PHOTONICS PUBLIC PRIVATE PARTNERSHIP

Photonics21 – Photonics cPPP
Progress Monitoring Report 2017

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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 support making European products more competitive. Thus 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 Horizon2020 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 responded 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.

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

- Photonics cPPP was evaluated *best in class* by 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 H2020 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 H2020 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)*

[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 €447 billion 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

[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), Brussel.

[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.

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].

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, current Photonics21 President, 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.

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].

[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.

[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 H2020 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) as well as in Part 4 of the Annex to this report.

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 as review milestones for the ongoing Photonics PPP projects and milestones 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 socio-economic needs upcoming 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 **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.

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

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. Promote technology entrepreneurship and investment in the European photonics sector and 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

[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.

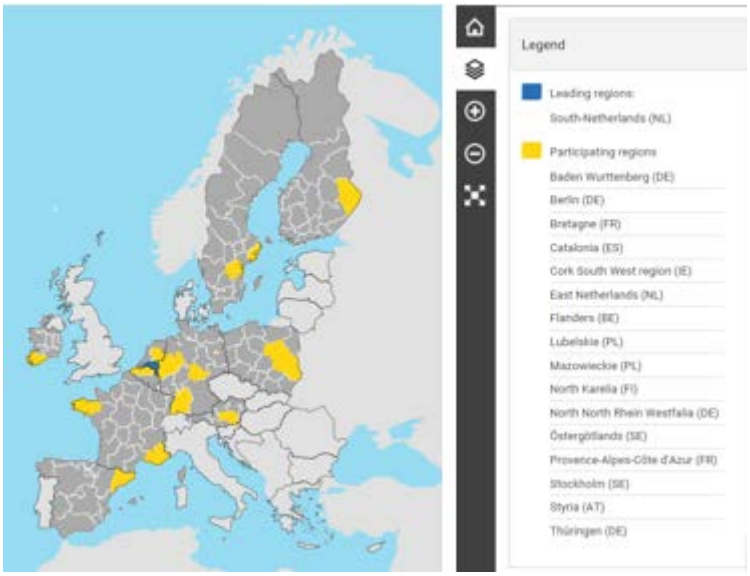
brings together 40 specialized investors or corporate partners to enhance investment interest and readiness amongst the SMEs and start-ups.

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.



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

Photonics PPP project impact and success stories reached out to nearly 15 mio 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 industry across Europe promote the value and potential uses of photonics as well as raising awareness with the public. Furthermore, in 2017, 7 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.

[17] https://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 Horizon2020 Photonics PPP: in the course of 2017, the Photonics21 website 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, Photonics PPP projects and activities in members states and regions.

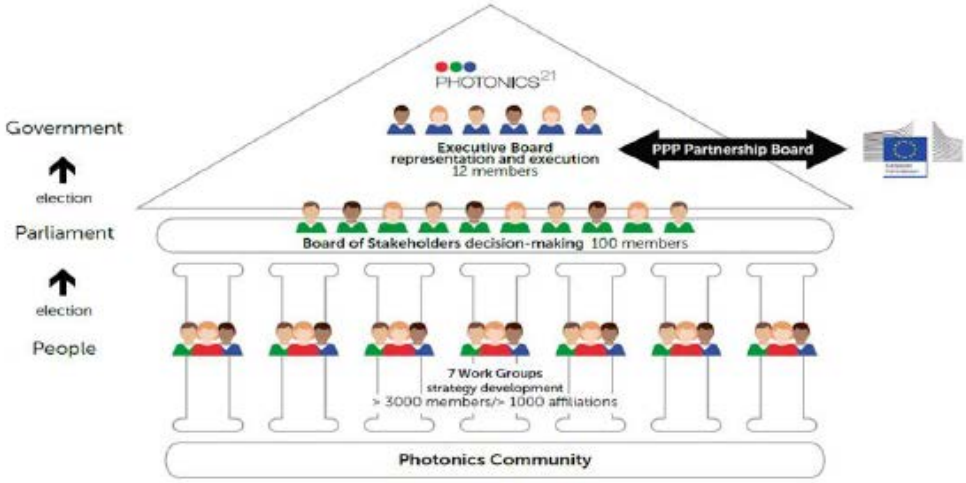
2.3 Governance

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 Horizon2020 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.

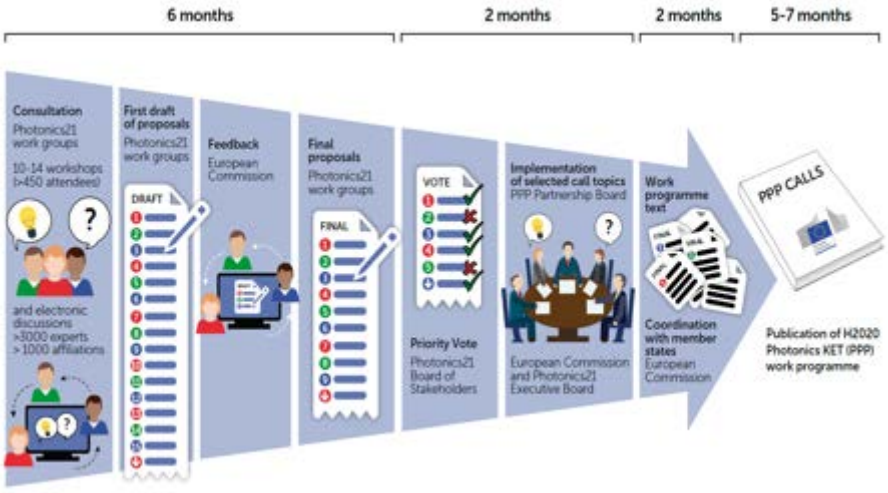
[19] cPPP PMR 2016.



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 H2020 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 (to be published in 2018): Photonics in Horizon 2020 – Project Analysis and Assessment of the role of Photonics in H2020.

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%.49 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 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 European photonic market.[25]

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

[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.

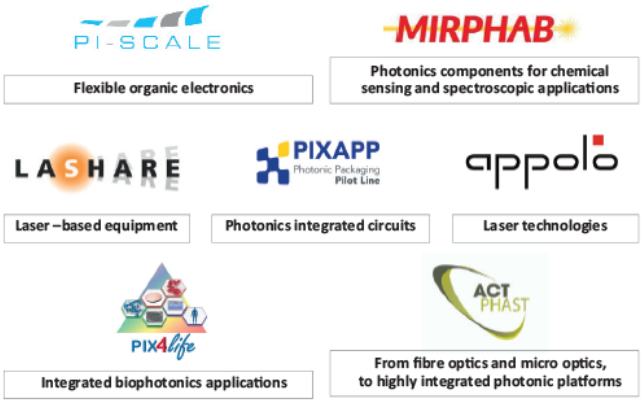
segments like Machine vision / measurement & image processing (CAGR +5.6%), medical technology (CAGR +5.3%) and production technology (CAGR +4.7%). Today, the European Photonics industry holds high global market share in Photonics for the production technology (50%), Optical measurement & image processing (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".

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

[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 https://www.innoradar.eu/.

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]

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

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]

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.

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

[29] http://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] http://www.cardis-h2020.eu/, last accessed on 2018/09/06.
[34] http://innoderm2020.eu/, last accessed on 2018/09/06.
[35] http://www.ultrasurface.eu/, last accessed on 2018/09/06.
[36] https://www.hiperdias.eu/, last accessed on 2018/09/06.

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.

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.

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

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 crises 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%.

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.

[37] http://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 2018.

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 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 cover 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.

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 H2020 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 H2020 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 H2020 programmes. From the 13643 projects examined in the Cordis database as of May 2017 they

[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 2018.

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

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

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

[53] Study to be published in 2018; for more details on the results of the study, see Annex Part 7.

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 EUR industry investments on Photonics Innovation in Europe in 2015[56]: In total European Photonics Industry showed in 2015 Innovation Spending (R&D spending and Capex) in Europe in the size of € 9.6 billion – about € 6.4 billion for R&D spending and € 3,1 billion for Investment (Capex). [57]

R&D intensity in the Photonics industry amounts to nearly 10%[58]: On average, European Photonics companies spent in 2015 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

[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 H2020 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.

[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.

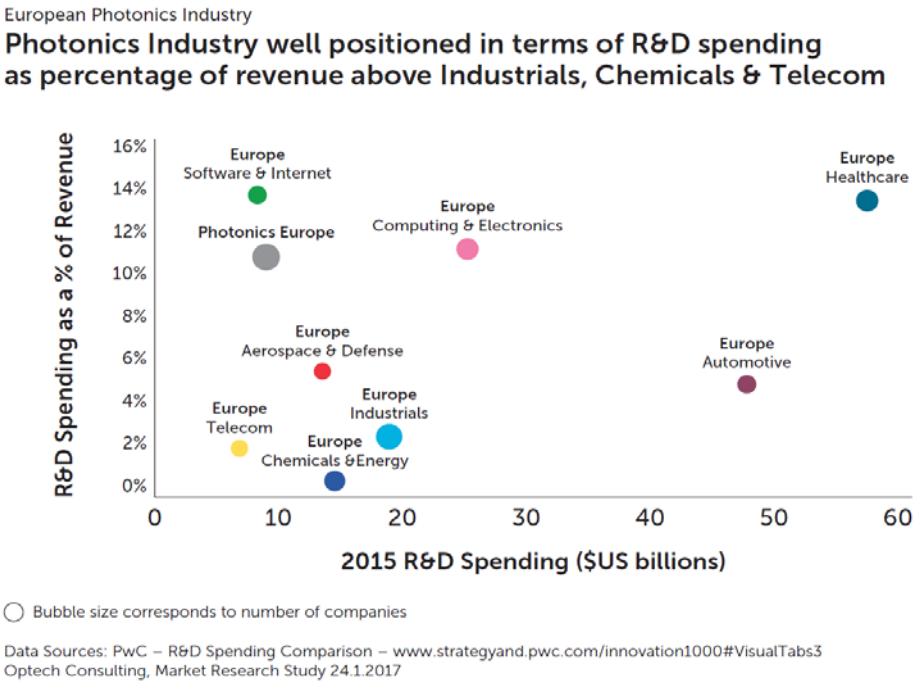
[59] European Technology Platform Photonics21 c/o VDI Technologiezentrum GmbH, Photonics21 Secretariat (2017): Market Research Study, Photonics 2017, Brüssel / Düsseldorf / Tägerwilen, May 2017.

[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.

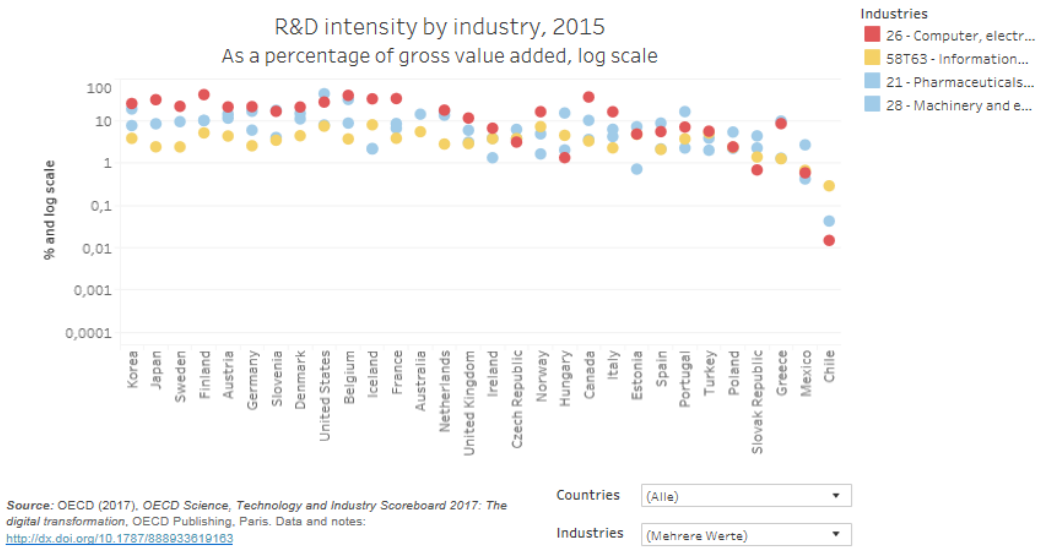
appears – according to a PwC Study - that the R&D intensity in the European Photonics industry is much higher than in most other industry sectors – even beyond the Aerospace & Defence sector, the automotive sector, the Industrials sector, and the Chemicals & Energy sector. [63]



R&D Spending in the Photonics Industry compared to other sectors

(Source: Key Data Photonics Research Study 2017, https://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]

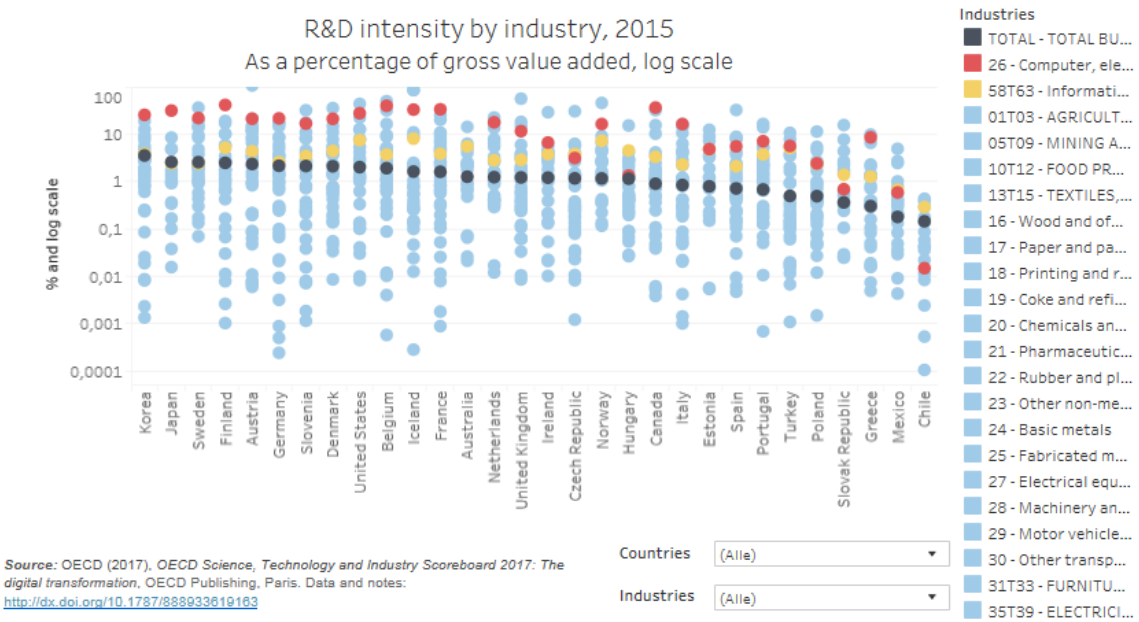


International comparison of R&D intensity by industry – Focus on Computer, electronic and optical products (Cat. 26), Information and Communication (Cat. 58T63), Pharmaceuticals, Medicinal chemical and botanic products (Cat. 21) and Machinery and Equipment (Cat. 28). -

(Source: OECD 2017, OECD's Analytical Business Enterprise Research and Development (ANBERD) database: http://www.oecd.org/innovation/inno/anberdanalyticalbusinessenterpriseresearchanddevelopmentdatabase.htm)

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

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



International comparison of R&D intensity by industry – All industries considered
(Source: OECD 2017, OECD's Analytical Business Enterprise Research and Development (ANBERD) database: http://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 (Horizon2020+2 years).

Already at this stage where most of the Photonics PPP project 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: € 9,6 bio. Euros + € R&D spending of 3,1 bio.) and indicates a far higher innovation spending than the EU funding for Photonics under Horizon 2020 which is in the range of € 0,7-1,0 bio.

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 H2020, 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), of which 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, they are 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 project 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/project (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-off's / Start-up's 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.

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 (Horizon2020 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.

[65] For full survey report – go to Annex Part 6.

[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".

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:

Call Reference	Submitted proposal			Evaluation results		Success rate%
	Submitted proposals	Eligible proposals	% of retained	Above threshold	Selected for funding	
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 Horizon2020 mid-term evaluation[67]:

Overview of evaluation results of the Horizon 2020 PPP:

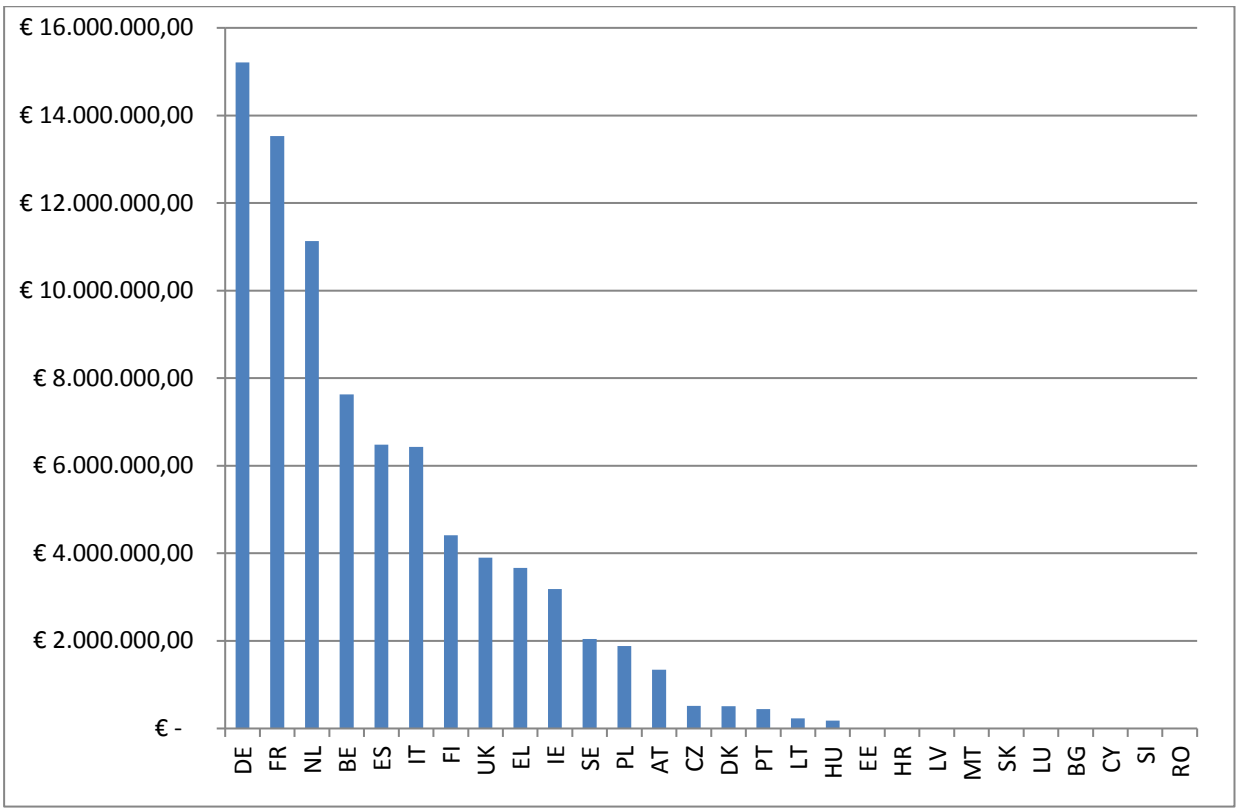
Table 7. Multi-dimensional analysis of all cPPPs. Evaluation levels: **WOT**="Well on Track", **STG**="Shift the Gear" and **NE**="Not evaluable".

Evaluation dimension	5G	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

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 Horizon2020 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 H2020 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 H2020 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 Horizon2020 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

[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] Study on the role and contribution of Photonics in past and current H2020 projects initiated and carried out by VDI TZ in its function as Photonics21 Secretariat in fall 2017 – to be published in 2018. For more details, see also Annex Part 7.

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.

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 (FP9) 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 Horizon2020. Make it easier to carry out joint funding activities with

[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.

these areas, 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.

PMR: Annex

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

[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.

	Key Performance Indicator (KPI)	Value in {2017}	Baseline at the start of H2020 (latest available)	Target (for the cPPP) at the end of H2020	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 H2020 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	
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	Reference to FP7 results	From the CA	

		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.			
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 H2020]	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 H2020 (latest available)	Target (for the cPPP) at the end of H2020	*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.

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;	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.

			6.8% have conducted more than 15 events. In nearly 50%, these events reached more than 50 people.			
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 5 Photonics related projects in almost all H2020 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 H2020 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*
7	Socio-economic Impacts	KPI 7: R&I investments of the photonics industry in the PPP objectives	Nearly 10 billion EUR industry investments on Photonics Innovation in Europe in 2015			*Extensive data can be found in the PPP Impact*

			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			*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.			
10	Operational aspects of the PPP	KPI 10: Success stories relating to key developments in photonics by H2020 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 5 Photonics Media Campaign 2017 Cf. 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.

11	Operational aspects of the PPP	KPI 11: Coordination of the PPP Implementation with the Member States and the Regions	Linking up the Horizon2020 Photonics PPP actions with member states and regions to maximize impact of the Photonics PPP Coordinating the regional and European photonics strategy – joined 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 Horizon2020 Photonics PPP Cf. §2.2 Cf. Annex Part 5 Photonics Media Campaign 2017			

Annex – Part 3 Contribution to Programme-Level KPI's[80] [81]

	Key Performance Indicator	Data	Baseline at the start of H2020 (latest available)	Target (for the cPPP) at the end of H2020	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 Euro, 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 0,94 per €10M funding	H2020: 3 patent applications per €10 million funding	H2020 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.
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*	No target	Baseline categories slightly different from the data collected in the online survey – not allowing a direct comparison.

[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.

			Standardisation Bodies: 4 (Based on 8 successful FP7 projects finished) *Number of pre-normative research files – prEN - under consultation in ESBs: Not reported*		
3	Operational performance	Average time-to-grant: 205 days.	256 (baseline, as displayed in the cPPP PMR 2016).		
4	**H2020 - 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: Overview on funded Photonics cPPP projects

The following table displays all current and past photonics PPP projects.[82]

Call	Project acronym	Funding Scheme	EU Funding	Description of Project & Objectives
H2020-ICT-2017-1	**3PEAT**	RIA - Research and Innovation action	EUR 3 993 285	3PEAT will develop a powerful photonic integration technology with all size, functionality and quality credentials in order to help a broad range of optical applications like optical switching and remote sensing, to achieve a strong commercial impact. In order to do so, the project will introduce a fully functional 3D photonic integration platform based on the use of multiple waveguiding layers and vertical couplers in a polymer technology (PolyBoard), as a means to disrupt the integration scale and functionality. Moreover, 3PEAT will combine this powerful 3D photonic technology with a silicon-nitride platform (TriPleX), via the development of a methodology for the deposition and processing of multilayer polymers inside etched windows on TriPleX chips. In parallel with the development of this hybrid 3D technology, 3PeaT will bring a number of key innovations at the integration and component level relating to: a) the heterogeneous integration of PZT films on TriPleX platform for development of phase shifters and switches for operation up to 50 MHz, b) the development of a disruptive external cavity laser on the same platform with linewidth less than 1 kHz, c) the development for the first time of an integrated circulator on PolyBoard with isolation more than 25 dB, and d) the development of flexible types of PolyBoards for the purpose of physical interconnection of other PICs. This enormous breadth of innovations can remove the current limitations and unleash the full potential of optical switching and remote sensing and ranging applications. The main switching module that will be fabricated will be a 36×36 optical switch with 20 ns switching time and possibility for power and cost savings of almost 95% compared to standard electronic solutions. The main sensing module on the other hand will be a disruptive Laser Doppler Vibrometer (LDV) with all of its optical units, including its optical beam scanning unit, integrated on a very large, hybrid 3D PIC. [Source: https://cordis.europa.eu/project/rcn/213145_en.html]
FP7-ICT-2013-11	**Actphast / FP 7**	CP - Collaborative project (generic)	EUR 8 000 000	ACTPHAST (Access CenTer for PHotonics innovAtion Solutions and Technology Support) is a unique “one-stop-shop” for supporting photonics innovation by European companies. ACTPHAST supports and accelerates the innovation capacity of European companies by providing them with direct access to the expertise and state-of-the-art facilities of Europe's leading photonics research centres (the ACTPHAST Partners), enabling companies to exploit the tremendous commercial potential of applied photonics. There are 23 research institutes who together make up the ACTPHAST Partners. Together the ACTPHAST Partners provide a full spectrum of photonics technology platforms ranging from fibre optics and micro optics, to highly integrated photonic platforms, with capabilities extending from design through to full system prototyping. The ACTPHAST program is particularly suited to the needs of small to medium-sized enterprises (SMEs) who do not have the financial resources to invest in in-house R&D expertise and state-of-the-art technologies, nor to undertake risky innovation projects. ACTPHAST support is 100% subsidized for projects undertaken with SMEs. [Source: www.actphast.eu]
H2020-ICT-2017-1	**ACTPHAST 4.0**	IA - Innovation action	EUR 9 999 946	ACTPHAST 4.0 (ACceleraTing PHotonics innovAtion for SMEs: a one STop-shop-incubator) is a unique photonics innovation incubator for Europe which is perfectly aligned with the needs of SMEs in overcoming the challenges and seizing the opportunities afforded by the new digital revolution of Industry 4.0 in which photonics technologies are a key enabler. ACTPHAST 4.0 will directly support the broader and faster take-up of photonics by a critical mass of SMEs by providing action-oriented solutions on two complementary levels, driven by the business needs of the companies: (i) ready-made access to rapid prototyping services using the top photonics technologies and expert know-how of Europe’s leading photonics competence centers covering the entire integrated supply chain of photonics technology platform capabilities to make deep interventions in the SMEs’ new product development through focused short-duration co-innovation projects; combined with (ii) professional coaching on the technical, business and financial aspects of the innovation process, from concept feasibility through to a mass-manufacturable marketable product. ACTPHAST 4.0 is designed to ensure that all of Europe’s SMEs, in

[82] All websites referenced to in the table were last accessed on 2018/05/08.

				particular first users and early adopters across a wide range of end user industries, have open access to the incubator for timely, efficient and cost-effective photonics innovation support. As a result, ACTPHAST 4.0 expects to boost photonics innovation in Europe at a scale and with a leveraging factor never seen before, delivering a substantial increase in the revenues, venture capital and jobs across all of the supported companies. In addition, through its tight links with the EU pilot lines, as well as its collaboration with smart "first mover" regions across the EU on best practices for co-funding on SME innovation, ACTPHAST 4.0 will act as a game-changer in revitalizing European manufacturing and as one of the vital catalysts to the successful digitization of European industry. [Source: https://cordis.europa.eu/project/rcn/212480_en.html]
H2020-FoF-2014	**ADALAM**	RIA - Research and Innovation action	EUR 3 764 635	The main objective of the project is to develop a sensor based adaptive micro machining system using ultra short pulsed lasers for zero failure manufacturing. Finalizing the project scope and objectives the developed solution will be extended and optimized for 3 applications: •Adaptive micro milling, •Defect detection and removal on wafer carriers, •Recognition and texturing of complex tool features [Source: http://adalam.eu]
FP7-2013-NMP-ICT-FOF	**APPOLO**	CP - Collaborative project (generic)	EUR 10 999 954	The APPOLO project seeks to establish and coordinate connections between the end-users, which have demand on laser technologies for (micro)fabrication, knowledge accumulated in the application laboratories of research institutes and universities and the laser equipment manufacturers (preferable SMEs: for integration, lasers, beam control and guiding, software, etc.) in order to facilitate faster validation of the process feasibility and adaptation or customization of the technology (equipment) for manufacturing conditions, including reliability of components and their interaction as well as assessment of the dedicated production processes in terms of the process speed, quality and repeatability. The HUB is established to prepare and offer laser equipment validation and certification services for businesses outside the project. Core of the consortium consist of laser application laboratories around Europe which are connected to a virtual hub to accumulate knowledge and infrastructure and promote the easy-to-access environment for development and validation of laser-based technologies. All partners selected a few directions (clusters) for validation of novel laser technologies, including equipments: the ultra-short pulse laser scribing for monolithic interconnects in CIGS solar cells: from laser to pilot line; use of lasers in smart surface texturing for automotive and printing/decoration industries and for the real-3D flexible electronics. Innovative SMEs are related to large system-integrators and end-users through the application laboratories. [Source: www.appolo-fp7.eu]
H2020-ICT-2016-1	**AQUARIUS**	RIA - Research and Innovation action	EUR 3 891 263,75	AQUARIUS proposes disruptive improvements in laser based water sensing employing MIR quantum cascade lasers (QCLs). It is motivated by i) the EC Water Framework Directive (2000/60/EC) where hydrocarbons are identified as priority hazardous substances, ii) the industrial and regulatory need for fast and continuous detection of contaminants and iii) the current state-of-the-art of measuring these substances using QCLs as defined by project partner QuantaRed Technologies and described in ASTM D7678. AQUARIUS covers the supply chain from research institutes to system integrator and end users. It will push the online system from TRL 3 to 7 and the inline system from TRL 2 to 4 and thus reinforce the industrial leadership of the project partners regarding QCL based liquid sensing and photonic components (source, detector and IOCs). [Source: http://cordis.europa.eu/project/rcn/206077_en.html]
H2020-ICT-2014-1	**CARDIS**	RIA - Research and Innovation action	EUR 3 629 206	The objective of CARDIS is to investigate and demonstrate the concept of a mobile, low-cost device based on a silicon photonics integrated laser vibrometer and validate the concept for the screening of arterial stiffness, detection of stenosis and heart failure. The objective will be met by: – Investigate, design and fabricate optical subsystems and components; – Integrate the subsystems and build a multi-beam interferometric laser vibrometer; – Develop a process flow scalable to high volumes for all sub-systems and their integration steps; – Investigate and develop the biomechanical model to translate optical signals related to skin-level vibrations into underlying CVD physiological events; – Validate the system in a clinical setting. [Source: http://www.cardis-h2020.eu]

H2020-ICT-2014-1	**CHEQUERS**	RIA - Research and Innovation action	EUR 3 325 668	In a world where explosive, toxic or otherwise lethal substances are, sadly, no longer restricted to theatres of war, but are becoming increasingly common in civilian areas (encountered either by misfortune or misadventure), the ability to detect and identify hazardous chemicals and compounds quickly, easily and at significant range is highly attractive. Even after a terrorist attack has occurred, significant danger still exists from the threat of further concealed devices, thus significantly impeding the rendering of aid whilst the scene is declared safe. Whilst there has been significant investment in sensor technology to address this need, no single solution has yet been demonstrated which can fulfil the often conflicting needs of high sensitivity, speed, low cost, ease of use, portability and the ability to detect and identify multiple target molecular compounds again confused and unforgiving scenes. In the CHEQUERS project, we will address this capability by realising two devices, both based around the same core technologies, which draw on the considerable expertise and excellence of the consortium partners. [Source: www.chequers.eu]
ICT-28a-2015	**COBIOPHAD**	IA - Innovation action	EUR 3 734 780,64	Aim of the COBIOPHAD project is to create a highly innovative, compact disc-based system for improved diagnosis of allergy to antibiotics. The COBIOPHAD project targets the development of a highly sensitive, selective, and multiplexed diagnostic device to provide a quick and inexpensive in vitro test. The test will integrate multiple key enabling technologies [KETs] including photonics, use of advanced materials, opto-electronics, and bio-analytical tools. Using this system, the consortium aims to improve the appropriateness of antibiotic prescriptions which in turn will contribute to the sustainability of healthcare systems and improve the health status and quality of life of millions of European citizens that suffer with β-lactam antibiotics allergies. [Source: http://www.cobiophad.eu/]
H2020-FoF-2014	**COMBILASER**	RIA - Research and Innovation action	EUR 3 439 420	The COMBILASER project presents a great advance with respect to the current state of the art since it is the first time that all issues linked defects avoidance in welding or cladding process applied to parts will be approached from an integral or holistic point of view. The added value will consist on the seamless set up and industrial integration of laser melting and processing manufacturing by the application of a »ICT expert« - The Self-Learning module, which will entail to minimize human expert intervention and reduce process optimization loop for any new application. The always changing market rules and increased production flexibility demands are behind these needs as industrial drivers. The main outcome is oriented to commercially incorporate self-learning systems (able to coordinate and synchronize process monitoring and NTD techniques) in laser beam welding or cladding equipment/systems. [Source: http://combilaser.eu/]
H2020-ICT-2014-1	**COMPLETE**	CSA - Coordination and support action	EUR 718 250	The ultimate goal of the project is to optimize the usage of public funds for building beyond state-of-the-art public networks. The key approach towards this goal is a creation of a common information platform for public procurers and support them in the whole procurement process chain by providing the organizational and technical expertise. [Source: http://photonics-complete.eu]
ICT 27-2015	**COSMICC**	RIA - Research and Innovation action	EUR 3 736 897,50	The COSMICC consortium partners share the vision of mass commercialization of Silicon photonics based transceivers being possible starting in 2019 by enhancing the existing photonic integration platform of ST-Microelectronics. COSMICC (Figure1). Combining CMOS electronics and Si-photonics with innovative-high-throughput fiber-attachment techniques, COSMICC will develop optical transceivers that will be packaged on-board and that are scalable to meet the future data-transmission requirements in data-centers and Super computing systems. [Source: http://www.h2020-cosmicc.com/]

H2020-ICT-2016-1	**CVENT**	RIA - Research and Innovation action	EUR 4 260 790	Cardiovascular disease (CVD), more specifically, vulnerable plaque rupture, remains the major cause of death for people at middle age. The CVENT consortium will revolutionize screening, diagnosis and monitoring of CVD by means of a compact photoacoustic imaging (PAI) system for vulnerable plaque imaging. In the carotid arteries feeding the brain, vulnerable plaque rupture initiates cerebrovascular ischemic attacks. The state-of-the-art decision-making approach for a high-risk surgical intervention to avoid plaque rupture is based on stenosis severity alone, measured with ultrasound (US) imaging. However, this does not distinguish between vulnerable (rupture-prone) and stable (harmless) plaques, leading to severe overtreatment. Consequently, there is a worldwide unmet and urgent clinical need for functional information to enable in-depth diagnosis of carotid plaque vulnerability, avoiding cardiovascular events (CVENT) and reducing overtreatment risk. The objective of the CVENT consortium is the development of a portable multimodal and multiwavelength PAI system with a 3 cm imaging depth, for diagnosis and monitoring of carotid plaque vulnerability. The combination of high optical contrast of PAI and the high resolution of US will be used to identify plaque vulnerability markers, typically lipid pools and intra-plaque haemorrhage. Improved diagnosis of carotid plaque vulnerability will lead to a significant reduction in CVD-related disability and mortality. Simultaneously, by stratifying patients into high and low risk groups, overtreatment is reduced, leading to better allocation of healthcare funds. [Source: http://cordis.europa.eu/project/rcn/206346_en.html]
H2020-ICT-2014-1	**DICOMO**	RIA - Research and Innovation action	EUR 3 277 034,75	X-ray examinations provide valuable information about your health and play an essential role in medical diagnostics. The state-of-art consists of indirect converters (e.g. amorphous Silicon backplane and photodiodes stacked with CsI scintillators) which achieve high sensitivity but suffer from poor resolution due to optical cross-talk and direct converters (e.g. amorphous Selenium detectors on amorphous Silicon backplane) which enable high resolution but suffer from poor sensitivity and robustness, especially temperature stability. The goal of the project DiCoMo is to combine the advantages of today's indirect and direct converters - with potential applications being improving the DQE performance of Mammography detectors and MTF performance of Radiography detectors. The new disruptive technology employed in DiCoMo also promises a radical reduction in material and fabrication costs so that the vision of DiCoMo is to provide opportunities for better diagnosis at lower dose and cost in radiography and mammography. [Source: http://dicomo-project.eu]
H2020-ICT-2015	**DIMENSION**	RIA - Research and Innovation action	EUR 2 621 758,75	Forecasts of the interconnect bandwidth trands in datacenters (DC) reveal that DC traffic will increase significantly while most of the DC traffic will remain within the DC in the next years. In order to achieve high-bandwidth energy-efficent and compact optical interconnects the electro-optical systems and components have to be fully integrated on chip. DIMENSION project aims for establish a truly integrated electro-optical platform. The **main objectives** of DIMENSION are: •Establish a silicon platform monolithically combining BiCMOS electronics with silicon photonics and III-V photonics; •Fully CMOS compatibility; •Integrated devices, with CMOS, photonic and III-V functionality at the cost of silicon volume fabrication. [Source: www.dimension-h2020.eu/]
H2020-FOF-2016	**DREAM**	RIA - Research and Innovation action	EUR 3 242 435	The aim of DREAM is to significantly improve the performances of laser Powder Bed Fusion (PBF) of titanium, aluminium and steel components in terms of speed, costs, material use and reliability, also using a LCA/LCC approach, whilst producing work pieces with controlled and significantly increased fatigue life, as well with higher strength-to-weight ratios. DREAM targets the development of a competitive supply chain to increase the productivity of laser-based AM and to bring it a significant step further towards larger scale industrial manufacturing. In order to upscale the results and to reach an industrial relevant level of productivity, the project is focused on the following four main challenges: (i) Part modeling and topology optimization; (ii) Raw material optimization to avoid powder contamination; (iii) Process optimization, including innovations of the control software of the AM machine, to enable high throughput production; (iv) Setup of laser-PBF of nanostructured Titanium alloys with unchanged granulometric dimension for an additional push to higher productivity, since nanostructured metal powders can be sintered with lower energy input and faster speed. The project, thanks to the three end-users involved, is focused on components for prosthetic, automotive and moulding applications to optimize the procedure for three different materials, respectively titanium, aluminium and steel. [Source: http://cordis.europa.eu/project/rcn/205518_en.html]

H2020-FOF-2016	**ENCOMPASS**	RIA - Research and Innovation action	EUR 4 040 371,25	The ENCOMPASS project principally aims to create a fully digital integrated design decision support (IDDS) system to cover the whole manufacturing chain for a laser powder bed fusion (L-PBF) process encompassing all individual processes within in. The ENCOMPASS concept takes a comprehensive view of the L-PBF process chain through synergising and optimising the key stages. The integration at digital level enables numerous synergies between the steps in the process chain and in addition, the steps themselves are being optimised to improve the capability and efficiency of the overall manufacturing chain. ENCOMPASS addresses the three key steps in the process chain: component design, build process, and post-build process steps (post-processing and inspection). By considering the entire AM process chain, rather than the AM machine in isolation, ENCOMPASS will integrate process decision making tools and produce substantial increases in AM productivity, with clear reductions in change over times and re-design, along with increased 'right-first time', leading to overall reductions in production costs, materials wastage, and over-processing. This will lead to higher economic and environmental sustainability of manufacturing, and re-inforce the EU's position in industrial leadership in laser based AM. [Source: http://cordis.europa.eu/project/rcn/205599_en.html]
H2020-ICT-2016-1	**EPRISE**	CSA - Coordination and support action	EUR 1 402 792,50	EPRISE project aims to promote and support Photonics as a KET with focus on Life Science applications in 4 target markets where Europe holds a leading position – Medical Technologies, Pharmaceuticals, Agriculture and Food. Companies developing photonics-based products for these markets face highly specific Go-to-Market challenges such as long time to market adoption, complex regulatory frameworks and high barriers to market entry to name but a few. They are often in need of support from public funding to help them cross the "Valley of death" between innovation ready phase (TRL 4), and investment ready phase (TRL 7). During this time, they are also in need of advice from market specific experts who can guide them on non-technological (business) topics. EPRISE consortium will organise a "European Photonics Roadshow", a series of 7 major events hosted by European regions, with the aim of providing SMEs with concrete solutions from market experts on how to overcome market barriers and boosting collaboration along the complete value chain via pre-arranged B2B meetings. The project also aims to provide regional policy makers with an overview of funding synergies to be considered in the current or following Multiannual Financial Framework (MFF). Furthermore, the project aims to establish a formal collaboration with the ongoing European Photonics projects offering technology support (ActPhast, Pix4Life) that can address potential technology issues linked to SMEs access to market. [Source: http://cordis.europa.eu/project/rcn/206199_en.html]
H2020-ICT-2016-1	**ESOTRAC**	RIA - Research and Innovation action	EUR 4 000 602,50	More than 450.000 people are diagnosed with esophageal cancer (EC) each-year worldwide and approximately 400.000 die from the disease. Esophageal cancer is the eighth most commonly diagnosed cancer, but it is the sixth leading cause of cancer-related death, with incidence rates steeply rising. Risk factors, including gastroesophageal reflux disease and Barrett's esophagus, may diagnostically implicate more than 300 million people worldwide. Nevertheless, the disease is detected late due to limitations in current diagnostic procedures leading to adverse prognosis and high treatment costs. ESOTRAC will change the landscape of esophageal diagnosis, over existing methods, based on cross-sectional optoacoustic and optical coherence endoscopy. The dual-modality system delivers a set of early-cancer imaging features necessary for improving early diagnosis, saving lives and leading to 3-5 Billion annual savings for the healthcare system. OCT provides micron scale subsurface morphological information based on photon scattering and optoacoustics provides deeper penetration and complementary pathophysiological features based on photon absorption. ESOTRAC develops novel photonic components (light sources, optical/optoacoustic scopes) and innovates novel medical system designs. Then, it performs pilot studies to investigate the functionality of the new endoscope and deliver a novel imaging-feature portfolio offering improved and earlier diagnosis. A central ESOTRAC ambition is that the new endoscope will become the new EC diagnostic standard by enabling quantitative and label-free three-dimensional endoscopy of early cancer with tremendous potential to impact esophageal care. ESOTRAC leverages European investment and know-how and strengthens the prospects of economic growth by leading the market position in endoscopic imaging. [Source: http://cordis.europa.eu/project/rcn/206370_en.html]

H2020-ICT-2016-1	**FLAIR**	RIA - Research and Innovation action	EUR 3 072 020	FLAIR aims at developing an airborne, compact and cost-effective air quality sampling sensor for sensitive and selective detection of molecular fingerprints in the 2-5 µm and 8-12 µm infrared atmospheric windows. The sensor is based on an innovative supercontinuum laser that provides ultra-bright emission across the entire spectrum of interest. Such a light source in combination with a novel type of multipass cell in conjunction with specifically developed uncooled detector arrays will ensure highly sensitive detection. Broadband single-shot 2D high resolution absorption spectra capture will allow highly selective molecular detection in complex gas mixtures in the ppbv levels in real time. This high performance sensor constitutes a breakthrough in the field of trace gas spectroscopy. Moreover, in a hybrid approach, the main spectroscopic sensor will be complemented by a fine particle detector in order to obtain a complete picture of the air quality. Mounted on an adapted and optimized UAV (drone), the sensor will enable pervasive sensing on large scales outside urban environments where air quality monitoring remains challenging, e.g. along gas pipelines or around chemical plants. Also, FLAIR can guide emergency measures in case of chemical fires or leaks, wildfires or volcanic eruptions or even serve for oil and gas exploration or explosives related molecules detection, by far more cost-effectively than for missions on manned research aircraft. As such FLAIR provides a novel and ubiquitous tool addressing air quality related safety issues. The sensor prototype will be tested at TRL 4 in the lab and at TRL 5 on-board a UAV in the context of a well-defined and controlled validation test setting. The project will be carried out by 3 SMEs, 1 industrial partner and 4 RTDs, covering the full value chain (development, implementation and application) of such a sensor for air quality monitoring. Business cases for commercialization routes in a global market will be provided. [Source: http://cordis.europa.eu/project/rcn/206007_en.html]
H2020-ICT-2014-1	**FLEXOLIGHTING**	RIA - Research and Innovation action	EUR 4 358 983,50	The Flexolighting programme targets future full scale up of novel systems for OLED (organic light emitting diodes) manufacture, specifically bridging the gap between new research prototypes and low cost mass production technologies. This three-year programme will develop a set of new materials, methods and processes to address the key issues of lifetime, light uniformity over large areas and manufacturing on flexible or conformable surfaces that currently limit OLED technology being widely adopted as a new lighting system of choice for an entire range of potential applications. The project will not only ensure the successful production of OLED lighting panels at a competitive cost but will also create unique know-how for European manufacturers to create sustainable technology and jobs in both materials and equipment manufacture. [Source: www.flexolighting.eu]
H2020-ICT-2016-1	**GALAHAD**	RIA - Research and Innovation action	EUR 3 996 780	The project GALAHAD targets the critical need for better glaucoma diagnostic systems. Glaucoma is an age-related major cause of blindness. The eye disease is characterized by an irreversible damage to the optic nerve head caused by increased intra-ocular pressure. The current screening and basic diagnostics for the disease involve intra-ocular pressure measurement, visual field tests and detection of structural damage to the optic nerve head and retinal nerve fibre layer. The present methods have high rates of false positive or false negative results since the in depth analysis of optical nerve head damage is not possible due to the poor resolution of available optical technologies. A leading candidate is optical coherence tomography (OCT), but the required axial resolution is ~1 µm, well beyond the 3-5 µm resolution of commercial systems. GALAHAD aims to develop a label free, compact and easy to operate high resolution diagnostic OCT system. The multiband and multimodal system will use submicron ultra-high resolution polarisation sensitive OCT (UHR PS OCT). The key breakthrough elements are: (i) A revolutionary low cost multiband supercontinuum light source. (ii.) Ground-breaking ultra-broadband photonic components required to exploit such a source. (iii.) Automated glaucoma screening algorithms: using end user evaluation of cell and animal models and tissue samples, automated algorithms will be developed, trained and tested so that non-expert operators will be able to perform glaucoma screening. The GALAHAD in depth glaucoma diagnostics after a positive screening with conventional methods will dramatically reduce false positive and false negative screening results and decrease the number of patients suffering from glaucoma-related disability. [Source: http://cordis.europa.eu/project/rcn/207029_en.html]

H2020-ICT-2015	**HAMLET**	RIA - Research and Innovation action	EUR 3 487 401,25	The new generation of broadband microwave systems in various fields (wireless communications, satellite communications, sensing, medical imaging) and especially the emerging 5G wireless technology, have very high requirements in terms of carrier frequency, bandwidth, dynamic range, size, power consumption, tunability, and immunity to electromagnetic interference. In parallel, when the microwave signals that need to be processed have a very high carrier frequency, the integrated circuits should be able to offer high-bandwidth modulation and detection. The aim of the project HAMLET is to extend the capabilities of two existing photonic platforms, develop an advanced hybrid integration engine and provide a new photonic platform tailored to needs of modern Microwave Photonics applications and especially the upcoming 5G wireless technology. [Source: www.ict-hamlet.eu]
ICT 27-2015	**HIPERDIAS**	RIA - Research and Innovation action	EUR 3 640 307,50	Driven by the end-users requirements and needs, the main objective of the HIPERDIAS project is to demonstrate highthroughput laser-based manufacturing using high-power, high-repetition rate sub-1ps laser. Although the laser system to be developed within HIPERDIAS can address other material processing applications, the focus here will be 3D structuring ofsilicon at high speed, precision processing of diamond material and fine cutting of metal for the watch and the medical industry. The final targest of the project are to demonstrate: •a 10-times increase of ablation rate and producitivity of large area 3D-structuring of silicon; •a 10 times increase of speed in fine cutting metals; •an increase of process speed at a low processing tools costs of diamond machining. [Source: www.hiperdias.eu]
H2020-FOF-2016	**HIPERLAM**	RIA - Research and Innovation action	EUR 3 756 256	HIPERLAM is an SME driven Research and Innovation Action (RIA) well-aligned to the Factories of the Future (FoF) Initiative with a strong emphasis upon demonstrating superior cost and speed performance in end-to-end processes featuring laser-based additive manufacturing in two key applications requiring high resolution printed conductive metallic lines, namely laser printed RFID antenna and laser printed Fingerprint sensors. Existing subtractive top-down process will be replaced by HIPERLAM's additive process for both Applications. Process maps illustrate the existing multiple processing steps compared to HIPERLAM's significantly fewer steps. Real-time diagnostics are included and Modelling investigations will be undertaken to support optimisation. The promise of HIPERLAM's high resolution laser based additive manufacturing solutions is to transform the manufacturing processing speed by 10x for laser printed RFID antenna (Application 1) and 5x in the case of the lead-time for laser printed fingerprint sensor design (Application 2). Similarly, HIPERLAM promises to reduce costs by 20x and 50% respectively for Application 1 and Application 2. HIPERLAM features high resolution LIFT Printing and Laser Sintering utilising novel high viscous inks to achieve printed conductive metallic structures down to 10 µm resolution over large areas (10 to 1000 cm2) suitable for scale-up to full production. The targeted applications address global market needs and will support mainstream adoption of AM processes in EU industry by displacing existing processes with smart, flexible, digitally enabled manufacturing technology. HIPERLAM business cases promise significant revenue growth in both application spaces and in the potential for consortium partners to establish themselves in pre-eminent positions in high resolution, low cost, high throughput AM technology. [Source: http://cordis.europa.eu/project/rcn/205763_en.html]

H2020-ICT-2016-1	**HYPOSENS**	RIA - Research and Innovation action	EUR 3 998 646,25	The Vision of HypoSens is to develop a widely accepted,non-invasive and crucial prognostic tool for breast cancer progression in early stages to help clinicians and specially oncologists to decide about prompt therapy approaches to patients and improve quality of life and expectancy. Our breakthrough research will focus on the development, pre-clinical and clinical validation, and industrial demonstration of a unique all optical cancer prognostic system that will determine presence of cancer cells in the breast lymph nodes and characterize them, which correlates with presence of metastasis and bad prognosis. HypoSens prognostic system will consist of a non-invasive Near-infrared imaging device able to register signals through scattering media enabled by the implementation of wavefront shaping,that will process data collected by injected tumour-targeted body antibody functionalised nano-particles containing porphyrin sensors that will determine local oxygen concentration and local temperature distribution in the cancer cells.The HypoSens imaging system is strategically designed to offer a non-invasive alternative to the Sentinel Lymph Node Biopsy,the current surgical procedure for breast cancer staging. With an approximate cost of 60,000€ per device unit and additional 5,000€ per patient, the device is an affordable, accurate, easy to use prognostic solution for clinicians towards more accurate and fast diagnostics and personalised treatment options.The initial target of the project is metastatic breast cancer, with potential later involvement in other cancer markets, e.g. vulval, renal, colorectal, gastric etc (via the use of different tumor-targeting moiety).With an estimated 1.7 million new cases each year, breast cancer is the most common cancer among women worldwide.Its low cost will enable a wide and fast take-up by clinicians and hospitals leading to an important reduction of the economic and societal burden related to the diagnosis and treatment of cancer. [Source: http://cordis.europa.eu/project/rcn/206198_en.html]
H2020-FOF-2016	**HYPROCELL**	IA - Innovation action	EUR 3 937 331	Individualised production is an emerging trend in manufacturing. Laser-based Additive Manufacturing (LBAM) fits well with this trend, due to its capability of transforming digital designs directly into physical products. LBAM is not yet competitive for a widespread industrial adoption: post-processing operations are necessary and they are not currently integrated, human intervention is needed to overcome technology gaps, and a poor integration with production planning systems hinders process traceability and resource optimisation. HyProCell proposes the combination of available cutting-edge LBAM machines and ICT innovations within an integrated multiprocess production cell, which will include at least LBAM and subtractive manufacturing machine/s, in order to ensure a fully finished product from the incoming raw material. The general objective of HyProCell is to implement and validate this concept in real settings, manufacturing real parts and measuring obtained benefits. HyProCell is expected to produce a sound impact on all the stakeholders of LBAM-related industry: - Making feasible a demand-driven LBAM production process supported on fast manufacturing procedure development capacities; - Creating highly automated and integrated multiprocess production cells, thus reducing dramatically downtime. - Enabling the rapid reconfiguration of the production cells, for scalability and/or new product demands, thanks to their modular architecture. - Fully enabling end-users to address new production trends. Relevant technological impacts are expected on hardware and software levels. A well-balanced consortium representing from machine manufacturers and end-users to Photonics experts, industrial automation specialist, ICT for smart manufacturing providers and technical services assures to meet project goals. Heavy involvement of SMEs (50% of the budget) guarantees an outstanding innovation push. [Source: http://cordis.europa.eu/project/rcn/205596_en.html]
H2020-ICT-2014-1	**I-ALLOW**	RIA - Research and Innovation action	EUR 2 409 223	I-ALLOW's main objective is to develop and demonstrate a civil low cost imaging solution based on a novel multifunctional approach camera system integrated with a high performance processing unit addressing a vast variety of outdoor scenarios for safety and security applications. The features of the solution will be specified, tested and benchmarked with the involvement of potential end-users operating in transportation and logistics and responsible for monitoring of critical infrastructures (railways, motorways, harbours). [Source: http://i-allow.eu]
ICT 27-2015	**ICT-STREAMS**	RIA - Research and Innovation action	EUR 2 917 134,50	ICT-STREAMS aims at developing a radically new optical technology for direct chip-to-chip, board level interconnection paradigm that overcomes the current limitations of server-board designs. It aims to deliver a 1.6 Tb/s mid-board transceiver together with a 25.6 Tb/s-throughput mid-board routing engine onto the same electro-optic PCB, releasing a point-to-point-linked 16-socket server board, increasing server-board density and throughput by >400% and 1600% respectively, with 10 fold reduced energy consumption. [Source: http://www.ict-streams.eu/]

H2020-ICT-2017-1	**IMCUSTOMEYE**	IA - Innovation action	EUR 5 931 669,13	IMCUSTOMEYE will develop a tool based on innovative photonics and modelling approaches in response to the need to personalize healthcare in ophthalmology, improve diagnostics and health outcomes, reduce costs and promote active and healthy ageing, while complying with the objectives of the EU Horizon 2020. IMCUSTOMEYE will contribute to a more effective, customised treatment of eye diseases and to reinforce industrial leadership in the area of diagnostic imaging in ophthalmology. [Source: http://www.imcustomeye.eu/]
ICT-28a-2015	**INNODERM**	IA - Innovation action	EUR 3 869 879,13	The aim of the INNODERM Project is to develop a novel optoacoustic device for earlier non-invasive skin cancer diagnosis. INNODERM will design and prototype a handheld, portable, scalable, label-free device using raster-scan optoacoustic mesoscopy (RSOM) for point-of care dermatology applications. INNODERM brings together key photonic & ultrasound technologies and will validate the technical and economic viability of RSOM in dermatology suites for fast diagnosis and skin disease monitoring. RSOM can go beyond the abilities of current optical or optoacoustic devices and offers a paradigm shift in dermatology imaging, substantiating successful business cases. [Source: http://innoderm2020.eu/]
H2020-ICT-2014-1	**INSPECT**	RIA - Research and Innovation action	EUR 4 143 460	Image-guided needle procedures - such as taking biopsies in screening cancerous tumours - are becoming increasingly important in clinical practice. Today, physicians are severely hampered by the lack of precision in positioning the needle tip. Real-time tissue-characterization feedback at the needle tip during these procedures can significantly improve the outcome of diagnosis and treatment, and reduce the cost of oncology treatment. Spectral tissue sensing using photonic needles has the promise to be a valuable diagnostic tool for screening tumours, as shown by several clinical trials. However, for widespread adoption the cost and size of these photonic needle systems - in particular the spectrometer console - needs to be improved dramatically. InSPECT aims at overcoming today's challenges and developing and integrating photonic building blocks for low-cost miniaturized spectral tissue sensing devices. [Source: http://cordis.europa.eu/project/rcn/194213_en.html]
ICT 27-2015	**L3MATRIX**	RIA - Research and Innovation action	EUR 3 123 966,25	The L3MATRIX project provides novel technological innovations in the fields of silicon photonics (SiP) and 3D device integration. The project will develop a novel SiP matrix with a scale larger than any similar device with more than 100 modulators on a single chip and will integrate embedded laser sources with a logic chip thus breaking the limitations on the bandwidth-distance product. L3MATRIX provides a new method of building switching elements that are both high radix and have an extended bandwidth of 25 Gb/s in single mode fibres and waveguides with low latency. The power consumption of DC networks built with these devices is 10-fold lower compared to the conventional technology. [Source: http://l3matrix.eu/]
FP7-2013-NMP-ICT-FOF	**Lashare**	CP - Collaborative project (generic)	EUR 11 200 000	LASHARE is a European Commission co-funded research project with the goal of sharing laser expertise. Coordinated by the Fraunhofer Institute for Laser Technology ILT, more than 36 partners from industry, small and medium sized businesses (SME) and six of the most renowned research and technology development organisations have teamed up to develop and apply an approach called Laser-based Equipment Assessment (LEA). In this, an industrial user, an SME equipment supplier and a research and technology development partner jointly conduct an assessment of a laser-based equipment. [Source: https://www.lashare.eu/en/publication-and-press/news-2014-12.html]
H2020-ICT-2016-1	**LEDLUM**	RIA - Research and Innovation action	EUR 4 118 521,25	The project LEDLUM (Tiny Light Engine for Large Scale LED Lighting) will make major improvements to the volume, the weight, the lifetime and the size of the driver (electrical engine) of light emitting diodes (LED), that are used in the majority of solid state light (SSL) systems. These improvements will be made while keeping the power rating of the driver. To achieve this, the operating frequency of the driver will be increased by approximately a factor of 1,000. The LEDLUM project aims to reach the following objectives: 90% size and weight reduction of the power electronics part in the LED driver, •reduction of material cost by a factor of 2, •reduction of energy losses by 45%, and •increase of the expected lifetime from 5 to 10 years. [Source: https://ledlum-project.eu/]
H2020-ICT-2014-1	**Light2015**	CSA - Coordination and support action	EUR 979 808,75	LIGHT2015 is a European project funded through the European Union's Horizon 2020 research and innovation programme of the European Commission. It aims to promote the importance of photonics to young people, entrepreneurs and the general public in all Member States of the EU during the International Year of Light and Light-based Technologies 2015 (IYL 2015). LIGHT2015 is structured in terms of three broad objectives: Explain Photonics, Inspire People, and Network Europe. [Source: www.europe.light2015.org]

H2020-ICT-2014-1	**LOMID**	RIA - Research and Innovation action	EUR 3 993 453	The LOMID project (Large cost-effective OLED microdisplays and their applications) will define pathways to the manufacture of flexible OLED microdisplays with an exceptionally large area (16 mm x 20 mm, screen diagonal of 25.4 mm) at acceptably high yields (>65%). This will be achieved by developing a robust silicon-based chip design allowing high pixel counts (1024×1280 (SXGA)) and high spatial resolution (pixel sizes of 10 µm x 10 µm corresponding to 2000 ppi). These display innovations will be coupled to a highly reliable manufacturing of the backplane. [Source: www.lomid.eu]
ICT-28a-2015	**LUCA**	IA - Innovation action	EUR 3 628 845,75	The Horizon 2020 project Laser and Ultrasound Co-analyzer for Thyroid Nodules (LUCA) aims to develop an innovative technology for thyroid cancer screening that will provide doctors with enhanced information required to provide better and more specific results in thyroid nodule screening and enable better diagnosis. Current methods do not provide sufficient support to surgeons in their decision on the appropriate course of action, which leads to significant number of unnecessary surgeries and a reduced quality of life for patients. This calls for an increased sensitivity and specificity of the conventionally applied screening process. LUCA tackles this need by producing a novel, point-of-care, low-cost device for the screening of thyroid nodules. The device will combine two photonics systems, near-infrared diffuse correlation spectroscopy and time-resolved spectroscopy, with a multi-modal ultrasound system and a probe that enables multimodal data acquisition for the screening of thyroid nodules for thyroid cancer. Once successful, LUCA will save millions of euros over the coming decades and improve the lives of millions of Europeans. [Source: http://luca-project.eu/]
H2020-ICT-2014-1	**LUMENTILE**	RIA - Research and Innovation action	EUR 2 470 113,75	LUMENTILE originates from an idea of disruptive innovation, where the joint use of new technologies creates added value and new functionalities for traditional materials, thus turning the classical ceramic tile into a “multifunctional electronic luminous tile” realized by large area and organic electronics. It will exploit frontier technologies in large-area and organic electronics and photonics to develop a new generation of modular luminous components for design-driven applications, where a different meaning is given to the use of light driven by the design, by empowering it to be used as a radical different designed element for architecture, as a skin integrated element for interior design, lighting or advertising purposes. [Source: www.lumentiel-project.eu]
H2020-FOF-2016	**MAESTRO**	RIA - Research and Innovation action	EUR 3 995 905	MAESTRO aims to develop and combine with existing Selective Laser Melting (SLM) techniques five innovations that will constitute the basis of a highly competitive manufacturing value chain: (1) a single pre-process software for a numerical chain combining all mandatory steps and configurations of SLM together with its related pre- and post-processes, (2) Hybridization of SLM with MIM, (3) Adaptive process control of SLM, (4) system level integration of a modular platform, (5) open access to an easy-to-use demonstration platform to reinforce to EU leadership in AM. These innovations will enable SLM to overcome the current limitations (speed, productivity, costs) to address large scale markets: productivity will be improved by 30%, cost reduced by 30% with quality towards zero defect. The performances of the MAESTRO platform will be assessed through a substantial number of demonstrators (7 in total: 4 brought by project partners, 3 selected through a EU-wide dissemination event). [Source: http://cordis.europa.eu/project/rcn/205398_en.html]
H2020-FoF-2014	**MASHES**	RIA - Research and Innovation action	EUR 3 673 157	MAShES aims to develop a breakthrough compact imaging system for RT closed-loop control of laser processing. It will be built on a novel multispectral optics and multisensor arrangement in the VIS-MWIR spectrum. Absolute temperature, geometry, and speed, will be imaged accurately and reliably. RT process control, and cognitive readjustment and process quality diagnosis will be embedded. MAShES will be designed under a modular approach, customizable for different laser processing applications. Scenarios of high added value and impact will be selected for demonstration (e.g. additive manufacturing of large parts, joining of dissimilar materials). As a result, MAShES addresses the development of a novel intelligent and self-adaptive system for continuous and autonomous process control. The use of MAShES system will allow the harmonization of high performance and quality with cost effective productivity, enabling at process level, reconfigurable, adaptive, and evolving factories. End-users would be capable to deal with highly dynamic operations in a productive way. [Source: www.mashesproject.eu]

H2020-ICT-2017-1	**MERLIN**	IA - Innovation action	EUR 4 867 660	The ambition of the MERLIN project is to improve in-depth diagnosis and therapeutic follow-up of diseases that impact the eye's retina. To do so, the MERLIN partners will deliver a novel medical imaging device able to detect pathological alterations in the retina with highly enhanced sensitivity and specificity. The medical applications of this device encompass a wide range of retinal pathologies, including age-related macular degeneration (AMD), as well as chronic vascular conditions, including diabetes. AMD and diabetic retinopathy (DR) are the leading cause of blindness worldwide in people over 55 years of age. Such diseases slowly develop at the microscopic scale in the retina. Using current imaging techniques, it is difficult to detect them at early stage, and it often takes months to assess the effects of treatments. These limitations hinders both the clinical management of patients and the investigation of new therapies. In order to overcome these issues, the device developed in MERLIN will for the first time enable doctors to examine the retina with multiple imaging modalities at both the macroscopic and microscopic scales. Modalities will include ultrafast scanning laser ophthalmoscopy (SLO), optical coherence tomography (OCT) and OCT angiography (OCT-A), while ultrahigh resolution will be provided by adaptive optics technology. This unique combination will reveal previously invisible cellular and microvascular retinal detail in 3 dimensions. The project partners will also develop advanced image processing software for the visualization and quantitative analysis of microscopic structures, and conduct experimentations to optimize and validate performance in AMD and DR patients. As the feasibility of this diagnostic approach has previously been demonstrated in another European R&D project (FP7 FAMOS, 2012-2017), MERLIN will translate the technology from a preexisting laboratory prototype to a nearly commercial device usable in clinical trials. [Source: https://cordis.europa.eu/project/rcn/213189_en.html]
H2020-ICT-2017-1	**MiLEDI**	RIA - Research and Innovation action	EUR 4 130 041,25	The MiLEDI ambition is to demonstrate that the combination of the laser/electron beam technology and the quantum dots (QDs) optical properties are suitable for the micro LED (mLEDs) and micro OLED (mOLEDs) array manufacturing. MiLEDI project will merge nanotechnology and photonics as building blocks that arranged in a proper way give rise to a robust technology that will be applied for industrial production of RGB mLEDs/OLEDs. [Source: https://www.miledi-h2020.eu/]
H2020-ICT-2017-1	**MIRACLE**	IA - Innovation action	EUR 6 133 635,88	MIRACLE will take towards commercialization the first mid-infrared (MIR) arthroscopy probe for in-depth evaluation of articular cartilage enabling early diagnosis of degenerative joint diseases such as osteoarthritis (OA). The proposed device is intended for use during a minimally invasive surgery (arthroscopy). Currently, the surgeon's decision-making is based on visual inspection and manual probing of the cartilage tissue which is highly subjective and of poor repeatability. Untreated or not-correctly treated joint injury will most likely progress towards OA, which will lead to joint pain, movement limitation, joint failure, and ultimately disability and joint replacement. OA constitutes a major challenge for the health systems and affects 242 million people globally. Moreover, OA is highly prevalent in Europe with an estimated 19.7-42.3% in the elderly population. MIRACLE concept is to access the biochemical on articular cartilage, which precedes OA. The feasibility of this approach as a diagnostic method has been demonstrated by MIRACLE consortium (TRL4). MIRACLE has also prototyped a MIR-probe with potential use for diagnostics (TRL4). By technology development reaching TRL 6-7, MIRACLE will bring to the arthroscopy market the first MIR-based probe providing an unique, accurate and quantitative diagnostic tool for the orthopedic surgeon. This will be achieved combining three novel photonics components: (i) a quantum cascade laser array tailored to biodiagnostics, (ii) an on-chip beam combiner for efficient radiation coupling, and (iii) MIR sensing probe for imaging. These components will be integrated in a medical device to be placed in the arthroscopy market (valued at $4 billion in 2015). In addition to add value to the European medical equipment industry, MIRACLE strives towards cost reduction of OA patients (currently costs/patient/year €10,452) contributing to more affordable public health care and promoting wellbeing in the European ageing population. [Source: https://cordis.europa.eu/project/rcn/213158_en.html]

H2020-ICT-2014-1	**MIREGAS**	RIA - Research and Innovation action	EUR 3 588 262	The project aims at demonstrating an innovative light source that covers 2.7…3.5 µm wavelength range with a resolution <1nm. The spectral bands are switchable and tuneable and they can be modulated. The source allows for the fabrication of an affordable multi-band gas sensor with good selectivity and sensitivity. The unit price can be lowered in high-volumes by utilizing tailored molded IR lens technology and automated packaging and assembling technologies. In safety and security applications, the Mid-IR wavelength range covered by the source allows for the detection of several harmful gas components with a single sensor. The market impact is expected to be disruptive, since the devices currently in the market are either complicated, expensive and heavy instruments, or the applied measurement principles are inadequate in terms of stability and selectivity. The source will be validated in several key applications including building ventilation, high voltage asset monitoring, emission monitoring, gas leakage monitoring as well as process control and safety. [Source: www.h2020-miregas.eu]
ICT 28 b-2015	**MIRPHAB**	IA - Innovation action	EUR 12 980 217,39	MIRPHAB (Mid InfraRed PHotonics devices fABrication for chemical sensing and spectroscopic applications) provides a platform to ensure the bridging between technology and component development and the commercial availability of such components avoiding the risks associated with the introduction of new disruptive technologies. [Source: www.mirphab.eu] Its main objectives are to: • provide a reliable supply of mid-infrared (MIR) photonic components for companies incl. in particular SMEs already active in analytical MIR sensing • reduce investment cost to access innovative MIR solutions for companies already active in the field of analytical sensors, but new to MIR photonics based sensing • attract companies new to the field of analytical sensors, aiming to integrate µ-sensors into their products. [Source: http://cordis.europa.eu/project/rcn/199179_en.html]
H2020-FOF-2016	**MODULASE**	IA - Innovation action	EUR 2 184 565	State-of-the-art fibre-delivered laser sources are an industrially accepted tool for performing a range of materials processing applications. Despite the unrivalled capability of fibre-delivered laser sources to perform a wide range of processes, the potential flexibility of the laser source is limited by the need to change the processing head for these processes to be performed. The majority of industrial laser systems are employed to perform low-variety and high-volume manufacturing operations. However, current manufacturing trends (such as increased automation, individualisation and next-shoring) are driving the need to develop manufacturing systems which are capable of performing a higher variety of manufacturing operations. The ModuLase project will develop a re-configurable highly flexible processing head system, which will be capable of covering welding, cladding and cutting. The ModuLase process head system will: Be capable of welding, cladding and cutting, through the use of three modular end-effectors; • Include intelligent sensor technologies for in-process monitoring; • Be linked to an intelligent system, in order to achieve adaptive process control, quality assurance, and semi-automated process parameter configuration. The development and pilot line validation of the ModuLase laser process head will unlock the potential flexibility of fibre-delivered laser sources, and address a number of arising industrial challenges; including: • An increasing need for flexible manufacturing systems to support an increasing variety of product mixes. • The need to maximise equipment utilisation rates, by eliminating down-time associated with changing of laser processing heads and equipment stoppages. • Reducing capital investment costs. [Source: http://cordis.europa.eu/project/rcn/205598_en.html]

H2020-ICT-2017-1	**MOICANA**	RIA - Research and Innovation action	EUR 3 999 302,25	MOICANA aims to deploy a versatile, low-cost and large-volume manufacturing transmitter PIC technology by monolithically integrating InP QD laser structures on a passive SiN waveguide platform and demonstrating a whole new series of high-performance cooler-less transmitter modules for a broad range of applications. MOICANA will invest in the best-in-class materials for the active and passive photonic functions, synergizing InP QD laser structures with the low-loss and temperature-tolerant SiN waveguide platform. It will grow InP QD layers directly on Si substrates and will proceed to Selective Area Growth on SiN chips, aiming at the fabrication and deployment of a whole new series of transmitter modules as monolithically integrated PICs: a) 25GbE SFP28 pluggable Directly Modulated Laser (DML), b) a WDM 100GbE QSFP28 pluggable DML, c) Externally Modulated Lasers, and d) a coherent tunable laser source. In this effort, MOICANA will deploy sophisticated integrated InP QD-on-SiN structures including 25Gb/s DMLs, low-linewidth DFBs and electro-optic modulators and will combine them into versatile and highly scalable transmitter layouts exploiting the rich and low-loss passive function portfolio of the SiN waveguide platform. Its transmitter PIC prototypes will be demonstrated in a broad range of applications in the areas of Data Center Interconnects, 5G mobile fronthaul and coherent communications, highlighting its versatility perspectives and its powerful credentials to form the transmitter technology for many-years-to-go. Finally, MOICANA's technology will be supported by an EDA software design kit library and PDKs that will be deployed withint its duration, paving the way for a standardized and fabless PIC transmitter eco-system with immediate market take-up capabilities. [Source: https://cordis.europa.eu/project/rcn/213149_en.html]
H2020-ICT-2017-1	**MOLOKO**	IA - Innovation action	EUR 5 479 159	The main objective of MOLOKO project is the manufacturing, implementation and validation of a self-managing and automatic miniaturized integrated photonic sensor to be used as process analytical instrumentation for fast-response on-site monitoring of interest analytes for security and quality within milk supply chain. These challenging objectives are achieved by integrating within the same device platform forefront technologies as organic photonics, nanoplasmonics, immunoassay diagnostics and microfluidics. Specifically, we aim at realizing multiplexing quantitative detection of up to 10 analytes among which food safety parameters, e.g. antibiotics (i.e. penicillin, ampicillin, cephalonium) and toxins (i.e. mycotoxins and bacterial toxins) and food quality parameters e.g. lactoferrin and caseins by implementing a highly-integrated optoplasmonic-microfluidic sensor in the strategic checkpoints along the entire supply and value chain of milk. The MOLOKO miniaturized integrated photonic sensor is specifically designed according to milk primary production, processing and distribution end-users in order to enable and guarantee fast, low-cost, robust, quantitative and high-sensitive multiplexing detection for the rapid acceptance screening of milk from primary producers (farm tank milk) or single bovine. The inherent versatility of the sensor guarantees disruptive effectiveness in multiple real settings applications, i.e. as automated sensor integrated in milking machine as handheld reusable analytical instrument for specialized and non-specialised milk operators. The effectiveness and market-placement of the engineered functional prototype is quantitatively evaluated by direct comparison with respect to standard analytical methods and commercially available optical biosensors. [Source: https://cordis.europa.eu/project/rcn/213172_en.html]

H2020-ICT-2016-1	**MOON**	RIA - Research and Innovation action	EUR 3 694 634	The rising life expectancy of EU citizens is creating a dramatic increase in age-related degenerative diseases and associated healthcare costs. The MOON Project (Multi-modal Optical Diagnostics for Ocular and Neurodegenerative Disease) meets this societal challenge by applying photonics to diagnose age-related diseases of the eye and central nervous system. MOON will design and build a multi-band, multimodal and functional imaging platform combining label-free molecularly sensitive Raman spectroscopy with high speed and high-resolution Optical Coherence Tomography (OCT), for in-depth diagnostics of ocular and neurodegenerative diseases. MOON will enhance OCT through the development of a disruptive laser technology that enables wide-field structural and functional imaging. MOON will establish a reference database for molecular biomarkers of addressed diseases that enables, for the first time, in-depth molecular-specific diagnosis of retinal diseases and neurodegenerative pathologies based on Raman spectroscopy. The MOON system will be validated in vivo in a clinical setting through close collaboration between clinicians and commercial partners. The clinical validation will establish the diagnostic accuracy of the multi-modal platform, while also verifying the ease-of-use needed for widespread adoption. MOON is driven by unmet medical user needs in diagnostic imaging with a clear business case addressing the highly promising ophthalmic market of early and in-depth molecularly sensitive diagnostics of retinal and neurodegenerative diseases. The three industrial partners cover the complete value/supply chain. MOON aims to bridge the gap between research and product development, thereby expediting the commercialization of the MOON technologies, strengthening the participating companies, and creating a competitive advantage for the European photonics market. [Source: http://cordis.europa.eu/project/rcn/206204_en.html]
H2020-ICT-2017-1	**MORPHIC**	RIA - Research and Innovation action	EUR 3 982 333,75	In MORPHIC, we will enhance an established Silicon Photonics platform with MEMS actuators so photonic circuits can be programmed, and reprogrammed, for a variety of optical functions with built-in redundancy and resilience. The ambition is to create a technology platform for generic Field-Programmable Photonic Integrated Circuits (FP-PIC), that can scale up to volume manufacturing while at the same time supply a variety of specialized applications, similar to field-programmable gate arrays (FPGA) in electronics. To enable programming and reconfigurability at the circuit level, MORPHIC introduces low-power photonic MEMS actuators into silicon photonics, with mechanical latching for non-volatile operation. Basic photonic MEMS building blocks, such as optical 1x2 and 2x2 switches, as well as continuously tuneable phase shifters and 2x2 couplers, are combined with monitor photodiodes and electronic feedback loops into self-configuring circuits to optimize their performance and scale circuit complexity. Programmable connectivity is implemented in a large-scale circuit matrix of waveguides coupled with photonic MEMS subcircuits. MORPHIC combines high-speed silicon photonics, non-volatile MEMS, and a reconfigurable connectivity matrix with control electronics, high-level design methodologies, and a programming interface to create a complete FP-PIC platform. MORPHIC will validate both the silicon photonic MEMS technology and the FP-PIC platform on three applications that benefit from low-power reconfigurability: an optical switch matrix, an optical beam forming network and a programmable microwave photonics filter. The demonstrators are implemented in two ways: as a dedicated photonic circuit, and as a programming scheme in a generic FP-PIC. With a complete technology portfolio, the MORPHIC consortium will establish a supply chain for field-programmable silicon photonics that leverages volume manufacturing and at the same time enables rapid access to complex photonic ICs. [Source: https://cordis.europa.eu/project/rcn/213129_en.html]

H2020-ICT-2017-1	**NEXIS**	IA - Innovation action	EUR 7 712 152,88	A photonics driven breakthrough in image quality and functionality of an interventional X-ray system will allow to perform stroke diagnosis directly in the treatment suite and have a huge impact: enhanced work flow, reduced diagnosis & treatment time (up to 50% time reduction) which will save people's life and reduce healthcare costs. NEXIS will establish enhanced contrast Cone Beam CT imaging while keeping high spatial resolution for 2D image guidance by an innovative spectral X-ray detector and related image processing (including deep learning). Two new key photonic components will be developed: 1) A thin foil based image sensor which has a (semi-) transparent TFT backplane, so that the photodiode array can receive light from both the top and the bottom side. This (semi-) transparency will be optimised, so that the image sensor can collect light effectively from top and bottom scintillator layers at the same time. 2) A 3D printed pixelated CT-like scintillator with high spatial and temporal resolution to enable fast Cone Beam CT imaging without image artefacts. The usability and applicability of the new spectral NEXIS X-ray system for stroke imaging will be clinically validated in a European top hospital. The project brings together a multidisciplinary consortium, involving the full value chain (photonics R&D, medical system integrator, application owner, supply chain and equipment manufacturing). It will allow key players in the European medical photonics industry to generate sales and stay competitive by providing new X-ray imaging modalities and EU based manufacturing. NEXIS will strengthen European competitiveness by developing a spectral Detector-on-Foil technology that meets the needs of the European and global X-ray image detectors market. NEXIS initiate the transition of standard (black&white) to spectral (colour) X-ray detectors, which will improve performance and functionality of X-ray imaging systems. [Source: https://cordis.europa.eu/project/rcn/213113_en.html]
H2020-ICT-2015	**OCTCHIP**	RIA - Research and Innovation action	EUR 3 997 450	Quick and cost-effective access to optical coherence tomography (OCT) scanning is critical to identify critical retinal diseases that often lead to blindness. The aim of the project OCTCHIP is to develop a hand-held OCT retinal scanner for early and cost-effective detection of diabetic retinopathy and other critical retinal diseases, allowing a globally easier access to optical coherence tomography. [Source: https://www.medtechmediaeurope.com/apex/f?p=200:105:::NO::P105_AUSWAHL,P105_TITLE:163,%25E2%2580%258BMiniaturising%20OCT%20to%20prevent%20blindness]
H2020-ICT-2014-1	**OPENAIS**	IA - Innovation action	EUR 7 893 553	Following the trends of the creation of the "The Internet of Things" (IoT) and the rapid penetration of SSL based lighting, it is very advantageous to connect the luminaires in buildings to the Internet. **OpenAIS** aims at setting the leading standard for inclusion of lighting for professional applications in to IoT, with a focus on office lighting. This will enable a transition from the currently existing closed and command oriented lighting control systems to an open and service oriented system architecture. The OpenAIS project will define the requirements and use cases for offices in 2020, define the best open system architecture, identify existing ICT components to be used and develop additional components. The system will be validated by a pilot installation in a real office setting. [Source: www.openais.eu]
H2020-ICT-2016-1	**PAMMOTH**	RIA - Research and Innovation action	EUR 4 352 007,50	X-ray mammography is the mainstay of breast cancer screening programs. It is estimated that between 20 - 50% of abnormal screening mammograms will prove to be negative. The paradigm in diagnosis is to establish whether a lesion is benign or malignant. All the imaging techniques conventionally used today – diagnostic x-ray, ultrasonography and magnetic resonance imaging have many limitations, leading to multiple and/or repeat imaging and often unnecessary biopsy. This leads to physical, psychological and economic burdens felt at individual, familial and societal levels. With an aging population, high incidence of breast cancer and tightening health-care budgets, there is an urgent requirement for a non-invasive method for in-depth assessment of the screening-detected lesion. In PAMMOTH we will showcase such an imager, combining photoacoustic and ultrasound imaging. With the use of quantitative image reconstruction of multi-wavelength photoacoustic data, information is gained of the vascular and oxygen status of the lesion relating to tumor physiology and function. From the ultrasound part, we derive ultrasound reflection from the lesion in a manner superior to conventional breast ultrasonography, relating to anatomic features and extent of a tumor. This information will enable the radiologist to come to a diagnosis accurately and rapidly without the use of contrast agents, without pain and discomfort to the patient, while being cost-effective and not requiring complex infrastructure. [Source: http://cordis.europa.eu/project/rcn/206191_en.html]

H2020-FOF-2016	**PARADDISE**	RIA - Research and Innovation action	EUR 3 761 402,25	The overall objective of PARADDISE project is to rationalize, to structure and to make available to the stakeholders of manufacturing value chain the knowledge and the tools for combining two antithetical processes: Laser Metal Deposition (LMD) and Machining (milling and turning). The project will develop expert CAx technologies, smart components and monitoring and control systems tailored for the hybrid process in a cost-effective way and with structured knowledge about LMD process. The PARADDISE solution will offer a synergetic combination among: i) the high flexibility for the designs and for the materials to be used, the high material efficiency and the high savings in material resources and its associated costs of the LMD operations; and ii) the high accuracy, the high robustness and the high productivity of subtractive operations. The solution will be integrated in the 'ZVH45/1600 Add+Process' hybrid machine from IBARMIA manufacturer (PARADDISE partner), which is already available in the market as well as at TECNALIA's facilities (PARADDISE coordinator). Thus, the PARADDISE project will conceive a process-machine-tools solution. By means of this combined manufacturing process, large scale manufacturers of value-added metallic components will be able to achieve high quality and high productivity with a minimum use of material and energy resources when manufacturing those parts, which will lead to a reduction in manufacturing costs. In that way, the PARADDISE project intends to boost and to spread the use of Laser Metal Deposition (LMD) technology along the life cycle of value-adding metal components. [Source: http://cordis.europa.eu/project/rcn/205478_en.html]
H2020-ICT-2017-1	**PASSION**	RIA - Research and Innovation action	EUR 7 535 747,50	The main goal of PASSION project is the development of application driven photonic technologies supporting an innovative transceiver and node featuring different levels of aggregation (in spectrum, polarization and space) for an envisaged network architecture able to match the growing traffic demand in metro connections. The proposed approach is capable to establish high capacity connection for metro network distances (a few hundreds of km) with high-throughput, low-cost, energy-efficient, reduced-footprint devices for massive deployment. End-to-end metro transport for novel services and business is achieved with dynamic SDN control of the different systems and subsystems to ensure metro connectivity and deployment of services. [Source: http://www.passion-project.eu/project/objectives/]
H2020-ICT-2016-1	**PHABLABS 4.0**	CSA - Coordination and support action	EUR 1 499 370	PHABLABS 4.0 aims to integrate photonics in a durable way into the rapidly expanding ecosystem of European Fab Labs and Makerslabs, resulting in a larger and better skilled photonics workforce with superior innovation capacity to achieve a lasting, positive impact on the next revolution in digitization. PHABLABS 4.0 will devise and deliver a comprehensive suite of Workshops, Challenger projects and Photonics Toolkits to enhance Fab Labs and Makerslab with photonics activities aimed at 3 specific target groups: young minds (age 10-14), students (age 15-18) and young professionals and technicians (age 18+). These activities will be extensively tested in 14 existing Fab Labs with the purpose of rolling them out to the entire growing network of European Fab Labs as a proven model at the end of the project. The ultimate impact of PHABLABS 4.0 will be seen in the emergence of a much larger and better trained workforce with 21st Century skills capable of translating the potential of photonics as a key enabling technology into tangible products for the benefit of society. [Source: http://cordis.europa.eu/project/rcn/206169_en.html]
H2020-ICT-2014-1	**PHEBE**	RIA - Research and Innovation action	EUR 3 931 688	The overall objective of the PHEBE project is to develop innovative, high-efficiency, blue emitters for white OLEDS, which will create a major breakthrough in the cost performance of OLED lighting. To produce the innovative blue emitters, two new types of molecular systems – without rare earth complexes - will be investigated: •intramolecular charge transfer systems that enable thermally activated delayed fluorescence (ICT-TADF); •intermolecular exciplex charge transfer systems that enable thermally activated delayed fluorescence (Exciplex- TADF) [Source: www.h2020-phebe.eu]
H2020-ICT-2017-1	**PHENOMENON**	RIA - Research and Innovation action	EUR 3 889 152,50	PHENOmenon will develop and validate an integral manufacturing approach (material, process and technology) for large area direct laser writing of 2&3D optical structures, targeting high speed production of optical surfaces with subwavelength resolution, using NonLinear Absorption. Developments in photochemistry and laser beam forming will allow producing structures at different scales (100 nm to 10 microns). An unedited productivity in freeform fabrication of 3D structures will trigger the manufacturing of new and powerful optostructures with applications in lighting, displays, sensing, etc. [Source: http://www.phenomenonproject.eu/project]

CIP-ICT-PSP-2013-7	**Phos-Istos**	PB - Pilot Type B	EUR 2 390 000	The objective of Phos-Istos is to develop illumination devices for the treatment of specific diseases such as Actinic Keratosis, Psoriasis and Baby Jaundice. These devices will be based on Light emitting Fabrics. To this aim the following objectives are planned to be achieved: ◦Development of flexible light sources based on optical fibres using weaving or knitting; ◦Connection of light emitting fabrics to specific laser diode in order to improve light coupling; ◦Integration of monitoring into the light emitting fabrics ; ◦Clinical evaluation of these devices [Source: http://www.phosistos.com/]
H2020-ICT-2014-1	**Photonics4All**	CSA - Coordination and support action	EUR 997 953	Photonics4All is a European Outreach project funded by the European Commission to promote photonics and light based technologies to young people, entrepreneurs and the general public across the EU. A number of educational tools are being developed as part of the project: a Photonics app, a game and an animated video – all to explain photonics and promote its study and use. Special events are also being provided for each target group: a business start-up challenge, activities for children at schools and universities and public photonics events to make photonics more popular. [Source: http://photonics4all.eu/wp-content/uploads/2015/05/1862_SEZ_Photonics4all_Lesezeichen_ENG.pdf]
ERANET COFUND 2015	**Photonic Sensing**	ERA-NET-Cofund - ERA-NET Cofund	EUR 5 666 733,93	PhotonicSensing is a joint initiative which contributes to the fast development and implementation of photonics based sensing technologies and therefore further improve the European market share in this domain. It is organised as a competition for funding and will be implemented jointly by the participating national and regional funding bodies from the following countries and regions: FFG, Austria (Coordinator); •VLAIO, Flanders Region (Belgium); •VDI, Germany; •MATIMOP-ISERD, Israel; •NCBR, Poland; •FCT, Portugal; •TÜBITAK, Turkey; •Regione Toscana, Tuscany Region (Italy); •Innovate UK, United Kingdom [source: https://photonicsensing.eu]
H2020-ICT-2016-1	**PICCOLO**	RIA - Research and Innovation action	EUR 3 997 655	Colorectal cancer represents around one tenth of all cancers worldwide. Early and accurate diagnosis and precise intervention can increase cure rate up to 90%. Improved diagnostic techniques with enough sensitivity and specificity are required to allow in situ assessment, safe characterization and resection of lesions during clinical practice interventions. The multidisciplinary PICCOLO team proposes a new compact, hybrid and multimodal photonics endoscope based on Optical Coherence Tomography (OCT) and Multi-Photon Tomography (MPT) combined with novel red-flag fluorescence technology for in vivo diagnosis and clinical decision support. By combining the outstanding structural information from OCT with the precise functional information from MPT, this innovative endoscope will provide gastroenterologists immediate and detailed in situ identification of colorectal neoplastic lesions and facilitate accurate and reliable in vivo diagnostics, with additional, grading capabilities for colon cancer as well as in-situ lesion infiltration and margin assessment. With the development of compact instrumentation, the cost of the components and thus the system will be significantly reduced. Human representative animal models will be used to generate imaging biomarkers that allow automated detection, assessment and grading of disease. The developed system will be tested in operating room conditions. [Source: http://cordis.europa.eu/project/rcn/206510_en.html]
H2020-ICT-2015	**PICs4All**	CSA - Coordination and support action	EUR 1 051 895	PICs4All aims at low-cost development of ASPICs (Application Specific PIC) using the generic foundry model, and rapid prototyping via industrial Multi-Project Wafer runs. To this end, PICs4All brings together the PIC-value chain of Europe's key players in the field of photonic integration, including manufacturing and packaging partners, photonic CAD software partners, R&D labs and Photonic IC design houses. PICs4All has set up an European Network of experts in photonics constituted by 9 Application Support Centres (ASC) distributed around Europe whose main task is to stimulate the development of novel applications based on Photonic ICs for various application fields, enhance cooperation between universities, clusters, industry, and research centres, and the most important, to enable access to the PIC technology. PICs4All aims to: 1. Increase the impact of photonics and enable access to the advanced photonic integrated circuit (PIC) technologies for academia, research institutes, SMEs and larger companies. 2. Establish a European network of Application Support Centers (ASCs) in the field of PIC technology. 3. Lower the barrier for applying advanced PICs, and thus to increase the awareness of the existence of the unique facility provided by JePPIX (InP and TriPleX PIC design, manufacturing, testing and packaging). [Source: http://www.pics4all.jeppix.eu/]

H2020-ICT-2017-1	**PICTURE**	RIA - Research and Innovation action	EUR 3 924 532,50	The objective of PICTURE project is to develop a photonic integration technology by bonding multi-III-V-dies of different epitaxial stacks to SOI wafers with a thinner and uniform dielectric bonding layer. This heterogeneous integration platform will enable higher performance lasers and photo-detectors using the optimized III-V dies. In addition, the thinner bonding layer will lead to record performance MOSCAP III-V/Si modulators, and to a new generation of wavelength tunable distributed feedback lasers. Moreover the full process including SOI process, bonding, III-V and back-end process will be made on a 200mm R&D CMOS line, leading to higher yield, smaller footprint and lower cost PICs. Two types of PICs with a total capacity of 400Gb/s will be developed, packaged and validated in system configuration. In parallel, PICTURE project will develop direct growth of high performance quantum-dot lasers and selective area growth on bonded templates for high density future generation of PICs. The project is coordinated by III-V Lab, and includes University of Southampton, CEA, University College London, Imec, Tyndall, Argotech and Nokia Bell Labs. The consortium is highly complementary, covering all skills required to achieve the project objectives: growth of semiconductor materials, silicon process and III-V process, design and characterization of PICs, prototyping and assessment of PICs in high bit rate digital communication systems: Apart from the adequacy of the consortium to achieve collectively the project objectives, the consortium partners have the potential to set up a comprehensive supply chain for the future exploitation of the project results, either by exploiting the results "in house" or by setting up suitable partnerships. [Source: https://cordis.europa.eu/project/rcn/213188_en.html]
H2020-ICT-2015	**PI-SCALE**	IA - Innovation action	EUR 13 999 792,76	"Bringing flexible organic electronics to pilot innovation scale" (PI-SCALE) is a highly needed response to bridge the gap which exists today between promising laboratory scale results of highly efficient flexible OLED modules and mass manufacturing of high value-added products. The project will integrate existing European infrastructures into a "European flexible OLED pilot line", which will operate in an open access mode and serve customers from along the value chain with individual product designs, validation of upscaling concepts, and system-level flexible OLED integration. [Source: http://cordis.europa.eu/project/rcn/199175_en.html] .
H2020-ICT-2015	**PIX4LIFE**	IA - Innovation action	EUR 8 557 337,88	PIX4life aims to mature a high performance, high yielding and CMOS-processing compatible SiN Photonic IC pilot line together with the accompanying supply chain for applications in the visible range (400-1000 nm) in order to become the world's premier pilot line for multitype integrated biophotonic applications. PIX4life will enable miniaturizing and increasing the cost effectiveness of bulky, expensive optical life science systems. PIX4life will pave the way towards making the platform available in open access for a broader number of customers from the (bio-)photonic and life science communities with industrial development in mind. [Source: http://www.pix4life.eu/]
H2020-ICT-2016-1	**PIXAPP**	IA - Innovation action	EUR 13 407 812,76	PIXAPP will establish the world's first open access Photonic Integrated Circuit (PIC) assembly & packaging Pilot Line. PIXAPP provides Europe's SMEs with a unique one-stop-shop, enabling them to exploit the breakthrough advantages of PIC technologies. PIXAPP bridges the 'valley of death', providing SMEs with an easy access route to take R&D results from lab to market, giving them a competitive advantage over global competition. Target markets include communications, healthcare & security, which are of great socio-economic importance to Europe. PIXAPP bridges missing gaps in the value chain, from assembly & packaging, through to equipment optimisation, test and application demonstration. To achieve these ambitious objectives, PIXAPP will; 1) Combine a group of Europe's leading industrial & research organisations in an advanced PIC assembly & packaging Pilot Line facility.2) Develop an innovative Pilot Line operational model that coordinates activities between consortium partners & supports easy user access through a single entry point. 3) Establish packaging standards that provide cost-efficient assembly & packaging solutions, enabling transfer to full-scale industrial manufacture. 4) Create the highly-skilled workforce required to manage & operate these industrial manufacturing facilities.5) Develop a business plan to ensure Pilot Line sustainability & a route to industrial manufacturing. PIXAPP will deliver significant impacts to a wide stakeholder group, highlighting how industrial & research sectors can collaborate to address emerging socio-economic challenges. [Source: http://cordis.europa.eu/project/rcn/206352_en.html]

H2020-ICT-2017-1	**plaCMOS**	RIA - Research and Innovation action	EUR 4 036 377,50	The goal of the PlaCMOS project is to develop and demonstrate the next generation optical-electronic CMOS platform that will enable transceivers capable of real-time communication with data rates exceeding 200 Gb/s. To achieve this goal the PlaCMOS platform will be based on the latest bipolar CMOS (BiCMOS) technology and will be cointegrated with a ferroelectric plasmonic and SiGe detector technology. By exploiting plasmonics rather than photonics PlaCMOS will not only be able to extend the bandwidth far beyond 100 GHz but also reduce the footprint of the photonics device to the micrometer scale. To demonstrate the technology, a single channel 200 Gb/s non-return-to-zero (NRZ) transmitter and receiver pair will be implemented. To further show the scalability an ultra-compact 4 x 50 Gb/s transceiver directly interfacing a multicore optical fiber will be implemented and tested for temperature stability beyond 150 degree Celsius. And while the project goes far beyond the current state-of-the art, the approach is not speculative but is substantiated by recent experiments performed by the members of the consortium that indicate that both electronic and photonic limits can be stretched beyond the current limits. To this end a team with complementary skill sets from both industry and universities – all with outstanding track records in the field – have committed to address the needs outlined in current roadmaps for data communication. This project will demonstrate the capabilities of the technology for a single exemplary field of applications. Yet, the project has far wider implications with applications that go beyond the field of communications. [Source: https://cordis.europa.eu/project/rcn/213185_en.html]
H2020-ICT-2015	**PLASMOfab**	RIA - Research and Innovation action	EUR 3 580 691,25	PLASMOfab aims to develop CMOS compatible plasmonics in a generic planar integration process as the means to consolidate photonic and electronic integration. Wafer scale integration will be used by PLASMOfab to demonstrate low cost, volume manufacturing and high yield of powerful PICs. The new integration technology will unravel a series of innovations with profound benefits of enhanced light-matter interaction enabled by plasmonics in optical transmitters and biosensors modules. [Source: www.plasmofab.eu]
H2020-FOF-2016	**POLAROLL**	IA - Innovation action	EUR 3 508 527,75	The overall objective of PoLaRoll project is to substitute the lithography step in current etching processes by directly structuring the lacquer with the PoLaRoll laser micro machining unit. The PoLaRoll-module will replace the current masking process within a continuous lithography etching process for micro-structuring stainless steel reels. This will enable a flexible and cost efficient process consequently increasing significantly the productivity . The modular concept of the laser structuring system will allow the integration into several other applications in order to substitute masking processes or direct digital structuring. When looking along the value chain of laser manufacturing systems, the laser sources typically are the starting point and are integrated into downstream machines and processing systems. To position the next generation Roll-to-Roll manufacturing technology in the global market place, time to market is a key factor. The PoLaRoll results will help Europe stay competitive on the international market of laser micro machining and roll-to- roll machinery solutions providing:• Improved competiveness of laser-based manufacturing industry (equipment and suppliers) and the end-user industry; •Improved competiveness and strengthened Europe's market position of laser-based manufacturing industry; •More efficient, more flexible and higher throughput of individualised laser-based production. Further impacts can be associated to PoLaRoll project: •Environmental impacts: the partial replacement of environmental unfriendly chemicals on the etching process chain currently used on the foil perforation by laser based machining will lead towards a greener manufacturing. The partial replacement of unfriendly chemicals will generate environmental impacts on the reduction of this production as well as on the reduction of its waste management, which represents a direct economical aspect as well. [Source: www.polaroll-project.eu]

H2020-ICT-2014-1	**POSEIDON**	RIA - Research and Innovation action	EUR 4 068 781	The objective of the POSEIDON project is to develop a SPR-based biosensing platform for the detection of L. pneumophila bacteria, with high sensitivity and high specificity, translating the results obtained as experimental proof of concept into an operating automated prototype usable in industrially relevant settings and by untrained personnel. The following challenges will be pursued throughout the development of the project: High sensitivity and low detection limit; •Selectivity towards target pathogen detection in order to avoid both false-positive and false-negative results; •Short analysis times •Ease of use, possibility of on-site monitoring and automation of the sample manipulation and detection procedure. •Efficient delivery of the bacteria: cells should remain intact throughout the whole fluid transportation system in the device, and should not adhere to the fluidic piping and microfluidic channels, so that virtually all of the bacteria cells in the sample are delivered to the sensing unit. •The size of the device should allow samples to be analyzed at the point of need rather than in a separate laboratory, allowing reduction of cost per single measurement and increase in throughput. [Source: www.poseidonproject.eu]
H2020-ICT-2017-1	**QAMeleon**	RIA - Research and Innovation action	EUR 7 999 558,75	QAMeleon aims to deliver a new generation of faster, cheaper, and greener photonic devices spanning from beyond state-of-the-art transponders to novel reconfigurable add drop multiplexers (ROADMs) towards scaling core and metro networks to the next decade enabling: - •SDN-enabled generation and reception of reconfigurable optical data-flows having increased spectral efficiency at ultra-high-speed rates up to 128 Gbaud with state-of-the-art modulation format techniques; - •the development of scalable Colorless Directionless Contentionless and Gridless Reconfigurable Optical Add Drop Multiplexing (ROADM) node architectures supporting spectrum sliceability and on-demand switching reconfigurability. [Source: https://ict-qameleon.eu/]
H2020-FoF-2014	**RADICLE**	RIA - Research and Innovation action	EUR 3 583 212	The RADICLE project will create a real-time adaptive control system for laser welding using a range of sensors in combination with intelligent and adaptive control technologies for in-process monitoring and control to eliminate defects. The project will focus on the materials and geometries for key high value, safety critical components from the aerospace, automotive and power sectors. The RADICLE system will also include pre- and post-welding measurement to give a completely integrated 3-loop quality system that aims to increase productivity of European manufacturers by 30%. [Source:http://radiclelaser.eu]
H2020-ICT-2014-1	**RAIS**	RIA - Research and Innovation action	EUR 2 988 572,50	The overall objective of the RAIS project is to develop a new point-of-care label-free microarray platform, based on a proprietary interferometric lens-less microscopy design, which overcomes existing problems, and to validate it for quantifying levels of specific Sepsis biomarkers within 30 minutes. Sepsis is a potentially fatal whole-body inflammatory reaction caused by severe infection and, with a mortality rate of 35%, is responsible for ~20,000 deaths per day worldwide. The cost of Sepsis is high – and rising. In 2008, > €10 billion was spent on hospitalizations for Sepsis in both Europe and USA. The rapid detection of Sepsis, essential to increase the survival rate of the patient/victim, is an ideal proof-of-concept to demonstrate the disruptive capability of the new proposed tool being developed within RAIS. However, it could also be extended to perform other types of disease screening or multiple simultaneous diagnoses, especially those requiring a large number of biochemical targets (more than 1 million) on a single microarray to be rapidly screened. [Source: www.rais-project.eu]
H2020-ICT-2017-1	**REDFINCH**	RIA - Research and Innovation action	EUR 3 993 211,25	The REDFINCH consortium is developing the next generation of miniaturised, portable optical sensors for chemical detection in both gases and liquids. Initial target applications are in the petrochemical and dairy industries. REDFINCH is a consortium of 8 European research institutes and companies, undertaking cutting edge R&D into novel, high performance, cost effective chemical sensors, based on Mid-Infrared Photonic Integrated Circuits (MIR PICs). Silicon PICs — integrating optical circuits onto millimetre-size silicon chips — create extremely robust miniature systems, in which discrete components are replaced by on-chip equivalents. This gives a simultaneous improvement in ease of use and a reduction in cost. [Source: http://www.redfinch.eu/]

ICT-28c-2015	**RespiceSME**	CSA - Coordination and support action	EUR 1 109 047,50	The RespiceSME project aims to reinforce the innovative capacity of Europe's photonics SMEs, clusters and national platforms by stimulating targeted collaborations in and beyond photonics. RespiceSME proposes new approaches for stronger innovative effectiveness using a 3-dimensional approach: 1. evaluating and stimulating the innovation potential in order to strengthen the innovation capacity of high-tech photonics SMEs. 2. enhancing the global technological exploitation of photonics innovation capacity by analysing different value chains valuable for high-tech photonics SMEs - allowing significant leveraging of non-photonic sectors such as Environment / Energy, Transport, and Manufacturing, thereby, enabling the penetration of new markets and/or new application areas close to markets. 3. creating a bridge over the 'Valley of Death' to increase the competitiveness of the European photonics sector by developing Best Practices for enabling photonics SMEs access to European and regional Research Technology Organisations, harnessing educational and training programmes aligned with their specific needs, determining next generation regional innovative smart specialisation strategies and providing access to public and private financial supports. [Source: www.respice-sme.eu]
H2020-ICT-2014-1	**SAPHELY**	RIA - Research and Innovation action	EUR 3 228 838	The SAPHELY project focuses on the development and the preclinical validation of a nanophotonic-based handheld point-of-care (POC) analysis device for its application to the minimally-invasive early diagnosis of diseases, with a focus in cancer. Disease identification will be based in the fast (<5 minutes), ultra-sensitive (sub-pM) and label-free detection of novel highly-specific microRNA (miRNA) biomarkers, using a small volume of whole blood (<100 µL). This POC analysis device, which will have a low cost (envisaged cost < €3000), will significantly help in the implementation of mass screening programs, with the consequent impact on clinical management, reducing also costs of treatments, and increasing survival rates. Moreover, this analysis device can also be used for its application in the monitoring and assessment of therapeutic response of a patient, opening the door to the practical implementation of the so-called "personalized medicine". [Source: https://saphely.eu; http://cordis.europa.eu/result/rcn/190188_en.html]
H2020-ICT-2014-1	**SEERS**	RIA - Research and Innovation action	EUR 3 750 535	SEERS (Snapshot Spectral Imager for IR Surveillance) will develop a modular, compact and cost effective snapshot spectral imaging system in the infrared domain (0.7-14 µm wavelength). It will be endowed with embedded vision and cognitive fusion capabilities. Robust visibility, robust temperature imaging, gas detection and discrimination, and spill detection will enable event-driven video analysis. Breakthrough performance will be demonstrated in two relevant application scenarios: coastal and road tunnel surveillance. [Source: www.seersproject.eu]
H2020-ICT-2016-1	**SOLUS**	RIA - Research and Innovation action	EUR 3 815 260	SOLUS aims at developing an innovative non-invasive, point-of-care, low-cost, easy-to-operate, multi-modal imaging system (diffuse optics and ultrasounds/shear wave elastography) for high-specificity diagnosis of breast cancer. Mammographic screening is effective in reducing mortality, however the 10-year cumulative false-positive risk is 50-60%, leading to needless additional invasive procedures (e.g. biopsy). The project addresses the unmet clinical need for higher specificity in breast cancer imaging following screening by fully combining photonics with non-photonics techniques, developing and clinically validating innovative and previously unthinkable photonics concepts and components: time-domain small source-detector distance optical tomography, miniaturized picosecond pulsed laser sources, high-dynamic-range time-gated single-photons detectors to achieve unprecedented sensitivity and depth penetration. For the first time, this allows a comprehensive quantitative characterization of breast tissue including composition (water, lipids, collagen), functional blood parameters, morphologic information and mechanical parameters (stiffness). This innovative multi-parametric characterization will significantly improve the specificity of breast screening, with great impact on the quality of life of millions of European women every year, and huge savings for the healthcare systems. The strong involvement of leading industrial players at all levels in the value chain will push the European innovation process and make a significant contribution to ensuring Europe's industrial leadership in the biophotonics healthcare market, while addressing one of the largest societal challenges in health and well-being. [Source: http://cordis.europa.eu/project/rcn/206348_en.html]
ICT 27-2015	**Teraboard**	RIA - Research and Innovation action	EUR 4 249 157,50	TERABOARD aims at demonstrating a scalable, low power, low cost photonic technology to sustain the continuous increase of bandwidth density by leveraging on combination of scalability and low energy consumption. TERABOARD is a new technology that enables very large aggregated bandwidth density (Tb/s/cm2) on board. The concentration of a large number of operations in a single board leads to a radical system innovation, reduction of total energy cost and reduction of hardware size and cost. [Source: http://www.teraboard.eu/]

H2020-ICT-2015	**TRESCLEAN**	RIA - Research and Innovation action	EUR 3 363 091,25	The aim of TresClean is to demonstrate high-throughput laser-based manufacturing applied to the production of plastic and metal component parts of consumer white goods and liquid filling machines respectively through the development of a novel industrial use of high-average power pulsed lasers in combination with high-performance optical devices and beam delivery systems. The technical field in which the objectives defined in ICT 27 will be applied and turned into a feasible industrial application is the development of fluid repellent and antibacterial surfaces. The motivation for the project is to go far beyond the state of the art in laser surface texturation and to gain industrial relevance by applying such a technique over large areas of machine parts or tools. As a consequence, the gap between the lab-tested feasibility of these laser-treated surfaces and the production for real applications will be bridged. Among the numerous industrial applications which can gain from functionalized surfaces the project is focused on the cleanliness and the asepticity of machine parts for the food industry and home appliances to deliver easier maintenance and longer service life of the laser treated components by making them superhydrophobic and thus enabling other highly desirable functionalities, such as anti-corrosion, antibiofouling, anti-microbial, and low friction resistance. [Source: www.tresclean.eu]
ICT 27-2015	**ultraSURFACE**	RIA - Research and Innovation action	EUR 2 927 455	In nearly every sector of industrial manufacturing a broad spectrum of surface processing techniques is used, e.g. for structuring, coating or polishing of aesthetical or functional surfaces. In many applications these laser based surface processing techniques already achieve highest precision and quality, but often the throughput is limiting the industrial capability. The idea of ultraSURFACE is to increase the throughput for laser surface processing by at least a factor of 10 without any drawbacks in the quality of the processing results by using sophisticated optics for specific laser beam manipulation. Two different optics concepts will be realized and combined with fast and synchronized mechanics, scanner and optics control. Optics Concept 1 refers to a dynamic and flexible beam-shaping approach with piezo-deformable mirrors which enables the realization and the fast adaption of application specific intensity distributions. Optics Concept 2 is a beam-splitting approach which allows simultaneous processing with multiple laser beams and thus a significant increase in throughput. For both concepts the implementation of prototypes is planned as well as their industrial validation in different fields of application (laser structuring, laser polishing, laser thin-film processing). [Source: www.ultrasurface.eu]
H2020-ICT-2016-1	**VOSTARS**	IA - Innovation action	EUR 3 816 440	The idea of integrating the surgeon's perceptive efficiency with the aid of new augmented reality (AR) visualization modalities has become a dominant topic of academic and industrial research in the medical domain since the 90's. AR technology appeared to represent a significant development in the context of image-guided surgery (IGS). Video-Optical See Through AR surgical System (VOSTARS) will be the first hybrid see-through HMD surgical navigator. Further, albeit VOSTARS will be specifically designed for medical procedures, its design is aimed to evolve into a multi-purpose AR platform for HMDs. [Source: http://cordis.europa.eu/project/rcn/206506_en.html]
H2020-ICT-2016-1	**WATERSPY**	RIA - Research and Innovation action	EUR 3 049 206,74	Pervasive and on-line water quality monitoring data is critical for detecting environmental pollution. Currently, water utilities rely heavily on frequent sampling and laboratory analysis in order to acquire this information. For this situation to be improved, portable and high-performance devices for pervasive water quality monitoring are required. Towards this end, there has been growing interest in expanding spectroscopic methods beyond the 2µm range of the infrared spectrum. That region of the spectrum is home to many vibrational & rotational absorptions of compounds related to water quality. Unfortunately, water itself is a strong absorber of infrared light. Thus, such methods were restricted to laboratory settings until now. WaterSpy addresses this challenge by developing water quality detection photonics technology suitable for inline, field measurements, operating in the 6-10 µm region. The solution is based on the combined use of advanced, tuneable Quantum Cascade Lasers and fibre-coupled, fast & sensitive Higher Operation Temperature photodetectors. [Source: http://cordis.europa.eu/project/rcn/206173_en.html]

H2020-ICT-2015	**WIPE**	RIA - Research and Innovation action	EUR 3 062 997,50	The WIPE project is about researching new technologies for connecting micro-photonic integrated circuits (PIC's) and micro-electronic integrated circuits (IC's) in a most advanced way, enabling Better performance, Faster design and manufacturing, Lower price of new photonic components which will form the core elements in a wide variety of applications which make life better, e.g. Ultra-high speed data communication for the next generation Internet, Extremely sensitive detectors for gasses, temperatures or strain in mechanical structures securing our environment and the safety of machines, New biomedical analysis devices for a quick diagnosis of diseases. The WIPE project aims to develop a technology which enables the direct connection of optical InP-based PIC's and electronic CMOS IC's at a wafer scale. The chips are electrically connected in the shortest way by VIA's through the insulating layer between PIC and IC. This strongly reduces parasitics and enables a far higher performance of the system than is currently present. The second goal of WIPE is to devise a chip design technology for an effective and efficient co-design of the matching optical and electronic circuits. [Source: http://wipe.jeppix.eu]

Annex – Part 5: European photonics success and impact stories – Media Campaign 2017

Europho21 has provided a central public relation and dissemination service to Horizon2020 Photonics PPP projects. Through bi-weekly telephone conferences between the coordinator VDI TZ, 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.

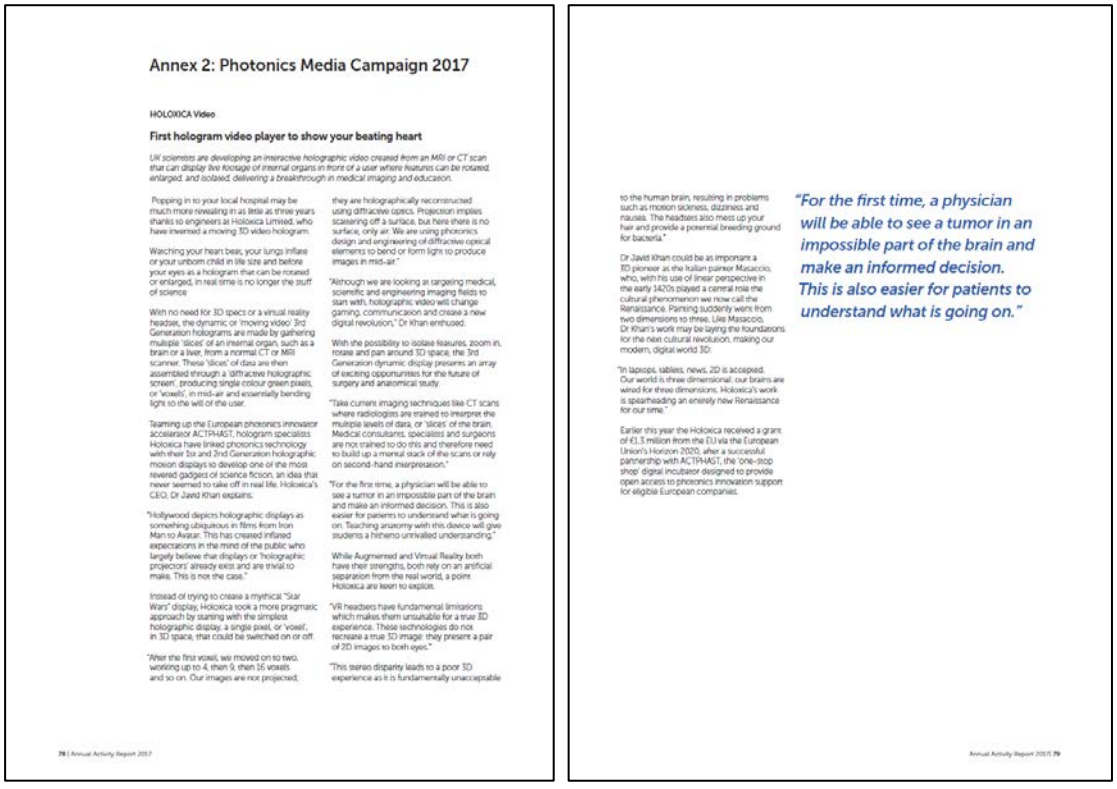
After a project has been chosen, the respective coordinators are contacted, interviewed and a press release is prepared and distributed. In total 7 success stories were prepared by Europho21 in 2017.

Overview on 2017 Press releases and related PPP Projects:

Headline	**H2020 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."

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 headset), 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 5 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 Universitari E Di Perfezionamento 'Sant'Anna; (United Kingdom/VREO) Innovasion; (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 unsulted 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:

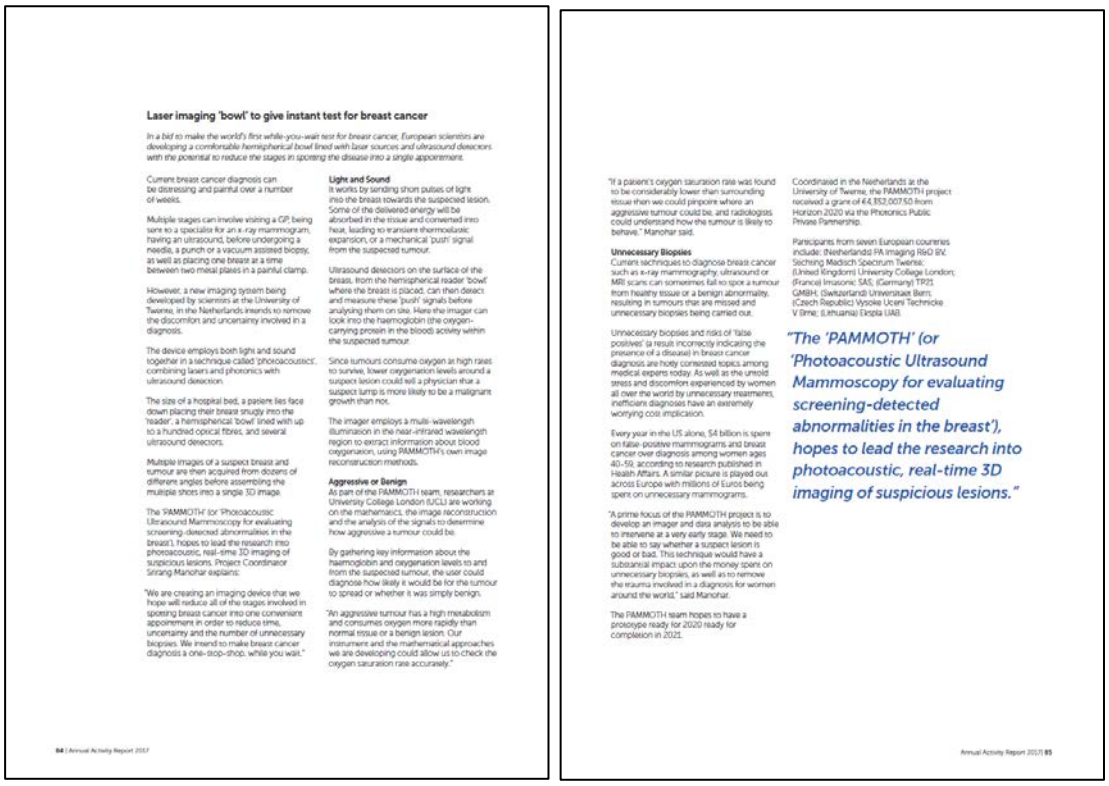
Smeesters sees the future benefits of this sensor being more widely available to users in the kitchen:

"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.

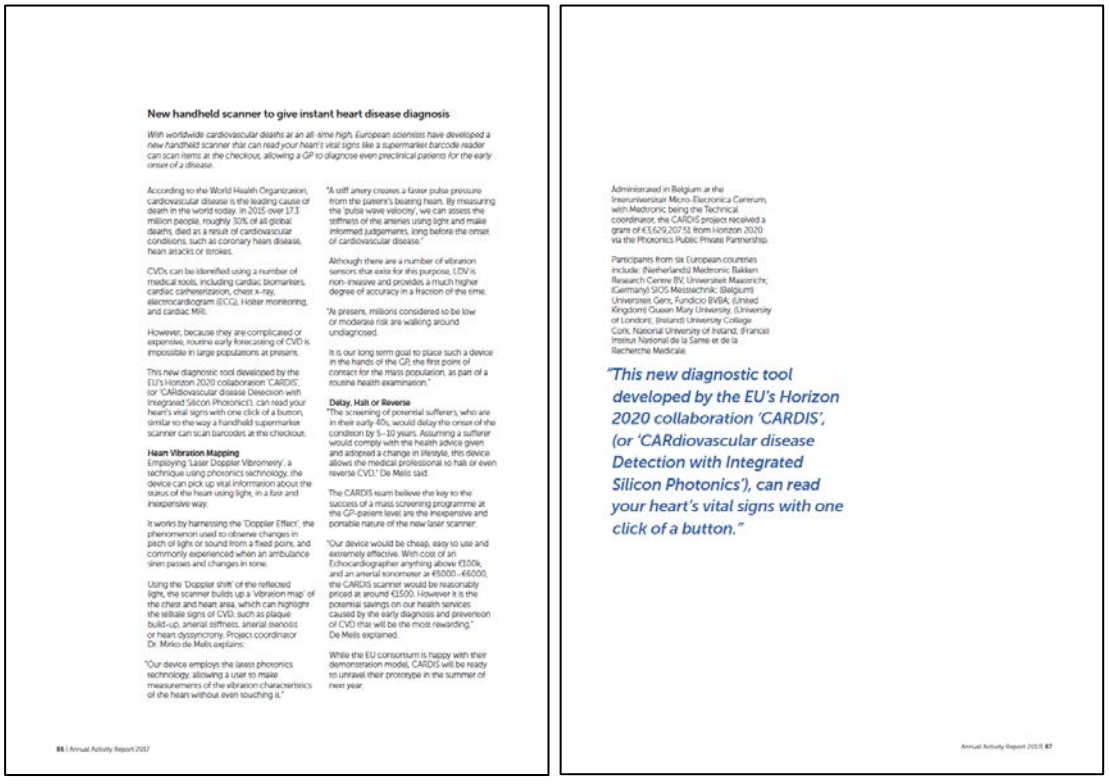
The PAMMOTH team hopes to have a prototype ready for 2020 ready for completion in 2021.

Coordinated in the Netherlands at the University of Twente, the PAMMOTH project received a grant of €4,852,007.50 from Horizon 2020 via the Photonics Public Private Partnership.

Participants from seven European countries include: (Netherlands) PA Imaging R&D BV; Stichting Madoch Spectrum Twente; (United Kingdom) University College London; (France) Imasonic SAS; (Germany) TPZS 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."

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 dyssynchrony. 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 €3.00k, and an arterial sonometer at €5000 - 46000, 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 prevension of CVD that will be the most rewarding," De Melis explained.

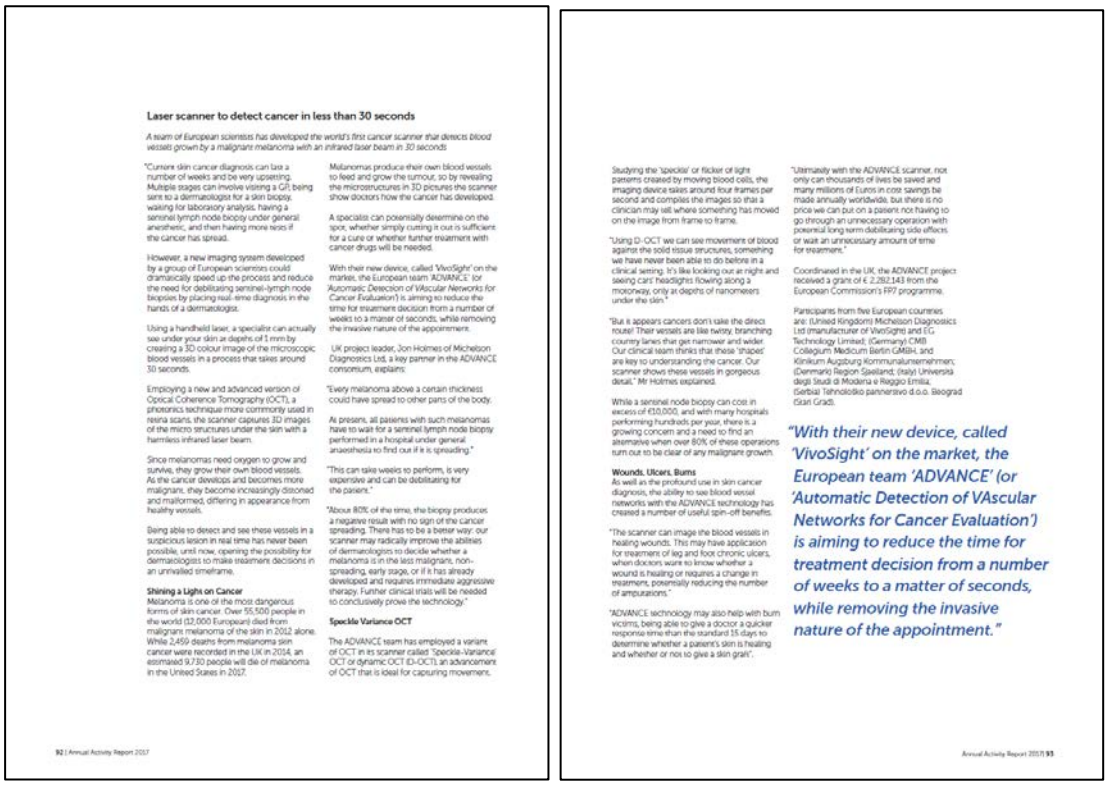
While the EU consortium is happy with their demonstration model, CARDIS will be ready to unravel their prototype in the summer of next year.

Administrated in Belgium at the Interuniversitair Micro-Electronica Centrum, with Medtronic being the Technical coordinator, the CARDIS project received a grant of €3,629,207.50 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 Nacional 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 presens, all pasiens with such melanomas have to wait for a seminel 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 beter way: our scanner may radically improve the abilities of dermacologists 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 see 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 sensinel 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".

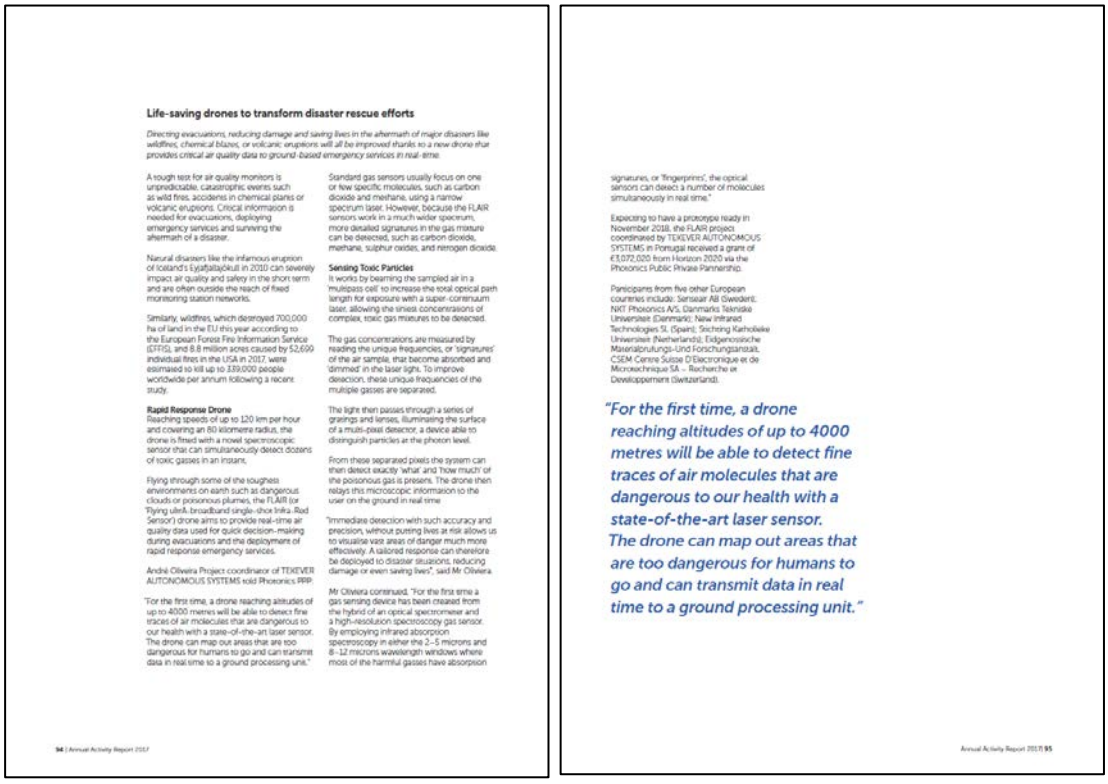
"Ultimately with the ADVANCE scanner, not only can thousands of lives be saved and many millions of Euros in cost savings be made annually worldwide, but there is no price we can put on a patient not having to go through an unnecessary operation with potential long-term debilitating side effects, or 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) Universita degli Studi di Modena e Reggio Emilia; (Serbia) Tehnolosko pannertsvo 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."

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 rough 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 surveying 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 roughest 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 lowest 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 so 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 Oliveira.

Mr Oliveira 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.

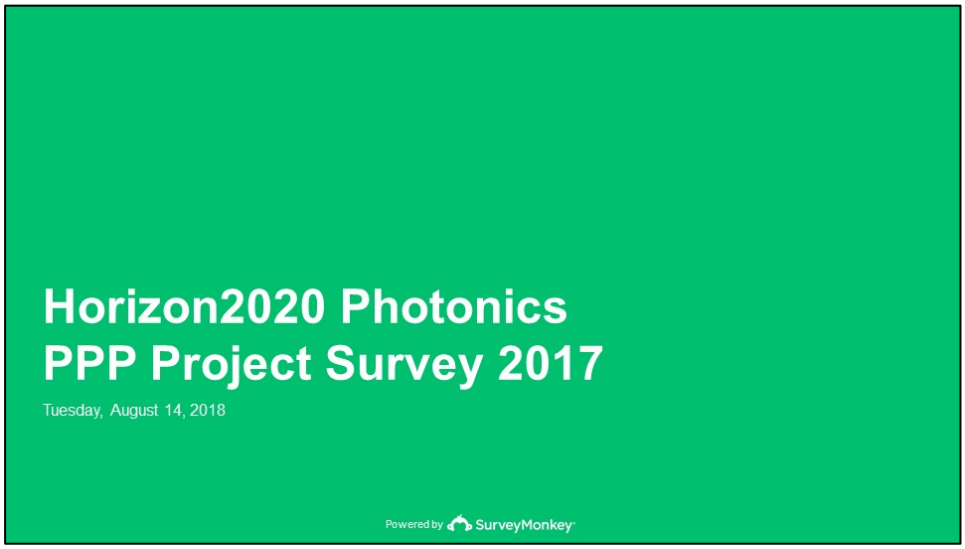
Participants from five other European countries include: Sensear AB (Sweden); NKT Photonics A/S, (Danmark); Teknisk Universitet (Danmark); New Infrared Technologies SL (Spain); Stichting Katholieke Universiteit (Netherlands); Eidgenossische Materialprufungs-Und Forschungsanstalt, CSEM Centre Suisse D'Electronique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

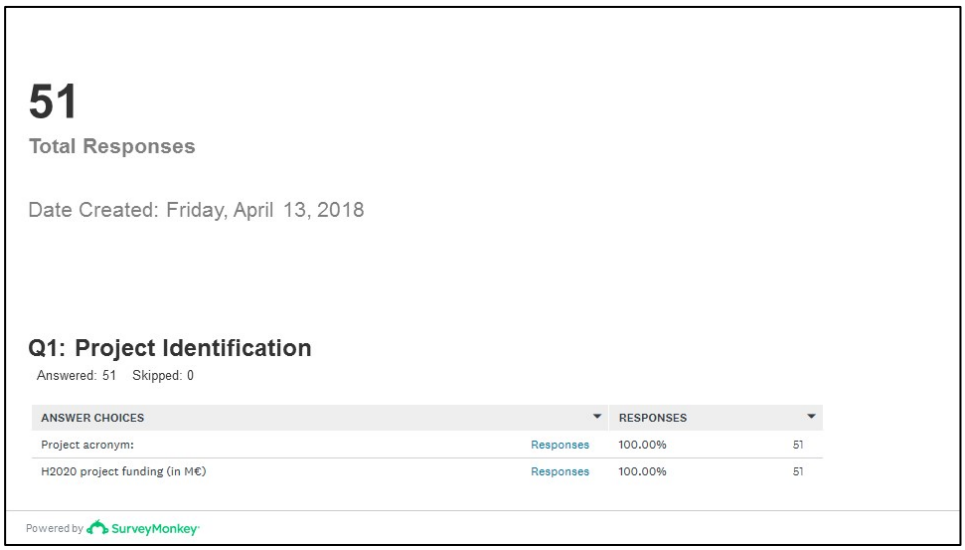
"For the first time, a drone reaching altitudes of up to 4000 metres will be able to detect fine traces of air molecules that are dangerous to our health with a state-of-the-art laser sensor. The drone can map out areas that are too dangerous for humans to go and can transmit data in real time to a ground 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 6: Online Survey Horizon2020 Photonics PPP Project Survey 2017 – conducted April 2018[83]

The online survey was conducted in April 2018 using SurveyMonkey[84]. The detailed results of the survey are displayed in the following slides:[85]





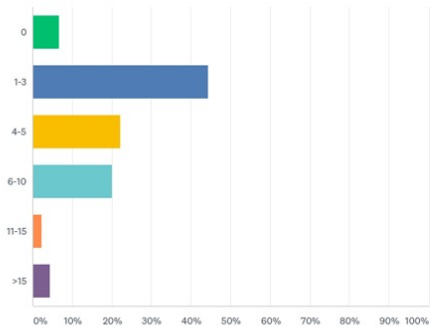
[83] It should be noted that remarks concerning the KPIs evaluation, as made in the final PMR review reports in 07/2018, could not be taken into consideration for this year's online survey, since the online survey among the cPPP Project coordinators had been completed before. All remarks will be addressed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

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

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

Q2: How many new systems and/or technologies are developed in your project?

Answered: 45 Skipped: 6

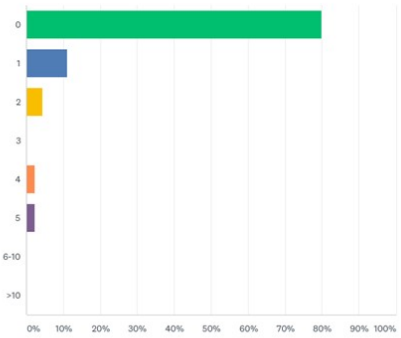


ANSWER CHOICES	RESPONSES	
0	6.67%	3
1-3	44.44%	20
4-5	22.22%	10
6-10	20.00%	9
11-15	2.22%	1
>15	4.44%	2
TOTAL		45

Powered by SurveyMonkey

Q3: How many patents have you already applied for in the Project in 2017?

Answered: 45 Skipped: 6

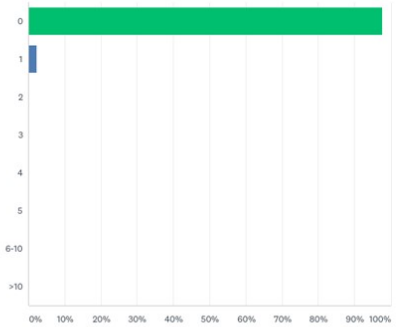


ANSWER CHOICES	RESPONSES	
0	80.00%	36
1	11.11%	5
2	4.44%	2
3	0.00%	0
4	2.22%	1
5	2.22%	1
6-10	0.00%	0
>10	0.00%	0
TOTAL		45

Powered by SurveyMonkey

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

Answered: 45 Skipped: 6

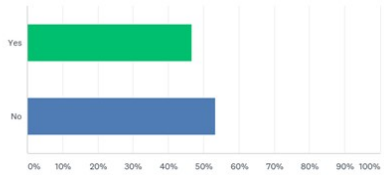


ANSWER CHOICES	RESPONSES	
0	97.78%	44
1	2.22%	1
2	0.00%	0
3	0.00%	0
4	0.00%	0
5	0.00%	0
6-10	0.00%	0
>10	0.00%	0
TOTAL		45

Powered by SurveyMonkey

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

Answered: 45 Skipped: 6

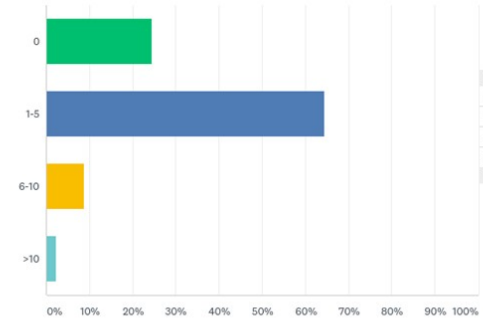


ANSWER CHOICES	RESPONSES	
Yes	46.67%	21
No	53.33%	24
TOTAL		45

Powered by SurveyMonkey

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

Answered: 45 Skipped: 6

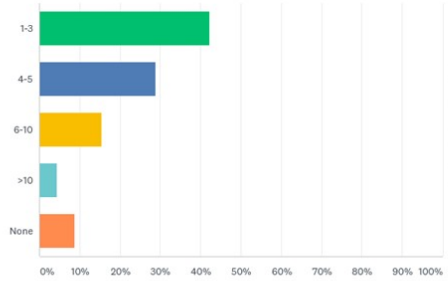


ANSWER CHOICES	RESPONSES	
0	24.44%	11
1-5	64.44%	29
6-10	8.89%	4
>10	2.22%	1
TOTAL		45

Powered by SurveyMonkey

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

Answered: 45 Skipped: 6

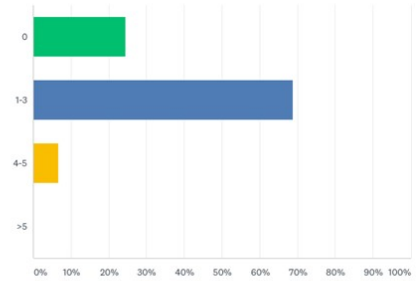


ANSWER CHOICES	RESPONSES	
1-3	42.22%	19
4-5	28.89%	13
6-10	15.56%	7
>10	4.44%	2
None	8.89%	4
TOTAL		45

Powered by SurveyMonkey

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

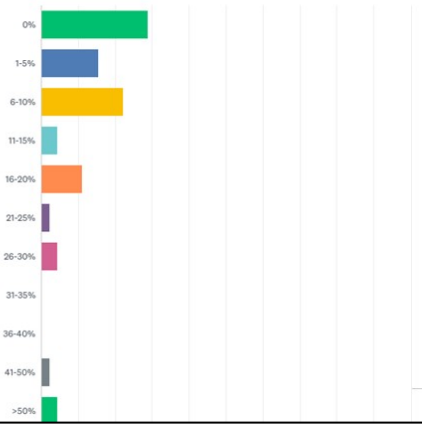


ANSWER CHOICES	RESPONSES	
0	24.44%	11
1-3	68.89%	31
4-5	6.67%	3
>5	0.00%	0
TOTAL		45

Powered by SurveyMonkey

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

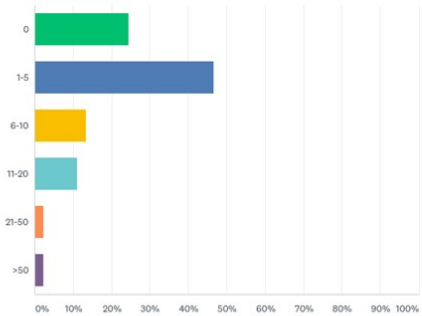
Answered: 45 Skipped: 6



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

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

Answered: 45 Skipped: 6

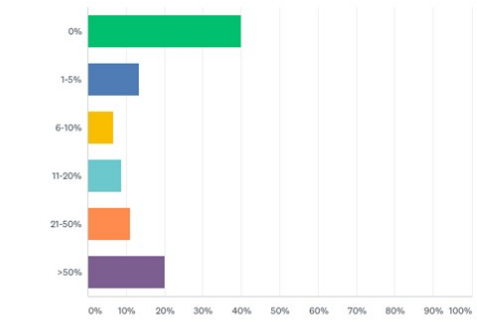


ANSWER CHOICES	RESPONSES	
0	24.44%	11
1-5	46.67%	21
6-10	13.33%	6
11-20	11.11%	5
21-50	2.22%	1
>50	2.22%	1
TOTAL		45

Powered by SurveyMonkey

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

Answered: 45 Skipped: 6

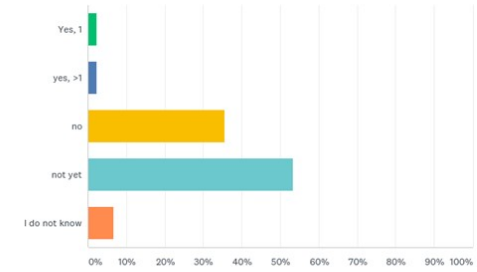


ANSWER CHOICES	RESPONSES	
0%	40.00%	18
1-5%	13.33%	6
6-10%	6.67%	3
11-20%	8.89%	4
21-50%	11.11%	5
>50%	20.00%	9
TOTAL		45

Powered by SurveyMonkey

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

Answered: 45 Skipped: 6

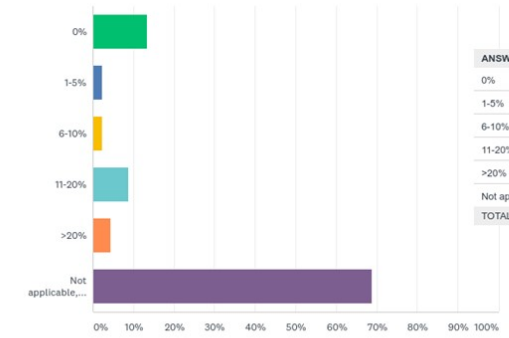


ANSWER CHOICES	RESPONSES	
Yes, 1	2.22%	1
yes, >1	2.22%	1
no	35.56%	16
not yet	53.33%	24
I do not know	6.67%	3
TOTAL		45

Powered by SurveyMonkey

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

Answered: 45 Skipped: 6

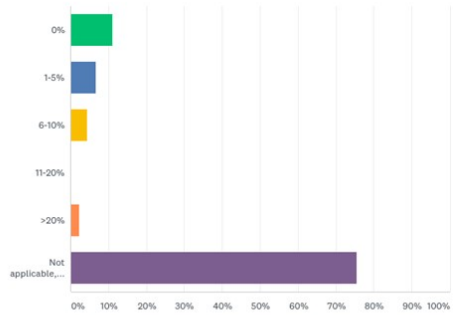


ANSWER CHOICES	RESPONSES	
0%	13.33%	6
1-5%	2.22%	1
6-10%	2.22%	1
11-20%	8.89%	4
>20%	4.44%	2
Not applicable, e.g. not scope of the project	68.89%	31
TOTAL		45

Powered by SurveyMonkey

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

Answered: 45 Skipped: 6

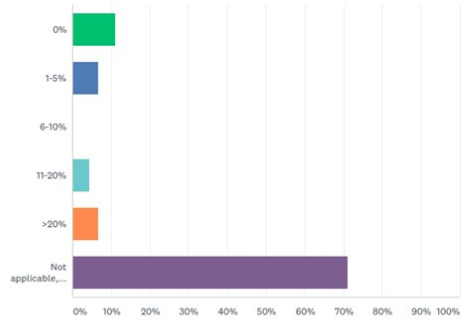


ANSWER CHOICES	RESPONSES	
0%	11.11%	5
1-5%	6.67%	3
6-10%	4.44%	2
11-20%	0.00%	0
>20%	2.22%	1
Not applicable, e.g. not scope of the project	75.56%	34
TOTAL		45

Powered by SurveyMonkey

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

Answered: 45 Skipped: 6

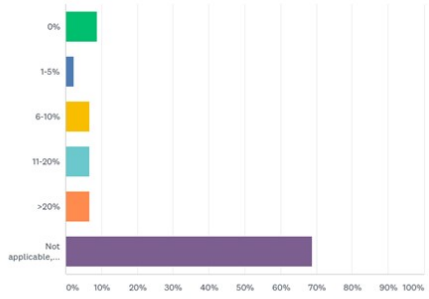


ANSWER CHOICES	RESPONSES	
0%	11.11%	5
1-5%	6.67%	3
6-10%	0.00%	0
11-20%	4.44%	2
>20%	6.67%	3
Not applicable, e.g. not scope of the project	71.11%	32
TOTAL		45

Powered by SurveyMonkey

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

Answered: 45 Skipped: 6

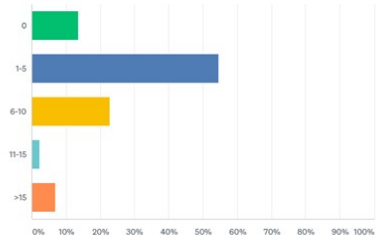


ANSWER CHOICES	RESPONSES	
0%	8.89%	4
1-5%	2.22%	1
6-10%	6.67%	3
11-20%	6.67%	3
>20%	6.67%	3
Not applicable, e.g. not scope of the project	68.89%	31
TOTAL		45

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

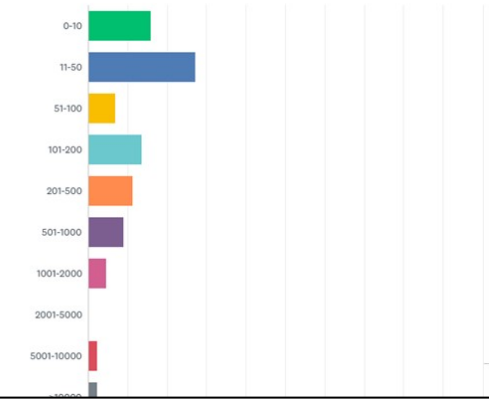


ANSWER CHOICES	RESPONSES	
0	13.64%	6
1-5	54.55%	24
6-10	22.73%	10
11-15	2.27%	1
>15	6.82%	3
TOTAL		44

Powered by SurveyMonkey

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

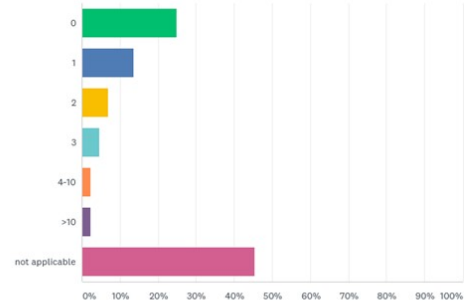
Answered: 44 Skipped: 7



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

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 7: Key results of the study "Photonics in Horizon 2020 – Project Analysis and Assessment of the role of Photonics in H2020"[86]

A study on the role and contribution of Photonics in past and current H2020 projects[87] 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 H2020 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 H2020 programmes. Overall, 891 "photonic based projects" were identified among all H2020 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 H2020 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 H2020 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 H2020 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 H2020 photonics related projects. It is likely that this is down to the success of the Photonics PPP for promoting H2020, 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.

[86] European Technology Platform Photonics21 c/o VDI Technologiezentrum GmbH, Photonics21 Secretariat (to be published in 2018): Photonics in Horizon 2020 – Project Analysis and Assessment of the role of Photonics in H2020.

[87] Study to be published in 2018; for more details on the results of the study, see Annex Part 7.