluation dimension	SG	BigData	EeB	EGVI	FoF	HPC	Photonics	Robotics	SPIRE
Open discussion on roadmaps	WOT	WOT	WOT	NE	WOT	WOT	WOT	WOT	WOT
Challenging and updated roadmaps	WOT	WOT	STG	STG	WOT	NE	WOT	WOT	STG
High number of industry and RTO {representativeness)	WOT	WOT	WOT	STG	WOT	STG	WOT	WOT	WOT
Portal of project results	WOT	NE	WOT	STG	WOT	WOT	WOT	WOT	WOT
Dissemination activities	WOT	WOT	WOT	NE	WOT	WOT	WOT	WOT	WOT
KPI reporting	WOT	STG	WOT	STG	STG	STG	WOT	STG	WOT
Methodology to compute Leverage KPI	STG	STG	STG	STG	STG	STG	STG	STG	STG
Easy access to information and membership (newcomers)	WOT	WOT	WOT	WOT	WOT	WOT	WOT	WOT	WOT
Links to other cPPPs and EU Actions and Instruments	STG	WOT	WOT	WOT	WOT	WOT	WOT	WOT	STG
Inclusion of SMEs	STG	WOT	WOT	STG	WOT	STG	WOT	STG	WOT
Inclusion of EU13	STG	WOT	WOT	STG	WOT	WOT	WOT	STG	WOT

Evaluation levels: WOT = Well on Track STG = Shift the Gear NE = Not Evaluable

Source: European Commission, DG Research and Innovation, Mid-term review of the contractual Public Private Partnerships (cPPPs) under Horizon 2020.[68]

[67] https://publications.europa.eu/en/publication-detail/-/publication/6de81abe-a71c-11e7-837e-01aa75ed71a1/language-en, last accessed on 2018/09/06.

[68] Ibid.



EC funding per country in the cPPP call closed in 2017.
(Source: European Commission, DG CONNECT.)

3.3 Evolution over the years

Since the establishment of the PPP Photonics21 gained more than 1000 new members to even further implement the European Photonics strategy. The Photonics cPPP has become over the last years "a dynamic and effective partnership recognised as the best PPP in Horizon 2020 by the Commission's independent evaluators"[69], and socio-economic as well as innovation-related outcomes of the efforts undertaken have been highlighted in the PPP Impact Report as well as in the Market Study – both published in 2017. Moreover, the main impact of Photonics as a Key Enabling Technology is to help end-user industry to develop more competitive innovation. To this end requesting end-user industry involvement in PPP Projects (cf. §3.1) is a critical issue for successfully implementing the PPP strategy. Consequently, the PPP managed to significantly increase the industry participation in the programme to about 49% in average in the period 2014–2017 (cf. table below). This figure is much higher than the average percentage of 37% participation of the private sector in all Horizon 2020 photonics related projects.[70] Moreover, the average involvement of SMEs in the PPP Projects amounts to more than 54% in the period 2014–2017. These figures may underpin the success of the Photonics PPP for promoting Horizon 2020 and make it an effective tool for photonic companies which still are very dependent on their research effort. Over the years, several measures and instruments have been implemented to optimize the innovation environment in photonics, bridge the "valley of death" and ensure quick market uptake of photonics innovation. An active steering and coordination of the strategic CSA and pilot and prototyping projects ensure a coordinated set of services towards the respective target groups like SMEs, cluster or regional authorities (cf. §3.1). Likewise, promoting a network of Photonics Digital Innovation Hub under the "Industrial Modernisation Platform", allowing regions with Photonics prototyping and pilot production facilities (and Horizon 2020 Photonics PPP innovation pilot production and prototyping projects) to build up a network of end to end pilot production services to end user industry (cf. §3.1) is currently implemented by the PPP. Finally, as the first Photonics PPP projects are coming to the end and innovations are ready to be taken further to the market, the Photonics PPP Partnership Board is teaming up with the European Investment Bank (EIB) and the Venture Capital Stakeholders to ensure the further financing of these innovations. To this end, the Photonics PPP co-organizes the European Photonics Venture Forum bringing together photonics start-ups and potential investors. Moreover, a Financing Task Force of the PPP Partnership Board and the EIB has been established to analyse if suitable banking products are available for High Tech industries like photonics.

"The main impact of Photonics as a Key Enabling Technology is to help end-user industry to develop more competitive innovation."

[69] A. Kamper, President Photonics21 in the Foreword to the Vision Paper "*Europe's age of light! How photonics will power growth and innovation*" (2017) published by European Technology Platform Photonics21 c/o VDI Technologiezentrum GmbH, Photonics21 Secretariat.

[70] European Technology Platform Photonics21 c/o VDI Technologiezentrum GmbH, Photonics21 Secretariat (2018): Photonics – a critical Key Enabling Technology for Europe – Role and impact of Photonics in H2020, Düsseldorf / Paris. For more details on the results of the study, see Annex Part 6. For more details, see also Annex Part 6.

Monitoring of the overall progress since the launch of the cPPP

Overview of funding budget and participants of the cPPP projects over the period 2014–2017

Subject	2014	2015	2016	2017	2014–2017
Total Budget* allocated for Projects (in €)	87,861,568.12	95,306,838.23	94,800,954.01	96,387,748.75	374,357,109.11
Number of Participants in Projects	215	209	230	200	854
Industrial Participation (# of Companies)	111	106	118	84	419
% of total participants	51.6%	50.7%	51.3%	42.0%	49.1%
Of which are SMEs (# of SMEs)	62	58	67	41	228
SME % of industry participants	55.9%	54.7%	56.8%	48.8%	54.4%
SME % of total participants	28.8%	27.8%	29.1%	20.05%	26.7%
Budget for Industry (in €)	45,846,170.94	33,306,845.17	45,219,997.46	34,095,825.14	158,468,838.71
% of total funding	52.20%	34.90%	47.70%	35.19%	42.33%

**Total EC Funding (in €) was 330,000,000.*
Source: European Commission, DG CONNECT

4. Outlook and lessons learnt

The rise from a niche technology sector to one of the most important industries for the future of Europe is closely related to long term funding of the European Commission and a strong commitment of the European photonics Industry. All stakeholders of the European Photonics community have been working together for years to develop and continuously update the European R&D strategy in Photonics in open, transparent, democratic and participative decision-making processes and to promote the implementation of this strategy in the framework of Horizon 2020. The success achieved so far – as highlighted above – underlines that we have struck the right path.

However, given the huge challenges Europe will be facing in the near future, in particular regarding the digitization of industry and society, and moving "from the age of electronics to the age of photonics"[71] and given the very highly competitive Photonics global market, the coming years will be decisive for Europe successfully overcoming the challenges or falling back. Of course, the next European framework programme for research and innovation (Horizon Europe) will play an essential role in promoting Europe's strengths and accompanying the digital transformation.

The Photonics PPP is working well and is having an impact:

- The PPP, its Partnership Board and members make a real difference in implementing the strategic photonics roadmap in Europe and continuously further develop the strategy within the digitization efforts (Digi Hubs) and increase the collaboration with other thematic topics and cPPPs, national and regional activities and programs as well as amongst CSA projects related to photonics and the pilot programs.
- The Photonics PPP governance is lean and efficient and continues to have high level involvement from the Photonics industry.
- The priorities from the PPP derived from an open, transparent and broad community consultation process and have been translated into a solid and competitive Work Programme, with dedicated actions for SMEs including manufacturing pilot lines and Digital Innovation Hubs.
- The priority setting in the PPP also has a strong impact on aligning research roadmaps in European industry, the R&D community and national road-mapping activities.
- The Photonics industry is amongst the leading sectors in terms of Capex and R&D spending in Europe and demonstrates the potential of a high leverage factor for other industries and sectors.

Outlook and lessons learned:

- Photonics continues to be an area of European strategic strength and will play an essential and strategic role in the digital transformation of European industry.[72]
- Due to SME based community in Photonics, it is essential to have a simple and lean governance structure as currently provided with the cPPP instrument.
- Openness of the PPP and ease of SME involvement is key to successful operation.
- Experience shows that it was difficult to establish joint funding activities with other fields like the societal challenges part of Horizon 2020. To carry out joint funding activities with these areas more easily, as the Photonics PPP did with Factories of the Future, would be valuable and is currently being discussed with the other cPPPs looking ahead at the next framework programme.
- The current ERANET Co-fund instrument requires heavy administration from the participating public parties from member states and regions. It would be valuable to come up with a simpler and easier to implement instrument to pool resources for joint funding activities.

"The PPP, its Partnership Board and members make a real difference in implementing the strategic photonics roadmap in Europe."

[71] A. Kamper, President Photonics21 in the Foreword to the Vision Paper "*Europe's age of light! How photonics will power growth and innovation*" (2017) published by European Technology Platform Photonics21 c/o VDI Technologiezentrum GmbH, Photonics21 Secretariat.

[72] The European Investment Bank lists 4 key factors that make the sectors so strategically important – aside from high economic leverage these are the multidisciplinary nature, the significant growth in demand and the great means of such topics like data protection, security and defence – Source see: European Investment Bank (2018): Innovation Finance Advisory Studies "*Financing the digital transformation – Unlocking the value of photonics and microelectronics*", prepared for DG Research and Innovation and DG Connect, European Commission, P. 11.

PMR: Annex

Annex – Part 1: Common Priority Key Performance Indicators[73] [74]

	Key Performance Indicator (KPI)	Value in {2017}	Baseline at the start of Horizon 2020 (latest available)	Target (for the cPPP) at the end of Horizon 2020	Comments
1	Mobilised Private Investments.	***Total amount of actual private expenditure mobilised in cPPP projects*** *(i.e. beneficiary contributions to eligible project costs plus possible additional private expenditures directly linked to project execution):* No data available yet – more data might be provided by the EC later on. ***Estimation of the factor of leverage investment in research and innovatin as compared to Horizon 2020 project funding in 2017:*** *(based on the online survey):* Most respondents declare a leverage factor of 1–3 (68.9%); For 6.7% of the respondents, the leverage factor is 4–5; 24.4% declare no leverage factor at all, which – since this figure does not reflect the reality (cf. high R&D investment of photonics industry amounting in §3.1) – suggests that this figure is very difficult to measure (as mentioned by some of the respondents) and that the responses have therefore to be interpreted with caution.	Reference to FP7 results.	From the CA.	

[73] The data displayed in the following table are based on the results on the online survey conducted in April 2018 among the coordinators of the Photonics cPPP projects. As such, they might not be exhaustive or might reflect only part of the actual situation.

[74] Remarks concerning the KPIs evaluation, as made in the final PMR review reports in 07/2018, could only be partly taken into consideration for this year's report, since the online survey among the cPPP Project coordinators had been completed before. All remarks will be addressed in-depth in the preparation of the cPPP PMR 2018.

Annex – Part 1: Common Priority Key Performance Indicators

	Key Performance Indicator (KPI)	Value in {2017}	Baseline at the start of Horizon 2020 (latest available)	Target (for the cPPP) at the end of Horizon 2020	Comments
2	New skills and/ or job profiles.	***Number of new types of high-skilled jobs developed in cPPP projects in 2017:*** Nearly half of the respondents declare the creation of 1–5 high-skilled jobs in 2017. In detail: 24.4% declare no job creation; 46.7% declare the creation of 1–5 high-skilled jobs; 13.3% declare the creation of 6–10 high-skilled jobs; 11.1% declare the creation of 11–20 high-skilled jobs; 2.2% declare the creation of 21–50 high-skilled jobs; 2.2% declare the creation of more than 50 high-skilled jobs. ***Share of job increase attributable to SMEs:*** for most participants (60%), this job increase is, at least partly, attributable to SMEs. In even 20% of the cases, more than 50% of this job increase is attributable to SMEs; for 11.1% of the respondents, the job increase is to 21–50% attributable to SMEs and in 8.9% of the cases, SMEs are responsible for the job increase with a share of 11–20%. Number of new curricula developed in cPPP projects in 2017: for 29.5% of the respondents, at least 1 new curricula was developed in the cPPP project.	Reference to FP7 results.	From the CA.	

Annex – Part 1: Common Priority Key Performance Indicators

	Key Performance Indicator (KPI)	Value in {2017}	Baseline at the start of Horizon 2020 (latest available)	Target (for the cPPP) at the end of Horizon 2020	Comments
3	Impact of a cPPP on SMEs.	***Number of SMEs participating in cPPP projects****:* 228 over the period 2014–2017 (cf. §3.3). ***Share of participation of SMEs in photonics cPPP projects:*** (cf. §3.3) 54.4% of all industry participants over the period 2014–2017. 26.7% of all participants over the period 2014–2017. ***Estimation of the increase in turnover in SMEs participating in the cPPP projects – based on the 50 respondents of the online survey:*** (cf. §3.3). **28.9% declare no increase at all;** 15.6% declare an increase of 1–5%; **22.2% declare an increase of 6–10%;** 4.4% declare an increase of 11–15%; 11.% declare an increase of 16–20%; 2.2% declare an increase of 21–25%; 4.4% declare an increase of 26–30%; 2.2% declare an increase of 41–50%; 4.4% declare an increase of more than 50%.	n.a. [new approach under Horizon 2020].	From the CA.	
4	Significant Innovations.	***Number of project results taken-up for higher TRLs using additional investments:*** 42.2% of the respondents declare 1–3 results to be taken up for higher TRL; 28.9% declare 4–5 results; 15.6% declare 6–10 results; 4.4% declare more than 10 results; Only 8.9% declare that no project result will be taken up for higher TRL using additional investment.	Reference to FP7 results.	From the CA.	

Annex – Part 2: Specific Key Performance Indicators for the Photonics cPPP[75]

	KPI domain	Key Performance Indicator (KPI)	Value in {2017}	Baseline at the start of Horizon 2020 (latest available)	Target (for the cPPP) at the end of Horizon 2020	Comments
1	Industrial Competitiveness and Economy Impact.	KPI 1: Maintain / Increase the (European) market share of the global photonics market.	European share of the global photonics market: 16.5% in 2015. 62% Growth of the European Photonics Industry in the period 2005–2015. European Photonics Production Growth rate more than 3.5 higher than EU GDP Growth rate. High long-term growth in European core photonics segments. Compared to 2011, European Photonics core segments remained strong and could defend a leading world position up to 50% – far beyond the average EU industry share of 15.5%.	In 2012, the global market share of Europe was 18%.	By 2020, keep a global market share of at least 18%.	Extensive data were collected in the scope of the PPP Impact Report 2017[76] as well as of the Market Study[77] (both studies were published in 2017). Cf. §3.1.
2	Industrial Competitiveness and Economy Impact.	KPI 2: (Develop) New photonics R&I capabilities.	4 PPP Pilot Lines and 3 PPP Prototyping Services help end user industry to speed up product development.			Cf. §3.1.

[75] Remarks concerning the KPIs evaluation, as made in the final PMR review reports in 07/2018, could only be partly taken into consideration for this year's report, since the online survey among the cPPP Project coordinators had been completed before. All remarks will be addressed in-depth in the preparation of the cPPP PMR 2018.

[76] European Technology Platform Photonics21 c/o VDI Technologiezentrum GmbH, Photonics21 Secretariat (2017): Jobs and Growth in Europe – Realizing the potential of Photonics, PPP Impact Report 2017, Düsseldorf.

[77] European Technology Platform Photonics21 c/o VDI Technologiezentrum GmbH, Photonics21 Secretariat (2017): Market Research Study, Photonics 2017, Brüssel / Düsseldorf / Tägerwilen, May 2017.

Annex – Part 2: Specific Key Performance Indicators for the Photonics cPPP

	KPI domain	Key Performance Indicator (KPI)	Value in {2017}	Baseline at the start of Horizon 2020 (latest available)	Target (for the cPPP) at the end of Horizon 2020	Comments
3	Industrial Competitiveness and Economy Impact.	KPI 3: (Improve) the innovation potential of photonics companies and notably of SMEs.	The 4 pilot lines foresee open access, and SME are either involved already in the project or will be involved in a later stage. End user industry involvement in PPP Projects ensuring quick market uptake of innovation.			New open access infrastructures and services to design, prototyping, manufacturing or testing, etc., and involvement of SME stakeholders. Cf. §3.1.
4	Socio-economic Impacts.	KPI 4: Number of people directly employed by the photonics industry.	By the end of 2015, the EU Photonics industry employed 290,000 people – compared to 271,000 employees in the sector in 2011. This represents a CAGR of +1.7%.	In 2012, there were 300,000 direct jobs.	By 2020, increase by at least 10% new jobs in photonics.	Forecast: +42,000 jobs in 2020 compared to 2011. Cf. PPP Impact Report 2017.[78] Cf. §3.1.
5	Socio-economic Impacts.	KPI 5: Education, training and skills development.	Activities targeting training and learning: - for children and teachers - for universities - for companies and employees - for the general public. Cf. §3.1. Based on the results of the online survey (cf. §3.3): 54.5% of the projects have conducted 1–5 outreach, education and training events in 2017; 22.7% have conducted 6–10 events; 2.3% have conducted 11–15 events; 6.8% have conducted more than 15 events. In nearly 50%, these events reached more than 50 people.	An FP7 initiative 'the Photonics Explorer' is quite successful and is further expanding by external sponsorship.		Number of specific activities undertaken to attract young minds to photonics or the number of young students addressed by educational material on photonics. Cf. §3.1.

[78] European Technology Platform Photonics21 c/o VDI Technologiezentrum GmbH, Photonics21 Secretariat (2017): Jobs and Growth in Europe – Realizing the potential of Photonics, PPP Impact Report 2017, Düsseldorf.

Annex – Part 2: Specific Key Performance Indicators for the Photonics cPPP

	KPI domain	Key Performance Indicator (KPI)	Value in {2017}	Baseline at the start of Horizon 2020 (latest available)	Target (for the cPPP) at the end of Horizon 2020	Comments
6	Socio-economic Impacts.	KPI 6: Scale of diffusion of photonics in application areas and in solutions addressing societal challenges.	Involvement of end-user industry: Cf. §3.1. Success stories: Cf. §2.2 Cf. Annex Part 4. Photonics related projects in almost all Horizon 2020 programmes / Photonics related projects covering all application markets of high relevance for tomorrow's society and economy from personalized healthcare, industry 4.0, smart cities to securing the digital society, connected mobility – to name but a few.			Representative examples of photonics in application areas and of breakthrough solutions for specific societal challenges. A study on the role and contribution of Photonics in past and current Horizon 2020 projects was initiated by VDI TZ and carried out from September to December 2017. The study aimed at examining whether, in Horizon 2020 Photonics plays indeed the role of an enabling technology for new and innovative products, services and developments in areas far beyond obvious lighting application fields. Cf. §3.1.

Annex – Part 2: Specific Key Performance Indicators for the Photonics cPPP

	KPI domain	Key Performance Indicator (KPI)	Value in {2017}	Baseline at the start of Horizon 2020 (latest available)	Target (for the cPPP) at the end of Horizon 2020	Comments
7	Socio-economic Impacts.	KPI 7: R&I investments of the photonics industry in the PPP objectives.	Nearly 10 billion Euro industry investments on Photonics Innovation in Europe in 2015. R&D intensity in the Photonics industry amounts to nearly 10%. R&D intensity in the Photonics industry much higher than in most other industry sectors. Cf. §3.1 & 3.2.			Extensive data can be found in the PPP Impact Report 2017[79] (published in 2017). Cf. §3.1.
8	Operational aspects of the PPP.	KPI 8: Efficiency, openness and transparency of the PPP Consultation Process Metrics.	Fully democratic structure and transparent decision-making processes: Cf. §2.3 and §3.2.			
9	Operational aspects of the PPP.	KPI 9: PPP Project Performance.	Cf. Outcomes of the online survey §3.2 and Annex Part 1 + Annex Part 3.			

[79] European Technology Platform Photonics21 c/o VDI Technologiezentrum GmbH, Photonics21 Secretariat (2017): Jobs and Growth in Europe – Realizing the potential of Photonics, PPP Impact Report 2017, Düsseldorf.

Annex – Part 2: Specific Key Performance Indicators for the Photonics cPPP

	KPI domain	Key Performance Indicator (KPI)	Value in {2017}	Baseline at the start of Horizon 2020 (latest available)	Target (for the cPPP) at the end of Horizon 2020	Comments
10	Operational aspects of the PPP.	KPI 10: Success stories relating to key developments in photonics by Horizon 2020 funded projects.	Photonics PPP project impact and success stories reflected in end-user media: in over 209 articles in newspapers, magazines, and websites in more than 15 countries, representing an advertising value in excess of around €500k; estimated readership of over 14.9 million people. Cf. §2.2. Cf. Annex Part 4 Photonics Media Campaign 2017. Cf. Annex Part 3.			
11	Operational aspects of the PPP.	KPI 11: Coordination of the PPP Implementation with the Member States and the Regions.	Linking up the Horizon 2020 Photonics PPP actions with member states and regions to maximize impact of the Photonics PPP. Coordinating the regional and European photonics strategy – joint implementation to link regional Smart Specialisation strategies. Cf. §2.2.			End-user workshops. Cooperation meetings with national technology platforms, mirror group meetings, etc. Cf. PPP Annual Activity Report 2017.
12	Operational aspects of the PPP.	KPI 12: Dissemination and Awareness.	Photonics PPP project impact and success stories reflected in end-user media. Promoting the visibility of Photonics and of the Photonics21 Platform in social media. Updating and relaunching the Photonics21 website as the central photonics communication platform for the Horizon 2020 Photonics PPP. Cf. §2.2. Cf. Annex Part 4 Photonics Media Campaign 2017.			

Annex – Part 3: Contribution to Programme-Level KPIs[80] [81]

	Key Performance Indicator (KPI)	Data	Baseline at the start of Horizon 2020 (latest available)	Target (for the cPPP) at the end of Horizon 2020	Comments
1	Patents.	***Survey Outcomes (Cf. §3.2):*** Regarding patent applications: Overall: 18 patent applications for the 41 RIA & IA projects that responded to the survey, i.e. 0.44 per project, or 4.4 every 10m Euros, considering an average funding of 1m/project/year. 80% of the respondents declare that they have not applied for any patent in 2017. 11.1% of the projects applied for 1 patent; 4.4% of the projects applied for 2 patents; Respectively 2.2% of the projects applied for 4 and 5 patents. Regarding patent awarding: Only 1 patent has been granted in the scope of a cPPP project in 2017.	5.2 per €10m funding	Horizon 2020: 3 patent applications per €10m funding.	Horizon 2020 indicator in Annex II – Council Decision 2013/743/EU. The figures seem to be a little bit lower than the target figures. However, as unfortunately, no further information is available on whether the other 44 patent applications are still pending or were not successful, the real figures might be higher.

[80] The data displayed in the following table are based on the results on the online survey conducted in April 2018 among the coordinators of the Photonics cPPP projects. As such, they might not be exhaustive or might reflect only part of the actual situation. However, and since no other data are available at the moment, they might give a first impression of the achievements of the Photonics cPPP regarding patents, standardisation, publications, etc.

[81] Remarks concerning the KPIs evaluation, as made in the final PMR review reports in 07/2018, could only be partly taken into consideration for this year's report, since the online survey among the cPPP Project coordinators had been completed before. All remarks will be addressed in-depth in the preparation of the cPPP PMR 2018.

Annex – Part 3: Contribution to Programme-Level KPI's

	Key Performance Indicator (KPI)	Data	Baseline at the start of Horizon 2020 (latest available)	Target (for the cPPP) at the end of Horizon 2020	Comments
2	Standardisation activities (project level). Contributions to new standards (PPP level).	***Survey Outcomes (Cf. §3.2):*** In 47% of the cases, there are standardization activities or contribution to new standards at project level.	Number of activities leading to standardization: 2 (Based on 8 successful FP7 projects finished). Number of working items in European Standardisation Bodies: 4 (Based on 8 successful FP7 projects finished). Number of pre-normative research files – prEN – under consultation in ESBs: Not reported.	No target.	Baseline categories slightly different from the data collected in the online survey – not allowing a direct comparison.
3	Operational performance.	Average time-to-grant: 205 days.	256 (baseline, as displayed in the cPPP PMR 2016).		
4	**Horizon 2020 – LEIT** – Number of joint public-private publications.	***Survey Outcomes (Cf. §3.2):*** In 64.4% of the projects, 1–5 joint public-private publications have been issued in the scope of the project. In 8.9% of the projects, 6–10 joint public-private publications were issued. In only 2.2% of the cases, more than 10 joint public-private publications were issued. In 24.4%, no joint public-private publication (yet).			Data collected in the online survey might not reflect the expectations for this KPI. Unfortunately, according to the EC Photonics Unit, there is no further data available (yet). These data may be completed by the EC services at a later stage.

Annex – Part 4: European photonics success and impact stories – Media Campaign 2017

VDI TZ GmbH in its function as Photonics21 Secretariat has provided a central public relation and dissemination service to Horizon 2020 Photonics PPP projects. Through bi-weekly telephone conferences between between VDI TZ GmbH, the communications agency Matter PR and the European Commission Photonics Unit (Anna Pelagotti) Photonics PPP projects have been selected according to their impact and newsworthiness.

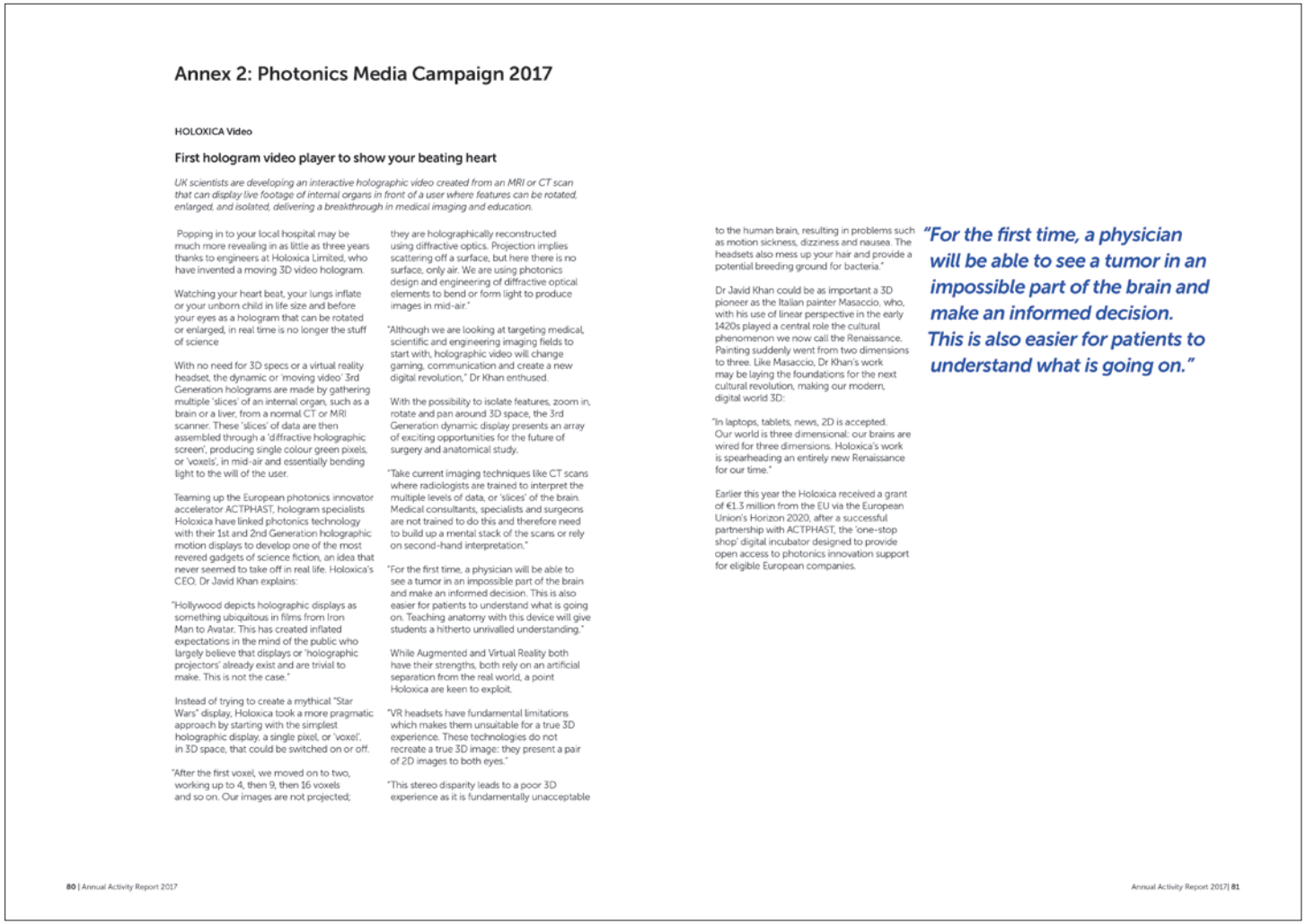
After a project has been chosen, the respective coordinators are contacted, interviewed and a press release is prepared and distributed. In total 7 success stories were prepared in 2017.

Overview on 2017 Press releases and related PPP Projects

Headline	**Horizon 2020 Photonics PPP Project**
First hologram video player to show your beating heart	Actphast – Holoxica
Augmented Reality visor to dramatically improve surgery	VOSTARS
New laser scanner to zap toxic French fries	Lien Smeesters – Student Innovation Award Winner
New handheld scanner to give instant heart disease diagnosis	CARDIS
Laser scanner to detect cancer in less than 30 seconds	ADVANCE
Life-saving drones use photonics to transform disaster rescue efforts	FLAIR
Laser 'bowl' to become world's first instant test for breast cancer	PAMMOTH

Source: VDI TZ GmbH / Matter PR.

The following figures display the press releases published in 2017, as presented in the Photonics PPP Annual Activity Report 2017.



Annex 2: Photonics Media Campaign 2017

HOLOXICA Video

First hologram video player to show your beating heart

UK scientists are developing an interactive holographic video created from an MRI or CT scan that can display live footage of internal organs in front of a user where features can be rotated, enlarged, and isolated, delivering a breakthrough in medical imaging and education.

Popping in to your local hospital may be much more revealing in as little as three years thanks to engineers at Holoxica Limited, who have invented a moving 3D video hologram.

Watching your heart beat, your lungs inflate or your unborn child in life size and before your eyes as a hologram that can be rotated or enlarged, in real time is no longer the stuff of science

With no need for 3D specs or a virtual reality headset, the dynamic or 'moving video' 3rd Generation holograms are made by gathering multiple 'slices' of an internal organ, such as a brain or a liver, from a normal CT or MRI scanner. These 'slices' of data are then assembled through a 'diffractive holographic screen', producing single colour green pixels, or 'voxels', in mid-air and essentially bending light to the will of the user.

Teaming up the European photonics innovator accelerator ACTPHAST, hologram specialists Holoxica have linked photonics technology with their 1st and 2nd Generation holographic motion displays to develop one of the most revered gadgets of science fiction, an idea that never seemed to take off in real life. Holoxica's CEO, Dr Javid Khan explains:

"Hollywood depicts holographic displays as something ubiquitous in films from Iron Man to Avatar. This has created inflated expectations in the mind of the public who largely believe that displays or 'holographic projectors' already exist and are trivial to make. This is not the case."

Instead of trying to create a mythical "Star Wars" display, Holoxica took a more pragmatic approach by starting with the simplest holographic display, a single pixel, or 'voxel', in 3D space, that could be switched on or off.

"After the first voxel, we moved on to two, working up to 4, then 9, then 16 voxels and so on. Our images are not projected; they are holographically reconstructed using diffractive optics. Projection implies scattering off a surface, but here there is no surface, only air. We are using photonics design and engineering of diffractive optical elements to bend or form light to produce images in mid-air."

"Although we are looking at targeting medical, scientific and engineering imaging fields to start with, holographic video will change gaming, communication and create a new digital revolution," Dr Khan enthused.

With the possibility to isolate features, zoom in, rotate and pan around 3D space, the 3rd Generation dynamic display presents an array of exciting opportunities for the future of surgery and anatomical study.

"Take current imaging techniques like CT scans where radiologists are trained to interpret the multiple levels of data, or 'slices' of the brain. Medical consultants, specialists and surgeons are not trained to do this and therefore need to build up a mental stack of the scans or rely on second-hand interpretation."

"For the first time, a physician will be able to see a tumor in an impossible part of the brain and make an informed decision. This is also easier for patients to understand what is going on. Teaching anatomy with this device will give students a hitherto unrivalled understanding."

While Augmented and Virtual Reality both have their strengths, both rely on an artificial separation from the real world, a point Holoxica are keen to exploit.

"VR headsets have fundamental limitations which makes them unsuitable for a true 3D experience. These technologies do not recreate a true 3D image: they present a pair of 2D images to both eyes."

"This stereo disparity leads to a poor 3D experience as it is fundamentally unacceptable to the human brain, resulting in problems such as motion sickness, dizziness and nausea. The headsets also mess up your hair and provide a potential breeding ground for bacteria."

Dr Javid Khan could be as important a 3D pioneer as the Italian painter Masaccio, who, with his use of linear perspective in the early 1420s played a central role the cultural phenomenon we now call the Renaissance. Painting suddenly went from two dimensions to three. Like Masaccio, Dr Khan's work may be laying the foundations for the next cultural revolution, making our modern, digital world 3D:

"In laptops, tablets, news, 2D is accepted. Our world is three dimensional; our brains are wired for three dimensions. Holoxica's work is spearheading an entirely new Renaissance for our time."

Earlier this year the Holoxica received a grant of €1.3 million from the EU via the European Union's Horizon 2020, after a successful partnership with ACTPHAST, the 'one-stop shop' digital incubator designed to provide open access to photonics innovation support for eligible European companies.

"For the first time, a physician will be able to see a tumor in an impossible part of the brain and make an informed decision. This is also easier for patients to understand what is going on."

80 | Annual Activity Report 2017

Annual Activity Report 2017| 81

Press release "First hologram video player to show your beating heart" related to the PPP Project Actphast – as displayed in the Annex to the Photonics PPP Annual Activity Report 2017. Source: VDI TZ GmbH / Matter PR.

Augmented Reality visor to dramatically improve surgery

Employing new photonics technology, European scientists are developing a new Augmented Reality surgical visor in a bid to improve accuracy of interventions, showing anesthetic and medical data while superimposing a patient's x-ray in perfect unison with their body, meaning surgeons never having to look away during an operation and surgery times reduced by over 20 mins for every 3 hours.

The VOSTARS ('Video Optical See-Through Augmented Reality surgical System') medical visor is a head-mounted display (HMD) system that is capable of superimposing the patient's x-ray images in perfect 3D unison with their anatomy.

The visor also presents a patient's anesthetic data, heart rate, body temperature, blood pressure, and breathing rates, conveniently into the surgeon's field of vision, in a drive to increase accuracy by focusing on the operation and reduce time by never having to look away.

The project forecasts a significant improvement of the intervention accuracy coupled with a reduction in times spent in an operation and under anaesthetic by at least 11 %.

Although Augmented Reality for surgical procedures has been talked about in academic and industrial research since the 1990s, a tool joining a surgeon's natural perception with patient data has not yet been widely implemented.

However it has been the use of photonics components, with the small, high-luminous micro display, the LED optical waveguide, and the array of microns to project a 2D x-ray image in front of the user that has been fundamental to realising this one time science fiction.

Project coordinator Dr Vincenzo Ferrari, biomedical engineering researcher at the Department of Information Engineering, at the University of Pisa, explains:

"With this state-of-the-art, highly ergonomic visor, we intend to provide all the information required to improve surgery. The primary goal is to reduce not just surgery times, but also the time spent under anaesthetic and the cost involved in any operation."

"For the patient, this means saving off 20 minutes of every 3 hours of surgery and the guarantee of an extremely accurate intervention," said Dr Ferrari.

In the same way that a facing camera on a smartphone films moving images, the VOSTARS system works by capturing what the surgeon sees from a head-mounted camera. The system then 'merges' this footage of reality with the patient's medical images, from CT, MRI, or 3DUS scans.

The central processor, using the most advanced registration techniques available for surgical navigation, then presents a real-time hybrid image on the visor "dashboard' to the surgeon.

"Imagine driving with a sat-nav: we know how to drive and roughly where to go, but with real-time information, like speed, distance and time presented to us, we can take the most efficient route in the quickest time and perhaps more safely."

"However, rather than having that information on a small GPS screen, our important patient data, like the surgical target in the anatomy, anaesthetic info, breathing and heart rates for example, are all integrated instantly into the surgical visor.

"A clinician can move freely while still seeing the patient, the hybrid x-ray image and all of critical data all at once in a surgical 'dashboard' inside the screen. The surgeon, the patient and the procedure are all at one."

Hybrid

Scientists at VOSTARS are building a hybrid of the two existing AR headsets approaches that combines all the benefits of both a video see-through (VST) system and optical see-through (OST) head-mounted display.

Fabrizio Cutolo, engineer and expert in wearable augmented reality systems, believes neither VST nor OST alone was suitable for operating on a live patient:

"When operating on a real person, it was clear to us that the benefits of OST and VST systems could be combined to make a hybrid device."

In 'optical see-through' (OST) systems, as in Microsoft Hololens, the user has a direct view of the natural environment with the computer-generated images superimposed on a user's field of vision using a semi-transparent mirror. This gives the user a more naturalistic experience, superimposing small amounts of the virtual onto the real world.

With 'video see-through' (VST) systems (as seen in the Occulus Rift headsets), the user is submerged in the virtual world, seeing through a closed head-mounted display (HMD) together with stereo cameras, experiencing life through screens. Since VST systems capture the video-image as seen by the user in real time it is good for aligning the real and virtual worlds.

"For something as critical as an operation, we had to have the naturalistic 'feel' of OST, while having the fluid interaction of the VST. Therefore a brand new device had to be made from scratch, rather than extend an existing technology. The VST-OST Augmented Reality hybrid was born".

Already 3 months into the 3 year project, VOSTARS aims to have a working prototype of the hybrid device ready for May of 2018. Initially being trialled on a number of procedures to the head, including Maxillofacial (jaws and face) surgery, neuro surgery, ENT (ear, nose and throat) and orthopedic surgery, the project hopes to be available to end users in 3 years, with mass production by 2022.

Coordinated in Italy at Department of Information Engineering and the EndoCAS Center for Computer Assisted Surgery (Pisa University), the VOSTARS project received a grant of €3,816,440 from Horizon 2020 via the Photonics Public Private Partnership.

Participants from four European countries include: (Germany) SCOPIS GMBH, Charité – Universitätsmedizin Berlin, Sankt Gertrauden Krankenhaus GMBH, Technische Universitaet Muenchen, Pilotfish GMBH; (Italy) Alma Mater Studiorum-Universita Di Bologna, Scuola Superiore Di Studi Universitare E Di Perfezionamento Sant'Anna; (United Kingdom)VREO Innovation; (France) Optinvent, Commissariat A L'Energie Atomique et aux Energies Alternatives.

www.vostars.eu

"With this state-of-the-art, highly ergonomic visor, we intend to provide all the information required to improve surgery. The primary goal is to reduce not just surgery times, but also the time spent under anaesthetic and the cost involved in any operation."

Press release "Augmented Reality visor to dramatically improve surgery" related to the PPP Project VOSTARS – as displayed in the Annex to the Photonics PPP Annual Activity Report 2017. Source: VDI TZ GmbH / Matter PR.

New laser scanner to zap toxic French fries

Amid growing concern about the discovery of cancer-causing chemicals in crisps and French fries, a young scientist has developed a new laser system that scans peeled potatoes in the factory to detect toxic compounds and prevent them from reaching the consumer.

Earlier this year, the Food Standards Agency (FSA) issued warnings about eating over-fried potatoes, burnt toast and crisps that can contain cancer-causing chemicals such as acrylamide deeming them a serious health threat to billions of consumers.

At present, raw potatoes that produce an excess of the carcinogenic chemical acrylamide cannot be detected in a fast, sensitive, and non-destructive way.

This new technique developed by Lien Smeesters, 28, at the B-PHOT Brussels Photonics Team at the University of Brussels, in collaboration with Tomra Sorting Solutions, employs a new sensor that scans peeled potatoes, weeding out food that may cause high levels of acrylamide.

Currently only general quality tests are available for assessing potatoes with no accurate acrylamide detection. Food safety measures involve a person examining a sample and accepting an entire batch if the small selection passes. However, with this new sensor, every potato or individual French fry can be examined in a rapid, safe and thorough manner for the first time.

Photonics for Factories
It works by scanning the 'free falling' food items, such as potatoes, from both the front and back with a laser that employs 'spatially resolved spectroscopy', a non-invasive imaging technique using infrared light.

A food item identified as a potentially high source of acrylamide is spotted in mid-air as it begins to fall. Selected by the internal processor, the potato is then 'knocked out' of the batch by being blasted with a stream of air and into a reject bin before it hits the conveyor belt below.

The sensor is able to do this with each and every individual potato scanning and rejecting in tiny fractions of a second. Dr Smeesters explains:

"Not all potatoes result in excessive acrylamide formation during frying. We have sought to spot the undesirable potatoes when they are in their raw, peeled stage. After scanning with laser beams, the good potatoes will emit a different light signal than the unsuited ones leading to an unambiguous detection."

Having filed a patent describing the use of this detection method, the laser scanner will be integrated into one of Tomra's industrial in-line sorting machines, detecting and discarding food items that may contain excessive acrylamide precursors.

Several tons of products could be examined per hour to look for these carcinogenic compounds without using dyes or chemical additives, and without damaging or even touching the food.

Lien Smeesters – Photonics21 Student Award Winner
The driving force behind the detection method, Dr Lien Smeesters, 28, post-doctoral researcher at the University in Brussels in the B-PHOT Brussels Photonics Team and recent winner of the Student Innovation Award at the Photonics Public Private Partnership Annual Meeting, describes the motivation for the project:

"When frying potatoes, acrylamide formation is one of the biggest concerns of the potato-processing agriculture industry. At present raw potatoes that produce an excess of acrylamide cannot be detected in a fast, sensitive and non-destructive way."

"Therefore, we have worked with Tomra Sorting Solutions to develop a spatially-resolved spectroscopic sensor that identifies raw potatoes with high acrylamide precursor concentrations, on basis of their internal scattering properties, in miliseconds."

Smeesters' development comes at a time where tougher acrylamide regulation has been called for by the sustainability group 'Changing Markets Foundation' as well as the recent 'Go for Gold' campaign by the Food Standards Agency, helping people understand how to minimize exposure to acrylamide when cooking at home.

"With so many products containing worrying levels of acrylamide above the EU Indicative Value guidelines, we had to take action. This research and collaboration will hopefully provide unprecedented levels of food safety for millions", Smeesters said.

Future Home Use
Working on scaled-down version, Smeesters sees the future benefits of this sensor being more widely available to users in the kitchen:

Smeesters sees the future benefits of this sensor being more widely available to users in the kitchen:

"Although we are a long way off this yet, the miniaturization of the technology would enable a compact potato quality test tool in your home. A hand-held device indicating whether a potato would be unsuited for frying could reduce our exposure to acrylamide."

"We hope that potatoes unsuited for frying or roasting can be removed from the food chain right up to the end point, at the user level. One day we envisage a world where toxic French fries will be a thing of the past!"

"We have worked with Tomra Sorting Solutions to develop a spatially-resolved spectroscopic sensor that identifies raw potatoes with high acrylamide precursor concentrations, on basis of their internal scattering properties, in miliseconds."

Press release "New laser scanner to zap toxic French fries" – as displayed in the Annex to the Photonics PPP Annual Activity Report 2017.
Source: VDI TZ GmbH / Matter PR.

Laser imaging 'bowl' to give instant test for breast cancer

In a bid to make the world's first while-you-wait test for breast cancer, European scientists are developing a comfortable hemispherical bowl lined with laser sources and ultrasound detectors with the potential to reduce the stages in spotting the disease into a single appointment.

Current breast cancer diagnosis can be distressing and painful over a number of weeks.

Multiple stages can involve visiting a GP, being sent to a specialist for an x-ray mammogram, having an ultrasound, before undergoing a needle, a punch or a vacuum assisted biopsy, as well as placing one breast at a time between two metal plates in a painful clamp.

However, a new imaging system being developed by scientists at the University of Twente, in the Netherlands intends to remove the discomfort and uncertainty involved in a diagnosis.

The device employs both light and sound together in a technique called 'photoacoustics', combining lasers and photonics with ultrasound detection.

The size of a hospital bed, a patient lies face down placing their breast snugly into the 'reader', a hemispherical 'bowl' lined with up to a hundred optical fibres, and several ultrasound detectors.

Multiple images of a suspect breast and tumour are then acquired from dozens of different angles before assembling the multiple shots into a single 3D image.

The 'PAMMOTH' (or 'Photoacoustic Ultrasound Mammoscopy for evaluating screening-detected abnormalities in the breast'), hopes to lead the research into photoacoustic, real-time 3D imaging of suspicious lesions. Project Coordinator Srirang Manohar explains:

"We are creating an imaging device that we hope will reduce all of the stages involved in spotting breast cancer into one convenient appointment in order to reduce time, uncertainty and the number of unnecessary biopsies. We intend to make breast cancer diagnosis a one-stop-shop, while you wait."

Light and Sound
It works by sending short pulses of light into the breast towards the suspected lesion. Some of the delivered energy will be absorbed in the tissue and converted into heat, leading to transient thermoelastic expansion, or a mechanical 'push' signal from the suspected tumour.

Ultrasound detectors on the surface of the breast, from the hemispherical reader 'bowl' where the breast is placed, can then detect and measure these 'push' signals before analysing them on site. Here the imager can look into the haemoglobin (the oxygen-carrying protein in the blood) activity within the suspected tumour.

Since tumours consume oxygen at high rates to survive, lower oxygenation levels around a suspect lesion could tell a physician that a suspect lump is more likely to be a malignant growth than not.

The imager employs a multi-wavelength illumination in the near-infrared wavelength region to extract information about blood oxygenation, using PAMMOTH's own image reconstruction methods.

Aggressive or Benign
As part of the PAMMOTH team, researchers at University College London (UCL) are working on the mathematics, the image reconstruction and the analysis of the signals to determine how aggressive a tumour could be.

By gathering key information about the haemoglobin and oxygenation levels to and from the suspected tumour, the user could diagnose how likely it would be for the tumour to spread or whether it was simply benign.

"An aggressive tumour has a high metabolism and consumes oxygen more rapidly than normal tissue or a benign lesion. Our instrument and the mathematical approaches we are developing could allow us to check the oxygen saturation rate accurately."

"If a patient's oxygen saturation rate was found to be considerably lower than surrounding tissue then we could pinpoint where an aggressive tumour could be, and radiologists could understand how the tumour is likely to behave." Manohar said.

Unnecessary Biopsies
Current techniques to diagnose breast cancer such as x-ray mammography, ultrasound or MRI scans can sometimes fail to spot a tumour from healthy tissue or a benign abnormality, resulting in tumours that are missed and unnecessary biopsies being carried out.

Unnecessary biopsies and risks of 'false positives' (a result incorrectly indicating the presence of a disease) in breast cancer diagnosis are hotly contested topics among medical experts today. As well as the untold stress and discomfort experienced by women all over the world by unnecessary treatments, inefficient diagnoses have an extremely worrying cost implication.

Every year in the US alone, $4 billion is spent on false-positive mammograms and breast cancer over diagnosis among women ages 40-59, according to research published in Health Affairs. A similar picture is played out across Europe with millions of Euros being spent on unnecessary mammograms.

"A prime focus of the PAMMOTH project is to develop an imager and data analysis to be able to intervene at a very early stage. We need to be able to say whether a suspect lesion is good or bad. This technique would have a substantial impact upon the money spent on unnecessary biopsies, as well as to remove the trauma involved in a diagnosis for women around the world," said Manohar.

The PAMMOTH team hopes to have a prototype ready for 2020 ready for completion in 2021.

Coordinated in the Netherlands at the University of Twente, the PAMMOTH project received a grant of €4,352,007.50 from Horizon 2020 via the Photonics Public Private Partnership.

Participants from seven European countries include: (Netherlands) PA Imaging R&D BV, Stichting Medisch Spectrum Twente; (United Kingdom) University College London; (France) Imasonic SAS; (Germany) TP21 GMBH; (Switzerland) Universitaet Bern; (Czech Republic) Vysoke Uceni Technicke V Brne; (Lithuania) Ekspla UAB.

"The 'PAMMOTH' (or 'Photoacoustic Ultrasound Mammoscopy for evaluating screening-detected abnormalities in the breast'), hopes to lead the research into photoacoustic, real-time 3D imaging of suspicious lesions."

86 | Annual Activity Report 2017

Annual Activity Report 2017| 87

Press release "Laser 'bowl' to become world's first instant test for breast cancer" related to the PPP Project PAMMOTH – as displayed in the Annex to the Photonics PPP Annual Activity Report 2017. Source: VDI TZ GmbH / Matter PR.

New handheld scanner to give instant heart disease diagnosis

With worldwide cardiovascular deaths at an all-time high, European scientists have developed a new handheld scanner that can read your heart's vital signs like a supermarket barcode reader can scan items at the checkout, allowing a GP to diagnose even preclinical patients for the early onset of a disease.

According to the World Health Organization, cardiovascular disease is the leading cause of death in the world today. In 2015 over 17.3 million people, roughly 30% of all global deaths, died as a result of cardiovascular conditions, such as coronary heart disease, heart attacks or strokes.

CVDs can be identified using a number of medical tools, including cardiac biomarkers, cardiac catheterization, chest x-ray, electrocardiogram (ECG), Holter monitoring, and cardiac MRI.

However, because they are complicated or expensive, routine early forecasting of CVD is impossible in large populations at present.

This new diagnostic tool developed by the EU's Horizon 2020 collaboration 'CARDIS', (or 'CARdiovascular disease Detection with Integrated Silicon Photonics'), can read your heart's vital signs with one click of a button, similar to the way a handheld supermarket scanner can scan barcodes at the checkout.

Heart Vibration Mapping

Employing 'Laser Doppler Vibrometry', a technique using photonics technology, the device can pick up vital information about the status of the heart using light, in a fast and inexpensive way.

It works by harnessing the 'Doppler Effect', the phenomenon used to observe changes in pitch of light or sound from a fixed point, and commonly experienced when an ambulance siren passes and changes in tone.

Using the 'Doppler shift' of the reflected light, the scanner builds up a 'vibration map' of the chest and heart area, which can highlight the telltale signs of CVD, such as plaque build-up, arterial stiffness, arterial stenosis or heart dyssyncrony. Project coordinator Dr. Mirko de Melis explains:

"Our device employs the latest photonics technology, allowing a user to make measurements of the vibration characteristics of the heart without even touching it."

"A stiff artery creates a faster pulse pressure from the patient's beating heart. By measuring the 'pulse wave velocity', we can assess the stiffness of the arteries using light and make informed judgements, long before the onset of cardiovascular disease."

Although there are a number of vibration sensors that exist for this purpose, LDV is non-invasive and provides a much higher degree of accuracy in a fraction of the time.

"At present, millions considered to be low or moderate risk are walking around undiagnosed.

It is our long term goal to place such a device in the hands of the GP, the first point of contact for the mass population, as part of a routine health examination."

Delay, Halt or Reverse

"The screening of potential sufferers, who are in their early 40s, would delay the onset of the condition by 5–10 years. Assuming a sufferer would comply with the health advice given and adopted a change in lifestyle, this device allows the medical professional to halt or even reverse CVD," De Melis said.

The CARDIS team believe the key to the success of a mass screening programme at the GP-patient level are the inexpensive and portable nature of the new laser scanner:

"Our device would be cheap, easy to use and extremely effective. With cost of an Echocardiographer anything above €100k, and an arterial tonometer at €5000–€6000, the CARDIS scanner would be reasonably priced at around €1500. However it is the potential savings on our health services caused by the early diagnosis and prevention of CVD that will be the most rewarding," De Melis explained.

While the EU consortium is happy with their demonstration model, CARDIS will be ready to unravel their prototype in the summer of next year.

Administrated in Belgium at the Interuniversitair Micro-Elecronica Centrum, with Medtronic being the Technical coordinator, the CARDIS project received a grant of €3,629,207.51 from Horizon 2020 via the Photonics Public Private Partnership.

Participants from six European countries include: (Netherlands) Medtronic Bakken Research Centre BV, Universiteit Maastricht; (Germany) SIOS Messtechnik; (Belgium) Universiteit Gent, Fundicio BVBA; (United Kingdom) Queen Mary University, (University of London); (Ireland) University College Cork, National University of Ireland; (France) Institut National de la Sante et de la Recherche Medicale.

"This new diagnostic tool developed by the EU's Horizon 2020 collaboration 'CARDIS', (or 'CARdiovascular disease Detection with Integrated Silicon Photonics'), can read your heart's vital signs with one click of a button."

Press release "New handheld scanner to give instant heart disease diagnosis" related to the PPP Project CARDIS – as displayed in the Annex to the Photonics PPP Annual Activity Report 2017. Source: VDI TZ GmbH / Matter PR.

Laser scanner to detect cancer in less than 30 seconds

A team of European scientists has developed the world's first cancer scanner that detects blood vessels grown by a malignant melanoma with an infrared laser beam in 30 seconds

"Current skin cancer diagnosis can last a number of weeks and be very upsetting. Multiple stages can involve visiting a GP, being sent to a dermatologist for a skin biopsy, waiting for laboratory analysis, having a sentinel lymph node biopsy under general anesthetic, and then having more tests if the cancer has spread.

However, a new imaging system developed by a group of European scientists could dramatically speed up the process and reduce the need for debilitating sentinel-lymph node biopsies by placing real-time diagnosis in the hands of a dermatologist.

Using a handheld laser, a specialist can actually see under your skin at depths of 1 mm by creating a 3D colour image of the microscopic blood vessels in a process that takes around 30 seconds.

Employing a new and advanced version of Optical Coherence Tomography (OCT), a photonics technique more commonly used in retina scans, the scanner captures 3D images of the micro structures under the skin with a harmless infrared laser beam.

Since melanomas need oxygen to grow and survive, they grow their own blood vessels. As the cancer develops and becomes more malignant, they become increasingly distorted and malformed, differing in appearance from healthy vessels.

Being able to detect and see these vessels in a suspicious lesion in real time has never been possible, until now, opening the possibility for dermatologists to make treatment decisions in an unrivalled timeframe.

Shining a Light on Cancer

Melanoma is one of the most dangerous forms of skin cancer. Over 55,500 people in the world (12,000 European) died from malignant melanoma of the skin in 2012 alone. While 2,459 deaths from melanoma skin cancer were recorded in the UK in 2014, an estimated 9,730 people will die of melanoma in the United States in 2017.

Melanomas produce their own blood vessels to feed and grow the tumour, so by revealing the microstructures in 3D pictures the scanner show doctors how the cancer has developed.

A specialist can potentially determine on the spot, whether simply cutting it out is sufficient for a cure or whether further treatment with cancer drugs will be needed.

With their new device, called *'VivoSight'* on the market, the European team 'ADVANCE' (or *'Automatic Detection of VAscular Networks for Cancer Evaluation'*) is aiming to reduce the time for treatment decision from a number of weeks to a matter of seconds, while removing the invasive nature of the appointment.

UK project leader, Jon Holmes of Michelson Diagnostics Ltd, a key partner in the ADVANCE consortium, explains:

"Every melanoma above a certain thickness could have spread to other parts of the body.

At present, all patients with such melanomas have to wait for a sentinel lymph node biopsy performed in a hospital under general anaesthesia to find out if it is spreading."

"This can take weeks to perform, is very expensive and can be debilitating for the patient."

"About 80% of the time, the biopsy produces a negative result with no sign of the cancer spreading. There has to be a better way: our scanner may radically improve the abilities of dermatologists to decide whether a melanoma is in the less malignant, non-spreading, early stage, or if it has already developed and requires immediate aggressive therapy. Further clinical trials will be needed to conclusively prove the technology."

Speckle Variance OCT

The ADVANCE team has employed a variant of OCT in its scanner called 'Speckle-Variance' OCT or dynamic OCT (D-OCT), an advancement of OCT that is ideal for capturing movement.

Studying the 'speckle' or flicker of light patterns created by moving blood cells, the imaging device takes around four frames per second and compiles the images so that a clinician may tell where something has moved on the image from frame to frame.

"Using D-OCT we can see movement of blood against the solid tissue structures, something we have never been able to do before in a clinical setting. It's like looking out at night and seeing cars' headlights flowing along a motorway, only at depths of nanometers under the skin."

"But it appears cancers don't take the direct route! Their vessels are like twisty, branching country lanes that get narrower and wider. Our clinical team thinks that these 'shapes' are key to understanding the cancer. Our scanner shows these vessels in gorgeous detail," Mr Holmes explained.

While a sentinel node biopsy can cost in excess of €10,000, and with many hospitals performing hundreds per year, there is a growing concern and a need to find an alternative when over 80% of these operations turn out to be clear of any malignant growth.

Wounds, Ulcers, Burns

As well as the profound use in skin cancer diagnosis, the ability to see blood vessel networks with the ADVANCE technology has created a number of useful spin-off benefits.

"The scanner can image the blood vessels in healing wounds. This may have application for treatment of leg and foot chronic ulcers, when doctors want to know whether a wound is healing or requires a change in treatment, potentially reducing the number of amputations."

"ADVANCE technology may also help with burn victims, being able to give a doctor a quicker response time than the standard 15 days to determine whether a patient's skin is healing and whether or not to give a skin graft".

"Ultimately with the ADVANCE scanner, not only can thousands of lives be saved and many millions of Euros in cost savings be made annually worldwide, but there is no price we can put on a patient not having to go through an unnecessary operation with potential long term debilitating side effects or wait an unnecessary amount of time for treatment."

Coordinated in the UK, the ADVANCE project received a grant of € 2,282,143 from the European Commission's FP7 programme.

Participants from five European countries are: (United Kingdom) Michelson Diagnostics Ltd (manufacturer of VivoSight) and EG Technology Limited; (Germany) CMB Collegium Medicum Berlin GMBH, and Klinikum Augsburg Kommunalunternehmen; (Denmark) Region Sjaelland; (Italy) Università degli Studi di Modena e Reggio Emilia; (Serbia) Tehnološko partnerstvo d.o.o. Beograd (Stari Grad).

"With their new device, called 'VivoSight' on the market, the European team 'ADVANCE' (or 'Automatic Detection of VAscular Networks for Cancer Evaluation') is aiming to reduce the time for treatment decision from a number of weeks to a matter of seconds, while removing the invasive nature of the appointment."

92 | Annual Activity Report 2017

Annual Activity Report 2017| 93

Press release "Laser scanner to detect cancer in less than 30 seconds" related to the PPP Project ADVANCE – as displayed in the Annex to the Photonics PPP Annual Activity Report 2017. Source: VDI TZ GmbH / Matter PR.

Life-saving drones to transform disaster rescue efforts

Directing evacuations, reducing damage and saving lives in the aftermath of major disasters like wildfires, chemical blazes, or volcanic eruptions will all be improved thanks to a new drone that provides critical air quality data to ground-based emergency services in real-time.

A tough test for air quality monitors is unpredictable, catastrophic events such as wild fires, accidents in chemical plants or volcanic eruptions. Critical information is needed for evacuations, deploying emergency services and surviving the aftermath of a disaster.

Natural disasters like the infamous eruption of Iceland's Eyjafjallajökull in 2010 can severely impact air quality and safety in the short term and are often outside the reach of fixed monitoring station networks.

Similarly, wildfires, which destroyed 700,000 ha of land in the EU this year according to the European Forest Fire Information Service (EFFIS), and 8.8 million acres caused by 52,699 individual fires in the USA in 2017, were estimated to kill up to 339,000 people worldwide per annum following a recent study.

Rapid Response Drone

Reaching speeds of up to 120 km per hour and covering an 80 kilometre radius, the drone is fitted with a novel spectroscopic sensor that can simultaneously detect dozens of toxic gasses in an instant.

Flying through some of the toughest environments on earth such as dangerous clouds or poisonous plumes, the FLAIR (or 'Flying ultrA-broadband single-shot Infra-Red Sensor') drone aims to provide real-time air quality data used for quick decision-making during evacuations and the deployment of rapid response emergency services.

André Oliveira Project coordinator of TEKEVER AUTONOMOUS SYSTEMS told Photonics PPP:

"For the first time, a drone reaching altitudes of up to 4000 metres will be able to detect fine traces of air molecules that are dangerous to our health with a state-of-the-art laser sensor. The drone can map out areas that are too dangerous for humans to go and can transmit data in real time to a ground processing unit."

Standard gas sensors usually focus on one or few specific molecules, such as carbon dioxide and methane, using a narrow spectrum laser. However, because the FLAIR sensors work in a much wider spectrum, more detailed signatures in the gas mixture can be detected, such as carbon dioxide, methane, sulphur oxides, and nitrogen dioxide.

Sensing Toxic Particles

It works by beaming the sampled air in a 'multipass cell' to increase the total optical path length for exposure with a super-continuum laser, allowing the tiniest concentrations of complex, toxic gas mixtures to be detected.

The gas concentrations are measured by reading the unique frequencies, or 'signatures' of the air sample, that become absorbed and 'dimmed' in the laser light. To improve detection, these unique frequencies of the multiple gasses are separated.

The light then passes through a series of gratings and lenses, illuminating the surface of a multi-pixel detector, a device able to distinguish particles at the photon level.

From these separated pixels the system can then detect exactly 'what' and 'how much' of the poisonous gas is present. The drone then relays this microscopic information to the user on the ground in real time

"Immediate detection with such accuracy and precision, without putting lives at risk allows us to visualise vast areas of danger much more effectively. A tailored response can therefore be deployed to disaster situations, reducing damage or even saving lives", said Mr Oliviera.

Mr Oliviera continued, "For the first time a gas sensing device has been created from the hybrid of an optical spectrometer and a high-resolution spectroscopy gas sensor. By employing infrared absorption spectroscopy in either the 2–5 microns and 8–12 microns wavelength windows where most of the harmful gasses have absorption signatures, or 'fingerprints', the optical sensors can detect a number of molecules simultaneously in real time."

Expecting to have a prototype ready in November 2018, the FLAIR project coordinated by TEKEVER AUTONOMOUS SYSTEMS in Portugal received a grant of €3,072,020 from Horizon 2020 via the Photonics Public Private Partnership.

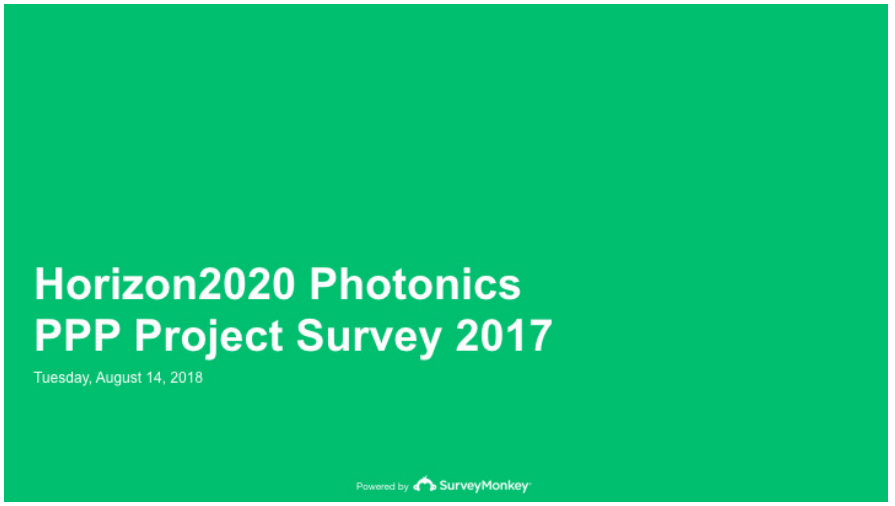
Participants from five other European countries include: Senseair AB (Sweden); NKT Photonics A/S, Danmarks Tekniske Universiteit (Denmark); New Infrared Technologies SL (Spain); Stichting Katholieke Universiteit (Netherlands); Eidgenossische Materialprufungs-Und Forschungsanstalt, CSEM Centre Suisse D'Electronique et de Microtechnique SA – Recherche et Developpement (Switzerland).

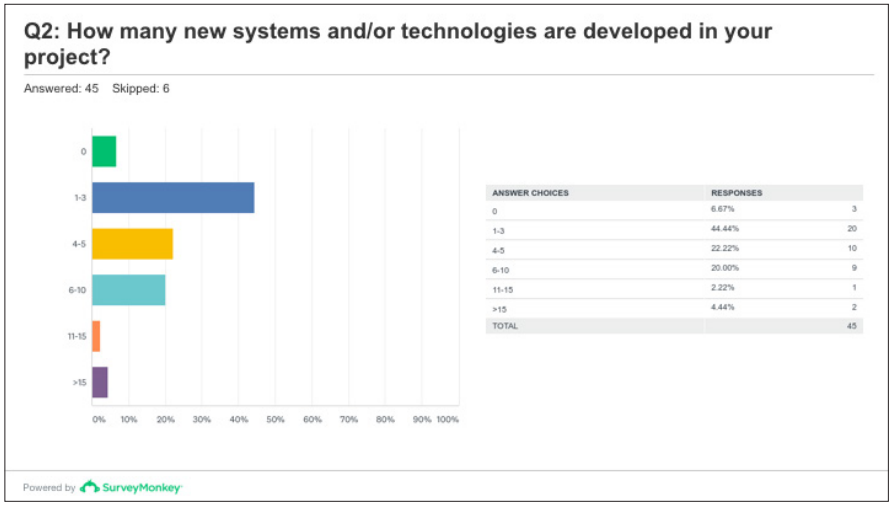
"For the first time, a drone reaching altitudes of up to 4000 metres will be able to detect fine traces of air molecules that are dangerous to our health with a state-of-the-art laser sensor. The drone can map out areas that are too dangerous for humans to go and can transmit data in real time to a ground processing unit."

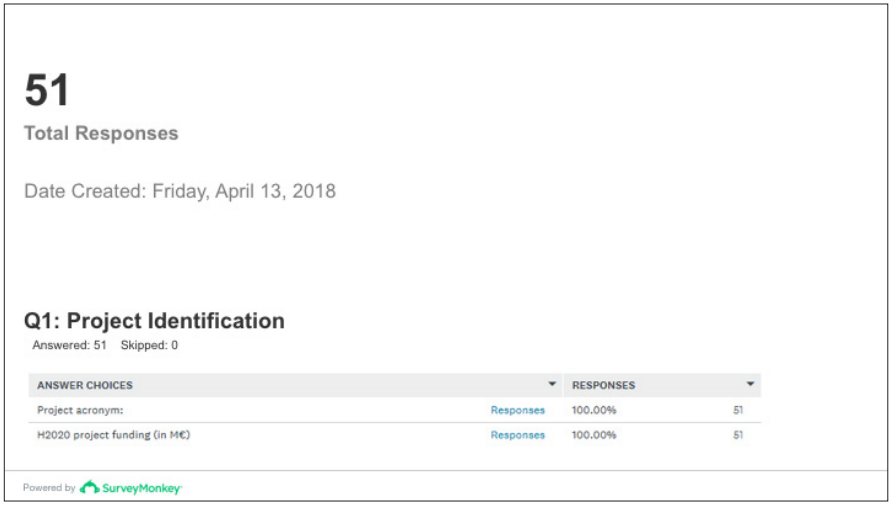
Press release "Life-saving drones use photonics to transform disaster rescue efforts" related to the PPP Project FLAIR – as displayed in the Annex to the Photonics PPP Annual Activity Report 2017. Source: VDI TZ GmbH / Matter PR.

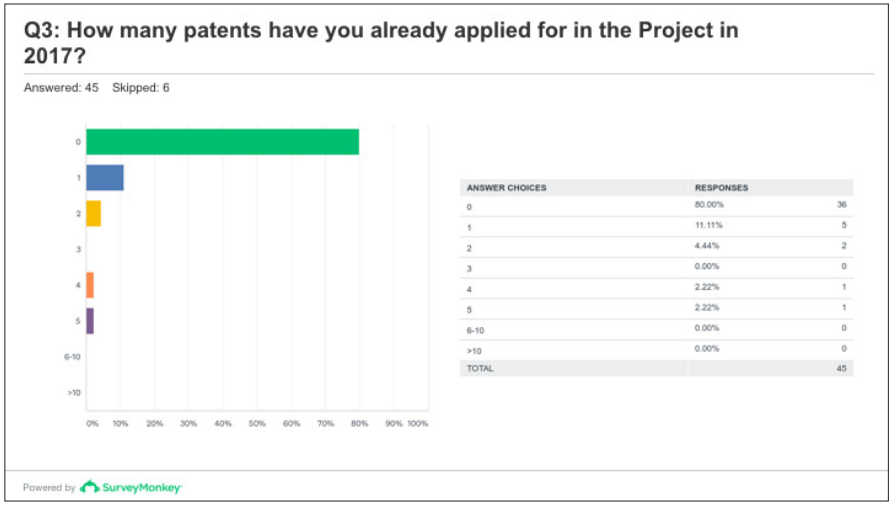
Annex – Part 5: Online Survey Horizon 2020 Photonics PPP Project Survey 2017 – conducted April 2018[82]

The online survey was conducted in April 2018 using SurveyMonkey[83]. The detailed results of the survey are displayed in the following slides:[84]









[82] It should be noted that remarks concerning the KPIs evaluation, as made in the final PMR review reports in 07/2018, could not be taken into consideration for this year's online survey, since the online survey among the cPPP Project coordinators had been completed before. All remarks will be addressed in-depth in the preparation of the cPPP PMR 2019.

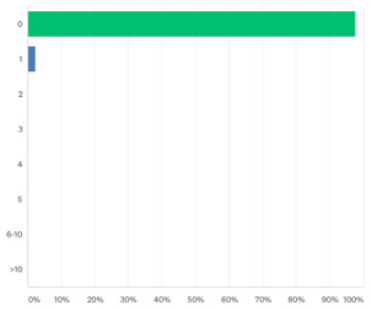
[83] SurveyMonkey Inc., San Mateo, California, USA, www.surveymonkey.com.

[84] Slides created by SurveyMonkey and edited by VDI TZ GmbH.

Annex – Part 5: Online Survey Horizon 2020 Photonics PPP Project Survey 2017 – conducted April 2018

Q4: How many patents have been granted to the Project in 2017?

Answered: 45 Skipped: 6

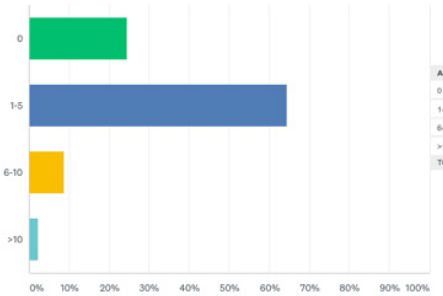


ANSWER CHOICES	RESPONSES	
0	97.78%	44
1	2.22%	1
2	0.00%	0
3	0.00%	0
4	0.00%	0
5	0.00%	0
6-10	0.00%	0
>10	0.00%	0
TOTAL		45

Powered by SurveyMonkey

Q6: How many joint public-private publications have been issued in the scope of the project?

Answered: 45 Skipped: 6

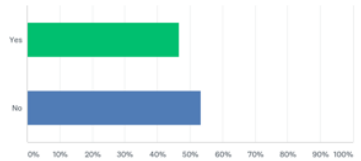


ANSWER CHOICES	RESPONSES	
0	24.44%	11
1-5	64.44%	29
6-10	8.89%	4
>10	2.22%	1
TOTAL		45

Powered by SurveyMonkey

Q5: Are there standardisation activities or contribution to new standards at project level?

Answered: 45 Skipped: 6

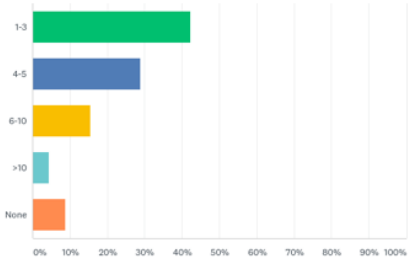


ANSWER CHOICES	RESPONSES	
Yes	46.67%	21
No	53.33%	24
TOTAL		45

Powered by SurveyMonkey

Q7: Please estimate how many project results will be taken-up for higher Technology Readiness Levels using additional investments?

Answered: 45 Skipped: 6



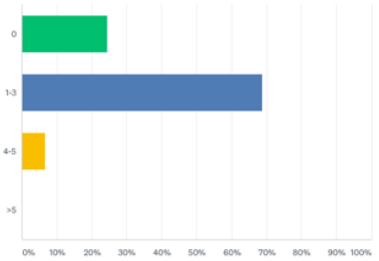
ANSWER CHOICES	RESPONSES	
1-3	42.22%	19
4-5	28.89%	13
6-10	15.56%	7
>10	4.44%	2
None	8.89%	4
TOTAL		45

Powered by SurveyMonkey

Annex – Part 5: Online Survey Horizon 2020 Photonics PPP Project Survey 2017 – conducted April 2018

Q8: Please roughly estimate the overall industrial project partners´ factor of leveraged investment in Research and Innovation (compared to H2020 project funding in 2017).

Answered: 45 Skipped: 6

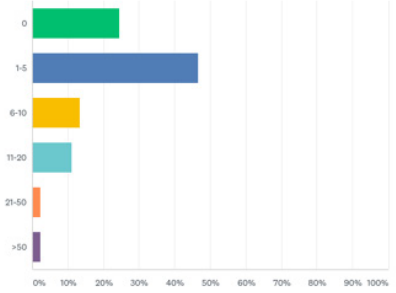


ANSWER CHOICES	RESPONSES	
0	24.44%	11
1-3	68.89%	31
4-5	6.67%	3
>5	0.00%	0
TOTAL		45

Powered by SurveyMonkey

Q10: Please roughly estimate the number of new high-skilled jobs created from your project in 2017:

Answered: 45 Skipped: 6

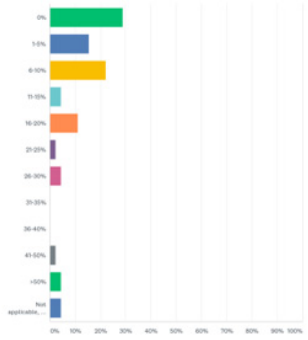


ANSWER CHOICES	RESPONSES	
0	24.44%	11
1-5	46.67%	21
6-10	13.33%	6
11-20	11.11%	5
21-50	2.22%	1
>50	2.22%	1
TOTAL		45

Powered by SurveyMonkey

Q9: Please roughly estimate the increase in turnover expected in SMEs participating in your Project in 2017?

Answered: 45 Skipped: 6

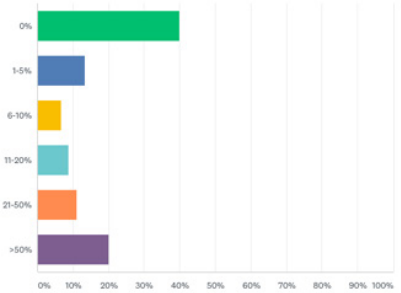


ANSWER CHOICES	RESPONSES	
0%	28.89%	13
1-5%	15.56%	7
6-10%	22.22%	10
11-15%	4.44%	2
16-20%	11.11%	5
21-25%	2.22%	1
26-30%	4.44%	2
31-35%	0.00%	0
36-40%	0.00%	0
41-50%	2.22%	1
>50%	4.44%	2
Not applicable, no SME participating in the project	4.44%	2
TOTAL		45

Powered by SurveyMonkey

Q11: Please estimate which percentage of this job increase is attributable to SMEs ?

Answered: 45 Skipped: 6



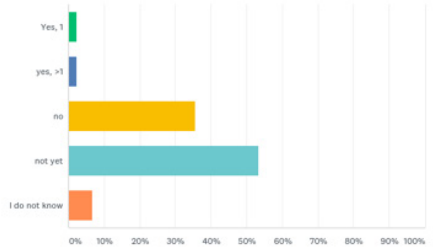
ANSWER CHOICES	RESPONSES	
0%	40.00%	18
1-5%	13.33%	6
6-10%	6.67%	3
11-20%	8.89%	4
21-50%	11.11%	5
>50%	20.00%	9
TOTAL		45

Powered by SurveyMonkey

Annex – Part 5: Online Survey Horizon 2020 Photonics PPP Project Survey 2017 – conducted April 2018

Q12: Has any spin-off / start-up arised from the project?

Answered: 45 Skipped: 6

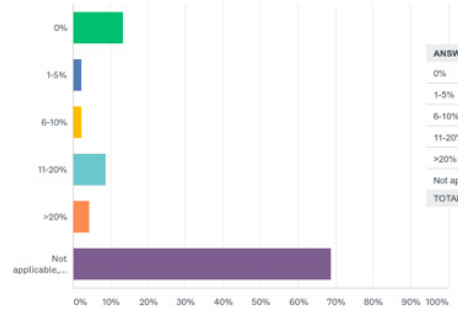


ANSWER CHOICES	RESPONSES	
Yes, 1	2.22%	1
yes, >1	2.22%	1
no	35.56%	16
not yet	53.33%	24
I do not know	6.67%	3
TOTAL		45

Powered by SurveyMonkey

Q13: How much reduction of energy use has been achieved by your project?

Answered: 45 Skipped: 6

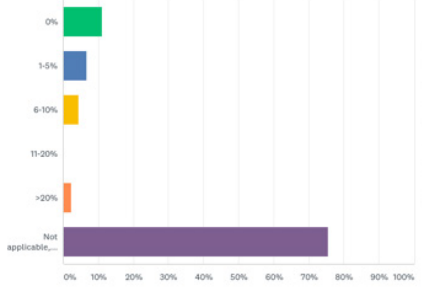


ANSWER CHOICES	RESPONSES	
0%	13.33%	6
1-5%	2.22%	1
6-10%	2.22%	1
11-20%	8.89%	4
>20%	4.44%	2
Not applicable, e.g. not scope of the project	68.89%	31
TOTAL		45

Powered by SurveyMonkey

Q14: How much reduction of CO2 emission has been achieved by your project?

Answered: 45 Skipped: 6

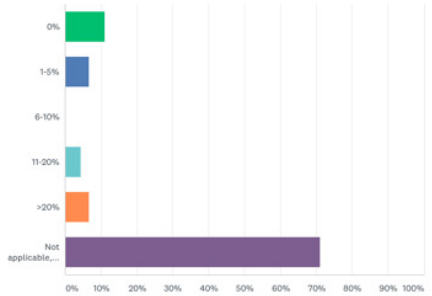


ANSWER CHOICES	RESPONSES	
0%	11.11%	5
1-5%	6.67%	3
6-10%	4.44%	2
11-20%	0.00%	0
>20%	2.22%	1
Not applicable, e.g. not scope of the project	75.56%	34
TOTAL		45

Powered by SurveyMonkey

Q15: How much reduction of waste has been achieved by the project?

Answered: 45 Skipped: 6



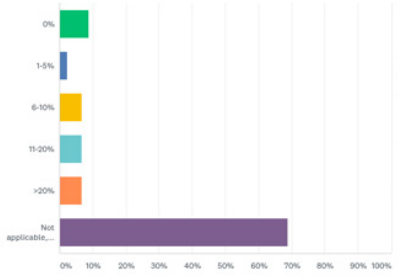
ANSWER CHOICES	RESPONSES	
0%	11.11%	5
1-5%	6.67%	3
6-10%	0.00%	0
11-20%	4.44%	2
>20%	6.67%	3
Not applicable, e.g. not scope of the project	71.11%	32
TOTAL		45

Powered by SurveyMonkey

Annex – Part 5: Online Survey Horizon 2020 Photonics PPP Project Survey 2017 – conducted April 2018

Q16: How much reduction of material resources has been achieved by your project?

Answered: 45 Skipped: 6

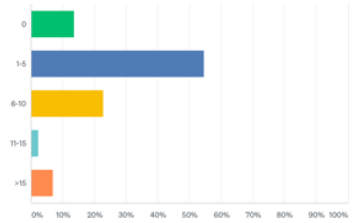


ANSWER CHOICES	RESPONSES	
0%	8.89%	4
1-5%	2.22%	1
6-10%	6.67%	3
11-20%	6.67%	3
>20%	6.67%	3
Not applicable, e.g. not scope of the project	68.89%	31
TOTAL		45

Powered by SurveyMonkey

Q17: How many Outreach, Education and Training events have been conducted in the scope of your project so far?

Answered: 44 Skipped: 7

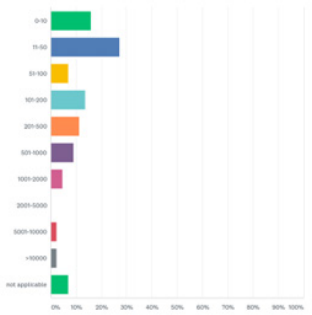


ANSWER CHOICES	RESPONSES	
0	13.64%	6
1-5	54.55%	24
6-10	22.73%	10
11-15	2.27%	1
>15	6.82%	3
TOTAL		44

Powered by SurveyMonkey

Q18: Please specify how many people have been reached or trained in these events?

Answered: 44 Skipped: 7

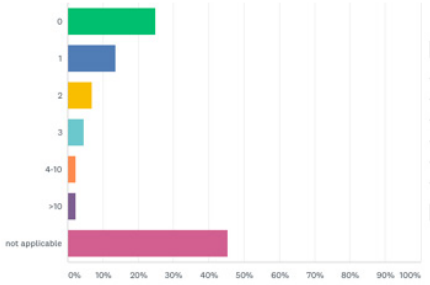


ANSWER CHOICES	RESPONSES	
0-10	15.91%	7
11-50	27.27%	12
51-100	6.82%	3
101-200	13.64%	6
201-500	11.36%	5
501-1000	9.09%	4
1001-2000	4.55%	2
2001-5000	0.00%	0
5001-10000	2.27%	1
>10000	2.27%	1
not applicable	6.82%	3
TOTAL		44

Powered by SurveyMonkey

Q19: Please specify how many new curricula are developed in your project?

Answered: 44 Skipped: 7



ANSWER CHOICES	RESPONSES	
0	25.00%	11
1	13.64%	6
2	6.82%	3
3	4.55%	2
4-10	2.27%	1
>10	2.27%	1
not applicable	45.45%	20
TOTAL		44

Powered by SurveyMonkey

Annex – Part 6: Key results of the study "Photonics in Horizon 2020 – Project Analysis and Assessment of the role of Photonics in Horizon 2020"[85]

A study on the role and contribution of Photonics in past and current Horizon 2020 projects has been initiated by VDI TZ in its function as Photonics21 Secretariat at the beginning of September 2017. The study aimed at examining whether, in Horizon 2020 (and not only in Horizon 2020 Photonics PPP Projects), Photonics plays indeed the role of an enabling technology for new and innovative products, services and developments in areas far beyond obvious lighting application fields.

The main results and highlights of the study, which was performed from September to December 2017, are briefly outlined in the following:

Photonics related projects can be found in almost all Horizon 2020 programmes. Overall, 891 "photonic based projects" were identified among all Horizon 2020 projects. Furthermore, 122 "photonic enabler development projects", i.e. projects developing technologies that will be critical for the implementation of a Photonic technology, as well as 132 projects for which "Photonics [is] a critical enabler" were identified. The share of "Photonics related projects" in Horizon 2020 is therefore about 8.4%. This figure can be put in perspective with the relative share of the Photonics in the European industry in terms of turnover which is around 3.3%. This underlines ***how much Photonics is a key enabling technology and a particularly research-intensive industry***.

Photonics related projects cover all high relevance application markets for tomorrow's society and economy, underlining the fact that ***Photonics is a Key Enabling Technology for providing solutions to tomorrow's major societal challenges***.

Photonics related projects are very well represented in the "Excellent Science" and "Industrial Leadership" pillars. More than 9% of the projects are photonics related. Despite its high relevance for coping with major socio-economic challenges of the future, the importance of photonics is not reflected in the Horizon 2020 pillar "Societal Challenges" (only 4.6% of photonics related within the pillar compared to the average for all programmes of 8.39%) – demonstrating the huge potential to be exploited in the future and, especially to be taken in to account in FP9.

European photonics companies are strongly committed to research and innovation, and Horizon 2020 private sector participation in the photonics segment ranks well above average. The participation of photonics companies in Horizon 2020 projects is higher than in other segments: 37% versus 33.2% on average. One reason for this high proportion of companies may be found in the 'bottom-up' approach of Photonics21 combined with the relevance of the calls proposed to the EC though the Photonics PPP.

At least 50% photonics related projects under ICT calls come from the private sector. This figure is much higher than the average 37% participation of the private sector in all Horizon 2020 photonics related projects. It is likely that this is down to the success of the Photonics PPP for promoting Horizon 2020, making it an effective tool for photonic companies which still are very dependent on their research effort.

Photonic Small and Medium size Enterprises (SMEs) have had a higher than average success rate in submitting 'SME Instrument' (SME-INT) projects, especially for the phase 2 calls. Nearly 15% of the projects which were funded under both phases 1 and 2 from 2014 to May 2017 were photonic projects. The consistency of the projects submitted by the photonic related SMEs was also recognized as 11.35% of the companies which signed a SME-INST-1 also signed a SME-INST-2, compared to the average 5.57% for all H2020.

[85] European Technology Platform Photonics21 c/o VDI Technologiezentrum GmbH, Photonics21 Secretariat (2018): Photonics – a critical Key Enabling Technology for Europe – Role and Impact of Photonics in H2020, Düsseldorf, September 2018.

www.photonics21.org