PROJECT FINAL REPORT

Grant Agreement number: 611528

Project acronym: BIOFOS

Project title: Micro-ring resonator-based biophotonic system for food analysis

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Dissemination level		
PU	Public	**X**
PP	Restricted to other programme participants (including the Commission Services).	
RE	Restricted to a group specified by the consortium (including the Commission Services).	
CO	Confidential, only for members of the consortium (incl. the Commission Services)	

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List of abbreviations

.gds files	Graphic Data System files
1G	first generation
2G	second generation
AFB1	Aflatoxin B1
AFM1	Aflatoxin M1
APT	Aptamers
CAD	Computer-aided design
DoW	Description of Work
EC	European Commission
EDTA	Ethylenediaminetetraacetic acid
LIFT	Laser Induced Forward Transfer
LoC	Lab-on-a-Chip
LoD	Level of Detection
LTO	Low Temperature Silicon Oxide
MICR	Monthly Internal Control Report
MMI	Multi-Mode Interference
MRR	Micro-Ring Resonator
MXX	Month XX
OTA	Ochratoxin A
PC	Project coordinator
PEG	Poly-Ethylene Glycol
SC	Steering Committee

SECTION A FINAL PUBLISHABLE SUMMARY REPORT

BIOFOS

Micro-ring resonator-based biophotonic system for food analysis

Grant Agreement No. 611528
Project duration: 36 months
Project website: http://www.ict-biofos.eu/

A1. Executive Summary

This report is a concluding summary describing the objectives, conducted work and achieved research outcomes derived within the active period of the BIOFOS project.

BIOFOS has offered a forum, driven by the end-users of the project, for identifying the needs of stakeholders from different sectors of the food industry. The outcomes of extended surveys done within the duration of the project verified that the actual specifications of BIOFOS system are in line with the stakeholder's requirements.

On the **biological platform** four aptameric sequences against OTA, AFM1, AFB1, and Copper ions were characterized and three new aptamers against Lactose, Penicillin and Phosmet were developed through the process of Capture-SELEX. In parallel, the use of the two-strand approach, manage to successfully immobilize all aptamers of interest onto functionalized Si_3N_4 surfaces at optimal concentrations, increasing thus the analyte binding and sensitivity of the final integrated biosensing platform was developed. Finally, a high number of regeneration cycles (30) have been achieved, with minimal losses in the binding affinity of the aptamers after each successive regeneration cycle catering for a truly reusable sensor platform.

On the **photonics platform**, emphasis was given on the design of the individual structures, MRR chips, Y-splitters, MMI splitters and various grating design for all the production runs. These designs where used in several mask designs which resulted in total five (5) production runs to produce passive and hybrid MRR chips and testing structures to optimize the sensor chips during the project. After the passive chip production run we have produced the G1 Hybrid chip run which contained MRR sensor chips and testing structures with gratings used for hybrid integration of an 850 nm VCSEL and a 12x photodiode array on the sensor. After the two G1 runs (Hybrid and passive) another two runs were performed with the second generation of passive and hybrid chips. VCSELs and Photodiodes were bonded directly to chip with the use of Au/Au thermo-compression bonding technique and attached a FPC cable to the side of the chip using anisotropic tape. This resulted in completely functional hybrid chip which can be directly inserted into the cartridge/fluidic handling system developed in BIOFOS.

On the **nanochemical platform** of the sensor different methods and approaches for the functionalization of the sensor substrate and the immobilization of the aptamers on the sensing surface of the optical sensing chip were employed including, novel laser-based immobilization approaches, alkenes based surface modification by photoactivation for site-specifically modification of the sensor sensing surface, and polymer-based layer functionalization approaches. Within the

course of the project, the application of laser-based approach, resulted in the efficient immobilization of the aptamers on functionalized surfaces developed both by Wu, Surfix and BRFAA and was employed for the bio-modification of the final optical chips used for validating the developed system. Moreover, the functionalization of an azide, synthesis of zwitterionic monomer for ATRP was synthesized and up-scaled it to gram scale. This resulted in the successful preparation of an antifouling zwitterionic copolymer coating bearing a variable amount (5-15%) of clickable moieties for introduction of aptamers using established click chemistry protocols (i.e. the so-called SPAAC reaction). As a result of the work achieved within the framework of these activities, **a PCT patent was filed by ICCS/NTUA** (in collaboration with Surfix and WU, as co-inventors) on 15.12.2016.

On the **microfluidic platform** the activities were devoted to the design and development of the fluidic sample pretreatment units for oil, milk and nut extract samples, the development of the microfluidic analysis cartridge, the development of the regeneration module and the electronic platform. During the project's lifetime, the pretreatment protocols for the three selected food types i.e. nuts, olive oil and milk have been established. They can be performed without the need of laboratory equipment. Maximum a blender for nuts and a vortex for olive oil is required. The common pretreatment steps of the three different food types have been combined into the automated pretreatment unit. This unit offers to either clean the sample by filtering or concentrating the sample by using solid phase extraction. A especially for BIOFOS developed pump allows to pump a number of different aggressive solvents which are required for the solid phase extraction. For additional exploitation, this pump module was additionally converted into a standalone dispensing pump. The development phases of the pretreatment unit started with a bread board setup and finalized with its integration into the BIOFOS-system. Washing solutions allow to clean reuse the pretreatment unit.

The integration of the BIOFOS-system was implemented with the focus was put on user friendliness. Bottles and sensor are protected within the housing and provide enough liquid for at least 30 measurements. The implemented touch screen offers the operator images and commands to guide him through the sample taking, sample treatment and sample adding into the machine. The pretreatment results were successful for the three food categories. In the framework of **system integration**, all components for the final system were integrated successfully and the BIOFOS prototype has been extensively tested for the pretreatment module, the electronics and user interface and software. The pretreatment results were successful for the three food categories. The detection unit was successfully validated with good specificity for the case of Copper.

BIOFOS gained remarkable visibility through a variety of dissemination actions and prestigious publications (including the Langmuir), and succeeded in defining concrete exploitation plans by all partners. The foreground knowledge produced in the last period of the project and the filling of the two PCT patents by the BIOFOS partners gives the credential for a potential exploitation of the project results.

A2. Summary of project context and objectives

With a market share of 14.5 % of the total manufacturing turnover (€917bn for the EU-27), the food industry is the second largest sector in the manufacturing industry of EU, consisting of about 310,000 enterprises. With 4.8 million employees, the food industry's share of employment is about 14% of the total manufacturing sector, of which 62% are employed in SMEs (undertakings of less than 250 persons) representing virtually the total number of enterprises. Despite the fact that Europe's food and drink sector has always been a pillar of the EU economy, current methodologies for detection of food contamination based on heavy analytical tools cannot guarantee a safe and stable food supply. The reasons are the complexity, the long time-to-result (2-3 days) and the cost of these tools, which limit the number of samples that can be practically analyzed at food processing and storage sites. The need for screening tools that will be still reliable but simple, fast, low-cost, sensitive and portable for in-situ application is thus urgent.

BIOFOS was conceived in 2013, with the aim to develop a simple, fast, low-cost, sensitive, portable and reliable, screening tool for in-situ detection of food contaminations in nuts, olive oil and milk and also for the quantitative detection of lactose in milk. In order to achieve these targets, BIOFOS combined the most promising concepts from the photonic, biological, nanochemical and fluidic parts of LoC systems, aiming to overcome limitations related to sensitivity, reliability, compactness and cost issues.

Specifically, BIOFOS relies on the ultra-low loss TriPleX photonic platform in order to integrate on a 10x10 mm^2 chip 7 micro-ring resonators, a VCSEL and 12 Si photodiodes and achieve a record detection limit in the change of the refractive index of $5 \cdot 10^{-8}$ RIU. The reusability and high specificity of the system is supported by the use of aptamers as biotransducers, while advanced surface functionalization techniques have been developed and used for their immobilization on the sensor surface. New microfluidic structures introduced for the sample pre-treatment and the regeneration process.

The main objectives of the BIOFOS project are listed below.

- Development of monolithic photonic circuits for label-free, high-throughput optical biosensing at 850 nm based on 1:8 MMI couplers and 8-fold MRR arrays for operation.
- Hybrid integration of actives elements (VCSEL and photodiode arrays) on TriPleX boards using flip-chip bonding and butt-coupling techniques.
- Design and production of aptamers for highly-selective detection of food contaminants and lactose in milk.
- Development of effective techniques for functionalization of sensor substrates and immobilization of biomediators (aptamers).
- Development of robust techniques for regeneration of biomediators (aptamers) and reusability of sensor arrays.
- Development of microfluidics for solid and liquid phase treatment.
- System integration in a cost-effective, reusable LoC system and system validation in real settings.

A3. Main Scientific and technical (S&T) results and foregrounds

To accomplish its objectives, BIOFOS based the organization of the necessary management and RTD around 9 work-packages (WPs) as shown in Figure 1 below.

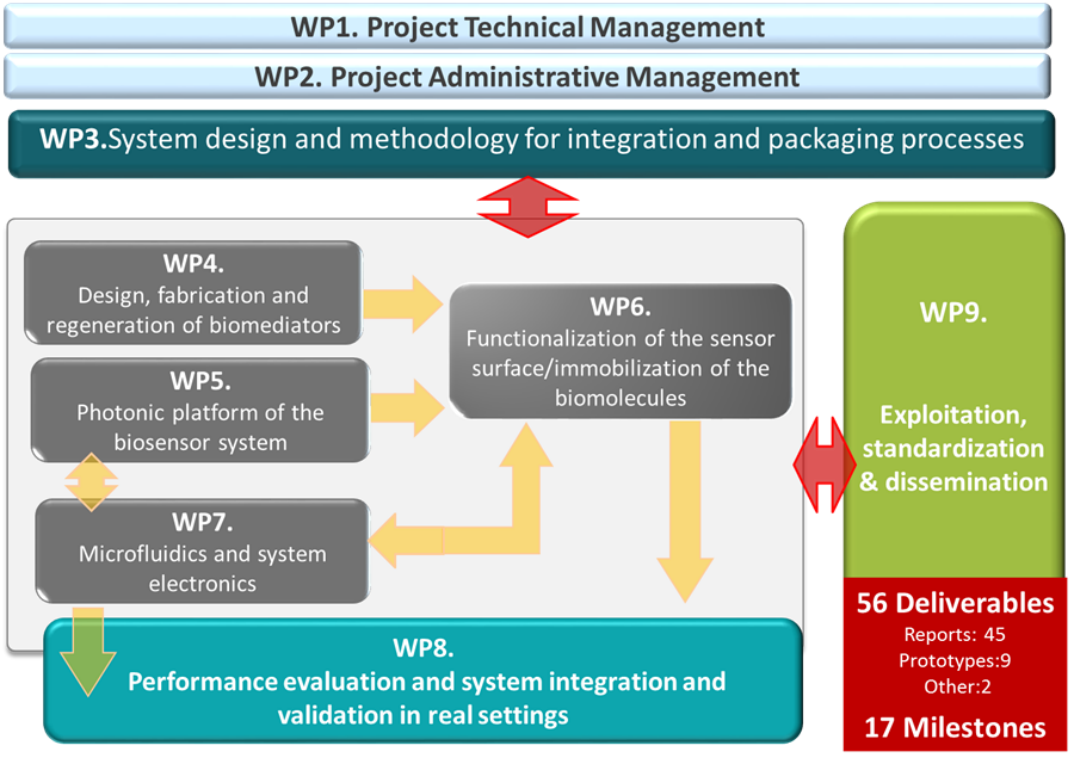

Figure 1: Structure of Work in BIOFOS Project.

Work-package 3: Innovation chain, stakeholders' requirements & specifications, System design and methodology for integration and packaging processes

Activities within WP3 aiming in defining the innovation chain of BIOFOS system, and the stakeholder's requirements involved in the relative food sectors and enable the definition and design of the system specifications and packaging methodologies of the system, as well as evaluation of the system through system level modelling and simulations.

During the course of the project, WP3 has offered a forum, driven by the end-users of the project, for identifying the needs of stakeholders from different sectors of the food industry. The outcomes of extended surveys done within the first year of the project, and updated in the following ones, verified that the actual specifications of BIOFOS system are in line with the stakeholder's requirements. In addition, during the project's lifetime, in the framework of WP3, the system specifications of BIOFOS components and systems, the packaging methodologies and integration methodologies have been defined taking into account the specific characteristics of the different integration platforms, and simulation studies regarding the system performance of BIOFOS devices and systems have been performed. WP3 has also taken care of a smooth transition of all these activities into WP8 at the final stages of the project.

Work-package 4: Design, fabrication and regeneration of biomediators

WP4 activities are devoted to the selection, characterization and design of aptameric sequences against specific targeted analytes which are commonly found as contaminants in food samples, their chemical modification, and identification and definition of the most efficient processes for their regeneration.

Within the BIOFOS project, UPVD selected all known aptameric sequences against OTA, AFM1, AFB1, and Copper ions and characterized them in terms of successful immobilization on functionalized surface while new aptamers against Lactose, Penicillin and Phosmet were developed through the process of Capture-SELEX. In parallel, BRFAA, by making use of the two-strand approach, manage to successfully immobilize all aptamers of interest onto functionalized Si_3N_4 surfaces at optimal concentrations, increasing thus the analyte binding and sensitivity of the final integrated biosensing platform. Finally, a high number of regeneration cycles have been achieved, with minimal losses in the binding affinity of the aptamers after each successive regeneration cycle catering for a truly reusable sensor platform.

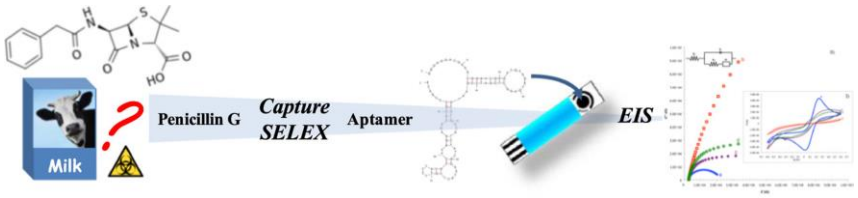

Figure 2: Graphical abstract of the selection of DNA aptamers against penicillin G using Capture-SELEX, by UPVD and their characterization using Impedimetric sensor.

The work achieved within the framework of WP4 activities, resulted in two publications in peer-review articles: 1. 'Selection of DNA aptamers against penicillin G using Capture-SELEX for the development of an impedimetric sensor', N. Paniel, G.Istamboulié, A. Triki, C. Lozano, L. Barthelmebs, T.Noguer. Talanta 162, 232 (2017) and 2. 'Development of an impedimetric aptasensor for the determination of aflatoxin M1 in milk', G. Istamboulié, N. Paniel, L. Zara, L. Reguillo Granados, L. Barthelmebs, T. Noguer. Talanta, 146, 464-469 (2016).

Work-package 5: Photonic platform of the biosensor system

WP5 activities are related to the design, production and optical characterization of the Micro ring resonator (MRR) chips. ICCS/NTUA has performed during the project simulations in several stages during the production to optimize the MRR chip design with respect to the Y-splitters, MMI splitters and various grating design for all the production runs. These designs where used in several mask designs developed by Lionix. With these design LioniX has performed in total five (5) production runs to produce passive and hybrid MRR chips and testing structures to optimize the sensor chips during the project.

At the start of the project LioniX has produced G0 chips which were based on a known design and where used for the first experiments and was followed by a passive chip production run G1 which contained the first series of testing structures and the G1 generation of the BIOFOS MRR sensor. These where all optically tested by SAXION and ICCS/NTUA and used in WP6 and WP8 for functionalization and "bio" testing.

After the passive chip production run we have produced the G1 Hybrid chip run which contained MRR sensor chips and testing structures with gratings used for hybrid integration of an 850 nm VCSEL and

a 12x photodiode array on the sensor. These where all characterized by ICCS/NTUA and SAXION. After the two G1 runs (Hybrid and passive) another two runs are performed with the second generation of passive and hybrid chips which were also characterized by ICCS/NTUA and SAXION and used in WP6 and WP8. For the Hybrid chips LioniX has also developed techniques to Flip-Chip the VCSELs and Photodiodes directly to chip with the use of Au/Au thermo-compression bonding technique and attached a FPC cable to the side of the chip using anisotropic tape. This resulted in completely functional hybrid chips which can be directly inserted into the cartridge/fluidic handling system developed in WP7.

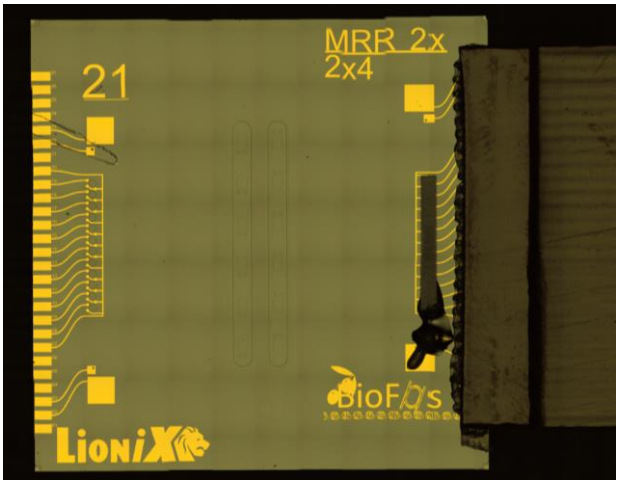

Figure 3: High resolution stitched picture of the Full hybrid chip with FPC cable connected to the side.

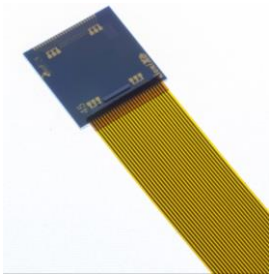

Figure 4: Fully assembled hybrid optical MRR sensor chip with a FPC flat cable.

Work-package 6: Functionalization of the sensor surface/immobilization of the biomolecules

WP6 is devoted to the nanochemical platform of the sensor. Different methods and approaches for the functionalization of the sensor substrate and the immobilization of the aptamers on the sensing surface of the optical sensing chip are employed including, novel laser-based immobilization approaches, alkenes based surface modification by photoactivation for site-specifically modification of the sensor sensing surface, and polymer-based layer functionalization approaches.

Within the course of the project, a new approach based on the Laser Induced Forward Transfer technique, namely known as LIFT, has been applied successfully for the bio-modification of the sensor surfaces with high spatial control, by ICCS/NTUA. The application of laser-based approach, resulted in the efficient immobilization of the aptamers on functionalized surfaces developed both by Surfix and BRFAA and was employed for the bio-modification of the final optical chips used for validating the developed system. Furthermore, the ability of the LIFT technique to deposit aptamers onto non-functionalized surfaces has been shown, which could be useful if further reductions in cost and time-

to-product. In parallel, an elegant approach, to exclusively modify silicon nitride while backfilling the surrounding silicon oxide so that it acts as a repellent and prohibits non-specific binding, has been successfully developed by Surfix. WU, on the other hand, synthesized an azide modified zwitterionic monomer for ATRP and upscaled it to gram scale. This resulted in the successful preparation of an antifouling zwitterionic copolymer coating bearing a variable amount (5-15%) of clickable moieties for introduction of aptamers using established click chemistry protocols (i.e. the so-called SPAAC reaction).

Finally, BRFFA has successfully developed an alternative protocol to functionalize silicon nitride based on silanes and studied and optimized two additional functionalization approaches, namely PAMAM dendrimers and polysaccharide meshes, to load more aptamers onto the surfaces and thus ultimately lower the detection limits and the sensitivity of the sensing platform.

As a result of the work achieved within the framework of WP6 activities, **a PCT patent was filed by ICCS/NTUA** (in collaboration with Surfic and WU, as co-inventors) on 15.12.2016, entitled "Method for activating click reactions through laser induced forward transfer of molecules" describing a novel method that has been developed within the BIOFOS project through the combination of the laser-based immobilization approach with click chemistry reactions. This work resulted also to a publication: 'Direct creation of biopatterns via combination of laser-based techniques and Click-chemistry', M. Chatzipetrou, M. Massaouti, G. Tsekenis, A. K. Trilling, E. van Andel, L. Scheres, M. M. J. Smulders, H. Zuilhof, I. Zergioti, Langmuir, 33(4), 848 (2017). In addition, the work of WU related to the work on the development of clickable and fully zwitterionic antifouling polymer brushes on stoichiometric silicon nitride resulted in a scientific Publication: 'Efficient and tunable three-dimensional functionalization of fully zwitterionic antifouling surface coatings'. Stefanie C. Lange, Esther van Andel, Maarten M.J. Smulders, Han Zuilhof, Langmuir 2016, *32* (40), 10199, which was selected as cover and highlighted as ACS Edistor's choice.

Work-package 7: Microfluidics and system electronics

WP7 activities are devoted to the design and development of the fluidic sample pretreatment units for oil, milk and nut extract samples, the development of the microfluidic analysis cartridge, the development of the regeneration module and the electronic platform.
During the project's lifetime, in the framework of WP7, pretreatment protocols for the three selected food types i.e. nuts, olive oil and milk have been established. They can be performed without the need of laboratory equipment. Maximum a blender for nuts and a vortex for olive oil is required.
The common pretreatment steps of the three different food types have been combined into the automated pretreatment unit. This unit offers to either clean the sample by filtering or concentrating the sample by using solid phase extraction. A especially for BIOFOS developed pump allows to pump a number of different aggressive solvents which are required for the solid phase extraction. For additional exploitation, this pump module was additionally converted into a standalone dispensing pump. The development phases of the pretreatment unit started with a bread board setup and finalized with its integration into the BIOFOS-system. Washing solutions allow to clean reuse the pretreatment unit.

Figure 5, standaloned pump module also known as cPDD (controlled Pressure Dispensing Device)

The pretreated sample is analyzed within the detection unit. The detection unit consists of a glass based microfluidic chip with an integrated rotary valve. This microfluidic chip provides a fluidic connection to the bio-optical-chip which can be inserted and later be removed via a clamping mechanism. Via the rotary valve the loaded sample can be pushed over the bio-optical chip. If required a dilution can be performed within the implemented mixing structure. Finally, regeneration buffers can be used to regenerate the bio-optical chip to perform at least 30 measurements. To speed-up the development process, a bread board system was build and following it an enhanced version was integrated into the BIOFOS-system.

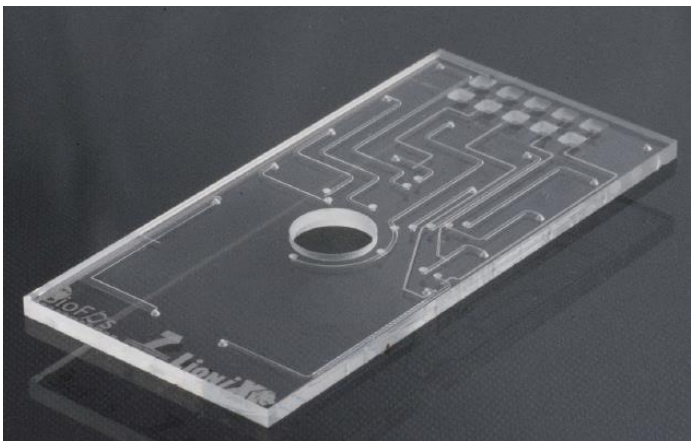

Figure 6. Glass based microfluidic chip with integrated rotary valve .

To control the individual units, electronics were developed which orchestrated pumps, valves, VSCEL, photo diodes, peltier element and much more. A simple user interface guides the operator via images and commands from the sample preparation to the result.

Work-package 8: Performance evaluation, and system integration and validation in real settings

Work Package 8 is devoted to the characterization and evaluation of the performance of the optical chips, the integration of the system components in a single box, the definition of the testing procedures and finally to the validation of the BIOFOS system performance.

After the individual units were developed in WP7, the integrated design of the BIOFOS-system was started. The focus was put on user friendliness.

Bottles and sensor are protected within the housing and provide enough liquid for at least 30 measurements. The implemented touch screen offers the operator images and commands to guide him through the sample taking, sample treatment and sample adding into the machine.

The validation of the BIOFOS prototype has been performed for the pretreatment module, the electronics and user interface and software. The pretreatment results were successful for the three food categories. The breadboard detection unit was successfully validated with good specificity for the case of Copper.

Figure 7. Integrated BIOFOS-system.

Work-package 9: Exploitation, standardization & dissemination.

The major objective of WP9 were to:

- Plan the exploitation of the project foreground knowledge.
- Prepare techno-economic studies on the deployment of BIOFOS technology (and the relevant solutions along the innovation chain) in biosensing systems for the food sector with emphasis on the three food systems under consideration (milk, olive oil, nuts).
- Generate and protect intellectual property (patents portfolio) in order to set the basis for potential commercialization of products relevant to the project outcomes.
- Continuously monitor intellectual property generated world-wide and assess the possible threats for BIOFOS exploitation plan.
- Coordinate activities towards contributions to standardization bodies.
- Interact with other EU and national projects.
- Disseminate project results to the scientific/technical community and towards the general public.

In overall, the major outcomes achieved in WP9, during the whole period of the BIOFOS project can be summarized in the following bullets:

- Extensive document on market outlook, system applicability and techno-economic analysis.
- Cost analysis of the BIOFOS prototype and the cost per analysis.
- Extensive overview of competing developments (companies, R&D literature).
- Identification of many potential business cases as a foundation for further developments.
- Follow-up projects, proposals and plans.
- Business case description of the milk contamination test at the delivery at the dairy processing plant.
- Standardization Plan and Agency (NEN-NL) as a highly interested partner in a IA proposal consortium.
- Extensive patent searches resulting in a positive evaluation in connection with Freedom-to-Operate.
- PCT patent application on laser surface functionalization by ICCS/NTUA (co-inventors Surfix, WU).
- Patent application by CSEM.

A4. Potential Impact

BIOFOS exploitation plan relies on the fact that four different technological platforms have been developed in parallel. BIOFOS has developed biological and nanochemical protocols for the successful immobilization of Biorecognition elements on the Si3N4 surface. It has also developed integrated hybrid photonic chip and microfluidics and pretreatment modules. The individual platforms are expected to give disruptive solutions on the sensors applications.

The achievement of the challenging objectives of BIOFOS brings Europe at the forefront of photonic sensors component market. The individual platforms and the integrated BIOFOS prototype are of TRL 4-5 and through the exploitation of the project results, BIOFOS partners will be in the position to offer a technology solution with unmatched and directly transfer this technology to food and to other sectors, such as the health sector. The ICT project BIOCDx (http://biocdx.eu/) is under this direction.

A5. The Project's Public web-site (www.ict-biofos.eu/)

The BIOFOS website (http://www.ict-biofos.eu) is updated on a regular basis with publications, press releases, news about recent achievements within BIOFOS. Apart from the public area of the web-site, the private area continued to be the point of reference for partners regarding the exchange of working documents, reports (deliverables), presentations (such as the PPR2 final presentation, presentations of the SC meetings etc.), meeting minutes etc.

The visibility of the BIOFOS website exhibits a continuous increase as shown in Figure 8, where the evolution of the number of unique visitors from the beginning of the web-site operation till March 2017, is presented.

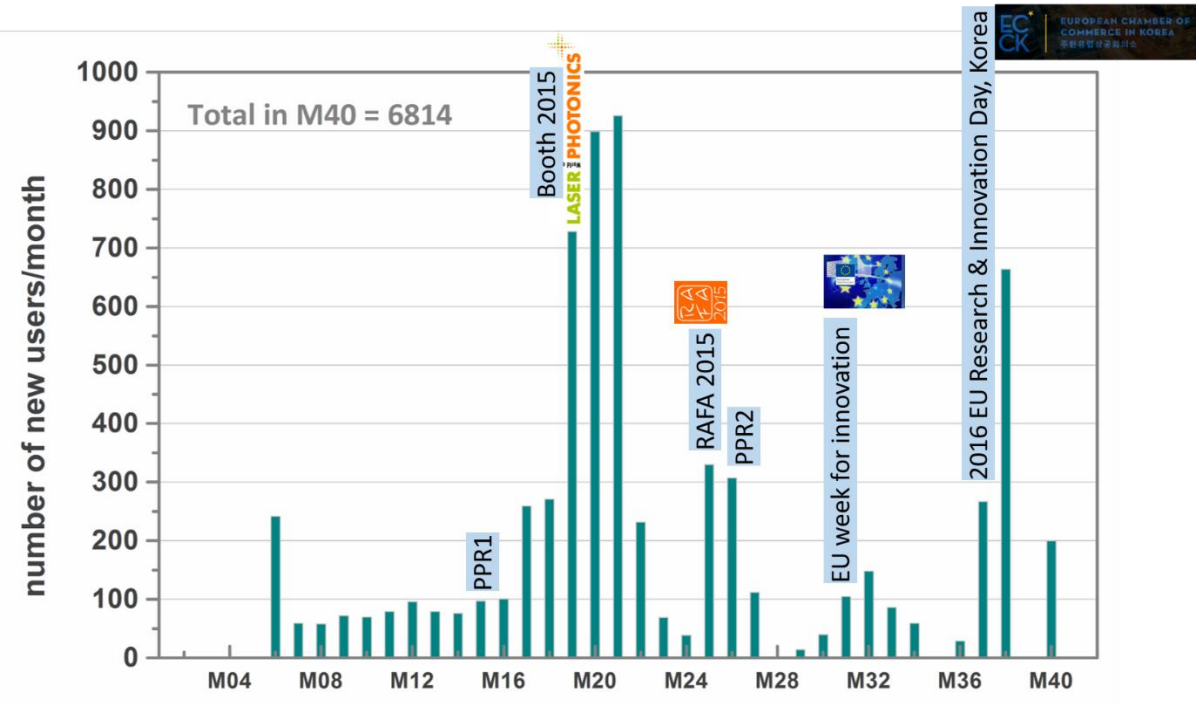

Figure 8: Distribution of entry of new BIOFOS web-site users over time from the beginning of the project till the end of the project. Actual data have been recorded till 2 March 2017 (M40).

A6. The BIOFOS Consortium

Contractors involved

	INSTITUTE OF COMMUNICATIONS & COMPUTER SYSTEMS/NATIONAL TECHNICAL UNIVERSITY OF ATHENS	GR
	LIONIX BV	NL
	CSEM CENTRE SUISSE D'ELECTRONIQUE ET DE MICROTECHNIQUE SA	CH
	UNIVERSITE DE PERPIGNAN VIA DOMITIA	FR
	BIOMEDICAL RESEARCH FOUNDATION, ACADEMY OF ATHENS	GR
	SURFIX BV	NL
	UNIVERSITY OF WAGENINGEN	NL
	INSTITUT DE RECERCA I TECHNOLOGIA AGROALIMENTARIES	ES
	SAXION UNIVERSITY	NL
	SOCIEDAD COOPERATIVA ANDALUZA GANADERA DEL VALLE DE LOS PEDROCHES	ES

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SECTION B - USE AND DISSEMINATION OF FOREGROUND

In this section, the dissemination and the exploitation of the project outcomes through interactions with industry, academia, and the scientific community and the potential impact of BIOFOS technology are presented.

B1. Dissemination of Foreground

The dissemination activities carried out within the BIOFOS project are described below per partner.

1. ICCS/NTUA

BIOFOS has been a significant opportunity for the MLMP group of ICCS/NTUA to promote the results and technology developed within the project at large scale EU events, international conferences and national scientific events.

In 2015, the achievements from the WP6 activities were disseminated in the invited talk for the Invited presentation at the 7th International Congress on Laser Advanced Materials Processing" conference, 26-29 May 2015, Fukuoka, Japan.

In 2016, Ioanna Zergioti (PC) was invited by the reviewer Anna Mignani to give a tutorial in the framework of the IEEE Sensors 2016 in Orlando, entitled "BIOFOS: Micro-ring resonator-based biophotonic system for food analysis".

Furthermore, the Coordinator of BIOFOS was invited by the EC MNBS unit to present the project results at two Research and Innovation events organized by the EU, the 2016 EU Research & Innovation Day, held 3-4 October 2016, Seoul, Korea (EU event) in co-organization with the Republic of Korea and the ECCK and the European Innovation Week in Taiwan**,** 30 May-3 June 2016. Both events aimed at promoting European excellence of science, technology and industry, expanding networks between participants and facilitating business and research cooperation. At both EU events, the project and its innovations presented by the coordinator and links have been done with companies for future promotion of BIOFOS device in the market of Taiwan.

The Coordinator has participated in the MNBS meetings every year since 2014, 2015, and 2016.

The MLMP group in collaboration with Surfix and WU have patented and published their disruptive results on combining laser transfer process and click chemistry which was published in Langmuir 2017, 33(4), 848 'Direct creation of biopatterns via combination of laser-based techniques and Click-chemistry'.

BIOFOS project has also been a great opportunity for the PCRL group of ICCS/NTUA to gain insight into photonic biosensors, develop new technology and obtain significant results which were published in prestigious conferences and journals with high impact factors.

More specifically, the initial simulation studies for the design of the photonic structures were presented in EUROPT(R)ODE 2014 with the title "*MRR-based photonic biosensing circuits of high complexity and compactness based on combination of monolithic and hybrid integration*". This work led to an invited paper in Sensors and Actuators B: Chemical entitled "*Design of grating couplers and MMI couplers on the TriPleX platform enabling ultra-compact photonic-based biosensors*".

A study that compared a new developed method based on FFT processing that can be used to relax the fabrication requirements of MRR based biosensors was published at Optics Express in 2016 entitled "*New set of design rules for resonant refractive index sensors enabled by FFT based processing of the measurement data*". Preliminary results from an extension of this study were accepted for

poster presentation in CLEO 2016 with the title "*Low Q-factor Ring Resonators With Ultra-Low Limit of Detection Based on FFT Processing of Spectral Scanning Data*". A detailed extension of this study entitled "*High performance refractive index sensor based on low Q-factor ring resonators and FFT processing of wavelength scanning data*" has been submitted to Optics Express for publication and is under review the time of preparation of this document.

2. LioniX

LioniX has disseminated project results in a variety of actions such as a comprehensive publication on bioassay experiments on the MRR platform, a number of exhibitions and conference presentations and, last but not least, by active involvement in the yearly MNBS workshops organized by EU-CONNECT.

The publication concerned the peer reviewed "Performance of Arrayed Microring Resonator Sensors with the TriPleX Platform" in the world-renowned Journal of Biosensors & Bioelectronics (open access)1.

As a partner in five EU-ICT FP7 projects on optofluidics for sensing and diagnostics applications in Food, Health and Marine LioniX organized a special booth at the huge (30,000 visitors) Laser World of Photonics trade fair in Munich in 2015 (www.world-of-photonics.com). This event had an added visibility and impact as that year had been chosen to be 'The Year of the Light'. The participating projects were, next to BIOFOS, FOODSNIFFER (www.foodsniffer.eu), SYMPHONY (http://www.symphony-project.eu/), LIPHOS (http://www.liphos.eu/) and BRAAVOO (www.braavoo.org). At the booth functional prototypes were shown and demonstrations were given In the satellite EOSOF 2015 (3rd EOS Conference on Optofluidics) of the World of Photonics congress (www.photonics-congress.com) the five project were presented by posters and other information material and was well received by the many visitors.

Next to this, LioniX had booths and presentations at the MicroNanotechnology Conferences every year, and a booth and presentation at the Lab-on-a-Chip & Microfluidics/Point-of care diagnostics/Single cell/molecule analysis - Select Biosciences, 15-16 March 2016, Madrid, Spain.

At the MNBS workshop 2015 (Leuven) LioniX demonstrated the MRR platform two days 'live'. At the MNBS workshop 2016 (Otranto) LioniX presented the BIOFOS project with a focus on the exploitation issues and moreover, had an invited contribution on Lab-on-Chip commercialization.

3. CSEM

BIOFOS has been the major project at CSEM to develop the automated sample preparation with the integrated pump module. For presentation purposes we developed the standalone pump module also known as the controlled Pressure Driven Dispensing Module (cPDD). It has been displayed at a number of shows over the years: e.g. MipTec 2015, MipTec 2016, SLAS 2016, SLAS 2017. The progress of BIOFOS was also published in the Scientific Technical Reports of CSEM over the years of 2014, 2015 and 2016.

[1] Besselink et al., J Biosens Bioelectron 2016, 7:2 (http://dx.doi.org/10.4172/2155-6210.1000209)

4. UPVD

As responsible of WP4, UPVD had the opportunities to present their research in aptasensors development in various national (France) or international events. Listed below are the oral presentations presented in different scientific events:

'Aptameric biosensors for aflatoxins detection' T. Noguer, G. Istamboulié, N. Paniel, C. Calas-Blanchard, L. Barthelmebs. 6ème journée Mycotoxines, Toulouse (France), 15-16 March 2016.

'Surveillance de nos aliments: des micro-méthodes basées sur l'utilisation des aptamères pour détecter les contaminants' L. Barthelmebs. 12ème édition du congrès BIOTRACE, Montpellier (France), 2 February 2017.

'Aptamères et sécurité alimentaire' N. Paniel, G. Istamboulié, L. Barthelmebs, T. Noguer. 14ème Colloque National du Groupe Français de Bioélectrochimie, Sète (France), 22-25 September 2014.

'Aptasensors for food Control (Electro)chemical immobilization and measurements' G. Istamboulié, N. Paniel, L. Barthelmebs, and T. Noguer. New Trends on Sensing – Monitoring. Telediagnosis for Life Sciences, Brasov (Romania), 24-26 July 2014.

And poster presentations:

'Aptamers for real time in situ food analysi'. N. Paniel, G. Istamboulie, L. Barthelmebs, T. Noguer. 20th Cross-border Meeting on Sensors and Biosensors, Perpignan (France), 1-2 Octobre 2015.
'An impedimetric aptasensor for the determination of aflatoxin M1 in milk'. G. Istamboulie, N. Paniel, L. Reguillo Granados, L. Barthelmebs, T. Noguer. 7th International symposium on Recent Advances in Food Analysis (RAFA 2015), Prague (Czech Republic), 3-6 November 2015.

5. BRFAA

The scientific work undertaken by BRFAA within BIOFOS, as well as the project as a whole has was presented in a number of international conferences both with poster as well as with oral presentations.

BIOFOS as a whole was presented in 2016 at an invited talk both at the 6TH Int. Conference on Biosensors and Bioelectronics in Phoenix AZ, USA as well as in 2015 at the 7th International symposium on Recent Advances in Food Analysis (RAFA 2015) in Prague (Czech Republic).

The work undertaken at BRFAA in close collaboration with ICCS/NTUA (MLMP group) was presented orally at pHealth 2016 in Herakleion, Crete and with poster presentations at the 4th Int. Conference on Bio-Sensing Technology in 2015 in Lisbon, Portugal, and the Biosensors 2016 in Gothenburg, Sweden.

6. Surfix

Within the BIOFOS project Surfix further developed the material-selective surface modification being a general advantage for waveguide based optical biosensor devices as it will further enhance performance by increasing its sensitivity (LoD) and reproducibility at low concentrations of analyte. The progress on this advanced surface modification approach obtained with the BioFos project was presented at different national and international conferences and fairs: Analytica 2016 (Munich, Germany), CompaMed 2015 and 2016 (Düsseldorf, Germany), and the International MicronanoConference 2014, 2015 and 2016 (Amsterdam, The Netherlands), and NanoTech 2017

(Tokyo, Japan). Oral presentations were given at the CompaMed (2015 and 2016) and the International MicroNanoConference (2015 and 2016).

7. WU

The research undertaken by WU as part of the BIOFOS project has been disseminated through various channels. Firstly, at national and international conferences WU's main findings have been presented to a broad audience. Of particular note are presentations at both the NWO Chains conference (2016), the largest chemistry-focused conference in The Netherlands, as well a presentation at more dedicated congress on biosensing (Switzerland 2017). In addition the work on creating 3D-functionalizable antifouling coatings was published in 2016 in the journal Langmuir 2016, 32(40), 10199 'Efficient and Tunable Three-Dimensional Functionalization of Fully Zwitterionic Antifouling Surface Coatings'. Finally collaborative work with Surfix and ICSS/NTUA resulted in both a patent and a publication on combining laser transfer process and click chemistry which was published in Langmuir 2017, 33(4), 848 'Direct creation of biopatterns via combination of laser-based techniques and Click-chemistry'.

8. IRTA

IRTA prepared and presented BIOFOS project and its concept, either through invited presentations or posters, in the following conferences as well as to technical events related to food quality control of olive oil and nuts. This aimed IRTA to reinforce its position of innovation capacity in front of the olive oil and nut industrial sector and scientific community.

In 2014, IRTA was invited to expose the concept of the project and its objectives to 30 engineers from Morocco who are responsible for olive science transferring to the growers. This was a good event that permitted IRTA to ask for pesticide detection requirements in that country, which were updated in WP3.

In 2015, BIOFOS was presented as research action in European Research Institutes Network, EUFRIN Board meeting. This is the biggest board on research in nuts in Europe. The same year, during a seminar on scientific activities of IRTA, BIOFOS goals and actual status of the project were presented to a group of 30 scientists for the field of agriculture (University of Lleida). The same university invites IRTA every year to expose BIOFOS advances in its master "Managing and Innovations in the food industry. Olive oil and table olives". BIOFOS goals were also presented at the "Shozu Agricultural Extension Center of Kagawa Prefecture", "Agricultural Experiment Station Shozu, Olive Research Institute" and "Agricultural Products Distribution Division" (Japan).

In 2016, IRTA was invited to explain BIOFOS to the World Congress on Food Nutrition (WCFN) in Taiwan. This action permitted stand out that the technological solutions adopted by BIOFOS are considered as relevant by teams from USA and GB that uses other biosensors but who have problems in the transducer system. The same year, IRTA explained BIOFOS at the International Olive Oil Meeting in Barcelona, were it was discussed with scientist from Italy, Tunisia and Japan.

The scientific scope of BIOFOS has been exposed and discussed in national and international events, related both for olive oil and nuts. In the forum of the International Society for Horticultural Science, there are any research group working neither on pesticides nor on mycotoxin detection.

Finally, BIOFOS has been presented to many dissemination activities done by IRTA through the olive oil and nut sectors in Spain.

9. SAXION

BIOFOS gave the Nano Physics Interface group at Saxion University of Applied Sciences the opportunity to promote results at national and international conferences, and other scientific exchanges.

In 2014 achievements from WP5 activities were presented by Saxion, in an oral presentation and a conference paper at the **Latin American Optics and Photonics Conference (LAOP 2014)**, 17-21 November 2014, in Cancún, Mexico.

SAXION contributed to the preparation of the material for the presentation of the BIOFOS project at the international EUROPT(R)ODE XII Conference.

Both in 2015 and 2016 results of characterization measurements on the several integrated optical platforms and substructures were presented at the **International MicroNanoConference** 2015. 8-9 December 2015, Amsterdam, the Netherlands; and the conference at 12-13 December 2016.

Finally several presentations, oral/poster, were given at national and local conferences/events, like e.g. the yearly **DAS Conferentie Applied Science**.

10. COVAP

COVAP prepared and presented BIOFOS project and its concept, either through invited presentations or posters, in the following conferences as well as to technical events related to food quality control of milk. In addition to this, COVAP has included in different technical forum related to milk quality advanced focused in Food Safety where the company presented the advanced of the project to the dairy sector. At the end of 2016, COVAP presented the results of the project in a technical meeting for farmers and technicians of the dairy sector organized by CICAP.

In 2015, BIOFOS sensing system was presented at the 7th International Symposium on Recent Advances in Food Analysis, RAFA 2015. 3-6 November 2015, Prague, Czech Republic. At this presentation, a review on the milk production and surveys distribution like the main tool of collecting info was presented.

The scientific scope of BIOFOS has been exposed and discussed in national and international events, related both for dairy sector like interfood forum where COVAP is included. Interfood Forum is a research group working for innovation focused in milk quality and food safety where mycotoxin and other contaminant are included as specific goal.

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Table 1: List of Scientific (peer reviewed) publications.

TABLE A1: LIST OF SCIENTIFIC (PEER REVIEWED) PUBLICATIONS										
NO.	**Title**	**Authors**	**Title of the periodical or the series**	**Number, date or frequency**	**Publisher**	**Place of publication**	**Year of publication**	**Relevant pages**	**Permanent identifiers[2] (if available)**	**Is/Will open access[3] provided to this publication?**
1	Direct Creation of Biopatterns via a Combination of Laser-Based Techniques and Click-Chemistry	M. Chatzipetrou, M. Massaouti, G. Tsekenis, A. K. Trilling, E. van Andel, L. Scheres, M. M. J. Smulders, H. Zuilhof, I. Zergioti	Langmuir	Volume 33, Issue 4	American Chemical Society	Washington, USA	January 1, 2017	848	http://pubs.acs.org/doi/abs/10.1021/acs.langmuir.6b02860	NO
2	Selection of DNA aptamers against penicillin G using Capture-SELEX for the development of an impedimetric sensor	N. Paniel, G. Istamboulié, A. Triki, C. Lozano, L.Barthelmebs, T. Noguer	Talanta	Volume 162	Elsevier	Amsterdam, The Netherlands	January 1, 2017	232–240	http://www.sciencedirect.com/science/article/pii/S003991401630728 7	NO
3	Efficient and tunable three-dimensional functionalization of fully zwitterionic antifouling surface coatings	S. C. Lange,E. van Andel, M. M. J. Smulders, H. Zuilhof	Langmuir	Volume 32, Issue 40	American Chemical Society	Washington, USA	September 30, 2016	10199–10205	http://pubs.acs.org/doi/pdf/10.1021/acs.langmuir.6b02622	NO
4	Performance of arrayed microring resonator sensors with the TriPleX platform	G. A. J. Besselink, R. G. Heideman, E. Schreuder, L.	Journal of Biosensors & Bioelectronics	Volume 7, Issue 2	OMICS International	USA	June 23, 2016	1000209	https://www.omicsonline.org/open-	YES

[2] A permanent identifier should be a persistent link to the published version full text if open access or abstract if article is pay per view) or to the final manuscript accepted for publication (link to article in repository).
[3] Open Access is defined as free of charge access for anyone via Internet. Please answer "yes" if the open access to the publication is already established and also if the embargo period for open access is not yet over but you intend to establish open access afterwards.

TABLE A1: LIST OF SCIENTIFIC (PEER REVIEWED) PUBLICATIONS

NO.	Title	Authors	Title of the periodical or the series	Number, date or frequency	Publisher	Place of publication	Year of publication	Relevant pages	Permanent identifiers[2] (if available)	Is/Will open access[3] provided to this publication?
		S. Wevers, F. Falke, H. H. Van den Vlekkert							access/performance-of-arrayed-microring-resonator-sensors-with-the-triplexplatform-2155-6210-1000209.php?aid=75795	
5	Laser-functionalized aptamer-based photonic biosensors	G. Tsekenis, M. Massaouti, I. Theodorakos, I.Zergioti	Newsroom	10.1117/2.1201605.006410	SPIE	USA	28 June 2016		http://spie.org/documents/Newsroom/Imported/	YES
6	Development of an impedimetric aptasensor for the determination of aflatoxin M1 in milk	G. Istanmboulié, N. Paiel, L. Zara, L. Reguillo Granados, L. Barthelmebs, T. Noguer	Talanta	Volume 146	Elsevier	Netherlands	2016	464-469	http://www.sciencedirect.com/science/article/pii/S003991401530305 2	NO
7	New set of design rules for resonant refractive index sensors enabled by FFT based processing of the measurement data	L. Gounaridis, P. Groumas, E. Schreuder, R.Heideman, H. Avramopoulos, C.Kouloumentas	Optics Express	Volume 24, Issue 7	OSA—The Optical Society	USA	30 March 2016		https://www.osapublishing.org/oe/abstract.cfm?uri=oe-24-7-7611	NO

TABLE A1: LIST OF SCIENTIFIC (PEER REVIEWED) PUBLICATIONS

NO.	Title	Authors	Title of the periodical or the series	Number, date or frequency	Publisher	Place of publication	Year of publication	Relevant pages	Permanent identifiers[2] (if available)	Is/Will open access[3] provided to this publication?
8.	Design of grating couplers and MMI couplers on the TriPleX platform enabling ultra-compact photonic-based biosensors	E. Gounaridis, P. Groumas, E. Schreuder, R. Heideman, V. Katopodis, C Kouloumentas, H. Avramopoulos	Sensors and Actuators B: Chemical	Volume 209	Elsevier	Netherlands	26 November 2014	1057-1063	http://www.sciencedirect.com/science/article/pii/S092540051401483X	NO
9.	TriPleX-based MicroRing Resonators for food safety applications	C. Damen, R. G. Heideman, G. J. Heesink, E. Schreuder	Latin America Optics and Photonics Conference		OSA	USA	2014		https://www.osapublishing.org/abstract.cfm?URI=LAOP-2014-LF2D.1	NO

Table 2: List of Dissemination Actions.

TABLE A2: LIST OF DISSEMINATION ACTIVITIES							
NO.	Type of activities[4]	Main leader	Title	Date	Place	Type of audience[5]	Countries addressed
1.	Presentation	ICCS/NTUA	Presentation of the BIOFOS project at "Smart systems for food industry" workshop	15 November 2013	Trento, Italy	Scientific Community	Europe
2.	Presentation	IRTA	Presentation of the BIOFOS project at Spanish national meeting "OLIVAR Y ACEITE DE OLIVA. IX Foro INIA"	2013	Cordoba, Spain	Scientific Community	Europe
3.	Presentation	IRTA	Presentation of the BIOFOS project at the International school "Expertos en cata de aceites"	2013	University of Jaén, Spain	Civil Society	Europe
4.	Poster	IRTA	"Micro-ring resonator- based biophotonic platform for food analysis"	7 September 2013	Spain	Scientific Community	Europe
5.	Workshop	IRTA	Presentation of the basic work-plan of BIOFOS, "Biosensors for a better environment" Workshop	7 September 2013	Spain	Scientific Community	Europe
6.	Presentation	ICCS/NTUA	Presentation of the BIOFOS project at EUROPT(R)ODE XII Conference	13-16 April 2014	Athens, Greece	Scientific Community	Europe
7.	Poster	ICCS/NTUA	Presentation of the BIOFOS photonic and hybrid platform at EUROPT(R)ODE XII Conference	13-16 April 2014	Athens, Greece	Scientific Community	Europe
8.	Presentation	ICCS/NTUA	Preparation of the BIOFOS innovation at the 8th annual concertation and consultation cluster workshop of European Commission funded projects on Micro-Nano-Bio Convergence Systems, 2014	21-22 October 2014	Toulouse, France	Scientific Community	Europe
9.	Poster	ICCS/NTUA	Preparation of the BIOFOS innovation at the 8th annual concertation and consultation cluster workshop of European Commission funded projects on Micro-Nano-Bio Convergence Systems, 2014	21-22 October 2014	Toulouse, France	EU Event/Scientific Community	Europe
10.	Presentation	LioniX	Presentation of the BIOFOS project at EUROPT(R)ODE XII Conference	13-16 April 2014	Athens, Greece	Scientific Community	Europe

[4] A drop down list allows choosing the dissemination activity: publications, conferences, workshops, web, press releases, flyers, articles published in the popular press, videos, media briefings, presentations, exhibitions, thesis, interviews, films, TV clips, posters, Other.

[5] A drop down list allows choosing the type of public: Scientific Community (higher education, Research), Industry, Civil Society, Policy makers, Medias ('multiple choices' is possible).

TABLE A2: LIST OF DISSEMINATION ACTIVITIES

NO.	Type of activities[4]	Main leader	Title	Date	Place	Type of audience[5]	Countries addressed
11.	Session	LioniX	Preparation of the BIOFOS at the innovation and user involvement session of the Micro-Nano-Bio Convergence Systems MNBS'14 Cluster workshop of EC	21-22 October 2014	Toulouse, France	EU Event/Scientific Community	Europe
12.	Presentation	CSEM	Presentation of the BIOFOS project at EUROPT(R)ODE XII Conference	13-16 April 2014	Athens, Greece	Scientific Community	Europe
13.	Session	CSEM	Preparation of the BIOFOS at the innovation and user involvement session of the Micro-Nano-Bio Convergence Systems MNBS'14 Cluster workshop of EC	21-22 October 2014	Toulouse, France	EU Event/Scientific Community	Europe
14.	Presentation	UPVD	Presentation of the BIOFOS project at EUROPT(R)ODE XII Conference	13-16 April 2014	Athens, Greece	Scientific Community	Europe
15.	Presentation	UPVD	"Aptasensors for food Control-(Electro) chemical immobilization and measurements", at International conference "New Trends on Sensing-Monitoring Telediagnosis for Life Sciences	24-26 July 2014	Brasov	Scientific Community	Worldwide
16.	Poster	UPVD	"Les aptamers nouveaux éléments de reconnaissance pour un contrôle qualité en temps reel", at the French NRA meeting Journées Recherche Industrie Microbiologie 2014, Management des Ressources Microbiennes	9 October 2014	Narbonne, France	Public/Scientific Community	Europe
17.	Presentation	BRFAA	Presentation of the BIOFOS project at EUROPT(R)ODE XII Conference	13-16 April 2014	Athens, Greece	Scientific Community	Europe
18.	Presentation	Surfix	Presentation of the BIOFOS project at EUROPT(R)ODE XII Conference	13-16 April 2014	Athens, Greece	Scientific Community	Europe
19.	Presentation/Poster	Surfix	Advanced Surface Modification of Optofluidic Biosensors at NanoCity 2014	27-28 October 2014	Utrecht, The Netherlands	Scientific Community	Europe
20.	Poster	Surfix	Advanced Surface Modification of Optofludi Bio(Sensors)" and shared booth at EUROPT(R)ODE 2014 XII XII International Conference on Optical Chemical Sensors & Biosensors	13-16 April 2014	Athens, Greece	Scientific Community	Europe
21.	Presentation	WU	Presentation of the BIOFOS project at EUROPT(R)ODE XII Conference	13-16 April 2014	Athens, Greece	Scientific Community	Europe
22.	Presentation	IRTA	Presentation of the BIOFOS project at EUROPT(R)ODE XII Conference	13-16 April 2014	Athens, Greece	Scientific Community	Europe
23.	Presentation	IRTA	BIOFOS presentation at the innovation and user involvement session of the Micro-Nano-Bio Convergence Systems MNBS'14 Cluster workshop of EC	21-22 October 2014	Toulouse, France	EU Event/Scientific Community	Europe

TABLE A2: LIST OF DISSEMINATION ACTIVITIES

NO.	Type of activities[4]	Main leader	Title	Date	Place	Type of audience[5]	Countries addressed
24.	Presentation	IRTA	Presentation of the main concept of BIOFOS project at "Regional conference on the olive oil sector Catalonia"	20 June 2014	Catalonia, Spain	Scientific Community	Europe
25.	Presentation	IRTA	IRTA's publication at weekly informations stem the participation of BIOFOS at the MNBS'14 workshop	30 October 2014	Catalonia, Spain	EU Event/Scientific Community	Europe
26.	Presentation	Saxion	Presentation of the BIOFOS project at EUROPT(R)ODE XII Conference	13-16 April 2014	Athens, Greece	Scientific Community	Europe
27.	Presentation	COVAP	Presentation of the BIOFOS project at EUROPT(R)ODE XII Conference	13-16 April 2014	Athens, Greece	Scientific Community	Europe
28.	Presentation	COVAP	Preparation of the BIOFOS presentation at the innovation and user involvement session of the Micro-Nano-Bio Convergence Systems MNBS'14 Cluster workshop of EC	21-22 October 2014	Toulouse, France	EU Event/Scientific Community	Europe
29.	Workshop	COVAP	Presentation of the BIOFOS project in Workshop for Smart Specialization (RIS3), coordinated by FIAB (Spanish Food and Drink Federation)	18 July 2014	Córdoba,Spain	Scientific Community	Europe
30.	Course	IRTA	Course at "International course on experts on tasting virgin oil"	26 November 2014	University of Jaén, Spain	Scientific Community	Worldwide
31.	Presentation	IRTA	Presentation of BIOFOS project and its objectives	2 November 2014	Marrakech, Morocco	Scientific Community/ Engineers - for olive science transferring to the growers	Europe
32.	Presentation	SAXION	Latin American Optics and Photonics Conference (LAOP 2014)	17-21 November 2014	Cancún, Mexico	Scientific Community	Worldwide
33.	Oral	ICCS/NTUA	"A Micro-ring resonator-based biophotonic system for food analysis"- 3rd Hellenic Forum for Science, Technology and Innovation, Workshop on Advanced Biosensing Devices for Biomedical and Food Analysis Applications	29 June 2015	Athens, Greece.	Scientific Community	Europe
34.	Presentation	ICCS/NTUA	Presentation of the BIOFOS project at 7th International Congress on Laser Advanced Materials Processing" Conference	26-29 May 2015	Fukuoka, Japan	Scientific Community	Worldwide
35.	Poster	ICCS/NTUA	"Laser printing and activation, a two-step procedure for the immobilization of aptamers on alkene/yne-functionalized sensor surfaces"	11- 15 May 2015	Lille, France	Scientific Community	Worldwide

TABLE A2: LIST OF DISSEMINATION ACTIVITIES

NO.	Type of activities[4]	Main leader	Title	Date	Place	Type of audience[5]	Countries addressed
			-2015 E-MRS Spring Meeting, session CC: Laser and plasma processing for advanced applications in material science				
36.	Presentation	ICCS/NTUA	Microfluidics, BioMEMS, and Medical Microsystems XIII" conference, SPIE BiOS	7-12 February 2015	San Francisco, California United States	Scientific Community	Worldwide
37.	Poster	ICCS/NTUA	Presentation of BIOFOS project at the special booth organized by Lionix at the 3rd EOS Conference on Optofluidics, EOSOF	22 - 23 June 2015	Munich, Germany	Scientific Community	Worldwide
38.	Poster	LioniX	Presentation of BIOFOS project at the Laser World of Photonics Event in Munchen, 3rd EOS Conference on Optofluidics,	23 June 2015	Munich, Germany	Scientific Community	Worldwide
39.	Presentation	LioniX	Presentation of results and achievements of BIOFOS project at Exhibition LASER World of PHOTONICS 2015	22 June 2015	Munich, Germany	Scientific Community	Worldwide
40.	Presentation	LioniX	"Live" demonstration by LioniX of the optical sensing platform on which the biosensors of both the BIOFOS and SYMPHONY project are based at MicroNanoBio Systems (MNBS) Workshop	12 -15 October 2015	Leuven, Belgium	EU Event/Scientific Community	Worldwide
41.	Presentation	CSEM	Presentation of achievements and results of BIOFOS project at SLAS 2015, 4th Annual International Conference and Exhibition Conference 2015	7-11 January 2015	Washington DC, US	Scientific Community	Worldwide
42.	Presentation	UPVD	"Open Day Event", in collaboration with Transfert LR, the Regional Development Agency committed to the promotion of innovation and technology transfer of the Languedoc Roussillon region	10 April 2015	Perpignan, French	Public/Open day event	Europe
43.	Presentation	UPVD	Presentation of the laboratory: Biosensors, generalities and applications", Journée Portes Ouvertes BIOCAPTEURS (Open Day Event)	10 April 2015	Perpignan, French	Public/Open day event	Europe
44.	Presentation	UPVD	"Catalytic biosensors"-Journée Portes Ouvertes BIOCAPTEURS (Open Day Event)	10 April 2015	Perpignan, French	Public/Open day event	Europe
45.	Presentation	UPVD	"Biosensors for measuring antioxidant capacity"-Journée Portes Ouvertes BIOCAPTEURS (Open Day Event)	10 April 2015	Perpignan, French	Public/Open day event	Europe

TABLE A2: LIST OF DISSEMINATION ACTIVITIES

NO.	Type of activities[4]	Main leader	Title	Date	Place	Type of audience[5]	Countries addressed
46.	Presentation	UPVD	"Affinity biosensors" - Journée Portes Ouvertes BIOCAPTEURS (Open Day Event)	10 April 2015	Perpignan, French	Public/Open day event	Europe
47.	Presentation	UPVD	"Biosensors for microorganisms" -Journée Portes Ouvertes BIOCAPTEUR (Open Day Event)	10 April 2015	Perpignan, French	Public/Open day event	Europe
48.	Poster	UPVD	Presentation "Aptamers for real time in situ food analysis" related to the BIOFOS project presented at the 20th Cross-border Meeting on Sensors and Biosensors	1-2 October 2015	Perpignan, French	Scientific Community	Europe
49.	Presentation	BRFAA	BIOFOS Presentation at 4th International Conference on Biosensing Technology	10-13 May 2015	Lisbon, Portugal	Scientific Community	Worldwide
50.	Press release	Surfix	BIOFOS Project	11th of June 2015	Wageningen The Netherlands	Scientific Community, Industry, Medias, Civil Society	Worldwide
51.	Presentation	WU	Colloquium entitled "Clickable Monomers for Functionalization of Zwitterionic Polymer Brushes", presented at the Laboratory of Organic Chemistry	20 April 201	Wageningen University, The Netherlands	Scientific Community	Europe
52.	Presentation	IRTA	Presentation of BIOFOS project and its concept to technical events related to food quality control of olive oil. Program "DAAM-IRTA" on milling technology and oil quality	11 June 2015	Catalan Government, Spain	Scientific Community	Europe
53.	Presentation	IRTA	IRTA Research and Development (R&D) activities on olive organized by ADAMA	4 June 2015	Spain	Scientific Community	Europe
54.	Presentation	IRTA	BIOFOS presentation in Session Quality, industrialization and marketing (IRTA) entitled BIOFOS: Micro-ring resonator-based biophotonic system for food analysis at XVI GREMPA Meeting	12-14 May 2015	Meknes, Morocco	Scientific Community	Europe
55.	Seminar	IRTA	Presentation of BIOFOS goals and actual status of the project to a group of 30 scientists for the field of agriculture	13 March 2015	University of Lleida (UdL), Spain	Scientific Community	Europe
56.	Lecture	IRTA	Lecture at "Managing and Innovations in the food industry. Olive oil and table olive"	February 2015	University of Lleida (UdL), Spain	Scientific Community	Europe

TABLE A2: LIST OF DISSEMINATION ACTIVITIES

NO.	Type of activities[4]	Main leader	Title	Date	Place	Type of audience[5]	Countries addressed
57.	Press Release	COVAP	"BIOFOS PROJECT: a solid positioning of COVAP beside the new technologies"	15 June 2015	Spain	Civil Society	Europe
58.	Presentation	ICCS/NTUA	Presentation of BIOFOS project as a whole, at 7th International Symposium on Recent Advances in Food Analysis	3-6 November 2015	Prague, Czech Republic	Scientific Community	Europe
59.	Presentation	Lionix	Regarding the overall BIOFOS system, "Detection of emerging contaminations in milk, olive oil and nuts at the point-of-need with a compact, microphotonics based diagnostic instrument" presented at the Innovation Award Competition 2015, Innovation Award Competition for FP7 Participants - "Micro/Nano Electronics" and "Smart System Integration"	1-2 December 2015	Berlin, Germany	Scientific Community	Europe
60.	Presentation	CSEM	Innovation of a "Novel pressure driven dispensing system", developed within EU-BIOFOS, presented at Award Competition, 2015	1-2 December 2015	Berlin, Germany	Scientific Community	Europe
61.	Poster	UPVD	An impedimetric aptasensor for the determination of aflatoxin M1 in milk"- 7th International symposium on Recent Advances in Food Analysis,2015	3-6 November 2015	Prague, Czech Republic	Scientific Community	Worldwide
62.	Poster	UPVD	Computational and biosensor investigation of molecular imprinted polymers for selective extraction of phosmet from olive oil" - 7th International symposium on Recent Advances in Food Analysis,2015	3-6 November 2015	Prague, Czech Republic	Scientific Community	Worldwide
63.	Poster	BRFAA	Poster Presentation entitled 'Optimization studies of optical biosensors for food applications', presented at 7th International Symposium on Recent Advances in Food Analysis	3-6 November 2015	Prague, Czech Republic	Scientific Community	Worldwide
64.	Presentation	BRFAA	Presentation of the BIOFOS project as a whole at 7th International Symposium on Recent Advances in Food Analysis	3-6 November 2015	Prague, Czech Republic	Scientific Community	Worldwide
65.	Poster	WU	Poster entitled "Efficient and Tunable 3D Functionalization of Antifouling Zwitterionic Polymer Brushes on Si3N4", presented at CHAINS	November 2015	Veldhoven, The Netherlands	Scientific Community	Europe
66.	Presentation	IRTA	Presentation of BIOFOS as research action in European Research Institutes Network, EUFRIN Board meeting	20 November, 2015	Belgium	Scientific Community	Europe

TABLE A2: LIST OF DISSEMINATION ACTIVITIES

NO.	Type of activities[4]	Main leader	Title	Date	Place	Type of audience[5]	Countries addressed
67.	Presentation	IRTA	Presentation of BIOFOS goals for olive oil to the "Shozu Agricultural Extension Center of Kagawa Prefecture", "Agricultural Experiment Station Shozu, Olive Research Institute" and "Agricultural Products Distribution Division"	16 November 2015	Japan	Scientific Community	Worldwide
68.	Presentation	IRTA	Presentation at the International school "Expertos en cata de aceites"	30 November 2015	University of Jaen, Spain	Scientific Community, Civil Society	Worldwide
69.	Press Release	IRTA	BIOFOS project, at IRTAs official website	December 2015	Barcelona, Spain	Scientific Community, Civil Society	Worldwide
70.	Oral	SAXION	"Characterization and performance measurements on various Micro Ring Resonator structures" at the International MicroNanoConference 2015	8-9 December 2015	Amsterdam, the Netherlands	Scientific Community	Worldwide
71.	Poster	COVAP	Poster presentation, focused on end-users requirements and specifications related to the BIOFOS sensing system presented at the 7th International Symposium on Recent Advances in Food Analysis, 2015	3-6 November 2015	Prague, Czech Republic	Scientific Community	Worldwide
72.	Presentation	COVAP	Presentation on dairy cooperatives requirements of tools necessary for quality and security control. 7th International Symposium on Recent Advances in Food Analysis	3-6 November 2015	Prague, Czech Republic	Scientific Community	Worldwide
73.	Presentation	ICCS/NTUA	Presentation of BIOFOS project and its innovations at 2016 EU Research & Innovation Day, promoting European excellence of science, technology and industry to Korea and expanding networks between participants	3-4 October 2016	Seoul, Korea	Scientific Community	Europe
74.	Presentation	ICCS/NTUA	Presentation of BIOFOS project and its innovations - European Innovation Week in Taiwan	30 May-3 June 2016	Taiwan	EU Event	Europe
75.	Presentation	ICCS/NTUA	Presentation of BIOFOS project at ISOCS & MINAB-ICT 2016	27-29 June 2016	Otranto (Lecce), Italy	Scientific Community	Europe
76.	Presentation	ICCS/NTUA	BIOFOS presentation at 4th Hellenic Forum for Science, Technology and Innovation	13 June 2016	Athens, Greece	Scientific Community	Europe
77.	Presentation	ICCS/NTUA	Presentation of the biochemical platform and the laser-based approach applied in the BIOFOs project at 17th International Symposium on Laser Precision Microfabrication	23-26 May 2016	Xi'an, China	Scientific Community	Worldwide

TABLE A2: LIST OF DISSEMINATION ACTIVITIES

NO.	Type of activities[4]	Main leader	Title	Date	Place	Type of audience[5]	Countries addressed
78.	Presentation	ICCS/NTUA	"Laser induced forward transfer: a novel tool for printing sensors and characterizing surface wetting properties", at SPIE Photonics West 2016	16-18 February 2016	San Francisco, United States	Scientific Community	Worldwide
79.	Presentation	Lionix	Participation for the ENF Innovation Award "Competitive Electronics Innovation Award", 2016	24 November 2016	Rome, Italy	Scientific Community	Europe
80.	Presentation	Lionix	ISOCS & MINAB-ICT 2016	27-29 June 2016	Otranto (Lecce), Italy	Scientific Community	Europe
81.	Presentation	CSEM	MipTec, The international Life Science Exhibition 2016	12-14 September 2016	Basel, Switzerland	Scientific Community	Europe
82.	Presentation	CSEM	Microfluidics Matchmaking & Networking Event 2016	14 September 2016	Basel, Switzerland	Scientific Community	Europe
83.	Presentation	CSEM	Participation for the ENF Innovation Award "Competitive Electronics Innovation Award", 2016	24 November 2016	Rome, Italy	Scientific Community	Europe
84.	Presentation	CSEM	cPDD presentation at CSEM booth at SLAS 2016, 5th Annual International Conference and Exhibition	23-27 January 2016	San Diego, California, US	Scientific Community	Worldwide
85.	Scientific and Technical Report	CSEM	Report for BIOFOS "Automation of Traditional Sample Preparation for Oil, Milk, and Nuts", in the CSEM Scientific and Technical Report 2015	January2016	Switzerland	Scientific Community	Worldwide
86.	Presentation	BRFAA	6th International Conference and Exhibition on Biosensors & Bioelectronics	22-23 September 2016	Phoenix, Arizona, USA	Scientific Community	Worldwide
87.	Presentation	BRFAA	The concept and results related to the nanochemical platform developed in the BIOFOS project, presented at pHealth conference	29-31 May 2016	Crete, Greece	Scientific Community	Europe
88.	Presentation	BRFAA	Biosensors 2016	25-27 May, 2016	Gothenburg, Sweden	Scientific Community	Europe
89.	Poster	BRFAA	Poster presentation entitled 'An Ochratoxin A (OTA) fluorimetric biosensor based on the quenching of the mycotoxin's natural fluorescence by the aptamer against it', presented at 4th International Conference on Biosensing Technology	10-13 May 2016	Lisbon, Portugal	Scientific Community	Worldwide
90.	Presentation	Surfix	Biosensors 2016	25-27 May, 2016	Gothenburg, Sweden	Scientific Community	Europe
91.	Presentation	Surfix	Presentation of work linked to BIOFOS project, at MicroNanoConference 2016	22 December 2016	Amsterdam, The Netherlands	Scientific Community	Worldwide

TABLE A2: LIST OF DISSEMINATION ACTIVITIES

NO.	Type of activities[4]	Main leader	Title	Date	Place	Type of audience[5]	Countries addressed
92.	Lecture	WU	Lecture entitled "Romantic surfaces – Combining functionality and zwitterionic properties into 3D-clickable antifouling coatings", given at Nanocity 2016	June 2016	Amsterdam, The Netherlands	Scientific Community	Europe
93.	Poster	WU	Poster entitled "Efficient and Tunable Three-Dimensional Functionalization of Fully Zwitterionic Antifouling Surface Coatings", presented at CHAINS	December 2016	Veldhoven, The Netherlands	Scientific Community	Europe
94.	Course	IRTA	International course on experts on tasting virgin oil	1 December 2016	University of Jaén, Spain	Scientific Community, Civil Society	Worldwide
95.	Presentation	IRTA	Presentation of BIOFOS project as a whole, at World Conference on Food and Nutrition	17-20 November 2016	Kaohsiung, Taiwan	Scientific Community	Worldwide
96.	Seminar	IRTA	International Seminary on Olive Oil (ISMOO)	26-27 October 2016	Barcelona, Spain	Scientific Community, Civil Society	Worldwide
97.	Presentation	IRTA	Presentation of "BIOFOS micro-ring resonator based biophotonic system for Food analysis. Olive oil application for contaminants detection" at VIII International Olive Symposium, International Society for Horticultural Science (ISHS)	10-14 October 2016	Split, Croatia	Scientific Community	Worldwide
98.	Presentation	IRTA	Congreso Ibérico de Olivicultura (SECH)	13-15 April 2016	Badajoz, Spain	Scientific Community	Europe
99.	Presentation	IRTA	Presentation of "IRTA's quality program for olive oil, 15 years of experiences", at World Olive Oil Event (WOOE),	2 March 2016	Madrid, Spain	Scientific Community	Europe
100.	Presentation	IRTA	"Master in Food Industry Innovations. Edible oils"	21 January 2016	University of Lleida, Spain	Civil Society	Europe
101.	Conference	IRTA	Presentation of "BIOFOS in the World Olive Oil", through conference titled: "IRTA's quality program for the Catalan olive oil sector"	March 2016	Madrid, Spain	Scientific Community, Civil Society	Worldwide
102.	Presentation	IRTA	Presentation of the BIOFOS project at the Spanish Congress on Olive growing	13-15 April 2016	Badajoz, Spain	Scientific Community/	Europe
103.	Poster	SAXION	'Micro-Ring Resonator-based photonic system for food analysis and metabolism monitoring" at the International MicroNanoConference 2016	12-13 December 2016	Amsterdam, the Netherlands	Scientific Community	Worldwide

TABLE A2: LIST OF DISSEMINATION ACTIVITIES							
NO.	Type of activities[4]	Main leader	Title	Date	Place	Type of audience[5]	Countries addressed
104.	Poster	SAXION	BIOFOS, Micro-ring resonator-based biophotonic system for food analysis, presented at Domain Applied Science (DAS) Conference 2016	24 March 2016	Utrecht, the Netherlands	Scientific Community	Europe
105.	Lecture	WU	Lecture entitled "Improved Signal-To-Noise Ratio by the 3D-Functionalization of Fully Zwitterionic Surface Coatings", presented at 19th International Conference on Biosensing Technology	January 2017	Zurich, Switzerland	Scientific Community	Worldwide
106.	Seminar	IRTA	Seminar on olive oil "Olive oil quality improvement program from IRTA"	5 February 2017	Athens, Greece	Scientific Community, Civil Society	Europe
107.	Presentation	CSEM	Report for BIOFOS project "Controlled, pressure driven, sequential actuation of fluids for a food quality monitoring system", published in the CSEM Scientific and Technical Report 2016.	January2017	Switzerland	Scientific Community	Europe

B2. Exploitation and Use of Foreground

BIOFOS beneficiaries have recognised the opportunities resulted from of their participation to the Project and elaborated on individual exploitation plans that consolidate the gained benefits. These plans for each beneficiary of the BIOFOS consortium are summarized below:

1. ICCS/NTUA

Within the framework of BIOFOS, the MLMP group of ICCS/NTUA has served as the responsible partner for the bio-modification of the fabricated optical chips based on laser-based techniques in WP6 and the validation of the fabricated biochips and testing of the BIOFOS system using spiked samples in WP8. During the course of the project, ICCS/NTUA has also been involved with the system validation using real food samples. Through these activities, the MLMP group of ICCS/NTUA accumulated significant experience and know-how and invested on valuable processes for the fabrication and validation of the system with respect to the following areas:

Immobilization techniques: For the needs of direct immobilization of the MRRs of the optical sensors, ICCS/NTUA optimized a laser-based experimental setup for printing and immobilizing biorecognition elements with spatial control on Si_3N_4 surfaces. Through the activities in BIOFOS project, ICCS/NTUA had the chance to gain knowledge regarding different functionalization approaches for modifying Silicon-based surfaces and in particular Silicon nitride surfaces and optimizing further the laser-based technique and immobilization process through its combination with chemical approaches.

Validation of photonic biosensors: Through the activities in BIOFOS project and collaboration with the PCRL group, BRFAA and with the help of LioniX, UPVD and the end-users IRTA and COVAP, ICCS/NTUA also obtained significant experience in the validation process and characterization of bio-photonic sensors.

Through the participation in BIOFOS, ICCS/NTUA had the opportunity to establish close collaboration with the other two partners of the consortium (Surfix, WU) within and outside the strict framework of the project. This close collaboration resulted in the application of a **PCT patent (P3808PC00)** applied by ICCS/NTUA on 2016-12-16 for a Method for activating click reactions through laser induced forward transfer of molecules with co-inventors partners from Surfix and WU.

A very concrete path for the exploitation of the participation in BIOFOS for ICCS/NTUA, is the creation of a spin-of company oriented in applications of laser-based techniques for direct printing of biomaterials, *Biophotonia*, and the coordination of MLMP group of ICCS/NTUA in the follow-up project, called BIOCDx, that was funded by the EC in the last call of H2020.

In BIOFOS, the PCRL group was responsible for the design of photonic structures in the biosensing chips, the development of the read-out electronics and has also performed studies that resulted in a new set of design rules for photonic biosensors based on MRRs. Through these activities, the PCRL group of ICCS/NTUA accumulated significant experience and know-how and invested on valuable processes for the fabrication and validation of the system with respect to the following areas

FFT based processing of MRR biosensor signals: PCRL developed a signal processing method based on the Fast-Fourier Transform which is fast, reliable and tolerant to noise. The method developed can calculate accurately how the signal changes, without the requirement of sophisticated hardware and without the need for ultra-high Q factor ring resonator cavities.

Design of photonic structures: PCRL has designed photonic structures that were not available in TriPleX that enabled the hybrid integration of active components on the complex circuitry already available. Specifically, grating couplers with high coupling efficiency were designed for out-of-plane coupling of light from VCSEL sources in the photonic chip, and from the chip to the photodiodes. The grating coupler designs were extended to feature two output ports and higher coupling efficiency. 1x4 and 1x8 MMI structures for splitting the light signal were also successfully designed.

Driving and read-out electronics: Driving and read-out electronics were developed for the optoelectronics, the microfluidics, and the pretreatment unit. The electronics were based on a mixture of open source and proprietary hardware. Custom amplifiers were also designed and fabricated in house for the photodiode signals. A software platform was also developed for controlling them, that also integrated the advanced signal processing algorithm mentioned above.

2. LioniX

LioniX main activity has been the further development of the biophotonic platform in both the system itself as well as the bioassays. The main improvement steps in this has been in the design of the biosensors, the chip processing and the hybrid integration of the active elements (laser, photodiode) on the biosensor chip, which has never been shown for this kind of applications to enable a cost-effective manufacturing solution for higher volumes and even a very cheap disposable chip solution in mass markets.

Next to the technical foreground a first version of a business plan has been developed based on an extensive market and competition analysis, in combination with a plan for certification of the future instrument in close collaboration with the national standardization agency NEN.

These results are going to be exploited in a number of follow up projects of which four are in a starting and one in a proposal phase. It concerned a contract for development of disposable fast inflammation test for use in developing countries (company name confidential), an EU-ICT03-2016 RIA project with core partners from BIOFOS (**BIOCDX**: *A miniature Bio-photonics Companion Diagnostics platform for reliable cancer diagnosis and treatment monitoring*), an EU EFRO project with Dutch partners (**BIOMEANDER:** *Development of a biosensor platform for screening of drug candidates and detection of viruses*), and an EU INTERREG ROCKET Germany-Netherlands - Feasibility Project (**VaxChip**: *On-chip molecular detection tool to detect viral pathogens during disease outbreaks, for the in-process control testing during vaccine production and for the detection of extraneous agents in vaccines.* Next to this, a proposal is in preparation for EU-ICT30-2017 IA Photonics KET, scope b): Sensing for process and product monitoring and analysis, again initiated by the core partners of BIOFOS.

3. CSEM

A core discipline at CSEM is to build advanced dispensing systems. Our clients often ask for means to monitor or even actively control the dispensed volumes. With the pump module developed in BIOFOS also known as the controlled Pressure Driven Dispensing (our cPDD) we can offer a smart solution to these requests since it is a perfect match to existing time-pressure-dispensing (TPD) systems. CSEM has therefore applied for the patent “APPARATUS AND METHODS FOR DISPENSING OR ASPIRATING FLUID” which has been filed in the US and a year later in Europe.

CSEM is currently in contact with a number of clients to add value to their TPD systems. The business model will either be licensing or technology transfer of the cPDD technology.

Simultaneously, CSEM exploits the potential of the automated sample preparation in participating in follow-up calls of BIOFOS and industrial projects with the need of automated sample preparations.

4. UPVD

Within the framework of BIOFOS, BAE-LBBM laboratory (formerly IMAGES) of UPVD has served as the responsible partner for WP4. “Design, fabrication and regeneration of biomediators”. During the course of the project, UPVD has also been involved with the system validation using real food samples. Through these activities, BAE-LBBM of UPVD accumulated significant expertise and know-how for the fabrication and validation of aptamers for aptasensors development:

Aptamers selection techniques

Selection of aptamers is classically performed using the so-called SELEX technique (Systematic Evolution of Ligands by EXponential enrichment), an iterative process based on the binding of random oligonucleotides on a target immobilized on a solid support. However, it was shown in this project that such selection is difficult when dealing with small size targets as toxins and pesticides. For this reason, it was chosen to use Capture-SELEX as alternative selection process. This technique is based on the selection of DNA aptamers using target in solution while the ssDNA library is fixed on a support.

This technique was used for the first time in BAE-LBBM lab in the frame of this project. It allowed the successful selection of aptamers against penicillin antibiotics.

5. BRFAA

Within the framework of BIOFOS, has served as the workpackage leader for WP6 and had a significant contribution in WP4 and WP8. Through its participation in BIOFOS it has gained considerable experience in a number of fields. More specifically:

Biomolecule modification and immobilization techniques: In WP4 it has gained considerable consolidated its experience in optimizing the immobilization of biomolecules onto functionalized surfaces and has consolidated its expertise in the use of aptamers as biorecognition elements. It has also developed an alternative, universally applicable strategy for the quantification of analytes with the use of fluorescent microscopy.

Functionalization techniques: In WP6, BRFAA has been instrumental in developing low cost and easy to fabricate functionalization strategies that were crucial in the success of BIOFOS as a whole. By doing so, it has gained experience with surface treatment protocols and their subsequent study with analytical instruments (SEM-EDAX, FT-IR, AFM). Furthermore, it has optimized two alternative strategies to achieve higher loading capacities of the biorecognition molecules onto surfaces that are applicable to all biosensing platforms. One of these, the use of polyssacharide meshes is novel and has given extremely promising results.

Validation of biosensors: Through its involvement in WP8, it has acquired invaluable know-how into system integration and has aided towards tackling problems that arise when individual platforms that have been developed separately come together. In addition, it has dealt with common issues that the validation of biosensors in real settings and with real samples face.

Through its participation in international conferences it has had many networking opportunities which, along with the experience it has gained, have been put to use in drafting proposals with existing BIOFOS partners as well as with new ones for national and European calls. Further to the development of new and novel biosensor platforms it will apply the gained knowledge in surface functionalization

and biomolecule modification in new cutting-edge technology fields such as the targeted cancer therapy with the use of nanoparticles.

6. Surfix

The within BIOFOS developed material-selective surface modification technology has great potential in biosensor and point-of-care diagnostic (PoC) applications. There are already several devices on the market and many more will follow, that consist of two base materials and material-selective modification has the ability to further improve their sensitivity, i.e. lower limit of detection (LoD) and reproducibility at low analyte concentrations.

As a result, Surfix is participating in one new H2020 research project (BioCDx) and one national funded project (BioMeander) to further explore and scale its developed material-selective surface modification technology for diagnostic applications.

Currently a patent search is ongoing to explore the patentability of the developed material-selective surface modification technology.

In addition, within BIOFOS, together with ICCS/NTUA and WU, a patent named 'METHOD FOR ACTIVATING OF CLICK REACTIONS THROUGH LASER INDUCED FORWARD TRANSFER OF MOLECULES.' was filed. This work was also published in the peer-reviewed journal Langmuir

7. WU

Within the framework of BIOFOS, WU has had the opportunity to develop novel routes towards surface coatings with dual purpose: 1) being antifouling; and 2) allowing a high degree of functionalization throughout the entire coating. The main achievements of our work within BIOFOS is finding a previously unachieved route towards such 3D-functionalizable antifouling coatings. In the development of this route, WU has gained value knowledge in monomer synthesis, surface modification and characterization, antifouling studies and selective analyte binding.

Through the participation in BIOFOS, WU had the opportunity to establish close collaboration with the other two partners of the consortium (ICCS/NTUA, WU) within and outside the strict framework of the project. This close collaboration resulted in the application of a **PCT patent (P3808PC00)** applied by ICCS/NTUA on 2016-12-16 for a Method for activating click reactions through laser induced forward transfer of molecules.

8. IRTA

During the project IRTA has contacted research groups and companies from the high-tech industry that are trying to move into the food sector. The capabilities of these new technologies is a new opportunity for IRTA to promote projects with the food sector for food safety, which was a less explored topic for IRTA, but a very relevant one for the growers.

The deep relationship with the growers and processing factories to carry on WP3, in order to define BIOFOS specifications, resulted in a better position of IRTA for food safety in Spain. From this relationship, new collaboration agreements set out with BARRY CALLEBAUD Company (on friendship agricultural practices for hazelnut in Spain) or IMPORTACO from the nut sector. Regarding olive oil, a new exploratory project in collaboration with the Agricultural Department of the Catalan Government, was launched by IRTA through the olive oil sector in order to stand out the prevalence of pesticide residues in the olive fruit deliveries from the growers to the mills.

In 2013, just before BIOFOS kick-off meeting, IRTA supported a scholarship to develop biosensors to detect water contaminants in the fisheries. The positive results of this research, join with the impact of BIOFOS project through the olive oil and nut sector in Catalonia, convinced IRTA to consolidate the scholarship as researcher, and now biosensors is a strategic topic for IRTA.

9. SAXION

In the BIOFOS FP7 project the Nano Physics Interface(NPI) group of Saxion University of Applied Sciences has been involved in the functional testing of the optical chips, more specifically the optical characterization of the passive and active optical chips in terms of overall sensor sensitivity, power-splitting of the input light by MMI and Y-splitters and efficiency measurements of the applied optical coupling methods.

Through these activities Saxion has gained a lot of knowledge about integrated optical platforms and more specifically MRR structures. Within the BIOFOS project Saxion established a close relationship with partner Lionix that produces the TriPlex MRR platforms.

Presently, Saxion is involved in 2 national projects concerning the exploitation of MRR platforms for various purposes like e.g. control of the human metabolism.

10. COVAP

COVAP prepared and presented BIOFOS project and its concept, either through invited presentations or posters, in the following conferences as well as to technical events related to food quality control of milk. In addition to this, COVAP has included in different technical forum related to milk quality advanced focused in Food Safety where the company presented the advanced of the project to the dairy sector. At the end of 2016, COVAP presented the results of the project in a technical meeting for farmers and technicians of the dairy sector organized by CICAP.

In 2015, BIOFOS sensing system was presented at the 7th International Symposium on Recent Advances in Food Analysis, RAFA 2015. 3-6 November 2015, Prague, Czech Republic. At this presentation, a review on the milk production and surveys distribution like the main tool of collecting info was presented.

The scientific scope of BIOFOS has been exposed and discussed in national and international events, related both for dairy sector like interfood forum where COVAP is included. Interfood Forum is a research group working for innovation focused in milk quality and food safety where mycotoxin and other contaminant are included as specific goal.

B3 Report on societal implications

Replies to the following questions will assist the Commission to obtain statistics and indicators on societal and socio-economic issues addressed by projects. The questions are arranged in a number of key themes. As well as producing certain statistics, the replies will also help identify those projects that have shown a real engagement with wider societal issues, and thereby identify interesting approaches to these issues and best practices. The replies for individual projects will not be made public.

A General Information *(completed automatically when **Grant Agreement number** is entered.*	
Grant Agreement Number:	611528
Title of Project:	Micro-ring resonator-based biophotonic system for food analysis
Name and Title of Coordinator:	Prof. Ioanna Zergioti

B Ethics	
1. Did your project undergo an Ethics Review (and/or Screening)? • If Yes: have you described the progress of compliance with the relevant Ethics Review/Screening Requirements in the frame of the periodic/final project reports? Special Reminder: the progress of compliance with the Ethics Review/Screening Requirements should be described in the Period/Final Project Reports under the Section 3.2.2 *'Work Progress and Achievements'*	***Yes***
2. Please indicate whether your project involved any of the following issues (tick box) :	***YES***
RESEARCH ON HUMANS	
• Did the project involve children?	
• Did the project involve patients?	

• Did the project involve persons not able to give consent?	
• Did the project involve adult healthy volunteers?	
• Did the project involve Human genetic material?	
• Did the project involve Human biological samples?	
• Did the project involve Human data collection?	
RESEARCH ON HUMAN EMBRYO/FOETUS	
• Did the project involve Human Embryos?	
• Did the project involve Human Foetal Tissue / Cells?	
• Did the project involve Human Embryonic Stem Cells (hESCs)?	
• Did the project on human Embryonic Stem Cells involve cells in culture?	
• Did the project on human Embryonic Stem Cells involve the derivation of cells from Embryos?	
PRIVACY	
• Did the project involve processing of genetic information or personal data (eg. health, sexual lifestyle, ethnicity, political opinion, religious or philosophical conviction)?	
• Did the project involve tracking the location or observation of people?	
RESEARCH ON ANIMALS	
• Did the project involve research on animals?	
• Were those animals transgenic small laboratory animals?	
• Were those animals transgenic farm animals?	
• Were those animals cloned farm animals?	
• Were those animals non-human primates?	
RESEARCH INVOLVING DEVELOPING COUNTRIES	
• Did the project involve the use of local resources (genetic, animal, plant etc)?	
• Was the project of benefit to local community (capacity building, access to healthcare, education etc)?	
DUAL USE	
• Research having direct military use	No
• Research having the potential for terrorist abuse	

C Workforce Statistics

3. Workforce statistics for the project: Please indicate in the table below the number of people who worked on the project (on a headcount basis).

Type of Position	Number of Women	Number of Men
Scientific Coordinator	0	1
Work package leaders	1	8
Experienced researchers (i.e. PhD holders)	5	20
PhD Students	1	5
Other	1	5

4. How many additional researchers (in companies and universities) were recruited specifically for this project?	**10**
Of which, indicate the number of men:	8

D Gender Aspects

5. Did you carry out specific Gender Equality Actions under the project?

○ Yes
● No

6. Which of the following actions did you carry out and how effective were they?

	Not at all effective				Very effective
❑ Design and implement an equal opportunity policy	○	○	○	○	○
❑ Set targets to achieve a gender balance in the workforce	○	○	○	○	○
❑ Organise conferences and workshops on gender	○	○	○	○	○
❑ Actions to improve work-life balance	○	○	○	○	○

○ Other:

7. Was there a gender dimension associated with the research content – i.e. wherever people were the focus of the research as, for example, consumers, users, patients or in trials, was the issue of gender considered and addressed?

○ Yes- please spec

● No

E Synergies with Science Education

8. Did your project involve working with students and/or school pupils (e.g. open days, participation in science festivals and events, prizes/competitions or joint projects)?

○ Yes- please specify

● No

9. Did the project generate any science education material (e.g. kits, websites, explanatory booklets, DVDs)?

● Yes- please specify: Lecture presentations, Video

○ No

F Interdisciplinarity

10. Which disciplines (see list below) are involved in your project?

●	Main discipline[6]: 2.2		
○	Associated discipline:4.1	○	Associated discipline:

G Engaging with Civil society and policy makers

11a	**Did your project engage with societal actors beyond the research community?** *(if 'No', go to Question 14)*	○ ●	Yes No

11b If yes, did you engage with citizens (citizens' panels / juries) or organised civil society (NGOs, patients' groups etc.)?

- ○ No
- ○ Yes- in determining what research should be performed
- ○ Yes - in implementing the research
- ○ Yes, in communicating /disseminating / using the results of the project

11c	**In doing so, did your project involve actors whose role is mainly to organise the dialogue with citizens and organised civil society (e.g. professional mediator; communication company, science museums)?**	○ ●	Yes No

12. Did you engage with government / public bodies or policy makers (including international organisations)

- ○ No
- ○ Yes- in framing the research agenda
- ○ Yes - in implementing the research agenda
- ● Yes, in communicating /disseminating / using the results of the project

13a Will the project generate outputs (expertise or scientific advice) which could be used by policy makers?

- ○ Yes – as a **primary** objective (please indicate areas below- multiple answers possible)
- ● Yes – as a **secondary** objective (please indicate areas below - multiple answer possible)
- ○ No

13b If Yes, in which fields?

X Agriculture Audiovisual and Media Budget Competition Consumers Culture Customs Development Economic and Monetary Affairs Education, Training, Youth Employment and Social Affairs		Energy Enlargement Enterprise Environment External Relations External Trade Fisheries and Maritime Affairs X Food Safety Foreign and Security Policy Fraud Humanitarian aid		Human rights Information Society Institutional affairs Internal Market Justice, freedom and security Public Health Regional Policy Research and Innovation Space Taxation Transport	x

[6] Insert number from list below (Frascati Manual).

13c If Yes, at which level? ○ Local / regional levels ○ National level ○ European level ● International level	
H Use and dissemination	
14. How many Articles were published/accepted for publication in peer-reviewed journals?	**8**
To how many of these is open access[7] provided?	**1**
How many of these are published in open access journals?	**1**
How many of these are published in open repositories?	**0**
To how many of these is open access not provided?	
Please check all applicable reasons for not providing open access:	
■ publisher's licensing agreement would not permit publishing in a repository ❑ no suitable repository available ❑ no suitable open access journal available ❑ no funds available to publish in an open access journal ❑ lack of time and resources ❑ lack of information on open access ❑ other[8]: ……	
15. How many new patent applications ('priority filings') have been made? *("Technologically unique": multiple applications for the same invention in different jurisdictions should be counted as just one application of grant).*	**2**
16. Indicate how many of the following Intellectual Property Rights were applied for (give number in each box). Trademark	**0**
Registered design	**0**
Other	**0**

17. How many spin-off companies were created / are planned as a direct result of the project?	**1**
Indicate the approximate number of additional jobs in these companies:	**0**

18. Please indicate whether your project has a potential impact on employment, in comparison with the situation before your project:

❑	Increase in employment, or	❑	In small & medium-sized enterprises
❑	Safeguard employment, or	❑	In large companies
❑	Decrease in employment,	❑	None of the above / not relevant to the project
■	Difficult to estimate / not possible to quantify		

19. For your project partnership please estimate the employment effect resulting directly from your participation in Full Time Equivalent (*FTE = one person working fulltime for a year*) jobs:	*Indicate figure:*
Difficult to estimate / not possible to quantify	■

[7] Open Access is defined as free of charge access for anyone via Internet.
[8] For instance: classification for security project.

I Media and Communication to the general public

20. As part of the project, were any of the beneficiaries professionals in communication or media relations?

○ Yes ● No

21. As part of the project, have any beneficiaries received professional media / communication training / advice to improve communication with the general public?

○ Yes ● No

22 Which of the following have been used to communicate information about your project to the general public, or have resulted from your project?

■	Press Release	■	Coverage in specialist press
■	Media briefing	❑	Coverage in general (non-specialist) press
❑	TV coverage / report	❑	Coverage in national press
❑	Radio coverage / report	❑	Coverage in international press
■	Brochures /posters / flyers	■	Website for the general public / internet
❑	DVD /Film /Multimedia	■	Event targeting general public (festival, conference, exhibition, science café)

23 In which languages are the information products for the general public produced?

❑	Language of the coordinator	■	English
■	Other language(s)		

***Question F-10*:** Classification of Scientific Disciplines according to the Frascati Manual 2002 (Proposed Standard Practice for Surveys on Research and Experimental Development, OECD 2002):

FIELDS OF SCIENCE AND TECHNOLOGY

1. NATURAL SCIENCES

1.1 Mathematics and computer sciences [mathematics and other allied fields: computer sciences and other allied subjects (software development only; hardware development should be classified in the engineering fields)]

1.2 Physical sciences (astronomy and space sciences, physics and other allied subjects)

1.3 Chemical sciences (chemistry, other allied subjects)

1.4 Earth and related environmental sciences (geology, geophysics, mineralogy, physical geography and other geosciences, meteorology and other atmospheric sciences including climatic research, oceanography, vulcanology, palaeoecology, other allied sciences)

1.5 Biological sciences (biology, botany, bacteriology, microbiology, zoology, entomology, genetics, biochemistry, biophysics, other allied sciences, excluding clinical and veterinary sciences)

2 ENGINEERING AND TECHNOLOGY

2.1 Civil engineering (architecture engineering, building science and engineering, construction engineering, municipal and structural engineering and other allied subjects)

2.2 Electrical engineering, electronics [electrical engineering, electronics, communication engineering and systems, computer engineering (hardware only) and other allied subjects]

2.3. Other engineering sciences (such as chemical, aeronautical and space, mechanical, metallurgical and materials engineering, and their specialised subdivisions; forest products; applied sciences such as geodesy, industrial chemistry, etc.; the science and technology of food production; specialised technologies of interdisciplinary fields, e.g. systems analysis, metallurgy, mining, textile technology and other applied subjects)

3. MEDICAL SCIENCES

3.1 Basic medicine (anatomy, cytology, physiology, genetics, pharmacy, pharmacology, toxicology, immunology and immunohaematology, clinical chemistry, clinical microbiology, pathology)

3.2 Clinical medicine (anaesthesiology, paediatrics, obstetrics and gynaecology, internal medicine, surgery, dentistry, neurology, psychiatry, radiology, therapeutics, otorhinolaryngology, ophthalmology)

3.3 Health sciences (public health services, social medicine, hygiene, nursing, epidemiology)

4. AGRICULTURAL SCIENCES

4.1 Agriculture, forestry, fisheries and allied sciences (agronomy, animal husbandry, fisheries, forestry, horticulture, other allied subjects)

4.2 Veterinary medicine

5. SOCIAL SCIENCES

5.1 Psychology

5.2 Economics

5.3 Educational sciences (education and training and other allied subjects)

5.4 Other social sciences [anthropology (social and cultural) and ethnology, demography, geography (human, economic and social), town and country planning, management, law, linguistics, political sciences, sociology, organisation and methods, miscellaneous social sciences and interdisciplinary , methodological and historical S1T activities relating to subjects in this group. Physical anthropology, physical geography and psychophysiology should normally be classified with the natural sciences].

6. HUMANITIES

6.1 History (history, prehistory and history, together with auxiliary historical disciplines such as archaeology, numismatics, palaeography, genealogy, etc.)

6.2 Languages and literature (ancient and modern)

6.3 Other humanities [philosophy (including the history of science and technology) arts, history of art, art criticism, painting, sculpture, musicology, dramatic art excluding artistic "research" of any kind, religion, theology, other fields and subjects pertaining to the humanities, methodological, historical and other S1T activities relating to the subjects in this group]

B4 List of Figures

B5 List of Tables