Photonics21 – Photonics PPP

Annual Activity Report 2017

PHOTONICS PUBLIC PRIVATE PARTNERSHIP

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Photonics PPP Progress

Feedback Calls 2016

In the work programme 2016, both calls '**FOF-13-2016**: *Photonics Laser-based production*' and '**ICT-29-2016**: *Photonics KET 2016*' sought photonics related proposals for a total budget of €99M[1].

The **FoF-13** topic covered the following 'Types of Actions':

Type(s) of action	Budget
RIA	EUR 15 million
IA	EUR 15 million

Research and Innovation Actions **FOF-13-2016.a** *"From design to piece" – Excellence in laser-based additive industrial manufacturing*, addressed the challenge of increasing the competitiveness of Additive manufacturing (AM) on a larger scale, where issues include production speed and costs[2].

Innovation Actions **FOF-13-2016.b** on *"Rapid individualised laser-based production"* aimed to develop and set up highly flexible, efficient, high throughput pilot facilities on the basis of existing processes for laser-based production and validate them in real settings. This required "advances in a number of aspects, including intelligent networking and machine cooperation, data handling, modelling, work piece handling, beam delivery, integration of different processes; monitoring, process control etc[3]."

Overall, all areas mentioned in call text were covered by the retained projects, except the modelling aspects as defined for the IA actions (s. above).

The funded proposals in **FOF-13-2016.a** were on powder-based direct metal deposition process and proposals on powder bed fusion processes.

The **FOF-13-2016.b** actions were on roll-to-roll manufacturing, Development and Pilot Line Validation of a Modular re-configurable Laser Process Head, and the 'Development and validation of integrated multiprocess hybrid production cells for rapid individualized laser-based production'.

The **ICT-29** topic covered the following 'Types of Actions':

Type(s) of action	Budget
RIA	EUR 40 million
IA	EUR 23 million
CSA	EUR 3 million

The RIA proposals **ICT-29-2016.a** were asked to address:
(i) Biophotonics: advanced imaging for in-depth disease diagnosis;
(ii) SSL ['Solid-State Lighting']: Breakthrough in miniaturisation of SSL light engines and systems;
(iii) Sensing: Pervasive high-specificity and high-sensitivity sensing for a safer environment.

The retained proposals provide a broad coverage throughout the three main sub-topics, however with a large predominance of the biophotonics topics: 36 of the 54 eligible RIA proposals addressed theme (i), 7 are addressed theme (ii), and 16 are addressed theme (iii).

The Innovation Action proposals **ICT-29-2016.b** intended to cover the following themes:
(i) Micro-display based immersive, augmented and virtual reality visualisation systems;
(ii) Pilot line for assembly and packaging.'

3 of the 5 received/eligible IA proposals addressed theme (i), and 2 addressed theme (ii).

The CSA sub-topic of the call intended to cover the following themes:
(i) Coordination of regional photonics strategies;
(ii) Photonics enhanced MakerLabs.

3 of the 7 received/eligible CSA proposals addressed theme (i), and 4 addressed theme (ii).

[1] The Photonics PPP contributed €10M funding to this topic on advances in Photonics for laser-based production the FoF Work Programme.
[2] Horizon 2020 Work Programme 2016–2017 in the area of Cross-cutting activities.
[3] Horizon 2020 Work Programme 2016–2017 in the area of Cross-cutting activities.

Implementation of the calls for proposals evaluated in 2016

Evaluation results on the cPPP calls closed in 2016:

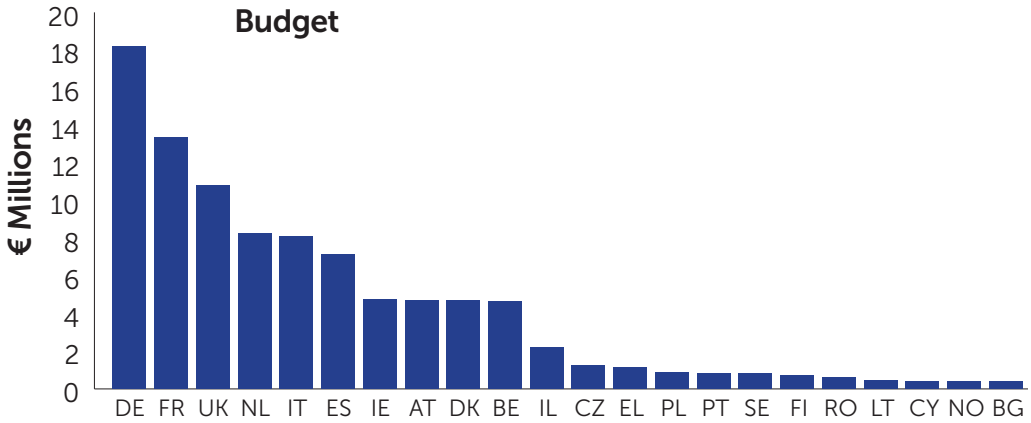
Call Reference	Submitted proposal			Evaluation results		Success rate%
	Submitted proposals	Eligible proposals	% of retained	Above threshold	Selected for funding	
H2020-Fof-13-2016	20	20	100%	9	8	40%
H2020 –ICT-29-2016	71	66	93%	42	20	28%

Source: European Commission, DG CONNECT.

Number of participations in the cPPP calls closed in 2016 and success rate by organisation type in 2016:

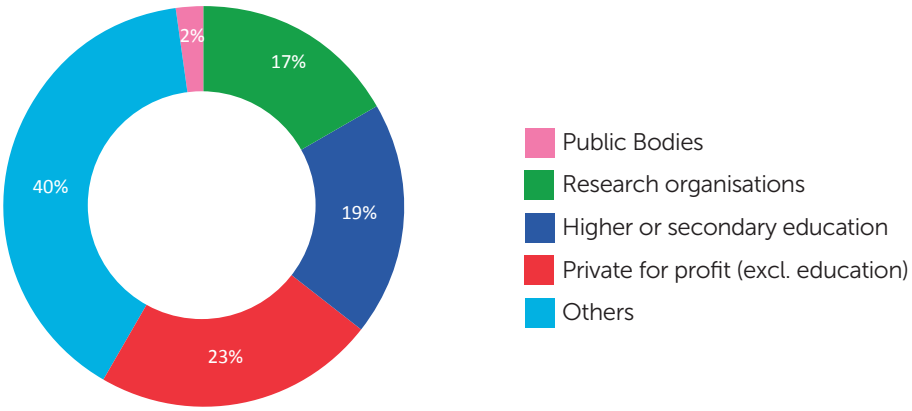
Type participant	Nr of participants in the Proposals	Nr of participants in the funded Projects	Participants success rate	Share of participation
Public Bodies	12	1	8%	0%
Research organisations	140	46	33%	20%
Higher or secondary education	171	50	29%	22%
Private for profit (excl. education)	302	100	33%	44%
Others	131	31	24%	14%
Total	**756**	**228**		**100%**
SMEs	**227**	**73**	**32%**	

Source: European Commission, DG CONNECT.



EC Funding per Country in cPPP Calls closed in 2016[4].
Source: EC, DG CONNECT.

[4] Please notice that the date classification provided in the tables C and Figure A and B is based on data self-declared by the participants at the moment of proposal submission, and quite a high number of "unclassified data" appear as "other". However, data provided in table 1 was extracted from the CORDA database, after the signature of the Grant Agreement and has been manually checked and amended if necessary.



EC funding per Type of organisation in cPPP calls closed in 2016.
Source: EC, DG CONNECT.

The Photonics PPP projects, resulting from the 2016 calls, started in the last months of 2016 or 2017.

An overview of the entire portfolio of the funded Photonics PPP projects can be found in the annex of this report (Stand: August 2017) as well as on www.photonics21.org/ppp-projects, where a summary of all the funded projects is provided, and divided by topic areas. Each project has a brief description of its objectives and is regularly updated.

For the 2016 calls, the EC funded 67 Photonics PPP Projects under the Horizon 2020 frame to the totaling approximately €278M. The industrial participation within PPP Projects accounts for more than 50%, of which more than 55% are SMEs (cf. Table 1).

An overview of the first 3 years is provided in Table 1. Here it shows the distribution of partners is slightly dependent on the topics and the industrial participation remains close or a little over 50%.

Key figures of Horizon 2020 Photonics PPP Projects:

Subject	2014	2015	2016	3 year period
Total Funding for Projects (in €)	87,861,568.12	95,306,838.23	94,800,954.01	277,969,360,36
Number of Participants in Projects	215	209	230	654
Industrial Participation (# of Companies)	111	106	118	335
% of total participants	51.60%	50.70%	51.30%	51.20%
Of which are SMEs (# of SMEs)	62	58	67	187
SME % of industry participants	55.90%	54.70%	56.80%	55.80%
SME % of total participants	28.80%	27.80%	29.10%	28.60%
Budget for Industry (in €)	45,846,170.94	33,306,845.17	45,219,997.46	124,373,013.57
% of total funding	52.20%	34.90%	47.70%	44.70%

Source: European Commission, DG CONNECT.

An analysis carried out by the EC of the tenderers and proposals submitted in 2014[5] showed that the distribution of funded projects was equal for both Photonics21, and non-Photonics21 members, an expected finding given that H2020 Photonics (KET) calls are open to everyone.

Feedback Calls 2017

In the work programme 2017, the **ICT-30-2017** call was for photonics related proposals.
The RIA proposals **ICT-30-2017.a** were asked to address:

(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;
(iii) Disruptive approaches to optical manufacturing by 2 and 3 D opto-structuring.

The Innovation Action proposals **ICT-30-2017.b** intended to cover the following themes:

(i) Innovation Incubator for SMEs;
(ii) Application driven core photonic devices integrated in systems – for:
- Biophotonics: imaging systems for in-depth disease diagnosis
- Sensing for process and product monitoring and analysis

The CSA sub-topic of the call intended to support the industrial strategy for photonics in Europe.

Among the submitted proposals, 52 were a RIA-proposal, 27 were a IA-proposal and 1 was a CSA-proposal.

Overview on received proposals for the H2020 ICT-30-2017 Call:

Number of Proposals	Proposal Topic Code	Proposal TOA Lvl1
1	ICT-30-2017	CSA
27	ICT-30-2017	IA
52	ICT-30-2017	RIA

Source: EC, DG CONNECT .

Of the received proposals, 10 RIA-proposals, 6 IA-proposals and the one CSA-proposal were retained.

The following table gives an overview on the budget allocated as well as the participants in the H2020 ICT-30-2017 call.

Overview on budget allocated and participants in the H2020 ICT-30-2017 Call:

RIA	€ 48,466,816.25
IA	€ 44,923,532.50
CSA	€ 2,997,400.00
TOTAL	**€ 96,387,748.75**
Number of participants in 2017	200
Number of research organisation in 2017	101
number of HLV Education in 2017	61
Number of industry participation	134
Number of SME's	42
Budget for Industry	€ 158,294,102.48
Budget for SME's	€ 86,380,341.78
Number of retained RIA	10
Number of retained IA	6
Number of retained CSA	1

Source: EC, DG CONNECT.

[5] 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.

Monitoring of the common KPIs and the specific KPIs of the cPPP

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/May 2017. An online questionnaire was addressed to 67 PPP Projects: 57 standard collaborative projects, 4 CSAs, 1 FP7 project (ACTPHAST) with relevant activities in H202022, 1 ERANET+, 4 Pilot Lines.

23 of the projects started in 2016 or after.

Overall 58% of the projects reacted to the questionnaire.

39 answers were collected, of which 14 were from projects started in late 2016 or after. It should be noted that, for the last 14 projects, results cannot yet be expected in terms of innovations, patents, exploitation.

Mostly RIA and IA projects participated in the survey, with only 1 CSA answering.
No response has been given from the pilot lines.

The answers with a higher significance are those from projects starting before 2016. Excluding CSAs and ACTPHAST, 25 projects responded to the survey. Considering that 36 "standard" collaborative projects started before 2016, 72% of the most high profile projects reacted – a respectable number to draw reliable conclusions from.

The results of the survey are presented in the table below.

ActPhast and the pilot lines have, by design, a high number of new developed systems or technologies, and therefore a much higher number of patent applications. ActPhast reported between 6 and 10 patent applications linked to projects supported within the scheme.

Overview of the Monitoring of the Common KPIs as a Result of an Online Survey:

Number of **new systems or technologies**:	3/project (excluding ACTPHAST and PILOT LINES).
Number of **patent applications**:	13 for the 22 RIA&IA projects that responded to the survey (excluding ACTPHAST and PILOT LINES), i.e.0,6 per project, or 6 every 10M euro, considering an average funding of =1M/project/year. Including ACTPHAST the number is 21.
Number of projects active in **standardisation activities**:	8 over 22 running projects (excluding ACTPHAST and PILOT LINES) and 6 over 12 of the projects that started in 2016, declare to take part to standardisation activities.
Leverage:	12 projects (over the 22 active projects that reacted to the survey) declare a 1–3 leverage factor, 5 projects a 4–5 leverage factor, and 5 projects declare 0 leverage.
SME turnover increase:	most projects (8 over the 22 active projects that reacted to the survey) declare 6–10% turnover increase.
New **jobs created**:	most projects (13 over the 22 active projects that reacted to the survey) declare 1–5 new jobs, 7 projects declare 6–10 new jobs.
Outreach:	most projects have 1–5 outreach activities.
Total number of new **curricula**:	30.
New jobs:	Most projects (18) declare 1–3 project results that will be further developed with private investment.

Source: EC, DG CONNECT.

Overview on funded Photonics PPP projects

An overview on all past and current funded Photonics PPP projects, arranged by Working Groups, is given in tabular form in the Annex.

This overview can also be found under the following link on the Photonics21 website: **www.photonics21.org/ppp-projects/** where a summary of all the funded projects is provided and divided by topic areas. For each project there is a brief description of its objectives. This list is regularly updated.

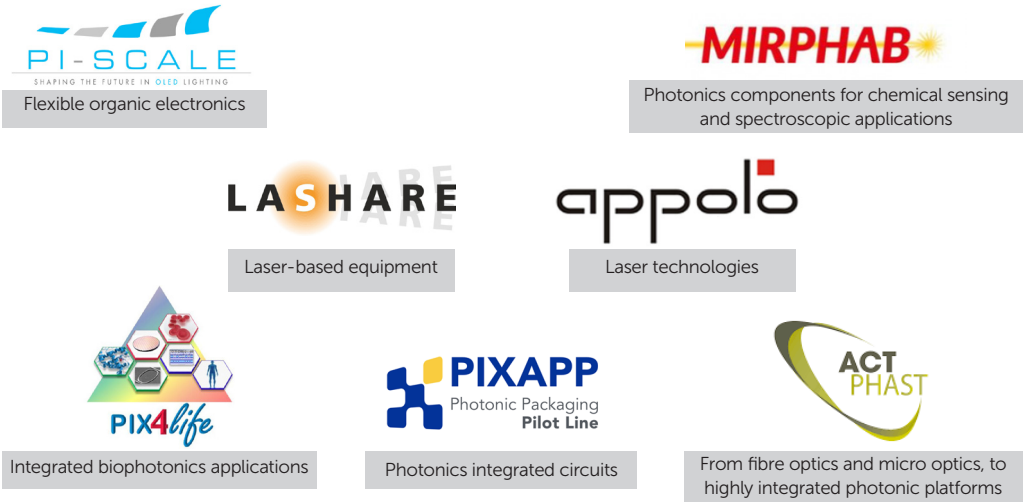
Bridging the valley of death: focus on Innovation actions

Four manufacturing Pilot Lines have been created in the frame of the Photonics cPPP, with more expected in future calls. The Pilot Lines intend to give European industry access to proven photonics solutions and manufacturing, allowing the opportunity to test and validate ideas and new products prior to market entry.

SMEs are a specific target since they often lack the financial resources and the infrastructure needed to bridge the gap between 'lab and fab' and to develop, test and manufacture new products.

The four cPPP Pilot Lines cover very different application domains, ranging from health applications (PPP Project PIX4Life)[6], flexible organic light-emitting diodes (PPP Project PI-SCALE), sensors for the detection of chemicals in gas and liquids (PPP Project MIRPHAB)[7] to Photonics Integrated Circuits (newly started PPP Project PIXAPP). The EC has invested €49 million in these Pilot Lines to speed up the process from 'lab to fab' and therefore boost the competitiveness of European Photonics industry. Up to now, the 4 Pilot Lines have reached companies in 15 countries.

In addition to these 4 Pilot Lines, 3 PPP Projects provide development support, mentoring and prototyping services to companies: ACTPHAST[8] supporting firms in designing and prototyping photonic solutions; LASHARE[9] helping companies to test laser based equipment in production environments; and APPOLO[10] which aims to support companies, especially SMEs, in validating laser technologies for (micro) fabrication, in the automotive sector or in the printing/decoration industries for example.



Bridging the gap between lab and fab: 4 PPP Pilot Lines and 3 PPP Prototyping Services help end user industry to speed up product development.
Source: VDI TZ.

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[6] http://www.pix4life.eu/.
[7] http://www.mirphab.eu/.
[8] The project ACTPHAST (http://www.actphast.eu/) was funded under the frame of FP7. However, since ACTPHAST services have been currently and successfully used under the frame of H2020, it makes sense to include ACTPHAST under the recently promoted Innovation Actions.
[9] https://www.lashare.eu/.
[10] http://www.appolo-fp7.eu/.

The statistics collected by ACTPHAST to measure its impact on European innovation are impressive: ACTPHAST is currently supporting a number of companies (over 90% are SMEs ranging in size) with photonics innovation across 15 different European member states.

ACTPHAST has succeeded in reaching companies that had not previously been supported under the frame of other EU innovation funding mechanisms, with nearly 60% of the funded companies having no previous experience in EU-funded innovation projects.

ACTPHAST has also managed to target companies beyond the Photonics sector: more than 40% of the supported enterprises are "non-photonic companies" of various sectors, for example healthcare, transport, consumer goods, and industrial manufacturing, etc.

With the support of ACTPHAST, more than 30% of the companies are able to conduct a first-time innovation process in photonics. Over the next five years, nearly 500 new EU jobs are expected to be created by companies that will benefit from support by ACTPHAST as a direct result of their ACTPHAST innovation projects[11].

Ensuring quick market uptake of innovation: End user industry involvement in PPP projects

The SWOT-analysis of the European Photonics industry, conducted by the EC a few years ago, showed that a key strength of the European Photonics industry was both the close participation of global market leaders in several core industrial segments and its established links with application industries. The Photonics PPP aimed to build on these strengths 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, for example DiCoMo, CardiS, INNODERM, or are directly driven by end-users requirements in the various potential sectors of application.

In the manufacturing sector, for example, the project ultraSURFACE aims to develop sophisticated optical concepts for more efficient laser structuring, laser polishing and laser thin-film processing applications. The HIPERDIAS project is driven by end-user requirements: aiming to demonstrate high-throughput laser-based manufacturing for a wide range of applications, it mainly focuses 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.

The SEERS project continues the theme of involving end-user industries: aiming to develop a modular, compact and cost effective snapshot spectral imaging system, SEERS will demonstrate this in coastal and road tunnel surveillance involving AIRBUS Defence & Space. These projects are only a small example of end-user involvement in the PPP Projects.

All the funded projects promise a quicker implementation of new photonics innovations into marketable products. Overcoming one of the former weaknesses of the European Photonics industry as identified by the EC a few years ago – the lengthy process of time-to market for innovations[12] – now looks realistic.

Additional private investments and outputs

The additional private investment has been derived from several sources. The additional investment as a consequence of the involvement in H2020 actions can be partially estimated on the basis of the funding schemes. References to public announcements of investments in photonics have also been collected.

[11] http://www.actphast.eu/support-statistics, last accessed on 2017/03/16.

[12] 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.

In Horizon2020, the reimbursement rates for RIA actions and for IA actions are 100% and 70% respectively. The indirect cost is fixed at 25% while industry has an indirect cost of 100% on average, according to the experience accumulated in FP7. Assuming that funding to industry participants is 50% of the total, this leads to the following estimation:

- For RIAs (€65 M in total, of which we assume €32,5M for industrial partners): extra private investment of 30% of EC funding or €9,75M
- For IAs (€26.8M in the sample in total, of which we assume €13,4M for industrial partners): extra private investment of 64% of EC funding or €8.57M

This results in €18.32M private investment on a total of €94,8M public investment or 19.14%, over the project duration

The projects have also indicated an estimated leveraged additional private investment between 1 and 5% of the received H2020 funding in 2016. (see table above on the results of the online survey).

More generally, other data can be derived from what has recently been published[13]. In total, the European Photonics Industry showed Innovation Spending (R&D spending and Capex) in Europe in 2015 to be around €9.6Bn – comprised of €6.4Bn for R&D spending and €3.1Bn for Investment (Capex)[14].

On average, European Photonics companies spent 9.7% of their revenues for R&D in 2015. They invested on average 4.7% of their revenues (Capex / sales) bringing the total R&D and investment quota to 13.8%[15].

Naturally the R&D intensity varies depending on the Photonics segment as well as on single companies. For example, 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 sector (e.g. 17.7% for Adva Optical and 16.6% for Alcatel Lucent).

A similar situation is played out when considering the Capex / sales ratio, which is particularly high for companies *"operating in product segments requiring costly manufacturing equipment and facilities"*[16]. The R&D intensity of companies in the Photonics sector may vary from 3% to 18% and the Capex / sales ratio ranges from 2% to 11%.

Moreover, R&D intensity in the Photonics industry is much higher than in most other industry sectors and the European Photonics Industry is devoting much more funding to R&D than many other industry sectors: the figure of 9.7% of revenues spent by the European Photonics Industry for R&D is more than treble the European industrial R&D intensity average of about 3.2%[17].

Comparing by industry sectors, it appears that the R&D intensity in the European Photonics industry is much higher than in most other industry sectors – even more than Aerospace & Defence, Automotive, Industrial, and Chemicals & Energy sectors[18].

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[13] The following data are the results presented in the PPP Impact Report 2017, published in March 2017: 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.

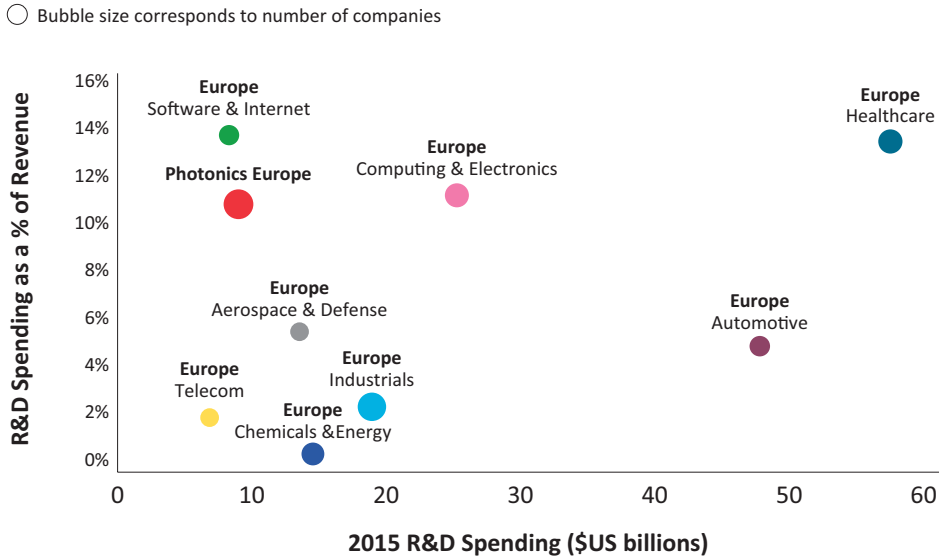
[14] Optech Consulting Market Research Study 24.1.2017 (unpublished); European Technology Platform Photonics21 c/o VDI Technologiezentrum GmbH, Photonics21 Secretariat (2017): Jobs and Growth in Europe – Realizing the potential of Photonics, PPP Impact Report 2017, Düsseldorf.

[15] Optech Consulting Market Research Study 24.1.2017 (unpublished); 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.

[16] Optech Consulting Market Research Study 24.1.2017 (unpublished); 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.

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

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



Comparison of R&D Spending in Photonics vs. other Industry Segments in Europe in 2015.
Source: VDI TZ GmbH, based on the data by PwC, www.strategyand.pwc.com/innovation1000#VisualTabs3.

One of the aims of the Photonics PPP is to provide an incentive for companies in the Photonics sectors to increase their R&D budget. A former study based on 2014 data, shows that the promise has been honoured: European industry and EU policy have joined forces to increase R&D&I investments, with the photonics sector leveraging public investment in the PPP projects by a factor of 4.3[19].

Today's Photonics industry is an attractive sector for investment: with companies already active in this sector wanting to consolidate their position or external investors seeking to profit from the potential offered, many see the lucrative appeal and potential of light technologies.

Over the last few years, industrial R&D spending and industrial investment in Photonics have made headlines: Plessey Semiconductors Ltd. for example announced in 2015 a £60M expansion of its LED manufacturing facility;[20] in 2015, the Hutchinson Group – one of the UK and Ireland's biggest laser engineering firms – announced the creation of 80 new jobs as part of a £4.1M (€5.5M) investment[21]. Last year, the science and technology company Merck KGaA opened a new production plant for OLED materials;[22] Indigo Diabetes, a new Belgian startup, won investment capital amounting to €7M for developing an optical glucose monitoring chip;[23] Trumpf, the world's largest industrial laser company set up a €40M venture fund;[24] the holographic display developer Holoxica won €1.3M to develop next-generation 3D medical displays[25] – to name but a few.

Investments made in the photonics sector aim to address a wide range of potential applications, from displays to laser applications or to applications in the healthcare sector. These investments are in line with the Photonics PPP roadmaps. As the roadmap is jointly prepared by the Photonics industry in Europe with participation of more than 1700 affiliations, it can be concluded that industry is following the PPP roadmap when investing on a company basis.

[19] 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.
[20] www.photonics.com/Article.aspx?AID=57690&PID=6&VID=124&IID=839, last accessed on 2017/03/16.
[21] http://optics.org/news/6/12/31, last accessed on 2017/03/16.
[22] www.photonics.com/Article.aspx?AID=61102&PID=6&VID=134&IID=909, last accessed on 2017/03/16.
[23] http://optics.org/news/7/12/30, last accessed on 2017/03/16.
[24] http://optics.org/news/7/9/13, last accessed on 2017/03/16.
[25] http://optics.org/news/7/2/16, last accessed on 2017/03/16.

European photonics strategy development & implementation

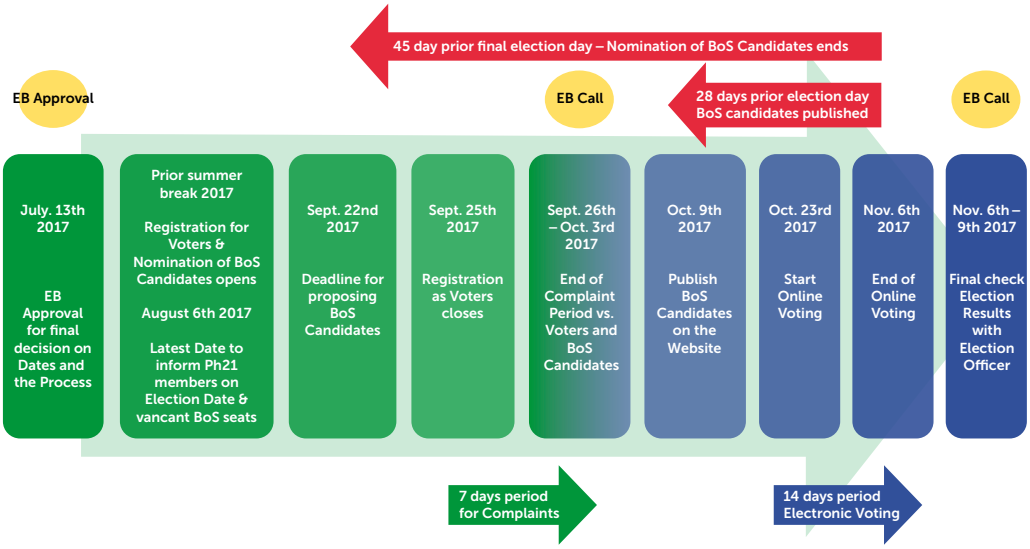
Ensuring a fair representation of the community in Photonics21 Board of Stakeholders – the main decision-making body of PPP

The Photonics21 Board of Stakeholders (BoS) represents the main decision-making body of the PPP. It prioritizes the proposals for PPP call topics (Research and Innovation priorities) coming from the Photonics21 work groups (where members are active). The BoS consists of 100 affiliations active in Photonics which are democratically elected by the membership of Photonics21.

BoS membership is limited to 4 years, with re-election being possible. Due to this central role in the process it is of utmost importance that the election takes place in an open and transparent way, so that a high level of engagement of the Photonics21 members can be assured. The election into the BoS is open to every affiliation involved in Photonics.

However, the Photonics21 Terms of References include some restrictions in order to ensure a balanced composition and industry focus of the BoS: at least 50% of the BoS member affiliations must come from industry and no more than 30 affiliations can come from one country. No restrictions on the composition of the BoS regarding Work Group affiliation were included because many of the C-level BoS members represent several work groups. This is especially true for Directors of Research and Technology Organisations. EuroPho21 has set up the election process and supervised the BoS election by applying an electronic voting platform.

The chart below shows the main steps and time schedule of the BoS election process 2017.



Time Schedule Photonics BoS Election 2017 – Main Due Dates.
Source: VDI TZ.

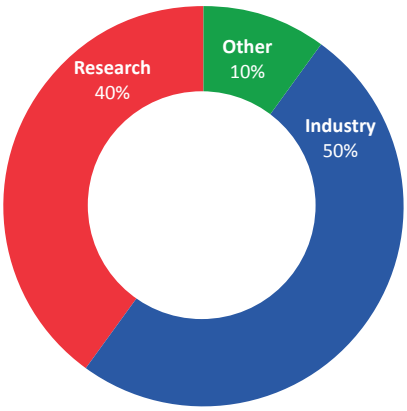
EuroPho21 was responsible for the overall process including the management of BoS applications, voter registration, uploading candidates' application letters to the system, issue management and the coordination with the Photonics21 Executive Board.
The following table shows key data of the 2017 Photonics21 BoS election:

Key data Photonics21 BoS election 2017:

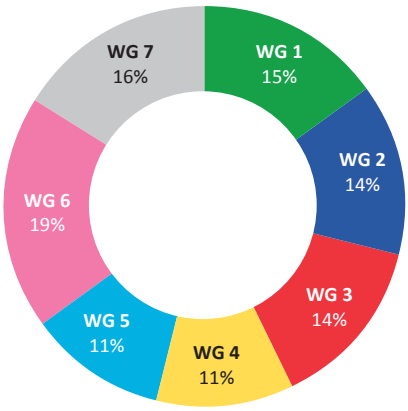
Open Seats:	22	Structure of Candidates by Type of Organization • Industry: 14 (= 52 %) • Others: 7 (= 26 %) • Research: 6 (= 22%)
Number of Candidates:	28	
Number of Voters:	292	

Source: VDI TZ.

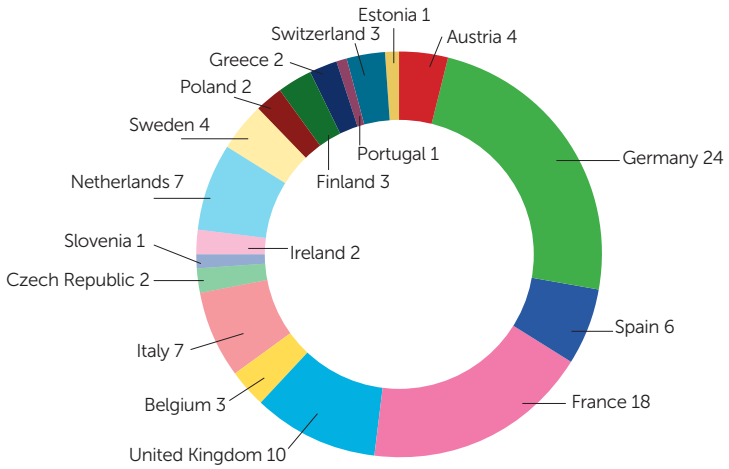
As a result of the Photonics21 BoS election 2017, the charts on page 17 provide an overview of the composition of the new Board of Stakeholders – in terms of the industry vs. research affiliation, the representation of each Work Group as well as in terms of regional composition.



Photonics21 BoS election 2017: Industry vs. Research affiliation (in %).
Source: VDI TZ.



Photonics21 BoS election 2017: Work Group Representation (in %).
Source: VDI TZ.

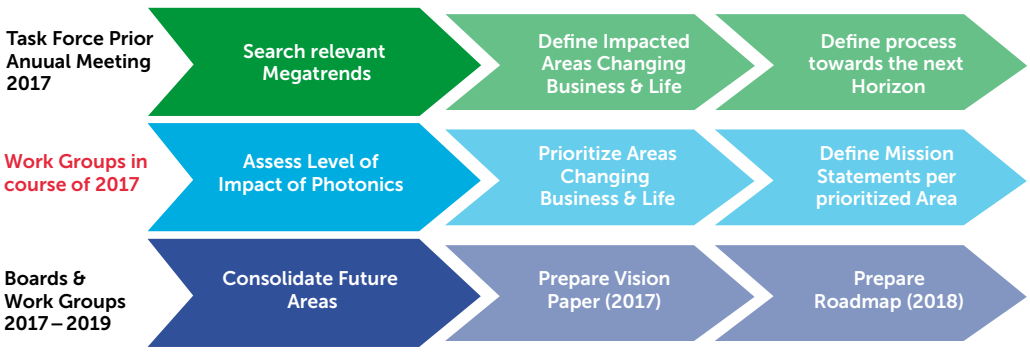


Photonics21 BoS election 2017: Regional Composition (in %).
Source: VDI TZ.

At the end of 2017, the Photonics21 membership exceeded 3000 members.

Towards 2030: the European Photonics Vision

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 (s. figure below). This process and its results are described in detail below.



Structure of the three-stage process of preparing a Vision for European Photonics towards 2030.
Source: VDI TZ.

Step 1: Identification of a first list of potentially relevant needs and trends by the Executive Board of Photonics21.

An Executive Board Task Force was installed at the beginning of 2017 to come up with an approach for workshop sessions which should reflect the discussion what will be needed for the Photonics Platform to be a successful private partner for the EU next framework program. The main questions raised addressed the following issues:

- Which Megatrends can be seen and which global challenges are foreseeable?
- Which are the large Social / Wealth and Social Technology Trends?
- Which are the future markets and how can we impact them?
- Which Technologies can contribute to solutions and innovations?
- Which Technological Convergence is needed to meet the challenges?
- Which platforms and co operations are needed to come to speedy and sustainable solutions?
- Which impact / role can a Photonics PPP and ETP play – what are our Visions and Missions for meeting societal challenges and technological trends?
- Which internal structures/experts/members are needed to support this?

The Task Force Strategy decided to start from the socioeconomic Megatrends (see below) evaluating the impact Photonics has in contributing to solutions in the areas discussed. This was done in the Work Group Sessions that were open to all members at the Annual Meeting 2017 in Brussels.

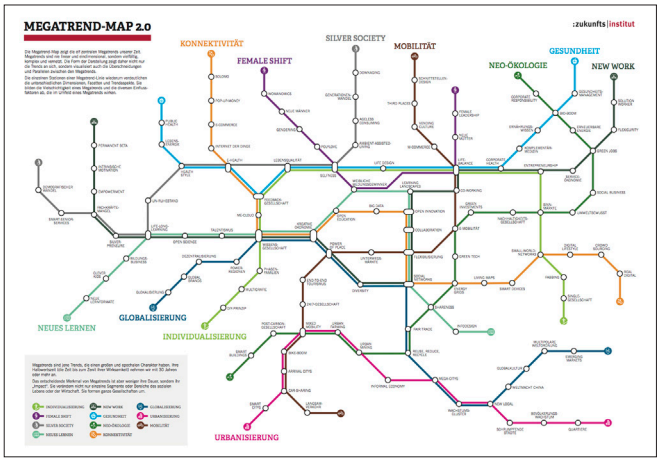
Urbanization
- Emerging megacities
- Growing population
- GDP of countries in one city
- Trend towards east and south

Technological change
- Ubiquity of change
- Convergence
- Miniaturization
- Speed of change

Aging
- Longer lifespan
- Health orientation
- New role interpretation

Glogal connection
- Trade and production
- People
- Data

Resource scarcity and climate change
- Scarce materials (e.g. rare metals)
- Water scarcity
- Climate change



Source: Zukunftsinstitut, www.career-women.org/megatrend-female-shift-zukunftsinstitut-zukunft-map_id7815.html

Approach of the Executive Board Task Force for identifying relevant Photonics Focus Areas.
Source: VDI TZ .

Approach:

Define the Megatrends shaping the future world

Outline the change in all areas of life and business along the Megatrends

Highlight markets in which Photonics is a key technology facilitating the change

Photonics Focus Areas addressing Future Changes

Approach of the Executive Board Task Force for identifying relevant Photonics Focus Areas.
Source: VDI TZ.

Step 2: Identification of relevant thematic areas by the Photonics21 Work Groups and Review Process.

The Work Group Sessions at the Annual Meeting 2017 resulted in a first identification, valuation and prioritization of Topics/Themes, focused on market needs and social challenges. They ranged from "Industry 4.0" and "Zero emission energy supply" to "Selftracking" and "Gamification". These topics then underwent a review process in the period from April to June 2017 involving the Executive Board, the Work Group Chairs, as well as the EU Commission.

The review process was coordinated by VDI TZ in its function as Photonics21 Secretariat. Modifications were made and, in particular, the topics proposed at the Annual Meeting were re-labelled and, if necessary, they were clustered to make sure that all areas covered by the Work Group up to this point were taken into account. As a result, the following possible thematic areas were agreed:

- pHealth – Photonics 4 personalized Healthcare
- pFood – Photonics 4 Smart Farming & Food Production
- pTransportation – Photonics 4 Connected Mobility
- pEnvironment – Photonics 4 Environment or Photonics 4 Sustainable Nature
- pManufacturing – Photonics 4 Industry 4.0
- pSociety – Photonic 4 Smart Cities&Homes
- Photonics 4 Secure Digital Society
- pEducation – Photonics 4 Smart Knowledge Transfer (or Photonics 4 Smart Learning)

Discussion in the Work Groups on the impact of Photonics in the various areas defined by the Megatrends.
Source: Natalie Hill Photography, VDI TZ.

It was recognized that, apart from a focus on markets and social challenges, a "technology push" perspective should also be taken into consideration. In particular, important socio-technological (mega-) trends – such as Digitization, Cognitive / Networking, Autonomous Systems, Social Innovation as well as Individualization – which have so far been given inadequate consideration, should have more emphasis placed upon them when developing a vision for European Photonics towards 2030.

In addition to the markets and societal challenges it was felt that Socio-technological trends, and how they can be impacted & fostered by photonics, could be the approach chosen to demonstrate that Photonics and the Photonics PPP are both indispensable and essential platforms for contributing to future wealth, economic growth and jobs.

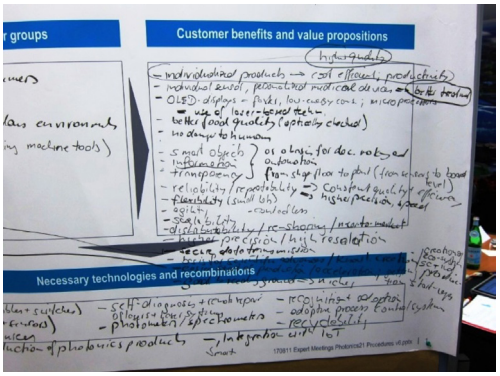
Reflecting on the impact photonics could have on those technological trends was the starting point for developing the vision for the photonics industries future impact and business models.

Step 3: Development of a Vision Paper for European Photonics towards 2030 by the BoS + external experts.

The Photonics Vision Document *"Europe's age of light! How photonics will power growth and innovation"* (Photonics21 Vision Paper)[26] was prepared in the period from August to October 2017 as the outcome of an extensive consultation process involving the European photonics community represented by the Photonics21 Board of Stakeholders and external experts.

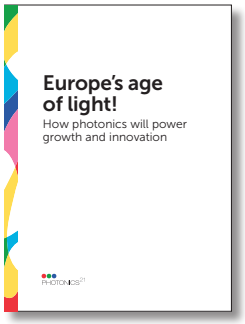
This process was coordinated by VDI TZ. An external consultant was contracted to support the organisation of expert workshops and provide counselling support for drafting the Vision Paper. By coordinating the process, VDI TZ gave high importance to taking various perspectives into consideration regarding potential future application markets of photonics.

Eight half-day thematic strategy workshops were organized in the beginning of September, focusing on the following topics: *Health; Transportation; Sustainability; Knowledge; Smart Farming; Digital Security; Smart Cities and Industry 4.0*, and involving respectively around 15–20 experts coming from industry and academia.



Impressions of the Expert Workshops.
Source: Ursula Tober, VDI TZ.

Each workshop started from a mind map, identifying the strengths and the potential of photonics in the area considered as well as the potential obstacles and strategies to overcome them.



Photonics21 Vision Paper.
Source: VDI TZ [26].

The results of each workshop were then analysed and passed on to researchers and photonics experts. The outcome, in October 2017, was the 'Vision Paper': *"Europe's age of light! How photonics will power growth and innovation"*.

Outlining 8 missions of the European photonics community, the Vision Paper set out provide insight into the future of European Photonics and create input to the new EU framework programme FP9. 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

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

The Eight Missions for future European Photonics as defined in the Vision Paper.
Source: VDI TZ[27] and references therein.

A list of recommendations for action by European photonics was presented in the Vision Paper. Twelve actions were identified as vital on a European and member-state level to ensure that Europe will maintain and continue to expand its strong market position in photonics. These were:

1. Create and implement a European strategy for photonics leadership
2. Build a truly European lab-to-fab infrastructure
3. Boost opportunities for entrepreneurship
4. Educate and train tomorrow's specialists
5. Open up current subsidy regimes to new technologies
6. Remove barriers to innovation by applying smart regulation
7. Accelerate the buildout of 5G and terrestrial broadband
8. Strengthen control over data and privacy standards
9. Coordinate cyber-security efforts
10. Turn the public sector into a lead innovator
11. Complete the Digital Single Market
12. Establish a strong digital innovation ecosystem

The Vision Paper was presented at the Board of Stakeholders Meeting on the 29th of November 2017 by Mr. Thomas Rettich, Photonics21 Executive Board Member. He encouraged all BoS, after having read the document, to market it towards their national and regional ministries.

After being officially published by VDI TZ at the beginning of December 2017, the Vision Paper was then available for download in electronic format on the Photonics21 website **www.photonics21.org**. Printed copies can be also be ordered through the Photonics21 Secretariat.

The Vision Paper was presented on the 28th of November 2017 at a European Parliament 'Breakfast Session'.

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

Advancing European photonics strategy – Photonics Public Private Partnership Annual Meeting

The Photonics Public Private Partnership Annual Meeting is the central community building and networking event for photonics in Europe. In 2017, more than 220 attendees gathered to mark the starting point for the Photonics21 strategic vision for the up and coming Framework Programme FP9.

Impressions of the Annual Meeting 2017.
Source: Natalie Hill Photography, VDI TZ.

The Photonics Public Private Partnership Annual Meeting 2017 was a two-day event consisting of different meetings, as illustrated in the following table.

Agenda and aims of the Photonics PPP Annual Meeting 2017:

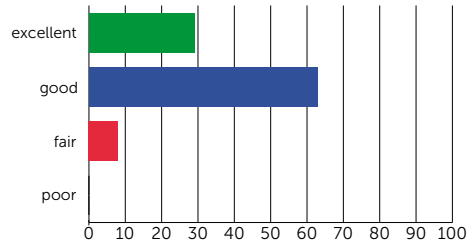
Meetings Day 1	Purpose
Photonics PPP Partnership Board Meeting (European Commission+Ph21 Executive Board) ~15 attendees	Photonics PPP strategy development and implementation issues, preparation of the BoS meeting.
Photonics21 Board of Stakeholder (BoS) meeting (Photonics PPP Partnership Board + 90 high level representatives from industry and research) ~100 attendees	Decision about Photonics PPP strategic issues.
Meetings Day 2	**Purpose**
General assembly / Plenary ~ >220 attendees (event is open to all)	Inform about Photonics21/PPP issues. Explain strategy processes. Raise overarching issues affecting the Photonics industry at large like digitisation of industry.
7 Photonics21 sector specific work group workshops ~each attended by 20–50 experts according to the size of the work group ~ >220 attendees (event is open to all)	Starting point for strategy development. Inform about ongoing action for the Photonics Vision.

Source: VDI TZ.

The Annual Meeting 2017 received very positive responses from the attendees:

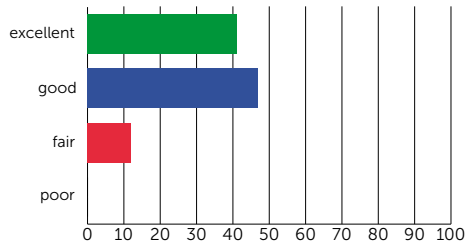
Q5: Quality of speakers – Evening Reception & Plenary

Answered: **52** Skipped: **0**



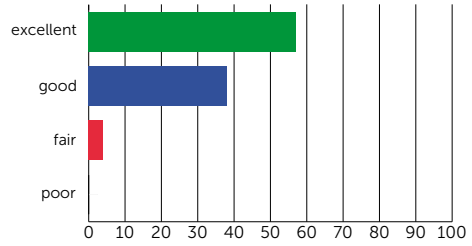
Q6: Quality of moderation – Work Group Sessions

Answered: **51** Skipped: **1**



Q8: Networking Opportunities

Answered: **52** Skipped: **0**



Outcome of the feedback survey to the Annual Meeting 2017 .

Source: VDI TZ.

The VDI TZ was responsible for the overall organization, the agenda concepts, preparation and coordination with work group chairs, coordination of speakers, invitations, preparation of Photonics21 /PPP presentations for all meetings and all the workshops conducted. EaPS also provided organizational and logistical support for the set-up and processing.

Strategic Analysis of ongoing Horizon 2020 PPP Projects

In order to support the next European Research & Innovation Framework Programme (FP9), Photonics21 launched several actions to provide a well-informed discussion and decision-making process. The role that photonics has played in past and present H2020 projects was examined closely.

In Horizon 2020 and elsewhere, the issue as to whether photonics has played the role of an enabling technology for new innovative products, services and developments in areas far beyond the obvious application fields of lighting, was examined.

At the start of September 2017 VDI TZ conducted a study into the role of Photonics in past and present H2020 projects. While VDI coordinated the study and defined and reviewed the methodology to be used, an external consultant was subcontracted for the data collection. VDI TZ then performed the final statistical analysis, drawing conclusions from the study.

Running from August to December 2017, the study had two aims: first to analyse and highlight Photonics based projects across all pillars of H2020; second, to cluster Photonics based H2020 projects along the thematic areas that had been focused on in the elaboration of the Vision Paper.

The study was based on European Commission's 'EU Open data Portal'. The methodology included the screening and analysis of the H2020 projects according to a previously defined set of definitions for "Photonics related projects".

The relevant projects selected were then analysed and arranged according to a number of criteria, such as: the project's relationship to the value chain position of the developed photonic technology, the photonic function of the developed technology, the criticality of the developed photonic technology in the project as well as the mega-market(s) to be served by the photonic technology developed (application markets).

Out of the 13,643 H2020 projects listed on the CORDIS database as of May 2017, 891 were *"photonic based projects"*. Of these, 122 were categorized as *"photonic enabler development projects"*, or projects developing technologies that will be critical for the implementation of a Photonic technology. In addition to these there were 132 projects identified for which *"Photonics [is] a critical enabler"*.

The share of *"Photonics related projects"* in the whole of H2020 is therefore about 8.4%. In terms of EC contribution in Euros, EC funding for purely "photonic based projects" and for all "photonics related projects" amounts to 6.1% and 7.6% of the total EC funding for H2020 projects respectively.

These two figures can be put into perspective by setting them against the backdrop of the 3.3% turnover relative share of the Photonics in European industry. This demonstrates how clearly Photonics technology is a key enabler and a research-intensive industry.

The main results of the study are:

- **Photonics related projects can be found in almost all H2020 programmes.** Covering all high relevance application markets for tomorrow's society and economy, they underline the status of photonics as Key Enabling Technology for providing solutions to tomorrow's major challenges in a variety of application fields.

- **Photonics related projects are very well represented in the pillars of "Excellent Science" and "Industrial Leadership"** where 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 projects within the pillar compared to an average of 8.4% for all programmes) – **demonstrating the huge potential that still has to be exploited in the future and, in particular, to be taken in to account in FP9**.

- **European photonics companies are highly committed to research and innovation. The private sector's involvement in Horizon 2020 in the photonics segment is above average.** The participation of photonics companies in H2020 projects is slightly higher (37% versus 33.2% on average) than in other segments. Perhaps a reason for this high proportion of companies can be found in the 'bottom-up' approach of Photonics21 and the relevance of the calls proposed to the EC though the Photonics PPP.

- **At least 50% of the photonics related projects under come from the private sector. Looking at the average participation of the private sector in all H2020 photonics related projects of 37%, it is clear that this ICT call participants figure is significantly higher.**

- **Photonic SMEs (Small and medium size enterprises) have performed way above average when submitting SME Instrument (SME-INT) projects**, especially for the 'Phase 2 calls'. Nearly 15% of the SME Instrument 'Phase 2' from 2014 to May 2017 were photonic projects.

- The consistency of the projects submitted by the photonic-related SMEs was also recognized as 11.3% of the companies which signed a SME-INST-1 also signed a SME-INST-2, compared to the average of 5.57% for all H2020 projects.

Publishing an economic impact study to monitor the socio-economic impact

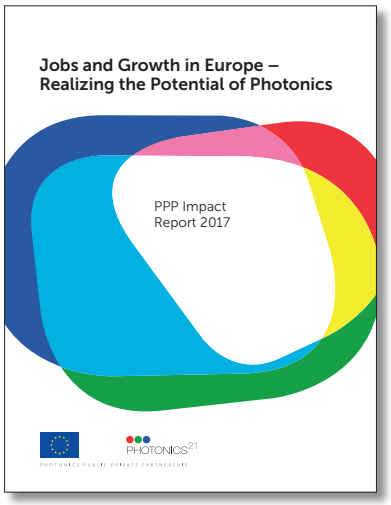
The Market Research Study was delivered in year two of the project. The report was published as the "Market Research Study Photonics 2017" at the 'Laser world of Photonics fair in Munich' in June 2017 and has since been distributed to the photonics community. The report can be downloaded from the Photonics21 website **www.photonics21.org**; print copies can be ordered from the Photonics21 Secretariat.

Market Research Study.
Source: VDI TZ[28].

In addition to the market research study, valuable insights on the impact of Photonics, and the Photonics PPP, on society and the economy are provided in the 2017 PPP Impact Report produced and published by VDI TZ.

While the majority of the report was prepared in 2016, the finished article appeared in March 2017 prior to the 2017 Photonics PPP Annual Meeting. It was first published as an online magazine available from the Photonics21 website.

Owing to the high level of interest in the report, the decision to launch the report at the Annual Meeting 2017 was taken in order to maximize its efficacy. Printed copies of the PPP Impact Report were made available in June 2017 and were first disseminated at the LASER World of Photonics 2017 in Munich.



Photonics PPP Impact Report.
Source: VDI TZ[29].

[28] European Technology Platform Photonics21 c/o VDI Technologiezentrum GmbH, Photonics21 Secretariat (2017): Market Research Study – Photonics 2017, Brussels / Düsseldorf, 2017.
[29] European Technology Platform Photonics21 c/o VDI Technologiezentrum GmbH, Photonics21 Secretariat (2017): Jobs and Growth in Europe – Realizing the Potential of Photonics, Brussels / Düsseldorf, 2017.

Engage the photonics community with end user industry

Engaging with end user industry at Horizon 2020 programme level

As agreed upon at the 2nd year review meeting, no further actions were conducted by the consortium in year 3 of the Project. The remaining resources were reallocated to Task 3.3.

Photonics Open Innovation – Establish links to the Maker Scene

In 2017 EuroPho21 improved relations with the Photonics PPP project Phablabs 4.0. It was included in the CSA coordination to find synergies with the other CSA projects currently running under the Photonics PPP umbrella. A Maker exhibition was conducted with the project as part of the Photonics PPP Annual Meeting 2017 to bring the photonics community together with the maker scene.

Phablabs 4.0 project website.
Source: Phablabs 4.0.

Phablabs 4.0 booth at the Photonics PPP Annual Meeting 2017.
Source: Natalie Hill Photography, VDI TZ.

Link photonics and end user industries at a national / regional level

By the end of 2017, 21 end user workshops had been conducted. Consequently the target number of 12 or more end user workshops was achieved within the frame of the project.

As described in the previous deliverable report 2.3, a common corporate design was defined for the end user workshops. It was agreed to announce the workshops at the Photonics21 web-page and link to the individual web-pages for the work-shops. The results and outcomes of the work-shops were documented following a template (also described in the deliverable report 2.3).

For quantifying the impact of the end user workshops, questionnaires were developed in 2016 (see deliverable report 2.4). Two different types of questionnaires were used: the first one to quantify the impact after the event and a second survey was generated to query the mid-term impacts of activities and business generated.

Below, the end user workshops conducted in 2017 are partially presented and results from the surveys are shown. It turned out that the first survey allowed the interviewees to draw conclusions about the quality and the short-term impact of the events. However, the second survey did not result in a significant number of replies.

One explanation could be that people who are attending many workshops during the year might not fully recall which business has resulted from a particular event. Another explanation could be that business development and co-operations were often considered confidential information, which would not be shared in a survey.

One valuable piece of advice from the second project review was to inform the participants about funding opportunities in the frame of the workshops. Therefore, during the workshops conducted in the second half of 2017 attendees were explicitly informed about funding opportunities. In conclusion the lessons learned by the workshop organisers are summarised.

Overview of end-user workshops conducted 2017 in the frame of EuroPho21:

Partner	Title	Location	Date
AEIT	Photonics for Industry 4.0	Milano	19.5.2017
FORTH	Photonics for smart road transportation	Athens	03.03.2017
FORTH	Photonics 4 Digitalisation of Industrial Manufacturing	Athens	8.12.2017
PCO	Photonics 4 Agriculture	Warzaw	09.03.2017
UPC	Photonics 4 Automotive	Barcelona	18.5.2017
UPC	Photonics 4 Blue Growth	Santiago de Compostela	12.7.2017
UPC	Photonics 4 Aeronautics	Madrid	24.11.2017
KTN	Photonics 4 Healthcare	Birmingham	28.02.2017
PA	Photonics 4 Sorting	Graz	8.6.2017
PA	Photonics 4 Additive Manufactured Products	Graz	6.12.2017
VLSP	Photonics 4 Luxury Coatings	Geneve	21.6.2017

Source: Photonics Austria.

Link up regional, national and European funding for photonics in Europe

Collecting regional and national photonics success and impact stories

Each participating National Technology Platform by regional Cluster was asked to collect, document, edit and share at least 3 national or regional photonics success stories in 2017.

These impact stories have been edited and communicated via the Photonics21 channels and the photonics trade media.

A total of 13 regional and national success stories have been shared by Photonics21 and their project partners via the Photonics21 channels.

Overview on regional and national success stories 2017:

No	Topic
1	Power Photonics receives new investment
2	Photonics innovation center in south west England
3	Foodsniffer: Light delving into our food and safeguarding our table
4	Photonics Park: A new global center of excellence in the field of photonics
5	Laser softens tumors to improve treatment outcomes
6	ADB Safegate wins Best Swedish Optics & Photonics Company 2016
7	Simulator for intraocular lens implants
8	Crystalline super mirrors from Austria
9	3D display without need for 3D glasses
10	Rolling the dice 300 million times per second – thanks to quantum physics and photonics
11	Austrian researchers to adapt laser ignition for rockets
12	SecureStamp, a technology for unforgeable printing of tickets
13	Graphene and Quantum Dots put in motion a CMOS-integrated camera that can see the invicible

Source: VDI TZ.

Involving Member States in the Photonics PPP through National Photonic Circles

The National Technology Platforms aim to set up and prepare National Photonic Circles at least once a year to establish contacts with policy decision makers.

They outline the potential for photonics on a national and regional level and engage them in both the Photonics21 mirror group and the ERANET+ schemes. The mirror group was instrumental in starting an additional Eranet project (Era-learn 2020 Photonics Sensing **www.era-learn.eu/network-information/networks/photonicsensing**).

Throughout 2017 each of the EuroPho21 project partners worked towards the above mentioned goals and provided information on their activities. The table below lists some important achievements for each country with respect to the most relevant meeting of the National Photonic circle and to the size of activity (number of high level meetings of the Photonics circles).

Overview of 2017 achievements of the National Technology Platforms:

National Technology Platform	Status by end of EuroPho21	Number meetings with ministry in 2017
AEIT-CORIFI (Italy)	• The Ministry of Economic Development (MISE) is going to recognise the photonics national technology platform, AEIT-CORIFI, as advisory group for the definition of the R&I national priority for Photonic topics; • The involvement of Tuscany region in the European regional initiative (e.g. the industrial modernization initiative) has been consolidated; • Lombardy Region includes Photonics as one among key-enabling technologies in a few of its RIS3 areas.	2 meetings
CNOP (France)	• A roadmap for French Photonics with support of Ministry of Economy was generated; • CNOP and AFOP have joined forces; • A day of photonics was held in the Ministry of Economics.	1 meeting
EaPS (Sweden)	• New collaboration in the ICT field called Digital Sweden (DS); • Good and regular contacts with the responsible person for RIS3 of the Stockholm region.	1 meeting
FORTH (Greece)	• GSRT decided to participate with a country contribution of 400K in the next ERANET call in photonics; • GSRT nominated a Greek delegate to photonics21 Mirror Group, Dr. Kostas Kyritsis who participated in the 2017 photonics21 Mirror Group meeting; • The Greek platform acted as a consultation and feedback authority to GSRT for upcoming calls for innovation cluster initiatives.	3 meetings
JSP (Finland)	• European level cooperation gives a lot of peer support, credibility and possibility to help Photonics companies. Because; • Tekes funded national Photonics survey which gives valuable information to communicate with other Photonics clusters in Europe.	3 meetings
LA&HA (Slovenia)	• Photonics was included in priority area Industry 4.0 as one of important enabling technology for Smart cities, Smart buildings, Medicine and Health and Mobility; • Collaboration between Government and Fotonika21 resulted in recognition of photonics and implementation of Photonics21 strategy through GOSTOP project funded by Ministry of Education, Science and Sports and SRIP FoF co-financed by Government Office for Development and European Cohesion Policy.	1 meeting
PA (Austria)	• ERANET+ call on Photonic Sensing was successfully organized; • Austria participates as "region" in the S3 Photonics Platform; • Austria has strengthened its position and has become a well-recognized "Photonics Region".	
PhotonicsNL (Netherlands)	• High level meeting with most stakeholders in (Integrated-) Photonics; • Report has been presented to the Ministry. Support from the Regions Noord Brabant and Overijssel has been confirmed; • S3 meeting took place in Hertogenbosch with representatives of EU photonic clusters and stakeholders in order to set up the international Photonics Hub.	1 meeting
VLSP (Switzerland)	• VLSP has now around 150 paying members, a stable structure, an advisory board and is very well networked with sister organisations worldwide.	1 meeting
KTN (United Kingdom)	• Photonics was again recognized as a key enabling technology supporting much of the UK challenge-led innovation agenda; • The establishment of the All Party Parliamentary Group has been an important step in engaging with government, in addition to continue close links with government departments, particularly Innovate UK.	1 meeting
PCO (Poland)	• Photonics stay as the KET Smart Specialisation of Poland; • Two Regions: Masovia and Lubelskie declared photonic as Regional smart specialisation. • The Strategic Research Program for Photonics in Poland cofounded by NCBiR is under evaluation; • Platform has built relation with state and regional governments.	2 meetings
UPC (Spain)	• Identification of the key agents in administration and meetings with support person in Brussels; • Designation of UPC-CD6 as official representative of the region in Photonics alliance meetings; • Explicit interest in the participation in the Alliance of the region.	1 meeting

Source: Swiss Photonics – VLSP.

Involvement of the Mirror group and EraNet projects

The Mirror Group constitutes the public side of the industry-led Photonics21 Board of Stakeholders. It supports and reflects, or "mirrors", the activities of Photonics21 at a policy level and from a governmental perspective.

The Mirror Group was established in July 2007. It is composed of representatives from relevant European, national and regional public authorities such as ministries involved with research and innovation, funding agencies and the European Commission.

On one hand, the Board of Stakeholders (including the Executive Board regarding political issues and objectives and governmental activities at national and European level) are informed and advised by the Mirror Group.

On the other, the Mirror Group may take up recommendations developed by Photonics21 and contribute to their implementation, for example through Public Private Partnerships. Generally, the Mirror Group functions as an inter-governmental panel for exchange, discussion and concerted planning on photonics-related research policy in Europe.

Mirror group overview:

National Technology Platform	Mirror group Representative Activity	Eranet+ activity and projects
AEIT-CORIFI (Italy)	National: Prof. Roberta Ramponi (academia), she is also the president of the NTP AEIT-CORIFI. Regional Tuscany: Roberto Pini also chair of the WG Biophotonics of the NTO AEIT CORIFI.	Participant (Tuscany region is partner): PhotonicSensing
CNOP (France)	Masafumi Tanaka, from the Ministry of Economy and finances.	
EaPS (Sweden)	Andre Litwin (Vinnova) with deputy Magnus Svensson (ECS). Vinnova is a Swedish government agency working under the Ministry of Enterprise and Innovation and acts as the national contact agency for the EU Framework Programme for R&D.	No funds available
FORTH (Greece)	Dr. Kostas Kyritsis, general secretariat for research and technology.	No funds available
JSP (Finland)	Used to come from Tekes (Tekes – the Finnish Funding Agency for Innovation. Tekes is the most important publicly funded expert organisation for financing research, development and innovation in Finland. Organisation). Not active at the moment. Photonics Finland working them to engage again.	No funds available
LA&HA (Slovenia)	No.	No funds available
PA (Austria)	MR Dipl.-Ing. Walter Prinz (bmvit). Austrian Ministry for Transport, Innovation and Technology.	Coordinator: Photonic Sensing (April 2016)
PhotonicsNL (Netherlands)	Dr. Ir. Eddy Schipper from Netherlands Enterprise Agency (RVO.nl). Netherlands Enterprise Agency (Rijksdienst voor Ondernemend Nederland) encourages entrepreneurs in sustainable, agrarian, innovative and international business.	No funds available
VLSP (Switzerland)	Stefan Oberholzer (Swiss Federal Office of Energy SFOE) Swiss Federal Office of Energy. The Swiss Federal Office of Energy (SFOE) is the country's competence centre for issues relating to energy supply and energy use at the Federal Department of the Environment, Transport, Energy and Communications (DETEC).	No funds available
KTN (United Kingdom)	Georgios Padadakis, Innovate UK Innovation Lead for Electronics Sensosrs and Photonics.	Piano+, Biophotonics+, OLEA+, PhotonicSensing
PCO (Poland)	NA.	Photonic Sensing
UPC (Spain)	David Rovirosa, Gustavo Orozco, Mariona Sanz.	No funds available
VDI TZ (Germany)	Hans Eggers, Sebastian Krug.	Photonic Sensing

Source: Swiss Photonics – VLSP.

Coordinating the regional and European photonics strategy – joined implementation to link regional Smart Specialisation strategies

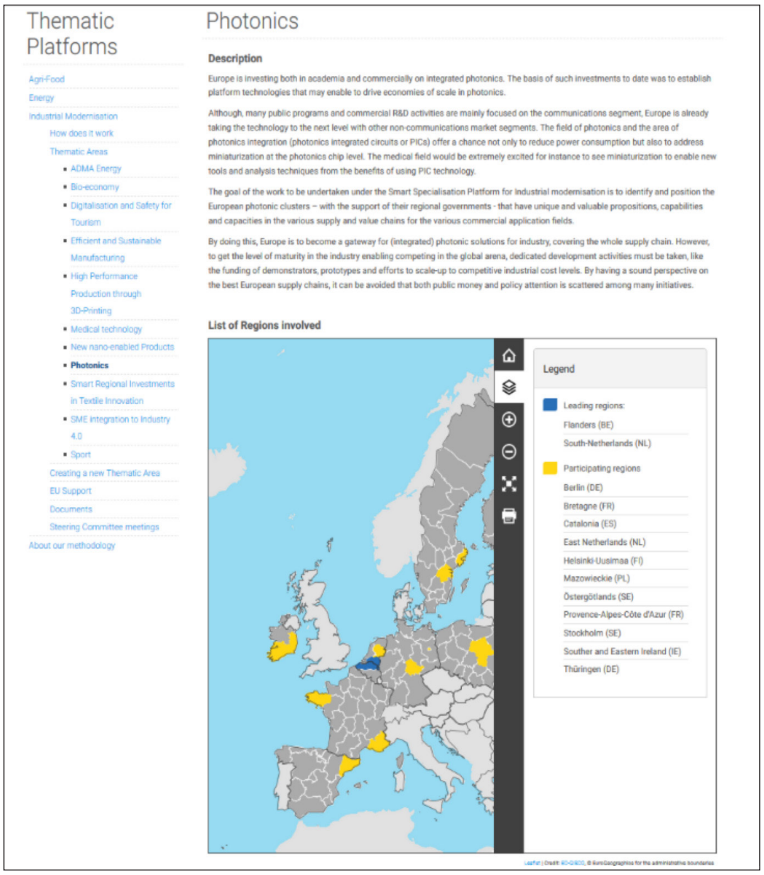
The participating National Technology Platforms have identified and contacted regions with an investment priority in Photonics in the Smart Specialisation Programme (deliverable of the previous period). Each National Technology platform contacted their regional clusters and the regional photonic representatives. The collected information was summarized and provided to regional photonics cluster managers as a tool-kit for photonics avocation at regional level (deliverable in the previous period).

Additionally, the consortia identified active participation of relevant Photonics regions in the Digital Innovation Hubs / Industrial Modernisation Initiatives of the European Commission (deliverable in this last period).

After mapping the regions that were considered to have a strong photonic ecosystem in the previous year, the objective became setting the favorable conditions to build a European interregional Photonics Alliance in the framework of the smart specialization strategy of the European commission. The details of this emerging alliance still need to be defined by the participating regions. Several meetings were conducted with clusters and regional authorities over the course of the past year.

A variety of communication channels have been used to inform the regional stakeholders about this initiative. Direct contact with EC employees working for the S3 platform in Seville was also conducted. Connections between the S3 platform and the leading regions have now been achieved.

To underline the photonics activities in this initiative a dedicated photonics section has been established on the S3 platform.



Smart Specialisation Platform section photonics – website.
Source: European Commission.

The goal of the Smart Specialisation Platform for Industrial Modernisation is to identify and position the European photonic clusters – with the support of their regional governments – that have unique and valuable propositions, capabilities and capacities in the various supply and value chains for commercial application fields.

By doing this, Europe is to become a gateway for photonic solutions for industry, covering the entire supply chain. However, in order to achieve the level of maturity in the industry competing in the global arena, dedicated development activities must be taken: for example the funding of demonstrators, prototypes and efforts to scale-up to competitive industrial cost levels will be essential. Having a sound perspective on the best European supply chains, both public money and policy attention will not be wasted across too many initiatives.

Following this work, the regions of North-Brabant (South Netherlands) and Flanders (Belgium) lead the photonics initiative in the framework of the S3 platform. A first workshop was organized with most of the Europho21 partners in St Hertogenbosch on the 12th/13th of September. Following this workshop, a scoping paper was made by the leading regions. Discussion will continue in Seville early January 2018 during a second workshop in the EC venue.

The Europho21 partners will continue to assist this initiative in the framework of the Nextpho21 project. Starting in early 2018, the partners will update and complete the mapping, circulate the information among European authorities and clusters and trigger interregional collaborations into improving photonics services to various end-user industry SMEs.

Increase participation of SMEs in the Horizon2020 Photonics KET calls

Throughout the EuroPho21 project the National Technology Platforms collect and prepare a regular update on current European, national and regional funding opportunities for photonics SMEs.

During the third reporting period, specific information on Horizon2020 project calls in the 2018 – 2019 period was collected. The criteria used for the selection included the relationship with Photonics Technologies, if: (i) they are directly mentioned in the call text or (ii) a photonics application might belong to a part of the call (sensing, imaging, lighting, communications, manufacturing, etc.). The report was distributed among the partners to be published on the National technologies Platform.

Coordination between Photonics PPP CSA projects

This coordination activity task was added during the EuroPho21 project and was started only in late 2016. This task focuses on the communication between Photonics PPP CSA projects and on the cooperation between them. There are tasks in the different CSA projects which are similar and which may have an overlap, potentially posing an opportunity for synergies. To maximize impact of the PPP activities an active coordination with other PPP CSA Projects was conducted, with particular emphasis on how to approach regions.

There are six CSA-COSME projects in the field of photonics active in 2017, down from seven in 2016.

Overview on 2017 CSA-COSME projects in the fields of Photonics:

Support and innovation action	Ending	Type	Webpage	Cordis
Photonics4All	2016	CSA	http://photonics4all.eu/	http://cordis.europa.eu/project/rcn/194221_en.html
EuroPho21	2017	CSA	www.photonics21.org	http://cordis.europa.eu/project/rcn/194126_de.html
LASER-GO	2017	COSME	NA	www.clustercollaboration.eu/escp-profiles/laser-go
RESPICESME	2017	CSA	www.respice-sme.eu/	http://cordis.europa.eu/project/rcn/199096_en.html
Pics4all	2018	CSA	http://pics4all.jeppix.eu/	http://cordis.europa.eu/project/rcn/199147_en.html
Eprise	2019	CSA	https://eprise.eu/	http://cordis.europa.eu/project/rcn/206199_de.html
PHABLABS4.0	2019	CSA	www.phablabs.eu/	http://cordis.europa.eu/project/rcn/206169_de.html

Source: Photonics Sweden.

There are a number of CSA projects supporting the PPP Photonics21 that also address regional aspects such as Digital Innovation Hubs. This task, 3.5 of EuroPho21, focuses on the communication between the active CSA projects and on the active cooperation between them.

There are tasks in the CSA projects which are similar and even overlap. Active cooperation among the PPP CSA Project in cooperation, and consent with the other CSA Project coordinators will be sought to increase the Impact of the CSA Actions in accordance with the PPP goals.

In 2016, the first communication between the organizations was established: overlapping characteristics of the projects, as well as possible synergies were identified.

After the activity mapping a number of joint activities were carried out during 2017. A special focus was placed on the services to SMEs. They have been summarized in a poster and put into more detail in a brochure.

The following collaborations between projects have been carried out during 2017 and should be carried out under the new CSA NextPho21 in 2018,:

1. Collaboration between Photonics4all and RespiceSME: Collection of sources for education & training programs for photonics. The partners of RespiceSME updated the brochure of education & training programmes for photonics with the courses for Ireland, Greece, Lithuania, Spain and Photonics4all contributed by establishing an html version of the brochure which is placed at www.respice-sme.eu/respicesme-toolbox/tools/

2. Collaboration between EuroPho21 and RespiceSME: Sergio Saez from SECPhO (R-SME) had a presentation on RespiceSME and the tools which have been developed in this project in a workshop on Photonics4Automotive organised by Santiago Royo from UPC (Fotonica21, EuroPho21) in Barcelona on May 2018.

3. Collaboration between RespiceSME and PHABLABs 4.0 and PICs4All: Nathalie Debaes (ND) and Katarzyna Lawniczuk (KL) had presentations at the workshop "aligning education with innovation" at the Laser World of Photonics in Munich, 28th of June 2017.

4. Collaboration between RespiceSME and EuroPho21/Photonics21: During the Laser World of Photonics in Munich, 28th of June 2017, a get together for the RespiceSME workshop participants "aligning education with innovation", job seekers and company representatives was organized at the Photonics21 booth in the entrance hall of the exhibition.

5. Collaboration between RespiceSME, PHABLABs 4.0, PICs4All, Laser-Go, Eprise, Actphast, EuroPho21: A poster has been created in order to show at a glance services to SMEs of all CSA projects including partners involved.

6. Collaboration between RespiceSME, PHABLABs 4.0, PICs4All, Laser-Go, Eprise, Actphast, EuroPho21: A brochure has been worked out which describes all services to SMEs offered by CSA projects and indicates a contact point for each service. This brochure is made for distribution to SMEs. www.dropbox.com/s/4bi3zskoy8iyrih/BROCHURE_CSA_Photonics_LATEST.docx?dl=0

7. Collaboration between Eprise and EuroPho21: The two projects are working together on the Smart Specialisation Platform "Industrial Modernisation" http://s3platform.jrc.ec.europa.eu/industrial-modernisation in order to put photonics on the agenda. This collaboration will be taken up also by the NextPho21 project.

8. Collaboration between NextPho21 and Eprise: An end user workshop on Life Sciences and Biotech will be organized in Stockholm in June 2018.

Communication and Advocacy

European photonics success and impact stories

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 a nd 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.

Further news arising from the projects themselves was then distributed to the photonics community through the Photonics21 dissemination channels website, newsletter, LinkedIn and Twitter.

End user media

The focus of the communication activity was not just to inform the general public about the impact of photonics, but to help the PPP projects promote their work and research. Aiming to promote 2–5 photonics success and impact stories per year, and reach out to 300,000 end users, the PPP wanted to forge new media collaborations and demonstrate the impact the PPP has.

The strategy was simple: the PPP wanted to show how photonics can be applied, not only to a wide variety of industrial sectors, but the importance of light technologies to our everyday lives.

The campaign focused on promoting a selection of high-impact projects funded through the Photonics Public Private Partnership. Original and engaging content was created and strong relationships with the media, especially in key target sectors such as aerospace, manufacturing, defence, healthcare, and security were developed.

In 2017 the campaign resulted in over 209 articles in newspapers, magazines, and websites in more than 15 countries, representing an advertising value in excess of around €500K.

Highlights included coverage in De Morgen, Fox News, Yahoo News, Digital Trends, News Medical, The Engineer, to name but a few. With an estimated readership of over 14.9 million people, the PR campaign helped applied photonics research groups and industry across Europe promote the value and potential uses of photonics as well as raise awareness with the public.

Quick facts for 2017 media campaign:
• 209 articles (105 End User Media)
• global readership of over 14.9 million people
• advertising value totalling +€495K
• Coverage in over 15 countries
• Science, Technology, Medical, Health, Electronics

Overview of individual H2020 Photonics PPP project PR actions:

Matter PR Code	Project Name	Press Release Created	Articles	Photonics	End User Media	News	Unique Monthly	Estimated Readership	Refined Readership
17 A01	HOLOXICA	*First Hologram Video Player to show your Beating Heart*	11	1	9	1	5,935,400	1,055,978	197,847
17 P01	VOSTARS	*Augmented Reality Visor to dramatically reduce surgery times*	44	4	27	13	71,027,599	12,636,965	2,367,587
17 P02	ANNUAL MEETING	*Next_Photonics.Forum*	6	5	1	0	614,400	109,283	20,480
17 P03	PAMMOTH	*Laser 'bowl' to become world's first instant test for Breast cancer*	30	1	12	17	503,147,920	89,518,372	2,795,266
17 P04	CARDIS	*New handheld scanner to give instant heart disease diagnosis*	38	4	17	17	33,303,560	5,925,230	1,110,119
17 P05	SMEESTERS	*New laser scanner to zap toxic French fries*	40	6	18	16	239,883,740	42,679,287	7,996,125
17 P06	FLAIR	*Green Drones to tackle Air Pollution*	16	3	11	2	1,554,490	276,541	13,115
17 P10	ADVANCE	*New Laser Scanner to detect Cancer in less than 30 Seconds*	21	4	9	8	6,893,490	1,226,438	57,446
16 P05	TRESCLEAN	*2016 Project with new coverage*	3		1	2	11,078,030	1,970,938	369,268
Totals			**209**	**28**	**105**	**76**	873,438,629	155,399,032	**14,927,253**

Source: VDI TZ.

Highlights

TV
Lien Smeesters
The Toxic French Fries story made it to ***De Redactie*** – Belgian TV News.
Watch the VIDEO here.

Industrial Equipment News produced an audio visual feature telling the story of the new laser that zaps acrylamide in overcooked starchy foods.
Watch the VIDEO here.

Printed press
For the Special 50th Anniversary Edition of *Electro Optics*, Matter PR secured a thought leadership piece for new Photonics21 President Aldo Kamper.

VOSTARS story gets front cover feature
PAMMOTH *The Engineer Magazine*

Other coverage includes:
Lien Smeesters' story in *De Morgen*
Fox News covers **PAMMOTH**

Digital Coverage

De Redactie
Eureka!
De Morgen
The Engineer
Yahoo News
Healthcare in Europe
Med Tech Intelligence
E Health News
R&D Magazine
Science News
News Medical
Electronics Specifier
Quality Assurance and Food Safety
Bakery & Snacks Magazine
The Engineer
Industrial Equipment News
De TIJD
Imaging Technology Online

Photonics21 Twitter / Linkedin – social media channeling

Throughout the 3rd year of the EuroPho21 project Photonics21 communicated the latest photonics news, impact stories and event information via twitter and LinkedIn.

Members of the EuroPho21 project consortium were encouraged to use the hashtags *#PhotonicsPPP* when communicating any relevant information via twitter. Additionally, Photonics21 coordinated with the coordinators of the other Photonics PPP CSA projects (funded under Horizon 2020 and FP7) and asked them to use the *#PhotonicsPPP* hashtag when communicating any information about their project activities. By the end of 2017 Photonics21 had gained **2492** Twitter followers. Europho21 sent out approximately 1000 tweets in 2017.

Photonics21 Twitter account.
Source: twitter.

Twitter Peer Analysis: Photonics PPP – other Horizon 2020 PPPs:

PPP Twitter Accounts	Tweets	Followers
Photonics PPP		
Photonics21	4198	2492
Factories of the Future PPP		
FoF_EU @FoF_EU	1481	891
EFFRA@EFFRA_Live	3735	2389
Process Industry PPP		
@SPIRE2030	1608	1068
5G PPP		
@5GPPP	2480	3474

Source: VDI TZ.

The EuroPho21 project activities consisted of photonics news and events published through the Photonics21 Twitter channel.

Photonics21 tweets successfully addressed a younger audience with 63% of Photonics21 Twitter followers fitting into the 18–34 categories (s. figure below).

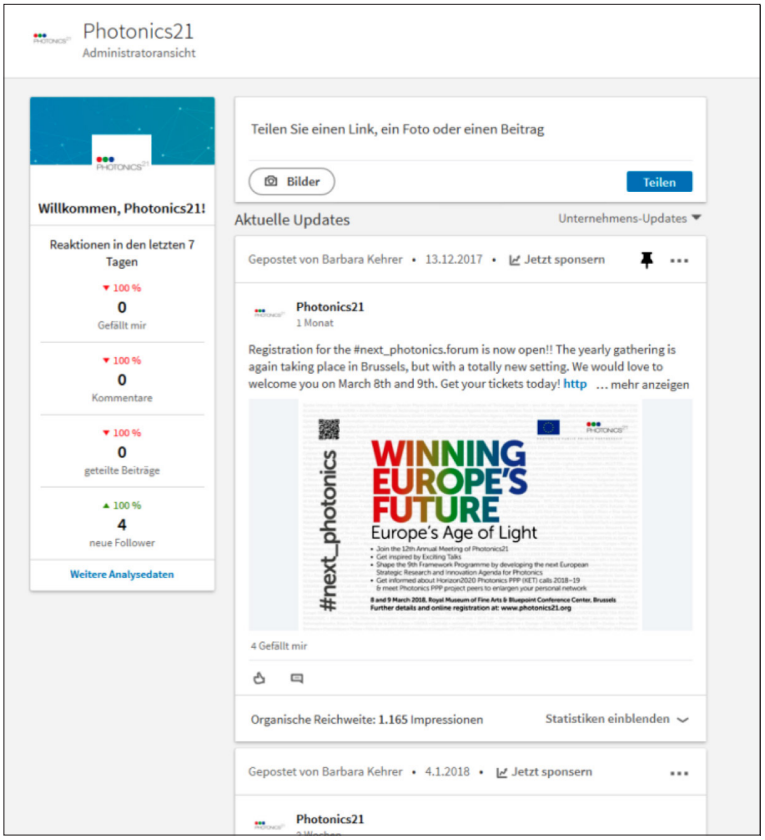
Age

Age category	% of audience
13 to 17	2%
18 to 24	13%
25 to 34	50%
35 to 44	22%
45 to 54	10%
55 to 64	2%
over 65	1%

Photonics21 Twitter followers by age.
Source: twitter analytics.

In order to further increase the level of engagement of photonics experts and inform about Photonics PPP activities and projects EuroPho21 started a dedicated Photonics21/PPP Linkedin account in 2016. In 2017 the account was 'revamped' with more up-to-date information.

Currently the Photonics21 Twitter account has 161 followers and has had 25 Updates posted during the year 2017.



Photonics21 Screenshot of the dedicated Photonics21/PPP Linkedin account.
Source: Photonics21 LinkedIn page.

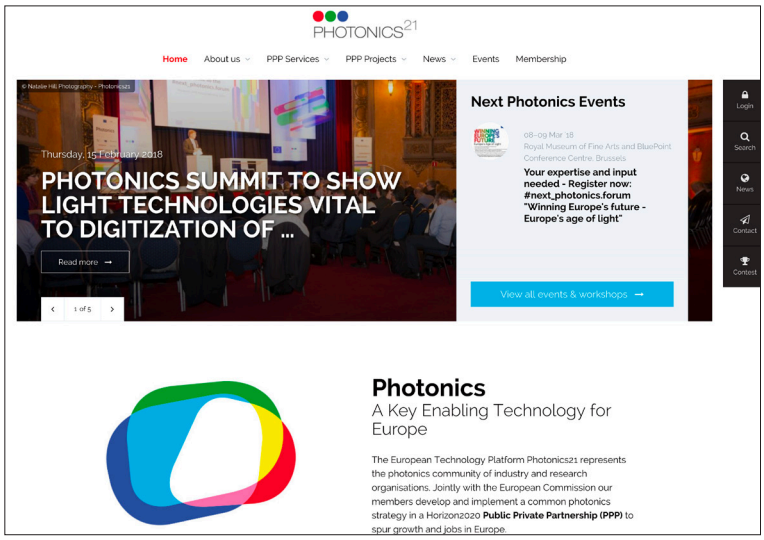
Photonics21 website: the photonics communication platform and Photonics21 Newsletters

Throughout the 3rd year of the project the Photonics21 website was constantly updated and provided latest information on photonics news, events as well as photonics reports and presentations for download. However, to keep a fresh and up-to-date feel the website underwent a relaunch at the end of 2017. VDI TZ acted as a coordinator and gave the first hints on what should be included on the new website.

A specification sheet was established which was sent to 5 web design agencies. Three agencies competed in the tender but it was felt that **e-nitio mediasign GmbH** produced the best offer and was awarded tender. In three face-to-face meetings and various phone calls the design and the new structure of the website has been finalized.

Several features of the old website did not make it into the new one. Among them is the European Photonics Database and the Training and Education section. Due to low visitor numbers on these pages, the difficulties to keep them up to date and the adjusted focus of the website to a more PPP project-oriented platform led to the decision to exclude these sections.

Screenshot of the Photonics21 Website prior to the relaunch.
Source: VDI TZ.



Screenshot of the relaunched Photonics21 Website.
Source: VDI TZ.

In order to improve our website towards a more platform-oriented approach we included the projects funded under the Photonics PPP umbrella more prominently and gave more details on the Photonics21 website. A new section on the PPP services for financing photonics, for SMEs/ industry and for photonics for education was also created. The sections on Photonics21 and the Photonics PPP have been merged in the new website to become a joint menu item "About us".

33 news items have been published on the Photonics21 website in 2017 with the possibility to share each news item in the common social media channels. Furthermore, the main page is connected to the live Photonics21 twitter account so that the website user can be informed on latest Photonics21 tweets. Photonics events can also be published by the photonics community autonomously via an event form on the website.

In order to keep our key stakeholders regularly briefed 6 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.

Photonics Information Day

There have been two InfoDays in 2017. The ICT30-PHOTONICS KET (Key Enabling Technology) InfoDay took place on 27/1/17 as well as the Photonics calls InfoDay on 08/12/17. The objective of both was to inform the constituency about the various topics addressed by the Photonics PPP calls.

A number of presentations were given by the European Commission and Photonics21 representatives and prospective proposers. Together with the EC Photonics Unit, VDI TZ was jointly responsible for agenda preparation, announcement of the event and speaker coordination. A number of attendees from 17 different countries participated in the InfoDays, many being new to the H2020 programme.

Advocating for Photonics at European level

In preparation for the new EU framework programme FP9, Photonics21 promoted the new Vision Document ***Europe's age of light!*** Participating in the 9th European Innovation Summit *"Turning knowledge and ideas into value for society"* running from 27th November until 1st December 2017, at the European Parliament in Brussels, Photonics21 circulated the Vision paper among the members of the European Parliament.

On the second day of the summit, a breakfast session going by the same name as the Vision Paper *"Europe's age of light! How photonics will power growth and innovation"* was attended by representatives of the European Parliament and the European Commission as well as regional representatives. The session, hosted by MEP Lieve Wirinck, saw Photonics21 demonstrate the impact of photonics by presenting the strategic vision for 2030.

Photonics21 Executive Board member Bernd Schulte presented the economic performance of the Photonics PPP in his *"The age of light – Photonics Impact 2017"* presentation. Photonics21 Executive Board member Thomas Rettich outlined the 8 missions of the European photonics community to drive the future of Europe in his *"The age of light – Photonics Vision for 2030"* presentation.

PHOTONICS PUBLIC PRIVATE PARTNERSHIP

Photonics21 Breakfast Session alongside the 9th European Innovation Summit

Turning knowledge and ideas into value for society

28th November 2017, 8.00 – 9.30

European Parliament, Brussels

Europe's age of light!
How photonics will power growth and innovation

Agenda

8.00 Welcome by Lieve Wierinck, MEP

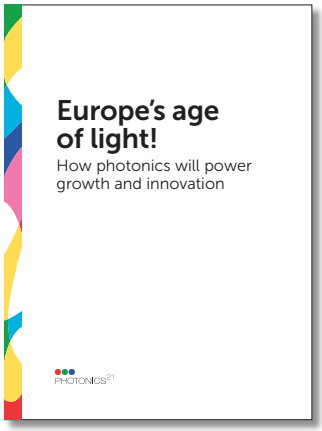
8.10 The age of light - Photonics Impact 2017
Bernd Schulte, President and Executive Board Member AIXTRON, Photonics21 EB member

8.35 The age of light - Photonics Vision for 2030
Thomas Rettich, Head of Research Coordination TRUMPF, Photonics21 EB member

9.00 Q&A and discussion moderated by Lieve Wierinck

9.30 End of breakfast session

Agenda of the Photonics21 Breakfast Session.
Source: VDI TZ.



Photonics21 Vision Paper.
Source: VDI TZ[30].

Impressions of the Photonics21 Breakfast Session.
Source: VDI TZ.

Advert of Photonics21 in the European Innovation Summit Brochure.
Source: VDI TZ.

Photonics21 Communication Toolkit

In order to ensure a common Corporate Identity and design whilst reporting and communicating about the PPP the Photonics21 secretariat started to work with the graphic design agency **Ocean Design** to develop new Photonics21 and PPP logos, and to create a new key visual.

A variety of brochures and studies have been produced in 2017 emblazoned with this new up-to-date logo, for example the Photonics PPP impact report, the Market Research Study 2017, Market Research Study – Key Data, and the Vision Paper. Additionally several event announcements for the Photonics PPP Annual Meeting 2017 and the Photonics21 Student Innovation Award were developed.

Photonics21 Exhibition Booths

The Europho21 booth was a central fixture at the Laser World of Photonics fair in Munich in June 2017. By informing the attendees about the Market Research Study Photonics 2017 as well as distributing the Photonics PPP impact report, Europho21 made contact with photonics experts and other groups seeking collaborations with other institutions.

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

Annex 1: Overview on funded Photonics PPP projects

Information and Communication Technologies

The following table displays all photonics projects affiliated to the Work Group 1 "Information and Communication Technologies" – all projects are still running.

Overview of projects affiliated to WG 1:

Call	Project acronym	Funding Scheme	EU Funding	Description of Project & Objectives
WG1 INFORMATION AND COMMUNICATION TECHNOLOGIES				
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: www.ict-streams.eu/]
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: www.teraboard.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: www.h2020-cosmicc.com/]
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/]

Source: VDI TZ.

Industrial manufacturing and quality

The following table displays all past and current photonics projects affiliated to the Work Group 2 "Industrial manufacturing and quality":

Overview of projects affiliated to WG 2:

Call	Project acronym	Funding Scheme	EU Funding	Description of Project & Objectives
INDUSTRIAL MANUFACTURING AND QUALITY				
H2020-FoF-2014	**COMBILASER**	RIA	EUR 3 439 420	IThe 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-FoF-2014	**ADALAM**	RIA	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]
H2020-FoF-2014	**RADICLE**	RIA	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]

Source: VDI TZ.

Overview of projects affiliated to WG 2:

Call	Project acronym	Funding Scheme	EU Funding	Description of Project & Objectives
INDUSTRIAL MANUFACTURING AND QUALITY				
H2020-FoF-2014	**MASHES**	RIA	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]
ICT 27-2015	**ultraSURFACE**	RIA	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]

Source: VDI TZ.

Overview of projects affiliated to WG 2:

Call	Project acronym	Funding Scheme	EU Funding	Description of Project & Objectives
INDUSTRIAL MANUFACTURING AND QUALITY				
ICT 27-2015	**HIPERDIAS**	RIA	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 of silicon at high speed, precision processing of diamond material and fine cutting of metal for the watch and the medical industry. The final targets of the project are to demonstrate: • a 10-times increase of ablation rate and productivity 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-ICT-2015	**TRESCLEAN**	RIA	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]

Source: VDI TZ.

Overview of projects affiliated to WG 2:

Call	Project acronym	Funding Scheme	EU Funding	Description of Project & Objectives
INDUSTRIAL MANUFACTURING AND QUALITY				
H2020-FOF-2016	**HYPROCELL**	IA	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]

Source: VDI TZ.

Overview of projects affiliated to WG 2:

Call	Project acronym	Funding Scheme	EU Funding	Description of Project & Objectives
INDUSTRIAL MANUFACTURING AND QUALITY				
H2020-FOF-2016	**MODULASE**	IA	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]

Source: VDI TZ.

Overview of projects affiliated to WG 2:

Call	Project acronym	Funding Scheme	EU Funding	Description of Project & Objectives
INDUSTRIAL MANUFACTURING AND QUALITY				
H2020-FOF-2016	**POLAROLL**	IA	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]

Source: VDI TZ.

Overview of projects affiliated to WG 2:

Call	Project acronym	Funding Scheme	EU Funding	Description of Project & Objectives
INDUSTRIAL MANUFACTURING AND QUALITY				
H2020-FOF-2016	**DREAM**	RIA	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	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]

Source: VDI TZ.

Overview of projects affiliated to WG 2:

Call	Project acronym	Funding Scheme	EU Funding	Description of Project & Objectives
INDUSTRIAL MANUFACTURING AND QUALITY				
H2020-FOF-2016	**HIPERLAM**	RIA	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]

Source: VDI TZ.

Overview of projects affiliated to WG 2:

Call	Project acronym	Funding Scheme	EU Funding	Description of Project & Objectives
INDUSTRIAL MANUFACTURING AND QUALITY				
H2020-FOF-2016	**MAESTRO**	RIA	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-2016	**PARADDISE**	RIA	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]

Source: VDI TZ.

Life science and health

The following table displays all past and current photonics projects affiliated to the Work Group 3 "Life science and health":

Overview of projects affiliated to WG 3:

Call	Project acronym	Funding Scheme	EU Funding	Description of Project & Objectives
LIFE SCIENCE AND HEALTH				
H2020-ICT-2014-1	**DICOMO**	RIA	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-2014-1	**SAPHELY**	RIA	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]

Source: VDI TZ.

Overview of projects affiliated to WG 3:

Call	Project acronym	Funding Scheme	EU Funding	Description of Project & Objectives
LIFE SCIENCE AND HEALTH				
H2020-ICT-2014-1	**RAIS**	RIA	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-2014-1	**CARDIS**	RIA	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: www.cardis-h2020.eu]
H2020-ICT-2014-1	**INSPECT**	RIA	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 tumors, 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]

Source: VDI TZ.

Overview of projects affiliated to WG 3:

Call	Project acronym	Funding Scheme	EU Funding	Description of Project & Objectives
LIFE SCIENCE AND HEALTH				
ICT-28a-2015	**INNODERM**	IA	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/]
ICT-28a-2015	**LUCA**	IA	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/]
ICT-28a-2015	**COBIOPHAD**	IA	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: www.cobiophad.eu/]

Source: VDI TZ.

Overview of projects affiliated to WG 3:

Call	Project acronym	Funding Scheme	EU Funding	Description of Project & Objectives
LIFE SCIENCE AND HEALTH				
H2020-ICT-2014-1	**POSEIDON**	RIA	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-2016-1	**CVENT**	RIA	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]

Source: VDI TZ.

Overview of projects affiliated to WG 3:

Call	Project acronym	Funding Scheme	EU Funding	Description of Project & Objectives
LIFE SCIENCE AND HEALTH				
H2020-ICT-2016-1	**MOON**	RIA	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]

Source: VDI TZ.

Overview of projects affiliated to WG 3:

Call	Project acronym	Funding Scheme	EU Funding	Description of Project & Objectives
LIFE SCIENCE AND HEALTH				
H2020-ICT-2016-1	**SOLUS**	RIA	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]

Source: VDI TZ.

Overview of projects affiliated to WG 3:

Call	Project acronym	Funding Scheme	EU Funding	Description of Project & Objectives
LIFE SCIENCE AND HEALTH				
H2020-ICT-2016-1	**GALAHAD**	RIA	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]

Source: VDI TZ.

Overview of projects affiliated to WG 3:

Call	Project acronym	Funding Scheme	EU Funding	Description of Project & Objectives
LIFE SCIENCE AND HEALTH				
H2020-ICT-2016-1	**PICCOLO**	RIA	EEUR 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]

Source: VDI TZ.

Overview of projects affiliated to WG 3:

Call	Project acronym	Funding Scheme	EU Funding	Description of Project & Objectives
LIFE SCIENCE AND HEALTH				
H2020-ICT-2016-1	**HYPOSENS**	RIA	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]

Source: VDI TZ.

Overview of projects affiliated to WG 3:

Call	Project acronym	Funding Scheme	EU Funding	Description of Project & Objectives
LIFE SCIENCE AND HEALTH				
H2020-ICT-2016-1	**ESOTRAC**	RIA	EEUR 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]

Source: VDI TZ.

Overview of projects affiliated to WG 3:

Call	Project acronym	Funding Scheme	EU Funding	Description of Project & Objectives
LIFE SCIENCE AND HEALTH				
H2020-ICT-2016-1	**PAMMOTH**	RIA	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]

Source: VDI TZ.

Emerging lighting, electronics and displays

The following table displays all past and current photonics projects affiliated to the Work Group 4 "Emerging lighting, electronics and displays":

Overview of projects affiliated to WG 4:

Call	Project acronym	Funding Scheme	EU Funding	Description of Project & Objectives
EMERGING LIGHTING, ELECTRONICS AND DISPLAYS				
H2020-ICT-2014-1	**PHEBE**	RIA	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-2014-1	**FLEXOLIGHTING**	RIA	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-2014-1	**OPENAIS**	IA	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]

Source: VDI TZ.

Overview of projects affiliated to WG 4:

Call	Project acronym	Funding Scheme	EU Funding	Description of Project & Objectives
EMERGING LIGHTING, ELECTRONICS AND DISPLAYS				
H2020-ICT-2014-1	**LOMID**	RIA	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]
H2020-ICT-2014-1	**LUMENTILE**	RIA	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-ICT-2015	**PI-SCALE**	IA	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].

Source: VDI TZ.

Overview of projects affiliated to WG 4:

Call	Project acronym	Funding Scheme	EU Funding	Description of Project & Objectives
EMERGING LIGHTING, ELECTRONICS AND DISPLAYS				
ERANET COFUND 2015	**PHOTONICS SENSING**	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	**LEDLUM**	RIA	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-2016-1	**VOSTARS**	IA	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]

Source: VDI TZ.

Security, Metrology, Sensing

The following table displays all past and current photonics projects affiliated to the Work Group 5 "Security, Metrology, Sensing":

Overview of projects affiliated to WG 5:

Call	Project acronym	Funding Scheme	EU Funding	Description of Project & Objectives
SECURITY, METROLOGY; SENSING				
H2020-ICT-2014-1	**SEERS**	RIA	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-2014-1	**I-ALLOW**	RIA	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]
H2020-ICT-2014-1	**MIREGAS**	RIA	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]

Source: VDI TZ.

Overview of projects affiliated to WG 5:

Call	Project acronym	Funding Scheme	EU Funding	Description of Project & Objectives
SECURITY, METROLOGY; SENSING				
H2020-ICT-2014-1	**CHEQUERS**	RIA	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 28 b-2015	**MIRPHAB**	IA	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]

Source: VDI TZ.

Overview of projects affiliated to WG 5:

Call	Project acronym	Funding Scheme	EU Funding	Description of Project & Objectives
SECURITY, METROLOGY; SENSING				
H2020-ICT-2016-1	**AQUARIUS**	RIA	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-2016-1	**WATERSPY**	RIA	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]

Source: VDI TZ.

Overview of projects affiliated to WG 5:

Call	Project acronym	Funding Scheme	EU Funding	Description of Project & Objectives
SECURITY, METROLOGY; SENSING				
H2020-ICT-2016-1	**FLAIR**	RIA	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]

Source: VDI TZ.

Design and Manufacturing of Components and Systems

The following table displays all past and current photonics projects affiliated to the Work Group 6 "Design and Manufacturing of Components and Systems":

Overview of projects affiliated to WG 6:

Call	Project acronym	Funding Scheme	EU Funding	Description of Project & Objectives
DESIGN AND MANUFACTURING OF COMPONENTS AND SYSTEMS				
H2020-ICT-2015	**DIMENSION**	RIA	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-ICT-2015	**PLASMOfab**	RIA	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-ICT-2015	**OCTCHIP**	RIA	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]

Source: VDI TZ.

Overview of projects affiliated to WG 6:

Call	Project acronym	Funding Scheme	EU Funding	Description of Project & Objectives
DESIGN AND MANUFACTURING OF COMPONENTS AND SYSTEMS				
H2020-ICT-2015	**WIPE**	RIA	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]
H2020-ICT-2015	**HAMLET**	RIA	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 immunit=y 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]

Source: VDI TZ.

Overview of projects affiliated to WG 6:

Call	Project acronym	Funding Scheme	EU Funding	Description of Project & Objectives
DESIGN AND MANUFACTURING OF COMPONENTS AND SYSTEMS				
H2020-ICT-2015	**PICs4All**	CSA	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: www.pics4all.jeppix.eu/]
H2020-ICT-2015	**PIX4LIFE**	IA	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: www.pix4life.eu/]

Source: VDI TZ.

Overview of projects affiliated to WG 6:

Call	Project acronym	Funding Scheme	EU Funding	Description of Project & Objectives
DESIGN AND MANUFACTURING OF COMPONENTS AND SYSTEMS				
H2020-ICT-2016-1	**PIXAPP**	IA	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]

Source: VDI TZ.

Photonics Research, Education and Training

The following table displays all past and current photonics projects affiliated to the Work Group 7 "Photonics Research, Education and Training":

Overview of projects affiliated to WG 7:

Call	Project acronym	Funding Scheme	EU Funding	Description of Project & Objectives
PHOTONICS RESEARCH, EDUCATION AND TRAINING				
H2020-ICT-2014-1	**Light2015**	CSA	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	**Photonics4All**	CSA	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]
H2020-ICT-2014-1	**COMPLETE**	CSA	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]

Source: VDI TZ.

Overview of projects affiliated to WG 7:

Call	Project acronym	Funding Scheme	EU Funding	Description of Project & Objectives
DESIGN AND MANUFACTURING OF COMPONENTS AND SYSTEMS				
ICT-28c-2015	**RespiceSME**	CSA	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-2016-1	**EPRISE**	CSA	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]

Source: VDI TZ.

Overview of projects affiliated to WG 7:

Call	Project acronym	Funding Scheme	EU Funding	Description of Project & Objectives
PHOTONICS RESEARCH, EDUCATION AND TRAINING				
H2020-ICT-2016-1	**PHABLABS 4.0**	CSA	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]
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]

Source: VDI TZ.

Overview of projects affiliated to WG 7:

Call	Project acronym	Funding Scheme	EU Funding	Description of Project & Objectives
DESIGN AND MANUFACTURING OF COMPONENTS AND SYSTEMS				
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]
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: www.lashare.eu/en/publication-and-press/news-2014-12.html]

Source: VDI TZ.

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."

Augmented Reality visor to dramatically improve surgery

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Hybrid

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

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

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

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

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

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

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

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

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

www.vostars.eu

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

New laser scanner to zap toxic French fries

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

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

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

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

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

Photonics for Factories

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

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

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

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

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

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

Lien Smeesters – Photonics21 Student Award Winner

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

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

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

Smeesters' development comes at a time where tougher acrylamide regulation has been called for by the sustainability group 'Changing Markets Foundation' as well as the recent

'Go for Gold' campaign by the Food Standards Agency, helping people understand how to minimize exposure to acrylamide when cooking at home.

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

Future Home Use

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Light and Sound

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

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

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

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

Aggressive or Benign

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

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

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

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

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

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

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

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

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

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

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

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

New handheld scanner to give instant heart disease diagnosis

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

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

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

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

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

Heart Vibration Mapping

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

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

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

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

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

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

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

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

Delay, Halt or Reverse

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

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

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

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

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

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

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

Light technologies dazzle at *Laser World of Photonics 2017*

With over 32,000 international researchers and professionals attending this year's LASER World of Photonics, 2017 saw one of the biggest ever crowds gather from the global community of light.

Munich, Germany, 26th – 28th June 2017
The Photonics PPP had a strong hand in this year's laser and photonics industry exhibition and trade fair which drew in over 32,000 trade visitors and 1293 exhibitors from over 90 different countries at the Messe Munich event.

In a four day programme that showcased the latest developments in medical diagnostics, autonomous driving and sensors, Photonics21 was pleased to reveal their new reports on Photonics Market Data giving insights on photonics market data and the European position in the World Market as well as the future challenges.

Photonics Impact
At the opening ceremony, Deputy CEO of Trumpf and spokesman for the BMBF funding program 'Photonik Forschung Deutschland', **Dr Peter Leibinger** delivered is keynote speech, *"Drawing on Photonics strength"* about the future of photonics.

Dr Leibinger drew upon two recent studies by **Photonics21** in *'Market Research Study Photonics 2017'*, and **VDMA**, the Mechanical Engineering Industry Association of Germany, in 'Photonics in Germany', showing that Light technologies provide tremendous potential for growth and innovation.

"Photonics21 was pleased to reveal their new reports on Photonics Market Data giving insights on photonics market data and the European position in the World Market as well as the future challenges."

Dr Leibinger revealed the world market volume of photonics in 2015 amounted to 447 billion Euros, with the exciting prospect of a further growth to 615 billion Euros by 2020. According to the VDMA report, in Germany alone the photonics industry had a domestic production value of €31 billion in 2016, with a projected value of €39 billion by 2020.

The VDMA market studies were also released at both the VDMA Photonics Forum Press Conference and the Optech Consulting '13th International Laser Marketplace', by Optech Consulting President, **Dr Arnold Mayer** in his *The Global Market for Industrial Lasers and Laser Systems – Rapid Change and Continued Growth* speech.

Photonics21 also took the opportunity to publish printed copies of the finalized 3 year Impact Report, *'Jobs and Growth in Europe – Realizing the Potential of Photonics'* which showed an industry worth €69 Billion per annum, with over 42,000 new jobs created by 2020.

Photonics21 Partners
The three major **Photonics Pilot Lines** which help SMEs take photonics technologies from lab into market, were in attendance. PIXAPP, MIRPHAB and PIX4life, who have the capacity to help thousands of high tech SMEs in Europe who lack access to the expertise needed to manufacture new and innovative products, taking their ideas, scaling them up and validating them for commercial production, were present in hall A3.

One of the most exciting pan-European photonics collaborations RespiceSME, a project stimulating collaborations in and beyond photonics, ran an innovative workshop at the Photonics21 booth.

The RespiceSME workshop "Aligning Education with Innovation" focused on how t o trigger innovation in photonics through improving the curricula of photonics courses in higher education.

RespiceSME also ran matchmaking event for job seekers, an informal get together where SMEs and students met to determine internships and jobs opportunities.

#Next_photonics.forum. Brussels, Belgium, 29th March 2017

With news of more than 42,000 new European jobs in the photonics industry forecast by 2020, and a global market share worth €447 billion, this year's Annual Meeting showed a Public Private Partnership that had created a significant impact in its three years of operation.

Taking place at Le Plaza Hotel, Brussels, this year's Photonics PPP Annual Meeting saw the incoming president Aldo Kamper, CEO Osram Opto Semiconductor, Khalil Rouhana, Deputy Director-General of DG CONNECT and Philippe Vannson, Head of Photonics Unit in DG CONNECT speak candidly about the achievements of the Photonics Public Private Partnership in the form of a continued growth, a creative ecosystem and being well placed to fulfill its investment pledges ahead of Horizon 2020.

Speaking about the success of the Photonics PPP in its first three years, Photonics21 Vice President Giorgio Anania showed spending on projects to exceed €277.9 million, with 335 industrial partners involved, where more than half are SMEs. With the Global Photonics Industry doubling from € 228 billion in 2005 to € 447 billion in 2015, Anania revealed how the industry had outstripped global GDP growth across the decade.

Giving a brief update on the latest Photonics PPP Impact Report and Photonics Market Data, Anania outlined the Potential of Photonics for Growth & Jobs in Europe with an impressive forecast of 42,000 newly created European jobs in the industry by the end of Horizon 2020.

These were substantial achievements and a very exciting time for incoming Photonics21 President, Aldo Kamper, CEO of Osram Opto Semiconductor to take over the good work of Dr Michael Mertin, CEO Jenoptik AG.

Kamper was clear in his desire to see strengthened links: "More work needs to be done between the partners of the photonics community. We must look at the even bigger picture to see where photonics technology can contribute and reach out, outside of photonics."

Khalil Rouhana emphasized the importance of the Digitising European Industry initiative, and the creative ecosystem that the Photonics PPP enables. "This initiative ensures that any industry in Europe can not only benefit from digital innovation but can compete on a global scale, grow and create jobs," Rouhana said. This Public Private Partnership, Rouhana explained, is a reflection of what Europe does best: "Working together in a competitive manner".

Philippe Vannson discussed how the European Commission had been focusing on this creative ecosystem to foster synergies among the members in the value chain, and what would be needed for the Commission's continued investment in the technologies that boost the digital innovation capacities of Europe.

This year's **Student Innovation Award** was presented by Photonics21 executive board member Jaap Lombaers, and won by Lien Smeesters, PhD student and research assistant at Vrije Universiteit Brussels.

Smeesters was applauded for her work on food safety, in particular the development of spectroscopic sensing techniques for the optical detection of carcinogens in food products as well as integrating this research into in-line industrial sorting machines. She picked up a certificate, a trophy and a cash prize of € 5,000.

"This initiative ensures that any industry in Europe can not only benefit from digital innovation but can compete on a global scale, grow and create jobs."

Powering Growth and Innovation

European Photonics Community's 2030 mission

Aldo Kamper, president of Photonics21, reveals the association's 2030 mission and discusses how Europe is to translate its current competencies into future leadership in a fast-growing global market.

"The photon will do for the twenty first century, what the electron did for the twentieth" says Aldo Kamper president of Photonics21 and CEO Osram Opto Semiconductors GmbH (left). Europe is already at the forefront of this technological revolution: harnessing the power of light to solve our greatest global challenges.

Photonics, the science of creating, manipulating, transmitting and detecting light, is part of our everyday lives. It is literally everywhere, from smartphone displays, fibre-optic broadband transmission, to the laser-assisted medical tools revolutionizing healthcare.

As light particles, or photons, replace electrons in many of our most important technologies, innovations already in the pipeline are improving healthcare, growing food, saving energy, reducing pollution, expanding connectivity, transforming manufacturing and ushering in a new era of mobility. Across the economy, photonics technology will create new jobs and drive growth.

'Best in H2020'

The Horizon2020 Photonics Public-Private Partnership (PPP) was created to build on the strengths of the European photonics sector and reinforce its competitiveness. For this purpose, the European Commission joined forces with the photonics industry – represented by Photonics21 – and the research community.

"The result is a dynamic and effective partnership with 3000 members recognised as the best in class contractual PPP in Horizon2020 by the Commission's independent evaluators, and as demonstrated by the PPP's impact on jobs and growth in Europe" summarizes Mr. Kamper the achievements of the Photonics21 as a Public Private Partnership.

And the effort will continue. It is the mission of the European photonics community over the next ten years to deliver 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, and zero downtime in a terabit economy.

Today's Market

Today, Europe's photonics sector comprises some 5,000 companies producing optical components and systems. Most of them are highly specialised SMEs. The sector is export-oriented and research-intensive. It invests close to 10% of revenues in R&D, about twice the rate of manufacturing as a whole.

The sector directly employs over 300,000 people. If we include everyone whose livelihood depends on the use of photonics – from workers using industrial lasers to doctors performing endoscopic surgery – 10% of the workforce and as much as 30% of the entire economy already depend on photonics technology.

Photonics is a highly dynamic and fiercely competitive global market that was worth €447 billion in 2015. At a compound annual growth rate of 6.2% between 2011 and 2015, the global market has been growing substantially faster than the economy as a whole. A global market share of 15.5% makes Europe the world's second-biggest supplier of photonics, after China.

With China currently focusing on photovoltaics, displays, lighting and other commodity products, Europe is arguably the centre of global photonics innovation today. That said China is pushing strategically into more innovative areas.

European companies are market leaders in sectors such as production technology (including industrial lasers), optical components and systems, sensors and automated vision, as well as photonics in medicine and life sciences.

The Future of Photonics

Fundamental innovation trends will continue to drive strong growth in photonics employment and revenues up to 2030 and

beyond. These trends include the development of optical computing to replace silicon circuits, as well as the spread of optical sensing and light-generating technologies in healthcare, mobility, industrial manufacturing, energy and many other sectors.

If Europe is to translate today's mastery of key technologies into future leadership in a fast-growing global market, further challenges need to be overcome.

Joint action by the European Commission, the member states and the photonics industry will clear the way to future innovation. However this will require a long term concerted public-private effort that pools Europe's strengths in photonics and builds out a highly innovative transnational ecosystem.

Aldo Kamper points out that "to achieve these goals, a number of specific measures will be needed:

1. A European strategy for photonics leadership that focuses on mission-oriented breakthrough innovations and large-scale collaborative projects across industries and sectors must be created and implemented.

2. A coordinated strategy involving all public and private stakeholders creates the momentum and unleashes the broad spill-over effects needed to address global challenges, exploit future markets and create jobs in Europe.

3. Boosting opportunities for entrepreneurship in the photonics sector is essential. Access to risk finance must be improved by establishing a Europe-wide fund for photonics start-up, growth and bridge capital.

4. A truly European lab-to-fab infrastructure for accelerating innovation and competitiveness must be created. Europe needs to speed up the uptake of technology and its translation into new products and services.

5. The education and training of tomorrow's specialists today cannot be over emphasised. Measures should include a coordinated public-private plan to define skill sets and curricula for professions in photonics. The harnessing of light should be a flagship science in schools, universities and across the education system."

With its industry and research community Photonics21 provides a strong European platform of stakeholders with a proven track record of collaborating within this sector ready to complete these objectives.

"The Horizon2020 Photonics Public-Private Partnership (PPP) was created to build on the strengths of the European photonics sector and reinforce its competitiveness. For this purpose, the European Commission joined forces with the photonics industry – represented by Photonics21 – and the research community."

Laser scanner to detect cancer in less than 30 seconds

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

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

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

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

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

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

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

Shining a Light on Cancer

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

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

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

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

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

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

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

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

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

Speckle Variance OCT

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

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

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

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

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

Wounds, Ulcers, Burns

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

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

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

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

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

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

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

Life-saving drones to transform disaster rescue efforts

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

signatures, or 'fingerprints', the optical sensors can detect a number of molecules simultaneously in real time."

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

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

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